Attachment 9

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Engineering & Planning

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Blackberry Hill Plat

Preliminary Stormwater Report

Site Location:
2817 Boulevard Rd
Olympia, WA 98501

Prepared for:
Kapa Construction LLC
PMB 121 1910 E 4TH AVE
Olympia, WA 98506

CHRISTIAN M. CRAMER
41796

Chris Cramer, P.E.
PATRICK HARRON & ASSOCIATES, LLC
8270 28th Court NE, Suite 201
Lacey, WA 98516

PHA Project #: 18525
Date: Sept. 2019
Rev Feb 2020
Rev April 2020

Project Engineer’s Certificate

> “I hereby certify that this drainage and erosion control plan for the project known as 2817 Blvd Rd Plat 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.”

CHRISTIAN M. CRAMER
STATE OF WASHINGTON
41796
REGISTERED
PROFESSIONAL ENGINEER

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1. PROPOSED PROJECT DESCRIPTION

This Stormwater Report is submitted in support of the Land Use application for the 2817 Blvd Road project.

The following tabulates the project site data:

The project site is located in the City of Olympia, Washington, within Section25 Township 18 North, Range 2 West, W.M.

This site is located in the Ward drainage basin.

Site address: 2817 Boulevard Rd SE

Assessor #: 12825110600

Well and Septic: None

Parcel Area: 5 Acres .

Abbreviated Legal Descriptions:

Section 25 Township 18 Range 2W N2 SE NE

The proposed storm systems have been designed in accordance with the 2016 Stormwater Management Manual for Western Washington as adopted by the City of Olympia.

Project Description:

This project proposes to construction 35 townhomes and 2 single family detached homes to the vacant property. Currently the site is mostly cleared, and access is from Blvd Rd to the east.

The eastern portion of the site is mostly flat with a slight slope to the west. The west half increases slope down to a localized low spot. Soils testing was conducted on the site along with a slope stability study. The slopes are stable for construction and stormwater runoff. The soils were found to not support infiltration in the eastern (uphill portion), but infiltration capacity was found in the lower eastern portion around the identified wetland. The localized low spot will be the ultimate destination for any runoff and enhanced by clearing out organics and topsoil at the base of the slope to act as an infiltration pond base. Filterra unit will be used to treat runoff meeting the enhanced treatment requirement and maintain the current runoff flow path. Roof collection system will be installed to direct runoff around the swales and directly to the pond area.

The proposed collection system has been designed in accordance with the City of Olympia standards and will treat stormwater events per the 2016 Manual and using the WWHM2012 modeling program. Stormwater analysis runoff will meet or exceed 2016 City of Olympia requirements.

Core Requirement #5 summary:

LID BMPs are not proposed for this project, but it will meet the 100% runoff infiltration guideline. The only area that will infiltrate is the eastern portion of the site. All runoff will be collected and directed to the east for treatment and infiltration.

Figure 1 – Vicinity Map

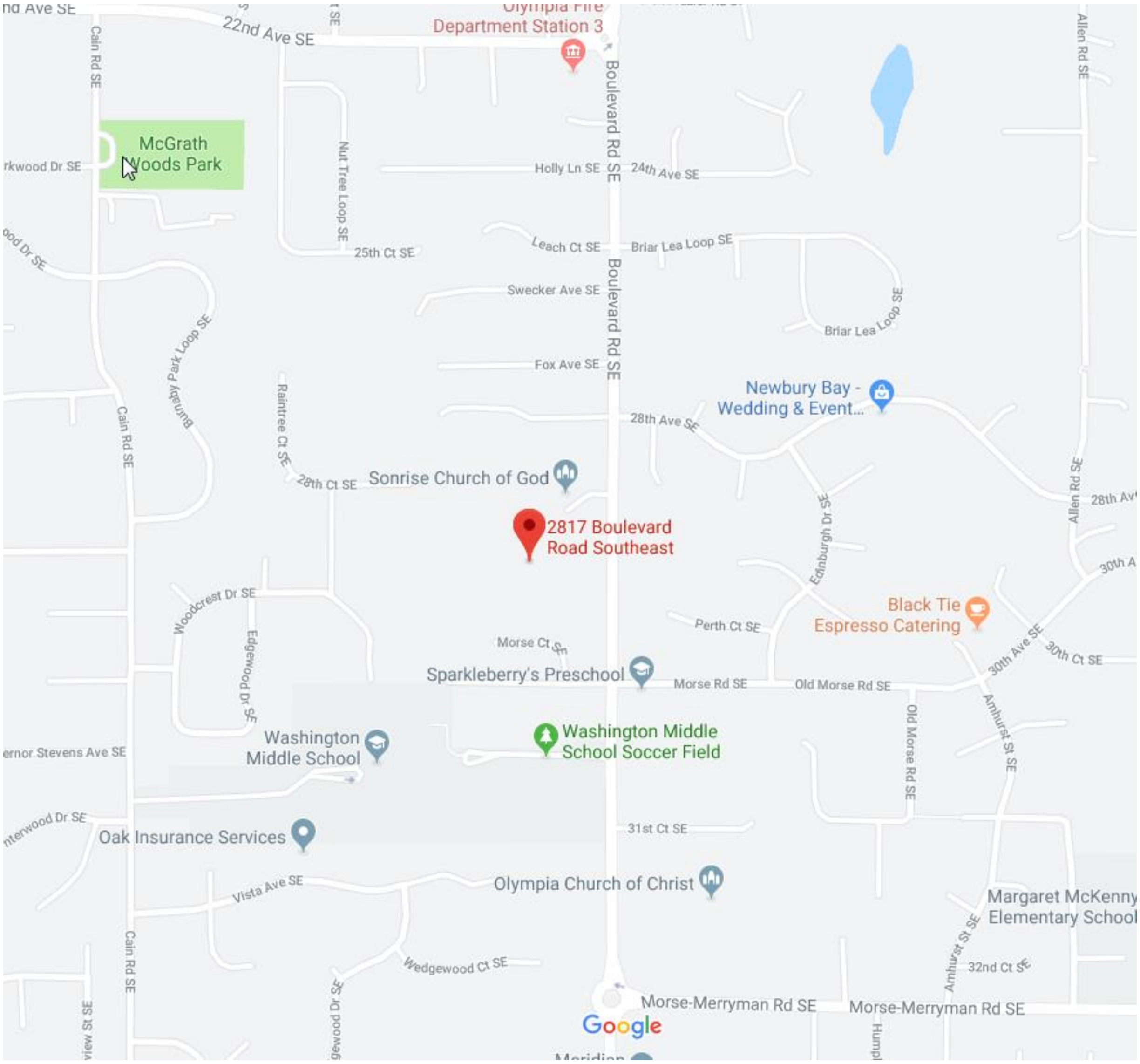
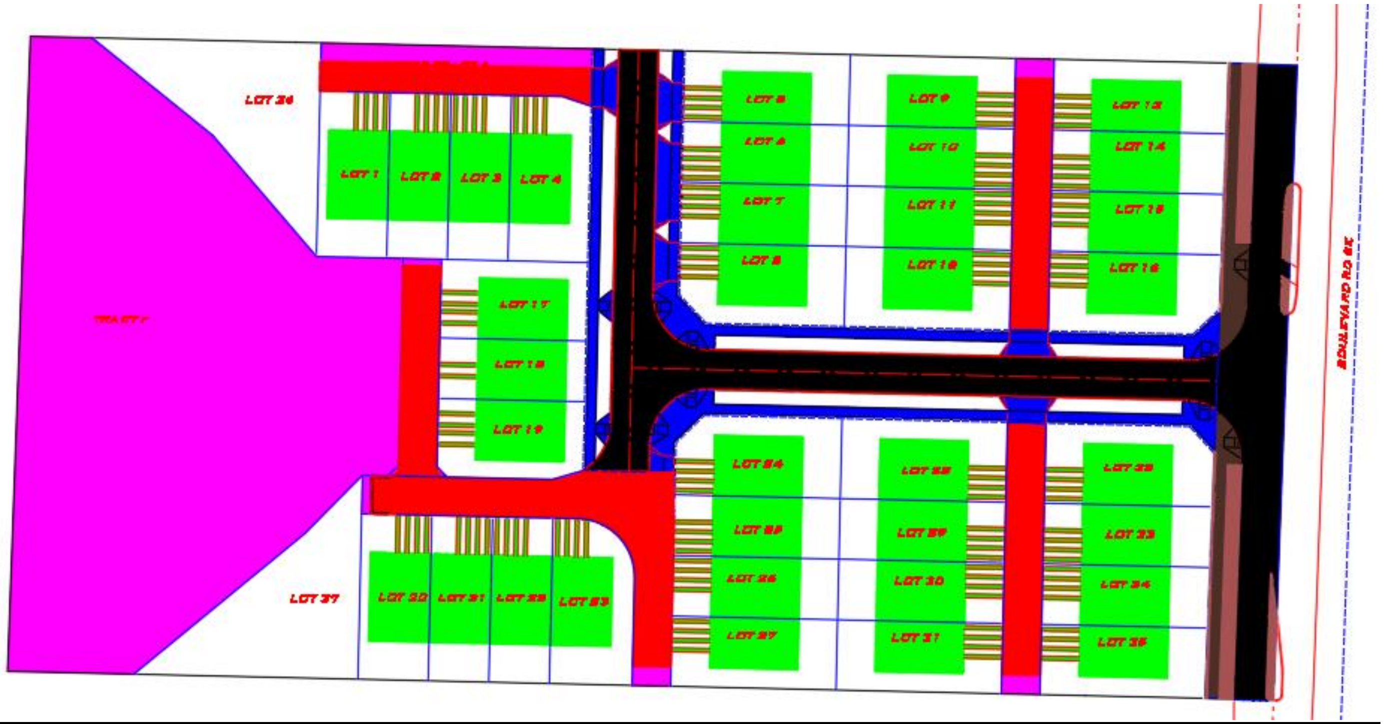


Figure 2 – Ex. Conditions

Figure 3 – Basin and Areas Map

The project consists of only one basin for all onsite and one offsite stormwater (tributary to the wetland area) basin:

Onsite Basin:



AREAS

OFFSITE AREAS (NEW ROW TO CL)	**SF**	**ACRE**
OFFSITE AREA TOTAL	11,725	0.27
ROAD, CURB,& ISLANDS	7,127	0.16
SIDEWALK	2,282	0.05
LANDSCAPE	2,316	0.05
TOTAL	11,725	0.27

ONSITE AREAS		
PARCEL AREA	205,605	4.72
ROAD & CURB	11,288	0.26
S/Ws, D/Ws, & CURB RAMPS	7,530	0.17
TRACT D/Ws	14,722	0.34
BUILDINGS & DWs	54,836	1.26
LANDSCAPE	117,229	2.69
RESOURCE PARCEL	46,596	1.07
TOTAL	205,605	4.72

Offsite Basin:

Tributary area for wetland flow sizing 1.5 Acres

CONDITIONS AND REQUIREMENTS SUMMARY

Core Requirement #1: Preparation of Stormwater Site Plans

Preliminary Land Use Engineering plans have been prepared as part of this submittal, see Appendix A.

Core Requirement #2: Construction Stormwater Pollution Prevention (SWPP)

SWPPP will be prepared with the final report

Core Requirement #3: Source Control of Pollution

Source Control plan will be prepared with the final report.

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

Currently the property drains to the west to the localized low point. The stormwater BMPs will maintain the natural direction of flow.

Core Requirement #5: On-site Stormwater Management

This project proposed to meet the LID performance standard through infiltration onsite of all stormwater runoff.

<u>Lawn and Landscape areas</u>

- Post-Construction Soil Quality and Depth (BMP LID.02) – All disturbed areas of the project to be landscaped shall implement BMP LID.02 to restore soil quality and depth.

  All disturbed areas due to grading for the building sites and driveways will have top soil stock piled onsite and placed back.

Core Requirement #6: Runoff Treatment

Runoff treatment for the roof area is not required. Parking/driveway lot enhanced runoff treatment will be met by the proposed Filterra Unit.

Core Requirement #7: Flow Control

Flow control will be met by the proposed infiltration pond. The existing berm along the west property line will be verified to meet the required 6.5' of depth to contain the 100 year storm event, with 1' of freeboard.

Core Requirement #8: Wetlands Protection

Wetland report was completed by ACERA in March 2019. An exempt Category IV wetland was found in the localized low portion of the site. No buffer is required.

Per Appendix 1-D, two thresholds are to be met for wetlands under 19 points:

After many iterations, it was found that the summer months, the flows were too low to meet the requirements. Since all runoff is directed to the wetland area, these months were ignored as it's not possible to add more runoff to the wetland area. The WWHM2012 model calculated failure to meet the 15% variance, but has been ignored. Also, for the individual days, some of the winter months had a few isolated days that showed an increase of over 20% in runoff. These single day inputs we also ignored as the pond design will allow for a buffer of the peak inflow rates from reaching the wetland and in reality would not produce as large of a variance in inflow rates that the WWHM2012 model can't calculate using the prescribed method of direct flow modeling.

CRITERION 1:

Per the City of Olympia Drainage Design and Erosion Control Manual (DDECM):
"Total volume of water into a wetland during a single precipitation event should not be more than 20% higher or lower than the pre-project volumes."

Summer months cannot be met, too low of flow. No feasible way to increase inflow as all runoff is currently being collected and directed to the wetland area. Isolated days in the winter months exceeded inflow rates, but would be mitigated by the pond design as inflow would not be directly to the wetland.

CRITERION 2:

Per the City of Olympia DDECM:
"Total volume of water into a wetland on a monthly basis should not be more than 15% higher or lower than the pre-project volumes."

All months cannot be met, too low of flow. No feasible way to increase inflow as all runoff is currently being collected and directed to the wetland area.

Core Requirement #9: Operation and Maintenance

O&M Manual will be prepared with the final report.

2. Existing Conditions Description

Ex. Site inventory and analysis per section 3.4.1 Vol 1 DDECM
A Geotech soils test (see attached) has concluded that infiltration is not feasible in the upper eastern portion of the site. The area around the wetland has a measured design rate by PIT of 1”/hr.

Existing drainage patterns are from the east to west, currently the site is mostly cleared and no erosion or runoff issues were noted. The surrounding streets have collection systems in place and functioning correctly. Part of this project will be upgrading the frontage along Blvd Rd that will include a new collection system to bring stormwater onsite for treatment and disposal.

This project is not in an aquifer recharge area or well head protection area.

Currently there is no offsite drainage to or through the project.

3. Soils Investigation

A Geotech soils test (see attached) has concluded that infiltration is only feasible in the western portion of the site, around the existing wetland.

Insight Geologic conducted the soils investigation and tested in several areas for a spot to infiltrate stormwater. No area was found suitable for infiltration in the eastern half.

Since this site was previously cleared, there is no opportunity to propose areas of native soil and vegetation protection. The western area will remain undisturbed except for slope grading of the lots, installation of the Filterra Unit and associated pipes.

This site is generally flat, sloping to the west, for most of the eastern half. The slopes in the west were evaluated for slope stability and the ability to disperse stormwater over. They were found stable and capable of dispersion

Enhanced Treatment is proposed and flow control is handled by the proposed infiltration pond.

Ground water was not encountered in the eastern soil pits.

Contaminated or sensitive soil areas were not found on the lot.

4. Wells and Septic Systems

The project area is served by City sewer and water. No wells, or septic systems exist onsite.

5. Fuel Tanks

No fuel tanks exist onsite.

6. Subbasin Description

The onsite and offsite development is contained in a single basin:

OFFSITE AREA TOTAL	9,908	0.23
ROAD	5,758	0.13
SIDEWALK	1,648	0.04
LANDSCAPE	2,502	0.06
TOTAL	9,908	0.23
ONSITE AREAS		
PARCEL AREA	207,750	4.77
ROAD	9,615	0.22
SIDEWALK & D/W	35,510	0.82
BUILDING	50,715	1.16
LANDSCAPE	62,601	1.44
RESOURCE PARCEL	49,309	1.13
TOTAL	207,750	4.77

Offsite tributary area:

Pasture Area to the north	1.5 Acres

7. Floodplain Analysis

The Site is listed as minimal flood hazard FEMA panel# 53067C0188F. There is a zone A identified in the area of the category IV wetland and the property to the west/southwest.

8. Aesthetic Considerations for Facilities

All storm facilities will consist of landscaping and soil amendment that create a natural look for the area.

Landscaping design will be provided for the disturbed areas onsite and road frontages.

9. Facility Selection and Sizing

Drainage Concept

The onsite road, Boulevard Road frontage (half street), lot areas and alleys will be collected and sent to the west for enhanced treatment through the proposed Filterra unit and then infiltrated in the lower eastern basin. The lower area will remain in the native conditons around the wetland to act as a pond. The existing berm along the west property line will be verified and enlarged if necessary to provide a full 6.5' of depth for the pond area. Roof runoff will be collected separately and piped directly to the infiltration pond.

Stormwater from the project will be treated and discharged offsite per City of Olympia standards (2016). Sizing of the treatment facilities was performed using the WWHM 2012 program.

Core Requirement #5: On-site Stormwater Management

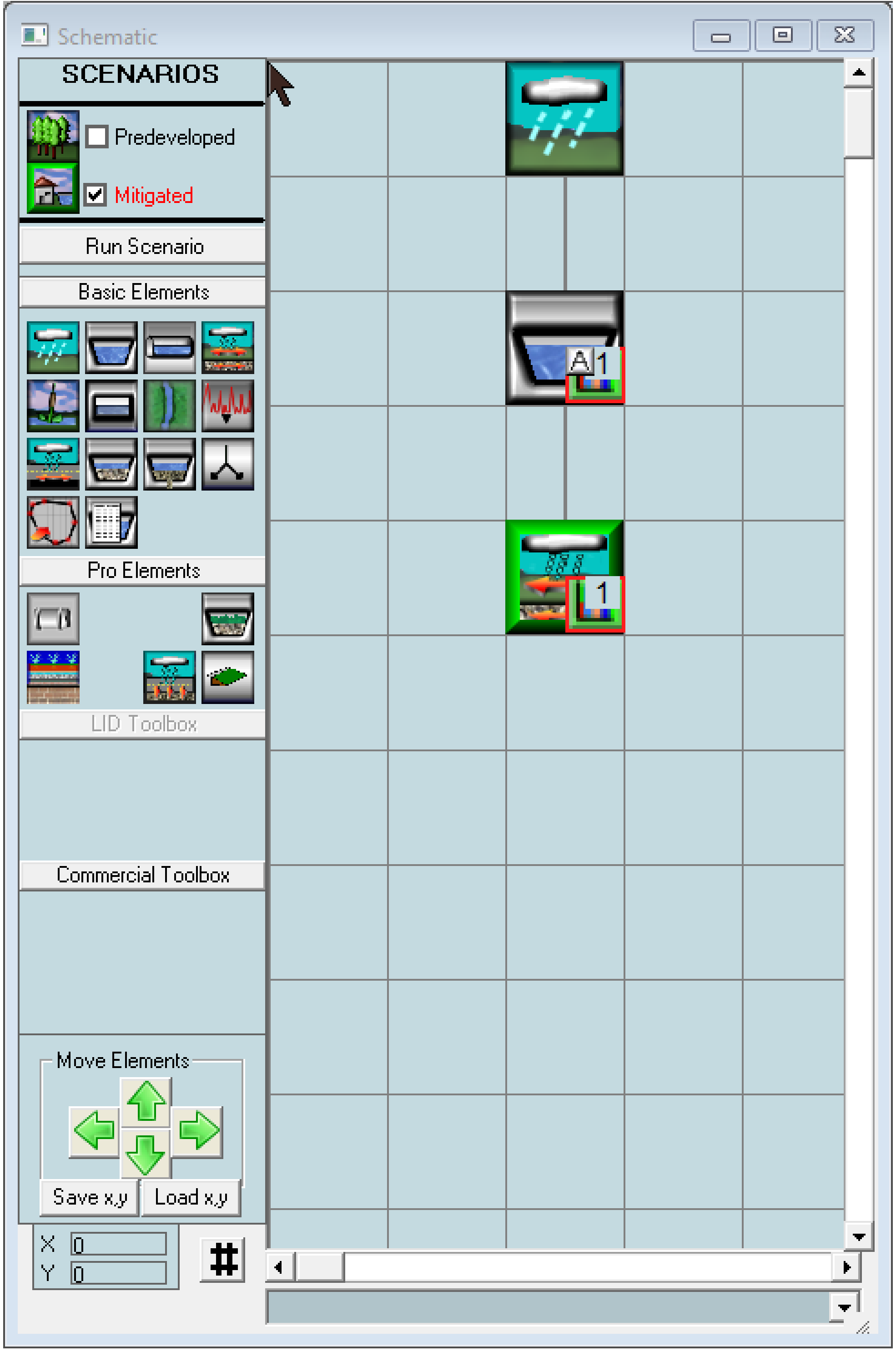
As stated above, all runoff will be collected and piped by an onsite system, serving the proposed road and Boulevard Rd frontage.

