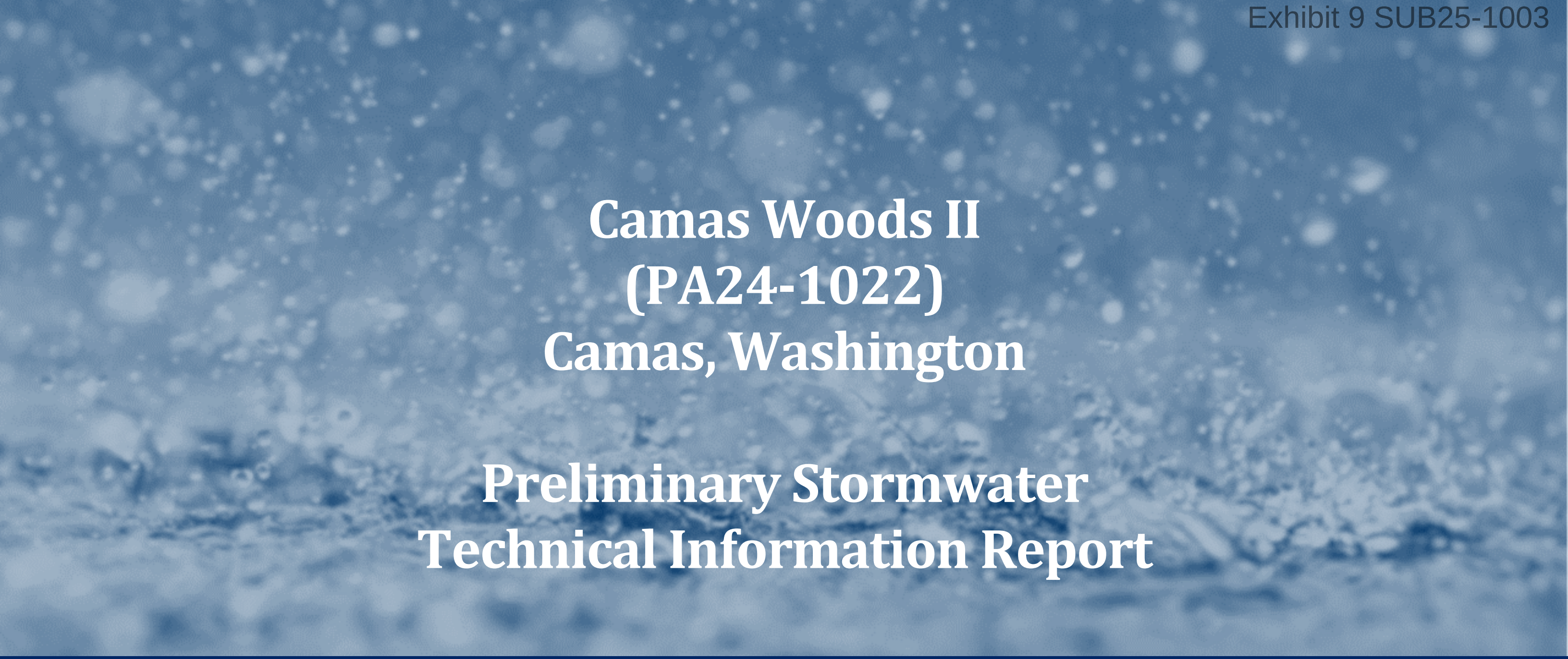
5. Preliminary Stormwater Design Report (TIR)

Exhibit 9 SUB25-1003



Camas Woods II
(PA24-1022)
Camas, Washington

Preliminary Stormwater Technical Information Report

Date:	April 2025
Submitted To:	City of Camas Community Development Department 616 NE 4th Avenue Camas, WA 98607
Applicant:	Camas Woods 3, LLC (Andy Swanson) 19120 SE 34th Street, Suite #103 Vancouver, WA 98683 (503) 936-8514 | andy@hsr-capital.com
Engineering Contact:	Bryce Hanson, PE (360) 882-0419 | bryceh@aks-eng.com
Prepared By:	AKS Engineering & Forestry, LLC 9600 NE 126th Avenue, Suite 2520 Vancouver, WA 98682
AKS Job Number:	8397-01

AKS
ENGINEERING & FORESTRY
www.aks-eng.com

Exhibit 9 SUB25-1003

Certificate of the Engineer

Camas Woods II Subdivision
Camas, Washington
Preliminary Technical Information Report

This Preliminary Technical Information Report (TIR) and the data contained herein were prepared by the undersigned, whose seal, as a Professional Engineer licensed to practice as such, is affixed below. All information required by Camas Municipal Code (CMC) Chapter 14.02 is included in the proposed stormwater plan and the proposed facilities are feasible.

4/14/2025

BRYCE D HANSON
51079

Bryce D. Hanson

Contents

Tables

Appendices

References

2024 Stormwater Management Manual for Western Washington, (Ecology Publication No. 24-10-013, July 2024) – “SWMMWW”

Preliminary Stormwater Technical Information Report (TIR)

CAMAS WOODS II SUBDIVISION
CAMAS, WASHINGTON

Section A – Project Overview

This report analyzes the effects the proposed development will have on the existing stormwater conveyance system; documents the criteria, methodology, and informational sources used to design the proposed stormwater system; and presents the results from the hydraulic analysis. The proposed plan is to subdivide the subject site into a 78-lot subdivision (Camas Woods II) and develop the lots with 78 attached single-family homes.

Section A.1 – Site Location

The Camas Woods II Subdivision is located on two parcels of land, totaling approximately 8.79 acres. Parcels 178109-000 and 178209-000 have a site address 26514 SE 8th Street, Camas, WA 98607, and 26416 SE 8th Street, Camas, WA 98607, respectively. Access to the site will be from SE 8th Street. The project is located within the Northeast ¼ of Section 35, Township 2 North, Range 3 East, Willamette Meridian, Clark County. The site is zoned North Shore Mixed Use (MX-NS), North Shore Higher Density Residential (HD-NS).

Section A.2 – Site Topography and Critical Areas

The site has two houses on it with a combination of asphalt and gravel driveways that access from SE 8th Street. The site is relatively flat, with a slight high spot in the southeast corner of the site. From this high point, a slight broad ridge extends from the southeast to the northwest corner of the site. According to Clark County Geographic Information Services (GIS), portions of the site have slopes up to 15 percent. However, the majority of the grades on site range from flat to between 5 and 10 percent. The existing vegetation consists of evergreen and deciduous trees and shrubs, turfgrass, and field grass.

Section A.3 – Existing On-Site Stormwater System

The site consists of two threshold discharge areas (TDAs). Currently the stormwater sheet flows as it infiltrates towards the northeast and southwest corners of the property. See the pre-developed basin plan within Appendix D for existing drainage patterns for the site.

Section A.4 – Site Parameters That Influence Stormwater Design

The Camas Woods II Subdivision project site mainly consists of (HcB) Hesson clay loam, 0-8% slopes, well drained, non-hydric, WWHMSoil Group 3 soil. Infiltration testing performed in January of 2025 by Columbia West Engineering concluded infiltration to be feasible on-site. Design recommendation and testing results are outlined within the project geotechnical report (Appendix G). The site is in the Lacamas watershed above Round Lake dam, water exiting the site will require phosphorus treatment for all pollution-generating surfaces. Due to the ridge in the middle of the site stormwater will be analyzed as two separate TDAs.

Section A.5 – Adjacent Property Drainage

Adjacent properties do not drain onto the project site. Surrounding parcels drain away from site.

Section A.6 – Adjacent Site Areas

The site is bounded by the SE 8th Street existing Right-of-Way to the south. Properties to the west are zoned North Shore Higher Density Residential (HD-NS). The property bordering the east side of the site is zoned both North Shore Lower Density Residential (LD-NS) and North Shore Higher Density Residential

(HD-NS) and also known at Camas Woods Subdivision (SUB24-1002). Properties north of the site are zoned North Shore Lower Density Residential (LD-NS).

Section A.7 – General Project Stormwater Description

Proposed site improvements for the development include sidewalks, public streets, open space tracts, 78 attached single-family homes. Construction will take place in one phase. Stormwater is proposed to infiltrate the majority of the runoff from the site utilizing 2 separate infiltration galleries. Each infiltration gallery will be equipped with an emergency overflow outlet that will release runoff at peak stormwater events, while keeping flows at or below the required release rates. Site stormwater will be collected by catch basins and conveyed to the respective treatment and detention facility within each basin or subbasin.

TDA 1 – Runoff from driveways, parking areas, sidewalks, roadways, and any landscaped areas that contribute runoff to the roadways, will be collected and conveyed to water quality/filter media manhole through a series of catch basins and manholes. Stormwater from the water quality manhole will then be discharged into an infiltration gallery where runoff will be stored and either infiltrate into the ground or will be released through the overflow/emergency outlet into Tract D, it's natural drainage outfall location. Tract D consists of an existing utility easement for above ground electric transmission lines. This TDA will meet MR #5 utilizing the LID Performance Standard to demonstrate compliance that discharges from the site will match developed discharges durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. The water quality manhole and infiltration gallery are located in Tract F. Stormwater from pollution generating surfaces will be treated by mechanical filtration to meet MR #6 guidelines for water quality. Roof runoff from the buildings and rear yard pervious landscaped areas are proposed to discharge to individual roof downspout drywells. The assumed roof areas are not included in the impervious surface mitigated basin area shown on the Post-Developed Basin Map (Appendix D).

TDA 2 – Runoff from driveways, parking areas, sidewalks, roadways, and any landscaped areas that contribute runoff to the roadways, will be collected and conveyed to water quality/filter media manhole through a series of catch basins and manholes. Stormwater from the water quality manhole will then be discharged into an infiltration gallery where runoff will be stored and either infiltrate into the ground or will be released through the overflow/emergency outlet into an existing drainage ditch located along the north side of SE 8th Street, west of the site, the natural drainage direction from this site. This TDA will meet MR #5 utilizing the LID Performance Standard to demonstrate compliance that discharges from the site will match developed discharges durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. The water quality manhole and infiltration gallery are located in Tract I. Stormwater from pollution generating surfaces will be treated by mechanical filtration to meet MR #6 guidelines for water quality. Roof runoff from the buildings and rear yard pervious landscaped areas are proposed to discharge to individual roof downspout drywells. The assumed roof areas are not included in the impervious surface mitigated basin area shown on the Post-Developed Basin Map (Appendix D).

Due to the location of the entire site being within the Lacamas Lake watershed above the Round Lake dam, water quality for the site is required to meet phosphorus treatment per the 2024 Stormwater Management Manual for Western Washington (SWMMWW). See the development plans, Appendix C, and the Stormwater Basin Map, Appendix D, for stormwater information.

Section B – Minimum Requirements

Section B.1 – Determination of Applicable Minimum Requirements

Proposed land disturbances shall include grading, excavation, and removal of unsuitable soils for the proposed developments. Due to the amount of proposed hard surfaces (greater than 5,000 square feet), the project is required to meet MR #'s 1 through 9 per Figure I-3.1 of the 2024 Stormwater Management Manual for Western Washington (SWMMWW) (see Appendix B).

The tables in this section provide information pertaining to each stormwater subbasin within the project area. See the Stormwater Basin Maps for basin locations (Appendix D).

Table B-1: Proposed Hard Surface and Landscaping

Sub-Basin	Existing Hard Surfaces (acres)	New Hard Surfaces (acres)	Replaced Hard Surfaces (acres)	Native Vegetation Replaced with Landscaping (acres)	Total Land Disturbed (acres)
1A	0.000	2.593	0.000	1.283	3.876
1B	0.000	0.007	0.000	0.000	0.007
2A	0.290	2.902	0.290	1.316	4.218
2B	0.000	0.000	0.000	0.000	0.000

Note: Assumes an average area of 450-square-foot driveway and 70% lot coverage for HD-NS Zoning.

Tables B-2 and B-3 present information for the mitigated site basins, differentiated between pollution- and non-pollution-generating surfaces. It is important to note that all non-pollution-generating areas directly mixing or having the opportunity to mix with stormwater runoff from pollution-generating surface areas are classified as pollution-generating.

Table B-2: Pollution-Generating Surfaces

Sub-Basin	Hard Surfaces (acres)	Pervious Surfaces (acres)	Total Surface Area (acres)
1A	1.243	0.817	2.060
1B	0.000	0.000	0.000
2A	1.568	0.987	2.555
2B	0.000	0.000	0.000

Note: Assumes an average area of 450-square-foot driveway and 70% lot coverage for HD-NS Zoning.

Table B-3: Non-Pollution-Generating Surfaces

Sub-Basin	Hard Surfaces (acres)	Pervious Surfaces (acres)	Total Surface Area (acres)
1A	1.350	0.466	1.816
1B	0.007	0.000	0.007
2A	1.334	0.329	1.663
2B	0.000	0.000	0.000

Note: Assumes an average area of 450-square-foot driveway and 70% lot coverage for HD-NS Zoning.

The developed basin's effective hard surfaces and the applicability of MRs #6 through #8 are summarized in Table B-4, below.

Table B-4: Effective Hard Surfaces

TDA	Hard Surface Area (acres)	MR #6 Required (Y/N)	MR #7 Required (Y/N)	MR #8 Required (Y/N)
1	1.243	Y	Y	N
2	1.568	Y	Y	N

Note: Assumes an average area of 450-square-foot driveway and 70% lot coverage for HD-NS Zoning.

Section C – Soils Evaluation

Section C.1 – Soil Suitability for Low Impact Development BMPs

The Camas Woods II development is suitable for infiltration of stormwater. The project geotechnical report dated February 18, 2025, and within Appendix G, and states, “Based on the tested infiltration rates, on-site systems are viable in the native soil at the site.” Recommendations for the design of the infiltration system are provided in section 6.6.3 of the report.

Section C.2 – Water Table Information

Per the project geotechnical report, groundwater seepage was observed at a depth of 12 feet below ground surface at TP-6 located in the southwest corner of the site. Groundwater was not present in any of the other test pit locations. See geotechnical report in Appendix G.

Section C.3 – Soil Parameters

Per Natural Resources Conservation Service (NRCS) Soil Survey of Clark County, Washington, on-site soils consist of the following:

- HcB (Hesson clay loam, 0 to 8 percent slopes), 98.7 percent of the site (Type C soil / WWHM Soil Group 3)
- WgE (Washougal gravelly loam, 8 to 30 percent slopes), 1.3 percent of the site (Type B soil / WWHM Soil Group 2)

In general, clay loam soils exhibit moderately slow permeability, however, are suitable for traditional infiltration facilities. The gravelly loam soils on-site are located in the northeast corner of the site where no development is proposed. An NCRS soils map is included in Appendix A. The NCRS soils map is consistent with the soils that were observed on site and documented in the geotechnical report.

Section C.4 – Infiltration Rate Testing

A geotechnical site investigation was performed on site by Columbia West Engineering. See Appendix G for the full report. Infiltration rates were measured at three test pit locations. The infiltration rate (coefficient of permeability) at the test pits ranged from 4 inches per hour to 20 inches per hour. The depth the tests were performed were at 3 and 6 feet below ground surface (bgs). A total of 6 pits were excavated that ranged from 12.5 to 16 feet below ground surface (bgs).

Section C.5 – Complex Soil Conditions

A geotechnical report has been prepared and is attached to this report, see Appendix G. Existing soil conditions are summarized, and recommendations are presented in relation to site stormwater design considerations. No complex soil conditions are present on-site.

Section D – Source Control

Volume IV of the SWMMWW contains the following applicable source control best management practices (BMPs) for residential development. The source control BMPs and applicable notes to control stormwater runoff impacted by these activities will be included in the Erosion Control Plans and Details and in the Stormwater Pollution Prevention Plan (SWPPP).

- S407: BMPs for Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots
- S411: BMPs for Landscaping and Lawn/Vegetation Management

Section E – On-Site Stormwater Management BMPs

Per Figure I-3.3 of the SWMMWW, the project proposes to meet the LID Performance Standard and not use List #2. Table I-3.2, Site runoff which is pollution-generating will be collected and treated by mechanical filtration. After receiving treatment stormwater will be retained/infiltrated and released at rates that are at or below pre-developed flows. All pervious areas that will be disturbed with construction activities will meet post-construction soil quality and quantity requirements per BMP T5.13.

Section F – Runoff Treatment Analysis and Design

MR #6 requires that at least 91% of the post-developed pollution-generating runoff volume, as predicted by a continuous runoff model, be treated. All water conveyed to the infiltration facilities through piping will be treated as pollutant-generating runoff due to the mixing of pollutant and non-pollutant generating surfaces before treatment. Stormwater will be treated by mechanical filter cartridges located in concrete manholes before entering each of the site's stormwater infiltration galleries.

The Camas Woods II development is within the Lacamas Lake watershed, above the Round Lake dam, which requires phosphorus treatment. Lacamas Lake is listed as a category 5-303d waterbody for total phosphorus. Phosphorous treatment will be met by using filter media approved by the Washington Department of Ecology. This design satisfies the design requirement of CMC Chapter 14.02 by adhering to all relevant regulations from the State of Washington and City of Camas.

Table F-1: Water Quality Structure

TDA & Subbasin	New Pollutant-Generating Impervious Surface (acres) (WWHM)	New Pollutant-Generating Pervious Surface (acres) (WWHM)	Required Water Quality Flow Rate (cubic feet per second)	Provided Water Quality Flow Rate* (cubic feet per second)	Required Number of Treatment Filter Cartridges (Cartridge size)
WQ Vault 1	1.243	0.817	0.1453	0.2100	5 (27")
WQ Vault 2	1.568	0.987	0.1832	0.210	5 (27")

**Note: Provided water quality flow rate is determined by using approved flow rates for Contech Phosphosorb media (0.042 cfs per 27" cartridge).*

Section G – Flow Control Analysis and Design

The Camas Woods II development consists of 2 TDAs. The site will be required to meet flow control standards as stated above. The project proposes infiltration galleries to meet flow control requirements. The galleries will be equipped with high flow/emergency overflow outlet that will only release runoff from

Exhibit 9 SUB25-1003

the system during high flow events while designed to maintain pre-development release rates at or below required flows.

TDA 1 is split into two subbasins (subbasin 1A & 1B). Subbasin 1A proposes to use an infiltration gallery utilizing 48” corrugated metal pipe (CMP) for retention embedded in drain rock trenches, consisting of four linked rows, 137.5’ long, and a standard drywell. Subbasin 1B is proposed to remain in it’s pre-developed condition with post-development runoff rates remaining the same as pre-development runoff conditions. Proposed overflow discharge from TDA 1 is proposed at or near its natural discharge location in the northeast corner of the site. The overflow conveyance pipe is proposed to daylight in Tract D of the project in the BPA easement. The soils in this location consist of well to excessively drained Type B soils where we anticipate discharge will dissipate subsurface into the gravelly soils. The outfall will be equipped with a discharge flow spreader. Discharge from TDA 1 has been analyzed and designed to meet MR #7.

TDA 2 is split into two subbasins (subbasin 2A & 2B). Subbasin 2A proposes to use an infiltration gallery utilizing 48” corrugated metal pipe (CMP) for retention embedded in drain rock trenches, consisting of eight linked rows, 95’ long, and a standard drywell. Subbasin 2B is proposed to remain in its pre-developed condition with post-development runoff rates remaining the same as pre-development runoff conditions. Proposed overflow discharge from TDA 2 is proposed at or near it’s natural discharge location in the southwest corner of the site. The overflow conveyance pipe is proposed to daylight west of the property into an existing ditch. The outfall will be equipped with riprap to protect the existing ditch from erosion from new construction installation. Discharge from TDA 2 has been analyzed and designed to meet MR #7.

All facilities were sized with the use of WWHM 2012 (see Appendix F for flow control WWHM output.

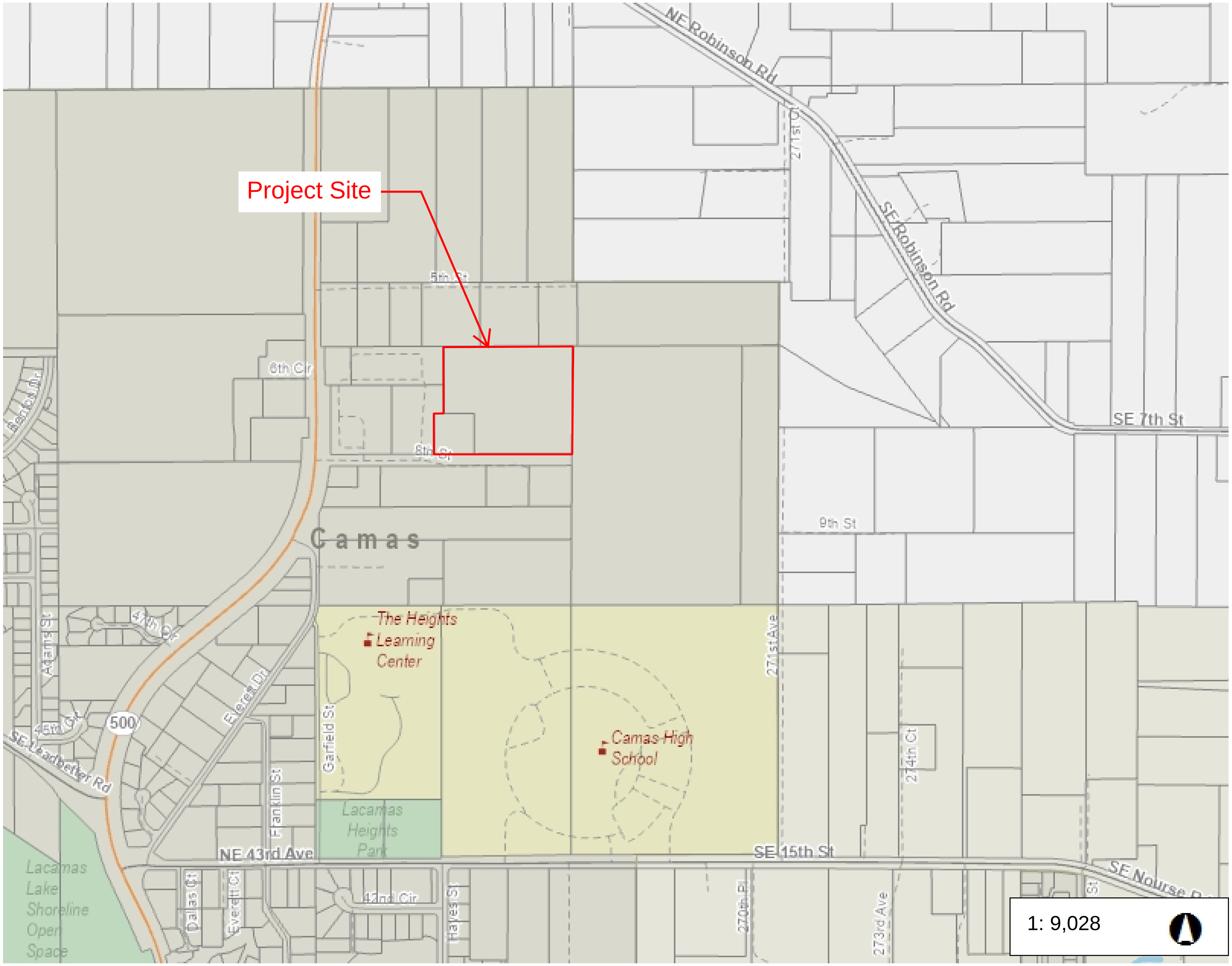
Section H – Wetland Protection

A Type III Wetland is located approximately 650’ northwest of the project site. Historically, TDA #1 would have contributed runoff in the direction of this wetland. However, between the project site and the wetland, single family residence homes with large outbuildings are now developed. The project does not contribute either direct or indirect runoff to a wetland.

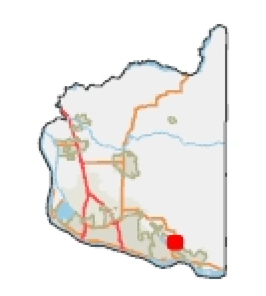
Appendix A: Map Submittals

Exhibit 9 SUB25-1003

Camas Woods



1: 9,028



Legend

☐ Taxlots

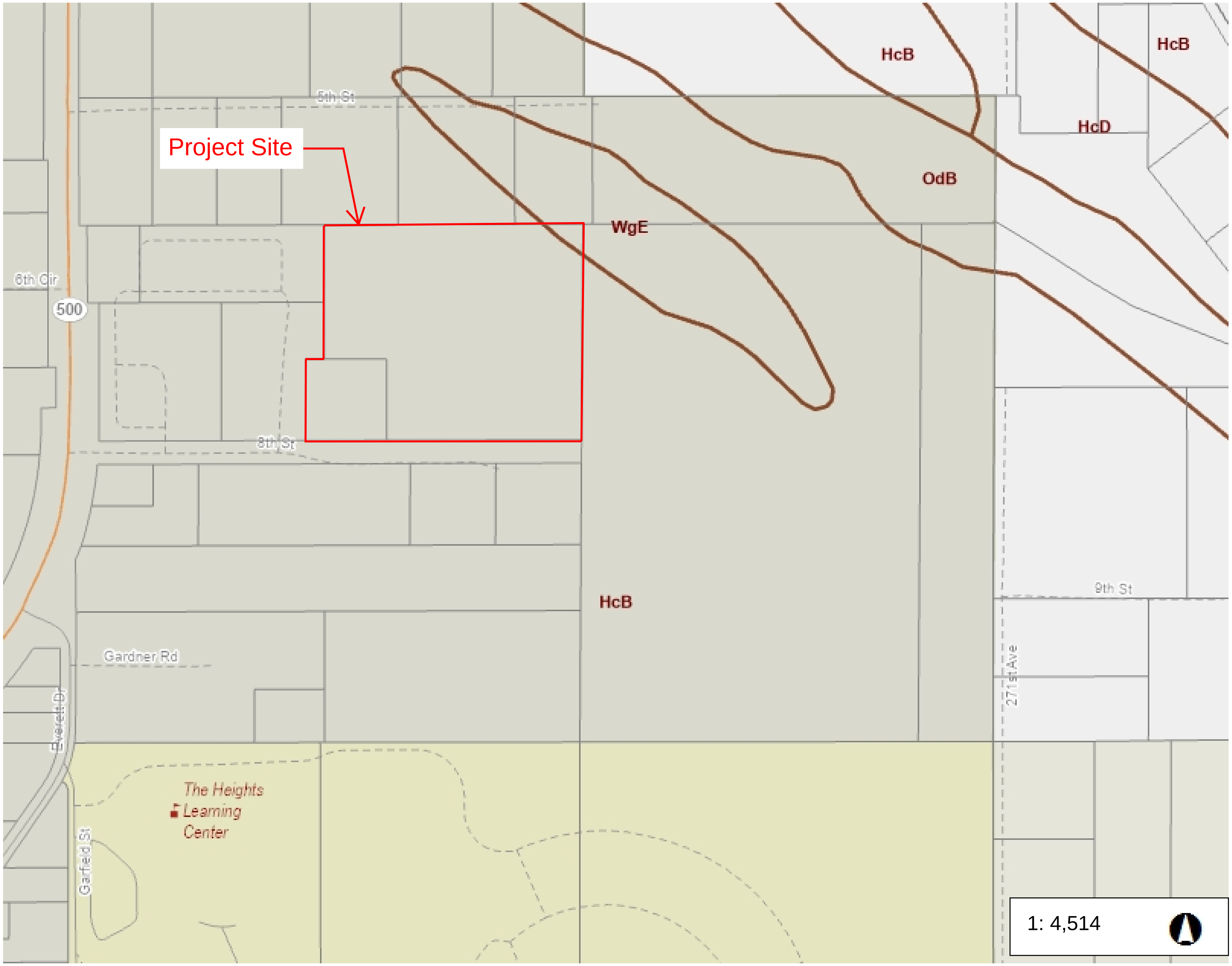
Notes:

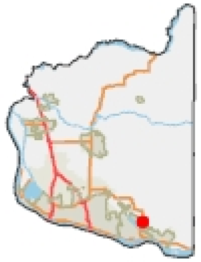
1,504.7 0 752.33 1,504.7 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere
Clark County, WA. GIS - http://gis.clark.wa.gov

Exhibit 9 SUB25-1003

Camas Woods Soils Map





Legend

☐ Taxlots

☐ Soil Type

Notes:

752.3 0 376.17 752.3 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere
Clark County, WA. GIS - http://gis.clark.wa.gov

This map was generated by Clark County's "MapsOnline" website. Clark County does not warrant the accuracy, reliability or timeliness of any information on this map, and shall not be held liable for losses caused by using this information. Taxlot (i.e., parcel) boundaries cannot be used to determine the location of property lines on the ground.

Exhibit 9 SUB25-1003

Soil Map

Map Scale: 1:1,580 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

Exhibit 9 SUB25-1003

MAP LEGEND

Area of Interest (AOI)

- ▭ Area of Interest (AOI)

Soils

- ▭ Soil Map Unit Polygons
- ～ Soil Map Unit Lines
- ■ Soil Map Unit Points

Special Point Features

- ◎ Blowout
- ⊠ Borrow Pit
- ✱ Clay Spot
- ◇ Closed Depression
- ✕ Gravel Pit
- ∴ Gravelly Spot
- ● Landfill
- ʎ Lava Flow
- ⫫ Marsh or swamp
- ⚒ Mine or Quarry
- ◉ Miscellaneous Water
- ○ Perennial Water
- ∨ Rock Outcrop
- + Saline Spot
- ⁙ Sandy Spot
- ⊖ Severely Eroded Spot
- ◇ Sinkhole
- ⊳ Slide or Slip
- ø Sodic Spot
- ≡ Spoil Area
- ● Stony Spot
- ●● Very Stony Spot
- ψ Wet Spot
- △ Other
- ╌ Special Line Features

Water Features

- ～ Streams and Canals

Transportation

- ┼┼┼ Rails
- ～ Interstate Highways
- ～ US Routes
- ～ Major Roads
- ～ Local Roads

Background

- ▨ Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Clark County, Washington
Survey Area Data: Version 22, Aug 26, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2022—Oct 11, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HcB	Hesson clay loam, 0 to 8 percent slopes	9.7	98.7%
WgE	Washougal gravelly loam, 8 to 30 percent slopes	0.1	1.3%
Totals for Area of Interest		**9.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Clark County, Washington

HcB—Hesson clay loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2dx8
Elevation: 300 to 1,000 feet
Mean annual precipitation: 50 to 75 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 170 to 210 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Hesson and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hesson

Setting

Landform: Terraces
Parent material: Alluvium

Typical profile

H1 - 0 to 12 inches: clay loam
H2 - 12 to 60 inches: clay

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 11.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F002XB004WA - Portland Basin Forest
Forage suitability group: Soils with Few Limitations (G002XV502WA)
Other vegetative classification: Soils with Few Limitations (G002XV502WA)
Hydric soil rating: No

WgE—Washougal gravelly loam, 8 to 30 percent slopes

Map Unit Setting

National map unit symbol: 2f03
Elevation: 100 to 490 feet

Mean annual precipitation: 60 to 90 inches
Mean annual air temperature: 48 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Washougal and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Washougal

Setting

Landform: Terraces
Parent material: Gravelly alluvium

Typical profile

H1 - 0 to 20 inches: gravelly medial loam
H2 - 20 to 28 inches: very gravelly medial loam
H3 - 28 to 60 inches: very cobbly coarse sand

Properties and qualities

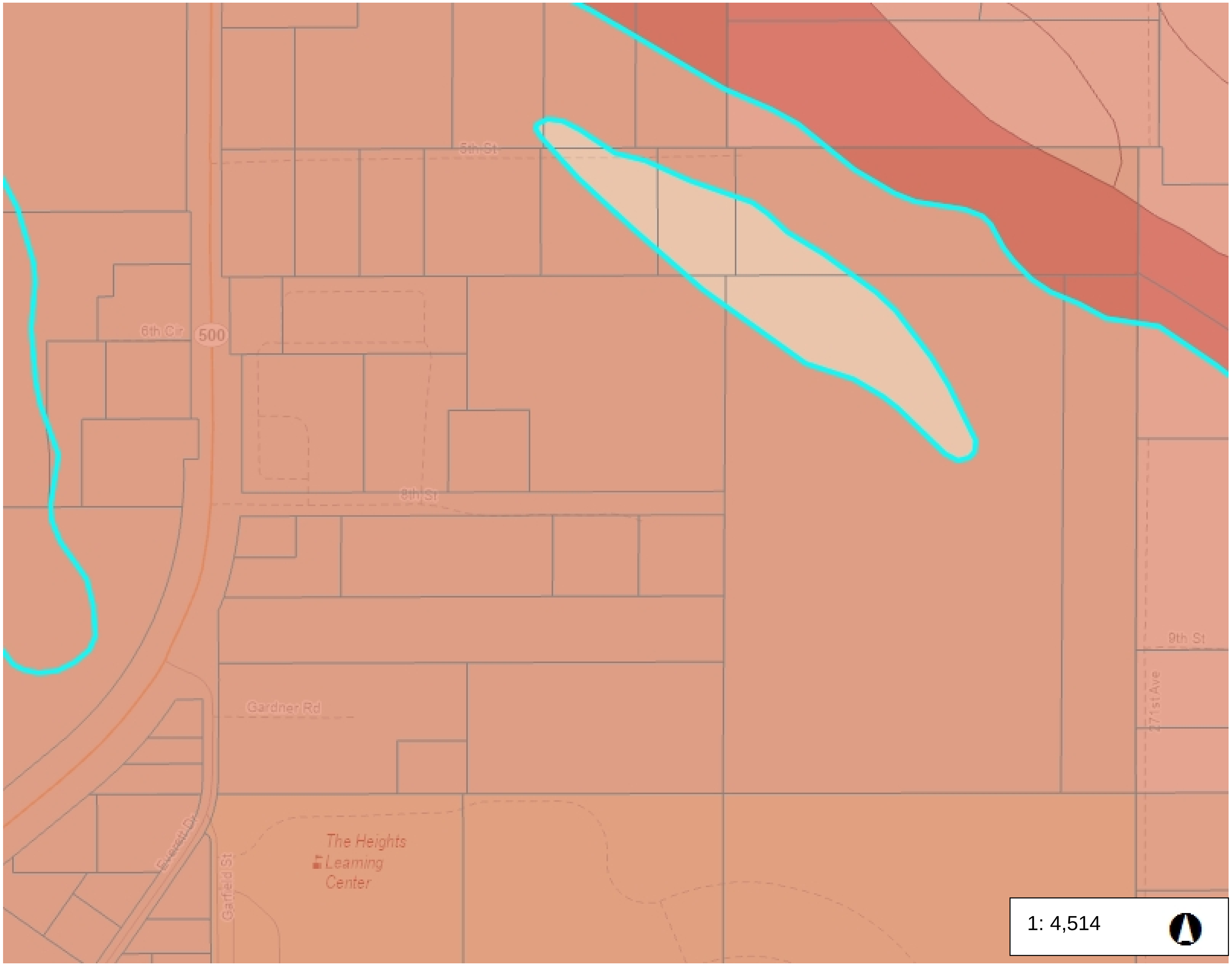
Slope: 8 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.8 inches)

Interpretive groups

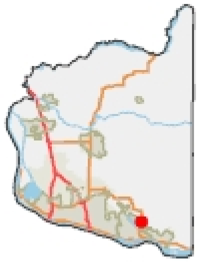
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: F002XB001WA - Portland Basin Dry Forest
Forage suitability group: Droughty Soils (G002XV402WA)
Other vegetative classification: Droughty Soils (G002XV402WA)
Hydric soil rating: No

Exhibit 9 SUB25-1003

WWHM Soil Group 3



1: 4,514



Legend

☐ Taxlots

WWHM Soil Group

- ■ 1 - Excessively drained soils
- ■ 2 - Well drained soils
- ■ 3 - Moderately drained soils
- ■ 4 - Poorly drained soils
- ■ 5 - Wetland soils
- ■ Unknown

752.3 0 376.17 752.3 Feet

WGS_1984_Web_Mercator_Auxiliary_Sphere
Clark County, WA. GIS - http://gis.clark.wa.gov

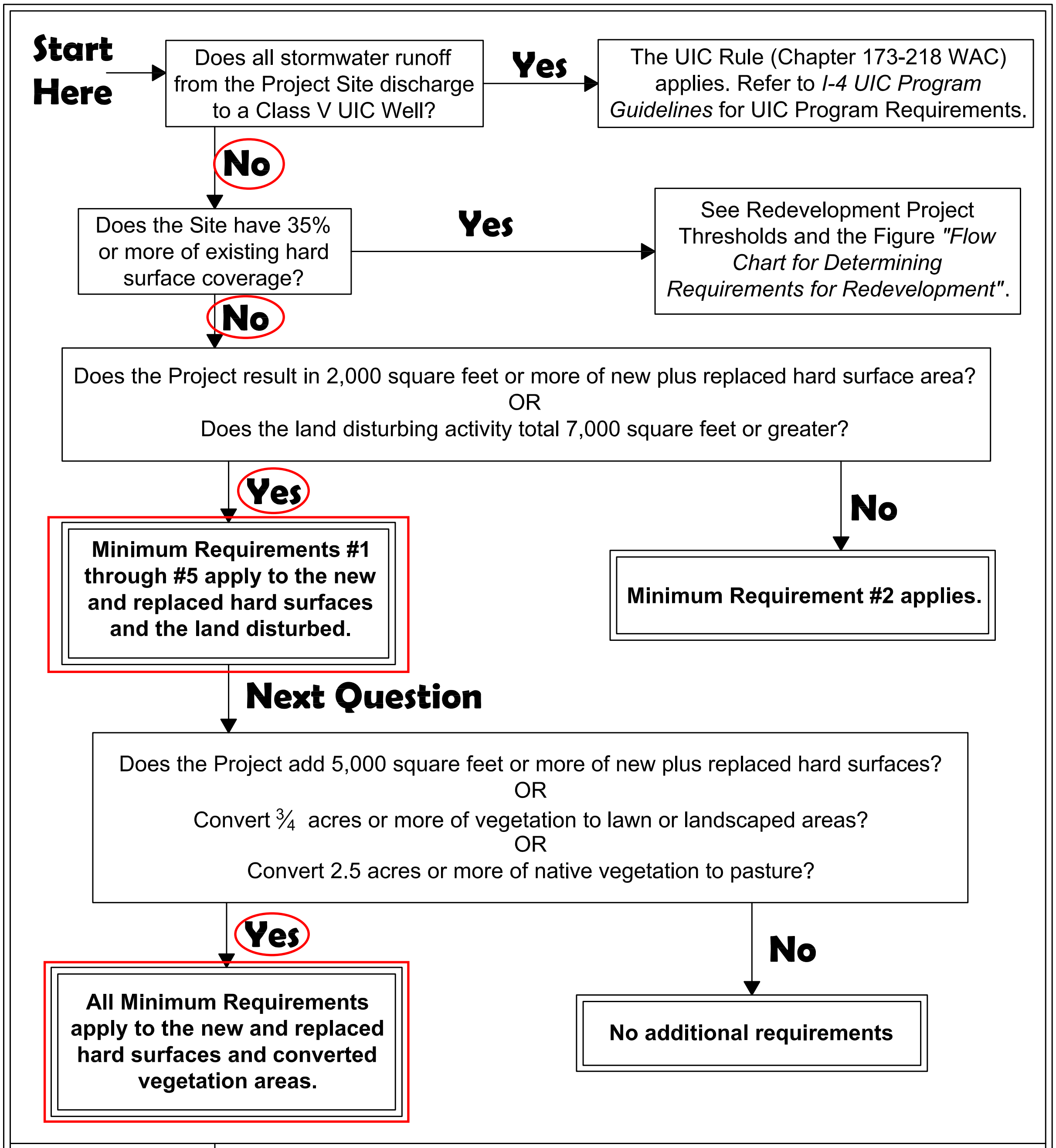
Notes:

Exhibit 9 SUB25-1003

Appendix B: New Development Flow Chart

Exhibit 9 SUB25-1003

Figure I-3.1: Flow Chart for Determining Requirements for New Development



Does all stormwater runoff from the Project Site discharge to a Class V UIC Well?

