DONALD AVENUE WATER QUALITY FACILITY RETROFIT

Agreement No. WQC-2021-BellPW-00018

DESIGN REPORT

June 2023

Prepared For:

City of Bellingham Public Works
Engineering Division
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Bellingham, WA 98225

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ENGINEER'S STAMP

Engineer's Declaration

I, _____, a Professional Engineer registered in the State of Washington as a Civil Engineer, do hereby declare that the Design Report titled "Donald Avenue Water Quality Facility Retrofit," dated _____, was prepared by me, or under my personal supervision, and that said report was prepared in accordance with generally accepted engineering practices.

Respectfully,

Name: _____

License No. _____

Pacific Surveying & Engineering, Inc.

1.0 INTRODUCTION

Project Originator:	State of Washington Department of Ecology Water Quality 300 Desmond Drive SE Lacey, WA 98503 (360) 255-4393 Contact: Shelby Giltner
Project Owner:	City of Bellingham Public Works – Engineering 104 W. Magnolia Street, Suite 109 Bellingham, WA 98225 (360) 778-7900 Contact: Jessica Bennett
Project Design Engineer:	Pacific Surveying & Engineering, Inc. 909 Squalicum Way, Suite 111 Bellingham, WA 98225 (360) 671-7387 Contact: Jeff Vander Yacht, PE Ian Hinton, PE

The purpose of this report is to clearly illustrate the basis of design for the City of Bellingham (City) Donald Avenue Water Quality Facility Retrofit project (Agreement No. WQC-2021-BellPW-00018). The State of Washington Department of Ecology (Ecology) awarded a grant to the City of Bellingham to proceed with planning, design, and construction of a water quality retrofit along the Northshore Drive right-of-way, near the intersection with Donald Avenue, and on an adjacent, City of Bellingham owned parcel. See the attached vicinity map in **Appendix A**. The overall project goal is to help protect and restore Water Quality in Washington by reducing stormwater impacts from existing infrastructure and development.

This project is part of the City's plan, in conjunction with Ecology, to improve water quality in Lake Whatcom by reducing total suspended solids (TSS), dissolved copper and zinc, and total phosphorus by retrofitting an existing, city-owned, stormwater treatment facility. Residents who depend on Lake Whatcom as their source of drinking water have seen an obvious decline in water quality due to residential development in the watershed. Phosphorus loading into Lake Whatcom, via stormwater runoff, is contributing to the decline in water quality. This project will retrofit the existing storm system with a system designed to maximize phosphorus removal.

Taking this project from concept to design, the current city-adopted 2019 Stormwater Management Manual for Western Washington (Ecology Manual) and the 2012 Western Washington Hydrologic Model (WWHM) continuous rainfall runoff modeling software were used as primary resources. This design proposes installation of an unstacked Phosphorus Optimized Stormwater Treatment (POST) media filter. The facility is strategically located to maximize the impact of pollution reduction with minimal disturbance to the environment.

2.0 BASIN DESCRIPTION

2.1 Basin Description

The area draining to the site the retrofit will occur on collects runoff primarily from the area east of Northshore Drive, a total of approximately 42 acres. Current land use is residential and is not anticipated to change. This area is divided into two basins (Basins 1 and 2) more or less divided by Donald Avenue. The city-owned parcel, along with the western half of Northshore Drive is considered to be a third, smaller basin (Basin 3). The primary focus of this project is the largest basin, Basin 1 with a secondary focus on Basin 2. See **Appendix B** for maps illustrating the project basin delineation.

2.2 Soils Information and Geotechnical Investigation

The existing project area contains three general Hydrologic Soil Groups; B, C, C/D, as identified via NRCS Web Soil Survey. The Hydrologic Soil Groups include five local units including Map Unit #49 – Everett very gravelly sandy loam (Hydrologic Soil Group B), Map Unit #93 – Labounty silt loam (Hydrologic Soil Group C/D), Map Unit #109 – Nati loam (Hydrologic Soil Group C), Map Unit #156 – Squalicum gravelly loam (Hydrologic Soil Group B), Map Unit #182 – Whatcom-Labounty silt loams (Hydrologic Soil Group C – C/D). Also based on Web Soil Survey information, the project area slope varies between 0% and 50%. This appears to be consistent with both site-specific topographic data and Lidar data; with flatter slopes near Lake Whatcom steepening toward the east, away from the lake.

A geotechnical investigation was performed including an evaluation of in-situ soils. Five borings were completed and groundwater levels from three of the borings were monitored for one calendar year. To view the geotechnical assessment and the groundwater data, see **Appendix C** for the report completed by Element Solutions.

2.3 Existing Basin Runoff Characteristics

Based on the consistent urban environment within the project area, impervious and pervious surface areas were established utilizing a combination of topographic survey, aerial imagery, and visual observations during site reconnaissance. Basin models were created using the WWHM2012 software to identify the peak flow rates generated by each treatment basin. The models were also utilized to quantify and size storm water quality treatment facilities basin on the Ecology 15-minute water quality treatment criteria. The basic assumptions for our WWHM2012 pre-developed basin modeling include:

- All impervious surfaces including roofs equate to a combination of “Roads/Mod” and “Roof Tops/Flat”, and
- Forested/Landscaped/vegetated areas equate to “Soil Type C, Forest, Flat”, “Soil Type C, Pasture, Flat”, and “Soil Type C, Lawn, Flat”.

See **Table 01** below for a schedule of sub-basin WWHM2012 modeling input and 100-yr peak flow results.

Table 01: Predeveloped Basin Model Data

Sub-Basin	Impervious Area (acre)	Pervious Area C Soils (acre)	Subtotal Area (acre)	WWHM 100-yr Flowrate (cfs)
1	4.726	33.364	38.090	17.3460
2	1.436	2.555	3.991	3.6905
3	0.125	0.331	0.456	0.2712
Totals	**6.287**	**36.250**	**42.537**	**13.7991**

See **Appendix H** for WWHM2012 model output of each basin.

2.4 Estimated Phosphorus Loading

Table 02 breaks down each basin and shows the estimated phosphorus loading for each basin.

Table 02: Estimated Phosphorus Loading

Sub-Basin	Surface Type	Area (acre)	Estimated P Loading (lbs/acre/yr)*	Estimated P Loading (lbs/yr)
1	Pavement/Roof	4.726	1.08	5.104
	Lawn/Pasture	13.945	1.08	15.061
	Forest	19.419	0.09	1.748
2	Pavement/Roof	1.436	1.08	1.551
	Lawn/Pasture	2.555	1.08	2.759
3	Pavement/Roof	0.125	1.08	0.135
	Lawn/Pasture	0.331	1.08	0.357
Totals		**42.537**		**26.715**

**Estimated phosphorus loading figures provided by the City of Bellingham Development = 1.08 lbs/acre/yr, Forest = 0.09 lbs/acre/yr*

2.5 Base Flows

Flows have been observed in the existing stormwater system during periods of no precipitation thereby indicating the presents of base flow. Monitor equipment was installed to estimate the amount of base flow. Although data continues to becollected, earlier data has shown that on average, approximately 0.050 cfs is constantly flowing in the system. This flow must be taken into account when exploring the potential treatment options. See **Appendix D** for flow monitoring results.

3.0 SITE DESCRIPTION

3.1 Project Limits

Construction of the project will be limited to the Northshore Drive and Donald Avenue right-of-way and the city-owned parcel described in Section 2.1 located between Northshore Drive and Lake Whatcom. The primary stormwater treatment facility, Stages 1 and 2 of the unstacked POST media system, will be located along both Northshore Drive and Donald Avenue to take advantage of the available right-of-way as well as increase the vertical difference between the proposed facility and the existing outfall to Lake Whatcom. Stage 3 of the POST media system will be located on the city-owned parcel. Vegetation throughout the project limits will be updated and re-established to meet permit conditions, beautify the site, and potential offering further runoff treatment.

3.2 Threshold Discharge Areas (TDAs)

Although two outfalls to Lake Whatcom exist; one for Basin 1 and one for Basin 2, the two outfalls are approximately 230 feet from one another. Therefore, by the definition of a Threshold Discharge Area (TDA) the project can be considered a single TDA as the discharge locations combine well below the one-quarter mile threshold listed in the Ecology Manual.

3.3 Current Use

Current use of the site is primarily an existing stormwater facility that has failed and is currently not being used. Properties adjacent to the site consists primarily of single-family residences as well as public roadways (Northshore Drive and Donald Avenue).

3.4 Proposed Use

The proposed use of the project area matches existing conditions. The purpose of the project is to retrofit the existing stormwater infrastructure with GULD Phosphorus Treatment facilities. Properties adjacent to the site are not anticipated to change from their current use.

3.5 Existing Stormwater Features

Existing stormwater features consist of standard roadway infrastructure including travel surfaces for sheet flows, culverts and ditches, catch-basins, stormwater conveyance pipes, etc.

There are currently two city-owned water quality features within the project area. One facility is a combination of an oil/water separator and downstream bioswale along the north side of Donald Avenue. The system collects runoff from an existing ditch, routes it to an oil/water separator, then discharges to a bioswale, routed under Northshore Drive, and collected in the north end of the existing sand filter. The second system collects runoff from the same ditch as the first system, bypasses the

oil/water separator and bioswale, is routed under Northshore Drive, and collected in the north end of the existing sand filter. The oil/water separator is thought to be installed in the early 1990s, while the bioswale and sand filter were constructed in 2005.

A second facility is located on the city-owned parcel and conveys runoff near, but not connected to, the south end of the existing sand filter, and conveyed to a flow spreader and bioswale above the sand filter through standard catch basins and piping. Runoff from either basin that is not infiltrated is discharged to Lake Whatcom. The failure of this second facility is the cause for this project.

3.6 Proposed Stormwater Features

The proposed Donald Avenue Water Quality Facility Retrofit will include typical stormwater infrastructure such as catch basin, and piping. An unstacked POST media filter system will provide phosphorus treatment. The POST media filter system consists of the following components:

- External high-flow bypass
- Internal high-flow bypass to protect the facility
- Upstream pretreatment to remove sediment and floatables
- Automated valving to distribute flow and allow the appropriate media drying time
- Media filter cells containing POST media

3.7 Total Area

The total area of Basin 1 is approximately 38.2 acres, all of which is proposed to be collected and treated through GULD phosphorus treatment facilities.

3.8 Vegetation

Existing vegetation adjacent to the roadway consists of lawn, and landscaped areas with small bushes and trees. Disturbed areas are proposed to be returned to equal or better than existing conditions in all areas.

3.9 Wetlands

There are no wetlands within the project area.

3.10 Soils

Existing soils are discussed in Section 2.2, and consist of three general Hydrologic Soil Groups; B, C, C/D, as identified via NRCS Web Soil Survey. Infiltration is considered infeasible in the project area. See **Appendix C** for additional information from the NRCS Web Soil Survey and geotechnical report.

3.11 Access

The site will be accessed via adjacent roadways. Access to each work location is not considered a challenge, however, staging of equipment and materials may need to be done remotely.

3.12 Other Relevant Information

It is important to note that, although not a high-traffic roadway, Northshore Drive and N. Shore Road. are the primary access roadways for residents living along the north side of Lake Whatcom. Prolonged roadway closures may cause massive delays and create extensive detours. During construction, the roadway should remain open to, at a minimum, one-way, flagged traffic. Additionally, due to proximity of adjacent utilities and infrastructure, careful layout and utility identification marking will be necessary to prevent damage of existing pipes, wires, etc.

4.0 MINIMUM REQUIREMENTS

This project is a stormwater retrofit project that will protect and restore water quality through the installation of water quality facilities. Impacts to existing infrastructure, including asphalt, and landscaping, will require replacement of in-kind facilities directly impacted by the project.

Existing pervious and impervious areas can be seen in **Table 03**.

Table 03: Predeveloped Basin Areas

Sub-Basin	Impervious	Pervious		Total (acre)
	Pavement / Roof (acre)	Lawn / Pasture (acre)	Forest (acre)	
1	4.726	13.945	19.419	38.090
2	1.436	2.555	0	3.991
3	0.125	0.331	0	0.456
Total	**6.287**	**16.831**	**19.419**	**42.537**
%	**14.78**	**85.22**		**100**

Table 03 shows the site has less than 35% existing hard surface coverage; the Ecology's Flow Chart for Determining Requirements for New Development applies. The project proposes only a minor change in hard surface area. The project's only change in hard surfaces will the additional of a gravel maintenance access adjacent to the proposed facility located in Basin 3. The gravel access will add 2,454 square feet of impervious area, thereby remaining under the 5,000 square foot threshold for new plus replaced hard surface area. Minimum Requirements #1 through #5 apply to the new plus replaced hard surfaces and the land disturbed. See **Figure 01** below for Ecology Manual Figures I-3.1 flow chart determination of the minimum requirements.

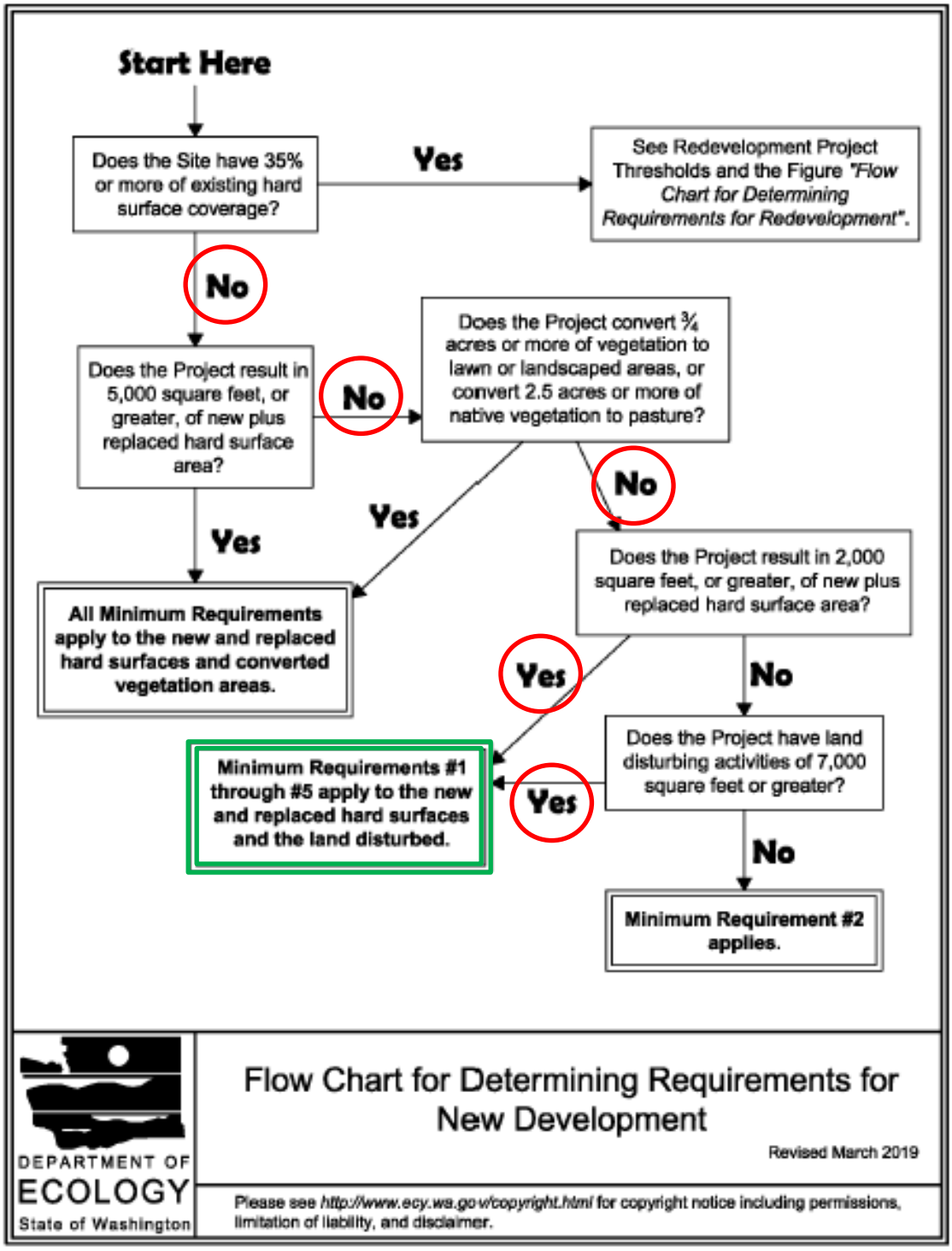


Figure 01: Minimum Requirements Determination for New Development

The five minimum requirements have been addressed as follows:

4.1 Requirement No. 1 – Prepare Storm Water Site Plans

We have completed the requirements of a storm water site plan per the Ecology Manual. The required steps have been performed as follows:

4.1.1 Collect and Analyze Existing Conditions Information

Site visits were performed to determine the existing on-site and off-site drainage conditions. A storm water hydrologic model was developed to estimate the runoff conditions. Downstream conveyance was investigated utilizing field surveyed topographic maps, as constructed plans, as well as site visit observations.

4.1.2 Prepare Preliminary Development Layout

A site development plan has been prepared which shows the proposed access, grading and drainage improvements. See **Appendix E**.

4.1.3 Perform Off-Site Analysis

A qualitative off-site analysis has been completed in accordance with the 2019 Ecology Manual supplemental guidelines for Off-site Analysis and Mitigation, Section I-3.5.3, Volume I. Surface water runoff from the site discharges to local drainage ditches, to the existing drainage system, to Lake Whatcom.

Overall, we have reviewed the existing and projected stormwater infrastructure deficiencies, and it is concluded that this project will not negatively impact existing conditions or increasingly languish the problems identified. If it has any impact at all, it will create a small amount of retention for treatment of the runoff.

4.1.4 Determine Applicable Minimum Requirements

This project shall meet the five minimum requirements for storm water management as outlined in the 2019 Ecology Manual.

4.1.5 Prepare a Permanent Storm Water Control Plan

A permanent storm water control plan has been developed and presented herein, in accordance with the guidelines outlined in Volume III-3.2, Step 5, of the 2019 Ecology Manual.

EXISTING SITE HYDROLOGY

Existing conditions are explained in detail in Sections 2 and 3. Drainage Basin Exhibits and Geotechnical Report can be found in **Appendix B**, and **Appendix C,** respectively.

DEVELOPED SITE HYDROLOGY

Proposed Alterations to the site are illustrated via design drawings included in **Appendix E** of this report. Drainage Basin Exhibits and the Geotechnical Report can be found **Appendix B** and **Appendix C**, respectively.

PERFORMANCE STANDARDS AND GOALS

The project will meet the five minimum stormwater requirements as defined in the Ecology Manual.

FLOW CONTROL SYSTEM

The project does not propose flow control systems, nor is it required to per the Ecology Manual.

WATER QUALITY SYSTEM

The project proposes to meet water quality standards with General Use Level Designation (GULD) Phosphorus Treatment. Runoff is proposed to be routed to the treatment facility directly through a combination of proposed and existing storm drains pipes. All proposed facilities will be fitted with high-flow bypasses. The proposed design also facilitates any baseflows that may be present and could saturate proposed treatment facilities. Redundancy will be implemented to allow proposed facilities adequate time to fully dry offline, while providing suitable phosphorus treatment in the redundant facility that remains online. As insurance against high sediment loads, the proposed design also includes upstream catch basins and pretreatment to capture sediment and reduce maintenance intervals.

CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Surface flow from the existing basins will be conveyed via sheet flow into existing ditches and conveyance systems where the concentrated flows are collected by catch basins with pipes discharging to the treatment facilities. A high-flow bypass is included on all facilities to provide protection for the proposed facility in large storm events.

PREPARE A CONSTRUCTION STORM WATER POLLUTION PREVENTION PLAN

Construction Storm Water Pollution Prevention Plan (SWPPP) and temporary erosion and sediment controls will be implemented, during the construction of the project. See Section 4.2 below for the SWPPP Narrative. See **Appendix E** for the SWPPP Drawings.

COMPLETE THE STORM WATER SITE PLAN

Per 2019 Ecology Manual, we have prepared a complete Stormwater Site Plan (SSP) consisting of construction drawings, and the narratives within Section 4 of this Design Report.

CHECK COMPLIANCE WITH ALL APPLICABLE MINIMUM REQUIREMENTS

The storm water management facilities proposed in this report comply with all of the applicable standards of the 2019 Ecology Manual.

4.2 Requirement No. 2 – Construction Storm Water Pollution Prevention Plan

A Storm Water Pollution Prevention Plan (SWPPP) has been developed. The SWPPP consists of two parts: a narrative and a set of site plan drawings. The narrative portion consists of the thirteen SWPPP elements per the Ecology Manual and as described below in addition to other components of this report including descriptions of existing site conditions, proposed project, critical areas, soils, etc.

4.2.1 Element 1 – Preserve Vegetation/Mark Clearing Limits

Prior to beginning land-disturbing activities, including clearing and grading, all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area should be clearly marked, both in the field and on the plans, to prevent damage and off-site impacts. Plastic, metal, or stake wire fence may be used to mark the clearing limits. Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practicable.

4.2.2 Element 2 – Establish Construction Access

a. Construction vehicle access and exit shall be limited to one route if possible.

b. Access points shall be stabilized with quarry spall or crushed rock to minimize the tracking of sediment onto public roads.

c. Wheel wash or tire baths should be located on site, if applicable.

d. Public roads shall at a minimum be cleaned thoroughly at the end of each day. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing will be allowed only after sediment is removed in this manner.

e. Street wash wastewater shall be controlled by pumping back on site, or otherwise be prevented from discharging into systems tributary to state surface waters.

f. Control street wash wastewater by pumping back on site, or otherwise prevent it from discharging into systems tributary to waters of the state.

4.2.3 Element 3 – Control Flow Rates

a. Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site.

b. Properties subject to Minimum Requirement No. 5 and/or No. 7 shall implement controls as early in the development as is practicable to mitigate for flow rates.

c. Where necessary to comply with Minimum Requirement No. 7, stormwater retention/detention facilities shall be constructed as one of the first steps in grading.

Detention facilities shall be functional prior to construction of site improvements (e.g., impervious surfaces).

d. If permanent infiltration ponds are used for flow control during construction, these facilities should be protected from siltation during the construction phase.

4.2.4 Element 4 – Install Sediment Controls

a. Design, install, and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.

b. Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs shall be functional before other land-disturbing activities take place.

c. Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.

d. Direct stormwater runoff from disturbed areas through a sediment pond or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard in subsection (F)(2)(e)(iii)(A) of this section.

e. Locate BMPs intended to trap sediment on site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.

f. Where feasible, design outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column.

4.2.5 Element 5 – Stabilize Soils

a. All exposed and unworked soils shall be stabilized by application of effective BMPs that protect the soil from the erosive forces of raindrop impact and flowing water, and wind erosion. Applicable BMPs include, but are not limited to: temporary and permanent seeding, sodding, mulching, plastic covering, erosion control fabrics and matting, soil application of polyacrylamide (PAM), the early application of gravel base early on areas to be paved, and dust control.

b. Control stormwater volume and velocity within the site to minimize soil erosion.

c. Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.

d. From October 1st through April 30th of each year, no soils shall remain exposed and unworked

for more than two days. From May 1st to September 30th of each year, no soils shall remain exposed and unworked for more than seven days. This condition applies to all soils on site, whether at final grade or not.

e. Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.

f. Minimize the amount of soil exposed during construction activity.

g. Minimize the disturbance of steep slopes.

h. Minimize soil compaction and, unless infeasible, preserve topsoil.

i. Applicable practices include, but are not limited to, temporary and permanent seeding, sodding, mulching, plastic covering, soil application of polyacrylamide (PAM), early application of gravel base on areas to be paved, and dust control.

j. Soil stabilization measures selected should be appropriate for the time of year, site conditions, estimated duration of use, and potential water quality impacts that stabilization agents may have on downstream waters or ground water.

k. Soil stockpiles must be stabilized and protected with sediment trapping measures and, where possible, locate away from storm drain inlets, waterways and drainage channels.

l. Work on linear construction sites and activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall not exceed the capability of the individual contractor for his portion of the project to install the bedding materials, roadbeds, structures, pipelines, and/or utilities, and to restabilize the disturbed soils, meeting the timing conditions listed above.

m. In addition, at the discretion of the public works director, those sites unable to maintain the quality of their stormwater discharge may be required to provide soil stabilization to all exposed soil areas regardless of the working status of the area. Upon written notification, the property owner shall provide full stabilization of all exposed soil areas within 24 hours.

4.2.6 Element 6 – Protect Slopes

a. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Applicable practices include, but are not limited to, reducing continuous length of slope with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).

b. Consider soil type and its potential for erosion.

c. Reduce slope runoff velocities by reducing the continuous length of slope with terracing and

diversions, reduce slope steepness, and roughen slope surface.

d. Divert upslope drainage and run-on waters from off site with interceptors at top of slope. Off-site stormwater should be handled separately from stormwater generated on the site. Diversion of off-site stormwater around the site may be a viable option. Diverted flows shall be redirected to the natural drainage location at or before the property boundary.

e. Contain down slope collected flows in pipes, slope drains, or protected channels to prevent erosion. Temporary pipe slope drains must handle the peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year one-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model to predict flows, bare soil areas should be modeled as "landscaped area."

f. Provide drainage to remove ground water intersecting the slope surface of exposed soil areas.

g. Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations.

h. Check dams shall be placed at regular intervals within trenches that are cut down a slope.

i. Stabilize soils on slopes, as specified in Element No. 5.

4.2.7 Element 7 – Protect Drain Inlets

a. All storm drain inlets made operable during construction shall be protected so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment.

b. All approach roads shall be kept clean, and all sediment and street wash water shall not be allowed to enter storm drains without prior and adequate treatment unless treatment is provided before the storm drain discharges to waters of the state.

4.2.8 Element 8 – Stabilize Channels and Outlets

a. All temporary on-site conveyance channels shall be designed, constructed and stabilized to prevent erosion from expected peak flows. Channels must handle the peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, one-hour flow rate indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic

analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis shall use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model to predict flows, bare soil areas should be modeled as "landscaped area."

b. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems.

4.2.9 Element 9 – Control Pollutants

a. Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants.

b. All pollutants, including waste materials and demolition debris, that occur on site during construction shall be handled and disposed of in a manner that does not cause contamination of stormwater.

c. Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and noninert wastes present on the site (see Chapter 173-304 WAC, as currently enacted or hereafter modified, for the definition of inert waste, which is incorporated herein by this reference).

d. Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on site using temporary plastic placed beneath and, if raining, over the vehicle.

e. Wheel wash, or tire bath wastewater, shall be discharged to a separate on-site treatment system or to the sanitary sewer.

f. Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations shall be followed for application rates and procedures.

g. Management of pH-modifying sources shall prevent contamination of runoff and stormwater collected on the site. These sources include, but are not limited to, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer

washout waters.

h. Adjust the pH of stormwater if necessary to prevent violations of water quality standards.

i. Assure that washout of concrete trucks is performed off site or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete on site, except in designated concrete washout areas. Concrete spillage or concrete discharge to surface waters of the state is prohibited.

j. Obtain written approval from Ecology before using chemical treatment other than CO2 or dry ice to adjust pH.

4.2.10 Element 10 – Control Dewatering

a. All foundation, vault, and trench dewatering water, which have similar characteristics to stormwater runoff at the site, shall be discharged into a controlled conveyance system, prior to discharge to a sediment trap or sediment pond. Channels must be stabilized, as specified in Element No. 8.

b. Clean, non-turbid dewatering water, such as well-point ground water, can be discharged to systems tributary to state surface waters, as specified in Element No. 8, provided the dewatering flow does not cause erosion or flooding of the receiving waters. These clean waters should not be routed through sediment ponds with stormwater.

c. Highly turbid or otherwise contaminated dewatering water, such as from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater at the site.

d. Other disposal options, depending on site constraints, may include, by way of example: (1) infiltration, (2) transport off site in vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters, (3) on-site treatment using Ecology approved chemical treatment or other suitable treatment technologies, (4) sanitary or combined sewer discharge with local sewer district approval, or there is no other option, (5) use of a sedimentation bag that discharges to a ditch or swale for small volumes of localized dewatering.

4.2.11 Element 11 – Maintain BMPs

a. All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with BMPs.

b. Sediment control BMPs shall be inspected weekly or after a runoff-producing storm event

during the dry season and daily during the wet season. All projects that disturb an area greater than one acre shall have a certified erosion control lead available to the site. This erosion control lead shall be responsible to provide overview of ongoing day-to-day erosion control requirements. The erosion control lead shall (within 24 hours) report to the city and Department of Ecology any site discharges that exceed state water quality standards that have or are likely to have entered waters of the state.

c. All temporary erosion and sediment control BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil areas resulting from removal of BMPs or vegetation shall be permanently stabilized.

4.2.12 Element 12 – Manage the Project

a. Phasing of Construction. Development projects shall be phased where feasible in order to prevent, to the maximum extent practicable, the transport of sediment from the development site during construction. Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.

b. When establishing these permitted clearing and grading areas, consideration should be given to minimizing removal of existing trees and minimizing disturbance/compaction of native soils except as needed for building purposes. Permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas, shall be delineated on the site plans and the development site.

c. Coordination with Utilities and Other Contractors. The primary project proponent shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the construction SWPPP.

d. Inspection and Monitoring. All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function.

e. For any project disturbing more than one acre, a certified professional in erosion and sediment control shall be identified in the construction SWPPP and shall be on site or on call at all times. Certification may be through the Washington State Department of Transportation/Associated General Contractors (WSDOT/AGC) Construction Site Erosion and Sediment Control Certification Program or any equivalent local or national certification and/or training program, in the city's discretion.

f. Whenever inspection and/or monitoring reveals that the BMPs identified in the construction

SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, the SWPPP shall be modified, as appropriate, in a timely manner.

g. Maintenance of the Construction SWPPP. The construction SWPPP shall be retained on site. The construction SWPPP shall be modified whenever there is a significant change in the design, construction, operation, or maintenance of any BMP.

4.2.13 Element 13 – Protect Low Impact Development BMPs

a. Protect all bioretention and rain garden BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the bioretention and/or rain garden BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden bioretention/rain garden soils, and replacing the removed soils with soils meeting the design specification.

b. Prevent compacting bioretention and rain garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.

c. Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements or base materials.

d. Pavement fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures in accordance with the Ecology Manual or the manufacturer's procedures.

e. Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

4.3 Requirement No. 3 – Source Control of Pollution

The following construction site source control Best Management Practices (BMP's) have been selected as requirements on this project, obtained from the Ecology Manual, Volume 2:

- BMP C101: Preserve Natural Vegetation
- BMP C103: High-Visibility Fence
- BMP C105: Stabilized Construction Access
- BMP C120: Temporary and Permanent Seeding
- BMP C140: Dust Control

- BMP C150: Materials on Hand
- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C162: Scheduling

The following runoff conveyance and treatment BMPs are required to be implemented during the construction of the project to minimize erosion and sedimentation impacts associated with construction activities:

- BMP C220: Storm Drain Inlet Protection
- BMP C233: Silt Fence

Detailed descriptions of each of the above BMP's are included in **Appendix F**.

Upon completion of construction, the following pollutant source control BMPs are recommended for implementation associated with the management and maintenance of the development, obtained from the Ecology Manual, Volume 4:

- BMPs for Illicit Connections to Storm Drains
- BMPs for Maintenance of Public and Private Utility Corridors and Facilities
- BMPs for Maintenance of Storm Water Drainage and Treatment Systems
- BMPs for Landscaping and Lawn / Vegetation Management

Detailed descriptions of each of the above Pollution Source-Specific BMPs are included in **Appendix G**.

4.4 Requirement No. 4 – Preservation of Natural Drainage Systems and Outfalls

Natural drainage systems and outfalls will be preserved as part of the project. Post-development flows will not be diverted and will continue to be discharged in the pre-development threshold discharge basin. Conveyance outfalls will not be changed and no natural drainage systems or outfalls will be altered.

4.5 Requirement No. 5 – On-site Storm Water Management

The project will employ a GULD Phosphorus Treatment system to treat stormwater runoff prior to discharge.

5.0 ALTERNATIVES CONSIDERED

5.1 Project Goals

The primary objective of this project is to improve water quality within Lake Whatcom via installation of stormwater system retrofits providing treatment predominantly for phosphorus. Washington State Technology Assessment Protocol – Ecology General Use Level Designation (GULD) BMPs are proposed, and are configured such that project goals will be met with minimal disturbance of the environment. See Section 5.4 for total treatment area summaries. In most cases, due to standard sizing, the selected BMPs treat in excess of this minimum target.

5.2 Treatment Option Evaluation

Phosphorus Treatment application per the Ecology Manual is being implemented on this project. The Ecology Manual requires phosphorus treatment for projects within watersheds that have been determined by local governments, Ecology, or the USEPA to be sensitive to phosphorus. Furthermore, Lake Whatcom currently has a Total Maximum Daily Load (TMDL) for total phosphorus. This project will align with the goals defined by the TMDL and Ecology Agreement WQC-2021-BELLPW-00018.

Proposed treatment facilities will be limited to the Northshore Drive and Donald Avenue public right-of-way (ROW) and the city-owned parcel described in Section 2.1 located between Northshore Drive and Lake Whatcom. Each of these locations presents benefits and challenges to the location of a treatment facility. The benefits and challenges of the following criteria were evaluated.

5.2.1 Public Right-of-Way

The Northshore Drive and Donald Avenue public right-of-way widths, adjacent to the project area, are 40 feet and 60 feet wide respectively. Currently located within the ROW is the existing roadway, drainage ditches, and public utilities thereby limiting locations for stormwater treatment facilities with large footprints. Despite the limitations presented within the ROW, a treatment facility within the ROW (outside of the city-owned parcel) would allow for elevation gains thereby increasing the potential options for GULD treatment.

5.2.2 City-Owned Parcel

The city-owned parcel is 60-feet wide by approximately 350-feet long. The conveyance pipes entering the site are located at two locations.

- Location 1, near the northeast corner of the parcel
- Location 2, approximately mid parcel, east side.

Two site discharges to Lake Whatcom are located across from the conveyance pipes entering the site.

The dimensions of the parcel make it infeasible to locate BMPs with large footprints onsite. Additionally, the elevation difference between the conveyance pipes entering the site and the discharge elevation at Location 1 and Location 2 is 2.2-feet and 0.4-feet respectively, thereby eliminating any BMPs that require depths exceeding those dimensions.

5.2.3 Base Flow

Early in the scoping phase of the project, a baseflow was observed. Monitoring equipment was installed and the flow was measured between February 2022 through April 2023. The results of the base flow monitoring can be seen in **Appendix D**. The average base flow was measured to be 0.050 cfs.

Base flow poses a challenge to any treatment system as it has the potential to leave treatment media or soils saturated. Potential solutions for dealing with the base flow include bypassing or splitting the base flow prior to treatment, or installing a sacrificial treatment system prior to the primary treatment facility. Both options present challenges.

Bypassing or splitting the base flow prior to treatment means that the base flow will not receive treatment and would be allowed to discharge directly to Lake Whatcom. Omitting the flow from treatment is contradictory to the purpose of the project.

Installing a sacrificial treatment system could lengthen the lifespan of the downstream treatment, however the sacrificial system will require more frequent maintenance and monitoring to ensure its functioning properly.

5.2.4 Groundwater

In February 2022, several soil borings were completed by Element Solutions (Element). Element installed monitoring wells and monitored groundwater elevations through December 2022. A detailed discussion about groundwater conditions can be found in the geotechnical report in **Appendix C.**

All phosphorus treatment options shown in **Table 04**, with the exception of Emerging Stormwater Treatment Technologies (GULD level) are part of the two-facility treatment trains provided in the Ecology Manual Volume III, Section III-1.2, Step 4, Table III-1.1. In either of these locations, utilization of a small footprint and self-contained GULD systems provides a number of realistic applications. Many GULD systems are specifically designed for retrofits. **Table 04** includes a summary of the feasibility analysis with notes pertaining to each category.

Table 04: Phosphorus Treatment Option Feasibility Summary

Ecology Phosphorus Treatment Option	Feasible	Notes
Basic, Wet, or Continuous Biofiltration Swale	No	Site constraints don't allow for required hydraulic residence time
Wetponds – Basic and Large, Wetvault, Stormwater Treatment Wetlands, or Combined Detention and Wetpool Facility	No	Site constraints don't allow for the required footprint
Vegetated Filter Strip	No	Site constraints don't allow for required hydraulic residence time
Basic Sand Filter or Sand Filter Vault	No	Potential solution, further evaluation of groundwater separation and vertical elevation required
Linear Sand Filter	No	Insufficient vertical elevation
Emerging Stormwater Treatment Technologies (GULD level)	Yes	Many retrofit options available

5.3 GULD Emerging Stormwater Treatment Option Evaluation

At the time of this report, the approved GULD Phosphorus Treatment list provides 17 approved treatment options. The list includes various systems from multiple manufacturers, most providing treatment via a filter, cartridge, or some other type of treatment media.

Parameters evaluated include drying/drain-down period between storms, hydraulic drop through the facility, maintenance, and most importantly phosphorus removal efficiency. BMPs considered include; Filterra Bioscape, Modular Wetlands Linear (both from Contech Engineered Solutions, LLC), and the Phosphorus Optimized Stormwater Treatment System (POST) developed by the City of Bellingham.

In the following sections, each of the BMPs is ranked for each parameter listed; 3 being the preferred BMP and 1 being the less desirable BMP. The BMP with the overall highest score is the selected BMP.

5.3.1 Drying / Drain-Down Period

Base flows exist onsite. As the goal of the project is to improve the water quality of Lake Whatcom, it is in the City's interest to allow base flows to enter the proposed treatment facility and receive phosphorus removal treatment. One risk to introducing base flows to any treatment facility is the potential to constantly saturate the treatment media. Constant saturation may cause the media to "biofoul", essentially clogging the media with organic growth. Therefore, treatment facilities must have to ability to remain saturated, or be built in tandem allowing the redundant facility to adequately dry while the other continues to provide treatment.

FILTERRA BIOSCAPE

Bioscape systems may or may not be designed with an underdrain. Systems without an underdrain must be able to store water beneath the treatment media and never allow the treatment media to become saturated. It is assumed that a Bioscape system would be designed with an underdrain for this project to eliminate the need for additional water storage. An underdrain would allow incoming base flows to quickly exit the facility after receiving treatment, yet baseflows would still continually saturate the media and damage any vegetation growing in the bioscope system.

MODULAR WETLANDS LINEAR

Ecology lists four findings in the Modular Wetlands Linear system that serve as maintenance triggers. One of those findings is standing water remaining in the vault between rain events. Allowing a base flow to enter the facility may cause some degree of standing water to remain in the vault. Standing water base flow could mask other maintenance issues that may also cause standing water. Standard water can also contribute to "biofoul" as previously mentioned.

POST MEDIA SYSTEM

The POST media system may be constructed in a stacked or unstacked configuration. An unstacked configuration separates the different media stages (layers) allowing Stages 1 and 2 to be apart from Stage 3. Stages 1 and 2 are able to withstand saturation far better than stage 3. Stage 3 must be allowed to dry for at least 12 hours out of every 36 hours. A tandem POST system must be constructed only for Stage 3 and the stormwater flows alternated between the two systems in order to allow adequate drying time. Stages 1 and 2 do not need to be constructed in tandem, thereby reducing the overall amount of infrastructure needed to treat the stormwater runoff.

The concept of construction tandem facilities does not only apply to the POST media system. The other treatment options could also apply this concept. The introduction of additional, tandem facilities has aesthetic as well as maintenance implications, both are discussed below.

Drying / Drain-Down Period Ranking:

1) Modular Wetlands Linear
2) Filterra Bioscape
3) POST Media System

5.3.2 Hydraulic Drop

As previously stated, the elevation difference between the conveyance pipes entering the site and the discharge elevation is 2.2-feet and 0.4-feet thereby eliminating any BMPs that require depths exceeding 2.2-feet or 0.4-feet. At Location 1, the elevation increases toward the east along Donald Avenue. A facility may be located along Donald Avenue in order to mitigate the 2.2-feet vertical limitation. At Location 2, locating a facility along the eastern side of Northshore Drive may conflict with existing potable water mains and communication utilities as well as impact adjacent homes and driveways.

Table 05 shows the required hydraulic drop through each of the treatment systems being evaluated.

Table 05: Minimum Hydraulic Drop

Treatment	Req'd Drop (ft)
Bioscape	2.5
Modular Wetland	1.4 to 3.4
POST System (stacked)	3.25
POST System (unstacked)	3.50

FILTERRA BIOSCAPE

The required hydraulic drop required by the Bioscape system eliminates the possibility of locating a facility on the city-owned parcel. A Bioscope system could be placed upstream along Donald Avenue at a higher elevation; however, portions of the project area would be excluded from receiving treatment as the areas would be lower than the treatment facility.

MODULAR WETLANDS LINEAR

The standard hydraulic drop for this system is 3.4-feet. The system can be configured to reduce the required hydraulic drop to 1.4-feet. The benefit of lowering the required hydraulic drop comes with the drawback of a larger overall facility footprint. If tandem modular wetlands are constructed to overcome the previously discussed drying / drain-down period, the overall footprint of the facility begins to increase significantly.

POST MEDIA SYSTEM

Despite the fact that the POST media system requires the largest hydraulic drop, the unstacked configuration has the ability to physically divide the stages of the system allowing a portion of the facility to be constructed at a different location. Splitting or unstacking the stages of the system will provide the required hydraulic drop while treating a significant portion of the project area.

Hydraulic Drop Ranking:

1) Modular Wetlands Linear
2) Filterra Bioscape
3) POST Media System

5.3.3 Aesthetics

As mentioned in Section 3.3, properties adjacent to the site consist of primarily single-family residences. The city-owned parcel is undeveloped but provides views of Lake Whatcom to the adjacent homes along Northshore Drive.

Although improving the water quality in Lake Whatcom is the primary purposed of this project, consideration should be given to the aesthetics of any proposed treatment facility as located residents could be negatively impacted.

FILTERRA BIOSCAPE

The Filterra Bioscape can be configured with and without a vault. Both options can be configured with an open top with various plantings. It is assumed that low growing plantings will be used. Low growing plantings will maintain lake views for local residents as the plants mature.

Storm drain cleanouts and other castings could be installed flush to the ground and relatively out of sight.

MODULAR WETLANDS LINEAR

The modular wetland system is a vaulted system. The pre-filter cartridges have a lid and large castings to provide maintenance access. The wetland media can be configured with and without a lid. Any lid would most likely have large castings or hatches for maintenance access. Without a lid, the media may provide opportunities for plantings.

POST MEDIA SYSTEM

Like the Bioscape, the POST Media system can also be configured with and without a vault, and can be configured and with and without a lid similar to the modular wetlands. The *Design Guide* for the POST media system prepared by Herrera Environmental Consultants recommends planting the primary media beds. There is no recommendation for the secondary media bed. Plantings and or fencing may be required to not only protect the public from entering the facility but also to help the structure blend into the surrounding area.

Aesthetics Ranking:

1) Filterra Bioscape
2) Modular Wetlands Linear
3) POST Media System

5.3.4 Phosphorus Removal Efficiency

The goal of this project is to improve water quality in Lake Whatcom by reducing the amount of several pollutants, specifically phosphorus. A report from November 2014 (revised February 2016) titled *Lake Whatcom Watershed Total Phosphorus and Bacteria Total Maximum Daily Loads* from Ecology concluded that “The City of Bellingham and Whatcom County need to develop plans to retrofit existing development to remove 87% of the phosphorus that is being generated in excess of what forested lands

would generate." Any proposed facility must meet this 87% treatment goal.

Ecology's approval for general use level for the treatment systems evaluated in this report provides multiple "bootstrap estimate(s) of the lower 95 percent confidence (LCL95) of the mean total phosphorus reduction" from lab testing and field testing. These results, and the figures of total phosphorus removal provided by the manufacturer/developer are used to compare each system's phosphorus removal efficiency. **Table 06** at the end of this Section shows the removal efficiency of each system.

FILTERRA BIOSCAPE

While the phosphorus removal efficiencies for the Filterra Bioscape meet Ecology's phosphorus treatment goals, it does not meet the 87% treatment goal set by the Lake Whatcom TMDL. The GULD approval from Ecology shows two field tests occurred. The first test, in Bellingham (2013) showed a LCL95 mean percent removal of 66.0%. The second test, in Tacoma (2008-2009) showed relatively poor treatment performance citing the system will not meet Ecology's 50 %removal performance goal with the majority of the phosphorus in the runoff is expected to be in the dissolved form.

Contech's brochure for the Bioscape system claims a median removal efficiency for total phosphorus of 70%.

MODULAR WETLANDS LINEAR

Similar to the Bioscape system, the phosphorus removal efficiencies for the Modular Wetlands meets the Ecology's phosphorus treatment goals, but does not meet the 87% treatment goal set by the Lake Whatcom TMDL. The GULD approval shows the results from a field test in Portland, OR (April 2012-May2013). The bootstrap LCL95 mean total phosphorus reductions was 58%.

Contech's brochure for the Modular Wetland system claims a median removal efficiency for total phosphorus of 61%.

POST MEDIA SYSTEM

From November 2019 through January 2021, Herrera Environmental Consultants, Inc. (Herrera) performed a field test in Bellingham. The results showed the bootstrap LCL95 mean total phosphorus reductions was 61.5%. Lab tests performed by Herrera show the POST media showed an average phosphorus removal rate of 96.7%. In November of 2019, Herrera issued a technical memorandum revising the infiltration capacity of the POST filter media. As a result, the total phosphorus removal rate was reduced to 89.4%. This removal rate was used by Herrera in the design of the Park Place Water Quality Facility.

Table 06: Phosphorus Removal Efficiency

Treatment	GULD Removal Rate	Manufacturer Removal Rate
Bioscape	66%	70%
Modular Wetland	58%	61%
POST System	61.5%	89.4%

Table 06 shows only one figure that meets the TMDL for Lake Whatcom, the POST media system.

Phosphorus Removal Efficiency Ranking:

1) Modular Wetlands Linear
2) Filterra Bioscape
3) POST Media System

5.3.5 Maintenance

Proper maintenance is crucial to the success of any treatment system. Things like frequency, simplicity/complexity, and familiarity or the system are some of the concerns that factor into the maintenance and functionality of a treatment system. The City of Bellingham is familiar with many types of stormwater facilities. Input from their Operations Department is key to evaluating the different treatment systems.

For all of the treatment systems, Ecology has published GULD guidelines stating the required maintenance is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not recommend a “one size fits all” maintenance cycle.

FILTERRA BIOSCAPE

Maintenance includes removing and replacing the mulch layer above the media as well as removing any accumulated sediment, trash, and captured organic materials, evaluating plant health, and pruning if needed. Contech has designed the system with a target maintenance interval of 6-months.

The City of Bellingham has several Bioscope systems installed throughout the City, most notable a large facility located at Harris Street. They are familiar with these types of facilities and have the equipment to perform the proper maintenance. However, the City’s Operations Department considers these facilities as high-maintenance for several reasons, namely obligations for the plantings.

MODULAR WETLANDS LINEAR

Once online, Ecology recommends the modular wetlands be inspected for a minimum of 12-months to determine site specific maintenance requirements. These inspections are to occur monthly during the

wet season (October 1 to April 30) and every other month during the dry season. After the 12-month inspection period, actual maintenance activities and schedules can be adjusted.

Contech's recommended Modular Wetlands Linear maintenance requires trash from the screening device to be removed every 6 to 12-months, sediment removed from the separation chamber every 12 to 24-months, cartridge filter media replaced every 12 to 24-months, drain down filter media replaced every 12 to 24-months, and vegetation trimmed every 6 to 12-months.

The City of Bellingham has many Modular Wetland systems installed throughout the City. There are approximately six already located within the Lake Whatcom Watershed. Like the Filterra Bioscape, the City's Operations Department is very familiar with the Modular Wetland System and have the equipment to perform the proper maintenance. The City considers this system to have the higher lifetime maintenance cost compared to the other alternatives.

POST MEDIA SYSTEM

Similar to the Modular Wetlands system, Ecology recommends the same 12-month inspection period once the POST media system is brought online.

POST media is designed to have a target maintenance interval of 1-year with visual inspections every 6-months. Maintenance includes removing trash, silt, and mulch from the filter surface; replacement of the surface mulch layer; raking of the media; and pruning of vegetation (if present). The POST media system can be configured as a stacked or unstacked system. The unstacked configuration allows for maintenance of Stage 3 filter media while allowing Stage 1 and 2 filter media to remain undisturbed.

The City of Bellingham installed a stacked POST media system within the Lake Whatcom watershed near the intersection of Britton Road and Northshore Drive. To-date, the City of Bellingham is still bringing the system fully online. However, the testing facility is fully operational. Early results lead the City to consider lower maintenance costs than the other alternatives.

