5. Preliminary Stormwater Technical Information Report (TIR)

Uhacz Subdivision
(PA25-1036)

Preliminary Stormwater Technical Information Report (TIR)

Date:	March 2026
Submitted To:	City of Camas Community Development Department 616 NE 4th Avenue Camas, WA 98607
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AKS Job Number:	12533

AKS ENGINEERING & FORESTRY

www.aks-eng.com

Certificate of the Engineer

Uhacz Subdivision
Camas, Washington
Preliminary Technical Information Report

This 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.

03/13/2026

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)

UHACZ 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 preliminary hydraulic analysis. Any changes to the proposed site and its effects on the hydraulic analysis, associated models and facility designs will be outlined and provided in the final technical information report.

Section A.1 – Site Location

The Uhacz Subdivision project site is addressed at 27429 SE 15th Street, Camas, WA 98607 and is a total of 6.98 acres in size. The site is composed of Clark County Parcel Number 178413-000 within the southwest quarter of Section 36, Township 2 North, Range 3 East, Willamette Meridian. The parcel is zoned Single Family Residential (R1-6) and contains an existing single family residence on-site. The site will be accessed from the East via NE 41st Avenue.

Section A.2 – Site Topography and Critical Areas

The site slopes generally to the Southeast, with a relatively flat ridge running through the upper center of the site. There is a small portion on the North side of the site that slopes down to the Northwest corner of the site. See appendix D for pre-developed basin map. Slopes on site range from 0.5 – 40 percent. The site is mostly covered in field grass and brush, with an existing single-family residence located near the center of the west property line. The site is within a Category 2 Critical Aquifer Recharge Area (CARA) and contains steep slopes greater than 15%, but does not contain any wetlands, critical species or habitat area, landslide areas, streams, shoreline area, or any other environmental constraints.

Section A.3 – Existing On-Site Stormwater System

Existing stormwater on site primarily disperses or sheet flows Southeast to the NE Woodburn Drive right-of-way, entering a curb inlet catch basin owned by the City of Camas and ultimately discharging to a tributary stream of Lacamas Creek. A small portion of the stormwater on the North side of the site flows Northeast to a local on-site low point, where it is captured by an existing driveway-adjacent 8" concrete culvert and conveyed North to discharge in the existing ditch within the SE 15th Street right-of way. An existing stormwater outfall from an adjacent property (Parcel No. 178417-000) exists on site and drains to this same local on-site low point.

Section A.4 – Site Parameters That Influence Stormwater Design

As previously discussed, the existing site conditions generally drain toward the Southeast of the site. The selected placement of the stormwater facilities and their respective outlets are designed to maintain the existing natural drainage path. These facilities and these locations are discussed in further detail subsequently in this report and can be found in proposed development plans, attached in Appendix C. Per the project geotechnical report completed by Columbia West Engineering, Inc (Columbia West) dated June 17, 2025, the native soil meets the classification criteria of WWHM Soil Group 4, and is not suitable for the design of infiltration facilities. Per Columbia West's recommendation, infiltration is not feasible on site and was the primary factor in determining water quality and quantity BMPs to be used on site. Further information on the native soil conditions is discussed subsequently in this report and within the project geotechnical report, attached in Appendix G.

Section A.5 –Adjacent Property Drainage

Apart from Parcel No. 178417-000 to the West, adjacent properties do not or minimally drain to the project site, and any off-site runoff has been determined as nominal for purposes of the preliminary stormwater model. Parcel 178417-000 to the West is undeveloped and does not have on-site stormwater infrastructure. Parcels along the East property line are developed and include their own stormwater infrastructure. To the North of the site, SE 15th Street and adjacent parcels drain away from the project site. To the South of the site, NE Woodburn Drive includes stormwater infrastructure; therefore, stormwater does not drain on-site from the street frontage.

Section A.6 –Adjacent Site Areas

The proposed development is bounded to the West by an undeveloped parcel, zoned Single Family Residential (R1-6). Similarly, adjacent properties to the north are undeveloped and zoned Single Family Residential (R1-6). To the East, adjacent properties are a part of a recently developed residential subdivision zoned Residential-6,000 (R-6). To the Northwest and South, the site fronts SE 15th Street and NE Woodburn Drive, respectively.

Section A.7 – General Project Stormwater Description

Proposed improvements for the development include 32 single-family lots, public and private streets, utilities, and associated site improvements. As previously discussed, the current drainage on site is encompassed within a primary existing basin (1X) that ultimately discharges at the Southeast corner of the site, and a secondary existing basin (2X) that discharges at the Northwest corner of the site. This pattern will be maintained with the proposed site improvements. The site is modeled as one threshold discharge area (TDA), flowing to one point of compliance (POC).

This TDA is comprised of 1 basin referred to as Basins 1S. Basin 2S contains an existing driveway access to the site and will be minimally altered from its existing state. The existing driveway will be blocked from vehicle access at SE 15th Street and reduced in width to be used as a pedestrian trail and a small usable open space area. These subbasins are depicted in the Post Developed Basin plans, attached in Appendix D. Basin 1S contains proposed stormwater quality and quantity facilities to manage runoff.

All runoff from pollution generating surfaces (PGS) and runoff from non-pollution generating surfaces (NPGS) that has a chance to mix with runoff from PGS will be conveyed to a water quality treatment manhole prior to discharge into the detention facility. All water quality and quantity facilities were sized using Western Washington Hydrology Model (WWHM) and reports from these models are included Appendix E and F. The stormwater system is designed per the Stormwater Management Manual for Western Washington (SWMMWW). See the development plans (Appendix C), Stormwater Basin Plans (Appendix D), and WWHM Analysis (Appendix E & F) for location, size, and analysis.

Section B – Minimum Requirements

Section B.1 – Determination of Applicable Minimum Requirements

Proposed land disturbances shall include grading and excavation of unsuitable soils for the construction of lots, streets, sidewalks, parking, and associated utilities. Due to the amount of proposed hard surfaces (greater than 5,000 square feet), the project is required to meet Minimum Requirements 1 through 9 per Figure I-3.1 of the 2024 SWMMWW, attached for reference in Appendix B.

The following tables summarize each stormwater basin within the project area. See the Stormwater Basin Plans for basin locations (Appendix D).

Table B-1: Proposed Hard Surface and Landscaping

Basin	Existing Hard Surfaces (acres)	New Hard Surfaces (acres)	Replaced Hard Surfaces (acres)	Hard Surface Replaced with Landscape (acres)	Native Vegetation Replaced w/ Landscape (acres)	Total Land Disturbed (acres)
1S	0.359	2.981	0.000	0.000	3.070	6.410
2S	0.113	0.000	0.048	0.020	0.451	0.544

Note: Areas listed are in acres. Assumes 400-square-foot driveways and the maximum 40% lot coverage per lot.

Tables B-2 and B-3 show the mitigated site basins, differentiating between pollution- and non-pollution-generating surfaces. It is important to note that any 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

Basin	Hard Surfaces (acres)	Pervious Surfaces (acres)	Total Surface Area (acres)
1S	2.69	2.42	5.11
2S	0.00	0.00	0.00

Note: Areas listed are in acres. Assumes 400-square-foot driveways and the maximum 40% lot coverage per lot.

Table B-3: Non-Pollution-Generating Surfaces

Basin	Hard Surfaces (acres)	Pervious Surfaces (acres)	Total Surface Area (acres)
1S	0.65	0.65	1.30
2S	0.09	0.45	0.54

Note: Areas listed are in acres. Assumes 400-square-foot driveways and the maximum 40% lot coverage per lot.

Each developed basin's effective hard surfaces and their applicability for meeting Minimum Requirements 6 through 8 are summarized in Table B-4 below.

Table B-4: Effective Hard Surfaces

Basin	Hard Surface Area (acres)	MR #6 Required (Y/N)	MR #7 Required (Y/N)	MR #8 Required (Y/N)
1S	3.34	Y	Y	N
2S	0.093	N	N	N

Note: Areas listed are in acres. Assumes 400-square-foot driveways and the maximum 40% lot coverage per lot.

Section C – Soils Evaluation

A geotechnical investigation was completed on the project site by Columbia West Engineering, Inc. The project geotechnical report, dated June 17, 2025, summarizes findings and results of the field work and subsequent testing performed with the site investigation. On-site, 8 test pits (TPs) were excavated between 12 and 13.5 feet below ground surface (BGS). Additionally, per The City of Camas requirements, infiltration testing was performed in 3 test pits. Results from these tests and their application to the stormwater system design are explained subsequently in this report and in the project geotechnical report, attached in Appendix G.

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

Per the recommendations of the geotechnical engineer, the Uhacz Subdivision project is not suitable for stormwater infiltration. Therefore, infiltration BMPs were not viable for flow control, runoff treatment, or list #2 and low impact development (LID) considerations. More information on results of infiltration testing performed on site are included in *Section C.4* below.

Additionally, all disturbed areas will meet post-construction soil quality and quantity requirements per best management practice (BMP) T5.13.

Section C.2 – Water Table Information

Per the project geotechnical report, groundwater seepage was encountered in several test pits between 7 and 11 feet BGS during the site exploration. It is anticipated that no stormwater facilities will be affected by groundwater presence. However, perched groundwater may be present on-site during the wetter months and periods of heavy rain, and dewatering during excavation may be required.

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), 0.7 percent of the site (Type D soil / WWHM Soil Group 4).
- OlB (Olympic clay loam, 3 to 8 percent slopes), 27.0 percent of the site (Type D soil / WWHM Soil Group 4).
- OlD (Olympic clay loam, 8 to 20 percent slopes), 45.3 percent of the site (Type D soil / WWHM Soil Group 4).
- OmE (Olympic stony clay loam, 3 to 30 percent slopes), 27.1 percent of the site (Type D soil / WWHM Soil Group 4).

In general, these soil types exhibit low permeability, and the NCRS soils map is consistent with the near surface soils that were observed on site and documented in the geotechnical report. The NCRS soils map and report are included in Appendix A.

Section C.4 –Infiltration Rate Testing

The project geotechnical report dated June 17, 2025, attached in Appendix G, details the infiltration testing operations conducted on site. Infiltration tests were completed in 3 of the 8 TPs excavated across the site, TP-2, TP-5, and TP-7. In all TPs, tests were conducted at 4 feet BGS, and the infiltration rates were determined to be negligible. Because of this, the site has been classified as WWHM soil group 4, and design on infiltration facilities on site was determined to be infeasible.

Section C.5 – Complex Soil Conditions

A geotechnical report has been prepared and is included with this report (see Appendix G). Existing soil conditions are summarized, and recommendations are presented in relation to site design considerations. All stormwater facility design is predicated upon the findings and subsequent recommendations presented in this report.

Section D –Source Control

Volume IV of the 2024 SWMMWW contains the following applicable source control 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). The project SWPPP will be submitted prior to commencement of any construction activities on the project site.

Section E –On-Site Stormwater Management BMPs

The project is required to adhere to meet Minimum Requirement #5. Figure I-3.3 of the SWMMWW is used to determine the applicable requirements and is attached in Appendix B. Due to the in-situ considerations discussed previously, the project will not achieve the LID Performance Standard. As such, the project is then required to utilize List #2, located in SWMMWW Table I-3.2, to evaluate the feasibility of listed BMPs. All LID BMPs per List #2 are infeasible for the hard surface areas of the project due to soil and site constraints. Full Dispersion (BMP T5.30), Downspout Dispersion Systems (BMP T5.10B), and Sheet Flow Dispersion (BMP T5.12) are not feasible, as site layout constraints do not allow for an appropriate flow path. Along with this, Full Infiltration (BMP T5.10A), Bioretention (BMP T7.30), Perforated Stub-outs (BMP T5.10C), and Permeable Pavements (BMP T5.15) are infeasible, as infiltration rates on-site have been determined as negligible. However, all disturbed areas to remain as pervious surface will meet post-construction soil quality and quantity requirements per BMP T5.13. See BMP Flow Chart, attached in Appendix B.

Section F –Runoff Treatment Analysis and Design

Surface water from pollution-generating surfaces will be treated utilizing Washington Department of Ecology (ECY)-approved manufactured treatment devices. As required per MR #6, at least 91% of the post-developed pollution generating runoff volume, as predicted by a continuous runoff model, will be treated. Lacamas Lake is listed as a category 5-303d waterbody for total phosphorus. This project basin drains to and discharges to a tributary stream of Lacamas Creek, which is ultimately below Lacamas lake and the Round Lake Dam, and therefore will not require phosphorus treatment. However, all preliminary water quality flow rate sizing was done utilizing ECY approved media approved for both basic and phosphorus treatment.