The UIC Rule (Chapter 173-218 WAC) applies. Refer to *I-4 UIC Program Guidelines* for UIC Program Requirements.

Does the Site have 35% or more of existing hard surface coverage?

See Redevelopment Project Thresholds and the Figure *"Flow Chart for Determining Requirements for Redevelopment"*.

Does the Project result in 2,000 square feet or more of new plus replaced hard surface area?
OR
Does the land disturbing activity total 7,000 square feet or greater?

Minimum Requirements #1 through #5 apply to the new and replaced hard surfaces and the land disturbed.

Minimum Requirement #2 applies.

Does the Project add 5,000 square feet or more of new plus replaced hard surfaces?
OR
Convert ¾ acres or more of vegetation to lawn or landscaped areas?
OR
Convert 2.5 acres or more of native vegetation to pasture?

All Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas.

No additional requirements

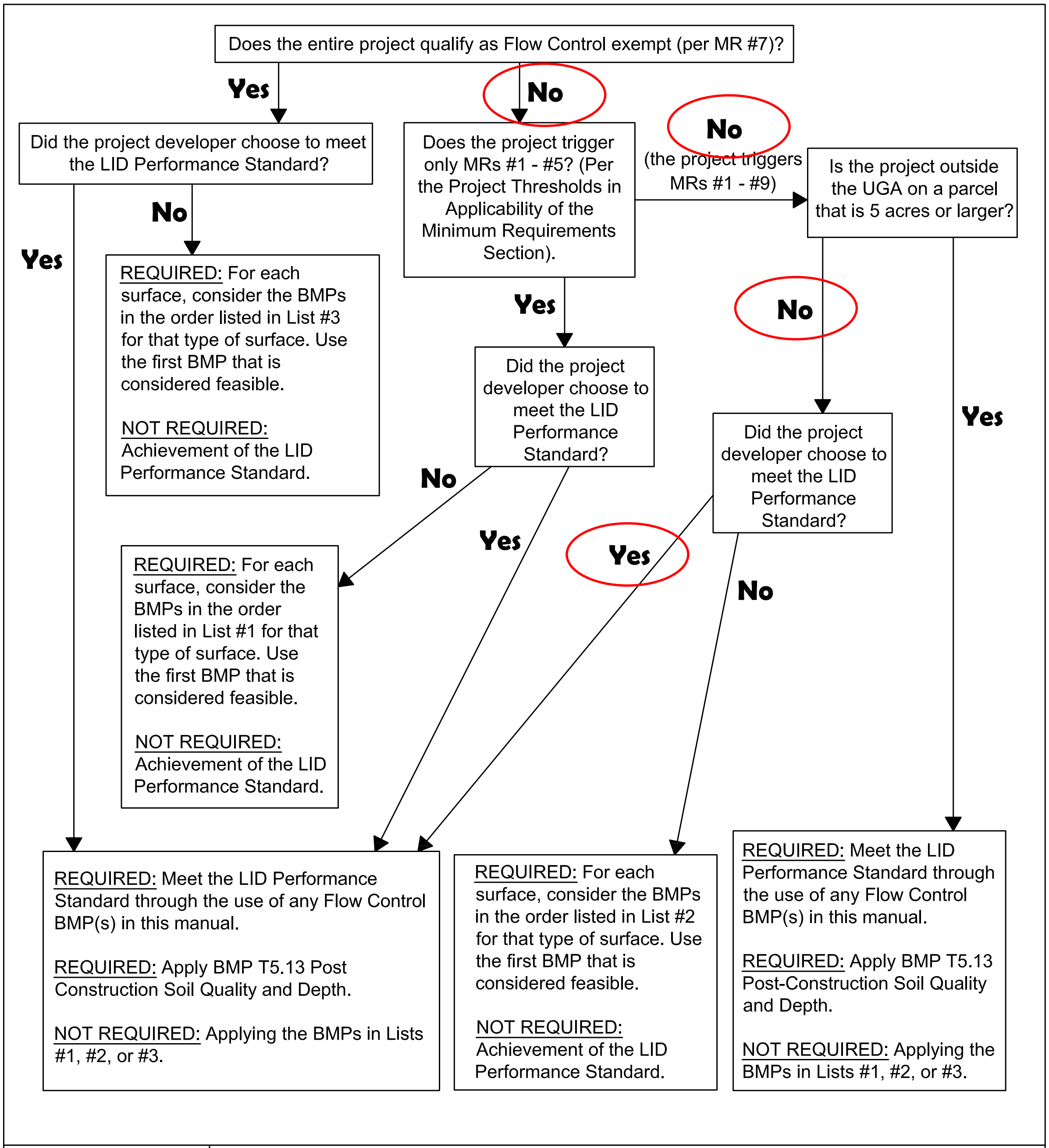
DEPARTMENT OF
ECOLOGY
State of Washington

Flow Chart for Determining Requirements for New Development

Revised September 2022

Exhibit 9 SUB25-1003

Figure I-3.3: Flow Chart for Determining MR #5 Requirements



DEPARTMENT OF
ECOLOGY
State of Washington

Flow Chart for Determining MR #5 Requirements

Revised March 2019

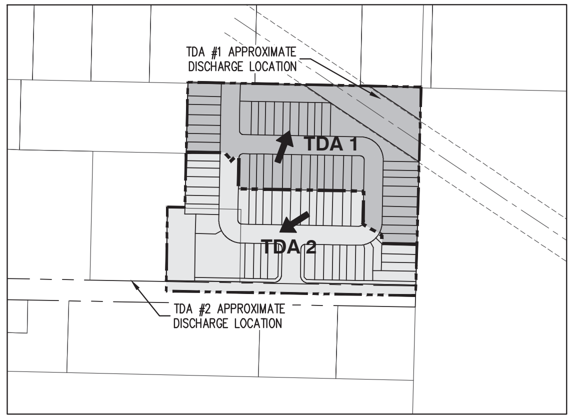
Appendix C: Development Plans

GENERAL NOTES

1. CONTOUR INTERVAL IS 2 FEET.
2. TREES ARE NOT SHOWN.
3. STORMWATER TREATMENT AND RETENTION/INFILTRATION FACILITIES FOR THIS DEVELOPMENT ARE TO BE OWNED AND MAINTAINED BY THE HOA.
4. ACCORDING TO CLARK COUNTY GIS, THE SITE IS NOT WITHIN OR ADJACENT TO A 100-YEAR FLOODPLAIN OR SHORELINE MANAGEMENT AREA.
5. THERE ARE NO KNOWN EXISTING ON-SITE STORMWATER FACILITIES.
6. ACCORDING TO CLARK GIS, NO FLOODPLAIN, FLOODWAYS, OR SHORELINE EXIST ON-SITE.
7. EXISTING DRAINAGE FLOW ROUTES ARE SOUTHWEST TOWARD INTO THE EXISTING DITCHES ALONG NE 8TH STREET AND NORTHEAST TOWARD TRACT E, WITH THE SITE BEING SPLIT DIAGONALLY AT APPROXIMATELY THE CENTER BY A RIDGE. THE SITE IS TWO THRESHOLD DISCHARGE AREAS (TDAs).
8. PROPOSED DRAINAGE FLOW ROUTES TO FOLLOW EXISTING FLOW ROUTES TO EXTENT POSSIBLE, WITH STORMWATER OVERFLOW DISCHARGED FROM STORMWATER INFILTRATION FACILITIES INTO EXISTING DITCH ALONG NE 8TH STREET AND NORTHEAST TOWARDS TRACT E.
9. ROOF AREAS FOR ALL LOTS DRAIN TO A PRIVATE STORMWATER DOWNSPOUT DRYWELL TO BE INSTALLED DURING HOME BUILD CONSTRUCTION.
10. SEE OVERALL THRESHOLD DISCHARGE AREA (TDA) VICINITY MAP ON THIS SHEET, P10.0.
11. PRELIMINARY STORM SIZING LISTED BELOW TO BE FINALIZED DURING FINAL ENGINEERING:
    STORM MAIN: 12" MIN. DIAMETER
    CATCH BASIN LEADS: 10" MIN. DIAMETER

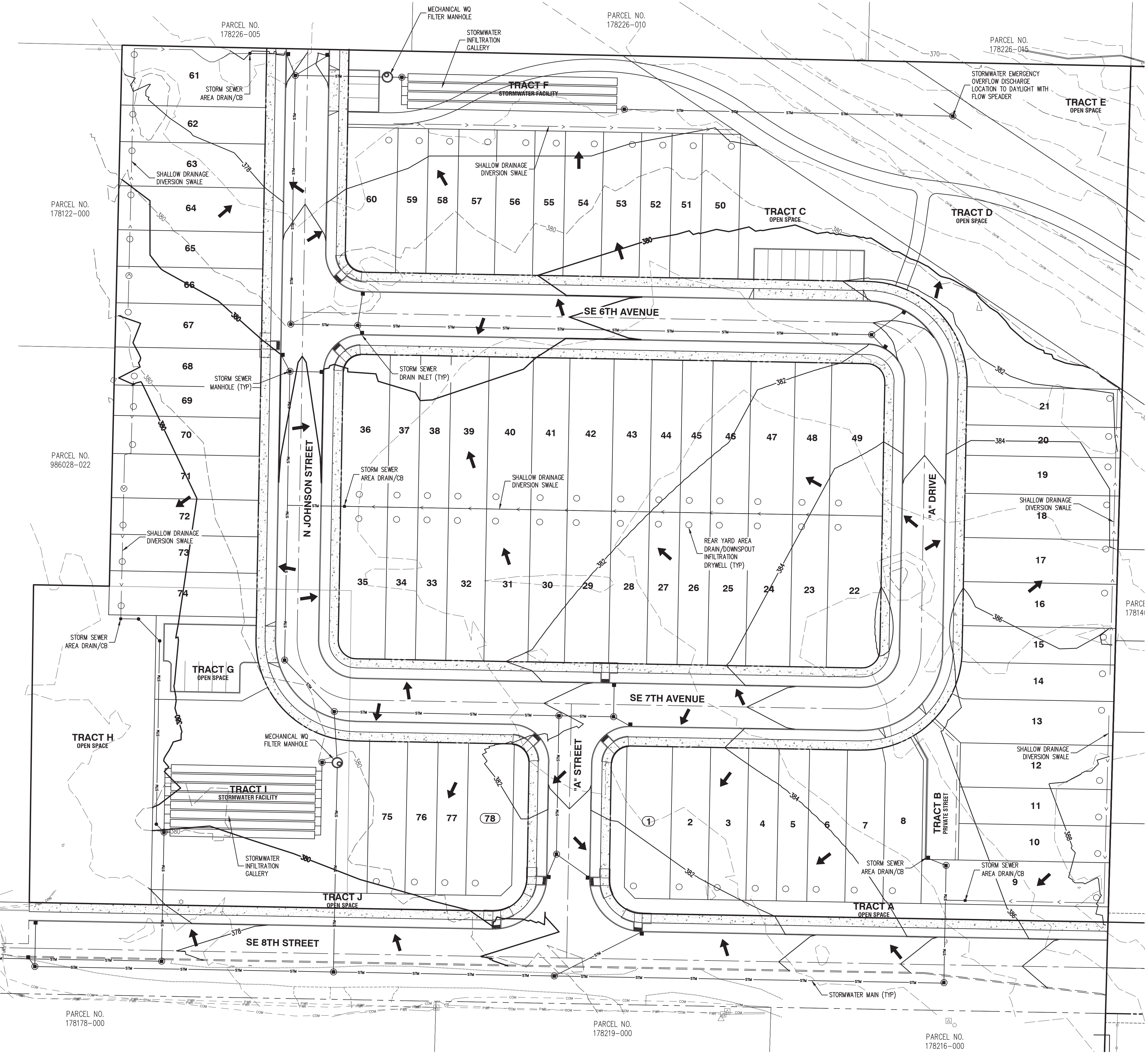
LEGEND

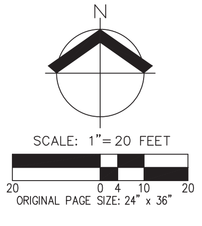
EXISTING GROUND CONTOUR (2 FT)	352
EXISTING GROUND CONTOUR (10 FT)	350
FINISHED GRADE CONTOUR (2 FT)	352
FINISHED GRADE CONTOUR (10 FT)	350
DRAINAGE FLOW DIRECTION	➞
GRADING LIMITS	— — —
DRAINAGE SWALE	- - - > - - -



TDA VICINITY MAP

N.T.S.





AKS DRAWING FILE: 8397-01 P10.0 STRM PLAN.DWG | LAYOUT: P10.0

AKS

AKS ENGINEERING & FORESTRY, LLC
9600 NE 126TH AVE, STE 2520
VANCOUVER, WA 98682
360.882.0419
WWW.AKS-ENG.COM

ENGINEERING · SURVEYING · NATURAL RESOURCES
FORESTRY · PLANNING · LANDSCAPE ARCHITECTURE

PRELIMINARY STORMWATER PLAN
CAMAS WOODS II
CAMAS WOODS 3, LLC
CAMAS, WASHINGTON

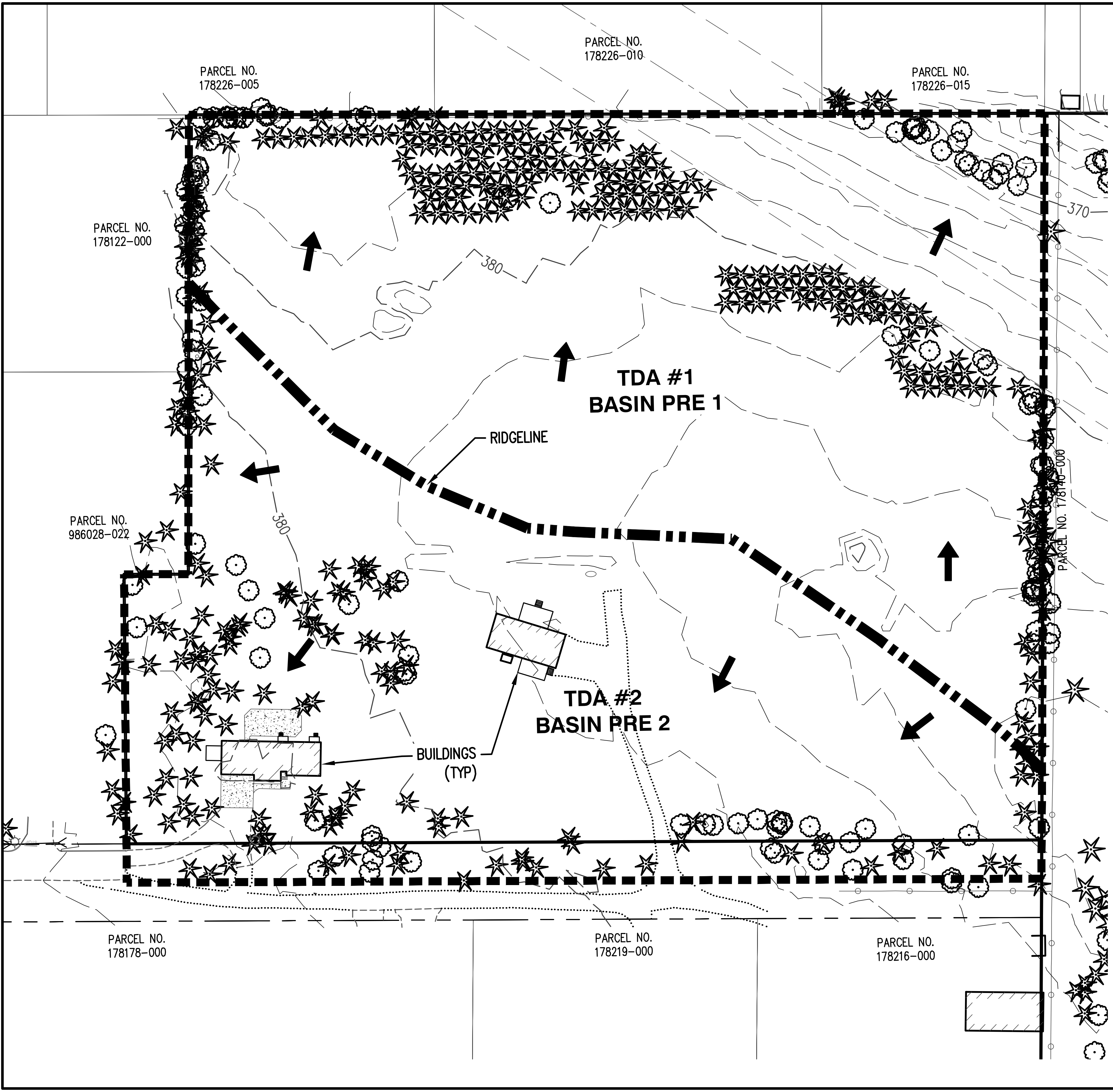
PRELIMINARY NOT FOR CONSTRUCTION
BRYCE D HANSON
STATE OF WASHINGTON
REGISTERED PROFESSIONAL ENGINEER

JOB NUMBER:	8397-01
DATE:	4/3/2025
DESIGNED BY:	MA
DRAWN BY:	SAG
CHECKED BY:	BDH

P10.0

Appendix D: Stormwater Basin Maps

Exhibit 9 SUB25-1003

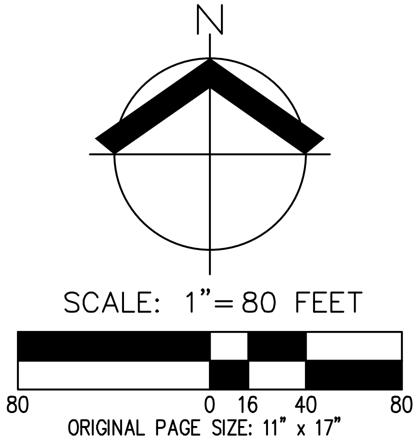


LEGEND

EXISTING GROUND CONTOUR (2 FT)	— — — — —
EXISTING GROUND CONTOUR (10 FT)	—— ——350—— ——
DRAINAGE FLOW DIRECTION	➡
PRE-DEVELOPED BASIN BOUNDARY	■ ■ ■ ■ ■ ■
PRE-DEVELOPED TDA BOUNDARY	▬ · · ▬ · · ▬

BASIN AREAS:

BASIN	FORESTED (AC)	PASTURE (AC)	IMPERVIOUS	TOTAL(AC)
BASIN PRE 1	4.69	0.00	0.00	4.69
BASIN PRE 2	4.59	0.00	0.00	4.59
TOTAL	9.28	0.00	0.00	9.28



SCALE: 1"=80 FEET

ORIGINAL PAGE SIZE: 11" x 17"

DATE: 3/7/2025

PRE-DEVELOPED BASIN MAP

CAMAS WOODS II

AKS ENGINEERING & FORESTRY, LLC
9600 NE 126TH AVE, STE 2520
VANCOUVER, WA 98682
360.882.0419 WWW.AKS-ENG.COM

EXHIBIT
A

DRWN: SAG
CHKD: BDH
AKS JOB:
8397-01

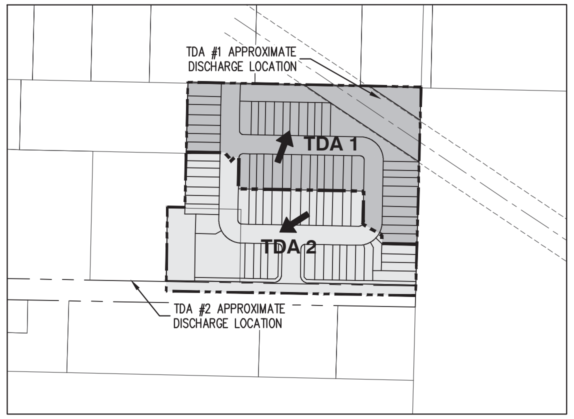
DWG: 8397-01 PREDEV BASIN MAP LU | EXHIBIT A

GENERAL NOTES

1. CONTOUR INTERVAL IS 2 FEET.
2. TREES ARE NOT SHOWN.
3. STORMWATER TREATMENT AND RETENTION/INFILTRATION FACILITIES FOR THIS DEVELOPMENT ARE TO BE OWNED AND MAINTAINED BY THE HOA.
4. ACCORDING TO CLARK COUNTY GIS, THE SITE IS NOT WITHIN OR ADJACENT TO A 100-YEAR FLOODPLAIN OR SHORELINE MANAGEMENT AREA.
5. THERE ARE NO KNOWN EXISTING ON-SITE STORMWATER FACILITIES.
6. ACCORDING TO CLARK GIS, NO FLOODPLAIN, FLOODWAYS, OR SHORELINE EXIST ON-SITE.
7. EXISTING DRAINAGE FLOW ROUTES ARE SOUTHWEST TOWARD INTO THE EXISTING DITCHES ALONG NE 8TH STREET AND NORTHEAST TOWARD TRACT E, WITH THE SITE BEING SPLIT DIAGONALLY AT APPROXIMATELY THE CENTER BY A RIDGE. THE SITE IS TWO THRESHOLD DISCHARGE AREAS (TDAs).
8. PROPOSED DRAINAGE FLOW ROUTES TO FOLLOW EXISTING FLOW ROUTES TO EXTENT POSSIBLE, WITH STORMWATER OVERFLOW DISCHARGED FROM STORMWATER INFILTRATION FACILITIES INTO EXISTING DITCH ALONG NE 8TH STREET AND NORTHEAST TOWARDS TRACT E.
9. ROOF AREAS FOR ALL LOTS DRAIN TO A PRIVATE STORMWATER DOWNSPOUT DRYWELL TO BE INSTALLED DURING HOME BUILD CONSTRUCTION.
10. SEE OVERALL THRESHOLD DISCHARGE AREA (TDA) VICINITY MAP ON THIS SHEET, P10.0.
11. PRELIMINARY STORM SIZING LISTED BELOW TO BE FINALIZED DURING FINAL ENGINEERING:
    STORM MAIN: 12" MIN. DIAMETER
    CATCH BASIN LEADS: 10" MIN. DIAMETER

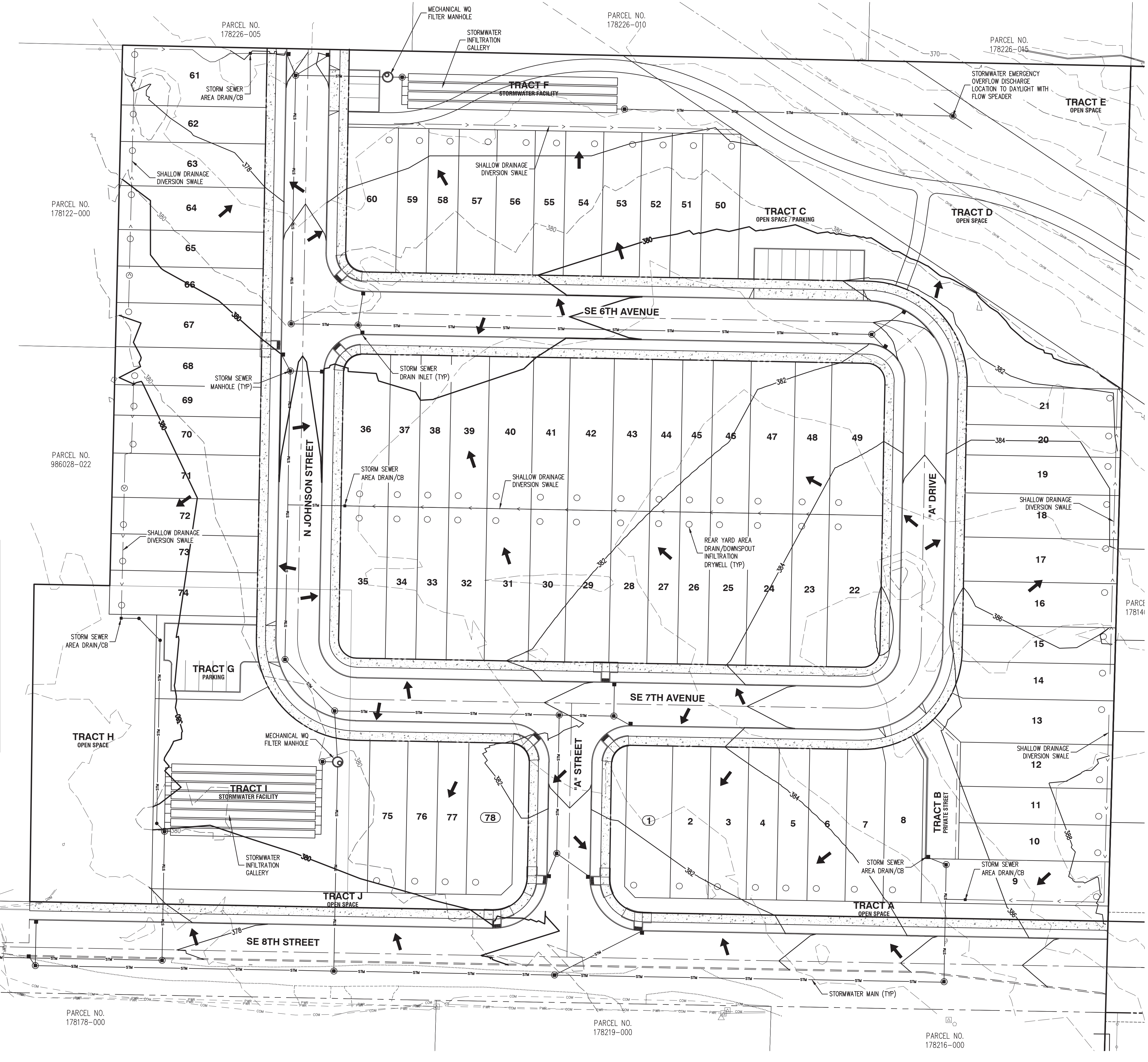
LEGEND

EXISTING GROUND CONTOUR (2 FT)	- - 352 - -
EXISTING GROUND CONTOUR (10 FT)	—— 350 ——
FINISHED GRADE CONTOUR (2 FT)	—— 352 ——
FINISHED GRADE CONTOUR (10 FT)	—— 350 ——
DRAINAGE FLOW DIRECTION	➡
GRADING LIMITS	▬ ▬ ▬
DRAINAGE SWALE	——— > ———



TDA VICINITY MAP

N.T.S.



N

SCALE: 1"=20 FEET

20 0 4 10 20

ORIGINAL PAGE SIZE: 24" x 36"

AKS DRAWING FILE: 8397-01 P10.0 STRM PLAN.DWG | LAYOUT: P10.0

AKS

AKS ENGINEERING & FORESTRY, LLC
9600 NE 126TH AVE, STE 2520
VANCOUVER, WA 98682
360.882.0419
WWW.AKS-ENG.COM

ENGINEERING · SURVEYING · NATURAL RESOURCES
FORESTRY · PLANNING · LANDSCAPE ARCHITECTURE

PRELIMINARY STORMWATER PLAN
CAMAS WOODS II
CAMAS WOODS 3, LLC
CAMAS, WASHINGTON

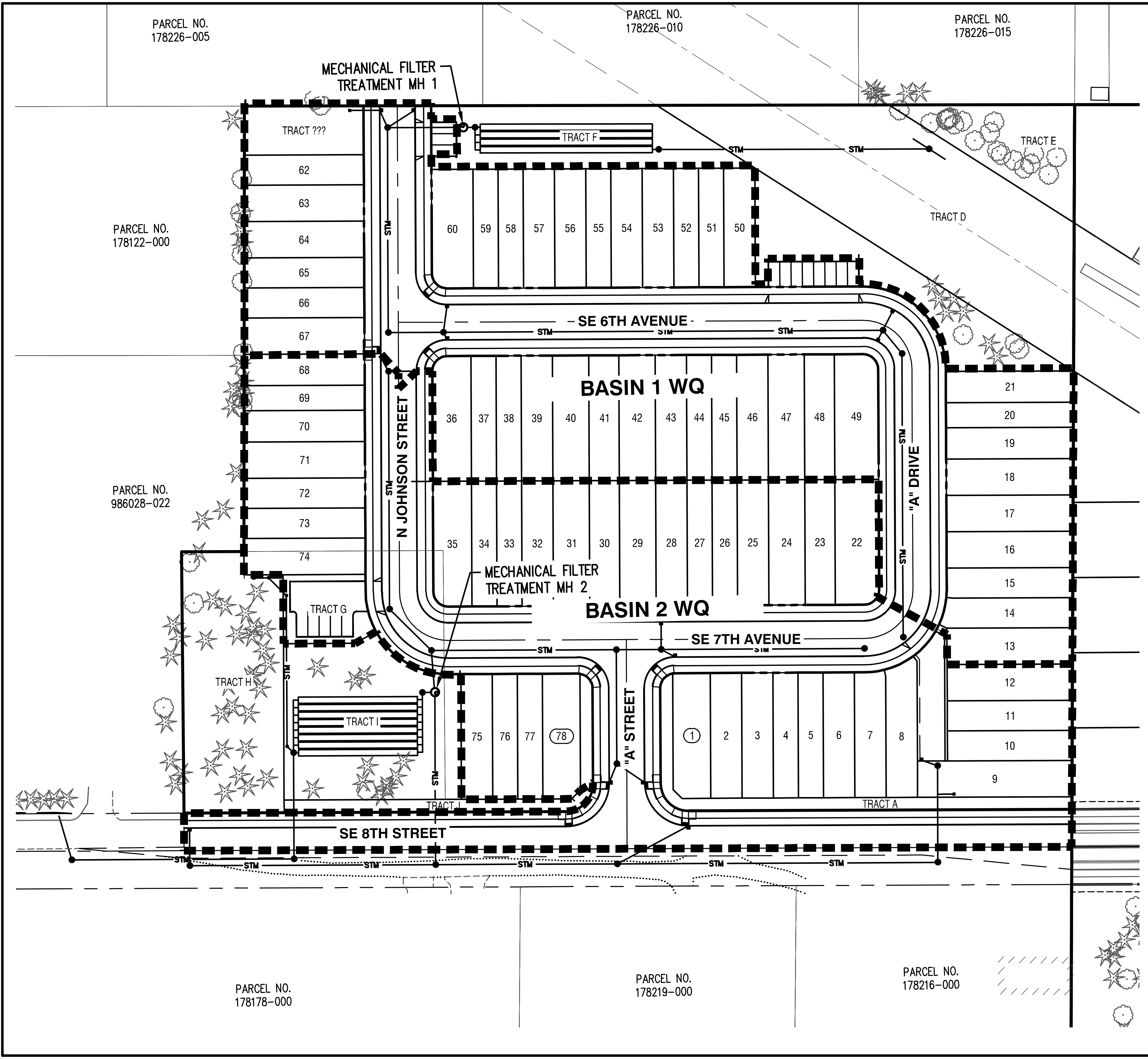
BRYCE D HANSON
51079

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	8397-01
DATE:	4/14/2025
DESIGNED BY:	MA
DRAWN BY:	SAG
CHECKED BY:	BDH

P10.0

Exhibit 9 SUB25-1003



LEGEND

WQ BASIN BOUNDARY - - - - - - -

BASIN AREAS:

BASIN	PERVIOUS (AC)	IMPERVIOUS (AC)	TOTAL(AC)
BASIN 1 WQ	0.817	1.243	2.060
BASIN 2 WQ	0.987	1.568	2.555

BASIN NOTES:

1. ROOF DOWNSPOUT BMP V-4.3, DOWNSPOUT INFILTRATION DRYWELLS ARE PROPOSED FOR ROOF RUNOFF. ASSUMED ROOF AREAS ARE NOT INCLUDED IN THE IMPERVIOUS SURFACE MITIGATED BASIN AREAS. THEY ARE CONSIDERED FULLY INFILTRATED.