Maintenance Ranking:

1) Modular Wetlands Linear
2) Filterra Bioscape
3) POST Media System

5.3.6 Summary and GULD Selection

Each of the treatment system was placed in order of preference for each of the criteria above. A rank of one indicates the least preferred options and a rank of three represents the most preferred options for that particular criterion. The treatment system with the highest total score is the preferred option. **Table 07** summarizes the results.

Table 07: Treatment System Rankings

Criterion	Bioscape	Modular Wetland	POST System
Drying/Draw-Down Period	2	1	3
Hydraulic Drop	2	1	3
Aesthetics	1	2	3
Phosphorus Removal Efficiency	2	1	3
Maintenance	2	1	3
Total Score	9	6	15

5.4 Alternatives Conclusion

In conclusion, an unstacked POST media system is selected as the most appropriate treatment option for this project with phosphorus removal efficiency being the most important deciding factor. The installation of the system will meet the goals of the project and provide the desired water quality improvement for Lake Whatcom.

6.0 DESIGN ANALYSIS

6.1 Description

The Phosphorus Optimized Stormwater Treatment (POST) system is a non-infiltrating structural stormwater treatment system developed by the City of Bellingham with GULD approval from Ecology. The POST system consists of a three-stage vertical filtration media bed with underdrain, typically housed in a precast concrete vault but may be constructed in lined earthen excavations with or without structural walls and, as such, can be configured for application in most urban drainage conditions.

The POST system consists of three media bed stages that are typically configured vertically "stacked" but can also be configured "unstacked" with the stages arranged horizontally in series, located in separate vaults or bays.

Stage 1 is a mulch prefilter that removes gross solids, debris, oils, and larger particulate matter. Stage 2 is a primary media bed optimized for the physical filtration of total suspended solids (TSS), dissolved pollutant sorption, and (optional) plant growth. Stage 3 is a polishing media bed specifically formulated for dissolved phosphorus and metals removal.

The POST system can be designed with an external or internal high flow bypass which must be appropriately sized based on the design (water quality treatment) flow rate.

6.2 Schematic Flow Through

The concept for the proposed unstacked POST media system is illustrated in the schematic below.

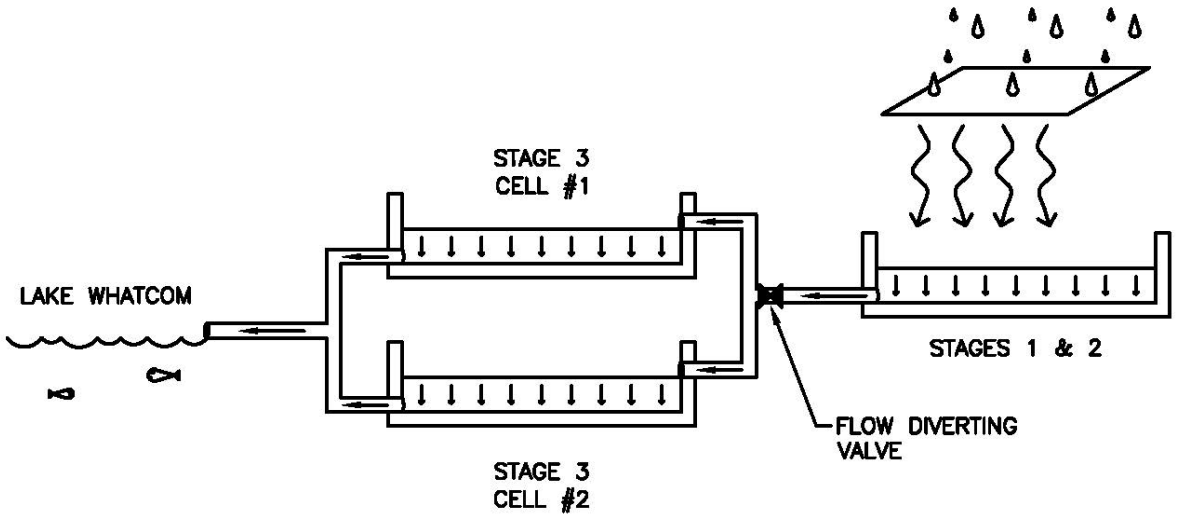


Figure 02: Proposed Treatment Schematic

Runoff is collected and sent to Stages 1 and 2 of the POST media system. Flows higher than the water quality treatment rate are allowed to bypass the system. Once treated, the runoff is sent to Stage 3. Prior to Stage 3, a valve will divert the flow between two identical cells allowing one cell to dry while the other provides treatment. Once the runoff has been treated and phosphorus has been removed, the runoff is discharged into Lake Whatcom.

6.3 Site Improvements

Plans for the proposed site improvements can be found in **Appendix E.**

6.4 Basin Description

A basin description is provided in Section 2.

6.5 Design Calculations and Water Quality Benefit

6.5.1 POST Media Calculations

The *Design Guide* for the POST media system prepared by Herrera Environmental Consultants, Inc. dated February 3, 2022 was used to design the proposed facility. The POST media system is design to treat, at a minimum, the offline 15-minute water quality flow rate from Basin 1 as calculated using WWHM. Basin 1 flow rates can be seen in **Table 08** below. In addition to treating the offline 15-minute water quality flow rate, the treatment system must also be designed to meet the Lake Whatcom TMDL of 87% phosphorus removal. An iterative design process is required to meet both of these requirements.

Table 08: Basin 1 Flow Rates

Event	Flow Rate (cfs)
2-yr	5.1279
5-yr	7.8848
10-yr	9.9206
25-yr	12.7201
50-yr	14.9658
100-yr	17.3460
Water Quality (offline)	0.7748

Ecology provides guidance on sizing the POST media system. Ecology lists a hydraulic loading rate of 0.62 gallons per minute per square foot of bioretention media surface area. Applying the hydraulic loading rate to the offline water quality flow rate from Table 08, the following sizing is calculated.

$$A_{media} = \frac{Q_{water\ quality}}{0.62\ {}^{gpm}/_{sf}}$$

Where:

$$A_{media} = \text{Bioretention Media Surface Area}$$

$$Q_{water\ quality} = \text{Offline } 15 - \text{minute Water Quality Flow Rate}$$

Solving for Area:

$$0.62\ gpm = 0.00138\ cfs$$

$$A_{media} = \frac{0.7748\ cfs}{0.00138\ {}^{cfs}/_{sf}} = \mathbf{561.45\ sf}$$

Additional design requirements limit the flow path length from an influent dispersion devise to any point on the prefilter media to no greater than 8-feet. Applying this requirement, the dimensions of the facility become:

$$A_{media} = 561.45\ sf = L \times W$$

Where:

$$W = 8\ ft$$

So:

$$L = \frac{561.45\ sf}{8\ ft} = 70.18\ ft \approx 71\ ft$$

The preliminary dimensions of the facility were confirmed with a WWHM model. If the model shows a facility with the dimensions of 8'x71' can treat the offline 15-minute water quality flow rate from Basin 1, then the dimensions are confirmed. Figure 03 shows the results of the WWHM Model.

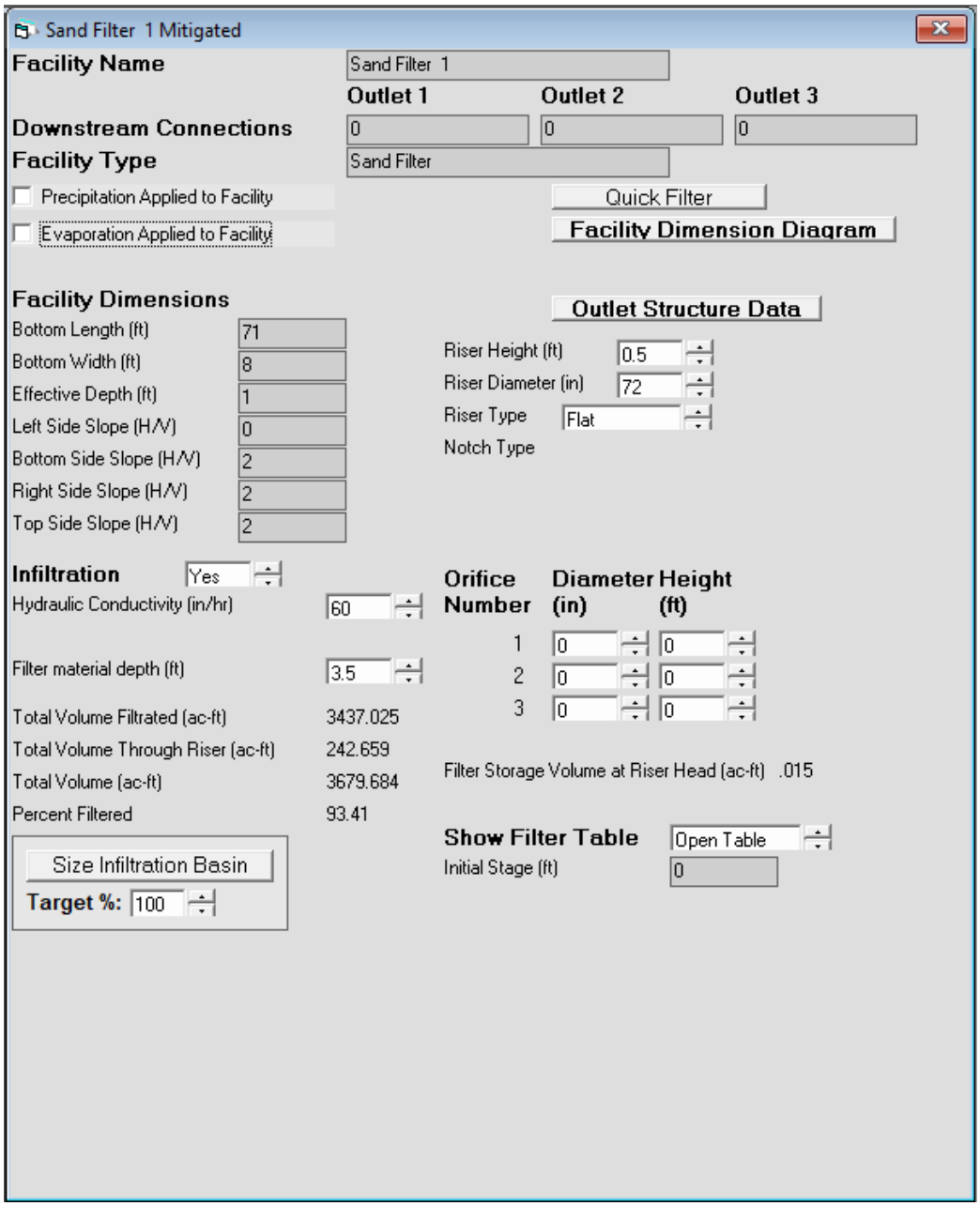


Figure 03: WWHM Modeling Results for POST Media (1st Iteration)

The model shows that a facility of the dimensions calculated actually filters 93.41%. The water quality benefit must be calculated to ensure the Lake Whatcom TMDL is met.

6.5.2 POST Media Water Quality Benefit

Phosphorus loading, phosphorus removal efficiency of the POST media, percentage of average annual runoff volume treated, and the resulting annual phosphorus load reduction in the basin can be seen in **Table 09**.

Table 09: Phosphorus Removed by POST Media (Basin 1)

Facility Dimensions (WxL)	Current Phosphorus Loading (lbs/yr)*	Removal Efficiency (%)	Annual Runoff Volume Treated (%)	Phosphorus Loading Removed (lbs/yr)	Phosphorus Loading Removed (%)
8' x 71'	21.913	89.4	93.41	18.30	83.5
8' x 110'	21.913	89.4	97.58	19.12	87.2

**Phosphorus loading calculated using 1.08 lb/ac/yr for developed area and 0.09 lb/ac/yr for forested areas, per the City of Bellingham*

Table 09 shows that while a facility with the dimensions of 8'x71' may treat the offline 15-minute water quality flow rate from Basin 1, it does not meet the 87% Lake Whatcom TMDL. The dimensions were adjusted and the calculations and modeling repeated until the percent of phosphorus loading was a minimum of 87%. This coincides with a facility that is 8'x110'. **Figure 04** shows a screen shot of the model results. Complete WWHM Model results can be found in **Appendix H**.

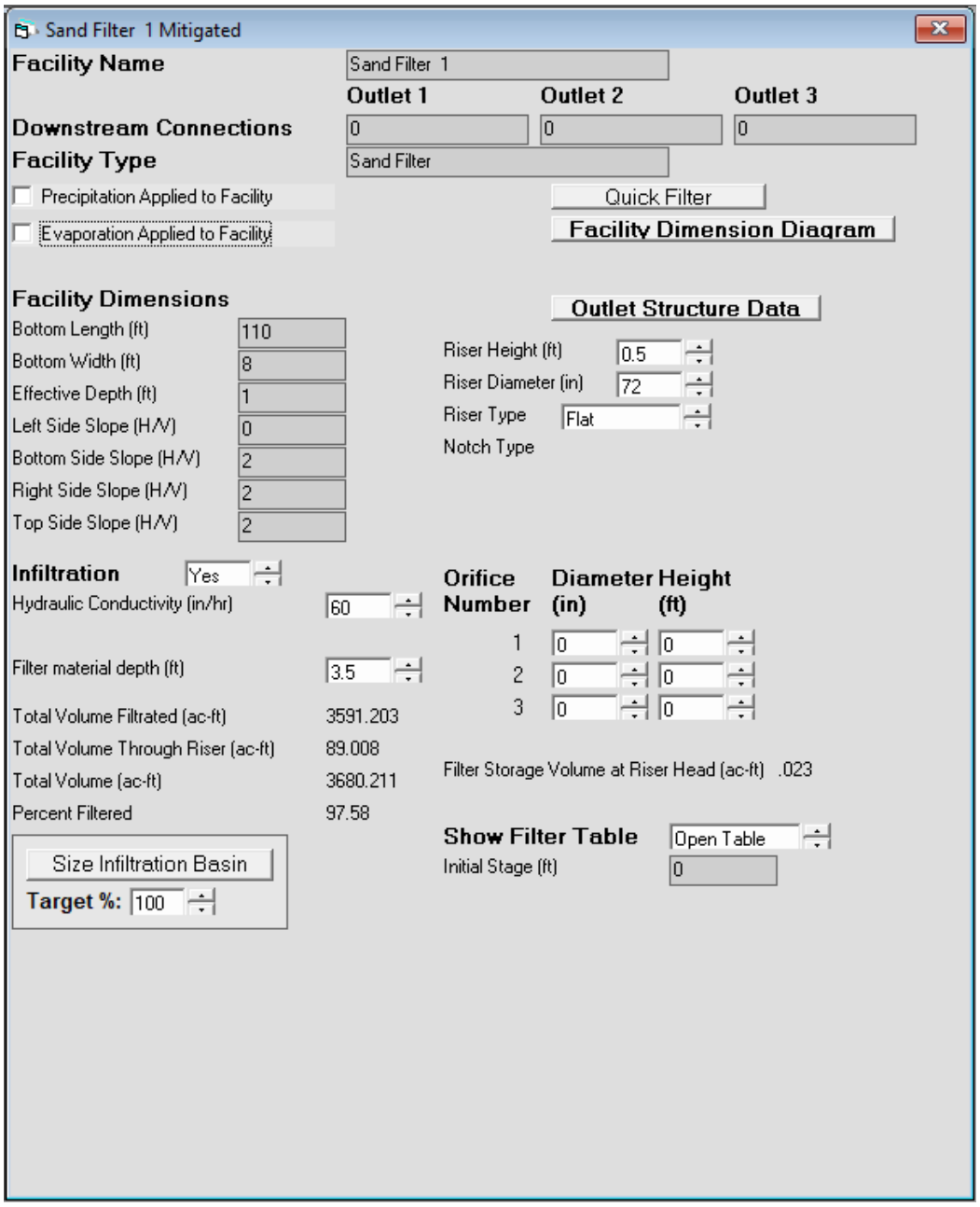


Figure 04: WWHM Modeling Results for POST Media (2nd Iteration)

6.5.3 High-Flow Bypass

In accordance with the *Design Guide* for the POST media system prepared by Herrera Environmental Consultants, a high-flow bypass must be designed to minimize ponding in the POST media system. Bypassing high-flows will also minimize damage to the media created by larger storm events. A weir was chosen for its simplicity and ease of maintenance. Flows larger than the water quality flow rate (0.7748 cfs) will flow over the weir and bypass the treatment facility.

To determine the height of the weir, the flow depth of the water quality flow rate must be determined. To find the flow depth, the following figure and equations are used.

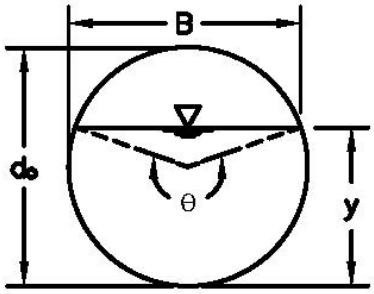


Figure 05: Partial Pipe Flow Parameters

Where:

$$Area = A = \frac{1}{8}(\emptyset - \sin\emptyset){d_o}^2$$

$$\emptyset = 2\cos^{-1}\left(1 - \frac{2y}{d_o}\right)$$

$$R = \frac{1}{4}\left(1 - \frac{\sin\emptyset}{\emptyset}\right)d_o$$

$$Velocity = V = \frac{1.49}{n}R^{\frac{2}{3}}{S_o}^{\frac{1}{2}}$$

Given:

$$Q = 0.7748\ cfs$$

$$n = 0.012$$

$$S_0 = 0.005\ ft/ft$$

$$d_0 = 8\ in = \ 0.67\ ft$$

Solve for y:

$$Velocity = V = \frac{1.49}{0.012} R^{\frac{2}{3}} (0.005)^{\frac{1}{2}} = 8.78 \left(R^{\frac{2}{3}} \right)$$

$$Q = VA = 8.78 \left(\frac{1}{4} \left(1 - \frac{\sin \emptyset}{\emptyset} \right) 0.67 \right)^{\frac{2}{3}} \frac{1}{8} (\emptyset - \sin \emptyset) 0.67^2 = 0.7748 \, cfs$$

$$\emptyset = 226.95 \, degrees$$

$$\emptyset = 2 \cos^{-1} \left(1 - \frac{2y}{0.67} \right) = 226.95 \, degrees$$

$$\boldsymbol{y = 0.466 \, feet}$$

The top of the bypass weir must be 0.466 feet above the invert of the pipe discharging to the treatment facility.

7.0 QUANTIFYING THE WATER QUALITY BENEFIT

The September 2019 Design Deliverables Guidelines for DOE Stormwater Projects outlines methods for quantifying the project's water quality benefit, with prescribed calculations for Flow Control BMPs and Runoff Treatment BMPs. A flow control ratio has not been calculated because the project discharges directly to Lake Whatcom, a flow control exempt water body per Appendix I-1, Table I-A.1 of the Ecology Manual.

7.1 Runoff Treatment Ratio

A Runoff Treatment Ratio for the proposed BMP was determined via the equation below:

$$\text{Ratio}_{\text{WRT}-1} = \frac{\text{Design flowrate or volume for proposed retrofit treatment BMP}}{\text{Design flowrate or volume to meet new/redevelopment criteria}}$$

$$If\ \text{Ratio}_{\text{WRT}-1} > 1, \qquad then\ set\ \text{Ratio}_{\text{WRT}-i} = 1$$

$$\text{Area}_{\text{WRT}-1} = \text{Ratio}_{\text{WRT}-1} \times \text{Contributing Basin Area}$$

The design flow rate of the POST media system is 1.3968 cfs, higher flows are allowed to bypass through an overflow. The design flowrate to meet new/redevelopment criteria for Basin 1 is 0.7748 cfs, the offline water quality flowrate as calculated by WWHM. The ratio of the proposed design flowrate to the required design flowrate is greater than one (1.3968 cfs ÷ 0.7748 cfs = 1.80), so the equivalent new/redevelopment area is equal to the total contributing base area of 38.090 acres.

8.0 COST ESTIMATE

Based on past stormwater treatment and retrofit projects, the total estimated cost for construction of the project is anticipated to be approximately $1,100,000. Due to the site location and permit conditions, all work is grant-eligible work. This project requires a Shoreline Permit which will have conditions such as additional landscaping and grading. Items like fencing and bollard are required to deter the public from parking on the site and potentially damaging the proposed facility. Other fencing, such as deer fencing, is required to prevent deer from eating the proposed plantings. See **Appendix I** for more details regarding the construction cost estimate.

9.0 PROPOSED SCHEDULE

This project is located within the Lake Whatcom Watershed. As such, land disturbing activities are limited to a seasonal work window from June 1 through September 30. This project proposes to complete design and final bid package for Department of Ecology review by end of September 2023. It is proposed that the construction phase be executed beginning in the June 2024 through October 2024. Milestones include:

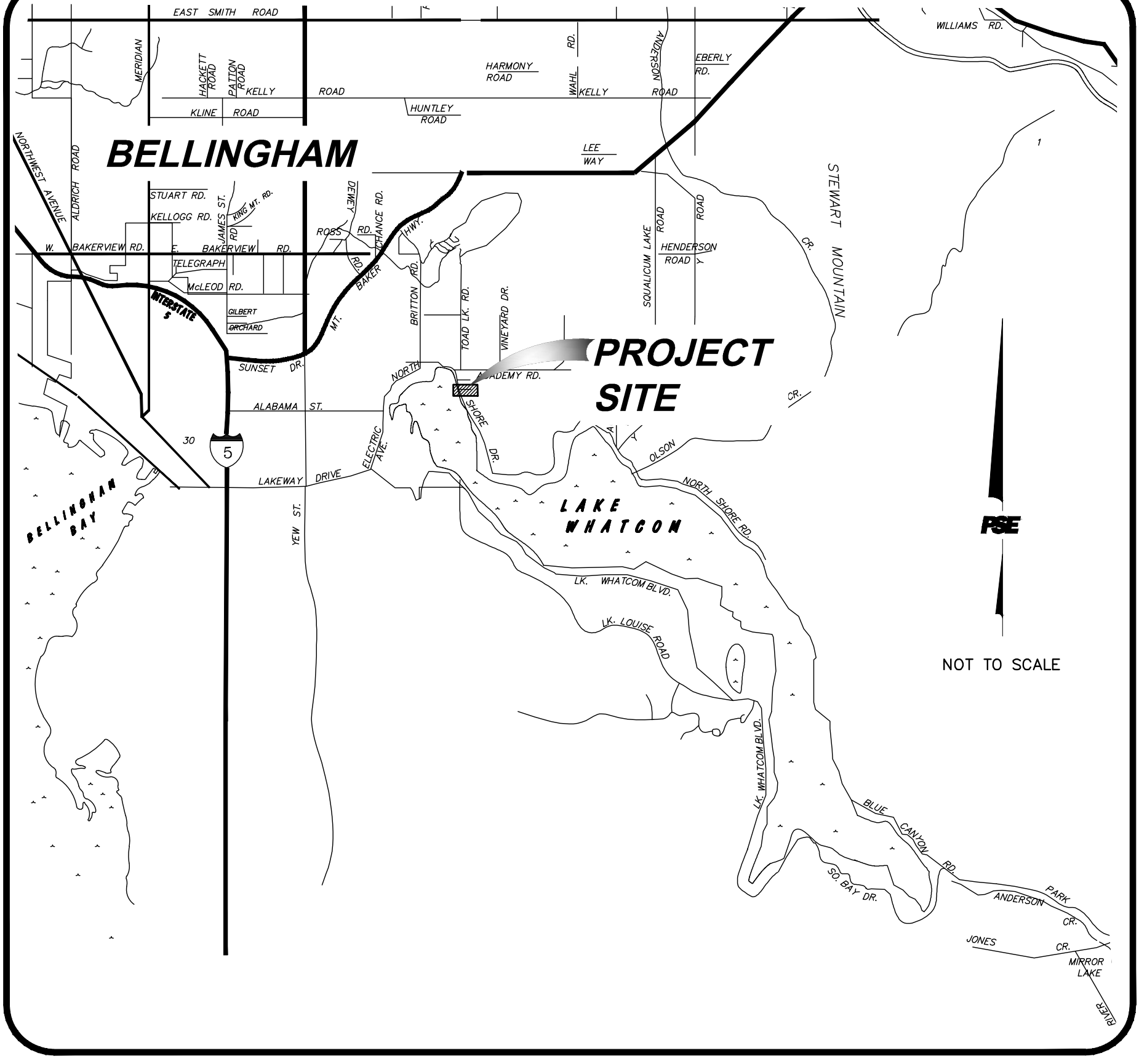
- Final Bid Plans, Specifications, and Estimate ..... November 2023
- Bid Opening..... April 2024
- Contract Award ..... May 2024
- Construction Begins ..... June 2024
- Construction Complete ..... October 2024

For a more detailed schedule including phases, tasks, durations, and dates, see the Gantt chart included in **Appendix J**.

10.0 APPENDICES

APPENDIX A – VICINITY MAP

VICINITY MAP



APPENDIX B – BASIN MAP

BASIN 1 - DONALD AVE CULVERT SURFACING SUMMARY

	ROOF	56,013 SF	1.286 AC
	ROAD/SIDEWALKS	149,861 SF	3.440 AC
	IMPERVIOUS TOTAL	205,874 SF	4.726 AC
	LAWN	358,256 SF	8.224 AC
	PASTURE	252,945 SF	5.807 AC
	FOREST	845,873 SF	19.419 AC
	TOTAL	1,662,948 SF	38.176 AC

BASIN 2 - NORTHSHORE RD CULVERT SURFACING SUMMARY

	ROOF	22,498 SF	0.516 AC
	ROAD/SIDEWALKS	40,071 SF	0.920 AC
	IMPERVIOUS TOTAL	62,569 SF	1.436 AC
	LAWN	111,285 SF	2.555 AC
	TOTAL	173,854 SF	3.991 AC

BASIN 3 - RAILROAD R/W SURFACING SUMMARY

	ROAD/SIDEWALKS	5,455 SF	0.125 AC
	IMPERVIOUS TOTAL	5,455 SF	0.125 AC
	LAWN	14,399 SF	0.331 AC
	TOTAL	19,854 SF	0.456 AC

CALL BEFORE YOU DIG 1-800-424-5555

REVISION	DATE	DESCRIPTION	ISSUE	DATE	DESCRIPTION

CITY OF BELLINGHAM - PUBLIC WORKS
104 W MAGNOLIA ST, SUITE 109
BELLINGHAM, WA 98225
360.778.7900

DONALD AVENUE
BELLINGHAM, WA
WATER QUALITY RETROFIT

SHEET NAME

PACIFIC SURVEYING & ENGINEERING, INC.
909 Squalicum Way, Suite 111 | BELLINGHAM, WA 98225
T. 360671.7387 | F. 360671.4685
WWW.PSESURVEY.COM | INFO@PSESURVEY.COM

DATA	DRAWN BY	CHECKED BY	FIELD BOOKS
BASE	XXX	XXX	DESIGN: XXX
DESIGN	JRG	JVY	STAKING: XXX
XREF:	XXX		ASBUILT: XXX
JOB#:	2021326		DATUM
HORIZ. SCALE:	1"=100'		HORIZ.: XXX
VERT. SCALE:	XXX		VERT.: XXX
DWG: P:\Pse Project\2021326\DWGs_SHEET\2021326_ecP_BD.dwg			

SHEET 01 OF 01

PRELIMINARY

APPENDIX C – GEOTECHNICAL REPORT

January 6, 2023

Client: **City of Bellingham Public Works**
Jessica Bennet, PE, *Project Engineer*
104 West Magnolia Street, Suite 109
Bellingham, WA 98225

Project: **Donald Avenue Stormwater Treatment Facility Improvements**
Intersection of Donald Avenue & Northshore Drive, Bellingham, WA

Subject: **Limited Geotechnical Evaluation - Proposed Facility Treatment Upgrades**

Dear Ms. Bennet,

Element Solutions was retained by the client to perform a Limited Geotechnical Evaluation in order to provide subsurface information and focused geotechnical recommendations for planning and design of the improvement project at the above-referenced project site on the northeast shoreline of Lake Whatcom. The overall intent of the project is to perform renovations and upgrades to the existing stormwater treatment facility in order to help meet new goals for water quality and pollution reduction. This letter contributes soil and groundwater monitoring data to assist in design of the improvements.

Facility design is currently in process. It is anticipated that the upgrades to treatment capacity will take one of two directions; (1) Installation of self-contained treatment units or filters within the existing basin, or (2) modification of the existing drainage characteristics and replacement of the existing filter media within the basin. For either approach, it is assumed that the facility basin landform will remain generally similar in size and shape to the existing stormwater basin, although some earthwork modifications such as resizing/reshaping to optimize treatment may apply.

The purpose of this evaluation was to perform explorations and document the existing site conditions, including subsurface soil and groundwater characteristics, at targeted locations within the existing stormwater basin and ancillary area. This work is intended to inform further planning and design by the project engineer (Pacific Surveying & Engineering – PSE). The extent of conclusions and recommendations presented herein are based on our understanding of the project components at this time, and are limited by the methods of investigation described below. Geotechnical commentary and recommendations are provided relating to interpretation of complex modified conditions, site preparations, excavations, and groundwater management / dewatering. Element Solutions has not performed field testing or provided analysis relating to stormwater infiltration, which is not a component of the facility and project.

This report has been compiled after collection of groundwater level monitoring data over a term consistent with the scope of investigation. Wells installed for this study have been left in place for additional use if necessary. Should you have any questions concerning this report, please contact us at (360) 671-9172.

Summary of Scope

In summary, our scope of site investigation and monitoring has included:

1) Desktop review of existing geologic and soils information for the project area (as based on mapping by others and public information), as well as review of site and proximal off-site topography and imagery via public GIS data.
2) Consultation on the anticipated facility improvements, and review of original construction plans and as-built information.
3) Initial site meeting and reconnaissance visits to plan test locations and drilling access, public utility notification marking/filing, and verification of utility clearances.
4) Completing applications and obtaining permits/approvals from local shorelines administrators and cultural resource protection agencies prior to conducting explorations.
5) Direction and observation of five (5) shallow geotechnical borings performed by Element personnel, using a hand-operated power auger and supplemented with hand tools. Borings were conducted to final depths of 7.0 to 7.5 feet below present grade (BPG) among the exterior of the basin (3 total), and 2.2 to 3.0 feet BPG within the basin (2 total).
6) Installation of five (5) monitoring wells, one per auger location, for groundwater level observations post-drilling and logging of seasonal groundwater fluctuations. Automated data-loggers were installed within three (3) wells [B2, B3, and B4].
7) Periodic visits to the site from February, 2022 to December, 2022 to collect direct measurements from wells and download interim logger data. Final data included in this report was collected on December 19, 2022.

Subsurface conditions were explored and PVC groundwater observation wells were installed on February 8, 2022. A site location and vicinity map (Figure 1), site existing conditions aerial photo and exploration location map (Figure 2), survey map excerpt with test locations (Figure 3), a field photo array (Exhibit A), and preliminary design plans for the original bioswale feature (2005; for reference only) are attached in Appendix I. Boring exploration and groundwater observation well construction logs are provided in Appendix II. Graphs of groundwater monitoring results are provided as Figures 4, 5, and 6 (B2, B3, and B4 locations, respectively), and are attached in Appendix III.

Site & Vicinity Conditions

The project site is generally located at the northeast end of Lake Whatcom, along the eastern margin of Bellingham, Washington. The site lies along the eastern shoreline of the lake and is bounded to the east by Northshore Drive. Single-family residential homes surround the site to the north, south, and east across the road. The site interior mostly consists of a municipal stormwater treatment detention pond system referred to as a bioswale. Site access is gained from the southeast along Northshore Drive. A community dock is located just off-site near the south end of the parcel. There is no developed parking or access road features within the small property. The project area is accessible and traversable on foot.

A relatively shallow, fully enclosed depression extends north to south between the shoreline and the roadway and dominates the site interior topography. The eastern edge of the swale consists of a 3- to 4-foot-tall slope that rises to meet the roadway. The west edge of the swale is bordered by another 3- to 4-foot-tall berm feature (height compared to basin floor) that separates the lake shoreline from the interior of the swale. The north end of the parcel consists of a relatively flat area that contains stormwater catch basins that feed water into the treatment facility from Donald Avenue (under normal operation, currently diverted). The south end of the parcel also contains a small flat area between the road and the lake. We understand that water is also fed to the swale from the ditch lining the east edge of Northshore Drive.

Vegetation is limited across the site. One large tree is found at the north end of the swale. Generally, the vegetation consists of grassy areas with small scattered scrub shrubs. Topographic and vegetation conditions are assumed to be highly modified, perhaps historically and certainly with basin construction.

Background Geology

Foothills of the northern Puget Sound were founded by a complex assemblage of rocks that accreted to the margin of North America during the mid-Cretaceous (~100 million years ago). Rocks forming the westernmost part of the North Cascades, underlying most of Whatcom and Skagit Counties, are associated with a broader structural assemblage known as the Northwest Cascade Thrust System. This system represents a prolonged large series of deformation, metamorphism, and uplift of mainly oceanic-derived rocks. During the subduction and later assemblage of these rocks, widespread volcanism and plutonic scattered the region. Later, during the early Eocene (~50 million years ago), strike-slip faulting in the region created a series of pull-apart basins. These basins filled with arkosic-rich sediment in river systems that are widely known as the Chuckanut and Huntingdon Formations prevalent in the Bellingham area. Widespread continental-scale glaciations beginning approximately 20,000 years ago have resulted in the relatively recent deposition of glacial-derived soils above the various bedrock formations in lowland areas. These glaciations are responsible for many of the topographic features in the Puget Sound and foothill regions, including many lakes and terraces.

Geologic Maps

The *Geologic Map of the Bellingham 1:100,000 Quadrangle, Washington* (Lapen, 2000) produced by the Washington Department of Natural Resources (DNR) indicates that the study area is underlain by the Bellingham Padden Member of the Chuckanut Formation (Ec_{cp}). The Padden Member is described as "Moderately to well-sorted sandstone and conglomerate alternating with mudstone and minor coal. Sandstone ranges from fine to coarse-grained, with pebbly to conglomeratic sandstone layers common. Sandstone is rich in chert and volcanic lithic clasts" (Lapen, 2000). In our experience, bedrock in this area is commonly mantled with glacial drift materials of various thicknesses. Cover deposits vary locally and are typically not differentiated on the map scale.

Our subsurface explorations found that controlled and uncontrolled fill soils lie within and adjacent to the stormwater treatment basin feature. In addition to the recent construction of the pond which heavily modified the land, shallow subsurface disturbance is likely to have occurred historically. Earlier topographic maps (up to approximately the 1970s) show that a railroad was located through the site.

NRCS Soil Survey

The USDA Natural Resource Conservation Service (NRCS) maps soils within the site as *Whatcom-Labounty silt loams, 0 to 8 percent slopes (unit 182).* This soil forms on hillslopes from a parent material of volcanic ash and loess over glaciomarine deposits. The soil characteristics are listed as:

- Typical soil profile of ashy silt loam to 16 inches and loam to 60 inches.
- Natural drainage class is *moderately well drained.*
- Depth to water table is listed as about 18 to 36 inches.
- Depth to restrictive feature is listed at over 80 inches.
- The unit is assigned to *Hydrologic Soil Group C* (moderately high runoff potential).
- Water transmission capacity of the unit is moderately low to moderately high.

Land Modifications and As-Built Information

Historical development across the site includes earlier railroad development, and the relatively recent construction of the existing stormwater bioswale and associated features. Little is known about the construction and extent of the railroad; however, historical topographic mapping shows a railroad traversing through the site from at least the 1908 to 1975 maps. Historical air photo review (City of Bellingham) suggests that the wide berm separating the bioswale location from the lake was the approximate location of the railroad. It is unknown what extent of subsurface improvements or fill modifications were made during the construction of the railroad corridor. We can only infer, based on exploration findings, that the site is now heavily modified and does not have a native shallow soil profile at any areas explored in the current study.

Preliminary design plans were provided for the existing bioswale at the subject site, attached for reference only (Appendix I). These plans show that water is gathered upland of the site along Donald Avenue and routed via a 12” culvert under Northshore Drive. Water then leads to a Type 1 catch basin at the north end of the site and diverts the water to the bioswale and lake separately. Similarly, water is gathered along a ditch on the east edge of Northshore Drive and is routed below the street into the southern end of the swale. The swale is shown as a 4- to 5-foot-deep feature that is bounded to the east and west, appearing to be as it is presently configured on site. The swale is shown to have a 1.0- to 1.5-foot-thick layer of amended soil infill overlying a 12-inch thick (minimum) layer of compacted bentonite soils. A perforated pipe is shown to run at the base of the amendment material and directly above the bentonite. Below the bentonite, plans show that 3 to 4 feet of “yard waste and bog materials” were to be removed and replaced with compacted pitrun gravel. The base of the profile view is identified as the approximate base of the “bog”.

The original design plans appear to indicate the waterward berm feature was already in place (likely an artifact of the railroad grade). Clearing limits for the basin improvements coincide roughly with the top-of-slope. There may have been some surficial landscaping improvements to accompany the bioswale project in the 2000s, but we assume primary berm construction via fill placement occurred in the far past. It is plausible that the berm was raised by earlier excavation of the basin and reuse of native glacial drift soils, followed by backfill of the basin with organic soils and vegetation waste.

Subsurface Evaluation

Subsurface explorations included the advancement of five (5) machine-augered borings on February 8, 2022, to evaluate the subsurface conditions underlying the project area and install shallow groundwater monitoring observation wells. Two borings were conducted within the bioswale basin (B2 and B4), two were conducted along the top of the western (lakeside) berm feature (B1 and B3), and one was conducted on the flat site pad at the north end of the project area (B5). Within the bioswale, borings were terminated on a very hard surface encountered at 3.0 and 2.2 feet BPG in B2 and B4, respectively. Due to the lack of even minor advancement or recovery of different materials at refusal depth, we suspect that refusal was met on something such as buried concrete or a large rocky obstruction. Borings along the berm and at the north end of the site were terminated between 7.0 and 7.5 feet BPG at maximum depths achievable with the tow-behind auger drill utilized for the limited-access field work.

Boring locations are indicated on Figures 2 and 3 in Appendix I, overlaying aerial photo and survey maps, respectively. Field photographs showing general existing site conditions and representative boring procedures as well as select soil recoveries are also attached in Appendix I (Exhibit A). Detailed exploration logs including well construction information are attached in Appendix II. Groundwater monitoring charts are included in Appendix III.

Boring Methods

Exploration locations were pre-selected by Element Solutions geotechnical staff based on the project understanding and field-located by an Element Solutions licensed project geologist during initial site reconnaissance. Each boring location was located and mapped in the field using identifiable features and hand measurements from fixed locations.

All borings were advanced by a team of two qualified Element Solutions geologists. Borings were advanced using a 6-inch diameter solid-shaft power auger mounted on a tow-behind drill machine. Auger tailings were documented and logged as recovered from the boring. Upon completion, auger flights were removed before well construction. Well casings were inserted and backfilled in slightly different configurations at each location to target soil layers and/or depths considered to yield the best groundwater information during monitoring. Well installation and monitoring methods are discussed in further detail in the groundwater monitoring section below.

Subsurface conditions were interpreted and documented during advancement by an Element Solutions Licensed Geologist. Soils were generally interpreted by observing soil cuttings produced during auger advancement, and supplemented with down-hole direct observations as view permitted. Soil classifications were determined per the Unified Soil Classification System (USCS – ASTM D-2487), and all stratigraphic depths and typical soil unit characteristics were recorded (as feasible with power auger borings). Soil moisture contents, seepages, and evidence of seasonal groundwater presence or fluctuations such as mottling and oxidation were also recorded as encountered. Samples of soils at representative depths were not collected due to the high degree of soil mixture that occurred during the augering process.

Subsurface Soil Conditions

The soil conditions encountered during auger advancement were distinctly different between borings within and outside of the bioswale. Generally, a thin cap of treatment media (sand) was found above clear gravel drain rock within the swale. A layer of fabric was found between the upper sand and lower gravel. In contrast, along the berm and at the north end of the site, thick deposits of fill and/or disturbed native soils were found over native clays (interpreted glacial drift) at depth. The following generalized soil units were encountered with depth:

Bioswale Basin (B2 and B4):

Treatment Sand: Coarse-grained sand with trace amounts of fines (<5%) was found at the surface within the bioswale below a thin layer of grass. Some organic debris (fine mulch) was found at both locations. The soil was damp, tan, and loose. The deposit was 1.0 feet thick in B2 and 0.8 feet thick in B4. A layer of filter fabric was found at the base of this controlled basin infill deposit.

Gravel Drain Rock: Clear, poorly-graded gravel with some coarse sand was found below the upper treatment sand at both test locations within the bioswale. The material resembled free-draining rock fill (not typical structural fill). The gravel was rounded with clasts generally ranging from 0.75 to 1.25 inches in diameter. The gravel was gray, medium dense to dense. Moisture conditions were damp before saturated conditions were found below 2.5 feet BPG in B2 and 1.5 feet BPG in B4. This controlled basin fill soil extended to termination at both locations where refusal was met on a very hard surface (underlying material not identified).

Along Berm Crest & Adjacent to Swale End (B1, B3, and B5):

Organic-rich Fill: Found at the surface of all borings outside of the bioswale was a thin deposit of organic-rich fill. This unit consists of soils ranging from silty sand with gravel, sand with gravel and silt, and sand with silt and gravel. Conditions were damp, dark brown, and loose to medium dense. Grass was found at the surface and the deposit extended to 0.6 to 0.8 feet BPG.

Upper Uncontrolled Fill: Below the upper organic layer, fill soils were encountered to approximately 2.5 to 3.0 feet BPG at borings B1 and B5. This fill appears somewhat uncontrolled due to its variable nature, consisting of silty sand with variable amounts of gravel found with charcoal intermixed. Conditions ranged from damp to very moist with depth, light to dark brown in color, and loose to medium dense. Rounded cobbles were found locally in B5.

Upper Gravel Fill: Gravel with sand and some silt was found locally at shallow depths in boring B3. This deposit contained rounded to subangular gravel clasts and was found in damp, brown, and dense conditions, resembling pit run material and suspected to be imported. The unit extended to 3.2 feet BPG similar to the uncontrolled fill soils noted above.

Lower Fill / Disturbed Native: Variable soils resembling disturbed or redeposited glacial drift soils were found below the upper uncontrolled fill and above the lower native clay unit at all borings outside of the bioswale. The unit was approximately 3.0 to 3.5 feet thick and extended to 6.0 feet and 5.8 feet BPG. This deposit generally consists of silty sand to silty sand with gravel. Variable amounts of gravel, silt, and clay content were encountered. Conditions were moist to wet with depth, light brown, and medium dense. Charcoal was noted locally.

Native Clay: Native blue sandy lean clay to clayey sand appearing to be intact and undisturbed was encountered at the base of all borings along the berm outside of the bioswale basin. Conditions were wet to saturated, soft to medium stiff, and bluish-green to bluish-brown. Locally, organic-rich clay was found at the surface of this deposit in B1 (suspected to be remnant topsoil). Minor interbedding was found in this deposit where undisturbed soils were recovered from augering.

Groundwater Conditions

The site is located directly along the shoreline of Lake Whatcom. Roadway drainage ditches are found along all adjacent roadway features, with some being routed directly into the subject bioswale. The interpreted interactions between the surrounding hydrology, changing lake levels, and stormwater inputs are discussed in further detail at the end of the report. Below, we document the groundwater levels observed during drilling and data gathered throughout the 10-month-long monitoring period by a combination of direct measurements and automated loggers. ***We understand that the primary inlet to the bioswale at the north end was capped and diverted prior to and throughout our study.***

Date of Exploration:

Saturated soils and free water was encountered at all boring locations during the February 8, 2022 explorations. Within the swale, the clean gravel drain rock became saturated by approximately 2.5 feet and 1.5 feet BPG in B2 and B4, respectively. Static water levels were then measured at 2.3 feet and 1.5 feet BPG before well installation at B2 and B4, respectively.

Saturated soils were encountered within the lower fill / disturbed native soil horizon at all borings outside of the bioswale. Static water levels were measured between 4.1 feet and 5.0 feet BPG at all locations. The measured depths to groundwater correlated to an elevation range of 312.0 to 312.5 feet AMS (NAVD88) across all test locations. Borings were left undisturbed for over an hour before measurements were made on the date of field work. The wells were constructed afterward on the date of drilling, and secondary measurements were not collected immediately due to disturbance during well construction. Stabilized water level measurements were later gathered on February 16, 2022; water depths ranged from 312.1 to 312.6 feet AMS (NAVD88). See the following section for details on well installation and a discussion of preliminary findings of groundwater monitoring which was performed until December, 2022.

Due to the widespread presence of fill soils across the site, and possibly limitations of the field exploration methods, reliable textural and visual indications of seasonally elevated water levels such as soil mottling and color hues were not encountered during exploration. Conditions observed in borings are interpreted

to represent developed mid-wet season groundwater levels, and are accurate only for the dates of exploration/measurement. Long-term groundwater monitoring completed over 2022 is discussed below.

Monitoring Well Installation & Monitoring Results

Monitoring wells were constructed in each boring on the date of drilling (February 8, 2022), yielding a total of 5 wells. All wells were constructed by a team of Element geologists in accordance with industry standard practices for shallow PVC observation wells. Well casings were extended to boring end depths to ensure reduced (seasonally-low) water levels could be captured as possible. Casings were composed of continuous 2-inch PVC pipe with perforated sections hand-drilled in the field. The lower 1.5 feet of the well casings were perforated in borings B2 and B4 within the swale. At borings B1 and B3, the lower 6.0 feet of the well casings were perforated. The lower 5.0 feet of the well casing in B5 was perforated. Wells were backfilled with gravel for approximately the entire screened section of the well casing. Bentonite was used to backfill and seal the remaining annular space up to the surface. Well casings were left exposed 0.5 feet above the surface at all locations. See attached boring logs for a graphical depiction of the well construction and end depths.

Element staff returned on February 16, 2022, to complete the install of automated water level monitoring equipment in borings B2, B3, and B4. Level logging units (Solinst system) were suspended within the well casing immediately above the base of each well. A barometric logger was installed on a tree nearby for on-site atmospheric data correction. Loggers were kept within wells full-time and remain installed as of the date of this report. Element staff periodically downloaded data from each logger and directly measured water levels on visits approximately 4 to 8 weeks apart. During the visits, lake levels were directly measured from the uppermost level of the dock located at the southern end of the site. Direct groundwater data measurements and lake levels converted to elevations (based on survey data) are provided in Table 1 below. Summary graphs of continuous monitoring data up to December 19, 2022 from select wells monitored with automated equipment (B2, B3, & B4) can be found in Appendix III.

Table 1: Summary of Direct Groundwater Measurements

Elevation Measurement Date	B1	B2^	B3^	B4^	B5	Lake Level (NAVD88)
2/16/2022	312.30	312.10	312.60	312.30	312.25	310.19*
3/8/2022	312.75	312.20	312.75	312.30	312.55	310.6
4/19/2022	313.4	312.4	312.7	312.30	312.90	N/A
6/9/2022	313.6	312.35	312.85	312.30	312.95	311.75
7/8/2022	312.8	312.15	312.47	311.95	312.6	311.85
7/11/2022	N/A	312.15	312.5	311.9	N/A	311.85
9/16/2022	311.15	DRY	DRY	DRY	310.9	310.5
10/11/2022	310.85	DRY	DRY	DRY	310.5	309.45
12/19/2022	311.95	311.95	312.33	312.13	312.15	309.15

* Lake Elevation Recorded at Geneva Gatehouse Ultrasonic Probe (provided by COB)
^ Location of auto-logger. See complete record graphs in Appendix III.

Interpretations and Commentary

Project Understanding & Key Considerations

The project generally entails upgrades to the existing facility to enhance stormwater treatment toward achieving new target goals for runoff pollution reduction in the Lake Whatcom watershed. Upgrades may include replacing and updating basin treatment media, and/or installation of modular contained treatment/filter units. The final approach and extent of earthwork modifications to the existing basin remain to be determined.

We anticipate these key considerations for planning and completion of the proposed project, which are discussed in the following sections:

1) Interpretation of the existing basin and berm soils and groundwater levels, with possible impacts to the project approach.
2) Site preparations and fill usage (imported and existing materials).
3) Excavation limitations, cutslope grading and protection, and shoring.
4) Dewatering and seasonal groundwater factors on construction.
5) Utility Improvements.