The stormwater treatment structure will be located upstream of proposed detention facility as shown in the proposed development plans, attached in Appendix C. Any non-pollution-generating runoff that has an opportunity to mix with pollution-generating runoff will be considered pollution-generating and conveyed through the treatment devices. Per City of Camas requirements, stormwater treatment structures will not be located within the right-of-way, but within the privately owned and maintained stormwater tracts and easements proposed on site.

As discussed previously, the project site contains one post-developed basin that will undergo treatment. This proposed basin will contain a central water quality manhole structure, directly upstream of the detention facility. This manhole will be used to treat all runoff of pollution-generating surfaces.

Basins 1S also contains non-pollution generating areas that will bypass the proposed treatment manhole. These are on-lot landscape and roof areas that will be captured and conveyed through rear yard storm lines, avoiding any potential mixture with pollutant-laden runoff, and discharge directly into the detention facility. A water quality basin plan delineating these areas has been prepared and attached in Appendix D. All stormwater quality facilities for the site have been designed in compliance with the 2024 SWMMWW. The approximate location of the proposed runoff treatment facility is shown on the development plans located in Appendix D.

Table F-1 below summarizes the offline water quality treatment flow provided with the preliminary structure. All offline water quality treatment flow rates were calculated using the 2012 Western Washington Hydrology Model (WWHM), the approved continuous runoff model. Results of that analysis, including water quality flow rates, is attached in Appendix F.

Table F-1: Water Quality Flow Rate

Proposed Structure	Basin	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)	Contech StormFilter Cartridges
96” StormFilter Manhole	1S	2.69	2.42	0.4488	0.4620	(11)-27” PHOS

Section G –Flow Control Analysis and Design

The development is required to adhere to MR #7, and all stormwater discharges from the project site are required to meet the flow control performance standard. As such, all mitigated stormwater discharges are designed to meet or exceed this standard, by matching pre-developed discharge rates from 50 percent of the 2-year peak flow up to the full 50-year peak flow.

As previously stated, the project site consists of one main basin with a single TDA and POC. This developed basin contains a proposed stormwater detention pond facility (BMP D.1), designed to capture and mitigate discharge of runoff generated with the post-developed conditions of the site as proposed in the project plans. This facility was designed using the approved continuous runoff model, WWHM, per the requirement of the 2024 SWMMWW. A complete WWHM analysis detailing the proposed facility design and it’s performance in successfully meeting MR #7 is attached in Appendix E.

The stormwater detention pond facility is proposed to be located within a stormwater tract and is to be privately owned and maintained. For the proposed location of this Tract and the associated facilities, see development plans attached in Appendix C.

Section H –Wetland Protection

Wetland protection requirements are not applicable to this project since there are no adjacent wetlands that could potentially be impacted by the project.

Section I –Other Permits

A Construction Stormwater General Permit from the Washington State Department of Ecology (ECY) will be obtained prior to construction of this project. The General Permit will encompass all phases of construction.

No additional permits relating to the design of the stormwater system are anticipated.

Section J – Conveyance System Analysis and Design

The proposed system design will include public conveyance pipe and structures located within the right-of-way, and private conveyance pipe and structures located within private stormwater easements on several lots within the project. The contributing area of the site is less than 40 acres in size and the final proposed conveyance systems will be designed for the 10-year, 24-hour peak storm event as required by the 2024 SWMMWW. A complete analysis of the conveyance system will be completed with the final technical information report.

Section K – Off-Site Analysis

Prior to discharge off-site, the proposed project will mitigate all stormwater and potential downstream impacts as required by MRs #1-9 of the 2024 SWMMWW. During construction, all applicable BMPs will be installed as feasible to prevent excessive sedimentation and stream bank erosion and prevent discharge of sediment-laden runoff to City facilities, adjacent properties, or waters of the State. All site stormwater design is centric to the principle of reducing impacts to downstream properties and groundwater sources. The ultimate discharge location for the project is in the Southeast corner of the site and includes an energy dissipating flow.

If site stormwater systems are constructed and maintained properly by the final technical information report and SWPPP, no downstream water quality impacts are anticipated as a result of this development.

Section L –Conditions of Approval

Any applicable conditions of approval as associated with the project’s stormwater design will be addressed with the final technical information report.

Section M – Special Reports and Studies

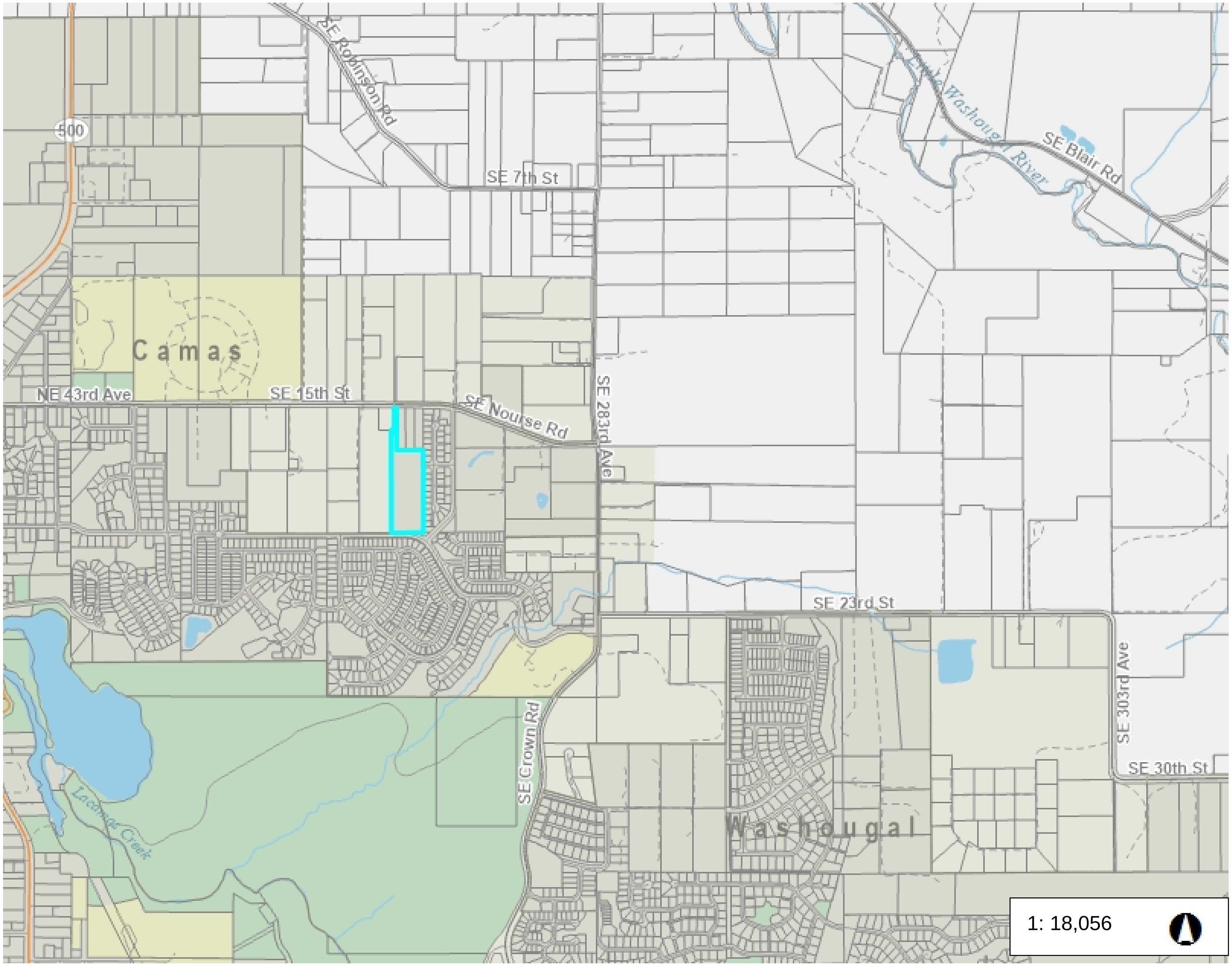
A geotechnical report by Columbia West Engineering, Inc, dated June 17, 2025, is included in Appendix G.

Section N – Maintenance and Operations

A maintenance and operations manual will be completed per the 2024 SWMMWW and will be included with the final technical information report.

Appendix A

12533 Vicinity Map



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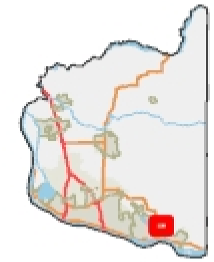

Legend

Taxlots

Notes:

3,009.3 | 0 | 1,504.67 | 3,009.3 | Feet

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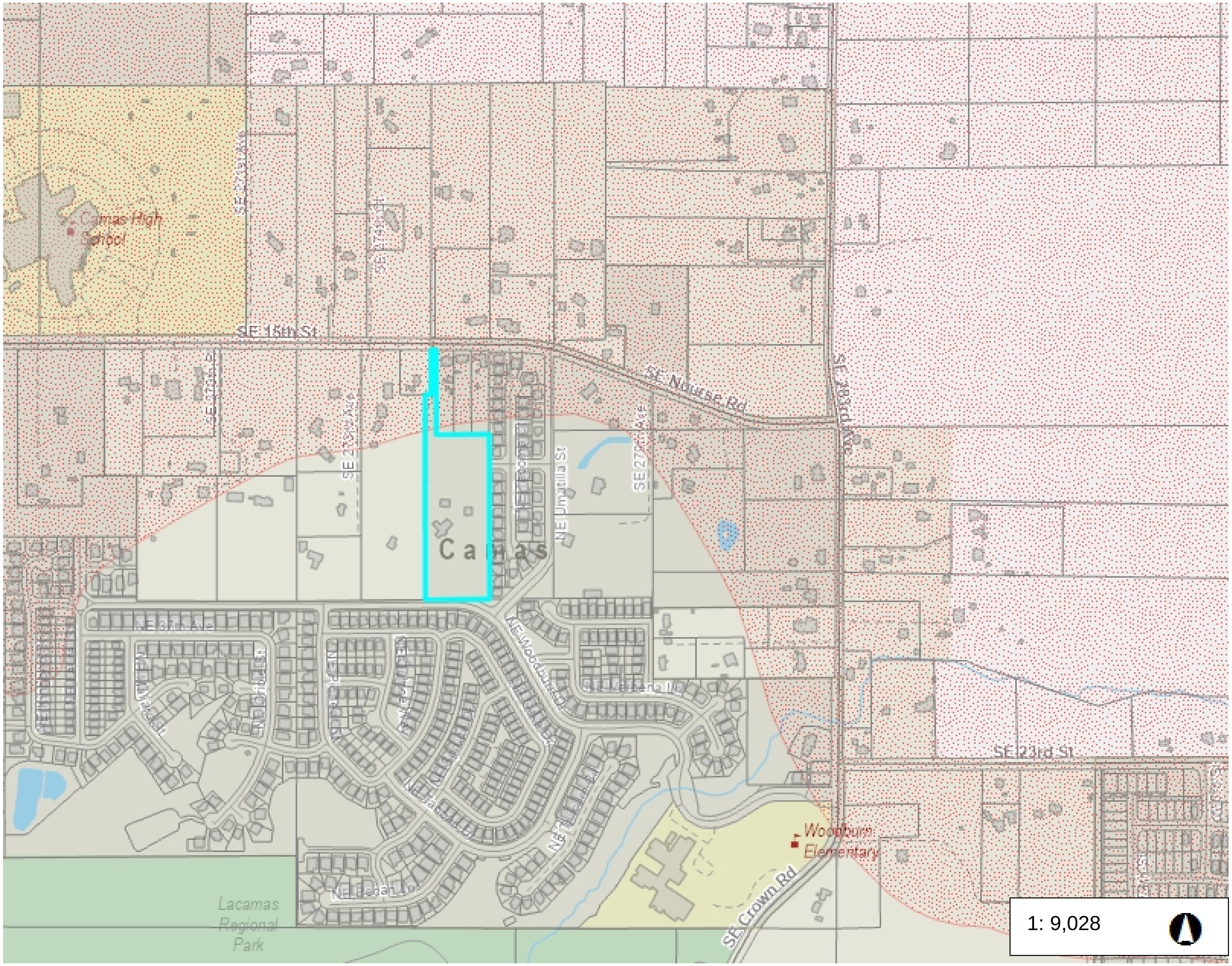
Clark County, WA. GIS - http://gis.clark.wa.gov