N

SCALE: 1"= 80 FEET

80 0 16 40 80

ORIGINAL PAGE SIZE: 11" x 17"

DATE: 3/13/2025

WQ BASIN MAP

EXHIBIT

C

CAMAS WOODS II

AKS ENGINEERING & FORESTRY, LLC
9600 NE 126TH AVE, STE 2520
VANCOUVER, WA 98682
360.882.0419 WWW.AKS-ENG.COM

DRWN: SAG
CHKD: BDH
AKS JOB:
8397-01

DWG: 8397-01 WQ BASIN MAP LU | EXHIBIT C

Exhibit 9 SUB25-1003

Appendix E: BMP Details

BMP T7.50: Drywells

Purpose and Definition

Drywells are subsurface concrete structures, typically precast, that convey stormwater runoff into the soil matrix. They can be used as standalone structures, or as part of a larger drainage system (i.e. the overflow for a biofiltration swale).

Note that drywells meet the definition of an Underground Injection Control (UIC) well, and must meet the regulations per I-4 UIC Program Guidelines. Also note that per I-3.3 Applicability of the Minimum Requirements if there is overflow to the MS4, then the Minimum Requirements apply and only the registration requirement of the UIC rule applies.

General Criteria

Figure V-5.29: Typical Infiltration Drywell – Type 1 and Figure V-5.30: Typical Infiltration Drywell – Type 2 show typical infiltration drywell systems.

These systems are designed as specified below. The following general requirements apply to design of drywells. Check with the local jurisdiction for outflow capacity or other local requirements:

- Drywell bottoms should be a minimum of 5 feet above seasonal high groundwater level or impermeable soil layers. Refer to V-5.6 Site Suitability Criteria (SSC).
- Drywells are typically a minimum of 48 inches in diameter and approximately 5 to 10 feet deep, or more.
- Filter fabric (geotextile) may need to be placed on top of the drain rock and on trench or drywell sides prior to backfilling to prevent migration of fines into the drain rock, depending on local soil conditions and local jurisdiction requirements.
- Drywells should be no closer than 30 feet center to center or twice the depth, whichever is greater.
- Drywells should not be built on slopes greater than 25% (4H:1V).
- Drywells may not be placed on or above a landslide hazard area or slopes greater than 15% without evaluation by a licensed engineer in the state of Washington with geotechnical expertise or licensed geologist and jurisdiction approval.

Design Procedure

Refer to the guidance earlier in this chapter that is applicable to the design for all infiltration BMPs.

Operation and Maintenance Criteria

The structural life of a drywell is approximately 20 years, although hydraulic failure could potentially occur at any time. Drywell performance is dependent on proper installation, regularly scheduled maintenance, and contaminants reaching the drywell. The following schedule is

Exhibit 9 SUB25-1003

recommended as a guide; actual schedule may need to be varied based on observed performance.

Table V-5.7: Maintenance Criteria for Drywells

Maintenance Interval	Description of Maintenance to Be Performed
Every 3 months	Visually inspect
Every 6 months	Remove debris and sediment
Annually	Check for structural damage
Whichever Is More Frequent: Above Schedule or Below Observed Events:	
Following substantial (> 24-hour) rainfall event	If possible, observe drywells in operation during the rainfall event. Aim to identify and correct problem prior to failure.
Following intense but short-duration event	
Following snowmelt event	It is especially important to observe the drywells if the melt occurred concurrently with frozen ground conditions.

Maintenance Tasks

Visual Inspection

Ensure metal grate and drywell are free of debris and obstructions. Remove any debris from on top of or around drywell and grate. Remove grate and inspect drywell for debris and sediment buildup in the barrel. Debris needs to be removed immediately, if possible. Sediment needs to be cleaned out before depth reaches the lowest row of slots providing outflow from drywell barrel.

Anytime that standing water is noticed in a drywell > 24 hours after an event has ceased, a visual inspection is warranted. When standing water is observed, the inspector should be aware of any signs of illicit discharge. If any of the following are observed, in addition to the sod and topsoil being affected and requiring replacement, if it is evident that discharge was made directly into the drywell, the drywell and affected surrounding drain rock must be replaced as soon as possible: oil sheen, spilled paint, burned area due to battery acid, multicolored appearance of antifreeze, brown to black fuel oil, or any other materials that may be deemed deleterious to water quality. Sod, topsoil and drain rock removed must be handled and disposed of in a manner consistent with a hazardous material.

Remove Debris and Sediment

Remove any large debris that would interfere with the vactoring (suction removal) of the drywell. Sediment must be completely suctioned out of the drywell barrel. Care should be taken to note the depth of the sediment. If it appears that the sediment is increasing with depth at each inspection, this may be a sign that the swale is not functioning properly; stormwater may be ponding and spilling, carrying sediment laden stormwater into the drywell, rather than infiltrating at the design rate.

Check for Structural Damage

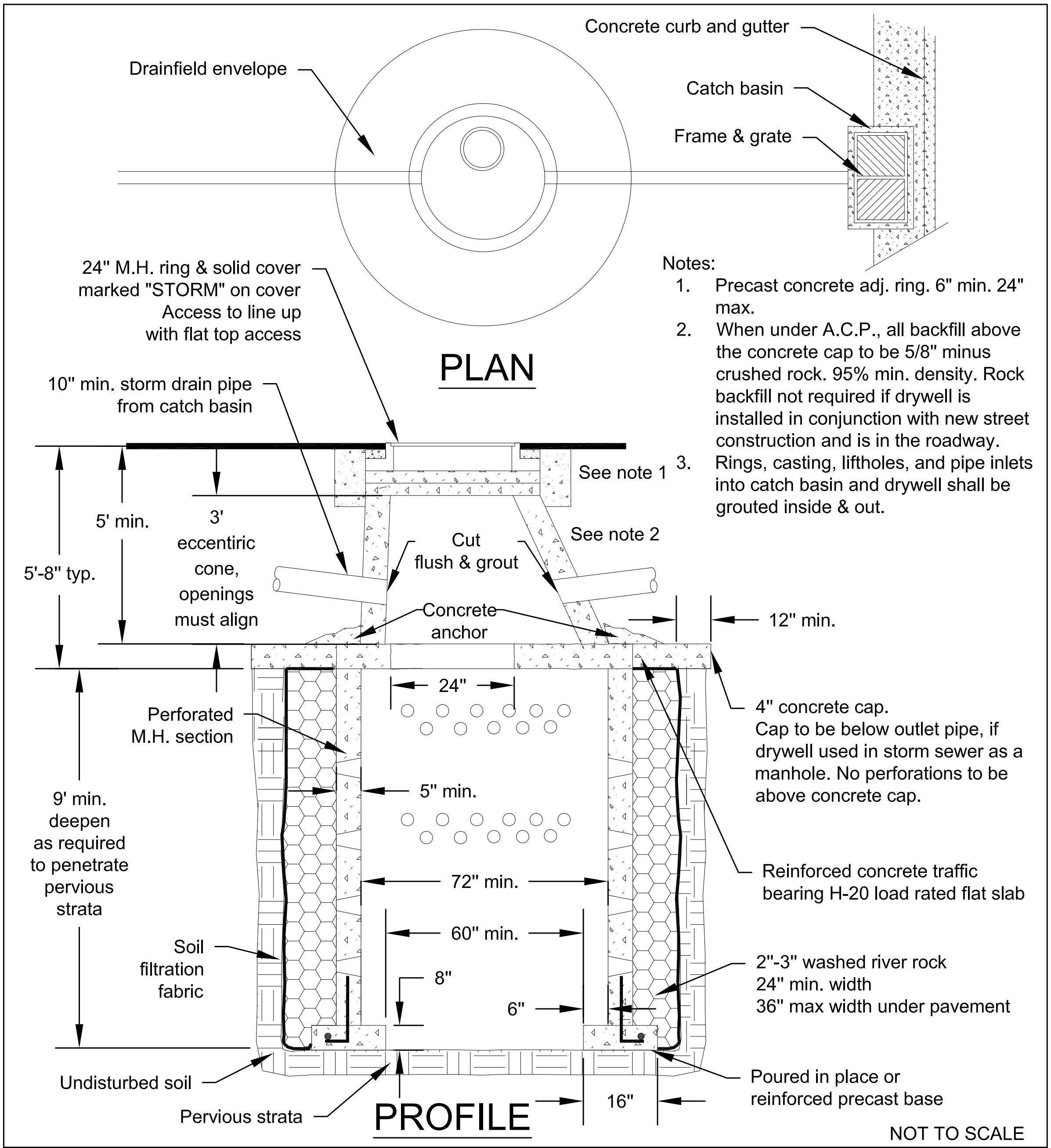
Inspect metal frame and grate, adjustment rings, mortar or any other visible parts of the drywell structure. The metal frame and grate should sit flush on the top ring. Any separation of ≥ 0.75 inches must be adjusted and repaired. The drywell should be replaced or repaired to design standards if it has settled > 2 inches or if standing water fails to drain out of the barrel slots. Adjustment rings should be free of cracks. Crack repair should adhere be performed when:

Location of Crack	Maximum Width of Crack
Top ring of drywell	0.25 inches
Drywell barrel	0.5 inches and longer than 3 feet
Drywell floor	0.5 inches and longer than 1 foot

Note: Any crack, regardless of location or width, in which sediment is observed, needs to be repaired as soon as possible. Cracks should be repaired with mortar similar to that used between the adjustment rings. Mortar or grout should be waterproof and of the nonshrink variety.

Exhibit 9 SUB25-1003

Figure V-5.29: Typical Infiltration Drywell – Type 1



Notes:

1. Precast concrete adj. ring. 6" min. 24" max.
2. When under A.C.P., all backfill above the concrete cap to be 5/8" minus crushed rock. 95% min. density. Rock backfill not required if drywell is installed in conjunction with new street construction and is in the roadway.
3. Rings, casting, liftholes, and pipe inlets into catch basin and drywell shall be grouted inside & out.

DEPARTMENT OF
ECOLOGY
State of Washington

Typical Infiltration Drywell
Type 1

Revised June 2018

BMP T7.20: Infiltration Trenches

Infiltration trenches are generally at least 24 inches wide, and are backfilled with a coarse stone aggregate, allowing for temporary storage of stormwater runoff in the voids of the aggregate material. Stored runoff then gradually infiltrates into the surrounding soil. The surface of the trench can be covered with grating and/or consist of stone, gabion, sand, or a grassed or asphalt area with a surface inlet. Perforated rigid pipe of at least 8-inch diameter can also be used to distribute the stormwater in an infiltration trench.

Refer to the guidance earlier in this chapter for information pertinent to all infiltration BMPs. Guidance specific to infiltration trenches is provided below.

Design Criteria

Due to accessibility and maintenance limitations, carefully design and construct infiltration trenches. Contact the local jurisdiction for additional specifications.

Runoff Treatment

If this BMP is proposed to be used for Runoff Treatment, the design must show that the subgrade soils (or an engineered soil layer) meet the criteria for Runoff Treatment in V-5.6 Site Suitability Criteria (SSC).

Catch basin and tee: A tee section should be provided in the nearest catch basin upstream of the infiltration trench if a catch basin is used. The tee will trap floatable debris and oils.

Infiltration Rate

See V-5.4 Determining the Design Infiltration Rate of the Native Soils for design infiltration rates. Check with the local jurisdiction for outflow capacity requirements.

Backfill Material

The aggregate material for the infiltration trench should consist of a clean aggregate with a maximum diameter of 1.5 inches and a minimum diameter of 3/8 inches conforming to the Gravel Backfill for Drywells specification in the current version of the WSDOT Standard Specifications. For calculations assume a void space of 30% maximum.

Access Port

Consider including an access port or open or grated top for accessibility to conduct inspections and maintenance.

Geotextile

Geotextile fabric liner – Completely encase the aggregate fill material in an engineering geotextile material. In the case of an aggregate surface, geotextile should surround all of the aggregate fill material except for the top one-foot, which is placed over the geotextile. Carefully select geotextile fabric with acceptable properties to avoid plugging (see V-1.3.4 Geotextile Specifications).

The bottom sand or geotextile fabric as shown in Figure V-5.15: Observation Well Details is optional.

See *Geosynthetic Design and Construction Guidelines* (FHWA, 1998) for design guidance on geotextiles in drainage applications. See the *NCHRP Long-Term Performance of Geosynthetics in Drainage Applications* (NCHRP, 1994), for long-term performance data and background on the potential for geotextiles to clog, blind, or to allow piping to occur and how to design for these issues.

Overflow Channel

Because an infiltration trench is generally used for small drainage areas, an emergency spillway is not necessary. However, provide a non-erosive overflow channel leading to a stabilized watercourse.

Surface Cover

An infiltration trench can be placed under a pervious or impervious surface cover to conserve space.

Observation Well

Install an observation well at the lower end of the infiltration trench to check water levels, drawdown time, sediment accumulation, and conduct water quality monitoring. Figure V-5.15: Observation Well Details illustrates observation well details. It should consist of a perforated PVC pipe that is 4 to 6 inches in diameter, and it should be constructed flush with the ground elevation. For larger trenches, a 12-36 inch diameter well can be installed to facilitate maintenance operations such as pumping out the sediment. Cap the top of the well to discourage vandalism and tampering.

Perforated Pipe

A minimum of 8-inch perforated pipe may be included to increase the storage capacity of the infiltration trench and to enhance conveyance of flows throughout the trench area.

Underground Injection Control (UIC) regulations apply to infiltration trenches when perforated pipe is used, unless the perforated pipe is included for the purpose of conveying overflows to surface.

- If the design, operation, and maintenance criteria in this section are met, only the registration requirement of the UIC regulations applies to the infiltration trench.
- Where perforated pipe is not used, the registration requirement does not apply.
- See I-4 UIC Program Guidelines for details.

Exhibit 9 SUB25-1003

Construction Criteria

Trench Preparation

Place excavated materials away from the trench sides to enhance trench wall stability. Take care to keep this material away from slopes, neighboring property, sidewalks, and streets. It is recommended that this material be temporarily covered with plastic. (See BMP C123: Plastic Covering).

Rock Aggregate Placement and Compaction

Place rock aggregate in lifts and compact using plate compactors. In general, a maximum loose lift thickness of 12 inches is recommended. The compaction process ensures geotextile conformity to the excavation sides, thereby reducing potential piping and geotextile clogging, and settlement problems.

Potential Contamination

Prevent natural or fill soils from intermixing with the rock aggregate. Remove all contaminated rock aggregate and replaced with uncontaminated rock aggregate.

Overlapping and Covering

Following the rock aggregate placement, fold the geotextile over the rock aggregate to form a 12 inch minimum longitudinal overlap. When overlaps are required between rolls, the upstream roll should overlap a minimum of 2 feet over the downstream roll in order to provide a shingled effect.

Voids Behind Geotextile

Voids between the geotextile and excavation sides must be avoided. Removing boulders or other obstacles from the trench walls is one source of such voids. Place natural soils in these voids at the most convenient time during construction to ensure geotextile conformity to the excavation sides. This remedial process will avoid soil piping, geotextile clogging, and possible surface subsidence.

Unstable Excavation Sites

Vertically excavated walls may be difficult to maintain in areas where the soil moisture is high or where soft or cohesionless soils predominate. Trapezoidal, rather than rectangular, cross-sections may be needed.

Maintenance Criteria

Monitor sediment buildup in the top foot of stone aggregate or the surface inlet on the same schedule as the observation well.

Exhibit 9 SUB25-1003

V-12 Miscellaneous LID BMPs

V-12.1 Introduction to Miscellaneous LID BMPs

BMPs in this section have been grouped because they have the following in common:

- They employ Low Impact Development (LID) Principles
- They cannot be used to meet I-3.4.6 MR6: Runoff Treatment
- They typically cannot, by themselves, be used to meet the Flow Control Performance Standard within I-3.4.7 MR7: Flow Control or the LID Performance Standard within I-3.4.5 MR5: On-Site Stormwater Management
    - Some of the BMPs in this chapter do allow for some amount of Flow Control credit. See the guidance for each individual BMP for details.
- The design methods for each BMP in this section are unique. They do not have strong enough design similarities to other BMPs in this volume to place them in the other BMP categories identified in this volume.

BMP T5.13: Post-Construction Soil Quality and Depth

Purpose and Definition

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves can become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter.

Establishing soil quality and depth can obtain greater stormwater functions in the post-development landscape and help preserve the plant and soil system more effectively. This type of approach provides a soil/landscape system with adequate depth, permeability, and organic matter to sustain itself and to continue working as an effective stormwater infiltration system.

Applications and Limitations

Amending soils to establish a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. However, establishing a minimum soil quality and depth will provide improved on-site management of stormwater flow and water quality.

This BMP can be considered infeasible on till soil slopes greater than 33 percent.

In addition to providing some amount of Flow Control benefit, this BMP also offers the following benefits:

- Amended soils can be included in designs for dispersion BMPs (see V-3 Dispersion BMPs) to improve dispersal and absorption of stormwater flows.
- This BMP creates a medium for healthy plant growth, reducing the need for fertilizers and pesticides and peak summer irrigation needs (Chollak, n.d.).
- This BMP can improve overall site water quality performance by promoting infiltration; increasing cation exchange capacity, pollutant adsorption, and filtration; and buffering soil pH (USDA and USCC, 2005).

Design Guidelines

Organic Matter

Soil organic matter can be attained through numerous materials such as compost, composted woody material, biosolids, forest product residuals, or other locally available materials deemed suitable for this application. The materials used must be appropriate and beneficial to the plant cover to be established and must not have an excessive percentage of clay fines.

Soil Retention

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

Soil Quality

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

1. A topsoil layer comprised as follows:
    - **Planting Beds:** 8-10 percent organic content using 3 inches of compost incorporated to an 8-inch depth or a topsoil mix containing 35-40 percent compost by volume.
    - **Turf areas:** 3-5 percent organic content using 1.75 inches of compost incorporated to an 8-inch depth or a topsoil mix containing 20-25 percent compost by volume.
    - pH between 6.0 and 8.0 or a pH appropriate for installed plants.
2. The topsoil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoils below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.

3. Mulch planting beds with 2 inches of organic material.
4. Use compost and other materials that meet the following organic content requirements:
    - The organic content must be met using the compost specification for BMP T7.30: Bioretention, with the exception that the compost may have up to 35% biosolids or manure.
    - The compost must also have an organic matter content of 40% to 65%, and a carbon to nitrogen ratio below 25:1. The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region.

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

Implementation Options

The soil quality design guidelines listed above can be met by using one of the methods listed below:

1. Leave undisturbed native vegetation and soil, and protect from compaction during construction.
2. Amend existing site topsoil or subsoil with organic content at the rates given above.
3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements as given above.
4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

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

Construction Criteria

Protecting and enhancing site soils requires planning and sequencing of construction activities to reduce impacts. The following recommended steps are adapted from the *Low Impact Development Technical Guidance Manual for Puget Sound* (WSU and PSP, 2012) and the Building Soil – A Foundation for Success website (http://www.buildingsoil.org/). These steps begin with land clearing and grading and continue through end of construction (prior to planting) and after planting is complete:

Land Clearing and Grading Phase

- Fence all vegetation and soil protection areas prior to first disturbance, and communicate those areas to clearing and grading operators. The root zones of trees that may extend into the grading zone should be protected or cut rather than ripped during grading.
- Chip land-clearing debris on-site and reuse as erosion-control cover or stockpile for reuse as mulch at end of project.

Exhibit 9 SUB25-1003

- Stockpile topsoil to be reused with a breathable cover, such as wood chips or landscape fabric.
- If amended, topsoils will be placed at end of project. Grade 8 to 12 inches below finish grade to allow for placing the topsoil.

Construction Phase

- Ensure erosion and sediment control BMPs are in place before and modified after grading to protect construction activities. Compost-based BMPs (compost “blankets” for surface, and compost berms or socks for perimeter controls) give a “two-for-one” benefit because the compost can be reused as soil amendment at the end of the project.
- Lay out roads and driveways immediately after grading and place rock bases for them as soon as possible. Keep as much construction traffic as possible on the road base, and off open soils. This will improve erosion compliance, reduce soil compaction, and increase site safety by keeping rolling equipment on a firm base.
- Protect amended/restored soils from equipment-caused compaction by using steel plates or other BMPs if equipment access is unavoidable across amended soils.
- Maintain vegetation and soil protection area barriers and temporary tree root zone protection BMPs throughout construction and ensure that all contractors understand their importance.

End of Construction, Soil Preparation Before Planting

- Ensure vegetation and soil protection barriers are maintained through the end of construction.
- Disturbed or graded soil areas that have received vehicle traffic will need to be decompacted to a minimum 12-inch depth. This can be done with a cat-mounted ripper or with bucket-mounted ripping teeth.
- Amend all disturbed areas with compost or other specified amendments ≥ 8 inches deep by tilling, ripping, or mixing with a bucket loader. Alternatively, place amended stockpiled topsoil or import an amended topsoil. It is good practice to scarify or mix amended soils several inches into the underlying subsoil to enhance infiltration and root penetration. Compost from erosion BMPs (compost blankets, berms, or socks) can be reused as appropriate if immediately followed by planting and mulching so there is no lapse in erosion control.
- Amended topsoil can be placed as soon as building exterior work is complete. During this step, vehicles should stay on roads and driveway pads. Compost, soil blends provide good ongoing erosion protection.
- Avoid tilling through tree roots – instead use shallow amendment and mulching.
- Final preparation for turf areas should include raking rocks, rolling, and possibly placing 1 to 2 inches of sandy loam topsoil before seeding or sodding.

- Plan for amended soil to settle by placing amended soil slightly higher than desired final grade, or retain or import a smaller amount of amended topsoil to meet final grades adjacent to hardscape such as sidewalks.
- Keep compost, topsoil, and mulch delivery tickets so inspector can verify that quantities and products used match those intended per the design.

After Planting and End of Project Phase

- Remove protection area barriers, including sediment fences, filter socks, and curb and storm drain barriers. Evaluate trees for stress and need for treatment, such as pruning, root-feeding, mulching etc. Plan to have an arborist on-site, as appropriate.
- Mulch all planting beds where soil has been amended and replanted with 2 to 3 inches of arborist wood chip or other specified mulch.
- Communicate a landscape management plan to property owners that includes: on-site reuse of organics (e.g. mulch leaves, mulch-mow grass clippings) to maintain soil health; avoiding pesticide use; and minimal organic-based fertilization.

Operation and Maintenance Criteria

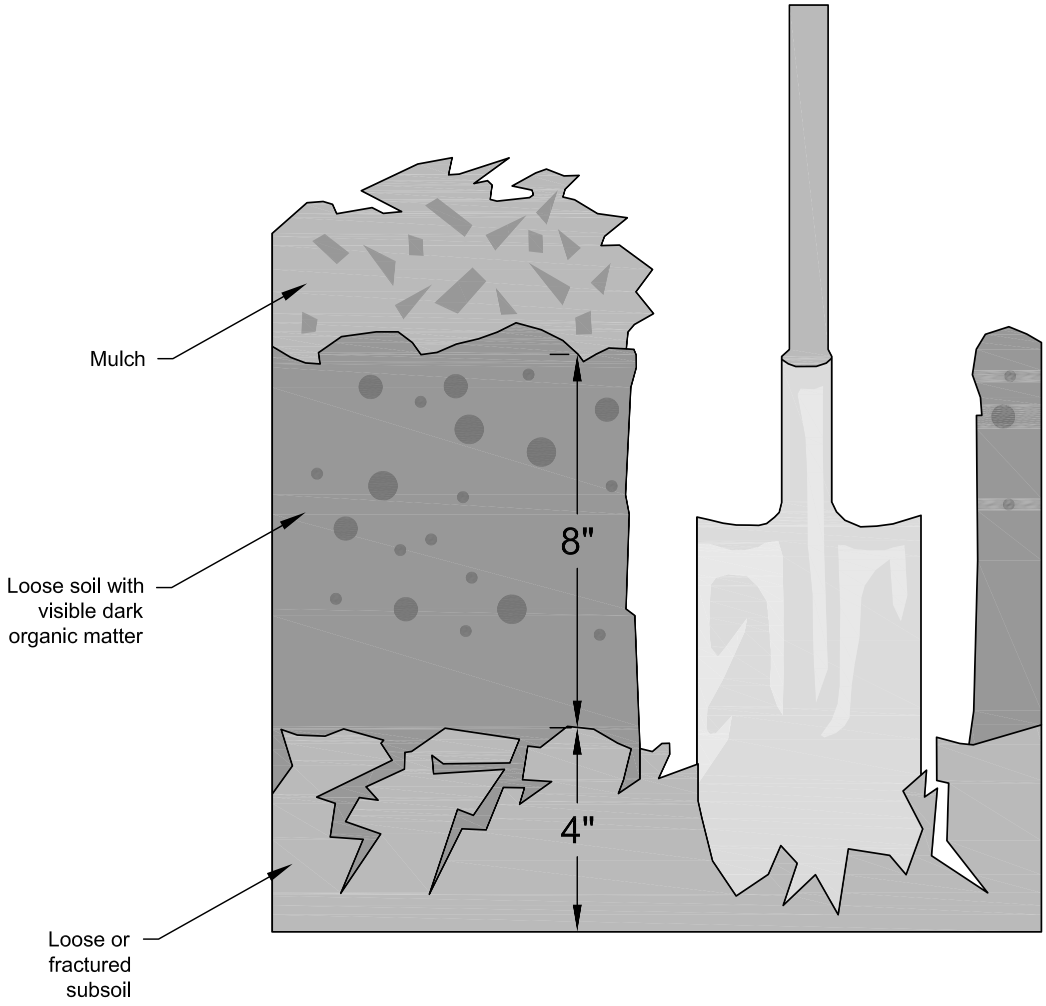
- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant and mulch areas immediately after amending and settling the soil to stabilize the site as soon as possible.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Landscape management plans should continually renew organic levels through mulch-mowing on turf areas, allowing fallen leaves to remain on beds, and/or replenishing mulch layers every 1 to 2 years.
- Minimize or eliminate use of irrigation, herbicides, pesticides and fertilizers. Landscape management personnel should be trained to minimize chemical inputs, use nontoxic alternatives, and manage the landscape areas to minimize erosion, recognize soil and plant health problems, and optimize water storage and soil permeability.
- Remove weeds as necessary or appropriate through manual removal, tilling and/or remulching.
- Protect amended areas from excessive foot traffic and equipment to prevent compaction and erosion.

Runoff Model Representation

All areas meeting the soil quality and depth design criteria may be entered into approved runoff models as “Pasture” rather than “Lawn/Landscaping”.

Exhibit 9 SUB25-1003

Figure V-12.1: Planting Bed Cross-Section



Reprinted from *Guidelines and Resources For Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington*, 2010, Washington Organic Recycling Council

NOT TO SCALE

DEPARTMENT OF
ECOLOGY
State of Washington

Planting Bed Cross-Section

Revised June 2016

Exhibit 9 SUB25-1003

V-11 Manufactured Treatment Devices as BMPs

V-11.1 Introduction to Manufactured Treatment Devices as BMPs

Traditional best management practices (BMPs) such as wetponds and filtration swales may not be appropriate in many situations due to size and space constraints or their inability to remove target pollutants. Because of this, the stormwater treatment industry emerged to develop new manufactured stormwater treatment devices.

Manufactured treatment devices are emerging technologies that are new to the stormwater treatment marketplace. These devices include both permanent and construction site treatment technologies. Many of these devices have not undergone complete performance testing, so their performance claims cannot be verified.

Ecology has established a program, the Technology Assessment Protocol – Ecology (TAPE), to evaluate the capabilities of manufactured treatment devices. Manufactured treatment devices that have been evaluated by TAPE are approved at some level of use designation under specified conditions. Their use is restricted in accordance with their evaluation as explained in V-11.3 Approval Process for Manufactured Treatment Devices. The recommendations for use of individual manufactured treatment devices may change as we collect more data on their performance. Updated recommendations on their use are posted to Ecology's TAPE website at the following address:

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

Manufactured treatment devices can also be considered for retrofit situations, where TAPE approval may not be required.

V-11.2 Use Level Designations of Manufactured Treatment Devices

Ecology's Technology Assessment Protocol - Ecology (TAPE) program developed "use level designations" to assess levels of development for manufactured treatment devices. The use level designations are based upon the quantity, quality, and type of performance data. There are three use level designations:

- pilot use level designation (PULD),
- conditional use level designation (CULD), and
- general use level designation (GULD).

Appendix F: Flow Control & Water Quality Analysis

Exhibit 9 SUB25-1003

WWHM2012

PROJECT REPORT

TDAs #1 AND #2 FLOW CONTROL (INFILTRATION WITH OVERFLOW/EMERGECY OUTLET

General Model Information

WWHM2012 Project Name: 8397 WWHM TDA 1 No Roof

Site Name:	Camas Woods II
Site Address:	
City:	Camas
Report Date:	4/11/2025
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.300
Version Date:	2024/06/28
Version:	4.3.1

POC Thresholds

Low Flow Threshold for POC1:	8 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	8 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

BASIN 1 PRE

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Forest, Flat	4.69
Pervious Total	4.69
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.69

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

BASIN 2 PRE

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Forest, Flat	4.59
Pervious Total	4.59
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.59

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 2	POC 2	

Mitigated Land Use

BASIN 1A

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Flat	1.283
Pervious Total	1.283
Impervious Land Use	acre
ROADS FLAT	0.537
DRIVEWAYS FLAT	0.428
SIDEWALKS FLAT	0.23
PARKING FLAT	0.048
Impervious Total	1.243
Basin Total	2.526

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
DRYWELL 1	DRYWELL 1	

BASIN 2A

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Flat	1.316
Pervious Total	1.316
Impervious Land Use	acre
ROADS FLAT	0.901
DRIVEWAYS FLAT	0.383
SIDEWALKS FLAT	0.289
PARKING FLAT	0.106
Impervious Total	1.679
Basin Total	2.995

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
DRYWELL 2	DRYWELL 2	

BASIN 2B

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
SG3, Forest, Flat	0.372
Pervious Total	0.372
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.372

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 2	POC 2	

BASIN 1B

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
SG3, Forest, Flat	0.744
Pervious Total	0.744
Impervious Land Use	acre
SIDEWALKS FLAT	0.07
Impervious Total	0.07
Basin Total	0.814

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

Routing Elements

Predeveloped Routing

Mitigated Routing

DRYWELL 1

Bottom Length:	10.00 ft.
Bottom Width:	10.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	13
Pour Space of material for first layer:	0.45
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	11.5
Infiltration safety factor:	0.1188
Total Volume Infiltrated (ac-ft.):	56.016
Total Volume Through Riser (ac-ft.):	278.879
Total Volume Through Facility (ac-ft.):	334.896
Percent Infiltrated:	16.73
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height:	6 ft.
Riser Diameter:	10 in.

Element Outlets:

Outlet 1	Outlet 2

Outlet Flows To:
Gravel Trench Bed 1

Gravel Trench Bed Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.002	0.000	0.000	0.000
0.1556	0.002	0.000	0.000	0.003
0.3111	0.002	0.000	0.000	0.003
0.4667	0.002	0.000	0.000	0.003
0.6222	0.002	0.000	0.000	0.003
0.7778	0.002	0.000	0.000	0.003
0.9333	0.002	0.001	0.000	0.003
1.0889	0.002	0.001	0.000	0.003
1.2444	0.002	0.001	0.000	0.003
1.4000	0.002	0.001	0.000	0.003
1.5556	0.002	0.001	0.000	0.003
1.7111	0.002	0.001	0.000	0.003
1.8667	0.002	0.001	0.000	0.003
2.0222	0.002	0.002	0.000	0.003
2.1778	0.002	0.002	0.000	0.003
2.3333	0.002	0.002	0.000	0.003
2.4889	0.002	0.002	0.000	0.003
2.6444	0.002	0.002	0.000	0.003
2.8000	0.002	0.002	0.000	0.003
2.9556	0.002	0.003	0.000	0.003
3.1111	0.002	0.003	0.000	0.003
3.2667	0.002	0.003	0.000	0.003
3.4222	0.002	0.003	0.000	0.003

Exhibit 9 SUB25-1003

3.5778	0.002	0.003	0.000	0.003
3.7333	0.002	0.003	0.000	0.003
3.8889	0.002	0.004	0.000	0.003
4.0444	0.002	0.004	0.000	0.003
4.2000	0.002	0.004	0.000	0.003
4.3556	0.002	0.004	0.000	0.003
4.5111	0.002	0.004	0.000	0.003
4.6667	0.002	0.004	0.000	0.003
4.8222	0.002	0.005	0.000	0.003
4.9778	0.002	0.005	0.000	0.003
5.1333	0.002	0.005	0.000	0.003
5.2889	0.002	0.005	0.000	0.003
5.4444	0.002	0.005	0.000	0.003
5.6000	0.002	0.005	0.000	0.003
5.7556	0.002	0.005	0.000	0.003
5.9111	0.002	0.006	0.000	0.003
6.0667	0.002	0.006	0.151	0.003
6.2222	0.002	0.006	0.835	0.003
6.3778	0.002	0.006	1.337	0.003
6.5333	0.002	0.006	1.597	0.003
6.6889	0.002	0.006	1.815	0.003
6.8444	0.002	0.007	2.009	0.003
7.0000	0.002	0.007	2.187	0.003
7.1556	0.002	0.007	2.351	0.003
7.3111	0.002	0.007	2.504	0.003
7.4667	0.002	0.007	2.648	0.003
7.6222	0.002	0.007	2.785	0.003
7.7778	0.002	0.008	2.916	0.003
7.9333	0.002	0.008	3.041	0.003
8.0889	0.002	0.008	3.161	0.003
8.2444	0.002	0.008	3.276	0.003
8.4000	0.002	0.008	3.388	0.003
8.5556	0.002	0.008	3.496	0.003
8.7111	0.002	0.009	3.601	0.003
8.8667	0.002	0.009	3.703	0.003
9.0222	0.002	0.009	3.802	0.003
9.1778	0.002	0.009	3.899	0.003
9.3333	0.002	0.009	3.993	0.003
9.4889	0.002	0.009	4.085	0.003
9.6444	0.002	0.010	4.175	0.003
9.8000	0.002	0.010	4.263	0.003
9.9556	0.002	0.010	4.350	0.003
10.111	0.002	0.010	4.434	0.003
10.267	0.002	0.010	4.517	0.003
10.422	0.002	0.010	4.599	0.003
10.578	0.002	0.010	4.679	0.003
10.733	0.002	0.011	4.758	0.003
10.889	0.002	0.011	4.836	0.003
11.044	0.002	0.011	4.912	0.003
11.200	0.002	0.011	4.987	0.003
11.356	0.002	0.011	5.061	0.003
11.511	0.002	0.011	5.134	0.003
11.667	0.002	0.012	5.206	0.003
11.822	0.002	0.012	5.277	0.003
11.978	0.002	0.012	5.347	0.003
12.133	0.002	0.012	5.416	0.003
12.289	0.002	0.012	5.485	0.003
12.444	0.002	0.012	5.552	0.003

12.600	0.002	0.013	5.619	0.003
12.756	0.002	0.013	5.685	0.003
12.911	0.002	0.013	5.750	0.003
13.067	0.002	0.013	5.814	0.003
13.222	0.002	0.014	5.878	0.003
13.378	0.002	0.014	5.941	0.003
13.533	0.002	0.014	6.003	0.003
13.689	0.002	0.015	6.065	0.003
13.844	0.002	0.015	6.126	0.003
14.000	0.002	0.015	6.186	0.003

Gravel Trench Bed 1

Bottom Length:	550.00 ft.
Bottom Width:	6.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	1
Pour Space of material for first layer:	0.3
Material thickness of second layer:	5
Pour Space of material for second layer:	0.9
Material thickness of third layer:	2
Pour Space of material for third layer:	0.3
Infiltration On	
Infiltration rate:	11.5
Infiltration safety factor:	0.1188
Total Volume Infiltrated (ac-ft.):	278.505
Total Volume Through Riser (ac-ft.):	0.379
Total Volume Through Facility (ac-ft.):	278.884
Percent Infiltrated:	99.86
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height: 7.5 ft.

