VISTA VIEWS AT BLACK LAKE
Agency # TUM-22-0991
Drainage Report

Prepared for: **Rob Rice Homes**
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Report Date: **August 6, 2024**

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Project No: 21-102

Project Name: VISTA VIEWS AT BLACK LAKE

H:\Office\JOBS\2021\21-102 Vista Views at Black Lake\LAND USE\Reports & Calculations\DRAINAGE\RPT - Drainage - 2024.04.23

I hereby state that this Preliminary Drainage Control Plan for, Vista Views at Black Lake located at 3825 58th Ln SW, Tumwater, WA 98502, has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that the CITY OF TUMWATER does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

Signature

August 6, 2024

Date

Seal

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DRAINAGE REPORT

Section 1 – Project Description

The Vista Views at Black Lake project is located at the southeast corner of the intersection of Black Lake-Belmore Rd SW and 49th Avenue SW in the City of Tumwater in Section 32, Township 18, Range 2 West, W.M. on tax parcel numbers 12832310700 and 12832310800; The site addresses are 3825 58th Ln SW, Tumwater, WA 98502.

The project proposes to construct Subdivide 55 acres into 186 single family lots. Proposed construction will include 7.25 acres of roads with 2.23 acres of sidewalk, and required drainage, landscaping, sewer, and water service improvements. The infiltration basin will be sized to include a future development to the east with an estimated 1.08 acres of roads with 0.35 ac sidewalks. Current assessment is based on Thurston County Assessor's office web site at $685,800. See proposed Site Plan on page 3.

The proposed project will require grading, encroachment, building, and utility permits. Water and sewer will be provided via connections to the City of Tumwater's utilities. Electricity and natural gas will be provided by Puget Sound Energy. Zoning for the property is SFL – Single Family Low Density Residential.

The site will have four basins North (access road), Middle, East (future), and 58th Lane basins. The site is also split into two Threshold Discharge Areas, Wetland A and 58th Lane. All the basins except 58th Lane drain to wetland A. 58th Lane drains to existing roadside ditches.

> ***North Access Road Basin*** consists of the northern 400 LF of the access road from 49th Avenue SW with and includes road, sidewalks, and landscaping. Runoff from this basin will be infiltrated 100% in an adequately sized R-Tank infiltration Gallery in Tract D1. Treatment will be provided by a BioPod. Treatment offline rate 0.0395 cfs.
>
> **Middle Basin** consists of the new single family lots landscaping, road, and sidewalks. **All roof areas will be connected to individual dry wells for 100% infiltration.** Runoff will be collected by catch basins and conveyed to a infiltration basin near Wetland A. Treatment will be provided by biopods.
>
> **Future East Development** consists of a possible future plat to the east. The Future East Basin will flow into the Middle basin and to the infiltration basin adjacent to Wetland A.
>
> **58th Lane Basin** consists of the frontage improvements including associated landscaping. The runoff from this basin will be collected by catch basins and routed to a BioPod for treatment and infiltration trench for 100% infiltration.
>
> **49TH Avenue SW** frontage improvement with less than 10,000 SF of new impervious area. BioPod or Filterra will provide treatment. Release to Wetland A.

Refer to Basin map on page 5.

	Table 1.1 - Area Summary All areas measured in acres					
Pre-Developed	**North**	**Middle**	**Future East Dev**	**49th Ave SW**	**58th Lane**	**Total**
Forest (C/D)	0.78	37.84	8.86	0.5	1.29	49.27
Total	0.78	37.84	8.86	0.5	1.29	49.27
100-Year Pre-Developed Flow Rate	POC 1 – 7.25 CFS				POC 2 - 0.19 CFS	
Developed	**North**	**Middle**	**Future East Dev**	**49th Ave SW**	**58th Lane**	**Total**
Roof*		11.10	2.33			13.43
Roads	0.26	5.45	1.08	0.30	0.46	7.55
Sidewalk	0.09	1.65	0.35	0.10	0.14	2.33
Driveway		1.71	0.36			2.07
Pasture (C)	0.43	15.48	4.74	0.10	0.69	23.79
Forest (A/B Flat)						
Pond		2.45				2.45
Total	0.78	37.84	8.86	0.50	1.29	49.27
100-Year Developed Flow Rate	POC 1 – 0.83 CFS				POC 2 - 0.00 CFS	0.83 CFS

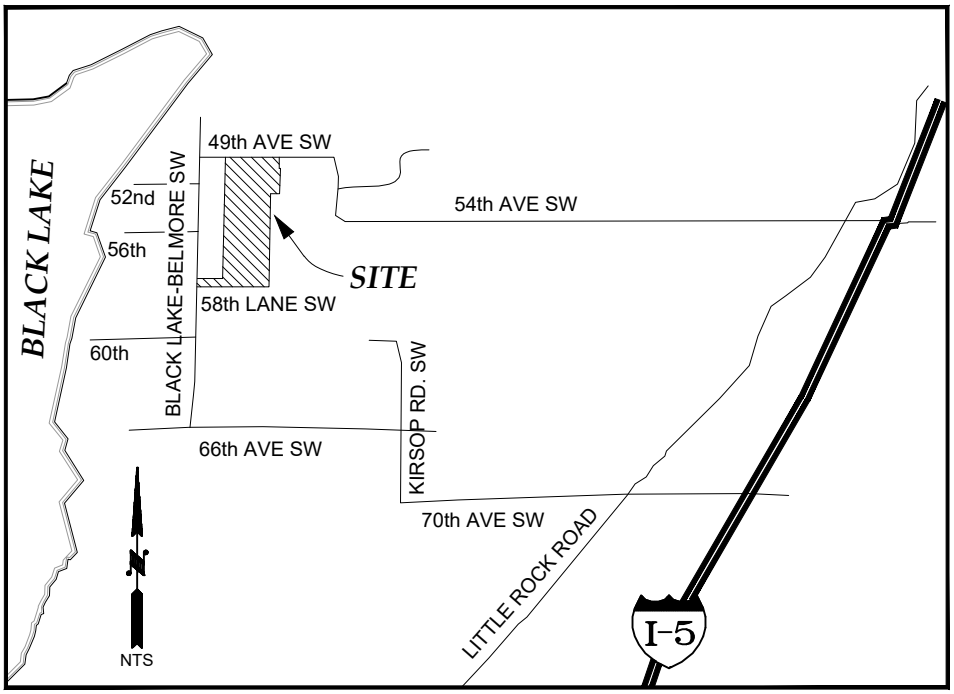
NOTE : All roofs are infiltrated individual drywells.

POC 1 = includes North, Middle, Future East Development, and 49th Avenue = 47.48 ac

POC 2 = includes 58th Lane = 1.29 ac

VISTA VIEWS AT BLACK LAKE

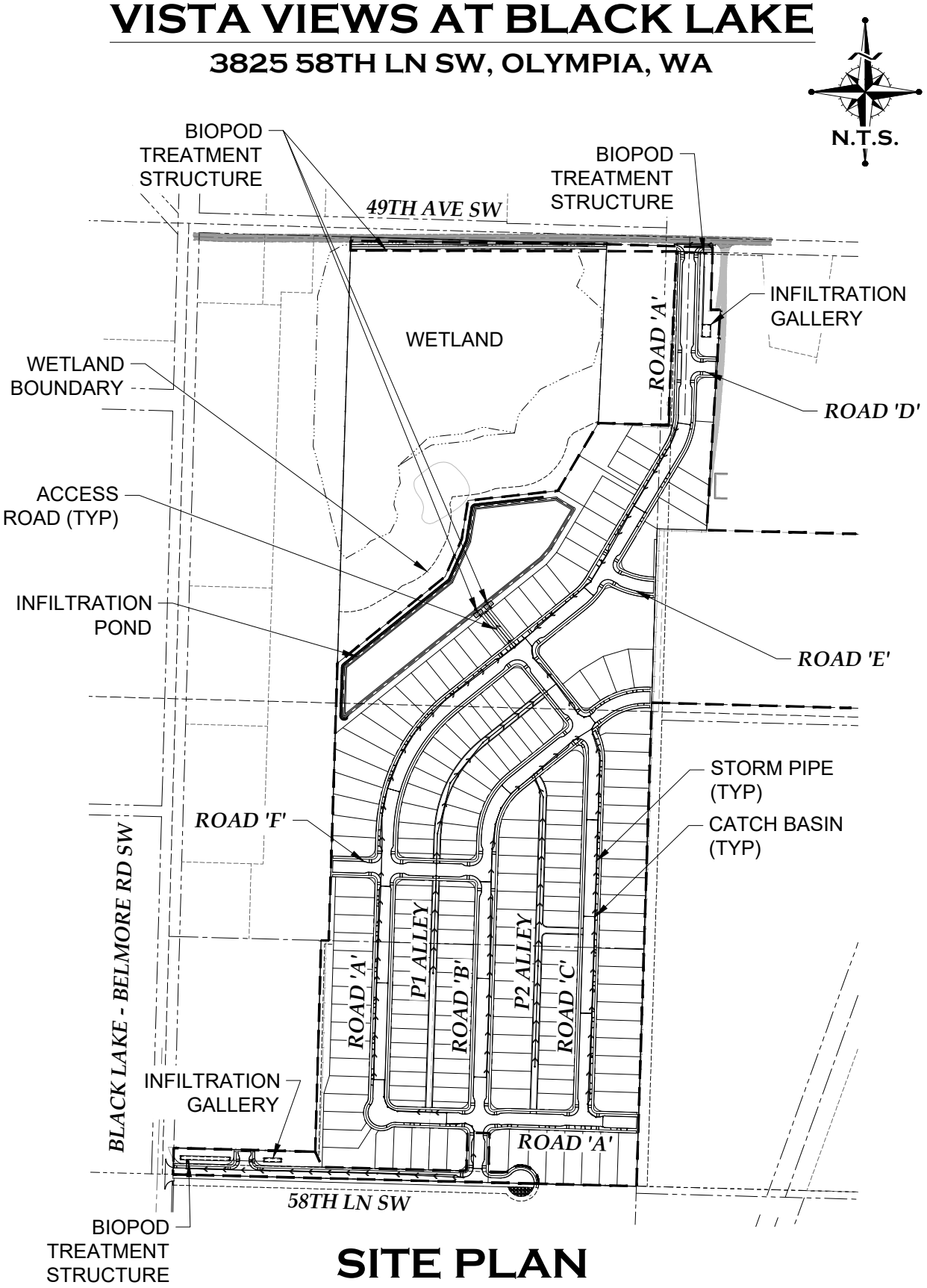
3825 58TH LN SW, OLYMPIA,WA



VICINITY MAP

VISTA VIEWS AT BLACK LAKE

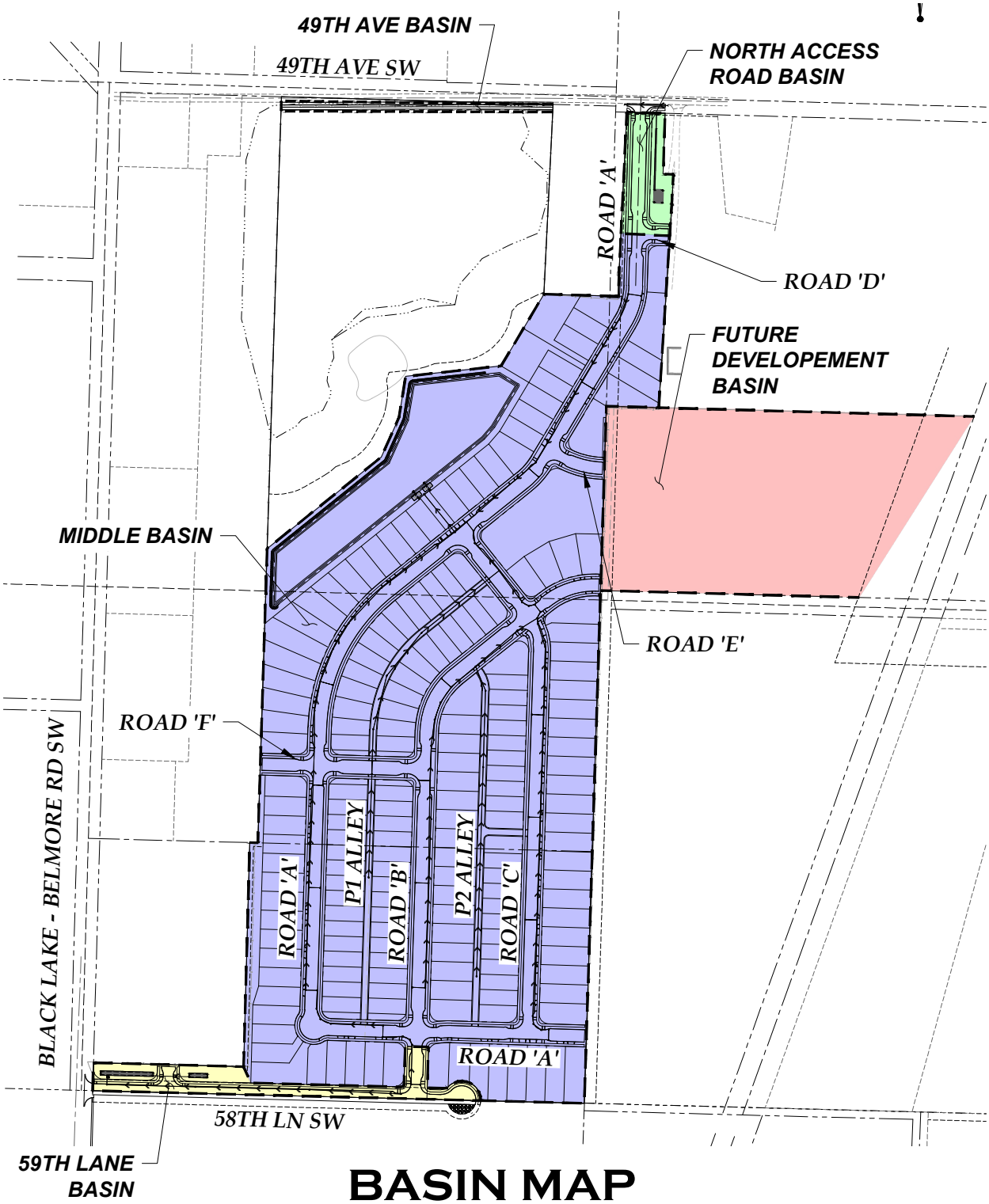
3825 58TH LN SW, OLYMPIA, WA



SITE PLAN

VISTA VIEWS AT BLACK LAKE

3825 58TH LN SW, OLYMPIA, WA



BASIN MAP

The City of Tumwater 2022 Drainage Design and Erosion Control Manual (DDECM) summarizes the thresholds which determine the applicability of the minimum requirements for each project. All new development projects are required to comply with Minimum Requirement #2; Construction Stormwater Pollution Prevention and Minimum Requirement #4; Preservation of Natural Drainage Systems and Outfalls. Table 1.2 summarizes the thresholds which trigger compliance with the remaining minimum requirements.

Table 1.2 – Thresholds for Minimum Requirement Applicability

	Required to comply with Minimum Requirements #1 through #5 & #11	Required to comply with Minimum Requirements #1 through #11
≥ 2,000 ft^2 of new, replaced, or new + replaced hard surface area	X	
≥ 7,000 ft^2 land disturbing activity	X	
≥ 5,000 ft^2 new + replaced hard surface area		X
Converts ≥ 0.75 acre of vegetation to lawn or landscape		X
Coverts ≥ 2.5 acres of native vegetation to pasture		X

This project adds 30.36 acres of impervious area; therefore, all minimum requirements apply.

The applicable minimum requirements are:

- Minimum Requirement #1: Preparation of Stormwater Site Plans
- Minimum Requirement #2: Construction Stormwater Pollution Prevention
- Minimum Requirement #3: Source Control of Pollution
- Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls
- Minimum Requirement #5: On-Site Stormwater Management
- Minimum Requirement #6: Runoff Treatment
- Minimum Requirement #7: Flow Control
- Minimum Requirement #8: Wetlands Protection
- Minimum Requirement #9: Operation and Maintenance
- Minimum Requirement #10: Financial Liability
- Minimum Requirement #11: Off-Site Analysis

Addressing these eleven minimum requirements, it is anticipated that the proposed project will have little or no adverse effects on the downstream and surrounding hydrology. Each of the minimum requirements is discussed below.

Minimum Requirement #1: Preparation of Stormwater Site Plans

The main components of Stormwater Site Planning are Construction Stormwater Pollution Prevention Planning and Permanent Stormwater Control Planning. This Drainage Report, a Construction Stormwater Pollution Prevention Plan, Soils Report, Maintenance and Source Control Manual, and copy of the proposed Maintenance Covenant for stormwater facilities will be submitted as part of the Vista Views at Black Lake Drainage Control Plan to meet this requirement.

Minimum Requirement #2: Construction Stormwater Pollution Prevention

A Construction Stormwater Pollution Prevention Plan (C-SWPPP) will be developed to address erosion and sediment control anticipated during construction. A Construction NPDES permit will be obtained prior to construction. The C-SWPPP will address all thirteen elements as required by the Department of Ecology.

Minimum Requirement #3: Source Control of Pollution

Source control BMPs are used to prevent stormwater from coming in contact with pollutants and are used as a cost-effective means of reducing pollutants in stormwater. The selection of permanent source control BMPs is based on the activities likely to occur on the site and the pollutants associated with those activities.

Methods to address source control of pollution from the post-developed project site will be provided in the Maintenance and Source Control Manual submitted as part of the Drainage Control Plan for this project. Construction source control BMPs will be addressed in the C-SWPPP.

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

LID Development techniques will be used to preserve existing site runoff patterns to the maximum extent feasible. In the existing condition, stormwater runoff sheet flows from the east and southeast towards Wetland A. The 58th Lane Basin generally sheet flows to the east toward existing roadside ditches along Black Lake-Belmore Road.

In the developed condition, Runoff generated from proposed roof areas will be infiltrated in individual drywells located on each lot per BMP LID T5.10A. Runoff from the driveways, road, and landscape areas will flow to catch basins and will be piped to either an infiltration basin or infiltration/gallery trench. Soil in the disturbed lawn/landscape areas will be amended per BMP T5.13 to increase treatment and infiltration capacity and to reduce runoff from the site. Stormwater runoff from the preserved native areas of the project will continue to sheet flow to Wetland A in the northwest corner of the property, matching existing conditions. 49th Avenue will be treated by a biopod or Filterra, and released to wetland A.

A WWHM model (using 15-minute time steps) of stormwater runoff tributary to the wetland indicates a pre-developed 100-year flow of 7.17cfs for tributary to wetland A and 0.19 cfs tributary to existing roadside ditches on Black Lake Belmore Road. Development of this site will result in 0.83 cfs runoff from all developed areas.

Minimum Requirement #5: On-Site Stormwater Management

The 2022 DDECM summarizes the requirements for employing on-site stormwater management BMPs, providing treatment, and flow control in decision charts. This project proposes to satisfy Minimum Requirement #5 by meeting the LID Performance Standard as defined in the 2022 DDECM

This project proposes to implement Post-Construction Soil Quality and Depth (Ecology BMP T5.13) in all new and disturbed lawn/landscape areas to retain greater stormwater functions, including increased infiltration potential and treatment of pollutants and sediments resulting from development. This project also proposes the use of a infiltration basin (Ecology BMP T7.10) to provide 100% infiltration. The north access road and 58th Lane will discharge to infiltrate trenches and galleries (Ecology BMP T7.20) to infiltrate 100% of tributary stormwater runoff from the proposed improvements. 49th Avenue SW will be treated and released to the wetland.

The combination of stormwater BMPs used for this project results in the site meeting the Low Impact Development Performance Standard as illustrated on Pages 29 and 36 of the site infiltration sizing Analysis WWHM report. See attached report in Appendix 1.

The proposed improvements will retain approximately 14 acres of existing vegetation in Wetland A and its buffers.

No impervious credits for new or existing trees are used in the calculations.

Minimum Requirement #6: Runoff Treatment

Table 1.3 – Thresholds for Minimum Requirement #6: Runoff Treatment

	Required to Comply
< 5,000 sf of total effective pollution-generating hard surface (PGHS)	
≥ 5,000 sf of total effective pollution-generating hard surface (PGHS)	X
< ¾ acres of pollution-generating pervious surface (PGPS) from which there will be a surface discharge in a natural or artificial conveyance system from the site	
≥ ¾ acres of pollution-generating pervious surface (PGPS) from which there will be a surface discharge in a natural or artificial conveyance system from the site	X

Table 1.3 above summarizes the thresholds for construction of stormwater treatment facilities. This project will add 7.24 of PGHS; therefore, treatment is required.

The proposed infiltration systems are within one quarter mile of freshwater bodies (wetland A) and therefore required to provide phosphorous control and enhanced treatment. This project proposes to provide phosphorus and enhanced treatment by using biopods followed by infiltrating 100% of stormwater through infiltration facilities. See further explanation of water quality facility sizing in Section 4 of this Drainage Report.

Minimum Requirement #7: Flow Control

Table 1.4 – Thresholds for Minimum Requirement #7: Flow Control	
	Required to Comply
< ¾ acres of native vegetation converted to lawn/landscape or < 2.5 acres converted to pasture from which there is a surface discharge in a natural or artificial conveyance system from the site	
≥ ¾ acres of native vegetation converted to lawn/landscape or ≥ 2.5 acres converted to pasture from which there is a surface discharge in a natural or artificial conveyance system from the site	X
< 10,000 sf of effective impervious area	
≥ 10,000 sf of effective impervious area	X
≥ 0.10 cfs increase in the 100-year storm flow frequency using 1-hour time steps or ≥ 0.15 cfs increase in the 100-year storm flow frequency using 15-minute time steps	X

Table 1.4 above summarizes the thresholds for achievement of the standard flow control requirement for Western Washington. This project will add 13.46 acres of effective impervious surface. Flow control is required.

This project proposes to provide flow control using infiltration basins (T7.10) and infiltration trenches and galleries (T7.20). See further explanation of flow control facility sizing in Section 4 of this Drainage Report.

Minimum Requirement #8: Wetlands Protection

49th Avenue Basin is the only basin with a discharge to a wetland. The other basins, North, Middle, Future East and 58th Lane are all infiltrated100%.

There is no other option than to release stormwater runoff to the existing wetland (matching existing conditions). This wetland has a contributing basin of >250 acres so I'm sure the impacts from these improvements (>0.5 ac new impervious) will not materially impact the hydroperiod (Core Req 8). I'm also confident that not detaining this runoff will not impact stream durations (Core Req 7). My only concern is that the drainage manual pretty clearly states that Category II wetlands require hydroperiod monitoring for an entire year to establish the hydroperiod. That feels unnecessary for such a minor improvement and I think there may be some wiggle room in interpretation of the DDECM that I'm hoping you'll go with me on.

Technically, the threshold discharge area for this project is the entire project. That is – all onsite areas draining to the onsite wetland A. While our development area is being mitigated with infiltration trenches and ponds, the frontage is still technically part of that TDA. However, the frontage improvements look like they will not create more than 10,000 sf of impervious area and all other onsite areas will be infiltrated rendering those impervious areas "ineffective". The flow chart for determining wetland protection level requirements (Figure 2.4 of the DDECM) states that wetland monitoring is only required for Category II wetlands which trigger the thresholds for Core Requirement 7 (>10,000 sf effective impervious surface). Since all onsite impervious surfaces will be infiltrated (i.e. ineffective), the only effective impervious

surfaces on this site are those created with the frontage improvements. If we keep that under 10,000 sf, we should not trigger the requirement for wetlands protection.

Minimum Requirement #9: Operation and Maintenance

Proper operation and maintenance of proposed stormwater facilities is a vital component to the success of stormwater mitigation. A Maintenance and Source Control Manual and Operation and Maintenance Agreement will be prepared and are included as part of the Drainage Control Plan for the Vista Views at Black Lake project.

Minimum Requirement #10: Financial Liability

Financial guarantees will be provided to ensure that:

1. The project will operate according to the design approved by the project engineer, and
2. Operation of erosion control facilities will provide protection against siltation of surface water, erosion, damage to permanent stormwater BMPs, and damage to adjacent properties.

Minimum Requirement #11: Off-Site Analysis and Mitigation

An off-site analysis was conducted to determine any potential water quality, erosion, slope stability, or drainage impacts that may be caused or aggravated by the proposed improvements. This project will adequately treat stormwater and infiltrate 100% of developed runoff. Downstream impacts are not anticipated.

See detailed analysis of off-site impacts in Section 3 of this report.

Section 2 – Existing Conditions Description

Section 2.1 Topography

The topography of the site is level with slopes 3% or less sloping to the northwest and southwest. Two ditches cross the southern half of the site. Ditch A flows from east to west and Ditch B south to north. The two ditches drain to a pipe system along the west property line that empties into the wetland area.

No Ravines, Gullies, Steep slopes, or Erosion hazards have been located on the site.

Section 2.2 Ground Cover

Most of the site is pasture with some scattered trees. The north 25% includes wetlands with trees. The existing site is ranching land, currently used to raise cattle. The site is mostly grassland with some trees and other vegetation mostly on the northern boundary. There are several fence lines running north/south and east/west to contain livestock. The approximate northernmost quarter of the site is a densely vegetated wetland with a small pond. The site is relatively flat with the exception of a ridge along the central eastern property boundary.

Section 2.3 Drainage

Site slopes to the west with 3% slopes to the farm pond and Wetland A. The south half of the site has a shallow ditch system connected to a culvert system draining to the north and into Wetland A. A small portion of the site drains to ditches along 58th Lane and to culverts under Black Lake Belmore Road.

Off-site drainage to the property includes the wetland area north of 49th Avenue SW flows drains to culverts under 49th to the south and onto the site, Wetland A. The runoff from the wetland to the north of 49th Avenue SW combines with the flow from the site and leaves the site to the southwest. Culverts under Black Lake Belmore Road convey the combined runoff to the west and to Black Lake approximately 3,000 feet to the west.

Section 2.4 Soils

The soils encountered by the Riley Group during field exploration include sands and gravels with variable silt content interpreted as glacial outwash. Silt content was generally traced to some isolated areas of silty sand, with some instances of dense to very dense sands and gravels, interpreted as glacial till. The apparent till was encountered at depths ranging from five to eight feet below the existing ground surface in exploration pits on the southwest portion of the site.

Soil infiltration rate was estimated by pit testing in 9 pits. The native infiltration rates varied from 3.84 to 27.91 inches/hour. The native rates were reduced by applying safety factors for testing, geometry and plugging to provide a design rate. The infiltration rate for the infiltration pond includes a geometry correction factor of 0.25, a testing correction factor of 0.5 and a plugging factor of 0.8. Results in an average design infiltration rate of 1.1 in/hr. The infiltration rate for the smaller infiltration trenches has an geometry factor of 1.0, testing correction of 0.5, and a plugging factor of 0.8. An average design infiltration rate of 4.4 in per hour. 4.0 inch per hour is used for design.

Test Pit	$I_{Measured}$ Rate (in/hr)	Infiltration Pond I_{Design} Rate (in/hr)	Infiltration Trenches I_{Design} Rate (in/hr)
IT-1	5.76	2.3	2.3
IT-2	19.80	2.0	7.9
IT-3	5.16	0.5	2.1
IT-4	10.08	1.0	4.0
IT-5	3.84	0.4	1.5
IT-6	11.0	1.1	4.4
IT-7	9.12	0.9	3.6
IT-8	6.48	0.6	2.6
IT-9	27.94	2.8	11.2
Average Infiltration Rate	-	1.1	4.4

Use 1.1 in/hr for pond, and 4.0 for infiltration trenches

See Appendix 3 for a copy of the soils/geotechnical reports.

- Pilot Infiltration Testing April 10, 2024 by Riley Group
- Preliminary Geotechnical Engineering Report Bodenhamer Property June 13, 2023 by Riley Group
- Groundwater level monitoring August 19, 2022 by Riley Group

Section 2.5 Critical Areas

A Critical Areas Report has been prepared by Enviro Vector and included in Appendix 3. The report identifies Wetlands A, B, C, and a farm pond. Wetland A is categorized as Category II wetland. Wetlands B and C are category IV wetlands. The farm pond is artificially constructed and is not regulated. Wetlands B and C will be filled as part of the project and will be compensated by enhancing and adding to Wetland A.