Exhibit 9 SUB26-1011

12533 CARA Map



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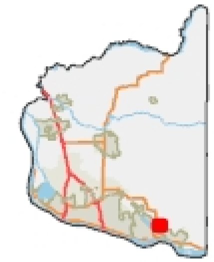


Legend

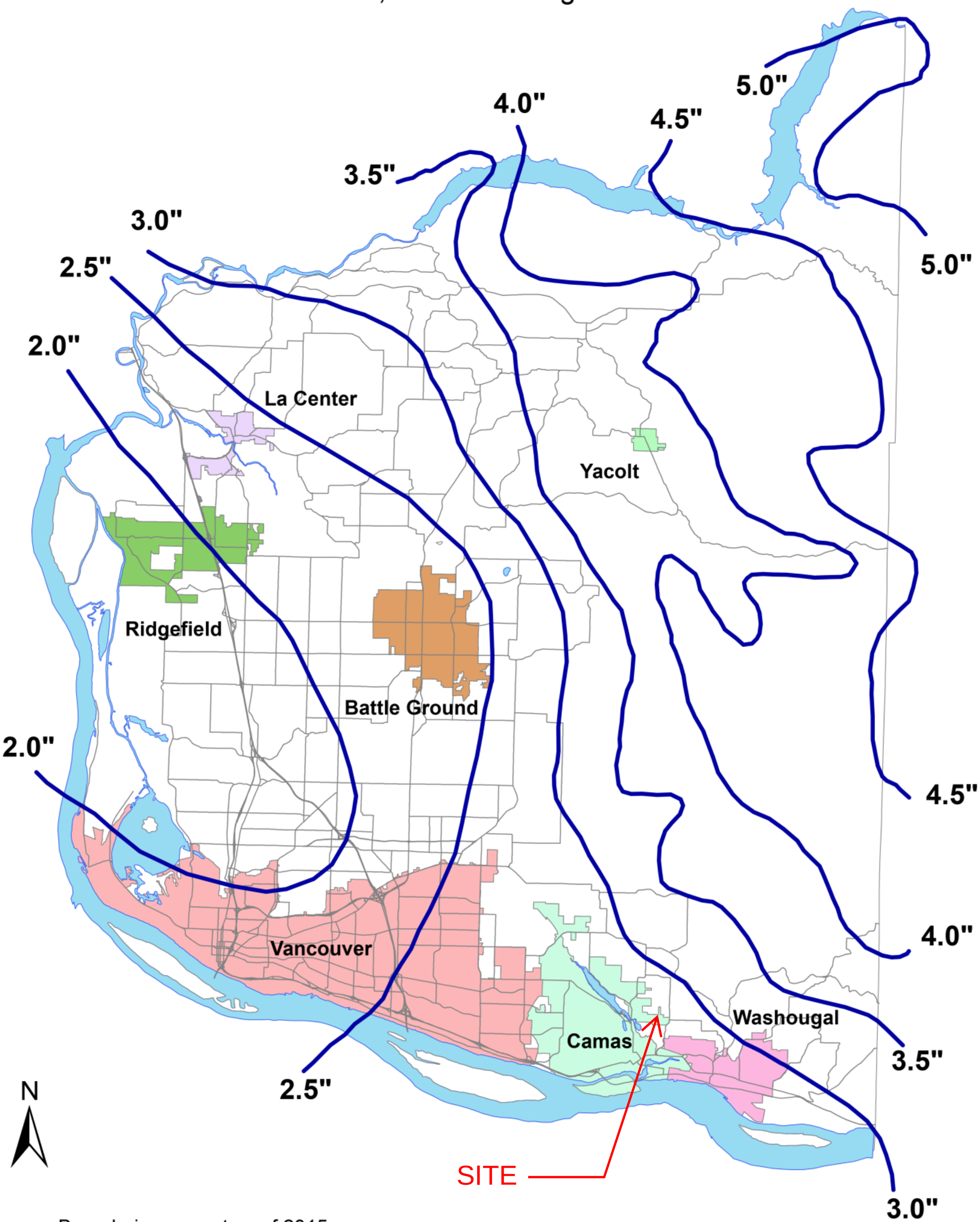
- Building Footprints
- Taxlots
- Critical Aquifer Recharge Area
  - Category 1 Recharge Areas
  - Category 2 Recharge Areas
  - Critical Aquifer Recharge Area (Var
  - Within 1900 foot buffer (Vancouver)

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

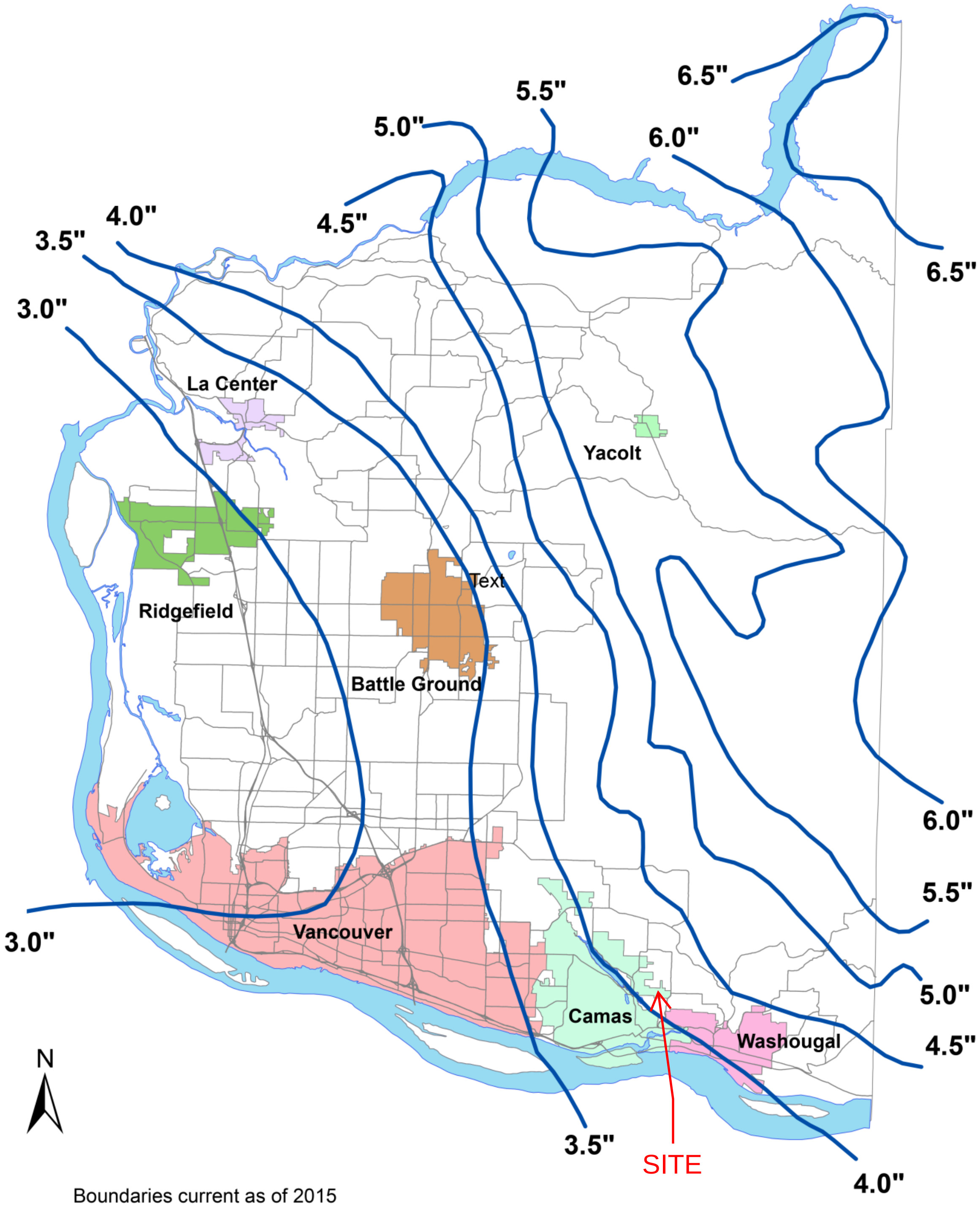
Isopluvial Map for Clark County
2-Year, 24-Hour Design Storm