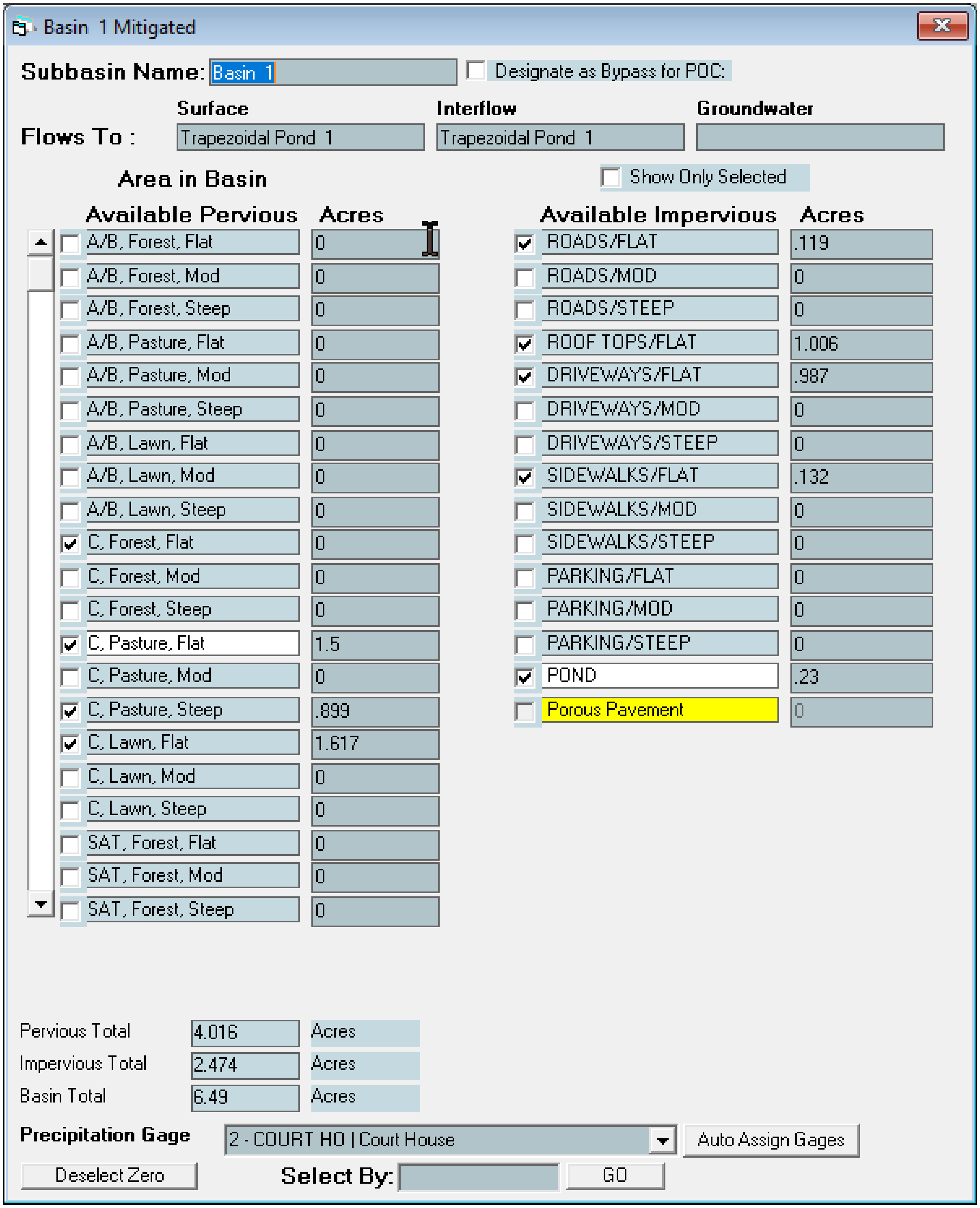
Core Requirement #7 Flow Control, is met using the proposed infiltration pond.

For roof areas, runoff will be collected and piped to the pond area.

(See Appendix B for the full WWHM2012 output file)

Pond Sizing:


Schematic
SCENARIOS
☐ Predeveloped
☑ Mitigated
Run Scenario
Basic Elements
Pro Elements
LID Toolbox
Commercial Toolbox
Move Elements
Save x,y
Load x,y
X 0
Y 0
A 1
1



Basin 1 Mitigated

Subbasin Name: Basin 1 ☐ Designate as Bypass for POC:

	Surface	Interflow	Groundwater
Flows To :	Trapezoidal Pond 1	Trapezoidal Pond 1	

Area in Basin ☐ Show Only Selected

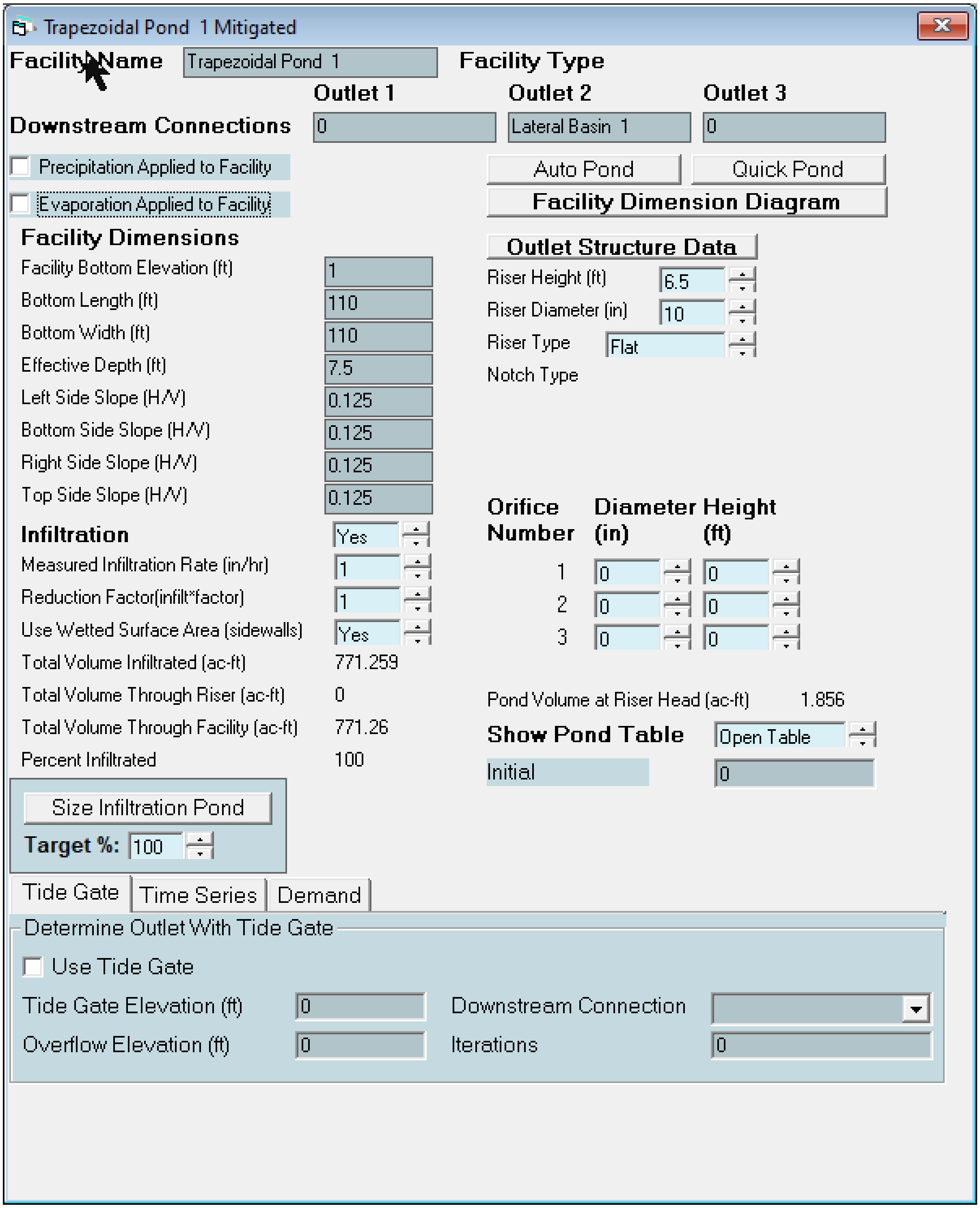
	Available Pervious	Acres
☐	A/B, Forest, Flat	0
☐	A/B, Forest, Mod	0
☐	A/B, Forest, Steep	0
☐	A/B, Pasture, Flat	0
☐	A/B, Pasture, Mod	0
☐	A/B, Pasture, Steep	0
☐	A/B, Lawn, Flat	0
☐	A/B, Lawn, Mod	0
☐	A/B, Lawn, Steep	0
☑	C, Forest, Flat	0
☐	C, Forest, Mod	0
☐	C, Forest, Steep	0
☑	C, Pasture, Flat	1.5
☐	C, Pasture, Mod	0
☑	C, Pasture, Steep	.899
☑	C, Lawn, Flat	1.617
☐	C, Lawn, Mod	0
☐	C, Lawn, Steep	0
☐	SAT, Forest, Flat	0
☐	SAT, Forest, Mod	0
☐	SAT, Forest, Steep	0

	Available Impervious	Acres
☑	ROADS/FLAT	.119
☐	ROADS/MOD	0
☐	ROADS/STEEP	0
☑	ROOF TOPS/FLAT	1.006
☑	DRIVEWAYS/FLAT	.987
☐	DRIVEWAYS/MOD	0
☐	DRIVEWAYS/STEEP	0
☑	SIDEWALKS/FLAT	.132
☐	SIDEWALKS/MOD	0
☐	SIDEWALKS/STEEP	0
☐	PARKING/FLAT	0
☐	PARKING/MOD	0
☐	PARKING/STEEP	0
☑	POND	.23
☐	Porous Pavement	0

Pervious Total	4.016	Acres
Impervious Total	2.474	Acres
Basin Total	6.49	Acres

Precipitation Gage 2 - COURT HO | Court House

Select By:



Facility Name: Trapezoidal Pond 1

Facility Type

	Outlet 1	Outlet 2	Outlet 3
Downstream Connections	0	Lateral Basin 1	0

☐ Precipitation Applied to Facility

☐ Evaporation Applied to Facility

Facility Dimensions

Facility Bottom Elevation (ft)	1
Bottom Length (ft)	110
Bottom Width (ft)	110
Effective Depth (ft)	7.5
Left Side Slope (H/V)	0.125
Bottom Side Slope (H/V)	0.125
Right Side Slope (H/V)	0.125
Top Side Slope (H/V)	0.125
Infiltration	Yes
Measured Infiltration Rate (in/hr)	1
Reduction Factor(infilt*factor)	1
Use Wetted Surface Area (sidewalls)	Yes
Total Volume Infiltrated (ac-ft)	771.259
Total Volume Through Riser (ac-ft)	0
Total Volume Through Facility (ac-ft)	771.26
Percent Infiltrated	100

Target %: 100

Outlet Structure Data

Riser Height (ft)	6.5
Riser Diameter (in)	10
Riser Type	Flat
Notch Type	

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

Pond Volume at Riser Head (ac-ft) 1.856

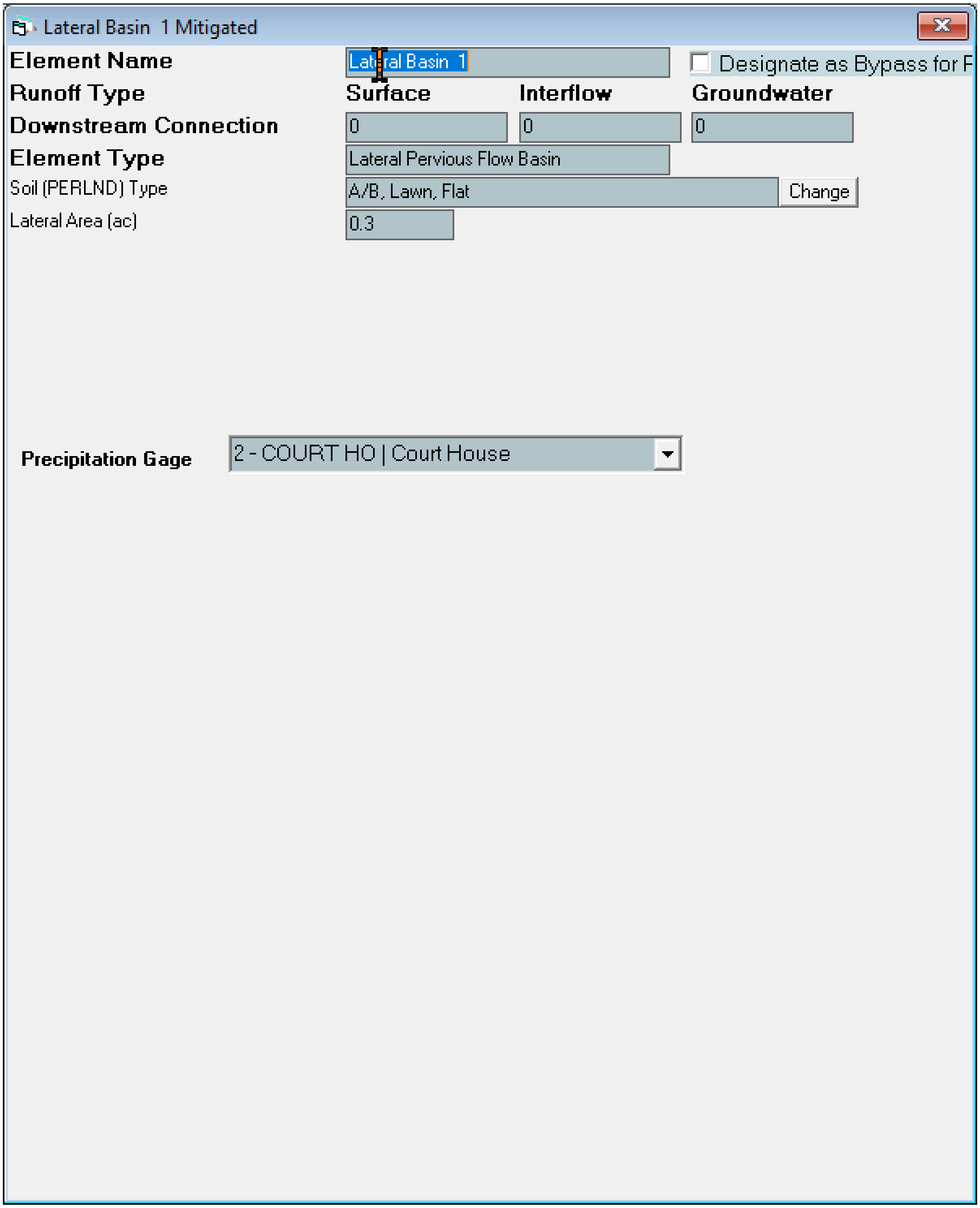
Show Pond Table: Open Table

Initial: 0

Determine Outlet With Tide Gate

☐ Use Tide Gate

Tide Gate Elevation (ft)	0	Downstream Connection	
Overflow Elevation (ft)	0	Iterations	0



Lateral Basin 1 Mitigated

Element Name Lateral Basin 1

☐ Designate as Bypass for F

Runoff Type	**Surface**	**Interflow**	**Groundwater**
Downstream Connection	0	0	0

Element Type Lateral Pervious Flow Basin

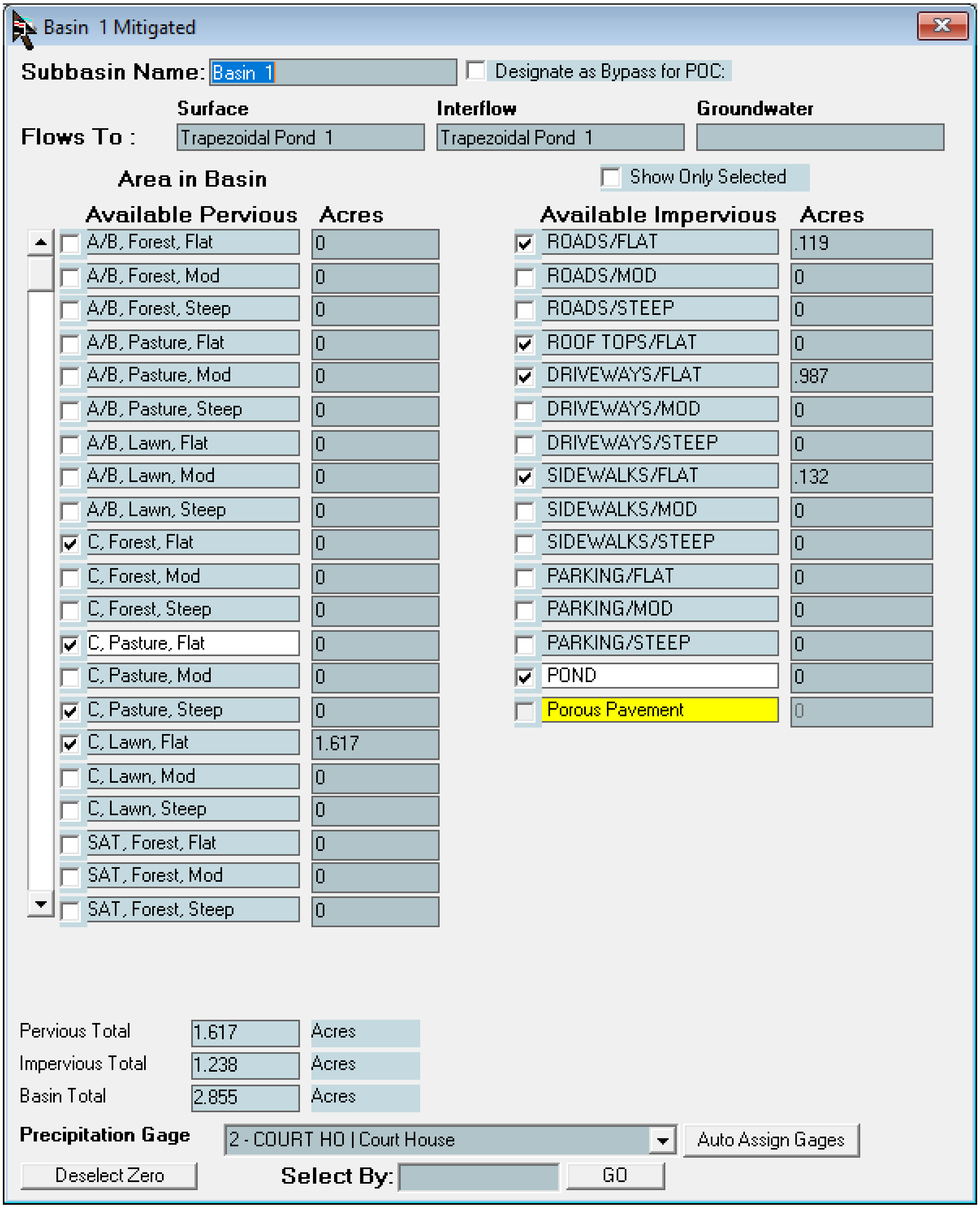
Soil (PERLND) Type A/B, Lawn, Flat

Lateral Area (ac) 0.3

Precipitation Gage 2 - COURT HO | Court House

Filterra Sizing:

Only the onsite road, Boulevard frontage road, and lot areas were used to size the Filterra unit for runoff treatment.