Soil Conditions Discussion & Interpretations

Summary of Findings & Interpretation

Our findings confirm that the project area consists of heavily modified land. All borings encountered a series of fills that differed between basin interior and exterior locations, but generally correlated within those areas. Basin exterior borings (B1, B3, B5) all successfully extended to 7 feet BPG or further, terminating at elevations of about 309 to 310 feet (NAVD88). At all basin-exterior locations, the upper approximately 6 feet of soil was interpreted as fill (both imported and apparent locally/site-sourced materials). The typical fill composition below surficial landscaping soils was silty sand with gravel. Native soils of clayey sand to sandy lean clay were consistently found beginning at 310.5 to 311.5 feet elevation. This soil type is broadly consistent with glacial drift deposits common to the site vicinity and our past experience in the project vicinity. However, the uppermost portions of the soil profile were likely removed during historical site activities (railroad use) and/or original stormwater facility construction.

Basin interior borings (B2 and B4) encountered approximately 1 foot of imported treatment media sand overlying clean gravel drain rock that is separated by filter fabric. Borings were terminated shallowly at 2.2 and 3.0 feet BPG (approximately 311.5 feet elevation) on a hard surface below the gravel suspected to be concrete or large cobble/boulder obstructions. Underlying materials were unable to be confirmed; tests were not advanced further to avoid potentially damaging existing system features. The end depth was noted to correspond roughly with the elevation of native soils at the exterior berm borings (allowing for some variation and more landward/upgradient locations of the in-basin explorations versus the outer berm locations). The elevation of native conditions at the outer berm borings also generally corresponds with the present-day elevation of the adjacent shoreline (between 311 to 312 feet).

Design & Construction Considerations:

Our findings indicate that most excavation locations outside of and along the margins of the existing bioswale basin will encounter moderately thick and variable fill soils that are relatively easy to excavate (i.e. not highly compacted material). Generally, it should be expected that fills comprising the outer berm feature are "uncontrolled" fills due to their relatively loose and variable condition (although the actual installation procedures are not known). Given the historical source evidence of past railroad usage, we also suspect that some refuse may be encountered during excavation such as remains of steel, lumber, or timber. Results from B1 and B5 indicate that these conditions also extend to the north and south of the existing bioswale basin. No information is available for the east edge of the bioswale due to exploration space limitations. However, some amount of modifications from prior roadway grading is anticipated due to the close proximity of Northshore Drive. Due to the unpredictable nature of uncontrolled fills and variable soils, these conditions present a possible settlement risk under loading. Additionally, the uppermost native soils underlying the fills are also relatively low strength and saturated (ranging from soft to medium stiff). Additional subsurface soil improvements will likely be needed to stabilize subgrades below new control or treatment structures, if employed. Since these types of facilities typically have moderate and distributed loads, we anticipate stabilization using common earthwork techniques and standard materials will suffice. Below we provide recommendations for subgrade preparation and stabilization to be used as needed.

Borings within the existing basin clearly found the upper 1.5 to 2.5 feet of soils consist of controlled, imported treatment and drainage fill used to construct the bioswale. We anticipate that these soils extend laterally until the basin sideslope walls are encountered, although the outer margin of the interior fills was not confirmed directly. We do not suspect that the drainage fill materials extend below the berm or below the slope rising to meet Northshore Drive. Excavations below the shallow drainage materials may be inhibited by densely compacted gravel soils (as indicated on the 2005 COB design plans), other backfill materials such as large cobbles or boulder rocky material, or possibly even hard surfaces used to line/seal the basin. Refusal depths for B2 and B4 within the bioswale generally correlate with the elevations of native clay-rich soils encountered below the berm feature and in B5 north of the swale. Similar native soils may be encountered below the refusal layer/feature encountered.

Groundwater Interpretations & Commentary

Interactions between surrounding upland hydrology, fluctuating lake levels, and stormwater inputs to the existing basin are complicated, and further complexity is caused by the presence of variable fill soils and historical/recent site modifications. After monitoring groundwater and lake levels over approximately one annual cycle within the basin and along the western berm, we have drawn the following key interpretations regarding subsurface hydrology of the project area based on the data available to date. ***Note that the primary northern inlet pipe to the basin was capped and diverted prior to monitoring.***

1. *Water levels at all boring locations do not appear to be directly related to the lake levels, but do appear to respond to local seasonal water conditions (dry vs. wet season). Note that 2022 experienced a prolonged spring season followed by a very dry summer; water levels generally lagged behind weather patterns and took some time to dissipate into the summer season.*

There is no obvious evidence in the data collected that the groundwater conditions within the basin of the bioswale and below the adjacent berm are being directly influenced by the lake levels. The observed groundwater levels are generally several feet above the lake levels throughout the year. Furthermore, elevated groundwater levels were commonly observed during periods of low lake levels, such as in the late winter and fall. We interpret that if lake levels had a significant impact on groundwater levels within or adjacent to the bioswale, then we would observe a correlation between periods of elevated/reduced groundwater levels with higher/lower lake levels, respectively. This was not observed during the monitoring period.

2. *Groundwater levels at wells within the bioswale basin responded to individual rain events differently. However, the "background" or baseline seasonal water levels for both appear to show a correlation with each other.*

   The wells within the existing bioswale basin were found to similarly reflect seasonal groundwater conditions. However, individual storm events were reflected differently between the two locations. Levels in B2 were noted to have sharp rises and falls on short intervals that appear to correlate well with regular storm events. Conversely, levels in B4 were relatively consistent through these same storm events. However, there is a clear correlation between the "baseline" water levels at both locations. Water levels were reduced to below the wells starting in early July at both locations. From this relation, we infer that B2 (southerly location) was receiving more of a direct input of stormwater in comparison to B4 to the north during the study period. This is likely related to the close proximity of B2 to the catch basin leading to the bioswale from along Northshore Drive. Levels in B4 may represent a more distributed level of groundwater as a result of the nearby northern inlet being inactive during the monitoring period, as the B4 location appears to have little or no direct association with the southern input from Northshore Drive.

3. *There appears to be some correlation between the water levels within the bioswale and those below the adjacent berm (which are elevated compared to adjacent lake levels). Thus, we interpret that the berm soils are somewhat transmissible and may be directly or indirectly influenced by water levels within and regular stormwater inputs to the bioswale basin.*

   We observed an apparent direct correlation between seasonal and short-term water levels below the bioswale and below the adjacent berm feature. In particular, graphs of water levels in B2 and B3 are nearly identical aside from the amplitude and duration of individual storm events. We interpret this to show that there is a direct relationship between the water levels within the bioswale and those below the berm. Since there is no evidence that lake levels are directly impacting the water levels below the berm or in the swale (#1 above), it can be inferred that the bioswale levels are directly impacting the levels below the adjacent berm. However, levels below the berm at B3 were also consistently about 0.4 to 0.5 feet higher than those below the basin. Thus, while each of the locations is responding to storm and seasonal water levels similarly, water from within the basin appears to be "downgradient". This is likely a result of the drainage infrastructure within the basin allowing for the faster release of water from the interior. It is plausible that a greater effect of groundwater below the berm would have been present if the bioswale was fully operational including the diverted northern inlet source.

Geotechnical Recommendations

Site Preparations

The extent of site preparations and earthwork proposed is not known, and will depend on the final design approach. At this time, we understand facility upgrades will likely include either replacing / upgrading treatment media of the existing basin (possibly with addition of an additional filter layer or system), or full replacement of the bioswale with a contained modular style of treatment for stormwater passing to the lake. Thus, the recommendations below are more general in nature, and may need to be refined or expanded for final design support.

We assume that any approach selected will include at minimum some drainage utility modifications and setting of new pre-cast control structures. Trenching for new drain lines is likely to be shallow. Utility improvements may involve crossing beneath paved roadways. Grading and cut/fill modifications of the project area may also be done.

If further recommendations or geotechnical guidance for site preparations is needed in support of the final design and its construction, Element Solutions should be contacted to review the applicable design information and provide revised or additional geotechnical recommendations as needed. Element Solutions may also be contacted to provide a further scope of work or consultation in support of the final design process and construction activities.

General Earthwork & Subgrade Preparation

We expect traditional mechanical equipment (such as excavators/backhoes, bulldozers) can be used for earth moving and grading given the soils encountered. Tooth-edge buckets may be preferable for rough excavation of dense or cemented materials, if encountered with depth. Flat-edged buckets should be used when preparing fine-grained subgrades to lessen disturbance of subgrade, and when trimming excavation bases to final foundation design grade.

We recommend stripping vegetation and removing topsoils, uncontrolled fills, unsuitably soft or loose subgrades, and soils containing organic remains or other deleterious materials from within areas to be improved for new structures. Stripping should include proposed structure and pavement/flatwork improvement footprints, and areas receiving structural fills to raise grade below or proximal to structures and pavements. Uncontrolled and undocumented fills, as present commonly, should also be removed from footprint and pavement locations. Any existing structural fills, as present, should be evaluated for suitability (material properties and compaction) and approved to remain on a case-by-case basis. Potholing should be conducted, if necessary, during construction to confirm stripping depths, or to assess the character and extent of existing fills, prior to full stripping or excavation of an area.

Once subgrade level is reached and any unsuitable materials are removed, disturbed granular subgrades should be recompacted to a suitably dense, uniform, and unyielding condition. We recommend subgrade beneath structures and pavements be evaluated by a geotechnical professional by appropriate means

including T-probing and visual assessment to confirm competent and unyielding conditions are established. Where unsuitable conditions are identified, additional stripping or over-excavation followed by replacement with structural fill should be conducted under guidance of the geotechnical consultant.

Proof-rolling of prepared building pads and slab or pavement subgrades with a loaded dump truck is recommended when access allows. If areas of excessive deflection/rutting, looseness, or pumping are identified, mark locations for rectification. Loose or rutting areas can be recompacted, subject to suitable moisture conditions, then re-assessed for suitability. Any pumping locations or persisting loose/soft areas likely reflect excessive moisture conditions and should be over-excavated until reaching suitable support conditions (or alternatively stabilized as directed by the geotechnical professional), then backfilled with new imported structural fill to restore planned grade level.

Wet Season Construction

Soils at the project site consist of historical fills with high fines content and buried native soils which are clay-rich. These types of soil are highly moisture sensitive, and are prone to significant issues such as weakening and degradation as a result of exposure to wet weather in the presence of construction traffic and activities. Furthermore, earthwork activities on moisture sensitive conditions can be difficult with additional costs and time commonly incurred for wet weather construction. Moisture-sensitive soils can be difficult to work and manage even in the dry season during periods of inclement weather. Finally, we recommend against placing frozen soil as fill, and against placing fill over frozen subgrade. Therefore, it is preferable to perform major earthwork construction for this project in the drier/warmer part of the year (early summer to early fall), and to avoid major grading activities during wet weather if possible. This will align the preferable construction timeframe with the unrestricted construction season for the Lake Whatcom Watershed (June 1 to September 30).

For project earthwork activities that take place in the winter season or in inclement weather, we recommend the following guidelines:

- Limit machine and truck traffic on exposed subgrades to only as necessary. If traffic through an area is unavoidable, consider capping with temporary stabilizing material and/or leaving stripped levels high to be trimmed to grade later.
- Be prepared to utilize imported structural fill. Be prepared to modify imported materials to a low-fines content free-draining aggregate or clear rock substitute if moisture cannot be adequately controlled or unmitigable free water is present in excavations.
- Grade subgrades for runoff, and provide outlets or dewatering for confined excavations that are susceptible to water inundation from runoff or seepage.
- Implement controls as possible to limit surface runoff from adjacent areas from entering the excavation or work area.
- Plan and conduct work in short stages to minimize open time for sensitive subgrades. Preferably, strip and cover moisture-prone subgrades quickly if working in rainy weather.

Structural Fills and Ground Improvements

Structural fill constitutes all fill soils placed underneath structures or pavements for support. Additionally, soil backfills against foundations and walls and soils used similarly for the purpose of providing lateral stability to structures are considered structural fill.

In general, structural fill shall consist of primarily granular and non-plastic (cohesionless) aggregate of suitable gradational characteristics that is relatively uniform in mineral composition, contains no discernible organic materials, and is free of other trash and deleterious materials. It is typically recommended that all aggregate be less than about 4 inches in diameter, maximum particle size. See below for imported structural fill specifications. For thin lifts or specific applications, a lesser maximum size may be required (maximum particle size of 2/3 lift thickness, or as specified for use).

Fill Installation and Compaction

Structural fills should be properly moisture controlled or conditioned to within 3 percent of optimum moisture level for the specific material to encourage proper compaction. In the dry season, granular fills residing in stockpiles may be excessively dry and need to be wetted prior to or during use. In the wet season, care should be taken to protect structural fill stockpiles from rainfall. Fills with excessive moisture levels must be removed and mixed, stored, or dried/aerated until within an acceptable range for use.

Installation of structural fill shall be done in horizontal lifts not exceeding about 8 to 10 inches maximum loose thickness. Thin lifts will be needed for small machinery or hand-operated equipment in order to achieve compaction. Per *WSDOT Standard Specifications 2-03.3(14)* and our professional judgment, fills should be benched when placed on grades steeper than 3H:1V.

Structural fills shall be compacted with appropriately sized equipment to a uniformly dense and unyielding condition. For all fills placed beneath or as backfill for structures, we recommend a minimum 95% compaction be attained. A minimum compaction standard of 95% is also recommended for the upper 2.0 feet of pavement subgrades, as well as the upper 4.0 feet of utility trench backfill beneath paved areas. Beyond 2.0 feet below the base of pavement away from structures (4.0 feet at utility trenches), and for non-structural utility backfills (outside of paved areas only), a minimum 90% compaction is suitable. Compaction shall be based on the maximum dry density of the material, determined by laboratory testing per ASTM D-1557 test method. Field compaction testing shall be conducted as necessary to verify compaction of each lift. Compaction testing should be performed frequently as work begins to establish suitable placement/densification methods, then as needed to assure project standards are met.

Material Specifications and Suitability of On-Site Soils

Imported aggregate is considered suitable for use as structural fill. For ***general-use structural fill***, we recommend a well-graded imported material meeting the specification for Gravel Borrow (*WSDOT SS 9-03.14(1)*). A performance equivalent may be approved for substitution by the project engineer and geotechnical consultant.

Laboratory testing should be conducted in advance of construction to evaluate and verify proposed imported materials are suitable for use. In the event that a material does not meet the project specification, the applicable engineer and geotechnical consultant may review the results for conditional acceptance. However, the contractor should also be prepared to find an acceptable alternative material if the initial source is unsuitable.

If work occurs during excessively wet weather, or if water is unavoidable within excavations, it may be preferable to substitute standard structural fill with a material not affected by water presence. For this purpose, a clear angular rock such as 1-1/4" clear ballast may be considered, subject to approval by the geotechnical consultant for the proposed use. If utilized, clear rock shall be installed as recommended above and compacted to an unshifting, unyielding, and uniformly dense condition as verified by visual methods and/or proof-roll.

Controlled-density fill (CDF) may be suitable for use in substitute for structural fill in some cases. If proposed, CDF use should be reviewed by the project engineer and geotechnical consultant before its placement.

On-site soils encountered in explorations, including various treatment/drainage fills, historical berm fills, and native clay-rich soils, are not suitable for reuse as structural fill. Historical fills consisting of silty sand with gravel may be suitable for grading purposes among non-structural areas (i.e. common site fill). That is, provided the material is of sufficient quantity, quality, and condition upon excavation to be compactable and meet other project requirements for the intended use. Existing site fills may need to be moisture-conditioned prior to placement. Soils proposed for reuse on site should be stockpiled separately from unsuitable materials and evaluated for suitability before installation. Additional testing and quality control efforts should be expected for reuse of existing fill soils in comparison to new imported fills.

Foundation / Slab Subgrade Preparation & Improvement

General preparations for structural areas (such as foundation locations and slab/precast structure footprints) should follow the typical guidelines for site preparations above. Below structures, we recommend that historical fills be removed (unless examined and explored further in construction and deemed suitable for the location and grade) down to native subgrade. Additional local over-excavation may be required to address problematic areas and variations in the originally shallow weathered soil deposits, or if historical fills are encountered to greater depth at areas not explored directly.

Due to the relatively soft to medium stiff consistency of native soils at all locations encountered at depth, we recommend shallow ground improvements where these soils will support new structures (either precast or built on site) based on this protocol:

1. First, ***carefully assess native subgrade once exposed*** at planned excavation depth. Identify *excessively* loose/soft soils, if present, and overexcavate these conditions unsuitable for structure support under the assessment and guidance of a geotechnical professional.

2. If subgrade soils are of marginal condition at the time of construction, placement of a stabilization/separation fabric may be necessary in lieu of additional excavation. For this purpose, we typically recommend a 6-ounce non-woven geotextile such as ***Mirafi 160N fabric***.

3. ***Place and compact imported structural fill to construct a base pad*** for structure placement/construction. For small structures (such as catch basins), a minimum 6-inch section is recommended. For larger structures, a minimum 18-inch section is recommended below the structure for bearing stability. Follow installation procedures provided above.

   Note: These are minimum values for planning and design purposes. Assessment during construction may find that additional excavation and backfill is necessary. The recommended fill thicknesses should be evaluated in construction on a per-case basis.

4. If water is present at the time of construction that cannot be abated for fill placement, a suitable substitute will be necessary. A clear angular rock material such as 1-1/4" ballast or 3/4" clear crushed rock is typically suitable for use in water-laden conditions as structural fill. The geotechnical professional shall confirm the necessity and suitability of use of alternative materials, as well as the procedures of placement/compaction for the construction conditions.

Excavation Cutslopes and Shoring

Excavation Shoring Considerations

In Washington State, shoring or sloping is required for excavations over 4.0 feet deep (WAC 296-155, Part N). Excavations for this project are anticipated to be primarily shallow, although some work may call for depths in excess of 4 feet. If shoring is elected due to space constraints, or as the preferred method of construction, the system must be evaluated and designed by a registered Professional Engineer licensed with the State of Washington. The shoring designer should review the findings of this report, and account for potential loads including soil pressures (active or at-rest, as applicable), hydrostatic influences, and loads from sources such as adjacent stockpiles, heavy equipment, and traffic.

In addition to providing safe excavation access and egress in accordance with OSHA requirements, shoring should be designed to adequately protect adjacent features (such as other utilities, structures, pavements) from detrimental effects including during installation and removal of the shoring. In the event that shoring is required in proximity to an existing feature/facility, we recommend the standards for protection be clearly established in project requirements. In some cases, an acceptable level of damage to adjacent conditions is suitable in order to expedite work. The standards for repair to existing features as a result of excavation shoring use should also be agreed upon prior to construction.

For deep excavations in close proximity to Northshore Drive ROW, if required, prohibiting road settlement and damage from shifting or caving of excavations is paramount. The current scope of work has not directly assessed the subsurface soil conditions beneath or along the edge of the roadway or among the adjacent slope along the east edge of the basin due to access and equipment limitations. If extensive ground work is anticipated along the edge of Northshore Drive, we advise additional explorations be done to provide adequate data for construction planning and shoring design.

Open Cut-Slopes

Temporary excavation cut slopes shall adhere to local, state, and federal requirements. Establishment and maintenance of suitable cut-slopes to provide for worker and site safety is the responsibility of the contractor. Temporary cut-slopes within the existing site soils should be sloped no greater than 1.5:1 (H:V), corresponding to "Type C" soils. If work proceeds in wet conditions, or if cut slope soils appear to be exceedingly soft/loose and unstable once cut at this grade, they should be reduced to 2:1 (H:V) as necessary. Excavations can be evaluated in construction by a qualified geotechnical professional to determine if steeper grades are permissible for short-term usage under optimal conditions and/or for relatively small slopes adjacent to shallow excavations.

Loads from external factors including but not limited to heavy equipment, traffic, stored materials, and soil stockpiles should be avoided directly above unreinforced cut-slopes. If loading is unavoidable, a lesser slope angle or temporary shoring of the location may be necessary. We recommend cut-slopes that will remain open for an extended duration be protected from exposure to inclement weather conditions as appropriate for the season of construction. Covering slopes with plastic can help prevent erosion and degradation of the slope face over time if rain is possible. If utilized, cover sheeting should be anchored sufficiently to resist wind displacement and overlapped to minimize leakage.

Open cut slopes are likely to be employed during installation of new system features across the existing basin and ancillary locations. Open slopes appear suitable for the project as long as adequate space remains between the slope feature and the Northshore drive ROW (approximately 10+ Feet). Guidelines for cut-slope preparation provided above are for general planning purposes only and should be revisited as necessary once conditions are open and observed during construction.

Dewatering Discussion

For excavations approaching or extending below the water table, dewatering efforts are expected to be required to allow for safe and successful work to commence. Our findings indicate that groundwater generally responds to seasonal conditions within and adjacent to the existing bioswale basin. Monitoring over 2022 found that water levels were generally at or just below 312.5 to 313.0 feet AMS (NAVD88) through most of the fall, winter, and spring seasons. Conversely, water levels fell to around 311.0 feet or below (roughly the shoreline elevation) once dry season conditions were fully developed in the mid-summer to early fall. We note that measurements in the wet seasons were likely influenced to some degree by the continued patial operation of the bioswale during the monitoring period, and thus findings do not necessarily represent a true "baseline" condition of the site.

The season of construction will have a significant influence on the extent and expense of dewatering. If work is planned for winter or spring timeframes, we expect it will be more difficult and costlier to adequately manage groundwater and seepage at the site. Thus, the summer and early fall seasons are anticipated to be the preferred time for construction to avoid the need for major dewatering. Additionally, this timeframe coincides with the unrestricted construction season for the Lake Whatcom watershed (June 1 to September 30).

Dewatering Planning & Design

Based on our experience, conventional methods such as on-demand or constant pumping from within the open excavation via a sump system for temporary evacuation is likely to be sufficient for removing the anticipated influx of water. Soils below the berm feature, and those anticipated adjacent or below the roadway, are anticipated to have a low to moderately low transmissivity. Thus, we anticipate the water input directly from these soils to be relatively low or moderate and manageable. It remains possible that water upslope of the site is perched above the native soils and/or fill soils and could also be transmitted through more permeable upper soil layers. Hence, some variation in flow rate could be encountered which could call for more aggressive pumping efforts.

A pumped drawdown well system or other dedicated, active dewatering system may be needed if exceptionally deep excavations are necessary which surpass the groundwater table and lake level (not anticipated for project at this time). Pumping from a series of wells near to and surrounding the exterior of the deep excavation zone is commonly an effective method for drawdown of an excavation area. However, such approaches are complex and must be sufficiently investigated and designed. The explorations done to date are not intended to cover data necessary for an extensive dewatering regiment. As with shoring design, a dewatering plan should be developed by a qualified Professional Engineer or Licensed Hydrogeologist with specialty experience in dewatering system design in the event that major dewatering is expected. The plan should be implemented in construction by a contractor with qualifications and experience in the selected approach.

It is common for contractors to be responsible for the planning and implementation of dewatering since it is closely tied to the methods of construction. Assuming that is the case for this project, we recommend the contractor submit a dewatering plan sufficiently in advance of construction to allow for review by the project team. If major dewatering is anticipated, the plan should include documentation by the designer presenting assumptions and analysis for the system to meet the necessary construction requirements.

Limitations on Dewatering Commentary

Element's scope for this project has not included a detailed hydrogeological evaluation or analysis of the site for dewatering design purposes. Groundwater monitoring was conducted only below the berm feature and within the artificial basin feature. We have not conducted down-hole testing that may be of interest to dewatering design, nor completed deeper explorations surpassing shoreline elevations. The effect of partial system operation on groundwater levels throughout the monitoring period is also not known. The information and commentary provided in this report is intended only for general planning purposes and does not necessarily provide recommendations or complete input for dewatering design by others.

Our commentary and findings rely solely upon the work completed to date, which may not cover the locations, depths, or detailed information needed for dewatering design. It is the responsibility of the designer to review the information presented and determine if further investigation is needed for a successful dewatering design. Element shall not be held responsible for the improper use of exploration data or the assumptions made by others based upon their interpretation of exploration data.

Utility Construction

Trenching for Utilities

Trenching and excavations for utility improvements at shallow depths will typically encounter existing site fills (generally silty sand with gravel). Deeper trenching may encounter weathered glacial drift soils (clayey sand to sandy lean clay) as well as the groundwater table with depth. We have made the following inferences based on conditions encountered:

- The site soils are moderately susceptible to raveling and sloughing in temporary excavations. Groundwater presence (either the water table or heavy seepage) will likely reduce stability of trench walls.
- If trench work is conducted during wet weather, temporary seepage from perched water and soil saturation may also increase the likelihood of trench wall raveling/sloughing.
- Due to the higher groundwater table in the winter and spring seasons, and significantly higher risk of seepage, deeper trenching and utility work is generally not recommended to be done in the winter or spring seasons.
- Where utility work is done below / adjacent to existing roads, the longitudinal extent of trenching should be kept to short intervals or segments, with pipe installation and back filling completed promptly and prior to opening new trench sections. This will limit the length of exposure time to trench wall drying or rain-wetting with the consequent sloughing that may be expected with exposure time, and minimize risks to existing features.

Backfill and Pipe Zone Bedding

Typical trench and pipe backfilling practices are considered appropriate for this project. Some on-site materials excavated during trenching may be suitable as replacement trench backfill outside of road prisms. Materials should be evaluated for suitability upon excavation but before reuse. The following recommendations are provided for trench backfill and pipe zone bedding considerations:

- Imported gravel for pipe zone bedding should consist of aggregate material satisfying the specification requirements of *WSDOT Standard Specifications 9-03.12(3)*.
- Unless otherwise specified by project or local municipal utility requirements, imported gravel for trench backfill below roadways and beneath paved areas should at minimum meet the specification requirements of *WSDOT Standard Specifications 9-03.19*. If allowed, trench backfill outside of paved and trafficked areas may consist of suitable non-structural material (per *WSDOT SS 9-03.15*).
    - Gravel Borrow (as recommended above for structural fill) is an acceptable performance substitute for bank run gravel / gravel base as trench backfill. If utilized for this purpose, the Gravel Borrow should have minimal content over 2.5" size (per 9-03.19). Final compliance and acceptance criteria for material use shall be at the discretion of the design engineer.
- As noted above, we recommend a stabilizing base layer of 6-inch minimum thick compacted structural fill below small utility structures (such as manholes and catch basins) to minimize localized settlement risk. Stabilizing base fills are not typically required below utility lines. However, if excessively poor / unsuitable soils are encountered at trench base depth,

conditions should be evaluated in construction to determine if local ground improvements are warranted.

- To limit potential future settlement of pavement sections above newly installed utilities, compact the pipe bedding zone material to not less than 95% of its maximum dry density. If a "self-compacting" material is used (such as pea gravel), the material should be well distributed and tamped as needed to achieve an unyielding condition before backfilling.
- For trench backfill below roadway pavements, it is preferable that the level of compaction achieved is at least 97% (no less than 95% standard minimum). However, the pipe manufacturer's specifications for compaction of materials adjacent and above the pipe should be observed to prevent possible damage to the pipe and any connections.

We recommend against using alternative soil densification measures such as jetting or flooding as a substitute for proper mechanical backfill compaction. Utility backfill and compaction procedures should adhere to the recommendations provided in this report for Structural Fill.

Where lateral thrust blocks are to be constructed to provide lateral pipe restraint, the concrete should be cast neat to undisturbed trench wall soils to ensure that adequate lateral load support is provided by the in-situ soils. Backfill placement for support of thrust blocks is not recommended.

Assumptions and Limitations

The depth and extent of explorations for this geotechnical evaluation was limited by reasonable feasibility constraints, available time and site access, and the approved scope of work. Exploration logs presented in this report represent the locations and dates of field work. Conditions may not be fully representative of areas of the site not explored, or other times of the year. A typical degree of natural variation should be anticipated for native subsurface conditions; greater variation is likely where previously altered conditions or uncontrolled fills are present. If conditions are found in construction that differ from those documented, Element Solutions should be contacted to provide additional review and consultation, and to reevaluate our recommendations if necessary.

We recommend a review of final project plans and specifications by Element Solutions to ensure that the intent of the recommendations provided is followed in design prior to the start of construction. If changes are made to the project scope that could impact the intent or applicability of the recommendations, Element Solutions should be contacted for additional review.

The groundwater levels reported on logs for the exploration date are valid only for the dates of observation. Fluctuation due to weather and seasonal influences is expected and was documented during subsequent monitoring. Groundwater level monitoring in wells installed has been completed over the 2022 calendar year as planned. During the monitoring period, the northern basin stormwater inlet was capped and diverted, resulting in a reduced system operation. Wells have been left in place at the time of this report. If needed, Element can extend our monitoring services and continue to monitor groundwater levels at the site on request.

References

Lapen, T.J., Geologic Map of the Bellingham 1:100,000 Quadrangle, Washington. Washington State Department of Natural Resources, Division of Geology and Earth Resources Open File Report 2000-5, December 2000.

Natural Resources Conservation Service, Web Soil Survey, U.S. Department of Agriculture. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Closure

Thank you for the opportunity to contribute our expertise to your project. Please feel free to contact us at (360) 671-9172 if you have any questions or comments regarding this report.

Sincerely,

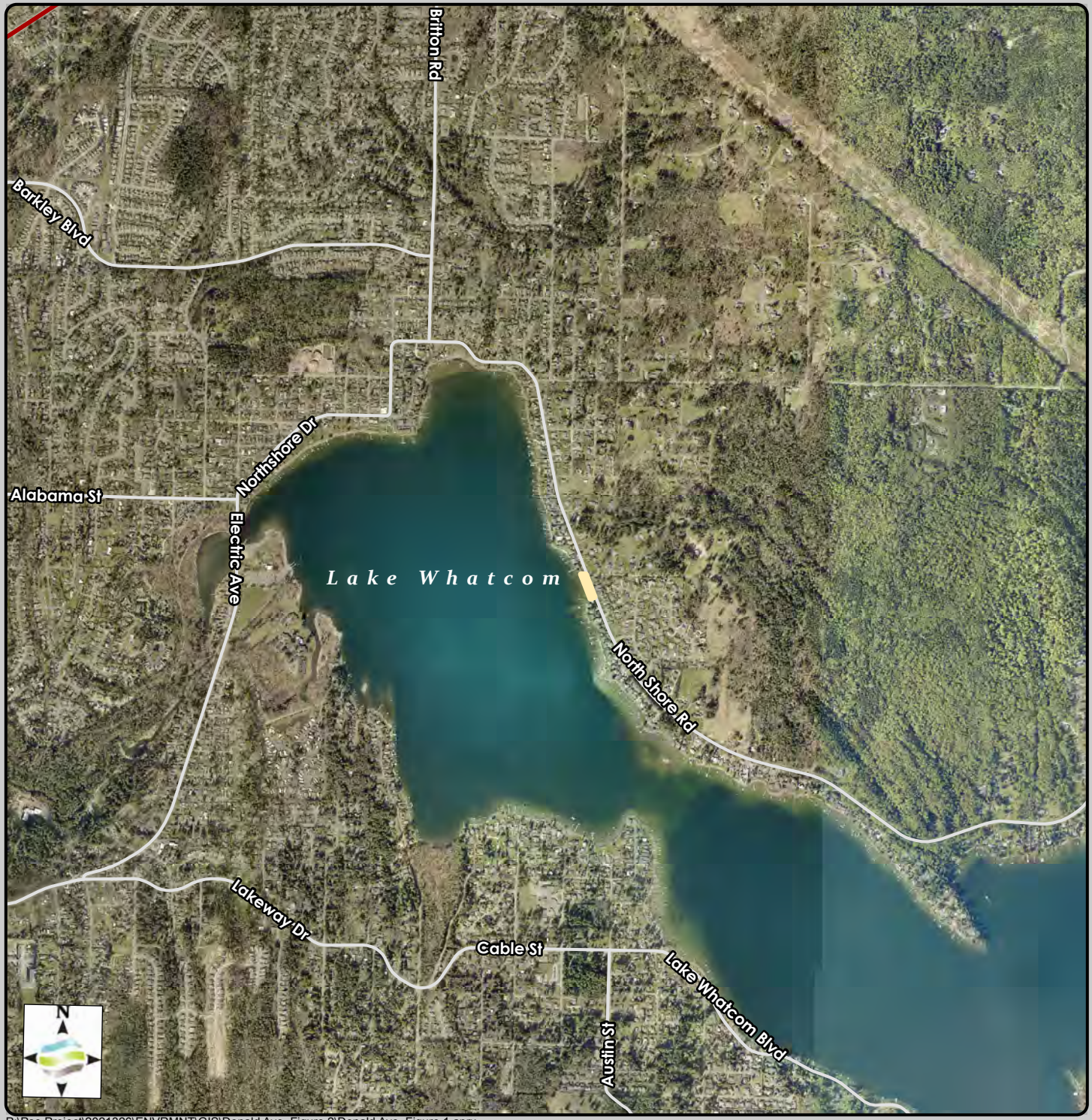
John Gillaspy, L.E.G.
Environmental Services Manager

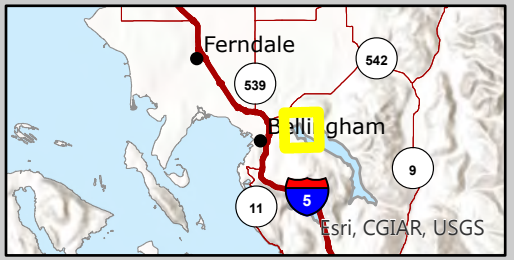
Kevin Quillan, L.G.
Senior Project Geologist

Statement of Limitations

Appendix I

1) Figure 1 – Site Location & Vicinity Map
2) Figure 2 – Aerial Photo Site Plan & Exploration Locations Map
3) Figure 3 – Survey Site Plan & Exploration Locations Map
4) Exhibit A – Field Photos (November 10, 2021 & February 8, 2022)
5) Exhibit B – Original Bioswale Construction Plans (City of Bellingham; 2005)





Data Credits:
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[Roads] COB 2018
[Imagery] Whatcom 2019

COB Parcel

1:24,000 Feet
0 1,000 2,000 4,000
1:24,000

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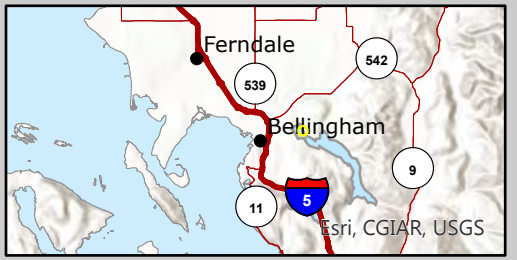
ELEMENT solutions

Figure 1

Donald Avenue Retrofit Project- 2021326
Targeted Geotech Evaluation
Site Vicinity Map

Date: 10/3/2022

P:\Pse Project\2021326\ENVRMNT\GIS\Donald Ave_Figure 2\Donald Ave_Figure 1.aprx



Data Credits:
[Parcels] Whatcom County 2018
[Roads] COB 2018
[Imagery] Whatcom 2019

COB Parcel
Well Locations
5-Foot Contour
1-Foot Contour

319.0' = ELEVATION FROM SITE PLANS

1:600
0 25 50 100 Feet
1:600

909 Squalicum Way, Ste 111
Bellingham, WA 98225
info@elementsolutions.org
Phone: 360. 671. 9172

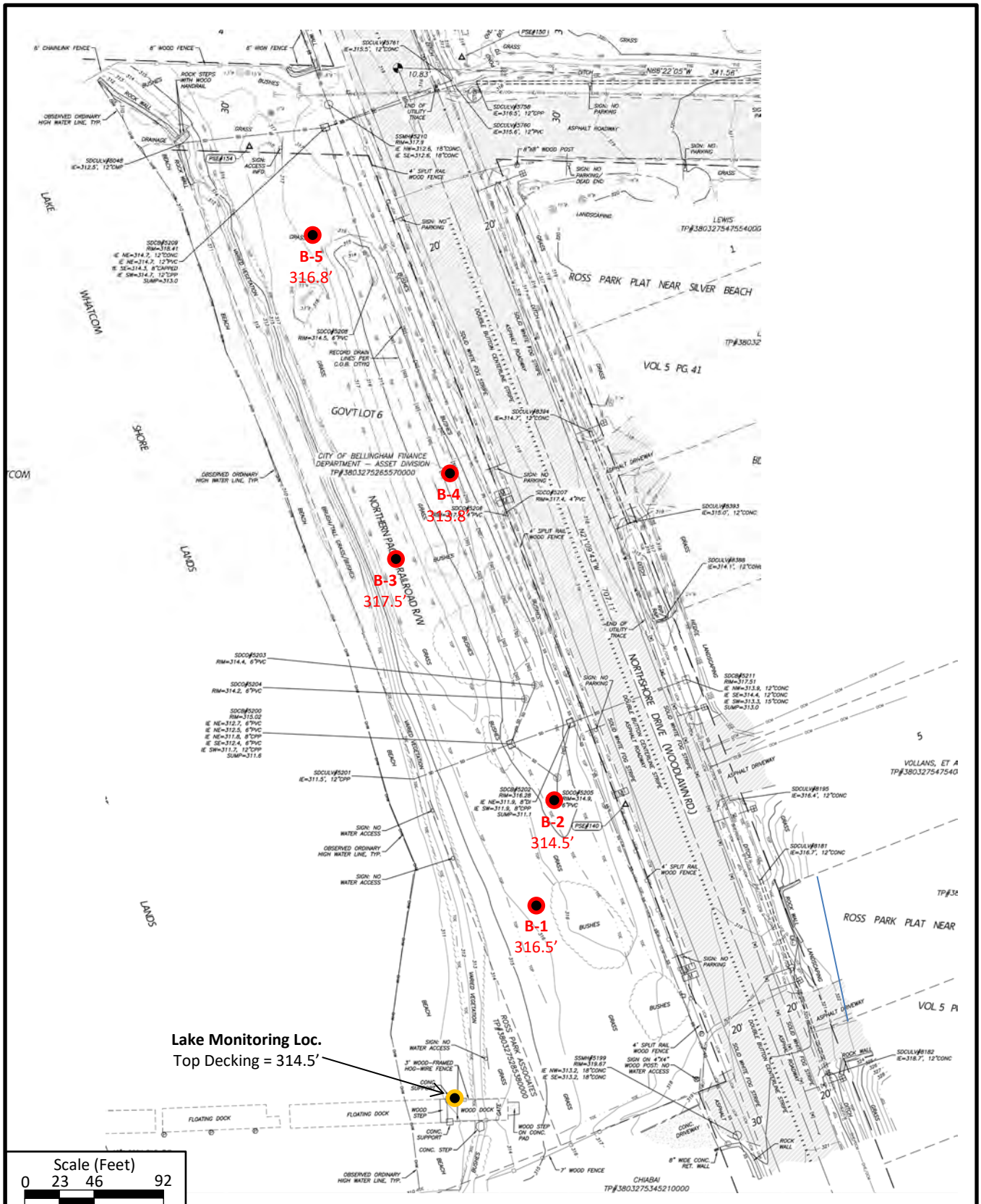
ELEMENT solutions

Figure 2

Donald Avenue Retrofit Project- 2021326
Targeted Geotech Evaluation
Aerial Photo & Exploration Location Map

Date: 10/14/2022

P:\Pse Project\2021326\ENVRMNT\GIS\Donald Ave_Figures\Donald Ave_Figure 2.aprx



Base Map: Topographic Survey
Drawn & Provided By: Pacific Surveying & Engineering, INC.
Modified By: Kevin Quillan – 10/17/2022
NOT INTENDED FOR CONSTRUCTION

ELEMENT solutions

Site Survey & Boring Locations

Donald Ave EV-44 Bio-Swale
Groundwater Monitoring

Figure
3

Exhibit A – November 10, 2021 & February 8, 2022 Field Photos

Photo 1: Subject site as viewed from the dock at south end of site. Note berm in foreground. (11-10-21)

Photo 2: View looking northeast towards south end of the existing bioswale. (11-10-21)

Photo 3: Conditions along the shoreline of Lake Whatcom within the site, looking North. (11-10-21)

Photo 4: Conditions at the south end of the existing bioswale feature, looking North. (11-10-21)

Photo 5: Conditions at the center of the existing bioswale feature, looking North. (11-10-21)

Photo 6: Conditions along the shoreline of Lake Whatcom within the site. (2-8-22)

Photo 7: Boring location B5 at the north end of the site with well casing installed. (2-8-22)

Photo 8: Conditons along the berm feature, looking South. (2-8-22)

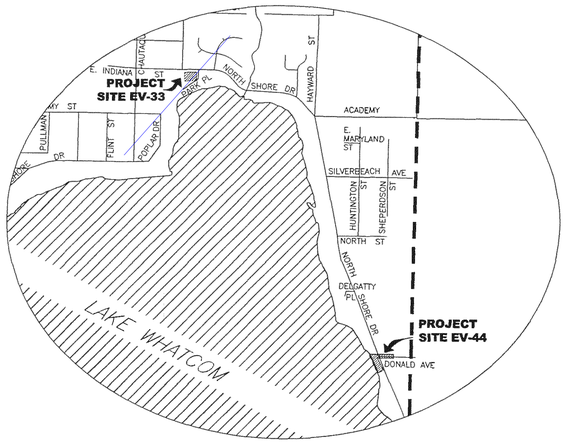
Photo 9: Conditions at boring location B1 at the south end of the berm feature, looking North. (2-8-22)

Photo 10: Conditions at boring location B2 within the southern poriton of the bioswale. (2-8-22)

LAKE WHATCOM WATER QUALITY PROJECTS-2005

CITY OF BELLINGHAM, WASHINGTON

~~EV-33~~ / EV-44



VICINITY MAP

GENERAL NOTES

ALL WORK SHALL CONFORM TO THE 2004 STANDARD PLANS AND SPECIFICATIONS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT), AND CITY OF BELLINGHAM STANDARDS UNLESS INDICATED OTHERWISE BY THE CONTRACT DOCUMENTS. IN CASE OF A CONFLICT BETWEEN THE REGULATORY STANDARDS OR SPECIFICATIONS, THE MORE STRINGENT REQUIREMENT WILL PREVAIL.

ALL TRENCH EXCAVATIONS CROSSING EXISTING PAVEMENT SHALL BE CONDUCTED IN ACCORDANCE WITH BELLINGHAM STANDARD PLAN ST-180

ALL TRENCH EXCAVATION SHALL BE ACCORDING TO SECTION 7-08 OF THE STANDARD SPECIFICATIONS.

THE BEDDING SHALL BE ACCORDING TO SECTION 7-08 OF THE STANDARD SPECIFICATIONS. THE BEDDING FOR PVC PIPE SHALL BE PEA GRAVEL, ACCORDING TO CITY OF BELLINGHAM STANDARD PLAN No. SS-750

ALL TRENCH BACKFILL UNDER EXISTING OR FUTURE PAVING SHALL BE BANK RUN GRAVEL FOR TRENCH BACKFILL AND SHALL BE COMPACTED TO 95% OF MAXIMUM DENSITY.

TRENCH EXCAVATIONS SHALL NOT BE LEFT OPEN OVERNIGHT.

CONNECT NEW CONSTRUCTION TO EXISTING AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

PLUG ALL CULVERTS, SEWERS, AND CONDUITS PRIOR TO ABANDONMENT.

ALL LAWN AND VEGETATED AREAS WILL BE RESTORED TO ORIGINAL CONDITION OR BETTER.

THIS PROJECT REQUIRES VARIOUS PERMITS AS OUTLINED IN THE SPECIFICATION GENERAL PROVISIONS. ALL WORK SHALL BE PERFORMED IN A MANNER TO ASSURE CONFORMANCE WITH THE PERMIT REQUIREMENTS.

THE CONTRACTOR SHALL ATTEND PRE-CONSTRUCTION CONFERENCE WITH THE CITY OF BELLINGHAM ENGINEERING DIVISION PRIOR TO BEGINNING CONSTRUCTION.

UNDERGROUND UTILITIES ARE KNOWN TO EXIST IN THE AREA OF CONSTRUCTION. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO CONTACT THE UTILITY OWNERS FOR LOCATIONS AND TO NOTIFY THE ENGINEER PROMPTLY OF ANY CONFLICT. THE ONE-CALL NUMBER FOR UNDERGROUND UTILITIES IS: 1-800-424-5555.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE INTEGRITY OF ADJACENT UTILITIES WHICH MAY INCLUDE, BUT ARE NOT LIMITED TO, WATER, SEWER, STORM SEWER, POWER, TELEPHONE, CABLE TV, GAS, IRRIGATION, AND STREET LIGHTING.

THE CONTRACTOR SHALL NOTIFY RESIDENTS AND BUSINESSES 48 HOURS IN ADVANCE OF ANY WORK AFFECTING ACCESS OR SERVICE AND SHALL MINIMIZE INTERRUPTIONS TO DRIVEWAYS FOR RESIDENTS AND BUSINESSES ADJACENT TO THE PROJECT.

PUBLIC RIGHTS-OF-WAY SHALL BE KEPT IN A CLEAN AND SERVICEABLE CONDITION AT ALL TIMES. IN THE EVENT MATERIALS ARE INADVERTENTLY DEPOSITED ON ROADWAYS, THE MATERIAL SHALL BE PROMPTLY REMOVED. MATERIALS ARE TO BE SWEPT AND REMOVED WITH A VACUUM SWEEPER. PUBLIC AND PRIVATE DRAINAGE WAYS SHALL BE PROTECTED FROM POLLUTION. NO MATERIAL IS TO BE DISCHARGED TO OR DEPOSITED IN STORMWATER SYSTEMS THAT MAY RESULT IN VIOLATION OF STATE OR FEDERAL WATER QUALITY STANDARDS.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTING, MAINTAINING, & REMOVING EROSION CONTROL MEASURES (SILT FENCE, ROCK CHECK DAMS, SILT PONDS, CATCH BASIN FILTERS, ETC.) THROUGHOUT THE DURATION OF THE PROJECT. ALL EROSION CONTROL WORK IS CONSIDERED INCIDENTAL TO THE ITEMS OF WORK IN THE CONTRACT FOR THIS PROJECT.

THE CITY OF BELLINGHAM WILL PROVIDE ALL CONSTRUCTION STAKING FOR THIS PROJECT.

STORM NOTES

BEDDING AND BACKFILL FOR PVC STORM MAIN PIPE SHALL CONFORM TO STANDARD PLAN No. SS-750.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING EROSION CONTROL MEASURES (SILT FENCE, ROCK CHECK DAMS, SILT PONDS, ETC., AS DIRECTED BY THE ENGINEER) THROUGHOUT THE DURATION OF THE PROJECT.

DURING CONSTRUCTION PLACE CB INSERTS UNDER ALL EXISTING AND PROPOSED CATCH BASIN GRATES WITHIN THE PROJECT SITE.

ALL CATCH BASINS WITHIN THE PROJECT LIMITS SHALL BE CLEANED OUT AT THE COMPLETION OF THE PROJECT AND ANY MATERIAL REMOVED SHALL BE PROPERLY DISPOSED OF. IN ADDITION, INLET PROTECTION MUST BE PROVIDED FOR ALL EXISTING CATCH BASINS DURING CONSTRUCTION. CB INSERTS OR ACCEPTABLE ALTERNATIVES CAN BE USED.

DURING ANY DITCH, CREEK & DRAINAGE WORK WATER SHALL BE DIVERTED AROUND THE PROJECT WITH A PUMP OR OTHER ADEQUATE METHOD APPROVED BY THE ENGINEER.

ANY MISCELLANEOUS DRAINAGE FOUND WILL BE REQUIRED TO BE REMOVED OR CONNECTED TO THE NEW DRAINAGE SYSTEM WITH THE DIRECTION OF THE ENGINEER.

A STORMWATER POLLUTION PREVENTION PLAN AND STORMWATER PERMIT APPLICATION (SWPPP) SHALL BE SUBMITTED BY THE CONTRACTOR. CONTRACTOR SHALL SUBMIT DETAILS ON CONSTRUCTION TIMING, HAUL ROUTES, CONSTRUCTION ENTRANCES AND GROUND STABILIZATION. THE SWPPP AND PERMIT SHALL BE REVIEWED AND APPROVED BY THE CITY PRIOR TO COMMENCEMENT OF WORK.

EROSION CONTROL NOTES

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE INSTALLATION, MAINTENANCE AND REMOVAL OF ALL EROSION CONTROL MEASURES (SILT FENCE, STRAW BALE DAMS, SILT PONDS, ETC., AS DIRECTED BY THE ENGINEER) THROUGHOUT THE DURATION OF THE PROJECT.

IN THE EVENT MATERIALS ARE INADVERTENTLY DEPOSITED ON ROADWAYS, THE MATERIAL SHALL BE PROMPTLY REMOVED. MATERIALS ARE TO BE SWEPT AND REMOVED PRIOR TO ANY STREET FLUSHING. PUBLIC AND PRIVATE DRAINAGE WAYS SHALL BE PROTECTED FROM POLLUTION. NO MATERIAL IS TO BE DISCHARGED OR DEPOSITED IN STORMWATER SYSTEMS THAT MAY RESULT IN VIOLATION OF STATE OR FEDERAL WATER QUALITY STANDARDS.