Based on Thurston County Geo Data the site contains portions of class 1 and 2 Critical Aquifer Recharge areas. In addition, a portion of the northwest corner of the site lies in a 5- and 10-year Wellhead Protection area for the Timberlane Mobile Estates (community – source ID 8838302)

No TMDL is mapped on the subject property by the Department of Ecology Water Quality Atlas Database. Black Lake located 3,000 feet to the west is included on the Washington DOE 303(d) list for phosphorus.

Section 2.6 Adjacent Areas

The subject site is comprised of two irregular-shaped parcels of land approximately 55 acres in size. The site is bound to the north by 49th Avenue Southwest, to the east and west by residential property, and to the south by 58th Lane Southwest. An equestrian facility, Miari Stables, occupies the land east of the site.

Section 2.8 Reports and Studies

The following reports and studies have been prepared for this project.

- Pilot Infiltration Testing April 10, 2024 by Riley Group
- Preliminary Geotechnical Engineering Report Bodenhamer Property June 13, 2023 by Riley Group
- Groundwater level monitoring August 19, 2022 by Riley Group
- Mazama Pocket Gopher Screening October 28, 2022 by Enviro Vector
- Bodenhamer Property Critical Areas Report and Wetland Mitigation Plan June 29, 2023 by Enviro Vector.
- Bodenhamer Property Advanced Studies Report June 14, 2023 by Enviro Vector
- Tree Plan for Vista Views at Black Lake March 18, 2024 by Professional Forestry Services, Inc.
- Traffic Impact Analysis Scoping Memo March 27, 2024 by Heath and Associates.

Section 2.9 – Wells and Septic Systems

Records at Thurston County and the Department of Ecology were searched in order to locate the presence of wells and septic systems that may be located within the setback distances from the bioretention cell and infiltration trenches In addition, the Project Engineer, or someone under his/her direct supervision, has visited the site to verify the presence or absence of wells and septic systems as best can be done visually without trespassing onto other properties. All wells and septic systems found to

be located within the setback distances from the bioretention basin and infiltration trenches have been shown on the plans.

Section 2.10 – Fuel Tanks

Records at Thurston County and the Department of Ecology were searched in order to locate the presence of above and below ground fuel storage tanks that may be located within the setback distances from the bioretention cell and infiltration trenches. In addition, the Project Engineer, or someone under his/her direct supervision, has visited the site to verify the presence or absence of fuel tanks as best can be done visually without trespassing onto other properties. All fuel tanks found to be located within the setback distances from the bioretention cell and infiltration trenches. have been shown on the plans.

Section 2.11 – Analysis of 100-Year Flood

The Federal Emergency Management Agency prepares maps for all areas within Thurston County, including the incorporated cities therein. Panel #53067CO280E depicts the areas, if any, subjected to flooding in the vicinity of this proposal. By inspection of this map, this proposal appears to be located in Zone X, an area of minimal flooding. This area, therefore, is not located within the 100-year flood plain.

VISTA VIEWS AT BLACK LAKE

3825 58TH LN SW, OLYMPIA, WA

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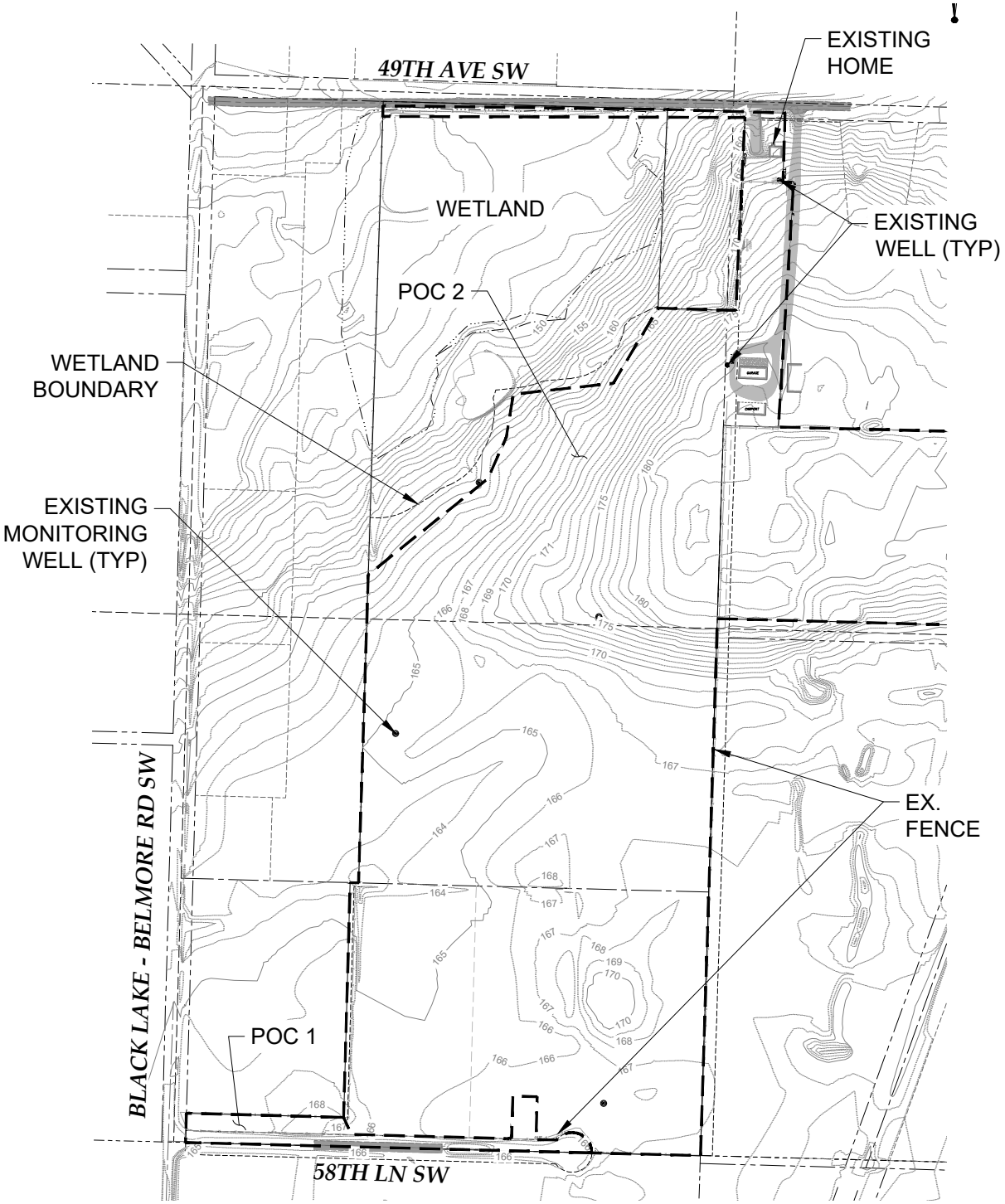


EXISTING CONDITIONS

Section 3 – Vicinity Analysis and Sub-Basin Description

In the existing condition, stormwater runoff from the project site generally sheet flows from southeast to northwest. The flow enters Wetland A prior to flowing west under Black Lake Belmore to Black Lake. Another small area drains from east to west along 58th Lane. See the Existing Conditions Map on page 12.

The project site consists of 5 basins for stormwater modeling, North Basin, Middle Basin, Future East Development, 49th Avenue, and 58th Lane. The North Basin consists of the paved access to 49th Avenue and includes the roadside landscaping areas, Pavement, and sidewalks. 49th Avenue basin includes the proposed frontage improvements, roadside landscaping, sidewalk, and pavement. The Middle Basin includes the middle portion of the plat with side landscape areas, paved streets, sidewalks, and roof areas. The Roof areas will be infiltrated in individual dry wells. The Future East Development Basin includes the possible platting of a parcel east of the site and includes Roads, sidewalks, landscaping, and roofs connected to individual dry wells. 58th Lane Basin includes the road improvements to 58th Lane, landscaping areas, road and sidewalks. This project proposes to use infiltration BMPs, stormwater runoff will infiltrate100% on-site. Runoff from pollution generating surfaces will be routed to on-site BioPod treatment structures sized for phosphorous and enhanced treatment improving the water quality prior to connection to infiltration systems. 49th Avenue Basin will be treated and released to Wetland A. The increases flow from the basin/site will continue to meet stream duration, due to the 100% infiltration in the other basins. See Basin Map on page 5.

Offsite flows include culverts under 49th Avenue SW and flow to Wetland A. The development will not affect these flow as it currently flows through the wetland and buffers.

Both Wetland A and 58th Lane TDA's ultimately flow to Black Lake approximately 0.57 mile to the west, and flow through existing culverts under Black Lake Belmore Road and wetlands to Black Lake. 58th lane roadside ditches drain to ditches along Black Lake Belmore to culverts and then wetlands to Black Lake.

WWHM model "Site Analysis" shows the pre-developed discharge from the site is 7.17 cfs to Wetland A and 0.19 cfs for 58th Lane for the 100-year flow. The 100-year developed site runoff flow rate is expected to be 0.83 cfs. 100% infiltration will be provided by North, Middle, and Future East Development. 49th basin will discharge to Wetland A. Proposed development will make no changes to the downstream existing conditions other than reducing the flow. There are no known conveyance system capacity issues, flooding issues, erosion hazards, or water quality standards violations which will be aggravated by the proposed development.

Table 4.1 – Infiltration Basin Stage-Storage Table			
Storm Recurrence Interval	Stage (ft)		Storage (ac-ft)
	Depth	Elevation	
2-Year	0.0567	160.06	0.072239
5-Year	0.1206	160.12	0.155828
10-Year	0.1864	160.19	0.243297
25-Year	0.3064	160.31	0.540580
50-Year	0.4300	160.43	0.582316
100-Year	0.5905	160.59	0.818846

Table 4.1 – North *Infiltration Gallery* Stage-Storage Table			
Storm Recurrence Interval	Stage (ft)		Storage (ac-ft)
	Depth	Elevation	
2-Year	0.25	148.25	0.004298
5-Year	0.63	148.48	0.013017
10-Year	1.07	149.07	0.022107
25-Year	1.90	149.57	0.020296
50-Year	2.81	150.40	0.039256
100-Year	4.00	151.55	0.082645

Table 4.1 – 58th Lane Infiltration Trench Stage-Storage Table			
Storm Recurrence Interval	Stage (ft)		Storage (ac-ft)
	Depth	Elevation	
2-Year	0.19	158.19	0.003751
5-Year	0.54	158.54	0.010611
10-Year	0.94	158.94	0.018558
25-Year	1.77	159.77	0.034945
50-Year	2.71	160.71	0.053504
100-Year	4.00	162.00	0.078972

Water Quality Treatment Facility Sizing

This project generates more than 5,000 square feet of pollution-generating hard surfaces and is therefore required to provide stormwater runoff treatment.

BMP and Facility Selection Process per Volume I Chapter 4 of the drainage manual.

Step 1) Determine and read the applicable Minimum requirements. Section one of this report provides the analysis of the Minimum requirements.

Step 2) Select Source Control BMPs. Review of the Drainage Manual Volume IV indicates the following recommendations to provide source control in a residential development. Applicable source control BMPs will be provided in the Stormwater Maintenance and Operations Manual.

Step 3) Determine threshold discharge areas and applicable requirements for treatment, flow control and wetlands protection. Section one of this report discusses the threshold areas and applicable requirements for each threshold area. Basin Map shows the threshold discharge areas and Table 1.1 Area Summary (page 6) provides the hard surface area for each sub-basin.

Step 4) Select flow Control BMPs and Facilities. As discussed in Section 2.4 soils, infiltration is possible but can not provide treatment. An infiltration at rate of 4.4 inch per hour was used for sizing calculations. North Basin has limited area, so infiltration gallery is proposed. Middle Basin will be routed to a infiltration basin. 58th Basin has limited area and will be routed to an infiltration trench.

Step 5a) Determine the receiving waters and pollutants of concern based on offsite analysis. Wetland A and Black Lake approximately 3,000 feet to the west is the receiving waters and is listed as a 303d for phosphorus. The proximity of Wetland A requires phosphorus control. The northwest corner of the site crosses the well head protection radius. This area is within the wetland buffers and no development or storm facilities are planned in this area.

Step 5b) Determine whether the facility will be city owned or privately owned. All storm facilities will be in tracts owned by the homeowner's association.

Step 5c) Determine whether an oil control facility/device is required. The project is residential (single family) and does not meet the high use criteria. No oil control required.

Step 5d) Determine whether infiltration for pollutant removal is practicable. Section 2.4 Soils describes the soils and the soils reports in Appendix 3 show that the soils are unable to provide treatment due to high native infiltration rates.

Use BioPods with infiltration basin and trenches for the North, 54th basins, and 49th basin. See Flow Control Facility Sizing for sizing of infiltration basin (100% treatment) and infiltration trench/gallery sizing.

BioPod sizing - The BioPod is sized according to the Department of Ecology TAPE guidance.

The proposed total development area draining to each of the BioPods has been used in WWHM to calculate stormwater runoff for sizing the BioPod treatment structure. The outcome form WWHM shows the standard offline water quality flow rate and the BioPod water quality design hydraulic rates for enhanced treatment provided by DOE is 1.6 gallons per minute (gpm) per square foot (sf). For systems with drain down outlet the flow rates multiplied by 1.05 for sizing the BioPod treatment structure. See the attached WWHM report and the DOE BioPod sizing guidance in Appendix 1.

Treatment WWHM 2012 (version 4.2.19) modeling in Appendix 1 using the most current precipitation for 15 min steps. Pre and post development drainage basins are included in the model. Pre-developed conditions are modeled as forested. Digital copies of the WWHM 2012 version 4.2.19 are included in Appendix 1

Treatment Facility Sizing Summary:

Bio Pod	Treatment Flow Rate (cfs)	Multiplier	GPM	Required SF
North	0.0395	1.05	18.62	11.6
Middle and Future	1.2756	1.05	601.16	375.7
49th Ave Basin	0.0795	1.05	37.47	23.4
58th Lane	0.0682	1.05	32.14	20.0

Provide 4 ft by 6 ft BioPod treatment structures with internal by pass for North and 58th Lane; 49th Avenue a 4x8 unit, and Middle and future provide two 10ft by 24ft bio pods.

Note: The 4 ft by 6 ft unit provides 4 ft x 5 ft = 20 ft^2 of treatment area. A 4x8 unit provides = 24 ft^2; Middle and Future 10 ft x 25 ft = 200 ft^2 each.

Flow Control Facility Sizing

This project generates more than 10,000 square feet of effective hard surfaces and is therefore required to provide flow control.

Infiltration Basin and infiltration trenches
The areas used to size the infiltration basin are provided in Table 1.1 and WWHM analysis in Appendix 1. The facilities will meet Core Requirement 7 by providing 100% infiltration. WWHM analyses are included in Appendix 1. The infiltration systems were designed using an infiltration rate of 1.1 inch per hour for infiltration pond and 4.0 inch per hour for the infiltration trenches. See Section 2.4 Soils for calculation of the infiltration rate.

Section 5 – Aesthetic Considerations for Facilities

All above ground stormwater facilities will be hydroseeded upon completion. Additional landscaping shall also be provided throughout the project in conformance with the approved landscaping and tree restoration plan, as applicable, and as otherwise required by the approving authority.

Signage provided by the City of Tumwater will be installed for all aboveground stormwater facilities and stormwater facilities located within development tracts B, D1, F and O.

Section 6 – Conveyance System Analysis and Design

Conveyance will be sized to convey the 25-year 24-hour storm per the 2022 DDECM. Conveyance calculations will be provided with permit submittal.

Section 7 – Covenants, Dedications and Easement

All stormwater facilities located on private property shall be owned, operated and maintained by the property owners, their heirs, successors and assigns. The property owners shall enter into an agreement

with the governing body, a copy of which agreement will be included in the Maintenance and Source Control Manual of the Drainage Control Plan. The agreement requires maintenance of the stormwater facilities in accordance with the maintenance plan provided and shall grant easement for access to the governing body to inspect the stormwater facilities. The agreement also makes provisions for the governing body to make repairs, after due notice is given to the owners, if repairs are necessary to ensure proper performance of the stormwater system and if the owners fail to make the necessary repairs. The cost of said repairs shall be borne by the property owners, their heirs, successors and assigns.

Section 8 – Agreements and Guarantees

The property owner is required to enter into a Stormwater Maintenance Agreement to maintain stormwater facilities and implement a Pollution Source Control Plan. A copy of the maintenance agreement is included in the Maintenance and Source Control Manual.

The owner is required to provide a financial guarantee to the Administrator to ensure satisfactory maintenance of drainage facilities for a minimum of 2 years from final plat acceptance or acceptance of the project, whichever is later. The guarantee shall be 15 percent of the construction cost of the drainage facilities.

Section 9 – Other Permits or Conditions Place on the Project

This section should provide the title of any other necessary permits, the agencies requiring the other permits, and identify the permit requirements that affect the project. Additional agencies that may require permits for projects include but are not limited to:

City of Tumwater	Right-of-Way Access Permit
City of Tumwater	Wetland Development Permit
City of Tumwater	Building Permit

APPENDIX 1 – Design Calculations

WASHINGTON STATE DEPARTMENT OF ECOLOGY

February 2024

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS), METALS, AND PHOSPHORUS TREATMENT

For

Oldcastle Infrastructure, Inc.'s
The BioPod™ Biofilter
(Formerly the TreePod Biofilter)

Ecology's Decision

Based on Oldcastle Infrastructure, Inc. application submissions for The BioPod™ Biofilter (BioPod), Ecology hereby issues the following use level designation:

1) General Use Level Designation (GULD) for Basic, Metals, and Phosphorus Treatment:
   - Sized at a hydraulic loading rate of 1.6 gallons per minute (gpm) per square foot (sq ft) of media surface area.
   - Constructed with a minimum media thickness of 18-inches (1.5-feet)
2) Ecology approves the BioPod at the hydraulic loading rate listed above, to achieve the maximum water quality design flow rate. The water quality design flow rates are calculated using the following procedures:
   - Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology- approved continuous runoff model.
   - Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.7.6 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
   - Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.
3) For systems that have a drain down outlet, designers must increase the water quality design flow rate calculated in Item 2, above, to account for the water that will enter the initial bay but won't be treated by the engineered soil. Multiply the flow rate determined above by 1.05 to determine the required flowrate for the BioPod unit.

4) Oldcastle produces alternative configurations of the version tested for TAPE approval. The system tested is the named the BioPod Planter. Alternative configurations that are also approved for use through this GULD are the BioPod Surface, the BioPod Tree, and the BioPod Underground.
5) The GULD has no expiration date, but may be amended or revoked by Ecology.

Ecology's Conditions of Use

The BioPod shall comply with these conditions:

1) Applicants shall design, assemble, install, operate, and maintain the BioPod installations in accordance with Oldcastle Infrastructure Inc.'s applicable manuals and the Ecology Decision.
2) The minimum size filter surface-area for use in Washington is determined by using the design water quality flow rate (as determined in Ecology Decision, Item 3, above) and the hydraulic loading rate (as identified in Ecology Decision, Item 1, above). Calculate the required area by dividing the water quality design flow rate (cu-ft/sec) by the hydraulic loading rate (converted to ft/sec) to obtain the required surface area (sq ft) of the BioPod unit.
3) BioPod media shall conform to the specifications submitted to and approved by Ecology.
4) The applicant tested the BioPod without plants. This GULD applies to the BioPod Stormwater Treatment System whether plants are included in the final product or not.
5) Maintenance: The required inspection/maintenance interval for stormwater treatment devices is often dependent on the efficiency of the device and the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.
    - The BioPod is designed for a target maintenance interval of 1 year. Maintenance includes replacing the mulch, assessing plant health, removal of trash, and raking the top few inches of engineered media.
    - The BioPod system initially tested at the Lake Union Ship Canal Test Facility in Seattle, WA required maintenance after 1.5 months, or 6.3% of a water year. Monitoring personnel observed similar maintenance issues with other systems evaluated at the Test Facility. Runoff from the Test Facility may be unusual and maintenance requirements of systems installed at the Test Facility may not be indicative of typical maintenance requirements. Because of this, the initial version of the GULD required Oldcastle to subsequently "conduct hydraulic testing to obtain information about maintenance requirements on a site with runoff that is more typical of the Pacific Northwest". Quarterly testing from a 15-month maintenance frequency assessment conducted on a BioPod system installed along a roadway in Des Moines, WA indicated the system was able to treat a full water year before requiring maintenance.
    - Test results provided to Ecology from a BioPod System evaluated in a lab following New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs have indicated the BioPod System is capable of longer maintenance intervals.

- Owners/operators must inspect BioPod systems for a minimum of twelve months from the start of post-construction operation to determine site-specific inspection/maintenance schedules and requirements. Owners/operators must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to the SWMMEW, the wet season in eastern Washington is October 1 to June 30.) After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.
- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flow rate and/or a decrease in pollutant removal ability.

6) Install the BioPod in such a manner that you bypass flows exceeding the maximum operating rate and you will not resuspend captured sediment.
7) Discharges from the BioPod shall not cause or contribute to water quality standard violations in receiving waters.

Approved Alternate Configurations

BioPod Internal Bypass

1) The BioPod Internal Bypass configuration may be combined with a Curb Inlet, Grated Inlet, and Piped-In Inlet. Water quality flows and peak flows are directed from the curb, overhead grate, or piped inlet to a contoured inlet rack. The inlet rack disperses water quality flows over the top surface of the biofiltration chamber. Excess flows are diverted over a curved bypass weir to the outlet area without passing through the treatment area. Both water quality flows and bypass flows are combined in the outlet area prior to being discharged out of the system.
2) To select a BioPod Internal Bypass unit, the designer must determine the size of the standard unit using the sizing guidance described above. Systems that have an internal bypass may use the off-line water quality design flow rate.
3) The internal bypass configuration has a maximum flow rate of 900 gallons per minute. Sites where the anticipated flow rate at the treatment device is larger than 900 gpm must use an external bypass, or size the treatment device for the on-line water quality design flow rate.

Applicant:	Oldcastle Infrastructure, Inc.
Applicant's Address:	7100 Longe St, Suite 100 Stockton, CA 95206

Application Documents:

BioPod™ Stormwater Filter Maintenance Frequency Assessment, Prepared for Oldcastle Infrastructure, Inc., Prepared by Herrera Environmental Consultants, Inc. February 2022

Technical Evaluation Report TreePod™ BioFilter System Performance Certification Project, Prepared for Oldcastle, Inc., Prepared by Herrera Environmental Consultants, Inc. February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., January 2018

Application for Pilot Use Level Designation, TreePod™ Biofilter – Stormwater Treatment System, Oldcastle Stormwater Solutions, May 2016

Emerging Stormwater Treatment Technologies Application for Certification: The TreePod™ Biofilter, Oldcastle Stormwater Solutions, April 2016

Applicant's Use Level Request:

- General Use Level Designation as a Basic, Metals, and Phosphorus Treatment device in accordance with Ecology's *Stormwater Management Manual for Western Washington*

Applicant's Performance Claims:

Based on results from laboratory and field-testing, the applicant claims the BioPod™ Biofilter operating at a hydraulic loading rate of 153 inches per hour is able to remove:

- 80% of Total Suspended Solids (TSS) for influent concentrations greater than 100 mg/L and achieve a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- 60% dissolved zinc for influent concentrations 0.02 to 0.3 mg/L.
- 30% dissolved copper for influent concentrations 0.005 to 0.02 mg/L.
- 50% or greater total phosphorus for influent concentrations 0.1 to 0.5 mg/L.

Ecology's Recommendations:

Ecology finds that:

- Oldcastle Infrastructure, Inc. has shown Ecology, through laboratory and field testing, that the BioPod™ Biofilter is capable of attaining Ecology's Basic, Total Phosphorus, and Metals treatment goals.

Findings of Fact:

Field Testing

- Herrera Environmental Consultants, Inc. conducted monitoring of the BioPod™ Biofilter at the Lake Union Ship Canal Test Facility in Seattle Washington between November 2016 and April 2018. Herrera collected flow-weight composite samples during 14 separate storm events and peak flow grab samples during 3 separate storm events. The system was sized at an infiltration rate of 153 inches per hour or a hydraulic loading rate of 1.6 gpm/ft^2.
  - The D_{50} of the influent PSD ranged from 3 to 292 microns, with an average D_{50} of 28 microns.
  - Influent TSS concentrations ranged from 17 mg/L to 666 mg/L, with a mean concentration of 98 mg/L. For all samples (influent concentrations above and below 100 mg/L) the bootstrap estimate of the lower 95 percent confidence limit (LCL 95) of the mean TSS reduction was 84% and the bootstrap estimate of the upper 95 percent confidence limit (UCL95) of the mean TSS effluent concentration was 8.2 mg/L.
  - Dissolved copper influent concentrations from the 17 events ranged from 9.0 µg/L to 21.1 µg/L. The 21.1 µg/L data point was reduced to 20.0 µg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean dissolved copper reduction was 35%.
  - Dissolved zinc influent concentrations from the 17 events ranged from 26.1 µg/L to 43.3 µg/L. A bootstrap estimate of the LCL95 of the mean dissolved zinc reduction was 71%.
  - Total phosphorus influent concentrations from the 17 events ranged from 0.064 mg/L to 1.56 mg/L. All influent data greater than 0.5 mg/L were reduced to 0.5 mg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean total phosphorus reduction was 64%.
  - The system experienced rapid sediment loading and needed to be maintained after 1.5 months. Monitoring personnel observed similar sediment loading issues with other systems evaluated at the Test Facility. The runoff from the Test Facility may not be indicative of maintenance requirements for all sites.
- Herrera Environmental Consultants, Inc. conducted a maintenance frequency assessment of the BioPod™ installed along a roadway in Des Moines, WA between September 2020 and January 2022.
  - Herrera collected influent grab samples during 10 storm events and paired effluent samples during 5 storm events. Influent concentrations ranged from 1 mg/L to 164 mg/L, with a median concentration of 23 mg/L. Effluent concentrations ranged from 1 mg/L to 19 mg/L, with a median of 5 mg/L.
  - Herrera collected influent PSD samples during 3 storm events. The D_{50} for the samples were 42, 1306, and 57 microns. The 1306 micron value was collected during an event with an influent TSS concentration of 1 mg/L. It is assumed this sample was atypical and that it contained a few grains of very coarse sand and almost no other particles.

- Herrera used a water truck to conduct flow testing 7 times to assess how long the system could filter at the design flow rate without bypass. Results show the system was able to treat up to a full water year before the system needed maintenance.

Laboratory Testing

- Good Harbour Laboratories (GHL) conducted laboratory testing at their site in Mississauga, Ontario in October 2017 following the New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs. The testing evaluated a 4-foot by 6-foot standard biofiltration chamber and inlet contour rack with bypass weir. The test sediment used during the testing was custom blended by GHL using various commercially available silica sands, which had an average d_{50} of 69 µm. Based on the lab test results:
  - GHL evaluated removal efficiency over 15 events at a Maximum Treatment Flow Rate (MTFR) of 37.6 gpm, which corresponds to a MTFR to effective filtration treatment area ratio of 1.80 gpm/ft^2. The system, operating at 100% of the MTFR with an average influent concentration of 201.3 mg/L, had an average removal efficiency of 99 percent.
  - GHL evaluated sediment mass loading capacity over an additional 16 events using an influent SSC concentration of 400 mg/L. The first 11 runs were evaluated at 100% of the MTFR. The BioPod began to bypass, so the remaining 5 runs were evaluated at 90% of the MTFR. The total mass of the sediment captured was 245.0 lbs and the cumulative mass removal efficiency was 96.3%.
- Herrera Environmental Consultants Inc. conducted laboratory testing in September 2014 at the Seattle University Engineering Laboratory. The testing evaluated the flushing characteristics, hydraulic conductivity, and pollutant removal ability of twelve different media blends. Based on this testing, Oldcastle Infrastructure, Inc. selected one media blend, Mix 8, for inclusion in their TAPE evaluation of the BioPod™ Biofilter.
  - Herrera evaluated Mix 8 in an 8-inch diameter by 36-inch tall polyvinyl chloride (PVC) column. The column contained 18-inches of Mix 8 on top of 6-inches of pea gravel. The BioPod will normally include a 3-inch mulch layer on top of the media layer; however, this was not included in the laboratory testing.
  - Mix 8 has a hydraulic conductivity of 218 inches per hour; however, evaluation of the pollutant removal ability of the media was based on an infiltration rate of 115 inches per hour. The media was tested at 75%, 100%, and 125% of the infiltration rate. Based on the lab test results:
    - The system was evaluated using natural stormwater. The dissolved copper and dissolved zinc concentrations in the natural stormwater were lower than the TAPE influent standards; therefore, the stormwater was spiked with 66.4 mL of 100 mg/L Cu solution and 113.6 mL of 1,000 mg/L Zn solution.
    - The BioPod removed an average of 81% of TSS, with a mean influent concentration of 48.4 mg/L and a mean effluent concentration of 9.8 mg/L.
    - The BioPod removed an average of 94% of dissolved copper, with a mean influent concentration of 10.6 µg/L and a mean effluent concentration of 0.6 µg/L.
    - The BioPod removed an average of 97% of dissolved zinc, with a mean influent concentration of 117 µg/L and a mean effluent concentration of 4 µg/L.

