Preliminary Drainage Report

For the Dos Lagos Lot 'E'
Parcel Number: 0419106028
405 39th Ave SE
Puyallup, Washington

For

Dos Lagos Asset, LLC
810 E. Pico Blvd, Unit B24
Los Angeles, CA. 90021

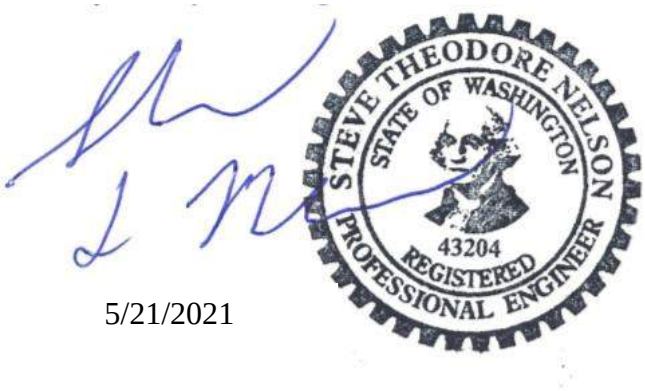
By

LeRoy Surveyors & Engineers, Inc.
P. O. Box 740
Puyallup, Washington 98371
(253) 848-6608

Contact: Steve T Nelson, P.E.

May 2021
Job No: 12896

I hereby state that this Preliminary Drainage Report for the Dos Lagos Lot 'E' Project 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 the City of Puyallup does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.



5/21/2021

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Section 1 – Proposed Project Overview

Project Name: Dos Lagos Lot 'E' Project

Permit Type: Multi-Family Residential

Permit No: P-20-0088

Site Address: 405 39th Ave SE, Puyallup, WA 98374

Parcel Numbers: 0419106028

Legal Descriptions:

PARCEL #: 0419106028
Lot 1 and Tract A of City of Puyallup Short Plat No. P-18-0174, recorded under Recording No. 201912305004, in Pierce County, Washington.
Zoning: Urban Center Mixed-use Zone (UCX)
Mixed-use Design Review Overlay Zone (MX-DRO)

The project proposes to construct a 46-unit apartment complex with associated parking on 1.89 acres, located at the corner of 5th Street SE and 39th Ave SE in Puyallup, Washington, 98374. Figure 1 illustrates the site parcel location within the local vicinity. Associated right-of-way (ROW) improvements will be constructed, including sidewalk and street trees. Access to the site will be from public road 39th Ave SE. The project is connected to a predevelopment application (No. P-20-0088) and requires a completed SEPA checklist. Site development permit previously submitted by LS&E, Inc.

Stormwater runoff in the existing condition partially infiltrates, while the remainder sheet flows to the adjacent wetland. There is one drainage basin onsite (Threshold Discharge Area, TDA) in the existing and developed condition. In the developed state, 48,314 square feet of new asphalt drive lanes, parking, sidewalks, and roof area are proposed. Stormwater runoff quality and quantity impacts from the proposed hard surfaces will be mitigated using stormwater cartridge style filter system and a detention vault, respectively. Runoff will be collected utilizing catch basins and conveyed via stormwater piping to an underground detention vault. Pump(s) will then convey stormwater from the vault to a dispersion trench, which releases to the wetland buffer.

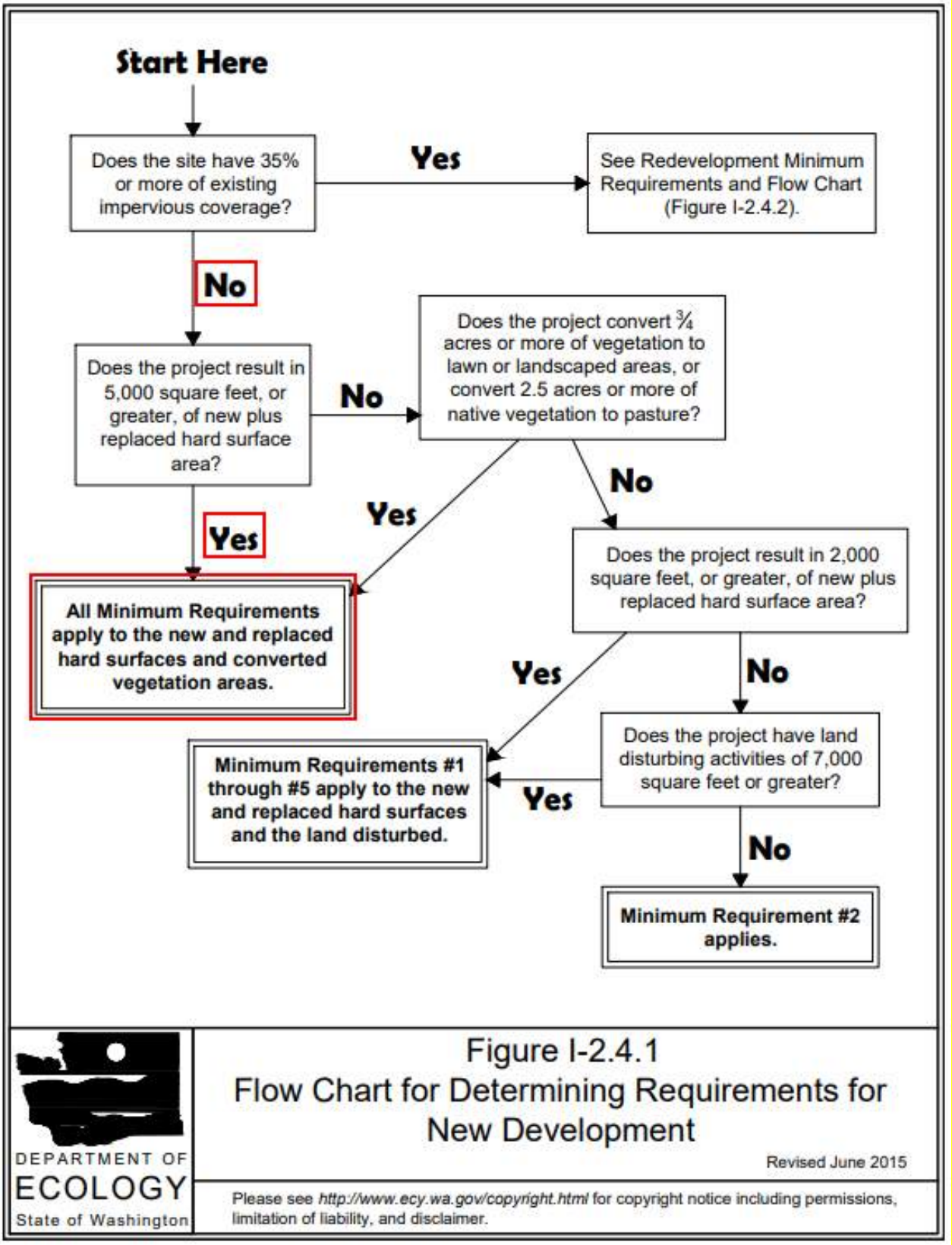
The proposed apartment building will be served by city sewer.

Figure 1: Site Vicinity Map

Minimum Requirements

The project shall comply with the requirements of the 2012 Stormwater Management Manual for Western Washington, as Amended in December 2014 (The 2014 SWMMWW), referred to hereon as 'The Manual', with amendments from City of Puyallup Municipal Code (PMC), Section 21.10. The Dos Lagos Lot 'E' Project is a new development project and proposes to add approximately 14,669 sq. ft. of impervious area in the form of building roofs, and an additional 33,645 sq. ft. of impervious surfaces in the form of concrete sidewalks and vehicle parking resulting in approximately 48,314 sq. ft. of total impervious surfaces. Less than 35% of the site consists of existing impervious coverage, and since more than 5,000 sq. ft. of new impervious surfaces are proposed to be added, minimum requirements 1 through 10 apply. The Washington State Department of Ecology (DOE) flow chart, "Figure I-2.4.1 – Flow Chart for Determining Requirements for New Development," is found in Figure 2 on the following page.

Figure 2: Flow Chart for Determining Requirements for New Development



- Minimum Requirement #1: Preparation of Stormwater Site Plans
    - In accordance with Volume 1, Chapter 2, Sections 2.4.1 & 2.5.1 of the Manual, a Stormwater Site Plan is required. This plan will include this Drainage Report, a Stormwater Pollution Prevention Plan (SWPPP), an Operation and Maintenance Manual, and the Site Development Drawings.

- Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)
    - In accordance with Volume 1, Chapter 2, Section 2.5.2, Construction Stormwater Pollution Prevention is required for all projects which replace or add more than 2,000 sq. ft. of impervious surfaces or disturb more than 7,000 sq. ft. of land. A Construction Stormwater Pollution Prevention Plan (SWPPP) is prepared and included as part of the project stormwater site plans with a narrative report included as part of this Drainage Report (See SWPPP in Appendix). The following thirteen (13) elements will be addressed in the SWPP plans and in the narrative report:

        Element 1: Preserve Vegetation/Mark Clearing Limits
        Element 2: Establish Construction Access
        Element 3: Control Flow Rates
        Element 4: Install Sediment Controls
        Element 5: Stabilize Soils
        Element 6: Protect Slopes
        Element 7: Protect Drain Inlets
        Element 8: Stabilize Channels and Outlets
        Element 9: Control Pollutants
        Element 10: Control De-Watering
        Element 11: Maintain BMPs
        Element 12: Manage the Project
        Element 13: Protect Low Impact Development BMPs

- Minimum Requirement #3: Source Control of Pollution
    - The project is a multi-family residential site that will be impacted by vehicular and foot traffic. A significant portion of the impervious surface will be the apartment building roof, which is a non-pollution generating impervious surface (non-PGIS). Stormwater from the building roof will be directed to the stormwater detention vault so as not to come in contact with the pollution-generating parking surfaces.
- Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls
    - Under existing conditions stormwater runoff infiltrates on site or sheet flows north and west into the adjacent wetland and Willow's Pond (see Drainage in Section 2, below). The project proposes to manage stormwater through on-site detention (see Minimum Requirement #5 and Minimum Requirement #7, below).

- The most accurate natural outfall on the project site is the adjoining wetland and Willow's Pond to the north and west of the parcel. This is due to the north-northwesterly sheet flow that occurs in the predeveloped condition.

- Minimum Requirement #5: On-Site Stormwater Management
  - Over 5,000 sq ft of new and replaced hard surfaces will be created, triggering On-Site Stormwater Management requirements. In accordance with Section 1.2.5.5 of the Manual, projects are required to employ On-site Stormwater Management BMPs to infiltrate, disperse, and retain stormwater runoff on-site to the extent feasible without causing flooding or erosion impacts. This project triggers Minimum Requirements #1-9, and therefore must meet the requirements in Table 1.2.5.1. The project chooses to utilize List #2.
- Minimum Requirement #6: Runoff Treatment
  - The project results in more than 5,000 sq. ft. of Pollution-Generating Impervious Surfaces (PGIS) and less than three-quarters (3/4) of an acre of Pollution-Generating Pervious Surfaces (PGPS), therefore quality mitigation is required. The project will utilize cartridge style stormwater treatment.
- Minimum Requirement #7: Flow Control
  - The project proposes greater than the 10,000 sq ft threshold of new and replaced hard surfaces, thus triggering the Flow Control Standard. This requires the project to match the developed durations to historical conditions between 50% of the 2-year and the 50-year peak historical flows. The project proposes to use onsite stormwater BMPs (detention) to mitigate flow control.
- Minimum Requirement #8: Wetlands Protection
  - There are wetlands on, and, or adjacent, to the project site. A hydroperiod and water quality analysis has been conducted by Enco Environmental Corporation, dated May 4, 2018, on the adjacent wetland and downstream discharge, which illustrates that impacts to the wetland in regard to flow and treatment would be minimal with development. Therefore, Minimum Requirement #8 is not triggered. Analysis found in Appendix E. The project shall comply with Guide Sheets #1 through #3 in Appendix 1-D: Guidelines for Wetlands when Managing Stormwater in the Manual.
- Minimum Requirement #9: Operations and Maintenance
  - To ensure that stormwater control facilities are adequately maintained and operated properly, an Operation and Maintenance Manual is prepared and included as part of the submittal.

Calculation Summary

MGS Flood version 4.54 was used to size the detention facility and determine requirements for conveyance sizing. (See Appendix A)

Predeveloped TDA:

Predeveloped Threshold Discharge Area Drainage Basin Land Use Breakdown

Actual Surface Description	Area (AC)	Surface Modeled As
Ex. Till Forest	1.775 AC	Till Forest
Total Area	**1.775 AC**	

Post Developed TDA:

Post Developed Threshold Discharge Area Drainage Basin Land Use Breakdown

Actual Surface Description	Area (SF)	Surface Modeled As
Roof	14,669	Impervious
Walkways	3,687	Impervious
Driveway/Parking	29,958	Impervious
Landscaping	28,998	Till Grass
Total Area	**77,312 SF**	**(1.775 AC)**

Calculations provided in the Appendix show that a detention vault 110 ft. long x 50 ft. wide x 6 ft. deep mitigates runoff from the post developed condition.

BMPs Utilized

- Detention Vault
  - Control Riser
  - Stormwater Pump
- Dispersion Trench

Section 2 – Existing Conditions Summary

Topography
Topographically, the majority of the site is generally level. The portions of the parcel that abut the public roadways are somewhat inclined from roadway to parcel, about 1 foot vertically.

Much of the parcel is characterized by a surficial layer of fill, including some debris, to an approximate depth of 3 to 5 feet.

Ground Cover
As stated above in 'Topography', a significant portion of the site is made up of fill. The site is covered by grass and blackberries, with deciduous trees and typical northwest understory along the western and northern property lines, and one or two mature conifers dispersed.

Drainage
Due to the site fill materials, which extend to depths of approximately three to five (3-5) feet in the locations of test pit excavation (see Dos Lagos Draft Geotechnical Report) the supplied expected infiltration rate of 30 inches per hour described in the geotechnical report pertains to the native medium to coarse outwash alluvial deposits underlying the fill material. Where clay

and till are encountered, the estimated infiltration rate is 10 inches per hour. It was a blue/gray fine sand with gravel that was found underlying the fill and debris at depth in the three onsite test pits. This appeared to be weathered glacial till more so than clay. Organics were present within this lowest layer excavated in at least one location.

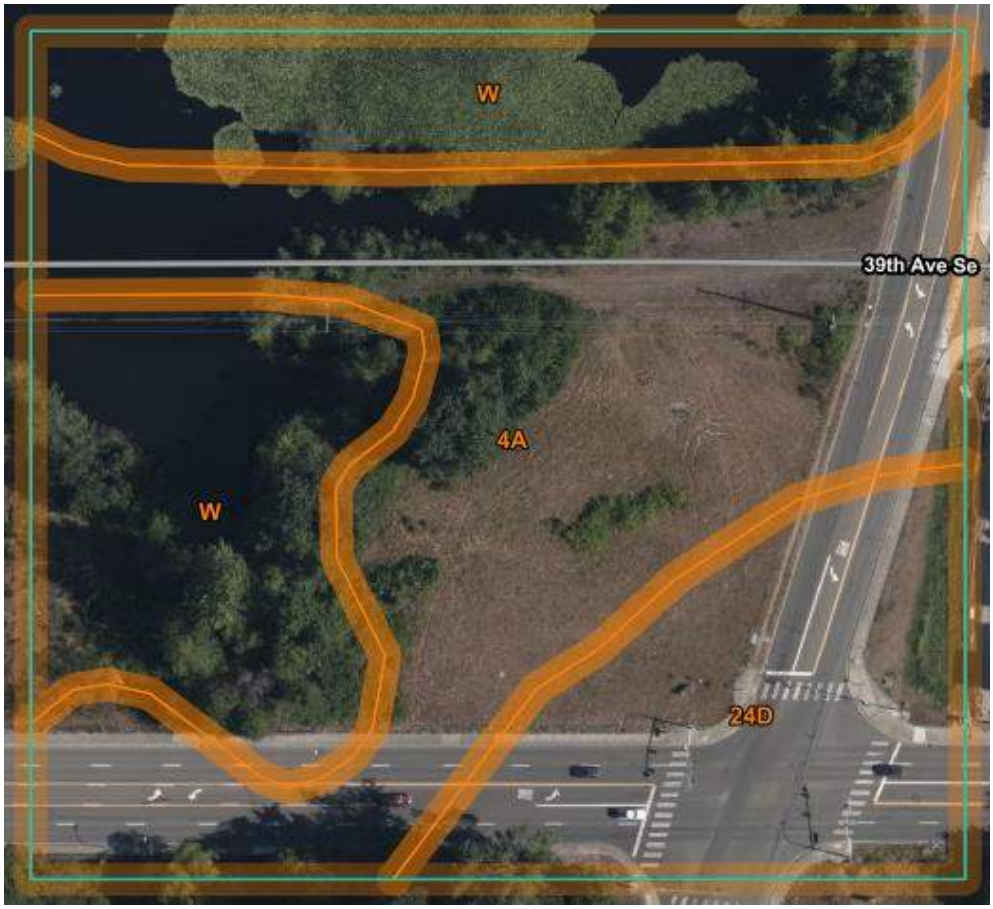
Runoff generally sheet flows north and west across the site into the existing adjacent wetland.