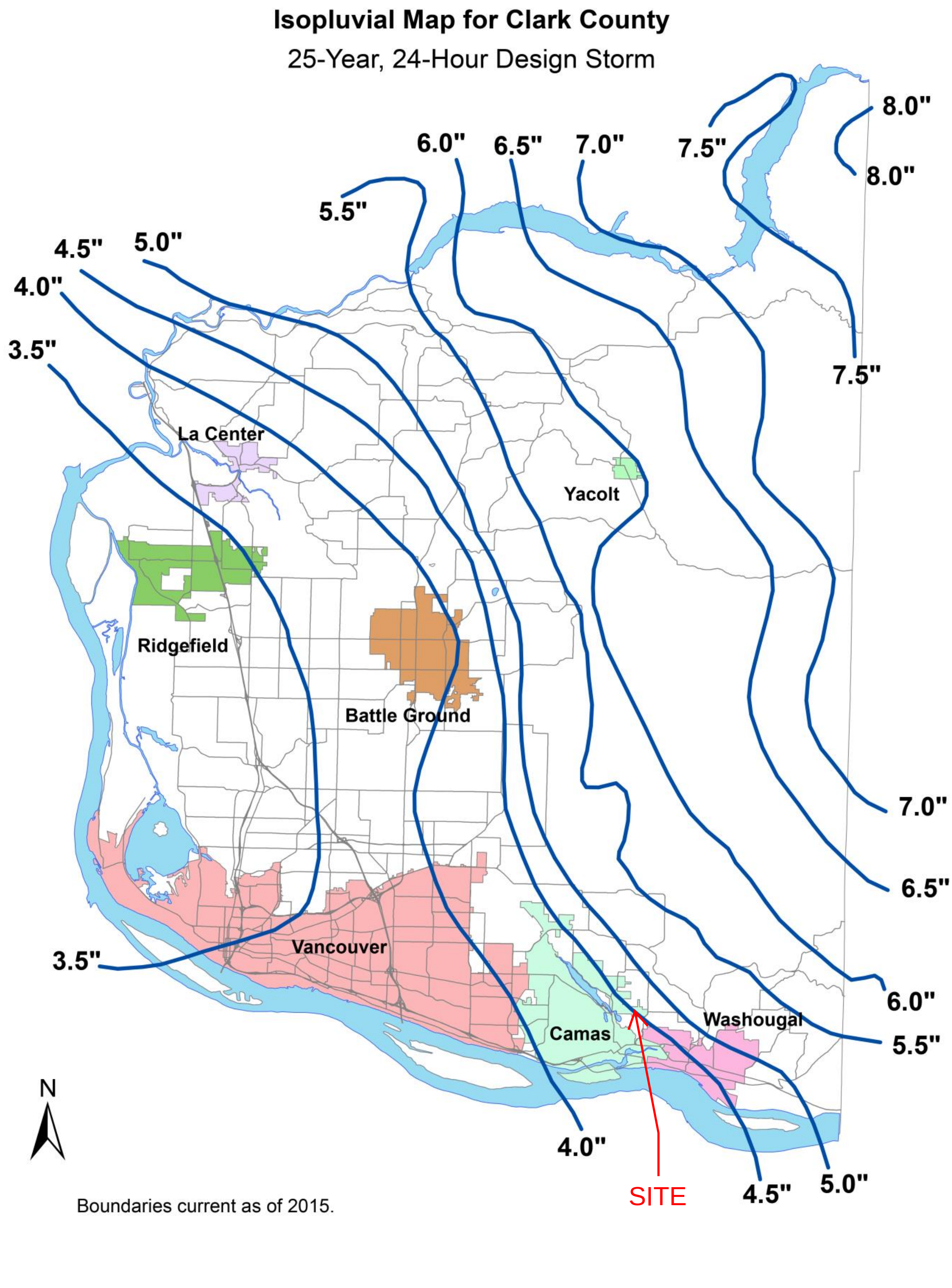


Boundaries current as of 2015

Isopluvial Map for Clark County

10-Year, 24-Hour Design Storm




Isopluvial Map for Clark County
25-Year, 24-Hour Design Storm
8.0"
8.0"
7.5"
7.5"
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4.0"
3.5"
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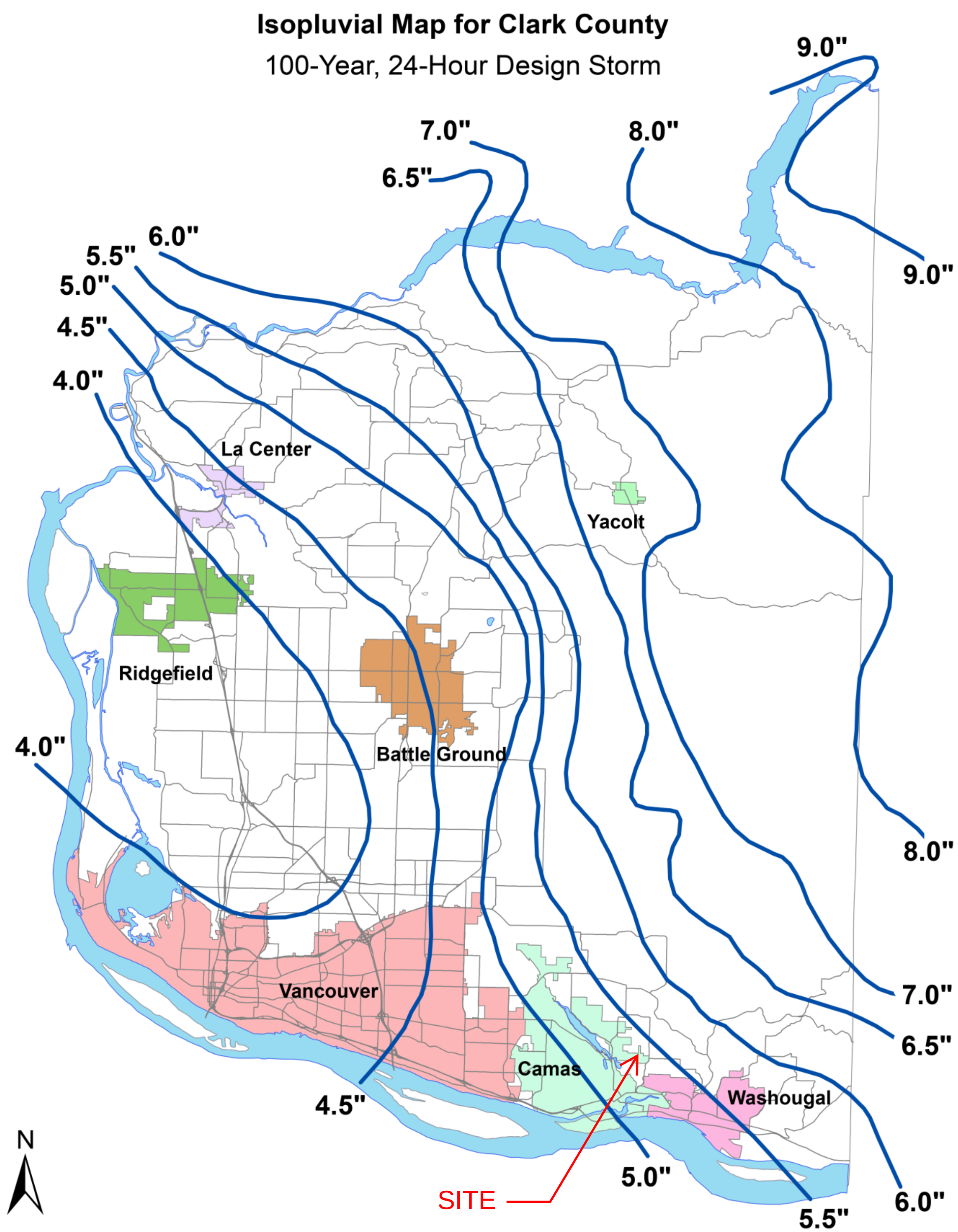
La Center
Yacolt
Ridgefield
Battle Ground
Vancouver
Camas
Washougal
N
SITE
Boundaries current as of 2015.



Boundaries current as of 2015.

Soil Map—Clark County, Washington
(12533 Uhacz Subdivision)

Map Scale: 1:2,290 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

Soil Map—Clark County, Washington
(12533 Uhacz Subdivision)

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
- 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
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- 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 23, Aug 28, 2025

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

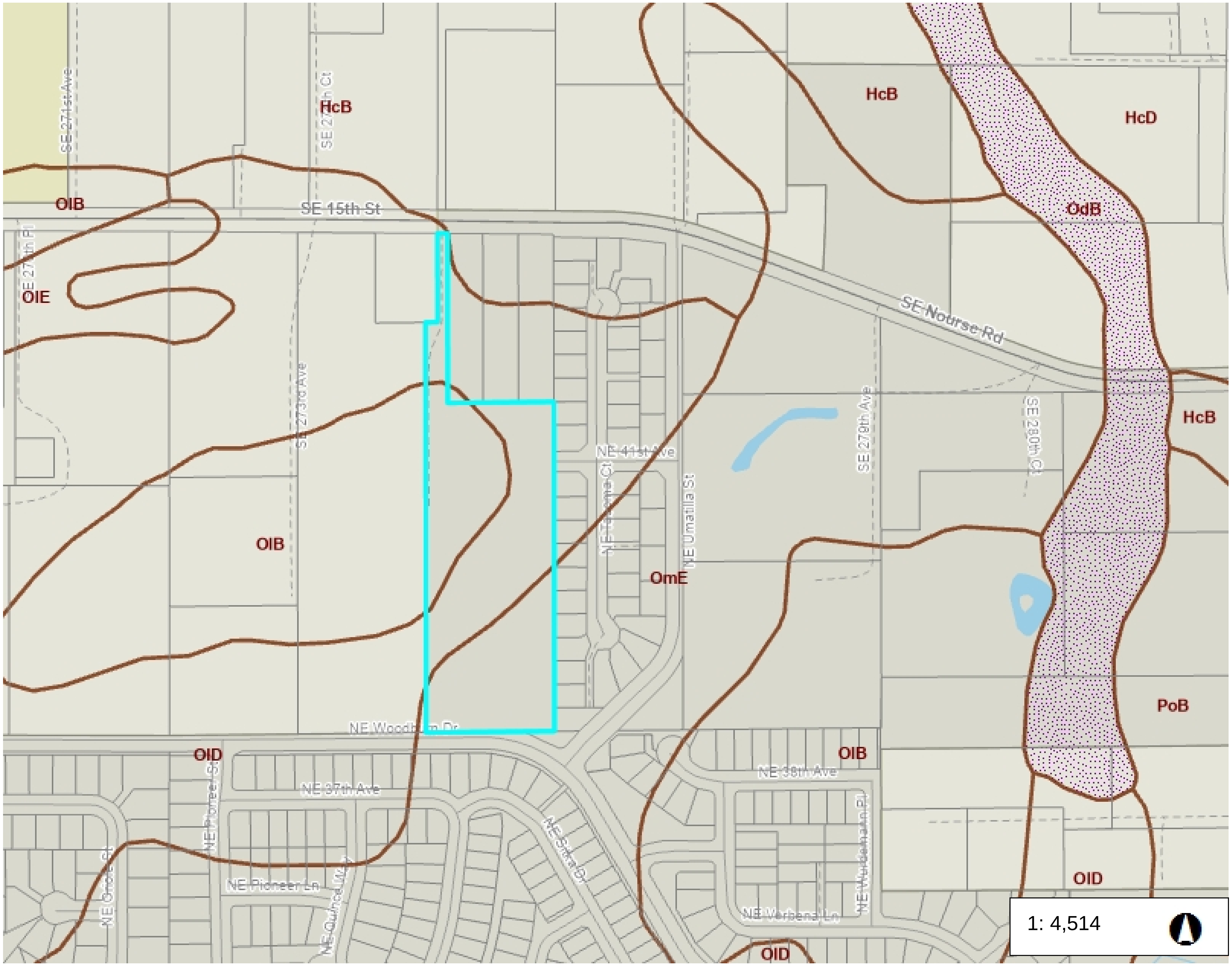
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HcB	Hesson clay loam, 0 to 8 percent slopes	0.1	0.7%
OlB	Olympic clay loam, 3 to 8 percent slopes	1.9	27.0%
OlD	Olympic clay loam, 8 to 20 percent slopes	3.2	45.3%
OmE	Olympic stony clay loam, 3 to 30 percent slopes	1.9	27.1%
Totals for Area of Interest		**7.2**	**100.0%**

Exhibit 9 SUB26-1011

12533 Soils Map



Legend

- Taxlots
- Soil Type
- Hydric Soils

Notes:

1: 4,514

752.3 0 376.17 752.3 Feet

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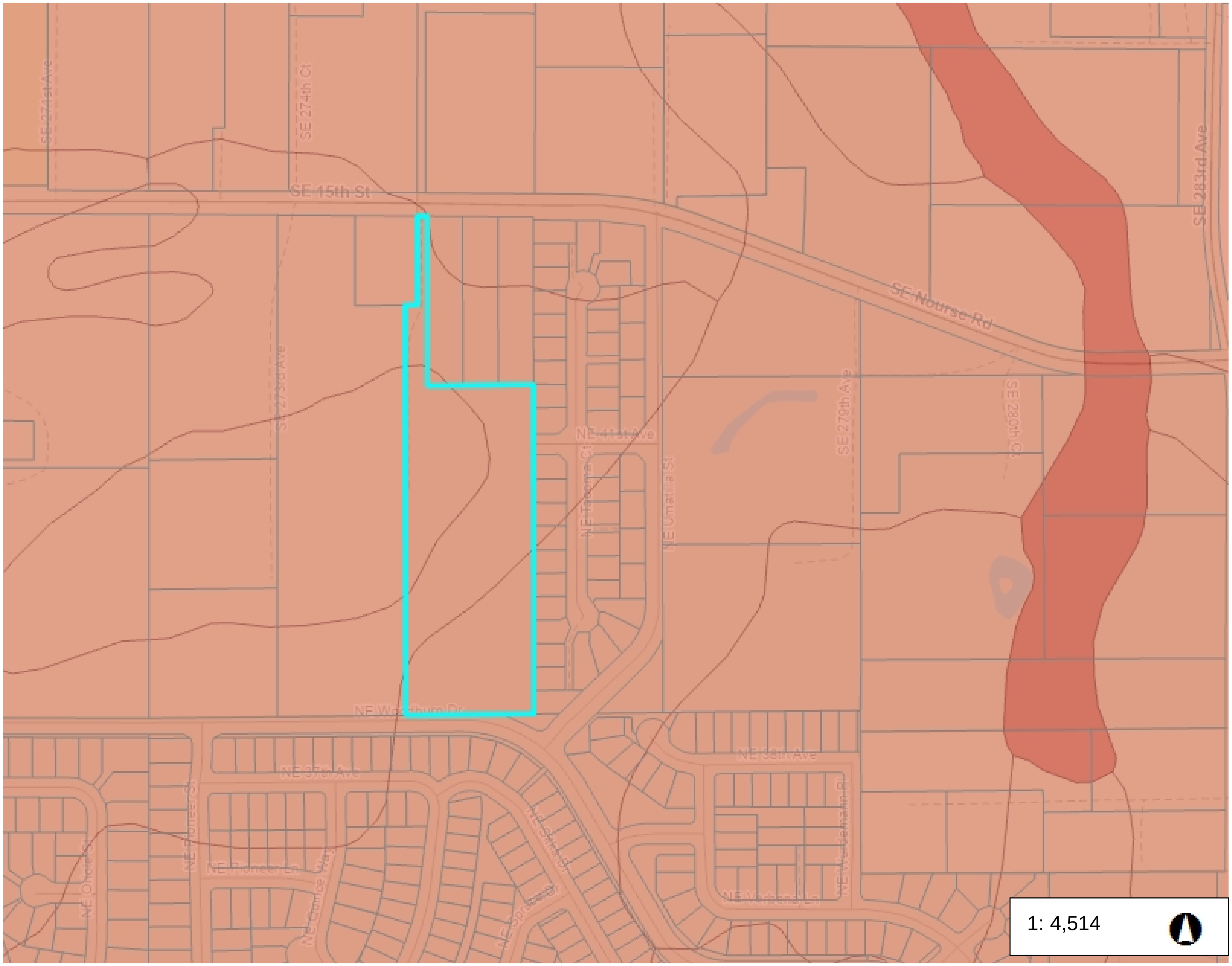
Clark County, WA. GIS - http://gis.clark.wa.gov

