Preliminary
Drainage Control Plan for
Evelyn Lane Light Industrial 1

Site Location:
7600 Evelyn Ln NE
Lacey, WA 98516

Prepared for:
Mardy Betschart
Betschart Investments 7520 LLC

Prepared by:
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Lacey, WA 98516
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Job No 21525
April 2023

Project Engineer's Certificate

"I hereby certify that this drainage and erosion control plan for the project known as Evelyn Lane Light Industrial 1 has been prepared by me or under my supervision and meets standard of care and expertise which is usual and customary in this community for professional engineers. I understand the City of Lacey does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

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Section 1: Proposed Project Description:
The project site is located in Lacey, Washington, within a portion of Section 2, Township 18 North, Range 1 West, W.M.

Site address: 7600 Evelyn Ln NE.

Tax Parcel No. 11802320300

Property Zoning: LI-C

Permits: Grading/Construction

Legal Description:
Section 02 Township 18 Range 1W Quarter NW SW BLA990654TC TR B Document 3257449

This project proposed to construct a 37,950 sf warehouse in place of the existing mini storage area. This lot was part of a BLA with the lot to the east. County parcel maps do not yet reflect the change. Future construction of a second warehouse will occur west of this proposed building. The lot is mostly impervious with gravel storage areas and mini storage buildings. West portion of this lot was previously outdoor storage for HD Fowler. Frontage improvements are proposed in phases to match the building construction. The onsite road, Evelyn Lane is private and entirely on this parcel. Properties to the west and south access through an easement. Onsite, parking lot and access road will be constructed along with water and sewer utility extension and stormwater collection system. The property generally slopes to the NE. Only neighboring parcel to the southwest that is not developed. Commercial lots across the road, to the north, west and east are mostly developed.

An infiltration gallery designed using WWHM2012 criteria will provide infiltration for roof runoff up to the 100 year storm and bioretention areas are proposed to provide enhanced treatment. Road runoff will be collected and bypass to maintain the current collection system for Evelyn Lane.

Area Tabulation:
Total of all project areas: 99,942 sf
Proposed Areas:

B1 Area	**81,947**
Paving	30,623
Sidewalks	2205
Buildings	37,950
Landscape	11,169
B1 ROW Area	**17,995**
Paving	9829
Sidewalks	187
Landscape	7978

Core Requirement #1 Preparation of Stormwater Site Plans and Reports

Per Figure 2.1

- Creates or adds 5,000 square feet, or more of new impervious surface area

Core Requirements 1-9 will apply to this project.

A Complete set of Stormwater facilities and conveyance will be prepared for this project to be review by and approved by the City of Lacey.

Core Requirement #2 Construction Stormwater Pollution Prevention

A SWPPP is provided in Attachment 2. (to be provided with final report at time of Construction Permit Submittal).

Core Requirement #3 Source Control of Pollution

Source Control plan is discussed in Section 8 and provided in Attachment 4 (to be provided with final report at time of Construction Permit Submittal).

Core Requirement #4 Preservation of Natural Drainage Systems and Outfalls

No natural drainage systems are found onsite. Evelyn Ln has an existing collection system in place on the north side of the road, consisting of several catch basins and road side ditches, this system is currently connecting to a ditch onsite to transmit runoff north. On the south side of the street, a shallow depressed ditch is located, (no outlet) and all systems are fully functional. Any onsite runoff sheet flows to the northeast and is infiltrated in place or in the ditch system located in the middle of the lot or along the north side of the lot. An existing 15" pipe discharges any runoff that doesn't infiltrate to the north. This pipe joins with Olympia Iron Works runoff and discharges to the undeveloped area north of Gateway Blvd NE. The proposed design maintains the same function by piping the Evelyn Lane runoff north for runoff from the east and west of our project site and maintains the same outlet and collection system for Olympic Iron Works.

Core requirement #5 Onsite Stormwater Management

LID performance standard is proposed for this project. Stormwater is being collected in several forms for infiltration up to the 100 year storm event.

The onsite roof area will be infiltrated on site in the proposed galleries.

Onsite parking lot, landscaping, and roads will be collected and sent to the proposed bioretention areas around the perimeter of the site for enhanced treatment and infiltration. The Evelyn Lane frontage and proposed access points are modeled as bypass areas and are joined with the Evelyn Lane runoff that is discharged to the north.

Post Construction Soil Quality and Depth will be applied to all disturbed areas of the project through several methods:

1. Retain and Protect Undisturbed Soil. For areas around the tree retention in the north and north east sections of the property.
2. Stockpile soil for the other areas with grading. Topsoil will be stockpiled on site for place back to the greatest extent possible.

3. Import Soil. For areas not meeting the required Soil Quality with stock pile and place back, imported soil will be used to meet the requirement.

See Section 4.

Core Requirement #6 Runoff Water Quality Treatment

Parking Lot and onsite road runoff is treated by the proposed bioretention areas. See Section 4.

Core Requirement #7 Flow Control

Flow control is handled in several ways. Onsite roads and onsite parking are sheet flowing to the perimeter bioretention areas for treatment and infiltration. Roof runoff is collected separately and piped directly to the proposed infiltration galleries on the east and west side of the proposed warehouse. Evelyn Lane has been modeled as bypass and did not require additional flow control when compared to pre-development conditions for the outdoor storage yard and existing paved road.

Core Requirement #8 Wetland Protection

No wetlands were found on or adjacent to the subject parcel.

Core Requirement #9 Operation and Maintenance

See Attachment 5 for Maintenance Plan (to be provided with final report at time of Construction Permit Submittal).

2.3.1 Financial Guarantees

20% Performance/Maintenance bond will be provided.

A Civil Site Plan was prepared to support the Site Plan Review application along with an Erosion Control Plan.

The project will amend all disturbed soils.

Section 2: Existing Conditions Description

Existing ground cover is mostly gravel for a lay down storage yard and outdoor RV storage. 5 ministorage buildings are located along the east property line.

The project is located in a Category 1 aquifer recharge area .

Drainage naturally flows to the northt, where any runoff infiltrated onsite or collected by the onsite ditches and continues north where is ultimately discharges to the undeveloped lot north of Gateway.

Marvin Rd and Evelyn Lane have existing stormwater collection systems in place.

Section 3: Vicinity Analysis and Subbasin Description

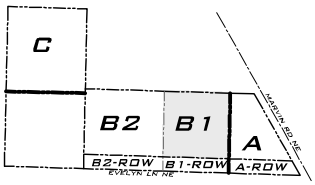
This parcel is one of the many commerical properties in the area. The west half is formerly a storage yard for HD Fowler and the eastern portion is an existing ministorage business. More storage is located to the west and east of the project site, Olympia Iron works is located to the north and general industrial south of Evelyn Lane. Only undeveloped parcel is located south and west of Evelyn Lane. The property is accessed by Evelyn Lane which has a functioning stormwater collection system. Basins are broken up into 2 areas, B1 ROW is Evelyn Ln and is bypassed and B1 is the portion outside the road easement for Evelyn Lane.

Refer to the next page for basin break out.

Project soils:

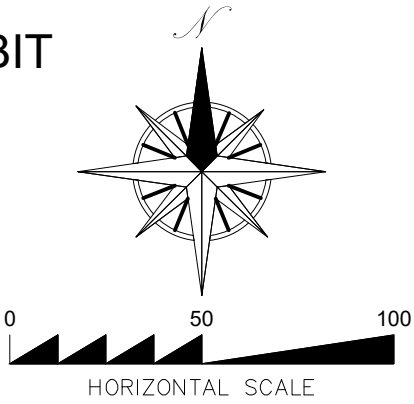
Type B soils, silty sand with gravel over shallow till. See full report in Appendix 4.

AREA CALCULATIONS EXHIBIT

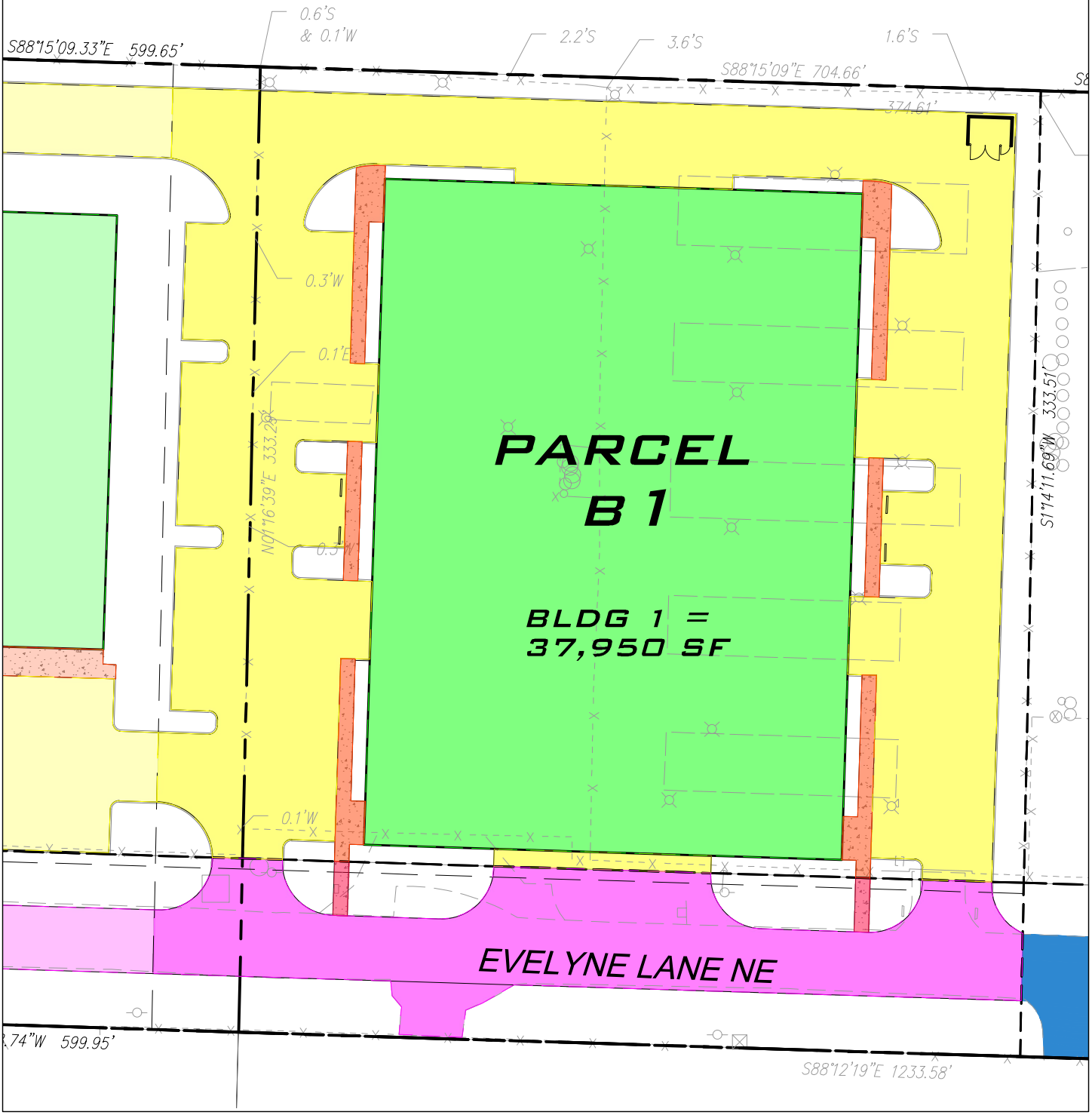


KEY PLAN

BETSCHART WAREHOUSE PARCEL B1 AREAS			
	DESCRIPTION	AREA (SF)	AREA (AC)
	PROPERTY AREA TOTAL	81,947	1.88
	PROPOSED ONSITE IMPERVIOUS AREAS		
	PROPOSED PAVEMENT	30,623	0.70
	PROPOSED CONCRETE	2,205	0.05
	PROPOSED BUILDINGS	37,950	0.87
	PROPOSED IMPERVIOUS AREAS TOTAL	70,778	1.62
	PROPOSED PERVIOUS AREAS TOTAL	11,169	0.26



HORIZONTAL SCALE



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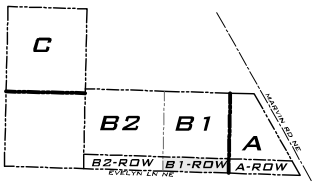
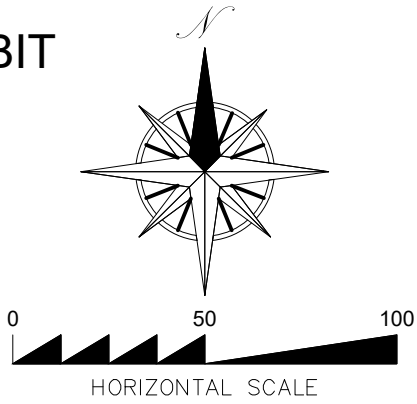
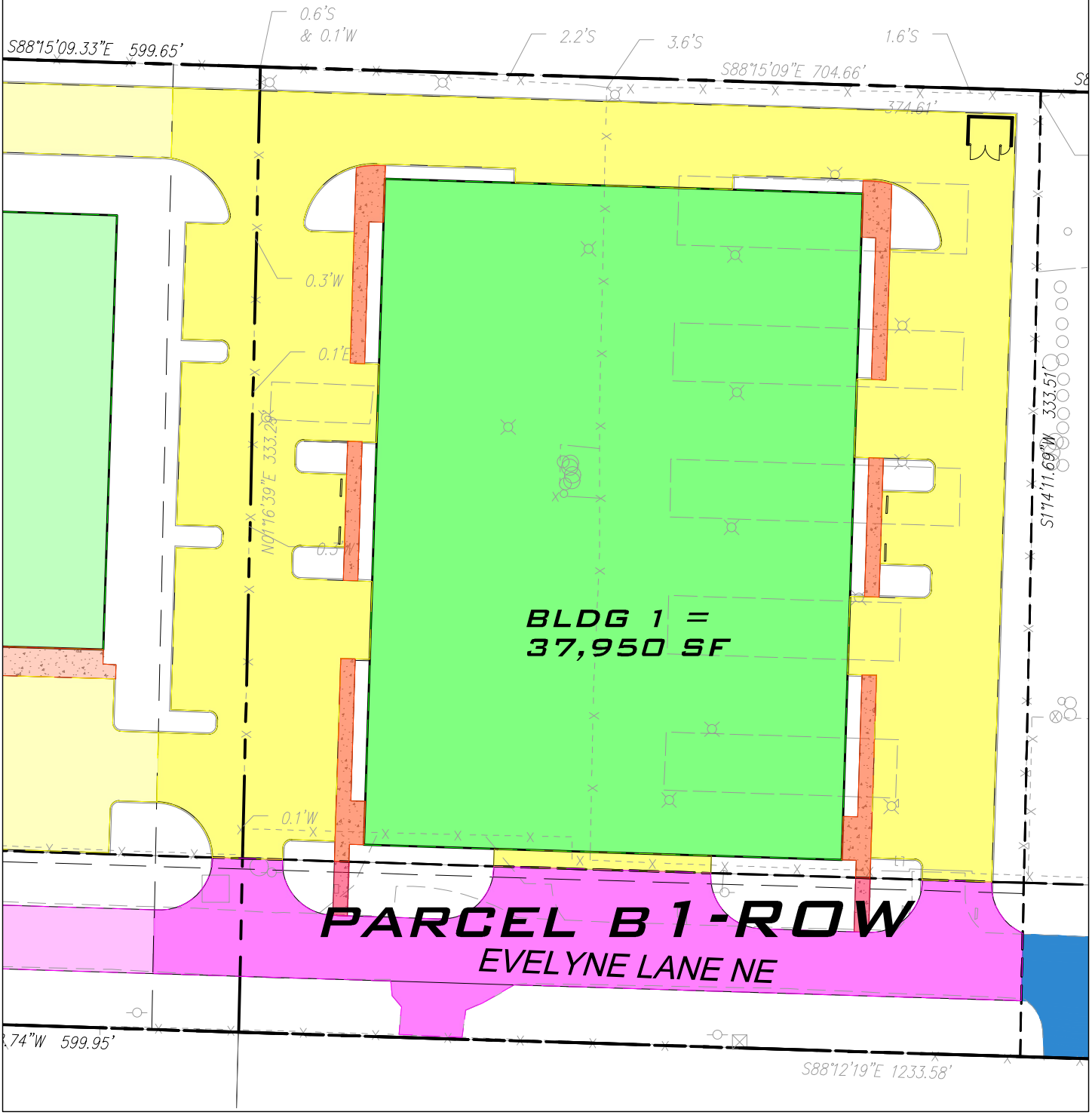


KEY PLAN

BETSCHART WAREHOUSE PARCEL B1-ROW AREAS			
	DESCRIPTION	AREA (SF)	AREA (AC)
	PROPERTY AREA TOTAL	17,995	0.41
PROPOSED ONSITE IMPERVIOUS AREAS			
	PROPOSED PAVEMENT	9,829	0.23
	PROPOSED CONCRETE	187	0.00
	PROPOSED IMPERVIOUS AREAS TOTAL	10,016	0.23
	PROPOSED PERVIOUS AREAS TOTAL	7,978	0.18





Section 4: Flow Control and Water Quality Sizing

This project is broken out into 2 main flow control areas:

1. Parking and landscaping are the largest areas onsite and is directed to the proposed stormwater facility for treatment and infiltration.
2. Roof Area: piped directly to the infiltration pond for flow control, water quality is not required.

   Note: the easement area for Evelyn Ln is designated as bypass.

