Attachment 23

Storm Drainage Report for Harrison Ave Mixed Use

Site Location:
4004-3840 Harrison Ave NW
Olympia, WA 98502

Prepared for:
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4004 Harrison Ave NW
Olympia, WA 98502

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Job No: 16523
Nov. 2016
Rev July 2019
Rev Oct 2020
Rev March 2021

Project Engineer's Certificate

"I hereby certify that this drainage and erosion control plan for the project known as Harrison Ave Mixed Use has been prepared by me or under my supervision and meets minimum standards of the City of Olympia and normal standards of engineering practice. I understand that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

3/19/21

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ITEM PAGE

Project Overview

The project site is located in the City of Olympia, Washington, within Section 17, Township 18 North, Range 2 West, W.M.

This site is located in the Percival Creek Watershed.

Site address: 4004-3840 Harrison Ave NW, Olympia, WA 98502

Assessor #: 12817140900, 12817140800

Well and Septic: The existing house is currently on well and septic, but City Sewer and Water are stubbed to the property.

Legal Description:

3840: Section 17 Township 18 Range 2W Quarter SE NE THE W 160 FT OF THE E 325 FT OF THE SE QTR OF THE SE QTR OF THE NE QTR; EXC CO RD KA OLYMPIA-MUD BAY RD ALG S BNDRY; EXC PTN FOR RD PER

4004: Section 17 Township 18 Range 2W Quarter SE NE SE QTR, W 325 FT; EXC 30 FT FOR RD ON S; EXC PTN FOR RD PER AFN:3223900; EXC PTN FOR RD PER AFN:4123227

Project Description:

This project proposes create 5 total lots from the existing 4004 and 3840 Harrison Lots. The existing home on 3840 (lot 3) will remain for the first phase and is currently being converted for commercial use. The sizing for the stormwater in this report assumes full buildout where the house is ultimately removed for a larger commercial building.

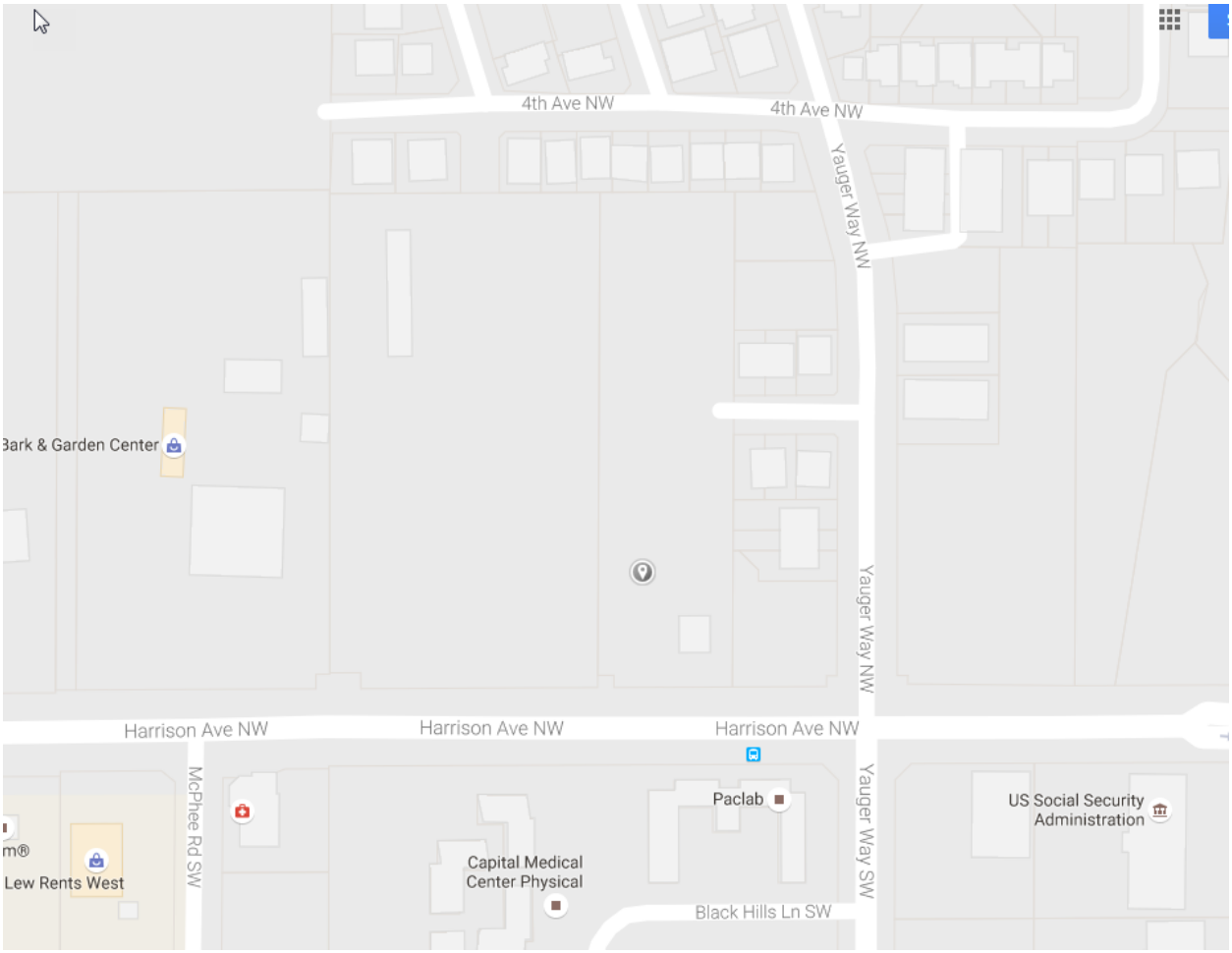
The stormwater consists of mostly pervious pavement throughout the development (with the exception being Craftsman Ave and 3rd Ave extensions) and the roof drains also being directed to the porous pavement section. For the public roads, Contech stormfilters are proposed for treatment with shallow infiltration trenches on Lots 2 and 5 under the porous parking lot.

The proposed collection system has been designed in accordance with the City of Olympia standards and will treat stormwater events per DOE 2009 Manual and using the continuous flow model from DOE (WWHM2012). Stormwater analysis runoff will meet or exceed 2009 DOE requirements.

In the case of a failure of the parking lot system. Overflow to Harrison Ave will occur by overflowing the porous pavement section and flow south across the proposed parking lot. This will ensure the buildings are not damaged due to flooding of the failing stormwater system.

Task 1 – Study Area Definition & Maps

Figure 1 Vicinity Map



Existing Site Hydrology

The site is generally sloping gently to the South and East. The property currently is under developed with a single family house near Harrison Ave. The area is served by City of Olympia sewer and water. The house is connected to onsite well and septic.

The surrounding property is developed fully and no runoff is expected to reach our site from any of those parcels.

There are currently no sensitive areas on this site or directly adjacent. There is little downstream influence as all the storm water will be treated and infiltrated onsite. The following sensitive areas were researched for existence on or around this site:

Creeks, Lakes, Ponds, Wetlands, Ravines, Gullies, Steep Slopes and Springs.

The methods used for determining the existence of these sensitive areas was site observation during the official site visit to this parcel and the Thurston County Website.

The Thurston County Geodata Website was used for research to determine if this parcel was located within either an “Aquifer Sensitive Area” or “Wellhead Protection Area”. Neither this parcel nor any of the adjacent areas were located within these sensitive or protected areas.

Figure 2 Existing Site Conditions

Note: the land is currently mostly cleared of trees since this arial photo was taken.

Task 2: Resource Review

The following resources and documents were reviewed in preparing this analysis. Pertinent maps from these reports have been included in this study.

1. Soils Report by Geotech – Appendix B
2. Sensitive Areas folios – City of Thurston County web site
3. U.S.D.A. SCS Soil Survey
4. 2009 DOE Stormwater Management Manual for Western Washington

Task 3 - Problem Screening

The Olympia research has indicated no drainage problems within the immediate downstream corridor nor does the site have any history of flooding problems.

WELLS AND SEPTIC SYSTEMS

Existing well and septic will be abandoned as part of this project.

FUEL TANKS

Document research has shown there is no evidence of any buried fuel tanks within or in the immediate area around the site.

ANALYSIS OF 100-YEAR FLOOD

FEMA maps were reviewed for this project to research the existence of any floodplain on this site. None were found

Task 4: Minimum Requirements

Minimum Requirement # 1: Preparation of Stormwater Plans

The proposed project qualifies for section 2.4.1 and shall comply with Minimum Requirements 1-10.

Section 2.4.1

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

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

Minimum Requirement # 2; Construction Stormwater Pollution Prevention

See Appendix D for SWPPP Plan.

Minimum Requirement # 3: Source Control of Pollution

See Appendix C for Source Control Plan.

Minimum Requirement # 4: Preservation of Natural Drainage Systems and Outfalls

Downstream Drainage System Description

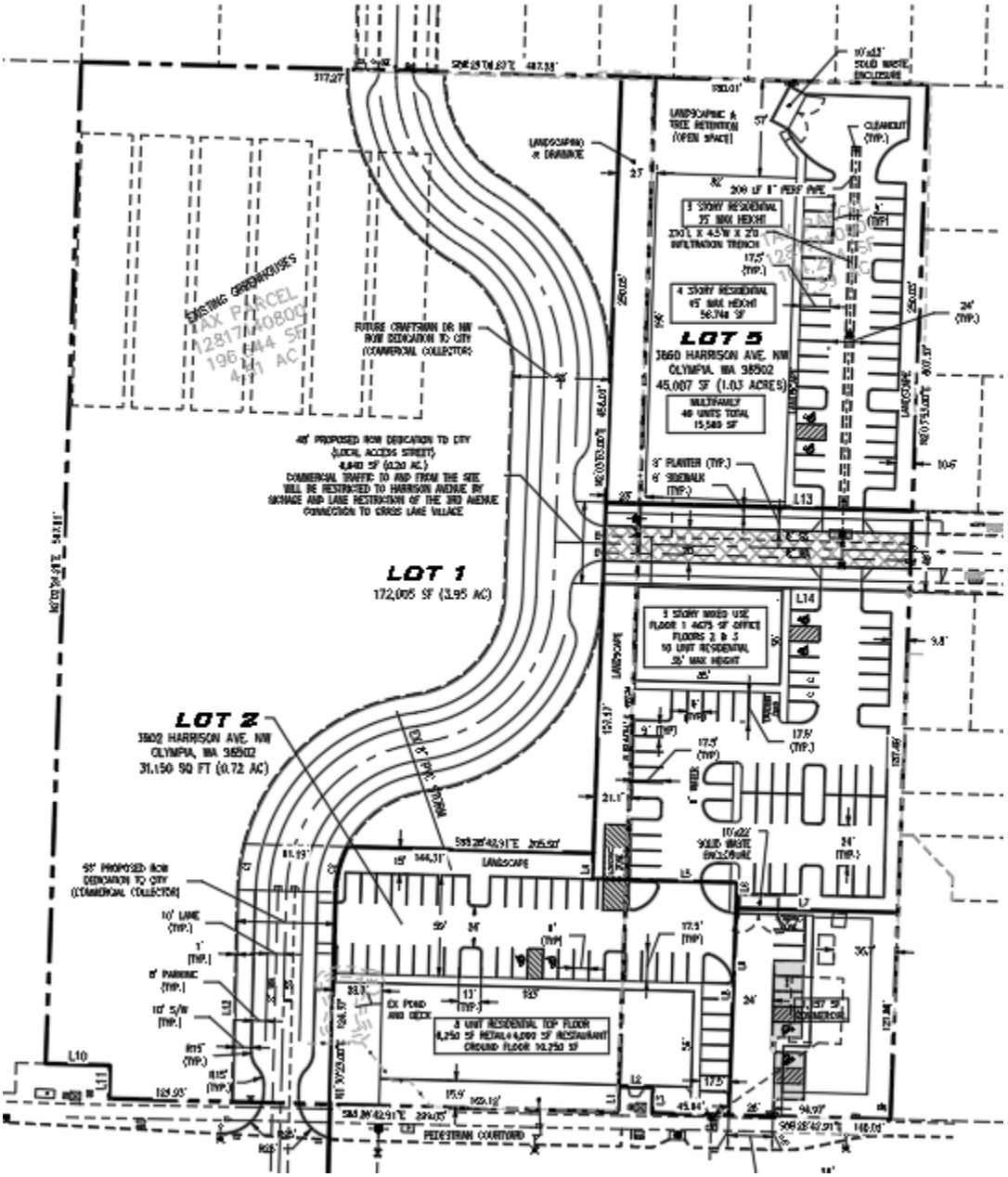
Harrison Ave is fully developed with in place collection system. The 12" pipe on the north side of Harrison directs water to the east, approx. 1000' until it reaches the Green Cove Creek. From there it travels to the SE to Yauger Park to the City regional Stormwater Facility.

Upstream Drainage System Description

From field observation and map research, there are no observable off-site contributing tributary areas. Harrison Ave, 3rd Ave, and the surrounding property currently have stormwater collection systems in place.

Minimum Requirement # 5: On-Site Stormwater Management

Figure 3 Proposed Site Plan



Recommended Drainage System Improvements:

Since on-site soils support shallow infiltration, stormwater from the project will be treated and detained onsite per current City of Olympia standards (2009 DOE) Sizing of the treatment facilities was performed using the Western Washington Hydrologic Modeling Version 2012 (WWHM2012) program.

Parking lot pavement will be porous and the proposed paving section is sized to handle all runoff from the paving, landscaping and building roof areas. 3rd Ave will be collected and treated by a Contech Filter vault and then infiltrated on Lot 5 using an infiltration trench under the proposed parking lot.

In the case of failure, the porous parking lots will overflow from the porous paving section and flow to Harrison Ave.

BMP T5.13 Post-Construction Soil Quality and Depth

Compost amended soils shall be used on all disturbed pervious areas, and street planter areas.

Soil retention. The duff layer and native topsoil should be retained in an undisturbed state to the maximum extent practicable. In any areas requiring grading remove an stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.

- Soil quality. 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 shall, at project completion, demonstrate the following:
    1. A topsoil layer with a minimum organic matter content of ten percent dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the original undisturbed soil The topsail layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoil's below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.
    2. Planting beds must be mulched with 2 inches of organic material
    3. Quality of compost and other materials used to meet the organic content requirements:

        a. The organic content for "pre-approved ' amendment rates can be met only using compost that meets the definition of "composted materials" in WAC 173-350-220

        The compost must also have an organic matter content of 35% to 65%, 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.

b. 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 meeting the contaminant standards of Grade A Compost.

The resulting soil should be conducive to the type of vegetation to be established

- Implementation Options the soil quality design guidelines listed above can be met by using one of the methods listed below

  1. Leave undisturbed native vegetation and soil, and protect from compaction during construction

  2. Amend existing site topsoil or subsoil either at default "pre-approved rates, or at custom calculated rates based on specifies tests of the soil and amendment

  3. Stockpile existing topsoil during grading, and replace it prior to planting Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default '"pre-approved rate or at a custom calculated rate

4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

Soil

- Soil must be un-compacted for a depth of at least 2 feet. Soil must be compost amended according to the following specifications:
- Grading Before Compost Amendment
- Estimating guide to obtain 24 inches of compost amended soil:
- Remove and stockpile 4 inches of topsoil (will expand by 1.5 inches to about 5.5 inches)
- Excavate and remove material in bioretention facility area to a depth of 18 inches below top of pavement (12 inches below finished grade).
- Till soil to a further depth of 14 inches (or 32 inches below pavement) which results in loose soil depth of about 19.8 inches.
- Add back the native topsoil from stockpile (adding about 5.5 inches for a total of about 25.4 inches of loose soil.

- Add 10 inches of loose compost. Loose soil + compost is now about 35 inches deep.
- Mix compost into loose soil. (Mixing causes about 20% loss in volume).
- Lightly compact compost amended soil to 2 inches below finished grade (8 inches below pavement).

- Add 2 inches of mulch to bring the elevation of facility up to final grade or 6 inches below pavement (mulch can be added after planting).

Compost Specifications

(from: Washington Department of Transportation Landscape Architectural Specifications)

- Compost shall be stable, mature, decomposed organic solid waste that is the result of the accelerated, aerobic biodegradation and stabilization under controlled conditions. The result is a uniform dark, soil-like appearance. Compost maturity or stability is the point at which the aerobic biodegradation of the compost has slowed and oxygen consumption and carbon dioxide generation has dropped. Subsequent testing provides consistent results.

- Compost production and quality shall comply with the Interim Guidelines for Compost Quality, #94-38 or superseding editions, and amendments, published by the Washington State Department of Ecology.

- Compost products shall meet the following physical criteria:
- 100 percent shall pass through a 1-inch sieve when tested in accordance with AASHTO Test Method T87 and T88. (Note: 7/16-inch size has shown to provide the optimum benefits (Kolsti, 1995) The pH range shall be between 5.5 and 8.5 when tested in accordance with WSDOT Test Method 417.
- Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1 percent on a dry weight or volume basis, whichever provides for the least amount of foreign material.
- Minimum organic matter shall be 30 percent dry weight basis as determined by loss on ignition. (LOI test) Soluble salt contents shall be less than 4.0 mmhos/cm.
- Compost shall score a number 5 or above on the Solvita Compost Maturity Test before planting (Woodsend Laboratories, Inc.[2]).

Maintenance

Soil quality and depth should be established toward the end of construction and once established, should be protected from compaction such as from large machinery use and from erosion.

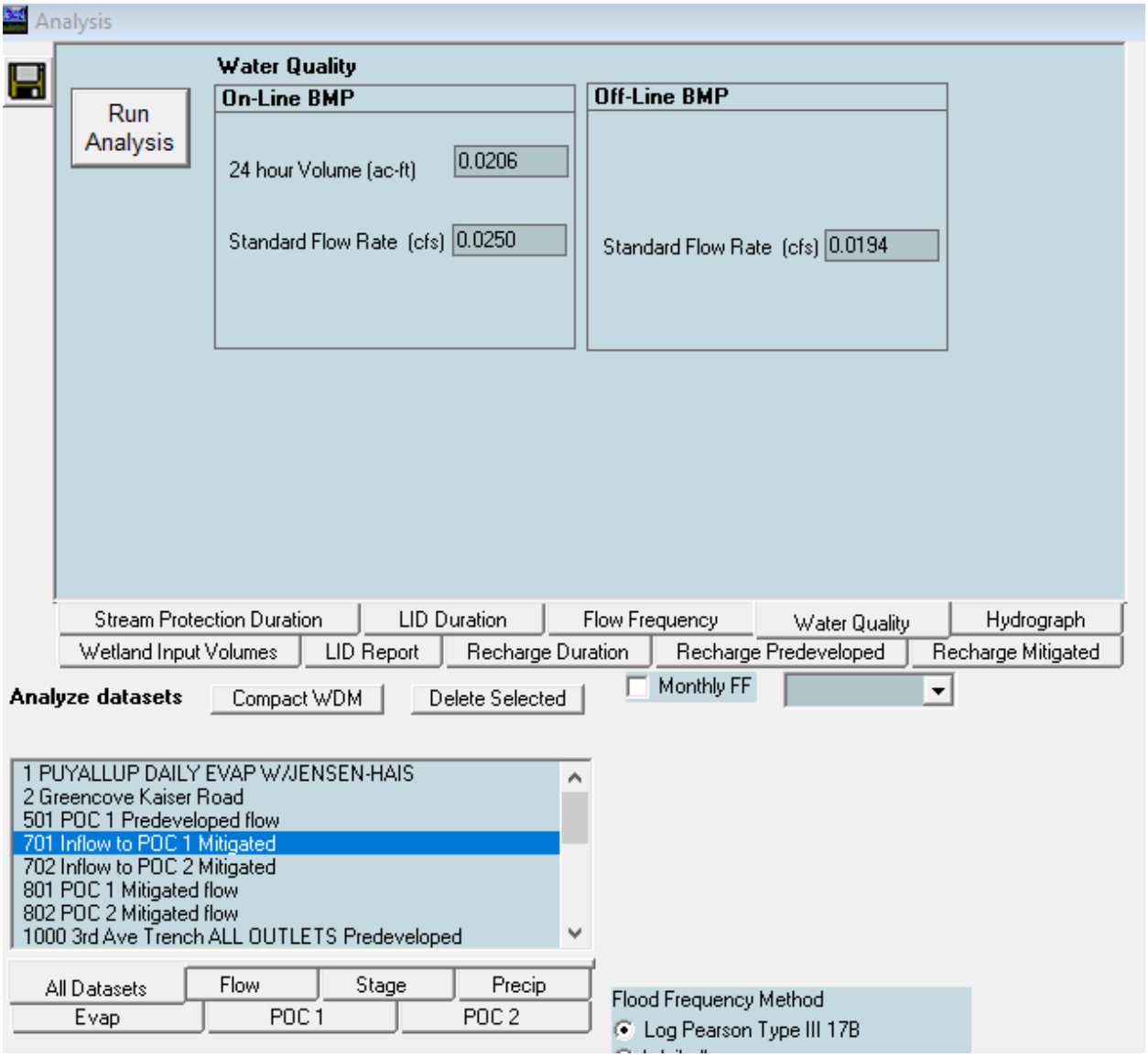
- Soil should be planted and mulched after installation
- Plant debris or its equivalent should be left on the soil surface to replenish organic matter
- It should be possible to reduce use of irrigation, fertilizers, herbicides and pesticides These activities should be adjusted where possible rather than continuing to implement formerly established practices.

Minimum Requirement # 6: Runoff Treatment

Treatment will be provided by the paving section and underlying soils for the majority of the site. For Craftsman Ave and 3rd Ave, filter vaults will treat the runoff collected in the ROW and then direct runoff onsite to infiltration trenches on Lots 2 and 5.

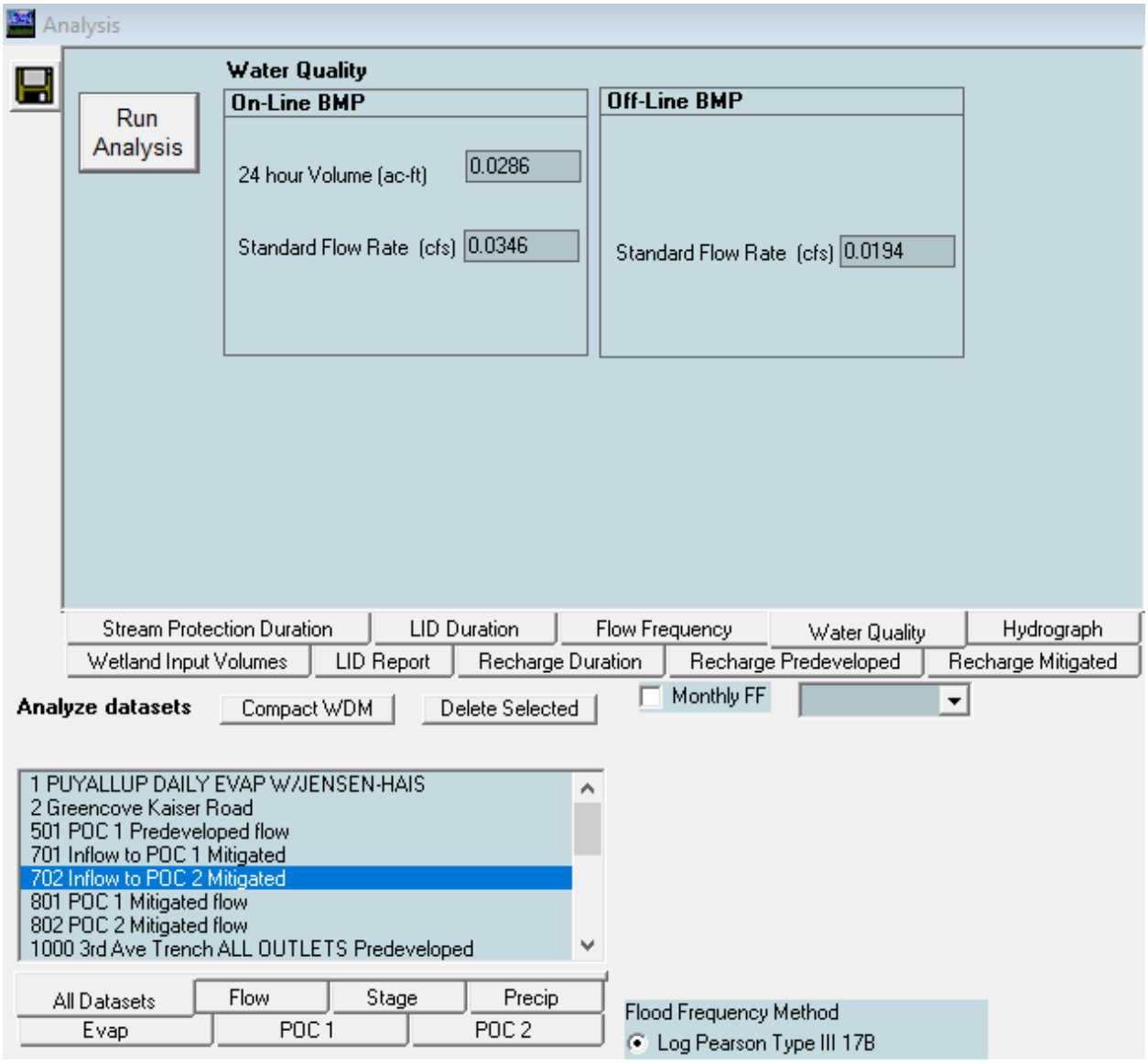
Sizing for the filter vaults are as follows:

3rd Ave treatment flows:



A single Contech Filter can treat up to .033 cfs

Craftsman Ave:



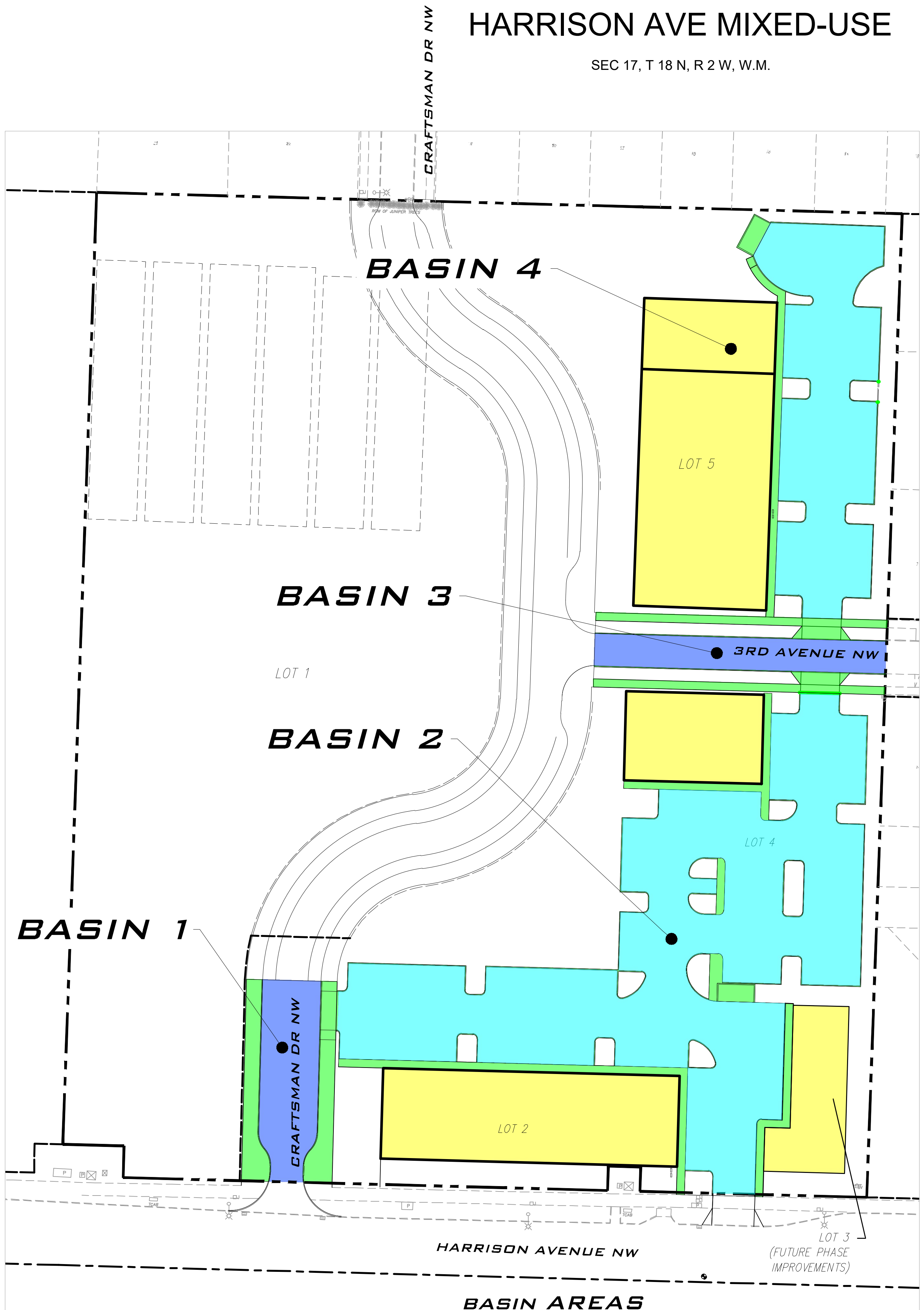
A single Contech Filter can treat up to .033 cfs, a dual cartridge unit is proposed.

Minimum Requirement # 7: Flow Control

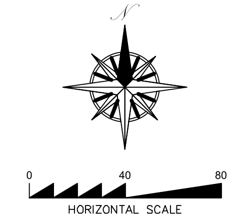
The following basin map area exhibit and the following screen shots of WWHM2012 are used for the sizing of the infiltration facilities of the 4 basins:

HARRISON AVE MIXED-USE

SEC 17, T 18 N, R 2 W, W.M.



BASIN AREAS



BASIN AREAS

BASIN #1		
DESCRIPTION	SQUARE FEET	ACRES
BASIN AREA	7,213	0.166
IMPERVIOUS AREAS		
IMPERVIOUS PAVEMENT	4,156	0.095
SIDEWALKS/CURBS	2,834	0.065
TOTAL IMPERVIOUS	6,990	0.160
12" PERVIOUS ROW	224	0.005
BASIN #2		
BASIN AREA	78,008	1.791
IMPERVIOUS AREAS		
BUILDINGS	18,895	0.434
SIDEWALKS/CURBS	4,209	0.097
TOTAL IMPERVIOUS	23,104	0.530
PERVIOUS AREAS		
PERVIOUS PAVEMENT	35,325	0.811
LANDSCAPE	19,579	0.449
TOTAL PERVIOUS	54,904	1.260
BASIN #3		
BASIN AREA	8,640	0.198
IMPERVIOUS AREAS		
IMPERVIOUS PAVEMENT	3,600	0.083
SIDEWALKS/CURBS	1,215	0.028
TOTAL IMPERVIOUS	4,815	0.111
LANDSCAPE	3,825	0.088
BASIN #4		
BASIN AREA	45,007	1.033
IMPERVIOUS AREAS		
BUILDINGS	15,580	0.358
SIDEWALKS/CURBS	1,705	0.039
TOTAL IMPERVIOUS	17,285	0.397
PERVIOUS AREAS		
PERVIOUS PAVEMENT	13,128	0.301
LANDSCAPE	14,594	0.335
TOTAL PERVIOUS	27,722	0.636

R#	DATE	DESCRIPTION	BY

BASIN AREAS

PATRICK HARRON & ASSOCIATES, LLC
Civil Engineering & Planning
8270 28th Court NE, Suite 201, Lacey, WA 98516
Phone : 360.459.1102 / Fax: 360.459.1013
Web : patrickharron.com

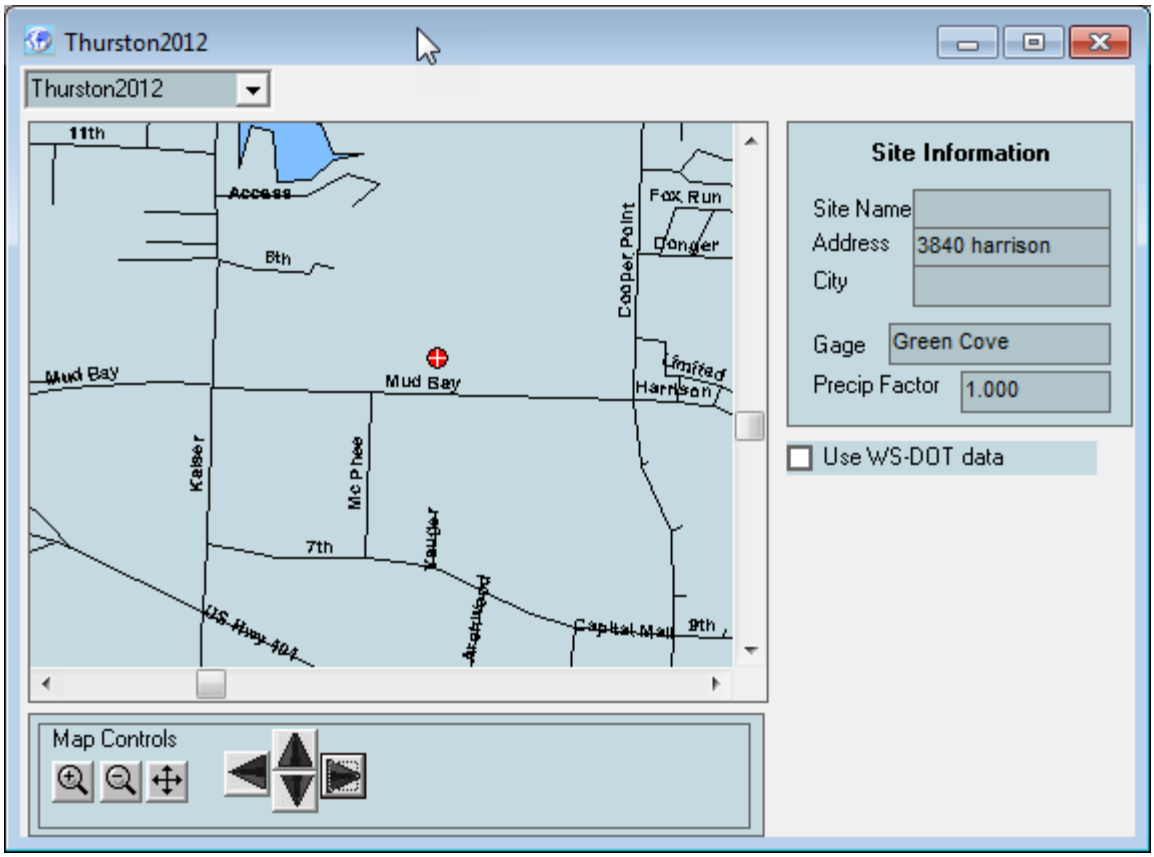
PROJ. NO.	DSN. BY:
16523	CMC
DWN. BY:	CHK. BY:
DAW	CMC