NO EARTHWORK, INCLUDING CLEANING OF VEGETATION, GRADING FILLING, EXCAVATION OR TRENCHING OF SOIL OR EARTH MATERIALS THAT WILL RESULT IN AN EXPOSED EARTH AREA THAT EXCEEDS 500 SQ.FT. SHALL BE PERMITTED FROM OCTOBER 1ST THROUGH APRIL 30TH.

STABILIZE SOILS- ALL EXPOSED AND UNWORKED SOILS SHALL BE STABILIZED BY APPLICATION OF EFFECTIVE BEST MANAGEMENT PRACTICES, THAT PROTECT THE SOIL FROM THE EROSIVE FORCES OF WATER & WIND EROSION. NO UNWORKED SOILS SHALL REMAIN EXPOSED FOR MORE THAN SEVEN (7) DAYS.

SAWCUTTING- SLURRY AND CUTTINGS SHALL BE VACUUMED DURING CUTTING AND SURFACING OPERATIONS. SLURRY AND CUTTINGS SHALL NOT REMAIN ON PAVEMENT OVERNIGHT.

AN EROSION CONTROL PLAN SHALL BE PROVIDED BY THE CONTRACTOR. THE PLAN WILL BE REVIEWED, APPROVED AND A PERMIT ISSUED BY THE CITY PRIOR TO COMMENCEMENT OF WORK. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING AND PAYING FOR PERMIT.

LEGEND

	EXISTING	PROPOSED
RIGHT OF WAY LINE		
PROPERTY LINE		
CENTER LINE		
WATER MAIN	W	
WATER SERVICE	W	
WATER VALVE		
FIRE HYDRANT		
SANITARY SEWER MAIN	S	
SANITARY SEWER SERVICE	S	
STORM SEWER MAIN	D	
STORM SEWER SERVICE	D	
SEWER MANHOLE		
STORM MANHOLE		
CATCH BASIN		
CULVERT		
DRAINAGE DITCH		
CREEK		
GAS MAIN	G	
GAS SERVICE	G	
UNDERGROUND TELEPHONE	T	
FIBER OPTIC LINE	FO	
MONUMENT		

	EXISTING	PROPOSED
UNDERGROUND POWER	P	
UTILITY POLE		
SIDEWALK		
CURB & GUTTER		
EDGE OF PAVEMENT		
EDGE OF GRAVEL/DIRT		
WHEELCHAIR RAMP		
BUILDING LINE		
TREE LINE		
FENCE LINE		
WALL LINE (ROCK)	OR	
WALL LINE		
SHRUBS		
TREES		
RIP RAP		
CATCH LINE		
JUNCTION BOX TYPE I		
LUMINAIRE		
SIGNAL POLE		
SILT FENCE		
SAND BAG CHECK DAM		

SHEET INDEX

7/27/05

EXPIRES: 3/4/06

SHEET 1 OF 4

EV-33 AND EV-44
LAKE WHATCOM WATER
QUALITY PROJECTS

FOR MORE INFORMATOIN CONTACT: BRIAN DEMPSEY, PROJECT ENGINEER, AT 676-6961

V0033-01

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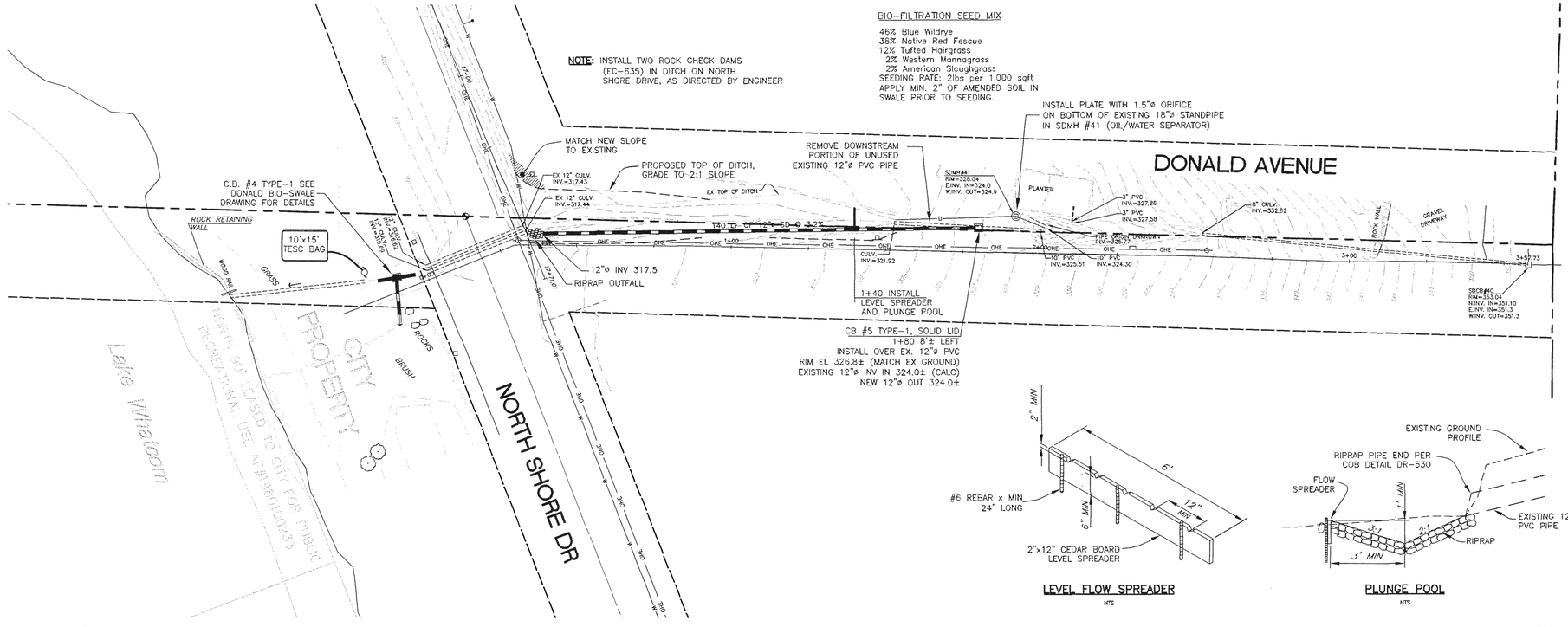
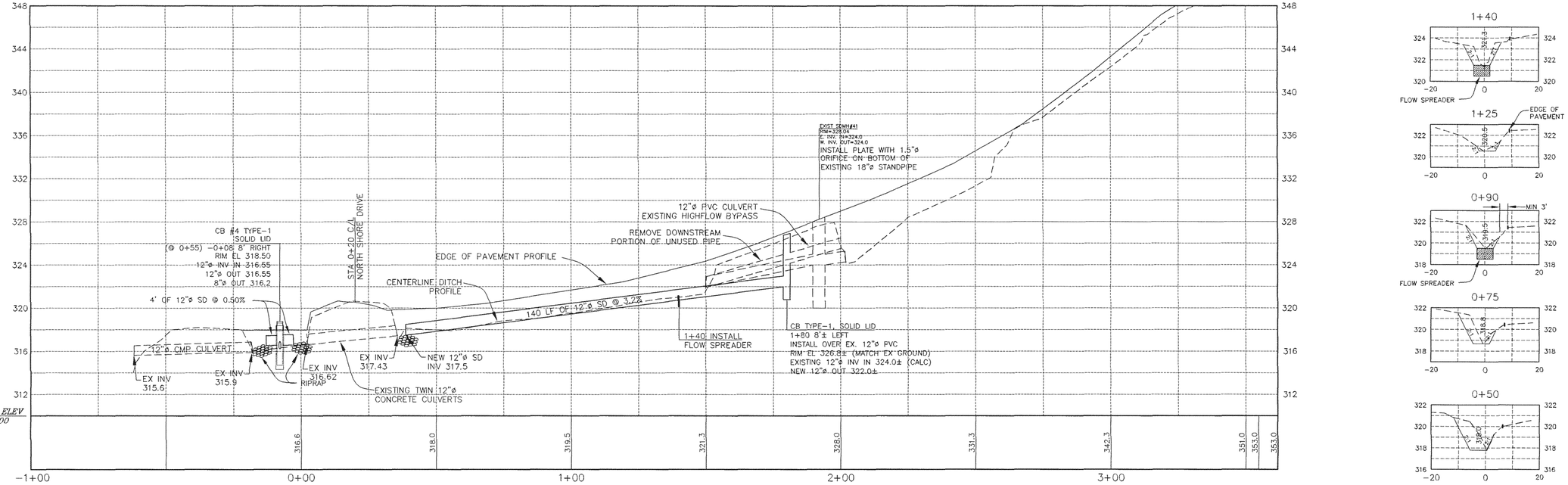




PROFILE DONALD AVENUE

	4			PROJECT ENGINEER BRD	DIR. PUBLIC WORKS R.E.M.	CITY OF BELLINGHAM, WASHINGTON	SCALE	DATUM	Job. No. EV0044	LAKE WHATCOM WATER QUALITY PROJECT - 2005	SHEET
	3			DESIGNED/DRAWN DFO	CITY ENGINEER R.A.R.	PUBLIC WORKS DEPARTMENT	Horiz. 1"=20'	CITY	Date 04/19/05	DONALD AVENUE - PLAN AND PROFILE EV-44	3 OF 4
	2			INSPECTOR	OPER. ENGINEER T.L.R.	ENGINEERING DIVISION	Vert. 1"=5'		Field Bk. 855-1		
	1										
Date	No	Revision	By								

CONTACT PERSON: BRIAN DEMPSEY , PROJECT ENGINEER AT 676-6961

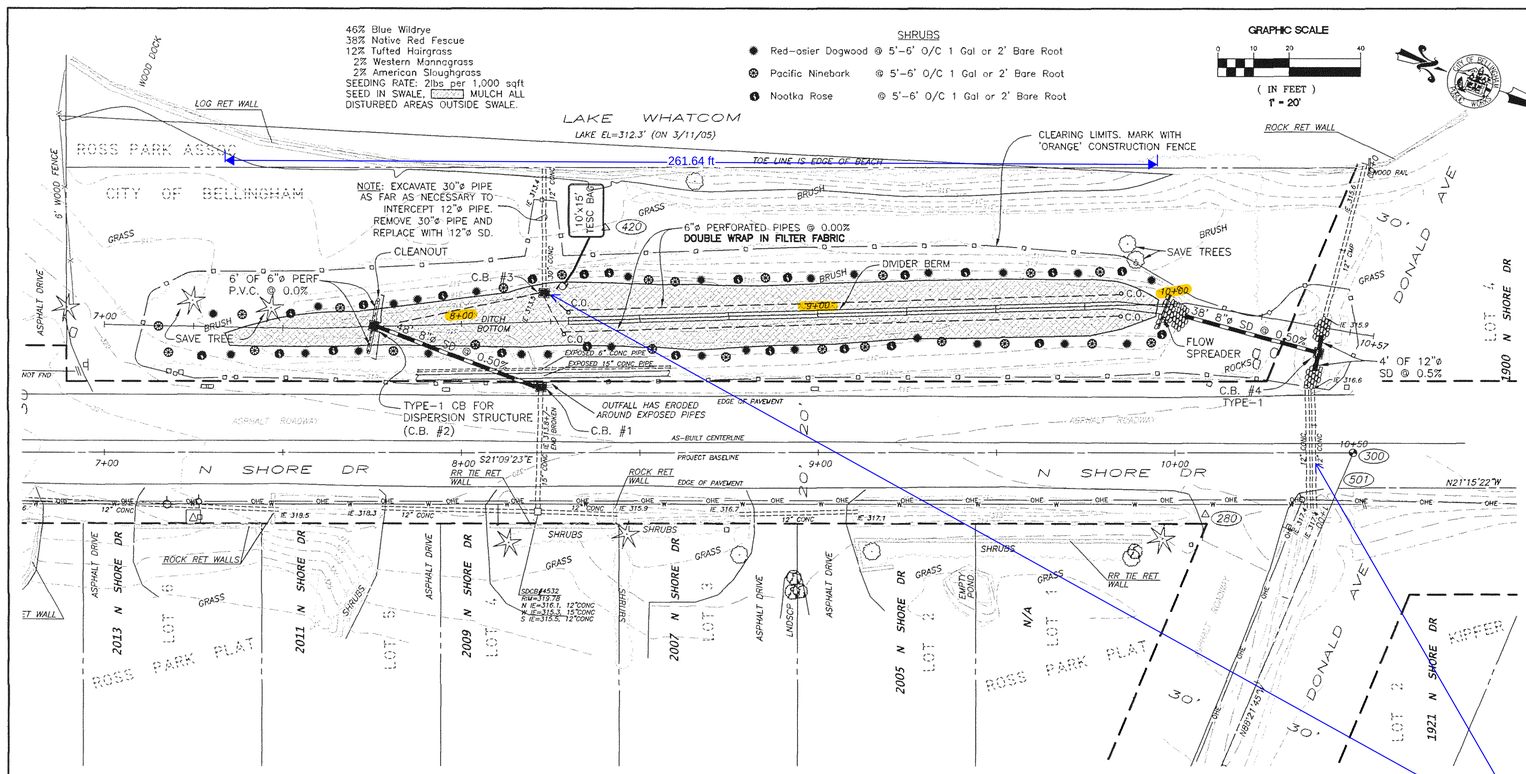
V0033-03

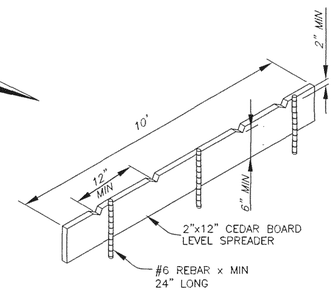
W:\Data\Land Desktop 2005\Projects\EV0044\eliel\Tidwg\SITE7_20X.dwg, DONALD BIOSWALE, 7/27/2005 12:30:56 PM

46% Blue Wildrye
38% Native Red Fescue
12% Tufted Hairgrass
2% Western Mannagrass
2% American Sloughgrass
SEEDING RATE: 2lbs per 1,000 sqft
SEED IN SWALE, [illegible] MULCH ALL DISTURBED AREAS OUTSIDE SWALE.

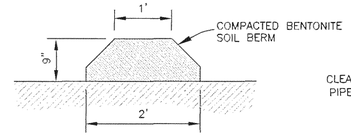
SHRUBS
- Red-osier Dogwood @ 5'-6' O/C 1 Gal or 2' Bare Root
- Pacific Ninebark @ 5'-6' O/C 1 Gal or 2' Bare Root
- Nootka Rose @ 5'-6' O/C 1 Gal or 2' Bare Root

GRAPHIC SCALE
0 10 20 40
(IN FEET)
1" = 20'

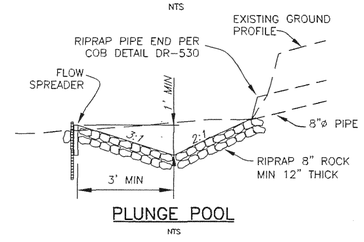




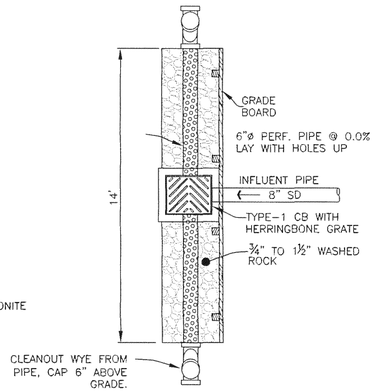
LEVEL SPREADER
NTS

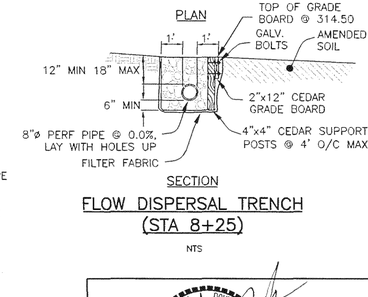


EARTH BERM DIVIDER
NTS



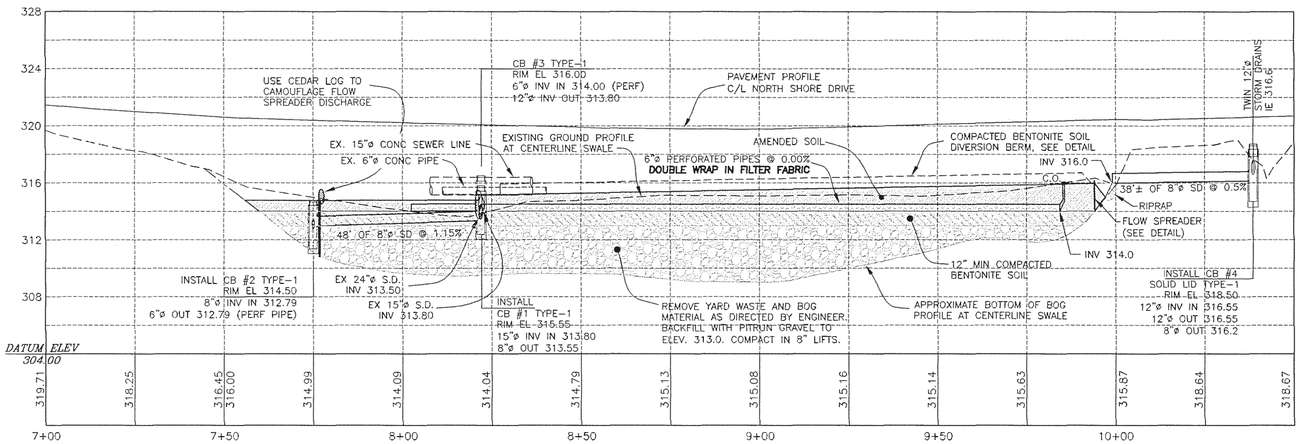
PLUNGE POOL
NTS



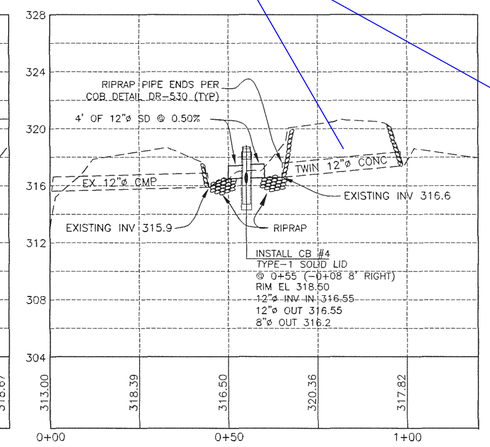


SECTION

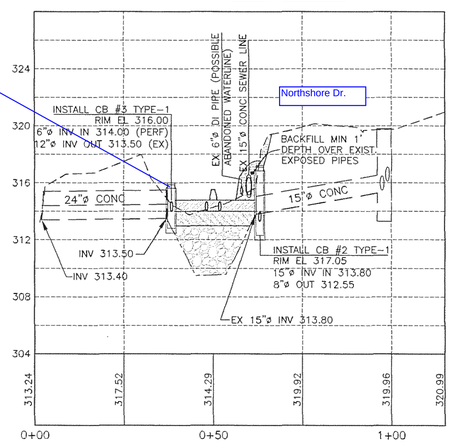
FLOW DISPERSAL TRENCH (STA 8+25)
NTS



SWALE PROFILE



DONALD OUTFALL



ROSS PARK OUTFALL

EXPIRES: 3/4/06

Date	No	Revision	By
	4		
	3		
	2		
	1		

PROJECT ENGINEER BRD
DESIGNED/DRAWN DFO
INSPECTOR

DIR. PUBLIC WORKS REM
CITY ENGINEER RAR
OPER. ENGINEER TLR

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. 1"=20'
Vert. 1"=5'

DATUM
CITY

Job. No. EV-0044
Date 4/5/05
Field Bk. FB#885-

LAKE WHATCOM WATER QUALITY PROJECT -2005
N SHORE DR and DONALD BIO-SWALE EV-44

SHEET 4 OF 4

CONTACT PERSON: BRIAN DEMPSEY, PROJECT ENGINEER AT 676-6961

V0033-04

Appendix II

1) Exploration Soil Logs & Well Construction Diagrams: B1 – B5 (February 8, 2022)

Element Solutions
909 Squalicum Way, Suite 111
Bellingham, WA 98225
Telephone: 360-671-9172

WELL NUMBER B-1

CLIENT City of Bellingham
PROJECT NAME Donald Avenue Retrofit Project
PROJECT NUMBER 2021326
PROJECT LOCATION Parcel #380327526557
DATE STARTED 2/8/22 **COMPLETED** 2/8/22
GROUND ELEVATION 316.5 ft **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Machine Auger
AT TIME OF DRILLING ---
LOGGED BY Kevin Quillan **CHECKED BY** John Gillaspy
AT END OF DRILLING 4.10 ft / Elev 312.40 ft
NOTES Standing H2O at 4.1' after 3 hours.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0.0					Casing Top Elev: 316.95 (ft) Casing Type: Drilled PVC
		SM		(SM) Organic-rich SILTY SAND WITH GRAVEL, damp, medium to dark brown, medium dense. **FILL**	
0.6					315.9
		SM		(SM) SILTY SAND, some gravel, damp to moist with depth, light brown, medium dense, some charcoal pieces. **FILL**	Bentonine Backfill
2.5					314.0
		SM		(SM) SILTY SAND, with clay, trace gravel, very moist to bet near base, light brown, medium dense, some charcoal. **Fill/Disturbed Native**	Pea Gravel Backfill
5.0					
6.0					310.5
		CL		(CL) SANDY LEAN CLAY to CLAYEY SAND, saturated, bluish green, soft. Organic-rich near surface (peat?). **NATIVE**	
7.5					309.0

Bottom of borehole at 7.5 feet.

Element Solutions
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Bellingham, WA 98225
Telephone: 360-671-9172

WELL NUMBER B-2

CLIENT City of Bellingham
PROJECT NAME Donald Avenue Retrofit Project
PROJECT NUMBER 2021326
PROJECT LOCATION Parcel #380327526557
DATE STARTED 2/8/22 **COMPLETED** 2/8/22
GROUND ELEVATION 314.5 ft **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Machine Auger
AT TIME OF DRILLING ---
LOGGED BY Kevin Quillan **CHECKED BY** John Gillaspy
AT END OF DRILLING 2.30 ft / Elev 312.20 ft
NOTES Standing H2O at 2.3' after 2.5 hours.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0.0					Casing Top Elev: 314.95 (ft) Casing Type: Drilled PVC
		SP		(SP) SAND, trace silt, some organics, damp, tan, loose. **TREATMENT SAND** **- Fabric at base.**	Bentonine Backfill
1.0					313.5
		GP		(GP) Clean, rounded GRAVEL, some coarse sand, gravel < 1.25", moist to saturated at 2.5', gray, medium dense to dense. **GRAVEL FILL**	Pea Gravel Backfill
2.5				▼ **-Terminated on obstruction.**	
3.0					311.5

Bottom of borehole at 3.0 feet.

Element Solutions
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Bellingham, WA 98225
Telephone: 360-671-9172

WELL NUMBER B-3

CLIENT City of Bellingham
PROJECT NAME Donald Avenue Retrofit Project
PROJECT NUMBER 2021326
PROJECT LOCATION Parcel #380327526557
DATE STARTED 2/8/22 **COMPLETED** 2/8/22
GROUND ELEVATION 317.5 ft **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Machine Auger
AT TIME OF DRILLING ---
LOGGED BY Kevin Quillan **CHECKED BY** John Gillaspy
AT END OF DRILLING 5.00 ft / Elev 312.50 ft
NOTES Standing H2O at 5.0' after 2 hours.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0.0		SP-SM		(SP-SM) Organic-rich SAND WITH GRAVEL AND SILT, damp, dark brown, medium dense.	Casing Top Elev: 317.95 (ft) Casing Type: Drilled PVC
0.6 (316.9)				**FILL**	
		GP		(GP) GRAVEL WITH SAND, some silt, rounded plutonic clasts and subangular phyllite clasts, damp, brown, dense, variable deposit.	Bentonine Backfill
				FILL	
2.5					
3.2 (314.3)					
		SM		(SM) SILTY SAND WITH GRAVEL, ~20% fines, very moist to wet at base, light brown, medium dense.	
				Fill/Disturbed Native	Pea Gravel Backfill
5.0				▼	
6.0 (311.5)					
		SC		(SC) CLAYEY SAND, saturated, bluish brown, medium stiff to soft.	
				NATIVE	
7.2 (310.3)					

Bottom of borehole at 7.2 feet.

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Telephone: 360-671-9172

WELL NUMBER B-4

CLIENT City of Bellingham
PROJECT NAME Donald Avenue Retrofit Project
PROJECT NUMBER 2021326
PROJECT LOCATION Parcel #380327526557
DATE STARTED 2/8/22 **COMPLETED** 2/8/22
GROUND ELEVATION 313.8 ft **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Machine Auger
AT TIME OF DRILLING ---
LOGGED BY Kevin Quillan **CHECKED BY** John Gillaspy
AT END OF DRILLING 1.50 ft / Elev 312.30 ft
NOTES Standing H2O at 1.5' after 1.5 hours.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0.0					Casing Top Elev: 314.25 (ft) Casing Type: Drilled PVC
		SP		(SP) SAND, trace silt, some organics, damp, tan, loose. **TREATMENT SAND**	Bentonine Backfill
0.8				313.0	
				- Fabric at base.	
		GP		(GP) Clean, rounded GRAVEL, some coarse sand, gravel < 1.25", moist to saturated at 2.5', gray, medium dense to dense. **GRAVEL FILL**	Pea Gravel Backfill
				-Terminated on obstruction.	
2.2				311.6	

Bottom of borehole at 2.2 feet.

Element Solutions
909 Squalicum Way, Suite 111
Bellingham, WA 98225
Telephone: 360-671-9172

WELL NUMBER B-5

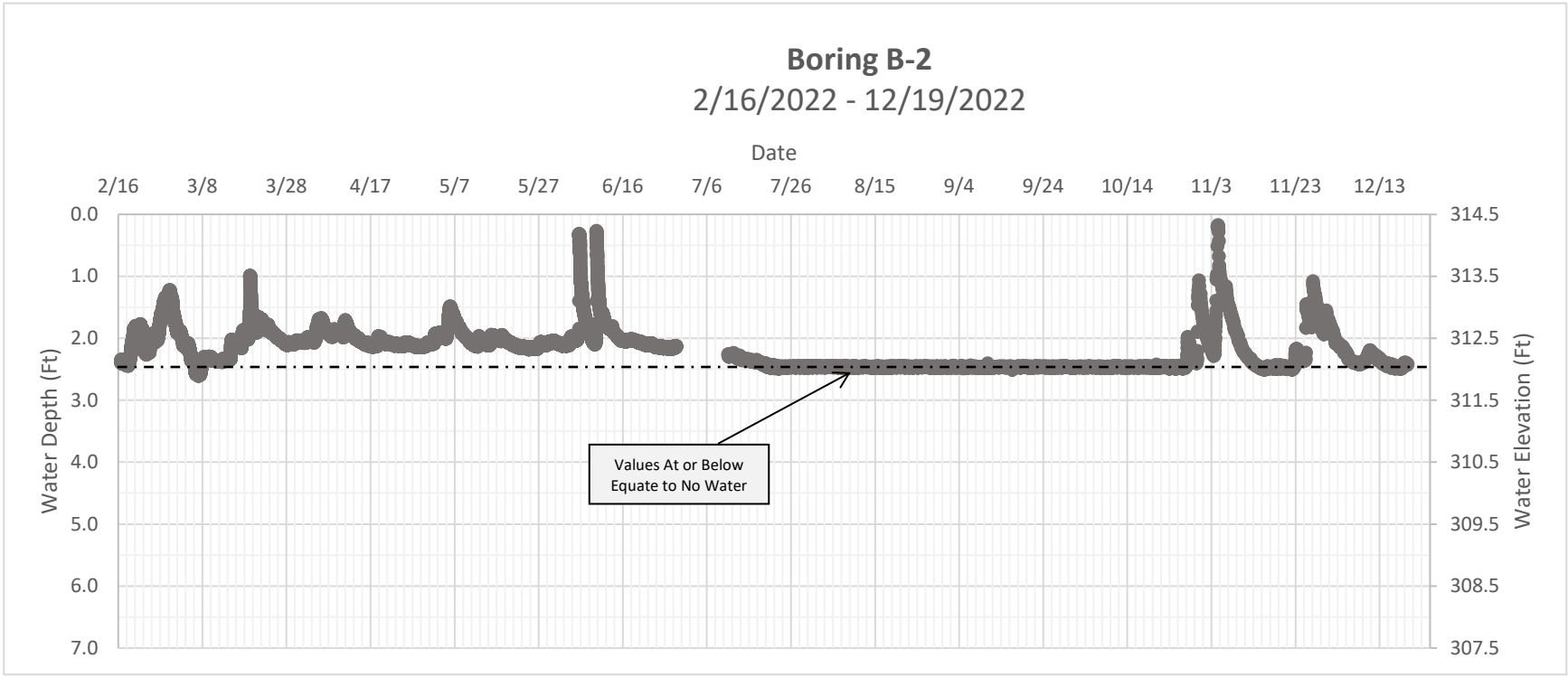
CLIENT City of Bellingham
PROJECT NAME Donald Avenue Retrofit Project
PROJECT NUMBER 2021326
PROJECT LOCATION Parcel #380327526557
DATE STARTED 2/8/22 **COMPLETED** 2/8/22
GROUND ELEVATION 316.8 ft **HOLE SIZE**
DRILLING CONTRACTOR
GROUND WATER LEVELS:
DRILLING METHOD Machine Auger
AT TIME OF DRILLING ---
LOGGED BY Kevin Quillan **CHECKED BY** John Gillaspy
AT END OF DRILLING 4.80 ft / Elev 312.00 ft
NOTES Standing H2O at 4.8' after 30 mins.
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0.0					Casing Top Elev: 317.25 (ft) Casing Type: Drilled PVC
		SP-SM		(SP-SM) Organic-rich SAND WITH SILT & GRAVEL, damp, dark brown, loose. **TOPSOIL**	
0.8					316.0
		SM		(SM) SILTY SAND WITH GRAVEL, some rounded cobbles, very moist, dark brown, dense. **FILL**	Bentonine Backfill
2.5					
3.0					313.8
		SM		(SM) SILTY SAND, some gravel, very moist to wet with depth, light brown, medium dense. **FILL**	Pea Gravel Backfill
5.0					
5.8					311.0
		SC		(SC) CLAYEY SAND to SANDY LEAN CLAY, wet, bluish brow, soft to medium stiff. **NATIVE**	
7.0					309.8

Bottom of borehole at 7.0 feet.

Appendix III

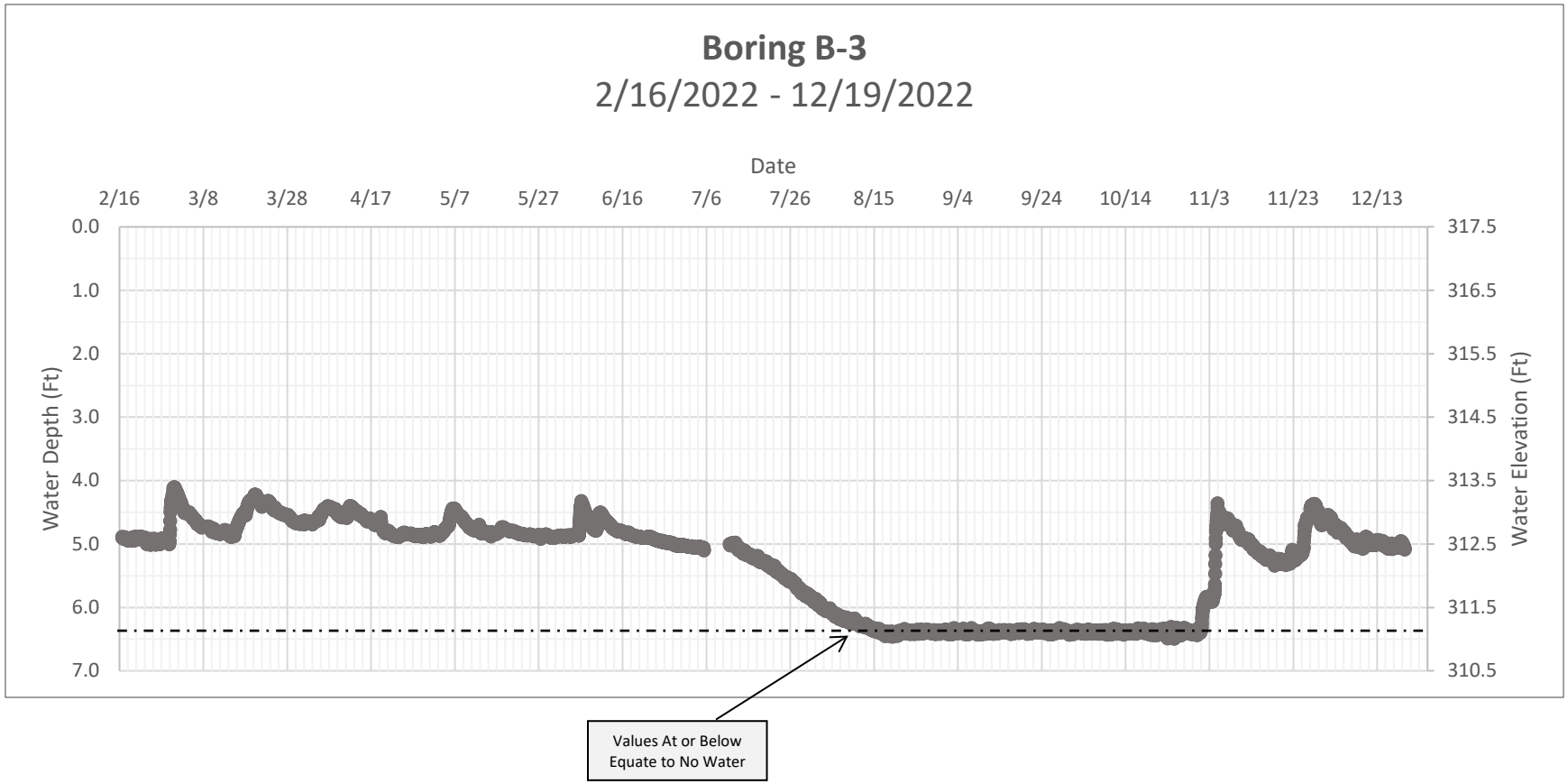
1) Figure 4 – B-2 Groundwater Monitoring Graphical Results (2/16/22 to 12/19/22)
2) Figure 5 – B-3 Groundwater Monitoring Graphical Results (2/16/22 to 12/19/22)
3) Figure 6 – B-4 Groundwater Monitoring Graphical Results (2/16/22 to 12/19/22)



Boring B-2 Groundwater Measurements

Donald Ave EV-44 Bio-Swale
Groundwater Monitoring

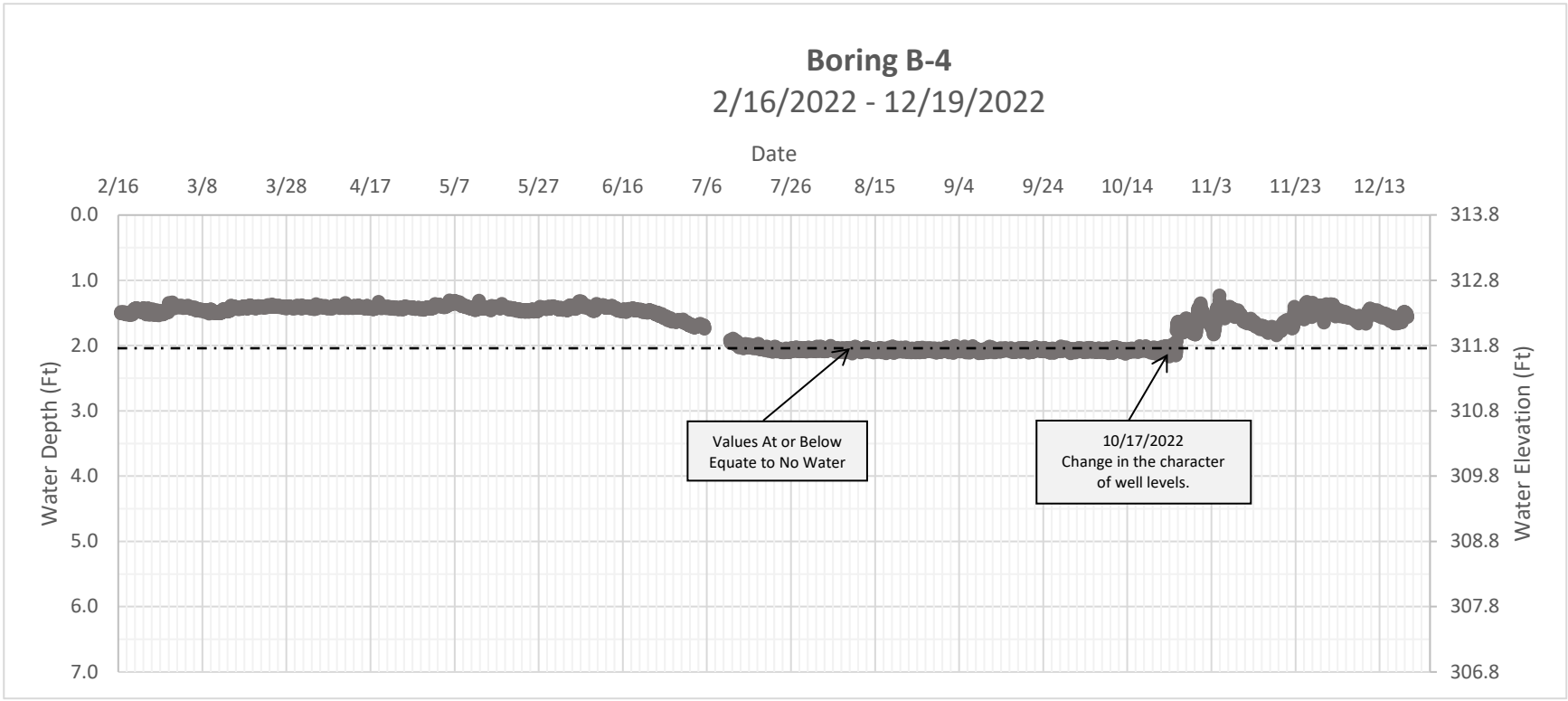
Figure 4



Boring B-3 Groundwater Measurements

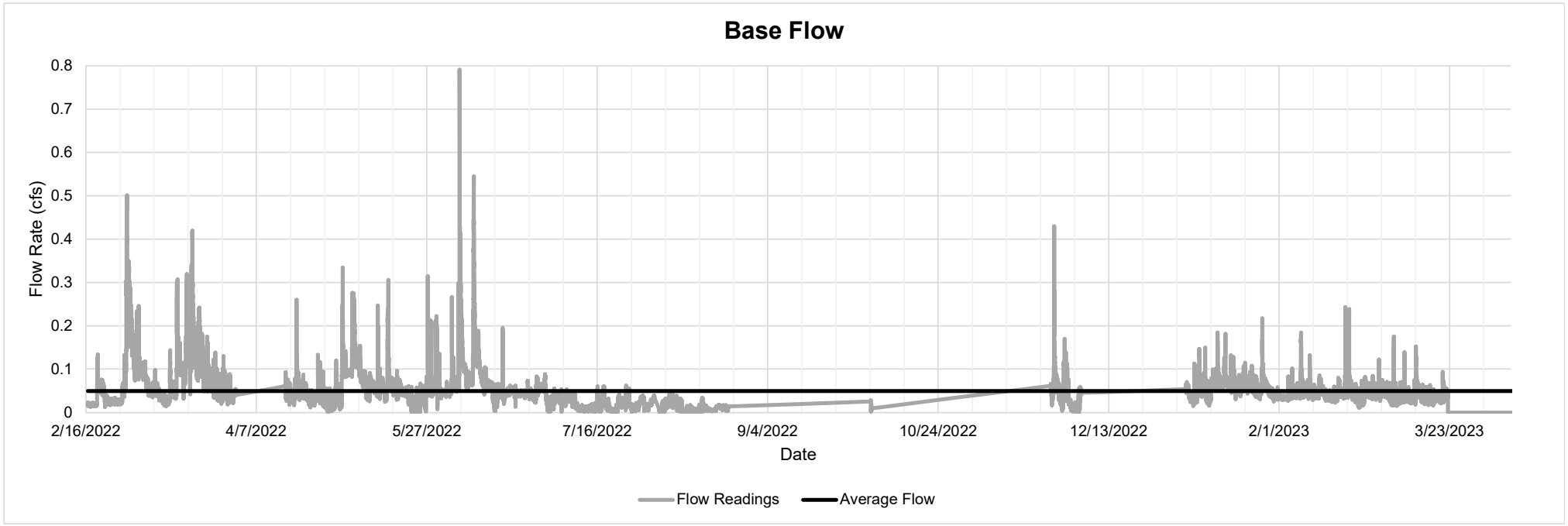
Donald Ave EV-44 Bio-Swale
Groundwater Monitoring

Figure 5



ELEMENT solutions	**Boring B-4 Groundwater Measurements** Donald Ave EV-44 Bio-Swale Groundwater Monitoring	Figure 6

APPENDIX D – BASE FLOW MONITORING RESULTS


Base Flow
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Flow Rate (cfs)
2/16/2022
4/7/2022
5/27/2022
7/16/2022
9/4/2022
10/24/2022
12/13/2022
2/1/2023
3/23/2023
Date
Flow Readings
Average Flow

APPENDIX E – CONCEPTUAL DESIGN PLANS

City of Bellingham WASHINGTON

PUBLIC WORKS DEPARTMENT, ENGINEERING DIVISION

FUNDED IN PART BY THE DEPARTMENT OF ECOLOGY State of Washington

GRANT #: WQC-2021-BELLPW-00018

DONALD AVENUE WATER QUALITY RETROFIT

CITY OF BELLINGHAM PROJECT #: EV-0171

PROJECT REPRESENTATIVES

CITY PROJECT ENGINEER:
JESSICA BENNETT, P.E.

CIVIL ENGINEER & LAND SURVEYOR:

PSE
Pacific Surveying & Engineering

GEOTECHNICAL ENGINEER

ELEMENT solutions

CITY OFFICIALS
MAYOR - SETH FLEETWOOD
PW DIRECTOR - ERIC JOHNSTON

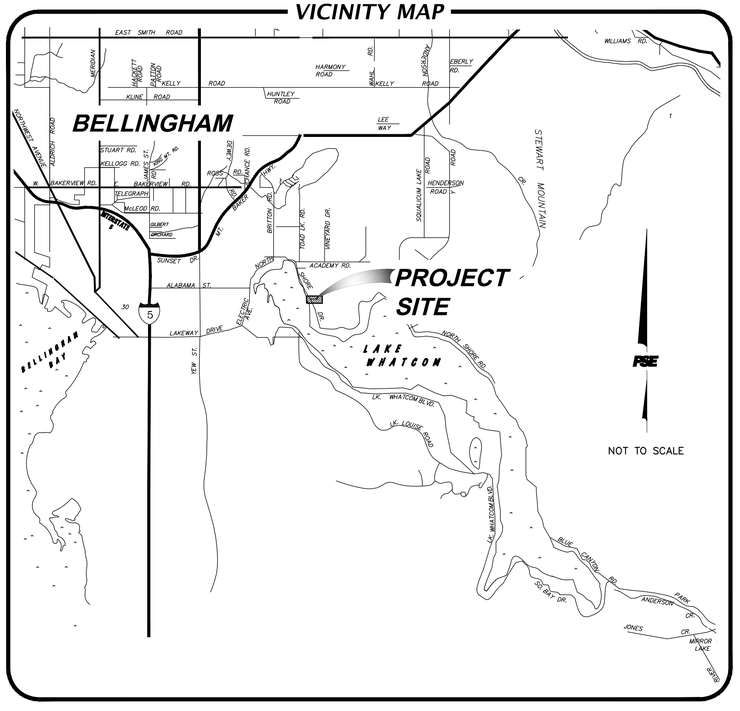
CITY COUNCIL
HANNAH STONE
HOLLIE HUTHMAN
DANIEL HAMMILL
EDWIN WILLIAMS
LISA ANDERSON
MICHAEL LILLIQUIST
KRISTINA MARTENS

CERTIFYING ENGINEER

IAN HINTON, P.E.
PACIFIC SURVEYING & ENGINEERING
360.671.7387

PRELIMINARY

VICINITY MAP



SHEET INDEX

NOTES

1. THE CITY OF BELLINGHAM'S TARGET ELEVATION FOR THE LAKE WHATCOM MAXIMUM WATER SURFACE ELEVATION IS CONSIDERED TO BE 314.50' (NGVD29) WHICH TRANSLATES TO 312.79' (NAVD88). WHATCOM COUNTY DECREE=314.94', CITY OF BELLINGHAM DECREE=313.23'. 314.94'–313.23'=1.71'. 314.50–1.71'=312.79'.