Infiltration Basin

Facility sizing is based on 1.06"/hr infiltration rate (design rate provided by Quality Geo, refer to Attachment 3) using WWHM 2012 modeling. The roof infiltration trench facility will be located under the parking lot, with the base set 3' below finished grade., 2.5' total depth of gravel with 6" of paving section on top to finished grade. Gallery bottom will be elevation 222.5, top 225.0, finished grade 225.5- Required volume: 0.160 Acre-ft = 6969.6 CF,

Project is located within a Critical Aquifer Recharge Area, Category 1, requiring enhanced treatment that will be met with a bioretention system around the perimeter of the site (north, west and east lot lines)

Bioretention area will handle treatment and infiltration for the parking and landscape areas. The system will be 2' wide, 700 linear feet (total) and 3:1 side slopes.

Section 5: Aesthetic Considerations for Facilities

The infiltration gallery will be located under the parking lot and bioretention areas will be planted with native plants.

Section 6: Conveyance System Analysis and Design

Conveyance system is existing for offsite and onsite all runoff is in the form of sheet flow to the proposed bioretention areas. Overflows from the bioretention areas are at ground level and allow any excess runoff to reach the existing 15" conveyance pipe for discharge to the north.

Pipe capacity analysis will be provided with final drainage report at Construction Permit submittal.

Section 7: Covenants, Dedications, Easements

The project will maintain the proposed stormwater improvements for the development. See Attachment 5 (to be prepared with final report).

Section 8: Agreements and Guarantees

Bonds will be provided for stormwater and maintenance agreement will be submitted prior to final approval.

Section 9: Other Permits or Conditions Placed on the Project

Right of Way Permit

Attachment 1
Drainage Control Plans

Attachment 2
Construction SWPPP Report

Construction SWPPP for
Evelyn Lane Light Industrial 1

Site Location:
7600 Evelyn Ln NE
Lacey, WA 98516

Prepared for:
Mardy Betschart
Betschart Investments 7520 LLC

Prepared by:
Chris Cramer
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Lacey, WA 98516
360.459.1102
360.459.1013 Fax

CESCL:
TBD

Job No:21525
April 2023

I hereby state that this Construction Stormwater Pollution Prevention Plan for Evelyn Lane Light Industrial 1 has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that the City of Lacey does not and will not assume liability for the sufficiency, suitability, or performance of Construction SWPPP BMPs prepared by me.

CESCL INFORMATION:
TBD

Project Description:
This project proposed to construct a 37,950 sf warehouse in place of the existing mini storage area. This lot was part of a BLA with the lot to the east. County parcel maps do not yet reflect the change. Future construction of a second warehouse will occur west of this proposed building. The lot is mostly impervious with gravel storage areas and mini storage buildings. West portion of this lot was previously outdoor storage for HD Fowler. Frontage improvements are proposed in phases to match the building construction. The onsite road, Evelyn Lane is private and entirely on this parcel. Properties to the west and south access through an easement. Onsite, parking lot and access road will be constructed along with water and sewer utility extension and stormwater collection system. The property generally slopes to the NE. Only neighboring parcel to the southwest that is not developed. Commercial lots across the road, to the north, west and east are mostly developed.

An infiltration gallery designed using WWHM2012 criteria will provide infiltration for roof runoff up to the 100 year storm and bioretention areas are proposed to provide enhanced treatment. Road runoff will be collected and bypass to maintain the current collection system for Evelyn Lane.

There are no critical areas onsite or adjacent. The lot is generally slopes to the north
Soils are Type B with low erosion potential.

Construction Stormwater Pollution Prevention Plan

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 shall be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts. Refer to the applicable Land Use Approval (Site Plan Review, Plat, etc.) for tree retention and grading permit requirements. Consultation with the City of Lacey Tree Protection Professional and/or Public Works inspectors may be required prior to beginning land disturbing activities. Contact the City of Lacey Community Development Department for further information. Plastic, metal, or stake wire fence may be used to mark the clearing limits, per the City of Lacey Tree Protection Professional.

The duff layer, native top soil, and natural vegetation shall be retained in an undisturbed state to the maximum extent practicable. If it is not practicable to retain the duff layer in place, it should be stockpiled on-site, covered to prevent erosion, and replaced immediately upon completion of the ground disturbing activities.

Clearing limits will be clearly marked, the entire site will be cleared.
BMP C101 Preserving Natural Vegetation
BMP C103 High Visibility Plastic or metal fence

Element 2: **Establish Construction Access**
Construction vehicle access and exit shall be limited to one route, if possible.
Access points shall be stabilized with a pad of quarry spalls or crushed rock or other equivalent BMP to minimize the tracking of sediment onto public roads.

Wheel wash or tire baths shall be located onsite, if the stabilized construction entrance(s) is not effective in preventing sediment from being tracked onto public roads.
If sediment is tracked off site, public roads shall be cleaned thoroughly at the end of each day, or more frequently during wet weather. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing is allowed only after sediment is removed in this manner.

Street wash wastewater shall be controlled by pumping back onsite, or shall otherwise be prevented from discharging into systems tributary to waters of the state.

Construction entrance will be provided from Evelyn Lane
BMP C105 Stabilized Construction Entrance

Element 3: **Control Flow Rates**
Properties and waterways downstream from development sites shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site, as required by the City of Lacey.
Downstream analysis is necessary if changes in flows could impair or alter conveyance systems, streambanks, bed sediment or aquatic habitat. See Chapter 2 for offsite analysis requirements.

Erosion control devices will be installed during construction.
BMP C235 Wattles
BMP C240 Sediment trap (if needed)

Element 4: **Install Sediment Controls**
Prior to leaving a construction site, or prior to discharge to an infiltration facility, stormwater runoff from disturbed areas shall pass through a sediment pond or other appropriate sediment removal BMP. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard of Element #3. Full stabilization means concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetative cover in a manner that will fully prevent soil erosion.

Sediment ponds, vegetated buffer strips, sediment barriers or filters, dikes, and other BMPs intended to trap sediment onsite shall be constructed as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.
Earthen structures such as dams, dikes and diversions shall be seeded and mulched according to the timing indicated in Element #5.

BMPs intended to trap sediment on site must be located in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages, often during non-storm events, in response to rain event changes in stream elevation or wetted area. Refer to Core Requirement #4: Preservation of Natural Drainage Systems and Outfalls.

Catch basin socks will be installed in the existing collection system as well as silt fence/wattles.
BMP C233 Silt Fence
BMP C235 Wattles
BMP C220 Storm Drain inserts

Element 5: **Stabilize Soils**
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. From October 1 through April 30, no soils shall remain exposed and unworked for more than 2 days. From May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days. This condition applies to all onsite soils, whether at final grade or not. The local permitting authority may adjust these time limits if it can be shown that a development site's erosion or runoff potential justifies a different standard.

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

Soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on the weather forecast.

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

Soil stockpiles must be stabilized from erosion, protected with sediment trapping measures, and when possible, be located away from storm drain inlets, waterways and drainage channels. Linear construction activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall be conducted to meet the soil stabilization requirement. Contractors shall install the bedding materials, roadbeds, structures, pipelines, and/or utilities, and re-stabilize the disturbed soils so that:
- from October 1 through April 30 no soils shall remain exposed and unworked for more than 2 days; and
- from May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days.

BMP C162 Scheduling
BMP C120 Temporary and Permanent Seeding
BMP C121 Mulching

Element 6: **Protect Slopes**
Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Reduce slope runoff velocities by reducing the continuous length of slope with terracing and diversions, reduce slope steepness, and roughen slope surface.

Off-site stormwater (run-on) shall be diverted away from slopes and disturbed areas with interceptor dikes and/or swales. Off-site stormwater should be managed separately from stormwater generated on the site.

At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion. Temporary pipe slope drains shall handle the peak flow from a 10 year, 24 hour event assuming a Type 1A rainfall distribution. Alternatively, the 10-year and 25-year, 1-hour flow rates indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. If a 15-minute (or less) time step is used, no correction factor is required. Permanent pipe slope drains shall be sized for the 100-year, 24-hour storm event.
Provide drainage to remove ground water intersecting the slope surface of exposed soil areas. Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations.

Check dams shall be placed at regular intervals within channels that are cut down a slope, such that slopes are protected from erosive flows.
Stabilize soils on slopes, as specified in Element #5.

Site is flat and slopes stabilization is not necessary.
BMP C120 Temporary and permanent seeding
BMP C121 Mulching

Element 7: **Protect Drain Inlets**
In order to protect stormwater infrastructure and downstream water resources, all storm drain inlets made operable during construction shall be protected, as needed, so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment. All approach roads shall be kept clean. All sediment and street wash water shall be prevented from entering storm drains without prior and adequate treatment.

Inlets shall be inspected weekly at a minimum and daily during storm events. Inlet protection devices shall be cleaned or removed and replaced when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

Catch basin socks will be installed.
BMP C220 Storm Drain inserts

Element 8: **Stabilize Channels and Outlets**
All temporary on-site conveyance channels shall be designed, constructed and stabilized to prevent erosion from the expected peak 10 minute velocity of flow from a Type 1A, 10- year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow

rate indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used.
Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems.

Not required. Existing storm drainage system will remain in place.

Element 9: **Control Pollutants**
All pollutants, including waste materials and demolition debris, that occur onsite during construction shall be handled and disposed of in a manner that does not cause contamination of stormwater. Woody debris may be chopped and spread on-site.

Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site (see Chapter 173-304 WAC for the definition of inert waste). On-site fueling tanks shall be dual-walled or provided with secondary containment, and shall be prohibited within 100 ft. of City supply wells. 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. Report all spills within the City to the City Maintenance Center: 491-5644. Emergency repairs may be performed onsite using temporary plastic placed beneath and, if raining, over the vehicle. Wheel wash, or tire bath wastewater, shall be discharged to a separate onsite treatment system or to the sanitary sewer.

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 for application rates and procedures shall be followed. BMPs shall be used to prevent or treat contamination of stormwater runoff by pH-modifying sources. 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. Stormwater discharges shall not cause or contribute to a violation of the water quality standard for pH in the receiving water.

Construction sites with significant concrete work shall adjust the pH of stormwater if necessary to prevent violations of water quality standards. To use any pH adjustment chemical other than CO2 or dry ice, construction site operators shall obtain prior approval from the DOE and present evidence of said approval to the City.

BMP C151 Concrete Handling
BMP C152 Sawcutting and Surfacing Pollution Prevention
BMP C153 Material Delivery, storage and containment

Element 10: **Control De-Watering**
Foundation, vault, and trench de-watering water which has 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 #8. Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to state surface waters or the municipal drain system, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of the receiving waters. These clean waters should not be routed through a stormwater sediment pond.

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.

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

Dewatering is not expected to be required.
BMP C203 Water Bars

Element 11: **Maintain BMPs**
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 BMP specifications.

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 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.

BMP C160 Certified Erosion and Sediment Control Lead
BMP C150 Materials on Hand

Element 12: **Manage the Project**

Phasing of Construction - Development projects shall be phased where feasible in order to prevent soil erosion and, to the maximum extent practicable, the transport of sediment from the

project site during construction. Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.
Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan that establishes permitted areas of clearing, grading, cutting, and filling. 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 as may be required by the City of Lacey shall be delineated on the site plans and the development site.
Lot-specific grading plans, including information specified by the City of Lacey, such as finished grades, finished floor elevations, buildable areas, and identified drainage outlets, may be required prior to preliminary plat approval subject to site-specific conditions as determined by the City of Lacey.

Seasonal Work Limitations - From October 1 through April 30, clearing, grading, and other soil disturbing activities shall be prohibited unless shown to the satisfaction of the City of Lacey that sediment-laden runoff will be prevented from leaving the site through a combination of the following:

1. Favorable site conditions (including existing vegetative coverage, slope, soil type and proximity to receiving waters); and
2. Limitations on activities and the extent of disturbed areas; and
3. Proposed erosion and sediment control measures.

Based on the information provided and/or local weather conditions, the City of Lacey may expand or restrict the seasonal limitation on site disturbance. The City of Lacey shall take enforcement action - such as a notice of violation, administrative order, penalty, or stop-work order under the following circumstances:

. If, during the course of any construction activity or soil disturbance during the seasonal limitation period, sediment leaves the construction site causing a violation of the surface water quality standard; or

. If clearing and grading limits shown in the plans are not observed or if erosion and sediment control measures shown in the approved plan are not installed or maintained.

The following activities are exempt from the seasonal clearing and grading limitations:
Routine maintenance and necessary repair of erosion and sediment control BMPs;
Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the soil's vegetative cover; and
Activities where there is one hundred percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

The City of Lacey may restrict clearing and grading activities where site conditions may present a significant risk of impact to property or critical areas.

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.

Inspection and Monitoring - All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. The person must have the skills to 1) assess the site conditions and construction activities that could impact the quality of stormwater, and 2) assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

For construction sites one acre or larger that discharge stormwater to surface waters of the state, a Certified Erosion and Sediment Control Lead shall be identified in the Construction SWPPP and shall be on-site or on-call at all times. Certification may be obtained through an approved training program that meets the erosion and sediment control training standards established by the Department of Ecology. If a pre-construction meeting is held, this person shall attend. Refer to Chapter 4, BMP C160.

Sampling and analysis of the stormwater discharges from a construction site may be necessary on a case-by-case basis to ensure compliance with standards. Monitoring and reporting requirements may be established by the City when necessary.
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, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP - The Construction SWPPP shall be retained onsite or within reasonable access to the site.

The SWPPP shall be modified whenever there is a significant change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

The SWPPP shall be modified if during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) calendar days following the inspection.

If a Construction SWPPP is found to be inadequate (with respect to erosion and sediment control requirements), the City shall require that additional BMPs be implemented, as appropriate.

BMP C150 Materials On Hand
BMP C160 CESCL
BMP C162 Scheduling

Element #13: Protect Low Impact Development BMPs
Protect all Bioretention and Rain Garden BMPs from sedimentation through installation and maintenance of Construction SWPPP 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.

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.

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, including permeable pavement subgrade, reservoir course, or wearing course.

Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures shown in Chapter 7 of this manual or the manufacturer's procedures.
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.

See Section 5.3 for more details on protecting LID BMPs.

Bioretention areas and infiltration trench areas will be protected from compaction and sediment. Grading will be limited in these areas to ensure a protective barrier above the proposed facility base.

Attachment 3
Soils Report

2/24/2023

Betschart Investment 7520, LLC
Attn: Mardy Betschart
PO Box 5758
Lacey, WA

c/o: Patrick Harron & Associates, LLC
Attn: Chris Cramer, PE
8270 28th Court NE, Ste 201
Lacey, WA

Subject: **Geotechnical Services Report**
Betschart Infiltration Geotechnical Consultation
TPN: 11802320300, -100; 7600 Evelyne Ln NE, Lacey, WA
Project Number: QG23-008

Dear Client,

At your request, Quality Geo NW, PLLC (QG) has completed a soils investigation of the above referenced project. The investigation was performed in accordance with our proposal for professional services.

We would be pleased to continue our role as your geotechnical consultant of record during the project planning and construction phases, as local inspection firms have not been found to be as familiar or reliably experienced with geotechnical design. This may include soil subgrade inspections, periodic review of special inspection reports, or supplemental recommendations if changes occur during construction. We will happily meet with you at your convenience to discuss these and other additional *Time & Materials* services.

We thank you for the opportunity to be of service on this project and trust this report satisfies your project needs currently. QG wishes you the best while completing the project.

Respectfully Submitted,
Quality Geo NW, PLLC

Luke Preston McCann, L.E.G.
Owner + Principal

Ray Gean II
Staff Geologist/Project Manager

SOILS REPORT

BETSCHART INFILTRATION
TPN 11802320300, -100; 7600 EVELYNE LN NE
LACEY, WA

Betschart Investment 7520, LLC
Attn: Mardy Betschart
PO Box 5758
Lacey, WA

c/o: **Patrick Harron & Associates, LLC**
Attn: Chris Cramer, PE
8270 28th Court NE, Ste 201
Lacey, WA

Prepared by:

Alexander Barnes, G.I.T.
Staff Geologist/Laboratory Supervisor

Approved by:

State of Washington
Engineering Geologist
19110623
Licensed Geologist
2/24/2023
LUKE PRESTON MCCANN

Luke Preston McCann, L.E.G.
Principal Licensed Engineering Geologist

Quality Geo NW, PLLC
Geotechnical Investigation & Engineering Consultation
Phone: 360-878-9750 | Web: qualitygeonw.com
Mail: 4631 Whitman Ln SE, Ste D, Lacey, WA 98513

2/24/2023

QG Project # QG23-008

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the findings and recommendations of Quality Geo NW's (QG) soil investigation conducted in support of new site surface improvements.

1.1 PROJECT DESCRIPTION

QG understands the project entails the new construction of multiple structures within two presently developed parcels. QG has been contracted to perform a soils investigation of the proposed site to provide stormwater and earthwork recommendations.

1.2 FIELD WORK

Site exploration activities were performed on 1/20/2023. Exploration locations were marked in the field by a QG Staff Geologist with respect to the provided map and cleared for public conductible utilities. Our exploration locations were selected by an QG Staff Geologist prior to field work to provide safest access to relevant soil conditions. The geologist directed the advancement of 7 excavated test pits (TP). The test pits were advanced within the vicinity of the anticipated development footprint areas, to maximum depths of 6.0 feet below present grade (BPG) in general accordance with the specified contract depth.

During explorations QG logged each soil horizon we encountered, and field classified them in accordance with the Unified Soil Classification System (USCS). Representative soil samples were collected from each unit, identified according to boring location and depth, placed in plastic bags to protect against moisture loss, and were transported to the soil laboratory for supplemental classification and other tests.