Basin 1 Mitigated

Subbasin Name: Basin 1 ☐ Designate as Bypass for POC:

	Surface	Interflow	Groundwater
Flows To :	Trapezoidal Pond 1	Trapezoidal Pond 1	

Area in Basin ☐ Show Only Selected

	Available Pervious	Acres
☐	A/B, Forest, Flat	0
☐	A/B, Forest, Mod	0
☐	A/B, Forest, Steep	0
☐	A/B, Pasture, Flat	0
☐	A/B, Pasture, Mod	0
☐	A/B, Pasture, Steep	0
☐	A/B, Lawn, Flat	0
☐	A/B, Lawn, Mod	0
☐	A/B, Lawn, Steep	0
☑	C, Forest, Flat	0
☐	C, Forest, Mod	0
☐	C, Forest, Steep	0
☑	C, Pasture, Flat	0
☐	C, Pasture, Mod	0
☑	C, Pasture, Steep	0
☑	C, Lawn, Flat	1.617
☐	C, Lawn, Mod	0
☐	C, Lawn, Steep	0
☐	SAT, Forest, Flat	0
☐	SAT, Forest, Mod	0
☐	SAT, Forest, Steep	0

	Available Impervious	Acres
☑	ROADS/FLAT	.119
☐	ROADS/MOD	0
☐	ROADS/STEEP	0
☑	ROOF TOPS/FLAT	0
☑	DRIVEWAYS/FLAT	.987
☐	DRIVEWAYS/MOD	0
☐	DRIVEWAYS/STEEP	0
☑	SIDEWALKS/FLAT	.132
☐	SIDEWALKS/MOD	0
☐	SIDEWALKS/STEEP	0
☐	PARKING/FLAT	0
☐	PARKING/MOD	0
☐	PARKING/STEEP	0
☑	POND	0
☐	Porous Pavement	0

Pervious Total	1.617	Acres
Impervious Total	1.238	Acres
Basin Total	2.855	Acres

Precipitation Gage 2 - COURT HO | Court House

```
Flow Frequency
Flow(cfs)  0701 15m
2 Year   =    0.6386
5 Year   =    0.9019
10 Year  =    1.0677
25 Year  =    1.2670
50 Year  =    1.4085
100 Year =    1.5445
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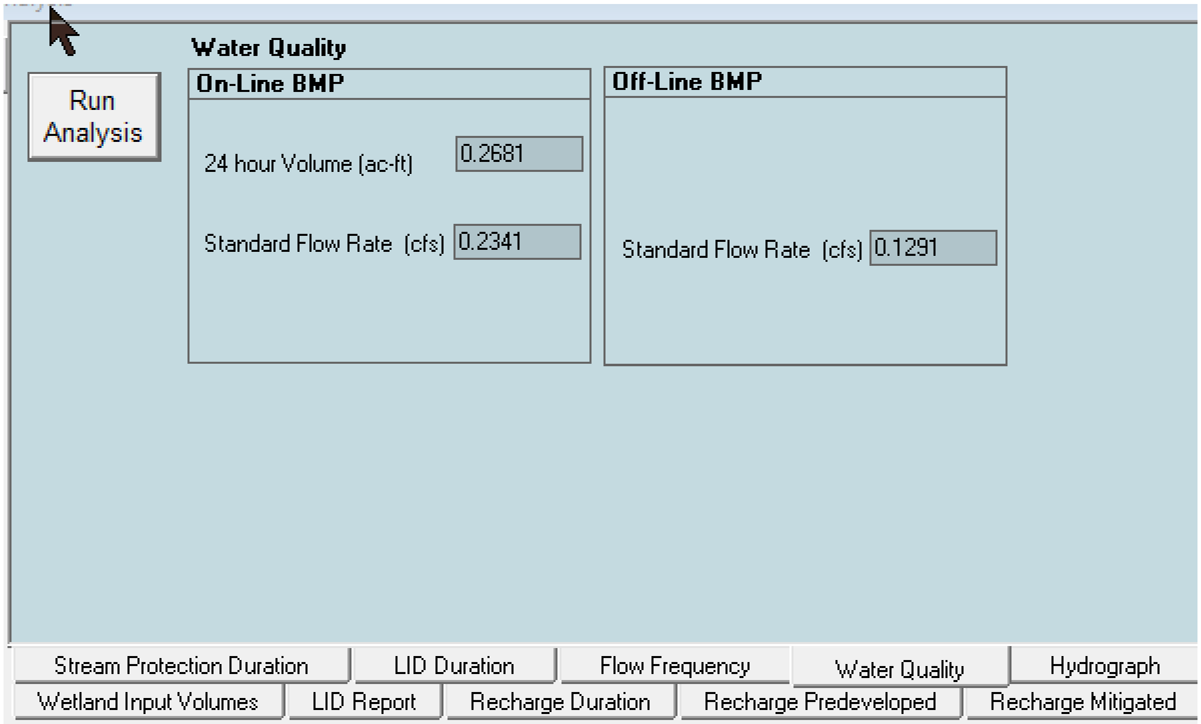


Water Quality

On-Line BMP

24 hour Volume (ac-ft) 0.2681

Standard Flow Rate (cfs) 0.2341

Off-Line BMP

Standard Flow Rate (cfs) 0.1291

10. Conveyance System Analysis and Design

Conveyance System will be installed for Boulevard Road frontage and the proposed onsite road will have a collection system installed to convey stormwater to the west for disposal. 12" min size and 0.5% slope will be used in the ROW.

11. Offsite Analysis and Mitigation

Project is located in the Ward Lake Drainage basin.

For this project, no offsite mitigation is proposed. Stormwater from the onsite areas of the parcel will have runoff collected and disposed of onsite. Downstream analysis is not required.

Frontage improvements will be completed to Boulevard Road for the western portion of the ROW.

12. Utilities

The parcel currently has City Sewer and Water in Boulevard road. Connections will be made to extend services onsite. No onsite septic systems exist.

13. Covenants, Dedications, Easements, Agreements

This project will have a maintenance agreement for the CAVFS, collection system, and landscaping.

The Program Operator will be the Owner.

No dedication of tracts will be required due to private Ownership and maintenance.

14. Other Permits or Conditions

The project will apply for Engineering permit along with the Building Permit from the City of Olympia.

No other permits or reviews required by agencies other than City of Olympia.

Appendix A

Storm Plans

Appendix B

Storm Calculations

WWHM2012
PROJECT REPORT

Project Name: 2817 blvd rd rev2
Site Name: 2817 blvd rd
Site Address:
City :
Report Date: 4/20/2020
Gage : Courthouse
Data Start : 1955/10/01
Data End : 2011/09/30
Precip Scale: 0.90
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, Pasture, Flat	1.5
C, Pasture, Steep	.899
C, Lawn, Flat	4.091
Pervious Total	6.49

Impervious Land Use	acre
Impervious Total	0
Basin Total	6.49

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	1.621
C, Pasture, Flat	1.5
C, Pasture, Steep	.899
Pervious Total	**4.02**

Impervious Land Use	**acre**
ROADS FLAT	0.42
ROOF TOPS FLAT	1.13
DRIVEWAYS FLAT	0.47
SIDEWALKS FLAT	0.22
POND	0.23
Impervious Total	**2.47**

Basin Total **6.49**

Element Flows To:

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

Name : Trapezoidal Pond 1
Bottom Length: 104.00 ft.
Bottom Width: 105.00 ft.
Depth: 7.5 ft.
Volume at riser head: 1.7008 acre-feet.
Infiltration On
Infiltration rate: 1
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 770.909
Total Volume Through Riser (ac-ft.): 0.02
Total Volume Through Facility (ac-ft.): 770.929
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Side slope 1: 0.4 To 1
Side slope 2: 0.08 To 1
Side slope 3: 0.08 To 1
Side slope 4: 0.4 To 1
Discharge Structure
Riser Height: 6.5 ft.
Riser Diameter: 10 in.

Element Flows To:

Outlet 1	**Outlet 2**
Lateral Basin 1	

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)

```
1.0000      0.250      0.000      0.000      0.000
1.0833      0.250      0.020      0.000      0.253
1.1667      0.251      0.041      0.000      0.253
1.2500      0.251      0.062      0.000      0.253
1.3333      0.251      0.083      0.000      0.253
1.4167      0.251      0.104      0.000      0.253
1.5000      0.251      0.125      0.000      0.253
1.5833      0.252      0.146      0.000      0.254
1.6667      0.252      0.167      0.000      0.254
1.7500      0.252      0.188      0.000      0.254
1.8333      0.252      0.209      0.000      0.254
1.9167      0.252      0.230      0.000      0.254
2.0000      0.253      0.251      0.000      0.255
2.0833      0.253      0.272      0.000      0.255
2.1667      0.253      0.294      0.000      0.255
2.2500      0.253      0.315      0.000      0.255
2.3333      0.253      0.336      0.000      0.255
2.4167      0.254      0.357      0.000      0.256
2.5000      0.254      0.378      0.000      0.256
2.5833      0.254      0.399      0.000      0.256
2.6667      0.254      0.421      0.000      0.256
2.7500      0.254      0.442      0.000      0.256
2.8333      0.254      0.463      0.000      0.257
2.9167      0.255      0.484      0.000      0.257
3.0000      0.255      0.506      0.000      0.257
3.0833      0.255      0.527      0.000      0.257
3.1667      0.255      0.548      0.000      0.257
3.2500      0.255      0.569      0.000      0.258
3.3333      0.256      0.591      0.000      0.258
3.4167      0.256      0.612      0.000      0.258
3.5000      0.256      0.633      0.000      0.258
3.5833      0.256      0.655      0.000      0.258
3.6667      0.256      0.676      0.000      0.259
3.7500      0.257      0.698      0.000      0.259
3.8333      0.257      0.719      0.000      0.259
3.9167      0.257      0.741      0.000      0.259
4.0000      0.257      0.762      0.000      0.259
4.0833      0.257      0.784      0.000      0.260
4.1667      0.258      0.805      0.000      0.260
4.2500      0.258      0.827      0.000      0.260
4.3333      0.258      0.848      0.000      0.260
4.4167      0.258      0.870      0.000      0.260
4.5000      0.258      0.891      0.000      0.261
4.5833      0.259      0.913      0.000      0.261
4.6667      0.259      0.934      0.000      0.261
4.7500      0.259      0.956      0.000      0.261
4.8333      0.259      0.978      0.000      0.261
4.9167      0.259      0.999      0.000      0.262
5.0000      0.260      1.021      0.000      0.262
5.0833      0.260      1.043      0.000      0.262
5.1667      0.260      1.064      0.000      0.262
5.2500      0.260      1.086      0.000      0.262
5.3333      0.260      1.108      0.000      0.262
5.4167      0.261      1.129      0.000      0.263
5.5000      0.261      1.151      0.000      0.263
5.5833      0.261      1.173      0.000      0.263
5.6667      0.261      1.195      0.000      0.263
5.7500      0.261      1.216      0.000      0.263
5.8333      0.261      1.238      0.000      0.264
```

```
5.9167      0.262      1.260      0.000      0.264
6.0000      0.262      1.282      0.000      0.264
6.0833      0.262      1.304      0.000      0.264
6.1667      0.262      1.326      0.000      0.264
6.2500      0.262      1.348      0.000      0.265
6.3333      0.263      1.370      0.000      0.265
6.4167      0.263      1.392      0.000      0.265
6.5000      0.263      1.413      0.000      0.265
6.5833      0.263      1.435      0.000      0.265
6.6667      0.263      1.457      0.000      0.266
6.7500      0.264      1.479      0.000      0.266
6.8333      0.264      1.501      0.000      0.266
6.9167      0.264      1.523      0.000      0.266
7.0000      0.264      1.546      0.000      0.266
7.0833      0.264      1.568      0.000      0.267
7.1667      0.265      1.590      0.000      0.267
7.2500      0.265      1.612      0.000      0.267
7.3333      0.265      1.634      0.000      0.267
7.4167      0.265      1.656      0.000      0.267
7.5000      0.265      1.678      0.000      0.268
7.5833      0.266      1.700      0.211      0.268
7.6667      0.266      1.723      0.575      0.268
7.7500      0.266      1.745      0.957      0.268
7.8333      0.266      1.767      1.242      0.268
7.9167      0.266      1.789      1.396      0.269
8.0000      0.267      1.811      1.546      0.269
8.0833      0.267      1.834      1.670      0.269
8.1667      0.267      1.856      1.785      0.269
8.2500      0.267      1.878      1.894      0.269
8.3333      0.267      1.901      1.996      0.270
8.4167      0.268      1.923      2.094      0.270
8.5000      0.268      1.945      2.187      0.270
8.5833      0.268      1.968      2.276      0.270
```

Name : Lateral Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
A B, Lawn, Flat	**.3**

Element Flows To:
Surface **Interflow** **Groundwater**

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:6.49

Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:4.32
Total Impervious Area:2.47

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.53368
5 year	0.970144
10 year	1.308091
25 year	1.781103
50 year	2.162309
100 year	2.56511

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.15418
5 year	0.219979
10 year	0.253709
25 year	0.286952
50 year	0.306268
100 year	0.321931

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

Year	Predeveloped	Mitigated
1956	0.436	0.198
1957	1.347	0.147
1958	0.570	0.080
1959	0.470	0.141
1960	2.053	0.219
1961	0.353	0.175
1962	0.143	0.091
1963	1.566	0.231
1964	0.345	0.171
1965	0.653	0.126
1966	0.266	0.111
1967	1.247	0.163
1968	0.682	0.104
1969	0.236	0.110
1970	0.372	0.181
1971	0.509	0.201
1972	1.486	0.234
1973	0.578	0.214
1974	0.779	0.154
1975	0.368	0.109
1976	0.639	0.200
1977	0.507	0.047
1978	0.469	0.217
1979	0.398	0.086
1980	0.382	0.191
1981	1.130	0.159
1982	0.694	0.172
1983	0.761	0.143
1984	1.456	0.098

1985	0.245	0.090
1986	0.730	0.181
1987	0.632	0.222
1988	0.267	0.112
1989	0.267	0.063
1990	1.150	0.200
1991	1.415	0.299
1992	0.636	0.192
1993	0.343	0.092
1994	0.340	0.082
1995	0.476	0.240
1996	1.598	0.318
1997	0.073	0.036
1998	0.092	0.039
1999	0.546	0.252
2000	0.266	0.145
2001	0.165	0.033
2002	0.748	0.246
2003	0.318	0.160
2004	2.022	0.207
2005	0.370	0.103
2006	0.562	0.204
2007	1.072	0.215
2008	0.928	0.203
2009	0.490	0.155
2010	0.184	0.099
2011	0.444	0.191

Stream Protection Duration

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	2.0533	0.3185
2	2.0224	0.2986
3	1.5980	0.2520
4	1.5662	0.2464
5	1.4860	0.2403
6	1.4565	0.2342
7	1.4146	0.2312
8	1.3466	0.2216
9	1.2472	0.2188
10	1.1495	0.2170
11	1.1304	0.2154
12	1.0720	0.2138
13	0.9281	0.2075
14	0.7787	0.2045
15	0.7610	0.2035
16	0.7479	0.2006
17	0.7300	0.2002
18	0.6940	0.1999
19	0.6821	0.1981
20	0.6530	0.1923
21	0.6393	0.1911
22	0.6360	0.1908
23	0.6320	0.1811
24	0.5782	0.1808
25	0.5702	0.1746
26	0.5619	0.1718
27	0.5460	0.1708

28	0.5091	0.1633
29	0.5067	0.1597
30	0.4896	0.1585
31	0.4763	0.1550
32	0.4703	0.1540
33	0.4690	0.1471
34	0.4444	0.1454
35	0.4365	0.1430
36	0.3985	0.1414
37	0.3816	0.1264
38	0.3717	0.1124
39	0.3697	0.1106
40	0.3684	0.1103
41	0.3529	0.1087
42	0.3446	0.1043
43	0.3426	0.1033
44	0.3402	0.0986
45	0.3177	0.0985
46	0.2671	0.0916
47	0.2669	0.0907
48	0.2665	0.0897
49	0.2663	0.0861
50	0.2445	0.0821
51	0.2364	0.0800
52	0.1839	0.0630
53	0.1655	0.0469
54	0.1427	0.0387
55	0.0922	0.0362
56	0.0728	0.0334

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2668	7271	1540	21	Pass
0.2860	5802	693	11	Pass
0.3051	4595	9	0	Pass
0.3243	3747	0	0	Pass
0.3434	3100	0	0	Pass
0.3626	2645	0	0	Pass
0.3817	2172	0	0	Pass
0.4009	1806	0	0	Pass
0.4200	1505	0	0	Pass
0.4392	1174	0	0	Pass
0.4583	973	0	0	Pass
0.4774	808	0	0	Pass
0.4966	699	0	0	Pass
0.5157	626	0	0	Pass
0.5349	561	0	0	Pass
0.5540	475	0	0	Pass
0.5732	406	0	0	Pass
0.5923	355	0	0	Pass
0.6115	316	0	0	Pass
0.6306	282	0	0	Pass
0.6498	248	0	0	Pass

```
0.6689    227      0       0       Pass
0.6881    208      0       0       Pass
0.7072    190      0       0       Pass
0.7263    173      0       0       Pass
0.7455    162      0       0       Pass
0.7646    144      0       0       Pass
0.7838    131      0       0       Pass
0.8029    117      0       0       Pass
0.8221    111      0       0       Pass
0.8412    103      0       0       Pass
0.8604    97       0       0       Pass
0.8795    92       0       0       Pass
0.8987    84       0       0       Pass
0.9178    79       0       0       Pass
0.9370    74       0       0       Pass
0.9561    67       0       0       Pass
0.9752    62       0       0       Pass
0.9944    60       0       0       Pass
1.0135    58       0       0       Pass
1.0327    57       0       0       Pass
1.0518    56       0       0       Pass
1.0710    51       0       0       Pass
1.0901    45       0       0       Pass
1.1093    44       0       0       Pass
1.1284    42       0       0       Pass
1.1476    35       0       0       Pass
1.1667    34       0       0       Pass
1.1859    28       0       0       Pass
1.2050    26       0       0       Pass
1.2241    23       0       0       Pass
1.2433    20       0       0       Pass
1.2624    18       0       0       Pass
1.2816    18       0       0       Pass
1.3007    15       0       0       Pass
1.3199    15       0       0       Pass
1.3390    15       0       0       Pass
1.3582    13       0       0       Pass
1.3773    13       0       0       Pass
1.3965    12       0       0       Pass
1.4156    10       0       0       Pass
1.4348    9        0       0       Pass
1.4539    9        0       0       Pass
1.4730    7        0       0       Pass
1.4922    6        0       0       Pass
1.5113    6        0       0       Pass
1.5305    6        0       0       Pass
1.5496    5        0       0       Pass
1.5688    4        0       0       Pass
1.5879    4        0       0       Pass
1.6071    3        0       0       Pass
1.6262    3        0       0       Pass
1.6454    3        0       0       Pass
1.6645    3        0       0       Pass
1.6837    3        0       0       Pass
1.7028    3        0       0       Pass
1.7219    3        0       0       Pass
1.7411    3        0       0       Pass
1.7602    3        0       0       Pass
1.7794    3        0       0       Pass
```

```
1.7985    3       0      0      Pass
1.8177    3       0      0      Pass
1.8368    3       0      0      Pass
1.8560    2       0      0      Pass
1.8751    2       0      0      Pass
1.8943    2       0      0      Pass
1.9134    2       0      0      Pass
1.9326    2       0      0      Pass
1.9517    2       0      0      Pass
1.9708    2       0      0      Pass
1.9900    2       0      0      Pass
2.0091    2       0      0      Pass
2.0283    1       0      0      Pass
2.0474    1       0      0      Pass
2.0666    0       0      0      Pass
2.0857    0       0      0      Pass
2.1049    0       0      0      Pass
2.1240    0       0      0      Pass
2.1432    0       0      0      Pass
2.1623    0       0      0      Pass
```

LID Duration

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

```
Year         Predeveloped    Mitigated
1956           0.436           0.198
1957           1.347           0.147
1958           0.570           0.080
1959           0.470           0.141
1960           2.053           0.219
1961           0.353           0.175
1962           0.143           0.091
1963           1.566           0.231
1964           0.345           0.171
1965           0.653           0.126
1966           0.266           0.111
1967           1.247           0.163
1968           0.682           0.104
1969           0.236           0.110
1970           0.372           0.181
1971           0.509           0.201
1972           1.486           0.234
1973           0.578           0.214
1974           0.779           0.154
1975           0.368           0.109
1976           0.639           0.200
1977           0.507           0.047
1978           0.469           0.217
1979           0.398           0.086
1980           0.382           0.191
1981           1.130           0.159
1982           0.694           0.172
1983           0.761           0.143
1984           1.456           0.098
```

```
1985           0.245          0.090
1986           0.730          0.181
1987           0.632          0.222
1988           0.267          0.112
1989           0.267          0.063
1990           1.150          0.200
1991           1.415          0.299
1992           0.636          0.192
1993           0.343          0.092
1994           0.340          0.082
1995           0.476          0.240
1996           1.598          0.318
1997           0.073          0.036
1998           0.092          0.039
1999           0.546          0.252
2000           0.266          0.145
2001           0.165          0.033
2002           0.748          0.246
2003           0.318          0.160
2004           2.022          0.207
2005           0.370          0.103
2006           0.562          0.204
2007           1.072          0.215
2008           0.928          0.203
2009           0.490          0.155
2010           0.184          0.099
2011           0.444          0.191
```

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

```
1         2.0533              0.3185
2         2.0224              0.2986
3         1.5980              0.2520
4         1.5662              0.2464
5         1.4860              0.2403
6         1.4565              0.2342
7         1.4146              0.2312
8         1.3466              0.2216
9         1.2472              0.2188
10        1.1495              0.2170
11        1.1304              0.2154
12        1.0720              0.2138
13        0.9281              0.2075
14        0.7787              0.2045
15        0.7610              0.2035
16        0.7479              0.2006
17        0.7300              0.2002
18        0.6940              0.1999
19        0.6821              0.1981
20        0.6530              0.1923
21        0.6393              0.1911
22        0.6360              0.1908
23        0.6320              0.1811
24        0.5782              0.1808
25        0.5702              0.1746
26        0.5619              0.1718
27        0.5460              0.1708
```

```
28          0.5091                  0.1633
29          0.5067                  0.1597
30          0.4896                  0.1585
31          0.4763                  0.1550
32          0.4703                  0.1540
33          0.4690                  0.1471
34          0.4444                  0.1454
35          0.4365                  0.1430
36          0.3985                  0.1414
37          0.3816                  0.1264
38          0.3717                  0.1124
39          0.3697                  0.1106
40          0.3684                  0.1103
41          0.3529                  0.1087
42          0.3446                  0.1043
43          0.3426                  0.1033
44          0.3402                  0.0986
45          0.3177                  0.0985
46          0.2671                  0.0916
47          0.2669                  0.0907
48          0.2665                  0.0897
49          0.2663                  0.0861
50          0.2445                  0.0821
51          0.2364                  0.0800
52          0.1839                  0.0630
53          0.1655                  0.0469
54          0.1427                  0.0387
55          0.0922                  0.0362
56          0.0728                  0.0334
```

LID Duration
POC #1
The Facility FAILED

Facility FAILED duration standard for 1+ flows.