The site is in the aquifer recharge area. It is also within a 10-year wellhead protection area.

Soils

Soil mapping was conducted using the United States Department of Agriculture Natural Resources Conservation Service (NRCS, The Survey) website. The site position within the NRCS soil map is illustrated in Figure 3 below. The soil map for all properties can also be found in the geotechnical report, along with soil descriptions and soil logs, in Appendix D.

Figure 3: Site Position in NRCS soil mapping (excerpt)



Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
4A	Bellingham silty clay loam	2.8	46.2%
24D	Neilton gravelly loamy sand, 8 to 25 percent slopes	1.2	19.7%
W	Water	2.1	34.2%
Totals for Area of Interest		**6.1**	**100.0%**

Section 3 – Off-Site Analysis Report

Upstream Analysis

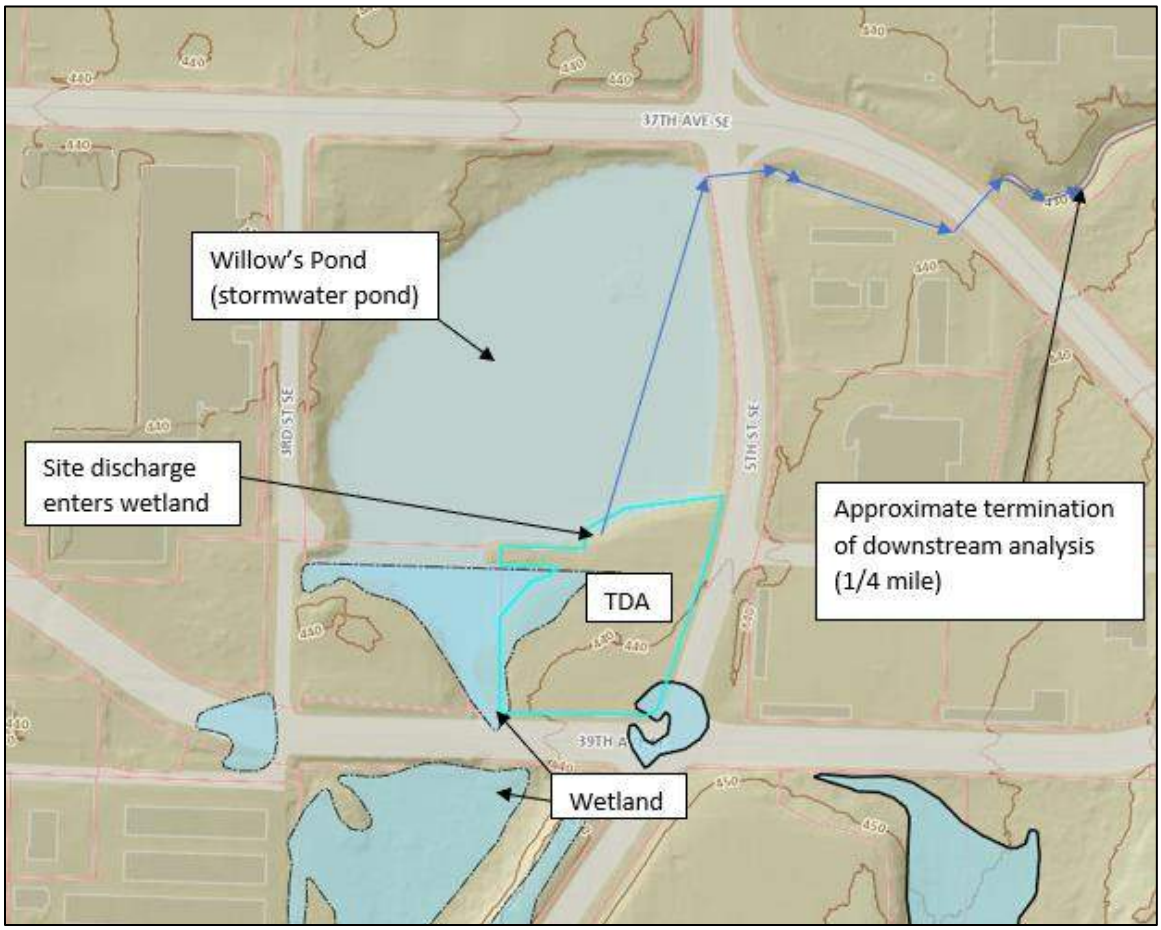
Virtually all stormwater originates on the property itself as precipitation. There is no relevant upstream analysis.

Downstream Analysis

A downstream (offsite) analysis has been completed by LS&E for this project. An offsite analysis study area definition map (Figure 4) is shown below. The study area for this project extends approximately ¼ mile to a portion of the unnamed stream that is released from Willow's Pond, in the vicinity of its crossing under 37th Ave SE. This stream eventually drains into Bradley Lake, then downstream for an unspecified distance.

No adverse impacts to downstream waters are anticipated as stormwater runoff will transmit first through the stormwater treatment cartridges, then into the detention facility before being dispersed into the wetland buffer via dispersion trench. These facilities have been sized using the MGS Flood continuous runoff model program. The stormwater treatment cartridges are designed to provide enhanced water quality treatment of the pavement runoff, which has received General Use Level Designation (GULD) for enhanced treatment by the Washington State Department of Ecology.

Figure 4: Downstream Analysis Map



Section 4 – Flow Control and Water Quality Facility Analysis and Design

Part A – Existing Site Hydrology

This project site is located in northwestern Pierce County at 405 39th Ave SE in the City of Puyallup in an area of existing commercial development. The site parcel comprises approximately 1.89 acres. This parcel is bordered by Willow's Pond to the west and north, 5th Street SE to the east, and 39th Ave SE to the South. Access to the project site will be a new driveway, located along 39th Ave SE.

Existing topography slopes gently to the north-northwest with grades near level. West of the roadway, the topography slopes gently toward the east. The northwest portion of the parcel consists of wetland and water. The existing ground cover for the majority of the site consists of deciduous trees and one or two conifers, along with typical northwest understory. Current stormwater runoff from the project site primarily sheet flows toward the adjacent wetland. Any infiltration that may occur in the area of proposed development is assumed to flow to the adjacent wetland via subsurface lateral flow basins.

Predeveloped Threshold Discharge Area Drainage Basin Land Use Breakdown

Actual Surface Description	Area (AC)	Surface Modeled As
Ex. Till Forest	1.775 AC	Till Forest
Total Area	**1.775 AC**	

Refer to the Drainage Plan set, C1 for development area.

Part B – Developed Site Hydrology

Post Developed Threshold Discharge Area Drainage Basin Land Use Breakdown

Actual Surface Description	Area (SF)	Surface Modeled As
Roof	14,669	Impervious
Walkways	3,687	Impervious
Driveway/Parking	29,958	Impervious
Landscaping	28,998	Till Grass
Total Area	**77,312 SF**	**(1.775 AC)**

The underground detention storage vault has been sized to mitigate 48,314 square feet of roof, parking, and sidewalk area. Stormwater runoff from a total of 48,314 square feet of impervious surface will be directed to this storage vault.

Part C – Performance Standards

This project proposes enhanced treatment for pollution-generating surfaces, which should provide a higher rate of removal of dissolved metals than basic treatment facilities. Enhanced treatment is provided through the use of a cartridge style stormwater media filter (Oldcastle Infrastructure BPU 412 Biopod Biofilter), which has received General Use Level Designation (GILD) for enhanced treatment by the Washington State Department of Ecology. Calculations (Appendix A) indicate that the cartridges infiltrate, and therefore treats, 100 percent of the runoff directed toward it. The cartridge style stormwater media filters are followed by detention, then dispersion.

Part D – Flow Control System

Flow control is provided within projects to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. This flow control standard requires that developed discharge durations match existing predeveloped durations from 50% of the 2-year peak flow up to the full 50-year peak flow.

The Flow Control BMP Requirements for this project will be met by providing an underground detention storage vault and gravel-filled dispersion trench. Continuous modeling demonstrates that the TDA will generate no more than a 0.15-cfs increase in the existing site conditions 100-year peak flow, using 15-minute time steps. The proposed stormwater detention vault will provide water quantity mitigation and has been sized per the design specifications in the Manual. The proposed dispersion trench has been designed and sized per the specifications in III-3.1.2 Downspout Dispersion Systems (BMP T5.10B) in the Manual.

The pre-developed 100-year peak flow rate for the TDA is 0.189 cfs and the post-developed 100-year peak flow rate is 0.106 cfs (decrease of 0.083 cfs in the 100-year flood frequency using 15-minute time step).

Part E – Water Quality System

This project must address water quality as it proposes 33,645 square feet of pollution-generating impervious surfaces, which is greater than the 5,000 square foot threshold. The proposed stormwater filtration cartridges will provide water quality mitigation and have been sized per the design specifications in Volume V of the Manual. Of the project's 48,314 square feet of impervious surface, 33,645 square feet will be mitigated using the stormwater filtration cartridges.

The required drawings of the water quality system are presented within Appendix F. Stormwater calculations are presented within Appendix A.

There are no special requirements for source control or oil control for this project. Per City of Puyallup – City Standard, 204.9 – Oil Control/Spill Containment, multi-family properties shall include, at a minimum, a spill control device shall be located upstream of any onsite water quality or flow control facility.

Part F – Conveyance System Design and Analysis

Conveyance system analysis to be provided in final draft.

Section 5 – Special Reports and Studies

- A geotechnical report entitled *Dos Lagos Asset, LLC Geotechnical Soil Observation Report* was completed by LS&E and a copy is submitted with this report in Appendix D.
- A wetland report entitled *Wetland 1 Hydroperiod and Water Quality Analysis* was completed by Enco Environmental Corporation for the Affinity at Puyallup project and is submitted with this report in Appendix E.

Section 6 – Other Permits

- Temporary Construction Easement (No Auditor File Number (AFN) currently available).
- A SEPA Environmental Checklist will be required.

Appendix A

Calculations

MGS FLOOD
PROJECT REPORT

Program Version: MGSFlood 4.54
Program License Number: 201010005
Project Simulation Performed on: 03/24/2021 4:10 PM
Report Generation Date: 03/24/2021 4:20 PM

Input File Name: Par E.fld
Project Name: Dos Lagos Lot E
Analysis Title: Detention Sizing Parcel E
Comments: LSE Project #12896

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Time Series Selected
Climatic Region Number: 39

Full Period of Record Available used for Routing
Precipitation Station : 910044 Pierce Co. East 44 in 10/01/1939-10/01/2097
Evaporation Station : 911044 Pierce Co. East 44 in
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********** Default HSPF Parameters Used (Not Modified by User) **********

********** WATERSHED DEFINITION **********

Predevelopment/Post Development Tributary Area Summary

	Predeveloped	Post Developed
Total Subbasin Area (acres)	1.930	1.930
Area of Links that Include Precip/Evap (acres)	0.000	0.000
Total (acres)	1.930	1.930

----------SCENARIO: PREDEVELOPED
Number of Subbasins: 1

---------- Subbasin : Predev Lot E ----------

	-------Area (Acres) --------
Till Forest	1.930
Subbasin Total	1.930

----------SCENARIO: POSTDEVELOPED
Number of Subbasins: 1

---------- Subbasin : Dev Basin Lot E ----------

	-------Area (Acres) --------
Till Grass	0.659
Impervious	1.271
Subbasin Total	1.930

********** **LINK DATA** **********

----------SCENARIO: PREDEVELOPED
Number of Links: 0

********** **LINK DATA** **********

----------SCENARIO: POSTDEVELOPED
Number of Links: 1

Link Name: Vault
Link Type: Structure
Downstream Link: None

Prismatic Pond Option Used
Pond Floor Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 106.00
Max Pond Elevation (ft) : 106.50
Storage Depth (ft) : 6.00
Pond Bottom Length (ft) : 110.0
Pond Bottom Width (ft) : 50.0
Pond Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 5500.
Area at Riser Crest El (sq-ft) : 5,500.
(acres) : 0.126
Volume at Riser Crest (cu-ft) : 33,000.
(ac-ft) : 0.758
Area at Max Elevation (sq-ft) : 5500.
(acres) : 0.126
Vol at Max Elevation (cu-ft) : 35,750.
(ac-ft) : 0.821

Hydraulic Conductivity (in/hr) : 0.00
Massmann Regression Used to Estimate Hydralic Gradient
Depth to Water Table (ft) : 100.00
Bio-Fouling Potential : Low
Maintenance : Average or Better

Riser Geometry
Riser Structure Type : Circular

Riser Diameter (in) : 18.00
Common Length (ft) : 0.010
Riser Crest Elevation : 106.00 ft

Hydraulic Structure Geometry

Number of Devices: 2

---Device Number 1 ---
Device Type : Circular Orifice
Control Elevation (ft) : 100.00
Diameter (in) : 0.71
Orientation : Horizontal
Elbow : No

--- Device Number 2 ---
Device Type : Vertical Rectangular Orifice
Control Elevation (ft) : 103.33
Length (in) : 0.10
Height (in) : 32.04
Orientation : Vertical
Elbow : No

**************************FLOOD FREQUENCY AND DURATION STATISTICS********************

----------SCENARIO: PREDEVELOPED
Number of Subbasins: 1
Number of Links: 0

----------SCENARIO: POSTDEVELOPED
Number of Subbasins: 1
Number of Links: 1

************ Subbasin: Dev Basin Lot E ************

Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.571
5-Year	0.724
10-Year	0.890
25-Year	1.107
50-Year	1.419
100-Year	1.755
200-Year	1.779
500-Year	1.803

********** Link: Vault ********** Link Inflow Frequency Stats
Flood Frequency Data(cfs)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.571
5-Year	0.724
10-Year	0.890
25-Year	1.107
50-Year	1.419
100-Year	1.755
200-Year	1.779
500-Year	1.803

********** Link: Vault ********** Link WSEL Stats

WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	101.887
1.11-Year	102.014
1.25-Year	102.290
2.00-Year	103.142
3.33-Year	103.718
5-Year	104.186
10-Year	104.793
25-Year	105.221
50-Year	105.457
100-Year	105.557

*************Groundwater Recharge Summary **************

Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Predev Lot E	366.925
Total:	366.925

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Dev Basin Lot E	84.860
Link: Vault	0.000
Total:	84.860

Total Predevelopment Recharge is Greater than Post Developed
Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 2.322 ac-ft/year, Post Developed: 0.537 ac-ft/year

*************Water Quality Facility Data **************

----------SCENARIO: PREDEVELOPED

Number of Links: 0

----------SCENARIO: POSTDEVELOPED

Number of Links: 1

********** Link: Vault **********

Basic Wet Pond Volume (91% Exceedance): 6911. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 10366. cu-ft

2-Year Discharge Rate : 0.024 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.20 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.11 cfs

Infiltration/Filtration Statistics----------
Inflow Volume (ac-ft): 799.69
Inflow Volume Including PPT-Evap (ac-ft): 799.69
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
Total Runoff Filtered (ac-ft): 0.00, 0.00%
Primary Outflow To Downstream System (ac-ft): 799.55
Secondary Outflow To Downstream System (ac-ft): 0.00
Volume Lost to ET (ac-ft): 0.00
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 0.00%

*************Compliance Point Results **************

Scenario Predeveloped Compliance Subbasin: Predev Lot E

Scenario Postdeveloped Compliance Link: Vault

***** Point of Compliance Flow Frequency Data *****
Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff		
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)	
2-Year	4.964E-02	2-Year	2.411E-02	
5-Year	8.013E-02	5-Year	4.544E-02	
10-Year	0.104	10-Year	6.908E-02	
25-Year	0.143	25-Year	8.883E-02	
50-Year	0.173	50-Year	0.101	
100-Year	0.189	100-Year	0.106	<0.15 cfs increase - PASS
200-Year	0.357	200-Year	0.121	
500-Year	0.583	500-Year	0.141	

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******

Excursion at Predeveloped 50%Q2 (Must be Less Than or Equal to 0%):	-25.9%	PASS
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than or Equal to 0%):	-25.9%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-22.8%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

MEETS ALL FLOW DURATION DESIGN CRITERIA: PASS

****** LID Duration Performance ******

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	293.5%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	419.4%	FAIL

LID DURATION DESIGN CRITERIA: FAIL

Appendix B

Stormwater Pollution Prevention Plan (SWPPP)

***SWPPP to be included in formal report**

Appendix C

Schedule of Structures

***To be included in formal report**

Appendix D

Soils (NRCS) Data & Geotechnical Evaluation

Dos Lagos Asset, LLC
810 E. Pico Blvd, Unit B24
Los Angeles, CA. 90021
213-614-8887

August 6, 2020
Updated April 23, 2021

Geotechnical Soil Observation Report
Parcel No. 0419102118, 0419106024, 0419106025, 0419106026, 0419106028, 0419106030
Site Address – 405 39th Ave SE
LS&E Job No. 12896
Assessments Performed: 7/7/2020

Project Description

A geotechnical site and soil assessment is necessary for the proposed development of multi-family apartment buildings and the associated hard surfaces on the above referenced properties in order to make recommendations for site development and stormwater design plans. For this report we reviewed available published geological and soil information and made on site observations to gather additional in-situ information. Using a track-mounted excavator, we made several excavations throughout the sites and examined soil depth, texture, and gathered samples for cation exchange capacity (CEC) testing.