No	Date	Revision	By
4			
3			
2	6/12/23	60% Design	
1	1/17/23	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. N/A
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
COVER

SHEET 01 OF 14

EXISTING LINE AND SYMBOL LEGEND

= EXISTING ROADWAY CENTERLINE
= EXISTING EDGE OF ASPHALT
= EXISTING EDGE OF CONCRETE
= EXISTING CONCRETE PAD
= EXISTING BUTTON STRIPE
= EXISTING WHITE STRIPE
= EXISTING STORM CULVERT
SD = EXISTING STORM DRAIN LINE
[SD] = RECORD STORM DRAIN LINE
SS = EXISTING SANITARY SEWER GRAVITY LINE
[SS] = RECORD SANITARY SEWER LINE
W = EXISTING WATER LINE
[W] = RECORD WATER LINE
OHE = EXISTING OVERHEAD ELECTRIC LINES
[OHE] = RECORD OVERHEAD ELECTRIC LINES
OHE/OCM = EXISTING OVERHEAD ELECTRIC & COMMUNICATION LINES
UGE = EXISTING UNDERGROUND POWER
[UGE] = RECORD UNDERGROUND POWER
UTV = EXISTING UNDERGROUND TV CABLE LINE
[UTV] = RECORD UNDERGROUND TV CABLE LINE
OTV = EXISTING OVERHEAD TV CABLE LINE
[OTV] = RECORD OVERHEAD TV CABLE LINE
UCM = EXISTING UNDERGROUND COMMUNICATIONS LINE
[UCM] = RECORD UNDERGROUND COMMUNICATIONS LINE
OCM = EXISTING OVERHEAD COMMUNICATIONS LINE
[OCM] = RECORD OVERHEAD COMMUNICATIONS LINE
UPH = EXISTING UNDERGROUND TELEPHONE LINE
[UPH] = RECORD UNDERGROUND TELEPHONE LINE
OPH = EXISTING OVERHEAD TELEPHONE LINE
[OPH] = RECORD OVERHEAD TELEPHONE LINE
GUY = EXISTING OVERHEAD GUY WIRE LINE
G = EXISTING UNDERGROUND GAS LINE
[G] = RECORD UNDERGROUND GAS LINE
TOP = EXISTING TOP OF SLOPE LINE
TOE = EXISTING TOE OF SLOPE LINE
120 = EXISTING GRADE INDEX CONTOUR
118 = EXISTING GRADE INTERVAL CONTOUR
>> = EXISTING FLOW LINE
OHW = EXISTING ORDINARY HIGH WATER LINE
= EXISTING EDGE OF BRUSH
= EXISTING EDGE OF TREES
= EXISTING CHAINLINK FENCE
X = EXISTING BARBED WIRE FENCE
= EXISTING WOOD FENCE
= EXISTING ROCK FENCE
= EXISTING MONUMENT
= EXISTING REBAR AND CAP PLS#...
= SET REBAR & ORANGE PLASTIC CAP
= EXISTING STORM DRAIN MANHOLE
= EXISTING STORM DRAIN CLEANOUT
= EXISTING CATCH BASIN
= EXISTING SANITARY SEWER MANHOLE
= EXISTING WATER METER
IR = EXISTING IRRIGATION BOX
= EXISTING POST
STOP = EXISTING STOP SIGN
= EXISTING STREET SIGN
M = EXISTING MAILBOX
= EXISTING POWER POLE
drp = EXISTING POWER POLE W/DROP
= EXISTING GROUND GUY
= EXISTING FIBER-OPTIC/COMM. HANDHOLD
= EXISTING FIBER-OPTIC/COMM. PEDESTAL/RISER
= EXISTING ELECTRIC HANDHOLD
= EXISTING TELEPHONE PEDESTAL/RISER
= EXISTING CONIFEROUS TREE (GENERIC)
= EXISTING DECIDUOUS TREE (GENERIC)
= EXISTING BIRCH TREE
= EXISTING COTTONWOOD TREE
= EXISTING ASPEN/POPLAR TREE
= EXISTING WILLOW TREE
= EXISTING PINE/SPRUCE TREE
= EXISTING FIR TREE
= EXISTING LANDSCAPE TREE/UNKNOWN SPECIES TREE
= EXISTING FRUIT TREE
= EXISTING CEDAR TREE
= EXISTING ALDER TREE
= EXISTING MADRONA TREE
= EXISTING MAPLE TREE
= EXISTING HEMLOCK TREE
= EXISTING OAK TREE
= EXISTING BUSH
= EXISTING SHRUB
= EXISTING STUMP
15"ø = DIAMETER OF EXISTING TREE
+123.45 = SPOT ELEVATION ON EXISTING GROUND
= EXISTING ASPHALT SURFACING
= EXISTING CONCRETE SURFACING
= EXISTING GRAVEL SURFACING

PROPOSED LINE AND SYMBOL LEGEND

= PROPOSED EDGE OF ASPHALT
= PROPOSED EDGE OF GRAVEL ROAD
= PROPOSED SAWCUT LIMITS
= PROPOSED DITCH LINE
SD = PROPOSED STORM DRAIN LINE
TOP = PROPOSED TOP OF SLOPE LINE
= PROPOSED SLOPE DIRECTION ARROW
TOE = PROPOSED TOE OF SLOPE LINE
125 = PROPOSED FINISHED GRADE INDEX CONTOUR
124 = PROPOSED FINISHED GRADE INTERVAL CONTOUR
= PROPOSED WOOD FENCE
= PROPOSED STORM DRAIN MANHOLE
= PROPOSED STORM DRAIN CLEANOUT
= PROPOSED CATCH BASIN
STOP = PROPOSED STOP SIGN
= PROPOSED STREET SIGN
= PROPOSED BOLLARD
= PROPOSED ASPHALT SURFACING
1 = CONSTRUCTION KEY NOTE
123.45 FG = PROPOSED FINISHED GRADE ELEVATION
= PROPOSED TREE REMOVAL

ABBREVIATIONS

A.D.	ALGEBRAIC DIFFERENCE
A.F.#	AUDITOR'S FILE NUMBER
ACP	ASPHALT CONCRETE PAVING
ADA	AMERICAN DISABILITIES ACT
APPROX.	APPROXIMATE
APWA	AMERICAN PUBLIC WORKS ASSOCIATION
B/C	BACK OF CURB
BMP	BEST MANAGEMENT PRACTICE
BVCE	BEGINNING VERTICAL CURVE ELEVATION
BVCS	BEGINNING VERTICAL CURVE STATION
BW	BOTTOM OF WALL
C&G	CURB & GUTTER
CB	CATCH BASIN
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CONC.	CONCRETE
CPSSP	CORRUGATED POLYETHYLENE STORM SEWER PIPE
CSTC	CRUSHED SURFACING TOP COURSE
D.I.	DUCTILE IRON
DIA.	DIAMETER
EG	EXISTING GRADE
EL.	ELEVATION
EOP	EDGE OF PAVEMENT
EVCE	ENDING VERTICAL CURVE ELEVATION
EVCS	ENDING VERTICAL CURVE STATION
EX.	EXISTING
F&G	FRAME AND GRATE
F.HYD.	FIRE HYDRANT
F/C	FACE OF CURB
FF	FINISH FLOOR
FG	FINISH GRADE
FL	FLOWLINE
FS	FINISH SURFACE
GA.	GAUGE
GALV.	GALVANIZED
H.C.	HANDICAP
I.E.	INVERT ELEVATION
INV.	INVERT
K	RATE OF VERTICAL CURVATURE
LF	LINEAR FEET
LT	LEFT
MAX.	MAXIMUM
MIN.	MINIMUM
N.I.C.	NOT IN CONTRACT
NVPA	NATIVE VEGETATION PROTECTION AREA
O.C.	ON CENTER
OHWM	ORDINARY HIGH WATER MARK
PC	POINT OF CURVATURE
PCC	PORTLAND CEMENT CONCRETE
PERF.	PERFORATED
PROP.	PROPOSED
PT	POINT OF TANGENCY
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INFLECTION
R&C	RING & COVER
R/W	RIGHT OF WAY
R=	CURVE RADIUS
RT	RIGHT
S.S.	STAINLESS STEEL
S/W	SIDEWALK
SD	STORM DRAIN
SDCB	STORM DRAIN CATCH BASIN
SDMH	STORM DRAIN MANHOLE
SDR	STANDARD DIAMETER RATIO
SF	SQUARE FOOT
SPEC.	SPECIFICATION
SSCO	SANITARY SEWER CLEAN-OUT
SSMH	SANITARY SEWER MANHOLE
STA	STATION
STD	STANDARD
SVC	SERVICE
T/W	TOP OF WALL
TBOC	TOP BACK OF CURB
TC	TOP OF CURB
TF	TOP OF FOOTING
TP	TOP OF PIPE
TYP.	TYPICAL
VC	VERTICAL CURVE LENGTH
W/	WITH
WM	WATER METER
WSDOE	WASHINGTON STATE DEPT. OF ECOLOGY
WSDOT	WASHINGTON STATE DEPT. OF TRANSPORTATION

LEGAL DESCRIPTION

(PER CHICAGO TITLE SUBDIVISION GUARANTEE ORDER NO. 245421032)

ALL THAT PORTION OF GOVERNMENT LOT 5, SECTION 22, TOWNSHIP 37 NORTH, RANGE 4 EAST OF W.M., LYING SOUTHWESTERLY OF LAKE WHATCOM BOULEVARD.

ALSO ALL THAT PART OF THE NORTHWEST QUARTER OF THE NORTHWEST QUARTER OF SECTION 27, TOWNSHIP 37 NORTH, RANGE 4 EAST OF W.M., LYING SOUTHWESTERLY OF LAKE WHATCOM BOULEVARD.

ALSO THE SOUTHWEST QUARTER OF THE NORTHWEST QUARTER; THE EAST HALF OF THE NORTHWEST QUARTER, EXCEPT THAT PART CONVEYED TO W A LESLIE BY DEED RECORDED IN VOLUME 237 OF DEEDS, PAGE 332, AND EXCEPT THAT PART LYING NORTHEASTERLY OF LAKE WHATCOM BOULEVARD, IN SECTION 27, TOWNSHIP 37 NORTH, RANGE 4 EAST OF THE WILLAMETTE MERIDIAN.

EXCEPT THAT PORTION CONVEYED TO WHATCOM COUNTY FOR COUNTY ROAD, AS DESCRIBED UNDER WHATCOM COUNTY AUDITOR'S FILE NO. 926898.

LESS ROADS.

SITUATE IN WHATCOM COUNTY, WASHINGTON.

NOTE

CONTRACTOR SHALL TAKE NECESSARY PRECAUTIONS TO LOCATE AND PROTECT ALL EXISTING SURVEY MONUMENTS, WHICH INCLUDES PROPERTY CORNERS, DURING CONSTRUCTIONS. ALL SURVEY MONUMENTS THAT MAY BE DISTURBED BY CONSTRUCTION SHALL BE IDENTIFIED AND REPLACED IN ACCORDANCE WITH RECOGNIZED SURVEYING PRACTICES BY A WASHINGTON STATE LICENSED LAND SURVEYOR PROVIDED BY THE CONTRACTOR.

IAN DWIGHT HAMILTON — STATE OF WASHINGTON — 48169 — REGISTERED PROFESSIONAL ENGINEER

PRELIMINARY

Date	No	Revision	By
	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. N/A
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
LEGEND & ABBREVIATIONS

SHEET 02 OF 14

PLACEHOLDER

	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	
Date	No	Revision	By

PROJECT ENGINEER _____
DESIGNED/DRAWN _____
INSPECTOR _____

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. N/A
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
SURVEY CONTROL

SHEET 03 OF 14

PLACEHOLDER

PRELIMINARY

	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	
Date	No	Revision	By

PROJECT ENGINEER _____
DESIGNED/DRAWN _____
INSPECTOR _____

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. N/A
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
TRAFFC CONTROL

SHEET 04 OF 14

GRAPHIC SCALE
(US SURVEY FEET)
0 20
20 10 40
1 inch = 20 feet

TOPO NOTES:

1) THIS TOPOGRAPHIC SURVEY WAS PERFORMED AND PREPARED IN ACCORDANCE WITH WAC 332-130-145.

2) DATA FOR THIS SURVEY WAS GATHERED BY FIELD TRAVERSE UTILIZING ELECTRONIC DATA COLLECTION IN JANUARY & FEBRUARY 2022.

3) EQUIPMENT USED: THEOMAT 00'01.5"
EDM: ± 2 PPM, ± 3 MM

4) HORIZONTAL DATUM: NAD 83/98 WASHINGTON STATE PLANE NORTH ZONE PER CITY OF BELLINGHAM 2005 HORIZONTAL CONTROL NETWORK.

5) VERTICAL DATUM: NAVD88 PER CITY OF BELLINGHAM PUBLISHED BENCHMARKS.

SITE BENCH MARK: PSE CONTROL ON-SITE, AS SHOWN

6) CONTOURS DEPICTED HEREON MEET OR EXCEED NATIONAL MAPPING STANDARDS FOR 1-FOOT ACCURACY TOPOGRAPHIC SURVEYS AND HAVE BEEN COMPUTER GENERATED FROM GROUND FIELD TOPOGRAPHY GATHERED FOR THIS SURVEY UTILIZING ELECTRONIC DATA COLLECTION.

7) CONDUCTIBLE UNDERGROUND UTILITY LOCATES SERVICES WERE PERFORMED AND PAINTED ON-SITE BY WASHINGTON STATE ONE-CALL UTILITY LOCATE SERVICES AND SURVEYED BY PSE FIELD CREWS IN FEBRUARY 2022. UTILITIES ARE KNOWN TO EXIST WITHIN THE LIMITS OF THIS SURVEY THAT WERE UNDETECTABLE. ADDITIONAL UTILITY VERIFICATION MAY BE WARRANTED IN AREAS CONSIDERED FOR CONSTRUCTION.

8) UTILITY LOCATION AREAS AND LEVEL OF LOCATE ACCURACY WERE DETERMINED BY SURVEYOR AND CLIENT PRIOR TO COMMENCEMENT OF FIELD SURVEY WORK.

9) THIS MAP IS NOT INTENDED TO REPRESENT A FORMAL BOUNDARY SURVEY, NOR DOES IT REFLECT ELEMENTS THAT A BOUNDARY SURVEY MAY DISCLOSE. BOUNDARY RELATED ELEMENTS DEPICTED HEREON ARE SHOWN PER AVAILABLE RECORD INFORMATION.

10) A CURRENT TITLE REPORT WAS NOT PROVIDED FOR THIS SURVEY. EASEMENTS AND/OR TITLE ENCUMBRANCES MAY EXIST THAT ARE NOT SHOWN HEREON.

PRIMARY SURVEY CONTROL TABLE

POINT NO.	NORTHING	EASTING	ELEVATION	DESCRIPTION
120	645143.1848	1262725.7196	328.55	SET NAIL & FLASHER
130	645525.2561	1262604.7422	326.06	SET #4 REBAR & ORANGE PLASTIC CAP
140	645809.8741	1262461.5843	317.80	SET #4 REBAR & ORANGE PLASTIC CAP
150	646063.1327	1262405.8485	318.94	SET #4 REBAR & ORANGE PLASTIC CAP
154	646032.8915	1262333.8115	317.02	SET #4 REBAR & ORANGE PLASTIC CAP
160	646042.9233	1262677.0744	342.29	SET MAG NAIL
170	646584.1677	1262165.5241	330.53	SET #4 REBAR & ORANGE PLASTIC CAP

Date	No	Revision	By
	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. 1"=20'
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
EXISTING CONDITIONS

SHEET 05 OF 14

IAN DWIGHT HUDSON
STATE OF WASHINGTON
48169
REGISTERED
PROFESSIONAL ENGINEER
PRELIMINARY

CITY OF BELLINGHAM WASHINGTON

GRAPHIC SCALE
(US SURVEY FEET)
0 20
20 10 40
1 inch = 20 feet

INSTALL:
420 LF HIGH VISIBILITY
SILT FENCE PER DETAIL

EX. FEMA 100-YR WATER
SURFACE ELEVATION
EL.=313.14

SUMMER TARGET WATER
SURFACE ELEVATION
EL.=312.80

INSTALL:
10 LF OF WOODEN
SPLIT RAIL FENCE

INSTALL:
163 LF OF WOODEN
SPLIT RAIL FENCE

INSTALL:
100 LF OF WOODEN
SPLIT RAIL FENCE

INSTALL:
17 LF OF WOODEN
SPLIT RAIL FENCE

NORTHERN PACIFIC RAILROAD R/W

NORTHSHORE DRIVE (WOODLAWN RD.)

100' OHWM SETBACK

200' OHWM SETBACK

ROSS PARK PLAT NEAR SILVER BEACH ON LAKE WHATCOM

CREWS SHORT PLAT VOL. 1 PG. 105

VANDERYACHT SHORT PLAT AMD. VOL. 16 PG. 66

VOL. 5 PG. 41

BLOCK 1

VACATED ALLEY ORD. 5900

AF NO. 1601698

EROSION CONTROL LEGEND

- PROPOSED CLEARING/GRUBBING LIMITS
- INSTALL CONSTRUCTION FENCING
- INSTALL SILT FENCING
- SHALLOW GRASS-LINED SWALE (OVERFLOW CONVEYANCE FLOWPATH) WITH CHECK DAMS MAX. 50 LF ON-CENTER)
- DRAINAGE FLOW DIRECTION ARROWS (SHEET FLOW OR SHALLOW CHANNEL FLOW)
- PROPOSED GRADING TOP OF SLOPE LINE
- PROPOSED SLOPE GRADE SYMBOL
- PROPOSED GRADING TOE OF SLOPE LINE

VG	WSDOE BMP C101 & C102 PRESERVING NATURAL VEGETATION (C101) & BUFFER ZONES (C102)	ID	WSDOE BMP C200 INTERCEPTOR DIKE/SWALE
CF	WSDOE BMP C103 HIGH VISIBILITY CONSTRUCTION FENCING	GC	WSDOE BMP C201 GRASS-LINED CHANNELS
CE	WSDOE BMP C105 STABILIZED CONSTRUCTION ENTRANCE	CL	WSDOE BMP C202 CHANNEL LINING
WW	WSDOE BMP C106 WHEEL WASH	WB	WSDOE BMP C203 WATER BARS
CS	WSDOE BMP C107 CONSTRUCTION STAGING AREA	PSD	WSDOE BMP C204 PIPE SLOPE DRAINS
PS	WSDOE BMP C120 TEMPORARY AND PERMANENT SEEDING	SSD	WSDOE BMP C205 SUBSURFACE DRAINS
MU	WSDOE BMP C121 MULCHING	LS	WSDOE BMP C206 LEVEL SPREADER
NB	WSDOE BMP C122 NETS AND BLANKETS	CD	WSDOE BMPs C207 or C208 TRIANGULAR SILT DIKE OR GRAVEL CHECK DAM (MAX. 50 LF ON CENTER)
PC	WSDOE BMP C123 PLASTIC COVERING	OP	WSDOE BMP C209 ROCK LINING OUTLET PROTECTION
SD	WSDOE BMP C124 SODDING	IP	WSDOE BMP C220 STORM DRAIN INLET PROTECTION
TS	WSDOE BMP C125 TOPSOILING	BB	WSDOE BMP C231 BRUSH BARRIER
PAM	WSDOE BMP C126 POLYACRYLAMIDE (PAM) FOR SOIL EROSION PROTECTION	GB	WSDOE BMP C232 GRAVEL FILTER BERM
SR	WSDOE BMP C130 SURFACE ROUGHING	SF	WSDOE BMP C233 SILT FENCE
GT	WSDOE BMP C131 GRADIENT TERRACES	VS	WSDOE BMP C234 VEGETATED STRIP
DC	WSDOE BMP C140 DUST CONTROL	SW	WSDOE BMP C235 STRAW WATTLES
MH	WSDOE BMP C150 MATERIALS ON HAND	VF	WSDOE BMP C236 VEGETATIVE FILTRATION
CH	WSDOE BMP C151 CONCRETE HANDLING	TST	WSDOE BMP C240 TEMPORARY SEDIMENT TRAP
SC	WSDOE BMP C152 SAWCUTTING AND SURFACING POLLUTION PREVENTION	TSP	WSDOE BMP C241 TEMPORARY SEDIMENT POND
DSC	WSDOE BMP C153 MATERIAL DELIVERY, STORAGE AND CONTAINMENT	CCT	WSDOE BMP C250 CONSTRUCTION STORMWATER CHEMICAL TREATMENT
CW	WSDOE BMP C154 CONCRETE WASHOUT AREA	CSF	WSDOE BMP C251 CONSTRUCTION STORMWATER FILTRATION
ESL	WSDOE BMP C160 CERTIFIED EROSION AND SEDIMENT CONTROL LEAD	PHN	WSDOE BMP C252 HIGH PH NEUTRALIZATION USING CO2
S	WSDOE BMP C161 SCHEDULING	PHC	WSDOE BMP C253 PH CONTROL FOR HIGH PH WATER

SEE STORM WATER MANAGEMENT REPORT FOR DETAILS

IAN DWIGHT HAMILTON
STATE OF WASHINGTON
18169
REGISTERED
PROFESSIONAL ENGINEER

PRELIMINARY

Date	No	Revision	By
	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. 1"=20'
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
TESC PLAN

SHEET 06 OF 14

GRAPHIC SCALE
(US SURVEY FEET)
0 20
20 10 40
1 inch = 20 feet

EX. FEMA 100-YR WATER SURFACE ELEVATION EL.=313.14
SUMMER TARGET WATER SURFACE ELEVATION EL.=312.80
NORTHERN PACIFIC RAILROAD R/W
GOVT LOT 6
CROWS SHORT PLAT VOL. 1 PG. 105
VANDERYACHT SHORT PLAT AM. VOL. 16 PG. 66
NORTHSHORE DRIVE (WOODLAWN RD.)
DONALD AVENUE
HINDS TP#380322543011000
KNUDSON, ET AL TP#380322559010000
200' OHWM SETBACK
100' OHWM SETBACK
MATCH LINE SAME SHEET
(PRESERVE)
(REMOVE)
(RELOCATE)
PRESERVE EX. MAILBOXES & STREET SIGN
PRESERVE EX. MAILBOX
REMOVE EX. WOOD FENCE
REMOVE & RELOCATE EX. MAILBOXES & STREET SIGN
PRESERVE EX. STREET SIGN
RELOCATE EX. TEL PED, (BY OTHERS)
PRESERVE EX. CULVERTS
PRESERVE EX. TEL PED
REMOVE & REINSTALL EX. ACCESS INFO. SIGN
REMOVE & REINSTALL EX. STOP SIGN
PRESERVE EX. MAILBOX

PRELIMINARY
IAN DWIGHT HAYDON
STATE OF WASHINGTON
48169
REGISTERED PROFESSIONAL ENGINEER

Date	No	Revision	By
	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

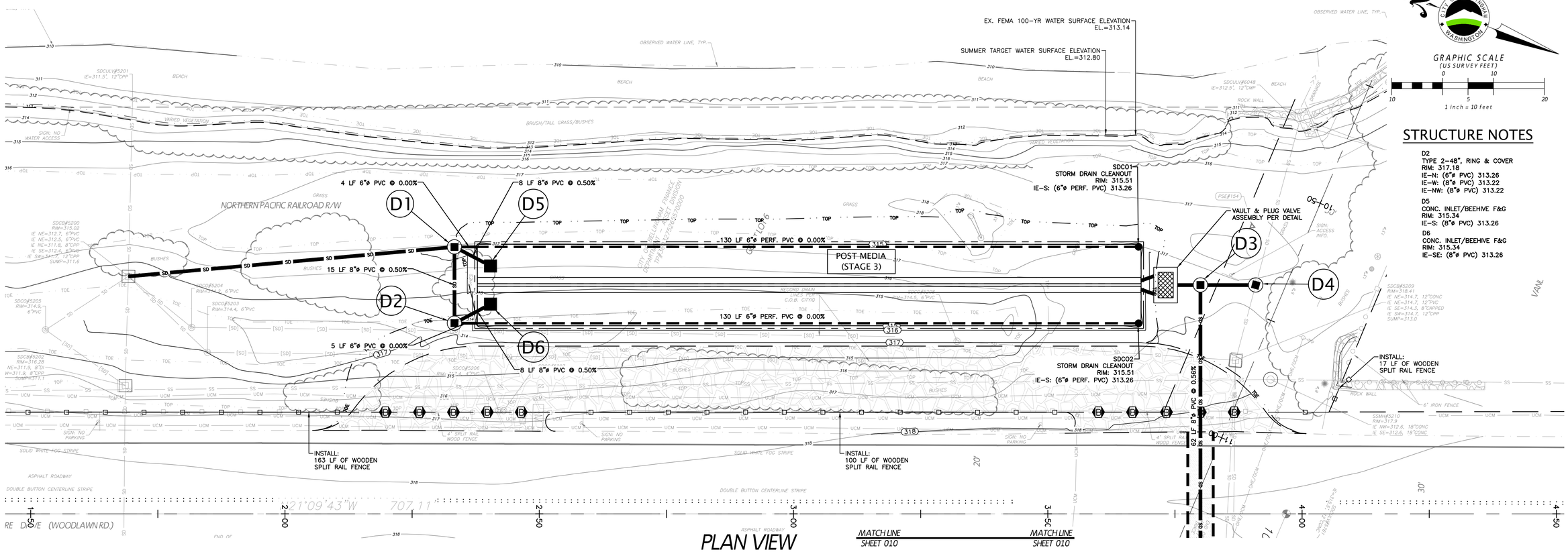
SCALE
Horiz. 1"=20'
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
DEMOLITION PLAN

SHEET 07 OF 14



Date	No	Revision	By
	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

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CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

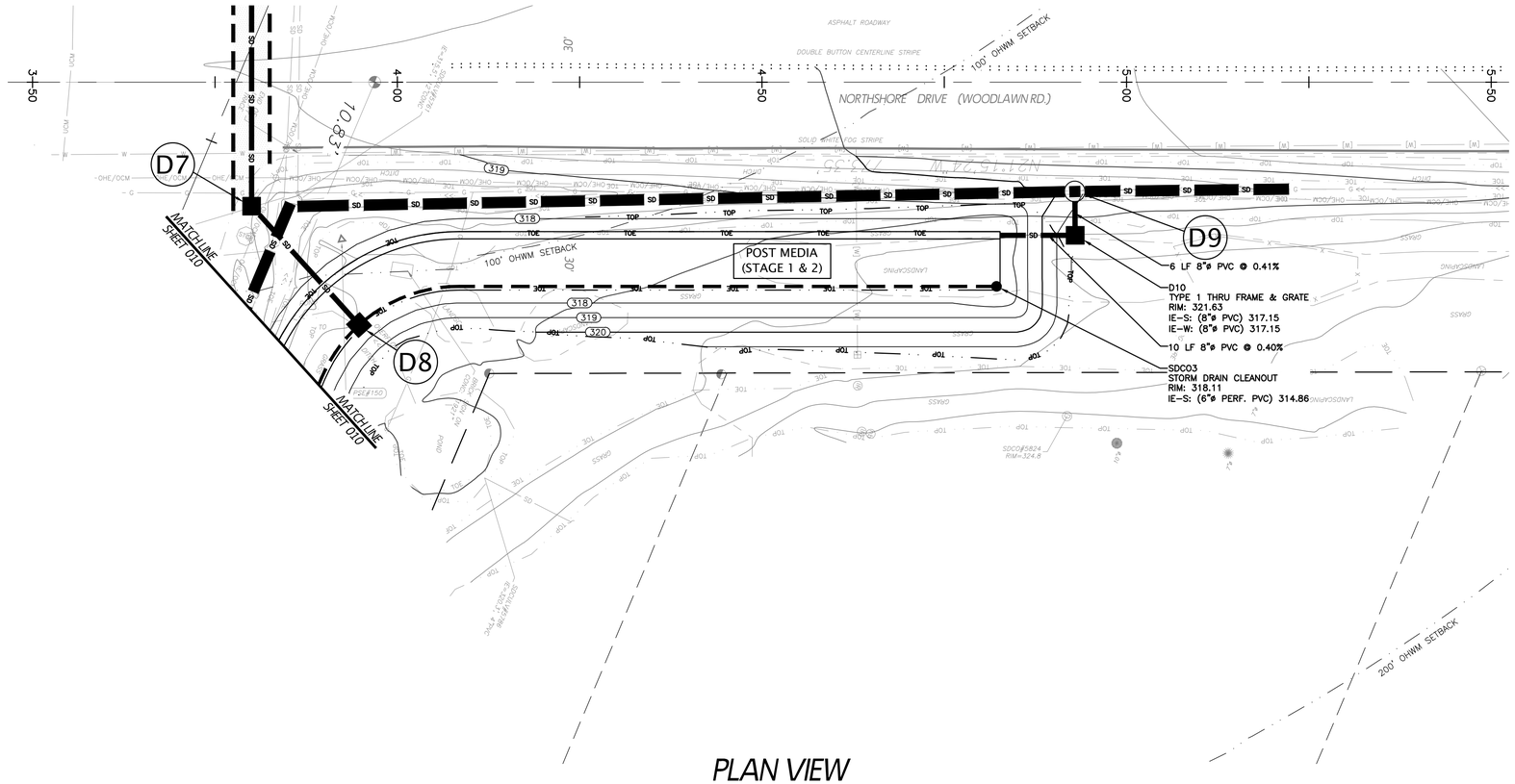
SCALE
Horiz. 1"=10'
Vert. 1"=4'

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
NORTHSHORE DR. IMPROVEMENTS - W. SIDE

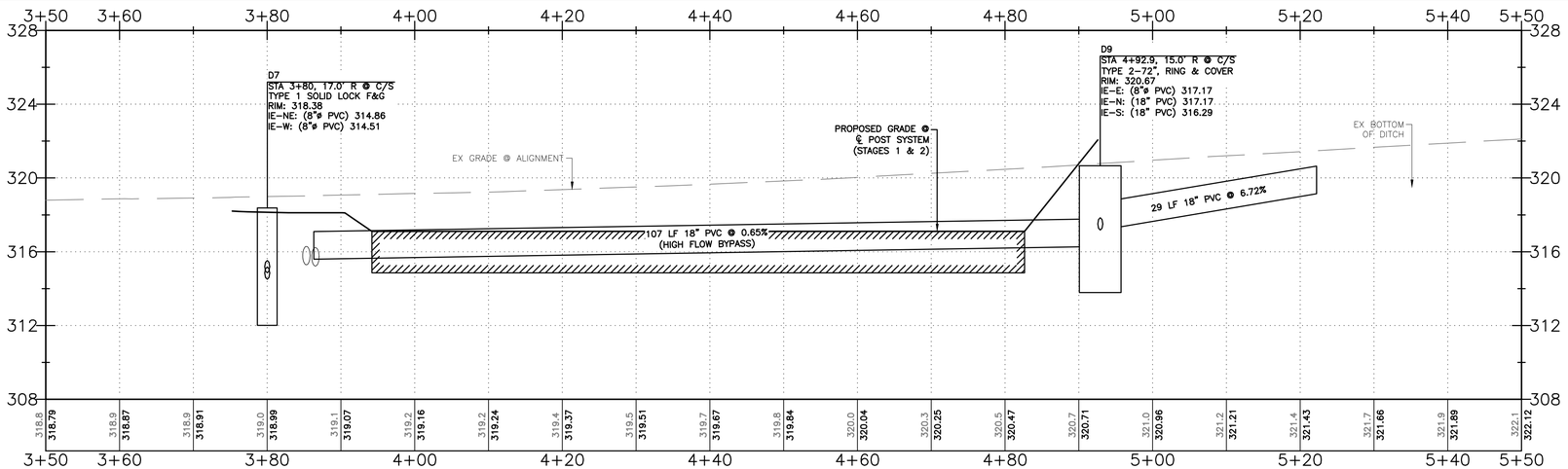
SHEET 08 OF 14



PLAN VIEW

SCALE: 1"=10'

GRAPHIC SCALE
(US SURVEY FEET)
0 10
10 5 20
1 inch = 10 feet



PROFILE VIEW

H. SCALE: 1"=10' V. SCALE: 1"=4'

IAN DWIGHT HIXSON
STATE OF WASHINGTON
48169
REGISTERED
PROFESSIONAL ENGINEER
PRELIMINARY

Date	No	Revision	By
	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

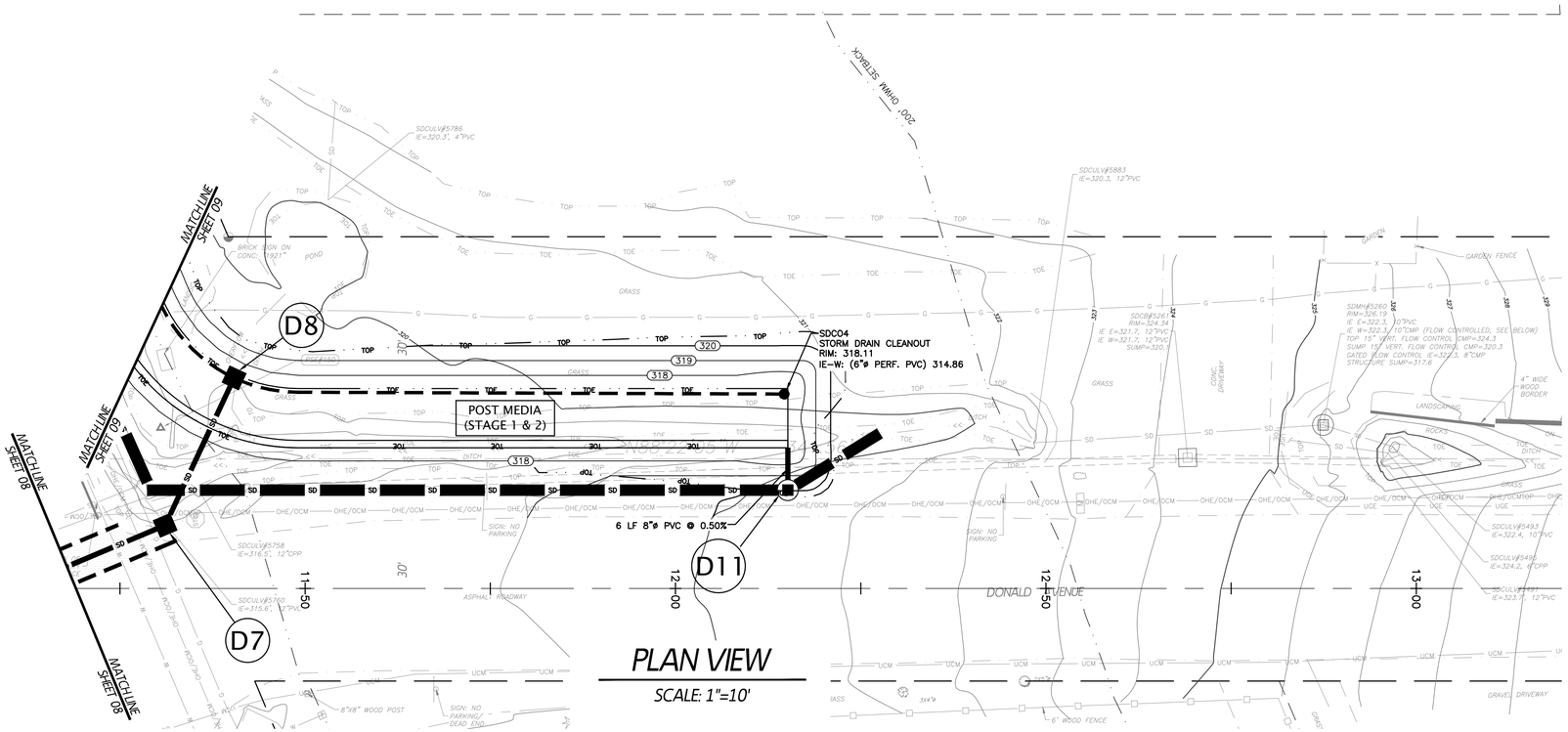
SCALE
Horiz. 1"=10'
Vert. 1"=4'

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

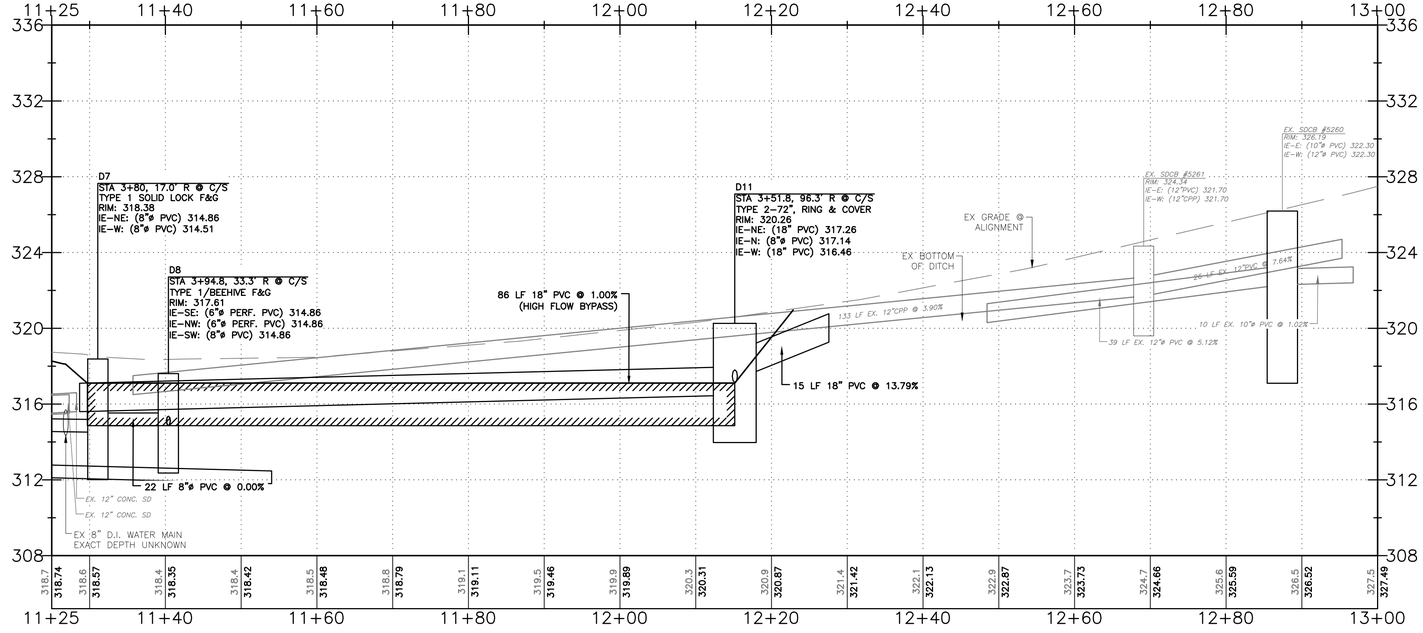
DONALD AVE. WATER QUALITY RETROFIT
NORTHSHORE DR. IMPROVEMENTS - E. SIDE

SHEET 09 OF 14



PLAN VIEW

SCALE: 1"=10'



PROFILE VIEW

H. SCALE: 1"=10' V. SCALE: 1"=4'

PRELIMINARY

IAN DWIGHT HAMILTON — STATE OF WASHINGTON — 48169 — REGISTERED PROFESSIONAL ENGINEER

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INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
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ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. 1"=10
Vert. 1"=4'

DATUM
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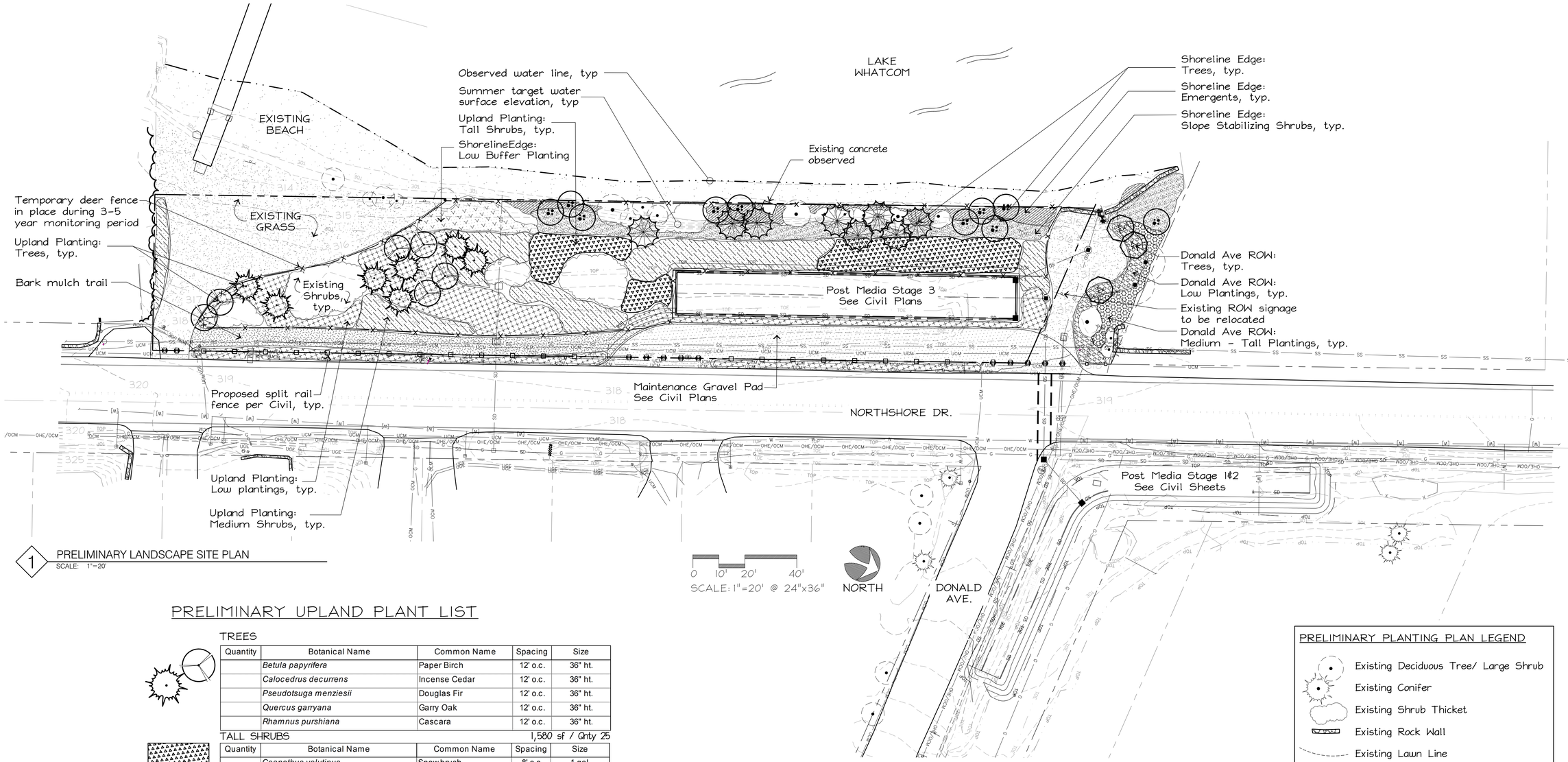
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
DONALD AVE. IMPROVEMENTS

SHEET 10 OF 14



1 PRELIMINARY LANDSCAPE SITE PLAN
SCALE: 1"=20'

0 10' 20' 40'
SCALE: 1"=20' @ 24"x36"

NORTH

PRELIMINARY UPLAND PLANT LIST

TREES

Quantity	Botanical Name	Common Name	Spacing	Size
	Betula papyrifera	Paper Birch	12' o.c.	36" ht.
	Calocedrus decurrens	Incense Cedar	12' o.c.	36" ht.
	Pseudotsuga menziesii	Douglas Fir	12' o.c.	36" ht.
	Quercus garryana	Garry Oak	12' o.c.	36" ht.
	Rhamnus purshiana	Cascara	12' o.c.	36" ht.

TALL SHRUBS 1,580 sf / Qnty 25

Quantity	Botanical Name	Common Name	Spacing	Size
	Ceanothus velutinus	Snowbrush	8' o.c	1 gal.
	Corylus cornuta	Beaked Hazelnut	8' o.c	B.R.
	Holodiscus discolor	Ocean Spray	8' o.c	B.R.
	Oemleria cerasiformis	Oso Berry	8' o.c	B.R.
	Sambucus racemosa	Red Elderberry	8' o.c.	B.R.
	Vaccinium ovatum	Evergreen Huckleberry	8' o.c	1 gal.

MEDIUM SHRUBS 2,300 sf / Qnty 36

Quantity	Botanical Name	Common Name	Spacing	Size
	Philadelphus lewisii	Mock Orange	8' o.c	B.R.
	Ribes sanguineum	Red-flowering Currant	8' o.c	B.R.
	Rosa nutkana	Nootka Rose	8' o.c	B.R.
	Rosa pisocarpa	Clustered Wild Rose	8' o.c.	B.R.
	Vaccinium ovatum	Evergreen Huckleberry	8' o.c	1 gal.

LOW PLANTINGS 3,412 sf / Qnty 136

Quantity	Botanical Name	Common Name	Spacing	Size
	Allium cernum	Taper-tip Onion	5' o.c.	Plugs
	Erigeron glaucus	Showy Fleabane	5' o.c.	Plugs
	Gaultheria shallon	Salal	5' o.c.	1 gal.
	Grindela hirsutula	Hairy gumplant	5' o.c.	Plugs
	Lupinus polyphyllus	Blue Lupine	5' o.c.	Plugs
	Mahonia nervosa	Low Oregon Grape	5' o.c.	1 gal.
	Mahonia repens	Creeping Oregon Grape	5' o.c.	1 gal.
	Spirea betulifolia var. lucida	Shiney Leaf Spirea	5' o.c.	B.R.
	Solidago lepida	Goldenrod	5' o.c.	Plugs
	Symphoricarpos albus	Snowberry	5' o.c.	B.R.

PRELIMINARY SHORELINE EDGE PLANT LIST

TREES

Quantity	Botanical Name	Common Name	Spacing	Size
	Salix hookeriana	Hookers Willow	8' o.c	B.R.
	Salix geyeriana	Geyer Willow	8' o.c	B.R.
	Salix sitchensis	Sitka Willow	8' o.c	B.R.
	Thuja plicata	Western Red Cedar	12' o.c	1 gal.

SLOPE STABILIZING SHRUBS 1,447 SF / Qnty 23

Quantity	Botanical Name	Common Name	Spacing	Size
	Cornus sericea	Red-Osier Dogwood	8' o.c	B.R.
	Rubus spectabilis	Salmonberry	8' o.c	B.R.
	Spireae douglasii	Douglass Spirea	8' o.c	B.R.

LOW BUFFER 570 sf / Qnty 23

Quantity	Botanical Name	Common Name	Spacing	Size
	Juncus effusus pacificus	Common Rush	5' o.c.	B.R.
	Juncus effusus pacificus	Slender Rush	5' o.c.	B.R.

EMERGENTS 630 sf / Qnty 25

Quantity	Botanical Name	Common Name	Spacing	Size
	Carex obnupta	Slough Sedge	5' o.c.	Plugs
	Carex stipata	Sawbeak Sedge	5' o.c.	Plugs
	Juncus ensifolius	Dagger-Leaved Rush	5' o.c.	Plugs
	Juncus tenuis	Slender Rush	5' o.c.	Plugs

PRELIMINARY PLANTING PLAN LEGEND

- Existing Deciduous Tree/ Large Shrub
- Existing Conifer
- Existing Shrub Thicket
- Existing Rock Wall
- Existing Lawn Line
- Bark Mulch Trail
- Existing Lawn To Remain
- Temporary Deer Fence
- Split Rail Fence (per Civil drawings)

PRELIMINARY DONALD AVE ROW PLANT LIST

TREES

Quantity	Botanical Name	Common Name	Spacing	Size
	Amelanchier alnifolia	Serviceberry	12' o.c.	36" ht.

MEDIUM-TALL SHRUBS 323 sf / Qnty 13

Quantity	Botanical Name	Common Name	Spacing	Size
	Gaultheria shallon	Salal	5' o.c.	1 gal.
	Vaccinium ovatum	Evergreen Huckleberry	5' o.c.	1 gal.

LOW PLANTINGS 334 sf / Qnty 14

Quantity	Botanical Name	Common Name	Spacing	Size
	Mahonia nervosa	Low Oregon Grape	5' o.c.	1 gal.
	Polystichum munitum	Western Sword Fern	5' o.c.	4"

mmla
MOLLY MAGUIRE LANDSCAPE ARCHITECTURE
1106 Harris Avenue
Suite 303
Bellingham, WA 98225
P 360 542 4052
F 360 543 5681
MMAGUIRE@MOLLYMAGUIRELA.COM

STATE OF WASHINGTON REGISTERED LANDSCAPE ARCHITECT

PRELIMINARY

Molly Maguire
CERTIFICATE NO. 1294

PROJECT:

DONALD AVENUE WATER QUALITY RETROFIT

CLIENT:

CITY OF BELLINGHAM
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SHEET TITLE:

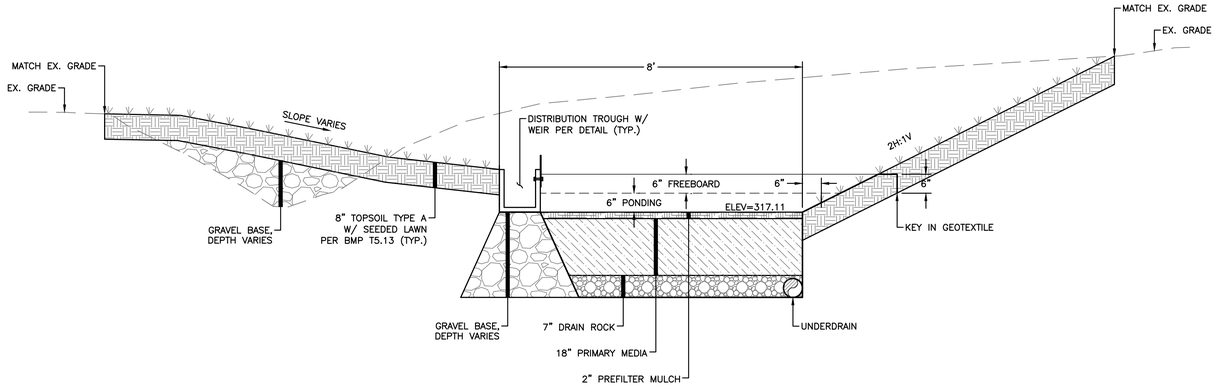
LANDSCAPE SITE PLAN

ISSUE: DATE:

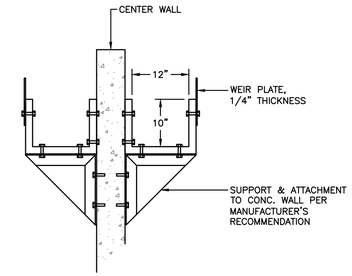
60% Submittal 06.23.2023

SHEET NO.