- The BioPod removed an average of 97% of total phosphorus, with a mean influent concentration of 2.52 mg/L and a mean effluent concentration of 0.066 mg/L. When total phosphorus influent concentrations were capped at the TAPE upper limit of 0.5 mg/L, calculations showed an average removal of 87%.

Other BioPod Related Issues to be Addressed by the Company:

1. None identified at this time.

Technology Description: Download at https://oldcastleprecast.com/stormwater/bioretention-biofiltration-applications/bioretention-biofiltration-solutions/

Contact Information:

Applicant: Chris Demarest
Oldcastle Infrastructure, Inc.
(925)667-7100
Chris.demarest@oldcastle.com

Applicant website: https://oldcastleprecast.com/stormwater/

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

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 870-0983
douglas.howie@ecy.wa.gov

Revision History

Date	Revision
March 2018	GULD granted for Basic Treatment
March 2018	Provisional GULD granted for Enhanced and Phosphorus Treatment
June 2016	PULD Granted
April 2018	GULD for Basic and Provisional GULD for Enhanced and Phosphorus granted, changed name to BioPod from TreePod
July 2018	GULD for Enhanced and Phosphorus granted
September 2018	Changed Address for Oldcastle
December 2018	Added minimum media thickness requirement
May 2019	Changed language on who must Install and maintain the device from Oldcastle to Applicants
August 2019	Added text on sizing using infiltration rate and water quality design flow rate

October 2019	Added text describing ability to use off-line design water quality flow rate for sizing due to internal bypass
December 2021	Extended approval to installations without plants, added sizing adjustment when using facilities with a drawdown outlet
March 2022	Added results from the maintenance frequency assessment to the Ecology's Conditions of Use and the Findings of Fact sections
January 2024	Revised Dissolved Metals (Enhanced) to Metals
February 2024	Added manufacturers names for the tested unit and the three alternative configurations to the text.

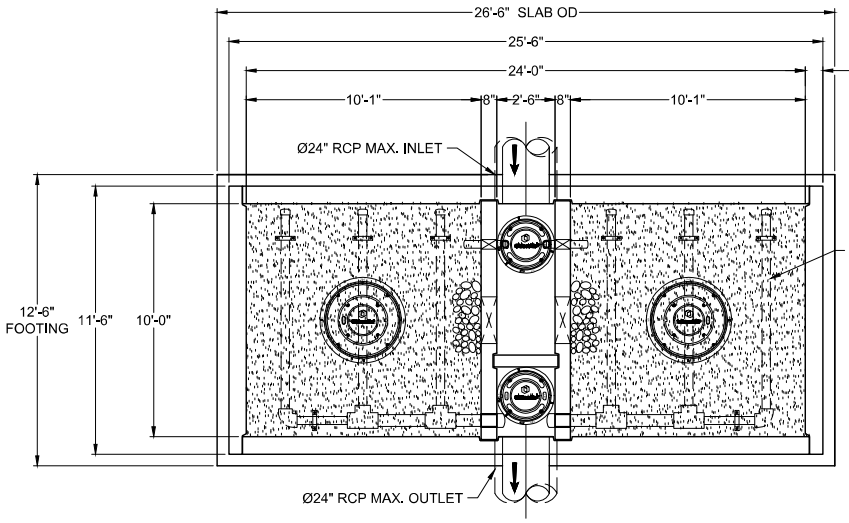
SITE SPECIFIC DATA	
Structure ID	ID
Treatment Flow Rate (cfs)	-
Peak Flow Rate (cfs)	-
Rim Elevation	-
Top of Vault Elevation	-

Pipe Data	Pipe Location	Pipe Size	Pipe Type	Invert Elevation
Inlet	-	-	-	-
Outlet	-	-	-	-

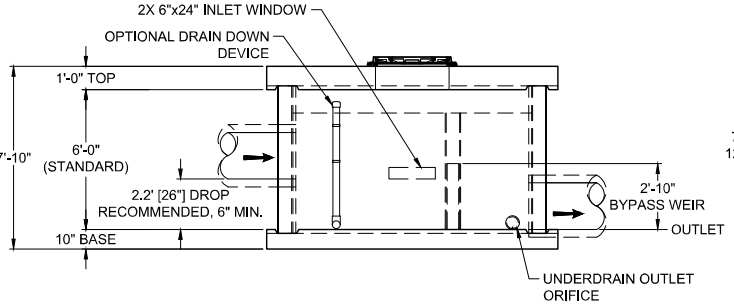
Notes:

PERFORMANCE SPECIFICATIONS	
Treatment Flow Capacities:	
NJDEP 80% Removal, 75 micron	0.810 cfs
WA Ecology GULD - Basic, Enhanced & Phosphorus	0.720 cfs
Bypass Capacity	20.00 cfs

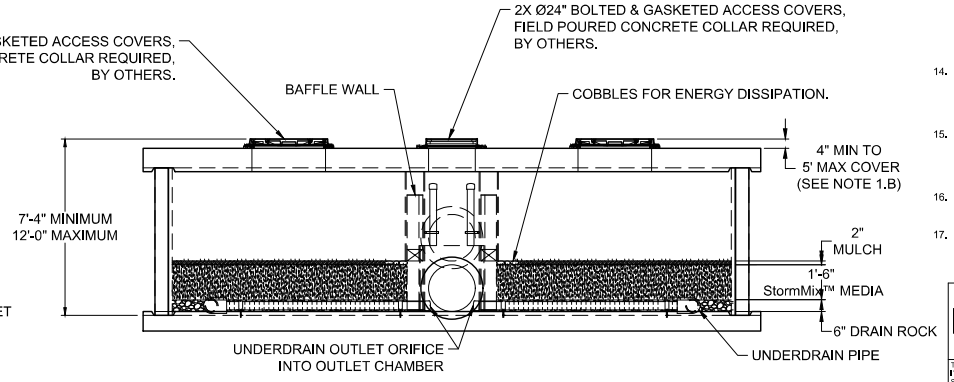
*Contact Oldcastle for alternative treatment flow capacities.



PLAN VIEW



LEFT END VIEW



ELEVATION VIEW

NOTES:

1. DESIGN LOADINGS:
   - A. AASHTO HS-20-44 (WITH IMPACT)
   - B. DESIGN SOIL COVER: 5'-0" MAXIMUM
   - C. ASSUMED WATER TABLE: BELOW BASE OF PRECAST (ENGINEER-OF-RECORD TO CONFIRM SITE WATER TABLE ELEVATION)
   - D. LATERAL EARTH PRESSURE: 45 PCF (DRAINED)
   - E. LATERAL LIVE LOAD SURCHARGE: 80 PSF (APPLIED TO 8'-0" BELOW GRADE)
   - F. NO LATERAL SURCHARGE FROM ADJACENT BUILDINGS, WALLS, PIERS, OR FOUNDATIONS.
2. CONCRETE 28-DAY MINIMUM COMPRESSIVE STRENGTH: 5,000 PSI MINIMUM.
3. REINFORCING: REBAR, ASTM A615/A706, GRADE 60
4. MESH REINFORCEMENT: ASTM A1064, S1.2, GRADE 80
5. CEMENT: ASTM C150
6. REQUIRED ALLOWABLE SOIL BEARING CAPACITY: 2,500 PSF
7. REFERENCE STANDARD:
   - A. ASTM C890
   - B. ASTM C913
   - C. ACI 318-14
8. THIS STRUCTURE IS DESIGNED TO THE PARAMETERS NOTED HEREIN. ENGINEER-OF-RECORD SHALL VERIFY THAT NOTED PARAMETERS MEET OR EXCEED PROJECT REQUIREMENTS. IF DESIGN PARAMETERS ARE INCORRECT, REVIEWING ENGINEER/AUTHORITY SHALL NOTIFY OLDCASTLE INFRASTRUCTURE UPON REVIEW.
9. OVERSIZED HOLES TO ACCOMMODATE SPECIFIC PIPE TYPE MUST BE CONCENTRIC TO PIPE ID. AFTER PIPES ARE INSTALLED, ALL ANNULAR SPACES SHALL BE FILLED WITH A MINIMUM OF 3,000 PSI CONCRETE FOR FULL THICKNESS OF PRECAST WALLS.
10. CONTRACTOR RESPONSIBLE TO VERIFY ALL SIZES, LOCATIONS, AND ELEVATIONS OF OPENINGS .
11. CONTRACTOR RESPONSIBLE TO ENSURE ADEQUATE BEARING SURFACE IS PROVIDED (I.E. COMPACTED AND LEVEL PER PROJECT SPECIFICATIONS).
12. ADAPTORS/ANGLES AND EXTERNAL PIPING BY OTHERS.
13. SECTION HEIGHTS, SLAB/WALL THICKNESSES, AND KEYWAYS ARE SUBJECT TO CHANGE AS REQUIRED FOR SITE REQUIREMENTS AND/OR DUE TO PRODUCT AVAILABILITY AND PRODUCTION FACILITY CONSTRAINTS.
14. MAXIMUM PICK WEIGHTS:
   - A. TOP SLAB: XX,XXX LBS
   - B. PANELS: XX,XXX LBS
   - C. BASE SLAB: XX,XXX LBS
15. INTERNALS SHALL CONSIST OF UNDERDRAIN PIPE, ROCK, STORMMIX™ MEDIA, MULCH, DIVIDER WALLS, BAFFLE WALLS, BYPASS WEIR AND OPTIONAL DRAIN DOWN.
16. SYSTEM SHIPPED EMPTY. INTERNALS INSTALLED BY CONTRACTOR.
17. CONTRACTOR RESPONSIBLE FOR OFF-LOAD AND INSTALLATION. OLDCASTLE REPRESENTATIVE TO BE ON SITE TO OVERSEE THE INSTALLATION OF ALL INTERNAL COMPONENTS.

Bioretention/ Biofiltration

Oldcastle Infrastructure
A CRH COMPANY

Ph: 800.579.8819 | www.oldcastleinfrastructure.com/stormwater

BioPod™ Biofilter System (STANDARD)

Underground Vault with Internal Bypass

CUSTOMER
-

PROJECT NAME
-

SHEET NAME	REVISION	SHEET
Specifier Drawing BPU-1024IB	- REV DATE -	1 OF 1

SITE SPECIFIC DATA				
Structure ID				ID
Treatment Flow Rate (cfs)				-
Peak Flow Rate (cfs)				-
Rim Elevation				-
Top of Vault Elevation				-
Pipe Data	**Pipe Location**	**Pipe Size**	**Pipe Type**	**Invert Elevation**
Inlet	-	-	-	-
Outlet	-	-	-	-
Notes:				

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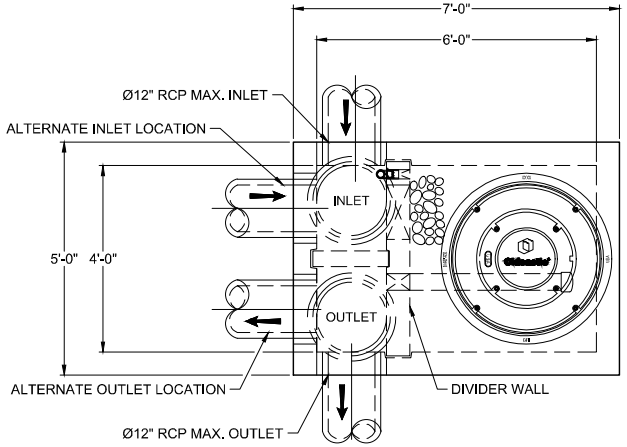
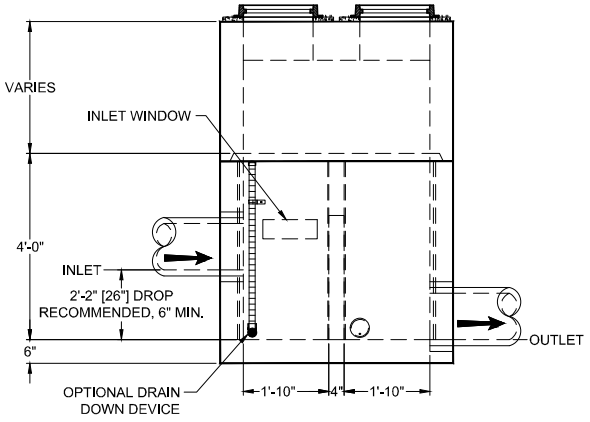
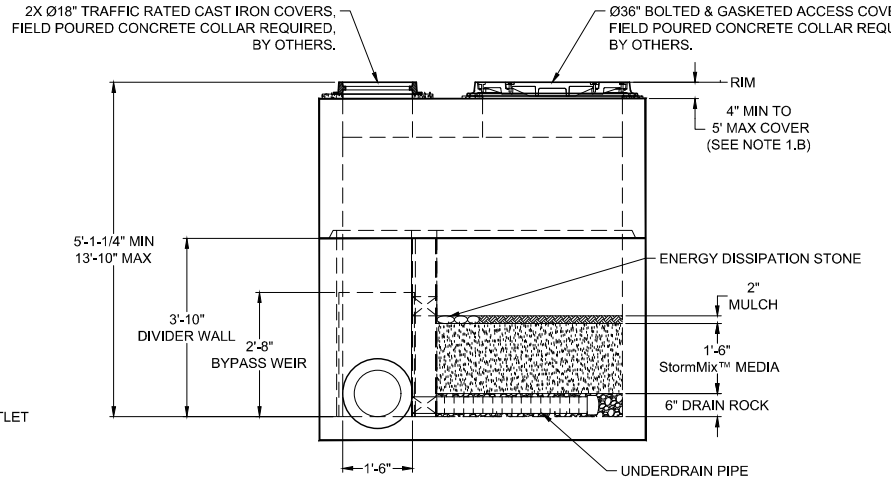
Bypass Capactiy	5.0 cfs
*Contact Oldcastle for alternative treatment flow capacities.	



PLAN VIEW



LEFT END VIEW



ELEVATION VIEW

NOTES:

1. DESIGN LOADINGS:
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   B. DESIGN SOIL COVER: 5'-0" MAXIMUM
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   D. LATERAL EARTH PRESSURE: 45 PCF (DRAINED)
   E. LATERAL LIVE LOAD SURCHARGE: 80 PSF (APPLIED TO 8'-0" BELOW GRADE)
   F. NO LATERAL SURCHARGE FROM ADJACENT BUILDINGS, WALLS, PIERS, OR FOUNDATIONS.
2. CONCRETE 28-DAY MINIMUM COMPRESSIVE STRENGTH: 5,000 PSI MINIMUM.
3. REINFORCING: REBAR, ASTM A615/A706, GRADE 60
4. CEMENT: ASTM C150
5. REQUIRED ALLOWABLE SOIL BEARING CAPACITY: 2,500 PSF
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7. THIS STRUCTURE IS DESIGNED TO THE PARAMETERS NOTED HEREIN. ENGINEER-OF-RECORD SHALL VERIFY FY THAT NOTED PARAMETERS MEET OR EXCEED PROJECT REQUIREMENTS. IF DESIGN PARAMETERS ARE INCORRECT, REVIEWING ENGINEER/AUTHORITY SHALL NOTIFY OLDCASTLE INFRASTRUCTURE UPON REVIEW.
8. INLET AND OUTLET HOLES WILL BE FACTORY CORED/CAST PER PLANS AND CUSTOMER REQUIREMENTS. INLET AND OUTLET LOCATIONS CAN BE MIRRORED.
9. CONTRACTOR RESPONSIBLE TO VERIFY ALL SIZES, LOCATIONS, AND ELEVATIONS OF OPENINGS.
10. CONTRACTOR RESPONSIBLE TO ENSURE ADEQUATE BEARING SURFACE IS PROVIDED (I.E. COMPACTED AND LEVEL PER PROJECT SPECIFICATIONS).
11. SECTION HEIGHTS, SLAB/WALL THICKNESSES, AND KEYWAYS ARE SUBJECT TO CHANGE AS REQUIRED FOR SITE REQUIREMENTS AND/OR DUE TO PRODUCT AVAILABILITY AND PRODUCTION FACILITY CONSTRAINTS.
12. MAXIMUM PICK WEIGHTS*:
   A. TOP: XX,XXX LBS
   B. BASE: XX,XXX LBS*
      (* COMBINED WEIGHT OF BASE INCLUDES BYPASS WEIR, DIVIDER WALL, ROCK & MEDIA)
13. INTERNALS SHALL CONSIST OF UNDERDRAIN PIPE, ROCK, STORMMIX™ MEDIA, MULCH, DIVIDER WALL, BYPASS WEIR AND OPTIONAL DRAIN DOWN.

Bioretention/
Biofiltration

Oldcastle Infrastructure™
A CRH COMPANY

Ph: 800.579.5819 | www.oldcastleinfrastructure.com/stormwater

BioPod™ Biofilter System (STANDARD)
Underground Vault with Internal Bypass

CUSTOMER
-

PROJECT NAME
-

SHEET NAME	REVISION	SHEET
Specifier Drawing BPU-46IB	-	1 OF 1
	REV DATE -	

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: Site Infiltration Sizing
Site Name:
Site Address:
City:

Report Date:	8/6/2024
Gage:	Courthouse
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2023/01/27
Version:	4.2.19

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

Middle

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	37.84
Pervious Total	37.84
Impervious Land Use	acre
Impervious Total	0
Basin Total	37.84

Future East devlopment

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	8.86
Pervious Total	8.86
Impervious Land Use	acre
Impervious Total	0
Basin Total	8.86

North Entrance

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	0.78
Pervious Total	0.78
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.78

58th Lane

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	1.29
Pervious Total	1.29
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.29

49th avenue

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	0.5
Pervious Total	0.5
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.5

Mitigated Land Use

Middle

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B IMP INF FLAT	11.1
C, Pasture, Flat	15.48
Pervious Total	26.58

Impervious Land Use	acre
ROADS FLAT	5.45
DRIVEWAYS FLAT	1.71
SIDEWALKS FLAT	1.65
POND	2.45
Impervious Total	11.26
Basin Total	37.84

future development

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	4.74
A B IMP INF FLAT	2.33
Pervious Total	7.07

Impervious Land Use	acre
ROADS FLAT	1.08
DRIVEWAYS FLAT	0.36
SIDEWALKS FLAT	0.35
Impervious Total	1.79
Basin Total	8.86

North Entrance

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.43
Pervious Total	0.43

Impervious Land Use	acre
ROADS FLAT	0.26
SIDEWALKS FLAT	0.09
Impervious Total	0.35
Basin Total	0.78

south

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Pasture, Flat	0.69
Pervious Total	0.69
Impervious Land Use	acre
ROADS FLAT	0.46
SIDEWALKS FLAT	0.14
Impervious Total	0.6
Basin Total	1.29

Basin 5

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.1
Pervious Total	0.1

Impervious Land Use	acre
ROADS FLAT	0.3
SIDEWALKS FLAT	0.1
Impervious Total	0.4
Basin Total	0.5

Routing Elements
Predeveloped Routing

Mitigated Routing

infiltration pond

Bottom Length:	956.29 ft.
Bottom Width:	100.00 ft.
Depth:	3 ft.
Volume at riser head:	4.6391 acre-feet.
Infiltration On	
Infiltration rate:	1.1
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	0
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	0
Percent Infiltrated:	0
Total Precip Applied to Facility:	494.999
Total Evap From Facility:	54.203
Side slope 1:	3 To 1
Side slope 2:	2 To 1
Side slope 3:	2.1 To 1
Side slope 4:	3 To 1
Discharge Structure	
Riser Height:	2 ft.
Riser Diameter:	48 in.
Element Flows To:	
Outlet 1	Outlet 2

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	2.195	0.000	0.000	0.000
0.0333	2.199	0.073	0.000	2.439
0.0667	2.203	0.146	0.000	2.444
0.1000	2.207	0.220	0.000	2.448
0.1333	2.211	0.293	0.000	2.453
0.1667	2.215	0.367	0.000	2.457
0.2000	2.220	0.441	0.000	2.462
0.2333	2.224	0.515	0.000	2.467
0.2667	2.228	0.589	0.000	2.471
0.3000	2.232	0.664	0.000	2.476
0.3333	2.236	0.738	0.000	2.480
0.3667	2.240	0.813	0.000	2.485
0.4000	2.244	0.888	0.000	2.489
0.4333	2.248	0.962	0.000	2.494
0.4667	2.253	1.038	0.000	2.499
0.5000	2.257	1.113	0.000	2.503
0.5333	2.261	1.188	0.000	2.508
0.5667	2.265	1.263	0.000	2.512
0.6000	2.269	1.339	0.000	2.517
0.6333	2.273	1.415	0.000	2.522
0.6667	2.277	1.491	0.000	2.526
0.7000	2.282	1.567	0.000	2.531
0.7333	2.286	1.643	0.000	2.535
0.7667	2.290	1.719	0.000	2.540
0.8000	2.294	1.795	0.000	2.544
0.8333	2.298	1.872	0.000	2.549

0.8667	2.302	1.949	0.000	2.554
0.9000	2.306	2.025	0.000	2.558
0.9333	2.311	2.102	0.000	2.563
0.9667	2.315	2.180	0.000	2.568
1.0000	2.319	2.257	0.000	2.572
1.0333	2.323	2.334	0.000	2.577
1.0667	2.327	2.412	0.000	2.581
1.1000	2.331	2.489	0.000	2.586
1.1333	2.336	2.567	0.000	2.591
1.1667	2.340	2.645	0.000	2.595
1.2000	2.344	2.723	0.000	2.600
1.2333	2.348	2.801	0.000	2.604
1.2667	2.352	2.880	0.000	2.609
1.3000	2.356	2.958	0.000	2.614
1.3333	2.361	3.037	0.000	2.618
1.3667	2.365	3.116	0.000	2.623
1.4000	2.369	3.195	0.000	2.628
1.4333	2.373	3.274	0.000	2.632
1.4667	2.377	3.353	0.000	2.637
1.5000	2.381	3.432	0.000	2.641
1.5333	2.386	3.512	0.000	2.646
1.5667	2.390	3.591	0.000	2.651
1.6000	2.394	3.671	0.000	2.655
1.6333	2.398	3.751	0.000	2.660
1.6667	2.402	3.831	0.000	2.665
1.7000	2.406	3.911	0.000	2.669
1.7333	2.411	3.991	0.000	2.674
1.7667	2.415	4.072	0.000	2.678
1.8000	2.419	4.152	0.000	2.683
1.8333	2.423	4.233	0.000	2.688
1.8667	2.427	4.314	0.000	2.692
1.9000	2.432	4.395	0.000	2.697
1.9333	2.436	4.476	0.000	2.702
1.9667	2.440	4.557	0.000	2.706
2.0000	2.444	4.639	0.000	2.711
2.0333	2.448	4.720	0.258	2.716
2.0667	2.453	4.802	0.730	2.720
2.1000	2.457	4.884	1.341	2.725
2.1333	2.461	4.966	2.065	2.730
2.1667	2.465	5.048	2.885	2.734
2.2000	2.469	5.130	3.791	2.739
2.2333	2.473	5.212	4.775	2.744
2.2667	2.478	5.295	5.831	2.748
2.3000	2.482	5.378	6.953	2.753
2.3333	2.486	5.461	8.137	2.758
2.3667	2.490	5.543	9.378	2.762
2.4000	2.495	5.627	10.67	2.767
2.4333	2.499	5.710	12.01	2.772
2.4667	2.503	5.793	13.40	2.776
2.5000	2.507	5.877	14.83	2.781
2.5333	2.511	5.960	16.30	2.786
2.5667	2.516	6.044	17.81	2.790
2.6000	2.520	6.128	19.35	2.795
2.6333	2.524	6.212	20.91	2.800
2.6667	2.528	6.296	22.51	2.804
2.7000	2.532	6.381	24.12	2.809
2.7333	2.537	6.465	25.75	2.814
2.7667	2.541	6.550	27.39	2.818

2.8000	2.545	6.635	29.04	2.823
2.8333	2.549	6.720	30.70	2.828
2.8667	2.554	6.805	32.36	2.832
2.9000	2.558	6.890	34.02	2.837
2.9333	2.562	6.975	35.68	2.842
2.9667	2.566	7.061	37.32	2.846
3.0000	2.570	7.146	38.96	2.851
3.0333	2.575	7.232	40.58	2.856

North Entrance infiltration

Bottom Length:	138.00 ft.
Bottom Width:	10.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	5
Pour Space of material for first layer:	0.4
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	4
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	107.696
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	107.696
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.031	0.000	0.000	0.000
0.0556	0.031	0.000	0.000	0.127
0.1111	0.031	0.001	0.000	0.127
0.1667	0.031	0.002	0.000	0.127
0.2222	0.031	0.002	0.000	0.127
0.2778	0.031	0.003	0.000	0.127
0.3333	0.031	0.004	0.000	0.127
0.3889	0.031	0.004	0.000	0.127
0.4444	0.031	0.005	0.000	0.127
0.5000	0.031	0.006	0.000	0.127
0.5556	0.031	0.007	0.000	0.127
0.6111	0.031	0.007	0.000	0.127
0.6667	0.031	0.008	0.000	0.127
0.7222	0.031	0.009	0.000	0.127
0.7778	0.031	0.009	0.000	0.127
0.8333	0.031	0.010	0.000	0.127
0.8889	0.031	0.011	0.000	0.127
0.9444	0.031	0.012	0.000	0.127
1.0000	0.031	0.012	0.000	0.127
1.0556	0.031	0.013	0.000	0.127
1.1111	0.031	0.014	0.000	0.127
1.1667	0.031	0.014	0.000	0.127
1.2222	0.031	0.015	0.000	0.127
1.2778	0.031	0.016	0.000	0.127
1.3333	0.031	0.016	0.000	0.127