```
Flow(cfs)  Predev   Mit Percentage Pass/Fail
0.0427     256248   279418 109     Fail
0.0450     243288   262335 107     Fail
0.0472     231114   246430 106     Fail
0.0495     219725   232488 105     Fail
0.0518     208925   218351 104     Fail
0.0540     198911   204802 102     Fail
0.0563     189368   191351 101     Fail
0.0585     180355   178667 99      Pass
0.0608     172108   167533 97      Pass
0.0631     164391   157558 95      Pass
0.0653     157106   148722 94      Pass
0.0676     150155   139905 93      Pass
0.0699     143577   132149 92      Pass
0.0721     137294   124354 90      Pass
0.0744     131344   117246 89      Pass
0.0767     125689   110903 88      Pass
0.0789     120289   104738 87      Pass
0.0812     115223   99554  86      Pass
0.0834     110334   94586  85      Pass
0.0857     105759   89068  84      Pass
0.0880     101439   84041  82      Pass
```

```
0.0902    97276   79702  81      Pass
0.0925    93270   75421  80      Pass
0.0948    89422   71887  80      Pass
0.0970    85828   68392  79      Pass
0.0993    82372   65034  78      Pass
0.1016    79152   61873  78      Pass
0.1038    76069   58593  77      Pass
0.1061    73163   55962  76      Pass
0.1084    70336   53292  75      Pass
0.1106    67665   50307  74      Pass
0.1129    65152   48029  73      Pass
0.1151    62756   45752  72      Pass
0.1174    60321   43690  72      Pass
0.1197    58161   42040  72      Pass
0.1219    56100   40293  71      Pass
0.1242    54156   38663  71      Pass
0.1265    52310   36955  70      Pass
0.1287    50464   35580  70      Pass
0.1310    48717   34166  70      Pass
0.1333    47028   32713  69      Pass
0.1355    45437   31103  68      Pass
0.1378    43945   29572  67      Pass
0.1401    42433   28177  66      Pass
0.1423    40980   26901  65      Pass
0.1446    39645   25644  64      Pass
0.1468    38329   24309  63      Pass
0.1491    37014   23013  62      Pass
0.1514    35777   21835  61      Pass
0.1536    34559   20814  60      Pass
0.1559    33440   19793  59      Pass
0.1582    32360   18780  58      Pass
0.1604    31260   17745  56      Pass
0.1627    30278   16916  55      Pass
0.1650    29257   16119  55      Pass
0.1672    28197   15363  54      Pass
0.1695    27313   14629  53      Pass
0.1717    26410   13943  52      Pass
0.1740    25546   13266  51      Pass
0.1763    24722   12645  51      Pass
0.1785    23897   11982  50      Pass
0.1808    23151   11348  49      Pass
0.1831    22404   10688  47      Pass
0.1853    21599   9975   46      Pass
0.1876    20932   9408   44      Pass
0.1899    20186   8895   44      Pass
0.1921    19467   8255   42      Pass
0.1944    18843   7693   40      Pass
0.1967    18206   7252   39      Pass
0.1989    17613   6814   38      Pass
0.2012    17119   6360   37      Pass
0.2034    16557   6009   36      Pass
0.2057    16046   5679   35      Pass
0.2080    15552   5296   34      Pass
0.2102    15071   4964   32      Pass
0.2125    14603   4677   32      Pass
0.2148    14179   4412   31      Pass
0.2170    13733   4135   30      Pass
0.2193    13331   3945   29      Pass
0.2216    12944   3778   29      Pass
```

```
0.2238    12563    3623    28      Pass
0.2261    12206    3472    28      Pass
0.2284    11829    3332    28      Pass
0.2306    11479    3187    27      Pass
0.2329    11165    3069    27      Pass
0.2351    10839    2959    27      Pass
0.2374    10539    2849    27      Pass
0.2397    10250    2741    26      Pass
0.2419    9944     2637    26      Pass
0.2442    9684     2547    26      Pass
0.2465    9382     2437    25      Pass
0.2487    9105     2348    25      Pass
0.2510    8846     2262    25      Pass
0.2533    8577     2195    25      Pass
0.2555    8320     2132    25      Pass
0.2578    8070     2032    25      Pass
0.2600    7821     1906    24      Pass
0.2623    7609     1775    23      Pass
0.2646    7418     1640    22      Pass
0.2668    7208     1487    20      Pass
```

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

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

```
Wetlands Input Volume
Average Annual Volume (acft)
Series 1: 501 POC 1 Predeveloped flow
Series 2: 801 POC 1 Mitigated flow
Month Series 1  Series 2 Percent Pass/Fail
 Jan    3.0585    2.9552    96.6   Pass
 Feb    2.2266    2.0341    91.4   Pass
 Mar    1.9492    1.7045    87.4   Pass
 Apr    1.1121    0.9140    82.2   Fail
 May    0.6001    0.4072    67.8   Fail
 Jun    0.4355    0.2428    55.8   Fail
 Jul    0.3052    0.1242    40.7   Fail
 Aug    0.2820    0.0887    31.5   Fail
 Sep    0.2945    0.1996    67.8   Fail
 Oct    0.6426    0.5703    88.7   Pass
 Nov    2.1452    2.3347   108.8   Pass
 Dec    2.6259    2.9422   112.0   Pass

Day   Series 1  Series 2 Percent Pass/Fail
Jan1    0.0825    0.0776    94.1   Pass
   2    0.0903    0.0798    88.3   Pass
   3    0.0968    0.0823    85.0   Pass
   4    0.0997    0.0848    85.0   Pass
   5    0.1027    0.0890    86.7   Pass
   6    0.1137    0.0916    80.5   Pass
   7    0.1138    0.0975    85.7   Pass
```

8	0.1067	0.1004	94.1	Pass
9	0.0983	0.1005	102.2	Pass
10	0.0895	0.1000	111.8	Pass
11	0.0963	0.1010	104.8	Pass
12	0.1089	0.1023	94.0	Pass
13	0.1122	0.1034	92.1	Pass
14	0.1072	0.1046	97.6	Pass
15	0.1081	0.1061	98.2	Pass
16	0.0978	0.1053	107.7	Pass
17	0.0963	0.1011	105.0	Pass
18	0.0971	0.0991	102.1	Pass
19	0.0982	0.0988	100.6	Pass
20	0.0902	0.0985	109.2	Pass
21	0.0762	0.0936	123.0	Fail
22	0.0883	0.0918	103.9	Pass
23	0.1085	0.0925	85.3	Pass
24	0.1196	0.0970	81.1	Pass
25	0.1055	0.0993	94.1	Pass
26	0.0972	0.0998	102.7	Pass
27	0.0916	0.0977	106.6	Pass
28	0.0913	0.0945	103.4	Pass
29	0.0974	0.0940	96.5	Pass
30	0.0995	0.0954	95.8	Pass
31	0.1038	0.0969	93.4	Pass
Feb1	0.0952	0.0954	100.2	Pass
2	0.0841	0.0919	109.2	Pass
3	0.0779	0.0873	112.0	Pass
4	0.0649	0.0806	124.2	Fail
5	0.0645	0.0731	113.4	Pass
6	0.0735	0.0701	95.3	Pass
7	0.0642	0.0677	105.4	Pass
8	0.0665	0.0652	98.1	Pass
9	0.0628	0.0621	98.8	Pass
10	0.0603	0.0592	98.2	Pass
11	0.0701	0.0576	82.2	Pass
12	0.0797	0.0588	73.8	Fail
13	0.0807	0.0600	74.4	Fail
14	0.0850	0.0625	73.6	Fail
15	0.0950	0.0677	71.3	Fail
16	0.0909	0.0716	78.8	Fail
17	0.0831	0.0727	87.6	Pass
18	0.0896	0.0731	81.6	Pass
19	0.0829	0.0744	89.8	Pass
20	0.0778	0.0739	95.0	Pass
21	0.0668	0.0706	105.6	Pass
22	0.0721	0.0678	94.0	Pass
23	0.0824	0.0688	83.5	Pass
24	0.0870	0.0701	80.6	Pass
25	0.0772	0.0694	89.9	Pass
26	0.0809	0.0692	85.5	Pass
27	0.0816	0.0703	86.1	Pass
28	0.1052	0.1045	99.3	Pass
29	0.0762	0.0722	94.8	Pass
Mar1	0.0751	0.0716	95.3	Pass
2	0.0815	0.0698	85.7	Pass
3	0.0793	0.0699	88.2	Pass
4	0.0845	0.0696	82.4	Pass
5	0.0777	0.0690	88.7	Pass
6	0.0665	0.0676	101.7	Pass

7	0.0621	0.0657	105.8	Pass
8	0.0669	0.0640	95.6	Pass
9	0.0710	0.0633	89.1	Pass
10	0.0733	0.0614	83.8	Pass
11	0.0805	0.0633	78.6	Fail
12	0.0763	0.0650	85.1	Pass
13	0.0703	0.0635	90.3	Pass
14	0.0647	0.0602	93.0	Pass
15	0.0584	0.0564	96.7	Pass
16	0.0537	0.0526	97.9	Pass
17	0.0494	0.0488	98.9	Pass
18	0.0457	0.0456	99.7	Pass
19	0.0484	0.0440	90.9	Pass
20	0.0491	0.0428	87.1	Pass
21	0.0536	0.0424	79.2	Fail
22	0.0562	0.0429	76.4	Fail
23	0.0575	0.0431	74.9	Fail
24	0.0559	0.0429	76.7	Fail
25	0.0526	0.0419	79.7	Fail
26	0.0513	0.0414	80.7	Pass
27	0.0510	0.0406	79.6	Fail
28	0.0564	0.0411	72.8	Fail
29	0.0545	0.0414	75.9	Fail
30	0.0497	0.0406	81.8	Pass
31	0.0468	0.0395	84.3	Pass
Apr1	0.0452	0.0384	85.0	Pass
2	0.0446	0.0374	84.0	Pass
3	0.0525	0.0364	69.2	Fail
4	0.0564	0.0370	65.6	Fail
5	0.0551	0.0390	70.8	Fail
6	0.0447	0.0397	88.7	Pass
7	0.0421	0.0399	94.9	Pass
8	0.0459	0.0406	88.5	Pass
9	0.0419	0.0398	95.1	Pass
10	0.0397	0.0380	95.7	Pass
11	0.0353	0.0357	101.0	Pass
12	0.0363	0.0336	92.6	Pass
13	0.0382	0.0324	85.0	Pass
14	0.0379	0.0320	84.5	Pass
15	0.0360	0.0306	84.8	Pass
16	0.0373	0.0293	78.5	Fail
17	0.0322	0.0279	86.6	Pass
18	0.0338	0.0264	78.1	Fail
19	0.0342	0.0258	75.3	Fail
20	0.0291	0.0245	84.3	Pass
21	0.0268	0.0234	87.4	Pass
22	0.0256	0.0223	87.4	Pass
23	0.0259	0.0219	84.6	Pass
24	0.0259	0.0212	81.9	Pass
25	0.0268	0.0206	76.8	Fail
26	0.0288	0.0203	70.4	Fail
27	0.0301	0.0204	67.6	Fail
28	0.0290	0.0202	69.5	Fail
29	0.0279	0.0199	71.2	Fail
30	0.0251	0.0192	76.3	Fail
May1	0.0239	0.0186	77.7	Fail
2	0.0252	0.0182	72.4	Fail
3	0.0223	0.0175	78.6	Fail
4	0.0230	0.0168	73.2	Fail

```
   5     0.0221     0.0163     73.7    Fail
   6     0.0210     0.0157     74.8    Fail
   7     0.0204     0.0154     75.7    Fail
   8     0.0201     0.0148     73.7    Fail
   9     0.0190     0.0142     74.6    Fail
  10     0.0188     0.0136     72.3    Fail
  11     0.0175     0.0130     74.2    Fail
  12     0.0181     0.0126     69.5    Fail
  13     0.0193     0.0124     64.4    Fail
  14     0.0245     0.0128     52.3    Fail
  15     0.0227     0.0132     57.9    Fail
  16     0.0203     0.0129     63.5    Fail
  17     0.0188     0.0125     66.7    Fail
  18     0.0193     0.0123     63.7    Fail
  19     0.0200     0.0126     62.8    Fail
  20     0.0172     0.0120     69.6    Fail
  21     0.0168     0.0115     68.4    Fail
  22     0.0165     0.0111     67.2    Fail
  23     0.0168     0.0108     64.4    Fail
  24     0.0170     0.0104     61.3    Fail
  25     0.0163     0.0101     62.1    Fail
  26     0.0149     0.0097     65.4    Fail
  27     0.0148     0.0095     64.3    Fail
  28     0.0152     0.0093     61.3    Fail
  29     0.0152     0.0091     59.6    Fail
  30     0.0182     0.0092     50.5    Fail
  31     0.0194     0.0094     48.3    Fail
Jun1     0.0208     0.0097     46.7    Fail
   2     0.0192     0.0097     50.7    Fail
   3     0.0183     0.0099     53.9    Fail
   4     0.0162     0.0097     59.7    Fail
   5     0.0146     0.0095     64.7    Fail
   6     0.0162     0.0094     58.2    Fail
   7     0.0162     0.0092     56.6    Fail
   8     0.0165     0.0091     54.9    Fail
   9     0.0168     0.0091     54.5    Fail
  10     0.0170     0.0093     54.5    Fail
  11     0.0172     0.0093     53.9    Fail
  12     0.0148     0.0091     61.2    Fail
  13     0.0137     0.0087     63.5    Fail
  14     0.0132     0.0084     63.3    Fail
  15     0.0124     0.0080     64.4    Fail
  16     0.0122     0.0077     63.4    Fail
  17     0.0122     0.0075     61.3    Fail
  18     0.0137     0.0075     54.5    Fail
  19     0.0129     0.0073     57.0    Fail
  20     0.0122     0.0071     58.3    Fail
  21     0.0120     0.0069     57.6    Fail
  22     0.0118     0.0067     57.1    Fail
  23     0.0126     0.0067     53.0    Fail
  24     0.0131     0.0067     51.4    Fail
  25     0.0120     0.0065     54.1    Fail
  26     0.0117     0.0063     54.2    Fail
  27     0.0116     0.0061     53.0    Fail
  28     0.0130     0.0062     47.9    Fail
  29     0.0118     0.0060     51.2    Fail
  30     0.0122     0.0059     48.4    Fail
Jul1     0.0115     0.0057     49.8    Fail
   2     0.0109     0.0055     50.6    Fail
```

3	0.0105	0.0053	50.1	Fail
4	0.0104	0.0051	49.0	Fail
5	0.0102	0.0049	48.1	Fail
6	0.0101	0.0047	46.5	Fail
7	0.0102	0.0046	45.0	Fail
8	0.0116	0.0047	40.1	Fail
9	0.0112	0.0046	41.6	Fail
10	0.0105	0.0045	43.1	Fail
11	0.0104	0.0044	42.7	Fail
12	0.0104	0.0044	42.3	Fail
13	0.0100	0.0043	42.4	Fail
14	0.0098	0.0041	42.1	Fail
15	0.0097	0.0040	41.6	Fail
16	0.0096	0.0039	41.1	Fail
17	0.0096	0.0039	40.4	Fail
18	0.0094	0.0037	39.6	Fail
19	0.0093	0.0036	38.6	Fail
20	0.0092	0.0035	37.6	Fail
21	0.0092	0.0034	36.7	Fail
22	0.0091	0.0032	35.7	Fail
23	0.0090	0.0031	34.6	Fail
24	0.0089	0.0030	33.6	Fail
25	0.0089	0.0029	32.8	Fail
26	0.0089	0.0029	32.2	Fail
27	0.0088	0.0027	31.3	Fail
28	0.0087	0.0026	30.4	Fail
29	0.0086	0.0025	29.4	Fail
30	0.0086	0.0024	28.5	Fail
31	0.0086	0.0024	28.1	Fail
Aug1	0.0086	0.0024	27.8	Fail
2	0.0085	0.0024	27.7	Fail
3	0.0085	0.0023	27.5	Fail
4	0.0084	0.0023	27.2	Fail
5	0.0086	0.0023	26.7	Fail
6	0.0091	0.0024	26.2	Fail
7	0.0097	0.0025	25.4	Fail
8	0.0089	0.0024	27.3	Fail
9	0.0085	0.0024	27.9	Fail
10	0.0082	0.0023	27.8	Fail
11	0.0081	0.0023	27.7	Fail
12	0.0081	0.0022	27.9	Fail
13	0.0080	0.0022	27.8	Fail
14	0.0083	0.0022	26.6	Fail
15	0.0087	0.0023	26.3	Fail
16	0.0083	0.0023	27.8	Fail
17	0.0082	0.0023	28.2	Fail
18	0.0086	0.0024	28.0	Fail
19	0.0084	0.0025	29.8	Fail
20	0.0081	0.0025	30.8	Fail
21	0.0084	0.0027	32.2	Fail
22	0.0091	0.0029	32.0	Fail
23	0.0090	0.0031	34.9	Fail
24	0.0113	0.0036	31.6	Fail
25	0.0129	0.0039	30.1	Fail
26	0.0115	0.0043	37.2	Fail
27	0.0106	0.0045	42.3	Fail
28	0.0102	0.0046	45.1	Fail
29	0.0110	0.0049	44.7	Fail
30	0.0095	0.0049	51.7	Fail

31	0.0087	0.0049	55.9	Fail
Sep1	0.0084	0.0049	58.4	Fail
2	0.0083	0.0049	59.1	Fail
3	0.0088	0.0050	56.6	Fail
4	0.0086	0.0050	57.7	Fail
5	0.0087	0.0050	57.5	Fail
6	0.0086	0.0050	58.9	Fail
7	0.0083	0.0050	60.4	Fail
8	0.0096	0.0052	54.8	Fail
9	0.0101	0.0055	54.3	Fail
10	0.0122	0.0060	49.2	Fail
11	0.0097	0.0060	62.1	Fail
12	0.0092	0.0060	65.3	Fail
13	0.0086	0.0061	70.7	Fail
14	0.0086	0.0062	72.1	Fail
15	0.0086	0.0062	71.5	Fail
16	0.0094	0.0062	66.3	Fail
17	0.0115	0.0067	58.0	Fail
18	0.0121	0.0073	60.3	Fail
19	0.0106	0.0075	70.6	Fail
20	0.0113	0.0076	67.5	Fail
21	0.0114	0.0077	68.0	Fail
22	0.0163	0.0085	52.4	Fail
23	0.0131	0.0093	70.7	Fail
24	0.0108	0.0092	84.7	Pass
25	0.0091	0.0089	98.3	Pass
26	0.0082	0.0087	106.3	Pass
27	0.0086	0.0085	99.6	Pass
28	0.0085	0.0084	98.9	Pass
29	0.0087	0.0082	94.0	Pass
30	0.0084	0.0079	94.3	Pass
Oct1	0.0079	0.0077	97.3	Pass
2	0.0075	0.0075	100.6	Pass
3	0.0073	0.0074	102.4	Pass
4	0.0079	0.0073	92.3	Pass
5	0.0168	0.0081	48.1	Fail
6	0.0164	0.0093	56.8	Fail
7	0.0162	0.0109	67.2	Fail
8	0.0189	0.0126	66.5	Fail
9	0.0185	0.0135	72.8	Fail
10	0.0171	0.0141	82.5	Pass
11	0.0139	0.0141	101.7	Pass
12	0.0135	0.0145	107.5	Pass
13	0.0113	0.0143	126.1	Fail
14	0.0117	0.0143	122.3	Fail
15	0.0108	0.0140	129.3	Fail
16	0.0141	0.0144	102.2	Pass
17	0.0156	0.0149	95.9	Pass
18	0.0187	0.0157	83.8	Pass
19	0.0306	0.0173	56.7	Fail
20	0.0436	0.0198	45.5	Fail
21	0.0329	0.0223	67.6	Fail
22	0.0261	0.0246	94.2	Pass
23	0.0258	0.0267	103.1	Pass
24	0.0323	0.0302	93.5	Pass
25	0.0346	0.0323	93.3	Pass
26	0.0344	0.0340	98.7	Pass
27	0.0304	0.0348	114.7	Pass
28	0.0292	0.0346	118.7	Pass

```
  29    0.0290    0.0351   121.2   Fail
  30    0.0412    0.0360    87.3   Pass
  31    0.0452    0.0386    85.5   Pass
Nov1    0.0447    0.0416    93.2   Pass
   2    0.0454    0.0436    96.0   Pass
   3    0.0506    0.0477    94.3   Pass
   4    0.0411    0.0484   117.8   Pass
   5    0.0489    0.0491   100.6   Pass
   6    0.0608    0.0516    84.9   Pass
   7    0.0569    0.0541    95.0   Pass
   8    0.0575    0.0579   100.7   Pass
   9    0.0633    0.0628    99.1   Pass
  10    0.0746    0.0680    91.1   Pass
  11    0.0714    0.0727   101.9   Pass
  12    0.0683    0.0759   111.2   Pass
  13    0.0806    0.0777    96.5   Pass
  14    0.0657    0.0776   118.2   Pass
  15    0.0567    0.0776   136.8   Fail
  16    0.0604    0.0783   129.6   Fail
  17    0.0614    0.0792   129.1   Fail
  18    0.0755    0.0808   107.0   Pass
  19    0.0915    0.0846    92.5   Pass
  20    0.0889    0.0891   100.1   Pass
  21    0.0873    0.0940   107.8   Pass
  22    0.0951    0.0980   103.0   Pass
  23    0.1262    0.1046    82.9   Pass
  24    0.1209    0.1125    93.0   Pass
  25    0.1016    0.1164   114.6   Pass
  26    0.0833    0.1184   142.1   Fail
  27    0.0680    0.1147   168.6   Fail
  28    0.0709    0.1103   155.6   Fail
  29    0.0825    0.1087   131.7   Fail
  30    0.0844    0.1079   127.8   Fail
Dec1    0.0931    0.1062   114.2   Pass
   2    0.1122    0.1060    94.5   Pass
   3    0.1012    0.1049   103.7   Pass
   4    0.0846    0.1048   123.8   Fail
   5    0.0760    0.1037   136.3   Fail
   6    0.0644    0.0994   154.3   Fail
   7    0.0604    0.0932   154.2   Fail
   8    0.0730    0.0884   121.2   Fail
   9    0.0835    0.0876   104.9   Pass
  10    0.0958    0.0906    94.5   Pass
  11    0.0968    0.0952    98.3   Pass
  12    0.0897    0.0964   107.4   Pass
  13    0.0959    0.0992   103.4   Pass
  14    0.1065    0.1037    97.4   Pass
  15    0.0986    0.1051   106.7   Pass
  16    0.0931    0.1050   112.8   Pass
  17    0.0759    0.1018   134.1   Fail
  18    0.0714    0.0972   136.1   Fail
  19    0.0792    0.0928   117.2   Pass
  20    0.0919    0.0928   101.0   Pass
  21    0.0862    0.0923   107.1   Pass
  22    0.0765    0.0898   117.4   Pass
  23    0.0753    0.0859   114.1   Pass
  24    0.0726    0.0826   113.8   Pass
  25    0.0967    0.0842    87.0   Pass
  26    0.1022    0.0898    87.9   Pass
```

27	0.0743	0.0898	120.8	Fail
28	0.0670	0.0853	127.3	Fail
29	0.0766	0.0824	107.7	Pass
30	0.0709	0.0783	110.4	Pass
31	0.0769	0.0761	98.9	Pass

LID Report

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

Trapezoidal Pond  1 POC            N      701.55                                       N      100.00

Trapezoidal Pond  1 POC            N      701.55                                       N      100.00

Total Volume Infiltrated                  1403.09        0.00      0.00                       100.00
0.00          0%             No Treat. Credit
Compliance with LID Standard 8
                           Duration Analysis Result = Passed
```

Perlnd and Implnd Changes

No changes have been made.