HARRISON AVE MIXED-USE

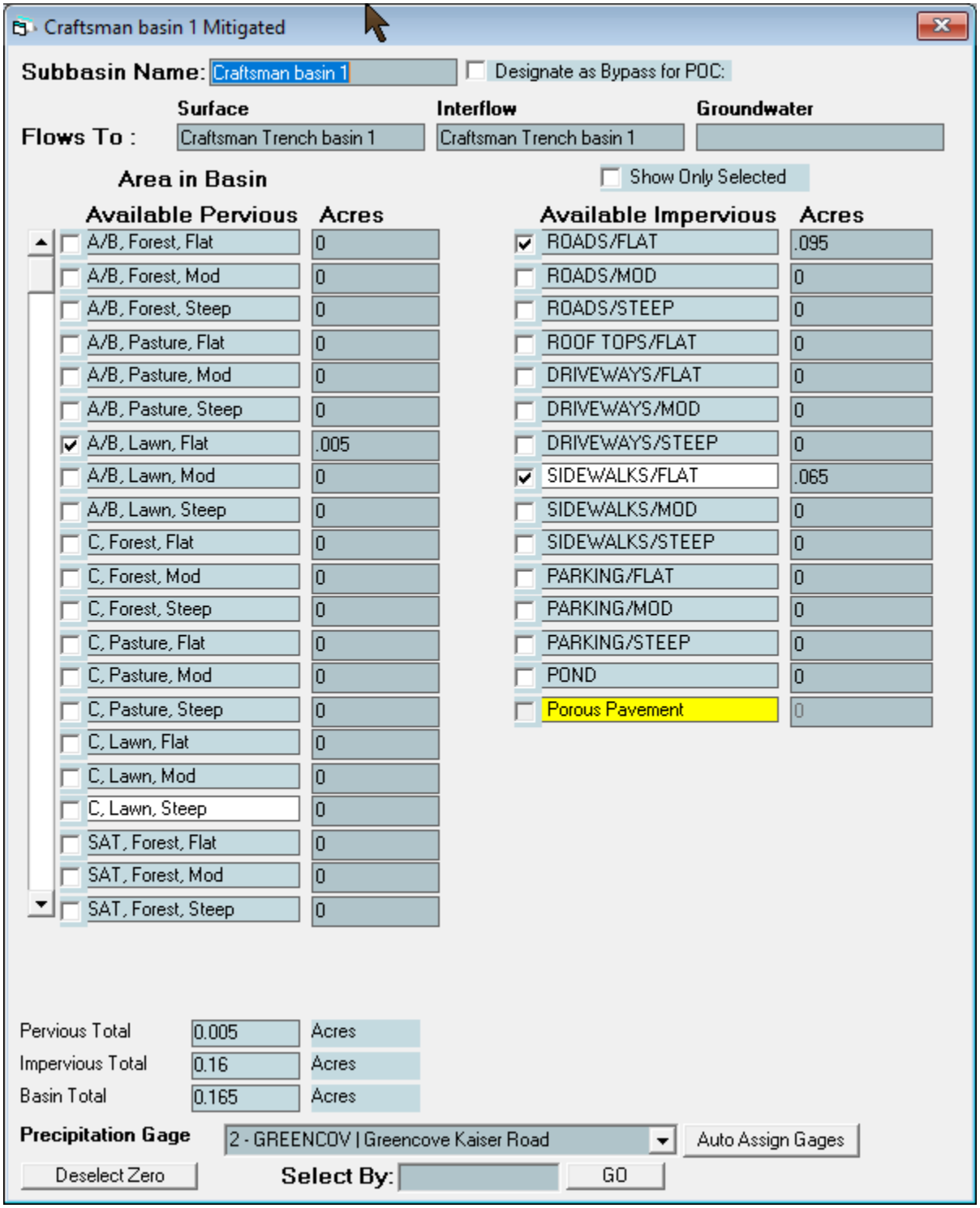
PARCEL # 12817140800
PARCEL # 12817140900
3840-4004 HARRISON AVE
OLYMPIA, WA 98502

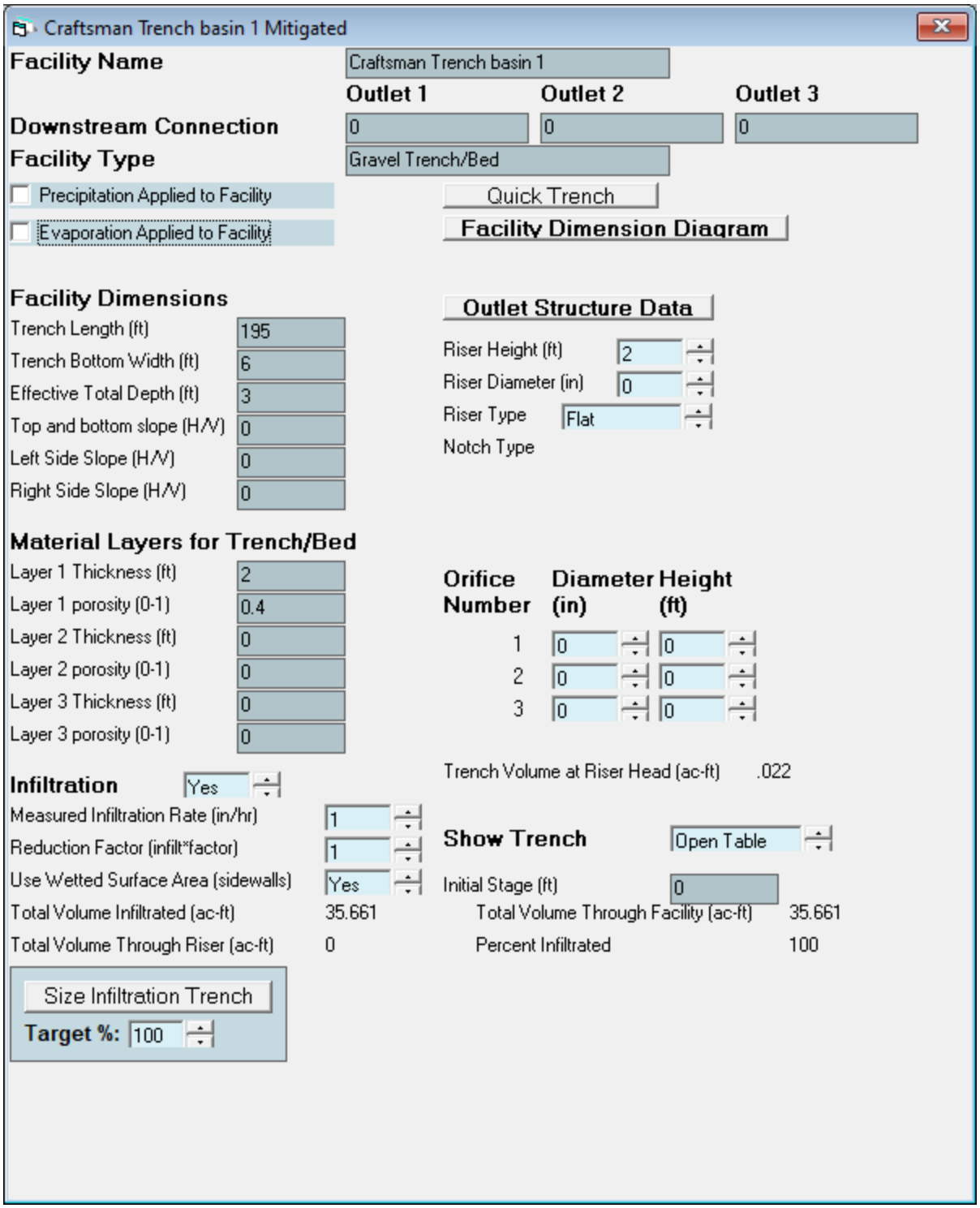
DATE: 3/19/21
SCALE: AS SHOWN
DRAWING NO. EX-02
1 OF 1

Mar 19, 2021 5:13:02PM - User Dan Witt
P:\2016\16523 4004-3840 harrison ave mixed use - Copy\P & E\Drawing\Working\Exhibits\16523 Basin Areas.dwg


Thurston2012
Thurston2012
11th
Access
8th
Mud Bay
Mud Bay
Kaiser
Mc Phee
7th
Kaiser
Cooper Point
Fox Run
Conger
Limited
Harrison
Capital Mall
9th
Site Information
Site Name
Address
3840 harrison
City
Gage
Green Cove
Precip Factor
1.000
Use WS-DOT data
Map Controls

Basin 1- Craftsman Ave sizing the infiltration trench on lot 2:




Craftsman Trench basin 1 Mitigated
Facility Name
Craftsman Trench basin 1
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Gravel Trench/Bed
Precipitation Applied to Facility
Evaporation Applied to Facility
Quick Trench
Facility Dimension Diagram
Facility Dimensions
Trench Length (ft) 195
Trench Bottom Width (ft) 6
Effective Total Depth (ft) 3
Top and bottom slope (H/V) 0
Left Side Slope (H/V) 0
Right Side Slope (H/V) 0
Outlet Structure Data
Riser Height (ft) 2
Riser Diameter (in) 0
Riser Type Flat
Notch Type
Material Layers for Trench/Bed
Layer 1 Thickness (ft) 2
Layer 1 porosity (0-1) 0.4
Layer 2 Thickness (ft) 0
Layer 2 porosity (0-1) 0
Layer 3 Thickness (ft) 0
Layer 3 porosity (0-1) 0
Orifice Number
Diameter (in)
Height (ft)
1 0 0
2 0 0
3 0 0
Trench Volume at Riser Head (ac-ft) .022
Infiltration Yes
Measured Infiltration Rate (in/hr) 1
Reduction Factor (infilt*factor) 1
Use Wetted Surface Area (sidewalls) Yes
Total Volume Infiltrated (ac-ft) 35.661
Total Volume Through Riser (ac-ft) 0
Show Trench
Open Table
Initial Stage (ft) 0
Total Volume Through Facility (ac-ft) 35.661
Percent Infiltrated 100
Size Infiltration Trench
Target %: 100

WWHM2012

PROJECT REPORT

Project Name: Harrison BSP 3rd Craftsman
Site Name:
Site Address:
City :
Report Date: 3/19/2021
Gage : Green Cove
Data Start : 1955/10/01
Data End : 2011/09/30
Precip Scale: 1.00
Version Date: 2019/09/13
Version : 4.2.17

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

High Flow Threshold for POC 1: 50 year

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

High Flow Threshold for POC 2: 50 year

PREDEVELOPED LAND USE

MITIGATED LAND USE

Name : Craftsman basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Lawn, Flat	.005
Pervious Total	0.005

Impervious Land Use	acre
ROADS FLAT	0.095
SIDEWALKS FLAT	0.065
Impervious Total	0.16
Basin Total	0.165

Element Flows To:

Surface	Interflow	Groundwater

Name : Craftsman Trench basin 1
Bottom Length: 195.00 ft.
Bottom Width: 6.00 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: 2
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
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 35.661
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 35.661
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Discharge Structure
Riser Height: 2 ft.
Riser Diameter: 0 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	0.026	0.000	0.000	0.000
0.0333	0.026	0.000	0.000	0.027
0.0667	0.026	0.000	0.000	0.027
0.1000	0.026	0.001	0.000	0.027
0.1333	0.026	0.001	0.000	0.027
0.1667	0.026	0.001	0.000	0.027
0.2000	0.026	0.002	0.000	0.027
0.2333	0.026	0.002	0.000	0.027
0.2667	0.026	0.002	0.000	0.027
0.3000	0.026	0.003	0.000	0.027
0.3333	0.026	0.003	0.000	0.027
0.3667	0.026	0.003	0.000	0.027
0.4000	0.026	0.004	0.000	0.027
0.4333	0.026	0.004	0.000	0.027
0.4667	0.026	0.005	0.000	0.027
0.5000	0.026	0.005	0.000	0.027
0.5333	0.026	0.005	0.000	0.027

0.5667	0.026	0.006	0.000	0.027
0.6000	0.026	0.006	0.000	0.027
0.6333	0.026	0.006	0.000	0.027
0.6667	0.026	0.007	0.000	0.027
0.7000	0.026	0.007	0.000	0.027
0.7333	0.026	0.007	0.000	0.027
0.7667	0.026	0.008	0.000	0.027
0.8000	0.026	0.008	0.000	0.027
0.8333	0.026	0.009	0.000	0.027
0.8667	0.026	0.009	0.000	0.027
0.9000	0.026	0.009	0.000	0.027
0.9333	0.026	0.010	0.000	0.027
0.9667	0.026	0.010	0.000	0.027
1.0000	0.026	0.010	0.000	0.027
1.0333	0.026	0.011	0.000	0.027
1.0667	0.026	0.011	0.000	0.027
1.1000	0.026	0.011	0.000	0.027
1.1333	0.026	0.012	0.000	0.027
1.1667	0.026	0.012	0.000	0.027
1.2000	0.026	0.012	0.000	0.027
1.2333	0.026	0.013	0.000	0.027
1.2667	0.026	0.013	0.000	0.027
1.3000	0.026	0.014	0.000	0.027
1.3333	0.026	0.014	0.000	0.027
1.3667	0.026	0.014	0.000	0.027
1.4000	0.026	0.015	0.000	0.027
1.4333	0.026	0.015	0.000	0.027
1.4667	0.026	0.015	0.000	0.027
1.5000	0.026	0.016	0.000	0.027
1.5333	0.026	0.016	0.000	0.027
1.5667	0.026	0.016	0.000	0.027
1.6000	0.026	0.017	0.000	0.027
1.6333	0.026	0.017	0.000	0.027
1.6667	0.026	0.017	0.000	0.027
1.7000	0.026	0.018	0.000	0.027
1.7333	0.026	0.018	0.000	0.027
1.7667	0.026	0.019	0.000	0.027
1.8000	0.026	0.019	0.000	0.027
1.8333	0.026	0.019	0.000	0.027
1.8667	0.026	0.020	0.000	0.027
1.9000	0.026	0.020	0.000	0.027
1.9333	0.026	0.020	0.000	0.027
1.9667	0.026	0.021	0.000	0.027
2.0000	0.026	0.022	0.000	0.027
2.0333	0.026	0.022	0.000	0.027
2.0667	0.026	0.023	0.000	0.027
2.1000	0.026	0.024	0.000	0.027
2.1333	0.026	0.025	0.000	0.027
2.1667	0.026	0.026	0.000	0.027
2.2000	0.026	0.027	0.000	0.027
2.2333	0.026	0.028	0.000	0.027
2.2667	0.026	0.029	0.000	0.027
2.3000	0.026	0.030	0.000	0.027
2.3333	0.026	0.031	0.000	0.027
2.3667	0.026	0.031	0.000	0.027
2.4000	0.026	0.032	0.000	0.027

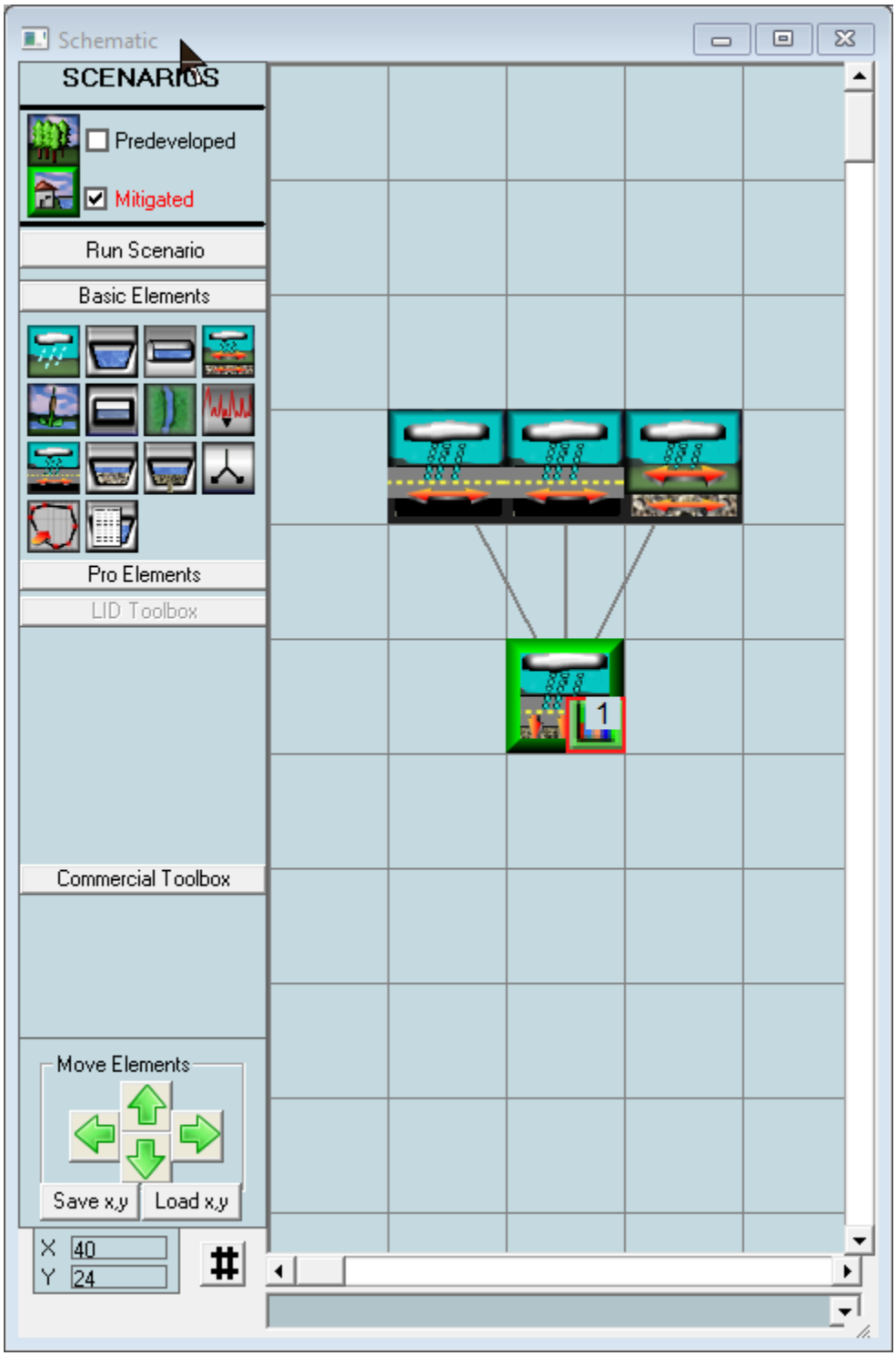
2.4333	0.026	0.033	0.000	0.027
2.4667	0.026	0.034	0.000	0.027
2.5000	0.026	0.035	0.000	0.027
2.5333	0.026	0.036	0.000	0.027
2.5667	0.026	0.037	0.000	0.027
2.6000	0.026	0.038	0.000	0.027
2.6333	0.026	0.039	0.000	0.027
2.6667	0.026	0.039	0.000	0.027
2.7000	0.026	0.040	0.000	0.027
2.7333	0.026	0.041	0.000	0.027
2.7667	0.026	0.042	0.000	0.027
2.8000	0.026	0.043	0.000	0.027
2.8333	0.026	0.044	0.000	0.027
2.8667	0.026	0.045	0.000	0.027
2.9000	0.026	0.046	0.000	0.027
2.9333	0.026	0.047	0.000	0.027
2.9667	0.026	0.048	0.000	0.027
3.0000	0.026	0.048	0.000	0.027

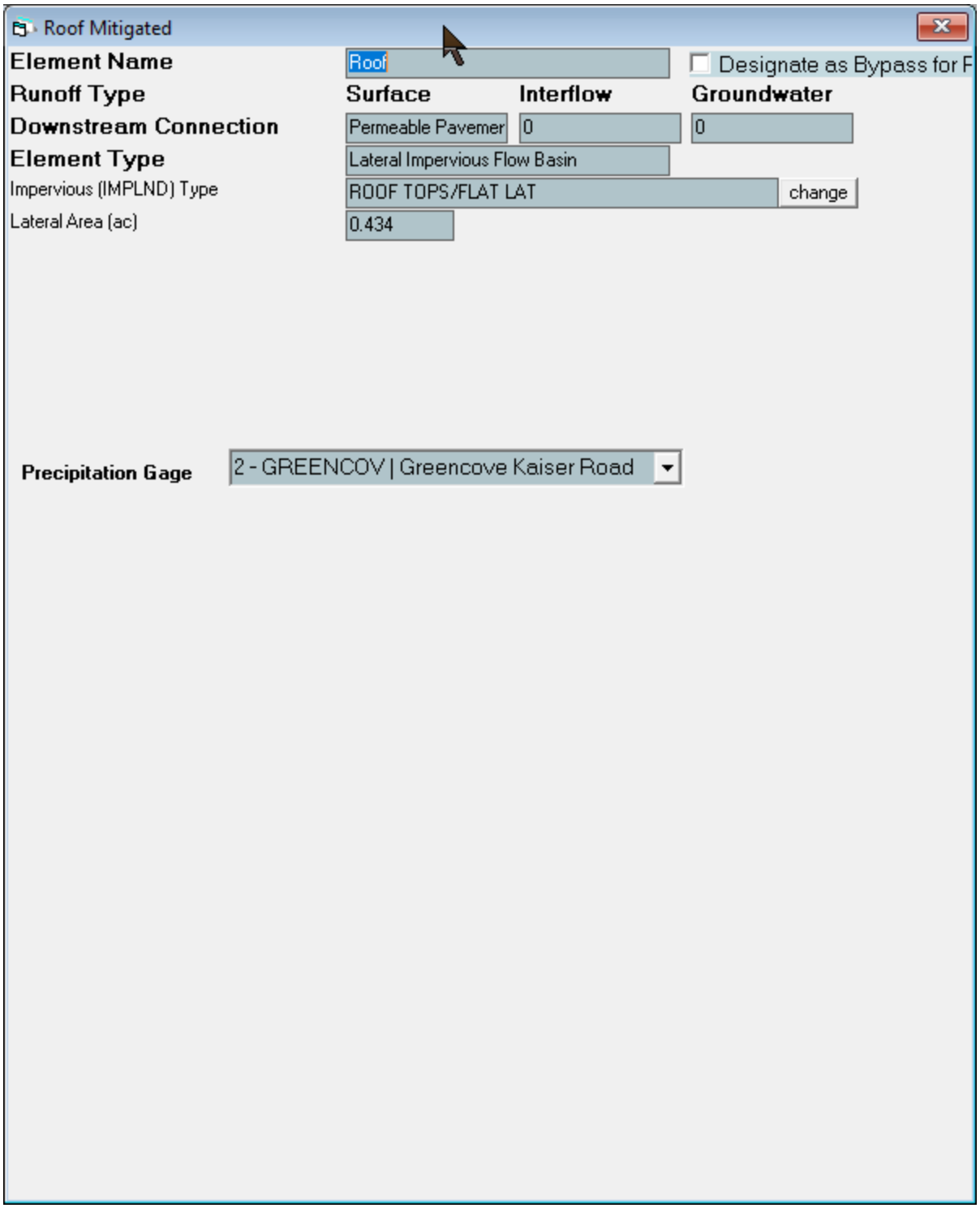
ANALYSIS RESULTS

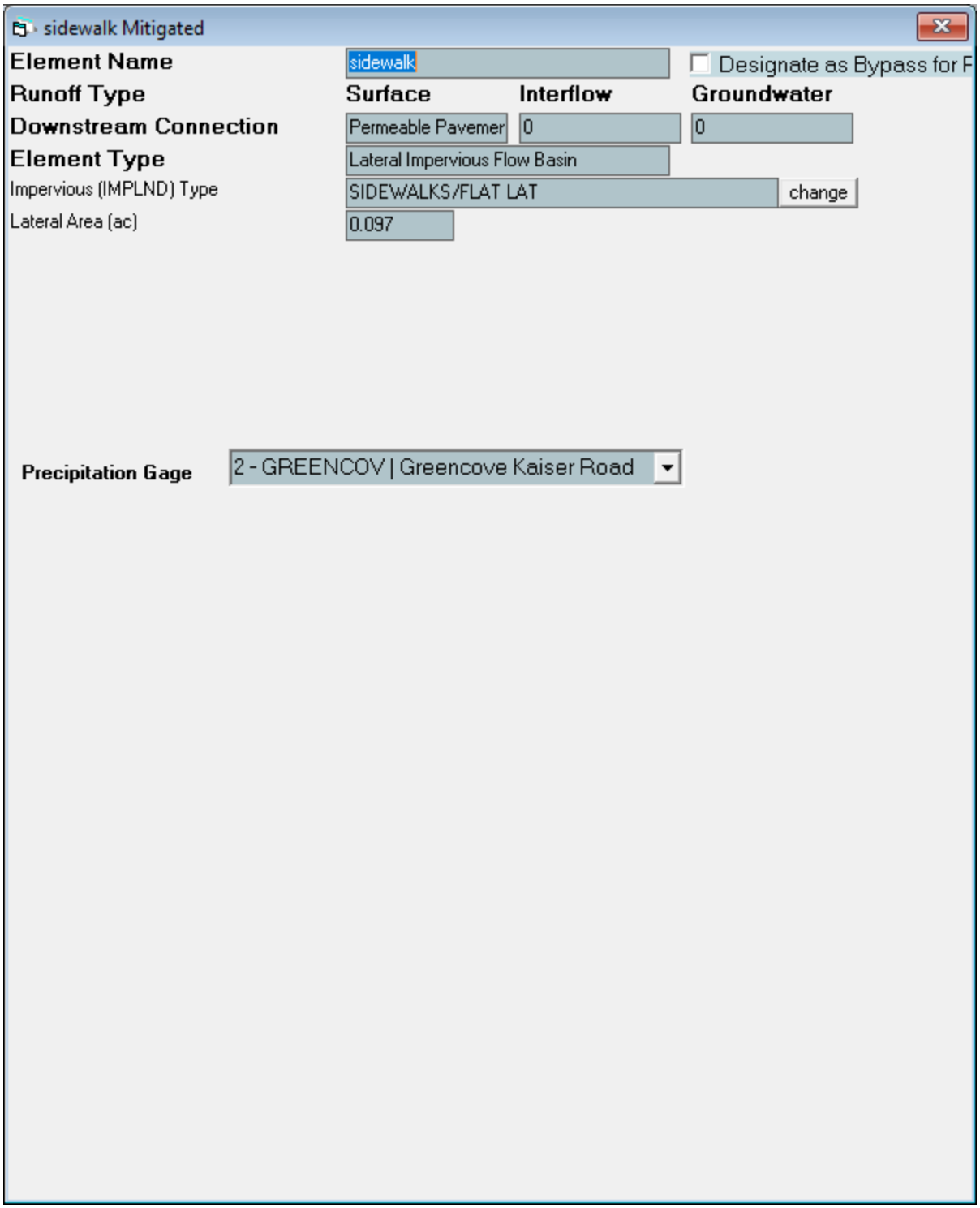
POC #1 was not reported because POC must exist in both scenarios and both scenarios must have been run. POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.Perlnd and Implnd Changes

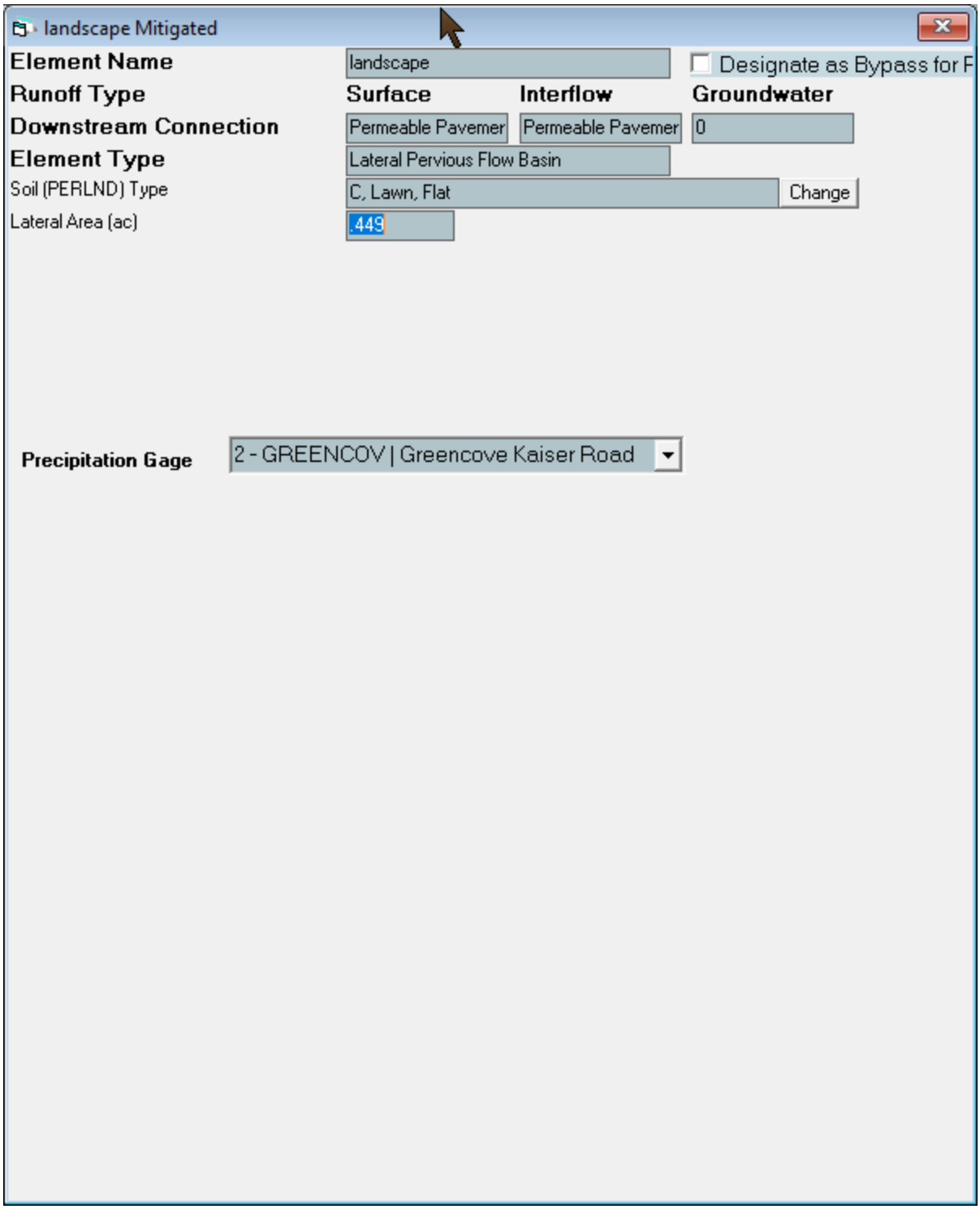
No changes have been made.

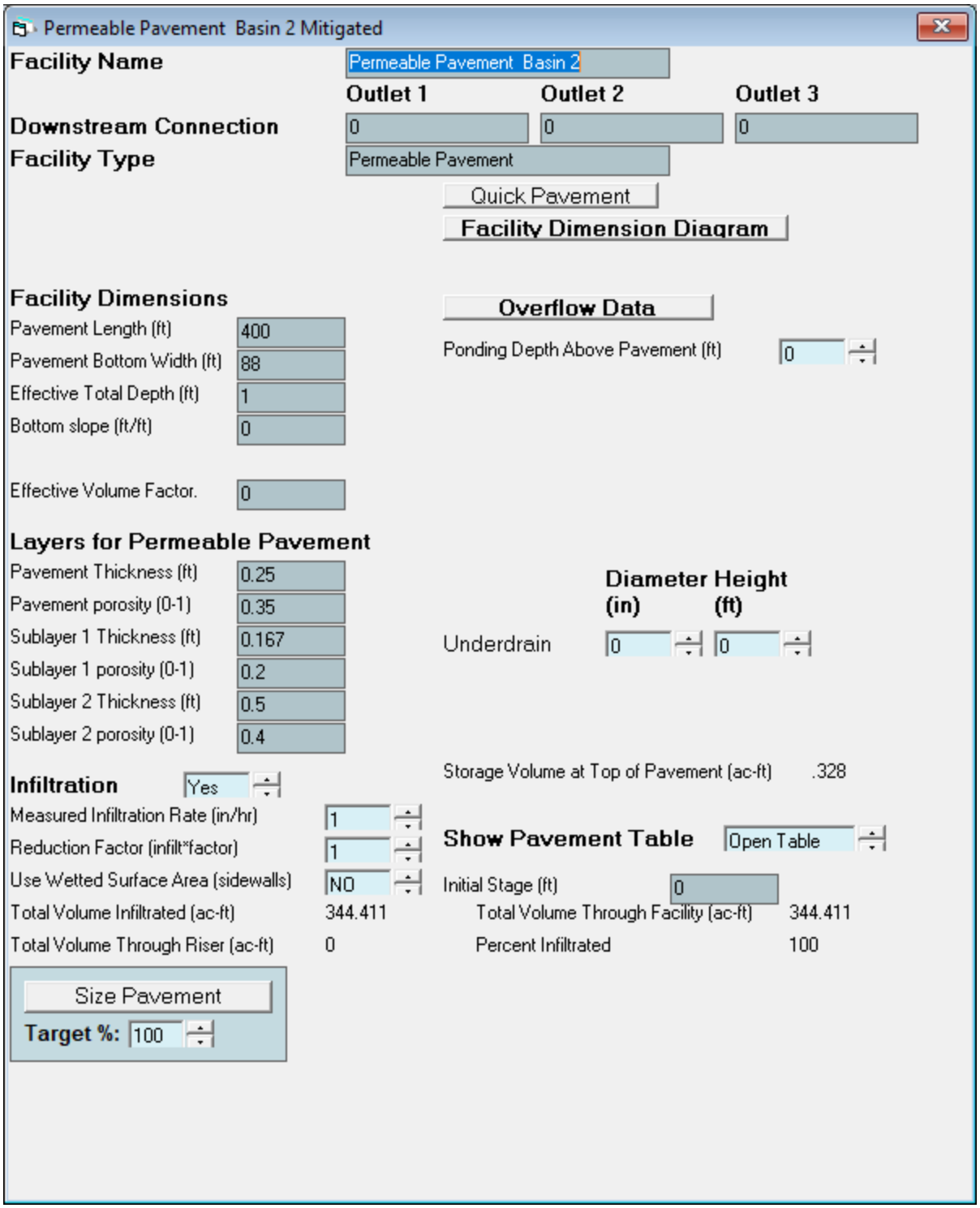
Basin 2- Porous Pavement Lot 2, 3 and 4




Roof Mitigated
Element Name
Roof
Designate as Bypass for F
Runoff Type
Surface
Interflow
Groundwater
Downstream Connection
Permeable Pavemer
0
0
Element Type
Lateral Impervious Flow Basin
Impervious (IMPLND) Type
ROOF TOPS/FLAT LAT
change
Lateral Area (ac)
0.434
Precipitation Gage
2 - GREENCOV | Greencove Kaiser Road


sidewalk Mitigated
Element Name
sidewalk
Designate as Bypass for F
Runoff Type
Surface
Interflow
Groundwater
Downstream Connection
Permeable Pavemer
0
0
Element Type
Lateral Impervious Flow Basin
Impervious (IMPLND) Type
SIDEWALKS/FLAT LAT
change
Lateral Area (ac)
0.097
Precipitation Gage
2 - GREENCOV | Greencove Kaiser Road


landscape Mitigated
Element Name
landscape
Designate as Bypass for F
Runoff Type
Surface
Interflow
Groundwater
Downstream Connection
Permeable Pavemer
Permeable Pavemer
0
Element Type
Lateral Pervious Flow Basin
Soil (PERLND) Type
C, Lawn, Flat
Change
Lateral Area (ac)
.449
Precipitation Gage
2 - GREENCOV | Greencove Kaiser Road


Permeable Pavement Basin 2 Mitigated
Facility Name
Permeable Pavement Basin 2
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Permeable Pavement
Quick Pavement
Facility Dimension Diagram
Facility Dimensions
Overflow Data
Pavement Length (ft)
400
Pavement Bottom Width (ft)
88
Effective Total Depth (ft)
1
Bottom slope (ft/ft)
0
Ponding Depth Above Pavement (ft)
0
Effective Volume Factor.
0
Layers for Permeable Pavement
Pavement Thickness (ft)
0.25
Pavement porosity (0-1)
0.35
Sublayer 1 Thickness (ft)
0.167
Sublayer 1 porosity (0-1)
0.2
Sublayer 2 Thickness (ft)
0.5
Sublayer 2 porosity (0-1)
0.4
Diameter (in)
Height (ft)
Underdrain
0
0
Storage Volume at Top of Pavement (ac-ft)
.328
Infiltration
Yes
Measured Infiltration Rate (in/hr)
1
Reduction Factor (infilt*factor)
1
Use Wetted Surface Area (sidewalls)
NO
Show Pavement Table
Open Table
Initial Stage (ft)
0
Total Volume Infiltrated (ac-ft)
344.411
Total Volume Through Facility (ac-ft)
344.411
Total Volume Through Riser (ac-ft)
0
Percent Infiltrated
100
Size Pavement
Target %:
100

WWHM2012
PROJECT REPORT

Project Name: Harrison BSP Pavement (basin 2)
Site Name:
Site Address:
City :
Report Date: 3/19/2021
Gage : Green Cove
Data Start : 1955/10/01
Data End : 2011/09/30
Precip Scale: 1.00
Version Date: 2019/09/13
Version : 4.2.17

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	.98
Pervious Total	**0.98**

Impervious Land Use	acre
Impervious Total	**0**
Basin Total	**0.98**

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Permeable Pavement Basin 2
Pavement Area: 0.8081 ft.
Pavement Length: 400.00 ft.
Pavement Width: 88.00 ft.