1.3889	0.031	0.017	0.000	0.127
1.4444	0.031	0.018	0.000	0.127
1.5000	0.031	0.019	0.000	0.127
1.5556	0.031	0.019	0.000	0.127
1.6111	0.031	0.020	0.000	0.127
1.6667	0.031	0.021	0.000	0.127
1.7222	0.031	0.021	0.000	0.127
1.7778	0.031	0.022	0.000	0.127
1.8333	0.031	0.023	0.000	0.127
1.8889	0.031	0.023	0.000	0.127
1.9444	0.031	0.024	0.000	0.127
2.0000	0.031	0.025	0.000	0.127
2.0556	0.031	0.026	0.000	0.127
2.1111	0.031	0.026	0.000	0.127
2.1667	0.031	0.027	0.000	0.127
2.2222	0.031	0.028	0.000	0.127
2.2778	0.031	0.028	0.000	0.127
2.3333	0.031	0.029	0.000	0.127
2.3889	0.031	0.030	0.000	0.127
2.4444	0.031	0.031	0.000	0.127
2.5000	0.031	0.031	0.000	0.127
2.5556	0.031	0.032	0.000	0.127
2.6111	0.031	0.033	0.000	0.127
2.6667	0.031	0.033	0.000	0.127
2.7222	0.031	0.034	0.000	0.127
2.7778	0.031	0.035	0.000	0.127
2.8333	0.031	0.035	0.000	0.127
2.8889	0.031	0.036	0.000	0.127
2.9444	0.031	0.037	0.000	0.127
3.0000	0.031	0.038	0.000	0.127
3.0556	0.031	0.038	0.000	0.127
3.1111	0.031	0.039	0.000	0.127
3.1667	0.031	0.040	0.000	0.127
3.2222	0.031	0.040	0.000	0.127
3.2778	0.031	0.041	0.000	0.127
3.3333	0.031	0.042	0.000	0.127
3.3889	0.031	0.042	0.000	0.127
3.4444	0.031	0.043	0.000	0.127
3.5000	0.031	0.044	0.000	0.127
3.5556	0.031	0.045	0.000	0.127
3.6111	0.031	0.045	0.000	0.127
3.6667	0.031	0.046	0.000	0.127
3.7222	0.031	0.047	0.000	0.127
3.7778	0.031	0.047	0.000	0.127
3.8333	0.031	0.048	0.000	0.127
3.8889	0.031	0.049	0.000	0.127
3.9444	0.031	0.050	0.000	0.127
4.0000	0.031	0.050	0.000	0.127
4.0556	0.031	0.051	0.138	0.127
4.1111	0.031	0.052	0.389	0.127
4.1667	0.031	0.052	0.703	0.127
4.2222	0.031	0.053	1.046	0.127
4.2778	0.031	0.054	1.383	0.127
4.3333	0.031	0.054	1.683	0.127
4.3889	0.031	0.055	1.921	0.127
4.4444	0.031	0.056	2.088	0.127
4.5000	0.031	0.057	2.203	0.127
4.5556	0.031	0.057	2.347	0.127

4.6111	0.031	0.058	2.462	0.127
4.6667	0.031	0.059	2.571	0.127
4.7222	0.031	0.059	2.676	0.127
4.7778	0.031	0.060	2.777	0.127
4.8333	0.031	0.061	2.875	0.127
4.8889	0.031	0.062	2.969	0.127
4.9444	0.031	0.062	3.060	0.127
5.0000	0.031	0.063	3.149	0.127

South infiltration Trench

Bottom Length:	190.00 ft.
Bottom Width:	12.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	5
Pour Space of material for first layer:	0.4
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	4
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	180.572
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	180.572
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

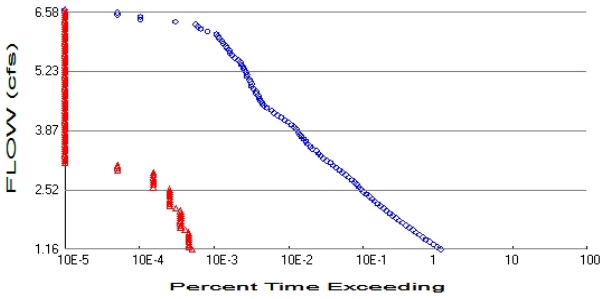
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.052	0.000	0.000	0.000
0.0556	0.052	0.001	0.000	0.211
0.1111	0.052	0.002	0.000	0.211
0.1667	0.052	0.003	0.000	0.211
0.2222	0.052	0.004	0.000	0.211
0.2778	0.052	0.005	0.000	0.211
0.3333	0.052	0.007	0.000	0.211
0.3889	0.052	0.008	0.000	0.211
0.4444	0.052	0.009	0.000	0.211
0.5000	0.052	0.010	0.000	0.211
0.5556	0.052	0.011	0.000	0.211
0.6111	0.052	0.012	0.000	0.211
0.6667	0.052	0.014	0.000	0.211
0.7222	0.052	0.015	0.000	0.211
0.7778	0.052	0.016	0.000	0.211
0.8333	0.052	0.017	0.000	0.211
0.8889	0.052	0.018	0.000	0.211
0.9444	0.052	0.019	0.000	0.211
1.0000	0.052	0.020	0.000	0.211
1.0556	0.052	0.022	0.000	0.211
1.1111	0.052	0.023	0.000	0.211
1.1667	0.052	0.024	0.000	0.211
1.2222	0.052	0.025	0.000	0.211
1.2778	0.052	0.026	0.000	0.211
1.3333	0.052	0.027	0.000	0.211

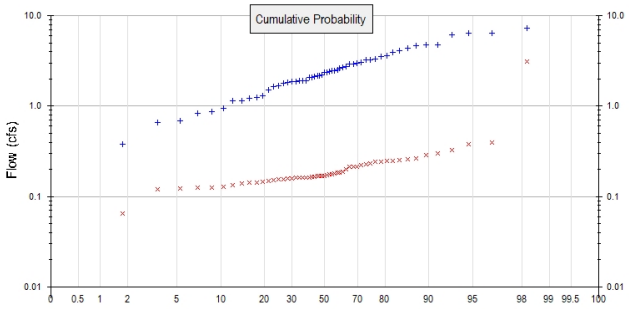
1.3889	0.052	0.029	0.000	0.211
1.4444	0.052	0.030	0.000	0.211
1.5000	0.052	0.031	0.000	0.211
1.5556	0.052	0.032	0.000	0.211
1.6111	0.052	0.033	0.000	0.211
1.6667	0.052	0.034	0.000	0.211
1.7222	0.052	0.036	0.000	0.211
1.7778	0.052	0.037	0.000	0.211
1.8333	0.052	0.038	0.000	0.211
1.8889	0.052	0.039	0.000	0.211
1.9444	0.052	0.040	0.000	0.211
2.0000	0.052	0.041	0.000	0.211
2.0556	0.052	0.043	0.000	0.211
2.1111	0.052	0.044	0.000	0.211
2.1667	0.052	0.045	0.000	0.211
2.2222	0.052	0.046	0.000	0.211
2.2778	0.052	0.047	0.000	0.211
2.3333	0.052	0.048	0.000	0.211
2.3889	0.052	0.050	0.000	0.211
2.4444	0.052	0.051	0.000	0.211
2.5000	0.052	0.052	0.000	0.211
2.5556	0.052	0.053	0.000	0.211
2.6111	0.052	0.054	0.000	0.211
2.6667	0.052	0.055	0.000	0.211
2.7222	0.052	0.057	0.000	0.211
2.7778	0.052	0.058	0.000	0.211
2.8333	0.052	0.059	0.000	0.211
2.8889	0.052	0.060	0.000	0.211
2.9444	0.052	0.061	0.000	0.211
3.0000	0.052	0.062	0.000	0.211
3.0556	0.052	0.064	0.000	0.211
3.1111	0.052	0.065	0.000	0.211
3.1667	0.052	0.066	0.000	0.211
3.2222	0.052	0.067	0.000	0.211
3.2778	0.052	0.068	0.000	0.211
3.3333	0.052	0.069	0.000	0.211
3.3889	0.052	0.071	0.000	0.211
3.4444	0.052	0.072	0.000	0.211
3.5000	0.052	0.073	0.000	0.211
3.5556	0.052	0.074	0.000	0.211
3.6111	0.052	0.075	0.000	0.211
3.6667	0.052	0.076	0.000	0.211
3.7222	0.052	0.077	0.000	0.211
3.7778	0.052	0.079	0.000	0.211
3.8333	0.052	0.080	0.000	0.211
3.8889	0.052	0.081	0.000	0.211
3.9444	0.052	0.082	0.000	0.211
4.0000	0.052	0.083	0.000	0.211
4.0556	0.052	0.084	0.138	0.211
4.1111	0.052	0.086	0.389	0.211
4.1667	0.052	0.087	0.703	0.211
4.2222	0.052	0.088	1.046	0.211
4.2778	0.052	0.089	1.383	0.211
4.3333	0.052	0.090	1.683	0.211
4.3889	0.052	0.091	1.921	0.211
4.4444	0.052	0.093	2.088	0.211
4.5000	0.052	0.094	2.203	0.211
4.5556	0.052	0.095	2.347	0.211

4.6111	0.052	0.096	2.462	0.211
4.6667	0.052	0.097	2.571	0.211
4.7222	0.052	0.098	2.676	0.211
4.7778	0.052	0.100	2.777	0.211
4.8333	0.052	0.101	2.875	0.211
4.8889	0.052	0.102	2.969	0.211
4.9444	0.052	0.103	3.060	0.211
5.0000	0.052	0.104	3.149	0.211

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 47.98
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 34.18
Total Impervious Area: 13.8

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	2.327226
5 year	3.829205
10 year	4.768173
25 year	5.852677
50 year	6.581645
100 year	7.245111

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.175508
5 year	0.280142
10 year	0.372672
25 year	0.521897
50 year	0.660699
100 year	0.827101

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	2.447	0.142
1957	4.424	0.263
1958	1.915	0.169
1959	1.818	0.170
1960	6.488	0.377
1961	2.112	0.135
1962	0.842	0.141
1963	4.691	0.298
1964	2.164	0.179
1965	2.059	0.168

1966	1.229	0.127
1967	3.902	0.256
1968	2.623	0.146
1969	1.146	0.125
1970	1.928	0.124
1971	2.473	0.143
1972	7.265	0.241
1973	2.172	0.160
1974	2.367	0.221
1975	1.249	0.159
1976	2.717	0.157
1977	0.665	0.245
1978	1.869	0.176
1979	1.876	0.214
1980	2.088	0.155
1981	3.288	0.228
1982	1.809	0.231
1983	3.037	0.328
1984	6.138	0.246
1985	0.947	0.211
1986	3.625	0.165
1987	2.936	0.155
1988	1.500	0.125
1989	1.651	0.120
1990	3.543	0.242
1991	6.406	3.087
1992	2.352	0.183
1993	1.293	0.147
1994	1.148	0.161
1995	3.232	0.167
1996	4.809	0.252
1997	0.236	0.060
1998	0.382	0.065
1999	2.408	0.177
2000	1.694	0.199
2001	0.688	0.161
2002	3.224	0.183
2003	1.894	0.161
2004	4.806	0.395
2005	2.213	0.152
2006	2.920	0.173
2007	2.502	0.213
2008	4.072	0.189
2009	2.975	0.288
2010	0.872	0.161
2011	2.689	0.164

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	7.2653	3.0865
2	6.4882	0.3948
3	6.4059	0.3767
4	6.1381	0.3284
5	4.8088	0.2980
6	4.8057	0.2879
7	4.6914	0.2626
8	4.4239	0.2558

9	4.0715	0.2516
10	3.9019	0.2465
11	3.6246	0.2452
12	3.5425	0.2419
13	3.2881	0.2413
14	3.2316	0.2309
15	3.2243	0.2285
16	3.0366	0.2212
17	2.9754	0.2137
18	2.9364	0.2128
19	2.9204	0.2113
20	2.7168	0.1986
21	2.6890	0.1892
22	2.6232	0.1828
23	2.5024	0.1826
24	2.4732	0.1787
25	2.4468	0.1770
26	2.4076	0.1763
27	2.3670	0.1727
28	2.3519	0.1698
29	2.2129	0.1689
30	2.1721	0.1675
31	2.1638	0.1672
32	2.1119	0.1650
33	2.0883	0.1640
34	2.0588	0.1615
35	1.9277	0.1611
36	1.9145	0.1610
37	1.8943	0.1605
38	1.8758	0.1603
39	1.8692	0.1586
40	1.8176	0.1572
41	1.8088	0.1554
42	1.6943	0.1553
43	1.6508	0.1520
44	1.5003	0.1472
45	1.2926	0.1460
46	1.2489	0.1431
47	1.2287	0.1417
48	1.1478	0.1407
49	1.1458	0.1346
50	0.9475	0.1271
51	0.8718	0.1250
52	0.8424	0.1250
53	0.6884	0.1239
54	0.6650	0.1202
55	0.3815	0.0647
56	0.2363	0.0600

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.1636	21482	10	0	Pass
1.2183	19200	9	0	Pass
1.2731	17018	9	0	Pass
1.3278	15072	9	0	Pass
1.3825	13476	9	0	Pass
1.4373	12182	9	0	Pass
1.4920	11063	9	0	Pass
1.5467	9987	9	0	Pass
1.6014	8976	8	0	Pass
1.6562	8104	7	0	Pass
1.7109	7322	7	0	Pass
1.7656	6615	7	0	Pass
1.8203	5952	7	0	Pass
1.8751	5355	7	0	Pass
1.9298	4893	7	0	Pass
1.9845	4453	7	0	Pass
2.0393	4025	7	0	Pass
2.0940	3646	6	0	Pass
2.1487	3318	5	0	Pass
2.2034	3024	5	0	Pass
2.2582	2794	5	0	Pass
2.3129	2594	5	0	Pass
2.3676	2372	5	0	Pass
2.4223	2148	5	0	Pass
2.4771	1966	5	0	Pass
2.5318	1816	5	0	Pass
2.5865	1708	3	0	Pass
2.6413	1601	3	0	Pass
2.6960	1482	3	0	Pass
2.7507	1369	3	0	Pass
2.8054	1260	3	0	Pass
2.8602	1143	3	0	Pass
2.9149	1034	3	0	Pass
2.9696	945	1	0	Pass
3.0244	852	1	0	Pass
3.0791	785	1	0	Pass
3.1338	714	0	0	Pass
3.1885	634	0	0	Pass
3.2433	575	0	0	Pass
3.2980	535	0	0	Pass
3.3527	498	0	0	Pass
3.4074	461	0	0	Pass
3.4622	404	0	0	Pass
3.5169	381	0	0	Pass
3.5716	355	0	0	Pass
3.6264	333	0	0	Pass
3.6811	310	0	0	Pass
3.7358	290	0	0	Pass
3.7905	275	0	0	Pass
3.8453	261	0	0	Pass
3.9000	247	0	0	Pass
3.9547	230	0	0	Pass
4.0094	214	0	0	Pass

4.0642	196	0	0	Pass
4.1189	173	0	0	Pass
4.1736	156	0	0	Pass
4.2284	138	0	0	Pass
4.2831	124	0	0	Pass
4.3378	115	0	0	Pass
4.3925	100	0	0	Pass
4.4473	92	0	0	Pass
4.5020	87	0	0	Pass
4.5567	82	0	0	Pass
4.6115	79	0	0	Pass
4.6662	76	0	0	Pass
4.7209	72	0	0	Pass
4.7756	71	0	0	Pass
4.8304	66	0	0	Pass
4.8851	63	0	0	Pass
4.9398	62	0	0	Pass
4.9945	60	0	0	Pass
5.0493	58	0	0	Pass
5.1040	55	0	0	Pass
5.1587	54	0	0	Pass
5.2135	52	0	0	Pass
5.2682	50	0	0	Pass
5.3229	48	0	0	Pass
5.3776	46	0	0	Pass
5.4324	44	0	0	Pass
5.4871	41	0	0	Pass
5.5418	37	0	0	Pass
5.5965	34	0	0	Pass
5.6513	32	0	0	Pass
5.7060	31	0	0	Pass
5.7607	29	0	0	Pass
5.8155	28	0	0	Pass
5.8702	26	0	0	Pass
5.9249	25	0	0	Pass
5.9796	23	0	0	Pass
6.0344	22	0	0	Pass
6.0891	21	0	0	Pass
6.1438	16	0	0	Pass
6.1986	13	0	0	Pass
6.2533	12	0	0	Pass
6.3080	11	0	0	Pass
6.3627	6	0	0	Pass
6.4175	2	0	0	Pass
6.4722	2	0	0	Pass
6.5269	1	0	0	Pass
6.5816	1	0	0	Pass

Water Quality

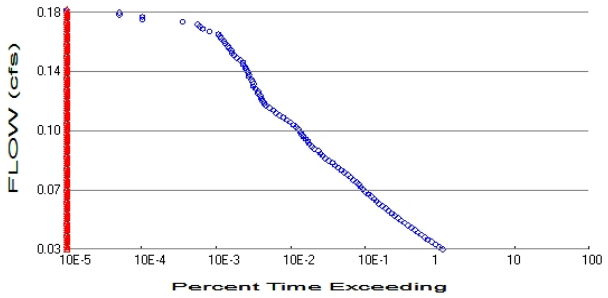
Water Quality BMP Flow and Volume for POC #1

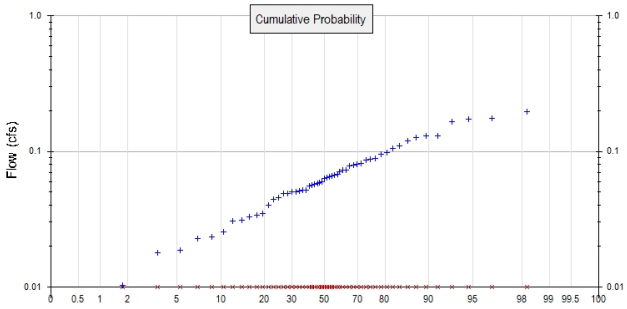
On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
infiltration pond POC	☐	3184.39			☐	99.99			
North Entrance infiltration	☐	98.00			☐	100.00			
Total Volume Infiltrated		3282.40	0.00	0.00		99.99	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 1.29
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.69
Total Impervious Area: 0.6

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.06257
5 year	0.102953
10 year	0.128198
25 year	0.157356
50 year	0.176955
100 year	0.194793

Flow Frequency Return Periods for Mitigated. POC #2

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

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1956	0.066	0.000
1957	0.119	0.000
1958	0.051	0.000
1959	0.049	0.000
1960	0.174	0.000
1961	0.057	0.000
1962	0.023	0.000
1963	0.126	0.000
1964	0.058	0.000
1965	0.055	0.000
1966	0.033	0.000

1967	0.105	0.000
1968	0.071	0.000
1969	0.031	0.000
1970	0.052	0.000
1971	0.066	0.000
1972	0.195	0.000
1973	0.058	0.000
1974	0.064	0.000
1975	0.034	0.000
1976	0.073	0.000
1977	0.018	0.000
1978	0.050	0.000
1979	0.050	0.000
1980	0.056	0.000
1981	0.088	0.000
1982	0.049	0.000
1983	0.082	0.000
1984	0.165	0.000
1985	0.025	0.000
1986	0.097	0.000
1987	0.079	0.000
1988	0.040	0.000
1989	0.044	0.000
1990	0.095	0.000
1991	0.172	0.000
1992	0.063	0.000
1993	0.035	0.000
1994	0.031	0.000
1995	0.087	0.000
1996	0.129	0.000
1997	0.006	0.000
1998	0.010	0.000
1999	0.065	0.000
2000	0.046	0.000
2001	0.019	0.000
2002	0.087	0.000
2003	0.051	0.000
2004	0.129	0.000
2005	0.059	0.000
2006	0.079	0.000
2007	0.067	0.000
2008	0.109	0.000
2009	0.080	0.000
2010	0.023	0.000
2011	0.072	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	0.1953	0.0000
2	0.1744	0.0000
3	0.1722	0.0000
4	0.1650	0.0000
5	0.1293	0.0000
6	0.1292	0.0000
7	0.1261	0.0000
8	0.1189	0.0000
9	0.1095	0.0000

10	0.1049	0.0000
11	0.0975	0.0000
12	0.0952	0.0000
13	0.0884	0.0000
14	0.0869	0.0000
15	0.0867	0.0000
16	0.0816	0.0000
17	0.0800	0.0000
18	0.0789	0.0000
19	0.0785	0.0000
20	0.0730	0.0000
21	0.0723	0.0000
22	0.0705	0.0000
23	0.0673	0.0000
24	0.0665	0.0000
25	0.0658	0.0000
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27	0.0636	0.0000
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29	0.0595	0.0000
30	0.0584	0.0000
31	0.0582	0.0000
32	0.0568	0.0000
33	0.0561	0.0000
34	0.0554	0.0000
35	0.0518	0.0000
36	0.0515	0.0000
37	0.0509	0.0000
38	0.0504	0.0000
39	0.0503	0.0000
40	0.0489	0.0000
41	0.0486	0.0000
42	0.0456	0.0000
43	0.0444	0.0000
44	0.0403	0.0000
45	0.0348	0.0000
46	0.0336	0.0000
47	0.0330	0.0000
48	0.0309	0.0000
49	0.0308	0.0000
50	0.0255	0.0000
51	0.0234	0.0000
52	0.0227	0.0000
53	0.0185	0.0000
54	0.0179	0.0000
55	0.0103	0.0000
56	0.0064	0.0000

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0313	21482	0	0	Pass
0.0328	19196	0	0	Pass
0.0342	17028	0	0	Pass
0.0357	15059	0	0	Pass
0.0372	13466	0	0	Pass
0.0386	12182	0	0	Pass
0.0401	11047	0	0	Pass
0.0416	9979	0	0	Pass
0.0431	8972	0	0	Pass
0.0445	8106	0	0	Pass
0.0460	7318	0	0	Pass
0.0475	6605	0	0	Pass
0.0489	5952	0	0	Pass
0.0504	5355	0	0	Pass
0.0519	4885	0	0	Pass
0.0534	4449	0	0	Pass
0.0548	4025	0	0	Pass
0.0563	3646	0	0	Pass
0.0578	3315	0	0	Pass
0.0592	3018	0	0	Pass
0.0607	2794	0	0	Pass
0.0622	2592	0	0	Pass
0.0637	2366	0	0	Pass
0.0651	2148	0	0	Pass
0.0666	1968	0	0	Pass
0.0681	1814	0	0	Pass
0.0695	1707	0	0	Pass
0.0710	1600	0	0	Pass
0.0725	1481	0	0	Pass
0.0740	1366	0	0	Pass
0.0754	1258	0	0	Pass
0.0769	1144	0	0	Pass
0.0784	1033	0	0	Pass
0.0798	945	0	0	Pass
0.0813	852	0	0	Pass
0.0828	785	0	0	Pass
0.0843	713	0	0	Pass
0.0857	633	0	0	Pass
0.0872	575	0	0	Pass
0.0887	534	0	0	Pass
0.0901	498	0	0	Pass
0.0916	461	0	0	Pass
0.0931	404	0	0	Pass
0.0946	380	0	0	Pass
0.0960	355	0	0	Pass
0.0975	333	0	0	Pass
0.0990	310	0	0	Pass
0.1004	291	0	0	Pass
0.1019	275	0	0	Pass
0.1034	264	0	0	Pass
0.1049	248	0	0	Pass
0.1063	230	0	0	Pass
0.1078	214	0	0	Pass

0.1093	196	0	0	Pass
0.1107	175	0	0	Pass
0.1122	156	0	0	Pass
0.1137	138	0	0	Pass
0.1152	125	0	0	Pass
0.1166	115	0	0	Pass
0.1181	101	0	0	Pass
0.1196	92	0	0	Pass
0.1210	87	0	0	Pass
0.1225	82	0	0	Pass
0.1240	80	0	0	Pass
0.1255	77	0	0	Pass
0.1269	72	0	0	Pass
0.1284	71	0	0	Pass
0.1299	67	0	0	Pass
0.1313	63	0	0	Pass
0.1328	62	0	0	Pass
0.1343	60	0	0	Pass
0.1358	58	0	0	Pass
0.1372	55	0	0	Pass
0.1387	54	0	0	Pass
0.1402	52	0	0	Pass
0.1416	50	0	0	Pass
0.1431	48	0	0	Pass
0.1446	46	0	0	Pass
0.1461	45	0	0	Pass
0.1475	41	0	0	Pass
0.1490	37	0	0	Pass
0.1505	34	0	0	Pass
0.1519	32	0	0	Pass
0.1534	31	0	0	Pass
0.1549	29	0	0	Pass
0.1564	28	0	0	Pass
0.1578	26	0	0	Pass
0.1593	25	0	0	Pass
0.1608	23	0	0	Pass
0.1622	22	0	0	Pass
0.1637	21	0	0	Pass
0.1652	16	0	0	Pass
0.1667	13	0	0	Pass
0.1681	12	0	0	Pass
0.1696	11	0	0	Pass
0.1711	7	0	0	Pass
0.1725	2	0	0	Pass
0.1740	2	0	0	Pass
0.1755	1	0	0	Pass
0.1770	1	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #2

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

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
South infiltration Trench POC	☐	164.32			☐	100.00			
Total Volume Infiltrated		164.32	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

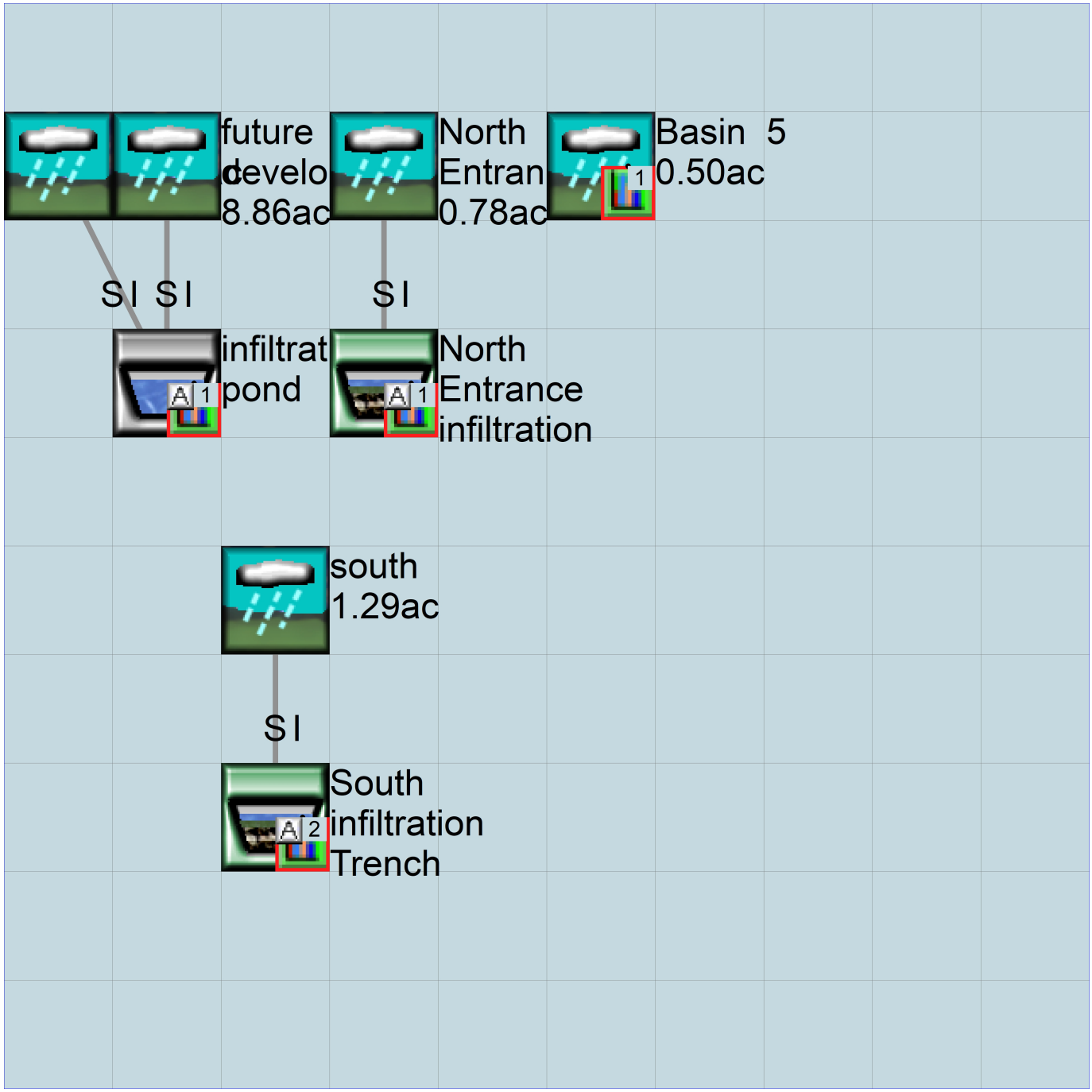
IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

Mitigated UCI File

Predeveloped HSPF Message File

Mitigated HSPF Message File

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APPENDIX 2 Supplemental Reports and Information

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

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PREPARED FOR:

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1868 STATE AVENUE
OLYMPIA, WASHINGTON 98501

RGI PROJECT NO. 2022-009-2

BODENHAMMER PROPERTY
3717 49TH AVENUE SOUTHWEST & 3825 58TH LANE SOUTHWEST
OLYMPIA, WASHINGTON

JUNE 13, 2023

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RILEYGROUP

June 13, 2023

Rob Rice
Rob Rice Homes
1868 State Avenue
Olympia, Washington 98501

Subject: **Preliminary Geotechnical Engineering Report**
Bodenhammer Property
3717 49th Avenue Southwest & 3825 58th Lane Southwest
Olympia, Washington
RGI Project No. 2022-009-2

Dear Mr. Rob Rice:

As requested, The Riley Group, Inc. (RGI) has performed a Preliminary Geotechnical Engineering Report (GER) for the Bodenhammer Property located at 3717 49th Avenue Southwest & 3825 58th Lane Southwest, Olympia, Washington. Our services were completed in accordance with our proposal dated April 18, 2023 and authorized by you on April 20, 2023. The information in this GER is based on our understanding of the proposed construction, and the soil and groundwater conditions encountered in the exploration pits completed by RGI at the site on May 9, 2023.