Riser Diameter: 12 in.

Element Outlets:

Outlet 1 Outlet 2

Outlet Flows To:

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.075	0.000	0.000	0.000
0.0889	0.075	0.002	0.000	0.104
0.1778	0.075	0.004	0.000	0.104
0.2667	0.075	0.006	0.000	0.104
0.3556	0.075	0.008	0.000	0.104
0.4444	0.075	0.010	0.000	0.104
0.5333	0.075	0.012	0.000	0.104
0.6222	0.075	0.014	0.000	0.104
0.7111	0.075	0.016	0.000	0.104
0.8000	0.075	0.018	0.000	0.104
0.8889	0.075	0.020	0.000	0.104
0.9778	0.075	0.022	0.000	0.104
1.0667	0.075	0.028	0.000	0.104
1.1556	0.075	0.034	0.000	0.104
1.2444	0.075	0.040	0.000	0.104
1.3333	0.075	0.046	0.000	0.104
1.4222	0.075	0.052	0.000	0.104
1.5111	0.075	0.058	0.000	0.104
1.6000	0.075	0.064	0.000	0.104
1.6889	0.075	0.070	0.000	0.104
1.7778	0.075	0.076	0.000	0.104
1.8667	0.075	0.082	0.000	0.104
1.9556	0.075	0.088	0.000	0.104
2.0444	0.075	0.094	0.000	0.104
2.1333	0.075	0.101	0.000	0.104

2.2222	0.075	0.107	0.000	0.104
2.3111	0.075	0.113	0.000	0.104
2.4000	0.075	0.119	0.000	0.104
2.4889	0.075	0.125	0.000	0.104
2.5778	0.075	0.131	0.000	0.104
2.6667	0.075	0.137	0.000	0.104
2.7556	0.075	0.143	0.000	0.104
2.8444	0.075	0.149	0.000	0.104
2.9333	0.075	0.155	0.000	0.104
3.0222	0.075	0.161	0.000	0.104
3.1111	0.075	0.167	0.000	0.104
3.2000	0.075	0.173	0.000	0.104
3.2889	0.075	0.179	0.000	0.104
3.3778	0.075	0.185	0.000	0.104
3.4667	0.075	0.191	0.000	0.104
3.5556	0.075	0.198	0.000	0.104
3.6444	0.075	0.204	0.000	0.104
3.7333	0.075	0.210	0.000	0.104
3.8222	0.075	0.216	0.000	0.104
3.9111	0.075	0.222	0.000	0.104
4.0000	0.075	0.228	0.000	0.104
4.0889	0.075	0.234	0.000	0.104
4.1778	0.075	0.240	0.000	0.104
4.2667	0.075	0.246	0.000	0.104
4.3556	0.075	0.252	0.000	0.104
4.4444	0.075	0.258	0.000	0.104
4.5333	0.075	0.264	0.000	0.104
4.6222	0.075	0.270	0.000	0.104
4.7111	0.075	0.276	0.000	0.104
4.8000	0.075	0.282	0.000	0.104
4.8889	0.075	0.288	0.000	0.104
4.9778	0.075	0.294	0.000	0.104
5.0667	0.075	0.301	0.000	0.104
5.1556	0.075	0.307	0.000	0.104
5.2444	0.075	0.313	0.000	0.104
5.3333	0.075	0.319	0.000	0.104
5.4222	0.075	0.325	0.000	0.104
5.5111	0.075	0.331	0.000	0.104
5.6000	0.075	0.337	0.000	0.104
5.6889	0.075	0.343	0.000	0.104
5.7778	0.075	0.349	0.000	0.104
5.8667	0.075	0.355	0.000	0.104
5.9556	0.075	0.361	0.000	0.104
6.0444	0.075	0.363	0.000	0.104
6.1333	0.075	0.365	0.000	0.104
6.2222	0.075	0.367	0.000	0.104
6.3111	0.075	0.369	0.000	0.104
6.4000	0.075	0.371	0.000	0.104
6.4889	0.075	0.373	0.000	0.104
6.5778	0.075	0.375	0.000	0.104
6.6667	0.075	0.377	0.000	0.104
6.7556	0.075	0.379	0.000	0.104
6.8444	0.075	0.381	0.000	0.104
6.9333	0.075	0.383	0.000	0.104
7.0222	0.075	0.385	0.000	0.104
7.1111	0.075	0.387	0.000	0.104
7.2000	0.075	0.389	0.000	0.104
7.2889	0.075	0.391	0.000	0.104

7.3778	0.075	0.393	0.000	0.104
7.4667	0.075	0.396	0.000	0.104
7.5556	0.075	0.398	0.138	0.104
7.6444	0.075	0.400	0.572	0.104
7.7333	0.075	0.402	1.115	0.104
7.8222	0.075	0.404	1.627	0.104
7.9111	0.075	0.406	1.996	0.104
8.0000	0.075	0.408	2.203	0.104

DRYWELL 2

Bottom Length:	10.00 ft.
Bottom Width:	10.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	13
Pour Space of material for first layer:	0.45
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	10.5
Infiltration safety factor:	0.1188
Total Volume Infiltrated (ac-ft.):	53.741
Total Volume Through Riser (ac-ft.):	369.643
Total Volume Through Facility (ac-ft.):	423.384
Percent Infiltrated:	12.69
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height:	6 ft.
Riser Diameter:	10 in.

Element Outlets:
Outlet 1 Outlet 2
Outlet Flows To:
Gravel Trench Bed 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.002	0.000	0.000	0.000
0.1556	0.002	0.000	0.000	0.002
0.3111	0.002	0.000	0.000	0.002
0.4667	0.002	0.000	0.000	0.002
0.6222	0.002	0.000	0.000	0.002
0.7778	0.002	0.000	0.000	0.002
0.9333	0.002	0.001	0.000	0.002
1.0889	0.002	0.001	0.000	0.002
1.2444	0.002	0.001	0.000	0.002
1.4000	0.002	0.001	0.000	0.002
1.5556	0.002	0.001	0.000	0.002
1.7111	0.002	0.001	0.000	0.002
1.8667	0.002	0.001	0.000	0.002
2.0222	0.002	0.002	0.000	0.002
2.1778	0.002	0.002	0.000	0.002
2.3333	0.002	0.002	0.000	0.002
2.4889	0.002	0.002	0.000	0.002
2.6444	0.002	0.002	0.000	0.002
2.8000	0.002	0.002	0.000	0.002
2.9556	0.002	0.003	0.000	0.002
3.1111	0.002	0.003	0.000	0.002
3.2667	0.002	0.003	0.000	0.002
3.4222	0.002	0.003	0.000	0.002
3.5778	0.002	0.003	0.000	0.002
3.7333	0.002	0.003	0.000	0.002

3.8889	0.002	0.004	0.000	0.002
4.0444	0.002	0.004	0.000	0.002
4.2000	0.002	0.004	0.000	0.002
4.3556	0.002	0.004	0.000	0.002
4.5111	0.002	0.004	0.000	0.002
4.6667	0.002	0.004	0.000	0.002
4.8222	0.002	0.005	0.000	0.002
4.9778	0.002	0.005	0.000	0.002
5.1333	0.002	0.005	0.000	0.002
5.2889	0.002	0.005	0.000	0.002
5.4444	0.002	0.005	0.000	0.002
5.6000	0.002	0.005	0.000	0.002
5.7556	0.002	0.005	0.000	0.002
5.9111	0.002	0.006	0.000	0.002
6.0667	0.002	0.006	0.151	0.002
6.2222	0.002	0.006	0.835	0.002
6.3778	0.002	0.006	1.337	0.002
6.5333	0.002	0.006	1.597	0.002
6.6889	0.002	0.006	1.815	0.002
6.8444	0.002	0.007	2.009	0.002
7.0000	0.002	0.007	2.187	0.002
7.1556	0.002	0.007	2.351	0.002
7.3111	0.002	0.007	2.504	0.002
7.4667	0.002	0.007	2.648	0.002
7.6222	0.002	0.007	2.785	0.002
7.7778	0.002	0.008	2.916	0.002
7.9333	0.002	0.008	3.041	0.002
8.0889	0.002	0.008	3.161	0.002
8.2444	0.002	0.008	3.276	0.002
8.4000	0.002	0.008	3.388	0.002
8.5556	0.002	0.008	3.496	0.002
8.7111	0.002	0.009	3.601	0.002
8.8667	0.002	0.009	3.703	0.002
9.0222	0.002	0.009	3.802	0.002
9.1778	0.002	0.009	3.899	0.002
9.3333	0.002	0.009	3.993	0.002
9.4889	0.002	0.009	4.085	0.002
9.6444	0.002	0.010	4.175	0.002
9.8000	0.002	0.010	4.263	0.002
9.9556	0.002	0.010	4.350	0.002
10.111	0.002	0.010	4.434	0.002
10.267	0.002	0.010	4.517	0.002
10.422	0.002	0.010	4.599	0.002
10.578	0.002	0.010	4.679	0.002
10.733	0.002	0.011	4.758	0.002
10.889	0.002	0.011	4.836	0.002
11.044	0.002	0.011	4.912	0.002
11.200	0.002	0.011	4.987	0.002
11.356	0.002	0.011	5.061	0.002
11.511	0.002	0.011	5.134	0.002
11.667	0.002	0.012	5.206	0.002
11.822	0.002	0.012	5.277	0.002
11.978	0.002	0.012	5.347	0.002
12.133	0.002	0.012	5.416	0.002
12.289	0.002	0.012	5.485	0.002
12.444	0.002	0.012	5.552	0.002
12.600	0.002	0.013	5.619	0.002
12.756	0.002	0.013	5.685	0.002

12.911	0.002	0.013	5.750	0.002
13.067	0.002	0.013	5.814	0.002
13.222	0.002	0.014	5.878	0.002
13.378	0.002	0.014	5.941	0.002
13.533	0.002	0.014	6.003	0.002
13.689	0.002	0.015	6.065	0.002
13.844	0.002	0.015	6.126	0.002
14.000	0.002	0.015	6.186	0.002

Gravel Trench Bed 2

Bottom Length:	760.00 ft.
Bottom Width:	6.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	1
Pour Space of material for first layer:	0.3
Material thickness of second layer:	5
Pour Space of material for second layer:	0.9
Material thickness of third layer:	2
Pour Space of material for third layer:	0.3
Infiltration On	
Infiltration rate:	10.5
Infiltration safety factor:	0.118
Total Volume Infiltrated (ac-ft.):	369.306
Total Volume Through Riser (ac-ft.):	0.357
Total Volume Through Facility (ac-ft.):	369.663
Percent Infiltrated:	99.9
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height:	7.5 ft.
Riser Diameter:	12 in.

Element Outlets:

Outlet 1 Outlet 2

Outlet Flows To:

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.104	0.000	0.000	0.000
0.0889	0.104	0.002	0.000	0.130
0.1778	0.104	0.005	0.000	0.130
0.2667	0.104	0.008	0.000	0.130
0.3556	0.104	0.011	0.000	0.130
0.4444	0.104	0.014	0.000	0.130
0.5333	0.104	0.016	0.000	0.130
0.6222	0.104	0.019	0.000	0.130
0.7111	0.104	0.022	0.000	0.130
0.8000	0.104	0.025	0.000	0.130
0.8889	0.104	0.027	0.000	0.130
0.9778	0.104	0.030	0.000	0.130
1.0667	0.104	0.039	0.000	0.130
1.1556	0.104	0.047	0.000	0.130
1.2444	0.104	0.055	0.000	0.130
1.3333	0.104	0.064	0.000	0.130
1.4222	0.104	0.072	0.000	0.130
1.5111	0.104	0.081	0.000	0.130
1.6000	0.104	0.089	0.000	0.130
1.6889	0.104	0.097	0.000	0.130
1.7778	0.104	0.106	0.000	0.130
1.8667	0.104	0.114	0.000	0.130
1.9556	0.104	0.122	0.000	0.130
2.0444	0.104	0.131	0.000	0.130
2.1333	0.104	0.139	0.000	0.130

2.2222	0.104	0.148	0.000	0.130
2.3111	0.104	0.156	0.000	0.130
2.4000	0.104	0.164	0.000	0.130
2.4889	0.104	0.173	0.000	0.130
2.5778	0.104	0.181	0.000	0.130
2.6667	0.104	0.189	0.000	0.130
2.7556	0.104	0.198	0.000	0.130
2.8444	0.104	0.206	0.000	0.130
2.9333	0.104	0.214	0.000	0.130
3.0222	0.104	0.223	0.000	0.130
3.1111	0.104	0.231	0.000	0.130
3.2000	0.104	0.240	0.000	0.130
3.2889	0.104	0.248	0.000	0.130
3.3778	0.104	0.256	0.000	0.130
3.4667	0.104	0.265	0.000	0.130
3.5556	0.104	0.273	0.000	0.130
3.6444	0.104	0.281	0.000	0.130
3.7333	0.104	0.290	0.000	0.130
3.8222	0.104	0.298	0.000	0.130
3.9111	0.104	0.307	0.000	0.130
4.0000	0.104	0.315	0.000	0.130
4.0889	0.104	0.323	0.000	0.130
4.1778	0.104	0.332	0.000	0.130
4.2667	0.104	0.340	0.000	0.130
4.3556	0.104	0.348	0.000	0.130
4.4444	0.104	0.357	0.000	0.130
4.5333	0.104	0.365	0.000	0.130
4.6222	0.104	0.374	0.000	0.130
4.7111	0.104	0.382	0.000	0.130
4.8000	0.104	0.390	0.000	0.130
4.8889	0.104	0.399	0.000	0.130
4.9778	0.104	0.407	0.000	0.130
5.0667	0.104	0.415	0.000	0.130
5.1556	0.104	0.424	0.000	0.130
5.2444	0.104	0.432	0.000	0.130
5.3333	0.104	0.441	0.000	0.130
5.4222	0.104	0.449	0.000	0.130
5.5111	0.104	0.457	0.000	0.130
5.6000	0.104	0.466	0.000	0.130
5.6889	0.104	0.474	0.000	0.130
5.7778	0.104	0.482	0.000	0.130
5.8667	0.104	0.491	0.000	0.130
5.9556	0.104	0.499	0.000	0.130
6.0444	0.104	0.502	0.000	0.130
6.1333	0.104	0.505	0.000	0.130
6.2222	0.104	0.508	0.000	0.130
6.3111	0.104	0.510	0.000	0.130
6.4000	0.104	0.513	0.000	0.130
6.4889	0.104	0.516	0.000	0.130
6.5778	0.104	0.519	0.000	0.130
6.6667	0.104	0.522	0.000	0.130
6.7556	0.104	0.524	0.000	0.130
6.8444	0.104	0.527	0.000	0.130
6.9333	0.104	0.530	0.000	0.130
7.0222	0.104	0.533	0.000	0.130
7.1111	0.104	0.536	0.000	0.130
7.2000	0.104	0.538	0.000	0.130
7.2889	0.104	0.541	0.000	0.130

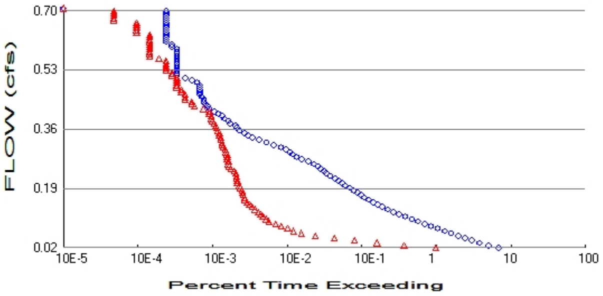
Exhibit 9 SUB25-1003

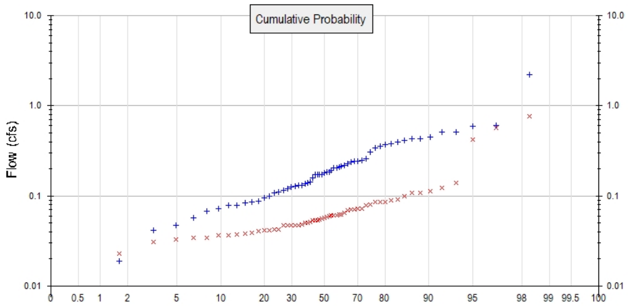
7.3778	0.104	0.544	0.000	0.130
7.4667	0.104	0.547	0.000	0.130
7.5556	0.104	0.549	0.138	0.130
7.6444	0.104	0.552	0.572	0.130
7.7333	0.104	0.555	1.115	0.130
7.8222	0.104	0.558	1.627	0.130
7.9111	0.104	0.561	1.996	0.130
8.0000	0.104	0.563	2.203	0.130

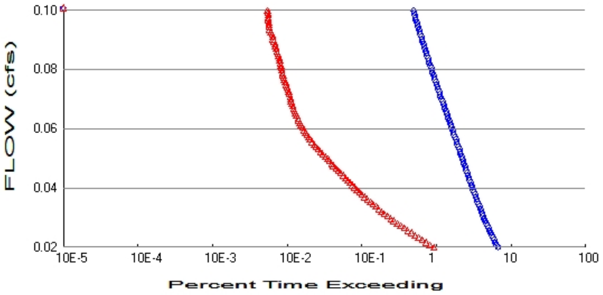
Exhibit 9 SUB25-1003

Analysis Results

POC 1







+ Predeveloped   x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	4.69
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	2.027
Total Impervious Area:	1.313

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.192774
5 year	0.369829
10 year	0.484555
25 year	0.615957
50 year	0.701957
100 year	0.77776

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.058024
5 year	0.104249
10 year	0.149067
25 year	0.227323
50 year	0.305475
100 year	0.404774

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.204	0.060
1950	0.194	0.047
1951	0.372	0.092
1952	0.131	0.047
1953	0.217	0.061
1954	0.431	0.112
1955	0.172	0.048
1956	0.513	0.109
1957	0.259	0.079
1958	0.143	0.065
1959	0.128	0.033
1960	0.100	0.035
1961	0.240	0.072
1962	0.088	0.037
1963	0.120	0.052
1964	0.183	0.053
1965	0.245	0.062
1966	0.207	0.062
1967	0.172	0.061
1968	0.213	0.070
1969	0.243	0.081
1970	2.231	0.422
1971	0.114	0.037
1972	0.203	0.054
1973	0.079	0.042
1974	0.378	0.085
1975	0.173	0.041
1976	0.355	0.085
1977	0.004	0.023
1978	0.507	0.122
1979	0.057	0.053
1980	0.184	0.043
1981	0.410	0.099
1982	0.308	0.073
1983	0.610	0.141
1984	0.138	0.038
1985	0.125	0.031
1986	0.096	0.047
1987	0.398	0.089
1988	0.085	0.037
1989	0.067	0.048
1990	0.084	0.042
1991	0.132	0.057
1992	0.158	0.059
1993	0.078	0.055
1994	0.181	0.050
1995	0.109	0.039
1996	0.595	0.769
1997	0.453	0.564
1998	0.135	0.071
1999	0.229	0.061
2000	0.173	0.050
2001	0.019	0.023
2002	0.431	0.109
2003	0.341	0.086
2004	0.047	0.041

Exhibit 9 SUB25-1003

2005	0.042	0.047
2006	0.243	0.054
2007	0.110	0.034
2008	0.072	0.071

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	2.2314	0.7689
2	0.6098	0.5644
3	0.5953	0.4218
4	0.5126	0.1406
5	0.5068	0.1217
6	0.4528	0.1124
7	0.4315	0.1090
8	0.4310	0.1089
9	0.4096	0.0991
10	0.3979	0.0921
11	0.3779	0.0892
12	0.3722	0.0860
13	0.3547	0.0855
14	0.3410	0.0846
15	0.3082	0.0806
16	0.2585	0.0786
17	0.2453	0.0729
18	0.2431	0.0720
19	0.2431	0.0710
20	0.2397	0.0706
21	0.2291	0.0696
22	0.2174	0.0651
23	0.2125	0.0618
24	0.2070	0.0616
25	0.2045	0.0613
26	0.2026	0.0612
27	0.1935	0.0607
28	0.1842	0.0598
29	0.1830	0.0588
30	0.1813	0.0569
31	0.1729	0.0554
32	0.1728	0.0544
33	0.1718	0.0536
34	0.1717	0.0534
35	0.1582	0.0533
36	0.1429	0.0516
37	0.1380	0.0504
38	0.1355	0.0497
39	0.1317	0.0479
40	0.1312	0.0475
41	0.1278	0.0471
42	0.1250	0.0468
43	0.1204	0.0468
44	0.1143	0.0466
45	0.1100	0.0428
46	0.1090	0.0425
47	0.0998	0.0419
48	0.0960	0.0415
49	0.0881	0.0409
50	0.0850	0.0388

51	0.0841	0.0377
52	0.0790	0.0372
53	0.0781	0.0367
54	0.0722	0.0367
55	0.0670	0.0346
56	0.0571	0.0344
57	0.0467	0.0328
58	0.0416	0.0310
59	0.0189	0.0227
60	0.0037	0.0226

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0154	140200	19385	13	Pass
0.0162	134646	17184	12	Pass
0.0171	129302	15308	11	Pass
0.0179	124337	13580	10	Pass
0.0187	119645	12133	10	Pass
0.0195	115375	10795	9	Pass
0.0203	111335	9697	8	Pass
0.0211	107548	8699	8	Pass
0.0220	104056	7786	7	Pass
0.0228	100732	6981	6	Pass
0.0236	97576	6257	6	Pass
0.0244	94652	5668	5	Pass
0.0252	91770	5148	5	Pass
0.0261	88992	4643	5	Pass
0.0269	86363	4210	4	Pass
0.0277	83838	3846	4	Pass
0.0285	81419	3516	4	Pass
0.0293	79146	3242	4	Pass
0.0301	76916	2977	3	Pass
0.0310	74770	2729	3	Pass
0.0318	72709	2501	3	Pass
0.0326	70731	2289	3	Pass
0.0334	68753	2112	3	Pass
0.0342	66881	1958	2	Pass
0.0350	65135	1809	2	Pass
0.0359	63431	1689	2	Pass
0.0367	61769	1576	2	Pass
0.0375	60212	1451	2	Pass
0.0383	58676	1352	2	Pass
0.0391	57140	1268	2	Pass
0.0400	55647	1185	2	Pass
0.0408	54195	1091	2	Pass
0.0416	52869	1023	1	Pass
0.0424	51607	949	1	Pass
0.0432	50324	880	1	Pass
0.0440	49125	825	1	Pass
0.0449	47947	773	1	Pass
0.0457	46789	734	1	Pass
0.0465	45632	678	1	Pass
0.0473	44496	629	1	Pass
0.0481	43402	586	1	Pass
0.0490	42287	548	1	Pass
0.0498	41214	513	1	Pass
0.0506	40183	480	1	Pass
0.0514	39195	449	1	Pass
0.0522	38206	427	1	Pass
0.0530	37238	405	1	Pass
0.0539	36333	387	1	Pass
0.0547	35408	370	1	Pass
0.0555	34545	352	1	Pass
0.0563	33619	339	1	Pass
0.0571	32799	320	0	Pass
0.0579	31978	311	0	Pass

0.0588	31179	301	0	Pass
0.0596	30379	293	0	Pass
0.0604	29622	282	0	Pass
0.0612	28844	272	0	Pass
0.0620	28107	264	0	Pass
0.0629	27371	257	0	Pass
0.0637	26656	250	0	Pass
0.0645	25940	241	0	Pass
0.0653	25267	236	0	Pass
0.0661	24573	233	0	Pass
0.0669	23963	230	0	Pass
0.0678	23374	223	0	Pass
0.0686	22764	221	0	Pass
0.0694	22196	216	0	Pass
0.0702	21670	211	0	Pass
0.0710	21123	202	0	Pass
0.0719	20599	199	0	Pass
0.0727	20119	190	0	Pass
0.0735	19612	188	0	Pass
0.0743	19130	186	0	Pass
0.0751	18680	182	0	Pass
0.0759	18221	177	0	Pass
0.0768	17820	175	0	Pass
0.0776	17390	173	0	Pass
0.0784	16974	170	1	Pass
0.0792	16545	168	1	Pass
0.0800	16157	166	1	Pass
0.0808	15796	159	1	Pass
0.0817	15461	157	1	Pass
0.0825	15103	153	1	Pass
0.0833	14782	149	1	Pass
0.0841	14420	146	1	Pass
0.0849	14104	144	1	Pass
0.0858	13774	140	1	Pass
0.0866	13456	136	1	Pass
0.0874	13157	134	1	Pass
0.0882	12850	132	1	Pass
0.0890	12535	127	1	Pass
0.0898	12265	121	0	Pass
0.0907	12005	120	0	Pass
0.0915	11754	120	1	Pass
0.0923	11489	119	1	Pass
0.0931	11228	117	1	Pass
0.0939	10955	117	1	Pass
0.0948	10732	117	1	Pass
0.0956	10513	115	1	Pass
0.0964	10292	114	1	Pass

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0154	143229	20666	14	Pass
0.0224	103888	7757	7	Pass
0.0293	80051	3360	4	Pass
0.0362	63136	1672	2	Pass
0.0432	50660	894	1	Pass
0.0501	40920	500	1	Pass
0.0570	32925	324	0	Pass
0.0640	27245	255	0	Pass
0.0709	21796	212	0	Pass
0.0778	17687	175	0	Pass
0.0848	14472	147	1	Pass
0.0917	11899	120	1	Pass
0.0986	9817	111	1	Pass
0.1056	7992	100	1	Pass
0.1125	6598	93	1	Pass
0.1194	5527	86	1	Pass
0.1264	4643	77	1	Pass
0.1333	3934	71	1	Pass
0.1402	3396	66	1	Pass
0.1472	2990	61	2	Pass
0.1541	2596	57	2	Pass
0.1611	2291	56	2	Pass
0.1680	2060	54	2	Pass
0.1749	1829	53	2	Pass
0.1819	1628	52	3	Pass
0.1888	1433	50	3	Pass
0.1957	1257	48	3	Pass
0.2027	1127	45	3	Pass
0.2096	1023	45	4	Pass
0.2165	920	44	4	Pass
0.2235	787	44	5	Pass
0.2304	705	43	6	Pass
0.2373	648	41	6	Pass
0.2443	590	37	6	Pass
0.2512	542	35	6	Pass
0.2581	476	34	7	Pass
0.2651	399	34	8	Pass
0.2720	330	33	10	Pass
0.2789	282	33	11	Pass
0.2859	250	33	13	Pass
0.2928	229	32	13	Pass
0.2997	203	31	15	Pass
0.3067	172	29	16	Pass
0.3136	137	28	20	Pass
0.3205	111	28	25	Pass
0.3275	89	27	30	Pass
0.3344	72	27	37	Pass
0.3414	63	26	41	Pass
0.3483	56	26	46	Pass
0.3552	48	25	52	Pass
0.3622	44	24	54	Pass
0.3691	43	23	53	Pass
0.3760	36	22	61	Pass

0.3830	34	21	61	Pass
0.3899	30	20	66	Pass
0.3968	28	20	71	Pass
0.4038	25	19	76	Pass
0.4107	22	19	86	Pass
0.4176	19	16	84	Pass
0.4246	18	12	66	Pass
0.4315	17	11	64	Pass
0.4384	16	11	68	Pass
0.4454	16	9	56	Pass
0.4523	15	9	60	Pass
0.4592	14	9	64	Pass
0.4662	14	8	57	Pass
0.4731	14	8	57	Pass
0.4800	14	7	50	Pass
0.4870	14	7	50	Pass
0.4939	13	7	53	Pass
0.5009	11	7	63	Pass
0.5078	9	7	77	Pass
0.5147	7	6	85	Pass
0.5217	7	6	85	Pass
0.5286	7	5	71	Pass
0.5355	7	5	71	Pass
0.5425	7	5	71	Pass
0.5494	7	5	71	Pass
0.5563	7	5	71	Pass
0.5633	7	4	57	Pass
0.5702	7	3	42	Pass
0.5771	7	3	42	Pass
0.5841	7	3	42	Pass
0.5910	7	3	42	Pass
0.5979	6	3	50	Pass
0.6049	6	3	50	Pass
0.6118	5	3	60	Pass
0.6187	5	3	60	Pass
0.6257	5	3	60	Pass
0.6326	5	3	60	Pass
0.6395	5	2	40	Pass
0.6465	5	2	40	Pass
0.6534	5	2	40	Pass
0.6603	5	2	40	Pass
0.6673	5	2	40	Pass
0.6742	5	1	20	Pass
0.6812	5	1	20	Pass
0.6881	5	1	20	Pass
0.6950	5	1	20	Pass
0.7020	5	1	20	Pass

Exhibit 9 SUB25-1003

Water Quality

Water Quality BMP Flow and Volume for POC #1

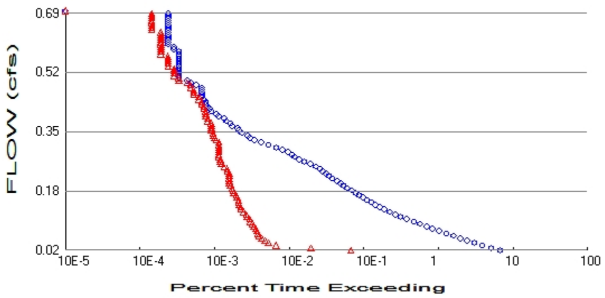
On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

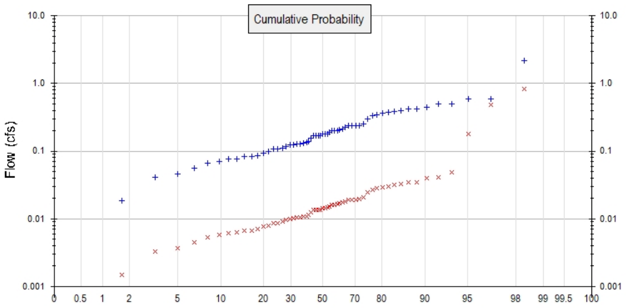
LID Report

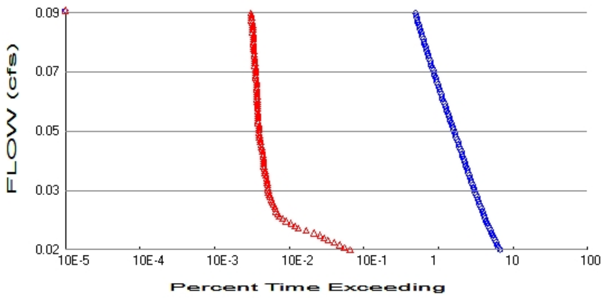
LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Gravel Trench Bed 1 POC	☐	253.78			☐	99.86			
DRYWELL 1	☐	304.76			☐	16.73			
Total Volume Infiltrated		558.54	0.00	0.00		54.50	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Exhibit 9 SUB25-1003

POC 2







+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2

Total Pervious Area:	4.59
Total Impervious Area:	0

Mitigated Landuse Totals for POC #2

Total Pervious Area:	1.688
Total Impervious Area:	1.679

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.188664
5 year	0.361944
10 year	0.474223
25 year	0.602824
50 year	0.68699
100 year	0.761176

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.013542
5 year	0.037169
10 year	0.065869
25 year	0.125498
50 year	0.194015
100 year	0.29086

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**

Exhibit 9 SUB25-1003

1949	0.200	0.016
1950	0.189	0.015
1951	0.364	0.030
1952	0.128	0.010
1953	0.213	0.017
1954	0.422	0.034
1955	0.168	0.014
1956	0.502	0.041
1957	0.253	0.021
1958	0.140	0.011
1959	0.125	0.010
1960	0.098	0.008
1961	0.235	0.019
1962	0.086	0.007
1963	0.118	0.010
1964	0.179	0.015
1965	0.240	0.019
1966	0.203	0.016
1967	0.168	0.014
1968	0.208	0.017
1969	0.238	0.019
1970	2.184	0.177
1971	0.112	0.009
1972	0.198	0.016
1973	0.077	0.006
1974	0.370	0.030
1975	0.169	0.014
1976	0.347	0.028
1977	0.004	0.000
1978	0.496	0.040
1979	0.056	0.005
1980	0.180	0.015
1981	0.401	0.032
1982	0.302	0.024
1983	0.597	0.048
1984	0.135	0.011
1985	0.122	0.010
1986	0.094	0.008
1987	0.389	0.032
1988	0.083	0.007
1989	0.066	0.005
1990	0.082	0.007
1991	0.129	0.010
1992	0.155	0.013
1993	0.076	0.006
1994	0.177	0.014
1995	0.107	0.009
1996	0.583	0.835
1997	0.443	0.485
1998	0.133	0.011
1999	0.224	0.018
2000	0.169	0.014
2001	0.018	0.001
2002	0.422	0.034
2003	0.334	0.027
2004	0.046	0.004
2005	0.041	0.003
2006	0.238	0.019

2007	0.108	0.009
2008	0.071	0.006

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	2.1839	0.8352
2	0.5968	0.4846
3	0.5826	0.1770
4	0.5016	0.0484
5	0.4960	0.0407
6	0.4431	0.0402
7	0.4223	0.0342
8	0.4218	0.0342
9	0.4009	0.0325
10	0.3894	0.0316
11	0.3698	0.0300
12	0.3642	0.0295
13	0.3471	0.0281
14	0.3337	0.0270
15	0.3016	0.0244
16	0.2530	0.0205
17	0.2401	0.0195
18	0.2380	0.0193
19	0.2379	0.0193
20	0.2346	0.0190
21	0.2243	0.0182
22	0.2128	0.0172
23	0.2080	0.0169
24	0.2026	0.0164
25	0.2001	0.0162
26	0.1983	0.0161
27	0.1894	0.0154
28	0.1803	0.0146
29	0.1791	0.0145
30	0.1774	0.0144
31	0.1693	0.0137
32	0.1692	0.0137
33	0.1681	0.0136
34	0.1681	0.0136
35	0.1548	0.0125
36	0.1398	0.0113
37	0.1351	0.0109
38	0.1326	0.0107
39	0.1289	0.0104
40	0.1284	0.0104
41	0.1250	0.0101
42	0.1223	0.0099
43	0.1178	0.0096
44	0.1118	0.0091
45	0.1076	0.0087
46	0.1066	0.0086
47	0.0977	0.0079
48	0.0940	0.0076
49	0.0862	0.0070
50	0.0832	0.0067
51	0.0823	0.0067
52	0.0774	0.0063

53	0.0764	0.0062
54	0.0707	0.0057
55	0.0655	0.0053
56	0.0559	0.0045
57	0.0457	0.0037
58	0.0407	0.0033
59	0.0185	0.0015
60	0.0037	0.0003