For the design of infiltration facilities, confirmation of available soil depth is required by the City of Puyallup. PIT infiltration testing or similar usually takes place at the time of observation of onsite groundwater ports. Terrain and soil depth indicators allow us to make preliminary estimates of depth and infiltration rates to begin the design. It was discovered during excavation of test pits that the onsite soil conditions are highly variable, shallow in many locations, rendering subsurface infiltration infeasible. More detail concerning soils and more specifically, infiltration capacity within, are found in 'Soil Characteristics' below. Bearing capacity recommendations are based on classification via the 2018 International Building Code (IBC), Table 1806.2 – Presumptive Load Bearing Values.

For the purposes of this report, Parcels 0419106026 & 0419106028 will be hereinafter referred to as Site B, 0419106024 & 0419106025 as Site C, 0419102118 as Site D, and 0419106030 as Site E.

Information Sources

Soil identification and mapping for this assessment is supported by information from the Natural Resource Conservation Service (the Survey) and from the excavation and observations of test pits throughout the sites conducted for our review. Geologic information for this assessment is supported by information from the United States Geological Survey (USGS) *Draft* Geologic Map of the Puyallup 7.5 Minute Quadrangle, Washington. Our understanding of site geology is supported by the review of geologic mapping, published topographic and relief map

layers from the Pierce County Geographical Information System (GIS), and site observations. Our opinions are based on our interpretation of the cumulative information and the contemporary conditions of the geologic setting.

Published Information Accuracy

It should be noted that the Survey, the USGS and/or DNR geologic maps, and the Pierce County GIS define general areas of soil deposits, geology, and landforms. Given the large areas to identify and limited sample points, the authors of the above sources had to infer boundaries, contacts, and other representations in some areas. Only through on-site reconnaissance can we further detail and adjust information from the maps as they relate to each site. They are not (from our experience) accurate on a lot by lot basis in all cases. In this case, the Survey, the USGS unit identification, and the in-situ conditions are in general concurrence, however the sites have been amended with mineral soil dominant fill (gravel and sand, with very limited organic material).

Site Description

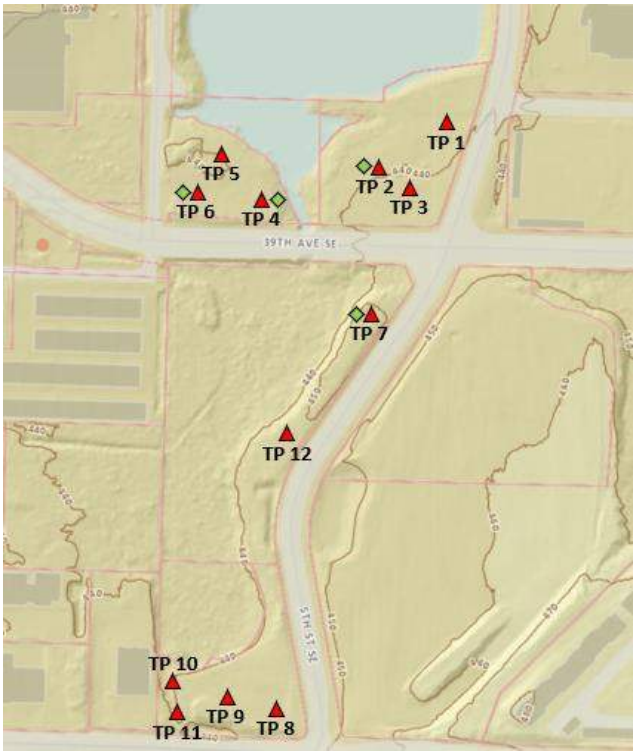
General

The sites in this project are in the City of Puyallup and situated on glacial till, flood, lacustrine, or outwash deposits. Figure 1, below, illustrates the location of individual parcels and sites of the project and Figure 2 illustrates the test locations on the sites. The site descriptions are as follows:

- Site B is undeveloped and mostly vegetated with grasses, small hardwoods, and understory. Much of the site has been modified with 3-5' of fill containing occasional debris placed on top of native soils, creating a mostly level property. It is bound by what appears to be a retention pond on the north side of the site, developed decades ago according to county pictures and maps, 3rd St SE on the west, 5th St SE on the east, and 39th Ave SE to the south.
- Site C is undeveloped with second-growth trees and understory, and is bound on the north by 39th Ave SE, the west and south by light industrial buildings, and to the east by Site D. Site C may not be developed in this project.
- Site D is comprised of a low-lying area in the west portion of the property, and a manmade bench that is about 10-15' higher in the east portion of the property. There is a large storm culvert and manhole that has an outlet into a drainage ditch in the southeast portion of the property. It appears that roadway stormwater, along with stormwater from some neighboring properties, is released to this low-lying portion of the site. It is bound by 39th Ave SE to the north, light industrial buildings and some vacant land to the west, 5th St SE to the east, and Site E to the south.
- Site E is mostly level due to fill placed over native soils, like Site B, with a slightly lower section in the extreme western portion of the site. Site E is bound by light industrial to the west, 5th St SE to the east, and 43rd Ave SE to the south. An assisted living facility is located on the east side of 5th St SE.

Figure 1: Site Map of Individual Parcel Locations and Corresponding Site Designations

Figure 2: Test Pit (▲) and CEC Sample (◆) Locations



Soil

As discussed in the 'Published Information Accuracy' section above; on-site reconnaissance is necessary to verify soil conditions on specific properties. Both the Survey and the geologic map describe materials of similar characteristics and origin. Per the Survey, the type of soil in Site B is Indianola loamy sand in the extreme western portion and Bellingham silty clay loam in the rest of the site; Site C is Everett very gravelly sandy loam; Site D is Bellingham silty clay loam in the lower, western portion, and Neilton gravelly loamy sand in the higher, eastern bench area (the soils found in the 8-10' depths in Site D are most likely found throughout the next lowest bench elevation on the site); Site E is Everett very gravelly sandy loam in the lower, western portion, and Neilton gravelly loamy sand in the higher, eastern portion. Our in-situ examination of soil supports the Survey and USGS findings (soil log forms to be included in final report, see Appendix A for transcribed soil logs), except that much of Site B and Site E have 3-5 feet of fill with occasional debris placed on top of the native soil. Below this is the native layers described above. Site C was not examined on-site for in-situ soil properties at this time. Find individual Test Pit Soil Log descriptions in "Attachments." Figure 3 below illustrates the site position within the soil environment.

Indianola Loamy Sand:

The Indianola loamy sand is somewhat excessively drained. It formed in sandy glacial outwash on broad uplands. Conifer forests are predominant. The typical elevation of this soil series ranges from 200 and 800 feet. This soil may be found adjacent to areas of a soil with shallow,

consolidated restrictive layers, or "hardpan" at depths of about three feet. In a typical profile the surface layer (approximately seven inches in thickness) is dark brown loamy sand. The underlying material, to a depth of more than 60 inches, is dark yellowish brown, brown, or olive brown sand. Permeability is rapid. The available water capacity is low to moderate. Surface runoff is medium, and the erosion hazard is moderate. Roots extend to a depth of more than 60 inches.

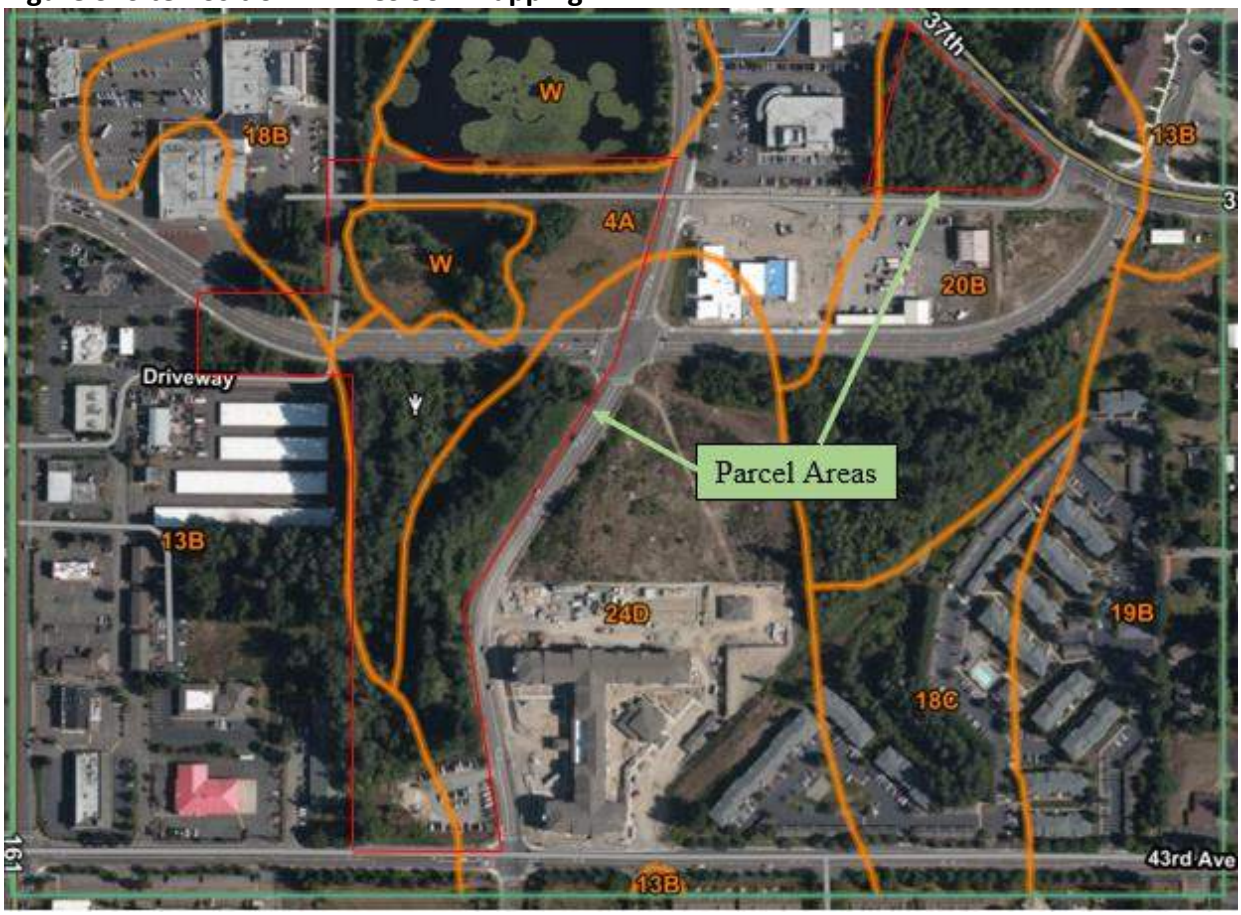
Bellingham Silty Clay Loam:
The Bellingham silty clay loam is a nearly level soil that is poorly drained. It formed in alluvium in upland depressions. Elevation ranges from 20 to 600 feet. Vegetation is primarily grasses and sedges and some conifers and hardwoods. This soil is generally in areas of five to 20 acres, but an area of 120 acres in on Anderson Island. Most areas are long and narrow, but a few are nearly round. Slopes dominantly range from zero to two percent, but in a few places the slope is as much as seven percent.

Included with this soil in mapping are areas of soils that have gravelly sand at a depth of 12 to 18 inches. In a typical profile the surface layer is mottled, very dark grayish brown silty clay loam about four inches thick. In places the surface layer is black muck. The subsoil, to a depth of 11 inches, is mottled dark grayish brown clay. Reaction ranges from strongly acid to neutral. Permeability is slow. The available water capacity is high. Surface runoff is ponded to slow, and the erosion hazard is none to slight. Very few roots penetrate the substratum. The primary limitations for urban development are a high water table, seasonal ponding, and the shrink-swell potential of the subsoil as it wets and dries. Septic tank drainage fields do not function properly during the wet season because of the high water table.

Neilton Gravelly Loamy Sand:
The Neilton gravelly loamy sand is excessively drained. It formed in stratified, gravelly glacial outwash deposits on uplands. Typical vegetation is made up of conifers. Elevation ranges from about 100 to 400 feet. In a typical profile a thin mat of undecomposed needles and wood overlies a three-inch, black gravelly loamy sand surface layer. The subsoil, to a depth of 21 inches, is composed of brown gravelly loamy sand. The substratum, to a depth of more than 60 inches, is made up of stratified layers of clean sand or very gravelly sand. Permeability is rapid. The available water capacity is low. Surface runoff is slow, and there is a slight erosion hazard. The effective rooting depth is 60 inches.

Everett Very Gravelly Sandy Loam:
This rolling soil is somewhat excessively drained. It formed in gravelly glacial outwash under conifers. The typical elevation range for this soil is from 200 to 700 feet. Included with this soil in mapping are about eight percent Alderwood soils. Also included are some areas that are as much as five percent sandy Indianola soils and ten percent gravelly Neilton soils and less sloping Everett soils. In a typical profile the surface layer is very dark brown gravelly sandy loam about two inches thick. The subsoil, between depths of two and 19 inches, is dark yellowish brown gravelly sandy loam and dark brown very gravelly coarse sandy loam. The substratum, between depths of 19 and more than 60 inches, is clean, loose very gravelly sand.

Figure 3: Site Position in NRCS Soil Mapping

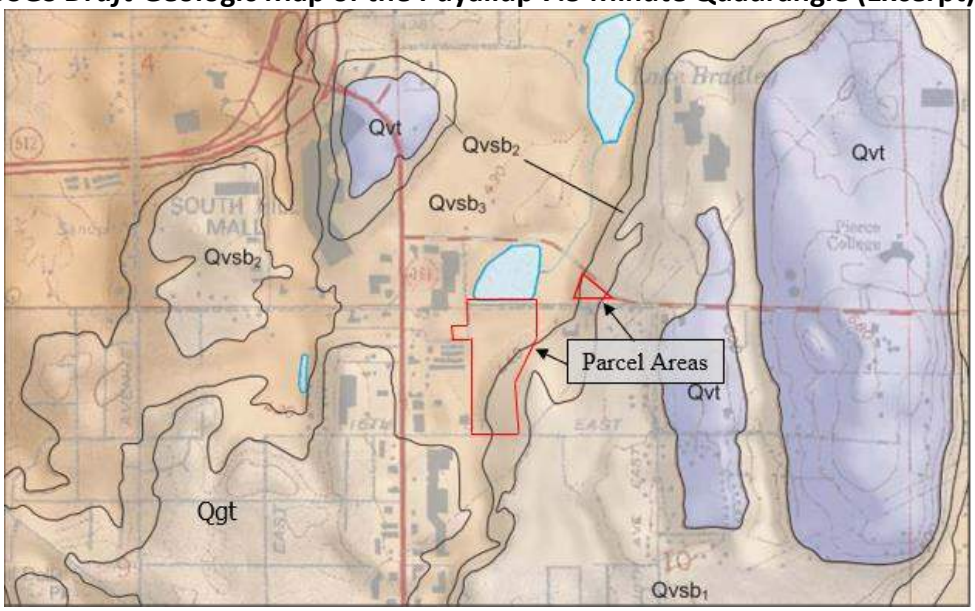


Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
4A	Bellingham silty clay loam	10.9	10.5%
13B	Everett very gravelly sandy loam, 0 to 8 percent slopes	28.3	27.3%
18B	Indianola loamy sand, 0 to 5 percent slopes	5.7	5.5%
18C	Indianola loamy sand, 5 to 15 percent slopes	6.7	6.5%
19B	Kapowsin gravelly ashy loam, 0 to 6 percent slopes	10.7	10.4%
20B	Kitsap silt loam, 2 to 8 percent slopes	13.3	12.9%
24D	Neilton gravelly loamy sand, 8 to 25 percent slopes	21.6	20.8%
W	Water	6.3	6.1%
Totals for Area of Interest		**103.5**	**100.0%**

Geology and Morphology

The property is situated on the broad deposit of glacial outburst flood deposits that occurred during and at the end of the Vashon Stade of the Fraser glaciation period. As glacial Lake Puyallup, located at the base of the Cascade Range foothills, would fill with seasonal runoff, the valley glaciers (acting as a natural dam) would repeatedly fail releasing vast amounts of water that would erode the lowland formations and subsequently deposit new sediment as floodwater abated. This local landscape still includes Kettle depressions formed by portions of ice blocks that were trapped in place. Outwash deposits surrounded the ice blocks. Figure 4 below illustrates the site position in the regional geology.