Pavement slope 1: 0 To 1
Pavement thickness: 0.25
Pour Space of Pavement: 0.35
Material thickness of second layer: 0.167
Pour Space of material for second layer: 0.2
Material thickness of third layer: 0.5
Pour Space of material for third layer: 0.4
Infiltration On
Infiltration rate: 1
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 344.411
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 344.411
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 16.331

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

Permeable Pavement Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.808	0.000	0.000	0.000
0.0111	0.808	0.003	0.000	0.814
0.0222	0.808	0.007	0.000	0.814
0.0333	0.808	0.010	0.000	0.814
0.0444	0.808	0.014	0.000	0.814
0.0556	0.808	0.018	0.000	0.814
0.0667	0.808	0.021	0.000	0.814
0.0778	0.808	0.025	0.000	0.814
0.0889	0.808	0.028	0.000	0.814
0.1000	0.808	0.032	0.000	0.814
0.1111	0.808	0.035	0.000	0.814
0.1222	0.808	0.039	0.000	0.814
0.1333	0.808	0.043	0.000	0.814
0.1444	0.808	0.046	0.000	0.814
0.1556	0.808	0.050	0.000	0.814
0.1667	0.808	0.053	0.000	0.814
0.1778	0.808	0.057	0.000	0.814
0.1889	0.808	0.061	0.000	0.814
0.2000	0.808	0.064	0.000	0.814
0.2111	0.808	0.068	0.000	0.814
0.2222	0.808	0.071	0.000	0.814
0.2333	0.808	0.075	0.000	0.814
0.2444	0.808	0.079	0.000	0.814
0.2556	0.808	0.082	0.000	0.814
0.2667	0.808	0.086	0.000	0.814
0.2778	0.808	0.089	0.000	0.814
0.2889	0.808	0.093	0.000	0.814
0.3000	0.808	0.097	0.000	0.814
0.3111	0.808	0.100	0.000	0.814
0.3222	0.808	0.104	0.000	0.814

0.3333	0.808	0.107	0.000	0.814
0.3444	0.808	0.111	0.000	0.814
0.3556	0.808	0.114	0.000	0.814
0.3667	0.808	0.118	0.000	0.814
0.3778	0.808	0.122	0.000	0.814
0.3889	0.808	0.125	0.000	0.814
0.4000	0.808	0.129	0.000	0.814
0.4111	0.808	0.132	0.000	0.814
0.4222	0.808	0.136	0.000	0.814
0.4333	0.808	0.140	0.000	0.814
0.4444	0.808	0.143	0.000	0.814
0.4556	0.808	0.147	0.000	0.814
0.4667	0.808	0.150	0.000	0.814
0.4778	0.808	0.154	0.000	0.814
0.4889	0.808	0.158	0.000	0.814
0.5000	0.808	0.159	0.000	0.814
0.5111	0.808	0.161	0.000	0.814
0.5222	0.808	0.163	0.000	0.814
0.5333	0.808	0.165	0.000	0.814
0.5444	0.808	0.167	0.000	0.814
0.5556	0.808	0.168	0.000	0.814
0.5667	0.808	0.170	0.000	0.814
0.5778	0.808	0.172	0.000	0.814
0.5889	0.808	0.174	0.000	0.814
0.6000	0.808	0.176	0.000	0.814
0.6111	0.808	0.177	0.000	0.814
0.6222	0.808	0.179	0.000	0.814
0.6333	0.808	0.181	0.000	0.814
0.6444	0.808	0.183	0.000	0.814
0.6556	0.808	0.185	0.000	0.814
0.6667	0.808	0.186	0.000	0.814
0.6778	0.808	0.189	0.000	0.814
0.6889	0.808	0.193	0.000	0.814
0.7000	0.808	0.196	0.000	0.814
0.7111	0.808	0.199	0.000	0.814
0.7222	0.808	0.202	0.000	0.814
0.7333	0.808	0.205	0.000	0.814
0.7444	0.808	0.208	0.000	0.814
0.7556	0.808	0.211	0.000	0.814
0.7667	0.808	0.215	0.000	0.814
0.7778	0.808	0.218	0.000	0.814
0.7889	0.808	0.221	0.000	0.814
0.8000	0.808	0.224	0.000	0.814
0.8111	0.808	0.227	0.000	0.814
0.8222	0.808	0.230	0.000	0.814
0.8333	0.808	0.233	0.000	0.814
0.8444	0.808	0.237	0.000	0.814
0.8556	0.808	0.240	0.000	0.814
0.8667	0.808	0.243	0.000	0.814
0.8778	0.808	0.246	0.000	0.814
0.8889	0.808	0.249	0.000	0.814
0.9000	0.808	0.252	0.000	0.814
0.9111	0.808	0.255	0.000	0.814
0.9222	0.808	0.264	0.011	0.814
0.9333	0.808	0.273	0.061	0.814
0.9444	0.808	0.282	0.133	0.814

0.9556	0.808	0.291	0.221	0.814
0.9667	0.808	0.300	0.324	0.814
0.9778	0.808	0.309	0.439	0.814
0.9889	0.808	0.318	0.564	0.814
1.0000	0.808	0.327	0.700	0.814

Name : Roof
Bypass: No

Impervious Land Use	**acre**
ROOF TOPS FLAT LAT	**0.434**

Element Flows To:

Outlet 1	**Outlet 2**
Permeable Pavement	Ba

Name : sidewalk
Bypass: No

Impervious Land Use	**acre**
SIDEWALKS FLAT LAT	**0.097**

Element Flows To:

Outlet 1	**Outlet 2**
Permeable Pavement	Ba

Name : landscape
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	**.449**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Permeable Pavement	Ba Permeable Pavement	Ba

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1

Total Pervious Area:0.98
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0.449
Total Impervious Area:1.339081

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.063367
5 year	0.121608
10 year	0.157978
25 year	0.198002
50 year	0.223131
100 year	0.244505

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

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

Year	Predeveloped	Mitigated
1956	0.084	0.000
1957	0.113	0.000
1958	0.031	0.000
1959	0.070	0.000
1960	0.077	0.000
1961	0.076	0.000
1962	0.020	0.000
1963	0.137	0.000
1964	0.054	0.000
1965	0.052	0.000
1966	0.043	0.000
1967	0.055	0.000
1968	0.041	0.000
1969	0.028	0.000
1970	0.046	0.000
1971	0.059	0.000
1972	0.117	0.000
1973	0.053	0.000
1974	0.058	0.000
1975	0.042	0.000
1976	0.076	0.000
1977	0.037	0.000
1978	0.050	0.000
1979	0.045	0.000
1980	0.050	0.000

1981	0.072	0.000
1982	0.052	0.000
1983	0.089	0.000
1984	0.079	0.000
1985	0.024	0.000
1986	0.093	0.000
1987	0.072	0.000
1988	0.041	0.000
1989	0.040	0.000
1990	0.216	0.000
1991	0.104	0.000
1992	0.042	0.000
1993	0.029	0.000
1994	0.023	0.000
1995	0.080	0.000
1996	0.105	0.000
1997	0.099	0.000
1998	0.092	0.000
1999	0.060	0.000
2000	0.000	0.000
2001	0.196	0.000
2002	0.065	0.000
2003	0.037	0.000
2004	0.091	0.000
2005	0.035	0.000
2006	0.076	0.000
2007	0.051	0.000
2008	0.147	0.000
2009	0.092	0.000
2010	0.031	0.000
2011	0.053	0.000

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

Rank	Predeveloped	Mitigated
1	0.2161	0.0000
2	0.1959	0.0000
3	0.1466	0.0000
4	0.1374	0.0000
5	0.1167	0.0000
6	0.1130	0.0000
7	0.1046	0.0000
8	0.1040	0.0000
9	0.0989	0.0000
10	0.0934	0.0000
11	0.0924	0.0000
12	0.0923	0.0000
13	0.0912	0.0000
14	0.0893	0.0000
15	0.0838	0.0000
16	0.0803	0.0000
17	0.0793	0.0000
18	0.0770	0.0000
19	0.0764	0.0000
20	0.0760	0.0000

21	0.0756	0.0000
22	0.0723	0.0000
23	0.0715	0.0000
24	0.0705	0.0000
25	0.0652	0.0000
26	0.0605	0.0000
27	0.0588	0.0000
28	0.0576	0.0000
29	0.0554	0.0000
30	0.0540	0.0000
31	0.0533	0.0000
32	0.0527	0.0000
33	0.0517	0.0000
34	0.0515	0.0000
35	0.0511	0.0000
36	0.0505	0.0000
37	0.0502	0.0000
38	0.0459	0.0000
39	0.0446	0.0000
40	0.0427	0.0000
41	0.0421	0.0000
42	0.0419	0.0000
43	0.0410	0.0000
44	0.0408	0.0000
45	0.0398	0.0000
46	0.0373	0.0000
47	0.0373	0.0000
48	0.0351	0.0000
49	0.0313	0.0000
50	0.0305	0.0000
51	0.0294	0.0000
52	0.0281	0.0000
53	0.0239	0.0000
54	0.0226	0.0000
55	0.0199	0.0000
56	0.0002	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0317	13710	0	0	Pass
0.0336	11644	0	0	Pass
0.0356	10052	0	0	Pass
0.0375	8534	0	0	Pass
0.0394	7283	0	0	Pass
0.0414	6240	0	0	Pass
0.0433	5392	0	0	Pass
0.0452	4756	0	0	Pass
0.0472	4180	0	0	Pass
0.0491	3697	0	0	Pass
0.0510	3220	0	0	Pass

0.0530	2800	0	0	Pass
0.0549	2464	0	0	Pass
0.0568	2201	0	0	Pass
0.0588	1942	0	0	Pass
0.0607	1688	0	0	Pass
0.0626	1470	0	0	Pass
0.0646	1281	0	0	Pass
0.0665	1119	0	0	Pass
0.0684	996	0	0	Pass
0.0704	879	0	0	Pass
0.0723	769	0	0	Pass
0.0742	686	0	0	Pass
0.0762	582	0	0	Pass
0.0781	510	0	0	Pass
0.0800	443	0	0	Pass
0.0820	388	0	0	Pass
0.0839	349	0	0	Pass
0.0858	307	0	0	Pass
0.0878	276	0	0	Pass
0.0897	250	0	0	Pass
0.0916	216	0	0	Pass
0.0936	171	0	0	Pass
0.0955	157	0	0	Pass
0.0974	139	0	0	Pass
0.0994	119	0	0	Pass
0.1013	111	0	0	Pass
0.1032	106	0	0	Pass
0.1052	101	0	0	Pass
0.1071	99	0	0	Pass
0.1090	95	0	0	Pass
0.1110	92	0	0	Pass
0.1129	86	0	0	Pass
0.1148	80	0	0	Pass
0.1168	74	0	0	Pass
0.1187	69	0	0	Pass
0.1206	64	0	0	Pass
0.1226	60	0	0	Pass
0.1245	56	0	0	Pass
0.1264	51	0	0	Pass
0.1284	45	0	0	Pass
0.1303	40	0	0	Pass
0.1322	36	0	0	Pass
0.1342	34	0	0	Pass
0.1361	31	0	0	Pass
0.1380	27	0	0	Pass
0.1400	24	0	0	Pass
0.1419	21	0	0	Pass
0.1438	14	0	0	Pass
0.1458	7	0	0	Pass
0.1477	5	0	0	Pass
0.1496	5	0	0	Pass
0.1516	5	0	0	Pass
0.1535	5	0	0	Pass
0.1554	5	0	0	Pass
0.1574	5	0	0	Pass
0.1593	5	0	0	Pass

0.1612	5	0	0	Pass
0.1632	5	0	0	Pass
0.1651	4	0	0	Pass
0.1671	3	0	0	Pass
0.1690	3	0	0	Pass
0.1709	3	0	0	Pass
0.1729	3	0	0	Pass
0.1748	3	0	0	Pass
0.1767	3	0	0	Pass
0.1787	3	0	0	Pass
0.1806	3	0	0	Pass
0.1825	3	0	0	Pass
0.1845	3	0	0	Pass
0.1864	3	0	0	Pass
0.1883	3	0	0	Pass
0.1903	3	0	0	Pass
0.1922	2	0	0	Pass
0.1941	2	0	0	Pass
0.1961	1	0	0	Pass
0.1980	1	0	0	Pass
0.1999	1	0	0	Pass
0.2019	1	0	0	Pass
0.2038	1	0	0	Pass
0.2057	1	0	0	Pass
0.2077	1	0	0	Pass
0.2096	1	0	0	Pass
0.2115	1	0	0	Pass
0.2135	1	0	0	Pass
0.2154	1	0	0	Pass
0.2173	0	0	0	Pass
0.2193	0	0	0	Pass
0.2212	0	0	0	Pass
0.2231	0	0	0	Pass

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.**

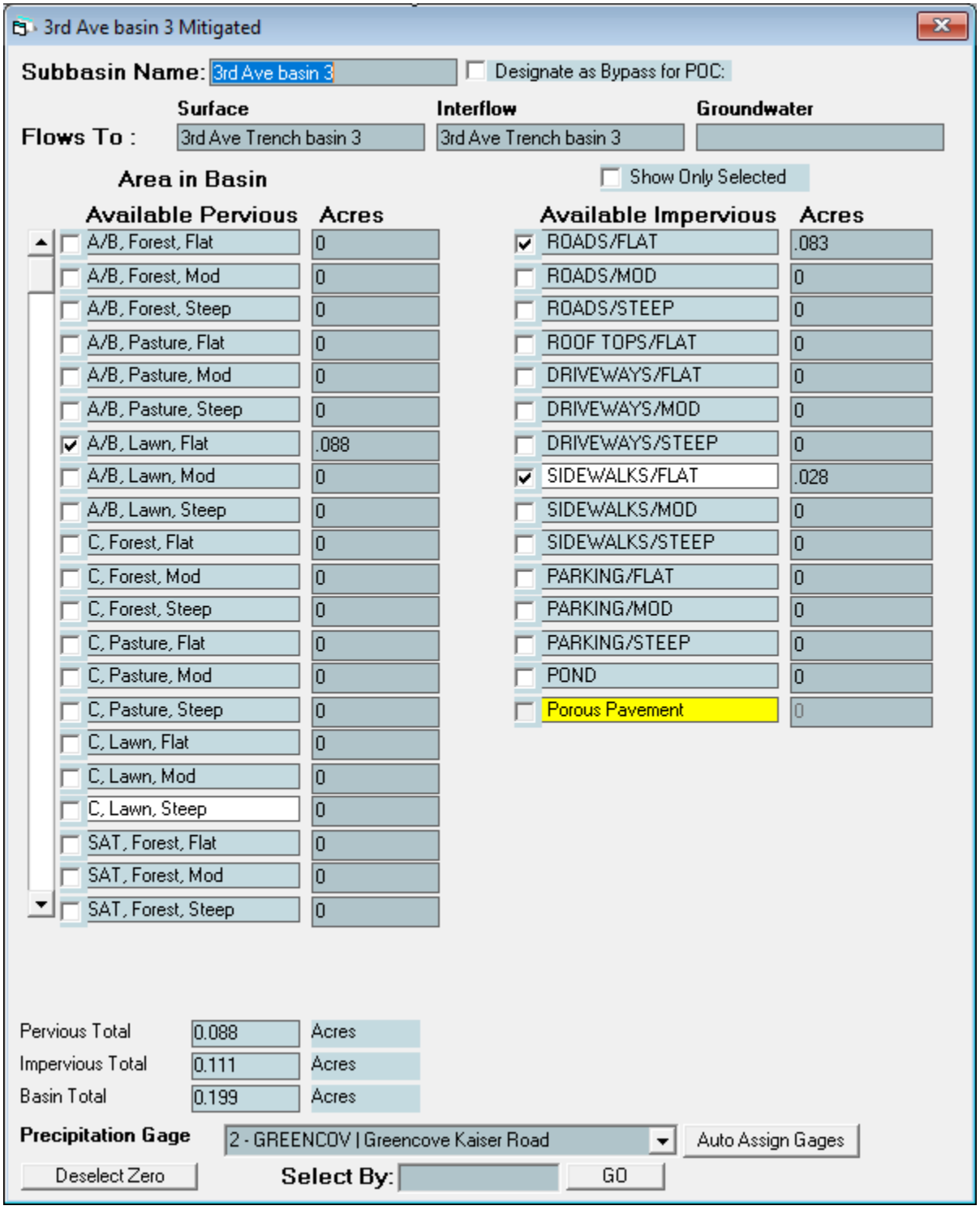
LID Report

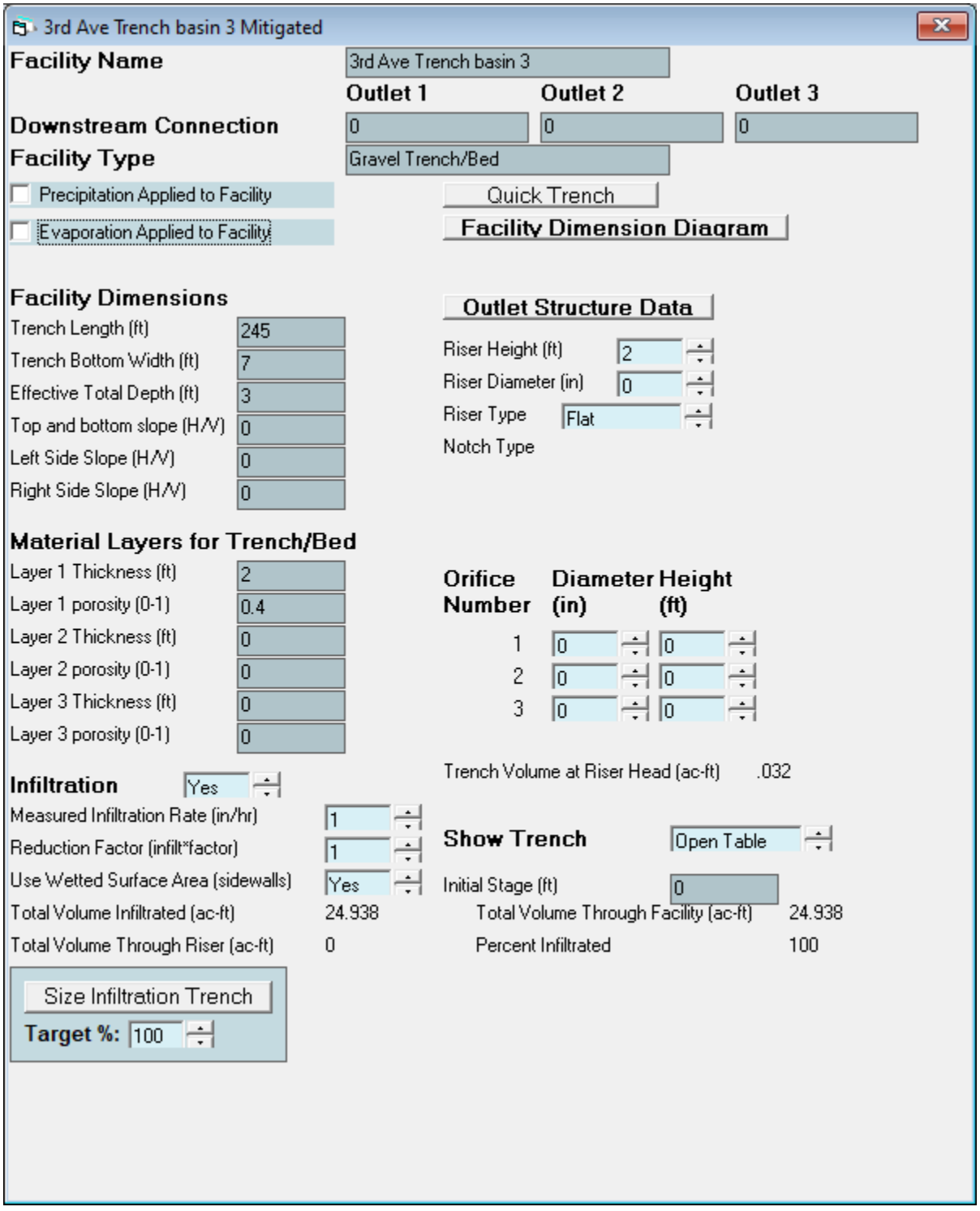
LID Technique		Used for Water Quality Treatment?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft.)	Cumulative Infiltration Credit	Percent Volume Infiltrated	Water Quality Percent Treated	Comment
Permeable Pavement	Basin 2 PO	N	313.41			N	100.00		
Total Volume Infiltrated			313.41	0.00	0.00		100.00	0.00	0% No Treat. Credit

Compliance with LID Standard 8
Duration Analysis Result = Passed

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.**Perlnd and Implnd Changes**
No changes have been made.

Basin 3- 3rd Ave- sizing infiltration trench on Lot 5




3rd Ave Trench basin 3 Mitigated
Facility Name
3rd Ave Trench basin 3
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Gravel Trench/Bed
Precipitation Applied to Facility
Evaporation Applied to Facility
Quick Trench
Facility Dimension Diagram
Facility Dimensions
Trench Length (ft) 245
Trench Bottom Width (ft) 7
Effective Total Depth (ft) 3
Top and bottom slope (H/V) 0
Left Side Slope (H/V) 0
Right Side Slope (H/V) 0
Outlet Structure Data
Riser Height (ft) 2
Riser Diameter (in) 0
Riser Type Flat
Notch Type
Material Layers for Trench/Bed
Layer 1 Thickness (ft) 2
Layer 1 porosity (0-1) 0.4
Layer 2 Thickness (ft) 0
Layer 2 porosity (0-1) 0
Layer 3 Thickness (ft) 0
Layer 3 porosity (0-1) 0
Orifice Number
Diameter (in)
Height (ft)
1 0 0
2 0 0
3 0 0
Trench Volume at Riser Head (ac-ft) .032
Infiltration Yes
Measured Infiltration Rate (in/hr) 1
Reduction Factor (infilt*factor) 1
Use Wetted Surface Area (sidewalls) Yes
Total Volume Infiltrated (ac-ft) 24.938
Total Volume Through Riser (ac-ft) 0
Show Trench
Open Table
Initial Stage (ft) 0
Total Volume Through Facility (ac-ft) 24.938
Percent Infiltrated 100
Size Infiltration Trench
Target %: 100

WWHM2012

PROJECT REPORT

Project Name: Harrison BSP 3rd Craftsman
Site Name:
Site Address:
City :
Report Date: 3/19/2021
Gage : Green Cove
Data Start : 1955/10/01
Data End : 2011/09/30
Precip Scale: 1.00
Version Date: 2019/09/13
Version : 4.2.17

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

High Flow Threshold for POC 1: 50 year

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

High Flow Threshold for POC 2: 50 year

PREDEVELOPED LAND USE

MITIGATED LAND USE

Name : 3rd Ave basin 3
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Lawn, Flat	.088
Pervious Total	0.088

Impervious Land Use	acre
ROADS FLAT	0.083
SIDEWALKS FLAT	0.028
Impervious Total	0.111
Basin Total	0.199

Element Flows To:

Surface	Interflow	Groundwater

Name : 3rd Ave Trench basin 3
Bottom Length: 245.00 ft.
Bottom Width: 7.00 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: 2
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
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 24.938
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 24.938
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Discharge Structure
Riser Height: 2 ft.
Riser Diameter: 0 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	0.039	0.000	0.000	0.000
0.0333	0.039	0.000	0.000	0.039
0.0667	0.039	0.001	0.000	0.039
0.1000	0.039	0.001	0.000	0.039
0.1333	0.039	0.002	0.000	0.039
0.1667	0.039	0.002	0.000	0.039
0.2000	0.039	0.003	0.000	0.039
0.2333	0.039	0.003	0.000	0.039
0.2667	0.039	0.004	0.000	0.039
0.3000	0.039	0.004	0.000	0.039
0.3333	0.039	0.005	0.000	0.039
0.3667	0.039	0.005	0.000	0.039
0.4000	0.039	0.006	0.000	0.039
0.4333	0.039	0.006	0.000	0.039
0.4667	0.039	0.007	0.000	0.039
0.5000	0.039	0.007	0.000	0.039
0.5333	0.039	0.008	0.000	0.039

0.5667	0.039	0.008	0.000	0.039
0.6000	0.039	0.009	0.000	0.039
0.6333	0.039	0.010	0.000	0.039
0.6667	0.039	0.010	0.000	0.039
0.7000	0.039	0.011	0.000	0.039
0.7333	0.039	0.011	0.000	0.039
0.7667	0.039	0.012	0.000	0.039
0.8000	0.039	0.012	0.000	0.039
0.8333	0.039	0.013	0.000	0.039
0.8667	0.039	0.013	0.000	0.039
0.9000	0.039	0.014	0.000	0.039
0.9333	0.039	0.014	0.000	0.039
0.9667	0.039	0.015	0.000	0.039
1.0000	0.039	0.015	0.000	0.039
1.0333	0.039	0.016	0.000	0.039
1.0667	0.039	0.016	0.000	0.039
1.1000	0.039	0.017	0.000	0.039
1.1333	0.039	0.017	0.000	0.039
1.1667	0.039	0.018	0.000	0.039
1.2000	0.039	0.018	0.000	0.039
1.2333	0.039	0.019	0.000	0.039
1.2667	0.039	0.019	0.000	0.039
1.3000	0.039	0.020	0.000	0.039
1.3333	0.039	0.021	0.000	0.039
1.3667	0.039	0.021	0.000	0.039
1.4000	0.039	0.022	0.000	0.039
1.4333	0.039	0.022	0.000	0.039
1.4667	0.039	0.023	0.000	0.039
1.5000	0.039	0.023	0.000	0.039
1.5333	0.039	0.024	0.000	0.039
1.5667	0.039	0.024	0.000	0.039
1.6000	0.039	0.025	0.000	0.039
1.6333	0.039	0.025	0.000	0.039
1.6667	0.039	0.026	0.000	0.039
1.7000	0.039	0.026	0.000	0.039
1.7333	0.039	0.027	0.000	0.039
1.7667	0.039	0.027	0.000	0.039
1.8000	0.039	0.028	0.000	0.039
1.8333	0.039	0.028	0.000	0.039
1.8667	0.039	0.029	0.000	0.039
1.9000	0.039	0.029	0.000	0.039
1.9333	0.039	0.030	0.000	0.039
1.9667	0.039	0.031	0.000	0.039
2.0000	0.039	0.032	0.000	0.039
2.0333	0.039	0.033	0.000	0.039
2.0667	0.039	0.034	0.000	0.039
2.1000	0.039	0.036	0.000	0.039
2.1333	0.039	0.037	0.000	0.039
2.1667	0.039	0.038	0.000	0.039
2.2000	0.039	0.040	0.000	0.039
2.2333	0.039	0.041	0.000	0.039
2.2667	0.039	0.042	0.000	0.039
2.3000	0.039	0.044	0.000	0.039
2.3333	0.039	0.045	0.000	0.039
2.3667	0.039	0.046	0.000	0.039
2.4000	0.039	0.048	0.000	0.039

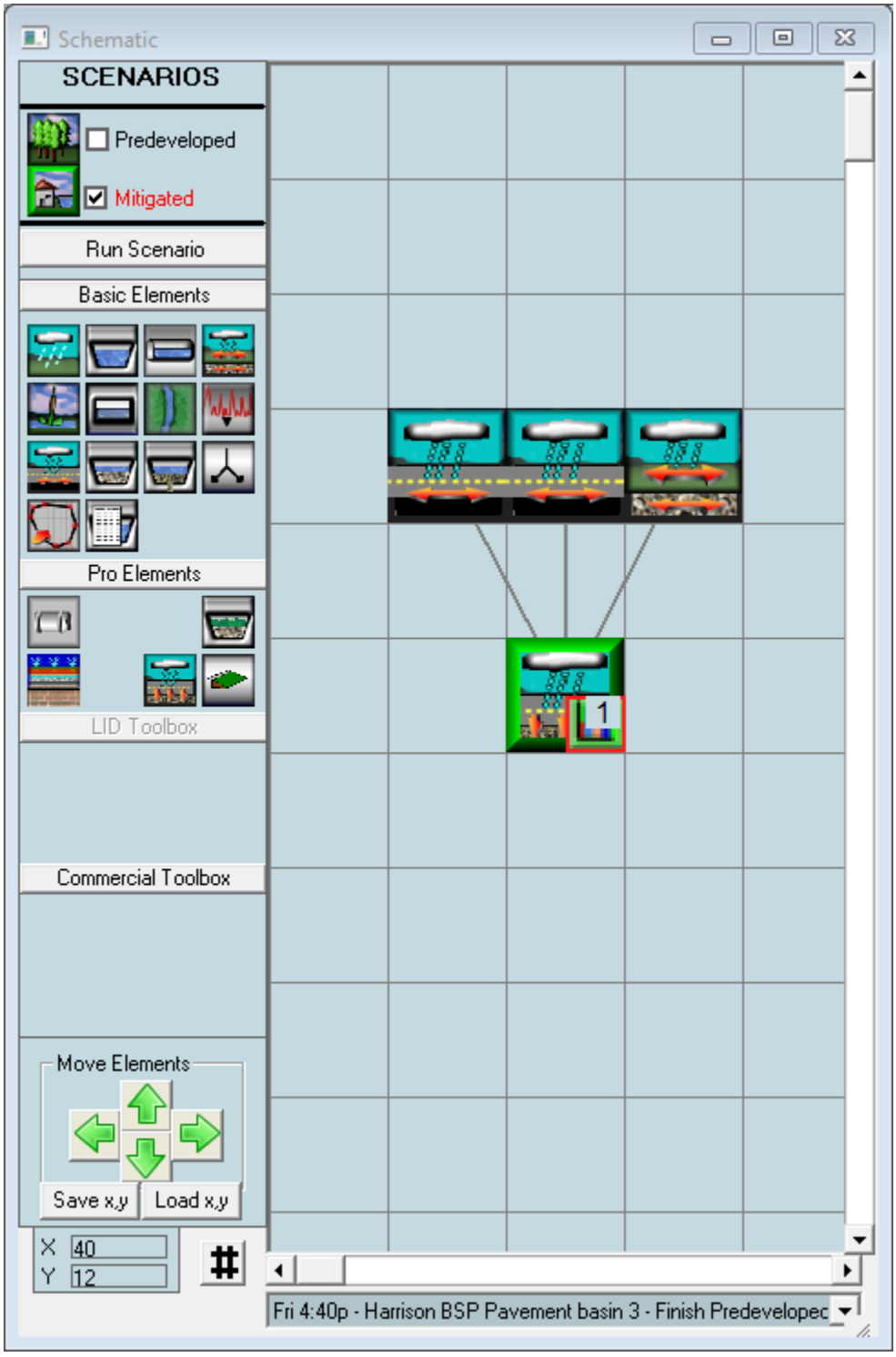
2.4333	0.039	0.049	0.000	0.039
2.4667	0.039	0.050	0.000	0.039
2.5000	0.039	0.052	0.000	0.039
2.5333	0.039	0.053	0.000	0.039
2.5667	0.039	0.054	0.000	0.039
2.6000	0.039	0.055	0.000	0.039
2.6333	0.039	0.057	0.000	0.039
2.6667	0.039	0.058	0.000	0.039
2.7000	0.039	0.059	0.000	0.039
2.7333	0.039	0.061	0.000	0.039
2.7667	0.039	0.062	0.000	0.039
2.8000	0.039	0.063	0.000	0.039
2.8333	0.039	0.065	0.000	0.039
2.8667	0.039	0.066	0.000	0.039
2.9000	0.039	0.067	0.000	0.039
2.9333	0.039	0.069	0.000	0.039
2.9667	0.039	0.070	0.000	0.039
3.0000	0.039	0.071	0.000	0.039