12533 WWHM Soil Map



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

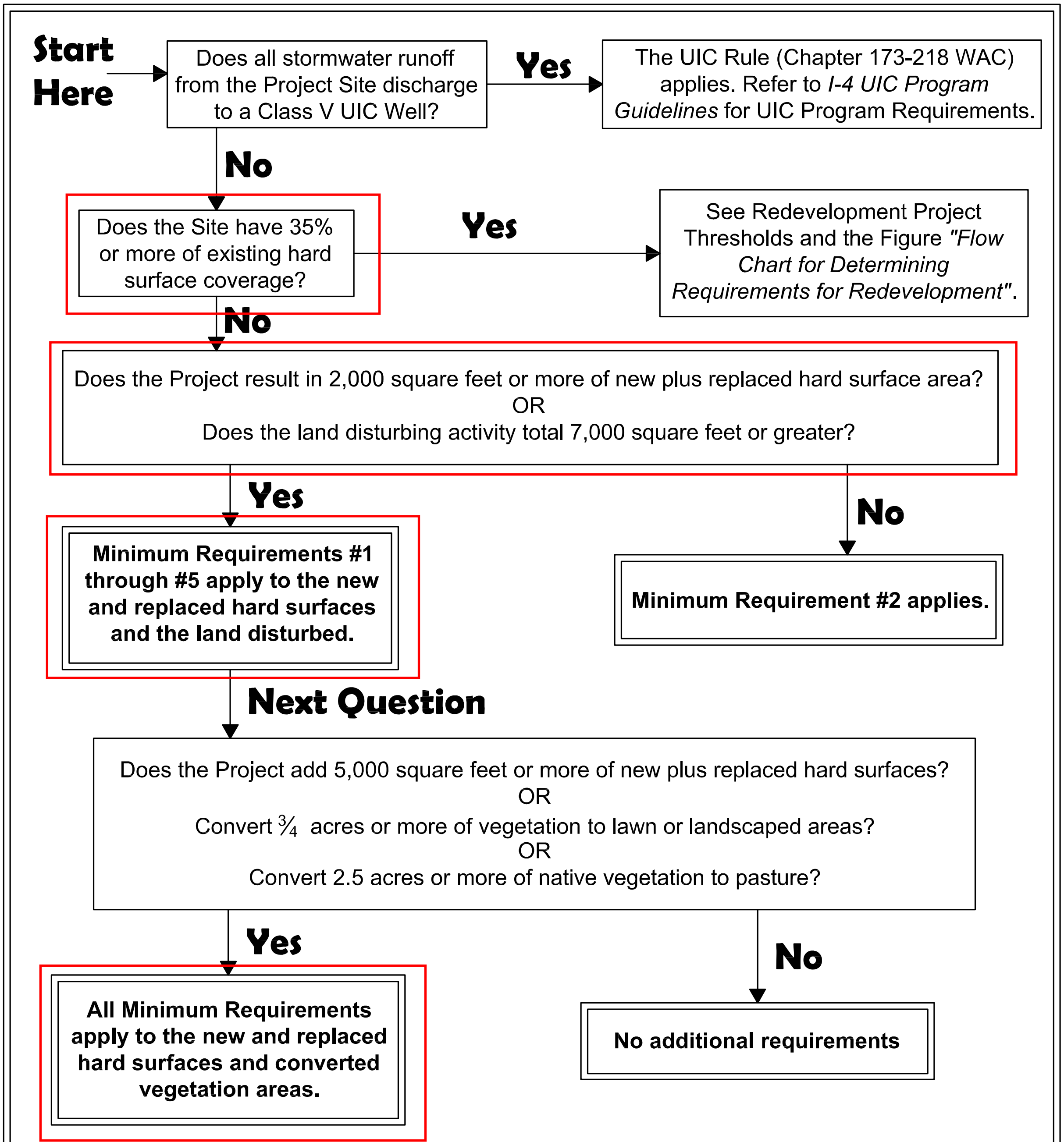
Notes:

752.3 0 376.17 752.3 Feet

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

Appendix B

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



DEPARTMENT OF
ECOLOGY
State of Washington

Flow Chart for Determining Requirements for New Development

Revised September 2022

b. If the 100-year peak discharge, as estimated using an approved continuous runoff model using 15-minute time steps, is less than or equal to 0.75 cfs under existing conditions and will remain less than or equal to 0.75 cfs under developed conditions, then the concentrated runoff may be discharged through a dispersal trench, such as those described in V-1.4.3 Outfall Systems, or other dispersal system, provided the applicant can demonstrate that there will be no significant adverse impact to downhill properties or drainage systems.

c. If the 100-year peak discharge, as estimated using an approved continuous runoff model using 15-minute time steps, is greater than 0.75 cfs for either existing or developed conditions, or if a significant adverse impact to downgradient properties or drainage systems is likely, then a conveyance system must be provided to convey the concentrated runoff across the downstream properties to an acceptable discharge point (i.e., an enclosed drainage system or open drainage feature where concentrated runoff can be discharged without significant adverse impact).

Stormwater control or treatment structures should not be located within the expected 25-year water level elevations for salmonid-bearing waters. Such areas may provide off-channel habitat for juvenile salmonids and salmonid fry.

Designs for outfall systems to protect against adverse impacts from concentrated runoff are included in V-1.4.3 Outfall Systems.

I-3.4.5 MR5: On-Site Stormwater Management

All new development and redevelopment projects meeting the Project Thresholds in I-3.3 Applicability of the Minimum Requirements shall apply Stormwater Management BMPs in accordance with the following thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff on site to the extent feasible without causing flooding or erosion impacts.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Compliance Options by Project Type

All projects that require Minimum Requirement #5 (per the Project Thresholds in I-3.3 Applicability of the Minimum Requirements) must employ Stormwater Management BMPs as detailed below. The compliance options for the project depend on the amount of improvements proposed, the location of the project, the size of the parcel the project is on, and whether or not the project is Flow Control exempt.

Each project must use a single compliance option (either the List Approach or the LID Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth). Use of both compliance options on a single project is not allowed.

Note that if a MR1-9 project spans multiple parcels (and/or rights-of-way), and one (or more) of those parcels is 5 acres or larger and outside the UGA, then the only compliance option available for the project is the LID Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth, since that is the only option for MR1-9 projects on a parcel 5 acres or larger and outside the UGA.

Projects that Trigger Only Minimum Requirements #1 - #5

Projects that are not Flow Control exempt that trigger only Minimum Requirements #1 through #5 (per the Project Thresholds in I-3.3 Applicability of the Minimum Requirements) shall either:

- Use the LID BMPs from List #1 for all surfaces within each type of surface in List #1;

  or

- Use any Flow Control BMP(s) desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth (if feasible).

Projects that Trigger Minimum Requirements #1 - #9

Projects that are not Flow Control exempt that trigger Minimum Requirements #1 through #9 (per the Project Thresholds in I-3.3 Applicability of the Minimum Requirements) have the compliance options shown in Table I-3.1: Minimum Requirement #5 Compliance Options for Projects Triggering Minimum Requirements #1 - #9.

Table I-3.1: Minimum Requirement #5 Compliance Options for Projects Triggering Minimum Requirements #1 - #9

<table>
<tr><th>Project Location and Parcel Size</th><th>Minimum Requirement #5 Compliance Options</th></tr>
<tr><td>Projects inside the UGA, on any size parcel</td><td rowspan="2">• Use the LID BMPs from List #2 for all surfaces within each type of surface in List #2;
or
• Use any Flow Control BMPs desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth (if feasible).</td></tr>
<tr><td>Projects outside the UGA, on a parcel smaller than 5 acres</td></tr>
<tr><td>Projects outside the UGA, on a parcel 5 acres or larger</td><td>Use any Flow Control BMPs desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth (if feasible).</td></tr>
<tr><td colspan="2">Note: This text refers to the Urban Growth Area (UGA) as designated under the Growth Management Act (GMA) (Chapter 36.70A RCW) of the State of Washington. If the project is located in a county that is not subject to planning under the GMA, the city limits shall be used instead.</td></tr>
</table>

Flow Control Exempt Projects

Projects qualifying as Flow Control exempt in accordance with the TDA Exemption in I-3.4.7 MR7: Flow Control shall either:

- Use the LID BMPs from List #3 for all surfaces within each type of surface in List #3;

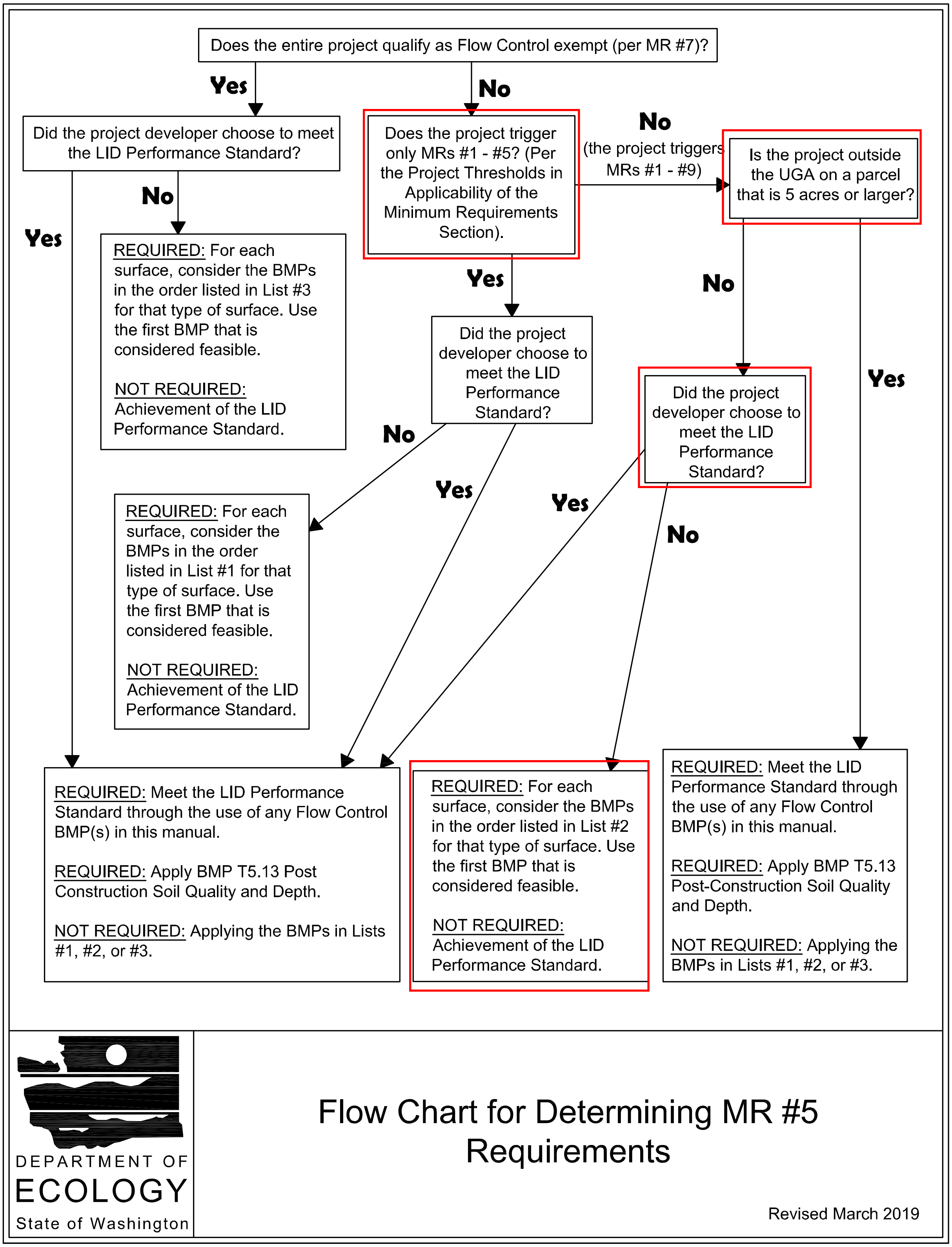
  or

- Use any Flow Control BMP(s) desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth (if feasible).