RGI recommends that you submit the project plans and specifications to RGI for a general review so that we may confirm that the recommendations in this GER are interpreted and implemented properly in the construction documents. RGI also recommends that a representative of our firm be present on-site during portions of the project construction to confirm that the soil and groundwater conditions are consistent with those that form the basis for the engineering recommendations in this GER.

If you have any questions or require additional information, please contact us.

Respectfully submitted,

THE RILEY GROUP, INC.

KRISTINA MARIE WELLER
STATE OF WASHINGTON
33182
REGISTERED
PROFESSIONAL ENGINEER

6/13/23

Angela L. Gelfer, LG
Project Geologist II

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Executive Summary

This Executive Summary should be used in conjunction with the entire Geotechnical Engineering Report (GER) for design and/or construction purposes. It should be recognized that specific details were not included or fully developed in this section, and the GER must be read in its entirety for a comprehensive understanding of the items contained herein. Section 7.0 should be read for an understanding of limitations.

RGI's geotechnical scope of work included the advancement of eight exploration pits to approximate depths of 7.5 to 10 feet below existing site grades. RGI previously provided a report entitled "Groundwater Level Monitoring Report" dated August 19, 2022.

Based on the information obtained from our subsurface exploration, the site is suitable for development of the proposed project. The following geotechnical considerations were identified:

Soil Conditions: The soils encountered during field exploration include outwash sands consisting of fine to medium sand and gravel with variable silt content, and lodgment till consisting of silty gravelly fine sand.

Groundwater: Light groundwater seepage was encountered at 3.5 to 10 feet below ground surface in six of the exploration pits during our subsurface exploration. Two pits (TP-6 and TP-7) encountered no groundwater.

1.0 Introduction

This Preliminary Geotechnical Engineering Report (GER) presents the results of the geotechnical engineering services provided for the Bodenhammer Property in Olympia, Washington. The purpose of this evaluation is to assess subsurface conditions and provide geotechnical recommendations for the construction of a residential development. Our scope of services included field explorations, laboratory testing, engineering analyses, and preparation of this preliminary GER.

The recommendations in the following sections of this preliminary GER are based upon our current understanding of the proposed site development as outlined below. Once development plans are completed, RGI should review them to modify our recommendations as required.

2.0 Project description

The project site is located at 3717 49th Avenue Southwest and 3825 58th Lane Southwest in Olympia, Washington. The approximate location of the site is shown on Figure 1.

The site currently consists of 55 undeveloped acres comprising Thurston County tax parcels #12832310700 and 12832310800. The existing site is ranching land, currently used to raise cattle. The proposed project will consist of a residential development and associated stormwater facilities, roads, utilities, and landscaping.

At the time of preparing this GER, development plans were not available for our review. Once plans are developed that show grades and proposed layout, RGI should review the plans and provide a final report.

3.0 Field Exploration and Laboratory Testing

3.1 Field Exploration

On May 9, 2023, RGI observed the excavation of eight exploration pits. The approximate exploration locations are shown on Figure 2.

Field logs of each exploration were prepared by the geologist that continuously observed the excavation. These logs included visual classifications of the materials encountered during excavation as well as our interpretation of the subsurface conditions between samples. The exploration pits logs included in Appendix A represent an interpretation of the field logs and include modifications based on laboratory observation and analysis of the samples.

3.2 LABORATORY TESTING

During the field exploration, a representative portion of each recovered sample was sealed in containers and transported to our laboratory for further visual and laboratory examination. Selected samples retrieved from the exploration pits were tested for moisture content and grain size analysis to aid in soil classification and provide input for the recommendations provided in this GER. The results and descriptions of the laboratory tests are enclosed in Appendix A.

4.0 Site Conditions

4.1 SURFACE

The subject site is comprised of two irregular-shaped parcels of land approximately 55 acres in size. The site is bound to the north by 49th Avenue Southwest, to the east and west by residential property, and to the south by 58th Lane Southwest. An equestrian facility, Miari Stables, occupies the land east of the site.

The existing site is ranching land, currently used to raise cattle. The site is mostly grassland with some trees and other vegetation mostly on the northern boundary. There are several fence lines running north/south and east/west to contain livestock. The approximate northernmost quarter of the site is a densely vegetated wetland with a small pond. The site is relatively flat with an overall elevation difference of approximately 10 feet.

4.2 GEOLOGY

Review of the *Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington,* by T.J. Walsh, etc. (2003) indicates that the soil in the project vicinity is mapped as Vashon recessional sand and minor silt (Qgos), which is moderately well-sorted, moderately to well-rounded fine- to medium-grained sand with minor silt. The deposit is generally non cohesive and very permeable. The deposit thickness is variable and can range to up to 420 feet, inferred from wells. These descriptions are generally similar to the findings in our field explorations.

4.3 SOILS

The soils encountered during field exploration include sands and gravels with variable silt content interpreted as glacial outwash. Silt content was generally trace to some with isolated areas of silty sand. We also encountered some instances of dense to very dense sands and gravels, interpreted as glacial till. The apparent till was encountered at depths ranging from five to eight feet below the existing ground surface in exploration pits on the southwest portion of the site.

More detailed descriptions of the subsurface conditions encountered are presented in the exploration pits included in Appendix A. Sieve analysis was performed on two selected soil samples. Grain size distribution curves are included in Appendix A.

4.4 GROUNDWATER

Light groundwater seepage was encountered at 3.5 to 10 feet below existing ground surface during our subsurface exploration at six of the exploration pits. Two pits (TP-6 and TP-7) encountered no groundwater. Groundwater monitoring was previously completed by RGI and the results were provided under separate cover; the groundwater contours are shown on Figure 2.

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the explorations were performed. In addition, perched water can develop within seams and layers contained in fill soils or higher permeability soils overlying less permeable soils following periods of heavy or prolonged precipitation.

4.5 SEISMIC CONSIDERATIONS

Based on the International Building Code (IBC), RGI recommends the following preliminary seismic parameters for design. Due to the potential for liquefaction on portions of the site, the site or at least portions of the site should be mapped as site class F. However, we expect the structures will meet the exception which allows the soils classification in accordance with Table 20.3.1 of ASCE 7-16. Additional exploration is necessary to confirm the site class.

Table 1 IBC

Parameter	2018 Value
Site Soil Class[1]	F(E)[2]
Site Latitude	47.00008
Site Longitude	-122.9622
Short Period Spectral Response Acceleration, S_S (g)	1.402
1-Second Period Spectral Response Acceleration, S_1 (g)	0.529
Adjusted Short Period Spectral Response Acceleration, S_{MS} (g)	1.683[3]
Adjusted 1-Sec Period Spectral Response Acceleration, S_{M1} (g)	1.133[3]
Numeric seismic design value at 0.2 second; S_{DS}(g)	1.122[3]
Numeric seismic design value at 1.0 second; S_{D1}(g)	0.756[3]

1. Note: In general accordance with Chapter 20 of ASCE 7-16, the Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.

2. Note: ASCE 7-16 require a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope of our services does not include the required 100 foot soil profile determination. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

3. Note: In accordance with ASCE 11.4.8, a ground motion hazard analysis is not required for the following cases:

- Structures on Site Class E sites with S_S greater than or equal to 1.0, provided the site coefficient Fa is taken as equal to that of Site Class C.
- Structures on Site Class D sites with S_1 greater than or equal to 0.2, provided that the value of the seismic response coefficient Cs is determined by Eq. 12.8-2 for values of $T \leq 1.5Ts$ and taken as equal to 1.5 times the value computed in accordance with either Eq. 12.8-3 for $T_L \geq T > 1.5T_s$ or Eq. 12.8-4 for $T > TL$.
- Structures on Site Class E sites with S_1 greater than or equal to 0.2, provided that T is less than or equal to T_s and the equivalent static force procedure is used for design.

The above exceptions do not apply to seismically isolated structures, structures with damping systems or structures designed using the response history procedures of Chapter 16.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations from a seismic event. Liquefaction mainly affects geologically recent deposits of fine-grained sands that are below the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction, thus reducing or eliminating the soil's strength.

RGI reviewed the results of the field and laboratory testing and assessed the potential for liquefaction of the site's soil during an earthquake. The site is underlain by loose to medium dense sand, gravel, and silty sand and has a shallow groundwater table, RGI considers that the possibility of liquefaction during an earthquake is moderate. Additional drilling and evaluation of the subsurface conditions especially in the high groundwater areas is necessary to address the liquefaction settlements.

4.6 GEOLOGIC HAZARD AREAS

Regulated geologically hazardous areas include erosion, landslide, earthquake, or other geological hazards. Based on the Tumwater GIS map, portions of the site are a high groundwater hazard area. Based on the Thurston County GIS the site is also mapped as a critical aquifer recharge area and is a seismic hazard area as discussed above. The site does not contain other geologically hazardous areas.

4.7 GEOTECHNICAL CONSIDERATIONS

Based on our study, the site is suitable for the proposed construction from a geotechnical standpoint. Further evaluation of the grading in the high groundwater areas is necessary due to the liquefaction potential of the soils. Foundations for the proposed residences can be supported on conventional spread footings bearing on medium dense native soil or structural fill. Slab-on-grade floors and pavements can be similarly supported.

Detailed recommendations regarding the above issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

4.8 EARTHWORK

Per our current understanding of the project, earthwork at the site will include stripping organics and topsoil from the site, excavation of stormwater facilities to design subgrade, and placement of structural fill to regrade the site.

4.8.1 EROSION AND SEDIMENT CONTROL

Potential sources or causes of erosion and sedimentation depend on construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. The impacts on erosion-prone areas can be reduced by implementing an erosion and sedimentation control plan. The plan should be designed in accordance with applicable city and/or county standards.

RGI recommends the following erosion control Best Management Practices (BMPs):

- Scheduling site preparation and grading for the drier summer and early fall months and undertaking activities that expose soil during periods of little or no rainfall
- Retaining existing vegetation whenever feasible
- Establishing a quarry spall construction entrance
- Installing siltation control fencing or anchored straw or coir wattles on the downhill side of work areas
- Covering soil stockpiles with anchored plastic sheeting
- Revegetating or mulching exposed soils with a minimum 3-inch thickness of straw if surfaces will be left undisturbed for more than one day during wet weather or one week in dry weather
- Directing runoff away from exposed soils and slopes
- Minimizing the length and steepness of slopes with exposed soils and cover excavation surfaces with anchored plastic sheeting (Graded and 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 and channeling. Some sloughing and raveling of slopes with exposed or disturbed soil should be expected.)
- Decreasing runoff velocities with check dams, straw bales or coir wattles
- Confining sediment to the project site
- Inspecting and maintaining erosion and sediment control measures frequently (The contractor should be aware that inspection and maintenance of erosion control BMPs is critical toward their satisfactory performance. Repair and/or replacement of dysfunctional erosion control elements should be anticipated.)

Permanent erosion protection should be provided by reestablishing vegetation using hydroseeding and/or landscape planting. Until the permanent erosion protection is established, site monitoring should be performed by qualified personnel to evaluate the effectiveness of the erosion control measures. Provisions for modifications to the erosion

control system based on monitoring observations should be included in the erosion and sedimentation control plan.

4.8.2 STRIPPING

Stripping efforts should include removal of pavements, vegetation, organic materials, and deleterious debris from areas slated for building, pavement, and utility construction. The exploration pits location encountered six to eight inches of topsoil and rootmass. Deeper areas of stripping may be required in forested or heavily vegetated areas of the site.

4.8.3 EXCAVATIONS

All temporary cut slopes associated with the site and utility excavations should be adequately inclined to prevent sloughing and collapse. The site soils consist of loose to medium dense sands and gravels with variable silt content.

Accordingly, for excavations more than 4 feet but less than 20 feet in depth, the temporary side slopes should be laid back with a minimum slope inclination of 1.5H:1V (Horizontal:Vertical). If there is insufficient room to complete the excavations in this manner, or excavations greater than 20 feet in depth are planned, using temporary shoring to support the excavations should be considered. For open cuts at the site, RGI recommends:

- No traffic, construction equipment, stockpiles or building supplies are allowed at the top of cut slopes within a distance of at least five feet from the top of the cut
- Exposed soil along the slope is protected from surface erosion using waterproof tarps and/or plastic sheeting
- Construction activities are scheduled so that the length of time the temporary cut is left open is minimized
- Surface water is diverted away from the excavation
- The general condition of slopes should be observed periodically by a geotechnical engineer to confirm adequate stability and erosion control measures

In all cases, however, appropriate inclinations will depend on the actual soil and groundwater conditions encountered during earthwork. Ultimately, the site contractor must be responsible for maintaining safe excavation slopes that comply with applicable OSHA or WISHA guidelines.

4.8.4 SITE PREPARATION

RGI anticipates that some areas of loose or soft soil will be exposed upon completion of stripping and grubbing. Proofrolling and subgrade verification should be considered an essential step in site preparation. After stripping, grubbing, and prior to placement of structural fill, RGI recommends proofrolling building and pavement subgrades and areas to receive structural fill. These areas should moisture conditioned and compacted to a firm

and unyielding condition in order to achieve a minimum compaction level of 95 percent of the modified proctor maximum dry density as determined by the American Society of Testing and Materials D1557-09 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (ASTM D1557).

Proofrolling and adequate subgrade compaction can only be achieved when the soils are within approximately ± 2 percent moisture content of the optimum moisture content. Soils which appear firm after stripping and grubbing may be proofrolled with a heavy compactor, loaded double-axle dump truck, or other heavy equipment under the observation of an RGI representative. This observer will assess the subgrade conditions prior to filling. The need for or advisability of proofrolling due to soil moisture conditions should be determined at the time of construction.

If fill is placed in areas of the site where existing slopes are steeper than 5:1 (Horizontal:Vertical), the area should be benched to reduce the potential for slippage between existing slopes and fills. Benches should be wide enough to accommodate compaction and earth moving equipment, and to allow placement of horizontal lifts of fill.

Subgrade soils that become disturbed due to elevated moisture conditions should be overexcavated to reveal firm, non-yielding, non-organic soils and backfilled with compacted structural fill. In order to maximize utilization of site soils as structural fill, RGI recommends that the earthwork portion of this project be completed during extended periods of warm and dry weather if possible. If earthwork is completed during the wet season (typically November through May) it will be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork will require additional mitigative measures beyond that which would be expected during the drier summer and fall months.

4.8.5 Structural Fill

Once stripping, clearing and other preparing operations are complete, cuts and fills can be made to establish desired building grades. Prior to placing fill, RGI recommends proofrolling as described above.

RGI recommends fill below the foundation and floor slab, behind retaining walls, and below pavement and hardscape surfaces be placed in accordance with the following recommendations for structural fill. The structural fill should be placed after completion of site preparation procedures as described above.

The suitability of excavated site soils and import soils for compacted structural fill use will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines (that portion passing the U.S. No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve. Soils containing more than about 5 percent fines cannot

be consistently compacted to a dense, non-yielding condition when the moisture content is more than 2 percent above or below optimum. Optimum moisture content is that moisture that results in the greatest compacted dry density with a specified compactive effort.

Non-organic site soils are only considered suitable for structural fill provided that their moisture content is within about two percent of the optimum moisture level as determined by ASTM D1557. Excavated site soils may not be suitable for re-use as structural fill depending on the moisture content and weather conditions at the time of construction. If soils are stockpiled for future reuse and wet weather is anticipated, the stockpile should be protected with plastic sheeting that is securely anchored.

Even during dry weather, moisture conditioning (such as, windrowing and drying) of site soils to be reused as structural fill may be required. Even during the summer, delays in grading can occur due to excessively high moisture conditions of the soils or due to precipitation. If wet weather occurs, the upper wetted portion of the site soils may need to be scarified and allowed to dry prior to further earthwork, or may need to be wasted from the site.

The site soil is moisture sensitive and will not be usable as structural fill in wet weather. If the soil cannot be moisture conditioned, it may become necessary to import clean, granular soils to complete site work that meet the grading requirements listed in Table 2 to be used as structural fill.

Table 2 Structural Fill Gradation

U.S. Sieve Size	Percent Passing
4 inches	100
No. 4 sieve	22 to 100
No. 200 sieve	0 to 5*

*Based on minus 3/4 inch fraction.

Prior to use, an RGI representative should observe and test all materials imported to the site for use as structural fill. Structural fill materials should be placed in uniform loose layers not exceeding 12 inches and compacted as specified in Table 3. The soil's maximum density and optimum moisture should be determined by ASTM D1557.

Table 3 Structural Fill Compaction ASTM D1557

Location	Material Type	Minimum Compaction Percentage	Moisture Content Range	
Foundations	On-site granular or approved imported fill soils:	95	+2	-2
Retaining Wall Backfill	On-site granular or approved imported fill soils:	92	+2	-2
Slab-on-grade	On-site granular or approved imported fill soils:	95	+2	-2
General Fill (non-structural areas)	On-site soils or approved imported fill soils:	90	+3	-2
Pavement – Subgrade and Base Course	On-site granular or approved imported fill soils:	95	+2	-2

Placement and compaction of structural fill should be observed by RGI. A representative number of in-place density tests should be performed as the fill is being placed to confirm that the recommended level of compaction is achieved.

4.8.6 CUT AND FILL SLOPES

All permanent cut and fill slopes (except interior slopes of detention pond) should be graded with a finished inclination no greater than 2H:1V. The interior slopes of the detention pond must be graded with a slope gradient no steeper than 3H:1V. Upon completion of construction, the slope face should be trackwalked, compacted and vegetated, or provided with other physical means to guard against erosion. All fill placed for slope construction should meet the structural fill requirements as described in Section 5.2.5.

Final grades at the top of the slopes must promote surface drainage away from the slope crest. Water must not be allowed to flow in an uncontrolled fashion over the slope face. If it is necessary to direct surface runoff towards the slope, it should be controlled at the top of the slope, piped in a closed conduit installed on the slope face, and taken to an appropriate point of discharge beyond the toe of the slope.

4.8.7 WET WEATHER CONSTRUCTION CONSIDERATIONS

RGI recommends that preparation for site grading and construction include procedures intended to drain ponded water, control surface water runoff, and to collect shallow subsurface seepage zones in excavations where encountered. It will not be possible to successfully compact the subgrade or utilize on-site soils as structural fill if accumulated water is not drained prior to grading or if drainage is not controlled during construction. Attempting to grade the site without adequate drainage control measures will reduce the

amount of on-site soil effectively available for use, increase the amount of select import fill materials required, and ultimately increase the cost of the earthwork phases of the project. Free water should not be allowed to pond on the subgrade soils. RGI anticipates that the use of berms and shallow drainage ditches, with sumps and pumps in utility trenches, will be required for surface water control during wet weather and/or wet site conditions.

4.9 FOUNDATIONS

Following site preparation and grading, the proposed residence foundations can be supported on conventional spread footings bearing on medium dense native soil or structural fill. In the high groundwater areas, further evaluation of foundation support is needed. Loose, organic, or other unsuitable soils may be encountered in the proposed building footprint. If unsuitable soils are encountered, they should be overexcavated and backfilled with structural fill.

Perimeter foundations exposed to weather should be at a minimum depth of 18 inches below final exterior grades. Interior foundations can be constructed at any convenient depth below the floor slab. Finished grade is defined as the lowest adjacent grade within 5 feet of the foundation for perimeter (or exterior) footings and finished floor level for interior footings.

Table 4 Foundation Design

Design Parameter	Value
Allowable Bearing Capacity	2,000 psf[1]
Friction Coefficient	0.30
Passive pressure (equivalent fluid pressure)	250 pcf[2]

1. psf = pounds per square foot
2. pcf = pounds per cubic foot

The allowable foundation bearing pressures apply to dead loads plus design live load conditions. For short-term loads, such as wind and seismic, a 1/3 increase in this allowable capacity may be used. At perimeter locations, RGI recommends not including the upper 12 inches of soil in the computation of passive pressures because they can be affected by weather or disturbed by future grading activity. The passive pressure value assumes the foundation will be constructed neat against competent soil or backfilled with structural fill as described in Section 5.2.5. The recommended base friction and passive resistance value includes a safety factor of about 1.5.

With spread footing foundations designed in accordance with the recommendations in this section, maximum total and differential post-construction settlements of 1 inch and 1/2 inch, respectively, should be expected.

4.10 RETAINING WALLS

If retaining walls are needed for the residences and in pond areas, RGI recommends cast-in-place concrete walls be used. Modular block walls may be used for grade changes in other areas. The magnitude of earth pressure development on retaining walls will partly depend on the quality of the wall backfill. RGI recommends placing and compacting wall backfill as structural fill. Wall drainage will be needed behind the wall face. A typical retaining wall drainage detail is shown in Figure 3.

With wall backfill placed and compacted as recommended, level backfill, and drainage properly installed, RGI recommends using the values in the following table for design.

Table 5 Retaining Wall Design

Design Parameter	Value
Active Earth Pressure (unrestrained walls)	35 pcf
At-rest Earth Pressure (restrained walls)	50 pcf

For seismic design, an additional uniform load of 7 times the wall height (H) for unrestrained walls and 14H in psf for restrained walls should be applied to the wall surface. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 5.3.

4.11 SLAB-ON-GRADE CONSTRUCTION

Once site preparation has been completed as described in Section 5.2, suitable support for slab-on-grade construction should be provided. RGI recommends that the concrete slab be placed on top of medium dense native soil or structural fill. Immediately below the floor slab, RGI recommends placing a four-inch thick capillary break layer of clean, free-draining sand or gravel that has less than five percent passing the U.S. No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab. Where moisture by vapor transmission is undesirable, an 8- to 10-millimeter thick plastic membrane should be placed on a 4-inch thick layer of clean gravel. For the anticipated floor slab loading, we estimate post-construction floor settlements of 1/4- to 1/2-inch.

4.12 DRAINAGE

4.12.1 SURFACE

Final exterior grades should promote free and positive drainage away from the building area. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building area. For non-pavement locations, RGI recommends providing a

minimum drainage gradient of 3 percent for a minimum distance of 10 feet from the building perimeter. In paved locations, a minimum gradient of 1 percent should be provided unless provisions are included for collection and disposal of surface water adjacent to the structure.

4.12.2 SUBSURFACE

RGI recommends installing perimeter foundation drains. A typical footing drain detail is shown on Figure 4. The foundation drains and roof downspouts should be tightlined separately to an approved discharge facility. Subsurface drains must be laid with a gradient sufficient to promote positive flow to a controlled point of approved discharge.

4.12.3 INFILTRATION

Infiltration of stormwater runoff may be feasible at the Site. However, the Site is located in a Critical Aquifer Recharge Area. Therefore, enhanced treatment of stormwater runoff from pollution generating surfaces may be required prior to infiltration of the runoff.

4.13 UTILITIES

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) specifications. For site utilities located within the right-of-ways, bedding and backfill should be completed in accordance with City of Tumwater specifications. At a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 5.2.5. Where utilities occur below unimproved areas, the degree of compaction can be reduced to a minimum of 90 percent of the soil's maximum density as determined by the referenced ASTM D1557.

4.14 PAVEMENTS

Pavement subgrades should be prepared as described in Section 5.2 and as discussed below. Regardless of the relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy construction equipment to verify this condition.

We understand pavement section for asphalt and concrete surfaces will be in accordance with the City of Tumwater standards contained in Table One of Chapter 4 of the development guide as modified in the Notice dated October 5, 2020. Based on the soils encountered in our explorations and the imported structural fill needed for the site, the pavement section should be adequate for the site roadways.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability.

For optimum pavement performance, surface drainage gradients of no less than 2 percent are recommended. Also, some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

5.0 Additional Services

RGI is available to provide further geotechnical consultation throughout the design phase of the project. RGI should review the final design and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and incorporated into project design and construction.

RGI is also available to provide geotechnical engineering and construction monitoring services during construction. The integrity of the earthwork and construction depends on proper site preparation and procedures. In addition, engineering decisions may arise in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this scope of work. If these services are desired, please let us know and we will prepare a cost proposal.

6.0 Limitations

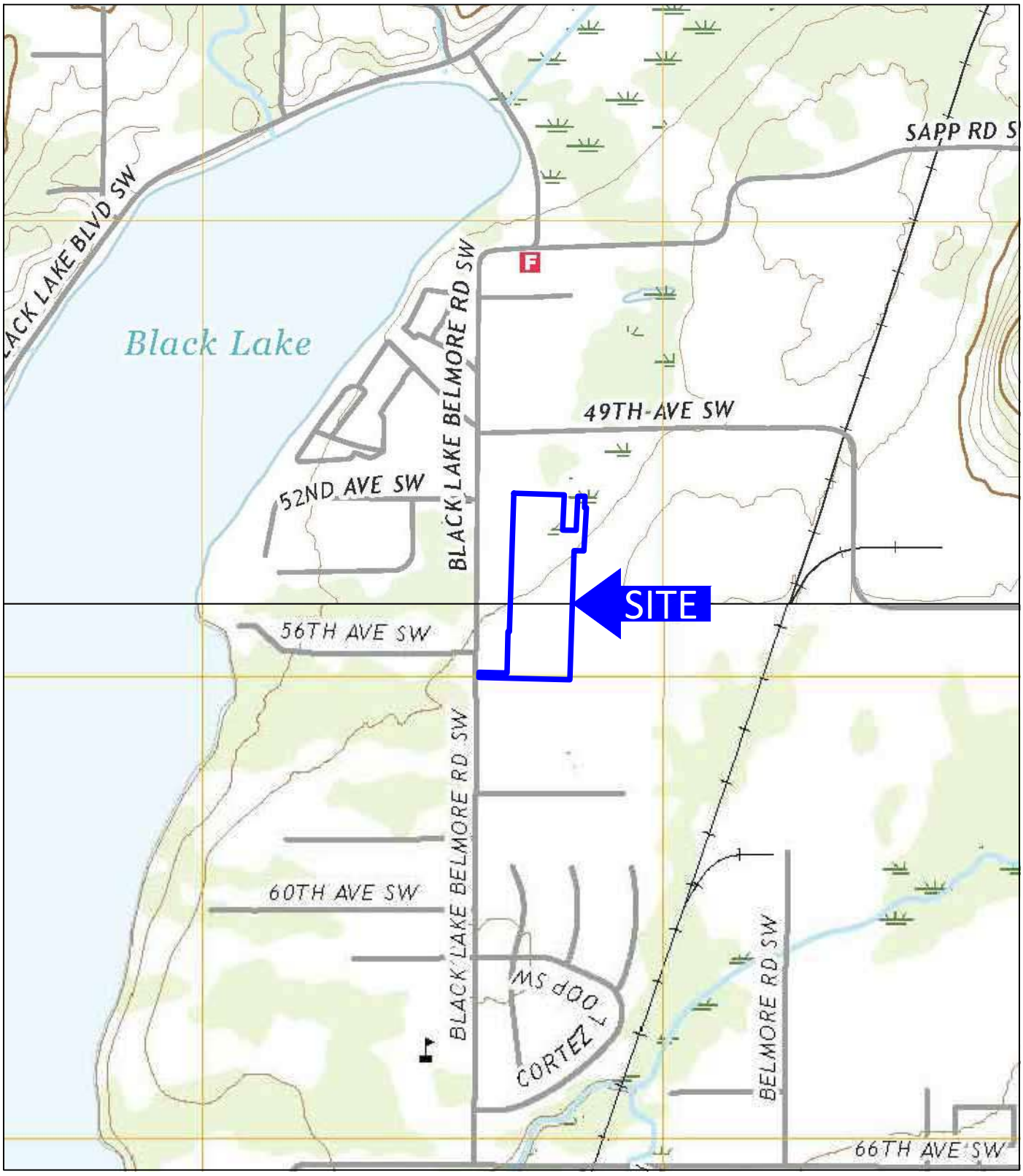
This GER is the property of RGI, Rob Rice Homes, and its designated agents. Within the limits of the scope and budget, this GER was prepared in accordance with generally accepted geotechnical engineering practices in the area at the time this GER was issued. This GER is intended for specific application to the Bodenhammer Property project in Olympia, Washington, and for the exclusive use of Rob Rice Homes and its authorized representatives. No other warranty, expressed or implied, is made. Site safety, excavation support, and dewatering requirements are the responsibility of others.