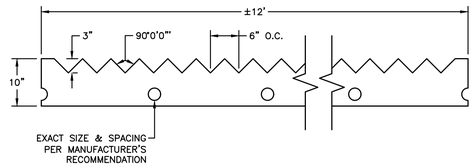
L-1



STAGE 1 & 2
(DONALD AVE)



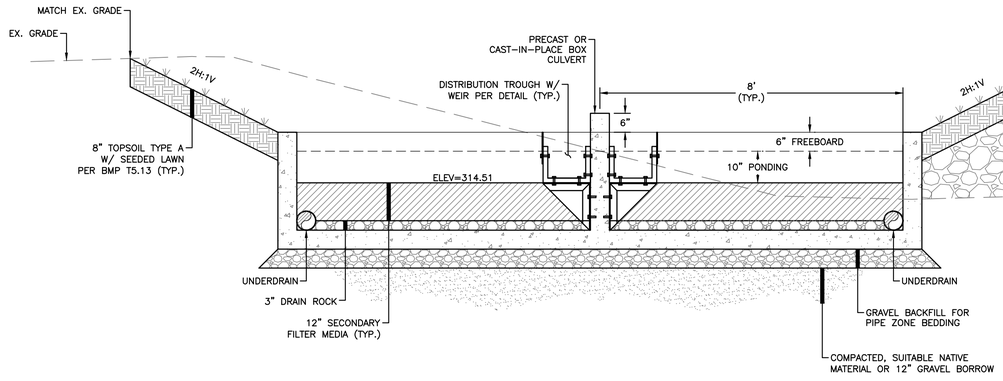
TROUGH & SUPPORT



WEIR PLATE

DISTRIBUTION TROUGH & WEIR

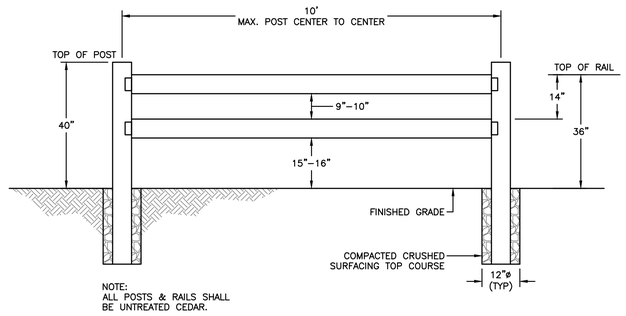
NTS



STAGE 3
(COB PROPERTY)

POST MEDIA, UNSTACKED CONFIGURATION

NTS



WOODEN SPLIT RAIL FENCE

NTS

PRELIMINARY

No	Date	Revision	By
4			
3			
2	6/12/23	60% Design	
1	1/17/23	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. N/A
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
DETAILS

SHEET 12 OF 14

BEDDING SPECIFICATIONS FOR PVC PIPE

THE FOLLOWING SUPPLEMENTAL SPECIFICATIONS ARE TO BE USED IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION, CURRENT EDITION:

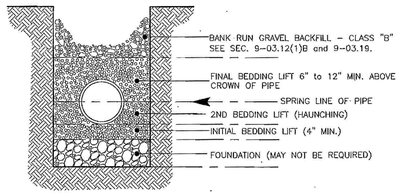
BEDDING FOR SEWERS, DRAINS AND CULVERTS FOR PVC PIPE–

BEDDING MATERIAL FOR PVC PIPE SHALL BE PEA GRAVEL CONFORMING TO THE FOLLOWING SPECIFICATIONS.

PEA GRAVEL – PEA GRAVEL BEDDING SHALL BE A CLEAN MIXTURE FREE FROM ORGANIC MATTER AND CONFORMING TO THE FOLLOWING GRADATION WHEN TESTED IN ACCORDANCE WITH ASTM D422:

U.S. STANDARD SIEVE SIZE	PERCENT PASSING, BY WT.
½"	100
⅜"	95–100
#8	0–10
#200	0–3

BACKFILL – WHEREVER A TRENCH IS EXCAVATED IN THE EXISTING OR PROPOSED ROADWAY, SIDEWALK OR OTHER AREAS WHERE SETTLEMENT WOULD BE DETRIMENTAL, THE ENTIRE TRENCH SHALL BE BACKFILLED WITH IMPORTED GRAVEL AND COMPACTED TO 95% OF MAXIMUM DENSITY.



APPROVED	CITY OF BELLINGHAM	DRAWING
City Engineer 11/8/07 Date	PVC PIPE BEDDING DETAILS	DR–538

BEDDING SPECIFICATIONS FOR PVC PIPE

THE FOLLOWING SUPPLEMENTAL SPECIFICATIONS ARE TO BE USED IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION, CURRENT EDITION:

BEDDING FOR SEWERS, DRAINS AND CULVERTS FOR PVC PIPE–

BEDDING MATERIAL FOR PVC PIPE SHALL BE PEA GRAVEL CONFORMING TO THE FOLLOWING SPECIFICATIONS.

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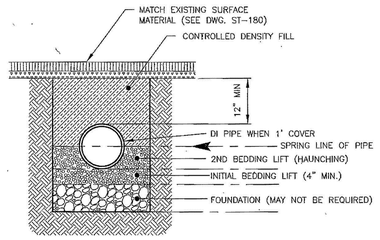
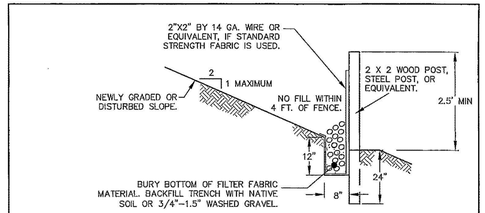
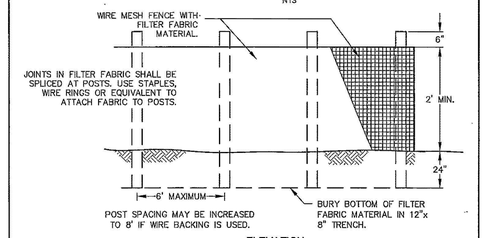


APPROVED	CITY OF BELLINGHAM	DRAWING
City Engineer 11/8/07 Date	PIPE BEDDING DETAILS FOR 2' OR LESS OF COVER	DR–539



TYPICAL CROSS SECTION
NTS

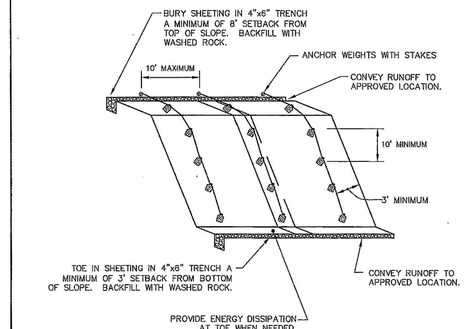


ELEVATION
NTS

NOTES:

1. FENCE SHALL NOT BE INSTALLED ON SLOPES STEEPER THAN 2:1.
2. JOINTS IN FILTER FABRIC SHALL BE OVERLAPPED 6 INCHES AT POST.
3. USE STAPLES, WIRE RINGS, OR EQUIVALENT TO ATTACH FABRIC TO WIRE FENCE.
4. REMOVE SEDIMENT WHEN IT REACHES 1/3 FENCE HEIGHT.

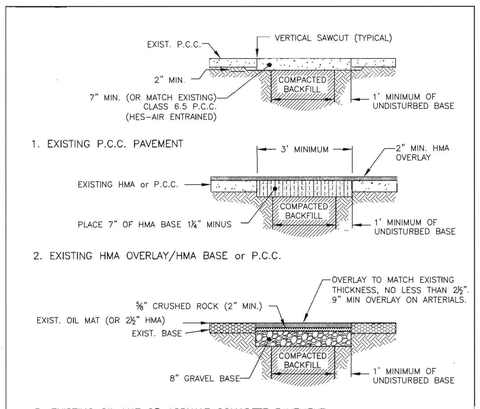
APPROVED	CITY OF BELLINGHAM	DRAWING
City Engineer 11/29/04 Date	REINFORCED SILT FENCE	EC–615



NOTES:

1. TIRES, SANDBAGS, OR EQUIVALENT MAY BE USED TO WEIGH DOWN PLASTIC SHEETING.
2. SEAMS BETWEEN SHEETS MUST OVERLAP A MINIMUM OF 12" AND BE WEIGHTED OR TAPED.
3. PLASTIC SHEETING SHALL HAVE A MINIMUM THICKNESS OF 6 MIL.
4. DUE TO RAPID RUNOFF CAUSED BY PLASTIC SHEETING, THIS METHOD SHALL NOT BE USED UPSLOPE OF AREAS THAT MIGHT BE ADVERSELY IMPACTED BY CONCENTRATED RUNOFF.
5. CONSTRUCT BERM OR SWALE AT TOP OF SLOPE AS DIRECTED BY THE CLEARING AND GRADING INSPECTOR.
6. CONSTRUCT DITCH AT BASE OF SLOPE AS REQUIRED BY CITY, AND DISCHARGE TO APPROVED LOCATION.

APPROVED	CITY OF BELLINGHAM	DRAWING
City Engineer 11/29/04 Date	PLASTIC COVERING FOR SLOPES AND STOCKPILES	EC–650



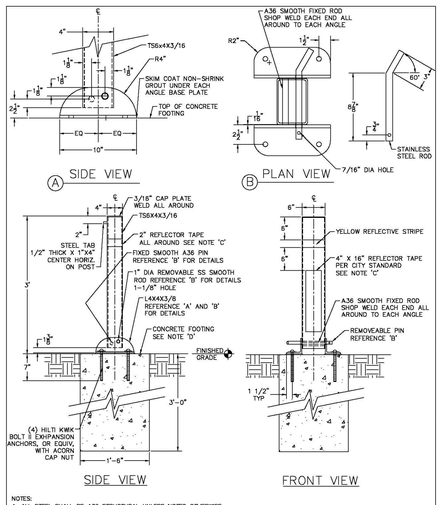
NOTES:

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF BELLINGHAM'S STANDARD SPECIFICATIONS FOR UTILITY CUTS IN STREET AREA.

PAVEMENT OVERLAYS No. 2 AND 3, TACK ALL EDGES AND HMA BASE SURFACE BEFORE PLACING HMA PAVEMENT. SEAL ALL JOINTS WITH HOT ASPHALT (AR-4000W) BETWEEN EXISTING AND NEW HMA PAVEMENT IMMEDIATELY AFTER FINISH ROLLING.

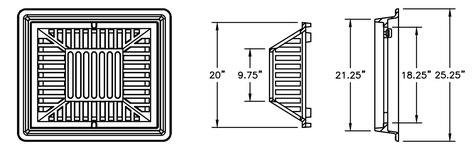
CONTRACTOR SHALL MATCH EXISTING SURFACES THAT ARE COLORED, TEXTURED, STAMPED OR INLAID WITH BRICK.

APPROVED	CITY OF BELLINGHAM	DRAWING
City Engineer 12/10/09 Date	HORIZONTAL PAVEMENT REPAIR (STREET CROSSINGS)	ST–180



NOTES:
A. ALL STEEL SHALL BE A36 STRUCTURAL UNLESS NOTED OTHERWISE.
B. ALL STEEL SHALL BE POWDER COATED BROWN UNLESS NOTED OTHERWISE. COLOR SHALL MATCH BENJAMIN MOORE IRON CLAD LATEX BRONZE TONE COLOR #363-60 (STOCKTON'S PAINT SUPPLY), OR EQUIVALENT.
C. REFLECTIVE TAP BOTH SIDES, YELLOW BACKGROUND, NO LETTERING, TO BE MADE OF TRAFFIC GRADE REFLECTIVE TAPE.
D. FOOTING DESIGN MAY VARY PER SITE CONDITIONS.
E. ORIENTATION AND LOCATION OF BOLLARD SHALL BE APPROVED BY PARKS IN THE FIELD.

PARKS AND RECREATION DESIGN AND DEVELOPMENT	CITY OF BELLINGHAM	DRAWING
last edit August 09, 2007	FOLD DOWN BOLLARD DETAIL	02840.01



BEEHIVE FRAME & GRATE

NTS

IAN DWIGHT HAMILTON — STATE OF WASHINGTON — 48169 — REGISTERED PROFESSIONAL ENGINEER

PRELIMINARY

	4				
	3				
6/12/23	2	60% Design			
1/17/23	1	30% Design			
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PUBLIC WORKS DEPARTMENT
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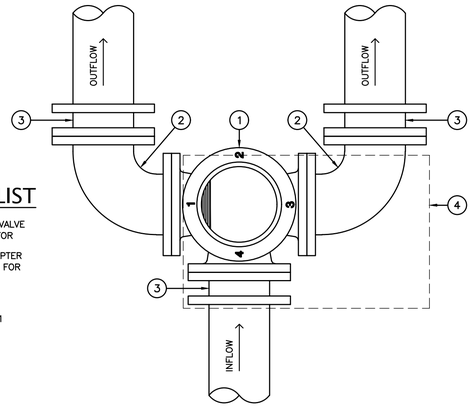
Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT DETAILS

SHEET 13 OF 14



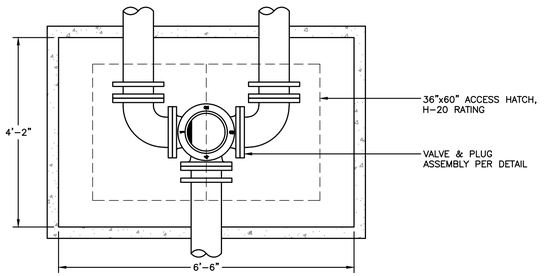
EQUIPMENT LIST

1. 3-WAY TAPERED PLUG VALVE W/ WORM GEAR ACTUATOR
2. 90° BEND
3. FLANGED COUPLING ADAPTER
4. ACTUATOR (NOT DRAWN FOR CLARITY)

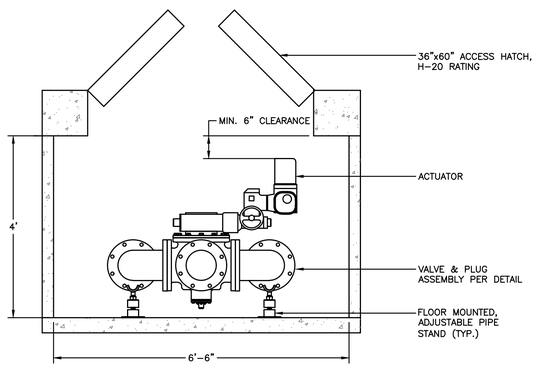
NOTE:
PLUG SHOWN IN POSITION 1

PLUG VALVE ASSEMBLY

NTS



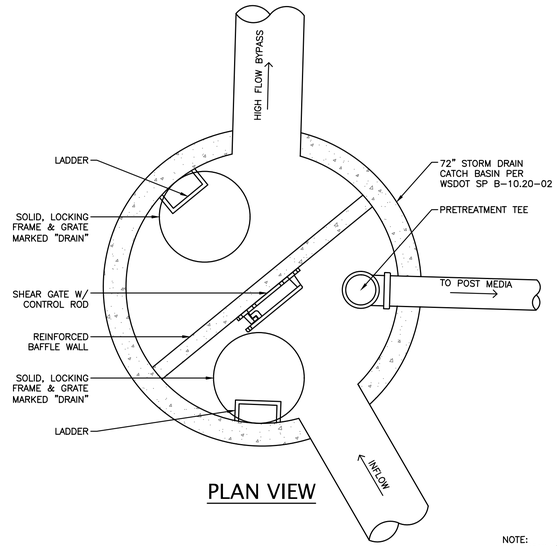
PLAN VIEW



SECTION VIEW

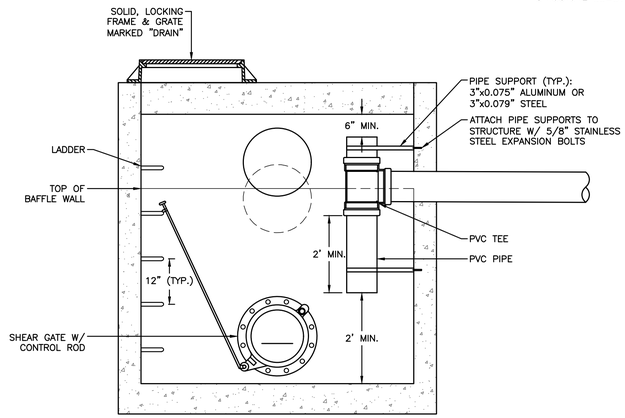
PLUG VALVE VAULT

NTS



PLAN VIEW

NOTE:
1. DETAIL DEPICTS A TYPICAL BYPASS STRUCTURE (D3, D9, D11). SEE PLANS FOR EXACT PIPING CONFIGURATION.
2. TOP OF BAFFLE WALL EL. FOR STRUCTURES D9 & D11=317.46.
3. TOP OF BAFFLE WALL EL. FOR STRUCTURE D3=314.86.



SECTION VIEW

BYPASS STRUCTURE

NTS

IAN DWIGHT HUDSON
STATE OF WASHINGTON
48169
REGISTERED
PROFESSIONAL ENGINEER
PRELIMINARY

Date	No	Revision	By
	4		
	3		
6/12/23	2	60% Design	
1/17/23	1	30% Design	

PROJECT ENGINEER
DESIGNED/DRAWN
INSPECTOR

DIRECTOR PUBLIC WORKS E.C.J.
CITY ENGINEER C.M.A.S.
ASSISTANT DIRECTOR M.A.O.

CITY OF BELLINGHAM, WASHINGTON
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

SCALE
Horiz. N/A
Vert. N/A

DATUM
NAD 83/98
NAVD 88

Job. No. EV-0171
Date 6/12/2023
Field Bk. 1062 SERIES

DONALD AVE. WATER QUALITY RETROFIT
DETAILS

SHEET 14 OF 14

APPENDIX F – CONSTRUCTION BMPS

BMP C101: Preserving Natural Vegetation

Purpose

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20-30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

Natural vegetation should be preserved on steep slopes, near perennial and intermittent water-courses or swales, and on building sites in wooded areas.

- As required by local governments.
- Phase construction to preserve natural vegetation on the project site for as long as possible during the construction period.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.
- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Plants need protection from three kinds of injuries:

- *Construction Equipment* - This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries.
- *Grade Changes* - Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can typically tolerate fill of 6 inches or less. For shrubs and other plants, the fill should be less.

  When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. The tile system should be laid out on the original grade leading from a dry well

around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant.

- *Excavations* - Protect trees and other plants when excavating for drainfields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:
    - Cut as few roots as possible. When you have to cut, cut clean. Paint cut root ends with a wood dressing like asphalt base paint if roots will be exposed for more than 24-hours.
    - Backfill the trench as soon as possible.
    - Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar, and Douglas fir do not readily adjust to changes in environment and special care should be taken to protect these trees.
- The windthrow hazard of Pacific silver fir and madrona is high, while that of Western hemlock is moderate. The danger of windthrow increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils less than 20 inches deep) have a low windthrow hazard.
- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and infiltration fields. On the other hand, they thrive in high moisture conditions that other trees would not.
- Thinning operations in pure or mixed stands of Grand fir, Pacific silver fir, Noble fir, Sitka spruce, Western red cedar, Western hemlock, Pacific dogwood, and Red alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

If tree roots have been exposed or injured, “prune” cleanly with an appropriate pruning saw or loppers directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C102: Buffer Zones

Purpose

Creation of an undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and stormwater runoff velocities.

Conditions of Use

Buffer zones are used along streams, wetlands and other bodies of water that need protection from erosion and sedimentation. Contractors can use vegetative buffer zone BMPs to protect natural swales and they can incorporate them into the natural landscaping of an area.

Do not use critical-areas buffer zones as sediment treatment areas. These areas shall remain completely undisturbed. The local permitting authority may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

The types of buffer zones can change the level of protection required as shown below:

Designated Critical Area Buffers - buffers that protect Critical Areas, as defined by the Washington State Growth Management Act, and are established and managed by the local permitting authority. These should not be disturbed and must protected with sediment control BMPs to prevent impacts. The local permitting authority may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

Vegetative Buffer Zones - areas that may be identified in undisturbed vegetation areas or managed vegetation areas that are outside any Designated Critical Area Buffer. They may be utilized to provide an additional sediment control area and/or reduce runoff velocities. If being used for preservation of natural vegetation, they should be arranged in clumps or strips. They can be used to protect natural swales and incorporated into the natural landscaping area.

Design and Installation Specifications

- Preserving natural vegetation or plantings in clumps, blocks, or strips is generally the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Mark clearing limits and keep all equipment and construction debris out of the natural areas and buffer zones. Steel construction fencing is the most effective method to protect sensitive areas and buffers. Alternatively, wire-backed silt fence on steel posts is marginally effective. Flagging alone is typically not effective.
- Keep all excavations outside the dripline of trees and shrubs.
- Do not push debris or extra soil into the buffer zone area because it will cause damage by

burying and smothering vegetation.

- Vegetative buffer zones for streams, lakes or other waterways shall be established by the local permitting authority or other state or federal permits or approvals.

Maintenance Standards

Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed. Replace all damaged flagging immediately. Remove all materials located in the buffer area that may impede the ability of the vegetation to act as a filter.

BMP C103: High-Visibility Fence

Purpose

High-visibility fencing is intended to:

- Restrict clearing to approved limits.
- Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
- Limit construction traffic to designated construction entrances, exits, or internal roads.
- Protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use

To establish clearing limits plastic, fabric, or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

High-visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high-visibility orange. The fence tensile strength shall be 360 lbs/ft using the ASTM D4595 testing method.

If appropriate install fabric silt fence in accordance with BMP C233: Silt Fence to act as high-visibility fence. Silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.

Metal fences shall be designed and installed according to the manufacturer's specifications.

Metal fences shall be at least 3 feet high and must be highly visible.

Fences shall not be wired or stapled to trees.

Maintenance Standards

If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

BMP C105: Stabilized Construction Access

Purpose

Stabilized construction accesses are established to reduce the amount of sediment transported onto paved roads outside the project site by vehicles or equipment. This is done by constructing a stabilized pad of quarry spalls at entrances and exits for project sites.

Conditions of Use

Construction accesses shall be stabilized wherever traffic will be entering or leaving a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential subdivision construction sites, provide a stabilized construction access for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size and configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized accesses not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

See Figure II-3.1: Stabilized Construction Access for details. Note: the 100' minimum length of the access shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100').

Construct stabilized construction accesses with a 12-inch thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. Do not use crushed concrete, cement, or calcium chloride for construction access stabilization because these products raise pH levels in stormwater and concrete discharge to waters of the State is prohibited.

A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the standards listed in Table II-3.2: Stabilized Construction Access Geotextile Standards.

Table II-3.2: Stabilized Construction Access Geotextile Standards

Geotextile Property	Required Value
Grab Tensile Strength (ASTM D4751)	200 psi min.

Table II-3.2: Stabilized Construction Access Geotextile Standards (continued)

Geotextile Property	Required Value
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will be paved; this can be used as a stabilized access. Also consider the installation of excess concrete as a stabilized access. During large concrete pours, excess concrete is often available for this purpose.
- Fencing (see BMP C103: High-Visibility Fence) shall be installed as necessary to restrict traffic to the construction access.
- Whenever possible, the access shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.
- Construction accesses should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction access must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

Alternative Material Specification

WSDOT has raised safety concerns about the Quarry Spall rock specified above. WSDOT observes that the 4-inch to 8-inch rock sizes can become trapped between Dually truck tires, and then released off-site at highway speeds. WSDOT has chosen to use a modified specification for the rock while continuously verifying that the Stabilized Construction Access remains effective. To remain effective, the BMP must prevent sediment from migrating off site. To date, there has been no performance testing to verify operation of this new specification. Jurisdictions may use the alternative specification, but must perform increased off-site inspection if they use, or allow others to use, it.

Stabilized Construction Accesses may use material that meets the requirements of WSDOT's *Standard Specifications for Road, Bridge, and Municipal Construction* Section 9-03.9(1) (WSDOT, 2016) for ballast except for the following special requirements.

The grading and quality requirements are listed in Table II-3.3: Stabilized Construction Access Alternative Material Requirements.

Table II-3.3: Stabilized Construction Access Alternative Material Requirements

Sieve Size	Percent Passing
2½"	99-100

Table II-3.3: Stabilized Construction Access Alternative Material Requirements (continued)

Sieve Size	Percent Passing
2″	65-100
¾″	40-80
No. 4	5 max.
No. 100	0-2
% Fracture	75 min.

- All percentages are by weight.
- The sand equivalent value and dust ratio requirements do not apply.
- The fracture requirement shall be at least one fractured face and will apply the combined aggregate retained on the No. 4 sieve in accordance with FOP for AASHTO T 335.

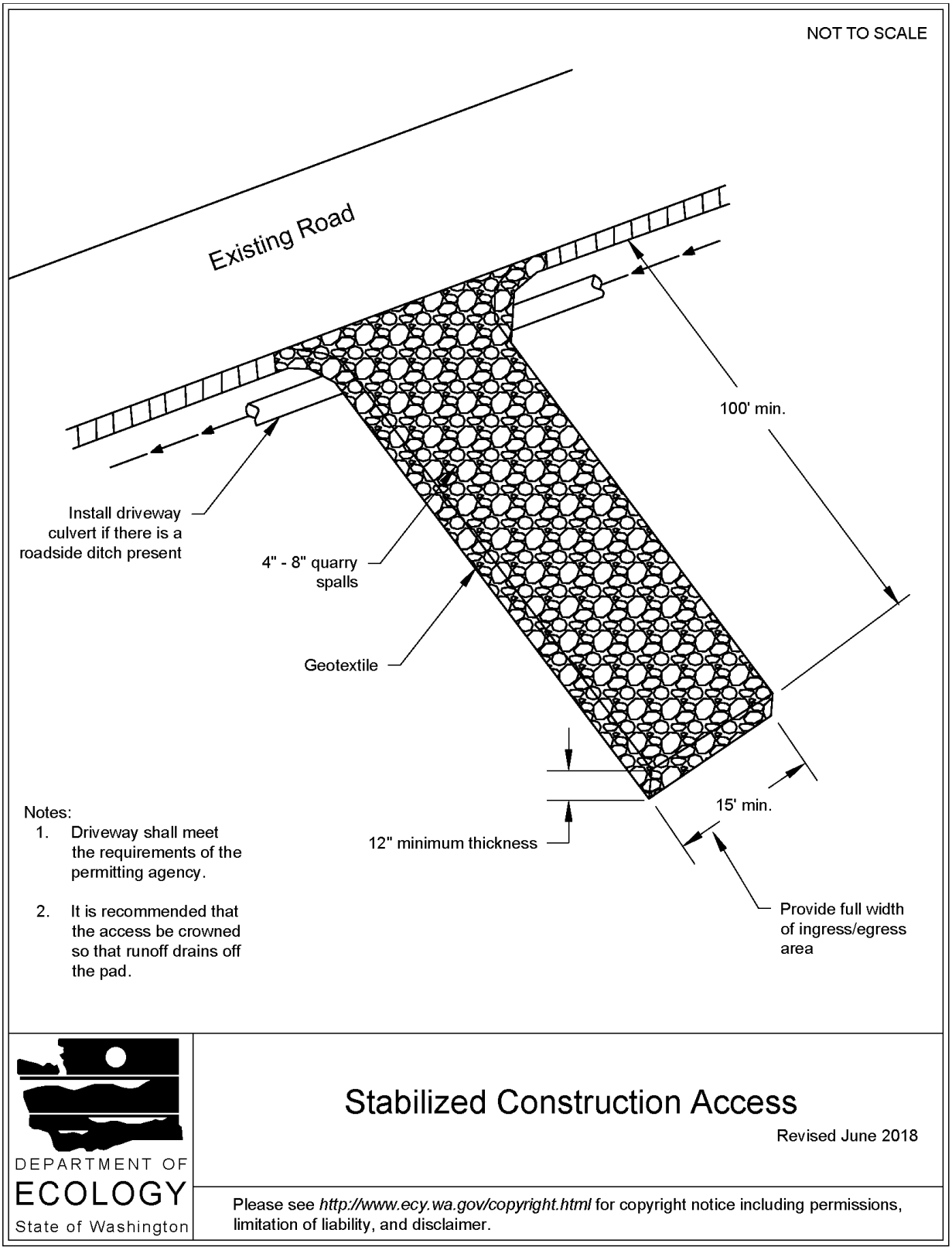
Maintenance Standards

Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- If the access is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the access, or the installation of BMP C106: Wheel Wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction access(es), BMP C103: High-Visibility Fence shall be installed to control traffic.

- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

Figure II-3.1: Stabilized Construction Access



Approved as Functionally Equivalent

Ecology has approved products as able to meet the requirements of this BMP. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept these products, or may require additional testing prior to consideration for local use. Products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

~~BMP C106: Wheel Wash~~

~~Purpose~~

~~Wheel washes reduce the amount of sediment transported onto paved roads by washing dirt from the wheels of motor vehicles prior to the motor vehicles leaving the construction site.~~

~~Conditions of Use~~

- ~~Use a wheel wash when BMP C105: Stabilized Construction Access is not preventing sediment from being tracked off site.~~
- ~~Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.~~
- ~~Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.~~
- ~~Wheel wash wastewater is not stormwater. It is commonly called process water, and must be discharged to a separate on-site treatment system that prevents discharge to waters of the State, or to the sanitary sewer with local sewer district approval.~~
- ~~Wheel washes may use closed-loop recirculation systems to conserve water use.~~
- ~~Wheel wash wastewater shall not include wastewater from concrete washout areas.~~
- ~~When practical, the wheel wash should be placed in sequence with BMP C105: Stabilized Construction Access. Locate the wheel wash such that vehicles exiting the wheel wash will enter directly onto BMP C105: Stabilized Construction Access. In order to achieve this, BMP C105: Stabilized Construction Access may need to be extended beyond the standard installation to meet the exit of the wheel wash.~~

~~Design and Installation Specifications~~

~~Suggested details are shown in Figure II-3.2: Wheel Wash. The Local Permitting Authority may allow other designs. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.~~

BMP C140: Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

Use dust control in areas (including roadways) subject to surface and air movement of dust where on-site or off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until the surface is wet. Repeat as needed. To prevent carryout of mud onto the street, refer to BMP C105: Stabilized Construction Access and BMP C106: Wheel Wash.
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection) added to water at a rate of 0.5 pounds per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may reduce the quantity of water needed for dust control. Note that the application rate specified here applies to this BMP, and is not the same application rate that is specified in BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection, but the downstream protections still apply.

  Refer to BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection for conditions of use. PAM shall not be directly applied to water or allowed to enter a water body.
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes

compliance with this BMP.

- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Techniques that can be used for unpaved roads and lots include:
    - Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
    - Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
    - Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.
    - Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
    - Encourage the use of alternate, paved routes, if available.
    - Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
    - Limit dust-causing work on windy days.
    - Pave unpaved permanent roads and other trafficked areas.

Maintenance Standards

Respray area as necessary to keep dust to a minimum.

BMP C150: Materials on Hand

Purpose

Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy rains. Having these materials on-site reduces the time needed to replace existing or implement new BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible

pipe, sandbags, geotextile fabric and steel “T” posts.

- Materials should be stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or project proponent could keep a stockpile of materials that are available for use on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum list of items that will cover numerous situations includes:

- Clear Plastic, 6 mil
- Drainpipe, 6 or 8 inch diameter
- Sandbags, filled
- Straw Bales for mulching
- Quarry Spalls
- Washed Gravel
- Geotextile Fabric
- Catch Basin Inserts
- Steel "T" Posts
- Silt fence material
- Straw Wattles

Maintenance Standards

- All materials with the exception of the quarry spalls, steel “T” posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials as needed.

BMP C151: Concrete Handling

Purpose

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. Concrete spillage or concrete discharge to waters of the State is prohibited. Use this BMP to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the State.

Conditions of Use

Any time concrete is used, utilize these management practices. Concrete construction project components include, but are not limited to:

- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors
- Runways

Disposal options for concrete, in order of preference are:

1. Off-site disposal
2. Concrete wash-out areas (see BMP C154: Concrete Washout Area)
3. De minimus washout to formed areas awaiting concrete

Design and Installation Specifications

- Wash concrete truck drums at an approved off-site location or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground (including formed areas awaiting concrete), or into storm drains, open ditches, streets, or streams. Refer to BMP C154: Concrete Washout Area for information on concrete washout areas.
    - Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete on site, except in designated concrete washout areas as allowed in BMP C154: Concrete Washout Area.
- Wash small concrete handling equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) into designated concrete washout areas or into formed areas awaiting concrete pour.
- At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.
- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.
- Do not allow washwater from areas, such as concrete aggregate driveways, to drain directly (without detention or treatment) to natural or constructed stormwater conveyances.
- Contain washwater and leftover product in a lined container when no designated concrete washout areas (or formed areas, allowed as described above) are available. Dispose of contained concrete and concrete washwater (process water) properly.

- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
- Refer to BMP C252: Treating and Disposing of High pH Water for pH adjustment requirements.
- Refer to the Construction Stormwater General Permit (CSWGP) for pH monitoring requirements if the project involves one of the following activities:
    - Significant concrete work (as defined in the CSWGP).
    - The use of soils amended with (but not limited to) Portland cement-treated base, cement kiln dust or fly ash.
    - Discharging stormwater to segments of water bodies on the 303(d) list (Category 5) for high pH.

Maintenance Standards

Check containers for holes in the liner daily during concrete pours and repair the same day.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry created through sawcutting or surfacing from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting or surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Vacuum slurry and cuttings during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
- Dispose of collected slurry and cuttings in a manner that does not violate ground water or surface water quality standards.
- Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose of process water in a manner that does not violate ground water or surface water quality standards.
- Handle and dispose of cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and/or vacuum trucks.

~~BMP C153: Material Delivery, Storage, and Containment~~

~~Purpose~~

~~Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials on-site, store materials in a designated area, and install secondary containment.~~

~~Conditions of Use~~

~~Use at construction sites with delivery and storage of the following materials:~~

- ~~Petroleum products such as fuel, oil and grease~~
- ~~Soil stabilizers and binders (e.g., Polyacrylamide)~~
- ~~Fertilizers, pesticides and herbicides~~
- ~~Detergents~~
- ~~Asphalt and concrete compounds~~

occurring that could generate release of turbid water.

- Duties and responsibilities of the CESCL shall include, but are not limited to the following:
  - Maintaining a permit file on site at all times which includes the Construction SWPPP and any associated permits and plans.
  - Directing BMP installation, inspection, maintenance, modification, and removal.
  - Updating all project drawings and the Construction SWPPP with changes made.
  - Completing any sampling requirements including reporting results using electronic Discharge Monitoring Reports (WebDMR).
  - Facilitate, participate in, and take corrective actions resulting from inspections performed by outside agencies or the owner.
  - Keeping daily logs, and inspection reports. Inspection reports should include:
    - Inspection date/time.
    - Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
    - Visual monitoring results, including a description of discharged stormwater. The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
    - Any water quality monitoring performed during inspection.
    - General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.
    - A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:
      1. Locations of BMPs inspected.
      2. Locations of BMPs that need maintenance.
      3. Locations of BMPs that failed to operate as designed or intended.
      4. Locations of where additional or different BMPs are required.

BMP C162: Scheduling

Purpose

Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

Conditions of Use

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided.

Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of ground cover leaves a site vulnerable to erosion. Construction sequencing that limits land clearing, provides timely installation of erosion and sedimentation controls, and restores protective cover quickly can significantly reduce the erosion potential of a site.

Design Considerations

- Minimize construction during rainy periods.
- Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding in order to revegetate cut and fill slopes as the work progresses.

~~II-3.3 Construction Runoff BMPs~~

~~BMP C200: Interceptor Dike and Swale~~

~~Purpose~~

~~Provide a dike of compacted soil or a swale at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site.~~

~~Conditions of Use~~

~~Use an interceptor dike or swale where runoff from an exposed site or disturbed slope must be conveyed to an erosion control BMP which can safely convey the stormwater.~~

- ~~Locate upslope of a construction site to prevent runoff from entering the disturbed area.~~
- ~~When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope.~~
- ~~Locate downslope to collect runoff from a disturbed area and direct it to a sediment BMP (e.g. BMP C240: Sediment Trap or BMP C241: Sediment Pond (Temporary)).~~

thickness is 2 feet.

- For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), use an engineered energy dissipator.
- Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion. See BMP C122: Nets and Blankets.

- Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a Hydraulic Project Approval (HPA) from the Washington State Department of Fish and Wildlife. See I-2.11 Hydraulic Project Approvals.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipator if sediment builds up.

BMP C220: Inlet Protection

Purpose

Inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Use inlet protection at inlets that are operational before permanent stabilization of the disturbed areas that contribute runoff to the inlet. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless those inlets are preceded by a sediment trapping BMP.

Also consider inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters can add significant amounts of sediment into the roof drain system. If possible, delay installing lawn and yard drains until just before landscaping, or cap these drains to prevent sediment from entering the system until completion of landscaping. Provide 18-inches of sod around each finished lawn and yard drain.

Table II-3.10: Storm Drain Inlet Protection lists several options for inlet protection. All of the methods for inlet protection tend to plug and require a high frequency of maintenance. Limit contributing drainage areas for an individual inlet to one acre or less. If possible, provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table II-3.10: Storm Drain Inlet Protection

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding may occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area requirement: 30'x30'/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No	Paved or Earthen	Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap	N/A	N/A	18 month expected life.

Design and Installation Specifications

Excavated Drop Inlet Protection

Excavated drop inlet protection consists of an excavated impoundment around the storm drain inlet. Sediment settles out of the stormwater prior to entering the storm drain. Design and installation specifications for excavated drop inlet protection include:

- Provide a depth of 1-2 ft as measured from the crest of the inlet structure.
- Slope sides of excavation should be no steeper than 2H:1V.
- Minimum volume of excavation is 35 cubic yards.
- Shape the excavation to fit the site, with the longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water.
- Clear the area of all debris.

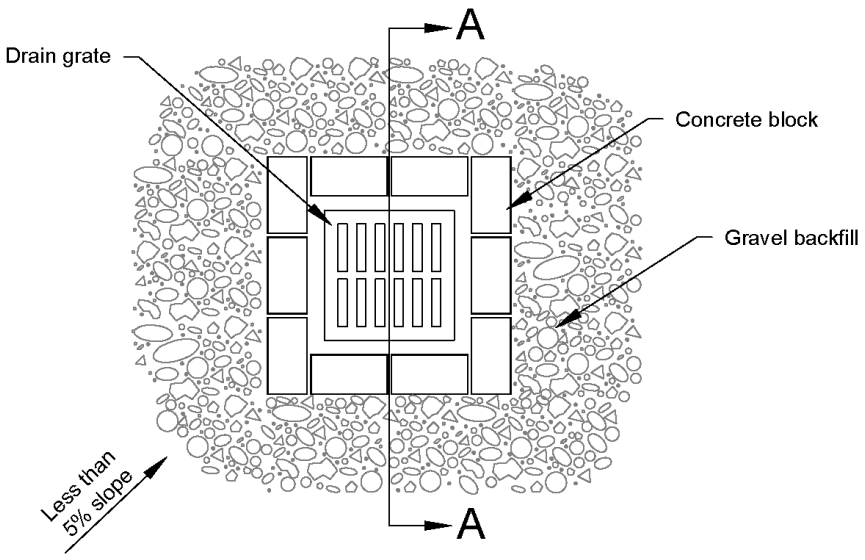
- Grade the approach to the inlet uniformly.
- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.
- Build a temporary dike, if necessary, to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter

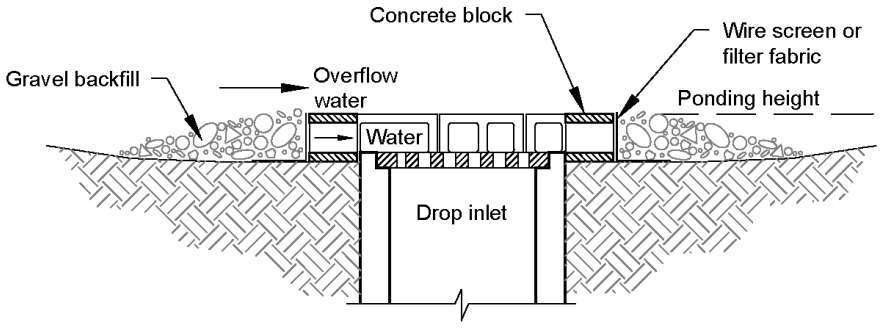
A block and gravel filter is a barrier formed around the inlet with standard concrete blocks and gravel. See Figure II-3.17: Block and Gravel Filter. Design and installation specifications for block gravel filters include:

- Provide a height of 1 to 2 feet above the inlet.
- Recess the first row of blocks 2-inches into the ground for stability.
- Support subsequent courses by placing a pressure treated wood 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side to allow for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel to just below the top of blocks on slopes of 2H:1V or flatter.
- An alternative design is a gravel berm surrounding the inlet, as follows:
    - Provide a slope of 3H:1V on the upstream side of the berm.
    - Provide a slope of 2H:1V on the downstream side of the berm.
    - Provide a 1-foot wide level stone area between the gravel berm and the inlet.
    - Use stones 3 inches in diameter or larger on the upstream slope of the berm.
    - Use gravel ½- to ¾-inch at a minimum thickness of 1-foot on the downstream slope of the berm.

Figure II-3.17: Block and Gravel Filter



Plan View



Section A-A

Notes:

1. Drop inlet sediment barriers are to be used for small, nearly level drainage areas. (less than 5%)
2. Excavate a basin of sufficient size adjacent to the drop inlet.
3. The top of the structure (ponding height) must be well below the ground elevation downslope to prevent runoff from bypassing the inlet. A temporary dike may be necessary on the downslope side of the structure.

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Block and Gravel Filter

Revised June 2016

Gravel and Wire Mesh Filter

Gravel and wire mesh filters are gravel barriers placed over the top of the inlet. This method does not provide an overflow. Design and installation specifications for gravel and wire mesh filters include:

- Use a hardware cloth or comparable wire mesh with ½-inch openings.
    - Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.
    - Overlap the strips if more than one strip of mesh is necessary.
- Place coarse aggregate over the wire mesh.
    - Provide at least a 12-inch depth of aggregate over the entire inlet opening and extend at least 18-inches on all sides.

Catch Basin Filters

Catch basin filters are designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements, combine a catch basin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way. Design and installation specifications for catch basin filters include:

- Provides 5 cubic feet of storage.
- Requires dewatering provisions.
- Provides a high-flow bypass that will not clog under normal use at a construction site.
- Insert the catch basin filter in the catch basin just below the grating.

Curb Inlet Protection with Wooden Weir

Curb inlet protection with wooden weir is an option that consists of a barrier formed around a curb inlet with a wooden frame and gravel. Design and installation specifications for curb inlet protection with wooden weirs include:

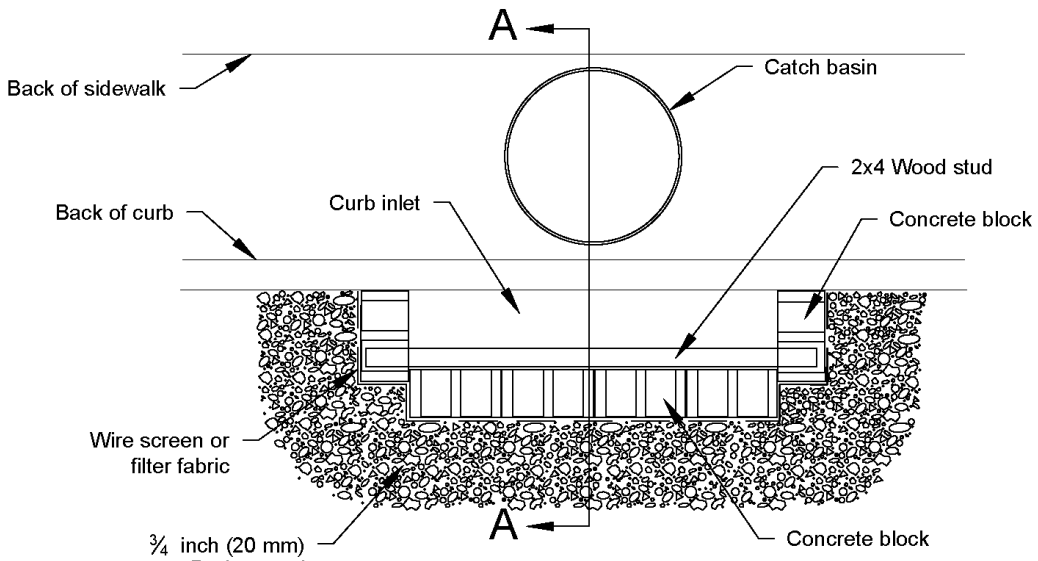
- Use wire mesh with ½-inch openings.
- Use extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against the wire and fabric.
- Place weight on the frame anchors.

Block and Gravel Curb Inlet Protection

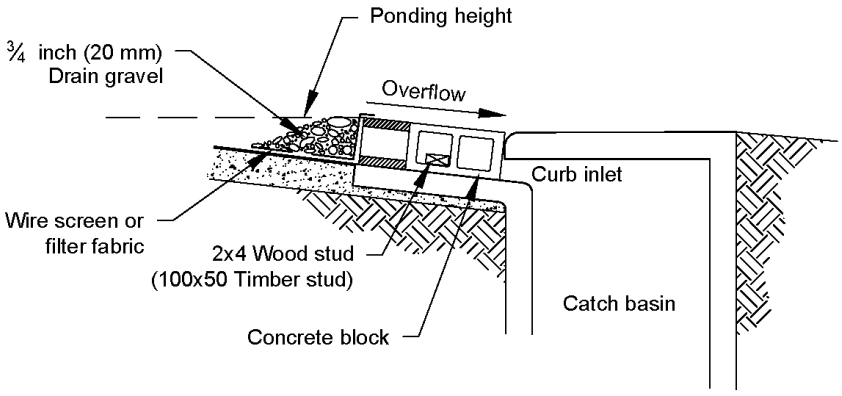
Block and gravel curb inlet protection is a barrier formed around a curb inlet with concrete blocks and gravel. See Figure II-3.18: Block and Gravel Curb Inlet Protection. Design and installation specifications for block and gravel curb inlet protection include:

- Use wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.
- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
- Place wire mesh over the outside vertical face.
- Pile coarse aggregate against the wire to the top of the barrier.

Figure II-3.18: Block and Gravel Curb Inlet Protection



Plan View



Section A-A

Notes:

1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

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Block and Gravel Curb Inlet Protection

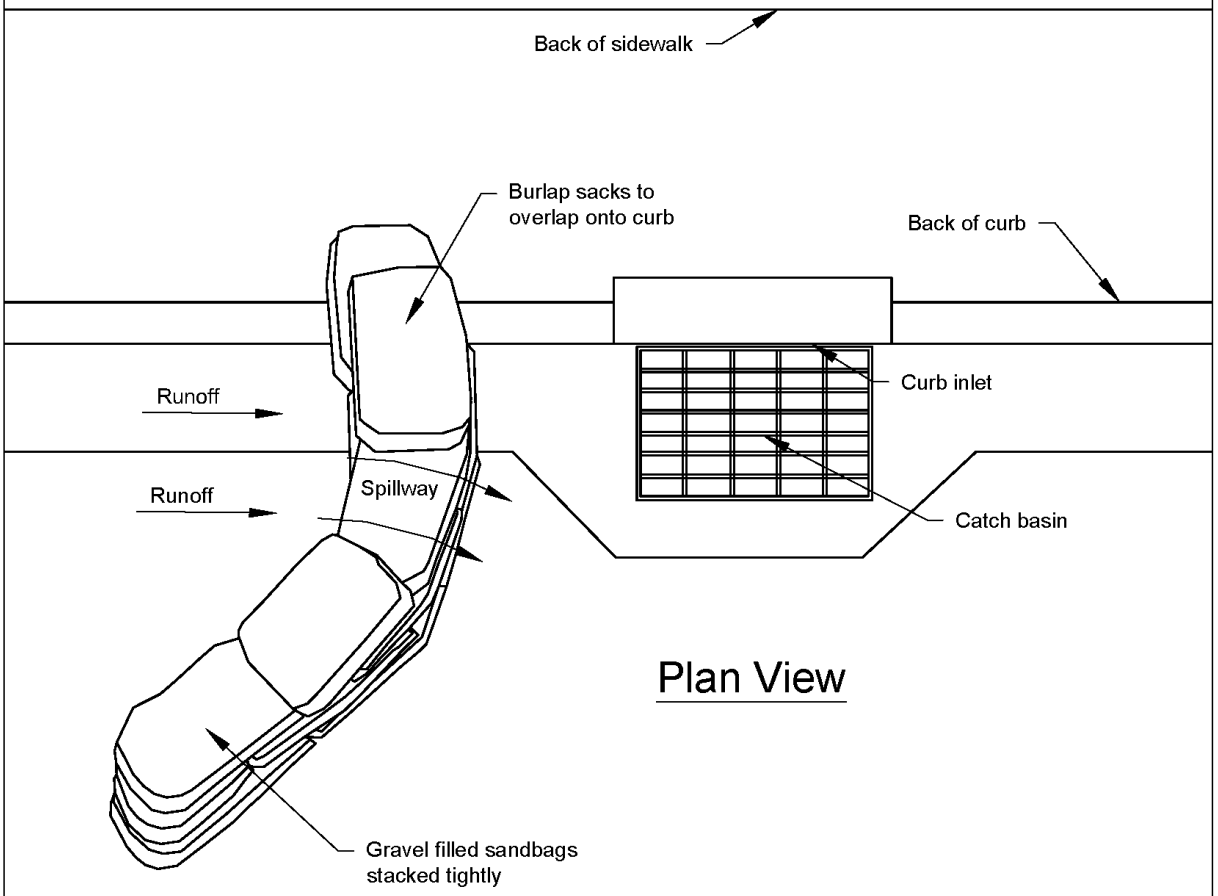
Revised June 2016

Curb and Gutter Sediment Barrier

Curb and gutter sediment barrier is a sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure II-3.19: Curb and Gutter Barrier. Design and installation specifications for curb and gutter sediment barrier include:

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet.
- Construct a horseshoe shaped sedimentation trap on the upstream side of the berm. Size the trap to sediment trap standards for protecting a culvert inlet.