Figure 4: USGS *Draft* Geologic Map of the Puyallup 7.5 Minute Quadrangle (Excerpt)



Qvs — Steilacoom Gravel of Walters and Kimmel (1968)—Sandy gravel and cobbles; clean to silty; poorly to well sorted; horizontally to cross bedded; loose to dense. Deposits vary from veneer of <1 to 15 m (3 to ~ 50 ft) thick. Deposited by multiple outburst floods from subsequently lower elevations of Glacial Lake Puyallup. Locally subdivided first by channel affiliation (Clover Creek or Bradley) and secondarily by relative age in descending series of deposits; higher number denotes younger (lower) deposit. Clover Creek channel (Bretz, 1913) begins in section 8, T19N, R4E. Bradley channel; herein named for Lake Bradley in section 3, T19N, R4E; begins in section 2, T19N, R4E. Numbering system contiguous w/adjacent Tacoma South quadrangle where multiple Clover Creek deposits are mapped (Troost, 2006). Mapable deposits consist of:

Qvs $_{b3}$ — Bradley deposit at elevation 420 – 440 ft

Qvs $_{b2}$ — Bradley deposit at elevation 440 – 460 ft

Soil Characteristics

Infiltration Feasibility

When proposing stormwater facilities within the City of Puyallup, infiltration feasibility is required. The City requires the available soil depth above seasonal groundwater to be verified between December 21st and March 31st, as required by the Stormwater Management Manual for Western Washington. To perform this observation, groundwater monitoring ports are installed at roughly equidistant and representative locations within the site and along the planned alignment of parking and stormwater facilities.

As stated in 'Project Description' above, the soil types and depths across the sites are highly variable, with most infeasible for infiltration. Where available soil depths were found to be deeper, most were overlain by fill debris, including stones and bricks. In the few locations where infiltration was believed to be feasible, the areal extent was too limited. It is due to the observation of these conditions that stormwater infiltration is considered infeasible for these sites, in our opinion. The concern that saturation and fouling of stormwater trenches and permeable pavement is high. Alternatives for stormwater capture, treatment, and release should be utilized.

Permeable Pavement Feasibility

Some types of stormwater design rely on treatment afforded by the native soil. Many chemicals of concern within stormwater runoff from pollution generating surfaces can be described as positively charged ions (Cations) and can be assimilated or held by negatively charged clay and organic particles within soil. A given soil's capacity to hold and exchange cations is referred to as Cation Exchange Capacity (CEC). Our firm collected four samples as shown in Figure 2 above. The samples exhibited positive results for treatment capability, but this is of little consequence as it is now our opinion that permeable pavement is infeasible for this project.

Not only were available soil depths or conditions infeasible for infiltration in most areas across the sites, but the over excavation required due to the presence of fill would compact and destroy the subsurface conditions needed for permeable pavement. Undisturbed, native subsurface soil conditions are required for the infiltrative capacity of permeable pavement, bearing capacity of the soil, and treatment capacity of the soil (CEC). Placement of structural fill for the proper infiltrative and bearing characteristics required for permeable pavement would essentially negate any of the treatment capabilities due to the competing nature of these requirements.

Foundation Bearing Capacity

Test pits demonstrate that the subsurface conditions throughout the sites are composed predominantly of 3-5' of long-existing, rather compact fine to medium sand with gravel fill placed directly upon native soils. Geologic maps and soil maps illustrate that the subsurface conditions throughout the sites are composed of fine to medium sand with gravel, and in some low-lying areas this is overlaying a moist silty sand. Sand is favorable for projects requiring average bearing capacity. The gravelly sand found throughout the project site is shown below

as having a presumptive load-bearing value of 3000 psf. We recommend the more conservative design value of 2000 psf bearing capacity per Figure 5. The 2018 International Building Code (IBC) Chapter 18 provides expected capacities based on material classification. Please see Figure 5 below for an illustration of expected bearing capacity per the IBC.

Bearing surfaces should be medium dense or denser, undisturbed native soils which have been stripped of surficial organic soils, or on properly compacted structural fill which bears on undisturbed native soils which have been stripped of surficial organic soils. In general, before foundation concrete is placed, any localized zones of loose soils exposed across the footing subgrades should be compacted to a firm, unyielding condition, and any localized zones of soft, organic, or debris-laden soils should be over-excavated and replaced with suitable structural fill.

Figure 5: 2018 International Building Code (IBC) Excerpt

TABLE 1806.2
PRESUMPTIVE LOAD-BEARING VALUES

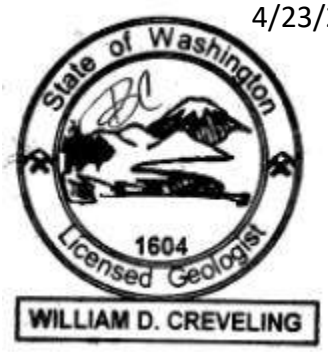
CLASS OF MATERIALS	VERTICAL FOUNDATION PRESSURE (psf)	LATERAL BEARING PRESSURE (psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction[a]	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	—	130

Closure

The information gathered for this report is standard practice and relevant for this type of project. The number and distribution of sampling locations is typical and reliable for obtaining an accurate understanding of the site. The conclusions and recommendations presented in this letter are based on our observations, interpretations, and assumptions regarding shallow subsurface conditions. However, if any variations in the site conditions are discovered later, please contact our office to review and if necessary, modify this report accordingly. We appreciate the opportunity to be of service on this project. If you have any questions regarding this letter or any aspects of the project, please feel free to contact our office.

Respectfully submitted,
LeRoy Surveyors & Engineers, Inc.

4/23/2021



William Creveling, L.G.
Principal Geologist

4/23/2021

Damon DeRosa, P.E.
Principal Engineer

Joshua Thompson, E.I.T.
Civil Engineering Technician

Attachments: Graphic Soil Logs

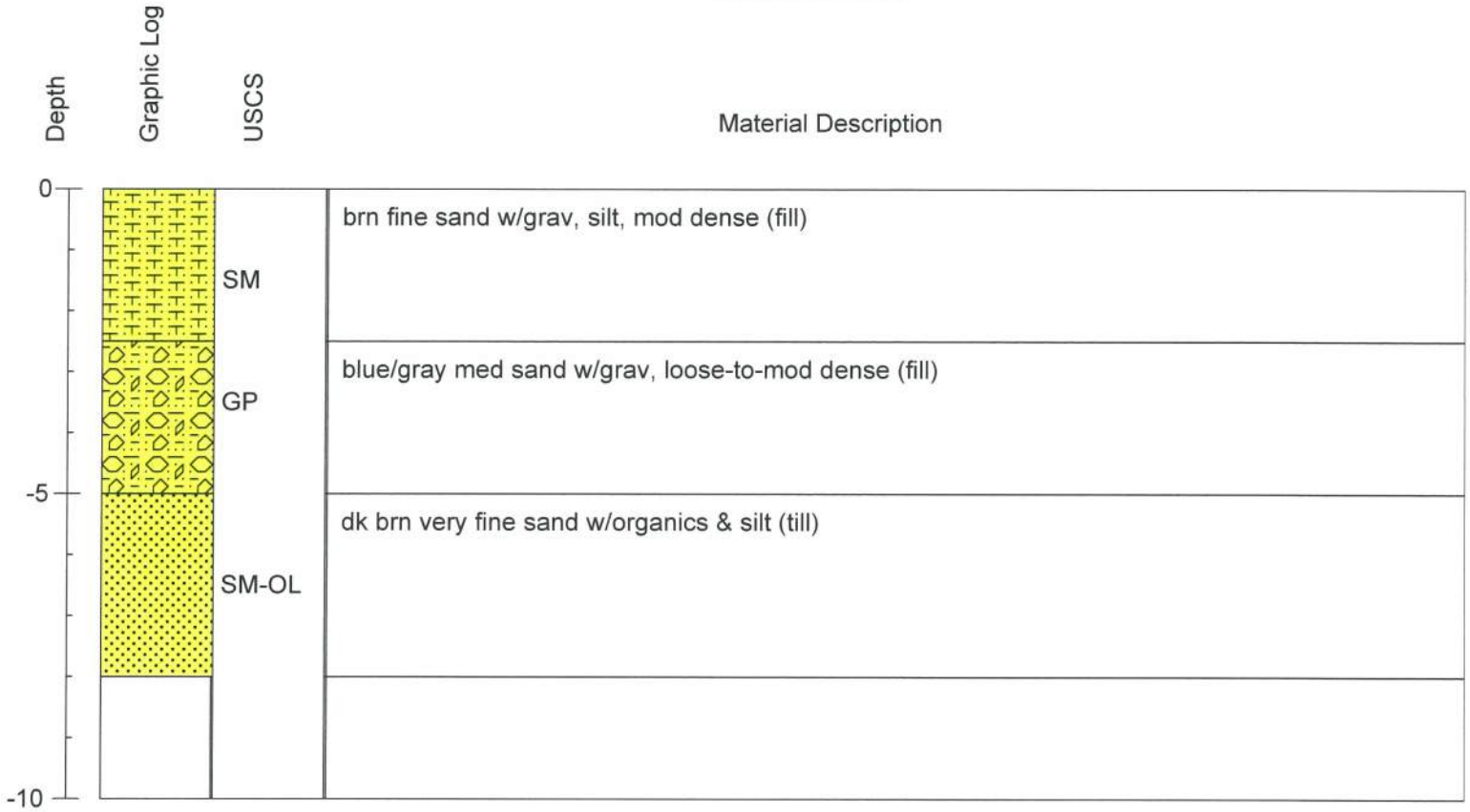
Appendix A: Graphic Soil Logs

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: _____

Test Pit Number: TP 1
Project Name: Dos Lagos
Ground Elevation: 438 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

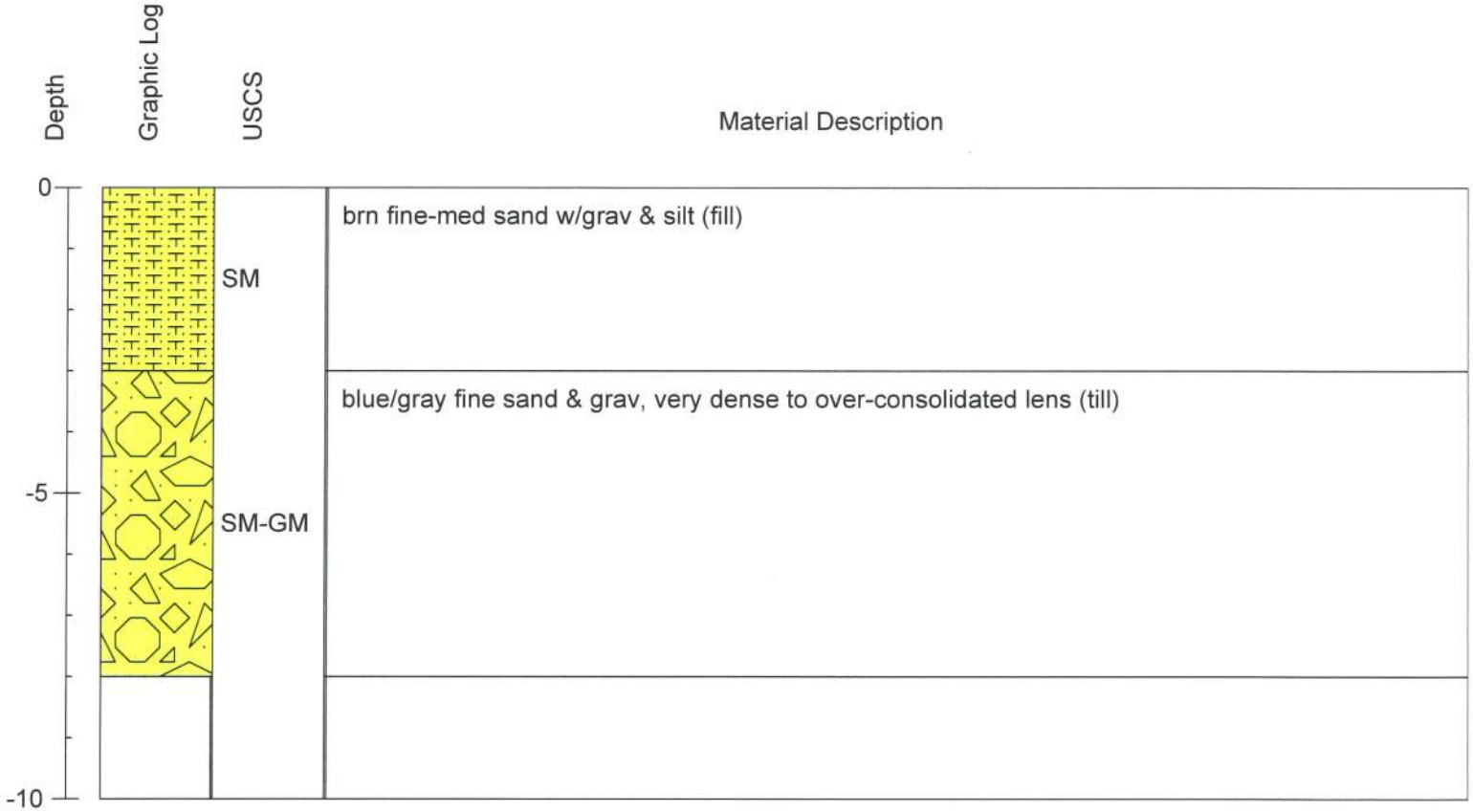
Bottome of Test Pit at: 8.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: _____

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Significant fill present, no organics within, preloaded condition.
None

Test Pit Number: TP 2
Project Name: Dos Lagos
Ground Elevation: 440 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

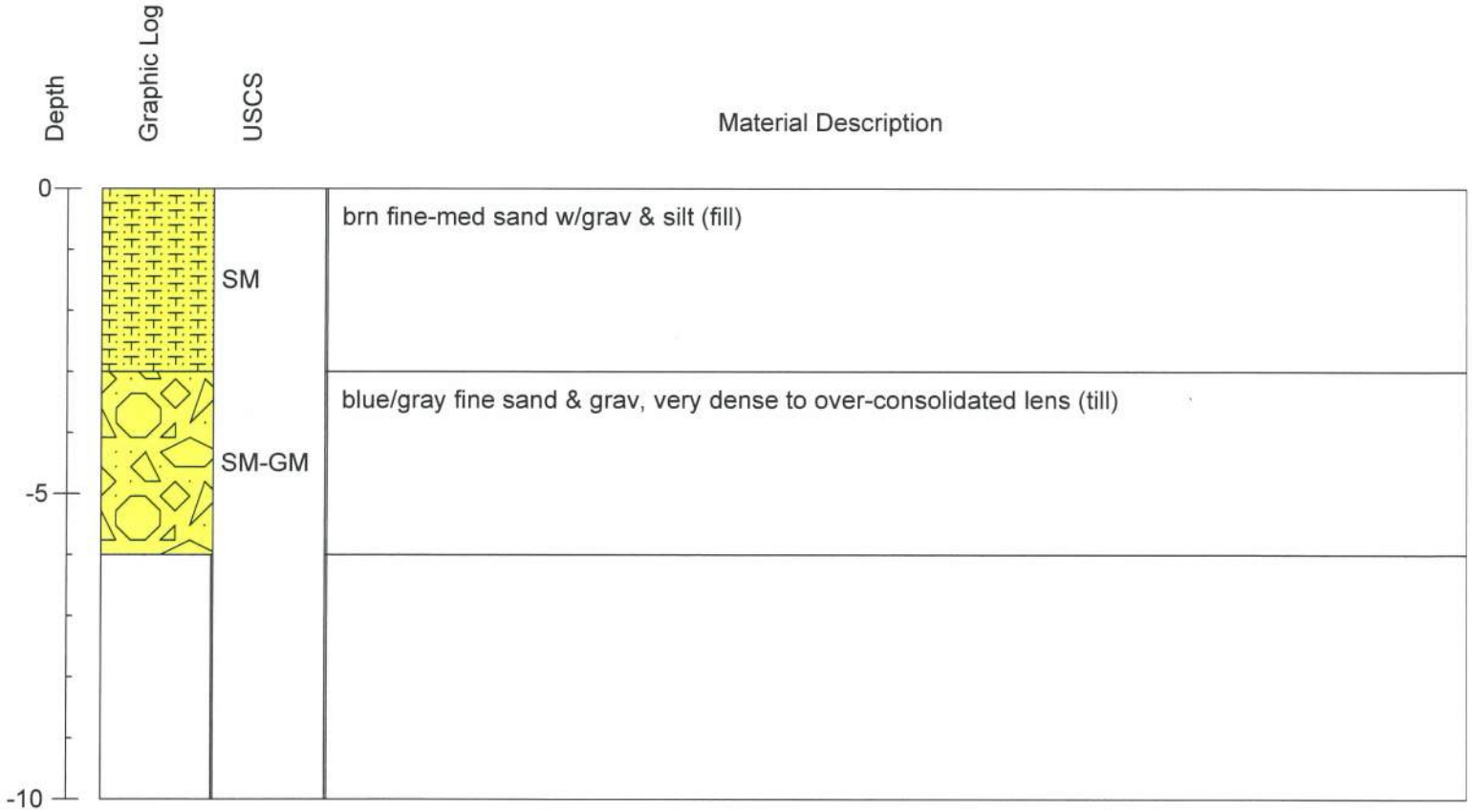
Bottome of Test Pit at: 8.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Significant fill present, no organics within, preloaded condition.
None