The scope of services for this project does not include either specifically or by implication any environmental or biological (for example, mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, we can provide a proposal for these services.

The analyses and recommendations presented in this GER are based upon data obtained from the explorations performed on site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, RGI should be requested to reevaluate the recommendations in this GER prior to proceeding with construction.

It is the client's responsibility to see that all parties to the project, including the designers, contractors, subcontractors, are made aware of this GER in its entirety. The use of

information contained in this GER for bidding purposes should be done at the contractor's option and risk.



USGS, 2020, Tumwater, Washington
USGS, 2020, Maytown, Washington
7.5-Minute Quadrangle

Approximate Scale: 1"=1000'

0 500 1000 2000

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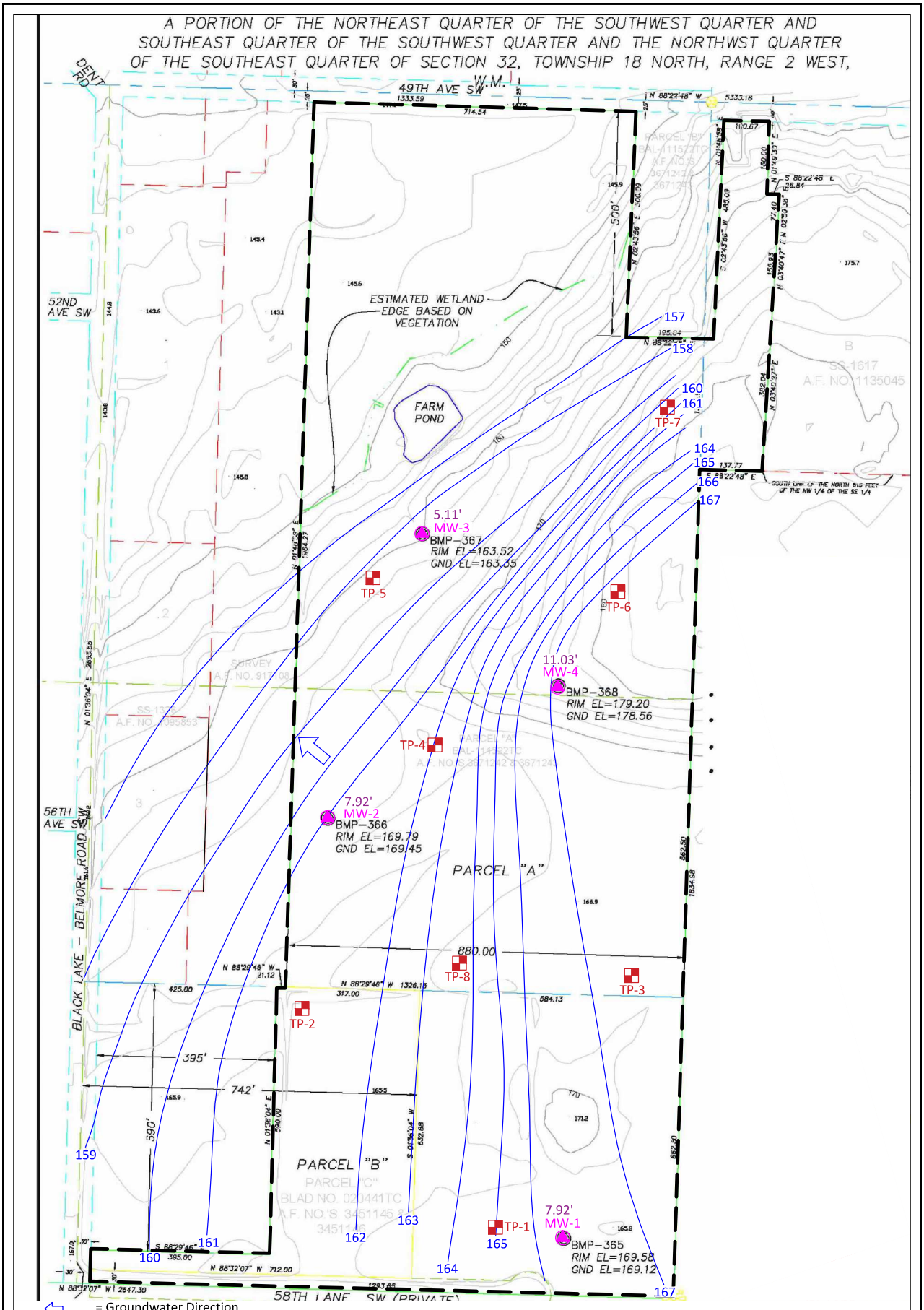
Bodenhammer Property		Figure 1
RGI Project Number: 2022-009-2	Site Vicinity Map	Date Drawn: 06/2023
Address: 3717 49th Avenue Southwest and 3825 58th Lane Southwest, Olympia, Washington 98512		



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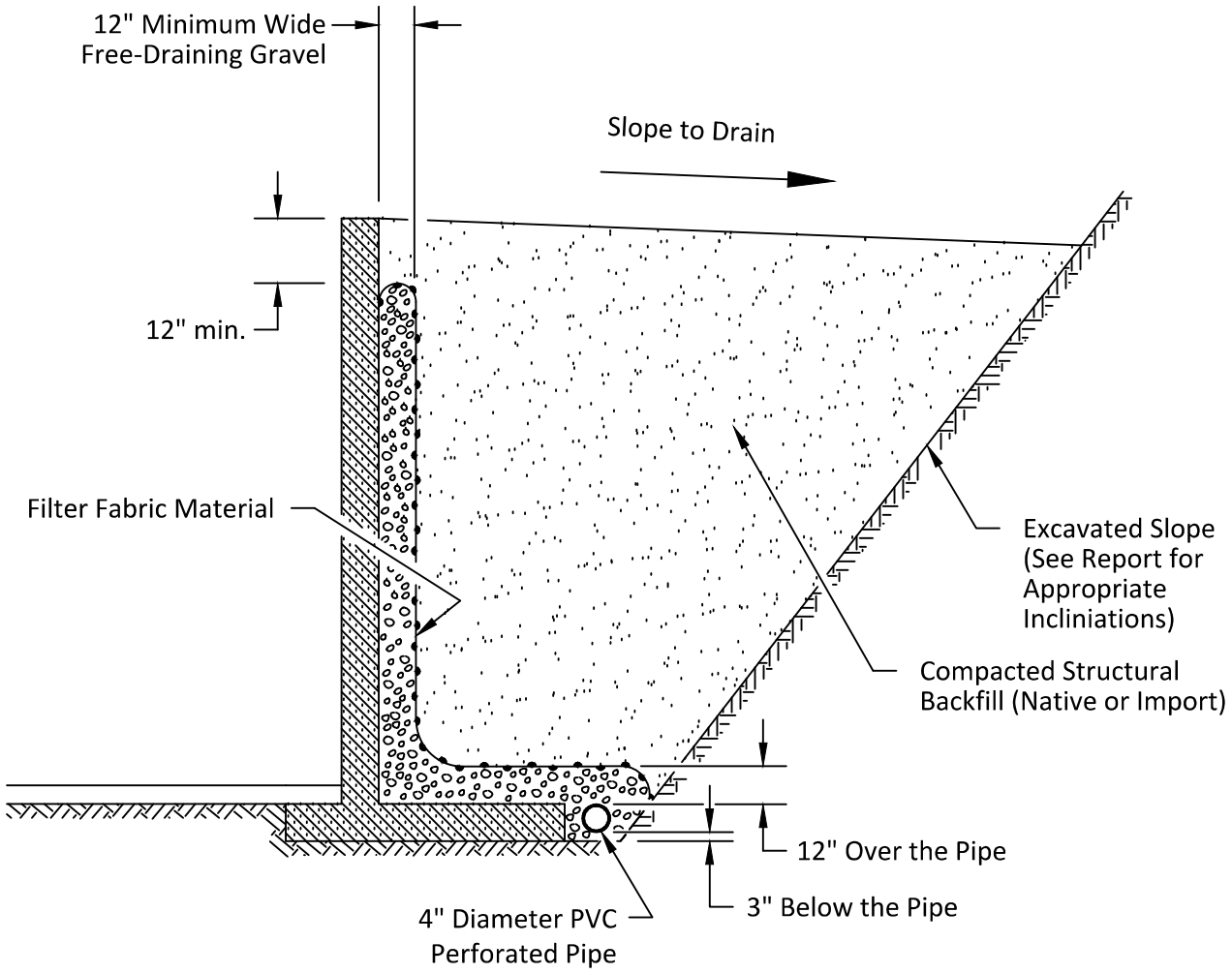
Bodenhammer Property		Figure 2
RGI Project Number: 2022-009-2	Geotechnical Exploration Plan	Date Drawn: 06/2023
Address: 3717 49th Avenue Southwest and 3825 58th Lane Southwest, Olympia, Washington 98512		



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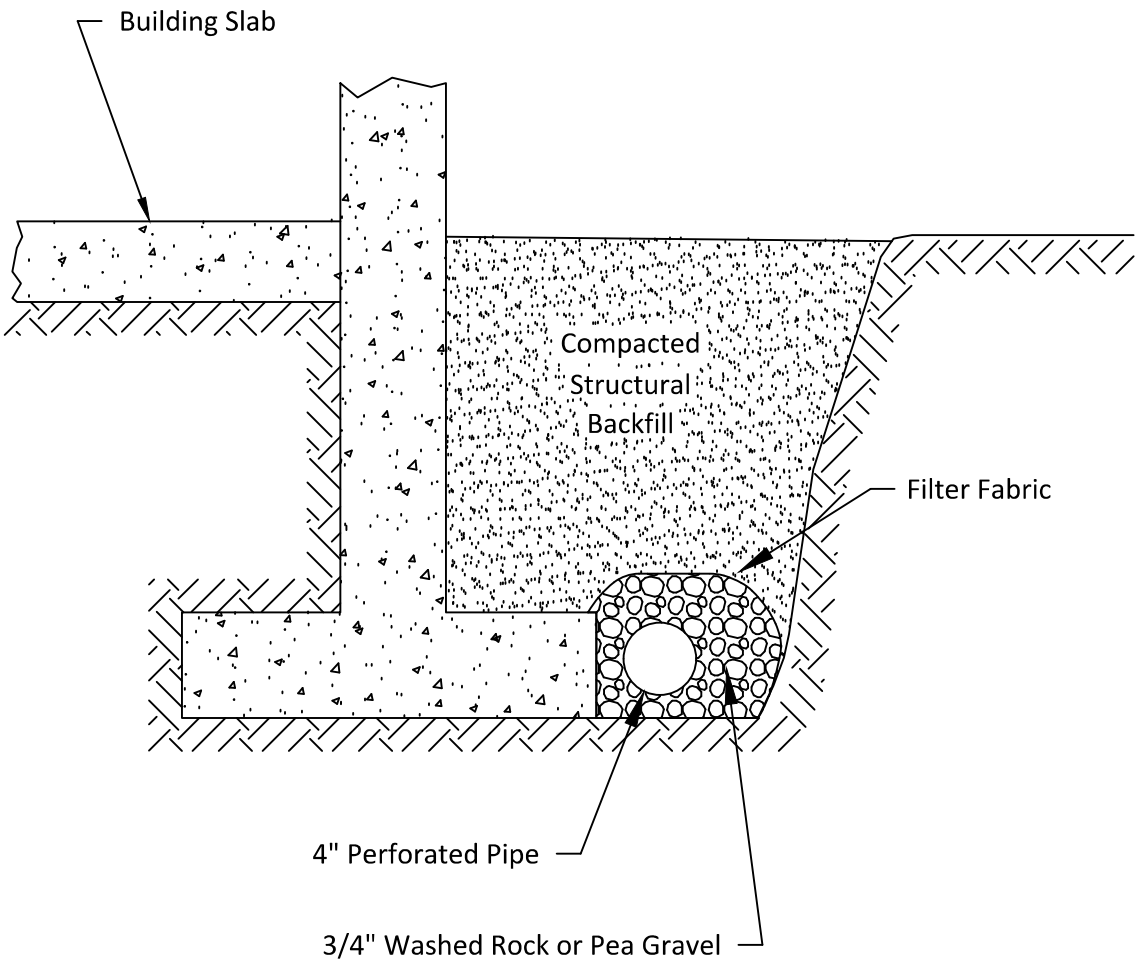
Bodenhammer Property		Figure 3
RGI Project Number: 2022-009-2	Retaining Wall Drainage Detail	Date Drawn: 06/2023
Address: 3717 49th Avenue Southwest and 3825 58th Lane Southwest, Olympia, Washington 98512		



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Bodenhammer Property		Figure 4
RGI Project Number: 2022-009-2	Typical Footing Drain Detail	Date Drawn: 06/2023
Address: 3717 49th Avenue Southwest and 3825 58th Lane Southwest, Olympia, Washington 98512		

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

On May 9, 2023, RGI performed field explorations using a rubber tracked mini excavator. We explored subsurface soil conditions at the site by observing the excavation of eight exploration pits to a maximum depth of 10 feet below existing grade. The exploration pits locations are shown on Figure 2. The exploration pits locations were approximately determined by measurements from existing property lines and paved roads.

A geologist/engineer from our office conducted the field exploration and classified the soil conditions encountered, maintained a log of each test exploration, obtained representative soil samples, and observed pertinent site features. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS).

Representative soil samples obtained from the explorations were placed in closed containers and taken to our laboratory for further examination and testing. As a part of the laboratory testing program, the soil samples were classified in our in house laboratory based on visual observation, texture, plasticity, and the limited laboratory testing described below.

Moisture Content Determinations

Moisture content determinations were performed in accordance with ASTM D2216-10 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (ASTM D2216) on representative samples obtained from the exploration in order to aid in identification and correlation of soil types. The moisture content of typical sample was measured and is reported on the exploration pits logs.

Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses was determined using D6913-04(2009) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis (ASTM D6913) on four of the samples.

Project Name: **Bodenhammer**
Project Number: **2022-009**
Client: **Rob Rice Homes**

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Test Pit No.: TP-1

Sheet 1 of 1

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **8.5 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **173**
Groundwater Level: **6 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
173	0			Topsoil			
				SM		Silty fine to medium SAND; brownish black, moist, loose, scattered organics, weathered zone	
				SP		Fine to medium SAND, some to trace silt; brown, moist, medium dense, oxidized, some apparent stratification of laminations, outwash	
				SP		Fine to medium SAND, some to trace silt; gray, moist, less oxidized, apparent stratified laminations, outwash	
168	5					Moderate seep observed at 6 feet, moderate caving, wet below seep	
						Test pit terminated at 8.5 feet. Groundwater seepage encountered at 6 feet. Moderate caving from 6 feet to bottom of hole (BOH).	
163	10						
158	15						

Project Name: **Bodenhammer**
Project Number: **2022-009**
Client: **Rob Rice Homes**

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Test Pit No.: TP-2
Sheet 1 of 1

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **8.5 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **175**
Groundwater Level: **5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
175	0			Topsoil			
				SM		Silty fine to medium SAND; brownish black, moist, loose, scattered organics, weathered zone	
				SP		Fine to medium SAND, some to trace silt; brown, moist, medium dense, oxidized, some apparent stratification of laminations, outwash	
				GP		Fine to coarse GRAVEL, some sand, trace to some silt; gray, moist, dense to very dense, operator noted very hard digging.	
170	5					Slow seep observed at 5 feet, minor caving from 5 feet to BOH.	
				SP-SM		Silty gravelly fine to coarse SAND; gray, wet, dense to very dense, operator noted very hard digging, apparent till.	
						Test pit terminated at 8.5 feet. Groundwater seepage encountered at 5 feet. Minor caving from 5 feet to BOH.	
165	10						
160	15						

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Project Name: **Bodenhammer**
Project Number: **2022-009**
Client: **Rob Rice Homes**

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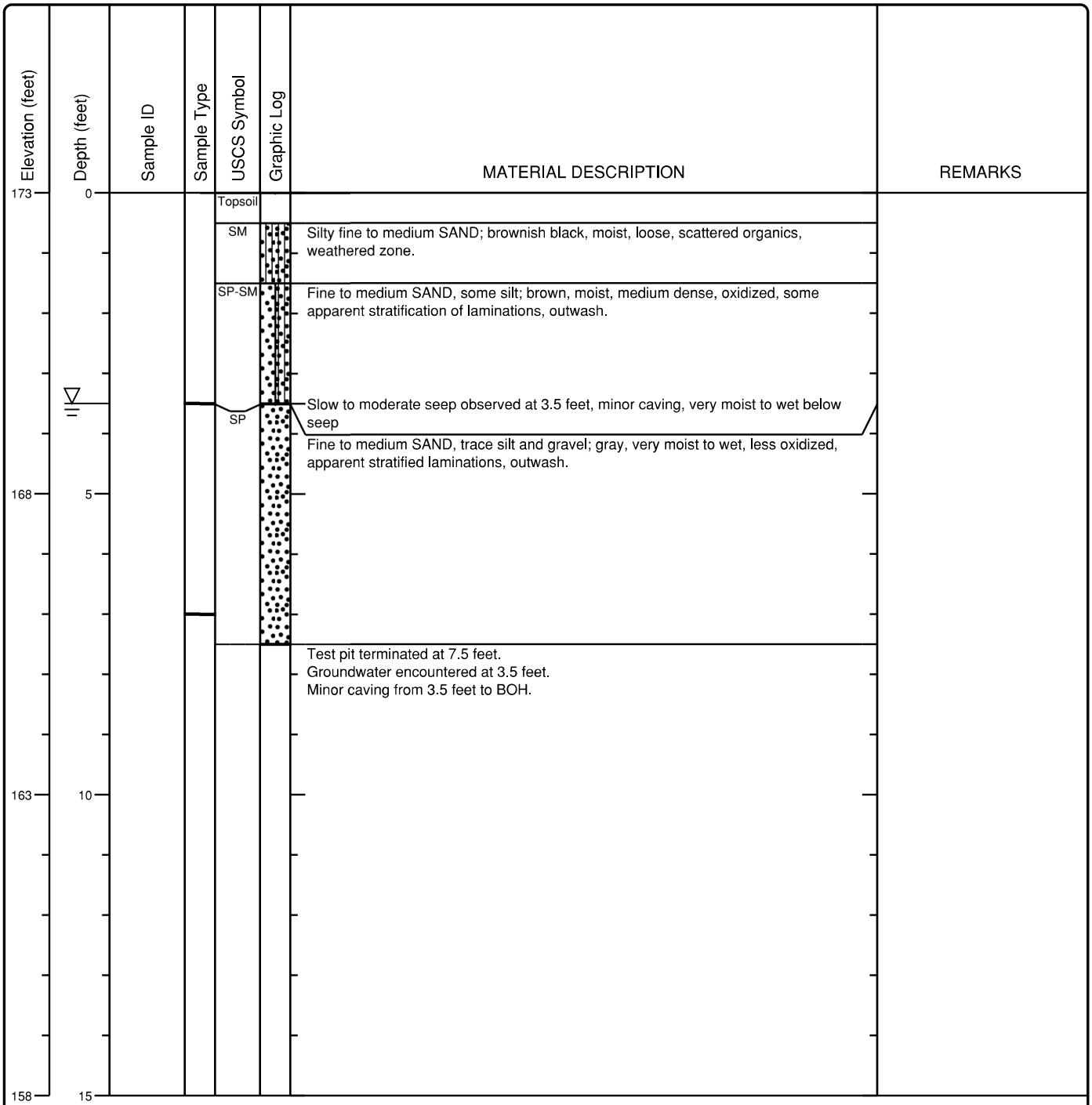
Test Pit No.: **TP-3**
Sheet 1 of 1

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **7.5 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **173**
Groundwater Level: **3.5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	



Project Name: **Bodenhammer**
Project Number: **2022-009**
Client: **Rob Rice Homes**

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Test Pit No.: TP-4
Sheet 1 of 1

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **10 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **173**
Groundwater Level: **7 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
173	0			Topsoil			
				SM		Silty fine to medium SAND; brownish black, moist, loose, scattered organics, weathered zone.	
				SP		Fine to medium SAND, some to trace silt; grayish brown, moist, medium dense, heavily oxidized (less with depth), some apparent stratification of laminations, minor caving, mostly medium sand at contact with underlying unit, outwash.	
168	5			SP-SM		Silty gravelly fine to coarse SAND; gray, moist, dense to very dense, upper 8-12 inches more silty and operator noted very hard digging, apparent diamict, till.	
						Very slow seep observed at 7 feet, minor caving	
163	10					Test pit terminated at 10 feet. Groundwater encountered at 7 feet. Minor caving from 1.3 feet to BOH.	
158	15						

Project Name: **Bodenhammer**
Project Number: **2022-009**
Client: **Rob Rice Homes**

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Test Pit No.: **TP-5**
Sheet 1 of 1

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **10 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **180**
Groundwater Level: **10 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
180	0			Topsoil			
				SM		Silty fine to medium SAND; brownish black, moist, loose, scattered organics, weathered zone.	
				SP		Fine to medium SAND, some silt; brown, moist, medium dense, oxidized, some apparent stratification of laminations, outwash.	
						Tree roots observed from 3-4 feet, possible disturbed soils on north side of test pit from felling, unit consistent from 1-4 foot on south side of pit	
				SP-SM		Fine to medium SAND, some to trace silt; gray, moist, operator noted easy digging through clean sands, coarsens downward, apparent stratified laminations of brown silts, outwash.	
175	5						
170	10					Test pit terminated at 10 feet. Very slow seep encountered at 10 feet. No caving. Very slow seep observed at 10 feet bgs	
165	15						

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Project Name: **Bodenhammer** Project Number: **2022-009** Client: **Rob Rice Homes**	Test Pit No.: **TP-6** **Sheet 1 of 1**

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **10 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **180**
Groundwater Level: **NA**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
180	0			Topsoil			
				SM		Silty fine to medium SAND; dark brown, moist, loose, scattered organics, weathered zone.	
				SP		Silty fine SAND, some medium sand; gray, moist, medium dense, some minor oxidation, some apparent stratification of laminations, coarsens downward, outwash.	
175	5						
170	10					Test pit terminated at 10 feet. No groundwater encountered. No caving.	
165	15						

Project Name: **Bodenhammer** Project Number: **2022-009** Client: **Rob Rice Homes**	Test Pit No.: **TP-7** **Sheet 1 of 1**

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **10 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **178**
Groundwater Level: **NA**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
178	0			Topsoil			
				SM		Silty fine to medium SAND; dark brown, moist, loose, scattered organics, weathered zone.	
				SP-SM		Silty fine to medium SAND, some medium sand; gray, moist, medium dense, some minor oxidation, some apparent stratification of laminations, operator notes easy digging, minor to no caving, outwash.	
173	5						
168	10					Test pit terminated at 10 feet. No groundwater encountered. Minor caving from 1.1 feet to BOH.	
163	15						

Project Name: **Bodenhammer**
Project Number: **2022-009**
Client: **Rob Rice Homes**

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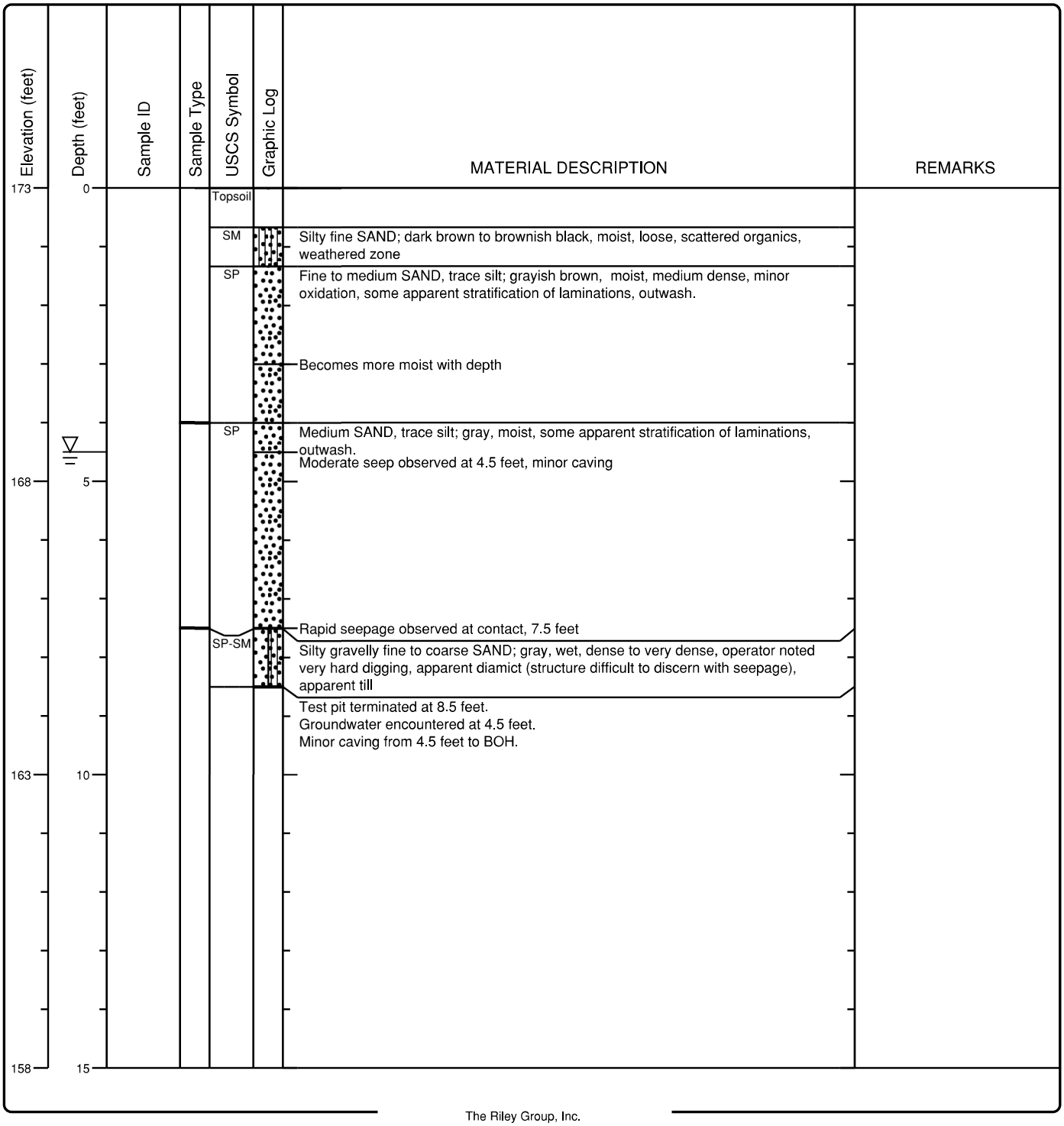
Test Pit No.: **TP-8**
Sheet 1 of 1

Date(s) Excavated: **05/09/23**	Logged By: **SA**	Surface Conditions: **Vegetated Field**
Excavation Method(s): **Pits**	Bucket Size: **4 feet**	Total Depth of Excavation: **8.5 feet**
Excavator Type: **Tracked Mini Excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **173**
Groundwater Level: **4.5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **3717 49th Avenue SW and 3825 58th Lane SW Olympia, Washington 98512**	



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Project Name: **Bodenhammer**
Project Number: **2022-009**
Client: **Rob Rice Homes**