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0151	140200	1373	0	Pass
0.0159	134604	1155	0	Pass
0.0167	129281	1009	0	Pass
0.0175	124316	840	0	Pass
0.0183	119666	699	0	Pass
0.0191	115396	615	0	Pass
0.0199	111314	547	0	Pass
0.0207	107548	457	0	Pass
0.0215	104077	352	0	Pass
0.0223	100753	277	0	Pass
0.0231	97618	249	0	Pass
0.0239	94652	223	0	Pass
0.0247	91770	191	0	Pass
0.0255	88992	171	0	Pass
0.0263	86384	155	0	Pass
0.0271	83838	147	0	Pass
0.0279	81440	140	0	Pass
0.0287	79146	138	0	Pass
0.0295	76895	135	0	Pass
0.0303	74770	128	0	Pass
0.0311	72688	125	0	Pass
0.0319	70710	120	0	Pass
0.0327	68753	116	0	Pass
0.0335	66881	114	0	Pass
0.0343	65135	110	0	Pass
0.0351	63431	110	0	Pass
0.0359	61769	109	0	Pass
0.0367	60212	108	0	Pass
0.0375	58676	107	0	Pass
0.0383	57140	106	0	Pass
0.0391	55647	104	0	Pass
0.0399	54195	102	0	Pass
0.0407	52869	99	0	Pass
0.0415	51607	99	0	Pass
0.0423	50324	97	0	Pass
0.0431	49125	96	0	Pass
0.0439	47947	95	0	Pass
0.0447	46810	95	0	Pass
0.0455	45632	95	0	Pass
0.0463	44496	94	0	Pass
0.0471	43423	94	0	Pass
0.0479	42287	92	0	Pass
0.0487	41214	91	0	Pass
0.0495	40183	90	0	Pass
0.0503	39195	88	0	Pass
0.0511	38206	87	0	Pass
0.0519	37238	86	0	Pass
0.0527	36312	84	0	Pass
0.0535	35387	84	0	Pass
0.0543	34545	83	0	Pass
0.0551	33619	83	0	Pass
0.0559	32799	83	0	Pass
0.0567	31978	83	0	Pass

0.0575	31179	81	0	Pass
0.0583	30379	80	0	Pass
0.0591	29622	80	0	Pass
0.0599	28865	80	0	Pass
0.0607	28107	80	0	Pass
0.0615	27371	79	0	Pass
0.0623	26656	79	0	Pass
0.0631	25940	79	0	Pass
0.0639	25267	79	0	Pass
0.0647	24573	78	0	Pass
0.0655	23984	78	0	Pass
0.0663	23374	78	0	Pass
0.0671	22764	77	0	Pass
0.0679	22196	77	0	Pass
0.0687	21670	77	0	Pass
0.0695	21144	77	0	Pass
0.0703	20597	77	0	Pass
0.0711	20117	77	0	Pass
0.0719	19612	76	0	Pass
0.0727	19128	75	0	Pass
0.0735	18678	75	0	Pass
0.0743	18221	75	0	Pass
0.0751	17815	75	0	Pass
0.0759	17388	75	0	Pass
0.0767	16974	73	0	Pass
0.0775	16545	73	0	Pass
0.0783	16160	72	0	Pass
0.0791	15796	72	0	Pass
0.0799	15461	71	0	Pass
0.0807	15103	71	0	Pass
0.0815	14784	71	0	Pass
0.0823	14420	70	0	Pass
0.0831	14104	70	0	Pass
0.0839	13774	70	0	Pass
0.0847	13460	70	0	Pass
0.0855	13157	70	0	Pass
0.0863	12850	70	0	Pass
0.0871	12537	70	0	Pass
0.0879	12267	68	0	Pass
0.0887	12005	68	0	Pass
0.0895	11758	68	0	Pass
0.0903	11487	68	0	Pass
0.0911	11228	67	0	Pass
0.0919	10955	66	0	Pass
0.0927	10732	66	0	Pass
0.0935	10513	65	0	Pass
0.0943	10292	64	0	Pass

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0151	140852	1402	0	Pass
0.0219	106181	412	0	Pass
0.0287	81124	140	0	Pass
0.0355	63641	110	0	Pass
0.0422	50787	99	0	Pass
0.0490	40836	90	0	Pass
0.0558	33746	83	0	Pass
0.0626	26929	79	0	Pass
0.0694	21459	77	0	Pass
0.0762	17342	75	0	Pass
0.0830	14556	70	0	Pass
0.0897	11920	68	0	Pass
0.0965	9791	63	0	Pass
0.1033	7950	62	0	Pass
0.1101	6524	57	0	Pass
0.1169	5590	56	1	Pass
0.1237	4689	51	1	Pass
0.1305	3949	47	1	Pass
0.1373	3396	47	1	Pass
0.1440	2979	45	1	Pass
0.1508	2636	44	1	Pass
0.1576	2314	44	1	Pass
0.1644	2039	42	2	Pass
0.1712	1804	41	2	Pass
0.1780	1631	38	2	Pass
0.1848	1432	37	2	Pass
0.1916	1255	36	2	Pass
0.1983	1123	34	3	Pass
0.2051	1015	33	3	Pass
0.2119	928	33	3	Pass
0.2187	792	33	4	Pass
0.2255	709	33	4	Pass
0.2323	648	33	5	Pass
0.2391	590	31	5	Pass
0.2458	543	31	5	Pass
0.2526	481	28	5	Pass
0.2594	402	26	6	Pass
0.2662	335	25	7	Pass
0.2730	283	25	8	Pass
0.2798	250	24	9	Pass
0.2866	229	24	10	Pass
0.2934	202	24	11	Pass
0.3001	170	24	14	Pass
0.3069	141	24	17	Pass
0.3137	111	24	21	Pass
0.3205	89	24	26	Pass
0.3273	72	22	30	Pass
0.3341	63	21	33	Pass
0.3409	58	20	34	Pass
0.3476	49	20	40	Pass
0.3544	44	19	43	Pass
0.3612	43	19	44	Pass
0.3680	36	19	52	Pass

0.3748	34	19	55	Pass
0.3816	30	17	56	Pass
0.3884	28	17	60	Pass
0.3952	24	16	66	Pass
0.4019	22	16	72	Pass
0.4087	19	16	84	Pass
0.4155	18	15	83	Pass
0.4223	17	15	88	Pass
0.4291	16	14	87	Pass
0.4359	16	14	87	Pass
0.4427	15	13	86	Pass
0.4495	14	13	92	Pass
0.4562	14	11	78	Pass
0.4630	14	11	78	Pass
0.4698	14	11	78	Pass
0.4766	14	10	71	Pass
0.4834	12	10	83	Pass
0.4902	10	9	90	Pass
0.4970	9	7	77	Pass
0.5037	7	7	100	Pass
0.5105	7	6	85	Pass
0.5173	7	6	85	Pass
0.5241	7	6	85	Pass
0.5309	7	6	85	Pass
0.5377	7	5	71	Pass
0.5445	7	5	71	Pass
0.5513	7	5	71	Pass
0.5580	7	5	71	Pass
0.5648	7	5	71	Pass
0.5716	7	4	57	Pass
0.5784	7	4	57	Pass
0.5852	6	4	66	Pass
0.5920	6	4	66	Pass
0.5988	5	4	80	Pass
0.6055	5	4	80	Pass
0.6123	5	4	80	Pass
0.6191	5	4	80	Pass
0.6259	5	4	80	Pass
0.6327	5	4	80	Pass
0.6395	5	3	60	Pass
0.6463	5	3	60	Pass
0.6531	5	3	60	Pass
0.6598	5	3	60	Pass
0.6666	5	3	60	Pass
0.6734	5	3	60	Pass
0.6802	5	3	60	Pass
0.6870	5	3	60	Pass

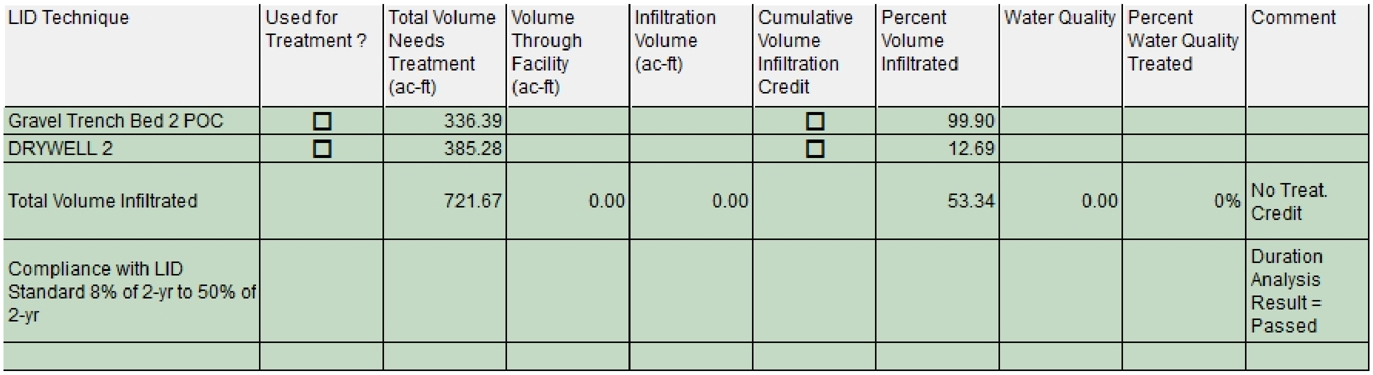
Water Quality

Water Quality BMP Flow and Volume for POC #2

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

Exhibit 9 SUB25-1003

LID Report



LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Gravel Trench Bed 2 POC	☐	336.39			☐	99.90			
DRYWELL 2	☐	385.28			☐	12.69			
Total Volume Infiltrated		721.67	0.00	0.00		53.34	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

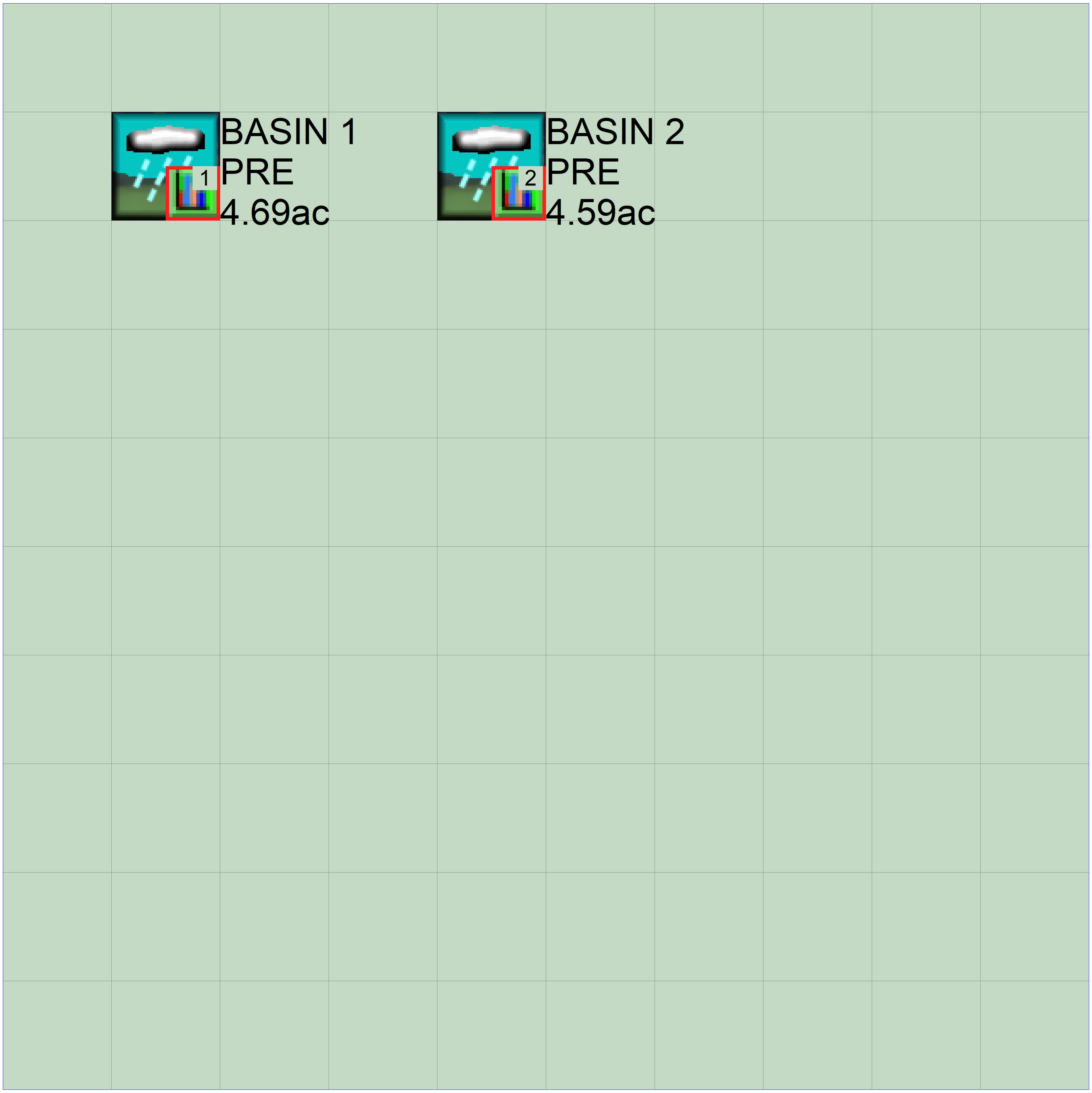
No PERLND changes have been made.

IMPLND Changes

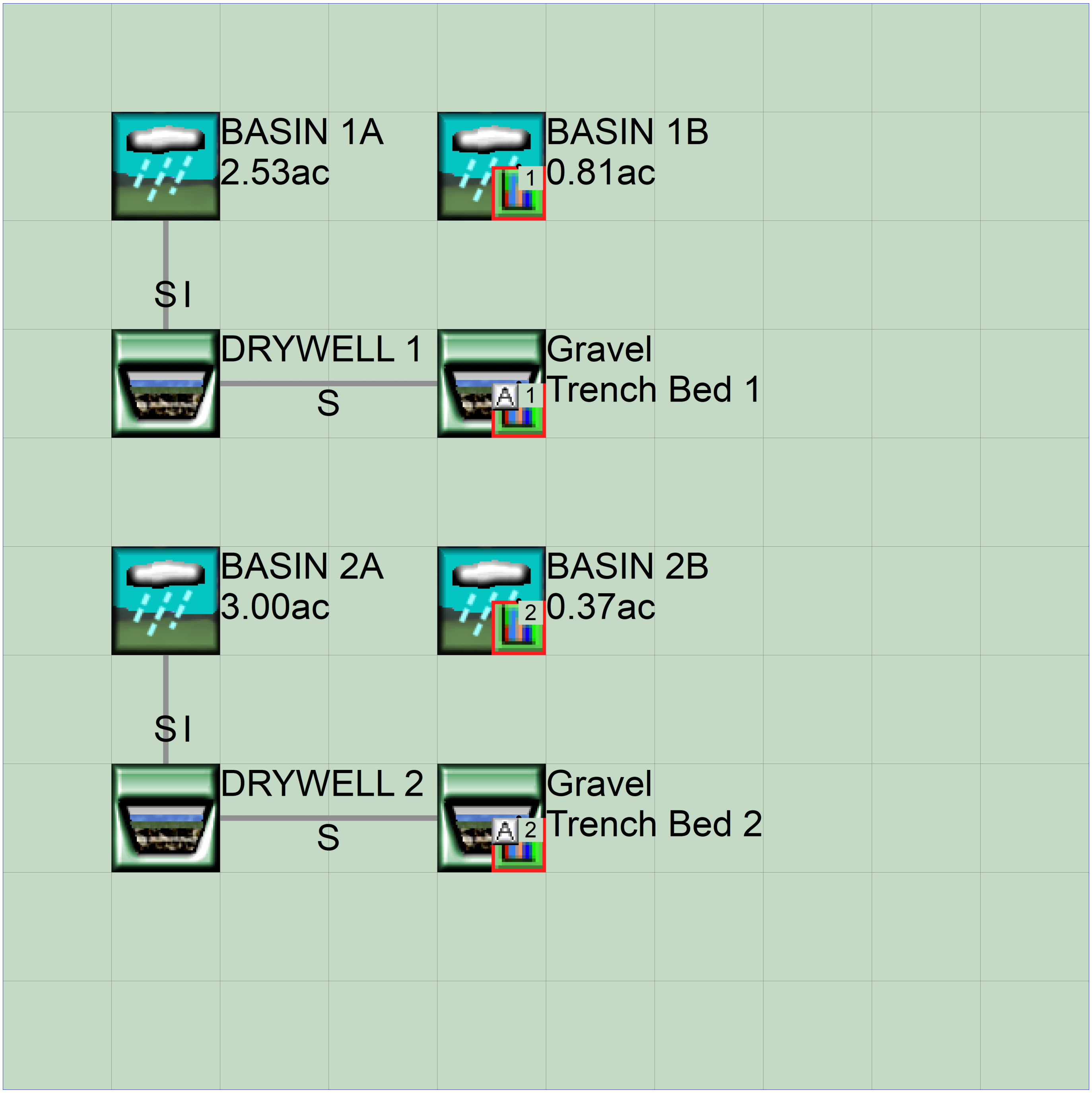
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Disclaimer

Legal Notice

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Exhibit 9 SUB25-1003

WWHM2012

PROJECT REPORT

TDAs #1 AND #2 Water Quality for Basins #1 & #2 (Mechanical Filter Manhole)

General Model Information

WWHM2012 Project Name: 8397 WWHM WQ

Site Name:	Camas Woods III
Site Address:	Water Quality
City:	Camas
Report Date:	3/13/2025
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.300
Version Date:	2024/06/28
Version:	4.3.1

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

BASIN 1 PRE WQ

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Forest, Flat	2.06
Pervious Total	2.06
Impervious Land Use	acre
Impervious Total	0
Basin Total	2.06

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

BASIN 2 PRE WQ

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Forest, Flat	2.555
Pervious Total	2.555
Impervious Land Use	acre
Impervious Total	0
Basin Total	2.555

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 2	POC 2	

Mitigated Land Use

BASIN 1 WQ

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Flat	0.817
Pervious Total	0.817
Impervious Land Use	acre
ROADS FLAT	0.537
DRIVEWAYS FLAT	0.428
SIDEWALKS FLAT	0.23
PARKING FLAT	0.048
Impervious Total	1.243
Basin Total	2.06

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

BASIN 2 WQ

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Flat	0.987
Pervious Total	0.987
Impervious Land Use	acre
ROADS FLAT	0.79
DRIVEWAYS FLAT	0.383
SIDEWALKS FLAT	0.289
PARKING FLAT	0.106
Impervious Total	1.568
Basin Total	2.555

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 2	POC 2	

Routing Elements

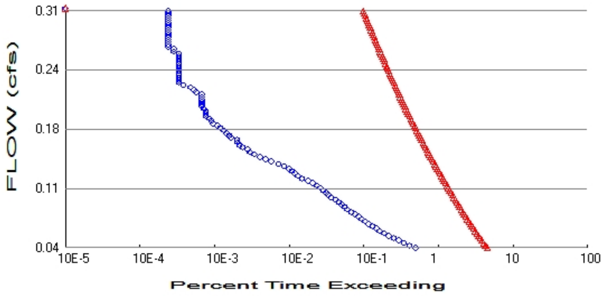
Predeveloped Routing

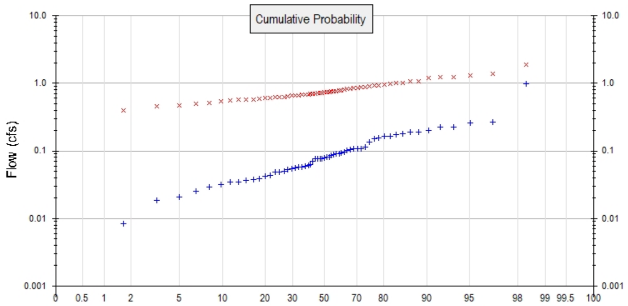
Mitigated Routing

Exhibit 9 SUB25-1003

Analysis Results

POC 1





+ Predeveloped   x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	2.06
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	0.817
Total Impervious Area:	1.243

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.084673
5 year	0.162441
10 year	0.212832
25 year	0.270548
50 year	0.308322
100 year	0.341617

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.739423
5 year	0.962872
10 year	1.115074
25 year	1.312796
50 year	1.464271
100 year	1.6195

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.090	1.062
1950	0.085	0.624
1951	0.163	0.755
1952	0.058	0.698
1953	0.095	0.675
1954	0.189	0.978
1955	0.075	0.605
1956	0.225	0.794
1957	0.114	0.821
1958	0.063	0.914

Exhibit 9 SUB25-1003

1959	0.056	0.568
1960	0.044	0.554
1961	0.105	0.736
1962	0.039	0.611
1963	0.053	0.754
1964	0.080	0.545
1965	0.108	0.580
1966	0.091	0.677
1967	0.075	0.699
1968	0.093	1.245
1969	0.107	1.193
1970	0.980	1.868
1971	0.050	0.651
1972	0.089	0.885
1973	0.035	0.742
1974	0.166	0.728
1975	0.076	0.501
1976	0.156	0.626
1977	0.002	0.402
1978	0.223	0.937
1979	0.025	1.009
1980	0.081	0.517
1981	0.180	0.873
1982	0.135	0.774
1983	0.268	1.000
1984	0.061	0.458
1985	0.055	0.579
1986	0.042	0.842
1987	0.175	0.590
1988	0.037	0.669
1989	0.029	0.846
1990	0.037	0.755
1991	0.058	0.799
1992	0.069	0.728
1993	0.034	0.922
1994	0.080	0.659
1995	0.048	0.684
1996	0.261	1.075
1997	0.199	1.396
1998	0.060	1.301
1999	0.101	0.625
2000	0.076	0.473
2001	0.008	0.386
2002	0.190	0.946
2003	0.150	0.703
2004	0.021	0.725
2005	0.018	0.825
2006	0.107	0.743
2007	0.048	0.637
2008	0.032	1.239

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.9801	1.8676
2	0.2679	1.3964
3	0.2615	1.3007
4	0.2251	1.2453

5	0.2226	1.2392
6	0.1989	1.1933
7	0.1895	1.0753
8	0.1893	1.0621
9	0.1799	1.0089
10	0.1748	0.9996
11	0.1660	0.9781
12	0.1635	0.9462
13	0.1558	0.9369
14	0.1498	0.9219
15	0.1354	0.9144
16	0.1136	0.8854
17	0.1078	0.8731
18	0.1068	0.8461
19	0.1068	0.8416
20	0.1053	0.8246
21	0.1006	0.8209
22	0.0955	0.7992
23	0.0933	0.7942
24	0.0909	0.7742
25	0.0898	0.7553
26	0.0890	0.7553
27	0.0850	0.7538
28	0.0809	0.7425
29	0.0804	0.7417
30	0.0796	0.7362
31	0.0760	0.7284
32	0.0759	0.7276
33	0.0755	0.7247
34	0.0754	0.7027
35	0.0695	0.6987
36	0.0627	0.6976
37	0.0606	0.6839
38	0.0595	0.6769
39	0.0578	0.6748
40	0.0576	0.6687
41	0.0561	0.6586
42	0.0549	0.6514
43	0.0529	0.6368
44	0.0502	0.6259
45	0.0483	0.6252
46	0.0479	0.6240
47	0.0438	0.6108
48	0.0422	0.6050
49	0.0387	0.5899
50	0.0374	0.5802
51	0.0369	0.5788
52	0.0347	0.5679
53	0.0343	0.5539
54	0.0317	0.5446
55	0.0294	0.5174
56	0.0251	0.5008
57	0.0205	0.4733
58	0.0183	0.4576
59	0.0083	0.4021
60	0.0016	0.3864

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0423	10294	94610	919	Fail
0.0450	8563	89371	1043	Fail
0.0477	7237	84595	1168	Fail
0.0504	6156	80156	1302	Fail
0.0531	5272	75991	1441	Fail
0.0558	4540	72141	1589	Fail
0.0585	3928	68606	1746	Fail
0.0611	3459	65303	1887	Fail
0.0638	3088	62168	2013	Fail
0.0665	2733	59265	2168	Fail
0.0692	2426	56446	2326	Fail
0.0719	2190	53795	2456	Fail
0.0746	1967	51313	2608	Fail
0.0773	1770	48851	2759	Fail
0.0800	1594	46684	2928	Fail
0.0826	1427	44622	3126	Fail
0.0853	1268	42645	3363	Fail
0.0880	1155	40730	3526	Fail
0.0907	1054	38921	3692	Fail
0.0934	976	37196	3811	Fail
0.0961	874	35534	4065	Fail
0.0988	763	34040	4461	Fail
0.1014	696	32631	4688	Fail
0.1041	648	31221	4818	Fail
0.1068	597	29875	5004	Fail
0.1095	556	28549	5134	Fail
0.1122	500	27371	5474	Fail
0.1149	437	26214	5998	Fail
0.1176	372	25141	6758	Fail
0.1203	311	24131	7759	Fail
0.1229	274	23121	8438	Fail
0.1256	247	22111	8951	Fail
0.1283	229	21228	9269	Fail
0.1310	208	20416	9815	Fail
0.1337	180	19559	10866	Fail
0.1364	151	18682	12372	Fail
0.1391	119	17946	15080	Fail
0.1417	101	17220	17049	Fail
0.1444	85	16551	19471	Fail
0.1471	71	15895	22387	Fail
0.1498	63	15276	24247	Fail
0.1525	58	14664	25282	Fail
0.1552	50	14100	28200	Fail
0.1579	45	13559	30131	Fail
0.1606	43	13071	30397	Fail
0.1632	42	12573	29935	Fail
0.1659	35	12097	34562	Fail
0.1686	33	11657	35324	Fail
0.1713	30	11222	37406	Fail
0.1740	28	10801	38575	Fail
0.1767	25	10403	41612	Fail
0.1794	23	10025	43586	Fail
0.1820	20	9657	48285	Fail
0.1847	19	9305	48973	Fail

0.1874	18	8975	49861	Fail
0.1901	16	8651	54068	Fail
0.1928	16	8310	51937	Fail
0.1955	16	7988	49925	Fail
0.1982	15	7719	51459	Fail
0.2009	14	7435	53107	Fail
0.2035	14	7178	51271	Fail
0.2062	14	6943	49592	Fail
0.2089	14	6713	47950	Fail
0.2116	14	6507	46478	Fail
0.2143	14	6307	45050	Fail
0.2170	12	6114	50950	Fail
0.2197	11	5899	53627	Fail
0.2223	10	5710	57100	Fail
0.2250	8	5516	68950	Fail
0.2277	7	5333	76185	Fail
0.2304	7	5167	73814	Fail
0.2331	7	5011	71585	Fail
0.2358	7	4845	69214	Fail
0.2385	7	4677	66814	Fail
0.2412	7	4517	64528	Fail
0.2438	7	4357	62242	Fail
0.2465	7	4227	60385	Fail
0.2492	7	4100	58571	Fail
0.2519	7	3972	56742	Fail
0.2546	7	3854	55057	Fail
0.2573	7	3736	53371	Fail
0.2600	7	3617	51671	Fail
0.2626	6	3509	58483	Fail
0.2653	6	3387	56450	Fail
0.2680	5	3278	65560	Fail
0.2707	5	3185	63700	Fail
0.2734	5	3086	61720	Fail
0.2761	5	2996	59920	Fail
0.2788	5	2912	58240	Fail
0.2815	5	2817	56340	Fail
0.2841	5	2722	54440	Fail
0.2868	5	2642	52840	Fail
0.2895	5	2552	51040	Fail
0.2922	5	2474	49480	Fail
0.2949	5	2405	48100	Fail
0.2976	5	2335	46700	Fail
0.3003	5	2270	45400	Fail
0.3029	5	2209	44180	Fail
0.3056	5	2127	42540	Fail
0.3083	5	2063	41260	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Exhibit 9 SUB25-1003

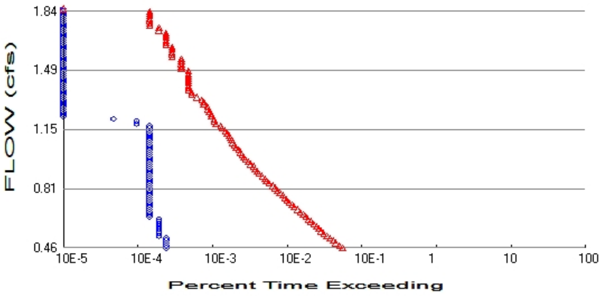
Water Quality

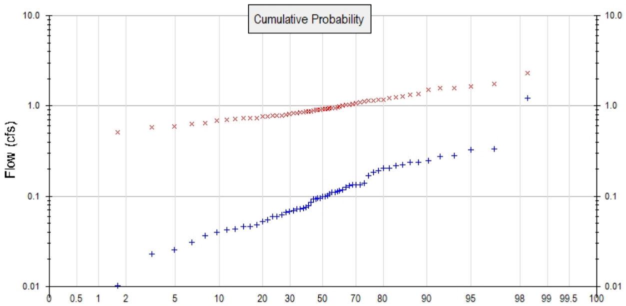
Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.2144 acre-feet
On-line facility target flow:	0.2602 cfs.
Adjusted for 15 min:	0.2602 cfs.
Off-line facility target flow:	0.1453 cfs.
Adjusted for 15 min:	0.1453 cfs.

Exhibit 9 SUB25-1003

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2	
Total Pervious Area:	2.555
Total Impervious Area:	0

Mitigated Landuse Totals for POC #2	
Total Pervious Area:	0.987
Total Impervious Area:	1.568

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.105019
5 year	0.201474
10 year	0.263974
25 year	0.335559
50 year	0.38241
100 year	0.423705

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.928726
5 year	1.208342
10 year	1.398677
25 year	1.645812
50 year	1.83506
100 year	2.028932

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.111	1.340
1950	0.105	0.784
1951	0.203	0.944
1952	0.071	0.876
1953	0.118	0.846
1954	0.235	1.223
1955	0.094	0.763
1956	0.279	0.991
1957	0.141	1.027
1958	0.078	1.145
1959	0.070	0.716

Exhibit 9 SUB25-1003

1960	0.054	0.699
1961	0.131	0.922
1962	0.048	0.767
1963	0.066	0.946
1964	0.100	0.686
1965	0.134	0.728
1966	0.113	0.849
1967	0.094	0.876
1968	0.116	1.570
1969	0.132	1.500
1970	1.216	2.327
1971	0.062	0.822
1972	0.110	1.117
1973	0.043	0.936
1974	0.206	0.910
1975	0.094	0.632
1976	0.193	0.783
1977	0.002	0.507
1978	0.276	1.171
1979	0.031	1.266
1980	0.100	0.650
1981	0.223	1.092
1982	0.168	0.975
1983	0.332	1.249
1984	0.075	0.575
1985	0.068	0.727
1986	0.052	1.060
1987	0.217	0.737
1988	0.046	0.842
1989	0.036	1.067
1990	0.046	0.953
1991	0.072	1.002
1992	0.086	0.913
1993	0.043	1.155
1994	0.099	0.831
1995	0.059	0.863
1996	0.324	1.346
1997	0.247	1.747
1998	0.074	1.637
1999	0.125	0.783
2000	0.094	0.593
2001	0.010	0.487
2002	0.235	1.184
2003	0.186	0.879
2004	0.025	0.914
2005	0.023	1.040
2006	0.132	0.937
2007	0.060	0.800
2008	0.039	1.563

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	1.2156	2.3269
2	0.3322	1.7471
3	0.3243	1.6369
4	0.2792	1.5701
5	0.2761	1.5627

Exhibit 9 SUB25-1003

6	0.2467	1.5003
7	0.2351	1.3459
8	0.2348	1.3398
9	0.2232	1.2658
10	0.2167	1.2492
11	0.2059	1.2235
12	0.2028	1.1838
13	0.1932	1.1710
14	0.1858	1.1545
15	0.1679	1.1449
16	0.1408	1.1168
17	0.1336	1.0919
18	0.1325	1.0673
19	0.1324	1.0601
20	0.1306	1.0402
21	0.1248	1.0273
22	0.1184	1.0018
23	0.1158	0.9906
24	0.1128	0.9752
25	0.1114	0.9527
26	0.1104	0.9458
27	0.1054	0.9438
28	0.1004	0.9367
29	0.0997	0.9356
30	0.0988	0.9215
31	0.0942	0.9141
32	0.0942	0.9134
33	0.0936	0.9105
34	0.0936	0.8791
35	0.0862	0.8763
36	0.0778	0.8760
37	0.0752	0.8625
38	0.0738	0.8491
39	0.0717	0.8458
40	0.0715	0.8425
41	0.0696	0.8307
42	0.0681	0.8217
43	0.0656	0.7998
44	0.0622	0.7836
45	0.0599	0.7831
46	0.0594	0.7827
47	0.0544	0.7665
48	0.0523	0.7632
49	0.0480	0.7374
50	0.0463	0.7282
51	0.0458	0.7272
52	0.0431	0.7157
53	0.0426	0.6985
54	0.0394	0.6863
55	0.0365	0.6504
56	0.0311	0.6316
57	0.0254	0.5929
58	0.0227	0.5752
59	0.0103	0.5072
60	0.0020	0.4867

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0525	5	1156	23120	Fail
0.0558	5	1049	20980	Fail
0.0592	5	942	18840	Fail
0.0625	5	863	17260	Fail
0.0658	5	785	15700	Fail
0.0692	4	713	17825	Fail
0.0725	4	652	16300	Fail
0.0758	4	599	14975	Fail
0.0792	4	551	13775	Fail
0.0825	4	516	12900	Fail
0.0858	4	475	11875	Fail
0.0892	4	436	10900	Fail
0.0925	4	403	10075	Fail
0.0958	3	375	12500	Fail
0.0992	3	346	11533	Fail
0.1025	3	313	10433	Fail
0.1058	3	290	9666	Fail
0.1092	3	259	8633	Fail
0.1125	3	243	8100	Fail
0.1158	3	224	7466	Fail
0.1192	3	209	6966	Fail
0.1225	3	195	6500	Fail
0.1258	3	183	6100	Fail
0.1292	3	167	5566	Fail
0.1325	3	155	5166	Fail
0.1358	3	146	4866	Fail
0.1392	3	136	4533	Fail
0.1425	3	120	4000	Fail
0.1458	3	110	3666	Fail
0.1491	3	105	3500	Fail
0.1525	3	97	3233	Fail
0.1558	3	88	2933	Fail
0.1591	3	83	2766	Fail
0.1625	3	77	2566	Fail
0.1658	3	75	2500	Fail
0.1691	3	67	2233	Fail
0.1725	3	63	2100	Fail
0.1758	3	58	1933	Fail
0.1791	3	55	1833	Fail
0.1825	3	52	1733	Fail
0.1858	3	50	1666	Fail
0.1891	3	47	1566	Fail
0.1925	3	43	1433	Fail
0.1958	3	41	1366	Fail
0.1991	3	39	1300	Fail
0.2025	3	38	1266	Fail
0.2058	3	36	1200	Fail
0.2091	3	35	1166	Fail
0.2125	3	33	1100	Fail
0.2158	3	31	1033	Fail
0.2191	3	28	933	Fail
0.2225	3	27	900	Fail
0.2258	2	23	1150	Fail
0.2291	2	22	1100	Fail