Region & vicinity maps are included in Appendix A. Exploration locations are shown in Appendix B. Complete test pit logs are provided in Appendix C of this report. Laboratory results are shown in Appendix D.

2.0 EXISTING SITE CONDITIONS

2.1 AREA GEOLOGY

QG reviewed available map publications to assess known geologic conditions and hazards present at the site location. The Washington Geologic Information Portal (WGIP), maintained by the Department of Natural Resources Division of Geology and Earth Resources, provides 1:24,000-scale geologic mapping of the region. Geology of the site location and vicinity consists of Vashon Stade till (Qgt). The till deposits on site are generally described as "Unstratified and, in most exposures, highly compacted mixture of clay, silt, sand, and gravel deposited directly by glacier ice; gray where fresh and light yellowish brown where stained; unsorted and, in most exposures, of very low permeability… typically, weakly developed modern soil has formed on the cap of loose gravel, but the underlying till is unweathered; local textural features in the till include flow banding and apophyses commonly extending 10 to 15 ft downward into underlying sand and gravel that are oriented transverse to ice flow direction."

The WGIP Map also offers layers of mapped geohazard conditions within the state. According to the regional-scale interactive map, and LiDAR imagery no known geohazards are mapped for the site.

The United States Department of Agriculture portal (USDA) provides a soil mapping of the region. The soils on site are mapped as Alderwood gravelly sandy loam (2). These soils are derived from glacial drift and/or glacial outwash over dense glaciomarine deposits, formed as hills and ridges. The soils are described as gravelly sandy loam from 0 to 7 inches, and very gravelly sandy loam from 7 to 59 inches. Depth to restrictive feature is 20 to 39 inches to densic material. Capacity of most limiting layer to transmit water (ksat) is listed as very low to moderately low (0.00 to 0.06 in/hr). Depth to water table is about 18 to 37 inches.

2.2 SITE & SURFACE CONDITIONS

The project area is relatively flat, near the same elevation as the adjacent road. The site is currently used as storage area to the west and contains five permanent existing structures to the east. The storage areas are mostly covered in compacted gravel, with sparse shrubby or grassy vegetation occupying the perimeter.

2.3 SOIL LOG

Site soil conditions were generally consistent across the property in all 7 test pits. Representative lab samples were taken from TP-1 and TP-2. Soil conditions on site were as follows:

- **0’ to 3.0’ – Silty Sand with Gravel (SM)**

  In general, there was a pervasive layer of silty sand with gravel underneath thin topsoil and compacted gravel areas. This layer was loose to medium dense, with some organics and cobbles to 3 inches. This layer is inferred to be a weathered soil derived from the more consolidated lower SM unit.

- **3.0’ to 6.0’ – Silty Sand with Gravel (SM)**

  Within the property, there is a consistent boundary where the overlying SM soils become dense and more consolidated, inferred to be glacial till. This layer was light tan with no organics and in a dense to very dense condition. Some mottling was present; however no groundwater was encountered in any of the test pit exploration locations.

2.4 SURFACE WATER AND GROUNDWATER CONDITIONS

No active surface water features are present on site. The closest water features to the site are retention ponds ~1,850 feet to the east. During our test pit explorations, no pervasive groundwater table was encountered. Based on well logs made publicly available by the WA Department of Ecology there does not appear to be a shallow groundwater table that can be inferred, since most reported boreholes were dry down to 10+ feet.

QG’s scope of work did not include determination or monitoring of seasonal groundwater elevation variations, formal documentation of wet season site conditions, or conclusive measurement of groundwater elevations at depths past the extent feasible for explorations at the time of the field explorations.

3.0 GEOTECHNICAL RECOMMENDATIONS

3.1 FOUNDATION RECOMMENDATIONS

QG recommends excavating loose or organic cover soils down to firm bearing conditions expected within 1.0 feet from the surface. As the variability in subgrade support between consolidated glacial deposits and weathered cover soils may result in differential settlement, QG recommends that foundations be placed on compacted native soils wherever, or on firm structural fill installed over these compacted soils to achieve footing grade.

For general foundation design considerations, QG recommends referring to guidelines and parameters of the International Building Code (IBC, 2018; or most recent edition at the time of construction). Footings should be placed to a minimum depth of 18 inches for freeze-thaw protection, but not less that required by the setback and factor of safety criteria above, as well as meeting minimum IBC (2018) requirements.

3.2 INFILTRATION RATE DETERMINATION

QG understands design of on-site stormwater controls are pending the results of this study to confirm design parameters and interpreted depths to perched seasonal groundwater and restrictive soil features.

3.2.1 INFILTRATION FEASIBILITY

During test pit excavations for general site investigation, QG additionally collected representative samples of native soil deposits among potential infiltration strata and depths. Representative soil samples were selected from test pits 1 and 2 to characterize the local infiltration conditions.

We understand the project will be subject to infiltration design based on the Washington Department of Ecology Stormwater Management Manual for Western Washington (DoE SMMWW). For initial site infiltration characterization within the scope of this study, laboratory gradation analyses were completed including sieve and hydrometer tests for stormwater design characterization and rate determination to supplement field observations. Results of laboratory testing in terms of rate calculation are summarized below.

Laboratory results were interpreted to recommended design inputs in accordance with methods of the 2019 DoE SMMWW. Gradation results were applied to the Massmann (2003) equation (1) to calculate Ksat representing the initial saturated hydraulic conductivity.

(1) $\log10(Ksat) = -1.57 + 1.90*D10 + 0.015*D60 - 0.013*D90 - 2.08*ff$

Corrected Ksat values presented below are a product of the initial Ksat and correction factor CFT. For a generalized site-wide design situation, we have applied a site variability factor of CFv = 0.7

along with typical values of CFt = 0.4 (for the Grain Size Method) and CFm = 0.9 (assuming standard influent control).

(2) CFT = CFv x CFt x CFm = 0.7 x 0.4 x 0.9 = 0.25

Results were cross-referenced with test pit logs to determine the validity and suitability of unique materials as an infiltration receptor. Additional reduction factors were applied for practical rate determination based on our professional judgement.

Table 1. Results Of Massmann Analysis

TP #	Sample Depth *(BPG)*	Unit Extent *(ft)*	Soil Type	D10	D60	D90	Fines (%)	Ksat *(in/hr)*	Corrected Ksat *(in/hr)*	LT Design Infiltration Rate*(in/hr)*	Cation Exchange Capacity (meq/100g)	Organic Content %
2	2.0	0 to 3.0 ft	SM	0.005	0.39	13.77	38.0	4.24	1.06	**1.06**	9.5	0.8
1	2.5	0 to 3.0 ft	SM	0.035	4.45	11.83	15.7	17.15	4.29	**4.29**	9.3	3.2
1	5.5	3.0 to 6.0 ft	SM	0.025	3.83	19.29	20.6	10.17	2.54	**2.54**	4.7	1.3

For in-ground facilities, a minimum of 5 feet of separation is generally required between the base of any gallery or drywell and any confining unit or water table. Available well logs did not indicate the potential for shallow ground water. However, due to relatively compact and impermeable soils within 3 feet of the subgrade, in-ground infiltration does not seem feasible for maintaining the required separation for high seasonal precipitation. At this time, QG does not recommend mounding analysis due to the generally suitable site conditions.

Beneath gravel, the brown soils were observed to generally exhibit moderate fines content and minimal oxidation patterns. **QG recommends the designer pursue shallow infiltration structures instead, such as bio swales, rain gardens, pervious pavements, etc. For shallow infiltration features utilizing treatment media, we recommend a maximum design rate of up to 1.06 inches/hour be considered**, which is typically suitable for most shallow infiltration features, and considers potential reductions from compaction during construction. These rates are considered applicable to all areas of the subject site at the specified depths.

QG recommends the facility designer review these results and stated assumptions per reference literature to ensure applicability with the proposed development, level of anticipated controls, and long- term maintenance plan. The designer may make reasonable adjustments to correction factors and the resulting design values based on these criteria to ensure design and operational intent is met. We recommend that we be contacted if substantial changes to rate determination are considered.

TREATMENT POTENTIAL

Depending on stormwater and runoff sources, some stormwater features, such as rain gardens or pervious pavements may require treatment. Stormwater facilities utilizing native soils as treatment media typically require Cation Exchange Capacities (CEC) of greater than 5 milliequivalents per 100grams (meq/100g) and organic contents greater than 1% (this may vary depending on local code). The soils directly beneath the gravel layer in general **do** meet the minimum treatment standards. The soils in TP-2 **did not** meet the required minimum treatment standards.

3.2.2 DRAINAGE RECOMMENDATIONS

QG recommends proper drainage controls for stormwater runoff during and after site development to protect the site. The ground surface adjacent to structures should be sloped to drain away at a 5% minimum to prevent ponding of water adjacent to them.

QG recommends all stormwater catchments (new or existing) be tightlined (piped) away from structures to an existing catch basin, stormwater system, established channel, or approved outfall to be released using appropriate energy-dissipating features at the outfall to minimize point erosion. Roof and footing drains should be tightlined separately or should be gathered in an appropriately sized catch basin structure and redistributed collectively. If storm drains are incorporated for impervious flatworks (driveways, sidewalks, etc.) collected waters should also be discharged according to the above recommendations.

3.3 IMPERVIOUS PAVEMENT CONSIDERATIONS

QG anticipates most pavements will be constructed of flexible Hot Mix Asphalt surfacing, with thickened sections for anticipated heavy load areas. The main entrance/exit drive will likely experience different traffic volumes than the far end of the pavement areas. As a result, consideration could be given to increasing the pavement section in the main entrance/exit drive. Pavement sections presented in the above table should not be used for areas which experience repeated truck traffic/parking, equipment or truck parking areas, entrances and exit aprons, or contain trash dumpster loading zones. In these areas, a Portland Cement Concrete (PCC) pavement should be used, as opposed to HMA.

One of the important considerations in designing a high quality and durable pavement is providing adequate drainage. Design of drainage for the proposed pavement section is outside of QG ’s scope of work at this time. It is important that bird baths (leeching basins) and surface waves are not created during construction of the HMA layer. A proper slope should also be allowed, and drainage should be provided along the edges of pavements and around catch basins to prevent accumulation of free water within the base course, which otherwise may result in subgrade softening and pavement deterioration under exposure and repeated traffic conditions.

All pavements require regular maintenance and repair in order to maintain the serviceability of the pavement. These repairs and maintenance are due to normal wear and tear of the pavement surface and are required in order to extend the serviceability life of the pavement. However, after 10 years of service, a normal pavement structure is likely to deteriorate to a point where pavement rehabilitation may be required to maintain the serviceability. The deterioration is more likely if the pavement is constructed over poor subgrade soils or in area of higher traffic volumes.

Rigid pavement components are commonly utilized for portions of accesses and ancillary exterior improvements. The project civil designer may re-evaluate the below general recommendations for pavement thicknesses and base sections, if necessary, to ensure proper application to a given structure and use. QG recommends that we be contacted for further consultation if the below sections are proposed to be reduced.

Concrete driveway aprons and curb alignments, if utilized, should consist of a minimum 6-inch thickness of unreinforced concrete pavement over structural base fill. Base thickness should correspond to related location and anticipated traffic loading. For light traffic areas, a 6-inch minimum base thickness (total 12-inch section) can be applied. For heavy traffic zones, we recommend allotting a 12- inch minimum base section beneath the pavement, or the incorporation of reinforcing steel in the concrete.

Concrete sidewalks, walkways and patios if present may consist of a minimum 4-inch section of plain concrete (unreinforced) installed over a 6-inch minimum compacted base of crushed rock. At locations where grade has been raised with structural fill, a 4-inch minimum crushed rock section may be used. Flatworks should employ frequent joint controls to limit cracking potential.

4.0 CONSTRUCTION RECOMMENDATIONS

4.1 EARTHWORK

4.1.1 GRADING & EXCAVATION

A grading plan was not available to QG at the time of this report. However, based on provided conceptual plans, this study assumes finished site grade will approximate current grade. Therefore, depths referred to in this report are considered roughly equivalent to final depths. Excavations can generally be performed with conventional earthmoving equipment such as bulldozers, scrapers, and excavators.

4.1.2 SUBGRADE EVALUATION & PREPARATION

After excavations have been completed to the planned subgrade elevations, but before placing fill or structural elements, the exposed subgrade should be evaluated under the part-time observation and guidance of an QG representative.

The special inspection firm should continuously evaluate all backfilling. Any areas that are identified as being soft or yielding during subgrade evaluation should be over excavated to a firm and unyielding condition or to the depth determined by the geotechnical engineer. Where over excavation is performed below a structure, the over excavation area should extend beyond the outside of the footing a distance equal to the depth of the over excavation below the footing. The over excavated areas should be backfilled with properly compacted structural fill.

4.1.3 SITE PREPARATION, EROSION CONTROLL, WET WEATHER

Any silty or organic rich native soils may be moisture-sensitive and become soft and difficult to traverse with construction equipment when wet. During wet weather, the contractor should take measures to protect any exposed soil subgrades, limit construction traffic during earthwork activities, and limit machine use only to areas undergoing active preparation.

Once the geotechnical engineer has approved subgrade, further measures should be implemented to prevent degradation or disturbance of the subgrade. These measures could include, but are not limited to, placing a layer of crushed rock or lean concrete on the exposed subgrade, or covering the exposed subgrade with a plastic tarp and keeping construction traffic off the subgrade. Once subgrade has been approved, any disturbance because the subgrade was not protected should be repaired by the contractor at no cost to the owner.

During wet weather, earthen berms or other methods should be used to prevent runoff from draining into excavations. All runoffs should be collected and disposed of properly. Measures may also be

required to reduce the moisture content of on-site soils in the event of wet weather. These measures can include, but are not limited to, air drying and soil amendment, etc.

QG recommends earthwork activities take place during the summer dry season.

4.2 STRUCTURAL FILL MATERIALS AND COMPACTION

4.2.1 MATERIALS

All material placed below structures or pavement areas should be considered structural fill. Excavated native soils may be considered suitable for reuse as structural fill on a case-by-case basis. Imported material can also be used as structural fill. Care should be taken by the earthwork contractor during grading to avoid contaminating stockpiled soils that are planned for reuse as structural fill with native organic materials. Frozen soil is not suitable for use as structural fill. Fill material may not be placed on frozen soil.

Structural fill material shall be free of deleterious materials, have a maximum particle size of 4 inches, and be compactable to the required compaction level. Imported structural fill material should conform to the WSDOT manual Section 9-03.14(1) Gravel Borrow, or an approved alternative import material. Controlled-density fill (CDF) or lean mix concrete can be used as an alternative to structural fill materials, except in areas where free-draining materials are required or specified.

Imported materials utilized for trench back fill shall conform to Section 9-03.19, Trench Backfill, of the most recent edition (at the time of construction) of the State of Washington Department of Transportation *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*. Imported materials utilize as grade fill beneath roads shall conform to WSDOT Section 9-03.10, Gravel Base.

Pipe bedding material should conform to the manufacturer's recommendations and be worked around the pipe to provide uniform support. Cobbles exposed in the bottom of utility excavations should be covered with pipe bedding or removed to avoid inducing concentrated stresses on the pipe.

Soils with fines content near or greater than 10% fines content may likely be moisture sensitive and become difficult to use during wet weather. Care should be taken by the earthwork contractor during grading to avoid contaminating stockpiled soils that are planned for reuse as structural fill with native organic materials.

The contractor should submit samples of each of the required earthwork materials to the materials testing lab for evaluation and approval prior to delivery to the site. The samples should be submitted **at least 5 days prior to their delivery** and sufficiently in advance of the work to allow the contractor to identify alternative sources if the material proves unsatisfactory.

4.2.2 FILL PLACEMENT AND COMPACTION

For lateral and bearing support, structural fill placement below footings shall extend at minimum a distance past each edge of the base of the footing equal to the depth of structural fill placed below the footing [i.e. extending at least a 1H:1V past both the interior and the exterior of the concrete footing].

Prior to placement and compaction, structural fill should be moisture conditioned to within 3 percent of its optimum moisture content. Loose lifts of structural fill shall not exceed 12 inches in thickness. All structural fill shall be compacted to a firm and unyielding condition and to a minimum percent compaction based on its modified Proctor maximum dry density as determined per ASTM D1557. Structural fill placed beneath each of the following shall be compacted to the indicated percent compaction:

- Foundation and Floor Slab Subgrades: 95 Percent
- Pavement Subgrades & wall backfill (upper 2 feet): 95 Percent
- Pavement Subgrades & wall backfill (below 2 feet): 90 Percent
- Utility Trenches (upper 4 feet): 95 Percent
- Utility Trenches (below 4 feet): 90 Percent

A sufficient number of tests should be performed to verify compaction of each lift. The number of tests required will vary depending on the fill material, its moisture condition and the equipment being used. Initially, more frequent tests will be required while the contractor establishes the means and methods required to achieve proper compaction.

Jetting or flooding is not a substitute for mechanical compaction and should not be allowed.

4.3 TEMPORARY EXCAVATIONS AND TRENCHES

All excavations and trenches must comply with applicable local, state, and federal safety regulations. Construction site safety is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing soil type information solely as a service to our client for planning purposes. Under no circumstances should the information be interpreted to mean that QG is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred. The contractor shall be responsible for the safety of personnel working in utility trenches. Given that steep excavations in native soils may be prone to caving, we recommend all utility trenches, but particularly those greater than 4 feet in depth, be supported in accordance with state and federal safety regulations. Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed near the top of any excavation.

Temporary excavations and trenches should be protected from the elements by covering with plastic sheeting or some other similar impermeable material. Sheeting sections should overlap by at least 12 inches and be tightly secured with sandbags, tires, staking, or other means to prevent wind from exposing the soils under the sheeting.