Appendix C

Geotech Report

INSIGHT GEOLOGIC, INC.

1015 East 4th Avenue
Olympia, Washington 98506
Telephone: (360) 754-2128
Fax: (360) 754-9299

State of Washington Licensed Geologist
Engineering Geologist
816
William E. Halbert
EXP 6/20

MEMORANDUM

TO: Pawel Oberc

FROM: William Halbert, L.E.G., L.Hg.

DATE: February 5, 2020

PROJECT: Boulevard Road Residential Development

SUBJECT: Supplemental Infiltration Rate Evaluation

At the request of Chris Cramer, of Patrick Harron and Associates we have conducted a supplemental evaluation for stormwater infiltration at the proposed Boulevard Road residential development to be located at 2817 Boulevard Road SE in Olympia, Washington.

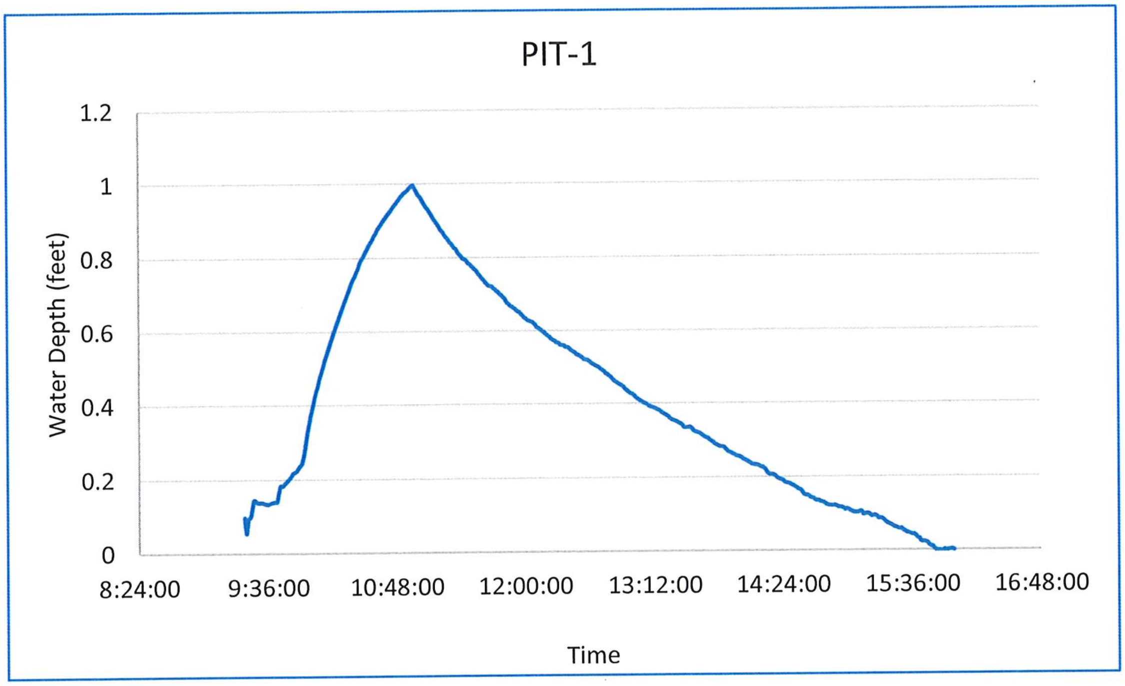
An existing wetland located in the base of a small, closed depression has been identified as a potential location for the disposal of stormwater. We understand that the depression is classified as an unregulated Class IV wetland and as a result, supplemental infiltration testing was requested for this area. On January 15, 2020, we completed a stormwater infiltration rate evaluation in general accordance with the 2016 Manual consisting of two modified Pilot Infiltration Tests (PITs). The PITs were performed within the depression at depths of 1 foot and 5 feet below the base.

The dimensions of PIT-1 were 4 x 5 x 1 foot. PIT-2 was 4 x 4 x 5 feet. The soil exposed in the base of the excavations consisted of brown silt which was consistent with our previous observations in the area.

Water was added to the excavations to maintain a water level of about 12 inches in each excavation and to saturate the underlying soils. We utilized a water truck provided by Kapa Construction as the source of the water. Following the soaking period, water flow to the excavations was stopped and the excavation was allowed to drain. A datalogging pressure transducer was placed in each excavation to record the depth of water as it drained. Graphs of water levels over time are shown in Figure 1, below. The initial infiltration rate was calculated using the change in water level over time.

We then applied the appropriate correction factors to the initial infiltration rate of 2.5 inches per hour as shown in Table 1, below. Our final design infiltration rate is 1.0 inches per hour.

Figure 1.


PIT-1
1.2
1
0.8
0.6
0.4
0.2
0
Water Depth (feet)
8:24:00
9:36:00
10:48:00
12:00:00
13:12:00
14:24:00
15:36:00
16:48:00
Time

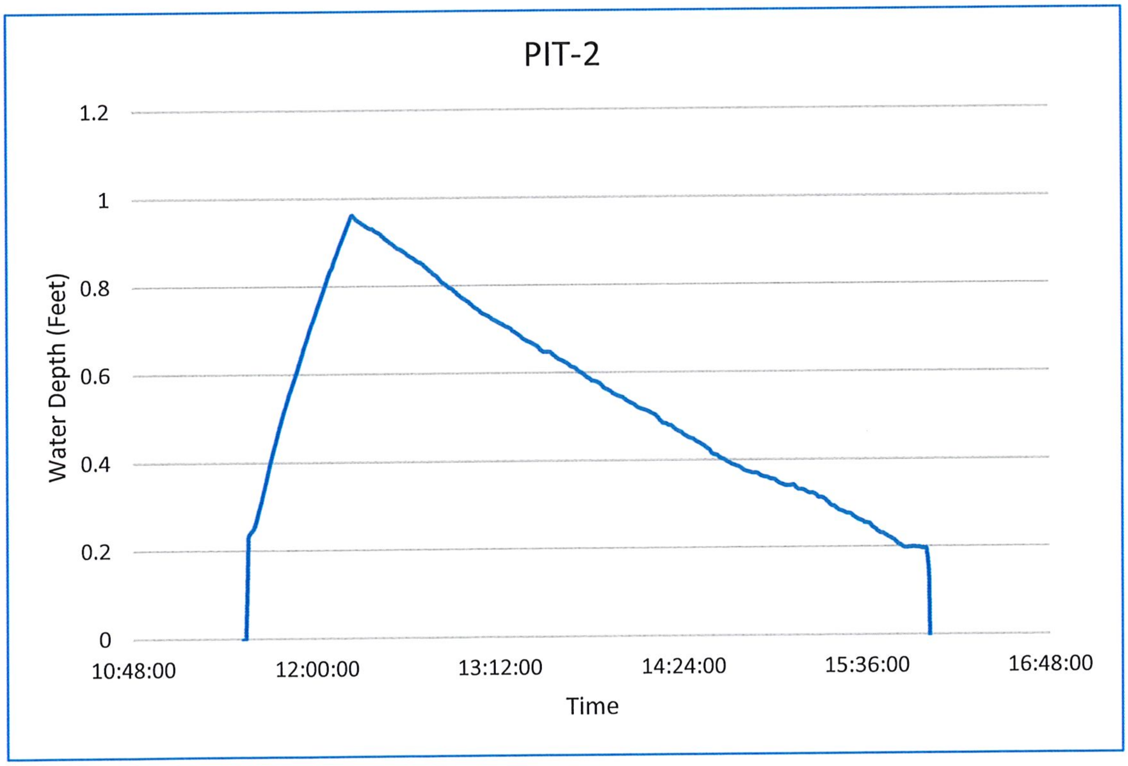

PIT-2
1.2
1
0.8
0.6
0.4
0.2
0
Water Depth (Feet)
10:48:00
12:00:00
13:12:00
14:24:00
15:36:00
16:48:00
Time

Table 1.

Design Infiltration Rate Calculation

PIT	Initial Infiltration Rate (in./hr.)	Testing Methodology Correction Factor	Site Variability Correction Factor	Plugging Correction Factor	Design Infiltration Rate (in./hr.)
PIT-1	2.46	0.5	0.9	0.9	1.0
PIT-2	2.53	0.5	0.9	0.9	1.0

We trust this meets your current requirements. Please contact us if you have any questions regarding our testing.

INSIGHT GEOLOGIC, INC.

August 2, 2018

Kapa Construction
8411 Old Highway 99 SE
Tumwater, Washington 98501
Attn: Pawel Oberc

Proposal
Geotechnical, Stormwater and Limited Environmental Investigation
Proposed Boulevard Road Residential Development
2817 Boulevard Road SE
Olympia, Washington
Project No. 1065-001-01

INTRODUCTION

Insight Geologic, Inc. is pleased to provide our report regarding our investigation of subsurface conditions for your proposed residential development to be located at 2817 Boulevard Road SE in Olympia, Washington. The location of the site is shown relative to surrounding physical features in the Vicinity Map, Figure 1. We understand that you are proposing a 16-lot residential development, along with appurtenant roadway, parking and driveway areas. Stormwater runoff will be routed to individual lot drywells for disposal. The site is currently undeveloped and vegetated with low-growing plants such as scotch broom and black berry, along with scattered alder, maple, and fir trees. A steep slope is located on the western portion of the property, which may qualify as a landslide hazard in accordance with the City of Olympia Critical Area Ordinance Chapter 18.32. Further, it is our understanding the City of Olympia Site Plan Review Committee has requested a limited environmental screening due to historic car-storage activities at the site.

Our services were performed in general accordance with our proposal dated June 25, 2018 and authorized on July 18, 2018.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface conditions as they pertain to stormwater infiltration and geotechnical parameters. We proposed to conduct our stormwater services in general accordance with the guidelines outlined in the City of Olympia's 2016 Drainage Design and Erosion Control Manual (DDECM). Our specific scope of services included the following tasks:

1. Excavated 10 exploratory test pits on the site using a small, track-mounted excavator. The test pits were excavated to a depth of 8 to 9 feet below ground surface (bgs) to evaluate shallow soils for the purposes of developing geotechnical recommendations for the project, as well as for stormwater infiltration from roadways and from individual residences. The test pits were backfilled using the excavated soil at the end of the field day.

2. Logged the soils encountered in the test pits in general accordance with ASTM D2487-06.
3. Conducted grain-size analyses on six (6) soil samples collected from the test pits. The grain-size analyses were used to derive design infiltration rates for the stormwater system in accordance with the DDECM.
4. Collected representative soil samples from the area of suspected vehicle storage for environmental analysis. Samples were collected into laboratory-supplied glass containers appropriate for the requested analyses.
5. Provided for the analysis of soil samples for the presence of petroleum hydrocarbons using Ecology method NWTPH-HCID with quantitative follow-up using NWTPH-Gx, Dx, and for MTCA 5 Metals using EPA method 7000/8000 series.
6. Evaluated the results of the laboratory analyses with respect to current cleanup levels as published by the Washington State Department of Ecology for unrestricted residential land use.
7. Prepared a report summarizing our field activities and containing recommendations for site grading, use of native material as structural fill, soil values for retaining wall design, seismic design parameters, and steep slope and landslide hazards, along with design infiltration rate for the proposed stormwater infiltration system. In addition, we have provided a summary of our limited environmental screening activities.

FINDINGS

Surface Conditions

The project site is situated at an elevation of between 160 and 204 feet above mean sea level (MSL). The site is bounded by Boulevard Road SE to the east, residential properties to the south, undeveloped land to the west, and a church to the north. The site is currently undeveloped and vegetated with low-growing plants, such as scotch broom and blackberry, along with scattered alder, maple, and fir trees. A moderate slope is located on the western portion of the property, leading down to a wetland area within a glacial kettle.

Steep Slope Assessment

We conducted a site reconnaissance of the slope descending approximately 30 feet to the base of the glacial kettle and the associated wetlands. Based on multiple measurements made using a hand-held clinometer, the steepest slopes are approximately 26 percent along the east side of the kettle formation.

No evidence of bedding planes or geologic contact zones were noted during our site reconnaissance. We did not observe the presence of groundwater seeps but did observe the presence of hydric vegetation within the wetland at the base of the slope, indicating the presence of groundwater. We did not observe the presence of historical soil failures or landslide features such as butt-bowed trees, hummocky or back-tilted topography, or ponded drainage on the slope.

Based on our evaluation of the slopes on the site, it is our opinion that no portion of the slope represents a landslide hazard area as per the City of Olympia Critical Area Ordinance. The slope does not exceed a slope of 40 percent and the site does not contain interbedded geology with groundwater seeps along the slope. As a result, no buffer is required.

Geology

Based on our review of available published geologic maps, Vashon age glacial recessional outwash deposits underlie the project site and surrounding area. The outwash material is described as fine to medium sand with few fines. This material was deposited around the margins of glacially-formed kettle lakes, during the waning stages of the most recent glacial period in the Puget Sound lowlands; the Fraser Stade of the Vashon glaciation. The outwash is typically found in a loose to moderately dense condition and is not glacially consolidated.

Subsurface Explorations

We explored subsurface conditions at the site on July 18, 2018 by excavating 10 test pits in the locations as shown on the Site Plan, Figure 2. The test pits were excavated using a track-mounted excavator owned and operated by Kapa Construction. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The test pits were completed between 8 and 9 feet bgs. The soils were visually classified in general accordance with the system described in ASTM D2487-06. The exploration logs are contained in Attachment A.

Soil Conditions

Soil conditions encountered were generally consistent across the site. Underlying approximately 6 inches of sod or forest duff, we encountered approximately 2 to 3 feet of orange-brown silt to silt with sand (ML) in a soft and moist condition. Underlying this upper unit, soils graded to a brown color, which extended to the base of the test pits at 8 to 9 feet bgs. One exception to this description was encountered in test pit TP-10, excavated near the base of the kettle formation. Soils in TP-10 graded to a sandy silt at a depth of 6.5 feet bgs.

The surficial soils encountered are generally consistent with Giles silt loam, which is mapped for the eastern half of the site. These soils are generally formed from volcanic ash and glacial outwash and generally have restrictive layers occurring at depths greater than 7 feet below grade, according to the U.S. Department of Agriculture Soil Survey. Soils on the west half of the site are mapped as Yelm fine sandy loam, however soils encountered in this area had a significantly higher silt content and more closely resemble a silt loam.

Groundwater Conditions

Groundwater was encountered in test pit TP-10, excavated near the base of the glacial kettle, at a depth of 8 feet bgs or an approximate elevation of 152 feet MSL.

Laboratory Testing

We selected 12 soil samples for laboratory testing. Six of the samples obtained were sent to an outside laboratory, Libby Environmental, Inc. of Olympia, Washington, for petroleum hydrocarbon and MTCA 5 Metals analyses by NWTPH-HCID and EPA Method 7000/8000 series, respectively. The remaining six soil samples were analyzed in general accordance with ASTM D422 to define soil class, obtain geotechnical parameters and develop stormwater infiltration rates. Our geotechnical laboratory test results are presented in Attachment B.

ENVIRONMENTAL SCREENING

Six soil samples were delivered to Libby Environmental, Inc. of Olympia, Washington, for analysis of petroleum hydrocarbon and MTCA 5 Metals using NWTPH-HCID and EPA Method 7000/8000 series methods, respectively.

Petroleum hydrocarbons were not detected within any of the six samples submitted for analysis. Lead and chromium were detected in each of the samples at concentrations less than the corresponding MTCA Method A cleanup level of 250 mg/kg and 2,000 mg/kg, respectively. A summary of the analytical data is presented in Table 1. Laboratory analytical reports are contained in Attachment B. The sampling locations are shown on the Site Plan, Figure 2.

Table 1. Summary of Environmental Screening

Sample Name	Sample Date	Petroleum Hydrocarbons	Lead (mg/kg)	Chromium (mg/kg)
S-1	7/18/2018	Not Detected	40	11
S-2	7/18/2018	Not Detected	73	25
S-3	7/18/2018	Not Detected	42	15
S-4	7/18/2018	Not Detected	64	8.6
S-5	7/18/2018	Not Detected	57	19
S-6	7/18/2018	Not Detected	16	26
MTCA Method A Cleanup Level (mg/kg)			250	2,000

STORMWATER INFILTRATION

We completed a stormwater infiltration rate evaluation in general accordance with the 2016 City of Olympia Drainage Design and Erosion Control Manual (2016 Manual). The 2016 Manual uses 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 proposed stormwater infiltration is approximately 0.1 inches per hour, after applying the appropriate correction factors. Our calculations assume that the stormwater infiltration will occur at a depth of at least 3 feet bgs. We further assumed that winter groundwater rises to within 40 feet of ground surface, or at about the elevation of the bottom of the kettle. Changes to these infiltration rates are possible depending on soil conditions at deeper depths and further determination of depth to groundwater.

Table 2. 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-3	ML	0.5 – 3.0	0.0	0.0	0.14	0.1
TP-3	ML	3.0 – 8.0	0.0	0.0	0.14	0.13
TP-5	ML	0.5 – 3.0	0.0	0.0	0.16	0.1
TP-5	ML	3.0 – 8.0	0.0	0.0	0.1	0.06
TP-10	ML	4.0 – 6.5	0.0	0.0	0.13	0.05
TP-10	ML	6.5 – 8.0	0.0	0.08	0.15	0.1

SEISMIC DESIGN CONSIDERATIONS

General

We understand that seismic design will likely be performed using the 2015 IBC standards. The following parameters may be used in computing seismic base shear forces:

Table 3. 2015 IBC Seismic Design Parameters

Spectral Response Accel. at Short Periods (SS) = 1.32
Spectral Response Accel. at 1 Second Periods (S1) = 0.54
Site Class = D
Site Coefficient (FA) = 1.0
Site Coefficient (FV) = 1.5

A full report for the seismic design parameters is presented in Attachment C.

Ground Rupture

Because of the location of the site with respect to the nearest known active crustal faults, and the presence of a relatively thick layer of glacial outwash deposits, it is our opinion that the risk of ground rupture at the site due to surface faulting is low.

Soil Liquefaction

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in the development of excess pore water pressures in saturated soils, and a subsequent loss of stiffness in the soil occurs. Liquefaction also causes a temporary reduction of soil shear strength and bearing capacity, which can cause settlement of the ground surface above the liquefied soil layers. In general, soils that are most susceptible to liquefaction include saturated, loose to medium dense, clean to silty sands and non-plastic silts within 50 feet of ground surface.

Based on our review of the *Liquefaction Susceptibility Map of Thurston County (Palmer, 2004)*, the project site is identified to have a low to moderate potential risk for soil liquefaction. Based on our experience with detailed seismic studies in the Olympia area, including areas that are mapped within the same recessional outwash soil deposits as the project site, we concur with the reviewed map. It is our opinion that there is a moderate risk for soil liquefaction at the site. Additional investigation and evaluation would be needed to further define this risk.

Seismic Compression

Seismic compression is defined as the accrual of contractive volumetric strains in unsaturated soils during strong shaking from earthquakes (Stewart et al., 2004). Loose to medium dense clean sands and non-plastic silts are particularly prone to seismic compression settlement. Seismic compression settlement is most prevalent on slopes, but it can also occur on flat ground. It is our opinion that the upper 9 feet of the soil profile at the site has a moderate risk for seismic compression settlement.

Seismic Settlement Discussion

Based on the materials encountered in our explorations, it is our preliminary opinion that seismic settlements (liquefaction-induced plus seismic compression) could potentially total a few inches at the site as the result of an IBC design level earthquake. We are available upon request to perform deep subsurface explorations and detailed seismic settlement estimates during the design phase.

Seismic Slope Instability

The maximum inclination of the slope on the western portion of the site is about 26 percent and we did not observe signs of slope instability during our site work. In our opinion, there is a low to moderate risk of seismic slope instability at the project site under current conditions. If slope instability due to a seismic event did occur, it could result in damage to the residential structures or infrastructure depending on final site layout and proximity to the slope edge.

Lateral Spreading

Lateral spreading involves the lateral displacement of surficial blocks of non-liquefied soil when an underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground or large grade changes are present. Based on our limited understanding of the subsurface conditions along the northeastern site slope, it is our opinion that there could be a low to moderate risk for the development of lateral spreading as a result of an IBC design level earthquake.

Seismic Slope Deformation Discussion

In our experience, it is unlikely that the potential slope deformations described above (seismic compression or lateral spreading) would be mitigated for in the typical design of a residential buildings. If necessary, we are available to perform detailed slope stability/lateral spreading evaluations to include deep borings and/or CPT soundings at the site.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our review, subsurface explorations and engineering analyses, it is our opinion that the proposed development is feasible from a geotechnical standpoint. We recommend that the proposed structures be supported on shallow concrete foundations that are designed using an allowable soil bearing capacity of 1,500 pounds per square foot (psf). If higher loads are anticipated, compacted stone columns, small diameter pilings, or a robust structural fill section may be used to increase the bearing strength of the soils beneath the building.

The soils encountered in our explorations are typically in a soft condition near ground surface. To limit the potential for structure settlement, we recommend that shallow foundations and slabs-on-grade be established on a minimum 1-foot thick layer of structural fill. Depending on final grading plans and the time of year earthwork is performed; it could be practical to reuse the on-site soils granular soils as structural fill under the foundations/slabs if adequate compaction can be achieved. Due to the fine nature of the soils, the use of a sheeps-foot roller will be critical to obtaining proper compaction. Smooth-drum, vibratory rollers are not recommended.