If the project has multiple TDAs, all TDAs must be Flow Control exempt per the TDA Exemption in I-3.4.7 MR7: Flow Control for the project to use the options listed here.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

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



Compliance Methods

LID Performance Standard

The LID Performance Standard compliance method for Minimum Requirement #5 requires modeling the proposed Flow Control BMPs to demonstrate the flow reduction as described below.

Stormwater discharges shall match developed discharge 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. Refer to the Flow Control Performance Standard section in I-3.4.7 MR7: Flow Control for information about the assignment of the pre-developed condition. Project sites that must also meet I-3.4.7 MR7: Flow Control must match flow durations between 8% of the 2-year flow through the full 50-year flow.

Designers selecting this option cannot use BMP T5.14: Rain Gardens to achieve the LID Performance Standard. They may choose to use BMP T7.30: Bioretention to achieve the LID Performance Standard.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

The List Approach

The List Approach compliance method for Minimum Requirement #5 requires evaluating the BMPs in Table I-3.2: The List Approach for MR5 Compliance (continued).

For each surface, evaluate the feasibility of the BMPs in the order listed for that type of surface, and use the first BMP that is considered feasible. The designer must document the site conditions and infeasibility criteria used to deem BMPs infeasible. Once a BMP is deemed feasible and used for a surface, no other BMP from the list is necessary for that surface.

If all BMPs in the list are infeasible, then the designer must document the site conditions and infeasibility criteria used to deem each BMP infeasible. This documentation will demonstrate compliance with Minimum Requirement #5.

Feasibility shall be determined by evaluation against:

- Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and
- Competing Needs Criteria as listed below.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Table I-3.2: The List Approach for MR5 Compliance

List #1 (For MR #1 - #5 Projects That Are Not Flow Control Exempt)	List #2 (For MR #1 - #9 Projects That Are Not Flow Control Exempt)	List #3 (For Flow Control Exempt Projects)
Surface Type: Lawn and Landscaped Areas		
BMP T5.13: Post-Construction Soil Quality and Depth	BMP T5.13: Post-Construction Soil Quality and Depth	BMP T5.13: Post-Construction Soil Quality and Depth
Surface Type: Roofs		
1. BMP T5.30: Full Dispersion or BMP T5.10A: Downspout Full Infiltration	1. BMP T5.30: Full Dispersion or BMP T5.10A: Downspout Full Infiltration	1. BMP T5.10A: Downspout Full Infiltration
2. BMP T5.14: Rain Gardens or BMP T7.30: Bioretention	2. BMP T7.30: Bioretention Infeasible - See Project TIR	2. BMP T5.10B: Downspout Dispersion Systems
3. BMP T5.10B: Downspout Dispersion Systems	3. BMP T5.10B: Downspout Dispersion Systems	3. BMP T5.10C: Perforated Stub-out Connections
4. BMP T5.10C: Perforated Stub-out Connections	4. BMP T5.10C: Perforated Stub-out Connections	
Surface Type: Other Hard Surfaces		
1. BMP T5.30: Full Dispersion	1. BMP T5.30: Full Dispersion	BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion
2. BMP T5.15: Permeable Pavement or BMP T5.14: Rain Gardens or BMP T7.30: Bioretention	2. BMP T5.15: Permeable Pavement Infeasible - See Project TIR	
3. BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion	3. BMP T7.30: Bioretention	
	4. BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion	

Table I-3.2: The List Approach for MR5 Compliance (continued)

List #1 (For MR #1 - #5 Projects That Are Not Flow Control Exempt)	List #2 (For MR #1 - #9 Projects That Are Not Flow Control Exempt)	List #3 (For Flow Control Exempt Projects)
Notes for using the List Approach: 1. Size BMP T5.14: Rain Gardens and BMP T7.30: Bioretention used in the List Approach to have a minimum horizontal projected surface area below the overflow which is at least 5% of the area draining to it. 2. When the designer encounters BMP T5.15: Permeable Pavement in the List Approach, it is not a requirement to pave these surfaces. Where pavement is proposed, it must be permeable to the extent feasible unless BMP T5.30: Full Dispersion is employed.		

Objective

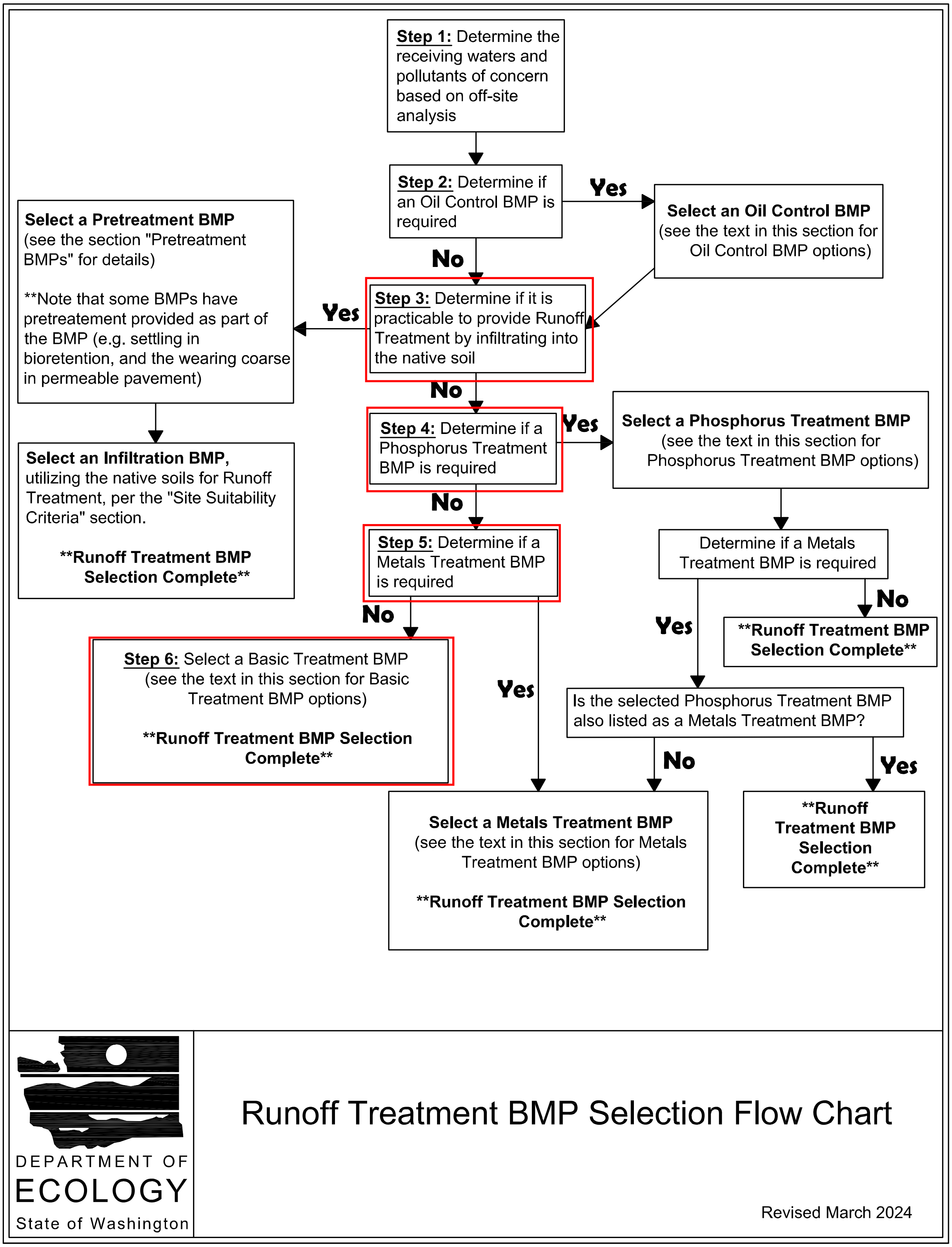
The objective of On-Site Stormwater Management is to use practices distributed across a development that reduce the amount of disruption of the natural hydrologic characteristics of the site.

Competing Needs Criteria

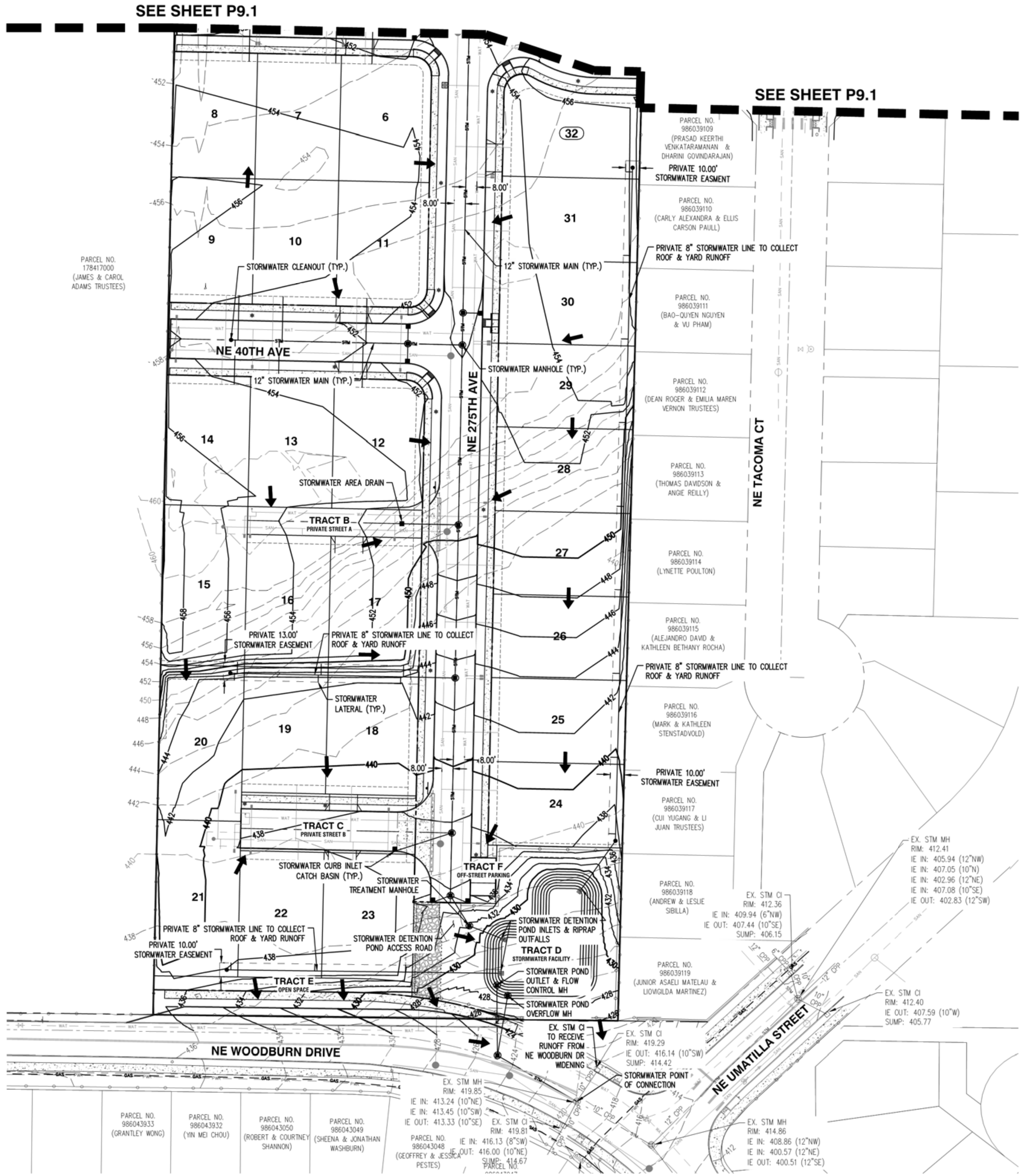
LID BMPs can be superseded or restricted where they are in conflict with:

- Requirements of the following federal or state laws, rules, and standards:
  - Historic Preservation Laws and Archaeology Laws as listed at https://dahp.wa.gov/project-review/preservation-laws,
  - Federal Superfund or Washington State Model Toxics Control Act,
  - Federal Aviation Administration requirements for airports,
  - Americans with Disabilities Act.
- When an LID requirement has been found to be in conflict with special zoning district design criteria adopted and being implemented pursuant to a community planning process. The existing local codes may supersede or reduce the LID requirement.
- Public health and safety standards (e.g. active zone of a skate park, bike park, or sport court where permeable pavement violates safety standards).
- Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way.
- A local Critical Area Ordinance that provides protection of tree species.
- A local code or rule adopted as part of a Wellhead Protection Program established under the Federal Safe Drinking Water Act; or adopted to protect a Critical Aquifer Recharge Area established under the State Growth Management Act.