Figure II-3.19: Curb and Gutter Barrier



Notes:

1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven 'geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

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Curb and Gutter Barrier

Revised June 2016

Maintenance Standards

- Inspect all forms of inlet protection frequently, especially after storm events. Clean and replace clogged catch basin filters. For rock and gravel filters, pull away the rocks from the inlet and clean or replace. An alternative approach would be to use the clogged rock as fill and put fresh rock around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

Approved as Functionally Equivalent

Ecology has approved products as able to meet the requirements of this BMP. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept these products, or may require additional testing prior to consideration for local use. Products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

~~BMP C231: Brush Barrier~~

~~Purpose~~

~~The purpose of brush barriers is to reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.~~

~~Conditions of Use~~

- ~~Brush barriers may be used downslope of disturbed areas that are less than one-quarter acre.~~
- ~~Brush barriers are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be directed to a sediment trapping BMP. The only circumstance in which overland flow can be treated solely by a brush barrier, rather than by a sediment trapping BMP, is when the area draining to the barrier is small.~~
- ~~Brush barriers should only be installed on contours.~~

~~Design and Installation Specifications~~

- ~~Height: 2 feet (minimum) to 5 feet (maximum).~~
- ~~Width: 5 feet at base (minimum) to 15 feet (maximum).~~
- ~~Filter fabric (geotextile) may be anchored over the brush berm to enhance the filtration ability of the barrier. Ten-ounce burlap is an adequate alternative to filter fabric.~~

BMP C233: Silt Fence

Purpose

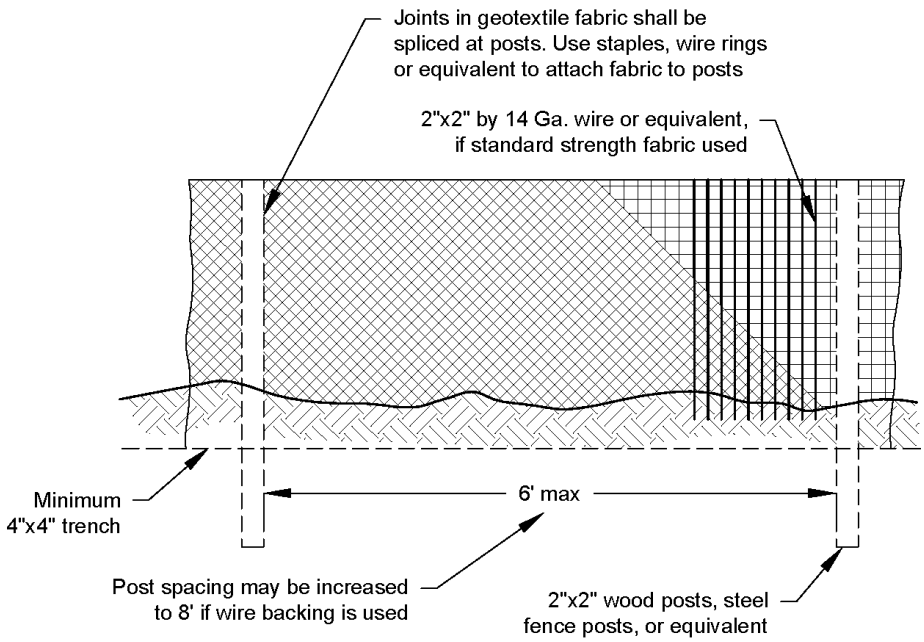
Silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

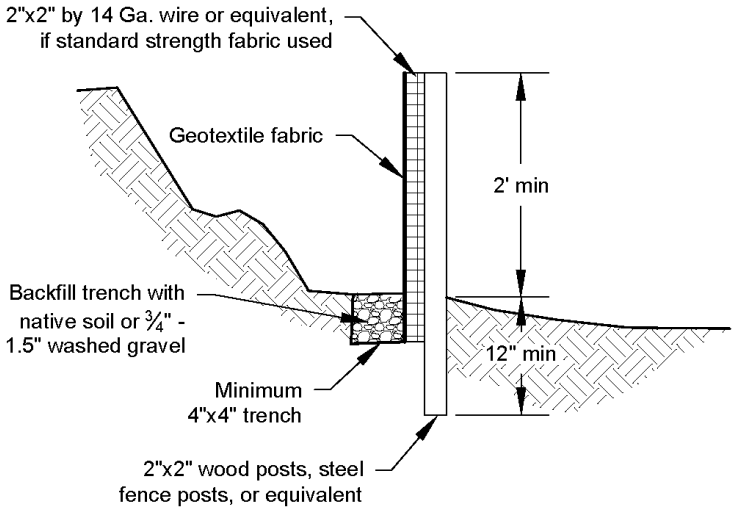
Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence shall prevent sediment carried by runoff from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Convey any concentrated flows through the drainage system to a sediment trapping BMP.
- Do not construct silt fences in streams or use in V-shaped ditches. Silt fences do not provide an adequate method of silt control for anything deeper than sheet or overland flow.

Figure II-3.22: Silt Fence





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State of Washington

Silt Fence

Revised July 2017

Design and Installation Specifications

- Use in combination with other construction stormwater BMPs.
- Maximum slope steepness (perpendicular to the silt fence line) 1H:1V.
- Maximum sheet or overland flow path length to the silt fence of 100 feet.
- Do not allow flows greater than 0.5 cfs.
- Use geotextile fabric that meets the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in Table II-3.11: Geotextile Fabric Standards for Silt Fence):

Table II-3.11: Geotextile Fabric Standards for Silt Fence

Geotextile Property	Minimum Average Roll Value
Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film woven (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Support standard strength geotextiles with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the geotextile. Silt fence materials are available that have synthetic mesh backing attached.
- Silt fence material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F to 120°F.
- One-hundred percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed, if permitted by the local jurisdiction.
- Refer to Figure II-3.22: Silt Fence for standard silt fence details. Include the following Standard Notes for silt fence on construction plans and specifications:

    1. The Contractor shall install and maintain temporary silt fences at the locations shown in the Plans.
    2. Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.

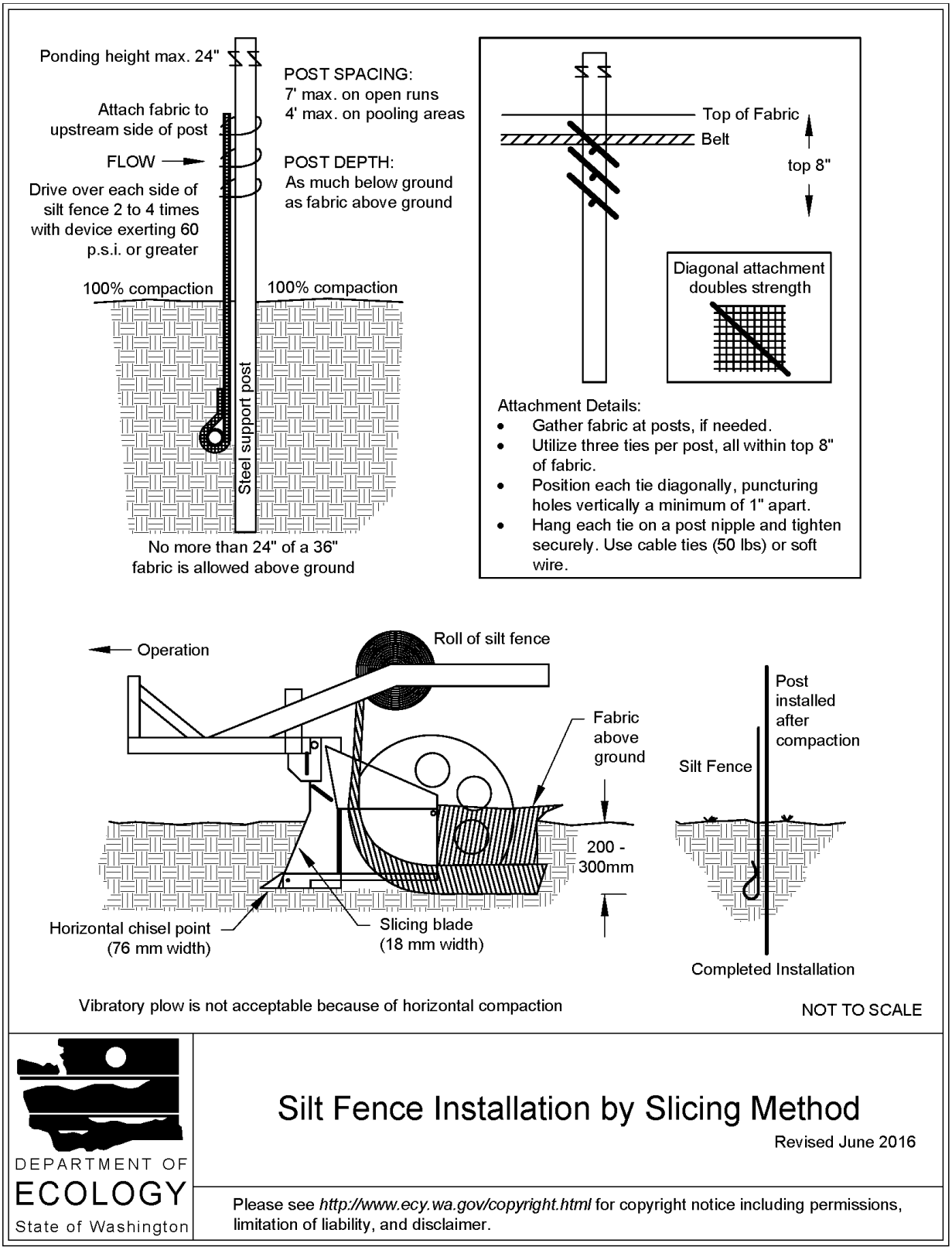
3. The silt fence shall have a 2-feet min. and a 2½-feet max. height above the original ground surface.
4. The geotextile fabric shall be sewn together at the point of manufacture to form fabric lengths as required. Locate all sewn seams at support posts. Alternatively, two sections of silt fence can be overlapped, provided that the overlap is long enough and that the adjacent silt fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.
5. Attach the geotextile fabric on the up-slope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the geotextile fabric to the posts in a manner that reduces the potential for tearing.
6. Support the geotextile fabric with wire or plastic mesh, dependent on the properties of the geotextile selected for use. If wire or plastic mesh is used, fasten the mesh securely to the up-slope side of the posts with the geotextile fabric up-slope of the mesh.
7. Mesh support, if used, shall consist of steel wire with a maximum mesh spacing of 2-inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the geotextile fabric it supports.
8. Bury the bottom of the geotextile fabric 4-inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the geotextile fabric, so that no flow can pass beneath the silt fence and scouring cannot occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the ground 3-inches min.
9. Drive or place the silt fence posts into the ground 18-inches min. A 12–inch min. depth is allowed if topsoil or other soft subgrade soil is not present and 18-inches cannot be reached. Increase fence post min. depths by 6 inches if the fence is located on slopes of 3H:1V or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.
10. Use wood, steel or equivalent posts. The spacing of the support posts shall be a maximum of 6-feet. Posts shall consist of either:
    - Wood with minimum dimensions of 2 inches by 2 inches by 3 feet. Wood shall be free of defects such as knots, splits, or gouges.
    - No. 6 steel rebar or larger.
    - ASTM A 120 steel pipe with a minimum diameter of 1-inch.
    - U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft.
    - Other steel posts having equivalent strength and bending resistance to the post sizes listed above.
11. Locate silt fences on contour as much as possible, except at the ends of the fence,

where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.

12. If the fence must cross contours, with the exception of the ends of the fence, place check dams perpendicular to the back of the fence to minimize concentrated flow and erosion. The slope of the fence line where contours must be crossed shall not be steeper than 3H:1V.
    - Check dams shall be approximately 1-foot deep at the back of the fence. Check dams shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence.
    - Check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Check dams shall be located every 10 feet along the fence where the fence must cross contours.

- Refer to Figure II-3.23: Silt Fence Installation by Slicing Method for slicing method details. The following are specifications for silt fence installation using the slicing method:
    1. The base of both end posts must be at least 2- to 4-inches above the top of the geotextile fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.
    2. Install posts 3- to 4-feet apart in critical retention areas and 6- to 7-feet apart in standard applications.
    3. Install posts 24-inches deep on the downstream side of the silt fence, and as close as possible to the geotextile fabric, enabling posts to support the geotextile fabric from upstream water pressure.
    4. Install posts with the nipples facing away from the geotextile fabric.
    5. Attach the geotextile fabric to each post with three ties, all spaced within the top 8-inches of the fabric. Attach each tie diagonally 45 degrees through the fabric, with each puncture at least 1-inch vertically apart. Each tie should be positioned to hang on a post nipple when tightening to prevent sagging.
    6. Wrap approximately 6-inches of the geotextile fabric around the end posts and secure with 3 ties.
    7. No more than 24-inches of a 36-inch geotextile fabric is allowed above ground level.
    8. Compact the soil immediately next to the geotextile fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips. Check and correct the silt fence installation for any deviation before compaction. Use a flat-bladed shovel to tuck the fabric deeper into the ground if necessary.

Figure II-3.23: Silt Fence Installation by Slicing Method



Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment trapping BMP.
- Check the uphill side of the silt fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence and remove the trapped sediment.
- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.
- Replace geotextile fabric that has deteriorated due to ultraviolet breakdown.

~~BMP C234: Vegetated Strip~~

~~Purpose~~

~~Vegetated strips reduce the transport of coarse sediment from a construction site by providing a physical barrier to sediment and reducing the runoff velocities of overland flow.~~

~~Conditions of Use~~

- ~~Vegetated strips may be used downslope of all disturbed areas.~~
- ~~Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to BMP C241: Sediment Pond (Temporary) or other sediment trapping BMP. The only circumstance in which overland flow can be treated solely by a vegetated strip, rather than by a sediment trapping BMP, is when the following criteria are met (see Table II-3.12: Contributing Drainage Area for Vegetated Strips):~~

~~Table II-3.12: Contributing Drainage Area for Vegetated Strips~~

~~Average Contributing Area Slope~~	~~Average Contributing Area Percent Slope~~	~~Max Contributing area Flowpath Length~~
~~1.5H : 1V or flatter~~	~~67% or flatter~~	~~100 feet~~
~~2H : 1V or flatter~~	~~50% or flatter~~	~~115 feet~~
~~4H : 1V or flatter~~	~~25% or flatter~~	~~150 feet~~
~~6H : 1V or flatter~~	~~16.7% or flatter~~	~~200 feet~~
~~10H : 1V or flatter~~	~~10% or flatter~~	~~250 feet~~

APPENDIX G – POLLUTION SOURCE SPECIFIC BMPS

IV-1 Source Control BMPs Applicable to All Sites

S410 BMPs for Correcting Illicit Discharges to Storm Drains

Description of Pollutant Sources: Illicit discharges are unpermitted sanitary or process wastewater discharges to a storm sewer or to surface water, rather than to a sanitary sewer, industrial process wastewater, or other appropriate treatment. They can also include swimming pool water, filter backwash, cleaning solutions/washwaters, cooling water, etc. Experience has shown that illicit discharges are common, particularly in older buildings.

Pollutant Control Approach: Identify and eliminate unpermitted discharges or obtain an NPDES permit, where necessary, particularly at industrial and commercial facilities.

Applicable Operational BMPs:

- For all real properties, responsible parties must examine their plumbing systems to identify any potential illicit discharges. Review site plans, engineering drawings, or other sources of information for the plumbing systems on the property.
- If an illicit discharge is suspected, trace the source using an appropriate method such as visual reconnaissance, smoke test, flow test, dye test with a nontoxic dye, or closed circuit television (CCTV) inspection. These tests are to be performed by qualified personnel such as a plumbing contractor. Note: Contact Ecology prior to performing a dye test which may result in a discharge to a receiving water.
- If illicit connections are found, permanently plug or disconnect the connections.
- Eliminate prohibited discharges to storm sewer, ground water, or surface water.
- Convey unpermitted discharges to a sanitary sewer if allowed by the local sewer authority, or to other approved treatment.
- Obtain all necessary permits for altering or repairing side sewers and plumbing fixtures. Restrictions on certain types of discharges, particularly industrial process waters, may require pretreatment of discharges before they enter the sanitary sewer. It is the responsibility of the property owner or business operator to obtain the necessary permits and to replace the connection.
- Obtain appropriate state and local permits for these discharges.

Recommended Additional Operational BMPs:

At commercial and industrial facilities, conduct a survey of wastewater discharge connections to storm drains and to surface water as follows:

- Conduct a field survey of buildings, particularly older buildings, and other industrial areas to locate storm drains from buildings and paved surfaces. Note where these discharge.
- During non-stormwater conditions, inspect each storm drain for non-stormwater discharges. Record the locations of all non-stormwater discharges. Include all permitted discharges.
- If useful, prepare a map of each area. Show on the map the known location of storm sewers, sanitary sewers, and permitted and unpermitted discharges. Aerial photos may be useful. Check records such as piping schematics to identify known side sewer connections and show these on the map. Consider using smoke, dye, or chemical analysis tests to detect connections between two conveyance systems (e.g., process water and stormwater). If desirable, conduct TV inspections of the storm drains and record the footage on videotape.
- Compare the observed locations of connections with the information on the map and revise the map accordingly. Note suspect connections that are inconsistent with the field survey.
- Identify all connections to storm sewers or to surface water and take the actions specified above as applicable BMPs.

~~S453 BMPs for Formation of a Pollution Prevention Team~~

~~The pollution prevention team should be responsible for implementing and maintaining all BMPs and treatment for the site. This team should be able to address any corrective actions needed on site to mitigate potential stormwater contamination. The team members should:~~

- ~~Consist of those people who are familiar with the facility and its operations.~~
- ~~Possess the knowledge and skills to assess conditions and activities that could impact stormwater quality at your facility, and who can evaluate the effectiveness of control measures.~~
- ~~Assign pollution prevention team staff to be on duty on a daily basis to cover applicable permittee facilities when those facilities are in operation.~~
- ~~Have the primary responsibility for developing and overseeing facility activities necessary to comply with stormwater requirements.~~
- ~~Have access to all applicable permit, monitoring, SWPPP, and other records.~~
- ~~Be trained in the operation, maintenance and inspections of all BMPs and reporting procedures.~~
- ~~Establish responsibilities for inspections, operation, maintenance, and emergencies.~~
- ~~Regularly meet to review overall facility operations and BMP effectiveness.~~

Maintenance Operations

- Use drip pans or absorbents wherever concrete, asphalt, asphalt emulsion, paint product, and drips are likely to spill, such as beneath discharge points from equipment.
- Cover and contain nearby storm drains to keep runoff from entering the drainage system.
- Collect and contain all solids, slurry, and rinse water. Do not allow these to enter gutters, storm drains, or drainage ditches or onto the paved surface of a roadway or driveway.
- Designate an area onsite for washing hand tools and collect that water for disposal.
- Conduct all fueling of equipment in accordance with S419 BMPs for Mobile Fueling of Vehicles and Heavy Equipment.
- Do not use diesel fuel for cleaning or prepping asphalt tools and equipment.
- Sweep areas as frequently as needed. Collect all loose aggregate and dust for disposal. Do not hose down areas into storm drains.
- Store all fuel, paint, and other products on secondary containment.
- Conduct paint striping operations during dry weather.

Recommended Additional BMPs:

- Where feasible and practicable, use roadway deicing chemicals that cause the least adverse environmental impact. Apply only as needed using minimum quantities. Consider the Pacific Northwest Snowfighters Qualified Products List when selecting roadway de-icers and anti-icers.
- Intensify roadway and drainage structure cleaning in early spring to help remove particulates from road surfaces.
- Include limits on toxic metals in the specifications for de/anti-icers.
- Install catch basin inserts to collect excess sediment and debris as necessary. Inspect and maintain catch basin inserts to ensure they are working correctly.
- Research admixtures (e.g. corrosion inhibitors, surfactants) to determine what additional pollutants may be an issue. Verify with the local jurisdiction if there are any restrictions on admixtures.

S415 BMPs for Maintenance of Public and Private Utility Corridors and Facilities

Description of Pollutant Sources: Corridors and facilities at petroleum product pipelines, natural gas pipelines, water pipelines, electrical power transmission corridors, and rights-of-way can be sources of pollutants such as herbicides used for vegetation management, and eroded soil particles from unpaved access roads. At pump stations, waste materials generated during maintenance activities may be temporarily stored outside. Additional potential pollutant sources include the leaching of

preservatives from wood utility poles, PCBs in older transformers, water removed from underground transformer vaults, and leaks/spills from petroleum pipelines. The following are potential pollutants: oil and grease, TSS, BOD, organics, PCBs, pesticides, and heavy metals.

Pollutant Control Approach: Implementation of spill control plans as well as control of fertilizer and pesticide applications, soil erosion, and site debris that can contaminate stormwater.

Applicable Operational BMPs:

- Minimize the amount of herbicides and other pesticides used to maintain access roads and facilities.
- Implement S411 BMPs for Landscaping and Lawn / Vegetation Management.
- Comply with WSDA Pesticide Regulations (see I-2.15 Other Requirements).
- When removing water or sediments from electric transformer vaults, determine the presence of contaminants before disposing of the water and sediments.
    - This includes inspecting for the presence of oil or sheen, and determining from records or testing if the transformers contain PCBs.
    - If records or tests indicate that the sediments or water are contaminated above applicable levels, manage these media in accordance with applicable federal and state regulations, including the federal PCB rules (40 CFR 761) and the state MTCA cleanup regulations (Chapter 173-340 WAC).
    - Water removed from the vaults can be discharged in accordance with the federal 40 CFR 761.79, and state regulations (Chapter 173-201A WAC and Chapter 173-200 WAC), or via the sanitary sewer if the requirements, including applicable permits, for such a discharge are met. (See also Requirements for Stormwater Discharges to Public Sanitary Sewers, Septic Systems, Dead-End Sumps, and Industrial Waste Treatment Systems and Ecology Requirements for Generators of Dangerous Wastes in I-2.15 Other Requirements).
- Stabilize access roads or areas of bare ground with gravel, crushed rock, or another method to prevent erosion. Use and manage vegetation to minimize bare ground/soils that may be susceptible to erosion.
- Provide maintenance practices to prevent stormwater from accumulating and draining across and/or onto roadways. Convey stormwater through roadside ditches and culverts. The road should be crowned, outsloped, water barred, or otherwise left in a condition not conducive to erosion. Appropriately maintaining grassy roadside ditches discharging to surface waters is an effective way of removing some pollutants associated with sediments carried by stormwater.
- Maintain ditches and culverts at an appropriate frequency to ensure that plugging and flooding across the roadbed, with resulting overflow erosion, does not occur.
- Apply the appropriate BMPs in this Volume for the storage of waste materials that can contaminate stormwater.

Recommended Operational BMPs:

- When selecting utility poles for a specific location, consider the potential environmental effects of the pole or poles during storage, handling, and end-use, as well as its cost, safety, efficacy, and expected life. Use wood products treated with chemical preservatives made in accordance with generally accepted industry standards such as the American Wood Preservers Association Standards (see http://www.awpa.com/standards/). Consider alternative materials or technologies if placing poles in or near an environmentally sensitive area, such as a wetland or a drinking water well. Alternative technologies include poles constructed with material (s) other than wood such as fiberglass composites, metal, or concrete. Consider other technologies and materials, such as sleeves or caissons for wood poles, when they are determined to be practicable and available.
- As soon as practicable remove all litter from wire cutting/replacing operations.
- Implement temporary erosion and sediment control in areas cleared of trees and vegetation and during the construction of new roads.

~~S416 BMPs for Maintenance of Roadside Ditches~~

~~**Description of Pollutant Sources:** Common road debris including eroded soil, oils, vegetative particles, and heavy metals can be sources of stormwater pollutants.~~

~~**Pollutant Control Approach:** Maintain roadside ditches to preserve the condition and capacity for which they were originally constructed, and to minimize bare or thinly vegetated ground surfaces. Maintenance practices should provide for erosion and sediment control (see S411 BMPs for Landscaping and Lawn / Vegetation Management).~~

~~**Additional Regulations:** Note that work in wet areas may be regulated by local, state, or federal regulations that impose additional obligations on the responsible party. Check with the appropriate authorities prior to beginning work in those areas.~~

~~Applicable Operational BMPs:~~

- ~~Inspect roadside ditches regularly to identify sediment accumulations and localized erosion.~~
- ~~Clean ditches on a regular basis, as needed. Keep ditches free of rubbish and debris.~~
- ~~Vegetation in ditches often prevents erosion and cleanses runoff waters. Remove vegetation only when flow is blocked or excess sediments have accumulated. Conduct ditch maintenance (seeding, fertilizer application, harvesting) in late spring and/or early fall, where possible. This allows re-establishment of vegetative cover by the next wet season thereby minimizing erosion of the ditch as well as making the ditch effective as a biofilter.~~
- ~~Do not apply fertilizer unless needed to maintain vegetative growth.~~
- ~~In the area between the edge of the pavement and the bottom of the ditch, commonly known as the "bare earth zone," use grass vegetation, wherever possible. Establish vegetation from the edge of the pavement, if possible, or at least from the top of the slope of the ditch.~~
- ~~Maintain diversion ditches on top of cut slopes constructed to prevent slope erosion by~~

intercepting surface drainage to retain their diversion shape and capability.

- Use temporary erosion and sediment control measures or re-vegetate as necessary to prevent erosion during ditch reshaping.
- Do not leave ditch cleanings on the roadway surfaces. Sweep, collect, and dispose of dirt and debris remaining on the pavement at the completion of ditch cleaning operations as described below:
    - Consider screening roadside ditch cleanings, not contaminated by spills or other releases and not associated with a stormwater treatment system such as a bioswale, to remove litter. Separate screenings into soil and vegetative matter (leaves, grass, needles, branches, etc.) categories. Compost or dispose of the vegetative matter in a municipal waste landfill. Consult with the jurisdictional health department to discuss use or disposal options for the soil portion. For more information, see Appendix IV-B: Management of Street Waste Solids and Liquids.
    - Roadside ditch cleanings contaminated by spills or other releases known or suspected to contain dangerous waste must be handled following the Dangerous Waste Regulations (Chapter 173-303 WAC). If testing determines materials are not dangerous waste but contaminants are present, consult with the jurisdictional health department for disposal options.
- Examine culverts on a regular basis for scour or sedimentation at the inlet and outlet, and repair as necessary. Give priority to those culverts conveying perennial and/or salmon-bearing streams and culverts near streams in areas of high sediment load, such as those near subdivisions during construction. Maintain trash racks to avoid damage, blockage, or erosion of culverts.

Recommended Treatment BMPs:

Install biofiltration swales and filter strips (see V-7 Biofiltration BMPs) to treat roadside runoff wherever practicable and use engineered topsoils wherever necessary to maintain adequate vegetation. These systems can improve infiltration and stormwater pollutant control upstream of roadside ditches.

S417 BMPs for Maintenance of Stormwater Drainage and Treatment Systems

Description of Pollutant Sources: Facilities include roadside catch basins on arterials and within residential areas, conveyance systems, detention facilities such as ponds and vaults, oil/water separators, biofilters, settling basins, infiltration systems, and all other types of stormwater treatment systems presented in Volume V. Oil and grease, hydrocarbons, debris, heavy metals, sediments and contaminated water are found in catch basins, oil and water separators, settling basins, etc.

Pollutant Control Approach: Provide maintenance and cleaning of debris, sediments, and other pollutants from stormwater collection, conveyance, and treatment systems to maintain proper operation.

Applicable Operational BMPs:

Maintain stormwater treatment facilities per the operations and maintenance (O&M) procedures presented in Appendix V-A: BMP Maintenance Tables in addition to the following BMPs:

- Inspect and clean treatment BMPs, conveyance systems, and catch basins as needed, and determine necessary O&M improvements.
- Promptly repair any deterioration threatening the structural integrity of stormwater facilities. These include replacement of clean-out gates, catch basin lids, and rock in emergency spillways.
- Ensure adequacy of storm sewer capacities and prevent heavy sediment discharges to the sewer system.
- Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and discharge to a sanitary sewer if approved by the sewer authority, or truck to an appropriate local or state government approved disposal site.
- Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to the invert of the lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe. Some catch basins (for example, WSDOT's *Catch Basin Type 1L* (WSDOT, 2011)) may have as little as 12 inches sediment storage below the invert. These catch basins need frequent inspection and cleaning to prevent scouring. Where these catch basins are part of a stormwater collection and treatment system, the system owner/operator may choose to concentrate maintenance efforts on downstream control devices as part of a systems approach.
- Properly dispose of all solids, polluted material, and stagnant water collected through system cleaning. Do not decant water back into the drainage system from eductor trucks or vacuum equipment since there may be residual contaminants in the cleaning equipment. Do not jet material downstream into the public drainage system.
- Clean woody debris in a catch basin as frequently as needed to ensure proper operation of the catch basin.
- Post warning signs; “Dump No Waste - Drains to Ground Water,” “Streams,” “Lakes,” or emboss on or adjacent to all storm drain inlets where possible.
- Disposal of sediments and liquids from the catch basins must comply with Appendix IV-B: Management of Street Waste Solids and Liquids.

~~S421 BMPs for Parking and Storage of Vehicles and Equipment~~

~~**Description of Pollutant Sources:** Public and commercial parking lots such as retail store, fleet vehicle (including rent-a-car lots and car dealerships), equipment sale and rental parking lots, and~~

can cause air pollution include grain dust, sawdust, coal, gravel, crushed rock, cement, and boiler fly ash. Air emissions can contaminate stormwater. The objective of this BMP is to reduce the stormwater pollutants caused by dust generation and control.

Pollutant Control Approach: Prevent dust generation and emissions where feasible, regularly clean-up dust that can contaminate stormwater, and convey dust contaminated stormwater to proper treatment.

Applicable BMPs:

- Clean, as needed, powder material handling equipment and vehicles.
- Regularly sweep dust accumulation areas that can contaminate stormwater. Conduct sweeping using vacuum filter equipment to minimize dust generation and to ensure optimal dust removal.
- Use dust filtration/collection systems such as baghouse filters, cyclone separators, etc. to control vented dust emissions that could contaminate stormwater. Control of zinc dusts in rubber production is one example.
- Maintain on-site controls to prevent vehicle track-out.
- Maintain dust collection devices on a regular basis.

Recommended BMPs:

- In manufacturing operations, train employees to handle powders carefully to prevent generation of dust.
- Use water spray to flush dust accumulations to sanitary sewers where allowed by the local sewer authority or to other appropriate treatment system.
- Use approved dust suppressants such as those listed in *Methods for Dust Control* (Ecology, 2016b). Application of some products may not be appropriate in close proximity to receiving waters or conveyances close to receiving waters. For more information check with Ecology or the local jurisdiction.

Recommended Treatment BMPs

Install sedimentation basins, wet ponds, wet vaults, catch basin filters, vegetated filter strips, or equivalent sediment removal BMPs.

S411 BMPs for Landscaping and Lawn / Vegetation Management

Description of Pollutant Sources: Landscaping can include grading, soil transfer, vegetation planting, and vegetation removal. Examples include weed control on golf course lawns, access roads, and utility corridors and during landscaping; and residential lawn/plant care. Proper management of vegetation can minimize excess nutrients and pesticides.

Pollutant Control Approach: Maintain appropriate vegetation to control erosion and the discharge of stormwater pollutants. Prevent debris contamination of stormwater. Where practicable, grow plant species appropriate for the site, or adjust the soil properties of the site to grow desired plant species.

Applicable BMPs:

- Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
- Select the right plants for the planting location based on proposed use, available maintenance,soil conditions, sun exposure, water availability, height, sight factors, and space available.
- Ensure that plants selected for planting are not on the noxious weed list. For example, butterfly bush often gets planted as an ornamental but is actually on the noxious weed list.

  The Washington State Noxious Weed List can be found at the following webpage:

  https://www.nwcb.wa.gov/printable-noxious-weed-list
- Do not dispose of collected vegetation into waterways or storm sewer systems.
- Do not blow vegetation or other debris into the drainage system.
- Dispose of collected vegetation such as grass clippings, leaves, sticks by composting or recycling.
- Remove, bag, and dispose of class A & B noxious weeds in the garbage immediately.
- Do not compost noxious weeds as it may lead to spreading through seed or fragment if the composting process is not hot enough.
- Use manual and/or mechanical methods of vegetation removal (pincer-type weeding tools, flame weeders, or hot water weeders as appropriate) rather than applying herbicides, where practical.
- Use at least an eight-inch "topsoil" layer with at least 8 percent organic matter to provide a sufficient vegetation-growing medium.
    - Organic matter is the least water-soluble form of nutrients that can be added to the soil. Composted organic matter generally releases only between 2 and 10 percent of its total nitrogen annually, and this release corresponds closely to the plant growth cycle. Return natural plant debris and mulch to the soil, to continue recycling nutrients indefinitely.
- Select the appropriate turfgrass mixture for the climate and soil type.
    - Certain tall fescues and rye grasses resist insect attack because the symbiotic endophytic fungi found naturally in their tissues repel or kill common leaf and stem-eating lawn insects.

        - The fungus causes no known adverse effects to the host plant or to humans.
        - Tall fescues and rye grasses do not repel root-feeding lawn pests such as Crane Fly larvae.
        - Tall fescues and rye grasses are toxic to ruminants such as cattle and sheep
    - Endophytic grasses are commercially available; use them in areas such as parks or golf courses where grazing does not occur.
    - Local agricultural or gardening resources such as Washington State University Extension office can offer advice on which types of grass are best suited to the area and soil type.
- Use the following seeding and planting BMPs, or equivalent BMPs, to obtain information on grass mixtures, temporary and permanent seeding procedures, maintenance of a recently planted area, and fertilizer application rates: BMP C120: Temporary and Permanent Seeding, BMP C121: Mulching, BMP C123: Plastic Covering, and BMP C124: Sodding.
- Adjusting the soil properties of the subject site can assist in selection of desired plant species. Consult a soil restoration specialist for site-specific conditions.

Recommended Additional BMPs:

- Conduct mulch-mowing whenever practicable.
- Use native plants in landscaping. Native plants do not require extensive fertilizer or pesticide applications. Native plants may also require less watering.
- Use mulch or other erosion control measures on soils exposed for more than one week during the dry season (May 1 to September 30) or two days during the rainy season (October 1 to April 30).
- Till a topsoil mix or composted organic material into the soil to create a well-mixed transition layer that encourages deeper root systems and drought-resistant plants.
- Apply an annual topdressing application of 3/8” compost. Amending existing landscapes and turf systems by increasing the percent organic matter and depth of topsoil can:
    - Substantially improve the permeability of the soil.
    - Increase the disease and drought resistance of the vegetation.
    - Reduces the demand for fertilizers and pesticides.
- Disinfect gardening tools after pruning diseased plants to prevent the spread of disease.
- Prune trees and shrubs in a manner appropriate for each species.
- If specific plants have a high mortality rate, assess the cause and replace with another more appropriate species.
- When working around and below mature trees, follow the most current American National Standards Institute (ANSI) ANSI A300 standards (see

http://www.tcia.org/TCIA/BUSINESS/ANSI_A300_Standards_/TCIA/BUSINESS/A300_Standards/A300_Standards.aspx?hkey=202ff566-4364-4686-b7c1-2a365af59669) and International Society of Arboriculture BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil).

- Monitor tree support systems (stakes, guys, etc.).
    - Repair and adjust as needed to provide support and prevent tree damage.
    - Remove tree supports after one growing season or maximum of 1 year.
    - Backfill stake holes after removal.
- When continued, regular pruning (more than one time during the growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location.
- Make reasonable attempts to remove and dispose of class C noxious weeds.
- Re-seed bare turf areas until the vegetation fully covers the ground surface.
- Watch for and respond to new occurrences of especially aggressive weeds such as Himalayan blackberry, Japanese knotweed, morning glory, English ivy, and reed canary grass to avoid invasions.
- Plant and protect trees per BMP T5.16: Tree Retention and Tree Planting.
- Aerate lawns regularly in areas of heavy use where the soil tends to become compacted. Conduct aeration while the grasses in the lawn are growing most vigorously. Remove layers of thatch greater than ¾-inch deep.
- Set the mowing height at the highest acceptable level and mow at times and intervals designed to minimize stress on the turf. Generally mowing only 1/3 of the grass blade height will prevent stressing the turf.
    - Mowing is a stress-creating activity for turfgrass.
    - Grass decreases its productivity when mowed too short and there is less growth of roots and rhizomes. The turf becomes less tolerant of environmental stresses, more disease prone and more reliant on outside means such as pesticides, fertilizers, and irrigation to remain healthy.

Additional BMP Information:

- King County's *Best Management Practices for Golf Course Development and Operation* (King County, 1993) has additional BMPs for Turfgrass Maintenance and Operation.
- King County, Seattle Public Utilities, and the Saving Water Partnership have created the following natural lawn and garden care resources that include guidance on building healthy soil with compost and mulch, selecting appropriate plants, watering, using alternatives to pesticides, and implementing natural lawn care techniques.

- *Natural Yard Care - Five steps to make your piece of the planet a healthier place to live* (King County and SPU, 2008)
- *The Natural Lawn & Garden Series: Smart Watering* (Saving Water Partnership, 2006)
- *Natural Lawn Care for Western Washington* (Saving Water Partnership, 2007)
- *The Natural Lawn & Garden Series: Growing Healthy Soil; Choosing the Right Plants; and Natural Pest, Weed and Disease Control* (Saving Water Partnership, 2012)

- The International Society of Arboriculture (ISA) is a group that promotes the professional practice of arboriculture and fosters a greater worldwide awareness of the benefits of trees through research, technology, and education. ISA standards used for managing trees, shrubs, and other woody plants are the American National Standards Institute (ANSI) A300 standards. The ANSI A300 standards are voluntary industry consensus standards developed by the Tree Care Industry Association (TCIA) and written by the Accredited Standards Committee (ASC). The ANSI standards can be found on the ISA website: www.isa-arbor.com/education/publications/index.aspx
- Washington State University's *Gardening in Washington State* website at http://gardening.wsu.edu contains Washington State specific information about vegetation management based on the type of landscape.
- See the *Pacific Northwest Plant Disease Management Handbook* (Pscheidt and Ocamb, 2016) for information on disease recognition and for additional resources.

~~S425 BMPs for Soil Erosion and Sediment Control at Industrial Sites~~

~~**Description of Pollutant Sources:** Industrial activities on soil areas; exposed and disturbed soils; steep grading; etc. can be sources of sediments that can contaminate stormwater runoff.~~

~~**Pollutant Control Approach:** Limit the exposure of erodible soil, stabilize, or cover erodible soil where necessary to prevent erosion, and/or provide treatment for stormwater contaminated with TSS caused by eroded soil.~~

~~Applicable BMPs:~~

- ~~Limit the exposure of erodible soil.~~
- ~~Stabilize entrances/exits to prevent track-out. See BMP C105: Stabilized Construction Access.~~
- ~~Stabilize or cover erodible soil to prevent erosion. Cover practice options include:~~
  - ~~Use vegetative cover such as grass, trees, shrubs, on erodible soil areas.~~
  - ~~Cover exposed areas with mats such as clear plastic, jute, synthetic fiber. See BMP C122: Nets and Blankets and BMP C123: Plastic Covering.~~

APPENDIX H – WWHM MODELING RESULTS

WWHM2012

PROJECT REPORT

POST MEDIA
STAGES 1 & 2

General Model Information

Project Name:	Basin 1_Stage 1&2
Site Name:	
Site Address:	
City:	
Report Date:	5/31/2023
Gage:	Blaine
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	19.419
C, Pasture, Flat	5.721
C, Lawn, Flat	8.224
Pervious Total	33.364

Impervious Land Use	acre
ROADS MOD	3.44
ROOF TOPS FLAT	1.286
Impervious Total	4.726
Basin Total	38.09

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	19.419
C, Pasture, Flat	5.721
C, Lawn, Flat	8.224
Pervious Total	33.364

Impervious Land Use	acre
ROADS MOD	3.44
ROOF TOPS FLAT	1.286
Impervious Total	4.726
Basin Total	38.09

Element Flows To:

Surface	Interflow	Groundwater
Sand Filter 1	Sand Filter 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Sand Filter 1

Bottom Length:	173.28 ft.
Bottom Width:	6.73 ft.
Depth:	1 ft.
Side slope 1:	0 To 1
Side slope 2:	2 To 1
Side slope 3:	2 To 1
Side slope 4:	2 To 1
Filtration On	
Hydraulic conductivity:	60
Depth of filter medium:	3.5
Total Volume Infiltrated (ac-ft.):	3637.53
Total Volume Through Riser (ac-ft.):	42.065
Total Volume Through Facility (ac-ft.):	3679.596
Percent Infiltrated:	98.86
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	0.5 ft.
Riser Diameter:	72 in.
Element Flows To:	
Outlet 1	Outlet 2

Sand Filter Hydraulic Table

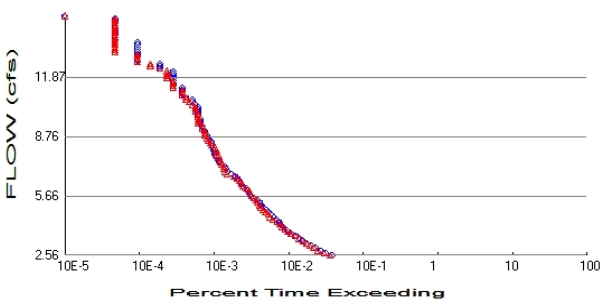
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.026	0.000	0.000	0.000
0.0111	0.026	0.000	0.000	1.624
0.0222	0.027	0.000	0.000	1.630
0.0333	0.027	0.000	0.000	1.635
0.0444	0.027	0.001	0.000	1.640
0.0556	0.027	0.001	0.000	1.645
0.0667	0.027	0.001	0.000	1.650
0.0778	0.027	0.002	0.000	1.655
0.0889	0.027	0.002	0.000	1.660
0.1000	0.027	0.002	0.000	1.666
0.1111	0.027	0.003	0.000	1.671
0.1222	0.027	0.003	0.000	1.676
0.1333	0.027	0.003	0.000	1.681
0.1444	0.028	0.004	0.000	1.686
0.1556	0.028	0.004	0.000	1.691
0.1667	0.028	0.004	0.000	1.696
0.1778	0.028	0.004	0.000	1.702
0.1889	0.028	0.005	0.000	1.707
0.2000	0.028	0.005	0.000	1.712
0.2111	0.028	0.005	0.000	1.717
0.2222	0.028	0.006	0.000	1.722
0.2333	0.028	0.006	0.000	1.727
0.2444	0.028	0.006	0.000	1.732
0.2556	0.029	0.007	0.000	1.737
0.2667	0.029	0.007	0.000	1.743
0.2778	0.029	0.007	0.000	1.748
0.2889	0.029	0.008	0.000	1.753
0.3000	0.029	0.008	0.000	1.758

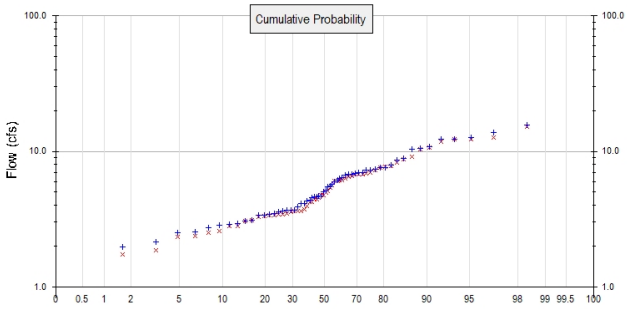
0.3111	0.029	0.008	0.000	1.763
0.3222	0.029	0.009	0.000	1.768
0.3333	0.029	0.009	0.000	1.773
0.3444	0.029	0.009	0.000	1.779
0.3556	0.029	0.010	0.000	1.784
0.3667	0.029	0.010	0.000	1.789
0.3778	0.030	0.010	0.000	1.794
0.3889	0.030	0.011	0.000	1.799
0.4000	0.030	0.011	0.000	1.804
0.4111	0.030	0.011	0.000	1.809
0.4222	0.030	0.012	0.000	1.815
0.4333	0.030	0.012	0.000	1.820
0.4444	0.030	0.012	0.000	1.825
0.4556	0.030	0.013	0.000	1.830
0.4667	0.030	0.013	0.000	1.835
0.4778	0.030	0.013	0.000	1.840
0.4889	0.031	0.014	0.000	1.845
0.5000	0.031	0.014	0.000	1.851
0.5111	0.031	0.014	0.074	1.856
0.5222	0.031	0.015	0.211	1.861
0.5333	0.031	0.015	0.387	1.866
0.5444	0.031	0.015	0.596	1.871
0.5556	0.031	0.016	0.834	1.876
0.5667	0.031	0.016	1.096	1.881
0.5778	0.031	0.016	1.381	1.887
0.5889	0.031	0.017	1.687	1.892
0.6000	0.032	0.017	2.013	1.897
0.6111	0.032	0.018	2.358	1.902
0.6222	0.032	0.018	2.720	1.907
0.6333	0.032	0.018	3.099	1.912
0.6444	0.032	0.019	3.494	1.917
0.6556	0.032	0.019	3.905	1.923
0.6667	0.032	0.019	4.330	1.928
0.6778	0.032	0.020	4.770	1.933
0.6889	0.032	0.020	5.224	1.938
0.7000	0.032	0.020	5.691	1.943
0.7111	0.033	0.021	6.171	1.948
0.7222	0.033	0.021	6.664	1.953
0.7333	0.033	0.022	7.170	1.959
0.7444	0.033	0.022	7.687	1.964
0.7556	0.033	0.022	8.217	1.969
0.7667	0.033	0.023	8.758	1.974
0.7778	0.033	0.023	9.310	1.979
0.7889	0.033	0.023	9.873	1.984
0.8000	0.033	0.024	10.44	1.989
0.8111	0.033	0.024	11.03	1.995
0.8222	0.033	0.024	11.62	2.000
0.8333	0.034	0.025	12.23	2.005
0.8444	0.034	0.025	12.84	2.010
0.8556	0.034	0.026	13.47	2.015
0.8667	0.034	0.026	14.10	2.020
0.8778	0.034	0.026	14.75	2.025
0.8889	0.034	0.027	15.40	2.031
0.9000	0.034	0.027	16.07	2.036
0.9111	0.034	0.028	16.74	2.041
0.9222	0.034	0.028	17.42	2.046
0.9333	0.034	0.028	18.11	2.051
0.9444	0.035	0.029	18.81	2.056

0.9556	0.035	0.029	19.51	2.061
0.9667	0.035	0.029	20.23	2.067
0.9778	0.035	0.030	20.95	2.072
0.9889	0.035	0.030	21.68	2.077
1.0000	0.035	0.031	22.42	2.082
1.0111	0.035	0.031	23.17	2.087

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 33.364
Total Impervious Area: 4.726

Mitigated Landuse Totals for POC #1
Total Pervious Area: 33.364
Total Impervious Area: 4.726

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	5.127937
5 year	7.884752
10 year	9.920597
25 year	12.720105
50 year	14.965768
100 year	17.34601

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	4.946328
5 year	7.665264
10 year	9.63765
25 year	12.303198
50 year	14.405331
100 year	16.601341

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	3.560	3.590
1950	6.930	6.912
1951	3.613	3.612
1952	2.879	2.564
1953	2.504	2.374
1954	7.403	7.219
1955	5.469	5.371
1956	5.951	6.019
1957	10.558	10.441
1958	4.634	4.580

1959	2.916	2.826
1960	3.699	3.634
1961	2.738	2.328
1962	5.135	4.963
1963	5.045	5.083
1964	13.826	12.324
1965	15.574	15.176
1966	12.225	11.808
1967	5.693	4.722
1968	4.278	4.227
1969	4.658	4.264
1970	3.481	3.359
1971	3.074	3.087
1972	7.962	7.639
1973	3.083	3.045
1974	4.354	4.451
1975	3.879	3.315
1976	7.548	7.760
1977	8.920	8.761
1978	6.107	6.113
1979	6.793	6.776
1980	4.524	4.402
1981	10.423	9.107
1982	7.011	6.794
1983	3.417	3.394
1984	12.602	12.632
1985	6.314	6.321
1986	12.255	12.381
1987	7.266	6.817
1988	2.541	2.513
1989	10.752	10.603
1990	5.554	5.619
1991	3.379	3.412
1992	3.681	3.452
1993	4.117	3.978
1994	1.959	1.665
1995	2.864	2.823
1996	6.716	6.934
1997	6.800	6.551
1998	2.147	1.861
1999	7.602	7.608
2000	3.662	3.282
2001	7.242	6.107
2002	4.615	3.620
2003	4.140	3.710
2004	8.604	8.232
2005	4.716	4.730
2006	6.893	6.500
2007	6.370	6.017
2008	1.978	1.745
2009	3.389	3.434