Stormwater infiltration at the site is not feasible. Soils located near the surface can effectively be considered impermeable with estimated infiltration rates of 0.05 to 0.13 inches per hour. We recommend that stormwater be collected and routed to a designed stormwater system. Soils with higher infiltration rates may exist on-site but would take further determination of soil conditions at depth and depth to groundwater.

Earthwork

General

We anticipate that site development earthwork will include clearing and stripping of existing vegetation and asphalt, preparing subgrades, excavating for utility trenches, and placing and compacting structural fill. We expect that the majority of site grading can be accomplished with conventional earthmoving equipment in proper working order.

Our explorations did not encounter appreciable amounts of debris or unsuitable soils associated with past site development. Still, it is possible that concrete slabs, abandoned utility lines or other development features from the existing onsite development could be encountered during construction. The contractor should be prepared to deal with these conditions during site grading activities.

Clearing and Stripping

Clearing and stripping should consist of removing surface and subsurface deleterious materials including sod/topsoil, trees, brush, debris and other unsuitable loose/soft or organic materials. Stripping and clearing should extend at least 5 feet beyond all structures and areas to receive structural fill.

We estimate that a stripping depth of about 6 inches will be required to remove the vegetation encountered in our explorations. Deeper stripping depths may be required if additional unsuitable soils are exposed during stripping operations.

Subgrade Preparation

After stripping and excavating to the proposed subgrade elevation, and before placing structural fill or foundation concrete, the exposed subgrade should be thoroughly compacted to a firm and unyielding condition. The exposed subgrade should then be proof-rolled using loaded, rubber-tired heavy equipment. We recommend that Insight Geologic be retained to observe the proof-rolling prior to placement of structural fill or foundation concrete. Areas of limited access that cannot be proof-rolled can be evaluated using a steel probe rod. If soft or otherwise unsuitable areas are revealed during proof-rolling or probing, that cannot be compacted to a stable and uniformly firm condition, we generally recommend that: 1) the subgrade soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted; or 2) the unsuitable soils be over-excavated and replaced with structural fill. In areas selected for infiltration of roof runoff or permeable pavement, the subgrade should be either non-compacted or minimally compacted to maximize infiltration into the subsurface.

Temporary Excavations and Groundwater Handling

Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls were required under the Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes should be inclined no steeper than about 1.5H:1V (horizontal: vertical). This guideline assumes that all surface loads are kept at a minimum distance of at least one-half the depth of the cut away from the top of the slope, and that significant seepage is not present on the slope face. Flatter cut slopes were necessary where significant seepage occurs or if large voids are created during excavation. Some sloughing and raveling of cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect slopes during periods of wet weather.

We anticipate that if perched groundwater is encountered during construction it can be handled adequately with sumps, pumps, and/or diversion ditches. Groundwater handling needs will generally be lower during the late summer and early fall months. We recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered during construction.

Permanent Slopes

Permanent slopes will be utilized for the proposed project on the western side of the parcel. Where permanent slopes are necessary, we recommend the slopes be constructed at a maximum inclination of 2H:1V. Where 2H:1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered.

To achieve uniform compaction, we recommend that fill slopes be overbuilt and subsequently cut back to expose well-compacted fill. Fill placement on slopes should be benched into the slope face and include keyways. The configuration of the bench and keyway depends on the equipment being used.

Bench excavations should be level and extend into the slope face. We recommend that a vertical cut of about 3 feet be maintained for benched excavations. Keyways should be about 1-1/2 times the width of the equipment used for grading or compaction.

Erosion Control

We anticipate that erosion control measures such as silt fences, straw bales and sand bags will generally be adequate during development. Temporary erosion control should be provided during construction activities and until permanent erosion control measures are functional. Surface water runoff should be properly contained and channeled using drainage ditches, berms, swales, and tightlines, and should not discharge onto sloped areas. Any disturbed sloped areas should be protected with a temporary covering until new vegetation can take effect. Jute or coconut fiber matting, excelsior matting or clear plastic sheeting is suitable for this purpose. Graded or disturbed slopes should be tracked in-place with the equipment running perpendicular to the slope contours so that the track marks provide a texture to help resist erosion. Ultimately, erosion control measures should be in accordance with local regulations and should be clearly described on project plans.

Wet Weather Earthwork

The majority of the near surface soils are predominantly silts. When the moisture content of the soil is more than a few percent above the optimum moisture content, the soil will become unstable and it may become difficult or impossible to meet the required compaction criteria. Disturbance of near surface soils should be expected if earthwork is completed during periods of wet weather.

The wet weather season in this area generally begins in October and continues through May. However, periods of wet weather may occur during any month of the year. If wet weather earthwork is unavoidable, we recommend that:

- The ground surface is sloped so that surface water is collected and directed away from the work area to an approved collection/dispersion point.
- Earthwork activities not take place during periods of heavy precipitation.
- Slopes with exposed soil be covered with plastic sheeting or otherwise protected from erosion.
- Measures are taken to prevent on-site soil and soil stockpiles from becoming wet or unstable. Sealing the surficial soil by rolling with a smooth-drum roller prior to periods of precipitation should reduce the extent that the soil becomes wet or unstable.
- Construction traffic is restricted to specific areas of the site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- A minimum 1-foot thick layer of 4- to 6-inch quarry spalls is used in high traffic areas of the site to protect the subgrade soil from disturbance.
- Contingencies are included in the project schedule and budget to allow for the above elements.

Structural Fill Materials

General

Material used for structural fill should be free of debris, organic material and rock fragments larger than 3 inches. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve.

On-Site Soil

We anticipate that the majority of the on-site soils encountered during construction will consist of silt located at or near the surface of the site. It is our opinion that this material is a suitable source for structural fill during a limited portion of the year due to the fines content and moisture sensitivity. We anticipate that thin lifts (6-inches or less) will likely be needed to obtain structural fill compaction specifications on native soils. Proper moisture conditioning will be critical for use of these soils. On-site materials used as structural fill should be free of roots, organic matter and other deleterious materials and particles larger than 3 inches in diameter.

Select Granular Fill

Select granular fill should consist of imported, well-graded sand and gravel or crushed rock with a maximum particle size of 3 inches and less than 5 percent passing a U.S. Standard No. 200 sieve based on the minus ¾-inch fraction. Organic matter, debris or other deleterious material should not be present. In our experience, "gravel borrow" as described in Section 9-03.14(1) of the 2018 WSDOT Standard Specifications is typically a suitable source for select granular fill during periods of wet weather, provided that the percent passing a U.S. Standard No. 200 sieve is less than 5 percent based on the minus ¾-inch fraction.

Structural Fill Placement and Compaction

General

Structural fill should be placed on an approved subgrade that consists of uniformly firm and unyielding inorganic native soils or compacted structural fill. Structural fill should be compacted at a moisture content near optimum. The optimum moisture content varies with the soil gradation and should be evaluated during construction.

Structural fill should be placed in uniform, horizontal lifts and uniformly densified with a sheep's-foot vibratory roller. A sheep's-foot vibratory roller is better suited to compact silty soils than a traditional smooth-drum vibratory roller. The maximum lift thickness will vary depending on the material and compaction equipment used, but should generally not exceed the loose thicknesses provided on Table 4. Structural fill materials should be compacted in accordance with the compaction criteria provided in Table 5.

Table 4. Recommended Uncompacted Lift Thickness

Compaction Equipment	**Recommended Uncompacted Fill Thickness (inches)**	
	Granular Materials Maximum Particle Size ≤ 1 1/2 inch	**Granular Materials Maximum Particle Size > 1 1/2 inch**
Hand Tools (Plate Compactors and Jumping Jacks)	4 – 8	Not Recommended
Rubber-tire Equipment	10 – 12	6 – 8
Light Roller	10 – 12	8 – 10
Heavy Roller	12 – 18	12 – 16
Hoe Pack Equipment	18 – 24	12 – 16

Note: The above table is intended to serve as a guideline and should not be included in the project specifications.

Table 5. Recommended Compaction Criteria in Structural Fill Zones

Fill Type	**Percent Maximum Dry Density Determined by ASTM Test Method D 1557 at ±3% of Optimum Moisture**		
	0 to 2 Feet Below Subgrade	**> 2 Feet Below Subgrade**	**Pipe Zone**
Imported or On-site Granular, Maximum Particle Size < 1-1/4-inch	95	95	-----
Imported or On-site Granular, Maximum Particle Size >1-1/4-inch	N/A (Proof-roll)	N/A (Proof-roll)	-----
Trench Backfill[1]	95	92	90

Note: [1]Trench backfill above the pipe zone in nonstructural areas should be compacted to at least 85 percent.

Shallow Foundation Support

General

We recommend that proposed structures be founded on continuous wall or isolated column footings, bearing on a minimum 1-foot thick over-excavation and replacement with compacted structural fill. The structural fill zone should extend to a horizontal distance equal to the over-excavation depth on each side of the footing. The actual over-excavation depth will vary, depending on the conditions encountered.

We recommend that an experienced geotechnical owner-representative observe the foundation surfaces before over-excavation, and before placing structural fill in over-excavations. This representative should confirm that adequate bearing surfaces have been prepared and that the soil conditions are as anticipated. Unsuitable foundation bearing soils should be recompacted or removed and replaced with compacted structural fill, as recommended by the geotechnical engineer.

Bearing Capacity and Footing Dimensions

We recommend an allowable soil bearing pressure of 1,500 psf for shallow foundations that are supported as recommended. This allowable bearing pressure applies to long-term dead and live loads exclusive of the weight of the footing and any overlying backfill. The allowable soil bearing pressure can be increased by one-third when considering total loads, including transient loads such as those induced by wind and seismic forces.

We recommend a minimum width of 18 inches for continuous wall footings and 2 feet for isolated column footings. For settlement considerations, we have assumed a maximum width of 4 feet for continuous wall footings and 6 feet for isolated column footings.

Perimeter footings should be embedded at least 12 inches below the lowest adjacent grade where the ground is flat. Interior footings should be embedded a minimum of 6 inches below the nearest adjacent grade.

Settlement

We estimate that total settlement of footings that are designed and constructed as recommended should be less than 1 inch. We estimate that differential settlements should be ½ inch or less between comparably loaded isolated footings or along 50 feet of continuous footing. We anticipate that the settlement will occur essentially as loads are applied during construction.

Lateral Load Resistance

Lateral loads on shallow foundation elements may be resisted by passive resistance on the sides of footings and by friction on the base of footings. Passive resistance may be estimated using an equivalent fluid density of 200 pounds per cubic foot (pcf), assuming that the footings are backfilled with structural fill. Frictional resistance may be estimated using 0.2 for the coefficient of base friction.

The lateral resistance values provided above incorporate a factor of safety of 1.5. The passive earth pressure and friction components can be combined, provided that the passive component does not exceed two-thirds of the total. The top foot of soil should be neglected when calculating passive resistance, unless the foundation perimeter area is covered by a slab-on-grade or pavement.

Slabs-On-Grade

Slabs-on-grade should be established on a minimum 1-foot thick section of structural fill extending to an approved bearing surface. A modulus of vertical subgrade reaction (subgrade modulus) can be used to design slabs-on-grade. The subgrade modulus varies based on the dimensions of the slab and the magnitude of applied loads on the slab surface; slabs with larger dimensions and loads are influenced by soils to a greater depth. We recommend a modulus value of 125 pounds per cubic inch (pci) for design of on-grade floor slabs with floor loads up to 500 psf. We are available to provide alternate subgrade modulus recommendations during design, based on specific loading information.

We recommend that slabs-on-grade in interior spaces be underlain by a minimum 4-inch thick capillary break layer to reduce the potential for moisture migration into the slab. The capillary break material should consist of a well-graded sand and gravel or crushed rock containing less than 5 percent fines based on the fraction passing the ¾-inch sieve. The 4-inch thick capillary break layer can be included when calculating the minimum 1-foot thick structural fill section beneath the slab.

If dry slabs are required (e.g., where adhesives are used to anchor carpet or tile to the slab), a waterproofing liner should be placed below the slab to act as a vapor barrier.

Subsurface Drainage

It is our opinion that foundation footing drains and underslab drains are likely necessary for the proposed structure. The site soils consisting of silt are generally poorly draining. Footing drains should be routed to existing on-site or planned storm drainage. Drains for surface water, such as downspout and area drains, should not be connected to the footing drain system.

Conventional Retaining Walls

General

The following sections provide general guidelines for retaining wall design on this site. We should be contacted during the design phase to review retaining wall plans and provide supplemental recommendations, if needed.

Drainage

Positive drainage is imperative behind any retaining structure. This can be accomplished by using a zone of free-draining material behind the wall with perforated pipes to collect water seepage. The drainage material should consist of coarse sand and gravel containing less than 5 percent fines based on the fraction of material passing the 3/4-inch sieve. The wall drainage zone should extend horizontally at least 12 inches from the back of the wall. If a stacked block wall is constructed, we recommend that a barrier such as a non-woven geotextile filter fabric be placed against the back of the wall to prevent loss of the drainage material through the wall joints.

A perforated smooth-walled rigid PVC pipe, having a minimum diameter of 4 inches, should be placed at the bottom of the drainage zone along the entire length of the wall. Drainpipes should discharge to a tightline leading to an appropriate collection and disposal system. An adequate number of cleanouts should be incorporated into the design of the drains in order to provide access for regular maintenance.

Roof downspouts, perimeter drains or other types of drainage systems should not be connected to retaining wall drain systems.

Design Parameters

We recommend an active lateral earth pressure of 29 pcf for a level backfill condition. This assumes that the top of the wall is not structurally restrained and is free to rotate. For restrained walls that are fixed against rotation (at-rest condition), an equivalent fluid density of 39 pcf can be used for the level backfill condition. For seismic conditions, we recommend a uniform lateral pressure of 14H psf (where H is the height of the wall) be added to the lateral pressures. This seismic pressure assumes a peak ground acceleration of 0.32 g. Note that if the retaining system is designed as a braced system but is expected to yield a small amount during a seismic event, the active earth pressure condition may be assumed and combined with the seismic surcharge.

The recommended earth pressure values do not include the effects of surcharges from surface loads or structures. If vehicles will be operated within one-half the height of the wall, a traffic surcharge should be added to the wall pressure. The traffic surcharge can be approximated by the equivalent weight of an additional 2 feet of backfill behind the wall. Other surcharge loads, such as construction equipment, staging areas and stockpiled fill, should be considered on a case-by-case basis.

DOCUMENT REVIEW AND CONSTRUCTION OBSERVATION

We recommend that we be retained to review the portions of the plans and specifications that pertain to earthwork construction and stormwater infiltration. We recommend that monitoring, testing and consultation be performed during construction to confirm that the conditions encountered are consistent with our explorations and our stated design assumptions. Insight Geologic would be pleased to provide these services upon request.

REFERENCES

International Code Council, “International Building Code”, 2015.

Seismic Compression of As-compacted Fill Soils with Variable Levels of Fines Content and Fines Plasticity, Department of Civil and Environmental Engineering, University of California, Los Angeles, July 2004.

Washington State Department of Transportation (WSDOT), Standard Specifications for Road, Bridge and Municipal Construction Manual, 2018.

LIMITATIONS

We have prepared this geotechnical, stormwater and limited environmental investigation report for the exclusive use of Kapa Construction and their authorized agents for the proposed residential development project to be located at 2817 Boulevard Road SE 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

State of Washington
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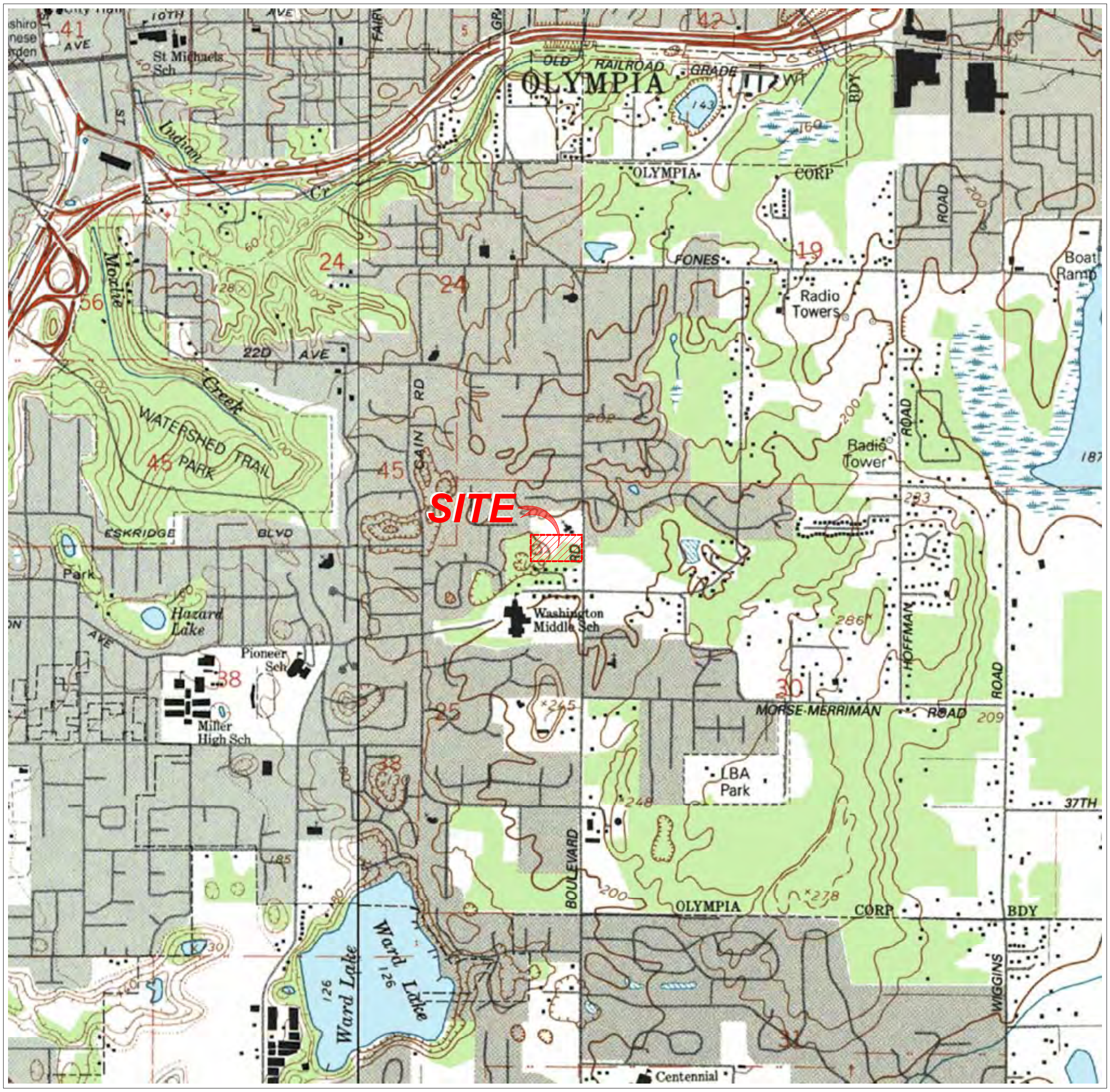
816
Licensed Geologist
William E. Halbert

Attachments

FIGURES



LACEY, WASHINGTON
7.5 MINUTE QUADRANGLE
Year 1994

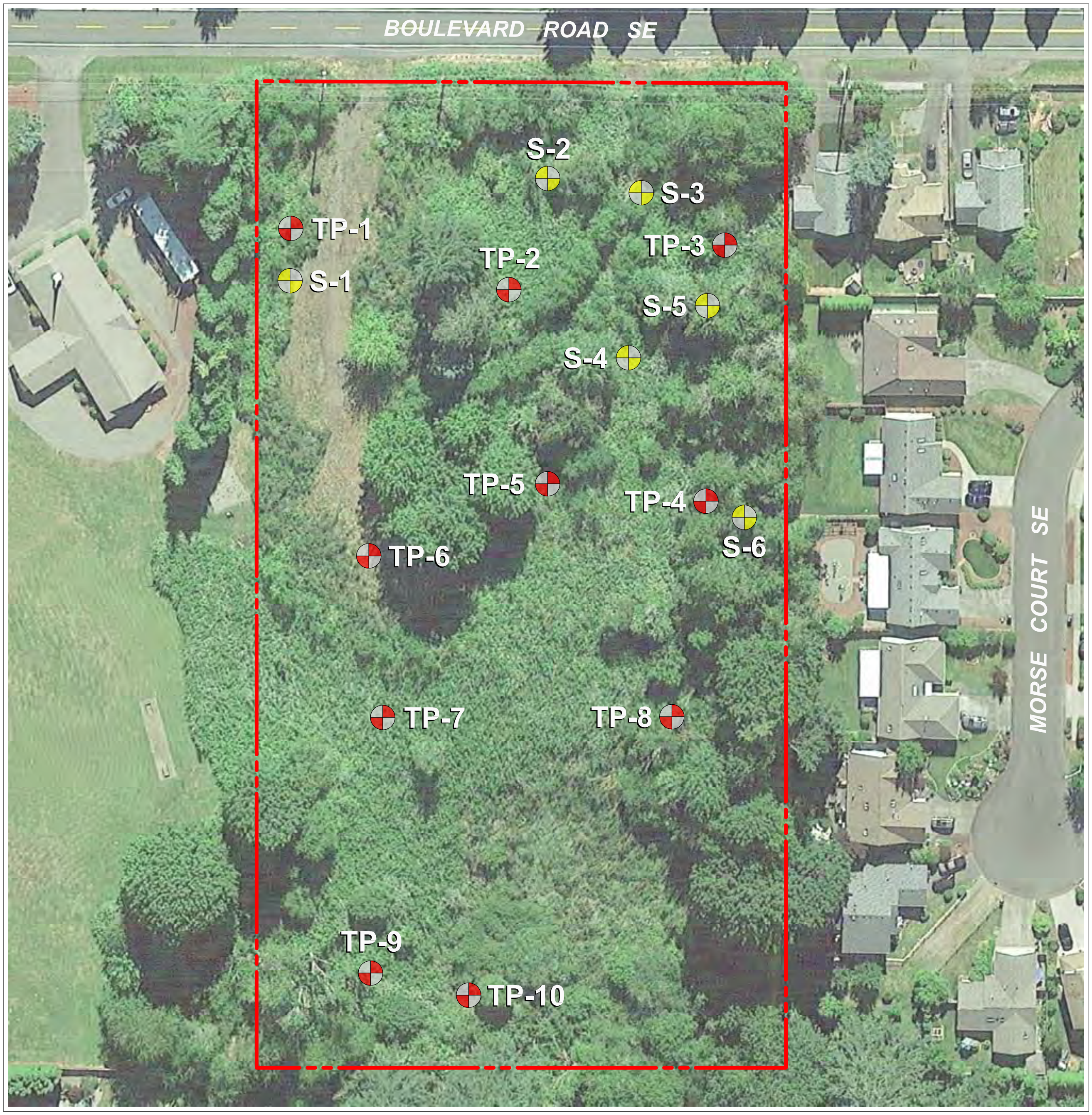
SCALE: 1: 24000

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



LEGEND:

⊕ **S-1** APPROXIMATE SAMPLE LOCATION

⊕ **TP-1** APPROXIMATE TEST PIT LOCATION

— APPROXIMATE PROJECT BOUNDARY

SCALE" 1" = 100'

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 2

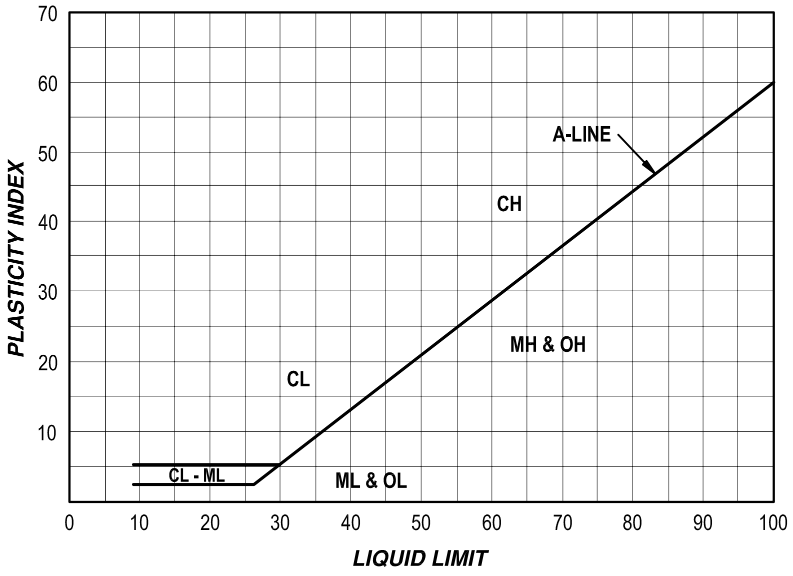
Site Plan

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	CR	▨	Black crushed rock	
	ML	▥	Orange-brown silt, medium stiff, moist	
3			Grades to brown silt, soft, moist	
8			Groundwater not encountered	
10				

LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

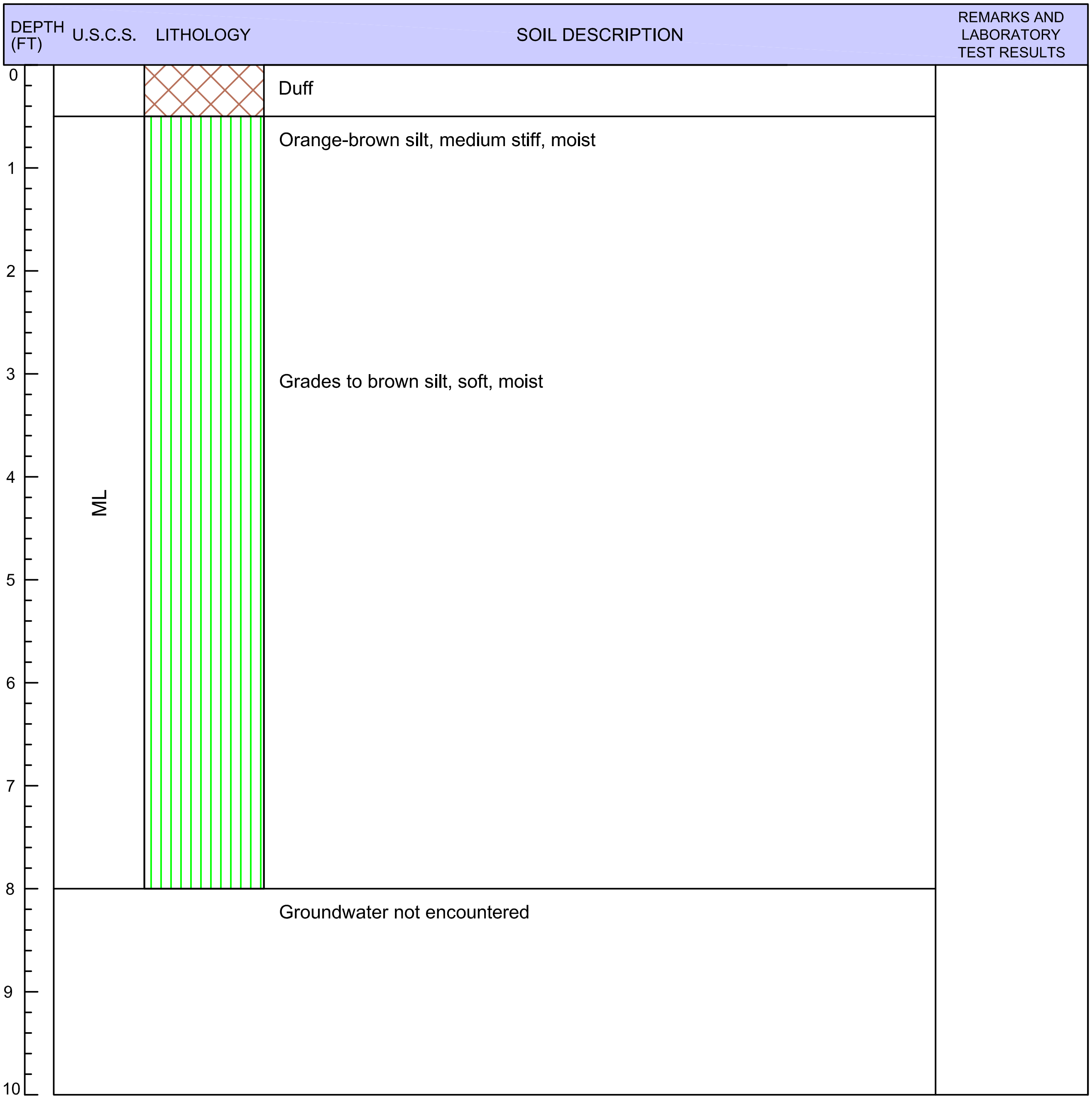
2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-1

TP-2



Duff

Orange-brown silt, medium stiff, moist

Grades to brown silt, soft, moist

Groundwater not encountered

LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE
OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-2

TP-3

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0		▨	Duff	
	ML	▥	Orange-brown silt, medium stiff, moist	
3			Grades to brown sandy silt, soft, moist	
8			Groundwater not encountered	

LEGEND:

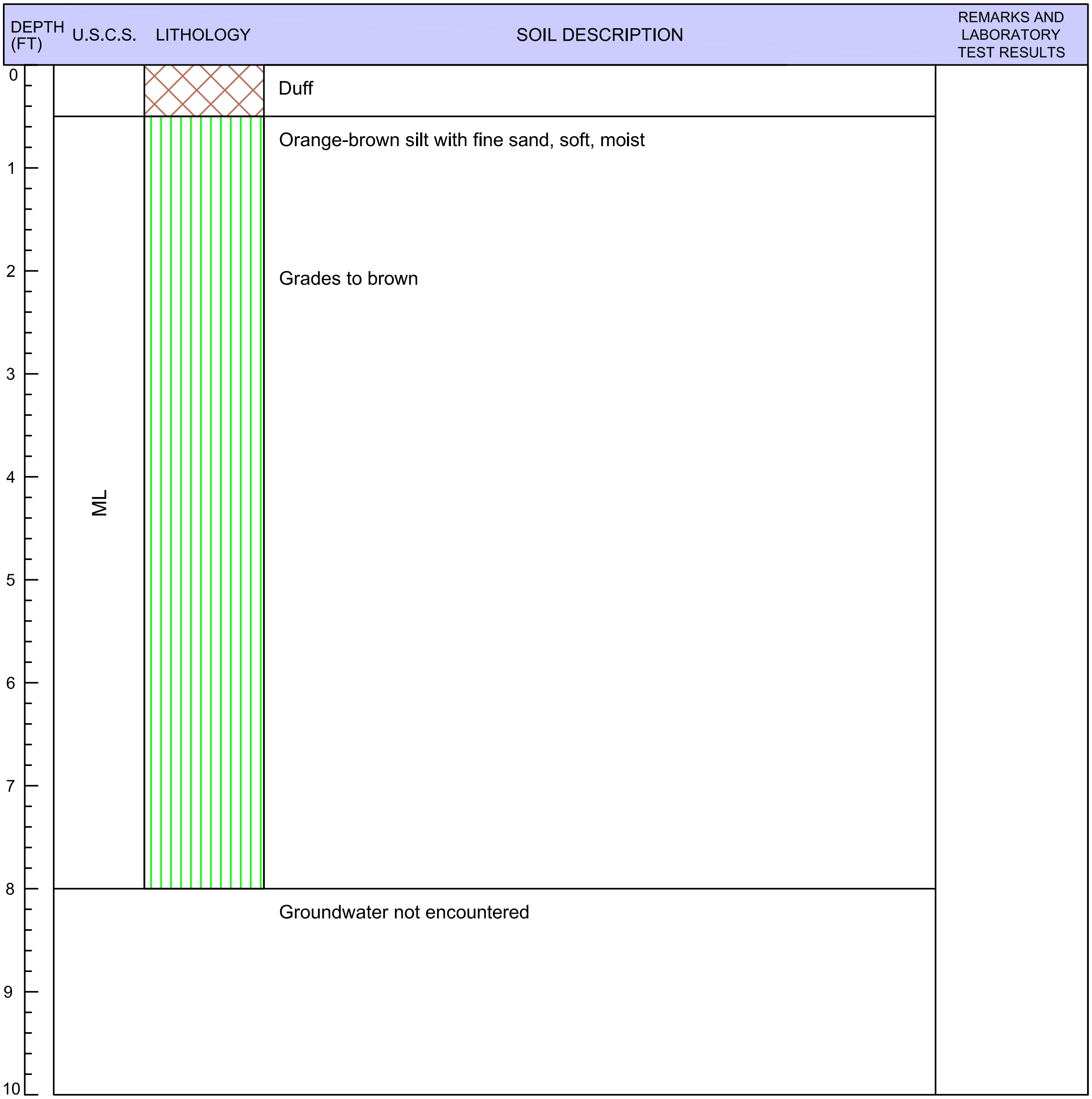
PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE
OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-3

TP-4



DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
		▨	Duff	
	ML	▥	Orange-brown silt with fine sand, soft, moist Grades to brown	
			Groundwater not encountered	

LEGEND:

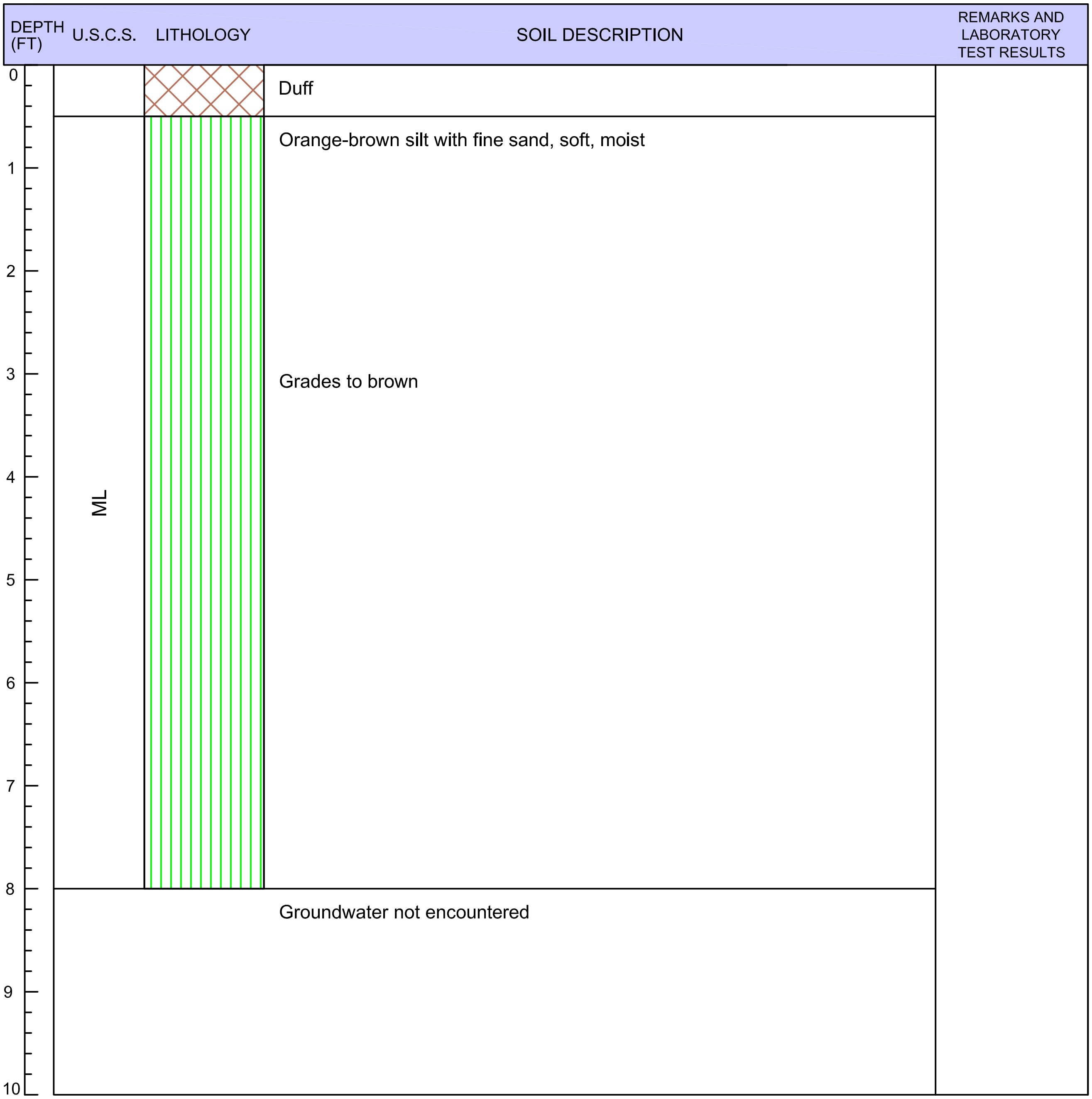
PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE
OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-4

TP-5



Duff

Orange-brown silt with fine sand, soft, moist

Grades to brown

Groundwater not encountered

LEGEND:

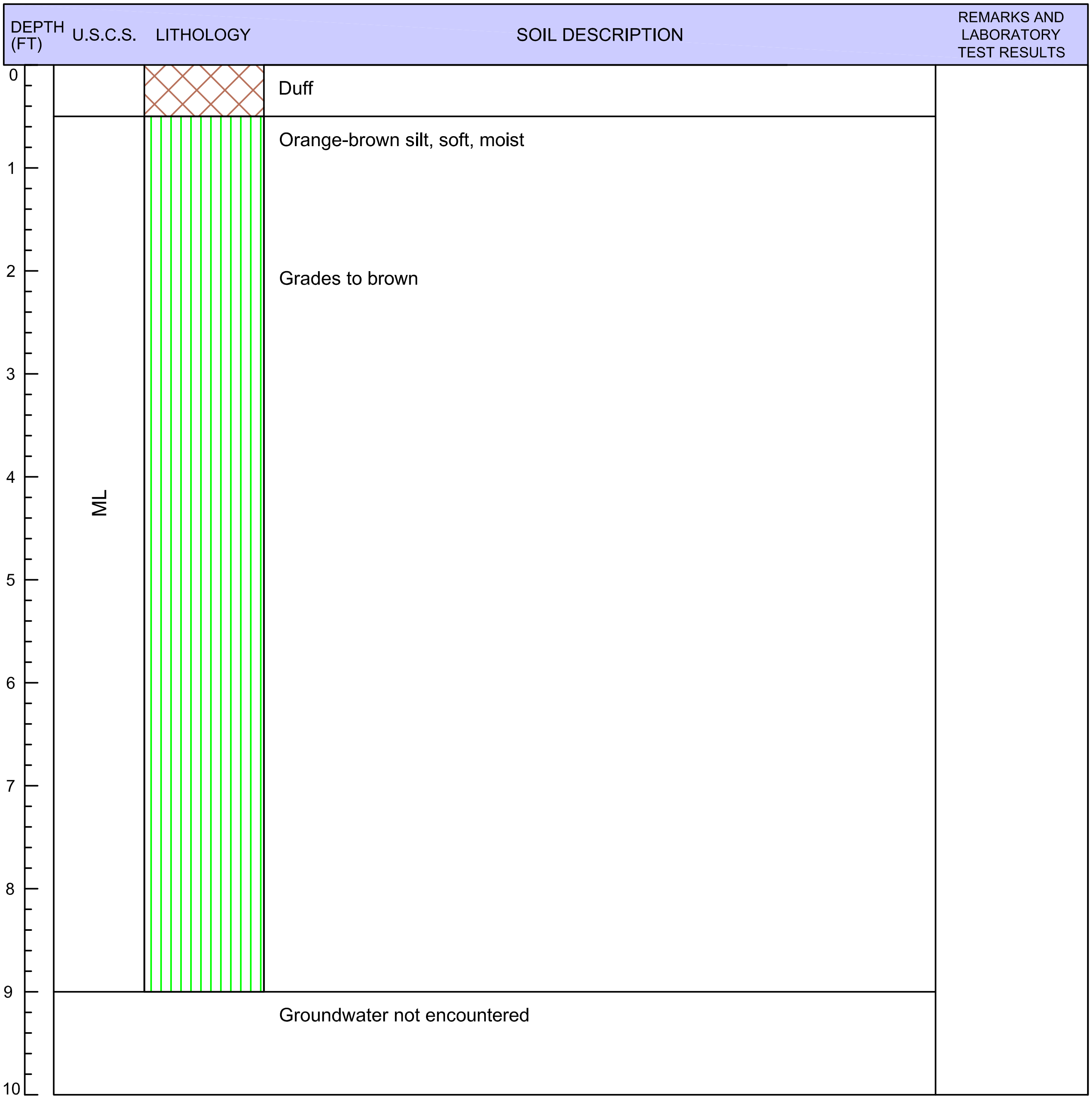
PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE
OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-5

TP-6



Duff

Orange-brown silt, soft, moist

Grades to brown

Groundwater not encountered

LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 9 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE
OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-6

TP-7

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0	ML		Orange-brown silt, soft, moist	
2			Grades to brown	
8			Groundwater not encountered	

LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE

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		▨	Duff	
1	ML	▥	Orange-brown silt, soft, moist	
3			Grades to brown	
8			Groundwater not encountered	
10				

LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE
OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-8

TP-9

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0		▨	Duff	
1	ML	▥	Orange-brown silt, soft, moist	
2		▥	Grades to brown	
8			Groundwater not encountered	
10				

LEGEND:

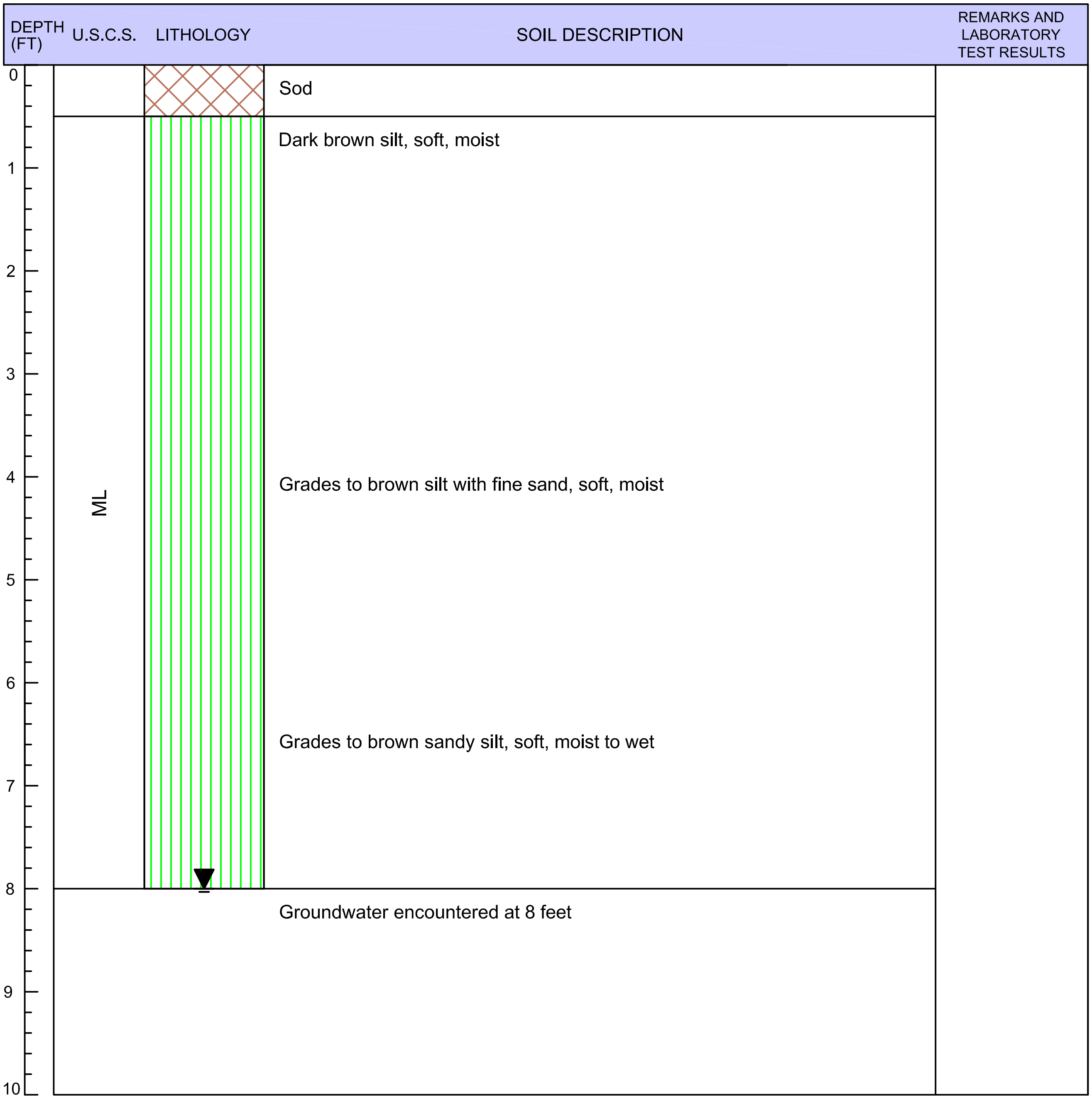
PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE
OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-9