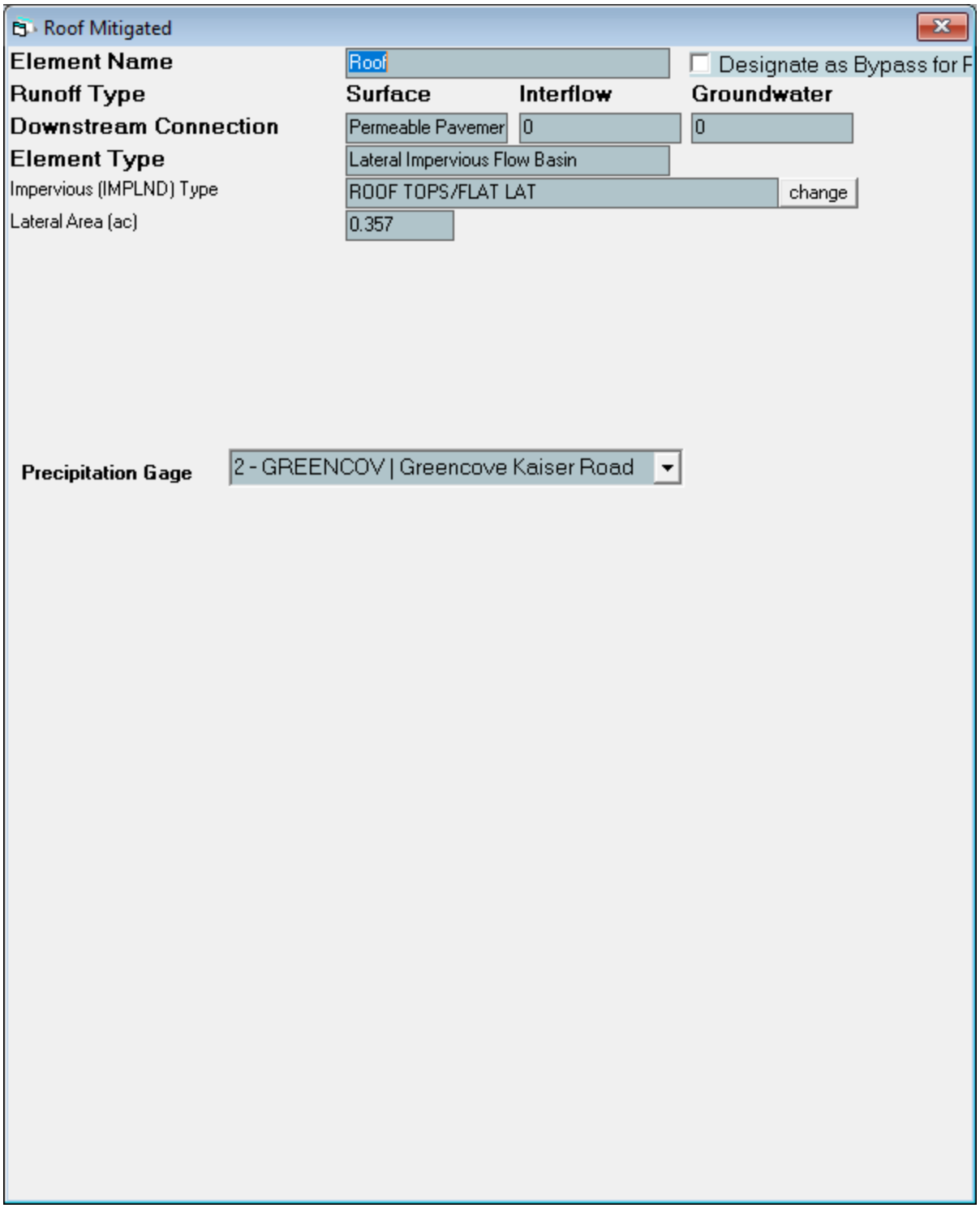
ANALYSIS RESULTS

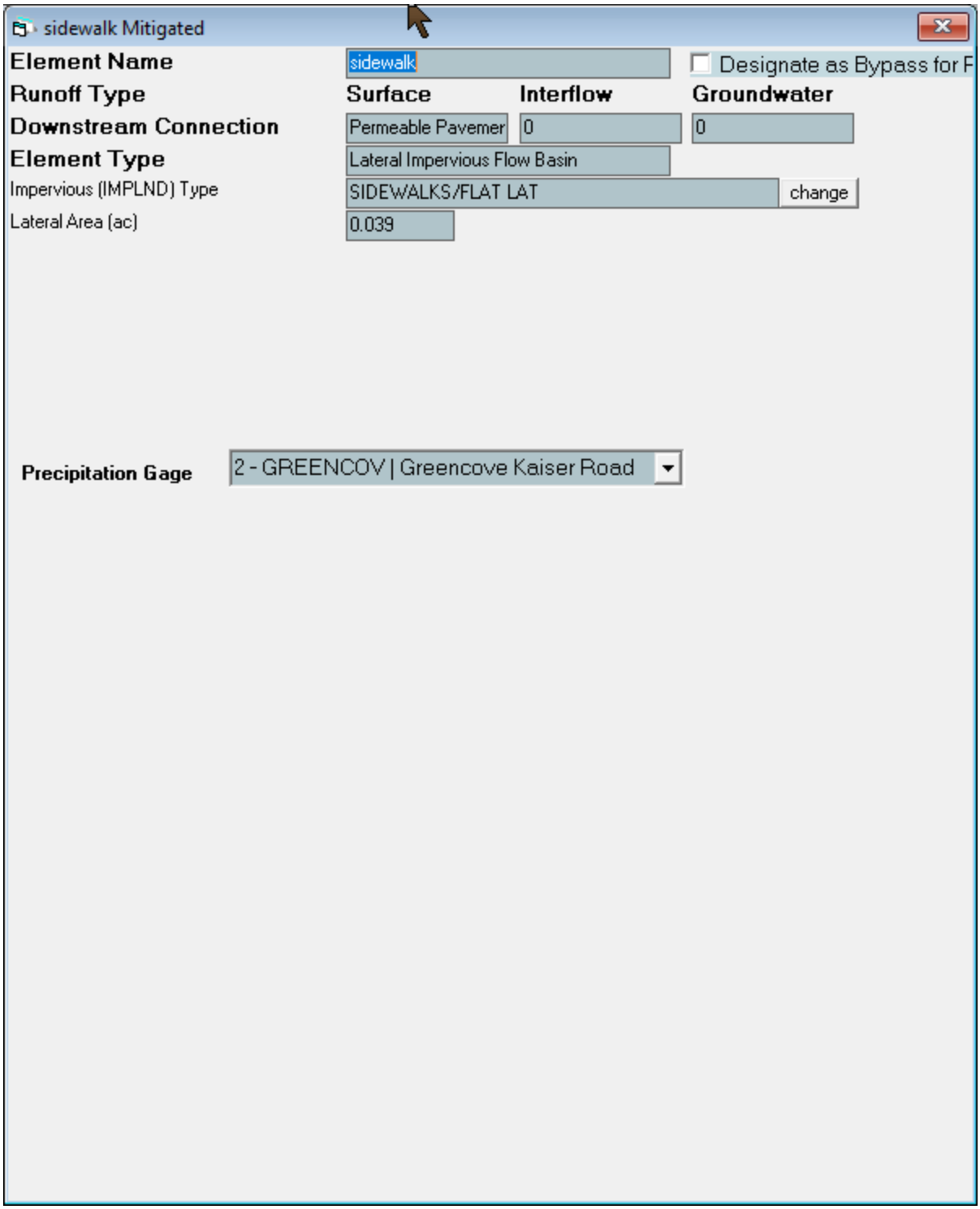
POC #1 was not reported because POC must exist in both scenarios and both scenarios must have been run. POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.Perlnd and Implnd Changes

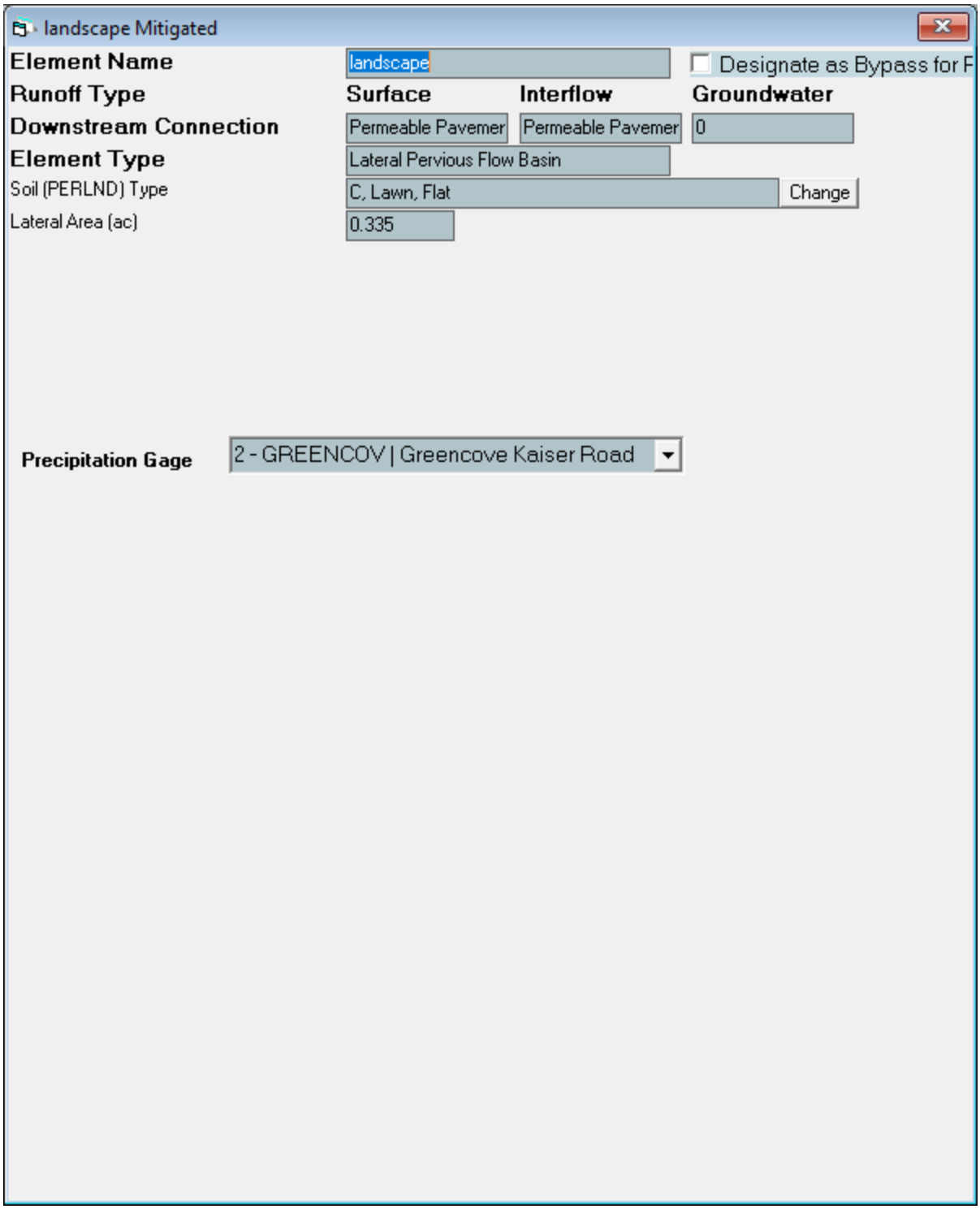
No changes have been made.

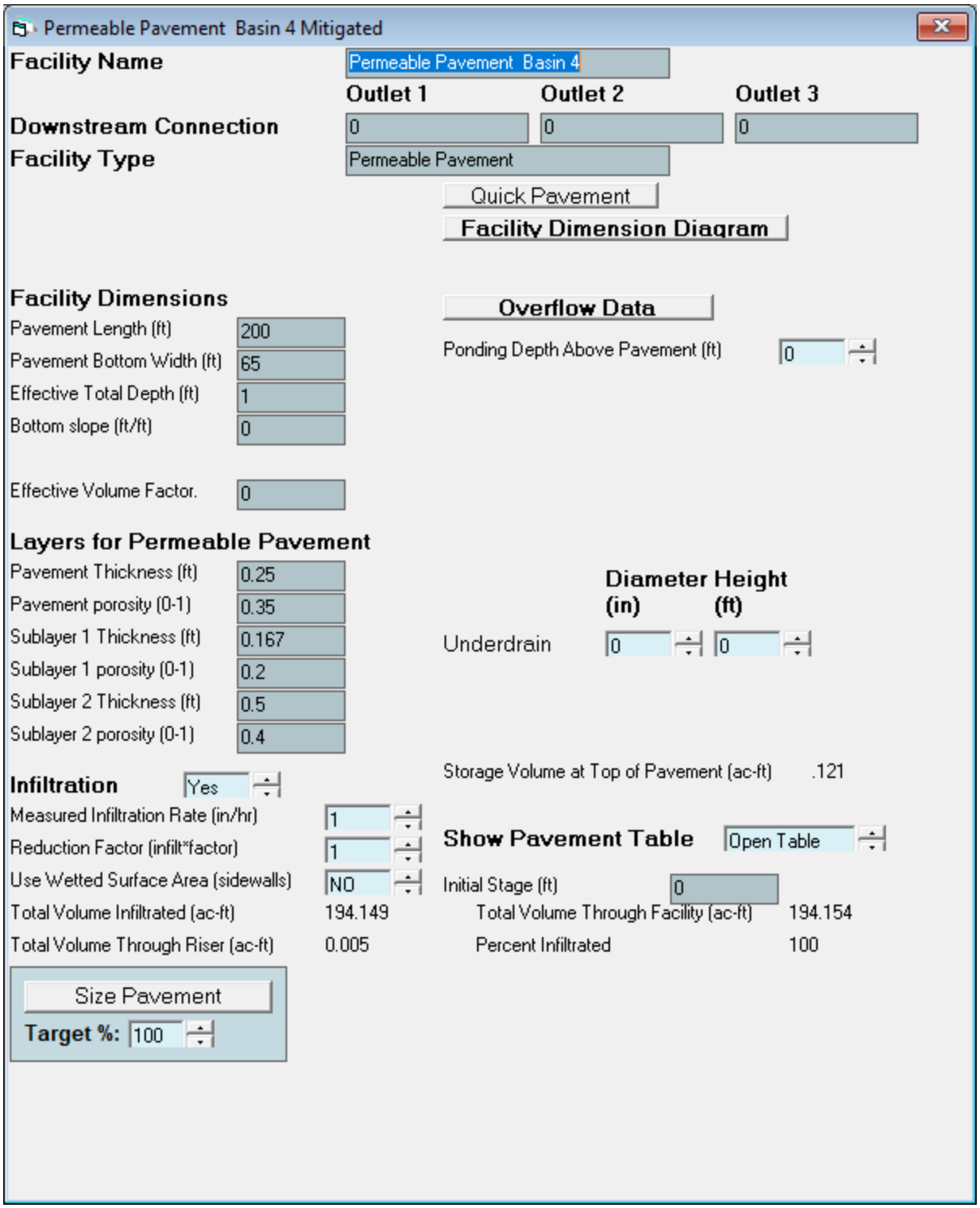
Basin 4- Porous Pavement on Lot 5




Roof Mitigated
Element Name
Roof
Designate as Bypass for F
Runoff Type
Surface
Interflow
Groundwater
Downstream Connection
Permeable Pavemer
0
0
Element Type
Lateral Impervious Flow Basin
Impervious (IMPLND) Type
ROOF TOPS/FLAT LAT
change
Lateral Area (ac)
0.357
Precipitation Gage
2 - GREENCOV | Greencove Kaiser Road


sidewalk Mitigated
Element Name
sidewalk
Designate as Bypass for F
Runoff Type
Surface
Interflow
Groundwater
Downstream Connection
Permeable Pavemer
0
0
Element Type
Lateral Impervious Flow Basin
Impervious (IMPLND) Type
SIDEWALKS/FLAT LAT
change
Lateral Area (ac)
0.039
Precipitation Gage
2 - GREENCOV | Greencove Kaiser Road


landscape Mitigated
Element Name
landscape
Designate as Bypass for F
Runoff Type
Surface
Interflow
Groundwater
Downstream Connection
Permeable Pavemer
Permeable Pavemer
0
Element Type
Lateral Pervious Flow Basin
Soil (PERLND) Type
C, Lawn, Flat
Change
Lateral Area (ac)
0.335
Precipitation Gage
2 - GREENCOV | Greencove Kaiser Road


Permeable Pavement Basin 4 Mitigated
Facility Name
Permeable Pavement Basin 4
Outlet 1
Outlet 2
Outlet 3
Downstream Connection
0
0
0
Facility Type
Permeable Pavement
Quick Pavement
Facility Dimension Diagram
Facility Dimensions
Overflow Data
Pavement Length (ft)
200
Pavement Bottom Width (ft)
65
Effective Total Depth (ft)
1
Bottom slope (ft/ft)
0
Ponding Depth Above Pavement (ft)
0
Effective Volume Factor.
0
Layers for Permeable Pavement
Pavement Thickness (ft)
0.25
Pavement porosity (0-1)
0.35
Sublayer 1 Thickness (ft)
0.167
Sublayer 1 porosity (0-1)
0.2
Sublayer 2 Thickness (ft)
0.5
Sublayer 2 porosity (0-1)
0.4
Diameter (in)
Height (ft)
Underdrain
0
0
Storage Volume at Top of Pavement (ac-ft)
.121
Infiltration
Yes
Measured Infiltration Rate (in/hr)
1
Reduction Factor (infilt*factor)
1
Use Wetted Surface Area (sidewalls)
NO
Show Pavement Table
Open Table
Initial Stage (ft)
0
Total Volume Infiltrated (ac-ft)
194.149
Total Volume Through Facility (ac-ft)
194.154
Total Volume Through Riser (ac-ft)
0.005
Percent Infiltrated
100
Size Pavement
Target %:
100

WWHM2012

PROJECT REPORT

Project Name: Harrison BSP Pavement basin 4
Site Name:
Site Address:
City :
Report Date: 3/19/2021
Gage : Green Cove
Data Start : 1955/10/01
Data End : 2011/09/30
Precip Scale: 1.00
Version Date: 2019/09/13
Version : 4.2.17

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	.731
Pervious Total	**0.731**

Impervious Land Use	acre
Impervious Total	**0**
Basin Total	**0.731**

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Permeable Pavement Basin 4
Pavement Area: 0.2984 ft.
Pavement Length: 200.00 ft.
Pavement Width: 65.00 ft.

Pavement slope 1: 0 To 1
Pavement thickness: 0.25
Pour Space of Pavement: 0.35
Material thickness of second layer: 0.167
Pour Space of material for second layer: 0.2
Material thickness of third layer: 0.5
Pour Space of material for third layer: 0.4
Infiltration On
Infiltration rate: 1
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 194.149
Total Volume Through Riser (ac-ft.): 0.005
Total Volume Through Facility (ac-ft.): 194.154
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 6.994

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

Permeable Pavement Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.298	0.000	0.000	0.000
0.0111	0.298	0.001	0.000	0.300
0.0222	0.298	0.002	0.000	0.300
0.0333	0.298	0.004	0.000	0.300
0.0444	0.298	0.005	0.000	0.300
0.0556	0.298	0.006	0.000	0.300
0.0667	0.298	0.008	0.000	0.300
0.0778	0.298	0.009	0.000	0.300
0.0889	0.298	0.010	0.000	0.300
0.1000	0.298	0.011	0.000	0.300
0.1111	0.298	0.013	0.000	0.300
0.1222	0.298	0.014	0.000	0.300
0.1333	0.298	0.015	0.000	0.300
0.1444	0.298	0.017	0.000	0.300
0.1556	0.298	0.018	0.000	0.300
0.1667	0.298	0.019	0.000	0.300
0.1778	0.298	0.021	0.000	0.300
0.1889	0.298	0.022	0.000	0.300
0.2000	0.298	0.023	0.000	0.300
0.2111	0.298	0.025	0.000	0.300
0.2222	0.298	0.026	0.000	0.300
0.2333	0.298	0.027	0.000	0.300
0.2444	0.298	0.029	0.000	0.300
0.2556	0.298	0.030	0.000	0.300
0.2667	0.298	0.031	0.000	0.300
0.2778	0.298	0.033	0.000	0.300
0.2889	0.298	0.034	0.000	0.300
0.3000	0.298	0.035	0.000	0.300
0.3111	0.298	0.037	0.000	0.300
0.3222	0.298	0.038	0.000	0.300

0.3333	0.298	0.039	0.000	0.300
0.3444	0.298	0.041	0.000	0.300
0.3556	0.298	0.042	0.000	0.300
0.3667	0.298	0.043	0.000	0.300
0.3778	0.298	0.045	0.000	0.300
0.3889	0.298	0.046	0.000	0.300
0.4000	0.298	0.047	0.000	0.300
0.4111	0.298	0.049	0.000	0.300
0.4222	0.298	0.050	0.000	0.300
0.4333	0.298	0.051	0.000	0.300
0.4444	0.298	0.053	0.000	0.300
0.4556	0.298	0.054	0.000	0.300
0.4667	0.298	0.055	0.000	0.300
0.4778	0.298	0.057	0.000	0.300
0.4889	0.298	0.058	0.000	0.300
0.5000	0.298	0.059	0.000	0.300
0.5111	0.298	0.059	0.000	0.300
0.5222	0.298	0.060	0.000	0.300
0.5333	0.298	0.061	0.000	0.300
0.5444	0.298	0.061	0.000	0.300
0.5556	0.298	0.062	0.000	0.300
0.5667	0.298	0.063	0.000	0.300
0.5778	0.298	0.063	0.000	0.300
0.5889	0.298	0.064	0.000	0.300
0.6000	0.298	0.065	0.000	0.300
0.6111	0.298	0.065	0.000	0.300
0.6222	0.298	0.066	0.000	0.300
0.6333	0.298	0.067	0.000	0.300
0.6444	0.298	0.067	0.000	0.300
0.6556	0.298	0.068	0.000	0.300
0.6667	0.298	0.069	0.000	0.300
0.6778	0.298	0.070	0.000	0.300
0.6889	0.298	0.071	0.000	0.300
0.7000	0.298	0.072	0.000	0.300
0.7111	0.298	0.073	0.000	0.300
0.7222	0.298	0.074	0.000	0.300
0.7333	0.298	0.075	0.000	0.300
0.7444	0.298	0.077	0.000	0.300
0.7556	0.298	0.078	0.000	0.300
0.7667	0.298	0.079	0.000	0.300
0.7778	0.298	0.080	0.000	0.300
0.7889	0.298	0.081	0.000	0.300
0.8000	0.298	0.082	0.000	0.300
0.8111	0.298	0.084	0.000	0.300
0.8222	0.298	0.085	0.000	0.300
0.8333	0.298	0.086	0.000	0.300
0.8444	0.298	0.087	0.000	0.300
0.8556	0.298	0.088	0.000	0.300
0.8667	0.298	0.089	0.000	0.300
0.8778	0.298	0.091	0.000	0.300
0.8889	0.298	0.092	0.000	0.300
0.9000	0.298	0.093	0.000	0.300
0.9111	0.298	0.094	0.000	0.300
0.9222	0.298	0.097	0.008	0.300
0.9333	0.298	0.101	0.045	0.300
0.9444	0.298	0.104	0.098	0.300

0.9556	0.298	0.107	0.163	0.300
0.9667	0.298	0.111	0.239	0.300
0.9778	0.298	0.114	0.324	0.300
0.9889	0.298	0.117	0.417	0.300
1.0000	0.298	0.121	0.517	0.300

Name : Roof
Bypass: No

Impervious Land Use	**acre**
ROOF TOPS FLAT LAT	**0.357**

Element Flows To:

Outlet 1	**Outlet 2**
Permeable Pavement	Ba

Name : sidewalk
Bypass: No

Impervious Land Use	**acre**
SIDEWALKS FLAT LAT	**0.039**

Element Flows To:

Outlet 1	**Outlet 2**
Permeable Pavement	Ba

Name : landscape
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	**.335**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Permeable Pavement	Ba Permeable Pavement	Ba

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1

Total Pervious Area:0.731
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0.335
Total Impervious Area:0.694439

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.047267
5 year	0.09071
10 year	0.117838
25 year	0.147693
50 year	0.166437
100 year	0.182381

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

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

Year	Predeveloped	Mitigated
1956	0.063	0.000
1957	0.084	0.000
1958	0.023	0.000
1959	0.053	0.000
1960	0.057	0.000
1961	0.057	0.000
1962	0.015	0.000
1963	0.103	0.000
1964	0.040	0.000
1965	0.038	0.000
1966	0.032	0.000
1967	0.041	0.000
1968	0.030	0.000
1969	0.021	0.000
1970	0.034	0.000
1971	0.044	0.000
1972	0.087	0.000
1973	0.040	0.000
1974	0.043	0.000
1975	0.031	0.000
1976	0.056	0.000
1977	0.028	0.000
1978	0.038	0.000
1979	0.033	0.000
1980	0.037	0.000

1981	0.053	0.000
1982	0.039	0.000
1983	0.067	0.000
1984	0.059	0.000
1985	0.018	0.000
1986	0.070	0.000
1987	0.054	0.000
1988	0.031	0.000
1989	0.030	0.000
1990	0.161	0.000
1991	0.078	0.000
1992	0.031	0.000
1993	0.022	0.000
1994	0.017	0.000
1995	0.060	0.000
1996	0.078	0.000
1997	0.074	0.000
1998	0.069	0.000
1999	0.045	0.000
2000	0.000	0.000
2001	0.146	0.000
2002	0.049	0.000
2003	0.028	0.000
2004	0.068	0.000
2005	0.026	0.000
2006	0.057	0.000
2007	0.038	0.000
2008	0.109	0.037
2009	0.069	0.000
2010	0.023	0.000
2011	0.039	0.000

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

Rank	Predeveloped	Mitigated
1	0.1612	0.0372
2	0.1461	0.0000
3	0.1094	0.0000
4	0.1025	0.0000
5	0.0870	0.0000
6	0.0843	0.0000
7	0.0780	0.0000
8	0.0775	0.0000
9	0.0738	0.0000
10	0.0697	0.0000
11	0.0689	0.0000
12	0.0688	0.0000
13	0.0680	0.0000
14	0.0666	0.0000
15	0.0625	0.0000
16	0.0599	0.0000
17	0.0592	0.0000
18	0.0574	0.0000
19	0.0570	0.0000
20	0.0567	0.0000

21	0.0564	0.0000
22	0.0539	0.0000
23	0.0533	0.0000
24	0.0526	0.0000
25	0.0486	0.0000
26	0.0451	0.0000
27	0.0439	0.0000
28	0.0429	0.0000
29	0.0413	0.0000
30	0.0403	0.0000
31	0.0398	0.0000
32	0.0393	0.0000
33	0.0386	0.0000
34	0.0384	0.0000
35	0.0381	0.0000
36	0.0376	0.0000
37	0.0374	0.0000
38	0.0342	0.0000
39	0.0333	0.0000
40	0.0319	0.0000
41	0.0314	0.0000
42	0.0313	0.0000
43	0.0306	0.0000
44	0.0304	0.0000
45	0.0297	0.0000
46	0.0278	0.0000
47	0.0278	0.0000
48	0.0261	0.0000
49	0.0233	0.0000
50	0.0228	0.0000
51	0.0220	0.0000
52	0.0210	0.0000
53	0.0178	0.0000
54	0.0169	0.0000
55	0.0149	0.0000
56	0.0001	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0236	13710	6	0	Pass
0.0251	11644	5	0	Pass
0.0265	10061	5	0	Pass
0.0280	8526	4	0	Pass
0.0294	7281	4	0	Pass
0.0308	6244	4	0	Pass
0.0323	5394	4	0	Pass
0.0337	4756	3	0	Pass
0.0352	4180	2	0	Pass
0.0366	3697	1	0	Pass
0.0381	3220	0	0	Pass

0.0395	2798	0	0	Pass
0.0409	2462	0	0	Pass
0.0424	2201	0	0	Pass
0.0438	1942	0	0	Pass
0.0453	1688	0	0	Pass
0.0467	1470	0	0	Pass
0.0482	1281	0	0	Pass
0.0496	1119	0	0	Pass
0.0510	996	0	0	Pass
0.0525	879	0	0	Pass
0.0539	770	0	0	Pass
0.0554	686	0	0	Pass
0.0568	582	0	0	Pass
0.0583	510	0	0	Pass
0.0597	443	0	0	Pass
0.0611	389	0	0	Pass
0.0626	349	0	0	Pass
0.0640	307	0	0	Pass
0.0655	276	0	0	Pass
0.0669	250	0	0	Pass
0.0683	216	0	0	Pass
0.0698	171	0	0	Pass
0.0712	157	0	0	Pass
0.0727	139	0	0	Pass
0.0741	119	0	0	Pass
0.0756	111	0	0	Pass
0.0770	106	0	0	Pass
0.0784	101	0	0	Pass
0.0799	99	0	0	Pass
0.0813	95	0	0	Pass
0.0828	91	0	0	Pass
0.0842	86	0	0	Pass
0.0857	80	0	0	Pass
0.0871	74	0	0	Pass
0.0885	69	0	0	Pass
0.0900	64	0	0	Pass
0.0914	60	0	0	Pass
0.0929	56	0	0	Pass
0.0943	51	0	0	Pass
0.0958	45	0	0	Pass
0.0972	40	0	0	Pass
0.0986	36	0	0	Pass
0.1001	34	0	0	Pass
0.1015	31	0	0	Pass
0.1030	27	0	0	Pass
0.1044	24	0	0	Pass
0.1059	21	0	0	Pass
0.1073	14	0	0	Pass
0.1087	7	0	0	Pass
0.1102	5	0	0	Pass
0.1116	5	0	0	Pass
0.1131	5	0	0	Pass
0.1145	5	0	0	Pass
0.1160	5	0	0	Pass
0.1174	5	0	0	Pass
0.1188	5	0	0	Pass

0.1203	5	0	0	Pass
0.1217	5	0	0	Pass
0.1232	4	0	0	Pass
0.1246	3	0	0	Pass
0.1260	3	0	0	Pass
0.1275	3	0	0	Pass
0.1289	3	0	0	Pass
0.1304	3	0	0	Pass
0.1318	3	0	0	Pass
0.1333	3	0	0	Pass
0.1347	3	0	0	Pass
0.1361	3	0	0	Pass
0.1376	3	0	0	Pass
0.1390	3	0	0	Pass
0.1405	3	0	0	Pass
0.1419	3	0	0	Pass
0.1434	2	0	0	Pass
0.1448	2	0	0	Pass
0.1462	1	0	0	Pass
0.1477	1	0	0	Pass
0.1491	1	0	0	Pass
0.1506	1	0	0	Pass
0.1520	1	0	0	Pass
0.1535	1	0	0	Pass
0.1549	1	0	0	Pass
0.1563	1	0	0	Pass
0.1578	1	0	0	Pass
0.1592	1	0	0	Pass
0.1607	1	0	0	Pass
0.1621	0	0	0	Pass
0.1636	0	0	0	Pass
0.1650	0	0	0	Pass
0.1664	0	0	0	Pass

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 Infiltration Credit	Percent Water Quality Volume	Percent Treated	Comment
Permeable Pavement	Basin 4 PO	N	176.68				N	100.00	
Total Volume Infiltrated			176.68	0.00	0.00				
100.00	0.00	0%	No Treat. Credit						

Compliance with LID Standard 8
Duration Analysis Result = Passed

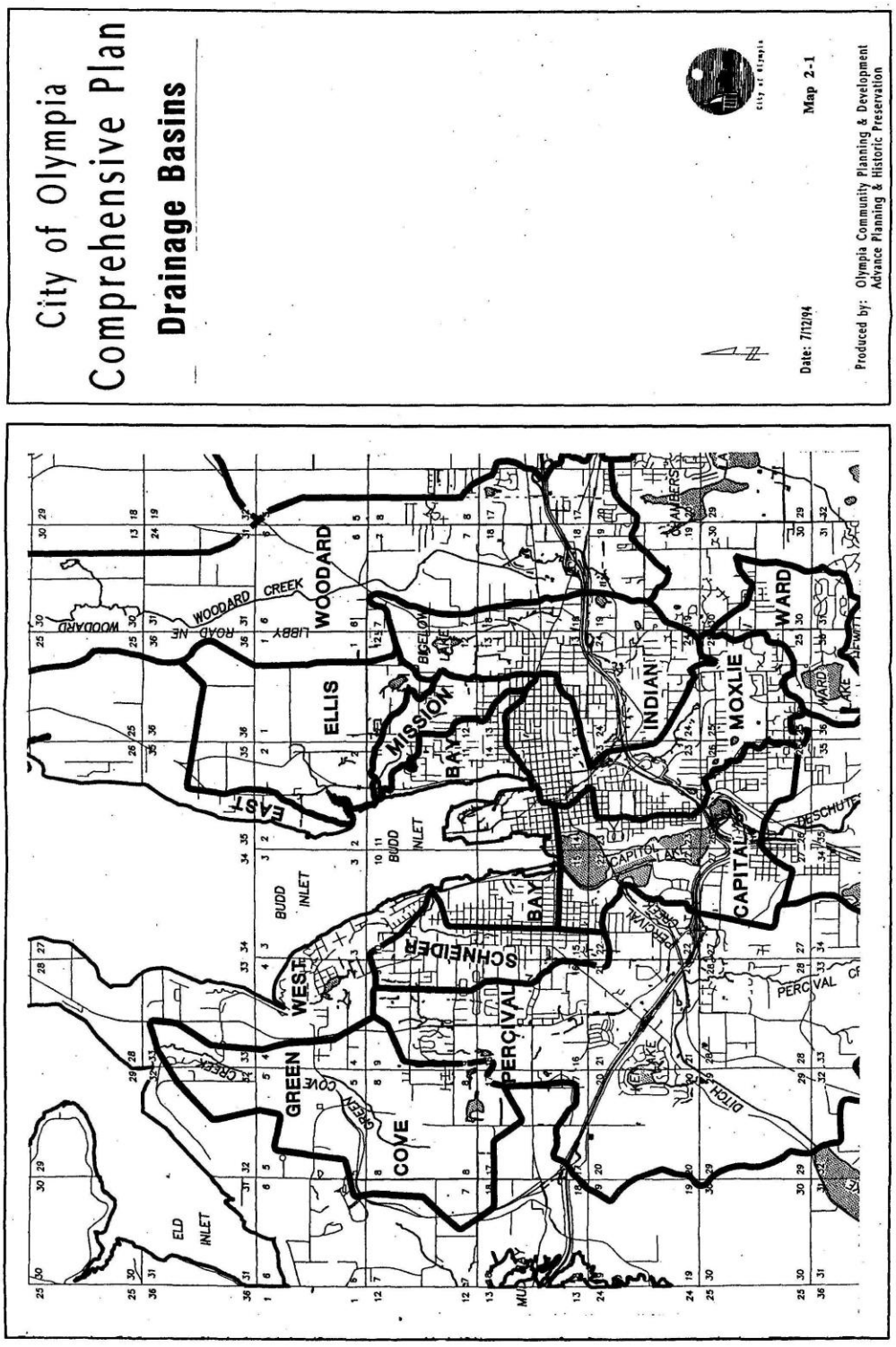
POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.**Perlnd and Implnd Changes**
No changes have been made.

Minimum Requirement # 8: Wetlands Protection

Not applicable. There are no wetlands on-site.

Minimum Requirement # 9: Basin/Watershed Planning

Woodard Creek Basin – no additional requirements



Minimum Requirement # 10: Operation and Maintenance

The following pages contain the maintenance schedule and checklist for the project.

Stormwater Facility Maintenance Guide

Table of Contents

What is Stormwater Runoff?

When urban and suburban development covers the land with buildings, houses, streets and parking lots, much of the native topsoil, duff, trees, shrubs, and grass are replaced by asphalt and concrete. Rainfall that would have directly soaked into the ground instead stays on the surface as *stormwater runoff* making its way into storm drains (including man-made pipes, ditches, or swale networks), stormwater ponds, surface and groundwater, and eventually to Puget Sound.

What is a Storm Drain System and how does it work?

The storm drain system for most developments includes components *that carry, store, cleanse, and release* the stormwater. These components work together to reduce the impacts of development on the environment. These impacts can include *flooding* which results in property damage and blocked emergency routes, *erosion* which can cause damage to salmon spawning habitat, and *pollution* which harms fish and/or drinking water supplies.

The storm drain system provides a safe method to carry stormwater to the treatment and storage areas. Swales and ponds filter pollutants from the stormwater by *physically* settling out particles, *chemically* binding pollutants to pond sediments, and *biologically* converting pollutants to less-harmful compounds. The ponds also store the treated water, releasing it gradually to a nearby stream or to groundwater. The various components of storm drain systems are described in the glossary.

What does Stormwater Runoff have to do with Water Quality?

Stormwater runoff needs to be treated because it carries litter, oil, gasoline, fertilizers, pesticides, pet wastes, sediments, and anything else that can float, dissolve, or be swept along by the moving water. Left untreated, polluted stormwater can reach nearby waterways where it can harm and even kill aquatic life. It can also pollute groundwater to the extent that it must be treated before it can be used for drinking, which has actually happened in Pierce County. Nationally, stormwater is recognized as a major threat to water quality. Remember to keep everything out of stormwater systems except the rainwater they are designed to collect.

Your Stormwater Facility

Stormwater facilities can be attractive as well as functional. They can provide both active and passive-use recreation areas and open space for wildlife. Perhaps you've noticed a wet or dry pond in your neighborhood. These different types of ponds are designed for different purposes. For example, wet ponds primarily provide treatment of stormwater. They also provide good cover and habitat for birds and small mammals, making them fine "wildlife preserves". Dry ponds or infiltration ponds are

designed to provide storage for stormwater and gradually release it downstream or allow it to filter into the ground. These types of ponds can be maintained as grassy play areas, and may even be modified to house more formal play equipment.

Who is Responsible for Maintaining Stormwater Facilities?

All stormwater facilities need to be maintained. Regular maintenance ensures proper functioning and keeps the facility visually appealing. This Stormwater Facility Maintenance Guide was designed to help explain how stormwater facilities work and provide user-friendly, straightforward guidance on how to maintain them.
As a homeowner or homeowner's association, you are responsible for regularly maintaining privately owned ponds, catch basins, pipes and other drainage facilities within your subdivision. Local governments maintain stormwater facilities located in public right-of-ways.

MAINTENANCE CHECKLISTS

The maintenance checklists in this packet are for you to use when checking the stormwater facilities in your neighborhood. If you feel that you are missing a checklist, or you have additional facilities not identified or addressed in this packet, please contact your developer or local jurisdiction.

The checklists are in table format for ease of use and brevity. Each checklist tells you what part of the feature to check, how often to check, what to check for, and what to do about it. Log sheets are included to help you keep track of when you last surveyed the storm drainage system.

Those systems using approved "emerging technologies", such as a StormFilter™, may not find a checklist covering the specific stormwater facility. Please refer to the manufacturer's guidelines for the appropriate maintenance activity schedule. If a checklist is provided, it is for guidance purposes only and not meant to supercede the manufacturer's recommendations.

Although it is not intended for the maintenance survey to involve anything too difficult or strenuous, there are a few tools that will make the job easier and safer. These tools include:

- A flashlight.
- A long pole or broom handle.
- Some kind of pry bar or lifting tool for pulling manhole and grate covers.
- Gloves.