Figure III-1.1: Runoff Treatment BMP Selection Flow Chart



Appendix C



LEGEND

EXISTING GROUND CONTOUR (2 FT)	348
EXISTING GROUND CONTOUR (10 FT)	350
FINISHED GRADE CONTOUR (2 FT)	348
FINISHED GRADE CONTOUR (10 FT)	350

GENERAL NOTES

1. STORMWATER TREATMENT AND DETENTION FACILITIES FOR THE DEVELOPMENT ARE TO BE OWNED AND MAINTAINED BY THE HOA.
2. THE SITE IS NOT WITHIN OR ADJACENT TO A 100-YEAR FLOODPLAIN OR SHORELINE MANAGEMENT AREA.
3. AN EXISTING STORMWATER CONVEYANCE DITCH EXISTS ON SITE BUT WILL BE FILLED DURING GRADING OF THE SITE.
4. STORMWATER INFRASTRUCTURE EXISTS IN SE 15 STREET AND UNDER EXISTING CONDITIONS RECEIVES RUNOFF FROM THE ON SITE TRAIL. A DITCH WILL BE CONSTRUCTED ALONG THE PEDESTRIAN PATH IN TRACT A TO CONTINUE TO CONVEY RUNOFF INTO CULVERTS IN SE 15TH STREET.
5. STORMWATER INFRASTRUCTURE EXISTS IN NE WOODBURN DRIVE AND AN EXISTING CURB INLET SHALL RECEIVE RUNOFF FROM THE NE WOODBURN DRIVE FRONTAGE IMPROVEMENTS.
6. RUNOFF FROM SE 15TH STREET & NE WOODBURN DRIVE DOES NOT CONTRIBUTE TO ON-SITE FLOWS.
7. NO WELLS, AGRICULTURAL DRAIN TILES, POTENTIAL SLOPE INSTABILITY, OR DRAIN FIELDS EXIST ON SITE.
8. NO FLOODPLAIN, FLOODWAYS, WETLANDS OR SHORELINE EXIST ON-SITE.
9. RUNOFF FROM ROOF AREAS FOR ALL LOTS TO DRAIN TO A STORMWATER LATERAL.
10. TRACT D TO BE COVERED IN ITS ENTIRETY BY A BLANKET SANITARY, WATER, AND STORMWATER EASEMENT & ACCESS TO THE CITY OF CAMAS.

N

SCALE: 1"=40 FEET

40 0 8 20 40

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VANCOUVER, WA 98682
360-882-0419
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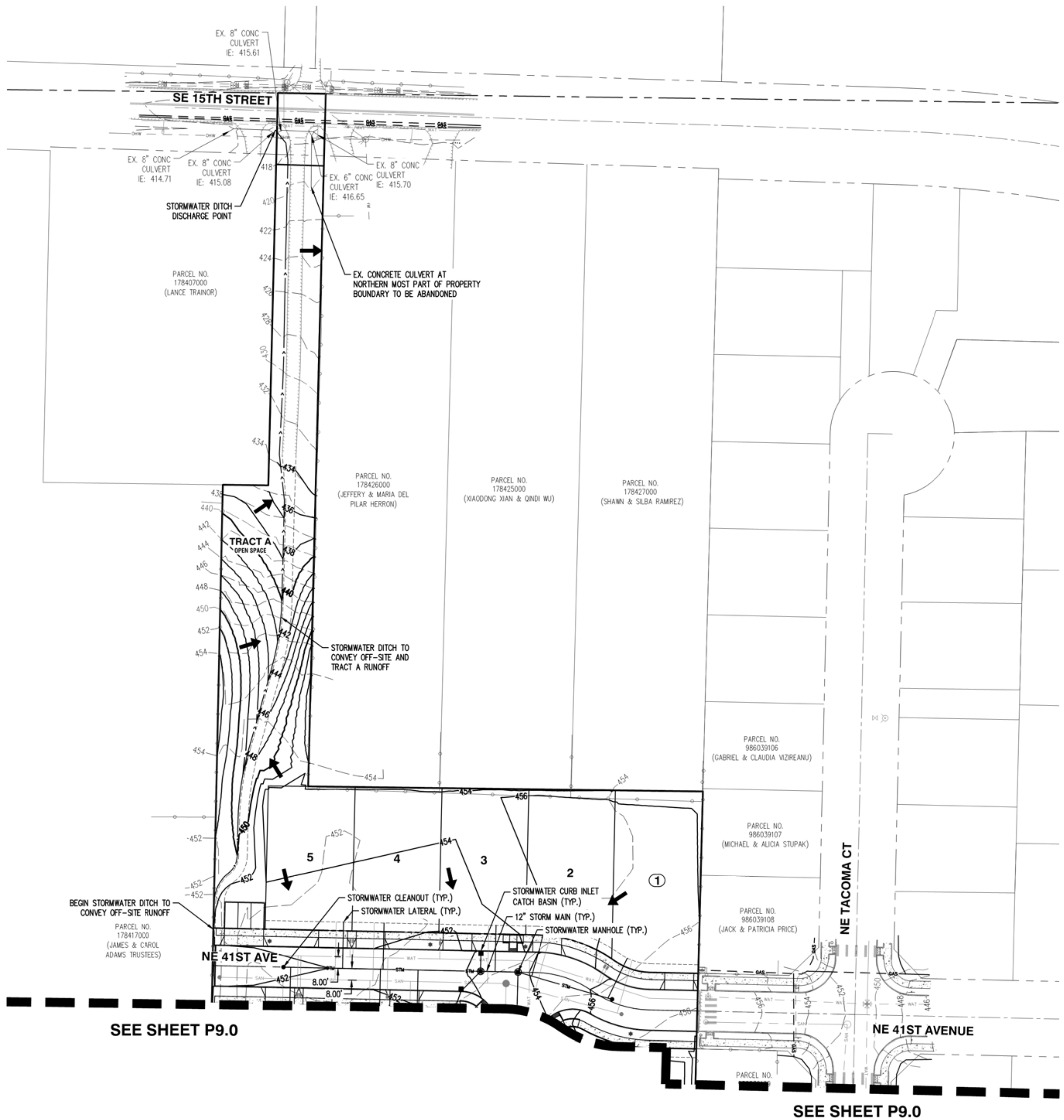
PRELIMINARY STORMWATER PLAN
UHACZ SUBDIVISION
ROMANO CAPITAL, INC
CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION — COLIN JAMES SHACKELFORD, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER

JOB NUMBER:	12533
DATE:	3/13/2026
DESIGNED BY:	JTG
DRAWN BY:	JLV
CHECKED BY:	CJS

P9.0

AKS DRAWING FILE: 12533 P9 STM.DWG | LAYOUT: P9.0



LEGEND

EXISTING GROUND CONTOUR (2 FT)	348
EXISTING GROUND CONTOUR (10 FT)	350
FINISHED GRADE CONTOUR (2 FT)	348
FINISHED GRADE CONTOUR (10 FT)	350

GENERAL NOTES

1. STORMWATER TREATMENT AND DETENTION FACILITIES FOR THE DEVELOPMENT ARE TO BE OWNED AND MAINTAINED BY THE HOA.
2. THE SITE IS NOT WITHIN OR ADJACENT TO A 100-YEAR FLOODPLAIN OR SHORELINE MANAGEMENT AREA.
3. AN EXISTING STORMWATER CONVEYANCE DITCH EXISTS ON SITE BUT WILL BE FILLED DURING GRADING OF THE SITE.
4. STORMWATER INFRASTRUCTURE EXISTS IN SE 15 STREET AND UNDER EXISTING CONDITIONS RECEIVES RUNOFF FROM THE ON SITE TRAIL. A DITCH WILL BE CONSTRUCTED ALONG THE PEDESTRIAN PATH IN TRACT A TO CONTINUE TO CONVEY RUNOFF INTO CULVERTS IN SE 15TH STREET.
5. STORMWATER INFRASTRUCTURE EXISTS IN NE WOODBURN DRIVE AND AN EXISTING CURB INLET SHALL RECEIVE RUNOFF FROM THE NE WOODBURN DRIVE FRONTAGE IMPROVEMENTS.
6. RUNOFF FROM SE 15TH STREET & NE WOODBURN DRIVE DOES NOT CONTRIBUTE TO ON-SITE FLOWS.
7. NO WELLS, AGRICULTURAL DRAIN TILES, POTENTIAL SLOPE INSTABILITY, OR DRAIN FIELDS EXIST ON SITE.
8. NO FLOODPLAIN, FLOODWAYS, WETLANDS OR SHORELINE EXIST ON-SITE.
9. RUNOFF FROM ROOF AREAS FOR ALL LOTS TO DRAIN TO A STORMWATER LATERAL.
10. TRACT D TO BE COVERED IN ITS ENTIRETY BY A BLANKET SANITARY, WATER, AND STORMWATER EASEMENT & ACCESS TO THE CITY OF CAMAS.

N

SCALE: 1"=40 FEET

40 0 8 20 40

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PRELIMINARY STORMWATER PLAN
UHACZ SUBDIVISION
ROMANO CAPITAL, INC
CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	12533
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DESIGNED BY:	JTG
DRAWN BY:	JLV
CHECKED BY:	CJS

P9.1

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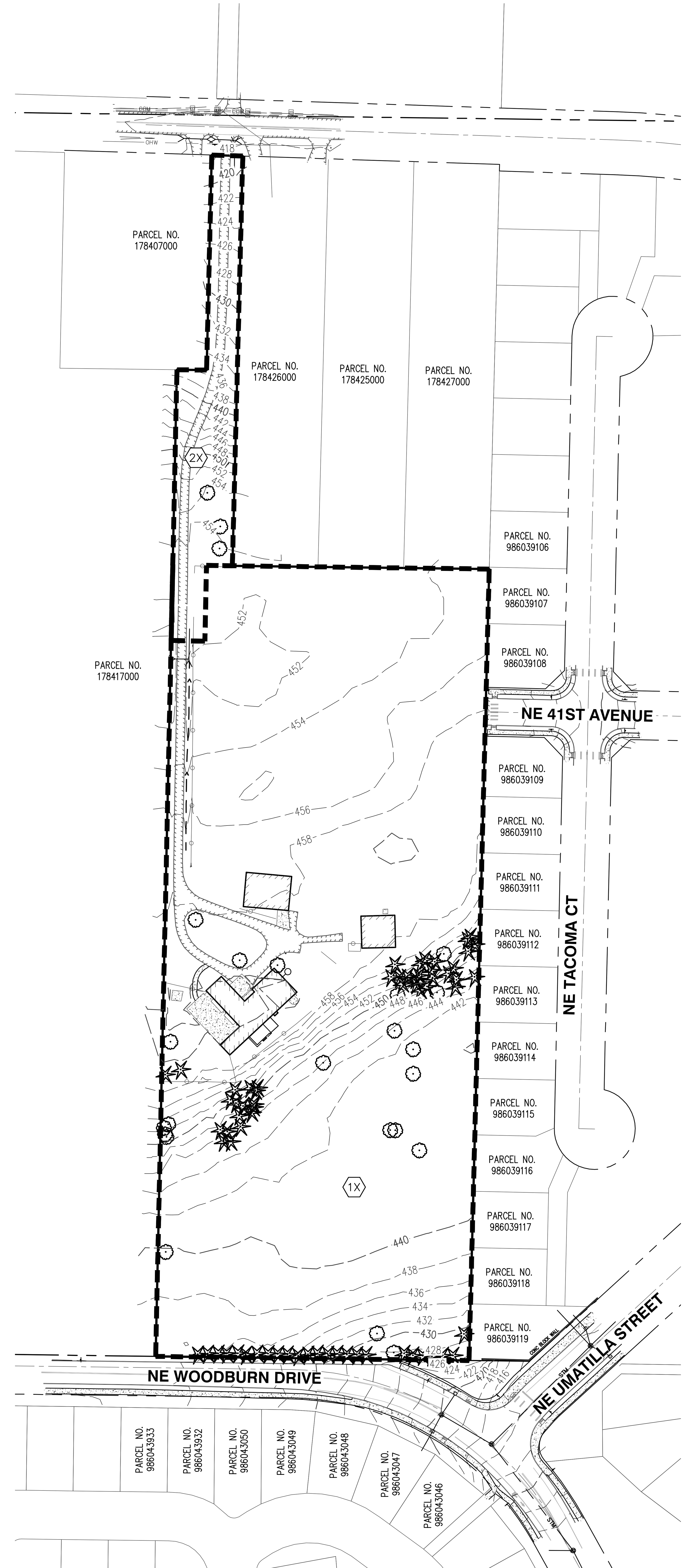
Appendix D