0.2325	1	22	2200	Fail
0.2358	0	20	n/a	Fail
0.2391	0	20	n/a	Fail
0.2425	0	19	n/a	Fail
0.2458	0	18	n/a	Fail
0.2491	0	18	n/a	Fail
0.2524	0	16	n/a	Fail
0.2558	0	16	n/a	Fail
0.2591	0	15	n/a	Fail
0.2624	0	13	n/a	Fail
0.2658	0	11	n/a	Fail
0.2691	0	11	n/a	Fail
0.2724	0	10	n/a	Fail
0.2758	0	10	n/a	Fail
0.2791	0	10	n/a	Fail
0.2824	0	10	n/a	Fail
0.2858	0	10	n/a	Fail
0.2891	0	10	n/a	Fail
0.2924	0	10	n/a	Fail
0.2958	0	10	n/a	Fail
0.2991	0	10	n/a	Fail
0.3024	0	8	n/a	Fail
0.3058	0	8	n/a	Fail
0.3091	0	8	n/a	Fail
0.3124	0	8	n/a	Fail
0.3158	0	8	n/a	Fail
0.3191	0	6	n/a	Fail
0.3224	0	6	n/a	Fail
0.3258	0	6	n/a	Fail
0.3291	0	6	n/a	Fail
0.3324	0	6	n/a	Fail
0.3358	0	5	n/a	Fail
0.3391	0	5	n/a	Fail
0.3424	0	5	n/a	Fail
0.3458	0	5	n/a	Fail
0.3491	0	5	n/a	Fail
0.3524	0	5	n/a	Fail
0.3558	0	4	n/a	Fail
0.3591	0	4	n/a	Fail
0.3624	0	3	n/a	Fail
0.3657	0	3	n/a	Fail
0.3691	0	3	n/a	Fail
0.3724	0	3	n/a	Fail
0.3757	0	3	n/a	Fail
0.3791	0	3	n/a	Fail
0.3824	0	3	n/a	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.2684 acre-feet
On-line facility target flow:	0.3278 cfs.
Adjusted for 15 min:	0.3278 cfs.
Off-line facility target flow:	0.1832 cfs.
Adjusted for 15 min:	0.1832 cfs.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

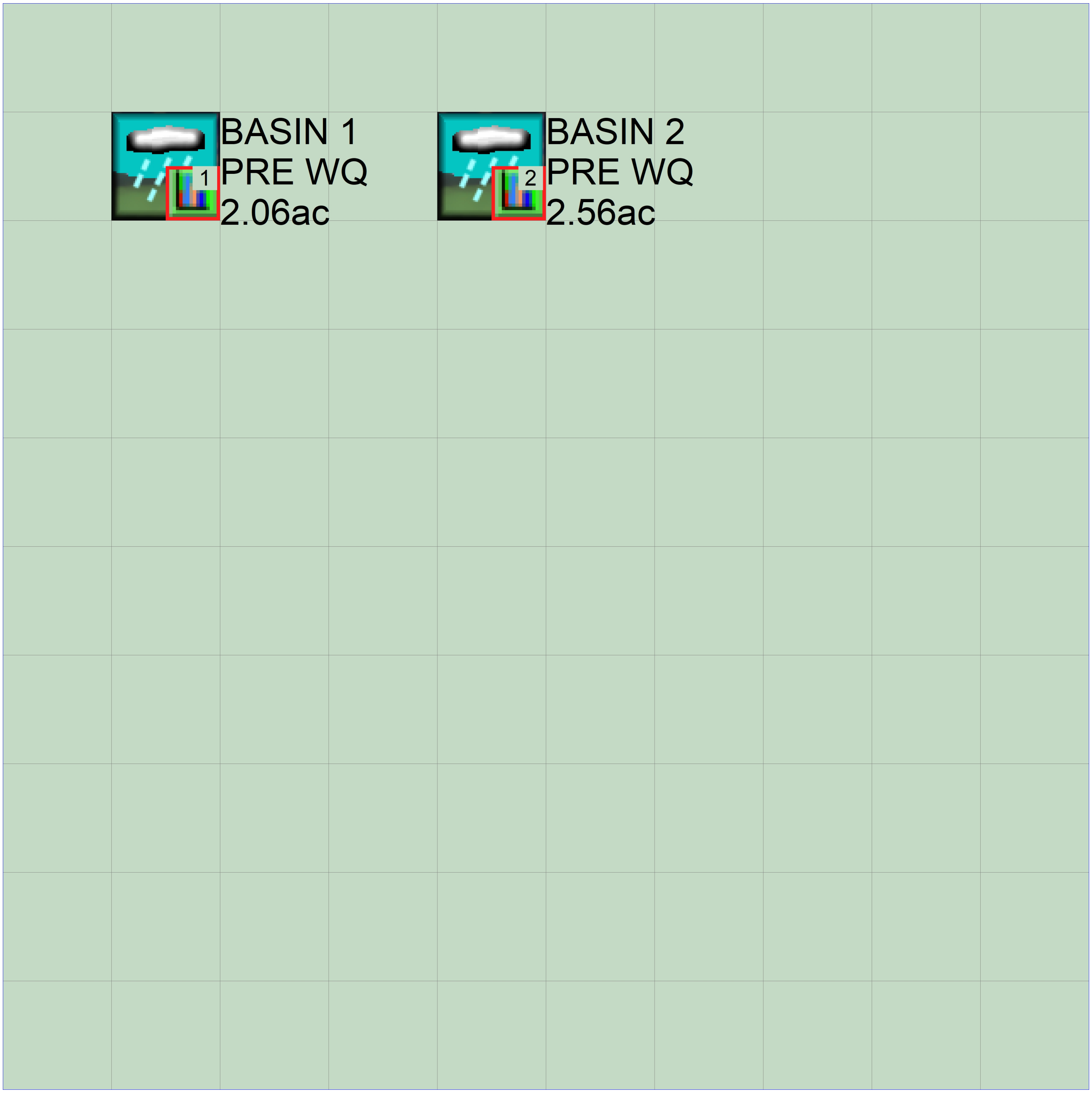
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic

Disclaimer

Legal Notice

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Exhibit 9 SUB25-1003

Appendix G: Soils Report

Exhibit 9 SUB25-1003

Report of Geotechnical Engineering Services

Camas Woods Phase 3

Camas, Washington

February 18, 2025

Geotechnical ▪ Environmental ▪ Special Inspections

Columbia West Engineering, Inc

www.columbia-west.com

Exhibit 9 SUB25-1003

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West
Engineering, Inc

Vancouver, Washington • Phone: 360-823-2900
Portland, Oregon • Phone: 971-384-1666
www.columbia-west.com

February 18, 2025

HSR Capital LLC
500 East Broadway, Suite 120
Vancouver, WA 98660

Attn: Kevin Miller

Re: Report of Geotechnical Engineering Services
Camas Woods Phase 3
26514 and 26416 SE 8th Street
Camas, Washington
CWE Project: HSR-4-01-1

Columbia West Engineering, Inc. (Columbia West) is pleased to present this geotechnical engineering report for the Camas Woods Phase 3 project located at 26514 and 26416 SE 8th Street (parcel numbers 178209000 and 178109000) in Camas, Washington. Our services were conducted in accordance with our proposal dated September 6, 2024.

We appreciate the opportunity to work on the project. Please contact us if you have any questions regarding this report.

Sincerely,

Michael A. Chacon, PE
Senior Staff Engineer

Daniel E. Lehto, PE, GE
Principal Engineer

DANIEL E. LEHTO
STATE OF WASHINGTON
44702
REGISTERED PROFESSIONAL ENGINEER

Signed 02/18/2025

Expires 06/05/2025

cc: Bryce Hanson, AKS Engineering & Forestry

MAC:ASR:DEL:kat
Attachments
Document ID: HSR-4-01-1-021825-geor.docx

EXECUTIVE SUMMARY

This section provides a summary of the geotechnical considerations associated with the Camas Woods Phase 3 project in Camas, Washington. Our conclusions and recommendations are based on the subsurface information presented in the report and proposed development information provided by the design team. A detailed discussion of the geotechnical considerations summarized here is presented in respective sections of the report.

- The proposed lightly loaded residential structures can be supported by conventional spread footings bearing on firm soil as described in the report.

- The near-surface native soil is sensitive to disturbance when at a moisture content that is above optimum. As discussed in the report, the subgrade should be protected from disturbance and damage by construction traffic.

- Cobbles and boulders were encountered in the explorations at the site. Cobbles and boulders will result in difficult excavation and trenches may be wider than anticipated, increasing the amount of backfill material required.

- Moisture conditioning will likely be required to use the on-site soil as structural fill. Accordingly, extended dry weather will be required to adequately condition and place the soil as structural fill. It will be difficult, if not impossible, to adequately compact the on-site soil during the rainy season or during prolonged periods of rainfall.

- Groundwater was encountered at 12 feet BGS in test pit TP-6 during our subsurface exploration on December 31, 2024. Dewatering may be required for deeper utilities, particularly in areas of cut and in the wet season.

Exhibit 9 SUB25-1003

TABLE OF CONTENTS

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

AC	asphalt concrete
AOS	apparent opening size
ASCE	American Society of Civil Engineers
ASTM	ASTM International
BGS	below ground surface
CSZ	Cascadia subduction zone
g	gravitational acceleration (32.2 feet/second^2)
GIS	geographic information system
HMA	hot mix asphalt
H:V	horizontal to vertical
IBC	International Building Code
in/hr	inch(es) per hour
km	kilometers
MCE	maximum considered earthquake
M_W	moment magnitude
NAVD 88	North American Vertical Datum of 1988
OSHA	Occupational Safety and Health Administration
pcf	pounds per cubic foot
pci	pounds per cubic inch
PG	performance grade
psf	pounds per square foot
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSS	Washington Standard Specifications for Road, Bridge, and Municipal Construction (2024)

REPORT OF GEOTECHNICAL ENGINEERING SERVICES
CAMAS WOODS PHASE 3
CAMAS, WASHINGTON

1.0 INTRODUCTION

Columbia West is pleased to submit this geotechnical engineering report for the Camas Woods Phase 3 project in Camas, Washington. The approximately 8.82-acre site is comprised of parcel numbers 178209000 and 178109000 and is located at 26514 and 26416 SE 8th Street in Camas, Washington. The site is shown relative to surrounding physical features on Figure 1. Figure 2 shows the existing conditions at the site and our exploration locations. Abbreviations and acronyms used herein are defined immediately following the Table of Contents.

Development plans include construction of a single-family residential subdivision with associated infrastructure. Infrastructure specifics and grading plans were not available for review at the time this report was prepared. Foundation loads were also unknown at the time this report was prepared; however, we estimate maximum column and wall loads will be less than 30 kips and 4 kips per lineal foot, respectively.

2.0 BACKGROUND

Based on historical aerial photographs, the site has been an undeveloped property since at least the 1950s, with single-family residences constructed in the 1970s. The site is bounded by a church to the west; single-family rural development to the north and south; and vacant, forested land to the east.

3.0 PURPOSE AND SCOPE

The purpose of our services was to provide geotechnical engineering recommendations for use in design and construction of the proposed development. Specifically, we completed the following tasks:

- Reviewed information available in Columbia West's files from previous geological and geotechnical studies conducted in the site vicinity.
- Coordinated and managed the field exploration program, which included locating public utilities, coordinating site access, and scheduling subcontractors and Columbia West field staff.
- Explored subsurface conditions at the site by excavating six test pits to depths between 12.5 and 16 feet BGS.
- Collected soil samples from the explorations for laboratory testing and maintained a log of encountered soil and groundwater conditions in the explorations.
- Conducted infiltration testing in three of the test pits at depths of 3 and 6 feet BGS.
- Performed laboratory testing on select soil samples collected from the explorations, including the following:
    - Seven moisture content determinations in general accordance with ASTM D2216
    - Six particle-size analyses in general accordance with ASTM D1140
    - One particle-size analysis in general accordance with ASTM D6913
    - Two Atterberg limits tests in general accordance with ASTM D4318

- Prepared this geotechnical engineering report that includes the following:
    - Summary of subsurface conditions at the site
    - Results of research of existing geologic and seismic maps and literature to determine relevant seismic risks, including locations of faults and earthquake magnitudes
    - Assessment of seismic hazards
    - Laboratory testing results
    - Foundation support recommendations, including allowable bearing capacity, estimated foundation settlement, and lateral resistance parameters
    - Recommendations for floor slab subgrade preparation
    - Recommendations for retaining walls, including lateral earth pressures, backfill, compaction, and drainage
    - Recommendations for site preparation, including grading and drainage, stripping depths, fill type for imported material, compaction criteria, trench excavation and backfill, use of on-site soil, and wet/dry weather earthwork
    - Recommendations for managing groundwater conditions that may affect the performance of structures and site improvements
    - Stormwater disposal recommendations
    - Code-based seismic design parameters in accordance with the 2021 IBC

4.0 SITE CONDITIONS

4.1 GEOLOGY

The site lies within the Willamette Valley/Puget Sound Lowland, a wide physiographic depression flanked by the mountainous Coast Range on the west and the Cascade Range on the east. Inclined or uplifted structural zones within the Willamette Valley/Puget Sound Lowland constitute highland areas, and depressed structural zones form sediment-filled basins. The site is located in the central portion of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

The near-surface soil is expected to consist of Pleistocene- to Pliocene-aged, semi-consolidated, pebble- to cobble-sized sedimentary Conglomerate (QTc). The conglomerate is underlain by Oligocene aged Elkhorn Mountain basaltic andesite flows (Evarts and O'Connor 2008). Well logs for 26416 SE 8th Street indicate that the conglomerate extends to a depth of at least 160 feet BGS (Washington State Department of Ecology 2025).

The USDA Web Soil Survey identifies the surface soil as Hesson clay loam (USDA 2025). Hesson series soils are generally fine-grained clays and silts with low permeability, moderate to high water capacity, and low shear strength. They are generally moisture sensitive, somewhat compressible, and described as having low to moderate shrink-swell potential. The erosion hazard is slight primarily based on slope grade.

4.2 SEISMOLOGY

Recent research and subsurface mapping investigations in the Pacific Northwest appear to suggest the historical potential risk for a large earthquake event with strong localized ground movement may be underestimated. Past earthquakes in the Pacific Northwest appear to have caused landslides and ground subsidence, in addition to severe flooding near coastal areas. Earthquakes may also induce soil liquefaction, which occurs when elevated horizontal ground acceleration and velocity cause soil particles to interact as a fluid as opposed to a solid. Liquefaction of soil can result in lateral spreading and temporary loss of bearing capacity and shear strength.

Three scenario earthquakes are possible with the local seismic setting. Two of the possible earthquake sources are associated with the CSZ, and the third event is a shallow, local crustal earthquake that could occur in the North American Plate. The three earthquake scenarios are discussed below.

4.2.1 CSZ

The CSZ is the region where the Juan de Fuca Plate is being subducted beneath the North American Plate. This subduction is occurring in the coastal region between Vancouver Island and northern California. Evidence has accumulated suggesting that this subduction zone has generated eight great earthquakes in the last 4,000 years, with the most recent event occurring approximately 300 years ago (Weaver and Shedlock 1991). The fault trace is mapped approximately 50 to 120 km off the Washington Coast.

Two types of subduction zone earthquakes are possible and considered in this report:

1. An interface event earthquake on the seismogenic part of the interface between the Juan de Fuca Plate and the North American Plate on the CSZ. This source is capable of generating earthquakes with a M_W of 9.0+.
2. A deep intraplate earthquake on the seismogenic part of the subducting Juan de Fuca Plate. These events typically occur at depths of between 30 and 60 km. This source is capable of generating an event with a M_W of up to 8.0.

4.2.2 Crustal Events

A significant earthquake could occur on a local fault near the site within the design life of the development. Such an event would cause ground shaking at the site that could be more intense than the CSZ events, although the duration would be shorter. Table 1 provides information on local faults close to the site.

Table 1. Faults within the Site Vicinity[1]

Fault Name	Proximity to Site (km)	Mapped Length (km)
Lacamas Lake fault	1	24
Portland Hills fault	22	49
East Bank fault	27	29

1. Reported by USGS (2025)

4.3 SURFACE CONDITIONS

The site is relatively undeveloped and flat. The site is primarily forested and contains two single-family residential structures. According to Clark County GIS, site elevations range from approximately 382 feet at the northwest area of the site to 390 feet in the southeast area of the site (NAVD 88).

4.4 SUBSURFACE CONDITIONS

Subsurface conditions at the site were explored by excavating six test pits (TP-1 through TP-6) to depths between 12.5 and 16 feet BGS. The exploration locations are shown on Figure 2. A description of our field exploration program and the exploration logs are presented in Appendix A. A description of the laboratory testing program and the testing results are presented in Appendix B. Photograph taken during our subsurface explorations are presented in Appendix C. A summary of the subsurface conditions is presented below.

4.4.1 Root and Topsoil Zones

The topsoil zone is generally 6 to 12 inches thick and consists of sandy silt with trace organics. The topsoil zone generally contains a 3-inch-thick root zone. Areas covered by forest may have deeper root zones or thicker topsoil zones.

4.4.2 Near-Surface Soil

Beneath the topsoil, the soil generally consists of silty gravel with sand and cobbles or clayey sand to silty sand with gravel to the maximum depth explored of 16 feet BGS. Variable amounts boulders up to 24 inches in diameter were encountered in several locations. Based on laboratory testing, the moisture content varied from 23 to 30 percent at the time of exploration.

4.4.3 Groundwater

Groundwater seepage was observed in test pit TP-6 at a depth of 12 feet BGS on December 31, 2024. Based on our knowledge of the surrounding area, perched water could be present in isolated, discontinuous zones below the ground surface and particularly where higher infiltrating soil is present above lower infiltrating soil.

4.5 INFILTRATION TESTING

Infiltration testing was completed in three of the test pits in December 2024 to assist in the evaluation of stormwater infiltration facilities for the project. The infiltration testing was conducted in general accordance with the recommendations for the encased falling head method in general accordance with the Clark County Stormwater Manual (Clark County 2021). Table 2 summarizes our infiltration testing results.

Table 2. Infiltration Testing Results

Location	Depth (feet BGS)	Soil Type	Fines Content[1] (percent)	Coefficient of Permeability, k (in/hr)
TP-1	3	Silty GRAVEL with sand (GM)	35	4
	6	Silty GRAVEL with sand (GM)	21	19
TP-3	3	Silty GRAVEL with sand (GM)	32	5
	6	GRAVEL with silt and sand (GP-GM)	20	4
TP-6	3	Clayey SAND (SC)	43	5
	6	Silty GRAVEL with sand (GM)	14	20

1. Fines content: percent passing U.S. Standard No. 200 sieve

Recommendations for design of infiltration system are provided in Section 6.6.3 (Stormwater Infiltration Systems).

5.0 GEOLOGICALLY HAZARDOUS AREAS

Camas Municipal Code, Section 16.59 defines geologic hazard requirements for proposed development in areas subject to City of Camas jurisdiction. Three potential geologic hazards are identified: (1) erosion hazard areas, (2) landslide hazard areas, and (3) seismic hazard areas.

Columbia West conducted a geologic hazard review to assess whether these hazards are present at the site proposed for development and, if so, to provide mitigation recommendations. The geologic hazard review was based on physical and visual reconnaissance, subsurface exploration, laboratory testing of collected soil samples, and review of maps and other published technical literature. The results of the geologic hazard review are discussed in the following sections.

5.1 EROSION HAZARDS

Camas Municipal Code, Section 16.59.020.A defines an erosion hazard as areas where slope grades meet or exceed 40 percent. Based on review of slope grade mapping published by Clark County Maps Online, maximum slope grades of 15 percent are mapped in the northeast corner of the site. Therefore, site slopes do not meet the definition of an erosion hazard according to Camas Municipal Code.

5.2 LANDSLIDE HAZARDS

Columbia West conducted a review of available mapping and Clark County GIS data and conducted a site reconnaissance to evaluate the potential presence of a landslide hazard on or near the site. Due to the relatively flat topography, the site does not pose a significant landslide hazard.

5.3 SEISMIC HAZARD AREAS

Seismic hazards include areas subject to severe risk of earthquake-induced damage. Damage may occur due to soil liquefaction, dynamic settlement, ground shaking amplification, or surface faulting rupture. These seismic hazards are discussed below.

5.3.1 Soil Liquefaction and Dynamic Settlement

According to the Liquefaction Susceptibility Map of Clark County, Washington (Palmer et al. 2004), the site is mapped as very low susceptibility for liquefaction. Liquefaction, defined as the transformation of the behavior of a granular material from a solid to a liquid due to increased pore water pressure and reduced effective stress, may occur when granular materials quickly compact under cyclic stresses caused by a seismic event. The effects of liquefaction may include immediate ground settlement, lateral spreading, and differential compaction.

Soil most susceptible to liquefaction is recent geologic deposits, such as river and floodplain sediments. This soil is generally saturated, cohesionless, loose to medium dense sand within 50 feet of the ground surface. Potentially liquefiable soil located above the existing, historical, or expected groundwater levels do not generally pose a liquefaction hazard. It is important to note that changes in perched groundwater elevation may occur due to project development or other factors not observed at the time of investigation.

Based on the results of subsurface exploration, literature review, and laboratory testing, the above-mentioned criteria were not observed during the geotechnical site investigation. Therefore, the potential for soil liquefaction is considered to be very low.

5.3.2 Ground Shaking Amplification

Review of the Site Class Map of Clark County, Washington, (Palmer et al. 2004) indicates that site soil may be represented by Site Class C as defined in 2021 IBC Section 1613.3.2. A designation of Site Class C indicates that minor amplification of seismic energy may occur during a seismic event due to subsurface conditions. However, this is typical for many areas within Clark County, does not represent a geologic hazard in Columbia West's opinion, and will not prohibit development if properly accounted for during the design process. Additional seismic information is presented in Section 6.3 (Seismic Design Criteria).

5.3.3 Fault Rupture

Because there are no known geologic seismic faults within the site boundaries, fault rupture is unlikely.

6.0 DESIGN

Based on the results of our explorations, laboratory testing, and analysis, the proposed project is feasible, provided the recommendations presented in this report are incorporated into design and implemented during construction.

6.1 SHALLOW FOUNDATION SUPPORT

6.1.1 General

The proposed residential structures may be supported by conventional spread footings bearing on firm, native soil or engineered structural fill. Any loose or disturbed soil should be improved or removed and replaced with structural fill. If the moisture content of the footing subgrade soil is above optimum moisture content, we recommend that a minimum of 6 inches of compacted aggregate be placed over exposed subgrade soil. The aggregate pad should extend 6 inches beyond the edges of the foundations and consist of imported granular material as described in Section 7.6.1 (Structural Fill). Columbia West should observe exposed subgrade conditions prior to placement of crushed aggregate to verify adequate subgrade support.

6.1.2 Footing Dimensions and Bearing Capacity

Continuous perimeter wall and isolated spread footings should have minimum widths of 18 and 24 inches, respectively. The bases of exterior footings should be at least 18 inches below the lowest adjacent exterior grade. The bases of interior footings should be at least 12 inches below the base of the floor.

Footings bearing on subgrade prepared as recommended above should be sized based on an allowable bearing pressure of 1,500 psf. As the allowable bearing pressure is a net bearing pressure, the weight of the footing and associated backfill may be ignored when calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads and may be increased by 50 percent for transient lateral forces such as seismic or wind.

6.1.3 Settlement

Provided the subgrade soil is prepared as described above and in Section 7.1 (Site Preparation), we anticipate that post-construction static foundation settlement will be less than approximately 1 inch. Differential settlement between comparably loaded foundations is not expected to exceed approximately 0.5 inch over a distance of 50 feet.

6.1.4 Resistance to Sliding

Lateral foundation loads can be resisted by passive earth pressure on the sides of footings and by friction at the bases of footings. Recommended passive earth pressure for footings confined by native soil or engineered structural fill is 250 pcf. The upper 6 inches of soil should be neglected when calculating passive pressure resistance. Adjacent floor slabs and pavement, if present, should also be neglected from the analysis. The recommended passive pressure resistance assumes that a minimum horizontal clearance of 10 feet is maintained between the footing face and adjacent down-gradient slopes.

The estimated coefficient of friction between in-situ native soil or engineered structural fill and in-place poured concrete is 0.35. The estimated coefficient of friction between compacted crushed aggregate and in-place poured concrete is 0.45.

6.2 FLOOR SLABS

Floor slabs can be supported on firm, competent, native soil or engineered structural fill prepared as described in this report. Disturbed soil and unsuitable fill in proposed slab locations, if encountered, should be removed and replaced with structural fill. Floor slabs with a maximum floor load of 100 psf may be designed assuming a modulus of subgrade reaction, k, of 125 pci.

To provide a capillary break, slabs should be underlain by at least 6 inches of compacted crushed aggregate that contains less than 5 percent fines by dry weight. Geotextile may be used below the crushed aggregate layer to increase subgrade support. Recommendations for floor slab aggregate base and subgrade geotextile are discussed in Section 7.6 (Materials).

6.3 SEISMIC DESIGN CRITERIA

The structures will likely be constructed in accordance with the 2021 IBC, which references ASCE 7-16 for design parameters. Based on our literature review of surrounding sites, the appropriate seismic site class for design is C. Seismic design parameters in accordance with ASCE 7-16 are provided in Table 3.

Table 3. ASCE 7-16 Seismic Design Parameters[1]

Parameter	Short Period (T_s)	1-Second Period (T_1)
MCE spectral response acceleration, S	$S_s = 0.787$ g	$S_1 = 0.345$ g
Site class	C	
Site coefficient, F	$F_a = 1.2$	$F_v = 1.5$
Adjusted spectral response acceleration, S_M	$S_{MS} = 0.945$ g	$S_{M1} = 0.518$ g
Design spectral response acceleration, S_D	$S_{DS} = 0.630$ g	$S_{D1} = 0.345$ g

1. The structural engineer should evaluate ASCE 7-16 code requirements and exceptions to determine if these parameters are valid for design.

Columbia West recommends the project structural engineer evaluate the requirements and exceptions presented in ASCE 7-16 to determine if the parameters for Site Class C provided in Table 3 can be used for design or if a site-specific seismic hazard evaluation is required.

6.4 RETAINING STRUCTURES

Lateral earth pressures should be considered during design of retaining walls and below-grade structures. Hydrostatic pressure and additional surcharge loading should also be considered. Wall foundation construction and bearing capacity should adhere to the specifications in Section 6.1 (Shallow Foundation Support).

Permanent retaining walls that are not restrained from rotation and are retaining undisturbed, native soil should be designed for active earth pressures using an equivalent fluid pressure of 39 pcf. Walls retaining undisturbed, native soil that are restrained from rotation should be designed for an at-rest equivalent fluid pressure of 64 pcf. For walls with imported well-drained granular backfill meeting WSS 9-03.12(2) – Gravel Backfill for Walls, equivalent fluid pressures of 34 pcf and 60 pcf are applicable for active and at-rest earth pressures, respectively.

The recommended earth pressures assume a maximum wall height of 10 feet with level backfill. These values also assume that adequate drainage is provided behind retaining walls to prevent hydrostatic pressure from developing. Lateral earth pressures induced by surcharge loads may be estimated using the criteria presented on Figure 3.

Seismic forces may be calculated by superimposing a uniform lateral force of $9H^2$ pounds per lineal foot of wall, where H is the total wall height in feet. The force should be applied as a distributed load with the resultant located at 0.6H from the base of the wall.

6.4.1 Wall Drainage and Backfill

A minimum 6-inch-diameter, perforated collector pipe should be placed at the bases of retaining walls. The pipe should be embedded in a minimum 2-foot-wide zone of angular drain rock that is wrapped in a drainage geotextile fabric and extends up the back of the wall to within 1 foot of finished grade. The drain rock and geotextile drainage fabric should meet the specifications in Section 7.6 (Materials). Perforated collector pipes should discharge at an appropriate location away from the base of the wall. Discharge pipes should not be tied directly into stormwater drainage systems, unless measures are taken to prevent backflow into the drainage system of the wall.

Backfill material placed behind walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of select granular material placed and compacted as described in Section 7.6.1 (Structural Fill).

Settlement of up to 1 percent of the wall height commonly occurs immediately adjacent to the wall as the wall rotates and develops active lateral earth pressures. Consequently, we recommend that construction of flatwork adjacent to retaining walls be delayed at least four weeks after placement of wall backfill, unless survey data indicates that settlement is complete prior to that time.

6.5 *PAVEMENT*

We recommend that public roadways for the subdivision be constructed in accordance with City of Camas standards. For dry weather construction, pavement surface sections should bear on competent subgrade consisting of scarified and compacted native soil or engineered structural fill. Wet weather construction may require an increased thickness of aggregate base as discussed in Section 7.2 (Construction Traffic and Staging). Refer to Section 7.6.3.2 (Cold Weather Paving Considerations) for compaction requirements.

6.6 *DRAINAGE*

At a minimum, site drainage should include surface water collection and conveyance to properly designed stormwater management structures and facilities. In general, drainage design should conform to City of Camas regulations. Finished site grading should be conducted with positive drainage away from structures at a minimum 2 percent slope for a distance of at least 10 feet. Depressions or shallow areas that may retain ponding water should be avoided. Recommendations for foundation drains and subdrains are presented in the following sections. Drain rock and geotextile drainage fabric should meet the requirements in Section 7.6 (Materials*)*. Drains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seepage become evident, the drainage provisions may require modification or additional drains. We should be consulted to provide appropriate recommendations.

6.6.1 Foundation Drains

Roof drains are recommended for all structures. Perimeter building foundation drains should be considered for shallow foundations constructed below existing site grades but are not necessary for the functionality of the buildings.

Foundation and roof drains, where installed, should consist of separate systems that gravity flow away from foundations to an approved discharge location. Perimeter foundation drains should consist of 4-inch-diameter, perforated PVC pipe surrounded by a minimum 2-foot-wide zone of clean, washed drain rock wrapped with geotextile drainage fabric. The wrapped drain rock zone should extend up the sides of embedded walls to within 12 inches of proposed finished grade. Foundation drains should be constructed with a minimum slope of 0.5 percent. The invert elevation of the drainpipe should be at least 18 inches below the elevation of the floor slab.

6.6.2 Subdrains

Subdrains should be considered if portions of the site are cut below surrounding grades. Shallow groundwater or seepage should be conveyed via a drainage channel or perforated pipe into an approved discharge. Recommendations for design and installation of perforated drainage pipe may be performed on a case-by-case basis by Columbia West during construction. Failure to provide adequate surface and subsurface drainage may result in soil slumping or unanticipated settlement of structures exceeding tolerable limits.

6.6.3 Stormwater Infiltration Systems

Based on the tested infiltration rates, on-site infiltration systems are viable in the native soil at the site. The rates in Table 2 are field infiltration rates and factors of safety have not been applied. Correction factors should be applied to the recommended infiltration rates to account for soil variations and the potential for long-term clogging due to siltation and buildup of organic material. Confirmation testing of infiltration systems should be completed as described below. In addition, the local jurisdiction may require a limit on the design infiltration rates. We recommend the stormwater system designer determine if a design rate limit is required.

We recommend a contingency be in place if tested rates do not meet design rates. Columbia West should be allowed to review the final design and provide comments, as necessary. The infiltration flow rate of disposal systems will diminish over time as suspended solids and precipitates in the stormwater slowly clog the void spaces between soil particles in the zone of infiltration. Accordingly, systems may eventually fail and need to be replaced.

7.0 CONSTRUCTION

7.1 SITE PREPARATION

7.1.1 General

Site grading should be performed in accordance with the requirements specified in the 2021 IBC, Chapter 18 and Appendix J, with exceptions noted in this report. Site preparation should be observed and documented by Columbia West.

7.1.2 Demolition

Where required, demolition includes removal of structural features that may be at the site. Abandoned foundations and utilities, if present, will need to be removed and the resulting excavations backfilled. Utility lines should be completely removed or, with prior approval, grouted full if left in place. Excavations left from demolition and removal of existing structures should be backfilled with compacted structural fill in accordance with the recommendations in Section 7.6 (Materials).

7.1.3 Stripping and Grubbing

The existing root zones should be stripped and removed from all areas to receive new structural improvements. A stripping depth of approximately 12 inches is anticipated in areas where the entire topsoil zone is removed. The actual stripping depth should be based on field observations at the time of construction and may increase in areas of heavy vegetation or deep tree roots. Stripped material should be transported offsite for disposal or used in landscaped areas on slopes less than 25 percent. The post-construction maximum depth of landscape fill placed or spread at any location onsite should not exceed 1 foot.

Trees and shrubs should be removed from fill areas. In addition, root balls should be grubbed out to the depth of the roots, which could exceed 3 feet BGS. Depending on the methods used to remove root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend that soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with structural fill. Columbia West recommends removing undocumented fill completely and backfilling, as needed, with clean structural fill. Undocumented structural fill material should be evaluated by Columbia West prior to being reused as structural fill to determine suitability.

7.1.4 Test Pits

Test pits excavated during our explorations were backfilled loosely with on-site soil. These excavations should be located and properly backfilled with structural fill during site improvement construction. Trees, stumps, and associated roots should also be removed from structural areas, individually and carefully. Resulting cavities and excavation areas should be backfilled with engineered structural fill.

7.1.5 Subgrade Evaluation

Upon completion of stripping and prior to the placement of structural fill or pavement improvements, exposed subgrade soil should be evaluated by proof rolling with a fully loaded dump truck or similar heavy, rubber-tired construction equipment. When the subgrade is too wet for proof rolling, a foundation probe may be used to identify areas of soft, loose, or unsuitable soil. Subgrade evaluation should be performed by Columbia West. If soft or yielding subgrade areas are identified during evaluation, we recommend the subgrade be over excavated and backfilled with compacted imported granular fill.

7.2 CONSTRUCTION TRAFFIC AND STAGING

The fine-grained soil present on this site is easily disturbed. If not carefully executed, site preparation, utility trench work, and roadway excavation can create extensive soft areas and significant repair costs can result. Earthwork planning, regardless of the time of year, should include considerations for minimizing subgrade disturbance.

If construction occurs during or extends into the wet season or if the moisture content of the surficial soil is more than a couple percentage points above optimum, site stripping and cutting may need to be accomplished using track-mounted equipment. Likewise, the use of granular haul roads and staging areas will be necessary for support of construction traffic during the rainy season or when the moisture content of the surficial soil is more than a few percentage points above optimum. The aggregate base thickness for pavement areas is intended to support post-construction design traffic loads and is not designed to support construction traffic. Moreover, if construction is planned for periods when the subgrade soil is wet, staging areas and haul roads with increased thicknesses of base rock will be required. The amount of staging areas and haul roads, as well as the required thickness of granular material, will vary with the contractor's sequencing of a project and type/frequency of construction equipment and should, therefore, be the responsibility of the contractor. Based on our experience, between 12 and 18 inches of imported granular material are generally required in staging areas and between 18 and 24 inches in haul roads. The contractor should also be responsible for selecting the type of material for construction of haul roads and staging areas. A geotextile fabric can be placed as a barrier between the subgrade and imported granular material in areas of repeated construction traffic to help prevent silt migration into the base rock. The imported granular material, stabilization material, and geotextile fabric should meet the specifications in Section 7.6 (Materials).

Cement amendment is an alternative to thickened crushed rock sections, haul roads, and utility work zones. Cement amendment recommendations are presented in Section 7.6.4 (Soil Amendment with Cement).

Project stakeholders should understand that wet weather construction is risky and costly. Proper construction methods and techniques are critical to overall project integrity and should be observed and documented by Columbia West.

7.3 CUT AND FILL SLOPES

Fill slopes should consist of structural fill material as discussed in Section 7.6.1 (Structural Fill). Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes greater than 6 feet in height should be vertically keyed into the existing subsurface soil. Drainage implementations, including subdrains or perforated drainpipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. The extent, depth, and location of drainage may be determined in the field by Columbia West during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion.