A listing of resources is also included within this packet. Here you will find the phone numbers of the agencies referred to in the tables.

SAFETY WARNING: Due to OSHA regulations, you should never stick your head or any part of your body into a manhole or other type of confined space. When looking into a manhole or catch basin, stand above it and use the flashlight to help you see. Use a pole or broom handle that is long enough when you are checking sediment depths in confined spaces. *NO PART OF YOUR BODY SHOULD BREAK THE PLANE OF THE OPEN HOLE.*

RESOURCE LISTING

If you are unsure whether a problem exists, please contact the local jurisdiction at the number below and ask for technical assistance with your situation. Other resources are listed for your convenience and as references associated with the checklists.

- Tumwater Public Works..... (360) 754-4140
- Olympia Public Works..... (360) 753-8346
- Lacey Public Works..... (360) 438-2686

- Thurston County Water and Waste Management…….. (360) 357-2491
- Pacific Disposal…….. (360) 352-2046
- Thurston County Environmental Health…… (360) 754-4111
- Thurston County Solid Waste…….. (360) 786-5136
- WSU Cooperative Extension…… (360) 786-5445

CHECKLIST INSTRUCTIONS

The following pages contain maintenance checklists covering most of the needs for the components of your drainage system, as well as for some components that you may not have. Let us know if there are any components missing from these pages. Ignore the requirements that are not part of your system. You should plan to complete a check for all system components on the following schedule:

1. Quarterly – plan to inspect the facility at least once during the following months – January, May, August, and November.
2. Annually – The best time for an annual inspection is in the late summer, preferably September.
3. Items marked "After Major Storm Event", use 1-inch in 24 hours as a guideline.

Using photocopies of these checklists and log sheet below, check off the problems that you look for each time you do an inspection. Add comments on problems found and actions taken on the log sheet. Keep the completed forms in your files for future reference.

Call one of the numbers listed above for technical guidance. Please do not hesitate to call, especially if you are unsure whether a situation you have discovered may be a problem.

LOG SHEET

Use copies of this log sheet to keep track of when maintenance checks occur and what items, if any, are repaired or altered. The completed sheets will serve as a record of past maintenance activities and will provide valuable information on how your facilities are operating. This information will be useful for future requirements regarding the types of facilities that are installed. It helps to keep all log sheets in a designated area so that others can easily access them.

Date Checked: _____/____/_____
Checked By:
Name: _____
Position: _____
Address: _____ City: _____ State: _____ Zip: _____
Phone Number: (_____) _____

Part of Facility Checked	*Observations (List things that should be done)*	*Follow-up Actions Taken*	*Date Action Taken*

Catch Basins and Inlets

These structures are typically located in the streets and public right-of-ways. The City is responsible for routine maintenance of the pipes and catch basins in the right-of-ways, while the homeowners association is responsible for keeping the grates clear of debris in all areas as well as pipes and catch basins in private areas.

Part of Structure To Check	How Often	Completed (Date/By)	Problem	Conditions to Check For	What to do
Grate	During and After Major Storms		Trash & Debris	Trash or debris accumulating in front of the catch basin opening and not allowing waters to flow in.	Remove blocking trash or debris with a rake and clean off the grate.
Grate	Quarterly		Vegetation	Vegetation is growing across and blocking more than 10% of the basin opening.	Remove vegetation.
Catch Basin	Quarterly		Sediments	Sediment or debris in the basin should be kept under 50% of the depth from the bottom of the pipe to the bottom of the basin. Use a long stick or broom handle to poke into sediment and determine depth.	Clean out the catch basin of sediment and debris.
Inlet and Outlet Pipes	Quarterly		Trash & Debris	Trash or debris in the pipes should not be more than 1/5 of its height. Also there should not be any roots or vegetation growing in the pipes.	Clean out the inlet and outlet pipes from trash, debris, or vegetation.
Inlet and Outlet Pipes Joints	Annually		Structural Damage	There should be no cracks wider than 0.5" and longer than 1 foot at the joint of any inlet or outlet pipe. Also, check for evidence of sediment entering the catch basin through the cracks.	Repair cracks or replace the joints. Contact the City for technical guidance.
Grate	Quarterly		Structural Damage	The grate should not have any cracks longer than 2". There should not be multiple cracks. There should be no opening wider than 7/8"	Replace the grate.
Frame	Quarterly		Structural Damage	Ensure that the frame is sitting flush on top of the concrete structure (slab). A separation of more than 3/4" between the frame and the slab should be corrected.	Repair or replace the frame so that it is flush with the slab.

Catch Basin	Annually		Structural Damage	Inspect the walls of the catch basin for cracks wider than 0.5" and longer than 3 feet. Also check for evidence of sediment entering the catch basin through the cracks. Determine whether or not the structure is sound.	Repair or replace the basin. Contact a professional engineer for evaluation.
Catch Basin	Quarterly		Pollution and Fire Hazard	There should be no chemicals such as natural gas, oil, and gasoline in the catch basin. Check for obnoxious color, odor, or oily sludge.	Clean out catch basin. Contact Thurston County Environmental Health if you detect a color, odor, or oily sludge.
Oil/Water Separator (down-turned elbow or "T" in catch basin)	Quarterly		Pollution	Water surface in catch basin has significant sludge, oil, grease, or scum layer covering all or most of the water surface.	Remove catch basin cover and skim off oil layer. Pour oil into disposable container, seal container, wrap securely in newspaper, and contact Thurston County Environmental Health for proper disposal methods. Water surface should be clear of oily layer.
Pipe Elbow	Quarterly		Structural Damage	Top or bottoms of pipe appear to have broken off. Check for any apparent damage and check to see if it's plumb.	Remove the catch basin lid and examine the pipe for damage. If broken, hire a contractor to replace pipe in accordance to approved system design.
Ladder (if applicable)	Annually		Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Replace ladder.
Catch Basin Cover	Annually		Structural Damage	Some catch basins have covers. In this case, check to make sure that the cover is properly placed, not difficult to remove using normal lifting pressure, and the locking mechanism (if applicable) is functioning properly.	Sit cover properly or replace if necessary. If difficult to remove, tap a few times with a heavy sledgehammer to open and then clean lip edges. Replace locking mechanism if necessary.

Comments:

Conveyance Pipes, Ditches, and Swales

Part of Structure To Check	How Often	Completed (Date/By)	Problem	Conditions to Check For	What to do
Pipes	Annually		Sediment, Debris, & Vegetation	Accumulated sediment should not exceed 20% of the diameter of the pipe. Vegetation should not reduce free movement of water through pipes. Ensure that the protective coating is not damaged or rusted. Dents should not significantly impede flow. Pipe should not have major cracks or tears allowing water to leak out.	Clean out pipes of all sediment and debris. Remove all vegetation so that water flows freely through pipes. Repair or replace pipe.
Open Ditches	Quarterly		Trash & Debris	There should not be any yard waste or litter in the ditch.	Remove trash and debris and dispose of them properly.
Open Ditches	Annually		Sediment Buildup	Accumulated sediment should not exceed 20% of the depth of the ditch.	Clean out ditch of all sediment and debris.
Open Ditches and Swales	Annually		Overgrowth of Vegetation	Check for vegetation (e.g., weedy shrubs or saplings) that reduces the free movement of water through ditches or swales.	Clear blocking vegetation so that water moves freely through the ditches. Grassy vegetation should be left alone.
Open Ditches and Swales	Quarterly		Erosion / Scouring	Check around inlets, outlets, and swale bottoms for signs of erosion. Check slopes for signs of sloughing or settling. Action is needed where eroded damage is over 2" deep and where there is potential for continued erosion.	Eliminate causes of erosion. Stabilize slopes by using the appropriate erosion control procedure (e.g., reinforce with rock, plant grass, and compact soil).
Open Ditches and Swales	Annually		Missing Rocks	Native soil beneath the rock splash pad, check dam, or lining should not be visible.	Replace rocks to design standard.
Swales	Quarterly		Vegetation	Grass cover is sparse and weedy, or areas are overgrown with woody vegetation. Overhanging limbs are shading out the grass.	Aerate soils and re-seed and mulch bare areas. Keep grass less than 8" high. Remove woody growth, re-contour, and re-seed as necessary. Trim back overhanging limbs to allow for more light.
Swales	Quarterly		Homeowner Conversion	Swale has been filled in or blocked by shed, woodpile, shrubbery, etc.	If possible, speak with the homeowner and request that the swale area be restored. Contact the City to report the problem if not rectified voluntarily.
Swales	Annually		Swale does not drain	Water stands in the swale or flow velocity is very slow. Stagnation occurs.	A survey may be needed to check grades. Grades need to be in 1-5% range if possible. If grade is less than 1%, under-drains may need to be installed.

Comments:

Control Structures and Flow Restrictors

These types of structures are usually placed out of sight in manholes that could be locked. They typically consist of two pipes, one placed above the other. The lower pipe will typically have a cover and a small hole drilled in it to allow for slow release of water. The upper pipe is usually larger to provide for emergency overflows.

Part of Structure To Check	How Often	Completed (Date/By)	Problem	Conditions to Check For	What to do
Orifice	Quarterly		Trash, Debris, & Sediment Buildup	Check to see if trash or debris is blocking orifice plate. There should be enough space to get the orifice plate open for maintenance.	Remove trash and debris and dispose of properly.
Outlet Pipe	Annually		Structural Damage	Open the manhole lid but do not put your head down it. You may need to use a flashlight in order to see down the manhole. While standing above the opening, check to see that the pipe is securely attached to the manhole wall. This "T" type pipe should be in an upright position. Check for rust holes that don't seem part of the design.	If you observe any of the preceding conditions, call the City for technical guidance.
Cleanout Gate	Quarterly		Structural Damage	Ensure that the cleanout gate is in place, watertight, and free of rust. You should be able to open the gate alone. Make sure the pull chain leading to the gate is intact and within reach. Check for trash, debris, sediment, or vegetation that is blocking the plate.	If you observe any of the preceding conditions or can't get the cleanout gate open, call the City for technical guidance.
Overflow Pipe	Quarterly		Obstructions	Trash, debris, sediment, or vegetation should not be blocking the overflow pipe.	Use a long-handled rake or pitchfork to remove all such obstructions. If you can't get the debris cleared, contact the City for technical guidance.

Comments:

Grounds and Landscaping

Part of Structure To Check	How Often	Completed (Date/By)	Problem	Conditions to Check For	What to do
Landscaped Areas	Quarterly		Weeds	Weeds growing out of control in landscaped area.	Pull weeds by hand, if possible, to avoid using chemical weed controls.
Landscaped Areas	Quarterly		Poisonous Plants & Insects	Check for any presence of poison ivy or any other poisonous vegetation or insect nests.	Remove any vegetation or insect nests that are present in landscaped areas.
Landscaped Areas	Quarterly		Litter	There should not be any litter or yard waste in the landscaped areas.	Remove and dispose of properly.
Landscaped Areas	Quarterly		Erosion	Noticeable rills are seen in the landscaped areas.	Identify the cause of erosion and take steps to slow down or disperse the water. Fill in contour and re-seed the area.
Trees & Shrubs	Annually		Damaged Trees	Limbs or parts of trees or shrubs that are split or broken.	Trim trees and shrubs to restore shape. Replace severely damaged trees and shrubs.
Trees & Shrubs	Annually		Damaged Trees	Trees and shrubs that have been blown down or knocked over.	Replant trees or shrubs, inspecting for injury to stem and roots. Replace if necessary.
Trees & Shrubs	Annually		Damaged Trees	Trees and shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Place stakes and rubber-coated ties around young trees/shrubs for support.

Comments:

Drywells, French Drains, or Downspouts

Part of Structure To Check	How Often	Completed (Date/By)	Problem	Conditions to Check For	What to do
Downspout	Annually		Overflow	Water overflows from the gutter or downspout during rain.	First try cleaning out the gutter and downspouts. If this doesn't solve the problem, you may need to install a bigger drywell.
Roof	Annually		Moss	Moss and algae are taking over the shadier parts of the shingles.	Disconnect the flexible part of the downspout that leads to the drywell. Then perform moss removal as desired. Pressure wash or use fatty acid solutions instead of highly toxic pesticides or chlorine bleach. Install a zinc strip as a preventative.

Comments:

Glossary

Best Management Practice (BMP) – structures, conservation practices, or regulations that improve quality of runoff or reduce the impact of development on the quantity of runoff.

Biofilter (Swale) – A wider and flatter vegetated version of a ditch over which runoff flows at a uniform depth and velocity. Biofilters perform best when vegetation has a thick mat of roots, leaves, and stems at the soil interface (such as grass).

Biofiltration – The process through which pollutant concentrations in runoff are reduced by filtering runoff through vegetation.

Buffer – The zone that protects aquatic resources by providing: protection of slope stability, attenuation of runoff, and reduction of landslide hazards. An integral part of a stream or wetland ecosystem, it provides shading, input of organic debris, and course sediments to streams. It allows room for variation in stream or wetland boundaries, habitat for wildlife, and protection from harmful intrusion.

Catch Basin – An inlet for stormwater set into the ground, usually rectangular and made of concrete and capped with a grate that allows stormwater to enter.

Check Dam – A dam (e.g., rock, earthen, log) used in channels to reduce water velocities, promote sediment disposition, and/or enhance infiltration.

Compost Stormwater Filter – A treatment facility that removes sediment and pollutants from stormwater by percolating water through a layer of specially prepared Bigleaf maple compost. Clean water exits the bottom of the facility through a pipe, while stormwater flows in excess of the facility design overflow the compost bed and bypass the facility.

Constructed Wetland – A wet pond with dead storage at varies depths and planted with wetland plants to enhance its treatment capabilities.

Control Structure or Flow Restrictor – A manhole and/or pipe structure with a flow-regulating or metering device such as a weir or plates with small holes known as orifices. The structure controls he rate at which water leaves the pond.

Conveyance – A mechanism or device for transporting water including pipes, channels (natural and man-made), culverts, gutters, manholes, etc.

Critical Area – Areas such as wetlands, streams, steep slopes, etc., as defined by ordinance or resolution by the jurisdiction. Also known as environmentally sensitive areas.

Culvert – A conveyance device (e.g., concrete box, pipe) which conveys water from a ditch, swale, or stream under (usually across) a roadway or embankment.

Dead Storage – The volume of storage in a pond below the outlet which does not drain after a storm event. This area provides treatment of the stormwater by allowing sediments to settle out.

Detention Facility – A facility (e.g., pond, vault, pipe) in which surface and stormwater is temporarily stored.

Detention Pond – A detention facility in the form of an open pond.

Dispersion Trench – An open-top trench filled with rip rap or gravel that takes the discharge from a pond, spreads it out, and spills (bubbles) the flow out along its entire length. Dispersion trenches are used to simulate "sheet flow" of stormwater from an area, and are often used to protect sensitive areas.

Drainage System – The combination of Best Management Practices (BMP's), conveyances, treatment, retention, detention, and outfall features or structures on a project.

Drop Structure – A structure for dropping water to a lower elevation and/or dissipating energy. A drop may be vertical or inclined.

Dry Pond – A detention facility that drains completely after a storm. This type of pond has a pipe outlet at the bottom.

Easement – A right afforded a person to make a limited use of another's real property. Typical easements are for pipes or access to ponds, and may be 15 to 20 feet wide.

Emergency Overflow or Spillway – An area on the top edge of the pond that is slightly lower in elevation than areas around it. This area is normally lined with riprap. The emergency overflow is used only if the primary and secondary outlets of the ponds fail, in the event of extreme storms, or if the infiltration capability of the pond becomes significantly diminished. If the emergency overflow ever comes into play, it may mean that the pond needs to be upgraded.

Energy Dissipater – A rock pad at an outlet designed to slow the velocity, spread out the water leaving the pipe or channel, and reduce the potential for erosion.

Freeboard – The vertical distance between the design high water mark and the elevation of the top of the pond. Most ponds have one to two feet of freeboard to prevent them from overflowing.

Infiltration – The soaking of water through the soil surface into the ground (percolation is essentially the same thing). Many ponds are designed to infiltrate or retain stormwater, and thus do not have a

regularly used discharge pipe.

Infiltration Facility (or Structure) – A facility (pond or trench) which retains and percolates stormwater into the ground, having no discharge (to any surface water) under normal operating conditions.

Junction – Point where two or more drainage pipes or channels converge (e.g., a manhole).

Jurisdiction – Olympia, Lacey, Tumwater, or Thurston County (as applicable).

Lined Pond or Conveyance – A facility, the bottom and sides of which have been made impervious (using, for example, a plastic liner or clay/silt soil layer) to the transmission of liquids.

Live Storage – The volume of storage in a pond above the outlet, which drains after a storm event. This storage area provides flood control and habitat protection for nearby streams.

Manhole – A larger version of the catch basin, often round with a solid lid. Manholes allow access to underground stormwater pipes for maintenance.

Natural Channel – Stream, creek, river, lake, wetland, estuary, gully, swale, ravine, or any open conduit where water will concentrate and flow intermittently or continuously.

Oil-Water Separator – A structure or device used to remove oil and greasy solids from water. They operate by using gravity separation of liquids that have different densities. Many catch basins have a down-turned plastic elbow that provides some oil-water separation.

Outfall – The point where water flows from a man-made conduit, channel, or drain into a water body or other natural drainage feature.

Retention Facility – An infiltration facility.

Retention Pond – A retention facility that is an open pond.

Revetments – Materials such as rock or keystones used to sustain an embankment, such as in a retaining wall.

Riprap – Broken rock, cobbles, or boulders placed on earth surfaces, such as on top of a berm for the emergency overflow, along steep slopes, or at the outlet of a pipe, for protection against the action of the water. Also used for entrances to construction sites.

Runoff – Stormwater.

Sand Filter – A treatment facility that removes pollutants and sediments from stormwater by percolating stormwater through a layer of sand. Clean water exits the bottom of the facility through a pipe.

Stormwater – The portion of precipitation that falls on property and that does not naturally percolate into the ground or evaporate, but flows via overland flow, channels or pipes into a defined surface water channel, or a constructed infiltration facility. Stormwater includes wash-down water and other wastewater that enters the drainage system.

Swale – A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less than 1 foot. This term is used interchangeably with Biofilter.

Trash Rack or Bar Screen – A device (usually a screen or bars) that fits over a pipe opening to prevent large debris such as rocks or branches from entering and partially blocking the pipe.

Wet Pond – A stormwater treatment pond designed with a dead storage area to maintain a continuous or seasonal static water level below the pond outlet elevation.

Additional Requirement "A" Financial Liability

The bonds required by the City of Olympia will be provided prior to construction.

Additional Requirement "B" Offsite Analysis and Mitigation

Downstream Analysis

Harrison Ave is fully developed with in place collection system. The 12" pipe on the north side of Harrison directs water to the east, approx.. 1000' until it reaches the Green Cove Creek. From there it travels to the SE to Yauger Park to the City regional Stormwater Facility.

Appendix “A"
Thurston Region Facility Summary

THURSTON REGION
FACILITY SUMMARY FORM

Complete one (1) for each facility (detention/retention, coalescing plate filter, etc.) on the project site. Attach 8 ½ X 11 sketch showing location of facility.

Proponent's Facility Name or Identifier (e.g. Pond A) ***Porous Pavemenet***

Name of Road or Street to Access Facility: **3840 Harrison Ave**
Olympia, WA 98502

Hearings Examiner Case Number: ***N/A***

Development Rev. Project No./Bldg Permit No.:

Parcel Number:

To be completed by Utility Staff:

Utility Facility Number _____

Project Number (num) _____

Parcel Number Status (num, 1ch) _____
0, Known; 1, Public; 2, Unknown; 3, Unassigned

Basin and Subbasin: (num, 6ch) _____
(2ch for basin, 2ch for subbasin, 2ch future)

Responsible jurisdiction: (alpha, 1ch) _____

PART 1 – PROJECT NAME AND PROPONENT

Project Name: **Harrison Ave Mixed Use**

Project Owner: **Kern Rexius**
4004 Harrison Ave NW
Olympia, WA 98502
Project Contact: **Chris Cramer _ Patrick Harron and Assoc.**

Address:

email:

Project Proponent (if different):

Address:

Phone:

Project Engineer: ***Chris Cramer, P.E.***

Firm: ***Patrick Harron & Assoc., LLC*** *Phone*: ***360.459.1102***

PART 2 – PROJECT LOCATION: **Section 17, Township 18, Range 1W**

Names and Addresses of Adjacent Property Owners:

East:

MMK RENTALS LLC
16000 CHRISTENSEN RD STE 150
TUKWILA
: 98188

West:

REXIUS LLC
4004 HARRISON AVE NW

South:

Harrison Ave

North:

CAPSTONE HOMES INC
: PO BOX 139
: MAPLE VALLEY
: WA
: 98038-0139

Part 3 – Type of Permit Application

*Type of permit (e.g., Commercial Bldg)**:*** **Construction**

	Other Permits (circle)
DOF/W HPA	*COE 404*
COE Wetlands	*DOE Dam Safety*
FEMA	*Floodplain*
Shoreline Mgmt	*Rockery/Retaining Wall*
Encroachment	*Grading*
NPDES	

Other _____

Other Agencies (Federal, State, Local, etc.) that have had or will review this Drainage Erosion Control Plan:

None

Part 4 – Proposed Project Description

What stream basin is this project in (e.g., Percival, Woodland): **Percival**

Project Size, acres: **3.188**

Zoning: **HDC4**

Onsite:

Residential Subdivision:

Number of Lots: **N/A**

Lot size (average), acres: **N/A**

Building Permit/Commercial Plat:

Building(s) Footprint, acres: **0.792**

Concrete Paving, acres (included with Private Road) **1.519**

Gravel Surface, acres: **0.00**

Lattice Block Paving, acres : ***N/A***

Public Roads (including gravel shoulder), acres: **0.00**

Private Roads (including gravel shoulder), acres: **0.98**

Onsite Impervious Surface Total, acres: **2.311**

Part 5 – Pre-developed Project Site Characteristics

Stream through site, y/n *NO*

Name: _____

DNR Type: _____

Type of feature this facility discharges to (i.e., lake, stream, intermittent stream, pothole, roadside ditch,sheetflow to adjacent property, etc.): Eventual outfall "Henderson Inlet".

Swales, Ravines, y/n: ***N***

Steep slopes, (steeper than 15%) y/n: ***N***

Erosion hazard, y/n: ***N***

100 yr. Floodplain, y/n: ***N***

Lakes or Wetlands, y/n: ***N***

Seeps/Springs, y/n: ***N***

High Groundwater Table, y/n: ***N***

Wellhead Protection or Aquifer Sensitive Area, y/n: ***N***

Other: _____

Part 6 – Facility Description

Total Area Tributary to Facility Including offsite (acres):		*3.188*
Total Onsite Area Tributary to Facility (acres):		*3.188*
Design Impervious Area Tributary to Facility (acres):		*2.311*
Design Landscaped Area Tributary to Facility (acres):		*0.877*
Design Total Tributary Area to Facility (acres):		*3.188*
Enter a one (1) for the type of facility:		
Wet pond detention		*0*
Wet pond water surface area, acres		*0*
Dry pond detention		*0*
Underground detention		*0*
Infiltration pond		*0*
Dry well infiltration		*2*
Coalescing plate separator		*0*
Centrifuge separator		*0*
Other	***Porous Pavement***	***2***

Outlet type (Enter a one (1) for each type present)

Filter	_____
Oil water separator	_____
Single orifice	_____
Multiple orifice	_____
Weir	_____
Spillway	_____
Pump(s)	_____
Other	

Part 7 – Release to Groundwater

Design Percolation Rate to Groundwater (if applicable) ***1"/hr***

Part 8 – Release to Surface Water (if applicable)

	Thurston County MSL Elevation (ft)	*Present Design Full*	*Volume (cu ft)*	*Discharge to Surface Water (cfs)*
Empty:	*0*	*0*	*0*	*0*
	0	*25%*	*0*	*0*
	0	*50%*	*0*	*0*
	0	*75%*	*0*	*0*
	0	*100%*	*0*	*0*

Appendix “B"
Geotechnical Report

INSIGHT GEOLOGIC, INC.

November 22, 2016

Kern Rexius
4004 Harrison Avenue NW
Olympia, Washington 98502

Report
Stormwater Infiltration Services
Residential Development
3840 and 4004 Harrison Avenue NW
Olympia, Washington
Project No. 894-001-02

INTRODUCTION

Insight Geologic is pleased to provide our report of site soil conditions as they relate to the infiltration and disposal of stormwater for the proposed site development at the Bark and Garden Center, located at 3840 and 4004 Harrison Avenue NW in Olympia, Washington. The site is shown relative to surrounding physical features in the Vicinity Map, Figure 1. We understand that you are planning on developing the property with residential and retail buildings, as well associated drive and parking areas. Stormwater is to be infiltrated around the perimeter of the property.

Our services were performed in general accordance with our proposal dated October 17, 2016 and authorized by you on October 18, 2016.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface soil conditions as they relate to the infiltration and disposal of stormwater from the site. We proposed to perform our stormwater evaluation in general accordance with the procedures outlined in the City of Olympia's Stormwater Manual. The specific tasks conducted were as follows:

1. Provide for the location of subsurface utilities on the property. We proposed to do this by notifying the "One Call" utility notification system and by utilizing a private utility location service.
2. Excavate 10 exploratory test pits using a small, track-mounted excavator. The test pits were excavated to depths of between 3 and 10.5 feet below ground surface (bgs) and were backfilled at the end of the field day using the excavated soil. Bark & Garden provided a mini excavator to excavate the test pits.
3. Drill two (2) exploratory borings at the site using a truck-mounted drilling rig. The borings were completed to the depth of 31 feet bgs.

4. Collect representative soil samples from the explorations and log the soils encountered in general accordance with ASTM D2487-06.
5. Conduct laboratory analyses on 10 soil samples collected from the borings and test pits for grain-size distribution.
6. Prepare a report summarizing our field activities and containing our recommendations for stormwater infiltration rates for the proposed project.

SITE CONDITIONS

Surface Conditions

The project site is situated at an elevation of approximately 178 feet above mean sea level. The property is bounded by Harrison Avenue NW to the south, Bark and Garden Center to the west, and residential properties to the north and east. The site is generally flat and is currently wooded with a residence located at the southern portion of the property, that is presently undergoing conversion to office space. The proposed project includes a lot line adjustment, which would acquire a portion of the west adjacent parcel with an existing stormwater facility. An existing stormwater pond is located west of the northern portion of the subject property.

Geology

Based on our review of available published geologic maps, Vashon age glacial outwash deposits underlie the project site and surrounding area. This material is described as poorly sorted fine to medium sand, gravel, and boulders with minor silt. This material was deposited during the waning stages of the most recent glacial period in the Puget Sound and is not glacially consolidated. Deposits underlying the outwash deposits consist of Vashon age glacial till. This material is described as an unstratified mixture of silts, sands, and gravels directly deposited by glacial ice and is glacially consolidated. Based on the results of our explorations, the unconsolidated deposits generally consist of silts and do not match the description of glacial outwash deposits mapped by the Washington State Department of Natural Resources.

Subsurface Explorations

We explored subsurface conditions at the subject site on October 31 and November 2, 2016 by advancing two borings and completing 10 test pits in the locations as shown on the Site Plan, Figure 2. The exploratory borings were completed by Holocene Drilling using a Diedrich D-120 hollow stem auger drill rig. The test pits were excavated using a track-mounted excavator owned and operated by Bark & Garden. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The borings were completed to the depth of 31 feet bgs. Test pit were completed at depths of between 3 and 10.5 feet bgs, generally after reaching dense glacial till. The soils were visually classified in general accordance with the system described in ASTM D2487-06. A copy of the explorations is contained in Attachment A.

Soil Conditions

Our explorations generally encountered 7 to 8 feet of brown silt (ML) in a soft and moist condition. Underlying this silt unit, we encountered gray silty sand with gravel to sand and gravels with silt and gravel (SM, SP-SM, GP-GM) in a very dense condition, which was identified as glacial till. Glacial till

was encountered from approximately 8 feet bgs to the base of the borings at 31 feet bgs. Several exceptions to this description were noted. Underlying the southern half of the parcel, near test pits TP-1 to TP-4 and TP-8, a 1 foot unit of gray poorly graded sand and gravel occasionally with silt (SP, SP-SM) in a moist and medium dense condition was encountered above the glacial till. Glacial till was identified in test pits TP-6 and TP-10 at the depth of approximately 2 feet bgs, in a topographically low area. Soils located near the existing stormwater facility, located in the southwestern most portion of the site, encountered 7 feet of brown silty sand with gravel (SM) overlying dense glacial till.

The soils encountered are not consistent with Yelm sandy loam, which is mapped for the majority of the project site, according to the U.S. Department of Agriculture Soil Survey. Yelm sandy loam soils are generally formed from glacial outwash and generally have restrictive layers occurring greater than 7 feet below grade. This is inconsistent with the silt overlying glacial till identified at the site.

The southwestern most portion of the site, including the existing stormwater facility, is surficially mapped as Alderwood gravelly sandy loam. Alderwood gravelly sandy loam soils are generally formed from glacial outwash or glacial drift and generally have restrictive layers approximately 2 to 3 feet below grade. We observed that the site soils encountered near the existing stormwater facility were consistent with this description, however glacial till was encountered approximately 7 feet bgs.

Groundwater Conditions

Groundwater was not encountered during exploratory activities at the subject site. However, minor amounts of perched water were encountered near the top of the till unit within isolated explorations at the site. Perched water was generally encountered between 5.5 and 10 feet bgs in explorations TP-2, TP-5, TP-7, B-1, and B-2. With the exception of TP-10, where perched water was at 1 foot. Test pit TP-10 is located in a low-lying area of the site, near a neighboring uphill stormwater infiltration pond. The neighboring stormwater pond may be contributing to the shallow perched water at this location.

Laboratory Testing

We selected ten soil samples for gradation analyses in general accordance with ASTM D422 to define soil class and obtain parameters for stormwater infiltration calculations. Our laboratory test results are provided in Attachment B.

STORMWATER INFILTRATION

We completed a stormwater infiltration rate evaluation in general accordance with the 2009 City of Olympia Drainage Design and Erosion Control Manual (2009 Manual). The 2009 Manual utilizes a detailed method that utilizes the relationship between the D_{10}, D_{60}, and D_{90} results of the ASTM grain-size distribution analyses, along with site specific correction factors to estimate long-term design infiltration rates.

Based on our gradation analyses, we estimate that the long-term design infiltration rate (F_{design}) for the subject site is 0.01 inches per hour, after applying the appropriate correction factors. The F_{design} for the southwestern extension of the parcel, in the area of the existing stormwater facility, is 0.18 inches

per hour, after applying the appropriate correction factors. The results of our stormwater infiltration evaluation are presented in Table 1 and Attachment C.

Table 1. Design Infiltration Rates – Detailed Method

Exploration	Unit	Depth Range (feet)	D_{10} Value	D_{60} Value	D_{90} Value	Long Term Design Infiltration Rate (Inches per hour)
TP-1	ML	0.0 – 2.0	N/A	0.08	2.0	0.01
	ML	2.0 – 7.0	N/A	N/A	N/A	
	SP	7.0 – 8.0	0.14	0.36	0.86	
TP-5	ML	7.0 – 8.0	N/A	N/A	0.08	Not Evaluated
	GP-GM	8.0 – 8.5	0.17	44.0	65.0	
TP-7	ML	2.5 – 5.5	N/A	N/A	N/A	0.01
	ML	5.5 – 6.5	N/A	N/A	0.10	
	SM	6.5 – 7.0	N/A	0.38	6.5	
TP-8	SM	3.0 – 4.0	0.07	0.20	0.31	Not Evaluated
B-1	SM	5.0 – 6.5	N/A	0.85	11	0.18

LIMITATIONS

We have prepared this stormwater infiltration services report for the exclusive use of Kern Rexius and his authorized agents for the proposed residential development to be located at 3840 and 4004 Harrison Avenue NW in Olympia, Washington.

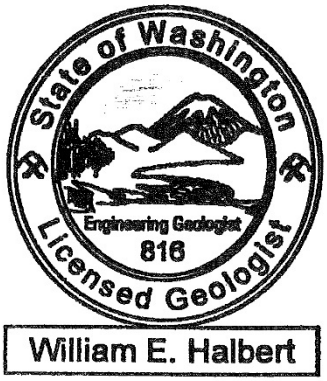
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Attachment D titled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have questions or require additional information.