5.0 SPECIAL INSPECTION

The recommendations made in this report assume that an adequate program of tests and observations will be made throughout construction to verify compliance with these recommendations. Testing and observations performed during construction should include, but not necessarily be limited to, the following:

- Geotechnical plan review and engineering consultation as needed prior to construction phase,
- Observations and testing during site preparation, earthwork, structural fill, and pavement section placement,
- Consultation on temporary excavation cutslopes and shoring if needed,
- Consultation as necessary during construction.

QG recommends that we be retained for construction phase soils testing and periodic earthwork observation in accordance with the local code requirements. We also strongly recommend that QG be retained as the project Geotechnical Engineering Firm of Record (GER) during the construction of this project to perform periodic supplementary geotechnical observations and review the special inspectors reports during construction.

Our knowledge of the project site and the design recommendations contained herein will be of great benefit in the event that difficulties arise and either modifications or additional geotechnical engineering recommendations are required or desired. We can also, in a timely fashion observe the actual soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

We would be pleased to meet with you at your convenience to discuss the *Time & Materials* scope and cost for these services.

6.0 LIMITATIONS

Upon acceptance and use of this report, and its interpretations and recommendations, the user shall agree to indemnify and hold harmless QG, including its owners, employees and subcontractors, from any adverse effects resulting from development and occupation of the subject site. Ultimately, it is the owner's choice to develop and live in such an area of possible geohazards (which exist in perpetuity across the earth in one form or another), and therefore the future consequences, both anticipated and unknown, are solely the responsibility of the owner. By using this report for development of the subject property, the owner must accept and understand that it is not possible to fully anticipate all inherent risks of development. The recommendations provided above are intended to reduce (but may not eliminate) such risks.

This report does not represent a construction specification or engineered plan and shall not be used or referenced as such. The information included in this report should be considered supplemental to the requirements contained in the project plans & specifications and should be read in conjunction with the above referenced information. The selected recommendations presented in this report are intended to inform only the specific corresponding subjects. All other requirements of the above-mentioned items remain valid, unless otherwise specified.

Recommendations contained in this report are based on our understanding of the proposed development and construction activities, field observations and explorations, and laboratory test results. It is possible that soil and groundwater conditions could vary and differ between or beyond the points explored. If soil or groundwater conditions are encountered during construction that differ from those described herein, or if the scope of the proposed construction changes from that described in this report, QG should be notified immediately in order to review and provide supplemental recommendations.

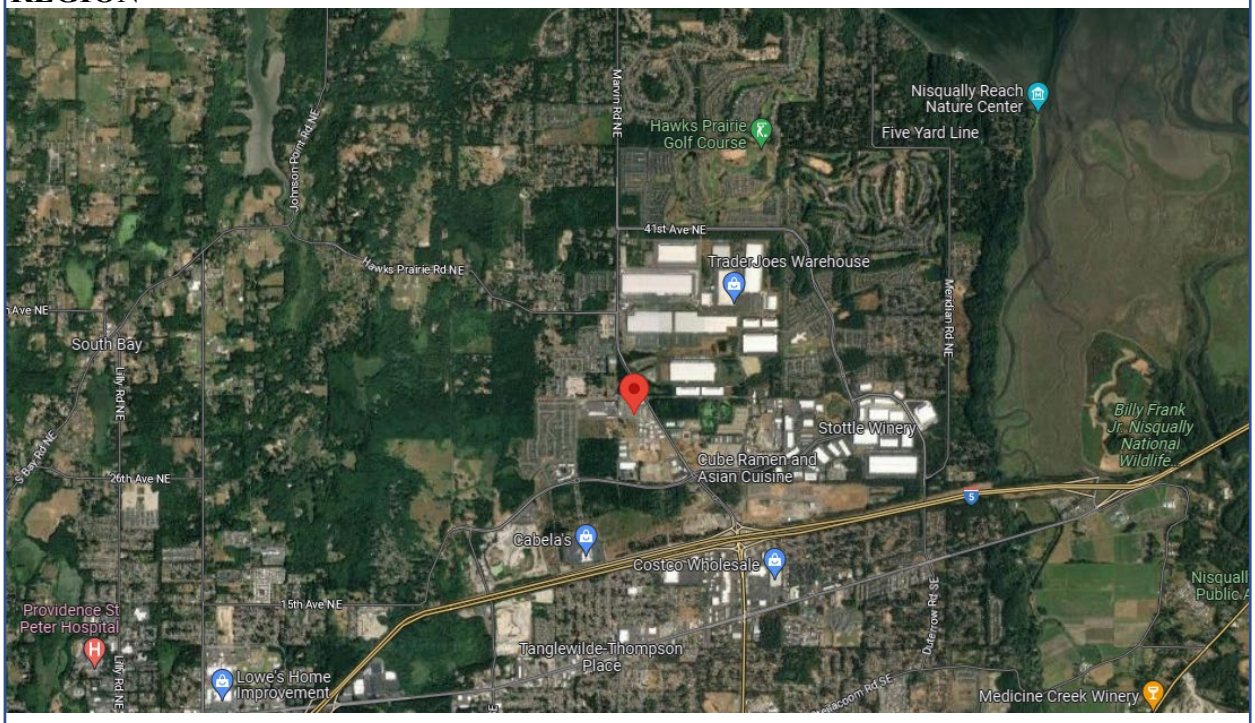
The findings of this study are limited by the level of scope applied. We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the subject region. No warranty, expressed or implied, is made. The recommendations provided in this report assume that an adequate program of tests and observations will be conducted by a WABO approved special inspection firm during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the Client and their design consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than 18 months from the date of the report. It is the Client's responsibility to ensure that the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. Note that if another firm assumes Geotechnical Engineer of Record responsibilities, they need to review this report and either concur with the findings, conclusions, and recommendations or provide alternate findings, conclusions and recommendation.

Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required. Based on the intended use of the report, QG may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release QG from any liability resulting from the use of this report. The Client, the design consultants, and any unauthorized party, agree to defend, indemnify, and hold harmless QG from any claim or liability associated with such unauthorized use or non-compliance. We recommend that QG be given the opportunity to review the final project plans and specifications to evaluate if our recommendations have been properly interpreted. We assume no responsibility for misinterpretation of our recommendations.

Appendix A. Region & Vicinity Maps

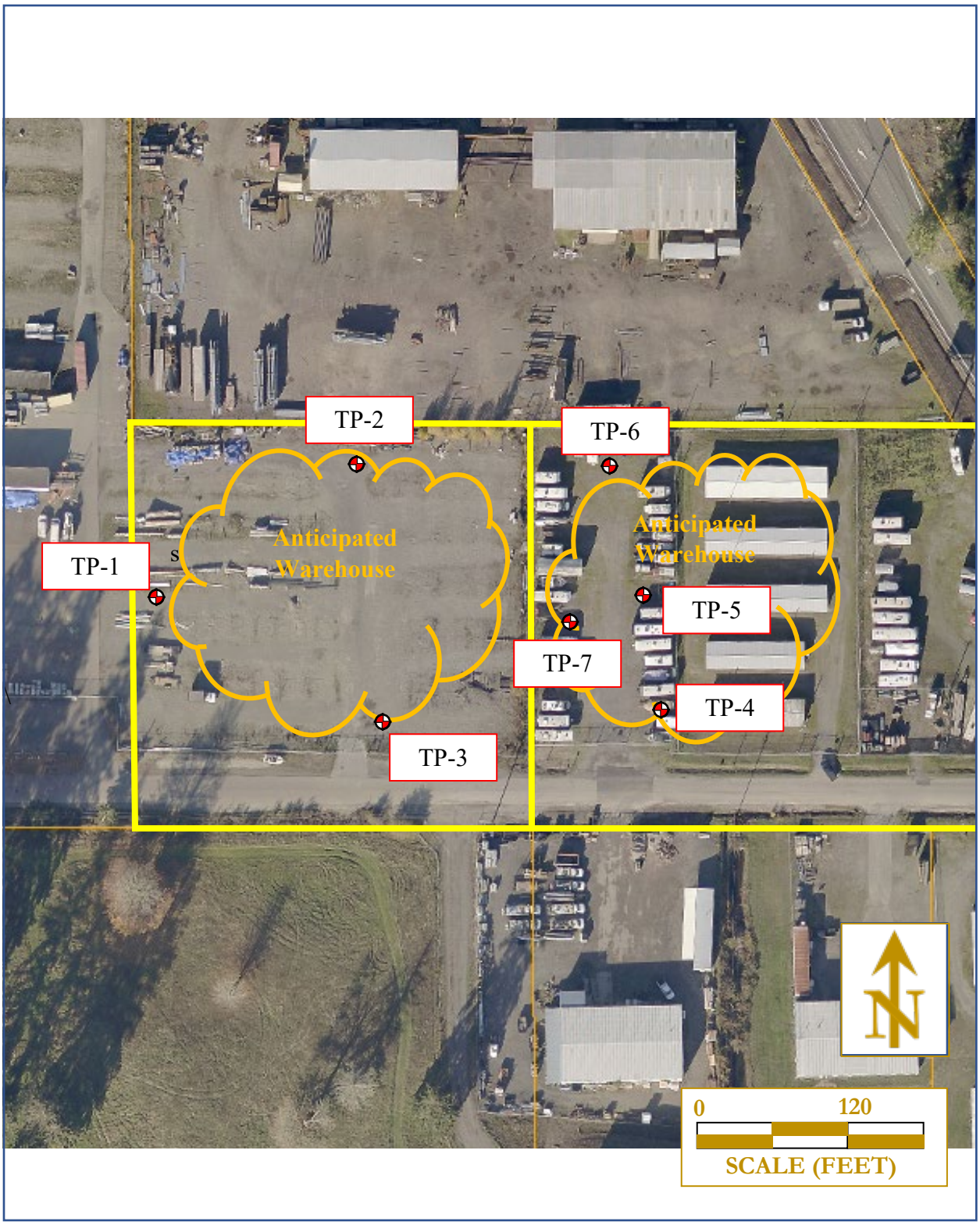
REGION



VICINITY

Quality Geo NW, PLLC	**Site Region** Betschart Infiltration	Source: Google Imagery, 2023 **Scale & Locations are approx.** **Not for Construction**	**Figure 1**

Appendix B. Exploration Map



Quality Geo NW, PLLC	**Site Map** Betschart Infiltration	Source: Thurston Co. GIS, 2023 **Scale & Locations are approx.** **Not for Construction**	**Figure 2**

Appendix C. Exploration Logs

TEST PIT LOG TP-1

PROJECT NUMBER QG23-008
PROJECT NAME Betschart Infiltration
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 1/20/2023
DRILLING METHOD Excavated Test Pit

BORING LOCATION TPN 11802320300; west side of parcel
SURFACE ELEVATION Existing
LOGGED BY AB

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				FILL	Imported, compacted gravel
0.5				SM	SILTY SAND with GRAVEL Dark brown to brown color, moist, some organics, no mottling, cobbles present to 3 inches, medium dense. Inferred to be weathered glacial till. Gravel %= 38; Sand %= 46; Fines %= 16
1					
1.5					
2					
2.5					
3					
3.5					SILTY SAND with GRAVEL Light tan, moist, no organics, some mottling, cobbles present to 3 inches, dense to very dense. Inferred to be glacial till. Gravel %= 37; Sand %= 42; Fines %= 21
4					
4.5					
5					
5.5					
6					Termination Depth at 6.0 Feet Terminated upon refusal and contracted depth No groundwater encountered

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TEST PIT LOG TP-2

PROJECT NUMBER QG23-008
PROJECT NAME Betschart Infiltration
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 1/20/2023
DRILLING METHOD Excavated Test Pit

BORING LOCATION TPN 11802320300; North side of parcel
SURFACE ELEVATION Existing
LOGGED BY AB

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				FILL	Imported, compacted gravel
0.5				SM	SILTY SAND with GRAVEL Light tan, moist, no organics, heavy mottling, cobbles present to 3 inches, medium dense to very dense. Inferred to be glacial till. Gravel %= 22; Sand %= 41; Fines %= 37
1					
1.5					
2					
2.5					
3					
3.5					
4					Termination Depth at 4.0 Feet Terminated upon refusal and contracted depth No groundwater encountered
4.5					
5					
5.5					
6					

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TEST PIT LOG TP-3

PROJECT NUMBER QG23-008
PROJECT NAME Betschart Infiltration
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 1/20/2023
DRILLING METHOD Excavated Test Pit

BORING LOCATION TPN 11802320300; south side of parcel by gate
SURFACE ELEVATION Existing
LOGGED BY AB

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				FILL	Imported, compacted gravel
				SM	SILTY SAND with GRAVEL Dark brown to brown color, moist, some organics, no mottling, cobbles present to 3 inches, medium dense. Inferred to be weathered glacial till. Gravel %= 38; Sand %= 46; Fines %= 16
3					SILTY SAND with GRAVEL Light tan, moist, no organics, some mottling, cobbles present to 3 inches, dense to very dense. Inferred to be glacial till. Gravel %= 37; Sand %= 42; Fines %= 21
4					Termination Depth at 4.0 Feet Terminated upon refusal and contracted depth No groundwater encountered

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TEST PIT LOG TP-4

PROJECT NUMBER QG23-008
PROJECT NAME Betschart Infiltration
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 1/20/2023
DRILLING METHOD Excavated Test Pit

BORING LOCATION TPN 11802320100; southeast corner of parcel
SURFACE ELEVATION Existing
LOGGED BY AB

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				FILL	Imported, compacted gravel
0.5				TS	TOPSOIL Dark brown, moist, organics, no mottling, cobbles present to 3 inches, medium dense.
1					
1.5				SM	SILTY SAND with GRAVEL Dark brown to brown color, moist, some organics, no mottling, cobbles present to 3 inches, medium dense. Inferred to be weathered glacial till. Gravel %= 38; Sand %= 46; Fines %= 16
2					
2.5					SILTY SAND with GRAVEL Light tan, moist, no organics, some mottling, cobbles present to 3 inches, dense to very dense. Inferred to be glacial till. Gravel %= 37; Sand %= 42; Fines %= 21
3					
3.5					
4					Termination Depth at 4.0 Feet Terminated upon refusal and contracted depth No groundwater encountered
4.5					
5					
5.5					
6					

TEST PIT LOG TP-5

PROJECT NUMBER QG23-008
PROJECT NAME Betschart Infiltration
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 1/20/2023
DRILLING METHOD Excavated Test Pit

BORING LOCATION TPN 11802320100; east side of parcel, center
SURFACE ELEVATION Existing
LOGGED BY AB

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				FILL	Imported, compacted gravel
0.5				SM	SILTY SAND with GRAVEL Dark brown to brown color, moist, some organics, no mottling, cobbles present to 3 inches, medium dense. Inferred to be weathered glacial till. Gravel %= 38; Sand %= 46; Fines %= 16
1					SILTY SAND with GRAVEL Light tan, moist, no organics, some mottling, cobbles present to 3 inches, dense to very dense. Inferred to be glacial till. Gravel %= 37; Sand %= 42; Fines %= 21
1.5					
2					
2.5					
3					
3.5					Termination Depth at 3.5 Feet Terminated upon refusal and contracted depth No groundwater encountered
4					
4.5					
5					
5.5					
6					

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TEST PIT LOG TP-6

PROJECT NUMBER QG23-008
PROJECT NAME Betschart Infiltration
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 1/20/2023
DRILLING METHOD Excavated Test Pit

BORING LOCATION TPN 11802320100; North side of parcel, center
SURFACE ELEVATION Existing
LOGGED BY AB

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				FILL	Imported, compacted gravel
0.5				TS	TOPSOIL Dark brown, moist, organics, no mottling, cobbles present to 3 inches, medium dense.
1				SM	SILTY SAND with GRAVEL Dark brown to brown color, moist, some organics, no mottling, cobbles present to 3 inches, medium dense. Inferred to be weathered glacial till. Gravel %= 38; Sand %= 46; Fines %= 16
1.5					
2					
2.5					
3					SILTY SAND with GRAVEL Light tan, moist, no organics, some mottling, cobbles present to 3 inches, dense to very dense. Inferred to be glacial till. Gravel %= 37; Sand %= 42; Fines %= 21
3.5					
4					
4.5					
5					Termination Depth at 5.0 Feet Terminated upon refusal and contracted depth No groundwater encountered
5.5					
6					

TEST PIT LOG TP-7

PROJECT NUMBER QG23-008
PROJECT NAME Betschart Infiltration
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 1/20/2023
DRILLING METHOD Excavated Test Pit

BORING LOCATION TPN 11802320100; West side of parcel, center
SURFACE ELEVATION Existing
LOGGED BY AB

COMMENTS

Depth (ft)	Samples	Is Analysed?	Graphic Log	USCS	Material Description
0				FILL	Imported, compacted gravel
0.5				SM	SILTY SAND with GRAVEL Dark brown to brown color, moist, some organics, no mottling, cobbles present to 3 inches, medium dense. Inferred to be weathered glacial till. Gravel %= 38; Sand %= 46; Fines %= 16
2.5					SILTY SAND with GRAVEL Light tan, moist, no organics, some mottling, cobbles present to 3 inches, dense to very dense. Inferred to be glacial till. Gravel %= 37; Sand %= 42; Fines %= 21
3.5					Termination Depth at 3.5 Feet Terminated upon refusal and contracted depth No groundwater encountered