TP-10



Sod

Dark brown silt, soft, moist

Grades to brown silt with fine sand, soft, moist

Grades to brown sandy silt, soft, moist to wet

Groundwater encountered at 8 feet

LEGEND:

PROJECT NO.: 1065-001-01
DATE: JULY 18, 2018
TOTAL DEPTH: 8 FEET
DRILLING EQUIPMENT: EXCAVATOR
LOGGED BY: KEVIN VANDEHEY

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-10

ATTACHMENT B

LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-3
Sample Name: TP-3 0.5'-3.0'
Depth: 0.5 - 3 Feet

Moisture Content (%) 19.4%

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)	99.6
No. 10 (2.00-mm)	98.6
No. 20 (.850-mm)	97.4
No. 40 (.425-mm)	96.5
No. 60 (.250-mm)	95.5
No. 100 (.150-mm)	94.1
No. 200 (.075-mm)	74.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.4
Coarse Sand	1.0
Medium Sand	2.1
Fine Sand	21.9
Fines	74.7
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.14

Cc - -
Cu - -

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-3
Sample Name: TP-3 3.0'-8.0'
Depth: 3 - 8 Feet

Moisture Content (%) 21.6%

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)	99.6
No. 40 (.425-mm)	98.9
No. 60 (.250-mm)	97.4
No. 100 (.150-mm)	95.5
No. 200 (.075-mm)	68.0

Size Fraction	**Percent by Weight**
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	1.0
Fine Sand	30.9
Fines	68.0
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.14

Cc - -
Cu - -

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-5
Sample Name: TP-5 0.5'-3.0'
Depth: 0.5 - 3 Feet

Moisture Content (%) 18.8%

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)	98.3
No. 10 (2.00-mm)	94.8
No. 20 (.850-mm)	92.6
No. 40 (.425-mm)	91.5
No. 60 (.250-mm)	90.6
No. 100 (.150-mm)	89.5
No. 200 (.075-mm)	75.4

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	1.7
Coarse Sand	3.5
Medium Sand	3.3
Fine Sand	16.1
Fines	75.4
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.16

Cc - -
Cu - -

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

Insight Geologic, Inc.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-5
Sample Name: TP-5 3.0'-8.0'
Depth: 3 - 8 Feet

Moisture Content (%) 20.2%

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)	99.5
No. 40 (.425-mm)	98.8
No. 60 (.250-mm)	97.8
No. 100 (.150-mm)	96.6
No. 200 (.075-mm)	85.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	1.2
Fine Sand	13.1
Fines	85.7
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.099

Cc - -
Cu - -

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-10
Sample Name: TP-10 4.0'-6.5'
Depth: 4 - 6 Feet

Moisture Content (%) 37.4%

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)	99.7
No. 20 (.850-mm)	99.2
No. 40 (.425-mm)	98.9
No. 60 (.250-mm)	98.2
No. 100 (.150-mm)	95.8
No. 200 (.075-mm)	74.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.3
Medium Sand	0.8
Fine Sand	24.5
Fines	74.3
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.13

Cc - -
Cu - -

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

Insight Geologic, Inc.

Gradation Analysis Summary Data

Job Name: 2817 Boulevard Road SE
Job Number: 1065-001-01
Date Tested: 7/19/18
Tested By: Kevin Vandehey

Sample Location: TP-10
Sample Name: TP-10 6.5'-8.0'
Depth: 6.5 - 8 Feet

Moisture Content (%) 30.4%

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)	100.0
No. 20 (.850-mm)	99.9
No. 40 (.425-mm)	99.6
No. 60 (.250-mm)	98.9
No. 100 (.150-mm)	96.1
No. 200 (.075-mm)	52.9

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.0
Medium Sand	0.4
Fine Sand	46.8
Fines	52.9
Total	**100.0**

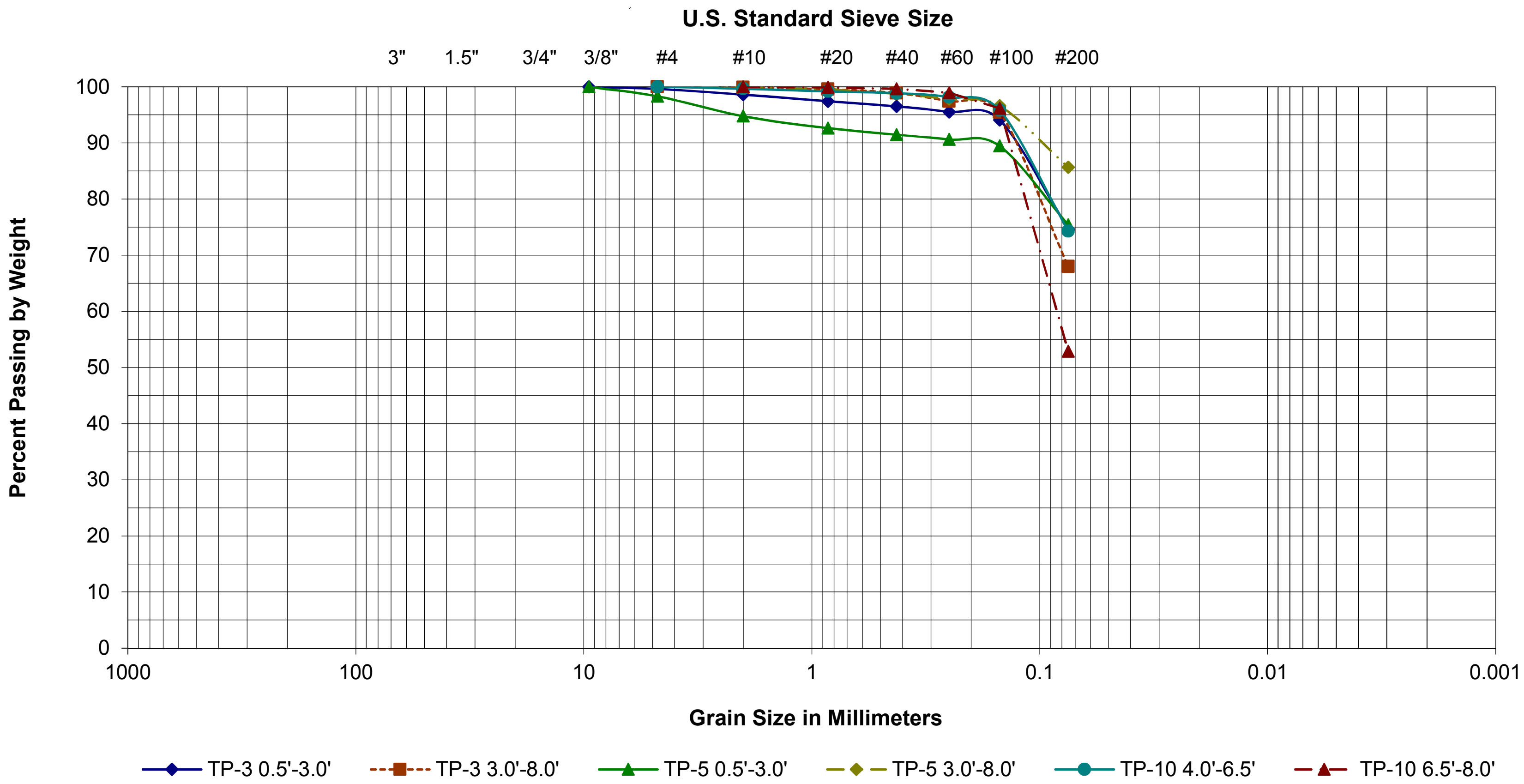
LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.084
D_{90} 0.15

Cc - -
Cu - -

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

INSIGHT GEOLOGIC, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

2817 BOULEVARD ROAD SE

OLYMPIA, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results

Libby Environmental, Inc.
4139 Libby Road NE • Olympia, WA 98506-2518

July 27, 2018

Bill Halbert
Insight Geologic, Inc.
1015 East Fourth Ave
Olympia, WA 98506

Dear Mr. Halbert:

Please find enclosed the analytical data report for the Kapa Const. Blvd. Rd. Res. Dev. Project located in Olympia, Washington.

The results of the analyses are summarized in the attached tables. Applicable detection limits and QA/QC data are included. The sample(s) will be disposed of in 30 days unless we are contacted to arrange long term storage.

Libby Environmental, Inc. appreciates the opportunity to have provided analytical services for this project. If you have any further questions about the data report, please give me a call. It was a pleasure working with you on this project, and we are looking forward to the next opportunity to work together.

Sincerely,

Sherry L. Chilcutt
Senior Chemist
Libby Environmental, Inc.

Phone (360) 352-2110 • Fax (360) 352-4154 • libbyenv@aol.com

Libby Environmental, Inc.

Chain of Custody Record

www.LibbyEnvironmental.com

4139 Libby Road NE
Olympia, WA 98506

Ph: 360-352-2110
Fax: 360-352-4154

Client: Insight Geologic
Address: 1015 East 4th Ave
City: Olympia State: WA Zip: 98506
Phone: 360-754-2128 Fax:
Client Project # 1065-001-01

Date: 7/18/18 Page: 1 of 1
Project Manager: Bill Halbert
Project Name: Kapa Const. Blvd. Rd. Res. Dev.
Location: Olympia City, State: WA
Collector: Kevin Vanderhey Date of Collection: 7/18/18
Email: BillH@InsightGeologic.com

	Sample Number	Depth	Time	Sample Type	Container Type	VOC 8260	NWTPH-Gx	BTEX 8021	NWTPH-HCID	NWTPH-Dx	NWTPH-Dx/Dx	c PAH 8270	PAH 8270	Semi Vol 8270	PCB 8082	MTCA 5 Metals	RCRA 8 Metals				Field Notes
1	S-1	6"	13:00	Soil	4oz, 2VOA				X							X					
2	S-2	6"	13:10						X							X					
3	S-3	6"	13:25						X							X					
4	S-4	6"	13:35						X							X					
5	S-5	6"	13:50						X							X					
6	S-6	6"	14:00						X							X					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					
17																					

Relinquished by:	Date / Time	Received by:	Date / Time
Kevin V	7/18/18 15:40	Melissa	7/19/18 15:40

Sample Receipt

Good Condition? [✓ Y] N
Temp. 23.2 °C
Seals Intact? [✓ Y] N N/A
Total Number of Containers 18

Remarks: call if hits on HCID

TAT: 24HR 48HR [✓ 5-DAY]

LEGAL ACTION CLAUSE: *In the event of default of payment and/or failure to pay, Client agrees to pay the costs of collection including court costs and reasonable attorney fees to be determined by a cout of law.*

Distribution: White - Lab, Yellow - File, Pink - Originator

Libby Environmental, Inc.

4139 Libby Road NE
Olympia, WA 98506
Phone: (360) 352-2110
FAX: (360) 352-4154
Email: libbyenv@aol.com

KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

Hydrocarbon Identification by NWTPH-HCID for Soil

Sample Number	Date Analyzed	Surrogate Recovery (%)	Gasoline (mg/kg)	Diesel (mg/kg)	Oil (mg/kg)
Method Blank	7/20/18	100	nd	nd	nd
S1	7/20/18	106	nd	nd	nd
S2	7/20/18	106	nd	nd	nd
S3	7/20/18	109	nd	nd	nd
S4	7/20/18	117	nd	nd	nd
S5	7/20/18	114	nd	nd	nd
S6	7/20/18	110	nd	nd	nd
S6 Dup	7/20/18	117	nd	nd	nd
Practical Quantitation Limit			20	50	250

"nd" Indicates not detected at listed detection limits.
"D" Indicates detected above the listed detection limit.
"int" Indicates that interference prevents determination.

ACCEPTABLE RECOVERY LIMITS FOR SURROGATE (2-F Biphenyl): 65% TO 135%

ANALYSES PERFORMED BY: Melissa Harrington

KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

Analyses of Total Metals in Soil by EPA Method 7010 Series

Sample Number	Date Analyzed	Lead (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Arsenic (mg/kg)
Method Blank	7/21/18	nd	nd	nd	nd
S1	7/21/18	40	nd	11	nd
S2	7/21/18	73	nd	25	nd
S3	7/21/18	42	nd	15	nd
S4	7/21/18	64	nd	8.6	nd
S5	7/21/18	57	nd	19	nd
S6	7/21/18	16	nd	26	nd
Practical Quantitation Limit		5.0	1.0	5.0	5.0

"nd" Indicates not detected at the listed detection limits.

ANALYSES PERFORMED BY: Dirk Peterson

KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

QA/QC for Total Metals in Soil by EPA Method 7010 Series

Sample Number	Date Analyzed	Lead (% Recovery)	Cadmium (% Recovery)	Chromium (% Recovery)	Arsenic (% Recovery)
LCS	7/21/18	95%	90%	90%	108%
L180718-3 MS	7/21/18	93%	90%	86%	
L180718-3 MSD	7/21/18	97%	92%	89%	93%
RPD	7/21/18	4%	2%	3%	100%

ACCEPTABLE RECOVERY LIMITS FOR MATRIX SPIKES: 75%-125%
ACCEPTABLE RPD IS 20%

ANALYSES PERFORMED BY: Dirk Peterson

Libby Environmental, Inc.

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FAX: (360) 352-4154
Email: libbyenv@aol.com

KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

Analyses of Total Mercury in Soil by EPA Method 7471

Sample Number	Date Analyzed	Mercury (mg/kg)
Method Blank	7/22/18	nd
S1	7/22/18	nd
S2	7/22/18	nd
S3	7/22/18	nd
S4	7/22/18	nd
S5	7/22/18	nd
S6	7/22/18	nd
Practical Quantitation Limit		0.5

"nd" Indicates not detected at the listed detection limits.

ANALYSES PERFORMED BY: Sherry Chilcutt

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KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Olympia, Washingon
Libby Project # L180719-3
Client Project # 1065-001-01

QA/QC for Total Mercury by EPA Method 7471

Sample Number	Date Analyzed	Mercury (% Recovery)
LCS	7/22/18	96%
L180718-3 MS	7/22/18	109%
L180718-3 MSD	7/22/18	102%
RPD	7/22/18	6%

ACCEPTABLE RECOVERY LIMITS FOR MATRIX SPIKES: 75%-125%
ACCEPTABLE RPD IS 20%

ANALYSES PERFORMED BY: Sherry Chilcutt

Libby Environmental, Inc.

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Olympia, WA 98506
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Email: libbyenv@aol.com

KAPA CONST. BLVD. RD. RES. DEV. PROJECT
Insight Geologic, Inc.
Libby Project # L180719-3
Date Received 7/19/2018
Time Received 3:40 PM
Received By MH

Sample Receipt Checklist

Chain of Custody

1. Is the Chain of Custody is complete? ☑ Yes ☐ No

2. How was the sample delivered? ☑ Hand Delivered ☐ Picked Up ☐ Shipped

Log In

3. Cooler or Shipping Container is present. ☐ Yes ☑ No ☐ N/A

4. Cooler or Shipping Container is in good condition. ☐ Yes ☐ No ☑ N/A

5. Cooler or Shipping Container has Custody Seals present. ☐ Yes ☐ No ☑ N/A

6. Was an attempt made to cool the samples? ☐ Yes ☑ No ☐ N/A

7. Temperature of cooler (0°C to 8°C recommended) N/A °C

8. Temperature of sample(s) (0°C to 8°C recommended) 23.2 °C

9. Did all containers arrive in good condition (unbroken)? ☑ Yes ☐ No

10. Is it clear what analyses were requested? ☑ Yes ☐ No

11. Did container labels match Chain of Custody? ☑ Yes ☐ No

12. Are matrices correctly identified on Chain of Custody? ☑ Yes ☐ No

13. Are correct containers used for the analysis indicated? ☑ Yes ☐ No

14. Is there sufficient sample volume for indicated analysis? ☑ Yes ☐ No

15. Were all containers properly preserved per each analysis? ☑ Yes ☐ No

16. Were VOA vials collected correctly (no headspace)? ☑ Yes ☐ No ☐ N/A

17. Were all holding times able to be met? ☑ Yes ☐ No

Discrepancies/ Notes

18. Was client notified of all discrepancies? ☐ Yes ☐ No ☑ N/A

Person Notified: ________ Date: ________

By Whom: ________ Via: ________

Regarding: ________

19. Comments.

ATTACHMENT C

SEISMIC DESIGN PARAMETERS

USGS Design Maps Summary Report

User–Specified Input

Report Title Boulevard Road Residential Development
Thu July 26, 2018 18:21:38 UTC

Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 47.0232°N, 122.8666°W

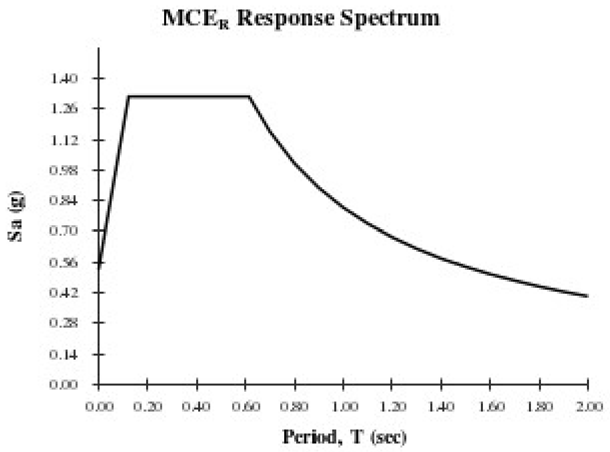
Site Soil Classification Site Class D – "Stiff Soil"

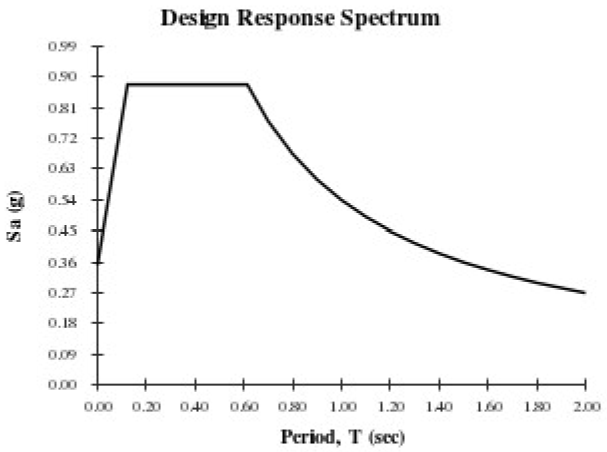
Risk Category I/II/III

USGS–Provided Output

S_S = 1.316 g
S_{MS} = 1.316 g
S_{DS} = 0.878 g
S_1 = 0.539 g
S_{M1} = 0.808 g
S_{D1} = 0.539 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.


MCE$_R$ Response Spectrum


Design Response Spectrum

Design Maps Detailed Report

2012/2015 International Building Code (47.0232°N, 122.8666°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1]	S_S = 1.316 g
From Figure 1613.3.1(2) [2]	S_1 = 0.539 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index $PI > 20$, • Moisture content $w \ge 40\%$, and • Undrained shear strength $\bar{s}_u < 500$ psf		

F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.316 g, F_a = 1.000

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.539 g, F_v = 1.500

Equation (16-37): $S_{MS} = F_aS_S = 1.000 \times 1.316 = 1.316$ g

Equation (16-38): $S_{M1} = F_vS_1 = 1.500 \times 0.539 = 0.808$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39): $S_{DS} = ⅔\, S_{MS} = ⅔ \times 1.316 = 0.878$ g

Equation (16-40): $S_{D1} = ⅔\, S_{M1} = ⅔ \times 0.808 = 0.539$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{DS} < 0.167g$	A	A	A
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.878 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{D1} < 0.067g$	A	A	A
$0.067g \leq S_{D1} < 0.133g$	B	B	C
$0.133g \leq S_{D1} < 0.20g$	C	C	D
$0.20g \leq S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.539 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ “the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)” = D

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf

2. *Figure 1613.3.1(2)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

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 Kapa Construction (Client) and their 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. Insight Geologic cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by Insight Geologic 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.