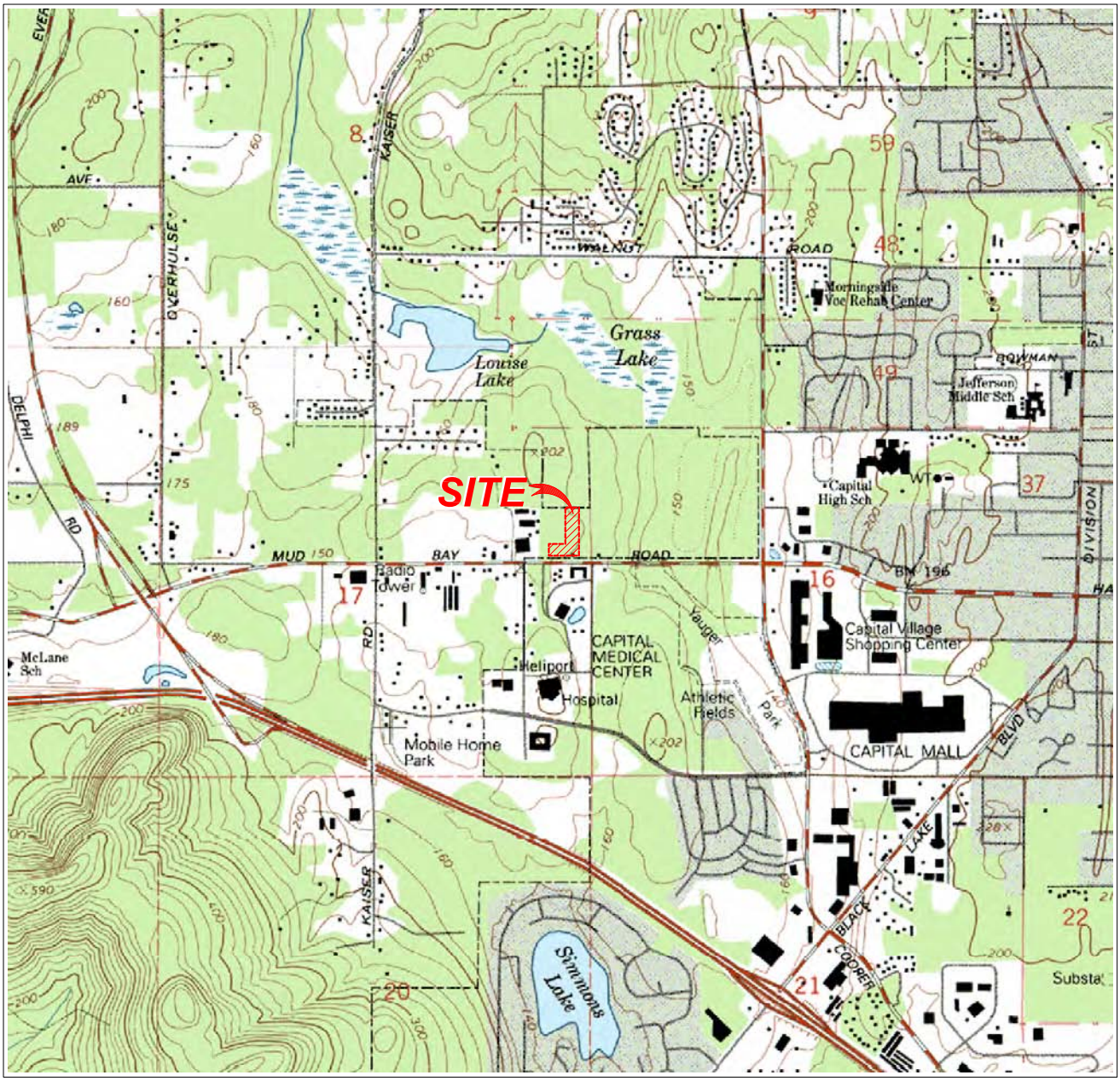
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

William E. Halbert, L.E.G., L.HG.
Principal



Attachments

FIGURES



Source: Terrain Navigator Image (c) 1997

TUMWATER, WASHINGTON
7.5 MINUTE QUADRANGLE
Year 1994

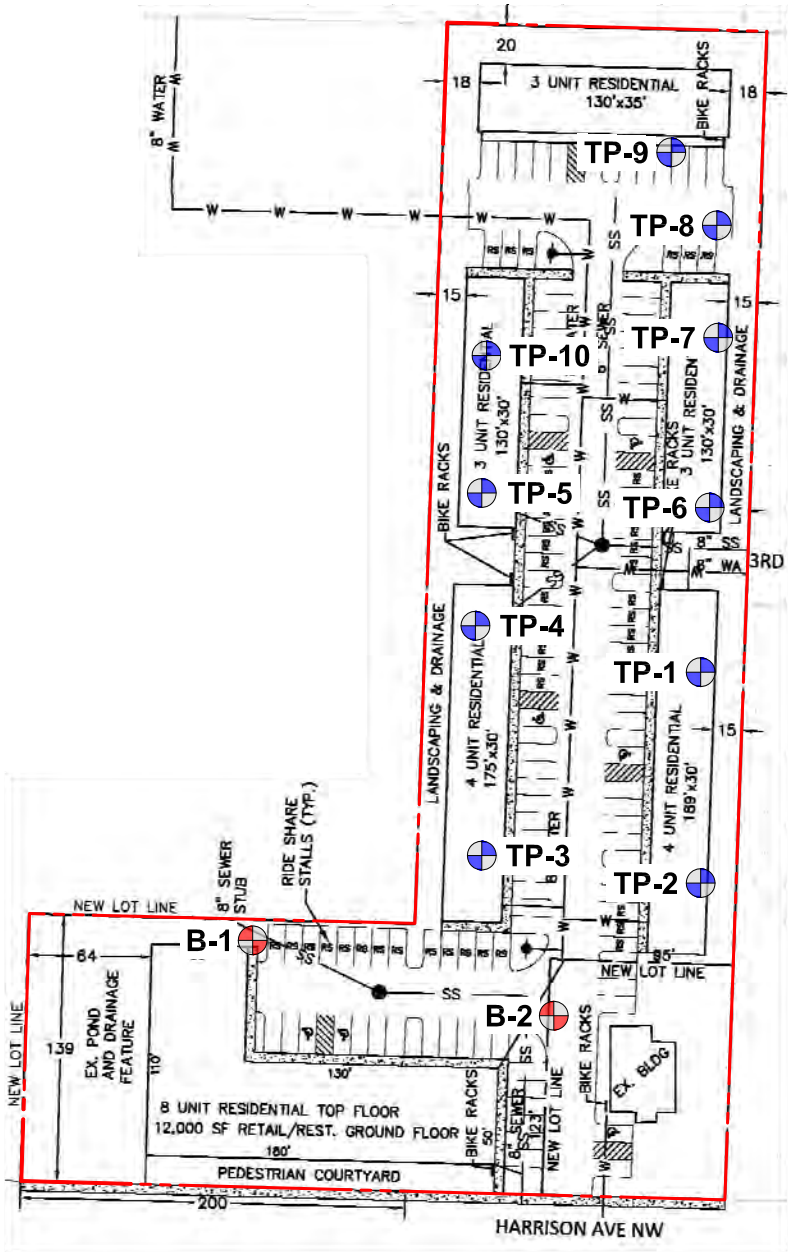
SCALE: 1: 24000

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



SOURCE: PATRICK HARRON & ASSOCIATES

LEGEND:

B-1 APPROXIMATE BORING LOCATION

TP-1 APPROXIMATE TEST PIT LOCATION

APPROXIMATE PROJECT BOUNDARY

SCALE: 1" = 100'

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

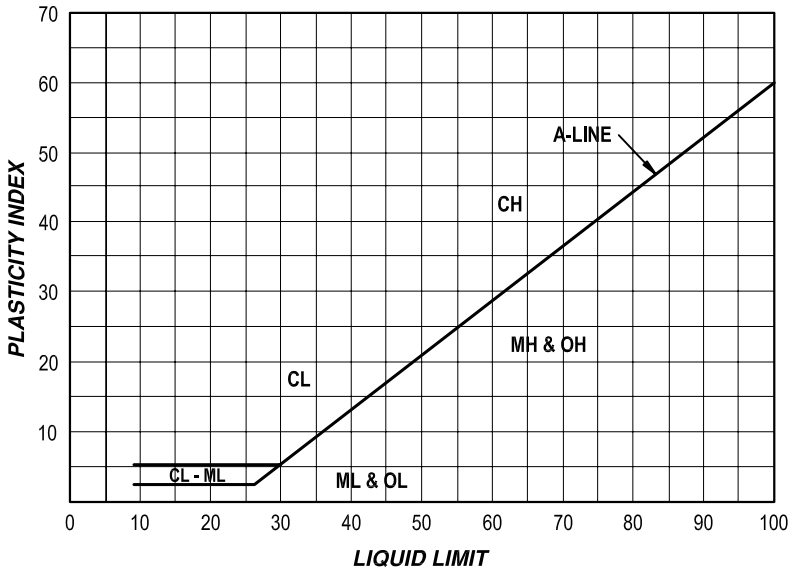
INSIGHT GEOLOGIC, INC.

Figure 2
Site Plan

ATTACHMENT A
EXPLORATION LOGS

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS	GROUP NAME
COARSE GRAINED SOILS (MORE THAN 50% RETAINED ON NO. 200 SIEVE)	GRAVEL AND GRAVELLY SOILS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE)	CLEAN GRAVEL <5% FINES	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY GRADED GRAVEL
		GRAVEL WITH FINES >12% FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND AND SANDY SOILS (MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE)	CLEAN SAND <5% FINES	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES >12% FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS (MORE THAN 50% PASSING NO. 200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILTS AND CLAYS (LIQUID LIMIT 50 OR MORE)	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT



SOIL MOISTURE MODIFIERS:
DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST - DAMP, BUT NO VISIBLE WATER
WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED BELOW WATER TABLE

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS	TYPICAL DESCRIPTION
CC	CEMENT CONCRETE
AC	ASPHALT CONCRETE
CR	CRUSHED ROCK / QUARRY SPALLS
TS	TOPSOIL/SOD/DUFF

GROUNDWATER EXPLORATION SYMBOLS

- MEASURED GROUNDWATER LEVEL IN EXPLORATION, WELL, OR PIEZOMETER
- GROUNDWATER OBSERVED AT TIME OF EXPLORATION
- PERCHED WATER OBSERVED AT TIME OF EXPLORATION
- MEASURED FREE PRODUCT IN WELL OR PIEZOMETER

STRATIGRAPHIC CONTACT

- APPROXIMATE CONTACT BETWEEN SOIL STRATA OR GEOLOGIC UNIT
- APPROXIMATE LOCATION OF SOIL STRATA CHANGE WITHIN GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE BETWEEN SOIL STRATA OR GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE OF SOIL STRATA WITHIN GEOLOGIC SOIL UNIT

LABORATORY / FIELD TEST CLASSIFICATIONS

- **%F** PERECENT FINES
- **AL** ATTERBERG LIMITS
- **CA** CHEMICAL ANALYSIS
- **CP** LABORATORY COMPACTION TEST
- **CS** CONSOLIDATION TEST
- **DS** DIRECT SHEAR
- **HA** HYDROMETER ANALYSIS
- **MC** MOISTURE CONTENT
- **MD** MOISTURE CONTENT AND DRY DENSITY
- **OC** ORGANIC COMPOUND
- **PM** PERMEABILITY OR HYDRAULIC CONDUCTIVITY
- **PP** POCKET PENETROMETER
- **SA** SIEVE ANALYSIS
- **TX** TRIAXIAL COMPRESSION
- **UC** UNCONFINED COMPRESSION
- **VS** VANE SHEAR

SAMPLER SYMBOLS

- 2.4 INCH I.D. SPLIT BARREL
- DIRECT-PUSH
- STANDARD PENETRATION TEST
- SHELBY TUBE
- PISTON
- BULK OR GRAB

SHEEN CLASSIFICATIONS

- **NS** NO VISIBLE SHEEN
- **SS** SLIGHT SHEEN
- **MS** MODERATE SHEEN
- **HS** HEAVY SHEEN
- **NT** NOT TESTED

INSIGHT GEOLOGIC, INC.

Key to Exploration Logs

TP-1

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0	ML		Dark brown sandy silt, occasional fine gravel, soft, moist	
2			Grades to light brown silt	
7	SP		Light gray fine to coarse sand, medium dense, moist	
8			Grades to gray fine to coarse sand with fine to coarse gravel, very dense (till)	
9			Groundwater not encountered	

LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 8.5 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

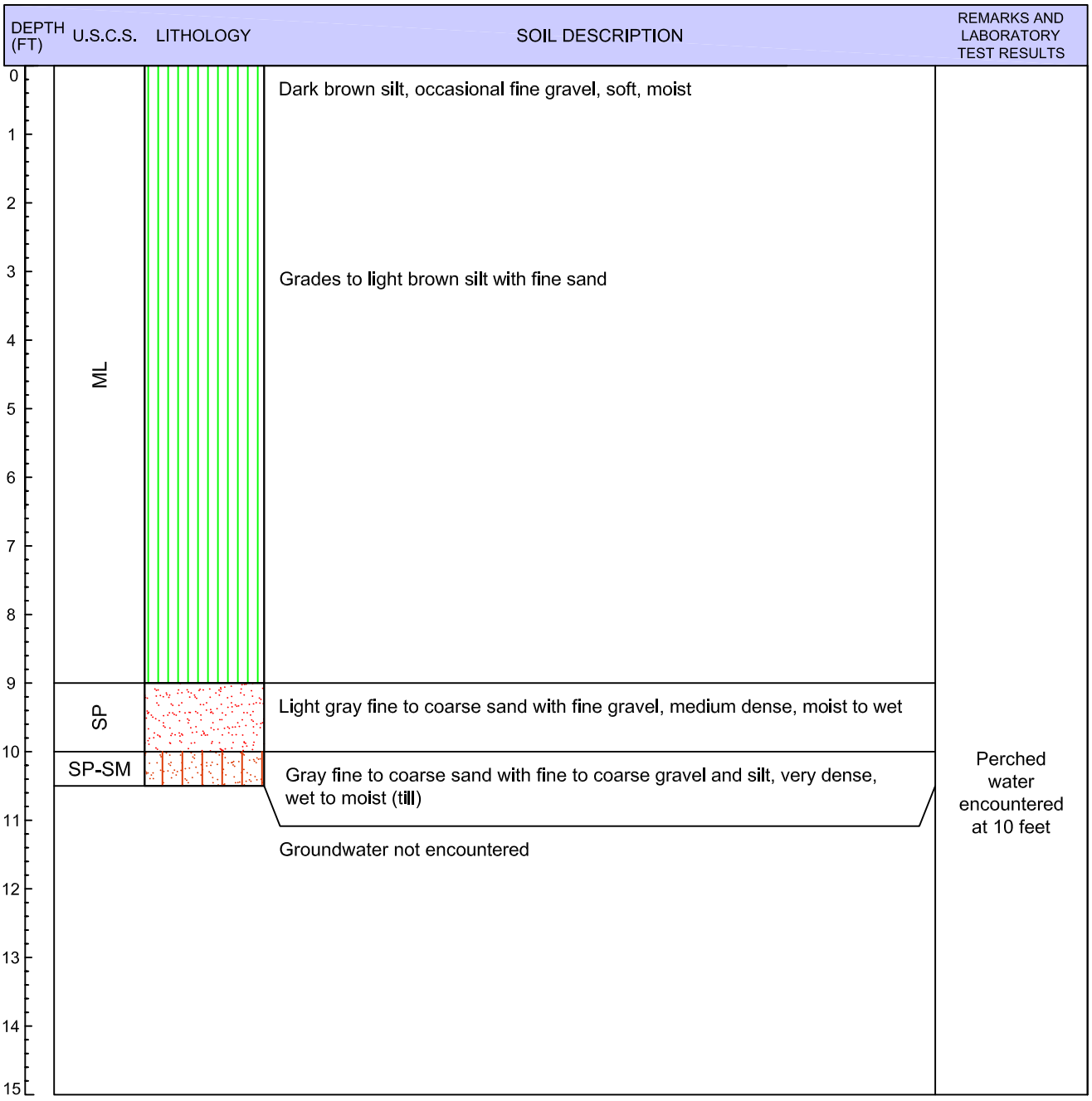
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-1

TP-2



LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 10.5 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

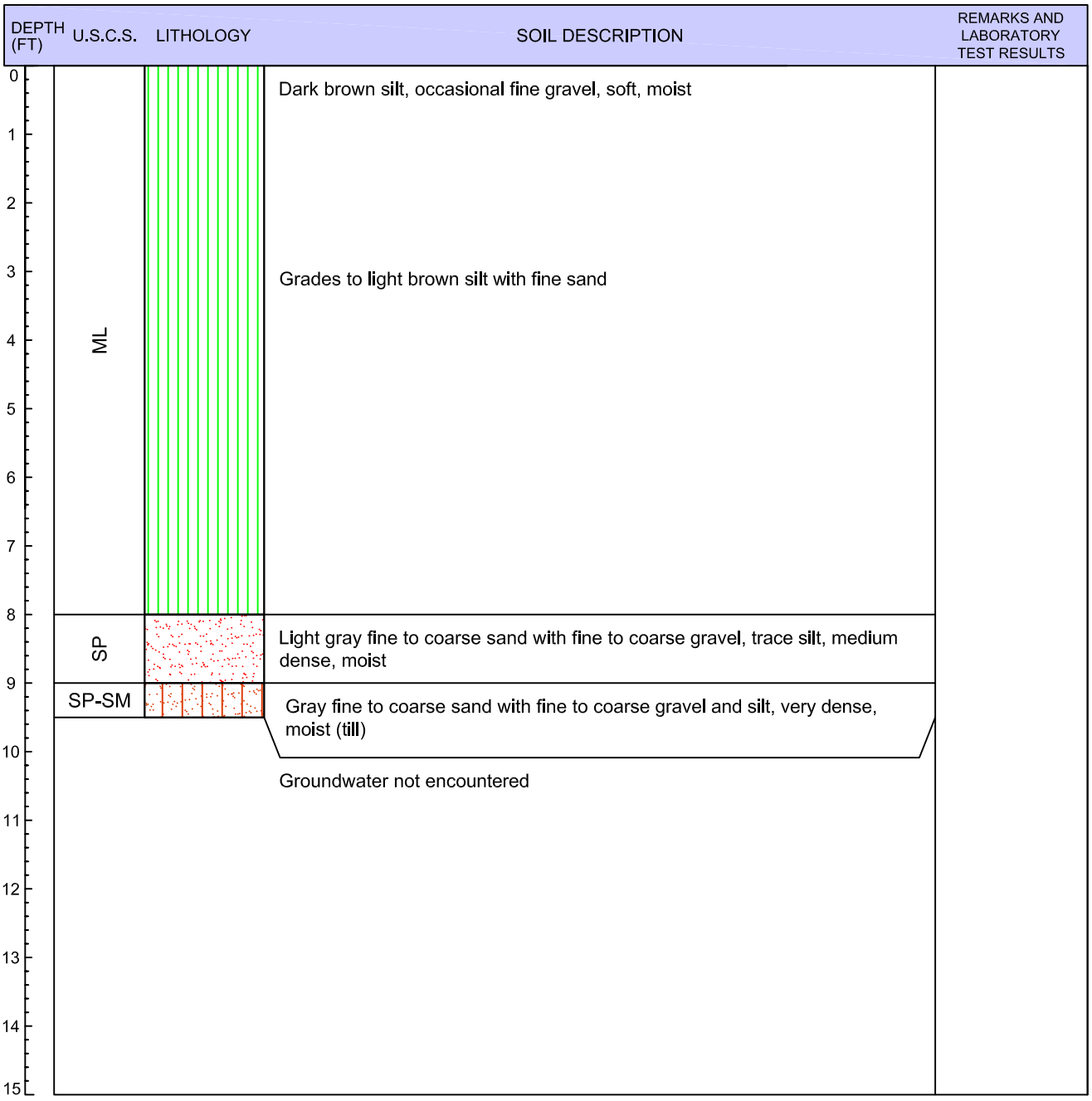
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-2

TP-3



LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 9.5 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

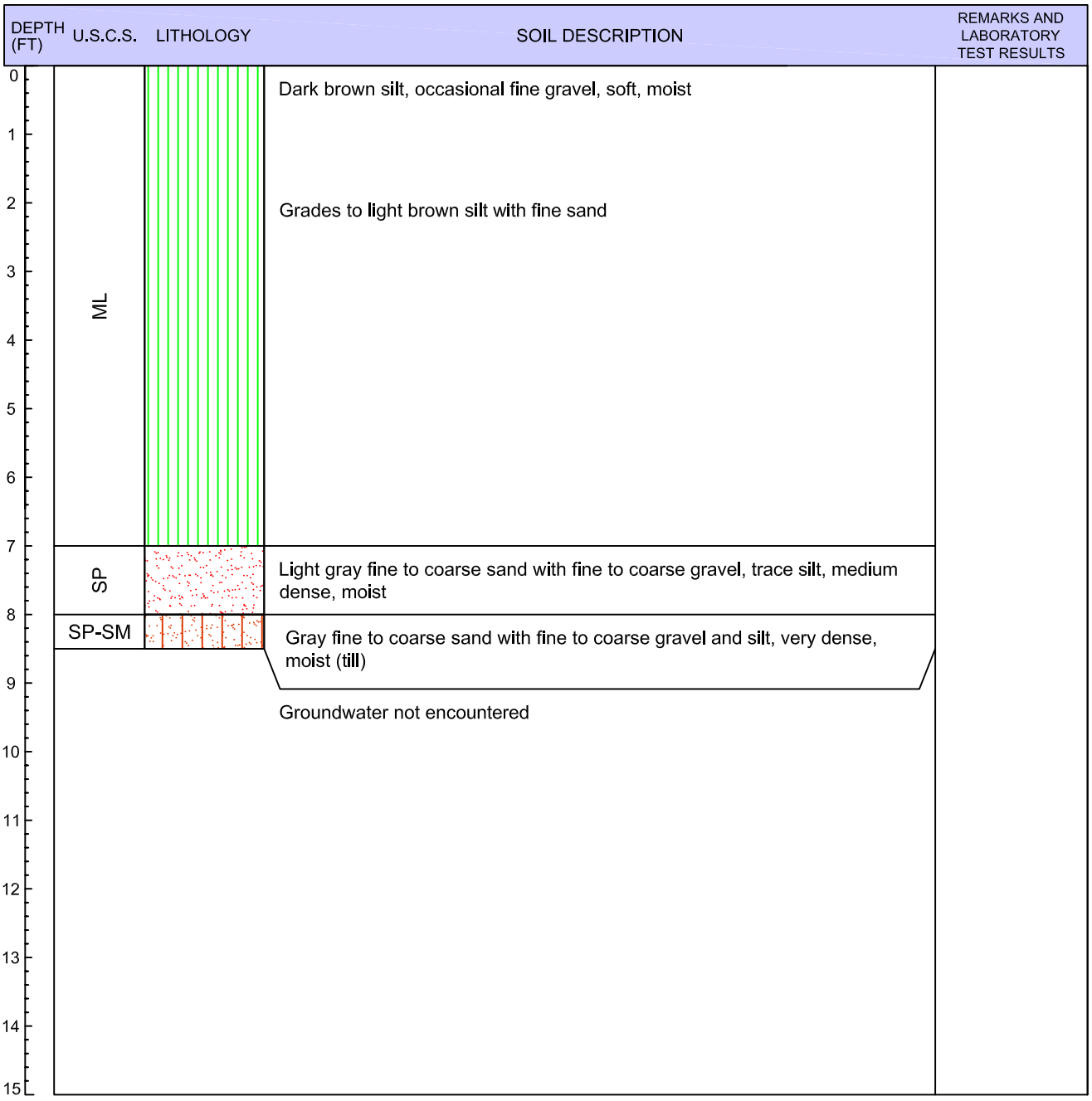
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-3

TP-4



LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 8.5 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

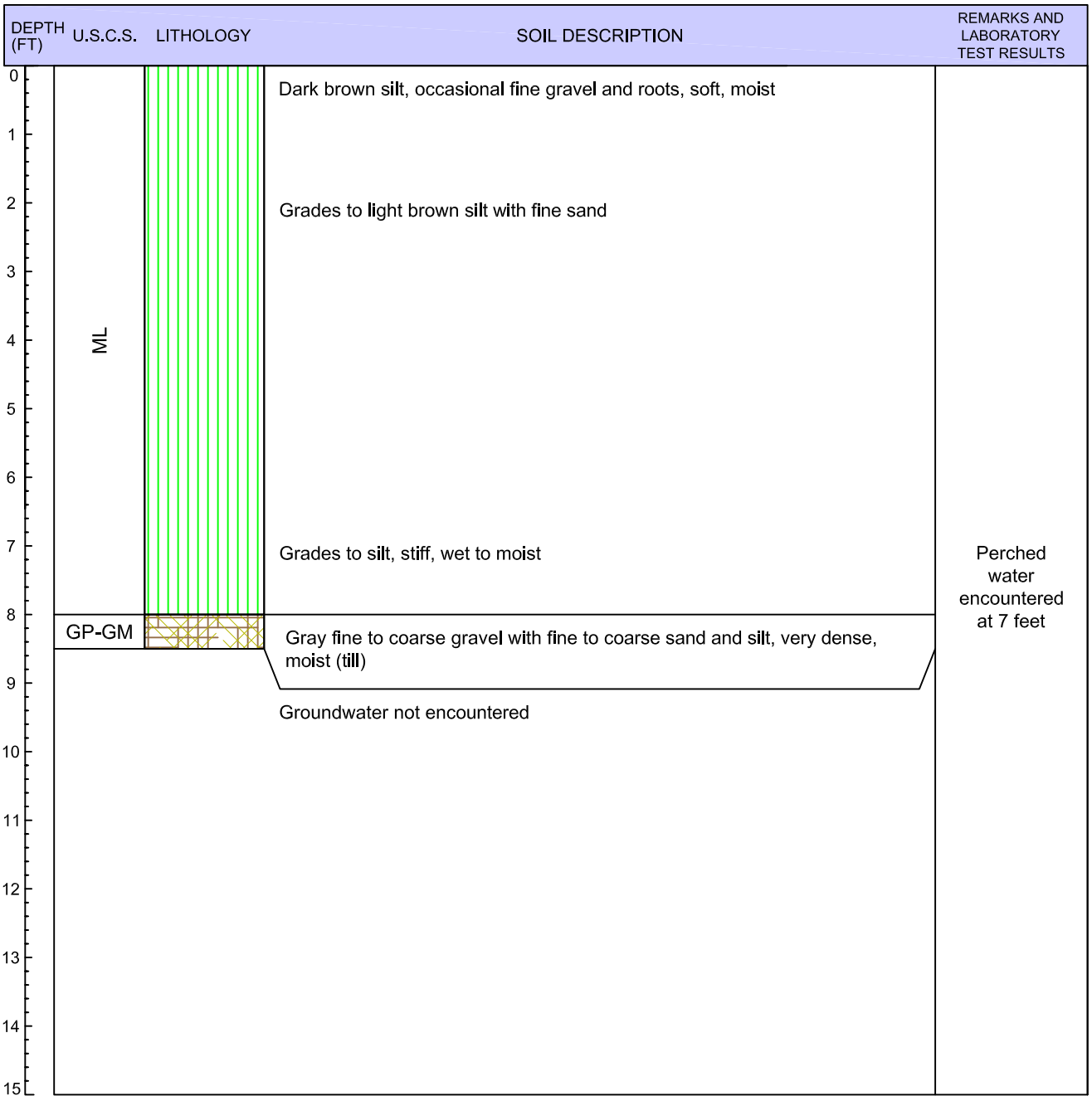
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-4

TP-5



LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 8.5 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

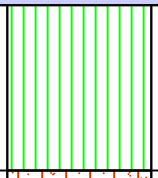
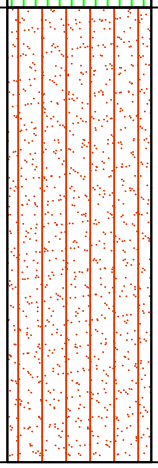
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-5

TP-6

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0 – 2	ML		Dark brown silt, trace fine gravel, abundant roots, soft, moist	
2 – 7.5	SP-SM		Gray fine to coarse sand with fine to coarse gravel and silt, very dense, moist	
7.5 – 15			Groundwater not encountered	

LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 7.5 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

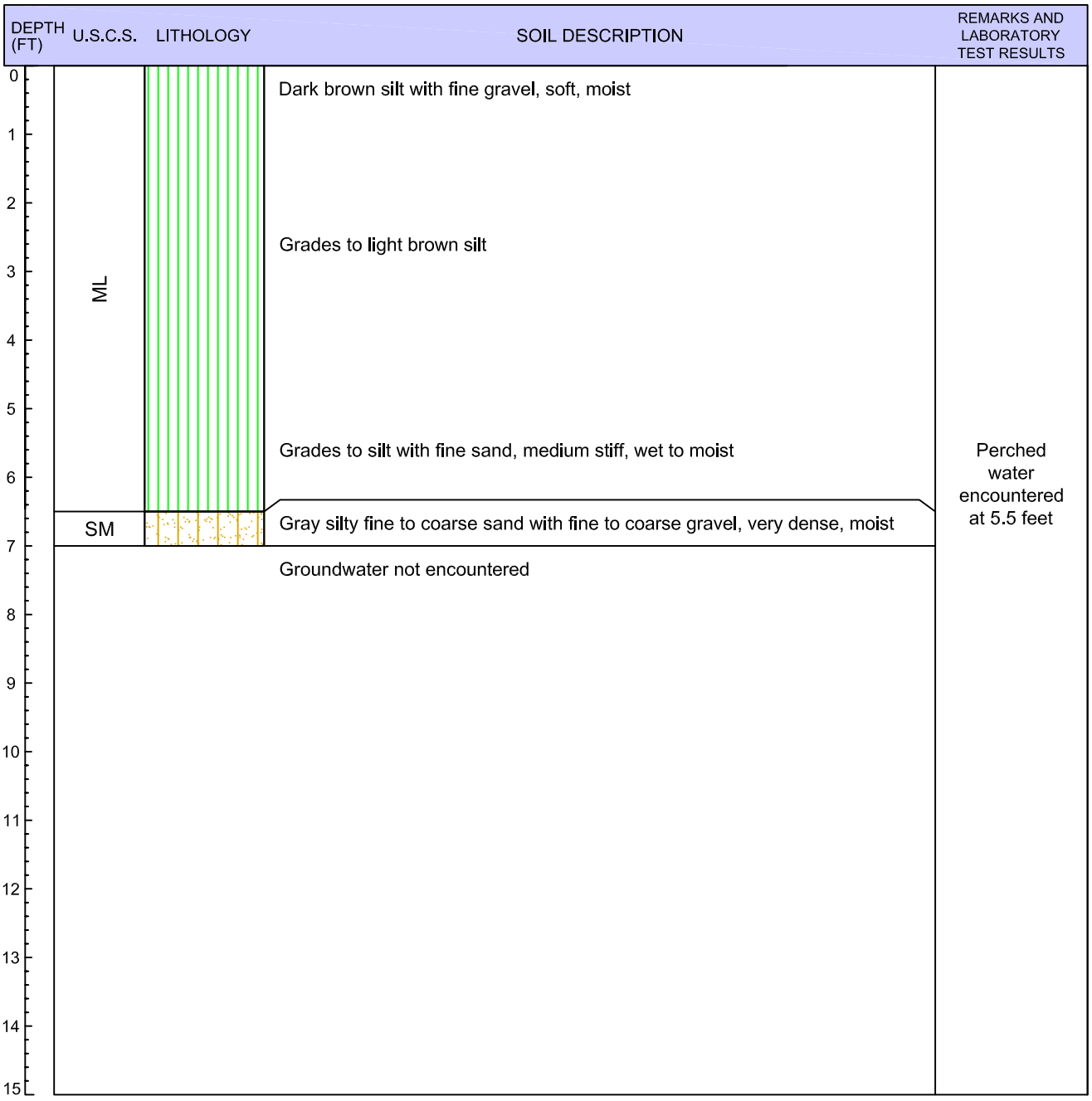
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-6

TP-7



LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 7 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

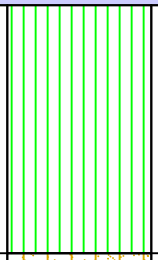
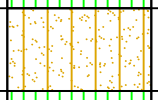
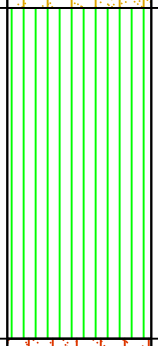
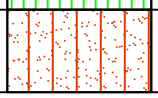
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-7

TP-8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0 – 3	ML		Dark brown silt with fine gravel, soft, moist Grades to light brown silt	
3 – 4	SM		Light brown silty fine sand, loose, moist	
4 – 8	ML		Light brown silt with fine sand, soft, moist	
8 – 9	SP-SM		Gray fine to coarse sand with fine to coarse gravel and silt, very dense, moist (till)	
9 – 15			Groundwater not encountered	

LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 9 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

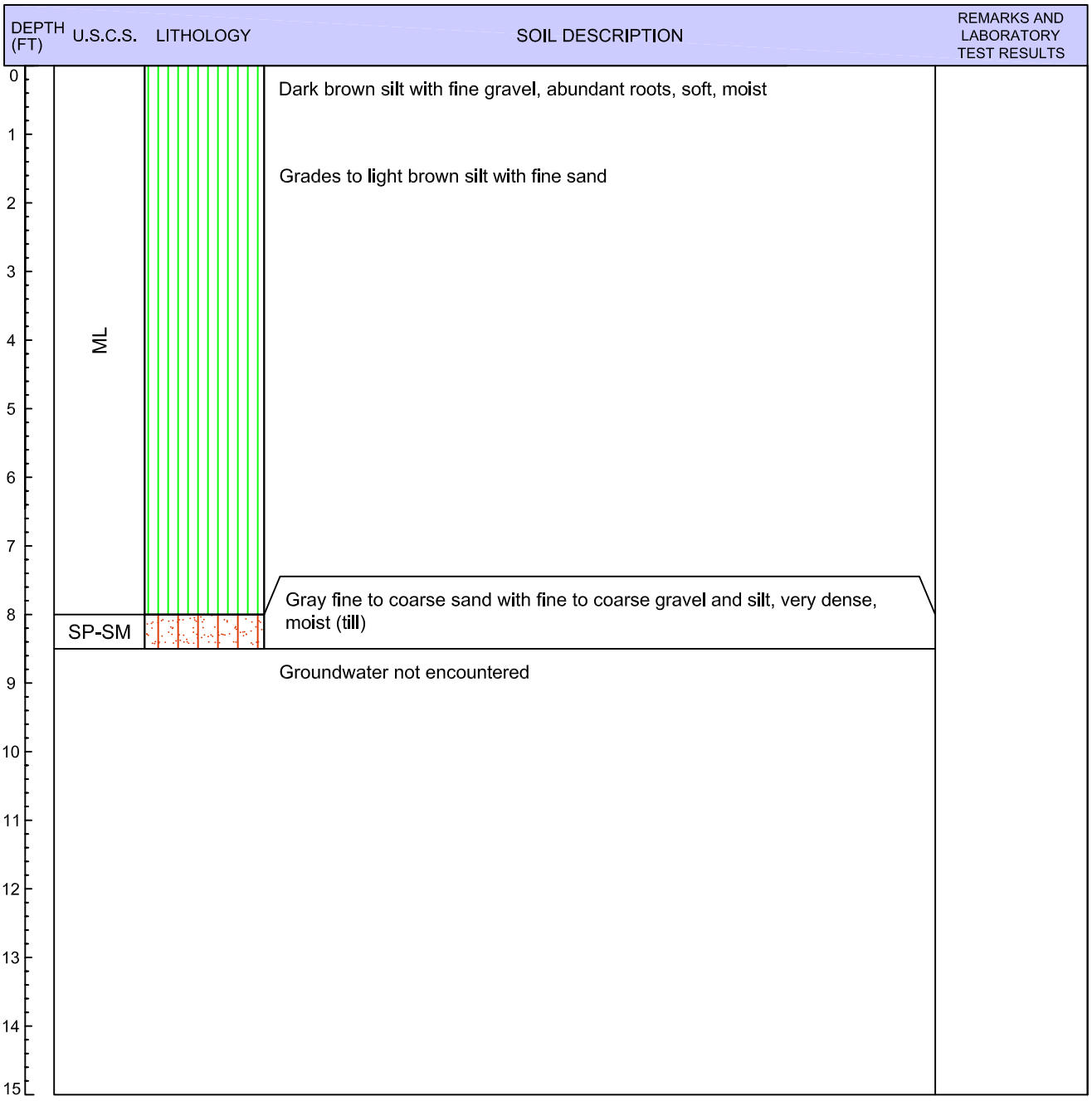
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-8

TP-9



LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 8.5 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

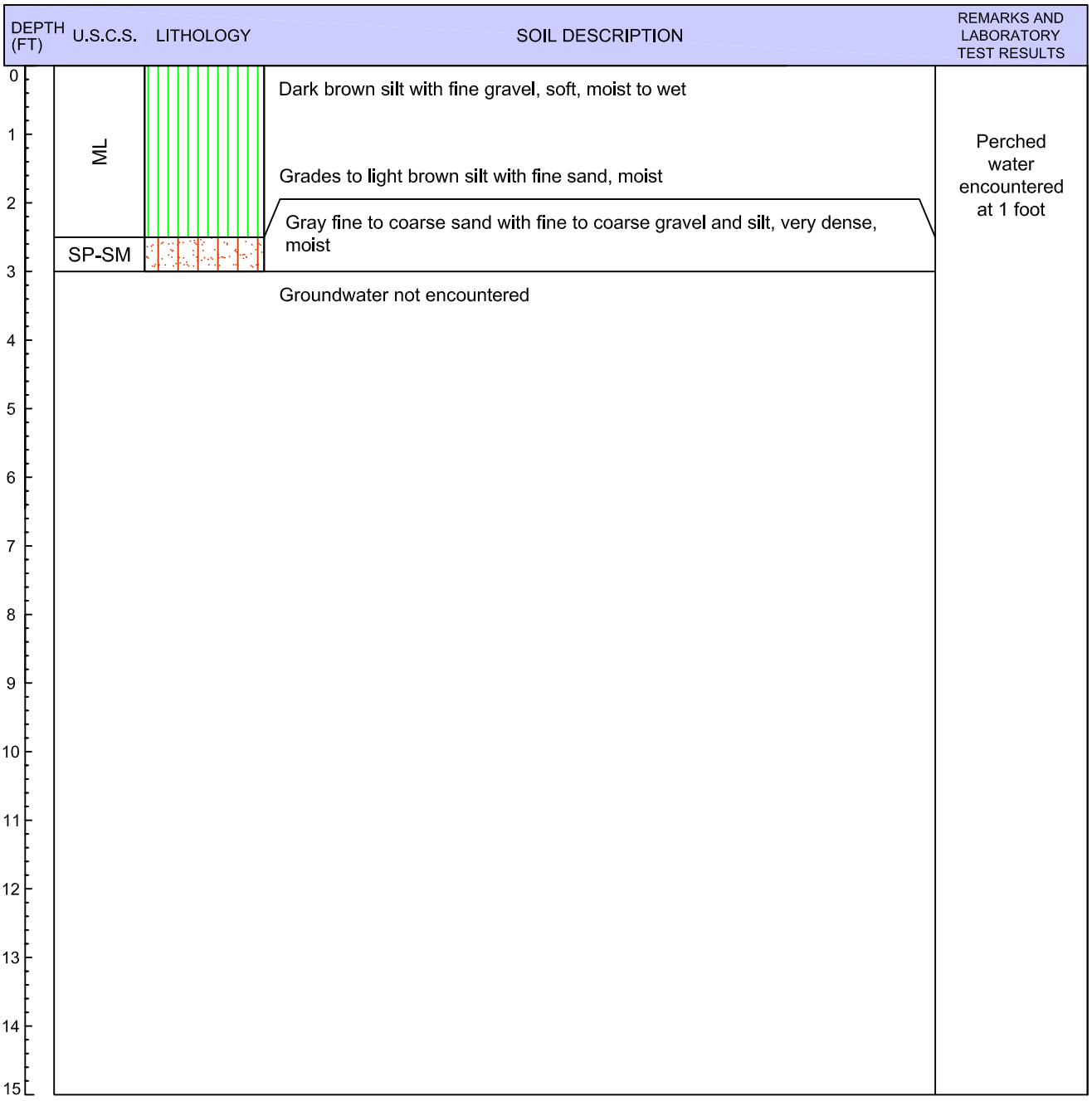
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-9