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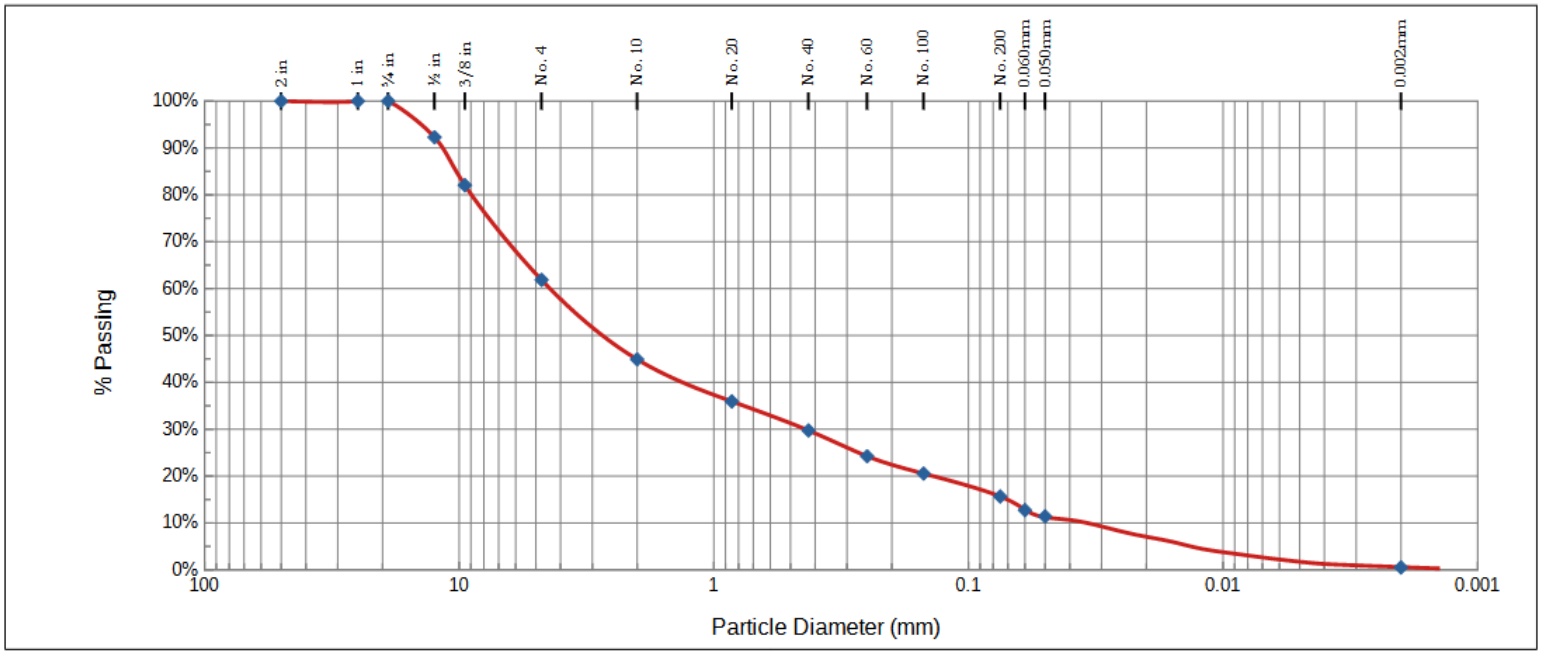
Appendix D. Laboratory Results

SAMPLE ID: TP-1@2.5 Ft

☑ Sieve Analysis | ☑ Wet Wash | ☑ Hydrometer | ☐ Atterberg Limits

Project Name:	Betschart Infiltraion
Project Number:	QG23-008
Date Collected:	01/20/23
Date Reported:	02/23/23
Boring ID:	TP-1
Boring Depth:	2.5 Ft



USCS Scale	Coarse Gravel		Fine Gravel			Coarse Sand		Medium Sand		Fine Sand			(% of Fines Passing #200 Sieve) Hydrometer Method			Sand Total	Gravel Total
Sieve #	2"	1"	¾"	½"	3/8"	4	10	20	40	60	100	200	0.060	0.050	0.002		
Diameter, mm	50	25	19	12.5	9.5	4.75	2	0.85	0.425	0.25	0.15	0.075					
Retained	0.0%	0.0%	0.0%	7.7%	17.9%	38.1%	55.1%	64.1%	70.3%	75.8%	79.5%	84.3%				**46.2%**	**38.1%**
Passing	100.0%	100.0%	100.0%	92.3%	82.1%	61.9%	44.9%	35.9%	29.7%	24.2%	20.5%	**15.7%**	12.7%	11.4%	0.52%		

Graph Values

D90	11.83				
D60	4.45	**Coefficient of Uniformity:**	10.04	**CEC:**	9.3 meq/100g
D30	0.443	**Coefficient of Gradation:**	1.24	**OM (LOI 360):**	3.2 %
D10	0.035				

Unified Soil Classification System (USCS) Description	
SM	SILTY SAND with GRAVEL

Staff Initials: T

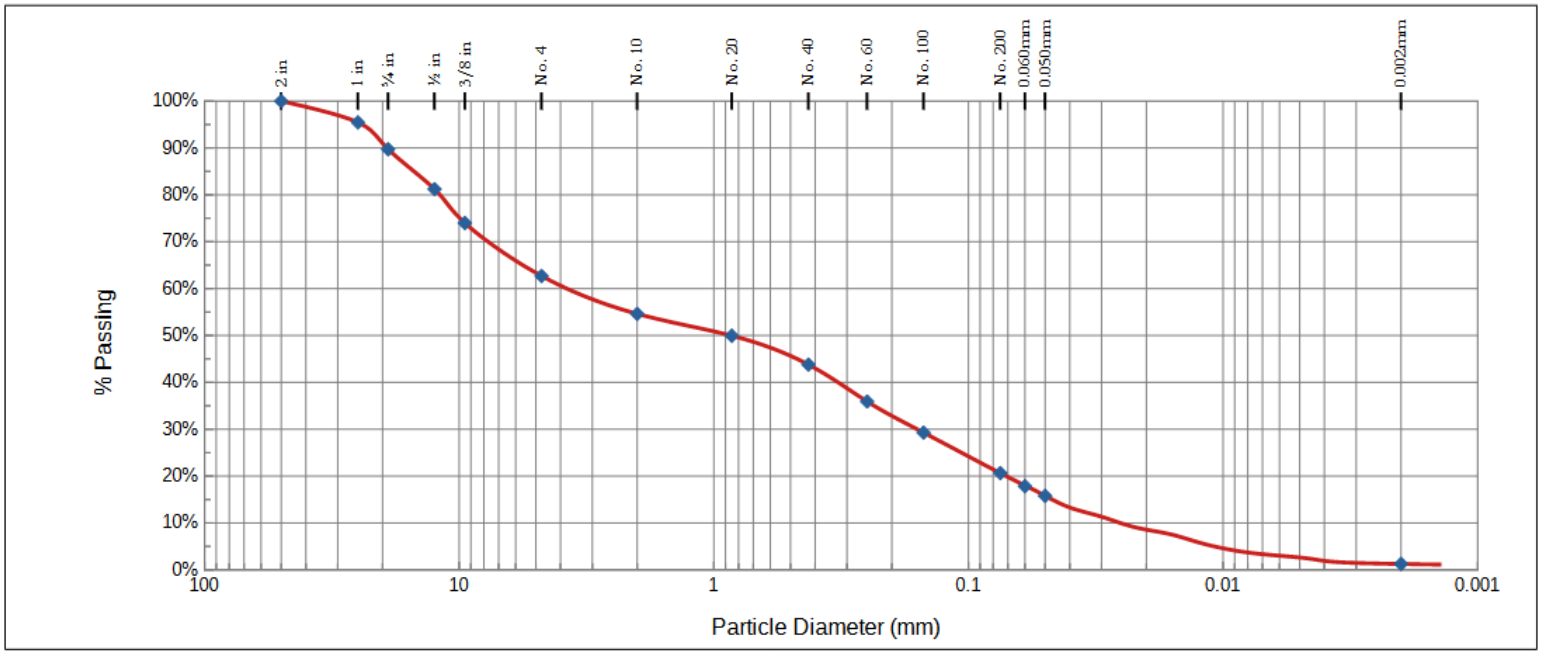
Test Methods: ASTM D6913, ASTM D7928

February 23, 2023

SAMPLE ID: TP-1@5.5ft

☑ Sieve Analysis | ☑ Wet Wash | ☑ Hydrometer | ☐ Atterberg Limits

Project Name:	Betschart Infiltraion
Project Number:	QG23-008
Date Collected:	01/20/23
Date Reported:	02/23/23
Boring ID:	TP-1
Boring Depth:	5.5ft



USCS Scale	Coarse Gravel		Fine Gravel			Coarse Sand		Medium Sand		Fine Sand			(% of Fines Passing #200 Sieve) Hydrometer Method			Sand Total	Gravel Total
Sieve #	2"	1"	¾"	½"	3/8"	4	10	20	40	60	100	200					
Diameter, mm	50	25	19	12.5	9.5	4.75	2	0.85	0.425	0.25	0.15	0.075	0.060	0.050	0.002		
Retained	0.0%	4.5%	10.3%	18.8%	26.0%	37.3%	45.4%	50.1%	56.2%	64.1%	70.7%	79.4%				**42.1%**	**37.3%**
Passing	100.0%	95.5%	89.7%	81.2%	74.0%	62.7%	54.6%	49.9%	43.8%	35.9%	29.3%	**20.6%**	17.9%	15.8%	1.27%		

Graph Values

D90	19.29				
D60	3.83	**Coefficient of Uniformity:**	23.81	**CEC:**	4.7 meq/100g
D30	0.161	**Coefficient of Gradation:**	0.27	**OM (LOI 360):**	1.3 %
D10	0.025				

Unified Soil Classification System (USCS) Description	
SM	SILTY SAND with GRAVEL

Staff Initials: T

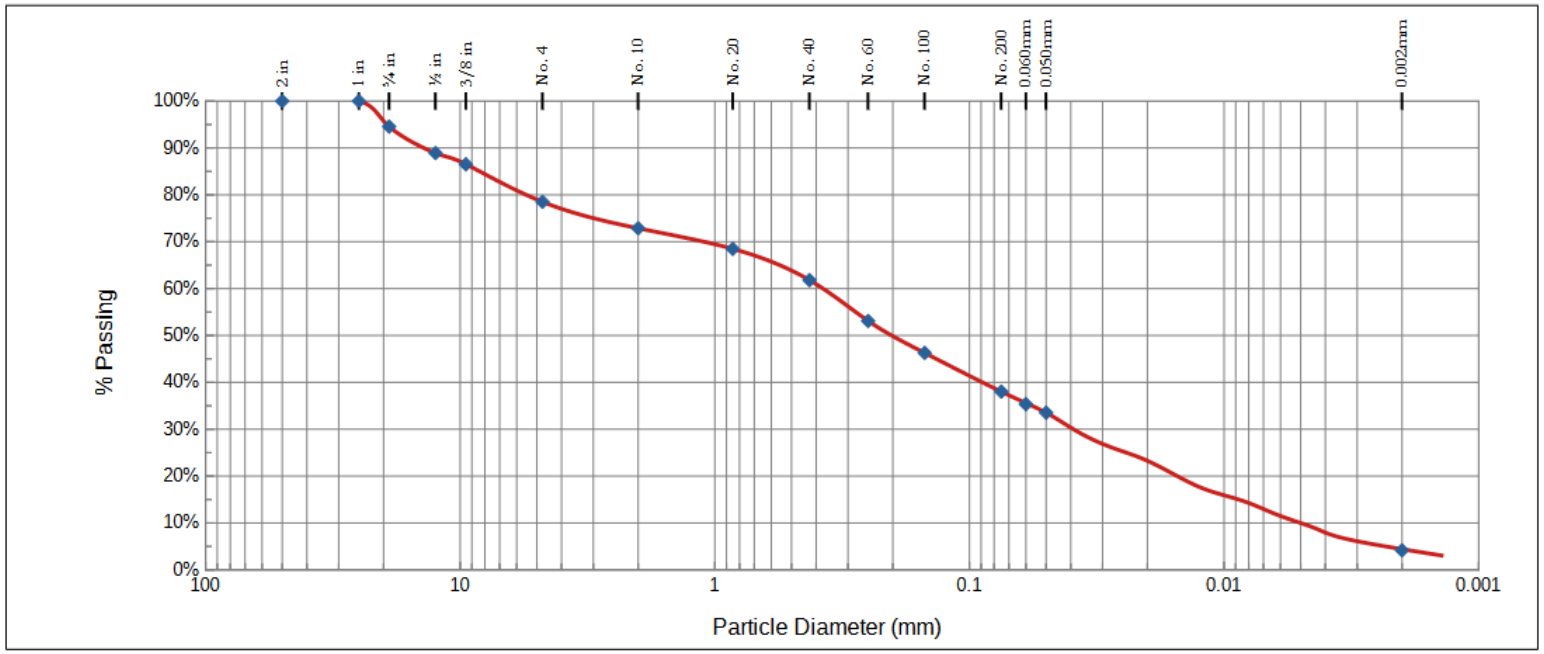
Test Methods: ASTM D6913, ASTM D7928

February 23, 2023

SAMPLE ID: TP-2@2ft

☑ Sieve Analysis | ☑ Wet Wash | ☑ Hydrometer | ☐ Atterberg Limits

Project Name:	Betschart Infiltration
Project Number:	QG23-008
Date Collected:	01/20/23
Date Reported:	02/23/23
Boring ID:	TP-2
Boring Depth:	2ft



USCS Scale	Coarse Gravel		Fine Gravel			Coarse Sand		Medium Sand		Fine Sand			(% of Fines Passing #200 Sieve) Hydrometer Method			Sand Total	Gravel Total
Sieve #	2"	1"	¾"	½"	3/8"	4	10	20	40	60	100	200					
Diameter, mm	50	25	19	12.5	9.5	4.75	2	0.85	0.425	0.25	0.15	0.075	0.060	0.050	0.002		
Retained	0.0%	0.0%	5.5%	11.1%	13.5%	21.5%	27.1%	31.5%	38.2%	46.9%	53.7%	62.0%				**40.5%**	**21.5%**
Passing	100.0%	100.0%	94.5%	88.9%	86.5%	78.5%	72.9%	68.5%	61.8%	53.1%	46.3%	**38.0%**	35.3%	33.5%	4.17%		

Graph Values

D90	13.77				
D60	0.39	**Coefficient of Uniformity:**	9.92	**CEC:**	9.5 meq/100g
D30	0.039	**Coefficient of Gradation:**	0.78	**OM (LOI 360):**	0.8 %
D10	0.005				

Unified Soil Classification System (USCS) Description	
SM	SILTY SAND with GRAVEL

Staff Initials: T

Test Methods: ASTM D6913, ASTM D7928

February 23, 2023

Attachment 4
Maintenance and Source Control Manual
(to be included with final report)

Attachment 5
Establishment of Maintenance Covenant
(to be included with final report)

Appendix 1
Design Calculations

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Betschart Warehouse b1
Site Name:	Betschart
Site Address:	Evelyne Lane
City:	
Report Date:	4/21/2023
Gage:	Fairgrounds (Kaiser)
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.000
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, Lawn, Flat	0.18
Pervious Total	0.18

Impervious Land Use	acre
PARKING FLAT	2.11
Impervious Total	2.11
Basin Total	2.29

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.26
Pervious Total	0.26

Impervious Land Use	acre
SIDEWALKS FLAT	0.05
PARKING FLAT	0.7
Impervious Total	0.75
Basin Total	1.01

Element Flows To:

Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

Roof

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROOF TOPS FLAT	0.87
Impervious Total	0.87
Basin Total	0.87

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Evelyn

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Flat	0.18
Pervious Total	0.18

Impervious Land Use	acre
ROADS FLAT	0.23
SIDEWALKS FLAT	0.004
Impervious Total	0.234
Basin Total	0.414

Element Flows To:

Surface	Interflow	Groundwater

Routing Elements
Predeveloped Routing

Mitigated Routing

Bioretention 1

Bottom Length:	700.00 ft.
Bottom Width:	2.00 ft.
Material thickness of first layer:	0.25
Material type for first layer:	ASTM 1
Material thickness of second layer:	1.5
Material type for second layer:	Sand
Material thickness of third layer:	1
Material type for third layer:	GRAVEL
Infiltration On	
Infiltration rate:	1.06
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	181.005
Total Volume Through Riser (ac-ft.):	0.008
Total Volume Through Facility (ac-ft.):	181.013
Percent Infiltrated:	100
Total Precip Applied to Facility:	36.913
Total Evap From Facility:	8.213
Underdrain not used	
Discharge Structure	
Riser Height:	1 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
1.0000	0.3043	0.0000	0.0000	0.0000
1.0522	0.3007	0.0003	0.0000	0.0000
1.1044	0.2954	0.0006	0.0000	0.0000
1.1566	0.2901	0.0010	0.0000	0.0000
1.2088	0.2849	0.0014	0.0000	0.0000
1.2610	0.2796	0.0020	0.0000	0.0000
1.3132	0.2743	0.0026	0.0000	0.0000
1.3654	0.2691	0.0033	0.0000	0.0009
1.4176	0.2638	0.0040	0.0000	0.0017
1.4698	0.2586	0.0048	0.0000	0.0030
1.5220	0.2533	0.0056	0.0000	0.0047
1.5742	0.2481	0.0065	0.0000	0.0071
1.6264	0.2429	0.0075	0.0000	0.0102
1.6786	0.2376	0.0085	0.0000	0.0111
1.7308	0.2324	0.0095	0.0000	0.0148
1.7830	0.2272	0.0106	0.0000	0.0158
1.8352	0.2220	0.0118	0.0000	0.0205
1.8874	0.2168	0.0130	0.0000	0.0248
1.9396	0.2116	0.0143	0.0000	0.0343
1.9918	0.2063	0.0156	0.0000	0.0444
2.0440	0.2012	0.0170	0.0000	0.0578
2.0962	0.1960	0.0184	0.0000	0.0738
2.1484	0.1908	0.0199	0.0000	0.0890
2.2005	0.1856	0.0214	0.0000	0.0989
2.2527	0.1804	0.0230	0.0000	0.1198