Test Pit Number: TP 3
Project Name: Dos Lagos
Ground Elevation: 440 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

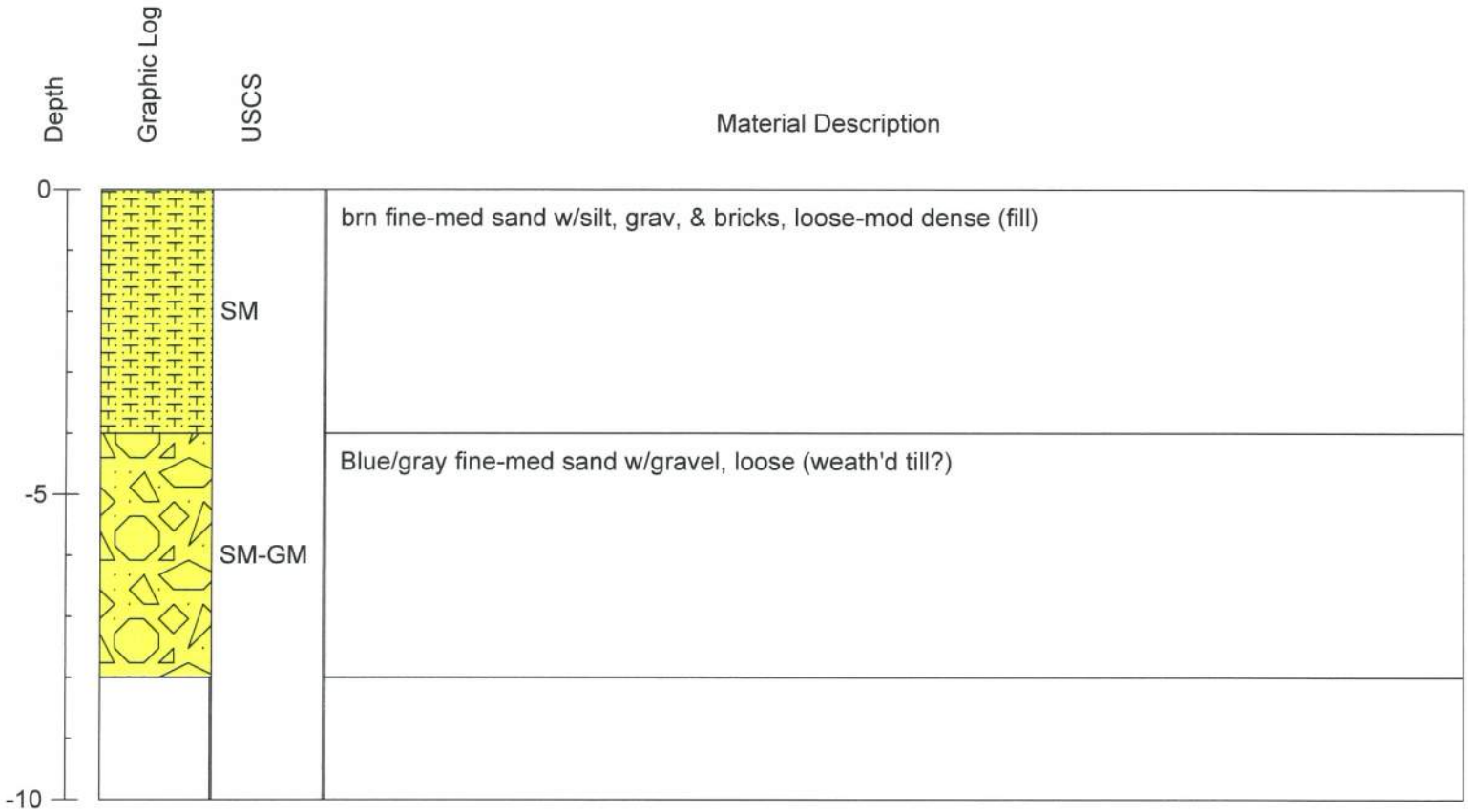
Bottome of Test Pit at: 6.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Significant fill present, no organics within, preloaded condition. Bricks found at depth.
None

Test Pit Number: TP 4
Project Name: Dos Lagos
Ground Elevation: 438 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

Bottome of Test Pit at: 8.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

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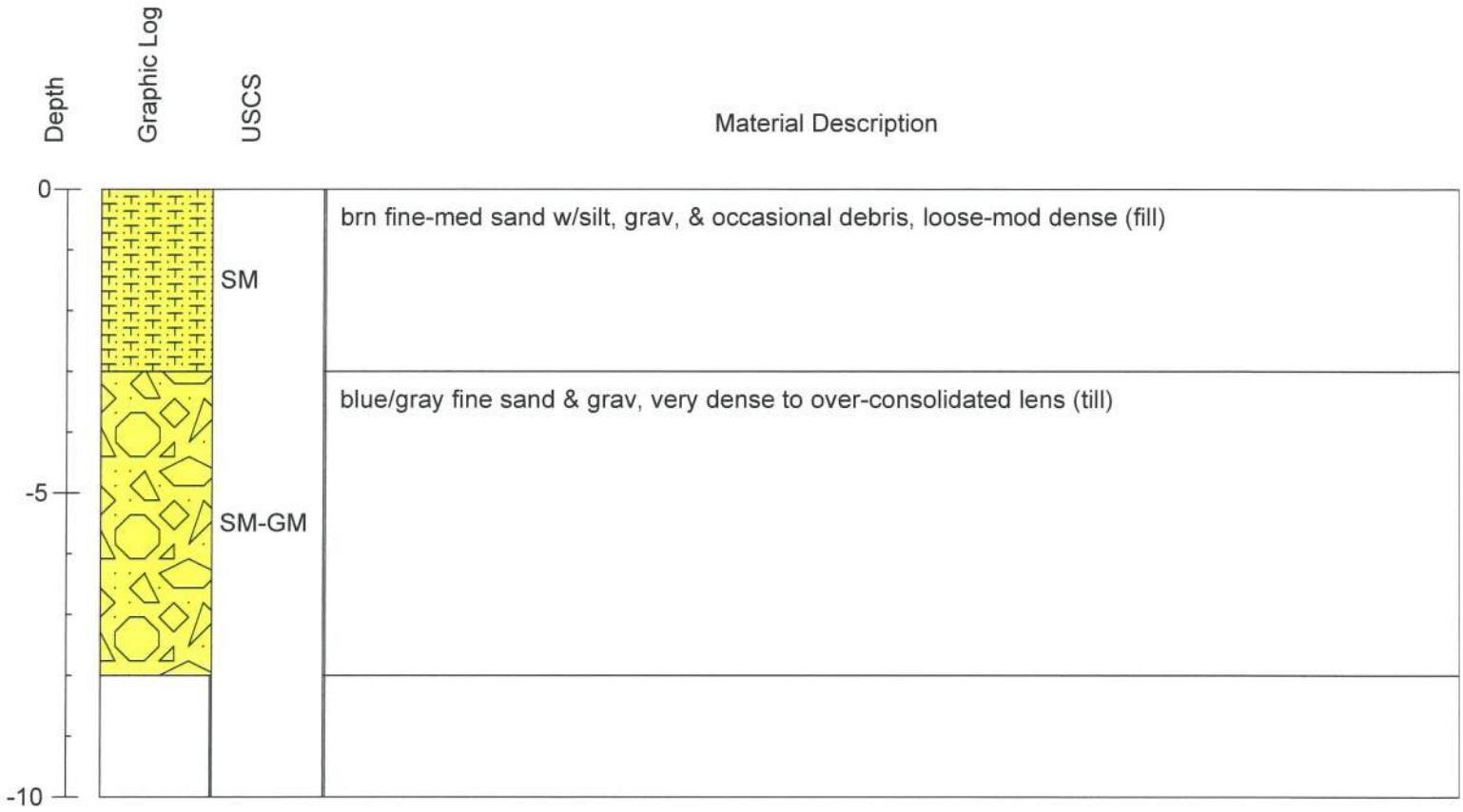
Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Significant fill present, no organics within, preloaded condition.
None

Test Pit Number: TP 5
Project Name: Dos Lagos
Ground Elevation: 438 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

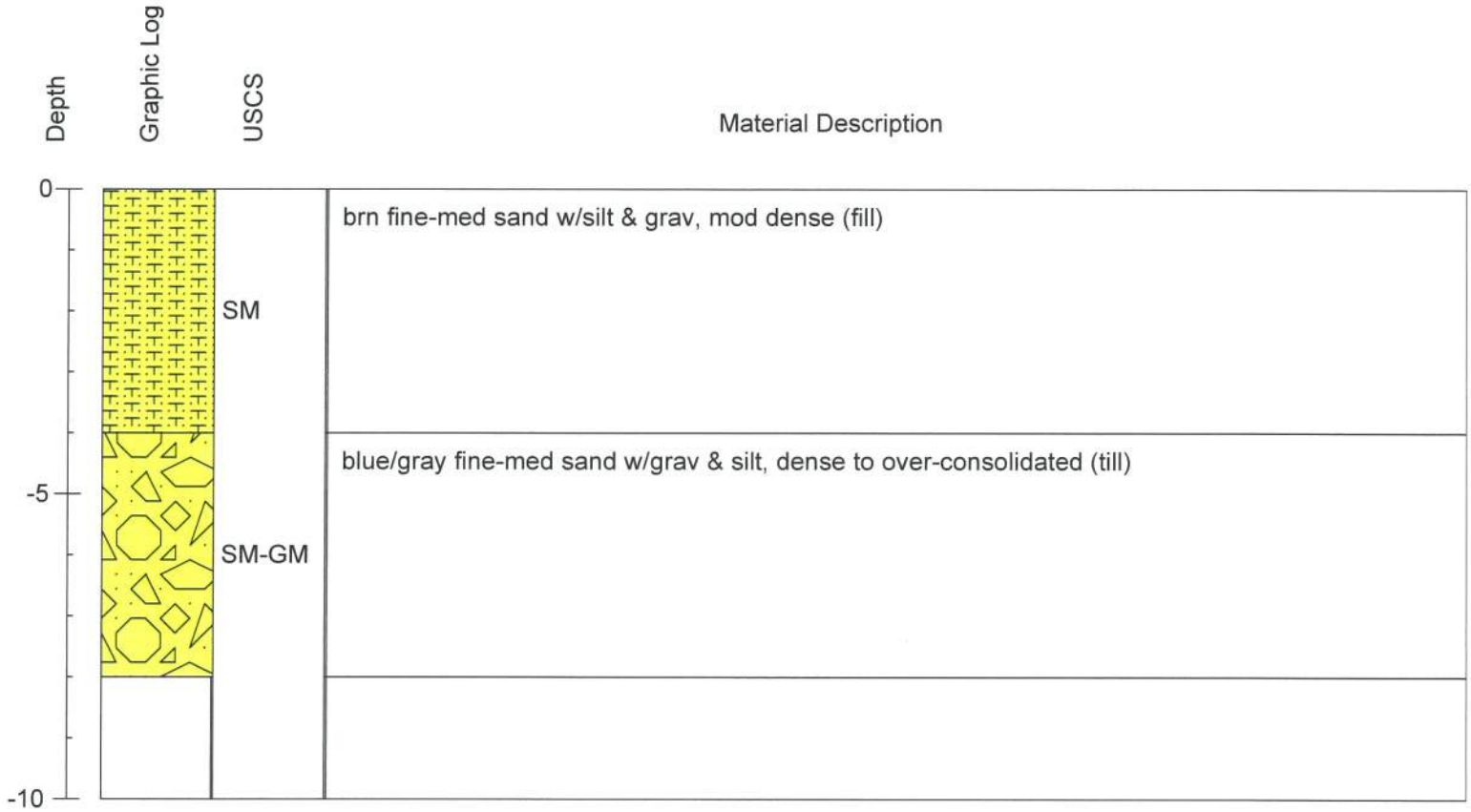
Bottome of Test Pit at: 8.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Significant fill present, no organics within, preloaded condition.
None

Test Pit Number: TP 6
Project Name: Dos Lagos
Ground Elevation: 438 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

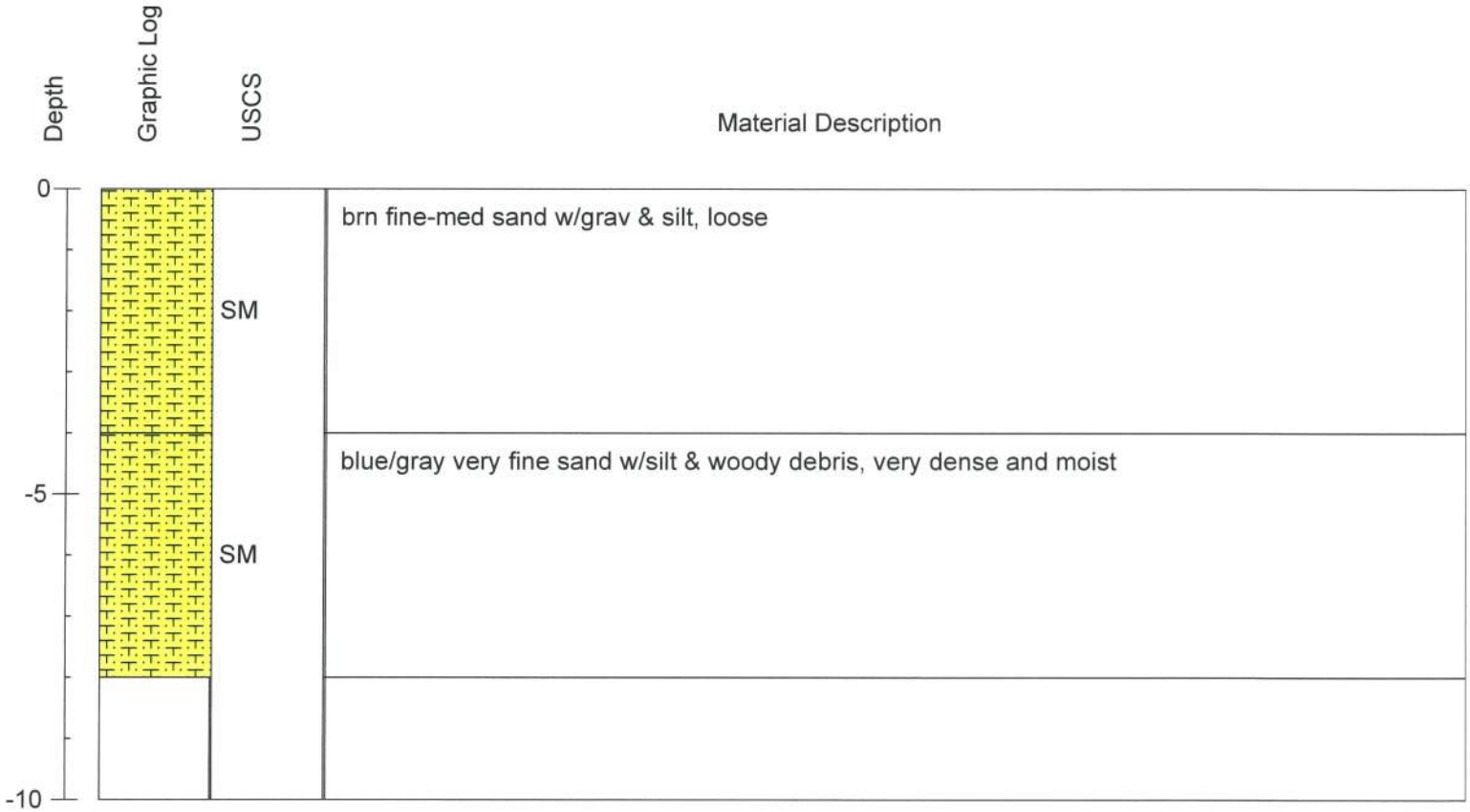
Bottome of Test Pit at: 8.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Woody debris at lower depths.
None