TP-10



LEGEND:

PROJECT NO.: 894-001-02
DATE: NOVEMBER 2, 2016
TOTAL DEPTH: 3 FEET
DRILLING EQUIPMENT: MINI EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-10

B-1

DEPTH (FEET)	SAMPLE NUMBER AND DEPTH	INCHES DRIVEN / RECOVERED	SPT "N" VALUE	U.S.G.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0				SM		Orange-brown silty fine to coarse sand, loose, moist	
5	1	18/6	1				
				SP-SM		Light gray fine to coarse sand with silt and fine to coarse gravel, very dense, wet to moist (till)	Perched water encountered at 7 feet
10	2	18/12	60				
15	3	17/13	50/5"				
20	4	12/8	50/6"				
25	5	11/6	15/5"				
30	6	9/4	50/3"				
						Groundwater not encountered	
35							
40							

LEGEND:

PROJECT NO.: 894-00102
DATE: OCTOBER 31, 2016
TOTAL DEPTH: 31 FEET
DRILLING CONTRACTOR: HOLOCENE DRILLING
DRILLING EQUIPMENT: DIEDRICH D-120
DRILLING METHOD: HOLLOW STEM AUGER
LOGGED BY: KEVIN VANDEHEY

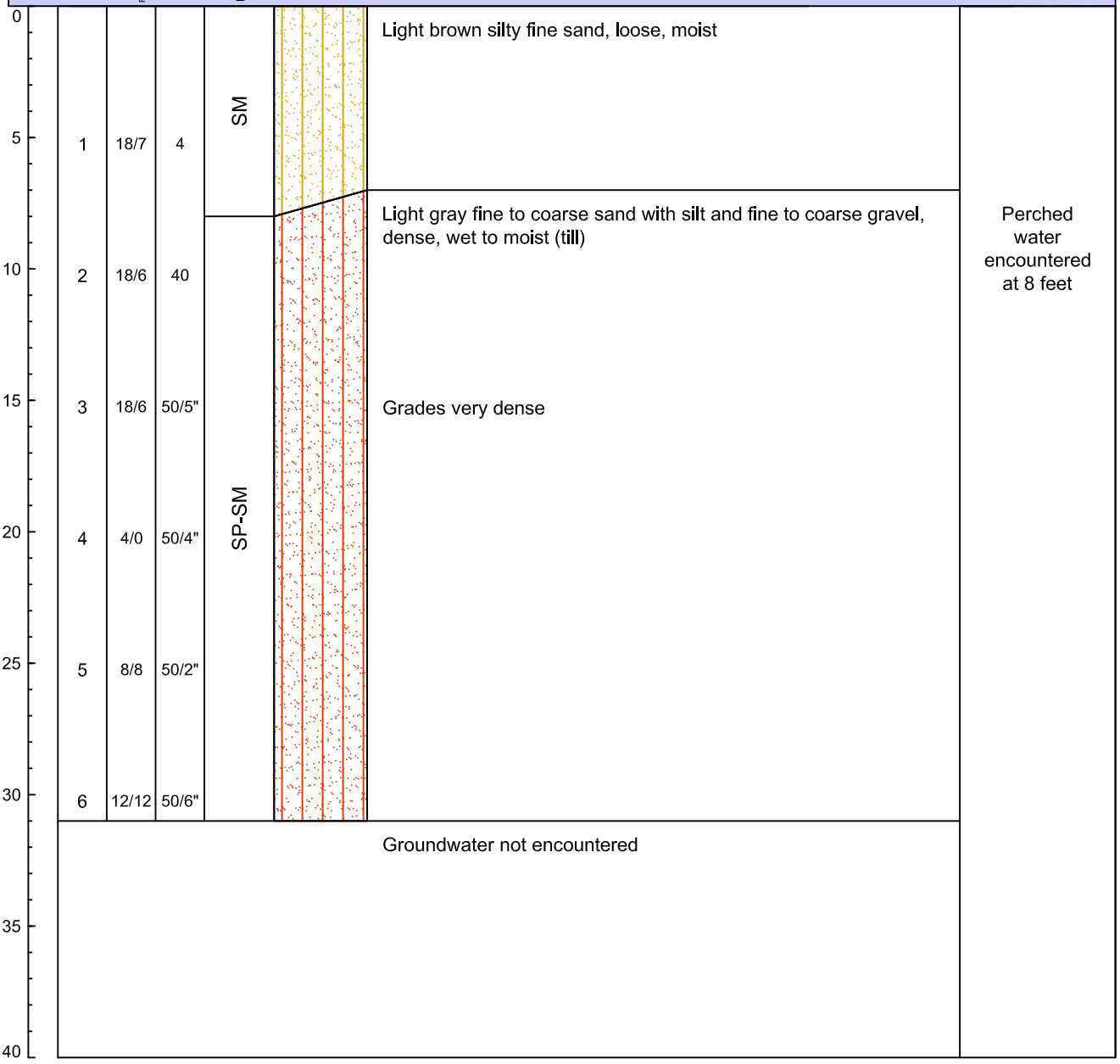
BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-1

B-2



LEGEND:

PROJECT NO.: 894-00102
DATE: OCTOBER 31, 2016
TOTAL DEPTH: 31 FEET
DRILLING CONTRACTOR: HOLOCENE DRILLING
DRILLING EQUIPMENT: DIEDRICH D-120
DRILLING METHOD: HOLLOW STEM AUGER
LOGGED BY: KEVIN VANDEHEY

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-2

ATTACHMENT B
LABORATORY RESULTS

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-1
Sample Name: TP-1 0 - 2.0
Depth: 0 - 2 feet

Moisture Content (%) 30.3%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	99.6
No. 4 (4.75-mm)	96.4
No. 10 (2.00-mm)	89.8
No. 20 (.850-mm)	86.1
No. 40 (.425-mm)	83.8
No. 60 (.250-mm)	76.7
No. 100 (.150-mm)	68.7
No. 200 (.075-mm)	60.2

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	3.6
Coarse Sand	6.6
Medium Sand	6.0
Fine Sand	23.6
Fines	60.2
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.08
D_{90}	2.00
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-1
Sample Name: TP-1 2.0 - 7.0
Depth: 2 - 7 feet

Moisture Content (%) 33.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	100.0
No. 20 (.850-mm)	100.0
No. 40 (.425-mm)	99.9
No. 60 (.250-mm)	99.7
No. 100 (.150-mm)	99.7
No. 200 (.075-mm)	98.4

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.0
Medium Sand	0.1
Fine Sand	1.5
Fines	98.4
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.0
D_{30}	0.0
D_{60}	0.0
D_{90}	0.0
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-1
Sample Name: TP-1 7.0 - 8.0
Depth: 7 - 8 feet

Moisture Content (%) 8.3%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	99.5
No. 10 (2.00-mm)	96.6
No. 20 (.850-mm)	89.5
No. 40 (.425-mm)	70.6
No. 60 (.250-mm)	35.9
No. 100 (.150-mm)	11.4
No. 200 (.075-mm)	4.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.5
Coarse Sand	2.9
Medium Sand	26.0
Fine Sand	66.3
Fines	4.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.14
D_{30}	0.22
D_{60}	0.36
D_{90}	0.86
Cc	0.96
Cu	2.57

ASTM Classification
Group Name: **Poorly Graded Sand**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-5
Sample Name: TP-5 7.0 - 8.0
Depth: 7 - 8 feet

Moisture Content (%) 38.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	100.0
No. 20 (.850-mm)	99.9
No. 40 (.425-mm)	99.7
No. 60 (.250-mm)	99.5
No. 100 (.150-mm)	99.3
No. 200 (.075-mm)	90.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.0
Medium Sand	0.2
Fine Sand	9.4
Fines	90.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	0.08
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-5
Sample Name: TP-5 8.0 - 8.5
Depth: 8 - 8.5 feet

Moisture Content (%) 4.5%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	47.8
3/4 in. (19.0)	42.3
3/8 in. (9.5-mm)	38.5
No. 4 (4.75-mm)	33.3
No. 10 (2.00-mm)	28.0
No. 20 (.850-mm)	22.7
No. 40 (.425-mm)	17.7
No. 60 (.250-mm)	12.7
No. 100 (.150-mm)	8.8
No. 200 (.075-mm)	5.0

Size Fraction	Percent by Weight
Coarse Gravel	57.7
Fine Gravel	9.0
Coarse Sand	5.3
Medium Sand	10.3
Fine Sand	12.7
Fines	5.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.17
D_{30}	2.70
D_{60}	44.00
D_{90}	65.00
Cc	0.97
Cu	258.82

ASTM Classification
Group Name: **Poorly Graded Gravel with Sand and Silt**
Symbol: **GP-GM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-7
Sample Name: TP-7 2.5 - 5.5
Depth: 2.5 - 5.5 feet

Moisture Content (%) 36.4%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.9
No. 20 (.850-mm)	99.9
No. 40 (.425-mm)	99.7
No. 60 (.250-mm)	99.6
No. 100 (.150-mm)	99.5
No. 200 (.075-mm)	99.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	0.2
Fine Sand	0.5
Fines	99.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	0.00
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-7
Sample Name: TP-7 5.5 - 6.5
Depth: 5.5 - 6.5 feet

Moisture Content (%) 35.5%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	100.0
No. 20 (.850-mm)	99.9
No. 40 (.425-mm)	99.8
No. 60 (.250-mm)	99.6
No. 100 (.150-mm)	99.2
No. 200 (.075-mm)	84.2

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.0
Medium Sand	0.2
Fine Sand	15.6
Fines	84.2
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.00
D_{90}	0.10
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silt with Sand**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-7
Sample Name: TP-7 6.5 - 7.0
Depth: 6.5 - 7 feet

Moisture Content (%) 13.9%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	94.2
No. 4 (4.75-mm)	86.8
No. 10 (2.00-mm)	80.7
No. 20 (.850-mm)	73.8
No. 40 (.425-mm)	62.1
No. 60 (.250-mm)	49.3
No. 100 (.150-mm)	39.6
No. 200 (.075-mm)	31.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	13.2
Coarse Sand	6.1
Medium Sand	18.6
Fine Sand	30.9
Fines	31.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.07
D_{60}	0.38
D_{90}	6.50
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silty Sand**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: TP-8
Sample Name: TP-8 3.0 - 4.0
Depth: 3 - 4 feet

Moisture Content (%) 18.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.9
No. 20 (.850-mm)	99.7
No. 40 (.425-mm)	98.4
No. 60 (.250-mm)	78.9
No. 100 (.150-mm)	39.1
No. 200 (.075-mm)	12.9

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	1.5
Fine Sand	85.5
Fines	12.9
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.07
D_{30}	0.12
D_{60}	0.20
D_{90}	0.31
Cc	1.03
Cu	2.86

ASTM Classification
Group Name: **Silty Sand**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Bark & Garden Development
Job Number: 894-001-02
Date Tested: 11/9/16
Tested By: Andrew Johnson

Sample Location: B-1
Sample Name: B-1 5.0 - 6.5
Depth: 5 - 6.5 feet

Moisture Content (%) 25.3%

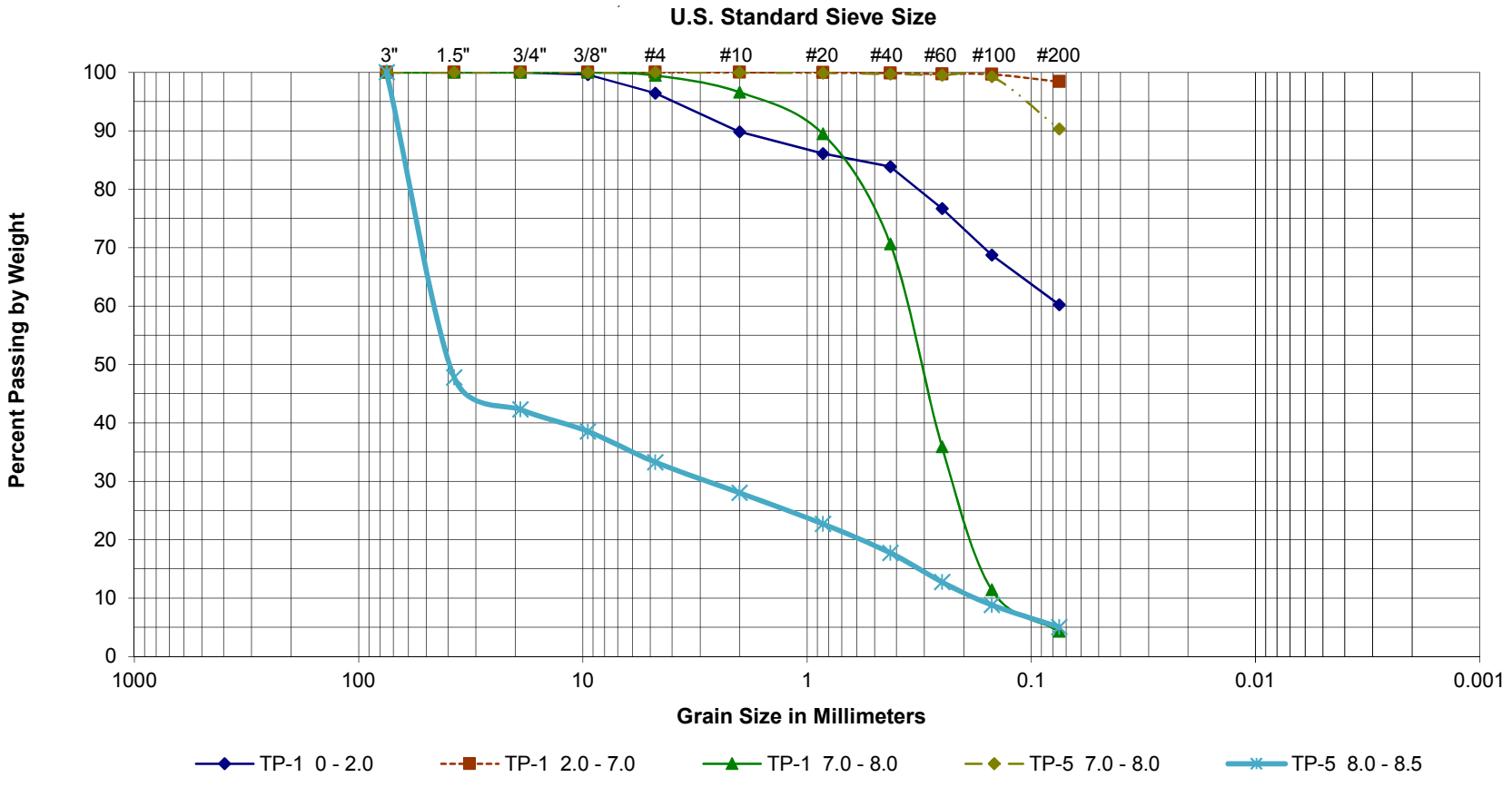
Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	88.1
No. 4 (4.75-mm)	80.2
No. 10 (2.00-mm)	71.7
No. 20 (.850-mm)	59.8
No. 40 (.425-mm)	39.6
No. 60 (.250-mm)	25.8
No. 100 (.150-mm)	19.8
No. 200 (.075-mm)	14.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	19.8
Coarse Sand	8.5
Medium Sand	32.1
Fine Sand	25.3
Fines	14.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.29
D_{60}	0.85
D_{90}	11.00
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Silty Sand with Gravel**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.



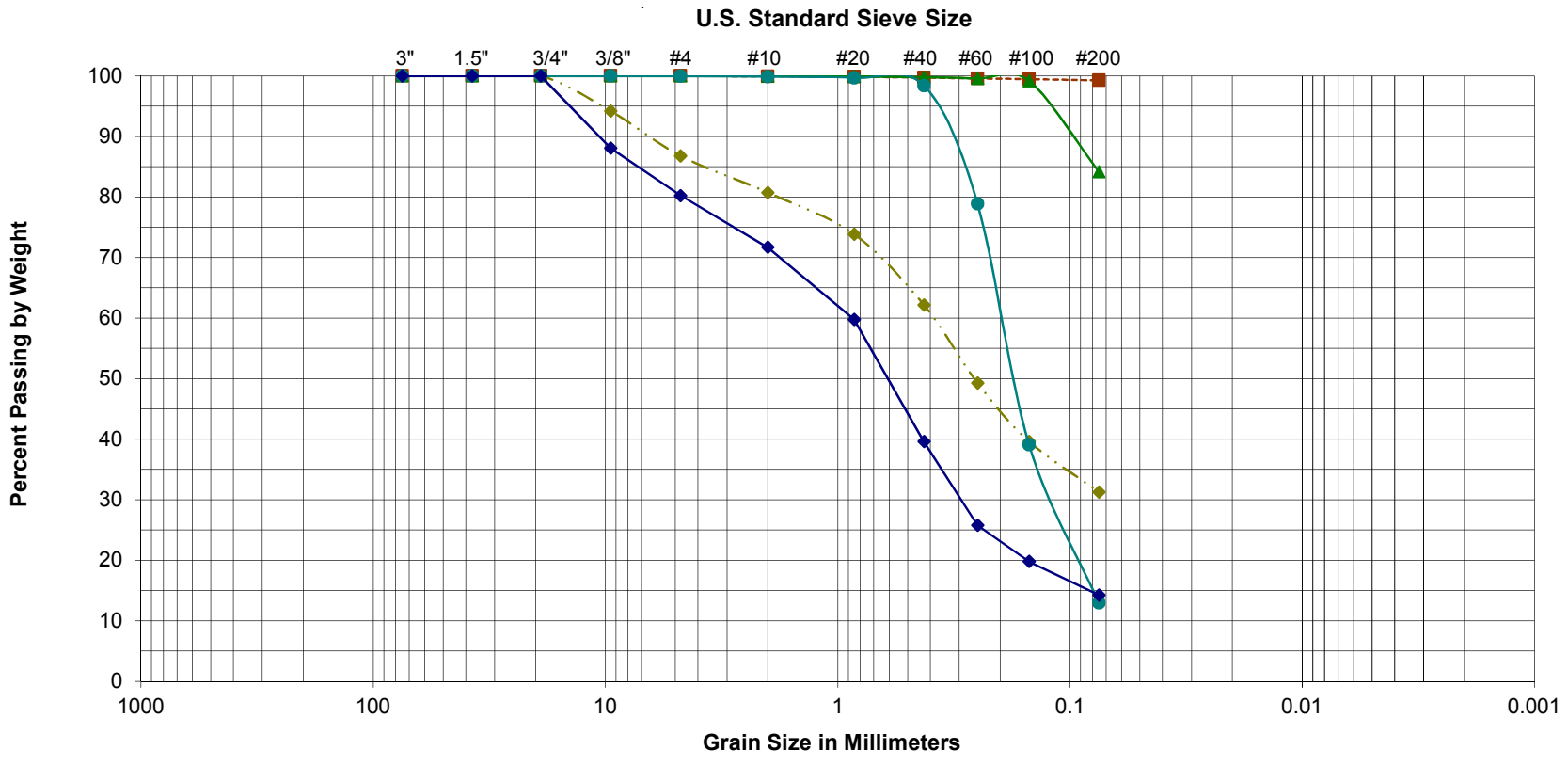
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 2
Gradation Analysis Results

ATTACHMENT C
INFILTRATION RATE CALCULATIONS

Detailed Method for Determining Infiltration Rate (Trench)
for
Bark & Garden Residential Development
Olympia, Washinton
Test Pit 1

Equation 1 - Saturated Potential Hydraulic Conductivity						
Layer	Soil Classification	D_{10}	D_{60}	D_{90}	f_{fines}	K_{sat}
Layer 1	ML	0.000	0.080	2.000	0.602	4.033
Layer 2	ML	0.000	0.000	0.000	0.984	0.685
Layer 3	SP	0.140	0.360	0.860	0.043	113.066

K_{sat} = $2835*10^{(-1.57 +1.90D10 +0.015D60 -0.013D90 -2.08ffines)}$

Where:

K_{sat}: Saturated Potential Hydraulic Conductivity, (ft/day)
D_n: Particle size for which "n" percent of particles by weight are smaller, (mm)
f_{fines}: Fraction of soil by weight passing the number 200 sieve, (gm/gm)

Equation 2 - Equivalent Potential Hydraulic Conductivity for Layers of Soils in One				
d Hole Depth	d_n	d_n/K_{sat}	SUM d_n/K_{sat}	K_{equiv}
96	24	5.951	93.620	1.025
72	60	87.563		
12	12	0.106		

K_{equiv} = d / SUM(Dn/Kn)

Where:

d: Total depth of soil column, (in)
dn: Thickness of layer "n" in soil column, (in)
Kn: Saturated potential hydraulic conductivity (Ksat) of layer "n", (ft/day)

Equation 3b - Equivalent Potential Hydraulic Conductivity for Trench			
D_{wt}	K_{equiv}	$K^{0.05}$	(i) (trench)
8.0	1.03	1.001	0.102

$i = (D_{wt}) / (78*K^{0.05})$

where:

D_{wt}: Depth to seasonal high water table from ground surface (ft)
K: Conductivity, (ft / day)
i: Hydraulic gradient, (ft/ft)

Equation 4 - Functional Saturated Hydraulic Conductivity		
K_{equiv}	(i) (trench)	f
1.025	0.102	0.05

f = $K_{equiv} * (i)/2$

where:

K_{equiv}: Equivalent Potential Hydraulic Conductivity
(i): Hydraulic gradient

Equation 5 - Facility Design Infiltration Rate				
f	$CF_{maintain}$	$CF_{watershed}$	f_{design} (ft/day)	f_{design} (in/hr)
0.05	1.50	2.00	0.02	0.01

f_{design} = $f /(CF_{maintain}*CF_{watershed})$

where:

f: Functional saturated Hydraulic Conductivity
$CF_{maintain}$: 1.5 for underground facility
$Cf_{watershed}$ 2.0 due to Class C soils

Detailed Method for Determining Infiltration Rate (Trench)
for
Bark & Garden Residential Development
Olympia, Washinton
Test Pit 7

Equation 1 - Saturated Potential Hydraulic Conductivity						
Layer	Soil Classification	D_{10}	D_{60}	D_{90}	f_{fines}	K_{sat}
Layer 1	ML	0.000	0.000	0.000	0.993	0.656
Layer 2	ML	0.000	0.000	0.100	0.842	1.349
Layer 3	SM	0.000	0.380	6.500	0.313	14.214

K_{sat} = $2835*10^{(-1.57 +1.90D10 +0.015D60 -0.013D90 -2.08ffines)}$

Where:

K_{sat}: Saturated Potential Hydraulic Conductivity, (ft/day)
D_n: Particle size for which "n" percent of particles by weight are smaller, (mm)
f_{fines}: Fraction of soil by weight passing the number 200 sieve, (gm/gm)

Equation 2 - Equivalent Potential Hydraulic Conductivity for Layers of Soils in One Hole				
d Hole Depth	d_n	d_n/K_{sat}	SUM d_n/K_{sat}	K_{equiv}
84	66	100.561	109.881	0.764
18	12	8.898		
6	6	0.422		

K_{equiv} = d / SUM(Dn/Kn)

Where:

d: Total depth of soil column, (in)
dn: Thickness of layer "n" in soil column, (in)
Kn: Saturated potential hydraulic conductivity (Ksat) of layer "n", (ft/day)

Equation 3b - Equivalent Potential Hydraulic Conductivity for Trench			
D_{wt}	K_{equiv}	$K^{0.05}$	(i) (trench)
7.0	0.76	0.987	0.091

$i = (D_{wt}) / (78*K^{0.05})$

where:

D_{wt}: Depth to seasonal high water table from ground surface (ft)
K: Conductivity, (ft / day)
i: Hydraulic gradient, (ft/ft)

Equation 4 - Functional Saturated Hydraulic Conductivity		
K_{equiv}	(i) (trench)	f
0.764	0.091	0.03

f = $K_{equiv} * (i)/2$

where:

K_{equiv}: Equivalent Potential Hydraulic Conductivity
(i): Hydraulic gradient

Equation 5 - Facility Design Infiltration Rate				
f	$CF_{maintain}$	$CF_{watershed}$	f_{design} (ft/day)	f_{design} (in/hr)
0.03	1.50	2.00	0.01	0.01

f_{design} = $f/(CF_{maintain}*CF_{watershed})$

where:

f: Functional saturated Hydraulic Conductivity
$CF_{maintain}$: 1.5 for underground facility
$Cf_{watershed}$ 2.0 due to Class C soils

Detailed Method for Determining Infiltration Rate (Pond)
for
Bark & Garden Residential Development
Thuston County, Washington
Boring B-1

Equation 1 - Saturated Potential Hydraulic Conductivity						
Layer	Soil Classification	D_{10}	D_{60}	D_{90}	f_{fines}	K_{sat}
Layer 1	SM	0.00	0.85	11.00	0.14	28.5

K_{sat} = $2835*10^{(-1.57 +1.90D10 +0.015D60 -0.013D90 -2.08ffines)}$

Where:

K_{sat}: Saturated Potential Hydraulic Conductivity, (ft/day)
D_n: Particle size for which "n" percent of particles by weight are smaller, (mm)
f_{fines}: Fraction of soil by weight passing the number 200 sieve, (gm/gm)

Equation 2 - Equivalent Potential Hydraulic Conductivity for Layers of Soils in One Hole				
d Hole Depth	d_n	d_n/K_{sat}	SUM d_n/K_{sat}	K_{equiv}
60	60	2.1	2.1	28.5

Kequiv = d / SUM(Dn/Kn)

Where:

d: Total depth of soil column, in
dn: Thickness of layer "n" in soil column, in
Kn: Saturated potential hydraulic conductivity (Ksat) of layer "n", ft/day.

Equation 3b - Equivalent Potential Hydraulic Conductivity for Pond					
$D_{water\ table}$	D_{pond}	Cf_{size}	K_{equiv}	$K^{0.1}$	(i) (shallow)
5.0	0.00	1.00	28.50	1.398	0.026

$i = (D_{wt} + D_{pond}) * CF_{size} / (138.62*K^{0.1})$

where:

D_{wt}: Depth to seasonal high water table, feet
D_{pond}: Depth of pond feet
K: Conductivity, ft / day
i: Hydraulic gradient, ft/ft

Equation 4 - Functional Saturated Hydraulic Conductivity		
K_{equiv}	(i) (shallow)	f
28.501	0.026	0.37

f = $K_{equiv} * (i)/2$

where:

K_{equiv}: Equivalent Potential Hydraulic Conductivity
(i): Hydraulic gradient

Equation 5 - Facility Design Infiltration Rate				
f	$CF_{maintain}$	$CF_{watershed}$	f_{design} (ft/day)	f_{design} (in/hr)
0.37	1.00	1.00	0.368	0.184

f_{design} = f /(CFmaintain*CFwatershed)

where:

f: Functional Saturated Hydraulic Conductivity (ft/day)
$Cf_{maintain}$: 1.0 for aboveground facility
$Cf_{watershed}$: 1.0 due to granular A/B soils

ATTACHMENT D
REPORT LIMITATIONS AND GUIDELINES FOR USE

ATTACHMENT D

REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This attachment provides information to help you manage your risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use of our client, Kern Rexius, and his authorized agents. This report may be made available to regulatory agencies for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

Insight Geologic Inc. structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our agreement with the client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Insight Geologic, Inc. considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Insight Geologic specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, Insight Geologic should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

[1]Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or ground water fluctuations. Always contact Insight Geologic before applying a report to determine if it remains applicable.

MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Insight Geologic reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from Insight Geologic's professional judgment and opinion. Insight Geologic's recommendations can be finalized only by observing actual subsurface conditions revealed during construction. We recommend that Insight Geologic be retained to perform construction monitoring. Alternatively, if Insight Geologic is not retained for construction observation, a full and complete record of construction activity including compaction measurements by a qualified individual should be retained by the client.

Sufficient monitoring, testing and consultation by Insight Geologic or other qualified individual should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Insight Geologic for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having Insight Geologic confer with appropriate members of the design team after submitting the report. Also retain Insight Geologic to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Insight Geologic participate in pre-bid and pre-construction conferences, and by providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or

other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with Insight Geologic and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. Insight Geologic includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with Insight Geologic if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

INSIGHT GEOLOGIC, INC.

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MEMORANDUM

TO: Chris Cramer, PE Patrick Harron & Associates, LLC

FROM: William Halbert, L.E.G

DATE: June 26, 2019

PROJECT: 894-001-04 Bark & Garden Residential Development

SUBJECT: Stormwater Infiltration Services – Pilot Infiltration Tests

At the request of Chris Cramer of Patrick Harron & Associates, LLC, we recently visited the Bark & Garden site located at 3840 and 4004 Harrison Avenue NW in Olympia, Washington to evaluate soil conditions on the site relating to stormwater infiltration. The location of the site is shown on the Vicinity Map, Figure 1. We have provided infiltration evaluation services previously at the site, however those infiltration rates were evaluated using the "Detailed Method" as described in the 2009 City of Olympia Drainage Design and Erosion Control Manual (2009 Manual). The purpose of our services for this phase is to evaluate shallow soils for infiltration using modified Pilot Infiltration Tests (PITs) using the updated 2016 City of Olympia Drainage Design and Erosion Control Manual (2016 Manual).

Three test pits were excavated at the site, along the south (PIT-1), central (PIT-2) and north (PIT-3) portions of the project area. The locations of the test pits are identified on the Site Plan, Figure 2. The test pits were excavated using a backhoe to depths of approximately 2.5 feet below ground surface (bgs). Soils consisted of brown silty fine sand in a loose to medium dense and moist condition.

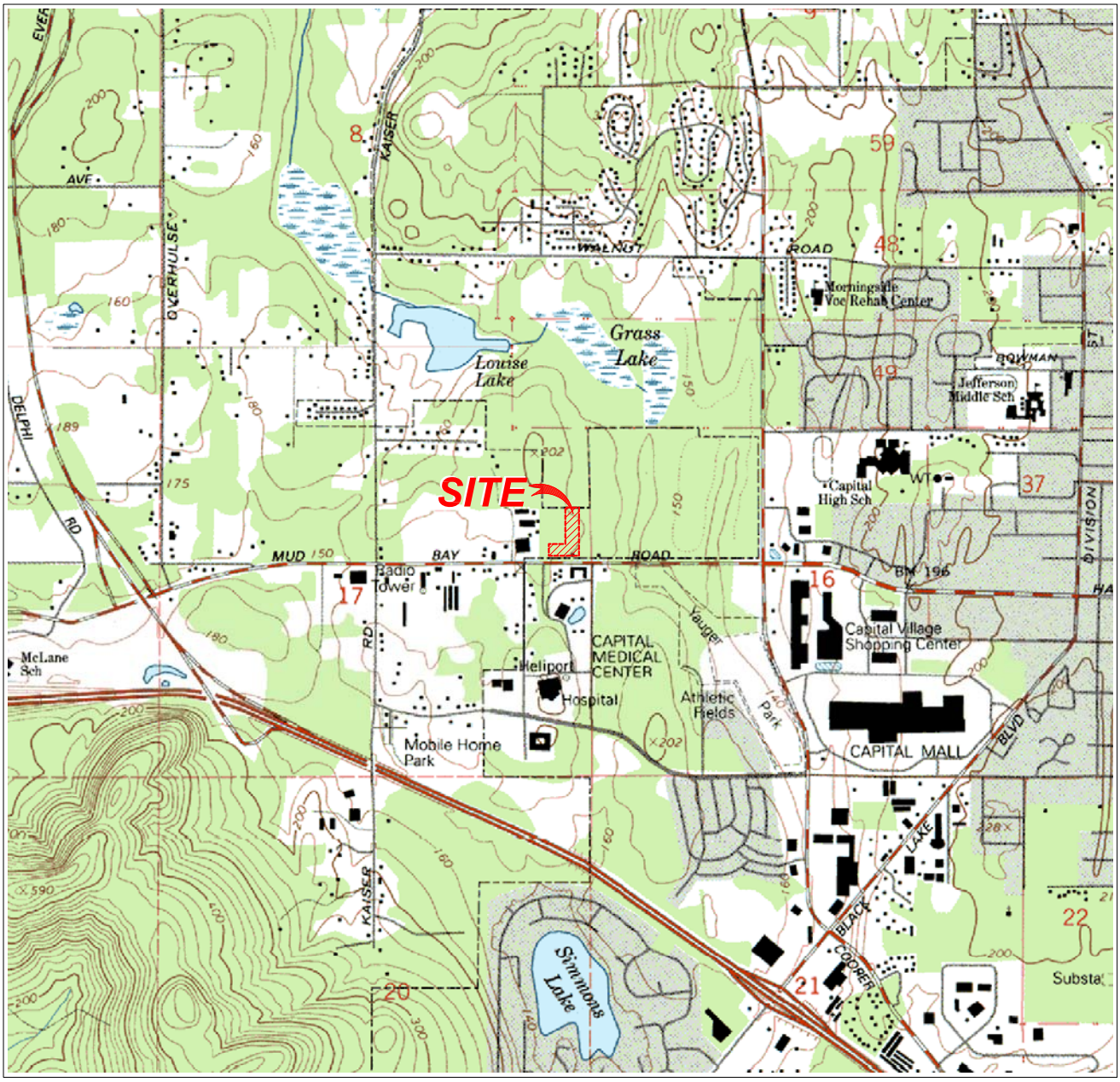
We completed a stormwater infiltration rate evaluation in general accordance with the 2016 Manual consisting of a full-scale PIT in each of the test pits.

For each of the PITs, a 10 foot by 10-foot area was excavated at the site. Water was added to each excavation for a period between 12 and 22 hours to maintain the level of water in the excavation and to saturate the underlying soils. Water was added for 22 hours in PIT-3 and was unable to raise the water level to a depth of 1 foot in that time period. The source of the water used was a garden hose from the nearby building. A datalogging pressure transducer was placed in the bottom of each excavation to provide a constant record of the water level. The water levels over time are shown in Figures 3 to 5. Following the soaking period, the water flow into each of the excavations was stopped and the water was allowed to drain. The initial infiltration rate was calculated using the fall of the water level in inches over time. We then applied the appropriate correction factors to the initial infiltration rates as shown in Table 1.

Table 1. Design Infiltration Rates

PIT	Initial Infiltration Rate (inches per hour)	Testing Methodology Correction Factor	Site Variability Correction Factor	Plugging Correction Factor	Design Infiltration Rate (inches per hour)
PIT-1	1.7	0.75	0.8	0.9	0.9
PIT-2	2.3	0.75	0.8	0.9	1.2
PIT-3	9.8	0.75	0.8	0.9	5.3

The results of the PIT tests indicate a long-term design infiltration rate for the site of between 0.9 and 5.3 inches per hour at a depth of 2.5 feet bgs, based on the initial infiltration rate and the site appropriate correction factors. We recommend using an average of the lower rates at 1.0 inch per hour for design purposes.