Key to Log of Boring

Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
1	2	3	4	5	6	7	8

COLUMN DESCRIPTIONS

1. Elevation (feet): Elevation (MSL, feet).
2. Depth (feet): Depth in feet below the ground surface.
3. Sample ID: Sample identification number.
4. Sample Type: Type of soil sample collected at the depth interval shown.
5. USCS Symbol: USCS symbol of the subsurface material.
6. Graphic Log: Graphic depiction of the subsurface material encountered.
7. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
8. REMARKS : Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Poorly graded GRAVEL (GP)
Poorly graded SAND (SP)
Silty SAND (SM)
Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
CME Sampler
Pitcher Sample
Bulk Sample
Grab Sample
2-inch-OD unlined split spoon (SPT)
3-inch-OD California w/ brass rings
2.5-inch-OD Modified California w/ brass liners
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Bodenhammer Property		**Exploration Type**	TP-2	
PROJECT NO.	2022-009-1		**Depth**	3.5'	
TECH/TEST DATE	SSB/EW	5/13/2023	**Date Received**	5/9/2023	

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	1956.0
Wt Dry Soil & Tare (gm)	(w2)	1875.9
Weight of Tare (gm)	(w3)	133.8
Weight of Water (gm)	(w4=w1-w2)	80.1
Weight of Dry Soil (gm)	(w5=w2-w3)	1742.1
Moisture Content (%)	(w4/w5)*100	5

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

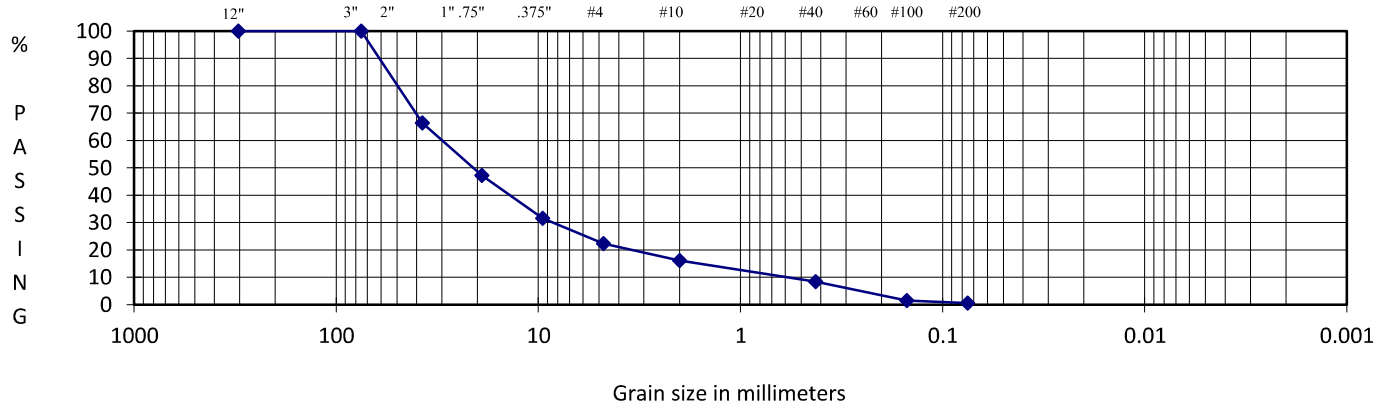
Weight Of Sample (gm)		1875.9
Tare Weight (gm)		133.8
Total Dry Weight (gm)	(W6)	1742.1

% COBBLES	**0.0**
% C GRAVEL	**52.8**
% F GRAVEL	**24.9**
% C SAND	**6.2**
% M SAND	**7.7**
% F SAND	**7.8**
% FINES	**0.6**
% TOTAL	**100.0**

D10 (mm)	0.55
D30 (mm)	8.5
D60 (mm)	30
Cu	54.5
Cc	4.4

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	133.8	0.00	0.00	100.00	cobbles
3.0"	133.8	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	719.3	585.50	33.61	66.39	coarse gravel
1.0"					coarse gravel
0.75"	1053.2	919.40	52.78	47.22	fine gravel
0.50"					fine gravel
0.375"	1326.0	1192.20	68.43	31.57	fine gravel
#4	1487.8	1354.00	77.72	22.28	coarse sand
#10	1595.1	1461.30	83.88	16.12	medium sand
#20					medium sand
#40	1729.6	1595.80	91.60	8.40	fine sand
#60					fine sand
#100	1849.1	1715.30	98.46	1.54	fine sand
#200	1865.5	1731.70	99.40	0.60	fines
PAN	1875.9	1742.10	100.00	0.00	silt/clay



DESCRIPTION	GRAVEL with some sand
USCS	GP

Prepared For:
Rob Rice Homes

Reviewed By:
ELW

RILEYGROUP

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GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Bodenhammer Property		**Exploration Type**	TP-3	
PROJECT NO.	2022-009-1		**Depth**	3.5'	
TECH/TEST DATE	SSB/EW	5/13/2023	**Date Received**	5/9/2023	

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	1388.6
Wt Dry Soil & Tare (gm)	(w2)	1160.0
Weight of Tare (gm)	(w3)	124.8
Weight of Water (gm)	(w4=w1-w2)	228.6
Weight of Dry Soil (gm)	(w5=w2-w3)	1035.2
Moisture Content (%)	(w4/w5)*100	22

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

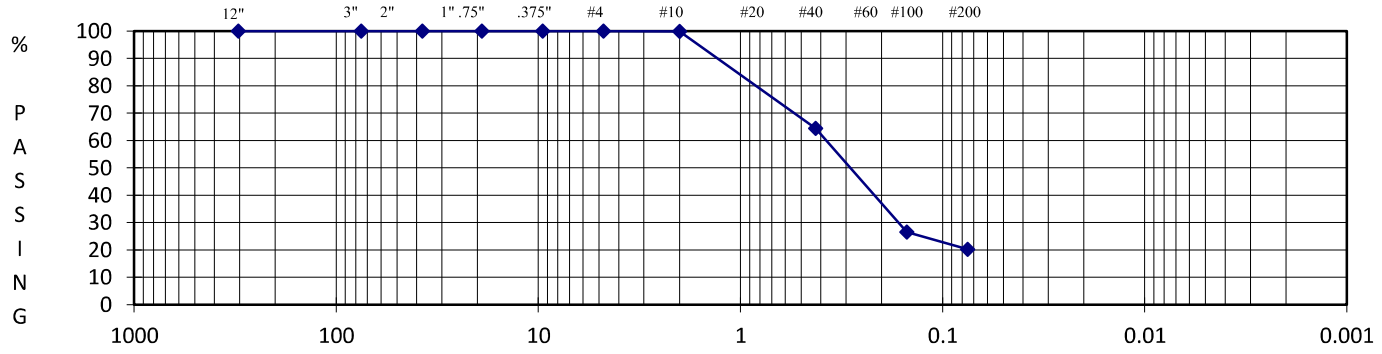
Weight Of Sample (gm)		1160.0
Tare Weight (gm)		124.8
(W6) Total Dry Weight (gm)		1035.2

% COBBLES	**0.0**
% C GRAVEL	**0.0**
% F GRAVEL	**0.1**
% C SAND	**0.1**
% M SAND	**35.4**
% F SAND	**44.2**
% FINES	**20.3**
% TOTAL	**100.0**

D10 (mm)	
D30 (mm)	
D60 (mm)	
Cu	
Cc	

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	124.8	0.00	0.00	100.00	cobbles
3.0"	124.8	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	124.8	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	124.8	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	124.8	0.00	0.00	100.00	fine gravel
#4	125.4	0.60	0.06	99.94	coarse sand
#10	126.5	1.70	0.16	99.84	medium sand
#20					medium sand
#40	492.5	367.70	35.52	64.48	fine sand
#60					fine sand
#100	885.4	760.60	73.47	26.53	fine sand
#200	950.1	825.30	79.72	20.28	fines
PAN	1160.0	1035.20	100.00	0.00	silt/clay



DESCRIPTION	Silty SAND
USCS	SM

Prepared For:
Rob Rice Homes

Reviewed By:
ELW

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17522 Bothell Way NE
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GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Bodenhammer Property		**Exploration Type**	TP-4	
PROJECT NO.	2022-009-1		**Depth**	3'	
TECH/TEST DATE	SSB/EW	5/13/2023	**Date Received**	5/9/2023	

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	1252.1
Wt Dry Soil & Tare (gm)	(w2)	1076.2
Weight of Tare (gm)	(w3)	133.7
Weight of Water (gm)	(w4=w1-w2)	175.9
Weight of Dry Soil (gm)	(w5=w2-w3)	942.5
Moisture Content (%)	(w4/w5)*100	19

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

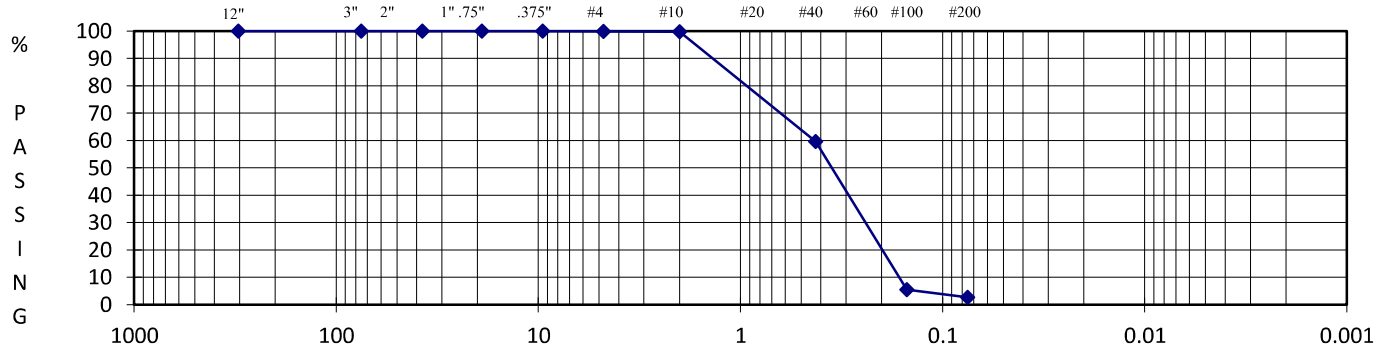
Weight Of Sample (gm)		1076.2
Tare Weight (gm)		133.7
Total Dry Weight (gm)	(W6)	942.5

% COBBLES	**0.0**
% C GRAVEL	**0.0**
% F GRAVEL	**0.1**
% C SAND	**0.1**
% M SAND	**40.1**
% F SAND	**57.0**
% FINES	**2.7**
% TOTAL	**100.0**

D10 (mm)	0.17
D30 (mm)	0.24
D60 (mm)	0.45
Cu	2.6
Cc	0.8

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	133.7	0.00	0.00	100.00	cobbles
3.0"	133.7	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	133.7	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	133.7	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	133.7	0.00	0.00	100.00	fine gravel
#4	134.6	0.90	0.10	99.90	coarse sand
#10	136.0	2.30	0.24	99.76	medium sand
#20					medium sand
#40	514.0	380.30	40.35	59.65	fine sand
#60					fine sand
#100	1024.2	890.50	94.48	5.52	fine sand
#200	1050.8	917.10	97.31	2.69	fines
PAN	1076.2	942.50	100.00	0.00	silt/clay



DESCRIPTION	SAND with trace silt
USCS	SP

Prepared For:
Rob Rice Homes

Reviewed By:
ELW

THE RILEY GROUP, INC.
17522 Bothell Way NE
Bothell, WA 98011

PHONE: (425) 415-0551
FAX: (425) 415-0311

GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2487, D6913

PROJECT TITLE	Bodenhammer Property		**Exploration Type**	TP-8	
PROJECT NO.	2022-009-1		**Depth**	4'	
TECH/TEST DATE	SSB/EW	5/13/2023	**Date Received**	5/9/2023	

WATER CONTENT (Delivered Moisture)

Wt Wet Soil & Tare (gm)	(w1)	1420.8
Wt Dry Soil & Tare (gm)	(w2)	1185.5
Weight of Tare (gm)	(w3)	134.2
Weight of Water (gm)	(w4=w1-w2)	235.3
Weight of Dry Soil (gm)	(w5=w2-w3)	1051.3
Moisture Content (%)	(w4/w5)*100	22

Total Weight Of Sample Used For Sieve Corrected For Hygroscopic Moisture

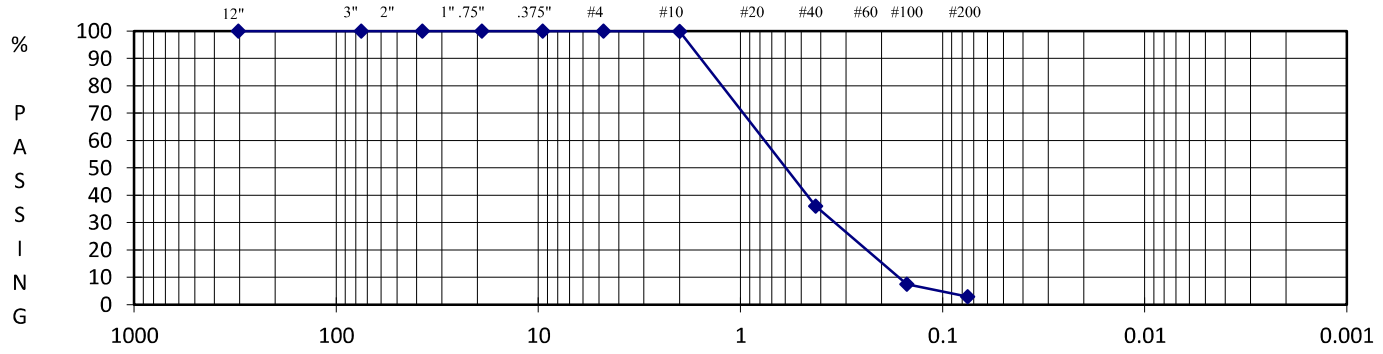
Weight Of Sample (gm)		1185.5
Tare Weight (gm)		134.2
Total Dry Weight (gm)	(W6)	1051.3

% COBBLES	**0.0**
% C GRAVEL	**0.0**
% F GRAVEL	**0.0**
% C SAND	**0.1**
% M SAND	**63.9**
% F SAND	**33.0**
% FINES	**2.9**
% TOTAL	**100.0**

D10 (mm)	0.17
D30 (mm)	0.23
D60 (mm)	0.75
Cu	4.4
Cc	0.4

SIEVE ANALYSIS

	Wt Ret +Tare	(Wt-Tare)	Cumulative (%Retained) {(wt ret/w6)*100}	% PASS (100-%ret)	
12.0"	134.2	0.00	0.00	100.00	cobbles
3.0"	134.2	0.00	0.00	100.00	coarse gravel
2.5"					coarse gravel
2.0"					coarse gravel
1.5"	134.2	0.00	0.00	100.00	coarse gravel
1.0"					coarse gravel
0.75"	134.2	0.00	0.00	100.00	fine gravel
0.50"					fine gravel
0.375"	134.2	0.00	0.00	100.00	fine gravel
#4	134.5	0.30	0.03	99.97	coarse sand
#10	135.4	1.20	0.11	99.89	medium sand
#20					medium sand
#40	807.4	673.20	64.04	35.96	fine sand
#60					fine sand
#100	1107.1	972.90	92.54	7.46	fine sand
#200	1154.5	1020.30	97.05	2.95	fines
PAN	1185.5	1051.30	100.00	0.00	silt/clay



DESCRIPTION	SAND with trace silt
USCS	SP

Prepared For:
Rob Rice Homes

Reviewed By:
ELW

RILEYGROUP

April 10, 2024

Rob Rice
Rob Rice Homes, LLC
1868 State Avenue
Olympia, Washington 98501

Subject: **Pilot Infiltration Testing**
Proposed Vista Views at Black Lake
3717 49th Avenue Southwest & 3825 58th Lane Southwest
Tumwater, Washington
RGI Project No. 2022-009-4

As requested, The Riley Group, Inc. (RGI) is providing this report documenting the completion of Pilot Infiltration Testing at the proposed Vista Views at Black Lake residential development in the proposed stormwater infiltration area on the northern portion site. The site location is shown on Figure 1.

Soil Conditions

RGI observed the completion of nine small-scale Pilot Infiltration Tests (PIT) at the site. Soil conditions in the infiltration test pits generally consisted of fine sand with varying amounts of silt and gravel and some organics. Fine sand with only a trace of silt was observed at the infiltration testing depth is infiltration test IT-9. Soil logs for the test pits are attached. The PIT tests were run per the 2022 City of Tumwater Drainage Design and Erosion Control Manual.

Infiltration Testing

RGI oversaw the completion of nine (IT-1 through IT-9) small-scale PIT tests as shown on Figure 2. The infiltration tests were run at depths corresponding to the bottom of the proposed infiltration facility. Depths of testing varied with variations in existing site grade. The infiltration test pits were all a minimum of 12 square feet in size.

Field measured infiltration rates ranged from 3.84 to 27.91 inches/hour. The highest field measured rate was in infiltration test IT-9, which was the testing location and horizon that had only a trace of silt.

Correction Factors were applied to the field measured infiltration rate.

$I_{design} = I_{measured} \times F_{testing} \times F_{geometry} \times F_{plugging}$

$F_{testing} = 0.5$ (small scale PIT)
$F_{geometry} = 1$ ($F_{geometry} = 4D/W + 0.05$, using 3 feet for D (depth to groundwater from the base of the facility) and a pond width of 12 feet $F_{geometry}$ is greater than 1.0.
$F_{plugging} = 0.8$ (fine sand and loamy sand)

A total correction factor of 0.40 was applied to field measured rates to estimate I_{design}

Cation Exchange Capacity and Organic Content

Twelve soil samples were submitted to Northwest Agricultural Consultants for analysis of soil cation exchange capacity (CEC) and organic content.

Infiltration Rates

Test Location	Test Depth (feet)	$I_{Measured}$ Rate (inches/hour)	I_{Design} Rate (inches/hour)
IT-1	3	5.76	**2.3**
IT-2	2.5	19.80	**7.9**
IT-3	4	5.16	**2.1**
IT-4	4	10.08	**4.0**
IT-5	2	3.84	**1.54**
IT-6	2.5	11	**4.4**
IT-7	2.5	9.12	**3.65**
IT-8	3	6.48	**2.6**
IT-9	5.5	27.94	**11.2**

Cation Exchange Capacity and Organic Content

Test Location	Test Depth (feet)	CEC meq/100g	Organic Content %
IT-1	3	9.6	3.48
IT-2	2.5	6.0	2.33
IT-3	4	5.2	1.67
IT-4	4	5.7	1.87
TP-10	4	5.7	1.90
IT-2	5	5.6	1.93
IT-5	2	12	5.43
IT-6	2.5	9.4	3.31
IT-7	2.5	7.3	2.59
IT-8	3	4.6	1.45
IT-9	5.5	3.0	1.07
IT-7	4	2.8	0.85

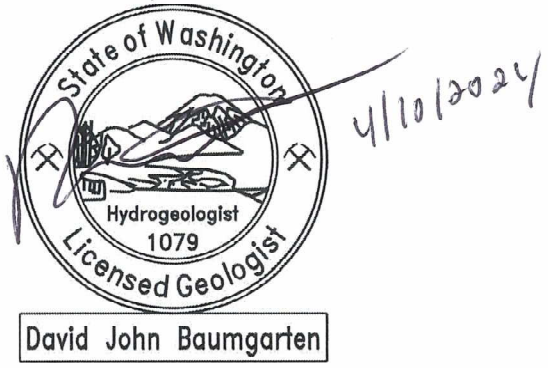
Limitations

This report is the property of RGI, Rob Rice Homes, LLC, and its designated agents. Within the limits of the scope and budget, this soils report was prepared in accordance with generally accepted geotechnical engineering practices in the area at the time this report was issued. This report is intended for specific application to the Vista Views at Black Lake site in Tumwater, Washington, and for the exclusive use of Rob Rice Homes and his authorized representatives. No other warranty, expressed or implied, is made.

Please call us at (425) 415-0551 if you have any questions or need additional information.

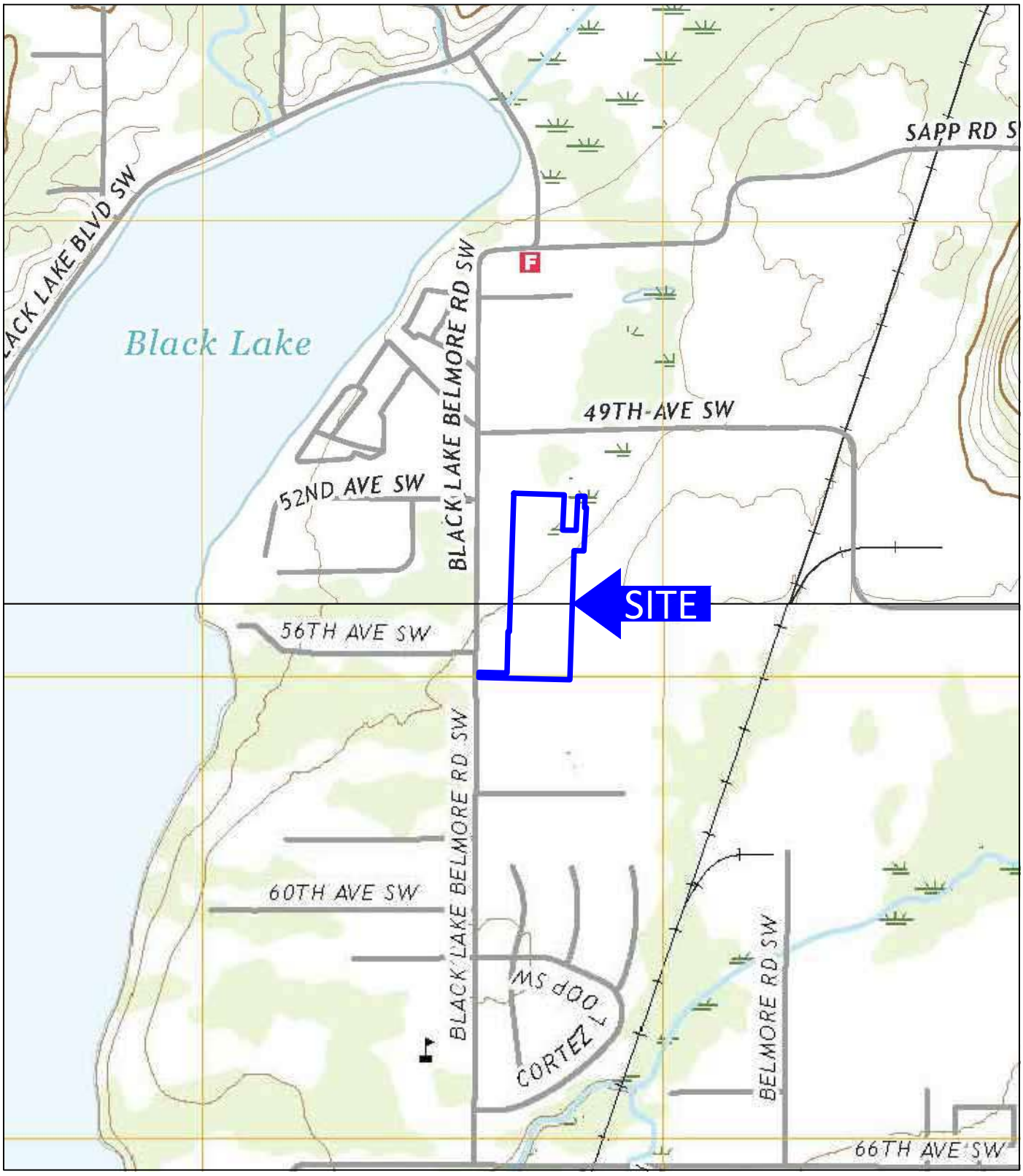
Respectfully submitted,

THE RILEY GROUP, INC.



David J. Baumgarten, LHG
Associate Hydrogeologist

Attachments: Figure 1, Vicinity Map
Figure 2, Geotechnical Exploration Plan
Infiltration/Test Pit Logs



USGS, 2020, Tumwater, Washington
USGS, 2020, Maytown, Washington
7.5-Minute Quadrangle

Approximate Scale: 1"=1000'

0 500 1000 2000

N

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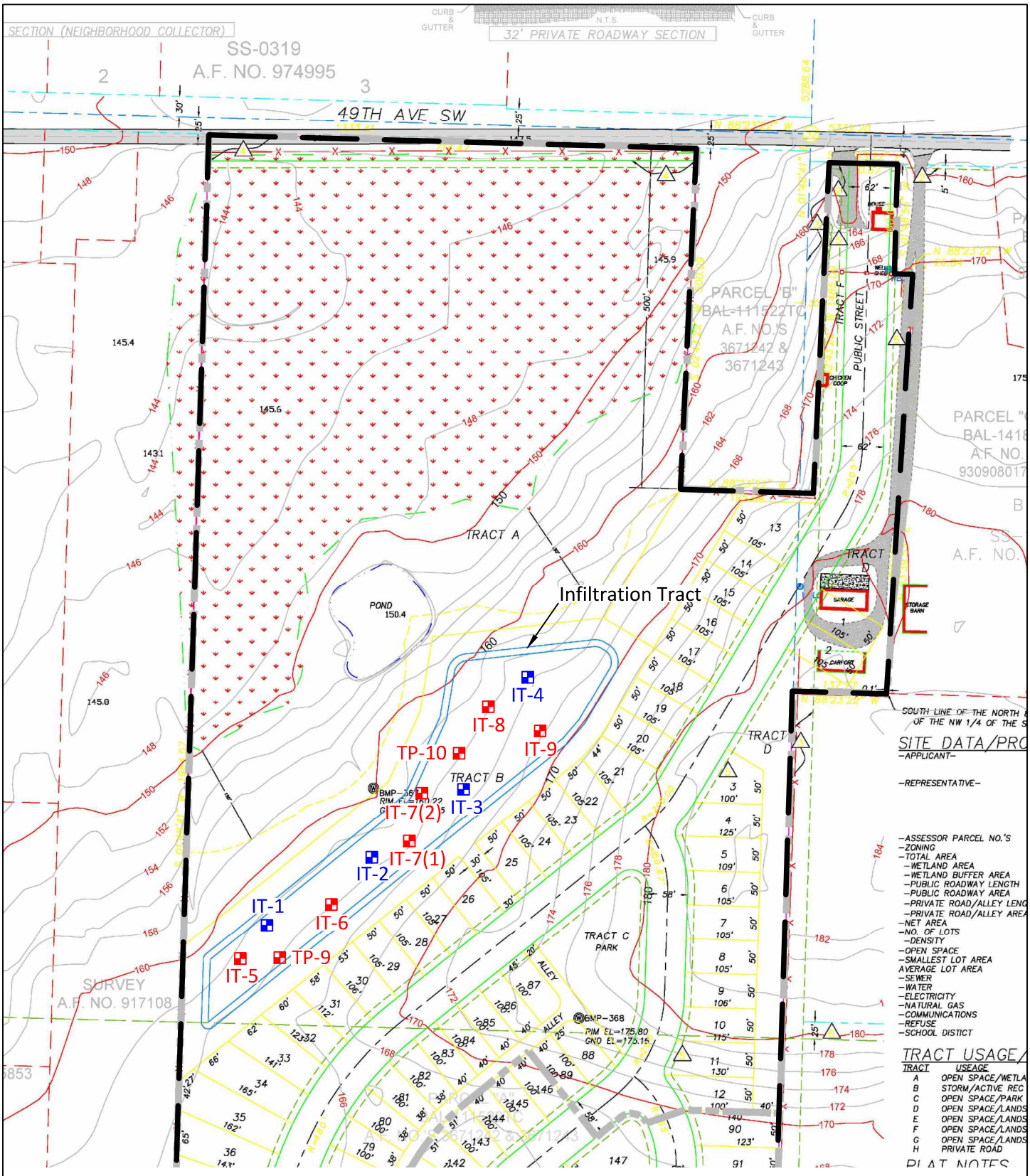
Vista Views at Black Lake		Figure 1
RGI Project Number: 2022-009-4	Site Vicinity Map	Date Drawn: 04/2024
Address: 3717 49th Avenue Southwest and 3825 58th Lane Southwest, Olympia, Washington 98512		