Final cut or fill slopes at the site should not exceed 2H:1V or 10 feet in height without individual slope stability analysis. The values above assume a minimum horizontal setback for loads of 10 feet from the top of the cut or fill slope face or overall slope height divided by three (H/3), whichever is greater.

Concentrated drainage or water flow over the face of slopes should be prohibited, and adequate protection against erosion is required. Fill slopes should be overbuilt, compacted, and trimmed at least 2 feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed and documented by Columbia West.

7.4 EXCAVATION

7.4.1 General

Conventional earthmoving equipment in proper working condition should be capable of making necessary site excavations. Temporary excavation sidewalls should maintain a vertical cut to a depth of approximately 4 feet BGS in the near-surface silt, provided groundwater seepage is not present in the sidewalls. In sandy soil, excavations will likely slough and cave, even at shallow depths. Open-cut excavation techniques may be used to excavate trenches between 4 and 8 feet deep, provided the walls of the excavation are cut at a maximum slope of 1.5H:1V and groundwater seepage does not occur. Excavation side slopes should be reduced to a stable inclination if excessive sloughing or raveling occurs.

Groundwater seepage was observed in test pit TP-6 at a depth of 12 feet BGS on December 31, 2024. Recommendations as described in Section 7.5 (Dewatering) should be considered where subsurface construction activities intersect the shallow groundwater table.

Shoring may be required if open-cut excavations are not feasible. As a wide variety of shoring and dewatering systems are available, we recommend that the contractor be responsible for selecting the appropriate shoring and dewatering systems. If box shoring is used, the contractor should understand it is a safety feature used to protect workers and does not prevent caving. If excavations are left open, caving of the sidewalls may occur. The presence of caved material will limit the ability to properly backfill and compact trenches. The contractor should be prepared to fill voids between the box shoring and the sidewalls of the trenches with sand or gravel before caving occurs.

All excavations should be made in accordance with applicable OSHA requirements and regulations of the state, county, and local jurisdiction. While this report describes certain approaches to excavation and dewatering, the contract documents should specify that the contractor is responsible for selecting the excavation and dewatering methods, monitoring the excavations for safety, and providing shoring (as required) to protect personnel and adjacent structural elements.

7.4.2 Cobbles and Boulders

Cobbles and boulders were encountered in the explorations at the site. Construction considerations associated with cobbles and boulders include the following:

- Excavations can become difficult, if not impossible, with conventional equipment.
- Excavation volumes for utility trenches may be greater than anticipated due to sloughing and the need to remove oversized material.
- We recommend that project bid documents include a contingency for boulder removal, as well as the associated increased trench volumes for backfilling.

7.5 DEWATERING

Groundwater or perched water tables may be encountered at the site. Therefore, groundwater may be encountered in utility trench excavations and in areas of cut. General recommendations for temporary construction dewatering are presented in the following section.

7.5.1 Construction Dewatering

The contractor should be responsible for temporary drainage of surface water, perched water, and groundwater. Dewatering should be performed to the extent necessary to prevent standing water and/or erosion of exposed site soil. During rough and finished grading of building pad areas, the contractor should keep all footing excavations and slab subgrade soil free of standing water.

The contractor's proposed dewatering plan should be capable of maintaining groundwater levels at least 2 feet below the bases of proposed trench excavations. Without adequate trench dewatering, running soil, caving, and sloughing will increase backfill volumes and may result in damage to adjacent structures or utilities. Significant pumping and dewatering may be required to temporarily reduce the groundwater elevation to the recommended depth. Dewatering via a sump within excavation zones may be insufficient to control groundwater and provide excavation side slope stability. Dewatering may be more feasibly conducted by installing a system of temporary well points and pumps around proposed excavation areas or utility trenches. Depending on proposed utility depths, a site-specific dewatering plan may be necessary.

If groundwater is present at the bases of utility excavations, we recommend placing 18 to 24 inches of stabilization material at the base of the excavation. Subgrade geotextile placed directly over trench subgrade soil may reduce the required thickness of the stabilization material. The actual thickness of stabilization material should be determined at the time of construction based on observed field conditions. Trench stabilization material should be placed in one lift and compacted until well keyed. Stabilization material and geotextile fabric should meet the requirements in Section 7.6 (Materials).

7.6 MATERIALS

7.6.1 Structural Fill

7.6.1.1 General

Areas proposed for fill placement should be appropriately prepared as described in Section 7.1 (Site Preparation). Engineered fill placement should be observed by Columbia West. Compaction of engineered structural fill should be verified by proof rolling or nuclear gauge field compaction testing performed in accordance with ASTM D6938. Field compaction testing should be performed for each vertical foot of engineered fill placed.

Various materials may be acceptable for use as structural fill. Structural fill should be free of organic material or other unsuitable material, should have a maximum particle size of less than 6 inches, and should meet the specifications provided in the following sections. Representative samples of proposed engineered structural fill should be submitted for laboratory testing and approval by Columbia West prior to placement.

7.6.1.2 On-Site Soil

The near-surface soil at the site generally consists of fine-grained soil. The native surficial soil at the site is generally suitable for use as structural fill if adequately dried or moisture conditioned to achieve recommended compaction specifications. Based on laboratory testing, we anticipate the moisture content of the soil will generally be above the optimum moisture content required to meet compaction requirements and drying of the soil will be necessary. Accordingly, extended dry weather will be required to adequately condition and place the soil as structural fill. It will be difficult, if not impossible, to adequately compact the on-site soil during the rainy season or during prolonged periods of rainfall.

On-site soil used as structural fill should be placed in loose lifts not exceeding 8 inches in thickness and compacted using standard conventional compaction equipment. The soil moisture content should be within a few percentage points of optimum conditions. The soil should be compacted to at least 95 percent of maximum dry density as determined by ASTM D698.

The on-site soil will likely expand during excavation and transport and consolidate during compaction. Development of site-specific expansion and consolidation factors is beyond the scope of this study. We can provide site-specific factors upon request.

7.6.1.3 Imported Granular Material

Imported granular material should consist of pit- or quarry-run rock, crushed rock, or crushed gravel and sand. Imported granular material should be placed in loose lifts not exceeding 12 inches in thickness and compacted to at least 95 percent of maximum dry density as determined by ASTM D1557. During wet weather conditions or where wet subgrade conditions are present, the initial loose lift of granular fill should be approximately 18 inches thick and should be compacted with a smooth-drum roller operating in static mode.

7.6.1.4 Stabilization Material

Stabilization material should consist of durable, 4- or 6-inch-minus pit- or quarry-run rock, crushed rock, or crushed gravel and sand that is free of organic material and other deleterious material. The material should have a maximum particle size of 6 inches with less than 5 percent by dry weight passing the U.S. Standard No. 4 sieve. The material should have at least two mechanically fractured faces.

Stabilization material should be placed in loose lifts between 12 and 24 inches thick and compacted to a firm, unyielding condition. Equipment with vibratory action should not be used when compacting stabilization material over wet, fine-grained soil. If stabilization material is used to stabilize soft subgrade below pavement or construction haul roads, a subgrade geotextile should be placed as a separation barrier between the soil subgrade and the stabilization material.

7.6.1.5 Trench Backfill

Trench backfill placed below, adjacent to, and up to at least 12 inches above utility lines (i.e., the pipe zone) should consist of well-graded granular material meeting the specifications in WSS 9-03.12(3) – Gravel Backfill for Pipe Zone Bedding. Pipe zone backfill should be compacted to at least 90 percent of maximum dry density as determined by ASTM D1557 or as required by the local jurisdictional agency or pipe manufacturer.

Within structural areas (below pavement and building pads), trench backfill above the pipe zone should consist of material meeting the specifications in WSS 9-03.19 – Bank Run Gravel for Trench Backfill or WSS 9-03.14(2) – Select Borrow with a maximum particle size of 2½ inches. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). Remaining trench backfill should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557 or as required by the local jurisdictional agency or pipe manufacturer.

Outside of structural areas, trench backfill placed above the pipe zone should be compacted to at least 90 percent of maximum dry density as determined by ASTM D1557 or as required by the local jurisdictional agency or pipe manufacturer.

7.6.1.6 Pavement and Floor Slab Aggregate Base

Imported granular material used as base rock for building floor slabs and pavement should consist of 1¼-inch-minus crushed aggregate meeting the specifications in WSS 9-03.9(3) – Crushed Surfacing. Pavement and slab aggregate base should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

7.6.1.7 Retaining Wall Backfill

Backfill placed behind retaining walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of imported granular material as described above and should have less than 7 percent fines by dry weight. We recommend the wall backfill be separated from general fill, native soil, and/or topsoil using a geotextile fabric that meets the specifications provided below for drainage geotextiles.

Wall backfill should be compacted to a minimum of 95 percent of maximum dry density as determined by ASTM D1557. However, backfill located within a horizontal distance of 3 feet from a retaining wall should only be compacted to approximately 90 percent of maximum dry density as determined by ASTM D1557. Backfill placed within 3 feet of the wall should be compacted in lifts less than 6 inches thick using hand-operated tamping equipment (e.g., jumping jack or vibratory plate compactor). If flatwork (sidewalks or pavement) will be placed atop the wall backfill, we recommend that the upper 2 feet of material be compacted to 95 percent of maximum dry density as determined by ASTM D1557.

7.6.1.8 Retaining Wall Leveling Pad

Crushed aggregate used as a leveling pad for retaining wall footings should consist of ¾- or 1¼-inch-minus crushed rock and should have less than 7 percent fines by dry weight. The leveling pad material should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

7.6.1.9 Drain Rock

Drain rock should consist of angular, granular material with a maximum particle size of 2 inches. The material should be free of roots, organic material, and other unsuitable material; should have less than 2 percent fines by dry weight; and should have at least two mechanically fractured faces. Drain rock should be compacted to a well-keyed, firm condition.

7.6.2 Geotextile Fabric

7.6.2.1 Subgrade Geotextile

A geotextile separation fabric will be required at the interface of the existing soil and imported granular material beneath proposed walls. In addition, geotextile fabric may be required where soft subgrade is encountered. The separation fabric should meet the specifications in WSS 9-33.2(1) – Geotextile Properties (Table 3) for soil separation. The geotextile should be installed in conformance with the specifications in WSS 2-12 – Construction Geosynthetic.

7.6.2.2 Drainage Geotextile

Drainage geotextile should meet the specifications in WSS 9-33.2(1), Table 2, Geotextile for Underground Drainage Filtration Properties. The AOS should be between U.S. Standard No. 70 and No. 100 sieves. The water permittivity should be greater than 1.5/sec. The geotextile should be installed in accordance with the manufacturer's recommendations. A minimum initial aggregate base lift of 6 inches is required over geotextiles.

7.6.3 Pavement

7.6.3.1 AC

The AC should conform to the specifications in WSS 5-04 – Hot Mix Asphalt and WSS 9-03.8 – Aggregates for Hot Mix Asphalt. The asphalt cement binder should be PG 28-22 Performance Grade Asphalt Cement meeting WSS 9-02.1(4) – Performance Graded (PG) Asphalt Binder. The AC should be ½-inch HMA. The lift thickness should be 2 to 3 inches. The AC should be compacted to 92 percent of maximum specific gravity of the mix as determined by ASTM D2041.

7.6.3.2 Cold Weather Paving Considerations

In general, AC paving is not recommended during cold weather (temperatures less than 40 degrees Fahrenheit). Compacting under these conditions can result in low compaction and premature pavement distress.

Each AC mix design has a recommended compaction temperature range that is specific for the particular AC binder used. In colder temperatures, it is more difficult to maintain the temperature of the AC mix as it can lose heat while stored in the delivery truck, as it is placed, and in the time between placement and compaction. In Washington, the AC surface temperature during paving should be at least 40 degrees Fahrenheit for lift thickness greater than 2.5 inches and at least 50 degrees Fahrenheit for lift thickness between 2 and 2.5 inches.

If AC paving activities must take place during cold weather construction as defined above, the contractor and design team should discuss options for minimizing risk of pavement serviceability.

7.6.4 Soil Amendment with Cement

The on-site soil can be amended with portland cement to obtain suitable properties for use as wet weather structural fill or subbase for pavement. The effectiveness of soil amendment is highly dependent on proper mixing techniques, soil moisture conditioning, and the quantity of cement. The quantity of cement applied during amendment should be based on an assumed dry unit weight of 100 pcf for the site soil.

7.6.4.1 Subbase Stabilization

Specific recommendations for soil amendment should be based on exposed site conditions at the time of construction. For preliminary design purposes, we recommend cement-amended subgrade for building pads and pavement subbase (below the aggregate base layer) achieve a target strength of 100 psi. The quantity of cement required to achieve the target strength will vary with moisture content and soil type. Laboratory testing of cement-amended soil should be used to confirm design expectations.

Based on our experience, near-surface soil will require approximately 6 to 7 percent cement by weight to achieve the target strength of 100 psi. This cement percentage assumes that the soil moisture content does not exceed 20 percent at the time of amendment. If the soil moisture content is in the range of 25 to 35 percent, 7 to 8 percent cement by weight may be required to achieve the target strength. The amount of cement added to the soil at the time of construction should be based on observed field conditions and subgrade performance. During extended periods of dry weather, water may need to be applied during the amendment and tilling process to achieve the optimum moisture content required for compaction.

Cement-amendment equipment should have balloon tires to minimize softening, rutting, and disturbance of fine-grained site soil. A sheepsfoot or segmented pad roller with a minimum static weight of 40,000 pounds should be used for initial compaction. Rollers with vibratory action should not be used to compact fine-grained, cement-amended soil. Final compaction should be conducted with a smooth-drum roller with a minimum applied linear force of 700 pounds per inch. The amended soil should be compacted to at least 95 percent of maximum dry density as determined by ASTM D558.

Following cement amendment, a minimum curing time of four days is required prior to exposure to construction traffic. Construction traffic should not be allowed on unprotected, cement-amended subgrade. To protect cement-amended areas from damage, the finished surface should be covered with 4 to 6 inches of imported granular material. The protective layer of crushed rock often becomes contaminated with soil during construction, particularly in staging and haul road areas. Contaminated aggregate, where present, should be removed and replaced with clean crushed aggregate prior to construction of pavement or other permanent site improvements supported by aggregate base.

Cement amendment should not be attempted during moderate to heavy precipitation or when the ambient air temperature is below 40 degrees Fahrenheit. Cement should not be placed in areas of standing water or where saturated subgrade conditions exist.

7.6.4.2 Cement-Amended Structural Fill

If adequate compaction is not achievable with the on-site fine-grained soil due to moisture or weather conditions, the soil may be cement amended and placed as general structural fill. Prior to placement of cement-amended fill, subgrade soil should be prepared as described in Section 7.1 (Site Preparation). Where multiple lifts of cement-amended fill are necessary to meet finished grade, consecutive lifts may be placed immediately following amendment and compaction of the underlying lift. However, where the final lift of cement-amended fill will serve as building pad or pavement subbase material, the four-day cure period as discussed above is recommended.

7.6.4.3 QA/QC Testing and Inspection

Cement amendment of site soil should be observed and tested by Columbia West to document conformance with design recommendations. Cement spread rate should be verified with a pan sample test conducted at one random location per lift per 20,000 square feet of cement-amended fill. Amendment depth should be verified through excavation of a small test pit and measurement at one random location per lift of cement-amended fill. Adequate compaction and moisture content should be verified by conducting nuclear gauge density testing at a frequency of approximately one test per 5,000 square feet of cement-amended fill in accordance with ASTM D6938. At least one representative sample should be collected per day of cement amendment, cured for seven days, and tested for unconfined compressive strength in accordance with ASTM D1633. The tested samples should have a minimum seven-day, unconfined compressive strength of 100 psi.

7.7 EROSION CONTROL

Soil at this site is susceptible to erosion by wind and water; therefore, erosion control measures should be carefully planned and installed before construction begins. Surface water runoff should be collected and directed away from sloped areas to prevent water from running down the slope face. Measures that can be employed to reduce erosion include the use of silt fences, hay bales, buffer zones of natural growth, sedimentation ponds, and granular haul roads. All erosion control methods should be in accordance with local jurisdiction standards.

8.0 OBSERVATION OF CONSTRUCTION

Satisfactory pavement, earthwork, and foundation performance depends to a large degree on the quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Columbia West should be retained to observe subgrade preparation, fill placement, foundation excavations, drainage system installation, and pavement placement and to review laboratory compaction and field moisture-density information.

Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

9.0 LIMITATIONS

We have prepared this report for use by the addressee and members of the design and construction team for the proposed project. This report is subject to the limitations expressed in Appendix D.

◆ ◆ ◆

We appreciate the opportunity to be of service to you. Please call if you have questions concerning this report or if we can provide additional services.

Sincerely,

Michael A. Chacon, PE
Senior Staff Engineer

Daniel E. Lehto, PE, GE
Principal Engineer

REFERENCES

ASCE 2016. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures.* ASCE Standard ASCE/SEI 7-16.

ASTM International 2022. *Annual Book of ASTM Standards,* Volume 04.08: Soil and Rock (I), D420-D5876/D5876m.

Clark County 2025. Geographic Information Services. https://gis.clark.wa.gov/gishome/?pid=menu. Accessed February 2025.

Clark County 2021. *Clark County Stormwater Manual,* Clark County, Washington, July.

Evarts, R.C., and J.E. O'Connor 2008. *Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon.* U.S. Geological Survey, Scientific Investigations Map 3017, scale 1:24,000.

International Code Council 2021. *2021 International Building Code*.

OSHA, Safety and Health Regulations for Construction, 29 CFR Part 1926, revised 2024.

Palmer, S.P., S.L. Magsino, J.L. Poelstra, R.A. Niggemann 2004. Liquefaction Susceptibility and Site Class Map of Clark County, Washington, Washington Division of Geology and Earth Resources, Open File Report 2004-20, September.

USDA 2025. Web Soil Survey. National Resources Conservation Services. https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. Accessed February 2025.

USGS 2025. Quaternary Fault and Fold Database for the United States. https://www.usgs.gov/natural-hazards/earthquake-hazards/faults. Accessed February 2025.

Washington State Department of Ecology 2025. Washington State Well Report Viewer. https://appswr.ecology.wa.gov/wellconstruction/map/WCLSWebMap/default.aspx. Accessed February 2025.

Washington State Department of Transportation 2024. *Standard Specifications for Road, Bridge, and Municipal Construction, M 41-10.*

Weaver, C.S., and K.M. Shedlock 1991. Program for earthquake hazards assessment in the Pacific Northwest: U.S. Geological Survey Circular 1067, 29 pgs.

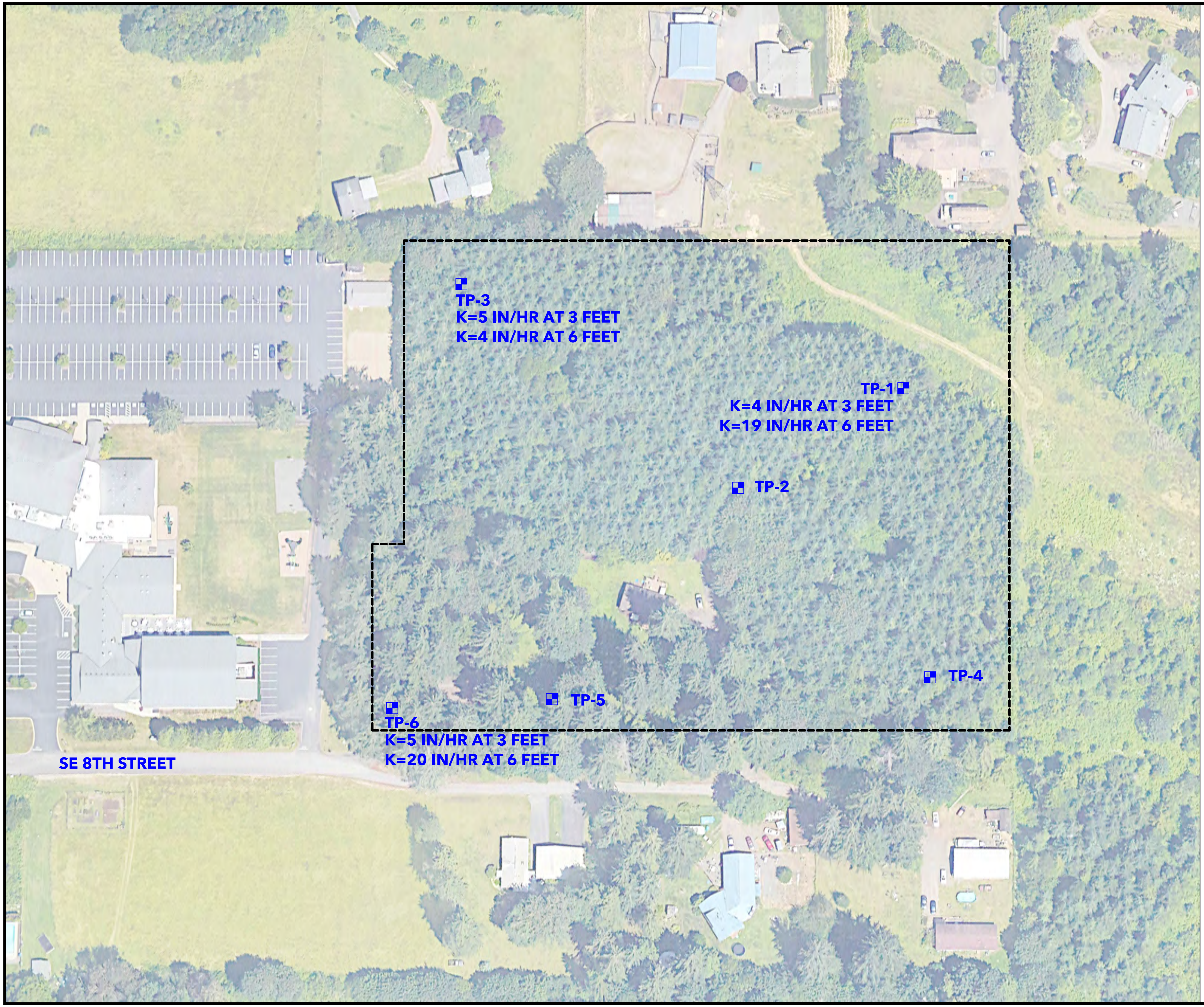
Exhibit 9 SUB25-1003

FIGURES

Exhibit 9 SUB25-1003

Geotechnical ▪ Environmental ▪ Special Inspections **Columbia West** Engineering, Inc	PROJECT NO.: HSR-4-01-1 FEBRUARY 2025	VICINITY MAP CAMAS WOODS PHASE 3 CAMAS, WASHINGTON	FIGURE 1

Exhibit 9 SUB25-1003



LEGEND

⛶	SITE BOUNDARY
▚	TEST PIT
K	UNFACTORED COEFFICIENT OF PERMEABILITY

N

0 26 52 78 80 130 260

NOTES:
1. AERIAL PHOTO SOURCED FROM GOOGLE EARTH.
2. EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
3. REFER TO REPORT TEXT FOR EXPLORATION DESCRIPTIONS.

Columbia West Engineering, Inc
Geotechnical ▪ Environmental ▪ Special Inspections

CAMAS WOODS PHASE 3
CAMAS, WASHINGTON
26514 AND 26416 SE 8TH STREET

SITE PLAN

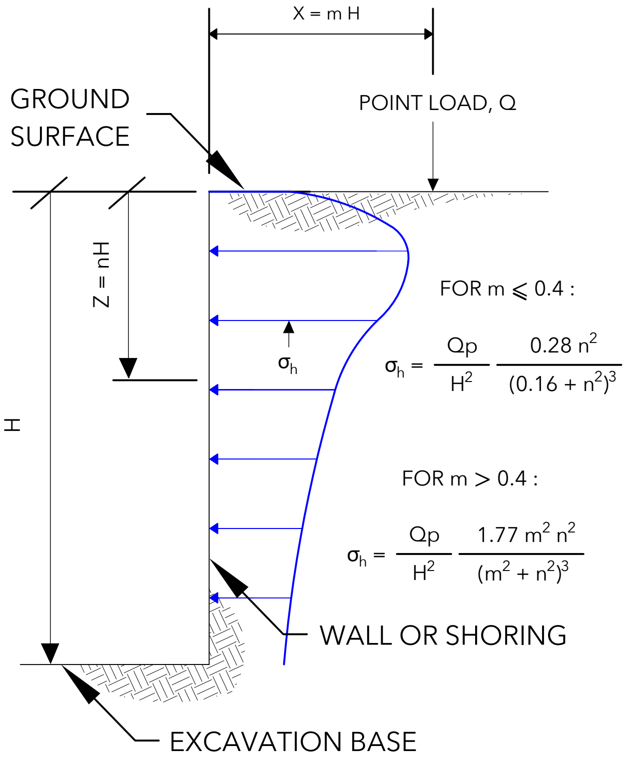
PROJECT NO:
HSR-4-01-1

FEBRUARY 2025

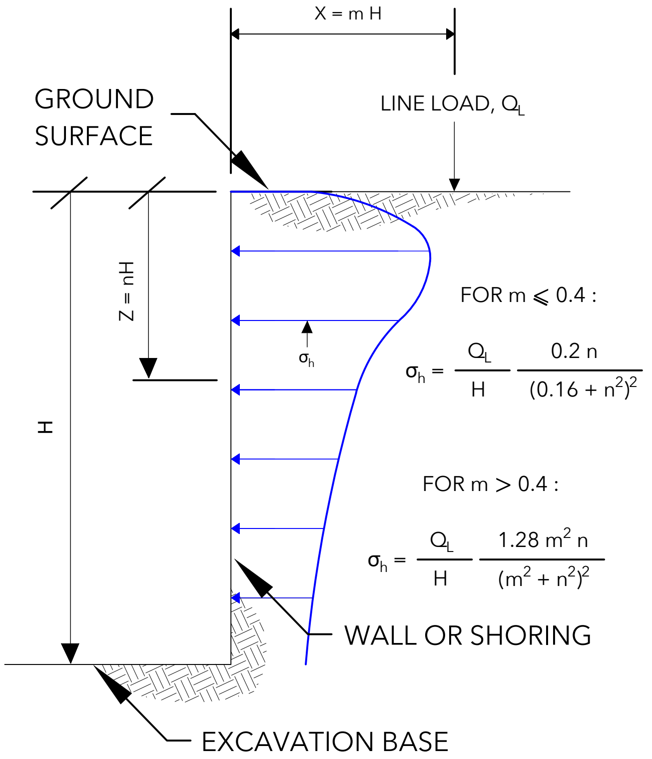
FIGURE
2

Exhibit 9 SUB25-1003

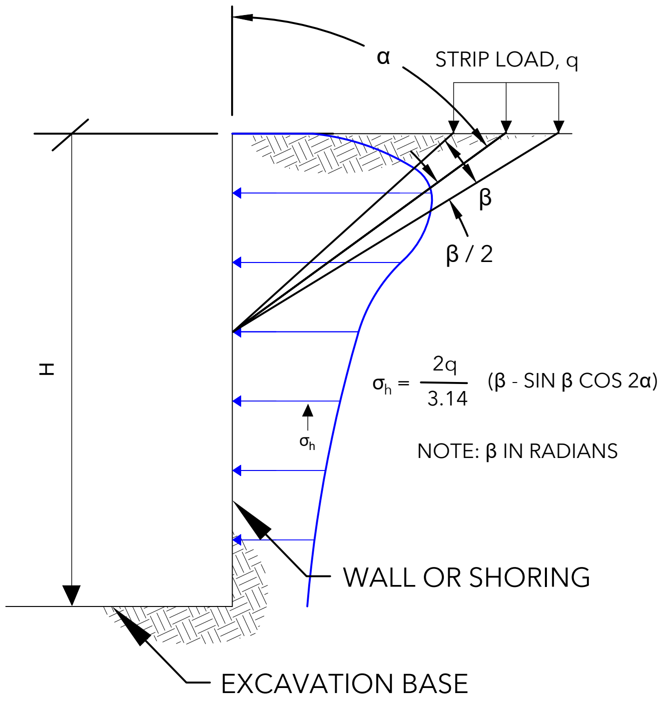
VERTICAL POINT LOAD



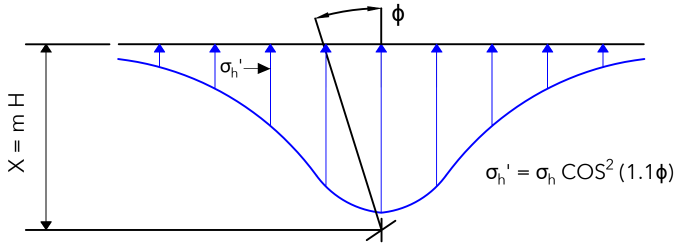
LINE LOAD PARALLEL TO WALL



STRIP LOAD PARALLEL TO WALL



VERTICAL POINT LOAD
HORIZONTAL PRESSURE DISTRIBUTION



NOTES:

1. FIGURE SHOULD BE USED JOINTLY WITH RECOMMENDATIONS PRESENTED IN THE REPORT TEXT.
2. LATERAL EARTH PRESSURES ASSUME RIGID WALLS WITH BACKFILL MATERIALS HAVING A POISSON'S RATIO OF 0.5.
3. TOTAL LATERAL EARTH PRESSURES RESULTING FROM COMBINED LOADS MAY BE CALCULATED USING SUPERPOSITION.
4. DRAWING IS NOT TO SCALE.

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West
Engineering, Inc

SURCHARGE-INDUCED LATERAL EARTH PRESSURES

FIGURE
3

Exhibit 9 SUB25-1003

APPENDIX A

APPENDIX A
FIELD EXPLORATIONS

GENERAL

We explored subsurface conditions at the site by excavating six test pits (TP-1 through TP-6) to depths between 12.5 and 16 feet BGS. Excavation services were provided by L&S Contracting LLC of Yacolt, Washington, on December 31, 2024. The explorations were logged on a full-time basis by Columbia West personnel. The exploration logs are presented in this appendix.

The approximate exploration locations are shown on Figure 2. The exploration locations are approximate and were not surveyed.

SOIL SAMPLING

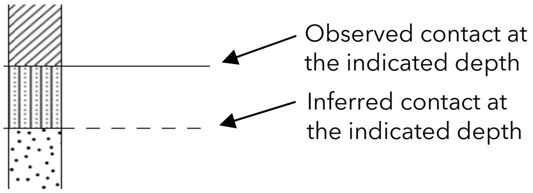
Representative disturbed samples of soil observed in the test pit explorations were collected from the test pit walls and base using the excavator bucket.

SOIL CLASSIFICATION

The soil samples were classified in accordance with the “Exploration Key,” “Soil Classification System,” and “AASHTO Soil Classification System,” which are presented in this appendix. The exploration logs indicate the depths at which the soils or their characteristics change, although the change actually could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications are shown on the exploration logs.

Exhibit 9 SUB25-1003

EXPLORATION LEGEND

<table>
<tr><th>SAMPLER TYPE</th><th colspan="2">DESCRIPTION</th></tr>
<tr><td>SPT</td><td colspan="2">Sample collected from the indicated depth in general accordance with ASTM D1586, <i>Standard Test Method Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils</i>, using an SPT sampler and 140-pound hammer</td></tr>
<tr><td>SH</td><td colspan="2">Sample collected from the indicated depth in general accordance with ASTM D1587, <i>Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes</i>, using a thin-walled Shelby tube</td></tr>
<tr><td>D&M</td><td colspan="2">Sample collected from the indicated depth in general accordance with ASTM D3550, <i>Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils</i>, using a Dames & Moore sampler and 140-pound hammer or pushed</td></tr>
<tr><td>CSS</td><td colspan="2">Sample collected from the indicated depth in general accordance with ASTM D3550, <i>Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils</i>, using a 3-inch-outside diameter California split-spoon sampler and 140-pound hammer</td></tr>
<tr><td>DP</td><td colspan="2">Sample collected from the indicated depth in general accordance with ASTM D6282, <i>Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations</i>, using a direct push soil sampler</td></tr>
<tr><td>GRAB</td><td>Grab sample collected from the indicated depth</td><td rowspan="2">
</td></tr>
<tr><td>CORE</td><td>Pavement or rock core interval at the indicated depth</td></tr>
</table>

<table>
<tr><th colspan="4">GEOTECHNICAL ABBREVIATIONS</th></tr>
<tr><td>ATT</td><td>Atterberg limits</td><td>PP</td><td>Pocket penetrometer</td></tr>
<tr><td>CBR</td><td>California bearing ratio</td><td>P200</td><td>Percent passing No. 200 sieve</td></tr>
<tr><td>CON</td><td>Consolidation test</td><td>RES</td><td>Resilient modulus</td></tr>
<tr><td>DD</td><td>Dry density</td><td>SIEV</td><td>Sieve analysis</td></tr>
<tr><td>DS</td><td>Direct shear</td><td>TS</td><td>Torvane shear</td></tr>
<tr><td>HYD</td><td>Hydrometer</td><td>tsf</td><td>Tons per square foot</td></tr>
<tr><td>MC</td><td>Moisture content</td><td>UC</td><td>Unconfined compressive strength</td></tr>
<tr><td>MD</td><td>Moisture-density relationship</td><td>UU</td><td>Unconsolidated undrained triaxial test</td></tr>
<tr><td>NP</td><td>Non-plastic</td><td>VS</td><td>Vane shear</td></tr>
<tr><td>OC</td><td>Organic content</td><td>WD</td><td>Wet density</td></tr>
<tr><th colspan="4">ENVIRONMENTAL ABBREVIATIONS</th></tr>
<tr><td>CA</td><td>Sample submitted for chemical analysis</td><td>ND</td><td>Not detected</td></tr>
<tr><td></td><td></td><td>NS</td><td>No sheen</td></tr>
<tr><td>PID</td><td>Photoionization detector headspace analysis</td><td>SS</td><td>Slight sheen</td></tr>
<tr><td></td><td></td><td>MS</td><td>Moderate sheen</td></tr>
<tr><td>ppm</td><td>Parts per million</td><td>HS</td><td>Heavy sheen</td></tr>
</table>

Exhibit 9 SUB25-1003

SOIL CLASSIFICATION SYSTEM

PARTICLE-SIZE CLASSIFICATION

COMPONENT	ASTM / USCS		AASHTO	
	Size Range	**Sieve Size Range**	**Size Range**	**Sieve Size Range**
Boulders	Greater than 300 mm	Greater than 12 inches	--	--
Cobbles	75 mm to 300 mm	3 inches to 12 inches	Greater than 75 mm	Greater than 3 inches
Gravel	75 mm to 4.75 mm	3 inches to No. 4 sieve	75 mm to 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm to 19.0 mm	3 inches to 3/4-inch sieve	--	--
Fine	19.0 mm to 4.75 mm	3/4-inch to No. 4 sieve	--	--
Sand	4.75 mm to 0.075 mm	No. 4 to No. 200 sieve	2.00 mm to 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm to 2.00 mm	No. 4 to No. 10 sieve	2.00 mm to 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm to 0.425 mm	No. 10 to No. 40 sieve	--	--
Fine	0.425 mm to 0.075 mm	No. 40 to No. 200 sieve	0.425 mm to 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	Less than 0.075 mm	Passing No. 200 sieve	Less than 0.075 mm	Passing No. 200 sieve

CONSISTENCY FOR COHESIVE SOIL

CONSISTENCY	SPT N-VALUE (blows per foot)	D&M N-VALUE (blows per foot)	POCKET PENETROMETER (unconfined compressive strength [tsf])
Very soft	0 to 2	0 to 3	Less than 0.25
Soft	2 to 4	3 to 6	0.25 to 0.5
Medium stiff	4 to 8	6 to 12	0.5 to 1.0
Stiff	8 to 15	12 to 25	1.0 to 2.0
Very stiff	15 to 30	25 to 65	2.0 to 4.0
Hard	Greater than 30	Greater than 30	Greater than 4.0

RELATIVE DENSITY FOR GRANULAR SOIL

RELATIVE DENSITY	SPT N-VALUE (blows per foot)	D&M N-VALUE (blows per foot)
Very loose	0 to 4	0 to 11
Loose	4 to 10	11 to 26
Medium dense	10 to 30	26 to 74
Dense	30 to 50	74 to 120
Very dense	Greater than 50	Greater than 120

MOISTURE DESIGNATIONS

TERM	FIELD IDENTIFICATION
Dry	Very low moisture, dry to touch
Moist	Damp, color appears darkened, without visible moisture, cohesive soil will clump, sand will bulk
Wet	Visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Percent	SILT AND CLAY IN		Percent	SAND AND GRAVEL IN		Percent	SECONDARY MATERIAL
	Fine-Grained Soil	**Coarse-Grained Soil**		**Fine-Grained Soil**	**Coarse-Grained Soil**		**Organics and Man-Made Debris**
< 5	trace	trace	< 5	trace	trace	< 4	trace
5 - 12	minor	with	5 - 15	minor	minor	4 - 12	some
> 12	some	silty/clayey	15 - 30	with	with		
			> 30	sandy/gravelly	with		

Exhibit 9 SUB25-1003

AASHTO SOIL CLASSIFICATION SYSTEM

TABLE 1. CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES

General Classification	Granular Materials (35 Percent or Less Passing No. 200 Sieve [0.075 mm])			Silty-Clay Materials (More Than 35 Percent Passing No. 200 Sieve [0.075 mm])			
Group Classification	A-1	A-3*	A-2	A-4	A-5	A-6	A-7
Sieve analysis, percent passing							
2.00 mm (No. 10)	--	--	--	--	--	--	--
0.425 mm (No. 40)	50 max.	51 min.	--	--	--	--	--
0.075 mm (No. 200)	25 max.	10 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid limit	--	--	**	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.	Non-plastic	**	10 max.	10 max.	11 min.	11 min.
General rating as subgrade	Excellent to Good			Fair to Poor			

* The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.
** See Table 2 for values.