2.3049	0.1752	0.0246	0.0000	0.1473
2.3571	0.1701	0.0263	0.0000	0.1762
2.4093	0.1649	0.0281	0.0000	0.1818
2.4615	0.1597	0.0299	0.0000	0.1873
2.5137	0.1546	0.0317	0.0000	0.1928
2.5659	0.1494	0.0336	0.0000	0.1984
2.6181	0.1443	0.0356	0.0000	0.2039
2.6703	0.1391	0.0376	0.0000	0.2094
2.7225	0.1340	0.0397	0.0000	0.2150
2.7747	0.1288	0.0419	0.0000	0.2206
2.8269	0.1237	0.0442	0.0000	0.2261
2.8791	0.1186	0.0465	0.0000	0.2317
2.9313	0.1135	0.0489	0.0000	0.2372
2.9835	0.1084	0.0513	0.0000	0.2428
3.0357	0.1032	0.0538	0.0000	0.2484
3.0879	0.0981	0.0563	0.0000	0.2540
3.1401	0.0930	0.0589	0.0000	0.2596
3.1923	0.0879	0.0616	0.0000	0.2652
3.2445	0.0828	0.0643	0.0000	0.2708
3.2967	0.0777	0.0671	0.0000	0.2764
3.3489	0.0727	0.0699	0.0000	0.2820
3.4011	0.0676	0.0728	0.0000	0.2876
3.4533	0.0625	0.0757	0.0000	0.2932
3.5055	0.0574	0.0787	0.0000	0.2988
3.5577	0.0524	0.0818	0.0000	0.3045
3.6099	0.0473	0.0849	0.0000	0.3101
3.6621	0.0422	0.0881	0.0000	0.3157
3.7143	0.0372	0.0913	0.0000	0.3214
3.7500	0.0321	0.0935	0.0000	0.3252

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Infilt(cfs)
2.7500	0.3043	0.0935	0.0000	0.0780	0.0057
2.8022	0.3096	0.1096	0.0000	0.0780	0.0113
2.8544	0.3149	0.1259	0.0000	0.0929	0.0170
2.9066	0.3202	0.1424	0.0000	0.0955	0.0226
2.9588	0.3255	0.1593	0.0000	0.0981	0.0283
3.0110	0.3308	0.1764	0.0000	0.1007	0.0340
3.0632	0.3361	0.1938	0.0000	0.1034	0.0397
3.1154	0.3414	0.2115	0.0000	0.1060	0.0453
3.1676	0.3467	0.2295	0.0000	0.1086	0.0510
3.2198	0.3520	0.2477	0.0000	0.1112	0.0567
3.2720	0.3574	0.2662	0.0000	0.1138	0.0624
3.3242	0.3627	0.2850	0.0000	0.1164	0.0681
3.3764	0.3680	0.3041	0.0000	0.1191	0.0738
3.4286	0.3734	0.3234	0.0000	0.1217	0.0795
3.4808	0.3787	0.3431	0.0000	0.1243	0.0853
3.5330	0.3841	0.3630	0.0000	0.1269	0.0910
3.5852	0.3894	0.3831	0.0000	0.1295	0.0967
3.6374	0.3948	0.4036	0.0000	0.1321	0.1024
3.6896	0.4001	0.4244	0.0000	0.1347	0.1082
3.7418	0.4055	0.4454	0.0000	0.1374	0.1139
3.7940	0.4109	0.4667	0.0977	0.1400	0.1197
3.8462	0.4163	0.4883	0.3147	0.1426	0.1254
3.8984	0.4216	0.5102	0.5952	0.1452	0.1312
3.9505	0.4270	0.5323	0.9111	0.1478	0.1369
4.0027	0.4324	0.5547	1.2343	0.1504	0.1427
4.0549	0.4378	0.5774	1.5367	0.1531	0.1485

4.1071	0.4432	0.6004	1.7939	0.1557	0.1543
4.1593	0.4486	0.6237	1.9905	0.1583	0.1600
4.2115	0.4540	0.6473	2.1274	0.1609	0.1658
4.2637	0.4594	0.6711	2.2575	0.1635	0.1716
4.3159	0.4649	0.6952	2.3694	0.1661	0.1774
4.3681	0.4703	0.7196	2.4763	0.1687	0.1832
4.4203	0.4757	0.7443	2.5787	0.1714	0.1890
4.4725	0.4811	0.7693	2.6772	0.1740	0.1948
4.5247	0.4866	0.7946	2.7723	0.1766	0.2006
4.5769	0.4920	0.8201	2.8641	0.1792	0.2065
4.6291	0.4975	0.8459	2.9531	0.1818	0.2123
4.6813	0.5029	0.8720	3.0395	0.1844	0.2181
4.7335	0.5084	0.8984	3.1236	0.1870	0.2200
4.7500	0.5101	0.9068	3.2054	0.1879	0.0000

Surface retention 1

Element Flows To:

Outlet 1	Outlet 2
	Bioretention 1

Gravel Trench Bed 1

Bottom Length:	230.00 ft.
Bottom Width:	30.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	3
Pour Space of material for first layer:	0.4
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	1.06
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	176.097
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	176.097
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	2.5 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

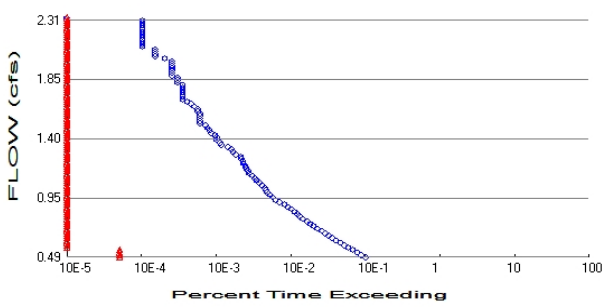
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.158	0.000	0.000	0.000
0.0389	0.158	0.002	0.000	0.169
0.0778	0.158	0.004	0.000	0.169
0.1167	0.158	0.007	0.000	0.169
0.1556	0.158	0.009	0.000	0.169
0.1944	0.158	0.012	0.000	0.169
0.2333	0.158	0.014	0.000	0.169
0.2722	0.158	0.017	0.000	0.169
0.3111	0.158	0.019	0.000	0.169
0.3500	0.158	0.022	0.000	0.169
0.3889	0.158	0.024	0.000	0.169
0.4278	0.158	0.027	0.000	0.169
0.4667	0.158	0.029	0.000	0.169
0.5056	0.158	0.032	0.000	0.169
0.5444	0.158	0.034	0.000	0.169
0.5833	0.158	0.037	0.000	0.169
0.6222	0.158	0.039	0.000	0.169
0.6611	0.158	0.041	0.000	0.169
0.7000	0.158	0.044	0.000	0.169
0.7389	0.158	0.046	0.000	0.169
0.7778	0.158	0.049	0.000	0.169
0.8167	0.158	0.051	0.000	0.169
0.8556	0.158	0.054	0.000	0.169
0.8944	0.158	0.056	0.000	0.169
0.9333	0.158	0.059	0.000	0.169

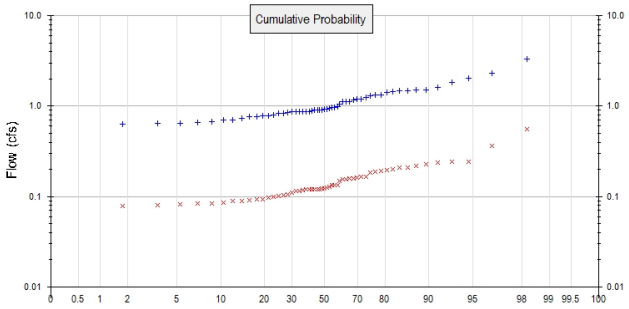
0.9722	0.158	0.061	0.000	0.169
1.0111	0.158	0.064	0.000	0.169
1.0500	0.158	0.066	0.000	0.169
1.0889	0.158	0.069	0.000	0.169
1.1278	0.158	0.071	0.000	0.169
1.1667	0.158	0.073	0.000	0.169
1.2056	0.158	0.076	0.000	0.169
1.2444	0.158	0.078	0.000	0.169
1.2833	0.158	0.081	0.000	0.169
1.3222	0.158	0.083	0.000	0.169
1.3611	0.158	0.086	0.000	0.169
1.4000	0.158	0.088	0.000	0.169
1.4389	0.158	0.091	0.000	0.169
1.4778	0.158	0.093	0.000	0.169
1.5167	0.158	0.096	0.000	0.169
1.5556	0.158	0.098	0.000	0.169
1.5944	0.158	0.101	0.000	0.169
1.6333	0.158	0.103	0.000	0.169
1.6722	0.158	0.106	0.000	0.169
1.7111	0.158	0.108	0.000	0.169
1.7500	0.158	0.110	0.000	0.169
1.7889	0.158	0.113	0.000	0.169
1.8278	0.158	0.115	0.000	0.169
1.8667	0.158	0.118	0.000	0.169
1.9056	0.158	0.120	0.000	0.169
1.9444	0.158	0.123	0.000	0.169
1.9833	0.158	0.125	0.000	0.169
2.0222	0.158	0.128	0.000	0.169
2.0611	0.158	0.130	0.000	0.169
2.1000	0.158	0.133	0.000	0.169
2.1389	0.158	0.135	0.000	0.169
2.1778	0.158	0.138	0.000	0.169
2.2167	0.158	0.140	0.000	0.169
2.2556	0.158	0.142	0.000	0.169
2.2944	0.158	0.145	0.000	0.169
2.3333	0.158	0.147	0.000	0.169
2.3722	0.158	0.150	0.000	0.169
2.4111	0.158	0.152	0.000	0.169
2.4500	0.158	0.155	0.000	0.169
2.4889	0.158	0.157	0.000	0.169
2.5278	0.158	0.160	0.049	0.169
2.5667	0.158	0.162	0.182	0.169
2.6056	0.158	0.165	0.361	0.169
2.6444	0.158	0.167	0.572	0.169
2.6833	0.158	0.170	0.804	0.169
2.7222	0.158	0.172	1.046	0.169
2.7611	0.158	0.174	1.284	0.169
2.8000	0.158	0.177	1.509	0.169
2.8389	0.158	0.179	1.710	0.169
2.8778	0.158	0.182	1.879	0.169
2.9167	0.158	0.184	2.013	0.169
2.9556	0.158	0.187	2.114	0.169
2.9944	0.158	0.189	2.192	0.169
3.0333	0.158	0.195	2.300	0.169
3.0722	0.158	0.202	2.382	0.169
3.1111	0.158	0.208	2.462	0.169
3.1500	0.158	0.214	2.539	0.169
3.1889	0.158	0.220	2.614	0.169

3.2278	0.158	0.226	2.686	0.169
3.2667	0.158	0.232	2.757	0.169
3.3056	0.158	0.239	2.826	0.169
3.3444	0.158	0.245	2.894	0.169
3.3833	0.158	0.251	2.960	0.169
3.4222	0.158	0.257	3.024	0.169
3.4611	0.158	0.263	3.087	0.169
3.5000	0.158	0.269	3.149	0.169

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.18
Total Impervious Area: 2.11

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.44
Total Impervious Area: 1.854

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.985028
5 year	1.344279
10 year	1.614196
25 year	1.9937
50 year	2.305712
100 year	2.644034

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.130493
5 year	0.187422
10 year	0.231924
25 year	0.296564
50 year	0.351269
100 year	0.411977

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.916	0.127
1957	1.318	0.198
1958	0.762	0.102
1959	0.977	0.115
1960	1.117	0.154
1961	0.629	0.079
1962	0.774	0.092
1963	1.517	0.227
1964	0.982	0.119
1965	0.926	0.133

1966	0.679	0.082
1967	0.787	0.099
1968	0.700	0.091
1969	0.705	0.089
1970	0.652	0.083
1971	0.867	0.119
1972	0.908	0.123
1973	0.868	0.119
1974	1.192	0.165
1975	0.910	0.125
1976	0.872	0.120
1977	1.420	0.192
1978	1.465	0.197
1979	1.195	0.148
1980	1.308	0.186
1981	1.241	0.184
1982	1.484	0.210
1983	1.815	0.210
1984	0.865	0.116
1985	0.795	0.094
1986	0.912	0.134
1987	0.851	0.121
1988	0.644	0.078
1989	0.665	0.080
1990	1.062	0.156
1991	1.443	0.242
1992	3.308	0.556
1993	1.177	0.158
1994	2.024	0.241
1995	1.336	0.162
1996	1.112	0.165
1997	2.319	0.365
1998	1.629	0.238
1999	0.938	0.118
2000	0.867	0.096
2001	0.736	0.085
2002	0.838	0.109
2003	0.631	0.084
2004	1.121	0.157
2005	0.896	0.121
2006	0.963	0.135
2007	0.866	0.105
2008	0.763	0.090
2009	0.933	0.121
2010	1.501	0.217
2011	0.827	0.103

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	3.3078	0.5565
2	2.3192	0.3653
3	2.0239	0.2421
4	1.8154	0.2409
5	1.6289	0.2380
6	1.5172	0.2266
7	1.5005	0.2171
8	1.4842	0.2105

9	1.4653	0.2102
10	1.4427	0.1981
11	1.4203	0.1975
12	1.3362	0.1924
13	1.3179	0.1864
14	1.3081	0.1845
15	1.2409	0.1650
16	1.1953	0.1647
17	1.1921	0.1615
18	1.1773	0.1577
19	1.1208	0.1568
20	1.1171	0.1556
21	1.1118	0.1542
22	1.0624	0.1476
23	0.9821	0.1348
24	0.9767	0.1336
25	0.9626	0.1328
26	0.9381	0.1271
27	0.9332	0.1253
28	0.9256	0.1231
29	0.9158	0.1215
30	0.9116	0.1214
31	0.9099	0.1206
32	0.9080	0.1203
33	0.8958	0.1194
34	0.8723	0.1191
35	0.8678	0.1190
36	0.8674	0.1176
37	0.8668	0.1155
38	0.8658	0.1148
39	0.8652	0.1093
40	0.8506	0.1053
41	0.8379	0.1032
42	0.8271	0.1016
43	0.7947	0.0994
44	0.7874	0.0963
45	0.7738	0.0940
46	0.7627	0.0925
47	0.7624	0.0913
48	0.7359	0.0897
49	0.7050	0.0885
50	0.7005	0.0847
51	0.6786	0.0839
52	0.6646	0.0832
53	0.6523	0.0820
54	0.6436	0.0800
55	0.6310	0.0788
56	0.6287	0.0777

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4925	1975	1	0	Pass
0.5108	1728	1	0	Pass
0.5291	1525	1	0	Pass
0.5475	1328	1	0	Pass
0.5658	1162	0	0	Pass
0.5841	1021	0	0	Pass
0.6024	913	0	0	Pass
0.6207	795	0	0	Pass
0.6390	706	0	0	Pass
0.6574	629	0	0	Pass
0.6757	567	0	0	Pass
0.6940	509	0	0	Pass
0.7123	448	0	0	Pass
0.7306	397	0	0	Pass
0.7489	359	0	0	Pass
0.7672	328	0	0	Pass
0.7856	285	0	0	Pass
0.8039	259	0	0	Pass
0.8222	241	0	0	Pass
0.8405	221	0	0	Pass
0.8588	202	0	0	Pass
0.8771	179	0	0	Pass
0.8954	162	0	0	Pass
0.9138	138	0	0	Pass
0.9321	123	0	0	Pass
0.9504	112	0	0	Pass
0.9687	104	0	0	Pass
0.9870	95	0	0	Pass
1.0053	92	0	0	Pass
1.0237	88	0	0	Pass
1.0420	81	0	0	Pass
1.0603	74	0	0	Pass
1.0786	68	0	0	Pass
1.0969	65	0	0	Pass
1.1152	61	0	0	Pass
1.1335	55	0	0	Pass
1.1519	53	0	0	Pass
1.1702	50	0	0	Pass
1.1885	48	0	0	Pass
1.2068	46	0	0	Pass
1.2251	45	0	0	Pass
1.2434	43	0	0	Pass
1.2617	42	0	0	Pass
1.2801	36	0	0	Pass
1.2984	33	0	0	Pass
1.3167	31	0	0	Pass
1.3350	28	0	0	Pass
1.3533	23	0	0	Pass
1.3716	22	0	0	Pass
1.3900	20	0	0	Pass
1.4083	20	0	0	Pass
1.4266	19	0	0	Pass
1.4449	17	0	0	Pass