Test Pit Number: TP 7
Project Name: Dos Lagos
Ground Elevation: 450 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

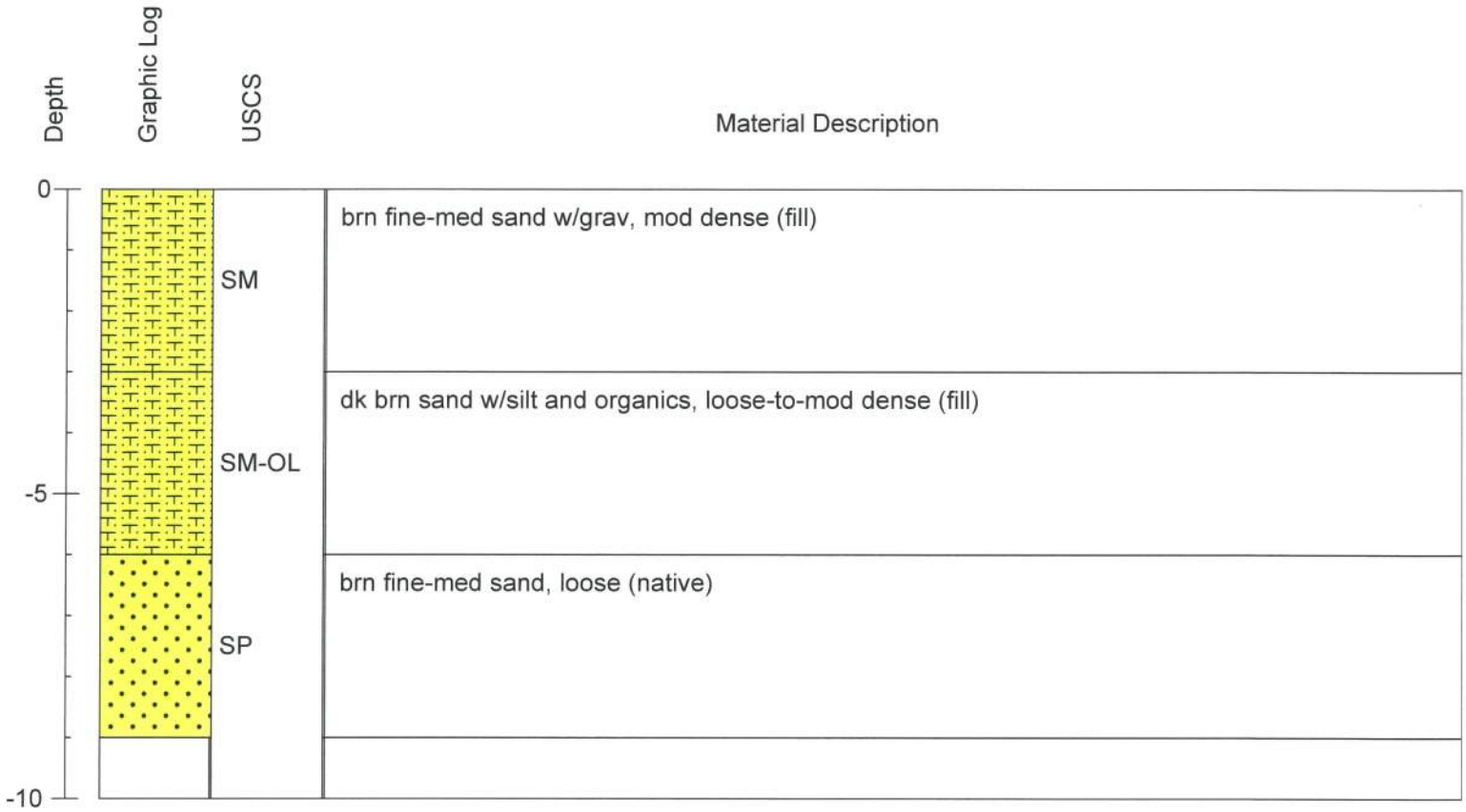
Bottome of Test Pit at: 8.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Significant fill present, no organics within, preloaded condition.
None

Test Pit Number: TP 8
Project Name: Dos Lagos
Ground Elevation: 444 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

Bottome of Test Pit at: 9.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Significant fill present, no organics within, preloaded condition.
None

Test Pit Number: TP 9
Project Name: Dos Lagos
Ground Elevation: 444 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None

The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

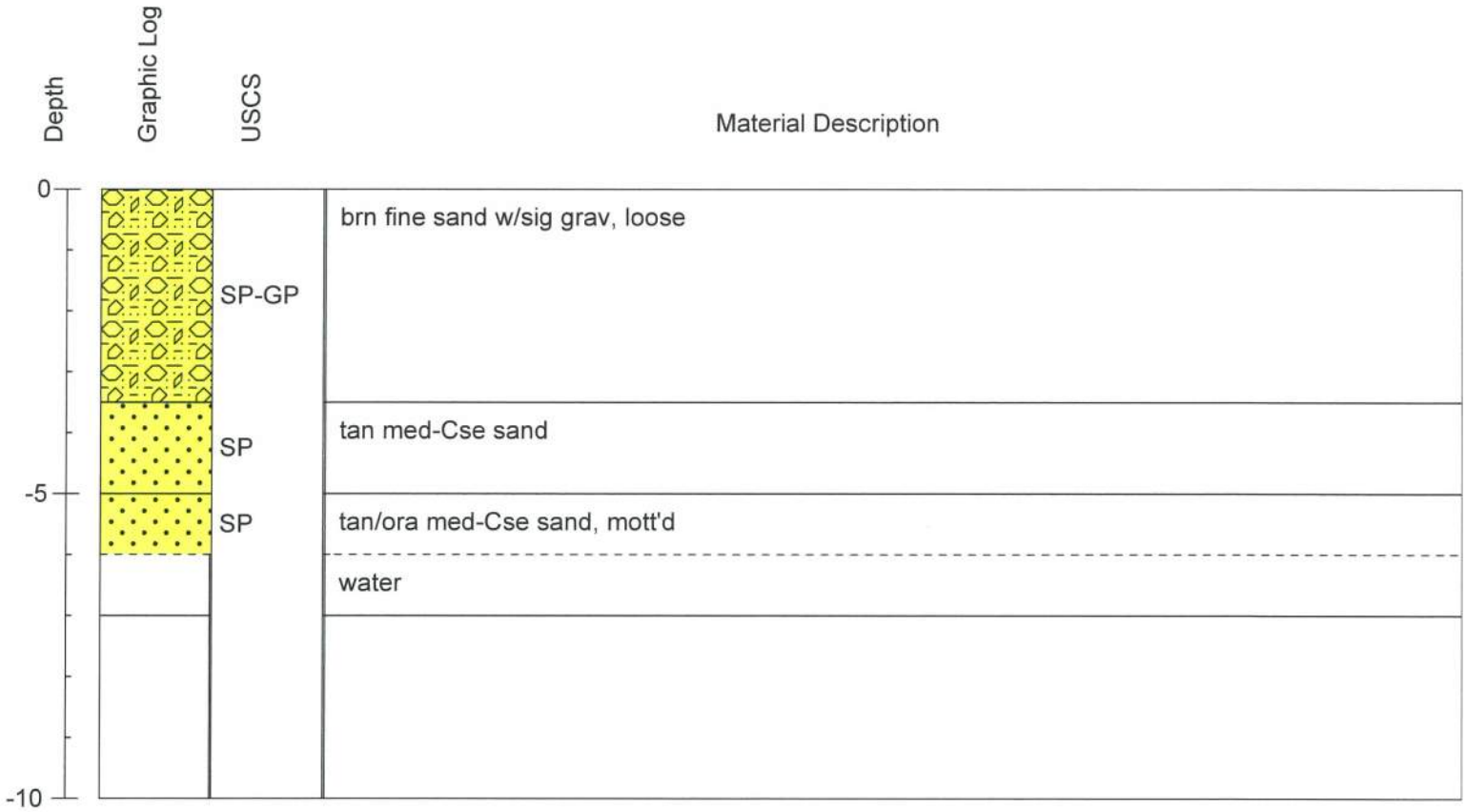
Bottome of Test Pit at: 7.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Water at 6 ft.
None

Test Pit Number: TP 10
Project Name: Dos Lagos
Ground Elevation: 436 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

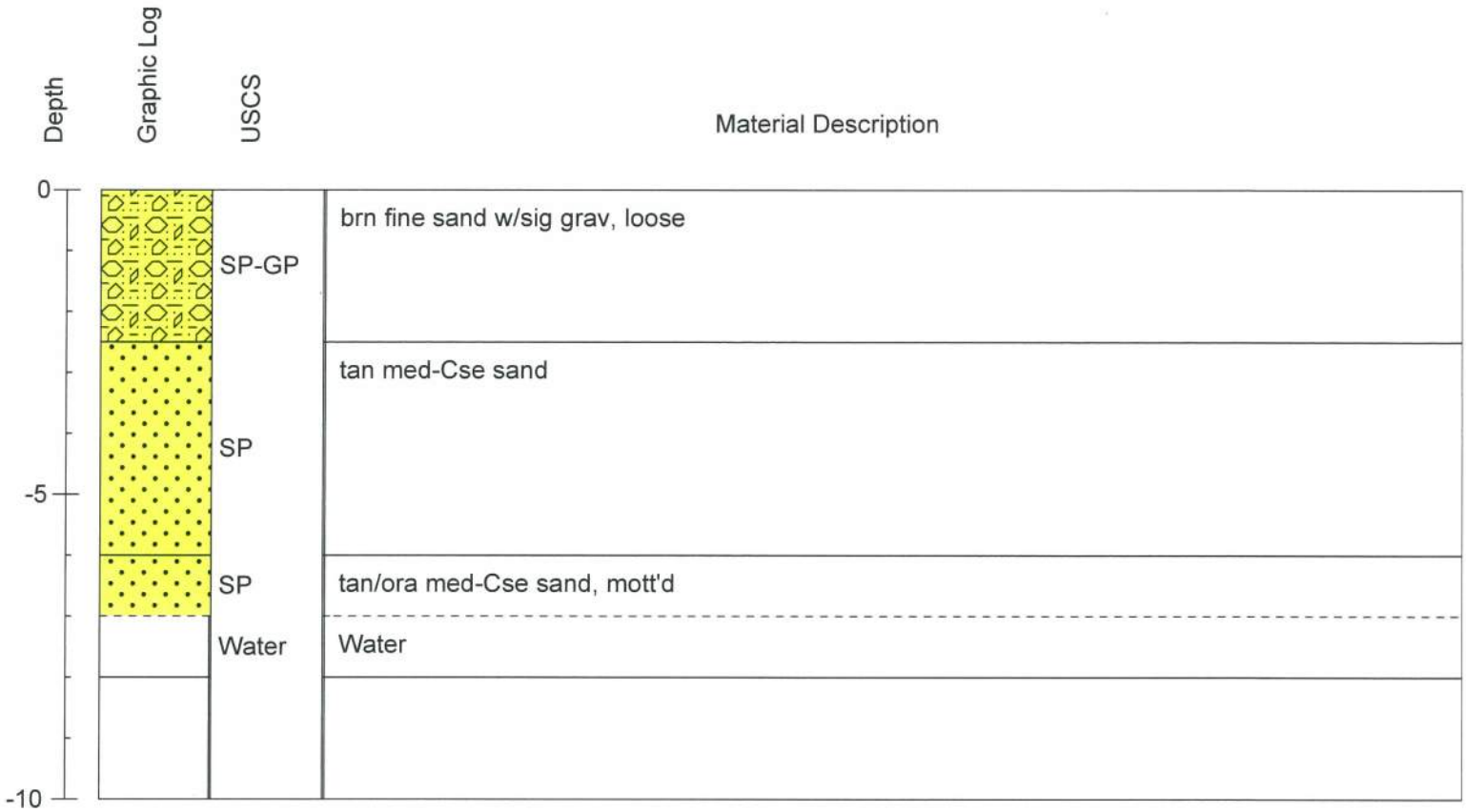
Bottome of Test Pit at: 7.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Water at 7 ft.
None

Test Pit Number: TP 11
Project Name: Dos Lagos
Ground Elevation: 438 Test Pit Size: 2x6
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

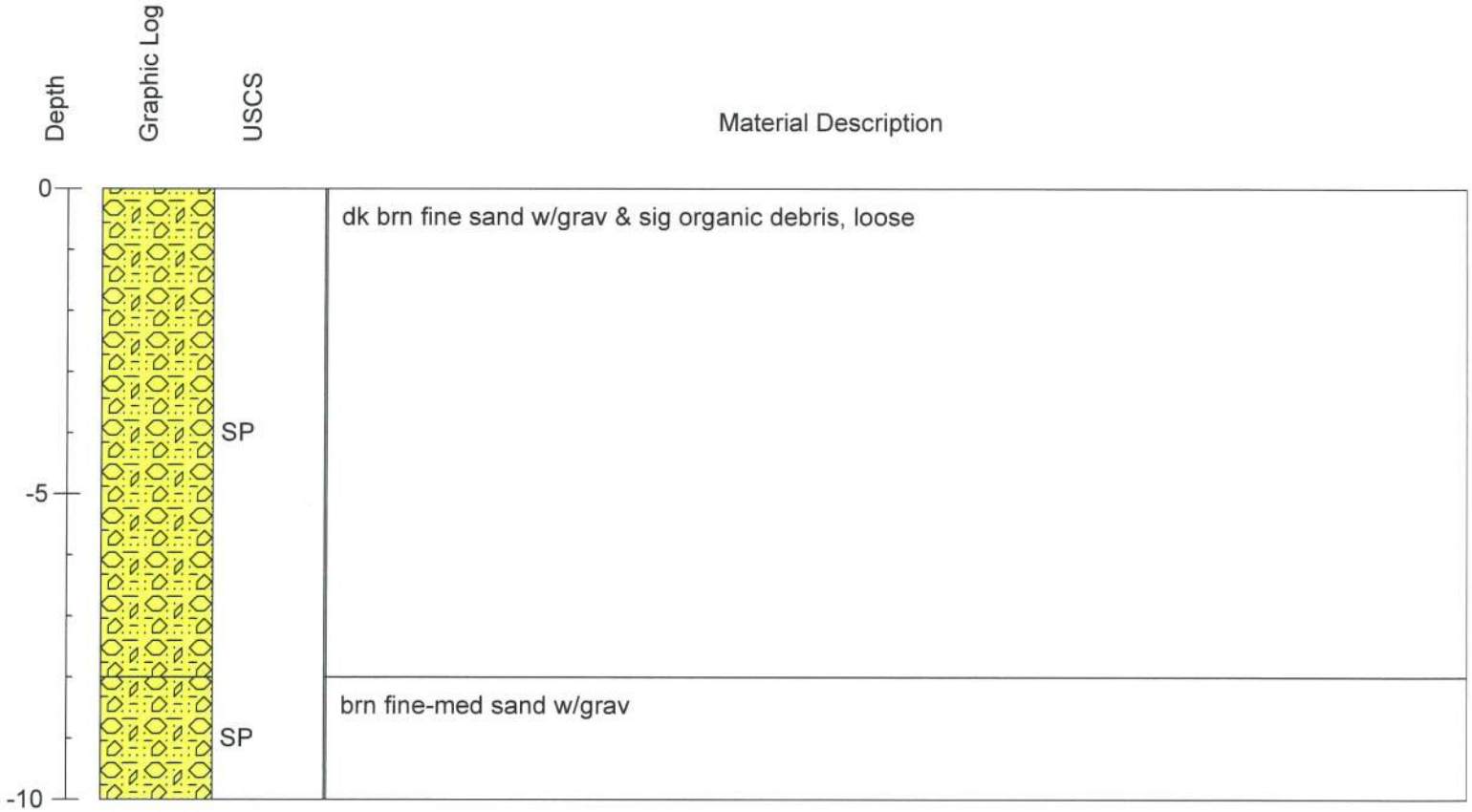
Bottome of Test Pit at: 8.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

LEROY SURVEYORS & ENGINEERS, INC.