= (IT5 - IT9) Infiltration test locations by RGI, 03/2024

= (IT1 - IT4) Infiltration test locations by RGI, 02/2024

= Site boundary

Approximate Scale: 1" = 200'

0 100 200 400

N

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Vista Views at Blacklake		Figure 2
RGI Project Number: 2022-009-4	Geotechnical Exploration Plan	Date Drawn: 04/2024
Address: 3717 49th Avenue Southwest and 3825 58th Lane Southwest, Olympia, Washington 98512		

Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-1** **Sheet 1 of 1**

Date(s) Excavated: **02/01/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **10.5 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **164 feet**
Groundwater Level: **6.0 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Southwest portion of stormwater infiltration pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
164	0			Topsoil			
				SP-SM		Light brown, fine SAND, some silt, trace gravel; loose to medium dense, moist; weathered (SP-SM)	
		S1		SP-SM		Brownish gray, fine SAND, some to trace silt, trace gravel; medium dense, moist	
				SP-SM		Gray, fine SAND, some to trace silt, trace gravel; medium dense, moist Infiltration test IT-1 ran at 3.0 feet	
159	5						
		S2		SP		Gray, fine SAND, some to trace silt, trace gravel; medium dense, very moist to wet (SP)	
154	10	S3				Bottom of exploration (BOE) 10.5 feet, moderate to severe caving 6.0-10.5 feet	

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Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-2** **Sheet 1 of 1**

Date(s) Excavated: **02/01/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **10.0 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **164 feet**
Groundwater Level: **5.5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Southwest central portion of stormwater infiltration pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
164	0			Topsoil			
				SP-SM		Light brown, fine SAND, some silt, trace gravel; loose to medium dense, moist; weathered (SP-SM)	
		S1		SP-SM		Brownish gray, fine SAND, some to trace silt, trace gravel; medium dense, moist (SP-SM)	
						Infiltration test IT-2 ran at 2.5 feet	
						Becomes gray	
159	5			SP-SM		Brown, fine SAND, some silt, trace gravel; medium dense (SP-SM)	
		S2		SP-SM		Gray, fine SAND, some to trace silt, trace gravel; medium dense, very moist (SP-SM)	
				SP		Gray, fine SAND, some to trace silt, trace gravel; medium dense (SP)	
		S3					
154	10					Bottom of exploration (BOE) 10.0 feet	

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Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-3** **Sheet 1 of 1**

Date(s) Excavated: **02/02/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **10.0 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **166 feet**
Groundwater Level: **8.0 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Northeast central portion of stormwater infiltration pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
166	0			Topsoil			
				SP-SM		Brownish gray, fine SAND, some to trace silt, trace gravel; loose to medium dense, moist; occasional organics that decrease with depth (SP-SM)	
				SM		Grayish brown, silty fine SAND, trace gravel; loose to medium dense, moist; occasional organics that decrease with depth; weathered (SM)	
		S1		SP-SM		Gray, fine SAND, some to trace silt, trace gravel; medium dense, moist; indistinct laminations (SP-SM)	
						Infiltration test IT-3 ran at 4.0 feet	
161	5			SP-SM		Gray, fine SAND, some silt, trace gravel; medium dense, very moist (SP-SM)	
				SP-SM		Grayish brown, fine SAND, some silt, trace gravel; medium dense, very moist (SP-SM)	
				SP-SM		Gray, fine SAND, some to trace silt, trace gravel; medium dense, very moist (SP-SM)	
156	10					Bottom of exploration (BOE) 10.0 feet	

Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-4** **Sheet 1 of 1**

Date(s) Excavated: **02/02/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **10.5 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **166 feet**
Groundwater Level: **9.5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Northeast portion of stormwater infiltration pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	MATERIAL DESCRIPTION	REMARKS
166	0			Topsoil		
				SP-SM	Grayish brown, fine SAND, some silt, trace gravel; loose to medium dense, moist; occasional organics (roots from nearby tree); weathered (SP-SM)	
		S1		SP-SM	Gray, fine SAND, some to trace silt, trace gravel; medium dense, moist (SP-SM)	
					Infiltration test IT-4 ran at 4.0 feet	
				SP-SM	Grayish brown, fine SAND, some silt, trace gravel; medium dense, very moist after infiltration testing (SP-SM)	
161	5			SP-SM	Grayish brown, fine SAND, some silt, trace gravel; medium dense, very moist; roots from 5.25-7.0 feet (SP-SM)	
				SP-SM	Gray, fine SAND, some to trace silt, trace gravel; medium dense, very moist (SP-SM)	
		S2			Becoming very moist to wet at 9.0 feet	
156	10				Bottom of exploration (BOE) 10.5 feet	

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Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-5** **Sheet 1 of 1**

Date(s) Excavated: **03/19/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **9.5 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **163 feet**
Groundwater Level: **5.0 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Southwest portion of stormwater pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
163	0			Topsoil			
		S1		SP-SM		Brown, fine SAND with silt, trace gravel, loose, moist; frequent organics (rootlets and some wood debris) (SP-SM)	
		S2					
		S3		SP-SM		Infiltration test IT-5 observed at 1.75 feet	
		S4		SP-SM		Gray, fine SAND with silt to trace silt, trace gravel, medium dense, moist to very moist (SP-SM)	
158	5			SM		Grayish brown, fine SAND with silt, trace gravel, medium dense, very moist to wet (SM)	
				SP-SM		Slow seep at 6.0 feet Gray, fine SAND with silt to trace silt, trace gravel, medium dense, very moist; sand is very fine (SP-SM)	
		S5				Bottom of exploration (BOE) 9.5 feet	
153	10						

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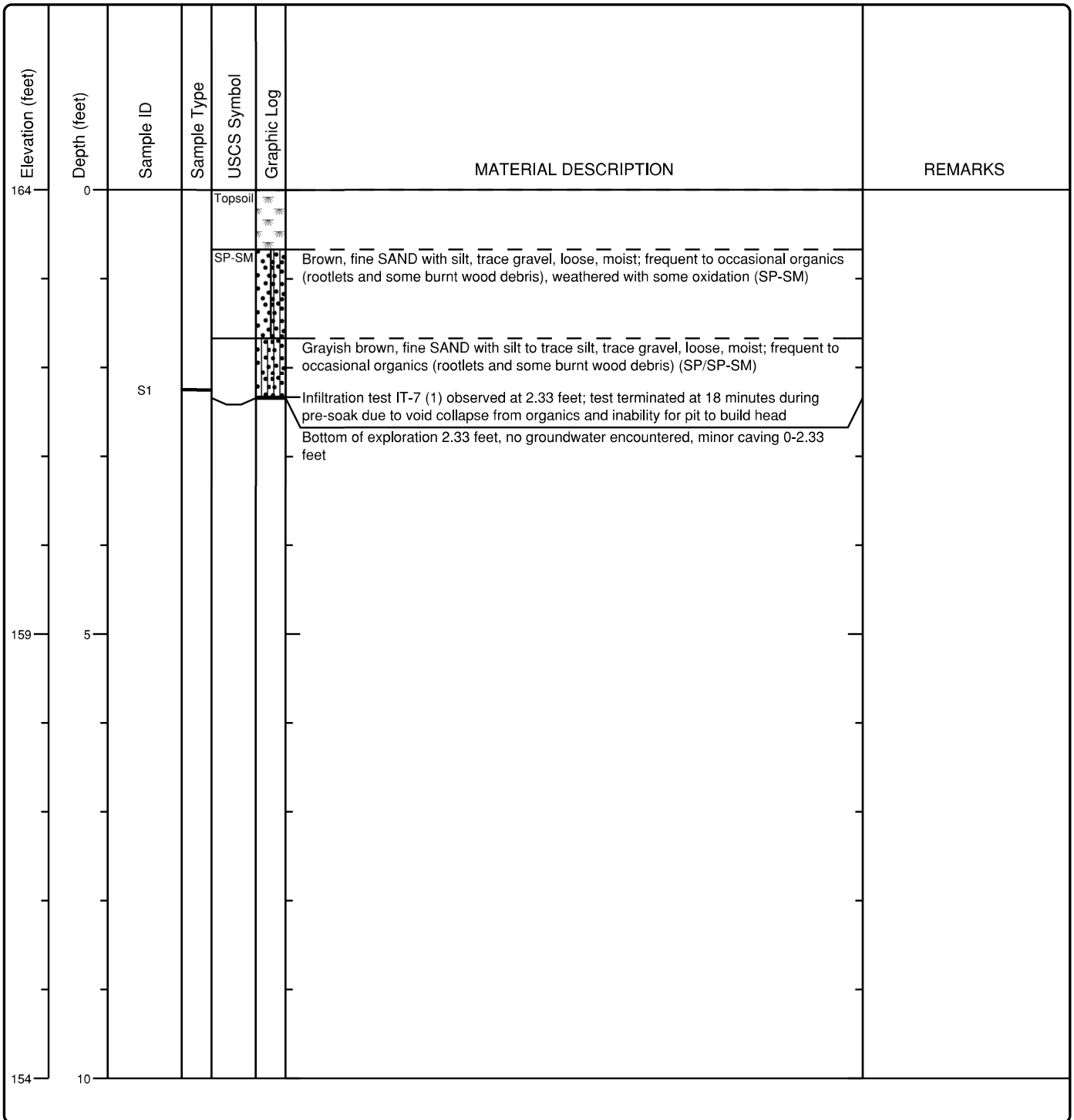
Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-6** **Sheet 1 of 1**

Date(s) Excavated: **03/19/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **9.5 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **164 feet**
Groundwater Level: **6.75 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Southwest central portion of stormwater pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
164	0			Topsoil			
				SP-SM		Brown, fine SAND with silt, trace gravel, loose, moist; frequent organics (rootlets) (SP-SM)	
		S1				Broken concrete at 1.5 feet (possible old fence post)	
		S2				Infiltration test IT-6 observed at 2.25 feet	
				SP-SM		Gray, fine SAND with silt to trace silt, trace gravel, medium dense, moist to very moist (SP-SM)	
159	5			SP		Gray, fine SAND with trace silt, trace gravel, medium dense, very moist to wet; large roots and wood debris to 5.0 feet (SP)	
		S3					
				SP-SM		Gray, fine SAND with silt to trace silt, trace gravel, medium dense, very moist to wet (SP-SM)	
		S4					
						Bottom of exploration (BOE) 9.5 feet	
154	10						

Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-7 (1)** **Sheet 1 of 1**

Date(s) Excavated: **03/20/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **2.33 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **164 feet**
Groundwater Level: **Not encountered**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Central portion of stormwater pond**	



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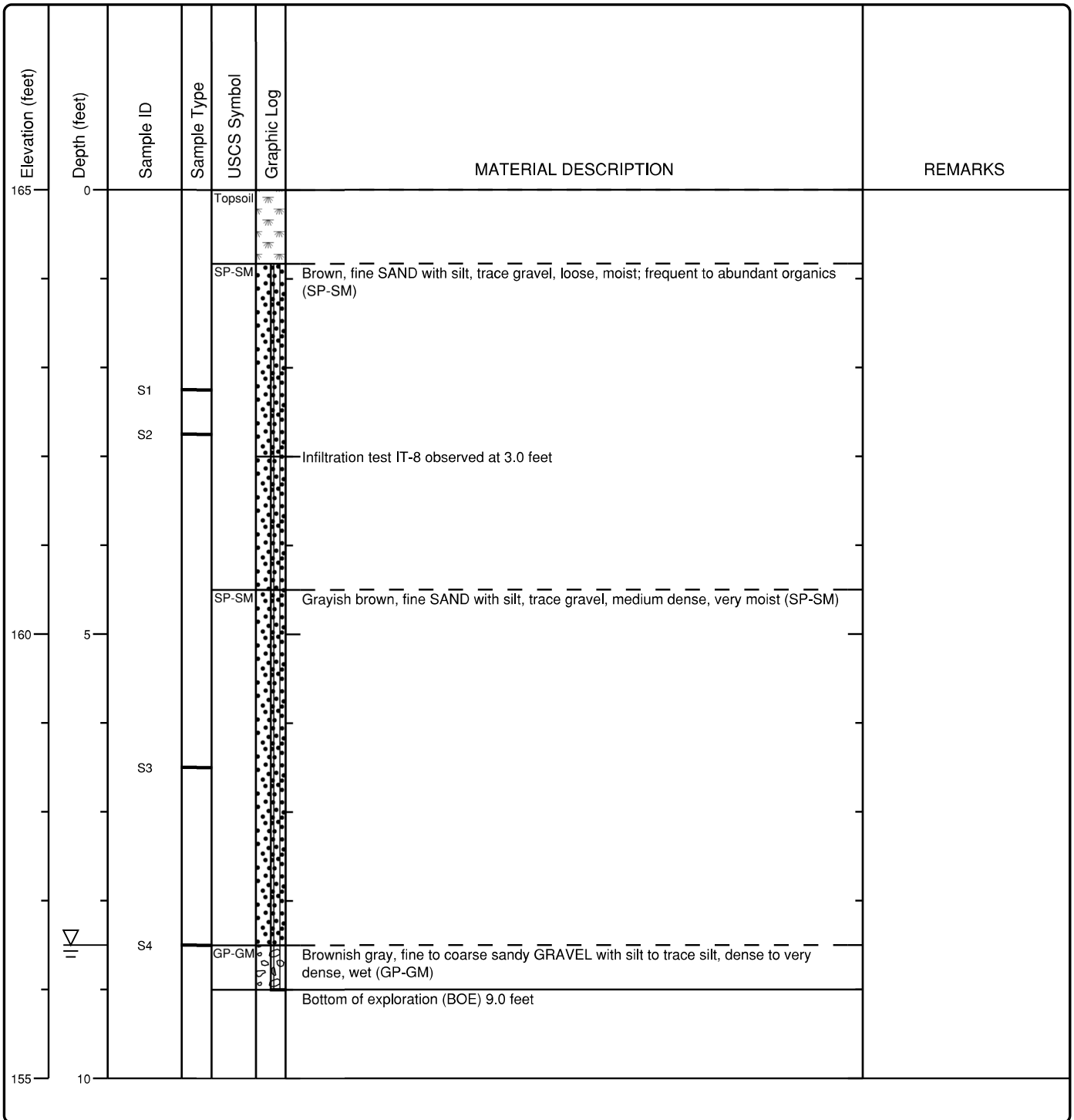
Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-7 (2)** **Sheet 1 of 1**

Date(s) Excavated: **03/20/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **8.5 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **164 feet**
Groundwater Level: **6.0 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Central portion of stormwater pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
164	0			Topsoil			
				SP-SM		Brown, fine SAND with silt, trace gravel, loose, moist; frequent to occasional organics (rootlets and some burnt wood debris), weathered with some oxidation (SP-SM)	
				SP-SM		Grayish brown, fine SAND with silt to trace silt, trace gravel, loose, moist; frequent to occasional organics (SP-SM)	
		S1				Infiltration test IT-7 (2) observed at 2.5 feet	
				SP		Gray, fine SAND, trace silt, trace gravel, medium dense, very moist; coarser fine sands with depth (SP)	
		S2		SP-SM		Grayish brown, fine SAND with silt, trace gravel, medium dense, very moist (SP-SM)	
159	5						
				SP-SM		Brownish gray, fine SAND with silt, trace gravel, medium dense, very moist (SP-SM)	
						Moderate seep at 7.0 feet	
		S3		SP-SM		Brownish gray, gravelly fine to coarse SAND with silt, dense, wet; hard digging (SP-SM)	
						Bottom of exploration (BOE) 8.5 feet	
154	10						

Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-8** **Sheet 1 of 1**

Date(s) Excavated: **03/20/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **9.0 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **165 feet**
Groundwater Level: **8.5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Northeast central portion of stormwater pond**	



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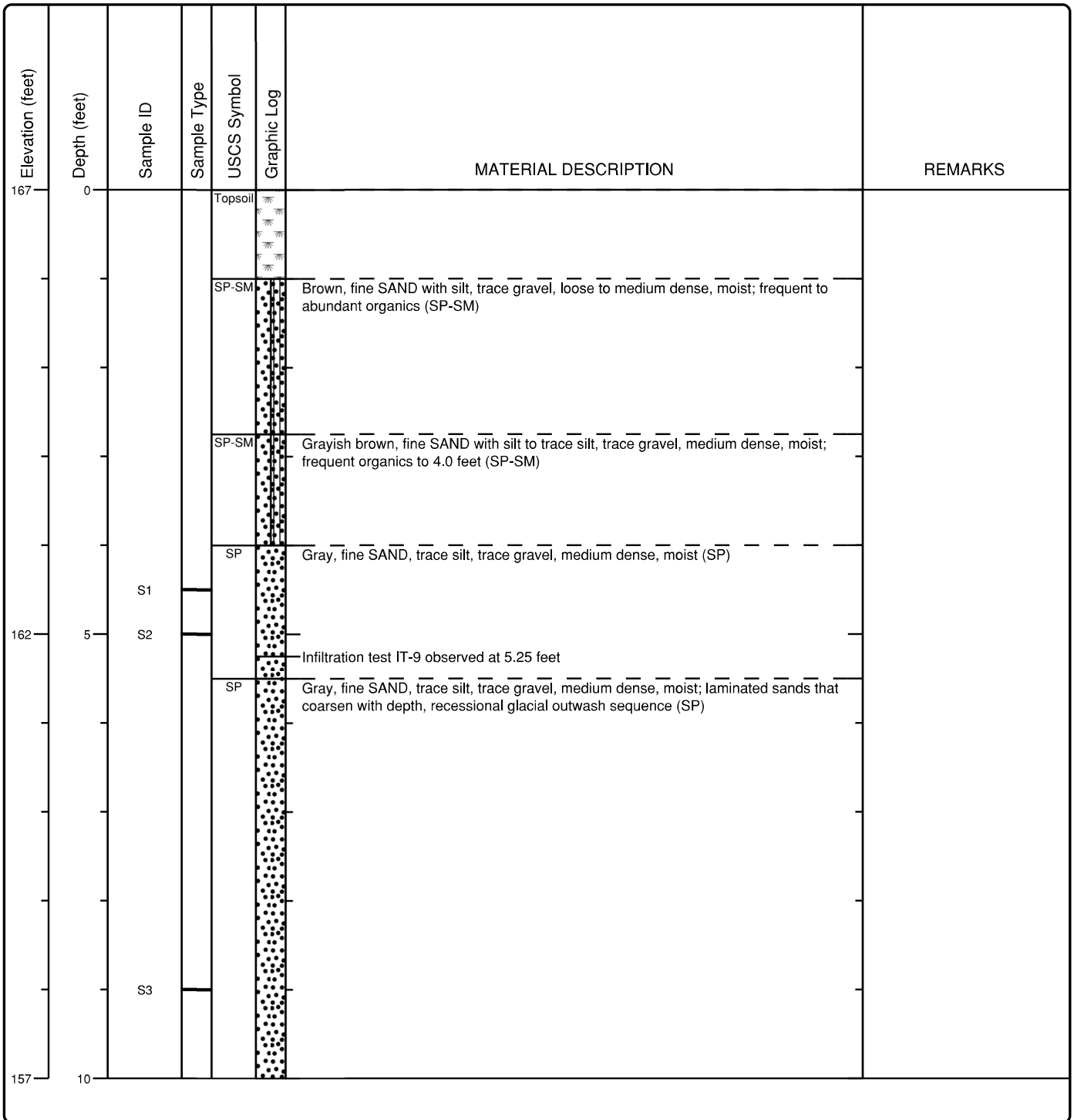
Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **IT-9** **Sheet 1 of 2**

Date(s) Excavated: **03/21/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **12.0 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **167 feet**
Groundwater Level: **9.75 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Northeast portion of stormwater pond**	



The Riley Group, Inc.
17522 Bothell Way NE, Bothell, WA 98011

Project Name: **Vista Views at Black Lake**
Project Number: **2022-009** Client: **Rob Rice Homes, LLC**

Test Pit No.: **IT-9**
Sheet 2 of 2

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
157	10			SP		Gray, fine SAND, trace silt, trace gravel, medium dense, moist; laminated sands that coarsen with depth, recessional glacial outwash sequence (SP)	
						Bottom of exploration (BOE) 12.0 feet	
152	15						
147	20						
142	25						

Project Name: **Vista Views at Black Lake** Project Number: **2022-009** Client: **Rob Rice Homes, LLC**	Test Pit No.: **TP-9** **Sheet 1 of 1**

Date(s) Excavated: **02/01/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **11.5 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **164 feet**
Groundwater Level: **7.5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Southwest portion of stormwater infiltration pond**	

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
164	0			Topsoil			
				SP-SM		Light brown, fine SAND, some silt, trace gravel; loose to medium dense, moist; weathered (SP-SM)	
		S1					
				SM		Grayish brown, silty fine SAND, trace gravel; medium dense, moist (SM)	
159	5			SP-SM		Gray, fine SAND, some to trace silt, trace gravel; medium dense, moist (SP-SM)	
		S2					
154	10			SP-SM		Brown, fine SAND, some silt, trace gravel; medium dense, very moist to wet (SP-SM)	
						Bottom of exploration (BOE) 11.5 feet	

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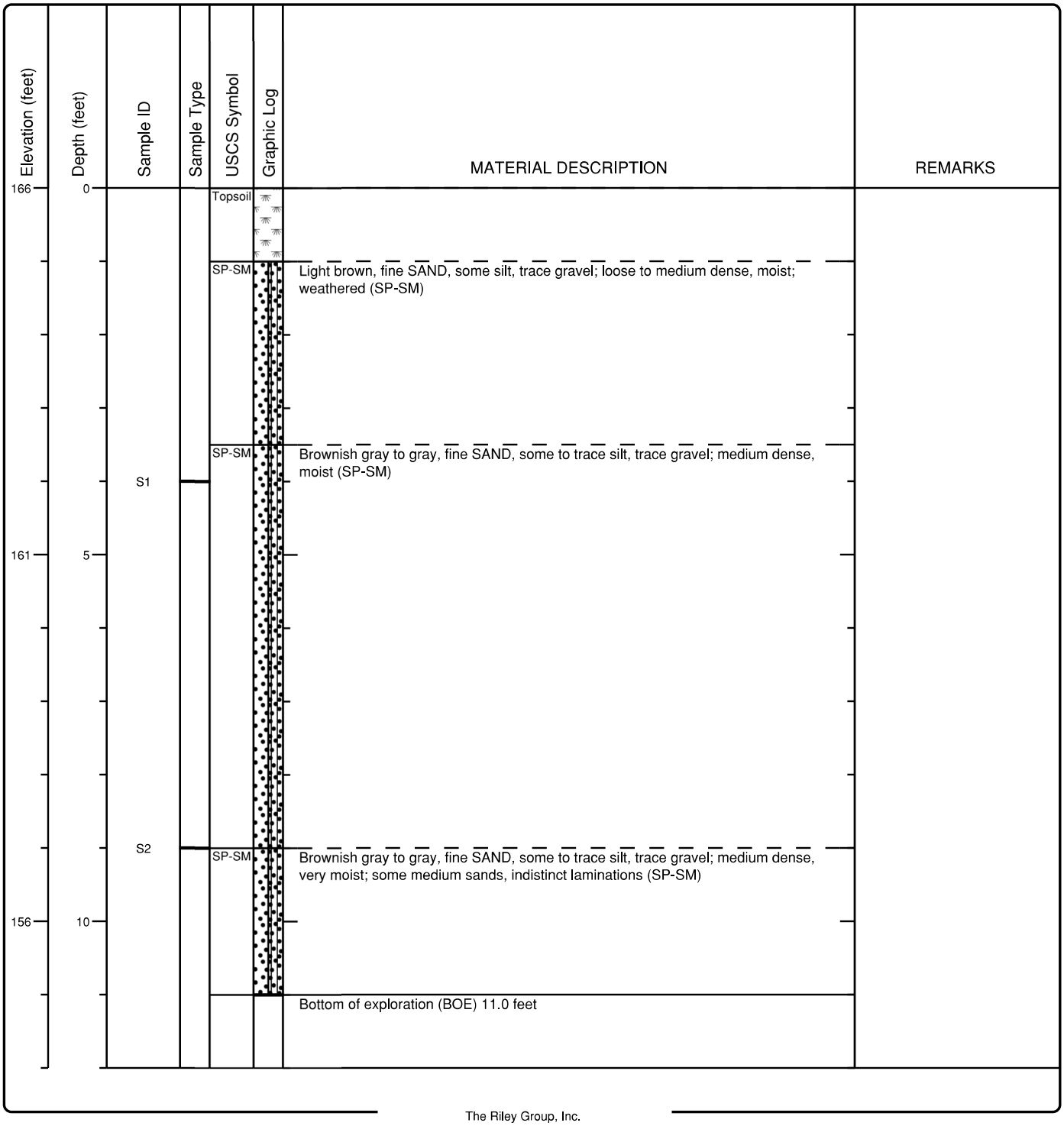
Project Name: **Vista Views at Black Lake**
Project Number: **2022-009** Client: **Rob Rice Homes, LLC**

Test Pit No.: **TP-10**
Sheet 1 of 1

Date(s) Excavated: **02/01/2024**	Logged By: **SA**	Surface Conditions: **Vegetated field**
Excavation Method(s): **Pits**	Bucket Size: **3 feet**	Total Depth of Excavation: **11.0 feet**
Excavator Type: **Tracked mini excavator**	Excavation Contractor: **Shane X**	Approximate Surface Elevation: **166 feet**
Groundwater Level: **8.5 feet**	Sampling Method(s): **Grab**	Compaction Method: **Bucket tamp**
Test Pit Backfill: **Spoils**	Location: **Northeast portion of stormwater infiltration pond**	



The Riley Group, Inc.
17522 Bothell Way NE, Bothell, WA 98011

Project Name: **Vista Views at Black Lake**

Project Number: **2022-009** Client: **Rob Rice Homes, LLC**

Key to Log of Boring

Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample ID	Sample Type	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS
1	2	3	4	5	6	7	8

COLUMN DESCRIPTIONS

1. Elevation (feet): Elevation (MSL, feet).
2. Depth (feet): Depth in feet below the ground surface.
3. Sample ID: Sample identification number.
4. Sample Type: Type of soil sample collected at the depth interval shown.
5. USCS Symbol: USCS symbol of the subsurface material.
6. Graphic Log: Graphic depiction of the subsurface material encountered.
7. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
8. REMARKS : Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Silty SAND (SM)
Poorly graded SAND (SP)
Poorly graded SAND with Silt (SP-SM)
No material type.

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Project Name: **Vista Views at Black Lake**
Project Number: **2022-009** Client: **Rob Rice Homes, LLC**

Key to Log of Boring
Sheet 1 of 1

1 Elevation (feet)	2 Depth (feet)	3 Sample ID	4 Sample Type	5 USCS Symbol	6 Graphic Log	7 MATERIAL DESCRIPTION	8 REMARKS

COLUMN DESCRIPTIONS

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MATERIAL GRAPHIC SYMBOLS

Poorly graded GRAVEL with Silt (GP-GM)
Silty SAND (SM)
Poorly graded SAND (SP)
Poorly graded SAND with Silt (SP-SM)
No material type.

TYPICAL SAMPLER GRAPHIC SYMBOLS

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NAPT

The Riley Group 17522 Bothell Way NE Bothell, WA 98011

Report: 67809-1-1
Date: March 29, 2024
Project No: 2022-009-4
Project Name: Vista Views at Black Lake

Sample ID	Organic Matter	Cation Exchange Capacity
IT-1-3	3.48%	9.6 meq/100g
IT-2-2.5	2.33%	6.0 meq/100g
IT-3-4.0	1.67%	5.2 meq/100g
IT-4-4.0	1.87%	5.7 meq/100g
TP-10-4.0	1.90%	5.7 meq/100g
IT-2-5.0	1.93%	5.6 meq/100g
IT-5-2.0	5.43%	12.0 meq/100g
IT-6-2.5	3.31%	9.4 meq/100g
IT-7-2.5	2.59%	7.3 meq/100g
IT-8-3.0	1.45%	4.6 meq/100g
IT-9-5.5	1.07%	3.0 meq/100g
IT-7-4.0	0.85%	2.8 meq/100g
Method	**ASTM D2974**	**EPA 9081**