1.4632	16	0	0	Pass
1.4815	15	0	0	Pass
1.4998	14	0	0	Pass
1.5182	12	0	0	Pass
1.5365	12	0	0	Pass
1.5548	12	0	0	Pass
1.5731	12	0	0	Pass
1.5914	12	0	0	Pass
1.6097	11	0	0	Pass
1.6281	11	0	0	Pass
1.6464	10	0	0	Pass
1.6647	9	0	0	Pass
1.6830	8	0	0	Pass
1.7013	7	0	0	Pass
1.7196	7	0	0	Pass
1.7379	7	0	0	Pass
1.7563	7	0	0	Pass
1.7746	7	0	0	Pass
1.7929	7	0	0	Pass
1.8112	7	0	0	Pass
1.8295	6	0	0	Pass
1.8478	6	0	0	Pass
1.8661	6	0	0	Pass
1.8845	5	0	0	Pass
1.9028	5	0	0	Pass
1.9211	5	0	0	Pass
1.9394	5	0	0	Pass
1.9577	5	0	0	Pass
1.9760	5	0	0	Pass
1.9944	5	0	0	Pass
2.0127	4	0	0	Pass
2.0310	3	0	0	Pass
2.0493	3	0	0	Pass
2.0676	3	0	0	Pass
2.0859	3	0	0	Pass
2.1042	2	0	0	Pass
2.1226	2	0	0	Pass
2.1409	2	0	0	Pass
2.1592	2	0	0	Pass
2.1775	2	0	0	Pass
2.1958	2	0	0	Pass
2.2141	2	0	0	Pass
2.2325	2	0	0	Pass
2.2508	2	0	0	Pass
2.2691	2	0	0	Pass
2.2874	2	0	0	Pass
2.3057	2	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total 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
retention 1 POC	☐	164.72			☐	100.00			
Gravel Trench Bed 1 POC	☐	160.25			☐	100.00			
Total Volume Infiltrated		324.97	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

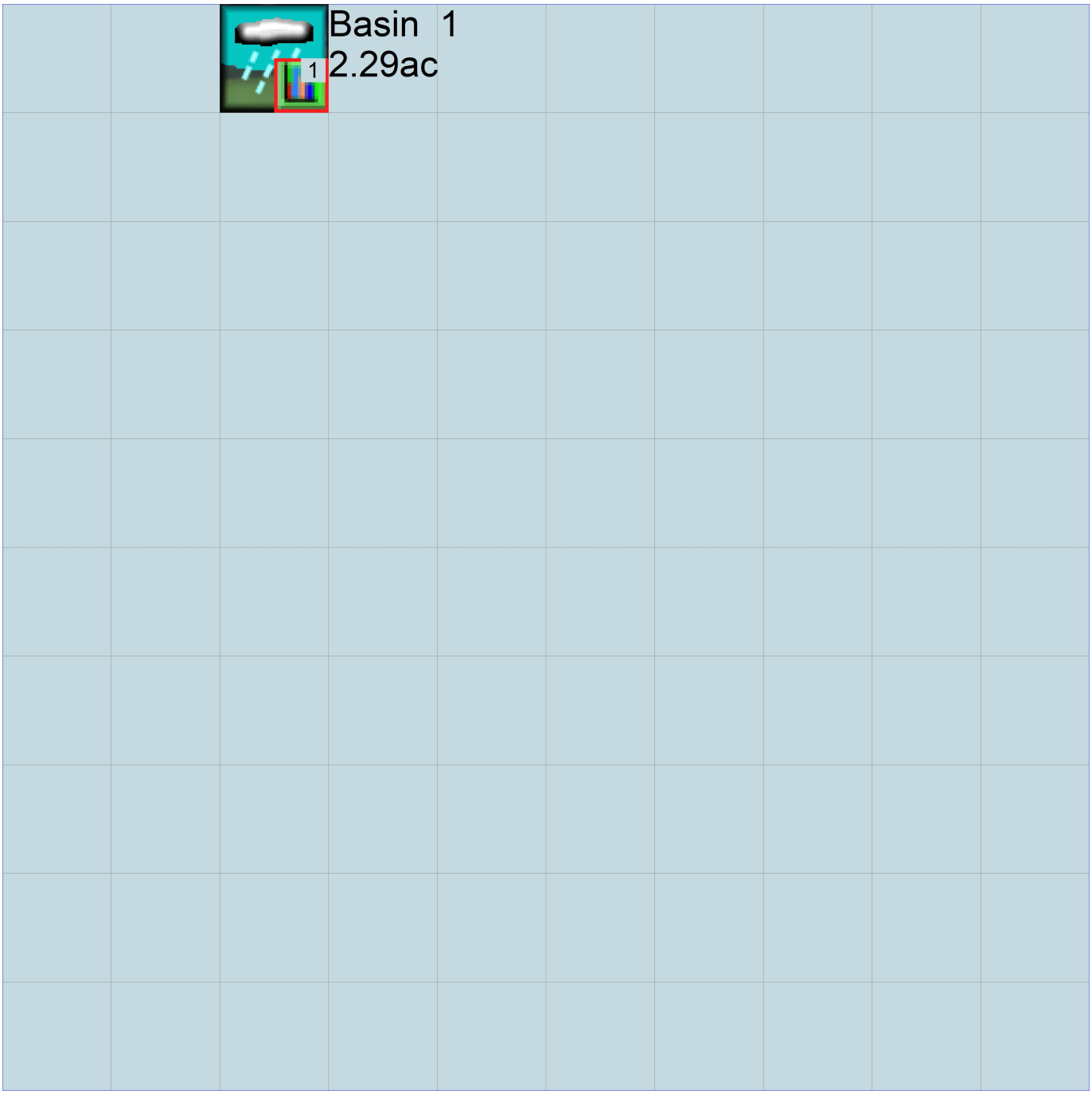
PERLND Changes

No PERLND changes have been made.

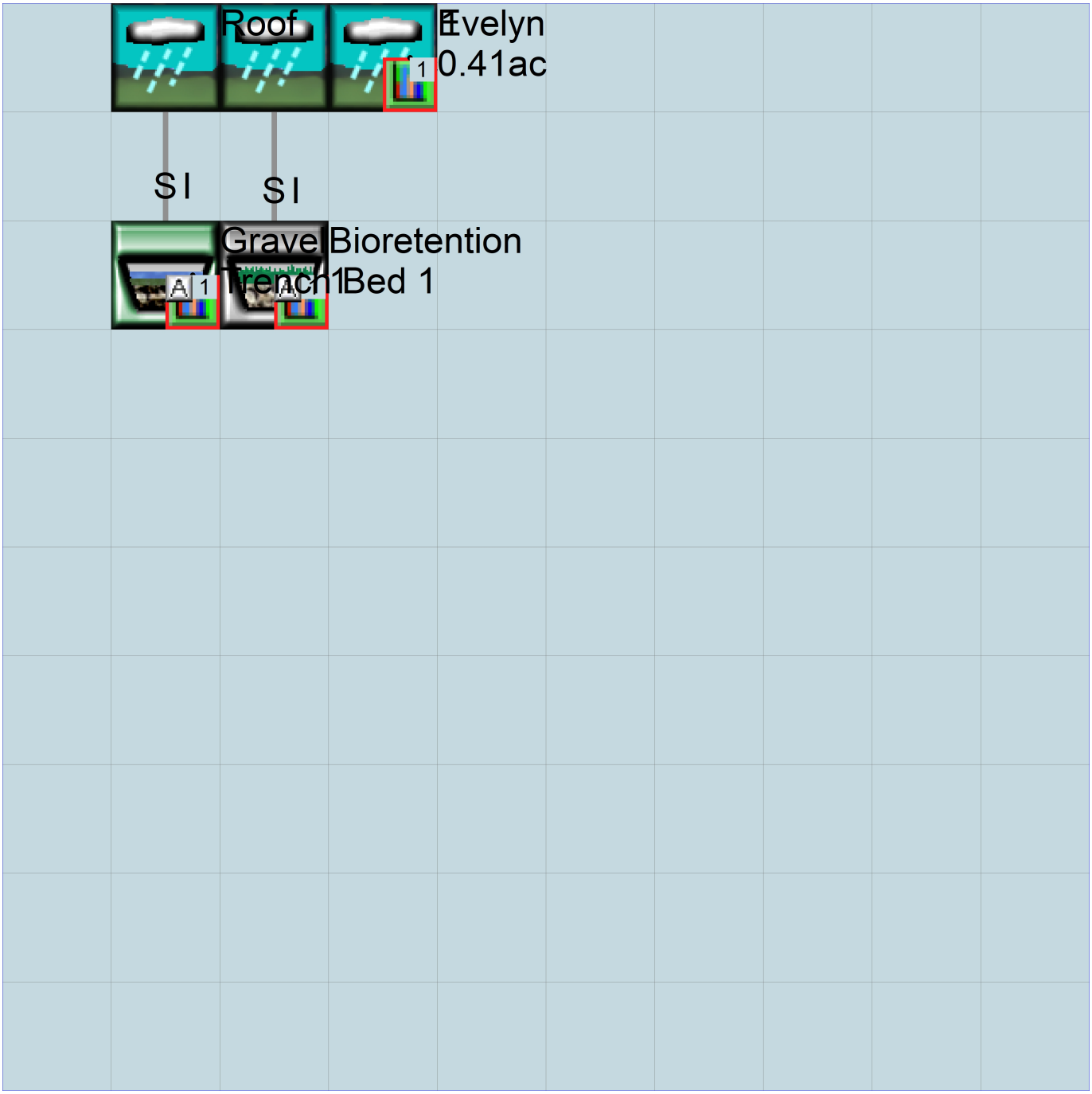
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2011 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   Betschart Warehouse b1.wdm
MESSU       25   PreBetschart Warehouse b1.MES
            27   PreBetschart Warehouse b1.L61
            28   PreBetschart Warehouse b1.L62
            30   POCBetschart Warehouse b11.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      16
      IMPLND      11
      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            ***
   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 ***
   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  *********
   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 ***
   16         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
   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
   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 ***
   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
   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           ***
   11      PARKING/FLAT           1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
   11         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
   11         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     ***
   11         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
   11            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
   11              0         0
```

```
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
   11             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  16                        0.18     COPY   501     12
PERLND  16                        0.18     COPY   501     13
IMPLND  11                        2.11     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              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              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       1955 10 01        END    2011 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   Betschart Warehouse b1.wdm
MESSU      25   MitBetschart Warehouse b1.MES
           27   MitBetschart Warehouse b1.L61
           28   MitBetschart Warehouse b1.L62
           30   POCBetschart Warehouse b11.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       7
      IMPLND       8
      IMPLND      11
      IMPLND       4
      PERLND      16
      IMPLND       1
      RCHRES       1
      RCHRES       2
      RCHRES       3
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Surface retention  1        MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         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           ***
    7     A/B, Lawn, 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 ***
    7         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  *********
    7         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 ***
    7         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
    7              0         5       0.8       400      0.05        0.3      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
    7              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 ***
    7            0.1       0.5      0.25         0       0.7      0.25
   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
    7              0         0         0         0         3          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           ***
    8      SIDEWALKS/FLAT         1    1    1   27    0
   11      PARKING/FLAT           1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    1      ROADS/FLAT             1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    8         0    0    1    0    0    0
   11         0    0    1    0    0    0
    4         0    0    1    0    0    0
    1         0    0    1    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    8         0    0    4    0    0    0    1    9
   11         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    1         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     ***
    8         0    0    0    0    0
   11         0    0    0    0    0
    4         0    0    0    0    0
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    8            400      0.01       0.1       0.1
   11            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
    1            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    8              0         0
   11              0         0
    4              0         0
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    8             0         0
   11             0         0
    4             0         0
    1             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                <--Area-->     <-Target->   MBLK   ***
<Name>   #                <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   7                      0.26     RCHRES   1      2
PERLND   7                      0.26     RCHRES   1      3
IMPLND   8                      0.05     RCHRES   1      5
IMPLND  11                       0.7     RCHRES   1      5
Roof***
IMPLND   4                      0.87     RCHRES   3      5
Evelyn***
PERLND  16                      0.18     COPY   501     12
PERLND  16                      0.18     COPY   601     12
PERLND  16                      0.18     COPY   501     13
PERLND  16                      0.18     COPY   601     13
IMPLND   1                      0.23     COPY   501     15
IMPLND   1                      0.23     COPY   601     15
IMPLND   8                     0.004     COPY   501     15
IMPLND   8                     0.004     COPY   601     15

******Routing******
```

```
PERLND   7                        0.26     COPY     1     12
IMPLND   8                        0.05     COPY     1     15
IMPLND  11                         0.7     COPY     1     15
PERLND   7                        0.26     COPY     1     13
RCHRES   1                           1     RCHRES   2      8
IMPLND   4                        0.87     COPY     1     15
RCHRES   2                           1     COPY   501     17
RCHRES   1                           1     COPY   501     17
RCHRES   3                           1     COPY   501     17
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     Surface retentio-009    3    1    1    1   28    0    1
    2     Bioretention  1         2    1    1    1   28    0    1
    3     Gravel Trench Be-011    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
    2         1    0    0    0    0    0    0    0    0    0
    3         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
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         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  6  0  0       0  0  0  0  0        2  2  2  2  2
    2      0  1  0  0    4  5  0  0  0       0  0  0  0  0        2  2  2  2  2
    3      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      0.01       0.0       1.0       0.0       0.0
    2              2      0.13       0.0       1.0       0.0       0.0
    3              3      0.04       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  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3            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      2
   54    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.304299  0.000000  0.000000  0.000000
  0.052198  0.300684  0.000290  0.000000  0.000000
  0.104396  0.295405  0.000621  0.000000  0.000000
  0.156593  0.290130  0.000995  0.000000  0.000000
  0.208791  0.284860  0.001411  0.000000  0.000000
  0.260989  0.279594  0.001984  0.000000  0.000000
  0.313187  0.274333  0.002610  0.000000  0.000000
  0.365385  0.269077  0.003289  0.000000  0.000913
  0.417582  0.263825  0.004022  0.000000  0.001736
  0.469780  0.258577  0.004807  0.000000  0.002970
  0.521978  0.253334  0.005645  0.000000  0.004714
  0.574176  0.248095  0.006536  0.000000  0.007071
  0.626374  0.242861  0.007481  0.000000  0.010151
  0.678571  0.237631  0.008479  0.000000  0.011080
  0.730769  0.232406  0.009530  0.000000  0.014802
  0.782967  0.227186  0.010634  0.000000  0.015766
  0.835165  0.221970  0.011792  0.000000  0.020528
  0.887363  0.216758  0.013003  0.000000  0.024770
  0.939560  0.211551  0.014268  0.000000  0.034317
  0.991758  0.206348  0.015587  0.000000  0.044448
  1.043956  0.201150  0.016959  0.000000  0.057760
  1.096154  0.195957  0.018384  0.000000  0.073841
  1.148352  0.190767  0.019863  0.000000  0.088973
  1.200549  0.185583  0.021396  0.000000  0.098856
  1.252747  0.180403  0.022983  0.000000  0.119796
  1.304945  0.175227  0.024624  0.000000  0.147253
  1.357143  0.170056  0.026318  0.000000  0.176240
  1.409341  0.164890  0.028066  0.000000  0.181762
  1.461538  0.159728  0.029869  0.000000  0.187289
  1.513736  0.154570  0.031725  0.000000  0.192821
  1.565934  0.149417  0.033635  0.000000  0.198357
  1.618132  0.144268  0.035600  0.000000  0.203899
  1.670330  0.139124  0.037618  0.000000  0.209445
  1.722527  0.133985  0.039691  0.000000  0.214996
  1.774725  0.128850  0.041898  0.000000  0.220552
  1.826923  0.123719  0.044161  0.000000  0.226113
  1.879121  0.118593  0.046481  0.000000  0.231678
  1.931319  0.113472  0.048857  0.000000  0.237248
  1.983516  0.108355  0.051289  0.000000  0.242824
  2.035714  0.103242  0.053778  0.000000  0.248404
  2.087912  0.098134  0.056324  0.000000  0.253988
  2.140110  0.093031  0.058926  0.000000  0.259578
  2.192308  0.087932  0.061584  0.000000  0.265172
  2.244505  0.082837  0.064300  0.000000  0.270772
  2.296703  0.077747  0.067072  0.000000  0.276376
  2.348901  0.072661  0.069901  0.000000  0.281984
  2.401099  0.067580  0.072787  0.000000  0.287598
  2.453297  0.062504  0.075730  0.000000  0.293217
  2.505495  0.057432  0.078730  0.000000  0.298840
  2.557692  0.052365  0.081787  0.000000  0.304468
  2.609890  0.047302  0.084901  0.000000  0.310101
  2.662088  0.042243  0.088072  0.000000  0.315739
  2.714286  0.037189  0.091300  0.000000  0.321381
  2.750000  0.032140  0.100261  0.000000  0.325245
  END FTABLE  2
  FTABLE      1
```