Source: Terrain Navigator Image (c) 1997

TUMWATER, WASHINGTON
7.5 MINUTE QUADRANGLE
Year 1994

SCALE: 1: 24000

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map

Source: Google Earth Aerial

LEGEND:

PIT-1 APPROXIMATE PIT TEST LOCATION

APPROXIMATE PROJECT BOUNDARY

SCALE: 1" = 100'

BARK & GARDEN DEVELOPMENT

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 2

Site Plan

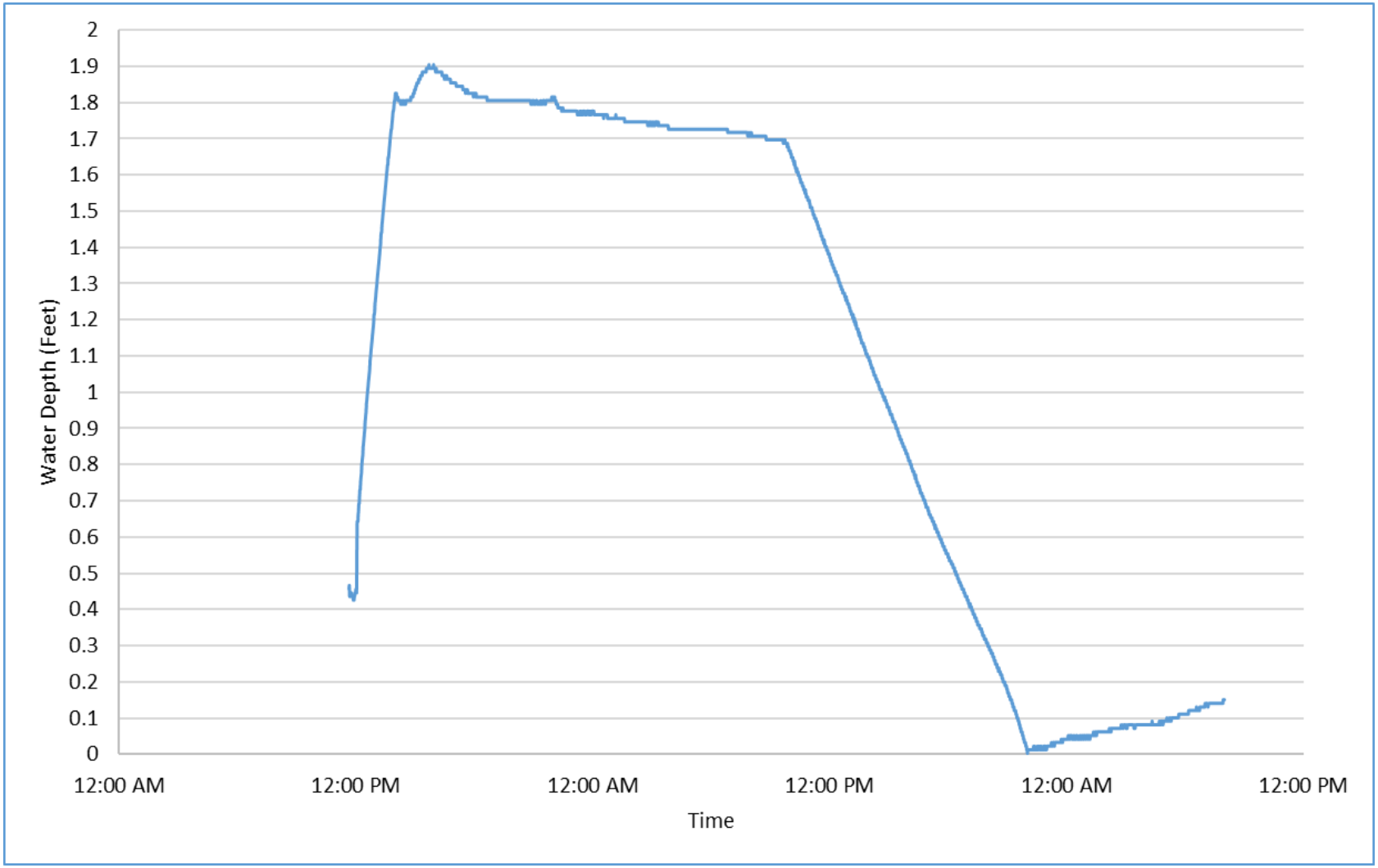


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Figure 3
PIT-1 Hydrograph

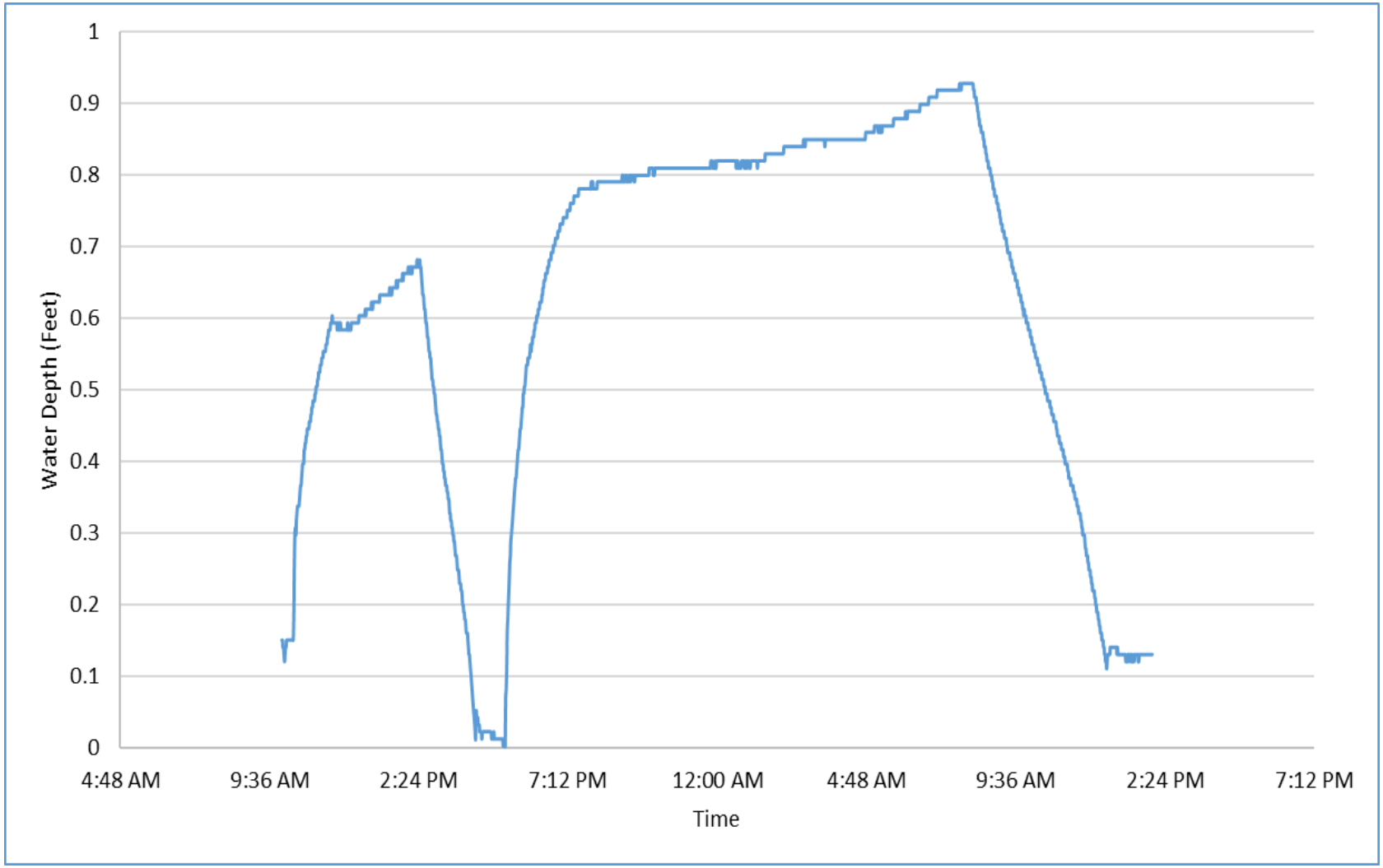

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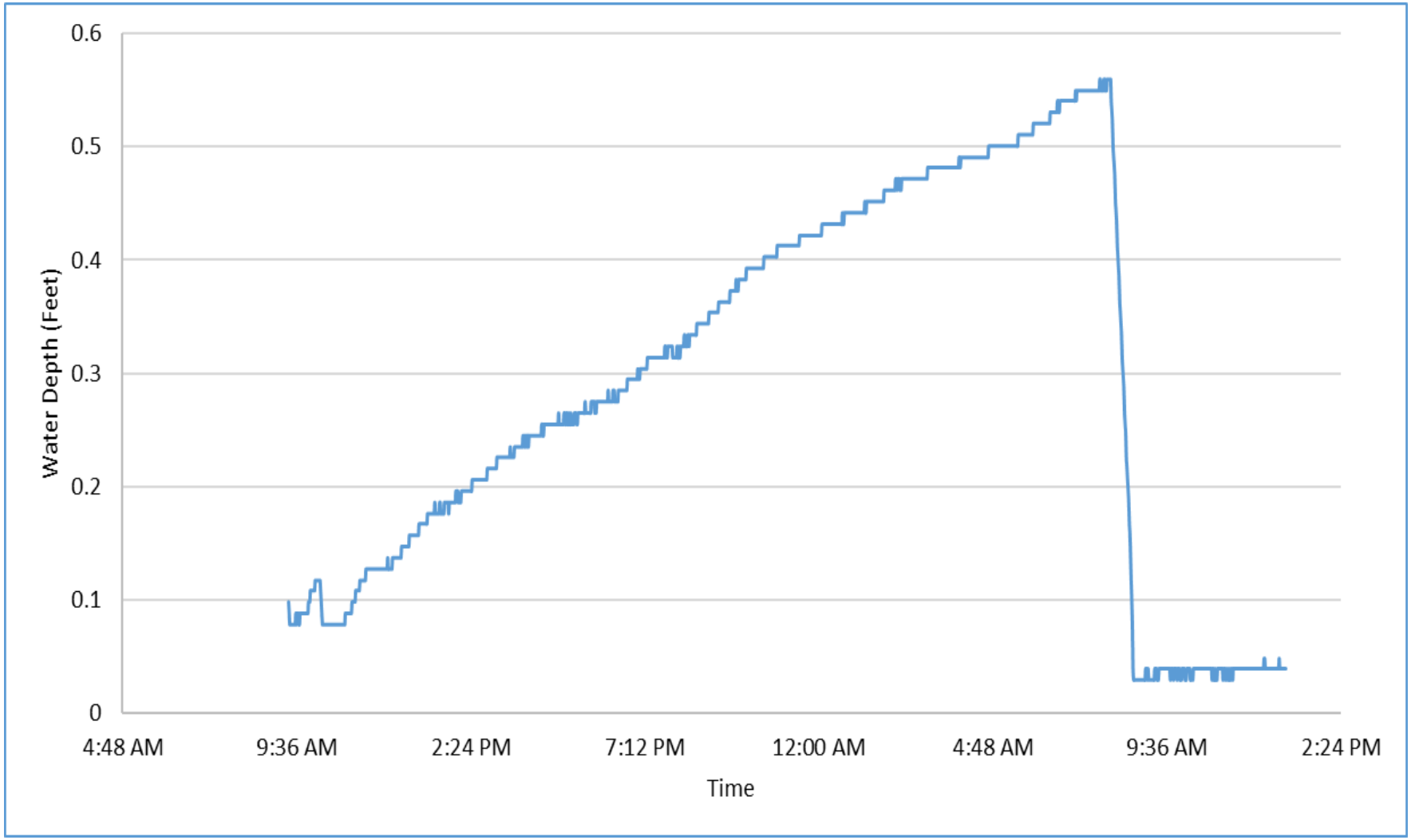
Figure 4
PIT-2 Hydrograph



INSIGHT GEOLOGIC, INC.

Figure 5
PIT-3 Hydrograph

Appendix “C"
Source Control Plan

Source Control Plan for Harrison Ave Mixed Use

ABOUT THIS PLAN

All commercial and industrial properties and activities, including multi-family residential complexes (i.e. apartments, condominiums), non-residential special uses, and government facilities in unincorporated Thurston County that have the potential to contribute pollutants to stormwater runoff or directly to receiving waters are required to implement stormwater pollution prevention source control measures. Stormwater runoff may seep into the ground, drain to a storm drain or a drainage ditch, or flow over the ground. Regardless of the way runoff leaves your site, it ends up in a stream river, lake, wetland, groundwater or Puget Sound.

All known, available and reasonable source control BMPs shall be applied. Source control BMPs shall be selected, designed, and maintained in accordance with Volume IV of the *Thurston County Drainage Design and Erosion Control Manual*.

Many people believe that stormwater runoff is "clean" and does not harm water quality. This perception is understandable since the amount of pollution from any one place is not usually significant by itself. But when all these small amounts are combined, they can cause significant pollution problems. Contaminated stormwater can negatively affect every water body it enters. Therefore, this plan provides detailed information to reduce the contamination of surface water, groundwater, and stormwater from the property and/or business.

The federal Clean Water Act mandates that cities and counties control the quality of stormwater runoff. One way to achieve this is to implement pollution prevention measures on individual properties. By following the "Best Management Practices" for your business as described in this plan you can do your part to protect our streams, groundwater, and Puget Sound.

The following operational source control BMPs must be implemented at the commercial and industrial establishments listed in Appendix IV-A, where required by Ecology's Industrial General Permit or by local government ordinances.

• Assign one or more individuals to be responsible for stormwater pollution control. Hold regular meetings to review the overall operation of the BMPs. Establish responsibilities for inspections, operation and maintenance, and availability for emergency situations. Train all team members in the operation, maintenance and inspections of BMPs, and reporting procedures.

• Promptly contain and clean up solid and liquid pollutant leaks and spills including oils, solvents, fuels, and dust from manufacturing operations on any exposed soil, vegetation, or paved area. If such materials are to be used on-site regularly in quantities less than those regulated by Thurston County's Non-Point Source Pollution Ordinance, it is strongly recommended that a "spill kit & plan" is located on the premises.

• Sweep paved material handling and storage areas regularly as needed, for the collection and disposal of dust and debris that could contaminate stormwater. Do not hose

down pollutants from any area to the ground, storm drain, conveyance ditch, or receiving water unless necessary for dust control purposes to meet air quality regulations **and** unless the pollutants are conveyed to a treatment system approved by the local jurisdiction.

• Clean oils, debris, sludge, etc. from all BMP systems regularly, including catch basins, settling/detention basins, oil/water separators, boomed areas, and conveyance systems, to prevent the contamination of stormwater. Refer to Appendix IV-D R.3 for references to assist in determining if a waste must be handled as hazardous waste.

• Promptly repair or replace all substantially cracked or otherwise damaged paved secondary containment, high-intensity parking and any other drainage areas, which are subjected to pollutant material leaks or spills.

• Promptly repair or replace all leaking connections, pipes, hoses, valves, etc. which can contaminate stormwater.

The following are recommended additional good housekeeping BMPs:

• Clean up pollutant liquid leaks and spills in impervious uncovered containment areas at the end of each working day.

• Use solid absorbents, e.g., clay and peat absorbents and rags for cleanup of liquid spills/leaks, where practicable.

• Recycle materials, such as oils, solvents, and wood waste, to the maximum extent practicable.

• Prevent the discharge of unpermitted liquid or solid wastes, process wastewater, and sewage to ground or surface water, or to storm drains which discharge to surface water, or to the ground.

• Do not connect floor drains in potential pollutant source areas to storm drains, surface water, or to the ground.

• Conduct all oily parts cleaning, steam cleaning, or pressure washing of equipment or containers inside a building, or on an impervious contained area, such as a concrete pad. Direct contaminated stormwater from such an area to a sanitary sewer where allowed by local sewer authority, or to other approved treatment.

• Do not pave over contaminated soil unless it has been determined that ground water has not been and will not be contaminated by the soil. Call Ecology for assistance.

• Construct impervious areas that are compatible with the materials handled. Portland cement concrete, asphalt, or equivalent material may be considered.

• Use drip pans to collect leaks and spills from industrial/ commercial equipment such as cranes at ship/boat building and repair facilities, log stackers, industrial parts, trucks and other vehicles, which are stored outside.

• At industrial and commercial facilities, drain oil and fuel filters before disposal. Discard empty oil and fuel filters, oily rags and other oily solid waste into appropriately closed and properly labeled containers, and in compliance with the Uniform Fire Code.

• For the storage of liquids use containers, such as steel and plastic drums, that are rigid and durable, corrosion resistant to the weather and fluid content, non-absorbent, water tight, rodent-proof, and equipped with a close fitting cover.

• For the temporary storage of solid wastes contaminated with liquids or other potential pollutant materials use dumpsters, garbage cans, drums and comparable containers, which are durable, corrosion resistant, non-absorbent, non-leaking, and equipped with a solid cover to prevent littering and spills from tipping. All containers must be labeled and the

container must be stored under a lean-to or equivalent structure to reduce environmental exposure.

• Where exposed to stormwater, use containers, piping, tubing, pumps, fittings, and valves that are appropriate for their intended use and for the contained material.

The following are recommended additional preventive maintenance BMPs:

• Where feasible, store potential stormwater pollutant materials inside a building or under a cover and/or containment.

• Minimize use of toxic cleaning solvents, such as chlorinated solvents, and other toxic chemicals.

• Use environmentally safer raw materials, products, additives, etc. such as substitutes for zinc used in rubber production.

• Recycle waste materials such as solvents, coolants, oils, degreasers, and batteries to the maximum extent feasible. Refer to Appendix IV-C for recommendations on recycling or disposal of vehicle waste liquids and other waste materials.

• Empty drip pans into the proper containment immediately after a spill or leak is collected in an uncovered area.

•Stencil warning signs at stormwater catch basins and drains, e.g., "Dump no waste."

Note: Evidence of stormwater contamination can include the presence of visible sheen, color, or turbidity in the runoff, or present or historical operational problems at the facility. Simple pH measurements with litmus or pH paper can be used to test for stormwater contamination in areas subject to acid or alkaline contamination.

• Immediately upon discovery, stop, contain, and clean up all spills.

• Contact the appropriate local agency (fire department, Thurston County Environmental Health, Ecology) for technical assistance and guidance.

• If pollutant materials are stored on-site, have spill containment and cleanup kits readily accessible.

• If the spill has reached or may reach a sanitary or a storm sewer, ground water, or surface water notify Ecology and the local sewer authority immediately. Notification must comply with federal spill reporting requirements. (See also record keeping at the end of this section and BMPs for Spills of Oil and Hazardous Substances)

• Do not flush absorbent materials or other spill cleanup materials to a storm drain. Collect the contaminated absorbent material as a solid and place in appropriate disposal containers.

The following is a recommended additional BMP:

Place and maintain emergency spill containment and cleanup kit(s) at outside areas where there is a potential for fluid spills. These kits should be appropriate for the materials being handled and the size of the potential spill.

Note: Ecology recommends that the kit(s) include salvage drums or containers, such as high density polyethylene, polypropylene or polyethylene sheet-lined steel; polyethylene or equivalent disposal bags; an emergency response guidebook; safety gloves/clothes/equipment; shovels or other soil removal equipment; and oil containment booms and absorbent pads; all stored in an impervious container.

Train all employees that work in pollutant source areas in identifying pollutant sources and in understanding pollutant control measures, spill response procedures, and environmentally acceptable material handling practices - particularly those related to

vehicle/equipment liquids such as fuels, and vehicle/equipment cleaning. Use Ecology's "Stormwater Pollution Prevention Planning for Industrial Facilities" (WQ-R-93-015, 9/93) as a training reference.

At a minimum during normal or dry weather years, conduct two visual inspections each year, one inspection during October 1-April 30, and the other during May 1-September 30, as follows:

• Verify that the descriptions of the pollutant sources identified in the stormwater pollution control program are accurate.

• Verify that the stormwater pollutant controls (BMPs) being implemented are adequate.

• Include observations of the presence of floating materials, suspended solids, oil and grease, discoloration, turbidity and odor in the stormwater discharges; in outside vehicle maintenance/repair; and liquid handling and storage areas. In areas where acid or alkaline materials are handled or stored use a simple litmus or pH paper to identify those types of stormwater contaminants where needed.

• Determine whether there is/are unpermitted non-stormwater discharges to storm drains or receiving waters, such as process wastewater and vehicle/equipment washwater, and either eliminate or obtain a permit for such a discharge.

Retain the following reports for three years:

•Visual inspection reports which should include: scope of the inspection, the personnel conducting the inspection, the date(s) of the inspection, major observations relating to the implementation of the SWPPP (performance of the BMPs, etc.) and actions taken to correct BMP inadequacies.

•Reports on spills of oil or hazardous substances in greater than Reportable Quantities (Code of Federal Regulations Title 40 Parts 302.4 and 117), including the following: oil, gasoline, or diesel fuel, that causes a violation of the State of Washington's Water Quality Standards, or, that causes a film or sheen upon or discoloration of the waters of the State or adjoining shorelines or causes a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

• To report a spill or to determine if a spill is a substance of a Reportable Quantity, call your Ecology regional office and ask for an oil spill operations or a hazardous waste specialist:

Southwest Region, (360) 407-6300 or call 911

Also refer to Emergency Spill Response in Washington State, Publication # 97-1165-CP.

The following is additional recommended record keeping:

• Maintain records of all related pollutant control and pollutant generating activities such as training, materials purchased, material use and disposal, maintenance performed, etc

BMPs for Landscaping and Lawn/ Vegetation Management

Description of Pollutant Sources: Landscaping can include grading, soil transfer, vegetation removal, pesticide and fertilizer applications, and watering. Stormwater contaminants include toxic organic compounds, heavy metals, oils, total suspended solids, coliform bacteria, fertilizers, and pesticides.

Lawn and vegetation management can include control of objectionable weeds, insects, mold, bacteria and other pests with chemical pesticides and is conducted commercially at commercial, industrial, and residential sites. Examples include weed control on golf course lawns, access roads, and utility corridors and during landscaping; sap stain and insect control on lumber and logs; rooftop moss removal; killing nuisance rodents; fungicide application to patio decks, and residential lawn/plant care. Toxic pesticides such as pentachlorophenol, carbamates, and organometallics can be released to the environment by leaching and dripping from treated parts, container leaks, product misuse, and outside storage of pesticide contaminated materials and equipment. Poor management of the vegetation and poor application of pesticides or fertilizers can cause appreciable stormwater contamination.

Pollutant Control Approach: Control of fertilizer and pesticide applications, soil erosion, and site debris to prevent contamination of stormwater.

Develop and implement an Integrated Pest Management Plan (IPM) and use pesticides only as a last resort. If pesticides/herbicides are used they must be carefully applied in accordance with label instructions on U.S. Environmental Protection Agency (EPA) registered materials. Maintain appropriate vegetation, with proper fertilizer application where practicable, to control erosion and the discharge of stormwater pollutants. Where practicable grow plant species appropriate for the site, or adjust the soil properties of the subject site to grow desired plant species.

Applicable Operational BMPs for Landscaping:

- Do not dispose of collected vegetation into waterways or storm drainage systems.

Recommended Additional Operational BMPs for Landscaping:

Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.

Conduct mulch-mowing whenever practicable

Dispose of grass clippings, leaves, sticks, or other collected vegetation, by composting, if feasible.

Use mulch or other erosion control measures when soils are exposed for more than one week during the dry season or two days during the rainy season.

If oil or other chemicals are handled, store and maintain appropriate oil and chemical spill cleanup materials in readily accessible locations. Ensure that employees are familiar with proper spill cleanup procedures.

Till fertilizers into the soil rather than dumping or broadcasting onto the surface. Determine the proper fertilizer application for the types of soil and vegetation encountered.

Till a topsoil mix or composted organic material into the soil to create a well-mixed transition layer that encourages deeper root systems and drought-resistant plants.

Use manual and/or mechanical methods of vegetation removal rather than applying herbicides, where practical.

Recommended Additional Operational BMPs for Vegetation Management:

- Use at least an eight-inch "topsoil" layer with at least 8 percent organic matter to provide a sufficient vegetation-growing medium. Amending existing landscapes and turf systems by increasing the percent organic matter and depth of topsoil can substantially improve the permeability of the soil, the disease and drought resistance of the vegetation, and reduce fertilizer demand. This reduces the demand for fertilizers, herbicides, and pesticides. Organic matter is the least water-soluble form of nutrients that can be added to the soil. Composted organic matter generally releases only between 2 and 10 percent of its total nitrogen annually, and this release corresponds closely to the plant growth cycle. If natural plant debris and mulch are returned to the soil, this system can continue recycling nutrients indefinitely.

Select the appropriate turfgrass mixture for your climate and soil type. Certain tall fescues and rye grasses resist insect attack because the symbiotic endophytic fungi found naturally in their tissues repel or kill common leaf and stem-eating lawn insects. They do not, however, repel root-feeding lawn pests such as Crane Fly larvae, and are toxic to ruminants such as cattle and sheep. The fungus causes no known adverse effects to the host plant or to humans. Endophytic grasses are commercially available and can be used in areas such as parks or golf courses where grazing does not occur. The local Cooperative Extension office can offer advice on which types of grass are best suited to the area and soil type.

Use the following seeding and planting BMPs, or equivalent BMPs to obtain information on grass mixtures, temporary and permanent seeding procedures, maintenance of a recently planted area, and fertilizer application rates: Temporary Seeding, Mulching and Matting, Clear Plastic Covering, Permanent Seeding and Planting, and Sodding as described in Volume II).

Selection of desired plant species can be made by adjusting the soil properties of the subject site. For example, a constructed wetland can be designed to resist the invasion of reed canary grass by layering specific strata of organic matters (e.g., compost forest product residuals) and creating a mildly acidic pH and carbon-rich soil medium. Consult a soil restoration specialist for site-specific conditions.

Aerate lawns regularly in areas of heavy use where the soil tends to become compacted. Aeration should be conducted while the grasses in the lawn are growing most vigorously. Remove layers of thatch greater than ¾-inch deep.

Mowing is a stress-creating activity for turfgrass. When grass is mowed too short its productivity is decreased and there is less growth of roots and rhizomes. The turf becomes less tolerant of environmental stresses, more disease prone and more reliant on outside means such as pesticides, fertilizers and irrigation to remain healthy. Set the mowing height at the highest acceptable level and mow at times and intervals designed to minimize stress on the turf. Generally mowing only 1/3 of the grass blade height will prevent stressing the turf.

Irrigation:

- The depth from which a plant normally extracts water depends on the rooting depth of the plant. Appropriately irrigated lawn grasses normally root in the top 6 to 12 inches of soil; lawns irrigated on a daily basis often root only in the top 1 inch of soil. Improper irrigation can encourage pest problems, leach nutrients, and make a lawn completely dependent on artificial watering. The amount of water applied depends on the normal rooting depth of the turfgrass species used, the available water holding capacity of the soil, and the efficiency of the irrigation system. Consult with the local water utility, Conservation District, or Cooperative Extension office to help determine optimum irrigation practices.

Fertilizer Management:

Turfgrass is most responsive to nitrogen fertilization, followed by potassium and phosphorus. Fertilization needs vary by site depending on plant, soil and climatic conditions. Evaluation of soil nutrient levels through regular testing ensures the best possible efficiency and economy of fertilization. For details on soils testing, contact the local Conservation District or Cooperative Extension Service.

Fertilizers should be applied in amounts appropriate for the target vegetation and at the time of year that minimizes losses to surface and ground waters. Do not fertilize during a drought or when the soil is dry. Alternatively, do not apply fertilizers within three days prior to predicted rainfall. The longer the period between fertilizer application and either rainfall or irrigation, the less fertilizer runoff occurs.

Use slow release fertilizers such as methylene urea, IDBU, or resin coated fertilizers when appropriate, generally in the spring. Use of slow release fertilizers is especially important in areas with sandy or gravelly soils.

Time the fertilizer application to periods of maximum plant uptake. Generally fall and spring applications are recommended, although WSU turf specialists recommend four fertilizer applications per year.

Properly trained persons should apply all fertilizers. At commercial and industrial facilities fertilizers should not be applied to grass swales, filter strips, or buffer areas that drain to sensitive water bodies unless approved by the local jurisdiction.

BMPs for Maintenance of Stormwater Drainage and Treatment Systems

Description of Pollutant Sources: Facilities include roadside catch basins on arterials and within residential areas, conveyance systems, detention facilities such as ponds and vaults, oil and water separators, biofilters, settling basins, infiltration systems, and all other types of stormwater treatment systems presented in Volume V. Roadside catch basins can remove from 5 to 15 percent of the pollutants present in stormwater. When catch basins are about 60 percent full of sediment, they cease removing sediments. Oil and grease, hydrocarbons, debris, heavy metals, sediments and contaminated water are found in catch basins, oil and water separators, settling basins, etc.

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

Applicable Operational BMPs:

Maintain stormwater treatment facilities according to the O & M procedures presented in Section 4.6 of Volume V, in addition to the following BMPs:

Routinely inspect and document the condition of all stormwater facilities every six months, before and after the wet season. Also, inspect all facilities immediately following significant rainfall events.

Clean treatment BMPs, conveyance systems, and catch basins as needed, and determine whether improvements in O & M are needed.

Promptly repair any deterioration threatening the structural integrity of the facilities. These include replacement of clean-out gates, catch basin lids, and rock in emergency spillways.

Ensure that storm sewer capacities are not exceeded and that heavy sediment discharges to the sewer system are prevented.

Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and discharge to a sanitary sewer if approved by the sewer authority, or truck to a local or state government approved disposal site.

Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to the invert of the lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe. Some catch basins (for example, WSDOT Type 1L basins) may have as little as 12 inches sediment storage below the invert. These catch basins will need more frequent inspection and cleaning to prevent scouring. Where these catch basins are part of a stormwater collection and treatment system, the system owner/operator may choose to concentrate maintenance efforts on downstream control devices as part of a systems approach.

Clean woody debris in a catch basin as frequently as needed to ensure proper operation of the catch basin.

Post warning signs; “Dump No Waste - Drains to Ground Water,” “Streams,” “Lakes,” or emboss on or adjacent to all storm drain inlets *where practical*.

Disposal of sediments and liquids from the catch basins must comply with “Recommendations for Management of Street Wastes” described in Appendix IV-G of this volume.

Additional Applicable BMPs:

Retain a professional civil engineer or other qualified professional for emergency repairs or assistance in operating and managing the facility.

Retain the services of a landscape professional or other qualified person for the routine maintenance of vegetated areas, including wetponds, infiltration ponds, grassed/lawn areas, etc.

The Integrated Pest Management Process

Step One: Correctly identify problem pests and understand their life cycle.

Learn more about the pest. Observe it and pay attention to any damage that may be occurring. Learn about the life cycle. Many pests are only a problem during certain seasons, or can only be treated effectively in certain phases of the life cycle.

Step Two: Establish tolerance thresholds for pests.

Every landscape has a population of some pest insects, weeds, and diseases. This is good because it supports a population of beneficial species that keep pest numbers in check. Beneficial organisms may compete with, eat, or parasitize disease or pest organisms. Decide on the level of infestation that must be exceeded before treatment needs to be considered. Pest populations under this threshold should be monitored but don't need treatment. For instance, European crane flies usually don't do serious damage to a lawn unless there are between 25 – 40 larvae per square foot feeding on the turf in February (in normal weather years). Also, most people consider a lawn healthy and well maintained even with up to 20% weed cover, so treatment, other than continuing good maintenance practices, is generally unnecessary.

Step Three: Monitor to detect and prevent pest problems.

Regular monitoring is a key practice to anticipate and prevent major pest outbreaks. It begins with a visual evaluation of the lawn or landscape's condition. Take a few minutes before mowing to walk around and look for problems. Keep a notebook, record when and where a problem occurs, then monitor for it at about the same time in future years. Specific monitoring techniques can be used in the appropriate season for some potential problem pests, such as European crane fly.

Step Four: Modify the maintenance program to promote healthy plants and discourage pests.

A healthy landscape is resistant to most pest problems. Lawn aeration and overseeding along with proper mowing height, fertilization, and irrigation will help the grass out-compete weeds. Correcting drainage problems and letting soil dry out between waterings in the summer may reduce the number of crane-fly larvae that survive.

Step Five: If pests exceed the tolerance thresholds

Use cultural, physical, mechanical or biological controls first. If those prove insufficient, use the chemical controls described below that have the least non-target impact. When a pest outbreak strikes (or monitoring shows one is imminent), implement IPM then consider control options that are the least toxic, or have the least non-target impact. Here are two examples of an IPM approach:

1 **Red thread disease** is most likely under low nitrogen fertility conditions and most severe during slow growth conditions. Mow and bag the clippings to remove diseased blades. Fertilize lightly to help the grass recover, then begin grasscycling and change to fall fertilization with a slow-release or natural-organic fertilizer to provide an even supply of nutrients. Chemical fungicides are not recommended because red thread cannot kill the lawn.

2 **Crane fly damage** is most prevalent on lawns that stay wet in the winter and are irrigated in the summer. Correct the winter drainage and/or allow the soil to dry between irrigation cycles; larvae are susceptible to drying out so these changes can reduce their numbers. It may also be possible to reduce crane fly larvae numbers by using a power de-thatcher on a cool, cloudy day when feeding is occurring close to the surface. Studies are being conducted using beneficial nematodes that parasitize the crane fly larvae; this type of treatment may eventually be a reasonable alternative.

Only after trying suitable non-chemical control methods, or determining that the pest outbreak is causing too much serious damage, should chemical controls be considered. Study to determine what products are available and choose a product that is the least toxic and has the least nontarget impact. Refer to the Operational BMPs for the use of Pesticides below for guidelines on choosing, storing and using lawn and garden chemicals.

Step Six: Evaluate and record the effectiveness of the control, and modify maintenance practices to support lawn or landscape recovery and prevent recurrence.

Keep records! Note when, where, and what symptoms occurred, or when monitoring revealed a potential pest problem. Note what controls were applied and when, and the effectiveness of the control. Monitor next year for the same problems. Review your landscape maintenance and cultural practices to see if they can be modified to prevent or reduce the problem.
A comprehensive IPM Program should also include the proper use of pesticides as a last resort, and vegetation/fertilizer management to eliminate or minimize the contamination of stormwater.

Appendix “D"
SWPPP

Project info:

Owner: Kern Rexius
Engineer: Patrick Harron and Assoc.
Contractor: TBD
Project Schedule:

Mark clearing limits:_____
Install ESC devices:_____
Clear, grub, demo:_____
Rough Grade:_____
Install utilities:_____
Building foundation:_____
Final grade:_____
Paving:_____
Landscape, and cleanup:_____

CESCL REQUIREMENT

A Certified Erosion and Sediment Control Specialist shall be identified in the Construction SWPPP and shall be onsite or oncall at all times. Certification may be obtained by an approved training program that meets the erosion and sediment control training criteria established by Ecology. If a preconstruction meeting is held, this person shall attend. See attached BMPC160 Certified Erosion and Sediment Control Lead (CESCL)

CESCL_____
24hr Contact number:_____
Fax number:_____
Address:_____
_____
_____

1.2.2.1 The Twelve Elements of Construction Stormwater Pollution Prevention Plans

Element 1: **Mark Clearing Limits**

Prior to beginning land disturbing activities, including clearing and grading all clearing limits, 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.

BMP C103 High Visibility Plastic or metal fence

Element 2: **Establish and Maintain 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 10th Ave.

BMP C106 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 C233 Silt Fence

BMP C220 Storm Drain inserts

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/compost socks.

BMP C233 Silt Fence

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

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.

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. Infiltration is proposed onsite.

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 C150 Matrials on Hand

BMP C151 Concrete Handling

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 C241 Temporary Sediment Pond if needed

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

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 C160 CESCL

BMP C162 Scheduling