Surveying • Engineering • Geology • Septic Design • GPS • GIS Mapping

Client: Dos Lagos Asset, LLC
Job Number: 12896
Date Started: 7/7/20
Date Completed: 7/7/20
Excavation Contractor: N/A
Excavation Method: Track Mounted Excavator
Logged By: JET Checked By: BC
Notes: Organic, woody debris.
None

Test Pit Number: TP 12
Project Name: Dos Lagos
Ground Elevation: 448 Test Pit Size: 2x8
Ground Water Levels:
At Time of Excavation: None
At End of Excavation None
Static Water Depth: None



The depths on te test pit logs are based on an average of measurements across the test pit and should be considered accurate to +/- 0.5 ft.

Bottome of Test Pit at: 10.0 ft
Ground Water/Seepage: None Observed
Side Wall Caving: None Observed

Appendix E

Wetland 1 Hydroperiod and Water Quality Assessment

PO Box 1212
Puyallup WA 98371
Telephone: 253.841.9710
jkemp@encoec.com
www.encoec.com

Mr. John Fisher, Project Manager
Inland Construction Group
120 West Cataldo Avenue, STE 100
Spokane WA 99201

May 4, 2018

RE: WETLAND 1 HYDROPERIOD & WATER QUALITY ASSESSMENT
Point Source & Non-Point Source Stormwater Assessment to Wetland 1
Project Name & Address: Affinity at Puyallup, 4211 5th St. SE, Puyallup WA 98374
Current Use: Vacant, Cleared Land **Proposed Land Use**: Senior Center & Amenities
Tax Parcels: 041910-2121 & 2122 on 9.42 Acres

Dear Mr. Fisher:

This letter is written in response to present a qualitative analysis to determine if stormwater management (as designed by the project civil engineer) for the proposed Affinity at Puyallup project will have any adverse impacts to the functionality of **Wetland 1** when compared to the baseline hydroperiods and water quality at the wetland.

1.0 BACKGROUND

Wetland 1 is located contiguous to the west of 5th Street SE. **Wetland 1** is a Category II, palustrine, forested, depressional wetland with a rated moderate water quality function, high hydrologic function, and moderate habitat function. The City approved Wetland Buffer Boundary for **Wetland 1** will be the Prior Grading Line as depicted on EXHIBIT F – Potential Building Envelopes & Access Information – Parcel 1 obtained from the 2.23.09 Old Standard Life Insurance Company Development Agreement (EnCo Wetland Delineation – June 2017).

The direction of surface water flow within the footprint of **Wetland 1** trends downward to the north. **Wetland 1** is directly connected to Willow's Pond via a 28-foot wide by 60-foot long, unrestricted flow regime, box culvert that passes under 39th Avenue SE. It has been determined by the project engineer that the flow of surface water out of Willow's Pond is unrestricted in the sense that no flow control structure is present. This allows water in **Wetland 1** to flow unimpeded and unrestricted to downstream sources. There are two unrestricted culverts that discharge water from **Wetland 1** at the northeast corner of Willow's Pond into a perennial, man-made stream located to the northeast of the pond.

Wetland 1 has four existing hydroperiods as listed below.

1. Permanently Flooded or Inundated
2. Seasonally Flooded or Inundated
3. Saturated Only
4. Permanently Flowing Stream in or Adjacent to the Wetland

2.0 WATER QUALITY IMPACTS TO WETLAND 1

2.1 Project Design using the MWS-Linear Modular Wetland System

The information presented in this section has been provided by the project engineer (Bush, Roed & Hitchings, Inc. (BRH), Land Surveyors & Civil Engineers of Seattle WA). The Bio-Clean Modular Wetland Systems, Inc. (MWS) – Linear Modular Wetland treatment system, as chosen by the project engineer, has a Washington Department of Ecology (Ecology) General Use Level Designation (GULD) for water quality treatment under the Emerging Stormwater Treatment Technologies program (TAPE). Per the Ecology GULD permit, the MWS Wetland meets enhanced water quality treatment for stormwater runoff if:

"Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (SF) of wetland cell area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm / SF of cartridge surface area.

The hydraulic loading rate for pollutant generating stormwater that is routed to the proposed Modular Wetland unit is 4.5 gpm prior to entry into the Basin A Detention Vault; as calculated in Western Washington Hydrology Model (WWHM) for the water quality design flow rate. The Modular Wetland will be equipped with an internal bypass weir that will bypass flows above this rate. The proposed 4-foot by 4-foot MWS unit to be installed for the project development provides 23 SF of filter surface area, which exceeds the 4.5 SF required. The MWS unit will have a minimum of 9.45 SF of prefilter media to meet the water quality requirements. The MWS unit contains wetland plants as part of the engineering design.

Discussion

The total flowage of water going into **Wetland 1** from a proposed point source at Stormwater Runoff Point Source A from the Basin A Detention Vault includes all of the stormwater from pollution generating surfaces and from the roof drains as depicted on the **WETLAND CONTRIBUTIONS FIGURE** (Attached).

Measures to be taken to minimize erosion and sediment and to minimize pollutants from entering **Wetland 1** from stormwater generated on the proposed site have reportedly been adequately engineered by BRH. According to BRH, the design of the stormwater site plan conforms to the Washington State Department of Ecology Stormwater

Management Manual for Western Washington, as Amended in December 2014 with amendments listed in Section 21.10 of the Puyallup Municipal Code.

To further protect erosion hazard and sedimentation from reaching **Wetland 1** from the Stormwater Runoff Point Source A, rip rap will be shored up and installed at the outlet.

Based on these factors, it is the professional opinion of this writer that stormwater which discharges into **Wetland 1** from the Basin A Detention Vault at Stormwater Runoff Point Source A will have no effect to the existing water quality of **Wetland 1**.

3.0 HYDROPERIOD IMPACTS TO WETLAND 1

3.1 Project Design using Infiltrating Bio-Retention Swale C – Basin B

The calculated percentage of surface area in SF for generated stormwater (inclusive of landscaping, lots, and roofs) from the project footprint that will enter into the Basin B infiltrating Bio-Retention Swale C is 84 percent (See **WETLAND CONTRIBUTIONS FIGURE**). The Basin B Bio-Retention Swale C mitigation area covers 210,830 SF (4.84 acres). The calculated typical monthly stormwater volumes for existing vs. mitigated by the Basin B Bio-Retention Swale C are shown on the **WETLAND CONTRIBUTIONS FIGURE**.

In summary the current design presents a 16 percent increase in the typical monthly volumes from existing conditions. Volumes are based on the WWHM model wetland analysis. The percent increase for Basin B stormwater is represented by a non-point source discharge (groundwater infiltration) and not by a point source discharge of surface flow of stormwater to **Wetland 1**.

The infiltrating Basin B Bio-Retention Swale C receives stormwater from non-infiltrating Bio-Retention Swales B, D, E, & F. These four non-infiltrating swales will be lined with an impermeable layer of material that will not allow any infiltration to groundwater. Infiltrating Bio-Retention Swale C has been designed to retain all stormwater in its defined catchment basin (Basin B), except for the 100-year storm event. The gravity overflow outlet for this pond is designed to release stormwater, as a point source, only during the 100-year storm event.

Discussion

Based on the project stormwater management design, the water flow component from infiltrating Basin B Bio-Retention Swale C to **Wetland 1** is defined as groundwater. Infiltrating Bio-Retention Swale C is located about 615 feet east of the edge of **Wetland 1**. In relation to **Wetland 1**, this connection is through the movement of groundwater from infiltrating Bio-Retention Swale C toward the northern segment of **Wetland 1** before is passes under 39th Avenue SE via a box culvert**.** Groundwater discharge to **Wetland 1** from infiltrating Bio-Retention Swale C is a non-point source of discharge.

Groundwater movement beneath the flat to gentle slopes (0 percent to 5 percent) across the project site will not move as fast horizontally in comparison to sites with slopes that exceed 5 percent. This flat to gentle slope condition across the project site slows the movement of groundwater toward **Wetland 1**. Based on the Earth Sciences NW investigation and field observations, the interpreted groundwater flow direction beneath the project site is generally to the northwest toward **Wetland 1** / Willows Pond as shown on the **WETLAND CONTRIBUTING FIGURE**.

The USDA hydrologic soil group identified by Mr. Doug Beyerlein, Licensed Hydrogeologist, from Clear Creek Solutions, LLC on the project site is Group / Category C. Group C is defined as having saturated hydraulic conductivity of the least transmissive layer from less than 10.0 um/s (1.42 in/hr.) to greater than 1.0 um/s (0.14 in/hr.). Group C soils have moderately high runoff potential when thoroughly wet. Water transmission through Group C soils is somewhat restricted. This somewhat restricted soil condition slows the movement of groundwater across the project site to **Wetland 1**.

Based on these factors, it is the professional opinion of this writer that stormwater which percolates into groundwater from the infiltrating Basin B Bio-Retention Swale C will have no effect to the existing hydroperiods of **Wetland 1**.

3.2 Project Design using Detention Vault – Basin A

The calculated percentage of surface area in SF for generated stormwater (inclusive of landscaping, lots, and roofs) from the project footprint that will enter into the three subsurface Basin A Detention Vaults is 16 percent. The Basin A Detention Vault mitigation area covers 39,640 SF (0.91 acre). The detention pipe system in Basin A will hold 10,013 cubic feet (74,897 gallons).

The flow out of the Basin A Detention Vault will be restricted to meet current ECOLOGY stormwater management requirements for Minimum Requirement 7 – Flow Control via the detention pipe system. The maximum flow rate from the Detention Vault has been designed and calculated to be 0.89 CFS for the 100-year storm.

The calculated typical monthly stormwater volumes for existing vs. mitigated by the Basin A Detention Vault are shown on the **WETLAND CONTRIBUTIONS FIGURE**. In summary the current design presents a 29 percent increase in the typical monthly volumes from existing conditions. Volumes are based on the WWHM model wetland analysis. The percent increase for Basin A stormwater is represented by a point source discharge (surface flow) to **Wetland 1**.

The current design presents a 29.0 percent monthly increase of water volume to **Wetland 1** as compared to existing conditions. This calculates out to be an average of 1,788 gallons of water per day that will be directly discharged to **Wetland 1** (See WWHM Wetland Volumes by Basin Table – Attached).

Discussion

Wetland 1 has a downstream unrestricted outlet in the northeast corner of Willow's Pond. The flow of surface water in the wetland out of Willow's Pond is unrestricted in the sense that no control structure is present. There are two culverts that discharge water from the wetland out of Willow's Pond into a man-made, perennial stream located to the northeast of the pond. These 2 unrestricted outlets provide free and fast movement of water out of the entire wetland, resulting in minimal water fluctuations and minimal changes to the existing hydroperiods in the wetland.

The degree of change in height of water storage within **Wetland 1** is minimal as indicated by observing no water marks on the concrete side walls of the 28-foot by 60-foot long box culvert under 39th Avenue SE that flows freely into Willow's Pond. This indicates that the existing hydrology that enters into **Wetland 1** flows relatively fast out of the wetland into the man-made perennial stream located northeast of Willow's Pond without raising the water level to any significance in the wetland. This rapid movement of water out of the wetland provides a very stable height of water storage in the wetland which in turn provides unchanged hydroperiods. Water levels in the wetland do not change to any significant degree during periods of wet weather and increased water inputs into the wetland.

Currently, surface water enters **Wetland 1** from several man-made stormwater runoff features to include three existing engineered stormwater retention ponds, street runoff, sheet flow over surrounding forested and cleared land, and via two stormwater runoff drainage ditches along the adjoining streets (east and west). These sources of water input into **Wetland 1** have not changed the hydroperiods of the wetland over time.

The southern segment of **Wetland 1** contains the best habitat for amphibians, reptiles, and mammals. This area consists of a mixture of saturated only and seasonally flooded or inundated hydroperiods. The dominant vegetation along the east edge of **Wetland 1** in this area is a well-established tree forested community of red alder and black cottonwood with an understory of black twinberry, Douglas spirea, salmonberry, Sitka willow, wild clustered rose, and sweet briar rose. These plants provide very good habitat by providing shade, down wood, and overhanging branches over shallow pools of water in the wetland for amphibians and other animals, especially during the spring months. The hydroperiods in this area will not be affected by stormwater entering **Wetland 1** from Stormwater Runoff Point Source A from the project site because this area is located upslope of this discharge pipe.

The permanently flooded or inundated hydroperiod of **Wetland 1** is located in the northern segment of **Wetland 1**. The hydroperiod in this area will not be affected by stormwater entering **Wetland 1** from Stormwater Runoff Point Source A from the project site because water in this area of the wetland flows rapidly and unrestricted in a northerly direction to Willow's Pond and out the two unrestricted culverts in the northeast corner to the man-made perennial stream.

The permanently flowing stream hydroperiod is located adjacent to the northeast of **Wetland 1**. The hydroperiod in this area will not be affected by stormwater entering **Wetland 1** from Stormwater Runoff Point Source A from the project site because water in this stream flows rapidly and unrestricted to Bradley Lake and points north.

Based on these factors, it is the professional opinion of this writer that stormwater which discharges into **Wetland 1** from the Basin A Detention Vault at Stormwater Runoff Point Source A will have no effect to the existing hydroperiods of **Wetland 1**.

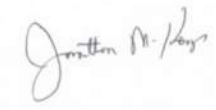
4.0 CONCLUSIONS

It is the professional opinion of this writer that stormwater which discharges into **Wetland 1** from the Basin A Detention Vault at Stormwater Runoff Point Source A will have no effect to the existing water quality of **Wetland 1**.

It is the professional opinion of this writer that stormwater which percolates into groundwater from the infiltrating Basin B Bio-Retention Swale C will have no effect to the existing hydroperiods of **Wetland 1**.

It is the professional opinion of this writer that stormwater which discharges into **Wetland 1** from the Basin A Detention Vault at Stormwater Runoff Point Source A will have no effect to the existing hydroperiods of **Wetland 1**.

Jonathan M. Kemp



Principal, PWS
EnCo Environmental Corporation
Sent via e-mail to John Fisher
Affinity_Wetland_1_Hydroperiod_Assessment_Rpt_May_4_2018

REFERENCES

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Bush, Roed, and Hitchings, Ted Dimof, P.E. Seattle WA, WWHM Wetland Volumes by Basin Table, Affinity at Puyallup, Puyallup WA, May 1, 2018

Clear Creek Solutions, Douglas Beyerlein, P.E. & Certified Professional Hydrologist, Mill Creek WA, Wetland Analysis, Affinity at Puyallup, Puyallup WA, September 8, 2017.

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Duryea & Associates – Surveying and Mapping, Spokane WA, Professional Land Survey with Cross – Sections through wetlands for Wetland Delineation, Project Site, June 2017.

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Earth Sciences NW, LLC, Raymond Coglas, P.E., Bellevue, WA, Response to Comments, Infiltration Assessment, Affinity at Puyallup, Puyallup WA, October 30, 2017.

Earth Sciences NW, LLC, Raymond Coglas, P.E., Bellevue, WA, Response to Comments, Email Interpretation of Groundwater Flow Direction, Affinity at Puyallup, Puyallup WA, October 31, 2017.

USDA, Natural Resources Conservation Service, Chapter 7, Hydrologic Soil Groups, Part 630 Hydrology National Engineering Handbook, May 2007.

Washington Department of Ecology, Lacey WA, Water Quality Program, Stormwater Management Manual for Western Washington, Volume 1 – Minimum Technical Requirements and Site Planning, Publication No. 14-10-055; Revision of Publication No. 12-10-030, December 2014.

Appendix F

Water Quality System – Oldcastle Infrastructure Biopod Biofilter Submittal Package

Oldcastle Infrastructure™
A CRH COMPANY

BIOPOD®

Submittal Package

Water

TABLE OF CONTENTS

SECTION 1

Submittal Drawing

SECTION 2

Features & Benefits

Oldcastle Infrastructure™
A CRH COMPANY

Stormwater Treatment, **NATURALLY**

BIOPOD™ SYSTEM WITH STORMMIX™ MEDIA

Sustainable Green Infrastructure for Stormwater Management

BioPod systems utilize an advanced biofiltration design for filtration, sorption and biological uptake to remove Total Suspended Solids (TSS), dissolved metals, nutrients, gross solids, trash and debris as well as petroleum hydrocarbons from stormwater runoff. Environmentally friendly and aesthetically pleasing, BioPod systems are a proven, Low-Impact Development (LID) solution for stormwater treatment. BioPod systems integrate seamlessly into standard site drainage and can accommodate a wide variety of vegetation to meet green infrastructure requirements.