```
   40    6
     Depth      Area    Volume  Outflow1  Outflow2  Outflow3  Velocity  Travel
Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)     (cfs)   (ft/sec)
(Minutes)***
  0.000000  0.032140  0.000000  0.000000  0.000000  0.005651
  0.052198  0.309585  0.016022  0.000000  0.078041  0.005651
  0.104396  0.314877  0.032319  0.000000  0.092905  0.011306
  0.156593  0.320172  0.048894  0.000000  0.095520  0.016966
  0.208791  0.325473  0.065744  0.000000  0.098135  0.022631
  0.260989  0.330777  0.082872  0.000000  0.100750  0.028301
  0.313187  0.336087  0.100276  0.000000  0.103365  0.033976
  0.365385  0.341400  0.117958  0.000000  0.105980  0.039656
  0.417582  0.346719  0.135917  0.000000  0.108595  0.045340
  0.469780  0.352041  0.154154  0.000000  0.111210  0.051029
  0.521978  0.357369  0.172669  0.000000  0.113825  0.056723
  0.574176  0.362701  0.191462  0.000000  0.116440  0.062422
  0.626374  0.368037  0.210533  0.000000  0.119056  0.068125
  0.678571  0.373378  0.229883  0.000000  0.121671  0.073834
  0.730769  0.378723  0.249512  0.000000  0.124286  0.079547
  0.782967  0.384073  0.269420  0.000000  0.126901  0.085265
  0.835165  0.389427  0.289608  0.000000  0.129516  0.090988
  0.887363  0.394786  0.310075  0.000000  0.132131  0.096716
  0.939560  0.400149  0.330822  0.000000  0.134746  0.102448
  0.991758  0.405517  0.351849  0.000000  0.137361  0.108185
  1.043956  0.410889  0.373156  0.097690  0.139976  0.113927
  1.096154  0.416266  0.394744  0.314653  0.142591  0.119674
  1.148352  0.421647  0.416612  0.595207  0.145206  0.125426
  1.200549  0.427033  0.438762  0.911089  0.147822  0.131183
  1.252747  0.432423  0.461193  1.234286  0.150437  0.136944
  1.304945  0.437818  0.483905  1.536717  0.153052  0.142710
  1.357143  0.443218  0.506899  1.793902  0.155667  0.148481
  1.409341  0.448621  0.530175  1.990542  0.158282  0.154257
  1.461538  0.454030  0.553734  2.127417  0.160897  0.160038
  1.513736  0.459443  0.577574  2.257510  0.163512  0.165823
  1.565934  0.464860  0.601697  2.369422  0.166127  0.171613
  1.618132  0.470282  0.626104  2.476282  0.168742  0.177408
  1.670330  0.475708  0.650793  2.578717  0.171357  0.183208
  1.722527  0.481139  0.675766  2.677236  0.173973  0.189013
  1.774725  0.486574  0.701022  2.772256  0.176588  0.194822
  1.826923  0.492014  0.726562  2.864126  0.179203  0.200637
  1.879121  0.497459  0.752386  2.953139  0.181818  0.206456
  1.931319  0.502907  0.778495  3.039546  0.184433  0.212280
  1.983516  0.508361  0.804888  3.123564  0.187048  0.218108
  2.000000  0.510084  0.813281  3.205380  0.187874  0.219950
  END FTABLE  1
  FTABLE      3
   92    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.158402  0.000000  0.000000  0.000000
  0.038889  0.158402  0.002464  0.000000  0.169306
  0.077778  0.158402  0.004928  0.000000  0.169306
  0.116667  0.158402  0.007392  0.000000  0.169306
  0.155556  0.158402  0.009856  0.000000  0.169306
  0.194444  0.158402  0.012320  0.000000  0.169306
  0.233333  0.158402  0.014784  0.000000  0.169306
  0.272222  0.158402  0.017248  0.000000  0.169306
  0.311111  0.158402  0.019712  0.000000  0.169306
  0.350000  0.158402  0.022176  0.000000  0.169306
  0.388889  0.158402  0.024640  0.000000  0.169306
  0.427778  0.158402  0.027104  0.000000  0.169306
  0.466667  0.158402  0.029568  0.000000  0.169306
  0.505556  0.158402  0.032032  0.000000  0.169306
  0.544444  0.158402  0.034496  0.000000  0.169306
  0.583333  0.158402  0.036961  0.000000  0.169306
  0.622222  0.158402  0.039425  0.000000  0.169306
  0.661111  0.158402  0.041889  0.000000  0.169306
  0.700000  0.158402  0.044353  0.000000  0.169306
  0.738889  0.158402  0.046817  0.000000  0.169306
```

0.777778	0.158402	0.049281	0.000000	0.169306
0.816667	0.158402	0.051745	0.000000	0.169306
0.855556	0.158402	0.054209	0.000000	0.169306
0.894444	0.158402	0.056673	0.000000	0.169306
0.933333	0.158402	0.059137	0.000000	0.169306
0.972222	0.158402	0.061601	0.000000	0.169306
1.011111	0.158402	0.064065	0.000000	0.169306
1.050000	0.158402	0.066529	0.000000	0.169306
1.088889	0.158402	0.068993	0.000000	0.169306
1.127778	0.158402	0.071457	0.000000	0.169306
1.166667	0.158402	0.073921	0.000000	0.169306
1.205556	0.158402	0.076385	0.000000	0.169306
1.244444	0.158402	0.078849	0.000000	0.169306
1.283333	0.158402	0.081313	0.000000	0.169306
1.322222	0.158402	0.083777	0.000000	0.169306
1.361111	0.158402	0.086241	0.000000	0.169306
1.400000	0.158402	0.088705	0.000000	0.169306
1.438889	0.158402	0.091169	0.000000	0.169306
1.477778	0.158402	0.093633	0.000000	0.169306
1.516667	0.158402	0.096097	0.000000	0.169306
1.555556	0.158402	0.098561	0.000000	0.169306
1.594444	0.158402	0.101025	0.000000	0.169306
1.633333	0.158402	0.103489	0.000000	0.169306
1.672222	0.158402	0.105953	0.000000	0.169306
1.711111	0.158402	0.108418	0.000000	0.169306
1.750000	0.158402	0.110882	0.000000	0.169306
1.788889	0.158402	0.113346	0.000000	0.169306
1.827778	0.158402	0.115810	0.000000	0.169306
1.866667	0.158402	0.118274	0.000000	0.169306
1.905556	0.158402	0.120738	0.000000	0.169306
1.944444	0.158402	0.123202	0.000000	0.169306
1.983333	0.158402	0.125666	0.000000	0.169306
2.022222	0.158402	0.128130	0.000000	0.169306
2.061111	0.158402	0.130594	0.000000	0.169306
2.100000	0.158402	0.133058	0.000000	0.169306
2.138889	0.158402	0.135522	0.000000	0.169306
2.177778	0.158402	0.137986	0.000000	0.169306
2.216667	0.158402	0.140450	0.000000	0.169306
2.255556	0.158402	0.142914	0.000000	0.169306
2.294444	0.158402	0.145378	0.000000	0.169306
2.333333	0.158402	0.147842	0.000000	0.169306
2.372222	0.158402	0.150306	0.000000	0.169306
2.411111	0.158402	0.152770	0.000000	0.169306
2.450000	0.158402	0.155234	0.000000	0.169306
2.488889	0.158402	0.157698	0.000000	0.169306
2.527778	0.158402	0.160162	0.049108	0.169306
2.566667	0.158402	0.162626	0.182234	0.169306
2.605556	0.158402	0.165090	0.361353	0.169306
2.644444	0.158402	0.167554	0.572643	0.169306
2.683333	0.158402	0.170018	0.804700	0.169306
2.722222	0.158402	0.172482	1.046030	0.169306
2.761111	0.158402	0.174946	1.284848	0.169306
2.800000	0.158402	0.177410	1.509672	0.169306
2.838889	0.158402	0.179875	1.710330	0.169306
2.877778	0.158402	0.182339	1.879270	0.169306
2.916667	0.158402	0.184803	2.013084	0.169306
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2.994444	0.158402	0.189731	2.192903	0.169306
3.033333	0.158402	0.195891	2.300165	0.169306
3.072222	0.158402	0.202051	2.382549	0.169306
3.111111	0.158402	0.208211	2.462179	0.169306
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3.188889	0.158402	0.220531	2.614172	0.169306
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3.305556	0.158402	0.239011	2.826879	0.169306
3.344444	0.158402	0.245171	2.894310	0.169306
3.383333	0.158402	0.251331	2.960205	0.169306
3.422222	0.158402	0.257492	3.024665	0.169306
3.461111	0.158402	0.263652	3.087780	0.169306

```
  3.500000  0.158402  0.269812  3.149630  0.169306
  3.538889  0.158402  0.275972  3.210289  0.169306
  END FTABLE  3
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              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              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
WDM      2 PREC     ENGL    1              RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.5            RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.76           RCHRES   2     EXTNL  POTEV

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   2 HYDR   RO     1 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1006 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1007 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1004 STAG     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1005 FLOW     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
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
RCHRES   3 HYDR   RO     1 1        1      WDM   1008 FLOW     ENGL      REPL
RCHRES   3 HYDR   O      1 1        1      WDM   1009 FLOW     ENGL      REPL
RCHRES   3 HYDR   O      2 1        1      WDM   1010 FLOW     ENGL      REPL
RCHRES   3 HYDR   STAGE  1 1        1      WDM   1011 STAG     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        8
RCHRES     OFLOW  OVOL   2                 RCHRES         INFLOW IVOL
  END MASS-LINK    8

  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       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17
```

```
END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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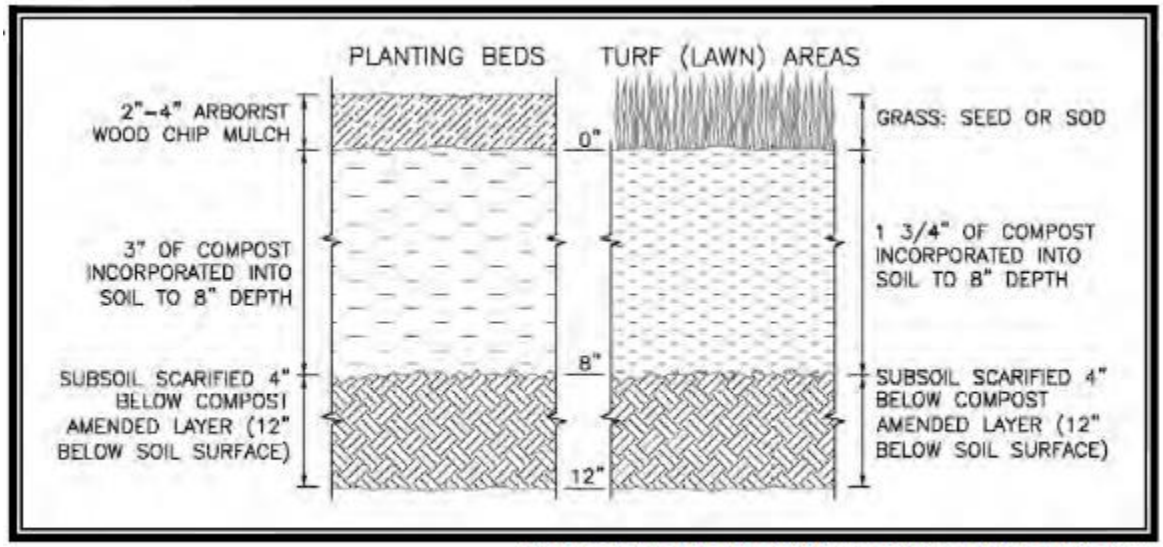
Appendix 2
Soil Management Plan

This project proposed to clear the lot with no Retention or Protection of soils. The Contractor has the options listed below to amend the soil:



Source: City of Seattle 2016 (reproduced with permission)

Figure 7.1. Cross-section of Soil Amendment.

Implementation Options

The soil quality design requirements can be met by using one of the four options listed below. Additional details for each option are provided in the subsequent subsections:

1. Retain and Protect Undisturbed Soil:

    • Leave undisturbed vegetation and soil, and protect from compaction by fencing and keeping materials storage and equipment off these areas during construction.

    • For all areas where soil or vegetation is disturbed, use option 2, 3, or 4.

2. Amend Soil:

    • Soil amendments shall be applied to all areas which are being set aside as nonbuildable areas (open space or natural resource protection areas) and are in need of rehabilitation because of past land use disturbances such as clearing and intrusion of invasive species. The purpose is to enhance and accelerate the rehabilitation of the soil structure. The application will be non-destructive to the existing vegetation that is retained by taking care to taper depths of soil amendment near the surface roots.

- Amend existing site topsoil or subsoil either at default "preapproved" rates, orat custom calculated rates to meet the soil quality guidelines based on engineering tests of the soil and amendment. (Refer to the Building Soil manual [Stenn et al. 2012] or web site Www.buildingsoil.org> for custom calculation methods.)

3. Stockpile Soil:

    • Stockpile existing topsoil during grading and replace it prior to planting. Amend stockpiled topsoil if needed to meet the organic matter or depth requirements either at the default "preapproved" rate or at a custom calculated rate (refer to the Building Soil manual [Stenn et al. 2012] or web site <www.buildingsoil.org> for custom calculation method). Scarify subsoil and mulch planting beds, as described under the Soil Amendment heading below.

4. Import Soil:

• Import topsoil mix of sufficient organic content and depth to meet the equirements. Imported soils must not contain excessive clay or silt fines (more than 5 percent passing the U.S. #200 sieve) because that could restrict stormwater infiltration. Use imported topsoil that meets default "preapproved" rates.
• Scarify subsoil and mulch planting beds, as described under the Soil Amendment heading below.

Note: more than one method may be used on different portions of the same site.

Soil Retention

In buildable areas where minimal excavation foundation systems may be applied, existing topsoils shall be left in place to the greatest extent feasible and shaped or feathered only with tracked grading equipment not exceeding 650 pounds per square foot machine loads. Where some re-grading is required, re-compaction of placed materials, which may include topsoils free of vegetated matter, shall be limited to the minimum densities required by the foundation system engineering.

Soil Amendment

If soil retention and protection is not feasible, disturbed soil must be amended. Soil organic matter is often missing from disturbed soils. Replenish organic matter by amending with compost. It is important that the materials used to meet the Postconstruction Soil Quality and Depth BMP are appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay or silt fines.

Amend existing site topsoil or subsoil either at default "preapproved" soil amendment rates or at custom calculated rates to meet the soil quality guidelines based on engineering tests of the soil and amendment. Both options are described in further detail below.

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility, or engineered as structural fill or slope must, at project completion, demonstrate the following:

• A topsoil layer meeting these requirements:
    o Turf areas: Place 1.75 inches of compost and till-in to an 8-inch depth. Achieve an organic matter content, as measured by the loss-on-ignition test, of a minimum 4 percent (target 5 percent) organic matter content(1).
    o Planting beds: Place 3 inches of compost and till-in to an 8-inch depth. Achieve an organic matter content, as measured by the loss-on-ignition test, of a minimum 8 percent (target 10 percent) dry weight(1).
    o A pH from 6.0 to 8.0 or matching the pH of the original undisturbed soil.
    o A minimum depth of 8 inches.
• Root zones where tree roots limit the depth of incorporation of amendments are exempted from this requirement. Fence and protect these root zones from stripping of soil, grading, or compaction to the maximum extent practical.
• Scarify (loosen) subsoils below the topsoil layer at least 4 inches for a finished minimum depth of 12 inches of uncompacted soil. Incorporate some of the upper material to avoid stratified layers, where feasible.
• For turf installations: Water or roll to compact to 85 percent of maximum dry density, rake to level, and remove surface woody debris and rocks larger than 1-inch diameter (Building Soil manual [Stenn et al. 2012] or web site <www.buildingsoil.org>).

• After planting: Mulch planting beds with 2 to 4 inches of organic material such as arborist wood chips, bark, shredded leaves, compost, etc. Do not use fine bark because it can seal the soil surface.

(1) Acceptable test methods for determining loss-on-ignition soil organic matter include the most current version of ASTM D2974 “Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils” and TMECC 05.07-A “Loss-On-Ignition Organic Matter Method”

• Use compost and other materials that meet the following organic content requirements:

o The organic content for “preapproved” amendment rates can only be met sing compost meeting the compost specification for bioretention (see Section 7.4.4), with the exception that the compost may have up to 35 percent biosolids or manure. The compost must have an organic matter content of 40 percent to 65 percent, and a carbon to nitrogen ratio below 25:1. The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region (Building Soil manual [Stenn et al. 2012] or web site <www.buildingsoil.org>).

o Within the 1-year capture zone of any drinking water well or wellhead rotection area, compost used within the site shall not include biosolids or animal manure components, as these can result in large concentrations of nitrates leaching into groundwater aquifers and are consequently prohibited within the wellhead protection area.

o Calculated amendment rates may be met through use of composted materials as defined above, or other organic materials amended to meet the carbon to nitrogen ratio requirements, and not exceeding the contaminant limits identified in Table 220-B, Testing Parameters, in WAC 173-350-220 (Building Soil manual [Stenn et al. 2012] or web site <www.buildingsoil.org>). Ensure that the resulting soil is conducive to the type of vegetation to be established.

Soil Stockpiling

In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, which is not adjacent to public resources and critical areas. Reapply to other portions of the site where feasible.

• In buildable areas of the site, where conventional grading is required, the areas requiring cuts shall have the upper native topsoil removed and stockpiled for replacement for areas of the development utilized for stormwater and/or vegetation management (yards, bioretention areas, interflow pathways, vegetated channels, or degraded natural resource protection areas).

• The depth of upper native topsoil required to be stockpiled and replaced shall be the entire depth of the native topsoil horizon up to a maximum of 3 feet.

• Over-excavation of cut sections may be necessary if the cut is in a location that will be utilized for stormwater management. Cut to a depth that will allow replacement of stockpiled native topsoil to the entire depth that was on the site postdevelopment up to a maximum of 3 feet.

• Cut sections where native topsoil replacement is required shall require ripping of any cemented till layers to a depth of 6 inches. Subsequently the replacement of stockpiled topsoil shall be thoroughly mixed into the ripped till to provide a gradual transition between the cemented till layer and the topsoil.

• Stockpiled topsoil shall be replaced in lifts no greater than 1-foot deep and compacted by rolling to a density that matches existing conditions.
• Amend stockpiled topsoil if needed to meet the organic matter or depth requirements either at the default "preapproved" rate or at a custom calculated rate (refer to the Building Soil manual [Stenn et al. 2012] or web site <www.buildingsoil.org> for custom calculation method).

Importing Soil

The default preapproved rates for imported topsoils are:

• For planting beds: Use a mix by volume of 35 percent compost with 65 percent mineral soil to achieve the requirement of a minimum 8 percent (target 10 percent) organic matter by loss-on-ignition test
• For turf areas: Use a mix by volume of 20 percent compost with 80 percent mineral soil to achieve the requirement of a minimum 4 percent (target 5 percent) organic matter by loss-on-ignition test.

Appendix 3
Supplemental Reports and Information
MWS Detail