TABLE 2. CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES

General Classification	Granular Materials (35 Percent or Less Passing No. 200 Sieve [0.075 mm])							Silty-Clay Materials (More Than 35 Percent Passing No. 200 Sieve [0.075 mm])			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve analysis, percent passing											
2.00 mm (No. 10)	50 max.	--	--	--	--	--	--	--	--	--	--
0.425 mm (No. 40)	30 max.	50 max.	51 min.	--	--	--	--	--	--	--	--
0.075 mm (No. 200)	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid limit	--	--	--	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		Non-plastic	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.*
Usual types of significant constituent materials	Stone fragments Gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soil		Clayey soil	
General rating as subgrade	Excellent to Good							Fair to Poor			

*Plasticity index of A-7-5 subgroup is equal to or less than liquid limit minus 30 (i.e., plastic limit greater than 30 percent). Plasticity index of A-7-6 subgroup is greater than liquid limit minus 30 (i.e., plastic limit less than 30 percent).

Exhibit 9 SUB25-1003

Geotechnical • Environmental • Special Inspections
Columbia West
Engineering, Inc

TEST PIT NUMBER: TP-1

Page 1 of 1

PROJECT NAME Camas Woods Phase 3
CLIENT HSR Capital LLC
PROJECT NO. HSR-4-01-1 **LOGGED BY** S. Chandra
PROJECT LOCATION Camas, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT 307E2
CAVING Not observed
DATE COMPLETED 12/31/2024
GROUNDWATER Not observed
TIME STARTED 11:20 AM **TIME COMPLETED** 2:22 PM

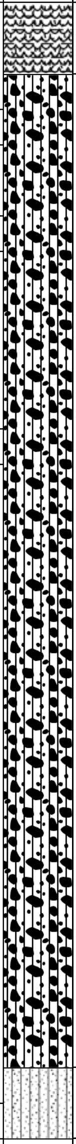
DEPTH (ft)	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (LL-PL-PI)	FINES (%)	REMARKS
				Medium stiff, brown sandy SILT, trace organics, moist (12 inches of topsoil, 3-inch-thick root zone). 1.0					
	TP1.1		GM	Medium dense, brown silty GRAVEL with sand and cobbles, moist, gravel is fine to coarse, sand is fine, cobbles are subrounded and up to 12 inches in diameter.					
	TP1.2					29	48-30-18	34	Infiltration test at 3 feet.
5									
	TP1.3					23		21	Infiltration test at 6 feet. Increase in cobbles at 6 feet.
									Decrease in fines at 9 feet.
10									
				With boulders at 11 feet.					
				15.0					
15	TP1.4		SM	Medium dense, brown-tan-orange silty SAND with gravel, moist, sand is fine to coarse, gravel is fine. 16.0					
				Exploration completed at 16 feet.					

Exhibit 9 SUB25-1003

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

TEST PIT NUMBER: TP-2

Page 1 of 1

PROJECT NAME Camas Woods Phase 3
CLIENT HSR Capital LLC
PROJECT NO. HSR-4-01-1 **LOGGED BY** S. Chandra
PROJECT LOCATION Camas, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT307E2
CAVING Not observed
DATE COMPLETED 01/01/2025
GROUNDWATER Not observed
TIME STARTED 11:32 AM **TIME COMPLETED** 12:07 PM

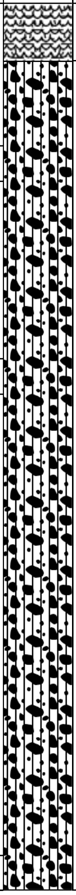
DEPTH (ft)	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (LL-PL-PI)	FINES (%)	REMARKS
				Medium stiff, brown sandy SILT, trace organics, moist (10 inches of topsoil, 4-inch-thick root zone). 0.8					
			GM	Medium dense, brown silty GRAVEL with sand and cobbles, moist, gravel is fine to coarse, sand is fine, cobbles are subrounded and up to 12 inches in diameter.					
	TP2.1					24	53-31-22	25	AASHTO soil classification: A-2-7(1)
5	TP2.2								
									Decrease in fines at 9 feet.
10									
	TP2.3			12.5					
				Exploration completed at 12.5 feet.					
15									

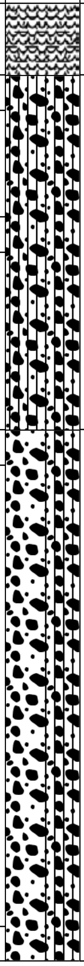
Exhibit 9 SUB25-1003

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West
Engineering, Inc

TEST PIT NUMBER: TP-3

Page 1 of 1

PROJECT NAME Camas Woods Phase 3
CLIENT HSR Capital LLC
PROJECT NO. HSR-4-01-1 **LOGGED BY** S. Chandra
PROJECT LOCATION Camas, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT307E2
CAVING Minor at 6.5 feet
DATE COMPLETED 12/31/2024
GROUNDWATER Not observed
TIME STARTED 9:49 AM **TIME COMPLETED** 10:50 AM



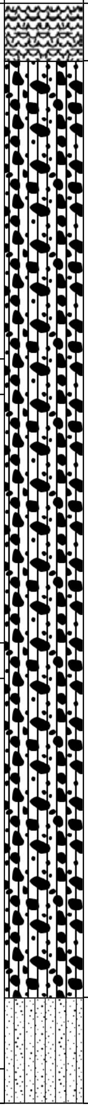
DEPTH (ft)	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
				Medium stiff, brown sandy SILT, trace organics, moist (12 inches of topsoil, 5-inch-thick root zone). 1.0				
5	TP3.1 TP3.2		GM	Medium dense, brown silty GRAVEL with sand and cobbles, moist, gravel is fine to coarse, sand is fine, cobbles are subrounded and up to 12 inches in diameter. 6.0		27	32	Infiltration test at 3 feet.
10	TP3.3 TP3.4		GP-GM	Medium dense, brown GRAVEL with silt, sand, and cobbles, moist, gravel is fine to coarse, sand is fine, cobbles are subrounded to rounded and up to 12 inches in diameter. 13.5		25	20	Infiltration test at 6 feet. Minor caving at 6.5 feet.
15				Exploration completed at 13.5 feet.				

Exhibit 9 SUB25-1003

TEST PIT NUMBER: TP-4

Page 1 of 1

PROJECT NAME Camas Woods Phase 3
CLIENT HSR Capital LLC
PROJECT NO. HSR-4-01-1 **LOGGED BY** S. Chandra
PROJECT LOCATION Camas, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT307E2
CAVING Not observed
DATE COMPLETED 12/31/2024
GROUNDWATER Not observed
TIME STARTED 12:33 PM **TIME COMPLETED** 1:05 PM

DEPTH (ft)	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
				Medium stiff, brown sandy SILT, trace organics, moist (10 inches of topsoil, 3-inch-thick root zone). 0.8			
			GM	Medium dense, brown silty GRAVEL with sand and cobbles, moist, gravel is fine to coarse, sand is fine to medium, cobbles are subrounded and 3 to 12 inches in diameter.			
5	TP4.1						
	TP4.2						Decrease in fines at 9 feet.
10							
				With boulders, boulders are 18 to 24 inches in diameter at 13 feet. 14.0			
			SM	Medium dense, brown-orange-tan silty SAND with gravel, moist, sand is fine to medium, gravel is coarse. 15.5			
15	TP4.3						

Exploration completed at 15.5 feet.

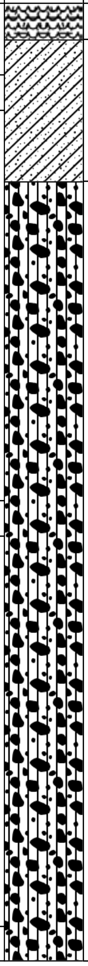
Exhibit 9 SUB25-1003

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

TEST PIT NUMBER: TP-5

Page 1 of 1

PROJECT NAME Camas Woods Phase 3
CLIENT HSR Capital LLC
PROJECT NO. HSR-4-01-1 **LOGGED BY** S. Chandra
PROJECT LOCATION Camas, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT307E2
CAVING Not observed
DATE COMPLETED 12/31/2024
GROUNDWATER Not observed
TIME STARTED 9:10 AM **TIME COMPLETED** 9:40 AM



DEPTH (ft)	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
0.5				Medium stiff, brown sandy SILT, trace organics, moist (6 inches of topsoil, 3-inch-thick root zone).			
2.5	TP5.1		SC	Medium dense, brown clayey SAND with gravel, moist, sand is fine, gravel is fine to coarse.			
13.5	TP5.2 TP5.3		GM	Medium dense, brown silty GRAVEL with sand, cobbles, and boulders, moist, gravel is fine to coarse, sand is fine, cobbles are rounded to subrounded, boulders are subrounded and up to 16 inches in diameter.			

Exploration completed at 13.5 feet.

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

TEST PIT NUMBER: TP-6

Page 1 of 1

PROJECT NAME Camas Woods Phase 3
CLIENT HSR Capital LLC
PROJECT NO. HSR-4-01-1 **LOGGED BY** S. Chandra
PROJECT LOCATION Camas, Washington
CONTRACTOR L&S Contracting LLC
EQUIPMENT CAT307E2
CAVING Minor from 12 to 13 feet.
DATE COMPLETED 12/31/2024
GROUNDWATER Moderate seepage at 12 feet
TIME STARTED 8:15 AM **TIME COMPLETED** 11:13 AM

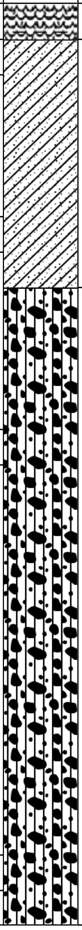
DEPTH (ft)	SAMPLE ID	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
				Medium stiff, brown sandy SILT, trace organics, moist (6 inches of topsoil, 3-inch-thick root zone). 0.5				
	TP6.1		SC	Medium dense, brown clayey SAND, trace gravel, moist, sand is fine to coarse.				
	TP6.2			4.0		30	43	Infiltration test at 3 feet.
5			GM	Medium dense, brown silty GRAVEL with sand and cobbles, moist, gravel is fine to coarse, sand is fine, cobbles are subrounded and up to 12 inches in diameter.				
	TP6.3					24	14	Infiltration test at 6 feet.
10								
	TP6.4			Wet at 12 feet. 13.0				Minor caving from 12 to 13 feet.
				Exploration completed at 13 feet.				
15								

Exhibit 9 SUB25-1003

APPENDIX B

APPENDIX B
LABORATORY TESTING

GENERAL

Laboratory testing was conducted on select soil samples to confirm field classifications and determine the index engineering properties. The laboratory classifications are shown on the exploration logs if those classifications differed from the field classifications. The locations of the tested samples are shown on the exploration logs. Descriptions of the tests are presented below, and results of the testing are presented in this appendix.

MOISTURE CONTENT

The natural moisture content of select soil samples was determined in general accordance with ASTM D2216. The natural moisture content is a ratio of the weight of the water to dry soil in a test sample and is expressed as a percentage.

PARTICLE-SIZE ANALYSIS

Particle-size analysis was performed on a select soil sample in general accordance with ASTM D6913. This test is a quantitative determination of the soil particle size distribution expressed as a percentage of dry soil weight. Particle-size analysis was also performed on select soil samples in general accordance with ASTM D1140 (P200). This test is a quantitative determination of the percent passing the U.S. Standard No. 200 sieve by dry weight.

ATTERBERG LIMITS TESTING

Atterberg limits (plastic and liquid limits) testing was performed on select soil samples in general accordance with ASTM D4318. The plastic limit is defined as the moisture content where the soil becomes brittle. The liquid limit is defined as the moisture content where the soil begins to act similar to a liquid. The plasticity index is the difference between the liquid and plastic limits.

Exhibit 9 SUB25-1003

11917 NE 95th Street
Vancouver, Washington 98682 • Phone: 360-823-2900
8880 SW Nimbus Avenue, Suite A
Portland, Oregon 97008 • Phone: 971-384-1666
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West
Engineering, Inc

MOISTURE CONTENT, PERCENT PASSING NO. 200 SIEVE BY WASHING

PROJECT
Camas Woods Phase 3
26514 and 26416 SE 8th Street
Camas, Washington

CLIENT
HSR Capital LLC
500 East Broadway, Suite 120
Vancouver, WA 98660

PROJECT NO. HSR-4-01-1

ISSUE DATE 01/21/25

PAGE 1 of 1

DATE SAMPLED 12/31/24

SAMPLED BY S. Chandra

LABORATORY TEST DATA

TEST PROCEDURE
ASTM D2216 - Method A, ASTM D1140

LAB ID	CONTAINER MASS (g)	MOIST MASS + CONTAINER (g)	DRY MASS + CONTAINER (g)	AFTER WASH DRY MASS + CONTAINER (g)	FIELD ID	SAMPLE DEPTH (ft)	PERCENT MOISTURE CONTENT	PERCENT PASSING NO. 200 SIEVE
S25-0073	777.12	3,002.92	2,505.70	1,907.74	TP1.2	3	29%	35%
S25-0074	772.20	4,644.63	3,912.20	3,259.20	TP1.3	6	23%	21%
S25-0075	579.10	4,256.49	3,550.51	sieved sample	TP2.1	2	24%	25%
S25-0076	780.04	4,041.64	3,338.44	2,519.96	TP3.2	3	27%	32%
S25-0077	787.34	5,353.00	4,449.88	3,714.65	TP3.3	6	25%	20%
S25-0078	771.52	2,452.58	2,069.49	1,514.03	TP6.2	3	30%	43%
S25-0079	752.77	4,771.61	3,983.45	3,517.80	TP6.3	6	24%	14%

NOTES:
Sample weights received for Lab ID: S25-0073, 0074, 0075, 0076, 0077, 0078, and 0079 did not meet the minimum size requirements; entire sample used for analysis.

DATE TESTED 01/13/25

TESTED BY M. Scherette

COLUMBIA WEST ENGINEERING, INC. authorized signature

Exhibit 9 SUB25-1003

11917 NE 95th Street
Vancouver, Washington 98682 • Phone: 360-823-2900
8880 SW Nimbus Avenue, Suite A
Portland, Oregon 97008 • Phone: 971-384-1666
www.columbiawestengineering.com

Geotechnical ■ Environmental ■ Special Inspections
Columbia West
Engineering, Inc

ATTERBERG LIMITS REPORT

PROJECT
Camas Woods Phase 3
26514 and 26416 SE 8th Street
Camas, Washington

CLIENT
HSR Capital LLC
500 East Broadway, Suite 120
Vancouver, WA 98660

PROJECT NO. HSR-4-01-1	
ISSUE DATE 01/21/25	PAGE 1 of 1
LAB ID S25-0073	FIELD ID TP1.2
DATE SAMPLED 12/31/24	SAMPLED BY S. Chandra

MATERIAL DATA

MATERIAL SAMPLED
Silty GRAVEL with Sand

MATERIAL SOURCE
Test Pit TP-1
depth = 3 feet

USCS SOIL TYPE
no data provided

LABORATORY TEST DATA

LABORATORY EQUIPMENT
Liquid Limit Machine, Hand Rolled

TEST PROCEDURE
ASTM D4318 - Method A

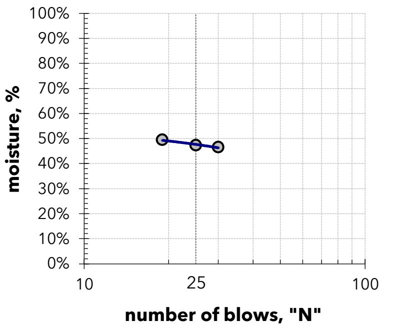
ATTERBERG LIMITS

liquid limit = 48
plastic limit = 30
plasticity index = 18

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	32.98	32.61	32.76	
dry soil + pan weight, g =	29.11	28.79	28.78	
pan weight, g =	20.79	20.71	20.73	
N (blows) =	30	25	19	
moisture, % =	46.5 %	47.3 %	49.4 %	

LIQUID LIMIT



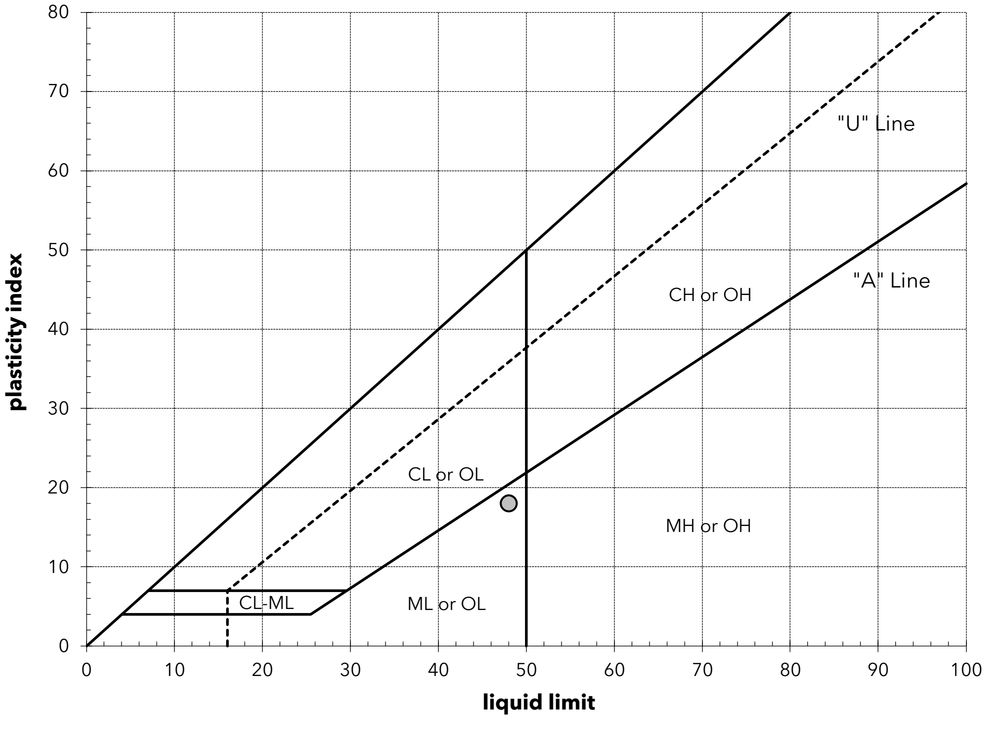
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	28.05	27.97		
dry soil + pan weight, g =	26.40	26.32		
pan weight, g =	20.95	20.94		
moisture, % =	30.3 %	30.7 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel = n/a
% sand = n/a
% silt and clay = n/a
% silt = n/a
% clay = n/a
moisture content = 29%

DATE TESTED 01/15/25	TESTED BY B. Taylor

COLUMBIA WEST ENGINEERING, INC. authorized signature

Exhibit 9 SUB25-1003

11917 NE 95th Street
Vancouver, Washington 98682 • Phone: 360-823-2900
8880 SW Nimbus Avenue, Suite A
Portland, Oregon 97008 • Phone: 971-384-1666
www.columbiawestengineering.com

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West
Engineering, Inc

PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	
Camas Woods Phase 3 26514 and 26416 SE 8th Street Camas, Washington	HSR Capital LLC 500 East Broadway, Suite 120 Vancouver, WA 98660	HSR-4-01-1	
		ISSUE DATE 01/21/25	PAGE 1 of 2
		LAB ID S25-0075	FIELD ID TP2.1
		DATE SAMPLED 12/31/24	SAMPLED BY S. Chandra

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Silty GRAVEL with Sand	Test Pit TP-2 depth = 2 feet	GM, Silty Gravel with Sand

SPECIFICATIONS	AASHTO CLASSIFICATION
none	A-2-7(1)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter, air-dried prep, hand washed, composite sieve - #4 split	ASTM D6913, Method A

ADDITIONAL DATA

initial dry mass (g) = 2971.41

as-received moisture content =	24%	coefficient of curvature, C_C =	n/a
liquid limit =	53	coefficient of uniformity, C_U =	n/a
plastic limit =	31	effective size, $D_{(10)}$ =	n/a
plasticity index =	22	$D_{(30)}$ =	0.138 mm
fineness modulus =	n/a	$D_{(60)}$ =	7.692 mm

NOTE: Entire sample used for analysis; did not meet minimum size required.

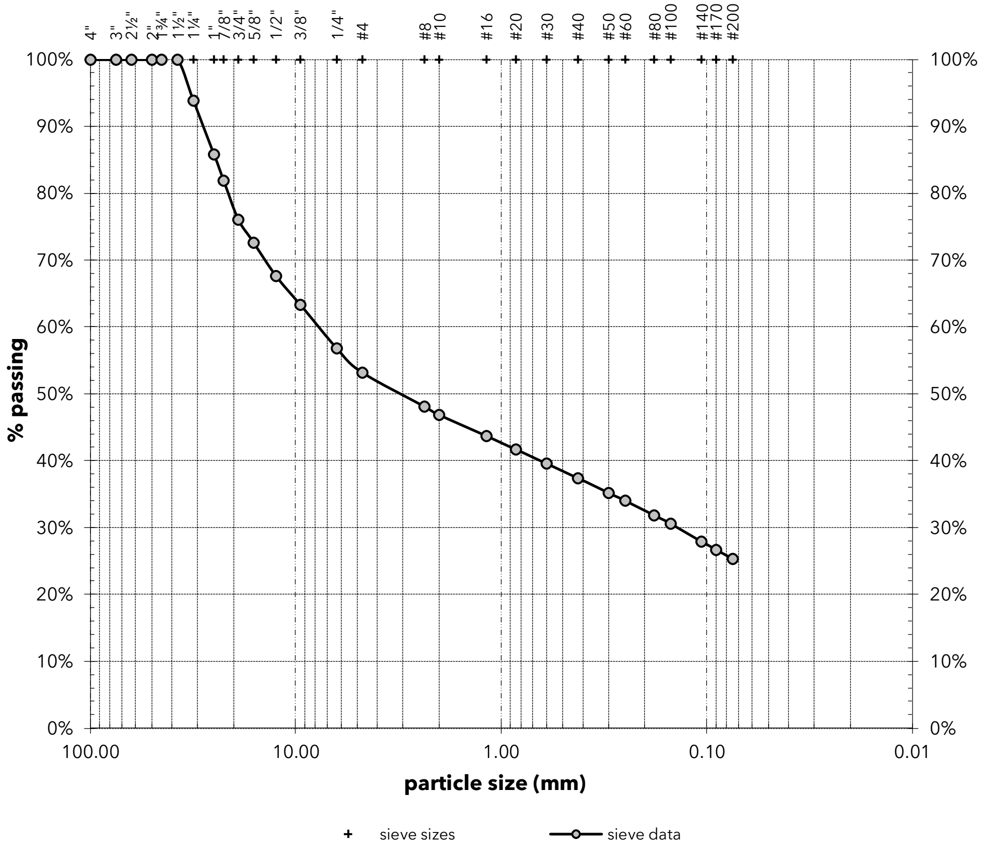
SIEVE DATA

% gravel = 46.8%
% sand = 27.8%
% silt and clay = 25.3%

	SIEVE SIZE		PERCENT PASSING			
			SIEVE		SPECS	
	US	mm	act.	interp.	max	min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5	100%			
	1.25"	31.5		94%		
	1.00"	25.0	86%			
	7/8"	22.4		82%		
	3/4"	19.0	76%			
	5/8"	16.0		73%		
	1/2"	12.5	68%			
	3/8"	9.50	63%			
	1/4"	6.30	57%			
	#4	4.75	53%			
SAND	#8	2.36		48%		
	#10	2.00	47%			
	#16	1.18		44%		
	#20	0.850	42%			
	#30	0.600		40%		
	#40	0.425	37%			
	#50	0.300		35%		
	#60	0.250	34%			
	#80	0.180		32%		
	#100	0.150	31%			
	#140	0.106		28%		
	#170	0.090		27%		
	#200	0.075	25%			

DATE TESTED	TESTED BY
01/15/25	M. Scherette

GRAIN SIZE DISTRIBUTION



COLUMBIA WEST ENGINEERING, INC. authorized signature

Exhibit 9 SUB25-1003

11917 NE 95th Street
Vancouver, Washington 98682 • Phone: 360-823-2900
8880 SW Nimbus Avenue, Suite A
Portland, Oregon 97008 • Phone: 971-384-1666
www.columbiawestengineering.com

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West
Engineering, Inc

ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	
Camas Woods Phase 3 26514 and 26416 SE 8th Street Camas, Washington	HSR Capital LLC 500 East Broadway, Suite 120 Vancouver, WA 98660	HSR-4-01-1	
		ISSUE DATE 01/21/25	PAGE 2 of 2
		LAB ID S25-0075	FIELD ID TP2.1
		DATE SAMPLED 12/31/24	SAMPLED BY S. Chandra

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Silty GRAVEL with Sand	Test Pit TP-2 depth = 2 feet	GM, Silty Gravel with Sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318 - Method A

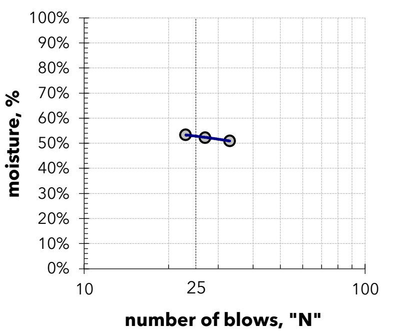
ATTERBERG LIMITS

liquid limit = 53
plastic limit = 31
plasticity index = 22

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	31.89	32.65	33.50	
dry soil + pan weight, g =	28.13	28.57	28.91	
pan weight, g =	20.75	20.76	20.31	
N (blows) =	33	27	23	
moisture, % =	51.0 %	52.2 %	53.4 %	

LIQUID LIMIT



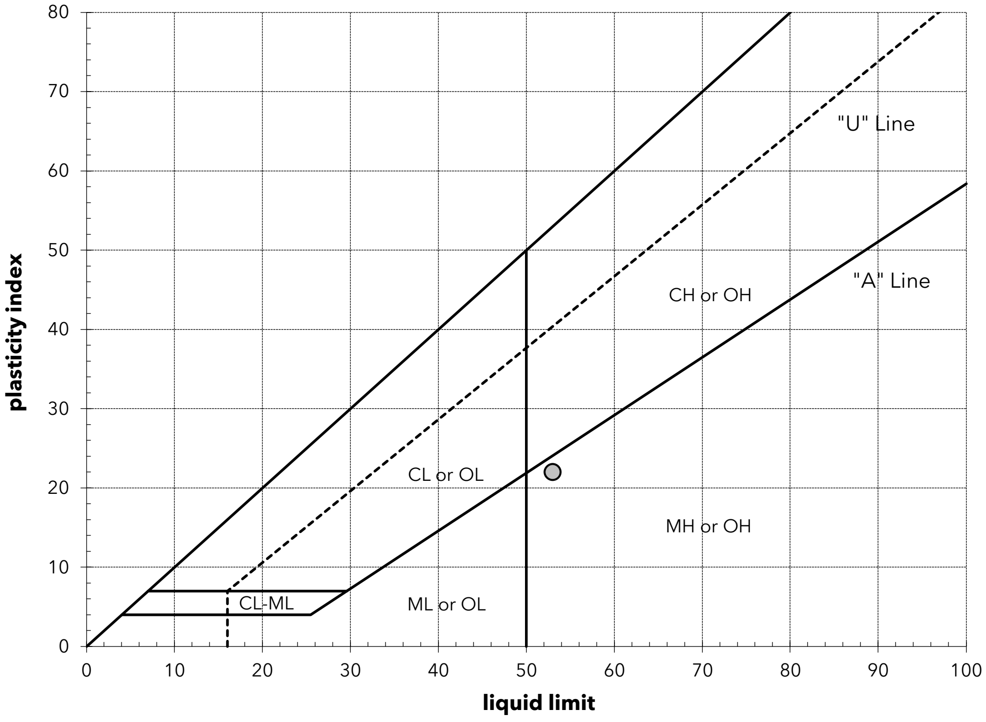
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.99	29.51		
dry soil + pan weight, g =	26.32	27.47		
pan weight, g =	20.93	20.92		
moisture, % =	31.0 %	31.2 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel = 46.8%
% sand = 27.8%
% silt and clay = 25.3%
% silt = n/a
% clay = n/a
moisture content = 24%

DATE TESTED	TESTED BY
01/16/25	B. Taylor

COLUMBIA WEST ENGINEERING, INC. authorized signature

APPENDIX C

Exhibit 9 SUB25-1003

APPENDIX C
PHOTO LOG

Photographs of the site are presented in this appendix.

Exhibit 9 SUB25-1003

Central portion of the site. Photograph taken facing south.

Test pit TP-1 profile.

Test pit TP-2 profile.

Test pit TP-3 profile.

Exhibit 9 SUB25-1003

Test pit TP-4 profile.

Test pit TP-5 profile.

Test pit TP-6 profile.

Exhibit 9 SUB25-1003

APPENDIX D

APPENDIX D
REPORT LIMITATIONS AND IMPORTANT INFORMATION

Report Purpose, Use, and Standard of Care

This report has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and/or environmental consulting, and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This report has been prepared to meet the specific needs of specific individuals for the indicated site. It may not be adequate for use by other consultants, contractors, or engineers, or if change in project ownership has occurred. It should not be used for any other reason than its stated purpose without prior consultation with Columbia West Engineering, Inc. (Columbia West). It is a unique report and not applicable for any other site or project. If site conditions are altered, or if modifications to the project description or proposed plans are made after the date of this report, it may not be valid. Columbia West cannot accept responsibility for use of this report by other individuals for unauthorized purposes, or if problems occur resulting from changes in site conditions for which Columbia West was not aware or informed.

Report Conclusions and Preliminary Nature

This geotechnical or environmental report should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. The exploration and associated laboratory analysis of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the subject property. However, soil conditions may differ between tested locations at different seasonal times of the year, either by natural causes or human activity. Distinction between soil types may be more abrupt or gradual than indicated on the soil logs. This report is not intended to stand alone without understanding of concomitant instructions, correspondence, communication, or potential supplemental reports that may have been provided to the client.

Because this report is based upon observations obtained at the time of exploration, its adequacy may be compromised with time. This is particularly relevant in the case of natural disasters, earthquakes, floods, or other significant events. Report conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the subject property. Groundwater conditions, if presented in this report, reflect observed conditions at the time of investigation. These conditions may change annually, seasonally or as a result of adjacent development.

Additional Investigation and Construction Observation

Columbia West should be consulted prior to construction to assess whether additional investigation above and beyond that presented in this report is necessary. Even slight variations in soil or site conditions may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent construction observation services and testing to verify soil conditions do not differ materially or significantly from the interpreted conditions utilized for preparation of this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Actual subsurface conditions are more readily observed and discerned during the earthwork phase of construction when soils are exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this report or future performance of structural facilities if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

Collected Samples

Uncontaminated samples of soil or rock collected in connection with this report will be retained for thirty days. Retention of such samples beyond thirty days will occur only at client's request and in return for payment of storage charges incurred. All contaminated or environmentally impacted materials or samples are the sole property of the client. The client maintains responsibility for proper disposal.

Report Contents

This geotechnical or environmental report should not be copied or duplicated unless in full, and even then, only under prior written consent by Columbia West, as indicated in further detail in the following text section entitled Report Ownership. The recommendations, interpretations, and suggestions presented in this report are only understandable in context of reference to the whole report. Under no circumstances should the soil boring or test pit excavation logs, monitor well logs, or laboratory analytical reports be separated from the remainder of the report. The logs or reports should not be redrawn or summarized by other entities for inclusion in architectural or civil drawings, or other relevant applications.

Report Limitations for Contractors

Geotechnical or environmental reports, unless otherwise specifically noted, are not prepared for the purpose of developing cost estimates or bids by contractors. The extent of exploration or investigation conducted as part of this report is usually less than that necessary for contractor's needs. Contractors should be advised of these report limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this report, but should rely upon their own interpretations as to how subsurface conditions may affect cost, feasibility, accessibility and other components of the project work. If believed necessary or relevant, contractors should conduct additional exploratory investigation to obtain satisfactory data for the purposes of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface ground conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

Report Ownership

Columbia West retains the ownership and copyright property rights to this entire report and its contents, which may include, but may not be limited to, figures, text, logs, electronic media, drawings, laboratory reports, and appendices. This report was prepared solely for the client, and other relevant approved users or parties, and its distribution must be contingent upon prior express written consent by Columbia West. Furthermore, client or approved users may not use, lend, sell, copy, or distribute this document without express written consent by Columbia West.

Client does not own nor have rights to electronic media files that constitute this report, and under no circumstances should said electronic files be distributed or copied. Electronic media is susceptible to unauthorized manipulation or modification, and may not be reliable.

Consultant Responsibility

Geotechnical and environmental engineering and consulting is much less exact than other scientific or engineering disciplines, and relies heavily upon experience, judgment, interpretation, and opinion often based upon media (soils) that are variable, anisotropic, and non-homogenous. This often results in unrealistic expectations, unwarranted claims, and uninformed disputes against a geotechnical or environmental consultant. To reduce potential for these problems and assist relevant parties in better understanding of risk, liability, and responsibility, geotechnical and environmental reports often provide definitive statements or clauses defining and outlining consultant responsibility. The client is encouraged to read these statements carefully and request additional information from Columbia West if necessary.