STANDARD SIZES

BioPod units are available in many standard and custom sizes to meet most site-specific requirements. Contact your local Oldcastle Infrastructure representative for additional sizes.

4′ x 4′	6′ x 6′
4′ x 6′	6′ x 8′
4′ x 8′	6′ x 12′
4′ x 10′	8′ x 16′

BIOPOD™ SYSTEM WITH STORMMIX™ MEDIA

BioPod systems use StormMix media, an engineered high-flow rate media (153 in/hr) to remove stormwater pollutants. The BioPod system has received a General Use Level Designation (GULD) approval from the Washington State Department of Ecology for Basic (TSS), Phosphorus, and Enhanced (dissolved metals) treatment.

Offering flexibility of design and construction for your storm drain system, the BioPod system comes as an all-in-one, single-piece unit composed of durable precast concrete for ease of installation and a long service life. The BioPod system is offered in four configurations:

BIOPOD TREE

Vault with media and tree(s).

BIOPOD PLANTER

Vault with media and vegetation.

BIOPOD SURFACE

At-grade vault with media only, no vegetation.

BIOPOD UNDERGROUND

Below-grade vault with media only, no vegetation.

High-Flow Bypass

BioPod system offers an optional internal high-flow bypass that eliminates the need for a separate bypass structure, reducing costs and simplifying design so unit can be placed in a "sag" condition.

Hydromodification

BioPod system can be used in conjunction with other Oldcastle detention systems to address hydromodification and water treatment requirements. Collected flows may be utilized to supplement irrigation of the unit or surrounding vegetated areas by integrating a harvesting system, reducing consumption of local potable water.

LEED WITH BIOPOD

Can assist in earning LEED credits for:

- Sustainable Sites (6.1, 6.2)
- Water Efficiency (1.1, 1.2, 3.1, 3.2)
- Materials & Resources (4.1, 4.2; 5.1, 5.2 in AZ, CA, NV, UT)

SECTION 3

WA Ecology GULD Approval

WASHINGTON STATE DEPARTMENT OF ECOLOGY

July 2018

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

For

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

Ecology's Decision:

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

1. **General Use Level Designation (GULD) for Basic, Enhanced, 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.**

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 2.2.5 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. **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) **Oldcastle Infrastructure, Inc. shall design, assemble, install, operate, and maintain the BioPod installations in accordance with Oldcastle Infrastructure, Inc.'s applicable manuals and the Ecology Decision.**

2) **BioPod media shall conform to the specifications submitted to and approved by Ecology**

3) **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.**
   - **A BioPod system 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. The runoff from the Test Facility may be unusual and maintenance requirements of systems installed at the Test Facility may not be indicative of maintenance requirements for all sites.**
   - **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.**

4) **Install the BioPod in such a manner that you bypass flows exceeding the maximum operating rate and you will not resuspend captured sediment.**

5) Discharges from the BioPod shall not cause or contribute to water quality standards violations in receiving waters.

Applicant: Oldcastle Infrastructure, Inc.

Applicant's Address: 360 Sutton Place
Santa Rosa, CA 95407

Application Documents:

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 Infrastructure, May 2016

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

Applicant's Use Level Request:

- General Use Level Designation as a Basic, Enhanced, 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 Enhanced treatment goals.

Findings of Fact:

Field Testing

1. 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.
2. The D_{50} of the influent PSD ranged from 3 to 292 microns, with an average D_{50} of 28 microns.
3. 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.
4. 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%.
5. 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%.
6. 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%.
7. 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.

Laboratory Testing

1. 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:

a. 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.
b. 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%.

2. 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.
   a. 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.
   b. 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. Conduct hydraulic testing to obtain information about maintenance requirements on a site with runoff that is more typical of the Pacific Northwest.

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

Contact Information:

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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

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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

SECTION 4

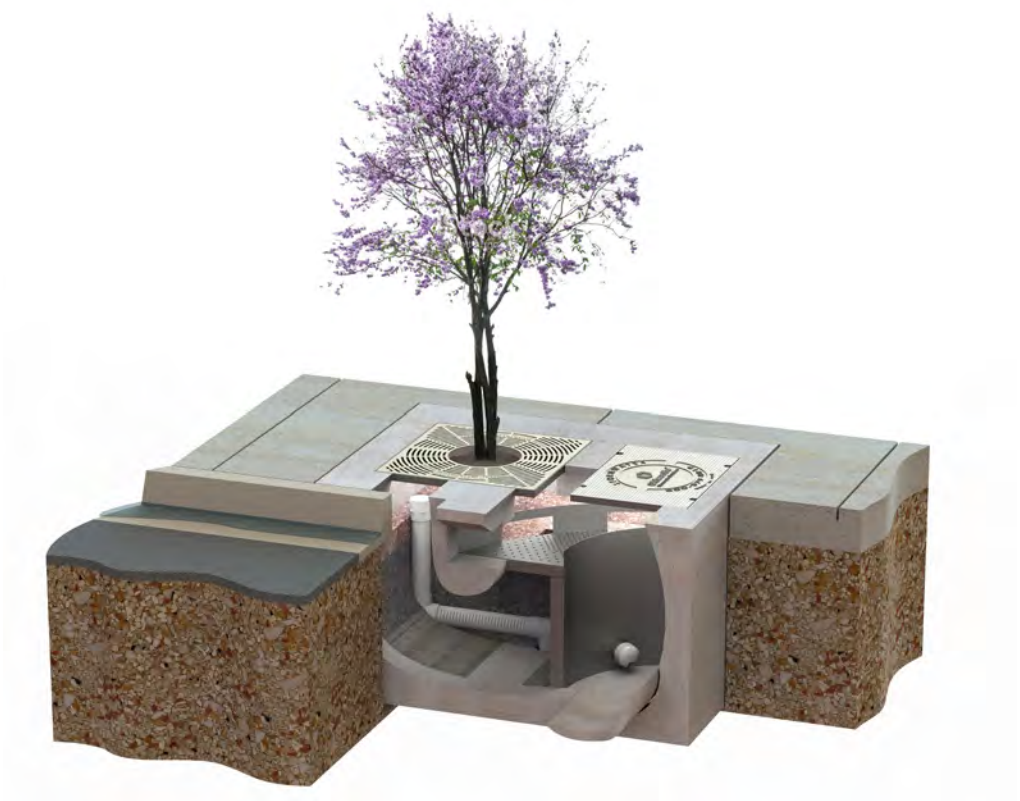
Inspection & Maintenance

Oldcastle Infrastructure™
A CRH COMPANY

BIOPOD™ SYSTEM

WITH STORMMIX™ MEDIA

Inspection and Maintenance Guide



Water

BioPod™ Biofilter with StormMix™ Biofiltration Media

Description

The BioPod™ Biofilter System (BioPod) is a stormwater biofiltration treatment system used to remove pollutants from stormwater runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters unless treatment is provided. The BioPod system uses proprietary StormMix™ biofiltration media to capture and retain pollutants including total suspended solids (TSS), metals, nutrients, gross solids, trash and debris as well as petroleum hydrocarbons.

Function

The BioPod system uses engineered, high-flow rate filter media to remove stormwater pollutants, allowing for a smaller footprint than conventional bioretention systems. Contained within a compact precast concrete vault, the BioPod system consists of a biofiltration chamber and an optional integrated high-flow bypass with a contoured inlet rack to minimize scour. The biofiltration chamber is filled with horizontal layers of aggregate (which may or may not include an underdrain), biofiltration media and mulch. Stormwater passes vertically down through the mulch and biofiltration media for treatment. The mulch provides pretreatment by retaining most of the solids or sediment. The biofiltration media provides further treatment by retaining finer sediment and dissolved pollutants. The aggregate allows the media bed to drain evenly for discharge through an underdrain pipe or by infiltration.

Configuration

The BioPod system can be configured with either an internal or external bypass. The internal bypass allows both water quality and bypass flows to enter the treatment vault. The water quality flows are directed to the biofiltration chamber while the excess flows are diverted over the bypass weir without entering the biofiltration chamber. Both the treatment and bypass flows are combined in the outlet area prior to discharge from the structure. BioPod units without an internal bypass are designed such that only treatment flows enter the treatment structure. When the system has exceeded its treatment capacity, ponding will force bypass flows to continue down the gutter to the nearest standard catch basin or other external bypass structure.

The BioPod system can be configured as a tree box filter with tree and grated inlet, as a planter box filter with shrubs, grasses and an open top, or as an underground filter with access risers, doors and a subsurface inlet pipe. The optional internal bypass may be incorporated with any of these configurations. In addition, an open bottom configuration may be used to promote infiltration and groundwater recharge. The configuration and size of the BioPod system is designed to meet the requirements of a specific project.

Inspection & Maintenance Overview

State and local regulations require all stormwater management systems to be inspected on a regular basis and maintained as necessary to ensure performance and protect downstream receiving waters. Without maintenance, excessive pollutant buildup can limit system performance by reducing the operating capacity of the system and increasing the potential for scouring of pollutants during periods of high flow.

Some configurations of the BioPod may require periodic irrigation to establish and maintain vegetation. Vegetation will typically become established about two years after planting. Irrigation requirements are ultimately dependent on climate, rainfall and the type of vegetation selected.

Maintenance Frequency

Periodic inspection is essential for consistent system performance and is easily completed. Inspection is typically conducted a minimum of twice per year, but since pollutant transport and deposition varies from site to site, a site-specific maintenance frequency should be established during the first two or three years of operation.

Inspection Equipment

The following equipment is helpful when conducting BioPod inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Flashlight
- Tape measure

Inspection Procedures

BioPod inspections are visual and are conducted without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers or tree grates are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided on page 6) to determine whether maintenance is required:

- If the BioPod unit is equipped with an internal bypass, inspect the contoured inlet rack and outlet chamber and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Infrastructure at (800) 579-8819 to determine appropriate corrective action.
- Note whether the curb inlet, inlet pipe, or – if the unit is equipped with an internal bypass – the inlet rack is blocked or obstructed.
- If the unit is equipped with an internal bypass, observe, quantify and record the accumulation of trash and debris in the inlet rack. The significance of accumulated trash and debris is a matter of judgment. Often, much of the trash and debris may be removed manually at the time of inspection if a separate maintenance visit is not yet warranted.
- If it has not rained within the past 24 hours, note whether standing water is observed in the biofiltration chamber.
- Finally, observe, quantify and record presence of invasive vegetation and the amount of trash and debris and sediment load in the biofiltration chamber. Erosion of the mulch and biofiltration media bed should also be recorded. Sediment load may be rated light, medium or heavy depending on the conditions. Loading characteristics may be determined as follows:
    - Light sediment load – sediment is difficult to distinguish among the mulch fibers at the top of the mulch layer; the mulch appears almost new.
    - Medium sediment load – sediment accumulation is apparent and may be concentrated in some areas; probing the mulch layer reveals lighter sediment loads under the top 1” of mulch.
    - Heavy sediment load – sediment is readily apparent across the entire top of the mulch layer; individual mulch fibers are difficult to distinguish; probing the mulch layer reveals heavy sediment load under the top 1” of mulch.

Often, much of the invasive vegetation and trash and debris may be removed manually at the time of inspection if a separate maintenance visit is not yet warranted.

Maintenance Indicators

Maintenance should be scheduled if any of the following conditions are identified during inspection:

- The concrete structure is damaged or the tree grate or access cover is damaged or missing.
- The curb inlet or inlet rack is obstructed.
- Standing water is observed in the biofiltration chamber more than 24 hours after a rainfall event (use discretion if the BioPod is located downstream of a storage system that attenuates flow).
- Trash and debris in the inlet rack cannot be easily removed at the time of inspection.
- Trash and debris, invasive vegetation or sediment load in the biofiltration chamber is heavy or excessive erosion has occurred.

Maintenance Equipment

The following equipment is helpful when conducting DVS maintenance:

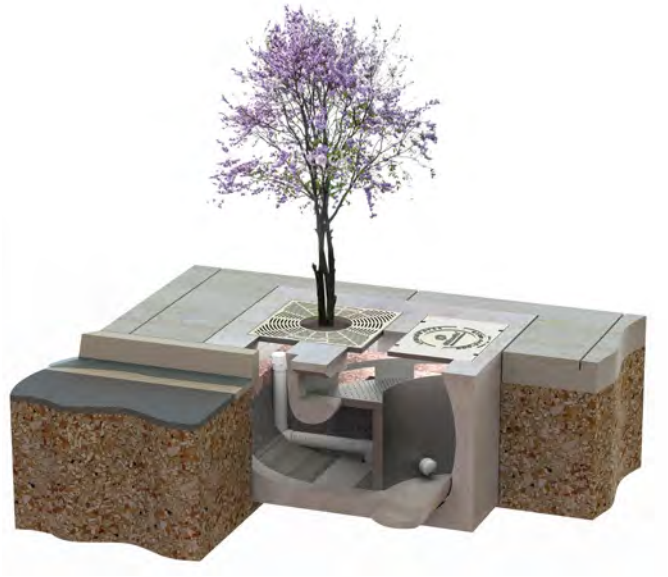
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Rake, hoe, shovel and broom
- Bucket
- Pruners
- Vacuum truck (optional)

Maintenance Procedures

Maintenance should be conducted during dry weather when no flows are entering the system. All maintenance may be conducted without entering the BioPod structure. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove all trash and debris from the curb inlet and inlet rack manually or by using a vacuum truck as required.
- Remove all trash and debris and invasive vegetation from the biofiltration chamber manually or by using a vacuum truck as required.
- If the sediment load is medium or light but erosion of the biofiltration media bed is evident, redistribute the mulch with a rake or replace missing mulch as appropriate. If erosion persists, rocks may be placed in the eroded area to help dissipate energy and prevent recurring erosion.
- If the sediment load is heavy, remove the mulch layer using a hoe, rake, shovel and bucket, or by using a vacuum truck as required. If the sediment load is particularly heavy, inspect the surface of the biofiltration media once the mulch has been removed. If the media appears clogged with sediment, remove and replace one or two inches of biofiltration media prior to replacing the mulch layer.
- Prune vegetation as appropriate and replace damaged or dead plants as required.
- Replace the tree grate and/or access covers and sweep the area around the BioPod to leave the site clean.
- All material removed from the BioPod during maintenance must be disposed of in accordance with local environmental regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.

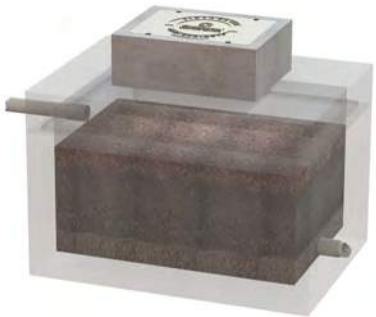
Natural, shredded hardwood mulch should be used in the BioPod. Timely replacement of the mulch layer according to the maintenance indicators described above should protect the biofiltration media below the mulch layer from clogging due to sediment accumulation. However, whenever the mulch is replaced, the BioPod should be visited 24 hours after the next major storm event to ensure that there is no standing water in the biofiltration chamber. Standing water indicates that the biofiltration media below the mulch layer is clogged and must be replaced. Please contact Oldcastle Infrastructure at (800) 579-8819 to purchase the proprietary StormMix™ biofiltration media.



BioPod Tree Module

BioPod Media Module

BioPod Planter Module



BioPod Media Vault

BioPod Inspection & Maintenance Log

BioPod Model_____ **Inspection Date**_____

Location_____

Condition of Internal Components Notes:

☐ Good ☐ Damaged ☐ Missing

Curb Inlet or Inlet Rack Blocked Notes:

☐ Yes ☐ No

Standing Water in Biofiltration Chamber Notes:

☐ Yes ☐ No

Trash and Debris in Inlet Rack Notes:

☐ Yes ☐ No

Trash and Debris in Biofiltration Chamber Notes:

☐ Yes ☐ No

Invasive Vegetation in Biofiltration Chamber Notes:

☐ Yes ☐ No

Sediment in Biofiltration Chamber Notes:

☐ Light ☐ Medium ☐ Heavy

Erosion in Biofiltration Chamber Notes:

☐ Yes ☐ No

Maintenance Requirements

☐ **Yes - Schedule Maintenance** ☐ **No - Schedule Re-Inspection**

BIOPOD®

OUR MARKETS

BUILDING STRUCTURES

COMMUNICATIONS

WATER

ENERGY

TRANSPORTATION