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	15.5738	15.1760
2	13.8262	12.6319
3	12.6021	12.3806

4	12.2553	12.3238
5	12.2251	11.8075
6	10.7521	10.6033
7	10.5577	10.4407
8	10.4231	9.1066
9	8.9197	8.7608
10	8.6043	8.2317
11	7.9622	7.7600
12	7.6018	7.6386
13	7.5479	7.6081
14	7.4028	7.2186
15	7.2657	6.9343
16	7.2422	6.9122
17	7.0112	6.8175
18	6.9299	6.7945
19	6.8934	6.7763
20	6.7997	6.5506
21	6.7934	6.4997
22	6.7160	6.3213
23	6.3697	6.1126
24	6.3142	6.1071
25	6.1070	6.0192
26	5.9508	6.0170
27	5.6932	5.6192
28	5.5540	5.3708
29	5.4690	5.0829
30	5.1350	4.9634
31	5.0451	4.7303
32	4.7157	4.7220
33	4.6577	4.5803
34	4.6344	4.4506
35	4.6152	4.4018
36	4.5238	4.2637
37	4.3535	4.2271
38	4.2781	3.9777
39	4.1399	3.7105
40	4.1168	3.6344
41	3.8790	3.6202
42	3.6989	3.6124
43	3.6812	3.5898
44	3.6625	3.4524
45	3.6129	3.4342
46	3.5602	3.4119
47	3.4814	3.3939
48	3.4175	3.3589
49	3.3887	3.3148
50	3.3792	3.2822
51	3.0832	3.0871
52	3.0740	3.0450
53	2.9160	2.8260
54	2.8795	2.8234
55	2.8639	2.5640
56	2.7382	2.5135
57	2.5415	2.3739
58	2.5038	2.3283
59	2.1465	1.8609
60	1.9784	1.7449
61	1.9591	1.6645

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
2.5640	825	771	93	Pass
2.6892	671	635	94	Pass
2.8145	566	532	93	Pass
2.9398	485	461	95	Pass
3.0651	428	406	94	Pass
3.1903	367	367	100	Pass
3.3156	328	330	100	Pass
3.4409	296	294	99	Pass
3.5661	266	259	97	Pass
3.6914	227	227	100	Pass
3.8167	208	208	100	Pass
3.9419	190	190	100	Pass
4.0672	178	174	97	Pass
4.1925	165	163	98	Pass
4.3178	159	150	94	Pass
4.4430	144	130	90	Pass
4.5683	135	120	88	Pass
4.6936	121	114	94	Pass
4.8188	113	104	92	Pass
4.9441	107	97	90	Pass
5.0694	97	90	92	Pass
5.1947	92	86	93	Pass
5.3199	88	82	93	Pass
5.4452	80	79	98	Pass
5.5705	72	73	101	Pass
5.6957	66	68	103	Pass
5.8210	63	65	103	Pass
5.9463	60	63	104	Pass
6.0715	54	58	107	Pass
6.1968	52	52	100	Pass
6.3221	49	50	102	Pass
6.4474	47	47	100	Pass
6.5726	44	43	97	Pass
6.6979	41	40	97	Pass
6.8232	36	32	88	Pass
6.9484	33	30	90	Pass
7.0737	31	29	93	Pass
7.1990	30	29	96	Pass
7.3243	27	27	100	Pass
7.4495	25	26	104	Pass
7.5748	24	26	108	Pass
7.7001	23	24	104	Pass
7.8253	22	23	104	Pass
7.9506	22	23	104	Pass
8.0759	21	23	109	Pass
8.2012	21	22	104	Pass
8.3264	20	20	100	Pass
8.4517	20	19	95	Pass
8.5770	19	18	94	Pass
8.7022	18	17	94	Pass
8.8275	17	16	94	Pass
8.9528	16	16	100	Pass
9.0780	16	16	100	Pass

9.2033	15	15	100	Pass
9.3286	15	15	100	Pass
9.4539	14	13	92	Pass
9.5791	14	13	92	Pass
9.7044	14	13	92	Pass
9.8297	13	13	100	Pass
9.9549	13	13	100	Pass
10.0802	13	12	92	Pass
10.2055	13	12	92	Pass
10.3308	13	12	92	Pass
10.4560	12	11	91	Pass
10.5813	11	10	90	Pass
10.7066	11	9	81	Pass
10.8318	9	9	100	Pass
10.9571	8	8	100	Pass
11.0824	8	8	100	Pass
11.2076	8	8	100	Pass
11.3329	8	6	75	Pass
11.4582	6	6	100	Pass
11.5835	6	6	100	Pass
11.7087	6	6	100	Pass
11.8340	6	5	83	Pass
11.9593	6	5	83	Pass
12.0845	6	5	83	Pass
12.2098	6	5	83	Pass
12.3351	4	4	100	Pass
12.4604	4	3	75	Pass
12.5856	4	3	75	Pass
12.7109	2	2	100	Pass
12.8362	2	2	100	Pass
12.9614	2	2	100	Pass
13.0867	2	2	100	Pass
13.2120	2	1	50	Pass
13.3372	2	1	50	Pass
13.4625	2	1	50	Pass
13.5878	2	1	50	Pass
13.7131	2	1	50	Pass
13.8383	1	1	100	Pass
13.9636	1	1	100	Pass
14.0889	1	1	100	Pass
14.2141	1	1	100	Pass
14.3394	1	1	100	Pass
14.4647	1	1	100	Pass
14.5900	1	1	100	Pass
14.7152	1	1	100	Pass
14.8405	1	1	100	Pass
14.9658	1	1	100	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	2.1447 acre-feet
On-line facility target flow:	1.3841 cfs.
Adjusted for 15 min:	1.3841 cfs.
Off-line facility target flow:	0.7748 cfs.
Adjusted for 15 min:	0.7748 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Sand Filter 1 POC	☐	3348.43			☐	0.00			
Total Volume Infiltrated		3348.43	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Basin 1_Stage 1&2.wdm
MESSU       25   PreBasin 1_Stage 1&2.MES
            27   PreBasin 1_Stage 1&2.L61
            28   PreBasin 1_Stage 1&2.L62
            30   POCBasin 1_Stage 1&21.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      13
      PERLND      16
      IMPLND       2
      IMPLND       4
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
   10     C, Forest, Flat         1    1    1    1   27    0
   13     C, Pasture, Flat        1    1    1    1   27    0
   16     C, Lawn, Flat           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
   13         0    0    1    0    0    0    0    0    0    0    0    0
   16         0    0    1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   13         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   10         0    0    0    0    0    0    0    0    0    0    0
   13         0    0    0    0    0    0    0    0    0    0    0
   16         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   10              0       4.5      0.08       400      0.05       0.5     0.996
   13              0       4.5      0.06       400      0.05       0.5     0.996
   16              0       4.5      0.03       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
   13              0         0         2         2         0         0         0
   16              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       0.7
   13           0.15       0.4       0.3         6       0.5       0.4
   16            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS      GWVS
   10              0         0         0         0       2.5          1         0
   13              0         0         0         0       2.5          1         0
   16              0         0         0         0       2.5          1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
```

```
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      19.419     COPY   501     12
PERLND  10                      19.419     COPY   501     13
PERLND  13                       5.721     COPY   501     12
PERLND  13                       5.721     COPY   501     13
PERLND  16                       8.224     COPY   501     12
PERLND  16                       8.224     COPY   501     13
IMPLND   2                        3.44     COPY   501     15
IMPLND   4                       1.286     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                       in  out                              ***
  END GEN-INFO
  *** Section RCHRES***
```

```
  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                    ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
           FG FG FG FG  possible  exit  *** possible  exit      possible  exit
            *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                       ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Basin 1_Stage 1&2.wdm
MESSU       25   MitBasin 1_Stage 1&2.MES
            27   MitBasin 1_Stage 1&2.L61
            28   MitBasin 1_Stage 1&2.L62
            30   POCBasin 1_Stage 1&21.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      13
      PERLND      16
      IMPLND       2
      IMPLND       4
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Sand Filter  1             MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                        in  out           ***
   10     C, Forest, Flat         1    1    1    1   27    0
   13     C, Pasture, Flat        1    1    1    1   27    0
   16     C, Lawn, Flat           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
```

```
   13         0    0    1    0    0    0    0    0    0    0    0    0
   16         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   13         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   10         0    0    0    0    0    0    0    0    0    0    0
   13         0    0    0    0    0    0    0    0    0    0    0
   16         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   10              0       4.5      0.08       400      0.05       0.5     0.996
   13              0       4.5      0.06       400      0.05       0.5     0.996
   16              0       4.5      0.03       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
   13              0         0         2         2         0         0         0
   16              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       0.7
   13           0.15       0.4       0.3         6       0.5       0.4
   16            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS       GWVS
   10              0         0         0         0       2.5          1          0
   13              0         0         0         0       2.5          1          0
   16              0         0         0         0       2.5          1          0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      19.419     RCHRES   1      2
PERLND  10                      19.419     RCHRES   1      3
PERLND  13                       5.721     RCHRES   1      2
PERLND  13                       5.721     RCHRES   1      3
PERLND  16                       8.224     RCHRES   1      2
PERLND  16                       8.224     RCHRES   1      3
IMPLND   2                        3.44     RCHRES   1      5
IMPLND   4                       1.286     RCHRES   1      5

******Routing******
PERLND  10                      19.419     COPY     1     12
PERLND  13                       5.721     COPY     1     12
PERLND  16                       8.224     COPY     1     12
IMPLND   2                        3.44     COPY     1     15
IMPLND   4                       1.286     COPY     1     15
PERLND  10                      19.419     COPY     1     13
PERLND  13                       5.721     COPY     1     13
PERLND  16                       8.224     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
```

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                         in  out                            ***
    1     Sand Filter  1          2    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                    ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
    1        0  1  0  0    4  5  0  0  0       0  0  0  0  0        2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.03       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                       ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPECT-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.026772  0.000000  0.000000  0.000000
  0.011111  0.026867  0.000298  0.000000  1.624829
  0.022222  0.026962  0.000597  0.000000  1.629970
  0.033333  0.027058  0.000897  0.000000  1.635112
  0.044444  0.027153  0.001198  0.000000  1.640254
  0.055556  0.027249  0.001501  0.000000  1.645396
  0.066667  0.027344  0.001804  0.000000  1.650538
  0.077778  0.027440  0.002108  0.000000  1.655680
  0.088889  0.027535  0.002414  0.000000  1.660822
  0.100000  0.027631  0.002720  0.000000  1.665963
  0.111111  0.027727  0.003028  0.000000  1.671105
  0.122222  0.027822  0.003336  0.000000  1.676247
  0.133333  0.027918  0.003646  0.000000  1.681389
  0.144444  0.028014  0.003957  0.000000  1.686531
  0.155556  0.028110  0.004268  0.000000  1.691673
  0.166667  0.028206  0.004581  0.000000  1.696815
```

0.177778	0.028302	0.004895	0.000000	1.701956
0.188889	0.028398	0.005210	0.000000	1.707098
0.200000	0.028494	0.005526	0.000000	1.712240
0.211111	0.028590	0.005843	0.000000	1.717382
0.222222	0.028686	0.006162	0.000000	1.722524
0.233333	0.028782	0.006481	0.000000	1.727666
0.244444	0.028879	0.006801	0.000000	1.732808
0.255556	0.028975	0.007123	0.000000	1.737950
0.266667	0.029071	0.007445	0.000000	1.743091
0.277778	0.029167	0.007769	0.000000	1.748233
0.288889	0.029264	0.008093	0.000000	1.753375
0.300000	0.029360	0.008419	0.000000	1.758517
0.311111	0.029457	0.008746	0.000000	1.763659
0.322222	0.029553	0.009074	0.000000	1.768801
0.333333	0.029650	0.009402	0.000000	1.773943
0.344444	0.029747	0.009732	0.000000	1.779084
0.355556	0.029843	0.010064	0.000000	1.784226
0.366667	0.029940	0.010396	0.000000	1.789368
0.377778	0.030037	0.010729	0.000000	1.794510
0.388889	0.030134	0.011063	0.000000	1.799652
0.400000	0.030231	0.011399	0.000000	1.804794
0.411111	0.030328	0.011735	0.000000	1.809936
0.422222	0.030425	0.012072	0.000000	1.815077
0.433333	0.030522	0.012411	0.000000	1.820219
0.444444	0.030619	0.012751	0.000000	1.825361
0.455556	0.030716	0.013091	0.000000	1.830503
0.466667	0.030813	0.013433	0.000000	1.835645
0.477778	0.030910	0.013776	0.000000	1.840787
0.488889	0.031007	0.014120	0.000000	1.845929
0.500000	0.031105	0.014465	0.000000	1.851070
0.511111	0.031202	0.014811	0.074635	1.856212
0.522222	0.031299	0.015159	0.211074	1.861354
0.533333	0.031397	0.015507	0.387724	1.866496
0.544444	0.031494	0.015856	0.596877	1.871638
0.555556	0.031592	0.016207	0.834077	1.876780
0.566667	0.031689	0.016558	1.096316	1.881922
0.577778	0.031787	0.016911	1.381389	1.887064
0.588889	0.031884	0.017265	1.687583	1.892205
0.600000	0.031982	0.017620	2.013525	1.897347
0.611111	0.032080	0.017975	2.358074	1.902489
0.622222	0.032178	0.018332	2.720269	1.907631
0.633333	0.032275	0.018690	3.099282	1.912773
0.644444	0.032373	0.019050	3.494390	1.917915
0.655556	0.032471	0.019410	3.904956	1.923057
0.666667	0.032569	0.019771	4.330412	1.928198
0.677778	0.032667	0.020134	4.770247	1.933340
0.688889	0.032765	0.020497	5.223997	1.938482
0.700000	0.032863	0.020862	5.691241	1.943624
0.711111	0.032962	0.021227	6.171590	1.948766
0.722222	0.033060	0.021594	6.664687	1.953908
0.733333	0.033158	0.021962	7.170201	1.959050
0.744444	0.033256	0.022331	7.687822	1.964191
0.755556	0.033355	0.022701	8.217264	1.969333
0.766667	0.033453	0.023072	8.758253	1.974475
0.777778	0.033551	0.023445	9.310537	1.979617
0.788889	0.033650	0.023818	9.873872	1.984759
0.800000	0.033748	0.024192	10.44803	1.989901
0.811111	0.033847	0.024568	11.03280	1.995043
0.822222	0.033946	0.024944	11.62797	2.000184
0.833333	0.034044	0.025322	12.23334	2.005326
0.844444	0.034143	0.025701	12.84872	2.010468
0.855556	0.034242	0.026081	13.47393	2.015610
0.866667	0.034340	0.026462	14.10881	2.020752
0.877778	0.034439	0.026844	14.75316	2.025894
0.888889	0.034538	0.027227	15.40685	2.031036
0.900000	0.034637	0.027612	16.06970	2.036178
0.911111	0.034736	0.027997	16.74156	2.041319
0.922222	0.034835	0.028383	17.42229	2.046461
0.933333	0.034934	0.028771	18.11174	2.051603
0.944444	0.035033	0.029160	18.80977	2.056745

```
  0.955556  0.035132  0.029550  19.51623  2.061887
  0.966667  0.035231  0.029941  20.23101  2.067029
  0.977778  0.035331  0.030333  20.95396  2.072171
  0.988889  0.035430  0.030726  21.68495  2.077312
  1.000000  0.035529  0.031120  22.42387  2.082454
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>             <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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WWHM2012

PROJECT REPORT

POST MEDIA
STAGE 3

General Model Information

Project Name:	Basin 1_Stage 3
Site Name:	
Site Address:	
City:	
Report Date:	5/31/2023
Gage:	Blaine
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	19.419
C, Pasture, Flat	5.721
C, Lawn, Flat	8.224
Pervious Total	33.364

Impervious Land Use	acre
ROADS MOD	3.44
ROOF TOPS FLAT	1.286
Impervious Total	4.726
Basin Total	38.09

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	19.419
C, Pasture, Flat	5.721
C, Lawn, Flat	8.224
Pervious Total	33.364

Impervious Land Use	acre
ROADS MOD	3.44
ROOF TOPS FLAT	1.286
Impervious Total	4.726
Basin Total	38.09

Element Flows To:

Surface	Interflow	Groundwater
Sand Filter 1	Sand Filter 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Sand Filter 1

Bottom Length:	130.90 ft.
Bottom Width:	6.48 ft.
Depth:	1 ft.
Side slope 1:	0 To 1
Side slope 2:	2 To 1
Side slope 3:	2 To 1
Side slope 4:	2 To 1
Filtration On	
Hydraulic conductivity:	60
Depth of filter medium:	3.5
Total Volume Infiltrated (ac-ft.):	3581.576
Total Volume Through Riser (ac-ft.):	97.457
Total Volume Through Facility (ac-ft.):	3679.033
Percent Infiltrated:	97.35
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	0.5 ft.
Riser Diameter:	72 in.
Element Flows To:	
Outlet 1	Outlet 2

Sand Filter Hydraulic Table

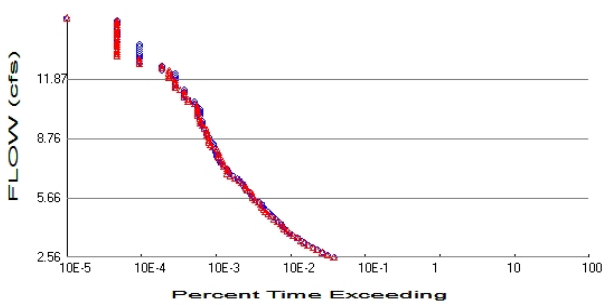
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.019	0.000	0.000	0.000
0.0111	0.019	0.000	0.000	1.181
0.0222	0.019	0.000	0.000	1.185
0.0333	0.019	0.000	0.000	1.189
0.0444	0.019	0.000	0.000	1.193
0.0556	0.019	0.001	0.000	1.196
0.0667	0.019	0.001	0.000	1.200
0.0778	0.020	0.001	0.000	1.204
0.0889	0.020	0.001	0.000	1.208
0.1000	0.020	0.002	0.000	1.211
0.1111	0.020	0.002	0.000	1.215
0.1222	0.020	0.002	0.000	1.219
0.1333	0.020	0.002	0.000	1.223
0.1444	0.020	0.002	0.000	1.226
0.1556	0.020	0.003	0.000	1.230
0.1667	0.020	0.003	0.000	1.234
0.1778	0.020	0.003	0.000	1.237
0.1889	0.020	0.003	0.000	1.241
0.2000	0.020	0.004	0.000	1.245
0.2111	0.020	0.004	0.000	1.249
0.2222	0.020	0.004	0.000	1.252
0.2333	0.021	0.004	0.000	1.256
0.2444	0.021	0.005	0.000	1.260
0.2556	0.021	0.005	0.000	1.264
0.2667	0.021	0.005	0.000	1.267
0.2778	0.021	0.005	0.000	1.271
0.2889	0.021	0.005	0.000	1.275
0.3000	0.021	0.006	0.000	1.279

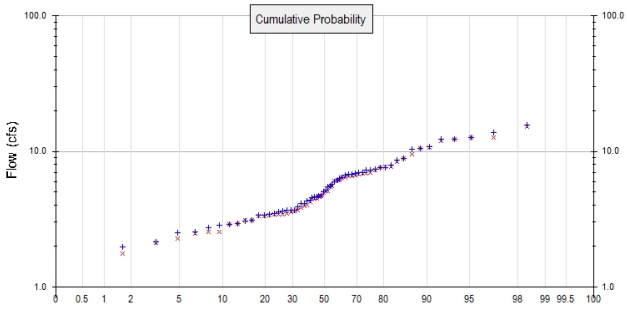
0.3111	0.021	0.006	0.000	1.282
0.3222	0.021	0.006	0.000	1.286
0.3333	0.021	0.006	0.000	1.290
0.3444	0.021	0.007	0.000	1.294
0.3556	0.021	0.007	0.000	1.297
0.3667	0.021	0.007	0.000	1.301
0.3778	0.022	0.007	0.000	1.305
0.3889	0.022	0.008	0.000	1.309
0.4000	0.022	0.008	0.000	1.312
0.4111	0.022	0.008	0.000	1.316
0.4222	0.022	0.008	0.000	1.320
0.4333	0.022	0.009	0.000	1.324
0.4444	0.022	0.009	0.000	1.327
0.4556	0.022	0.009	0.000	1.331
0.4667	0.022	0.009	0.000	1.335
0.4778	0.022	0.010	0.000	1.338
0.4889	0.022	0.010	0.000	1.342
0.5000	0.022	0.010	0.000	1.346
0.5111	0.022	0.010	0.074	1.350
0.5222	0.023	0.011	0.211	1.353
0.5333	0.023	0.011	0.387	1.357
0.5444	0.023	0.011	0.596	1.361
0.5556	0.023	0.011	0.834	1.365
0.5667	0.023	0.012	1.096	1.368
0.5778	0.023	0.012	1.381	1.372
0.5889	0.023	0.012	1.687	1.376
0.6000	0.023	0.012	2.013	1.380
0.6111	0.023	0.013	2.358	1.383
0.6222	0.023	0.013	2.720	1.387
0.6333	0.023	0.013	3.099	1.391
0.6444	0.023	0.013	3.494	1.395
0.6556	0.023	0.014	3.905	1.398
0.6667	0.024	0.014	4.330	1.402
0.6778	0.024	0.014	4.770	1.406
0.6889	0.024	0.015	5.224	1.410
0.7000	0.024	0.015	5.691	1.413
0.7111	0.024	0.015	6.171	1.417
0.7222	0.024	0.015	6.664	1.421
0.7333	0.024	0.016	7.170	1.424
0.7444	0.024	0.016	7.687	1.428
0.7556	0.024	0.016	8.217	1.432
0.7667	0.024	0.016	8.758	1.436
0.7778	0.024	0.017	9.310	1.439
0.7889	0.024	0.017	9.873	1.443
0.8000	0.024	0.017	10.44	1.447
0.8111	0.025	0.018	11.03	1.451
0.8222	0.025	0.018	11.62	1.454
0.8333	0.025	0.018	12.23	1.458
0.8444	0.025	0.018	12.84	1.462
0.8556	0.025	0.019	13.47	1.466
0.8667	0.025	0.019	14.10	1.469
0.8778	0.025	0.019	14.75	1.473
0.8889	0.025	0.020	15.40	1.477
0.9000	0.025	0.020	16.07	1.481
0.9111	0.025	0.020	16.74	1.484
0.9222	0.025	0.020	17.42	1.488
0.9333	0.025	0.021	18.11	1.492
0.9444	0.025	0.021	18.81	1.496

0.9556	0.026	0.021	19.51	1.499
0.9667	0.026	0.022	20.23	1.503
0.9778	0.026	0.022	20.95	1.507
0.9889	0.026	0.022	21.68	1.511
1.0000	0.026	0.022	22.42	1.514
1.0111	0.026	0.023	23.17	1.518

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 33.364
Total Impervious Area: 4.726

Mitigated Landuse Totals for POC #1
Total Pervious Area: 33.364
Total Impervious Area: 4.726

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	5.127937
5 year	7.884752
10 year	9.920597
25 year	12.720105
50 year	14.965768
100 year	17.34601

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	5.003699
5 year	7.752075
10 year	9.745423
25 year	12.438904
50 year	14.562807
100 year	16.781354

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	3.560	3.594
1950	6.930	6.869
1951	3.613	3.611
1952	2.879	2.546
1953	2.504	2.465
1954	7.403	7.269
1955	5.469	5.436
1956	5.951	6.024
1957	10.558	10.495
1958	4.634	4.650

1959	2.916	2.919
1960	3.699	3.678
1961	2.738	2.267
1962	5.135	5.078
1963	5.045	5.135
1964	13.826	12.699
1965	15.574	15.301
1966	12.225	11.939
1967	5.693	4.959
1968	4.278	4.264
1969	4.658	4.470
1970	3.481	3.422
1971	3.074	3.098
1972	7.962	7.729
1973	3.083	3.107
1974	4.354	4.451
1975	3.879	3.470
1976	7.548	7.665
1977	8.920	8.857
1978	6.107	6.151
1979	6.793	6.783
1980	4.524	4.461
1981	10.423	9.529
1982	7.011	6.834
1983	3.417	3.342
1984	12.602	12.617
1985	6.314	6.370
1986	12.255	12.363
1987	7.266	6.611
1988	2.541	2.557
1989	10.752	10.694
1990	5.554	5.584
1991	3.379	3.375
1992	3.681	3.438
1993	4.117	4.013
1994	1.959	1.495
1995	2.864	2.912
1996	6.716	6.935
1997	6.800	6.604
1998	2.147	2.108
1999	7.602	7.632
2000	3.662	3.312
2001	7.242	6.387
2002	4.615	3.860
2003	4.140	3.971
2004	8.604	8.358
2005	4.716	4.681
2006	6.893	6.651
2007	6.370	6.118
2008	1.978	1.762
2009	3.389	3.407

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	15.5738	15.3010
2	13.8262	12.6991
3	12.6021	12.6170

4	12.2553	12.3634
5	12.2251	11.9388
6	10.7521	10.6937
7	10.5577	10.4947
8	10.4231	9.5293
9	8.9197	8.8568
10	8.6043	8.3580
11	7.9622	7.7289
12	7.6018	7.6652
13	7.5479	7.6322
14	7.4028	7.2686
15	7.2657	6.9355
16	7.2422	6.8690
17	7.0112	6.8342
18	6.9299	6.7834
19	6.8934	6.6508
20	6.7997	6.6106
21	6.7934	6.6039
22	6.7160	6.3868
23	6.3697	6.3704
24	6.3142	6.1513
25	6.1070	6.1185
26	5.9508	6.0240
27	5.6932	5.5837
28	5.5540	5.4360
29	5.4690	5.1349
30	5.1350	5.0779
31	5.0451	4.9590
32	4.7157	4.6811
33	4.6577	4.6498
34	4.6344	4.4695
35	4.6152	4.4606
36	4.5238	4.4508
37	4.3535	4.2637
38	4.2781	4.0128
39	4.1399	3.9705
40	4.1168	3.8597
41	3.8790	3.6784
42	3.6989	3.6110
43	3.6812	3.5944
44	3.6625	3.4698
45	3.6129	3.4378
46	3.5602	3.4219
47	3.4814	3.4067
48	3.4175	3.3754
49	3.3887	3.3421
50	3.3792	3.3118
51	3.0832	3.1068
52	3.0740	3.0980
53	2.9160	2.9188
54	2.8795	2.9116
55	2.8639	2.5569
56	2.7382	2.5456
57	2.5415	2.4654
58	2.5038	2.2668
59	2.1465	2.1079
60	1.9784	1.7624
61	1.9591	1.4952

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
2.5640	825	803	97	Pass
2.6892	671	660	98	Pass
2.8145	566	567	100	Pass
2.9398	485	478	98	Pass
3.0651	428	426	99	Pass
3.1903	367	364	99	Pass
3.3156	328	323	98	Pass
3.4409	296	289	97	Pass
3.5661	266	259	97	Pass
3.6914	227	231	101	Fail
3.8167	208	208	100	Pass
3.9419	190	193	101	Fail
4.0672	178	174	97	Pass
4.1925	165	166	100	Pass
4.3178	159	157	98	Pass
4.4430	144	143	99	Pass
4.5683	135	127	94	Pass
4.6936	121	116	95	Pass
4.8188	113	106	93	Pass
4.9441	107	98	91	Pass
5.0694	97	92	94	Pass
5.1947	92	88	95	Pass
5.3199	88	84	95	Pass
5.4452	80	79	98	Pass
5.5705	72	71	98	Pass
5.6957	66	67	101	Pass
5.8210	63	66	104	Pass
5.9463	60	63	104	Pass
6.0715	54	56	103	Pass
6.1968	52	53	101	Pass
6.3221	49	53	108	Pass
6.4474	47	47	100	Pass
6.5726	44	43	97	Pass
6.6979	41	38	92	Pass
6.8232	36	33	91	Pass
6.9484	33	30	90	Pass
7.0737	31	30	96	Pass
7.1990	30	30	100	Pass
7.3243	27	27	100	Pass
7.4495	25	27	108	Pass
7.5748	24	26	108	Pass
7.7001	23	24	104	Pass
7.8253	22	23	104	Pass
7.9506	22	23	104	Pass
8.0759	21	23	109	Pass
8.2012	21	22	104	Pass
8.3264	20	19	95	Pass
8.4517	20	18	90	Pass
8.5770	19	17	89	Pass
8.7022	18	17	94	Pass
8.8275	17	17	100	Pass
8.9528	16	16	100	Pass
9.0780	16	16	100	Pass
9.2033	15	16	106	Pass

9.3286	15	15	100	Pass
9.4539	14	14	100	Pass
9.5791	14	13	92	Pass
9.7044	14	13	92	Pass
9.8297	13	13	100	Pass
9.9549	13	12	92	Pass
10.0802	13	12	92	Pass
10.2055	13	12	92	Pass
10.3308	13	12	92	Pass
10.4560	12	12	100	Pass
10.5813	11	11	100	Pass
10.7066	11	9	81	Pass
10.8318	9	9	100	Pass
10.9571	8	8	100	Pass
11.0824	8	8	100	Pass
11.2076	8	8	100	Pass
11.3329	8	7	87	Pass
11.4582	6	6	100	Pass
11.5835	6	6	100	Pass
11.7087	6	6	100	Pass
11.8340	6	6	100	Pass
11.9593	6	5	83	Pass
12.0845	6	5	83	Pass
12.2098	6	5	83	Pass
12.3351	4	5	125	Fail
12.4604	4	4	100	Pass
12.5856	4	4	100	Pass
12.7109	2	2	100	Pass
12.8362	2	2	100	Pass
12.9614	2	2	100	Pass
13.0867	2	1	50	Pass
13.2120	2	1	50	Pass
13.3372	2	1	50	Pass
13.4625	2	1	50	Pass
13.5878	2	1	50	Pass
13.7131	2	1	50	Pass
13.8383	1	1	100	Pass
13.9636	1	1	100	Pass
14.0889	1	1	100	Pass
14.2141	1	1	100	Pass
14.3394	1	1	100	Pass
14.4647	1	1	100	Pass
14.5900	1	1	100	Pass
14.7152	1	1	100	Pass
14.8405	1	1	100	Pass
14.9658	1	1	100	Pass

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.

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	2.1447 acre-feet
On-line facility target flow:	1.3841 cfs.
Adjusted for 15 min:	1.3841 cfs.
Off-line facility target flow:	0.7748 cfs.
Adjusted for 15 min:	0.7748 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Sand Filter 1 POC	☐	3347.92			☐	0.00			
Total Volume Infiltrated		3347.92	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Basin 1_Stage 3.wdm
MESSU       25   PreBasin 1_Stage 3.MES
            27   PreBasin 1_Stage 3.L61
            28   PreBasin 1_Stage 3.L62
            30   POCBasin 1_Stage 31.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      13
      PERLND      16
      IMPLND       2
      IMPLND       4
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
   10     C, Forest, Flat         1    1    1    1   27    0
   13     C, Pasture, Flat        1    1    1    1   27    0
   16     C, Lawn, Flat           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
   13         0    0    1    0    0    0    0    0    0    0    0    0
   16         0    0    1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   13         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   10         0    0    0    0    0    0    0    0    0    0    0
   13         0    0    0    0    0    0    0    0    0    0    0
   16         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   10              0       4.5      0.08       400      0.05       0.5     0.996
   13              0       4.5      0.06       400      0.05       0.5     0.996
   16              0       4.5      0.03       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
   13              0         0         2         2         0         0         0
   16              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       0.7
   13           0.15       0.4       0.3         6       0.5       0.4
   16            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS       AGWS      GWVS
   10              0         0         0         0       2.5          1         0
   13              0         0         0         0       2.5          1         0
   16              0         0         0         0       2.5          1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
```

```
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      19.419     COPY   501     12
PERLND  10                      19.419     COPY   501     13
PERLND  13                       5.721     COPY   501     12
PERLND  13                       5.721     COPY   501     13
PERLND  16                       8.224     COPY   501     12
PERLND  16                       8.224     COPY   501     13
IMPLND   2                        3.44     COPY   501     15
IMPLND   4                       1.286     COPY   501     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                       in  out                              ***
  END GEN-INFO
  *** Section RCHRES***
```

```
  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                    ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
           FG FG FG FG  possible  exit  *** possible  exit      possible  exit
            *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                       ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Basin 1_Stage 3.wdm
MESSU       25   MitBasin 1_Stage 3.MES
            27   MitBasin 1_Stage 3.L61
            28   MitBasin 1_Stage 3.L62
            30   POCBasin 1_Stage 31.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      13
      PERLND      16
      IMPLND       2
      IMPLND       4
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Sand Filter  1             MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
   10     C, Forest, Flat         1    1    1    1   27    0
   13     C, Pasture, Flat        1    1    1    1   27    0
   16     C, Lawn, Flat           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
```

```
   13         0    0    1    0    0    0    0    0    0    0    0    0
   16         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   13         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   10         0    0    0    0    0    0    0    0    0    0    0
   13         0    0    0    0    0    0    0    0    0    0    0
   16         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   10              0       4.5      0.08       400      0.05       0.5     0.996
   13              0       4.5      0.06       400      0.05       0.5     0.996
   16              0       4.5      0.03       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
   13              0         0         2         2         0         0         0
   16              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       0.7
   13           0.15       0.4       0.3         6       0.5       0.4
   16            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS       GWVS
   10              0         0         0         0       2.5          1          0
   13              0         0         0         0       2.5          1          0
   16              0         0         0         0       2.5          1          0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      19.419     RCHRES   1      2
PERLND  10                      19.419     RCHRES   1      3
PERLND  13                       5.721     RCHRES   1      2
PERLND  13                       5.721     RCHRES   1      3
PERLND  16                       8.224     RCHRES   1      2
PERLND  16                       8.224     RCHRES   1      3
IMPLND   2                        3.44     RCHRES   1      5
IMPLND   4                       1.286     RCHRES   1      5

******Routing******
PERLND  10                      19.419     COPY     1     12
PERLND  13                       5.721     COPY     1     12
PERLND  16                       8.224     COPY     1     12
IMPLND   2                        3.44     COPY     1     15
IMPLND   4                       1.286     COPY     1     15
PERLND  10                      19.419     COPY     1     13
PERLND  13                       5.721     COPY     1     13
PERLND  16                       8.224     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
```

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<----------------><---> User T-series  Engl Metr LKFG             ***
                                        in  out                             ***
    1     Sand Filter  1          2    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                    ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><--------><--------> ***
    1             1      0.02       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                       ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.019473  0.000000  0.000000  0.000000
  0.011111  0.019546  0.000217  0.000000  1.181840
  0.022222  0.019620  0.000434  0.000000  1.185580
  0.033333  0.019693  0.000653  0.000000  1.189320
  0.044444  0.019767  0.000872  0.000000  1.193060
  0.055556  0.019840  0.001092  0.000000  1.196800
  0.066667  0.019914  0.001313  0.000000  1.200540
  0.077778  0.019988  0.001535  0.000000  1.204280
  0.088889  0.020061  0.001757  0.000000  1.208020
  0.100000  0.020135  0.001980  0.000000  1.211760
  0.111111  0.020209  0.002204  0.000000  1.215500
  0.122222  0.020283  0.002429  0.000000  1.219240
  0.133333  0.020357  0.002655  0.000000  1.222980
  0.144444  0.020431  0.002882  0.000000  1.226720
  0.155556  0.020505  0.003109  0.000000  1.230460
  0.166667  0.020579  0.003337  0.000000  1.234200
```

0.177778	0.020653	0.003567	0.000000	1.237940
0.188889	0.020727	0.003796	0.000000	1.241680
0.200000	0.020801	0.004027	0.000000	1.245420
0.211111	0.020875	0.004259	0.000000	1.249160
0.222222	0.020950	0.004491	0.000000	1.252900
0.233333	0.021024	0.004724	0.000000	1.256640
0.244444	0.021098	0.004958	0.000000	1.260380
0.255556	0.021173	0.005193	0.000000	1.264120
0.266667	0.021247	0.005429	0.000000	1.267860
0.277778	0.021322	0.005665	0.000000	1.271600
0.288889	0.021396	0.005903	0.000000	1.275340
0.300000	0.021471	0.006141	0.000000	1.279080
0.311111	0.021545	0.006380	0.000000	1.282820
0.322222	0.021620	0.006619	0.000000	1.286560
0.333333	0.021695	0.006860	0.000000	1.290300
0.344444	0.021770	0.007102	0.000000	1.294040
0.355556	0.021844	0.007344	0.000000	1.297780
0.366667	0.021919	0.007587	0.000000	1.301520
0.377778	0.021994	0.007831	0.000000	1.305260
0.388889	0.022069	0.008076	0.000000	1.309000
0.400000	0.022144	0.008321	0.000000	1.312740
0.411111	0.022219	0.008568	0.000000	1.316480
0.422222	0.022294	0.008815	0.000000	1.320220
0.433333	0.022369	0.009063	0.000000	1.323960
0.444444	0.022445	0.009312	0.000000	1.327700
0.455556	0.022520	0.009562	0.000000	1.331440
0.466667	0.022595	0.009813	0.000000	1.335180
0.477778	0.022670	0.010064	0.000000	1.338920
0.488889	0.022746	0.010317	0.000000	1.342660
0.500000	0.022821	0.010570	0.000000	1.346400
0.511111	0.022897	0.010824	0.074635	1.350140
0.522222	0.022972	0.011078	0.211074	1.353880
0.533333	0.023048	0.011334	0.387724	1.357620
0.544444	0.023123	0.011591	0.596877	1.361360
0.555556	0.023199	0.011848	0.834077	1.365100
0.566667	0.023275	0.012106	1.096316	1.368840
0.577778	0.023350	0.012365	1.381389	1.372580
0.588889	0.023426	0.012625	1.687583	1.376320
0.600000	0.023502	0.012886	2.013525	1.380060
0.611111	0.023578	0.013147	2.358074	1.383800
0.622222	0.023654	0.013410	2.720269	1.387540
0.633333	0.023730	0.013673	3.099282	1.391280
0.644444	0.023806	0.013937	3.494390	1.395020
0.655556	0.023882	0.014202	3.904956	1.398760
0.666667	0.023958	0.014468	4.330412	1.402500
0.677778	0.024034	0.014734	4.770247	1.406240
0.688889	0.024110	0.015002	5.223997	1.409980
0.700000	0.024186	0.015270	5.691241	1.413720
0.711111	0.024263	0.015539	6.171590	1.417460
0.722222	0.024339	0.015809	6.664687	1.421200
0.733333	0.024415	0.016080	7.170201	1.424940
0.744444	0.024492	0.016352	7.687822	1.428680
0.755556	0.024568	0.016624	8.217264	1.432420
0.766667	0.024645	0.016898	8.758253	1.436160
0.777778	0.024721	0.017172	9.310537	1.439900
0.788889	0.024798	0.017447	9.873872	1.443640
0.800000	0.024874	0.017723	10.44803	1.447380
0.811111	0.024951	0.018000	11.03280	1.451120
0.822222	0.025028	0.018278	11.62797	1.454860
0.833333	0.025105	0.018556	12.23334	1.458600
0.844444	0.025181	0.018836	12.84872	1.462340
0.855556	0.025258	0.019116	13.47393	1.466080
0.866667	0.025335	0.019397	14.10881	1.469820
0.877778	0.025412	0.019679	14.75316	1.473560
0.888889	0.025489	0.019962	15.40685	1.477300
0.900000	0.025566	0.020245	16.06970	1.481040
0.911111	0.025643	0.020530	16.74156	1.484780
0.922222	0.025720	0.020815	17.42229	1.488520
0.933333	0.025798	0.021101	18.11174	1.492260
0.944444	0.025875	0.021388	18.80977	1.496000

```
  0.955556  0.025952  0.021676  19.51623  1.499740
  0.966667  0.026029  0.021965  20.23101  1.503480
  0.977778  0.026107  0.022255  20.95396  1.507220
  0.988889  0.026184  0.022545  21.68495  1.510960
  1.000000  0.026262  0.022837  22.42387  1.514700
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>             <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

```
ERROR/WARNING ID:   341   6

DATE/TIME: 1963/12/ 4 17: 0

RCHRES:     1

The volume of water in this reach/mixed reservoir is greater than the value
in the "volume" column of the last row of RCHTAB().  To continue the
simulation the table has been extrapolated, based on information contained
in the last two rows.  This will usually result in some loss of accuracy.
If depth is being calculated it will also cause an error condition.
Relevant data are:

NROWS         V1         V2        VOL
91  982.06     994.78    1016.1
```

```
ERROR/WARNING ID:   341   5

DATE/TIME: 1963/12/ 4 17: 0

RCHRES:     1

Calculation of relative depth, using Newton's method of successive
approximations, converged to an invalid value (not in range 0.0 to 1.0).
Probably ftable was extrapolated.  If extrapolation was small, no problem.
Remedy; extend ftable.  Relevant data are:

A          B          C      RDEP1      RDEP2  COUNT
3.3977E+00 2281.2     -6.114E+03    2.6695  2.6695E+00      3
```

Disclaimer

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APPENDIX I – ENGINEER'S ESTIMATE

City of Bellingham

DONALD AVENUE WATER QUALITY RETROFIT

Bellingham, Washington

PRELIMINARY ENGINEER'S ESTIMATE

Prepared: June 30, 2023

Estimate Prepared By:

Pacific Surveying and Engineering, Inc.
909 Squalicum Way, Suite 111
Bellingham, WA 98225
(360) 671-7387

Estimate Prepared For:

City of Bellingham
104 W. Magnolia St., Suite 109
Bellingham, WA 98225
(360) 778-7900

		ESTIMATED CONSTRUCTION COST			
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
1	Mobilization	1	LS	$ 100,000.00	$ 100,000.00
2	SPCC Plan	1	LS	$ 500.00	$ 500.00
3	Project Temporary Traffic Control	1	LS	$ 15,000.00	$ 15,000.00
4	Clearing and Grubbing	1	LS	$ 15,000.00	$ 15,000.00
5	Removal of Structures and Obstructions	1	LS	$ 10,000.00	$ 10,000.00
6	Sawcut Asphalt	425	LF-IN	$ 1.00	$ 425.00
7	Roadway Excavation Incl. Haul	1,075	CY	$ 25.00	$ 26,875.00
8	Embankment Compaction	650	CY	$ 20.00	$ 13,000.00
9	Pothole Existing Underground Utility	6	EA	$ 500.00	$ 3,000.00
10	Shoring or Extra Excavation Class B	650	SF	$ 1.00	$ 650.00
11	Construction Geotextile for Separation	350	SY	$ 10.00	$ 3,500.00
12	Gravel Base	275	TON	$ 25.00	$ 6,875.00
13	Crushed Surfacing Top Course	70	TON	$ 55.00	$ 3,850.00
14	Commercial HMA	10	TON	$ 200.00	$ 2,000.00
15	Temporary Trench Patch	150	SF	$ 5.00	$ 750.00
16	Post Media Structure	1	LS	$ 125,000.00	$ 125,000.00
17	Underdrain Pipe 6 In. Diam.	425	LF	$ 20.00	$ 8,500.00
18	Solid Wall PVC Storm Sewer Pipe 6 In. Diam.	10	LF	$ 200.00	$ 2,000.00
19	Solid Wall PVC Storm Sewer Pipe 8 In. Diam.	230	LF	$ 40.00	$ 9,200.00
20	Solid Wall PVC Storm Sewer Pipe 18 In. Diam.	240	LF	$ 75.00	$ 18,000.00
21	Distribution Trough and Weir	435	LF	$ 225.00	$ 97,875.00
22	Catch Basin Type 1	3	EA	$ 1,500.00	$ 4,500.00
23	Catch Basin Type 2 48 In. Diam.	3	EA	$ 4,500.00	$ 13,500.00
24	Catch Basin Type 2 72 In. Diam.	3	EA	$ 25,000.00	$ 75,000.00
25	Concrete Inlet	2	EA	$ 1,500.00	$ 3,000.00
26	Adjustments to Finished Grade	1	LS	$ 5,000.00	$ 5,000.00
27	Vault and Plug Valve Assembly	1	LS	$ 100,000.00	$ 100,000.00
28	Storm Sewer Cleanout	4	EA	$ 2,000.00	$ 8,000.00
29	Erosion Control and Water Pollution Prevention	1	LS	$ 10,000.00	$ 10,000.00
30	Landscaping	1	LS	$ 100,000.00	$ 100,000.00
31	POST Media Blending, Delivery, Protection, and Placement Plan	1	LS	$ 3,500.00	$ 3,500.00
32	Filter Mulch	160	SY	$ 12.00	$ 1,920.00
33	Primary Filter Media	85	CY	$ 650.00	$ 55,250.00
34	Secondary Filter Media	90	CY	$ 2,000.00	$ 180,000.00
35	Underdrain Media	55	CY	$ 200.00	$ 11,000.00
36	Wooden Split Rail Fence	295	LF	$ 40.00	$ 11,800.00
37	Mailbox Support, Type 1	5	EA	$ 750.00	$ 3,750.00
38	Bollard	12	EA	$ 1,500.00	$ 18,000.00
39	Permanent Signing	1	LS	$ 2,500.00	$ 2,500.00
40	Repair Existing Public and Private Facilities	1	EST	$ 10,000.00	$ 10,000.00
	Total				**$ 1,078,720.00**

Note:
This estimate was prepared without a complete design and shall therefore be considered preliminary and subject to change due to actual quantities of work incorporated into the project and changes in unit prices over time.

APPENDIX J – PROPOSED SCHEDULE

EV-0171

DONALD AVENUE WATER QUALITY FACILITY RETROFIT

WQC-2021-BELLPW-00018 GRANT EXPIRATION: 6/30/2025

ID	Task Name	Start	Finish
1	**Alternatives Analysis**	**Mon 10/10/22**	**Fri 12/16/22**
2	Review Vertical Hydraulic Limitations	Mon 10/10/22	Fri 10/21/22
3	Review Horizontal Space Constraints	Mon 10/24/22	Fri 11/4/22
4	Determine Physically Viable BMP's	Mon 10/24/22	Fri 11/11/22
5	Prepare alternatives analysis narrative and graphics	Mon 11/14/22	Fri 11/25/22
6	City to Review Altenatives Analysis and Finalize Project Direction	Mon 11/28/22	Fri 12/16/22
7	**Plans, Specs, and Estimate**	**Mon 12/19/22**	**Fri 11/3/23**
8	Prepare 30% Plans	Mon 12/19/22	Fri 1/13/23
9	City Review of 30% Plans	Mon 1/16/23	Fri 2/17/23
10	Prepare Preliminary Plans, Specs, and Estimate	Mon 2/20/23	Fri 3/17/23
11	Prepare Draft Design Report	Mon 2/20/23	Fri 4/7/23
12	City Review of 60% Plans, Specs, and Estimate	Mon 4/10/23	Fri 5/12/23
13	Incorporate City's 60% Comments Into Draft Design Report	Mon 5/15/23	Fri 5/26/23
14	Ecology Review of Draft Design Report	Mon 5/29/23	Fri 7/14/23
15	Prepare 90% Plans, Specs, and Estimate	Mon 7/17/23	Fri 8/4/23
16	Prepare Final Design Report	Mon 7/17/23	Fri 8/4/23
17	City Review of 90% Plans, Specs, and Estimate	Mon 8/7/23	Fri 9/1/23
18	Ecology Review of Final Design Report, 90% PS&E	Mon 8/7/23	Fri 9/22/23
19	Prepare Final Bid Plans, Specs, and Estimate	Mon 9/25/23	Fri 10/6/23
20	Ecology Review of Final Bid Package	Mon 10/9/23	Fri 11/3/23
21	**Permitting and Outreach**	**Thu 3/30/23**	**Wed 11/8/23**
22	SEPA	Mon 5/15/23	Fri 6/16/23
23	Shoreline Substantial Development Permit	Mon 6/19/23	Fri 9/8/23
24	Public Outreach	Thu 3/30/23	Wed 11/8/23
25	Prepare Inadvertent Discovery Plan	Mon 8/7/23	Wed 8/9/23
26	City Stormwater Permit	Mon 8/7/23	Fri 9/1/23
27	City Street Tree Permit	Mon 9/4/23	Fri 10/6/23
28	Construction Quality Assurance Plan	Mon 9/25/23	Tue 9/26/23
29	**Contractor Selection and Construction**	**Wed 4/17/24**	**Tue 11/5/24**
30	Solicit for Bids	Wed 4/17/24	Tue 4/30/24
31	Bidder Evaluation	Wed 5/1/24	Tue 5/7/24
32	Contract Award	Wed 5/8/24	Tue 6/4/24
33	Construction	Wed 6/5/24	Tue 10/22/24
34	Punchlist / Contract Closeout	Wed 10/23/24	Tue 11/5/24