LEGEND

EXISTING GROUND CONTOUR (2 FT)	— — 272 — —
EXISTING GROUND CONTOUR (10 FT)	— — 270 — —
PRE-DEVELOPED BASIN BOUNDARY	■ ■ ■ ■ ■
PRE-DEVELOPED BASIN NUMBER	XX

N

SCALE: 1" = 80 FEET

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ORIGINAL PAGE SIZE: 22" x 34"

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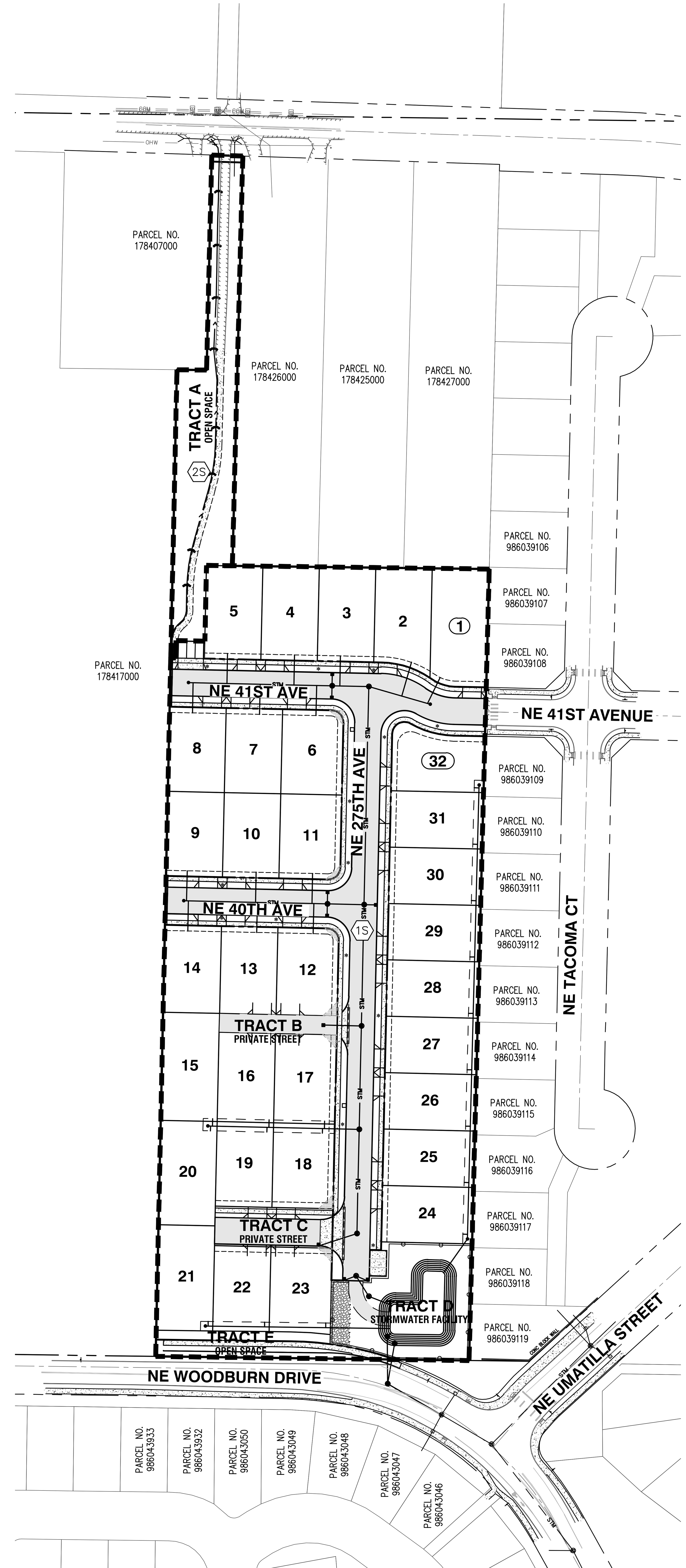
PRE DEVELOPED BASIN MAP
UHACZ SUBDIVISION
ROMANO CAPITOL, INC.
CAMAS, WASHINGTON

JOB NUMBER:	12533
DATE:	2/19/2026
DESIGNED BY:	JTG
DRAWN BY:	JTG
CHECKED BY:	JMM

EX A

AKS DRAWING FILE: 12533 PRE BASINS.DWG | LAYOUT: A



LEGEND

POST-DEVELOPED BASIN BOUNDARY

POST-DEVELOPED BASIN NUMBER XS

NOTES

1. ALL STORMWATER FACILITIES WITHIN PUBLIC RIGHT-OF-WAY SHALL BE PUBLICLY OWNED AND MAINTAINED BY CITY OF CAMAS.
2. STORMWATER QUALITY AND QUANTITY REQUIREMENTS WILL BE MET THROUGH THE USE OF MECHANICAL FILTERS AND A DETENTION POND WITH A FLOW CONTROL MANHOLE.
3. ALL LOT DRIVEWAYS AND LANDSCAPED AREAS APPROXIMATELY 20' BACK FROM SIDEWALK SHALL DRAIN TO THE STREET AS SHOWN ON THE GRADING PLANS, UNLESS OTHERWISE NOTED.
4. LOT ROOF DRAINS, FOUNDATIONS, CRAWLSPACES, AND REAR YARD TO BE DIRECTED TO PRIVATE STORMWATER LATERALS AND CONVEYED TO THE DETENTION POND.

N

SCALE: 1" = 80 FEET

80 0 16 40 80

ORIGINAL PAGE SIZE: 22" x 34"

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POST DEVELOPED BASIN MAP
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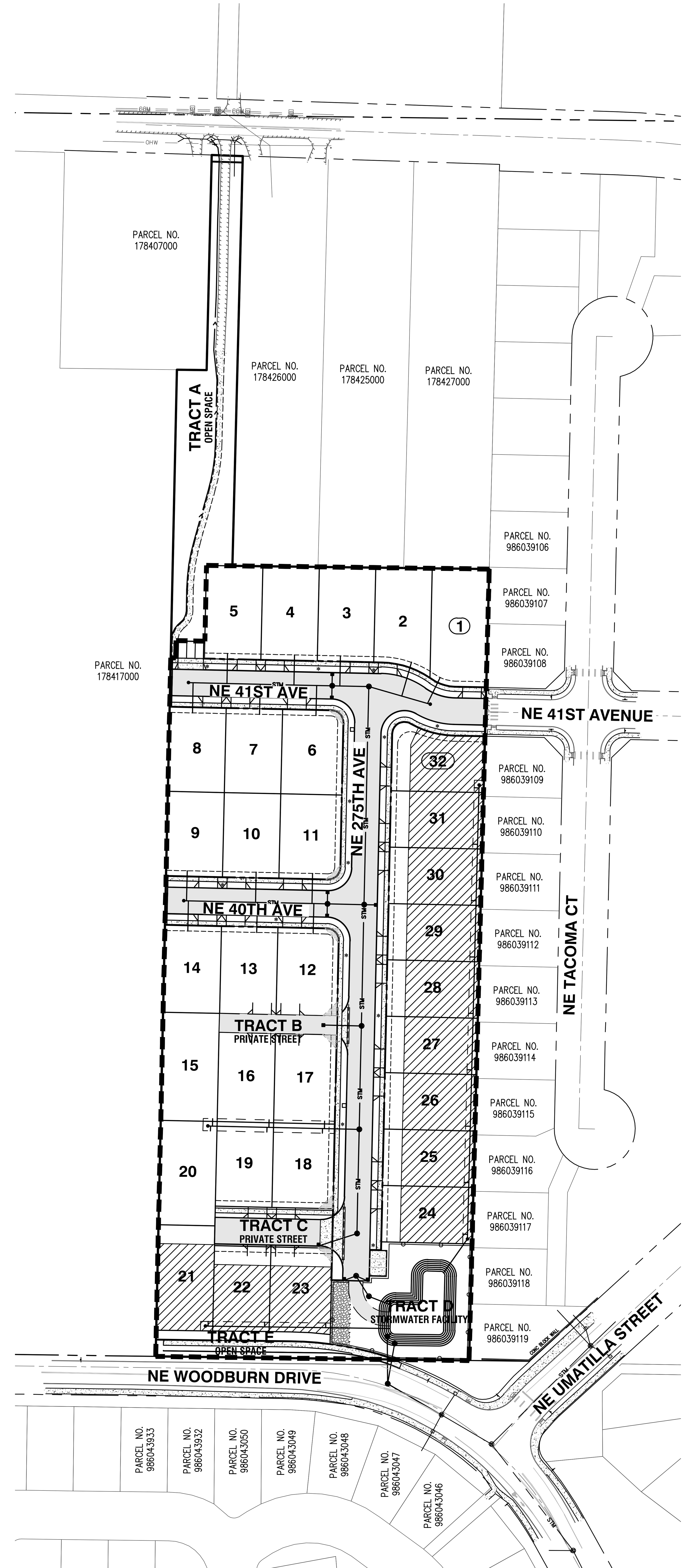
CAMAS, WASHINGTON

JOB NUMBER:	12533
DATE:	2/19/2026
DESIGNED BY:	JTG
DRAWN BY:	JTG
CHECKED BY:	JMM

EX B

AKS DRAWING FILE: 12533 POST BASINS.DWG | LAYOUT: B



LEGEND

WATER QUALITY BASIN BOUNDARY	
AREA BYPASSING STORMWATER TREATMENT (NON-POLLUTION GENERATING RUNOFF)	

NOTES

1. ALL STORMWATER FACILITIES WITHIN PUBLIC RIGHT-OF-WAY SHALL BE PUBLICLY OWNED AND MAINTAINED BY CITY OF CAMAS.
2. STORMWATER QUALITY AND QUANTITY REQUIREMENTS WILL BE MET THROUGH THE USE OF MECHANICAL FILTERS AND A DETENTION POND WITH A FLOW CONTROL MANHOLE.
3. ALL LOT DRIVEWAYS AND LANDSCAPED AREAS APPROXIMATELY 20' BACK FROM SIDEWALK SHALL DRAIN TO THE STREET AS SHOWN ON THE GRADING PLANS, UNLESS OTHERWISE NOTED.
4. LOT ROOF DRAINS, FOUNDATIONS, CRAWLSPACES, AND REAR YARD TO BE DIRECTED TO PRIVATE STORMWATER LATERALS AND CONVEYED TO THE DETENTION POND.
5. AREAS THAT CREATE NON-POLLUTION GENERATING RUNOFF ARE SHOWN ACCORDING TO THE LEGEND ON THIS SHEET. THESE AREAS ARE CAPTURED BY A SEPARATE PRIVATE STORMWATER PIPE AND CONVEYED DIRECTLY INTO THE STORMWATER DETENTION POND, BYPASSING MECHANICAL FILTER TREATMENT.

N

SCALE: 1"= 80 FEET

80 0 16 40 80

ORIGINAL PAGE SIZE: 22" x 34"

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WATER QUALITY BASIN MAP
UHACZ SUBDIVISION
ROMANO CAPITOL, INC.
CAMAS, WASHINGTON

JOB NUMBER:	12533
DATE:	2/19/2026
DESIGNED BY:	JTG
DRAWN BY:	JTG
CHECKED BY:	JMM

EX C

AKS DRAWING FILE: 12533 WQ BASINS.DWG | LAYOUT: C

Appendix E

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: 12533 Pond

Site Name:

Site Address:

City:

Report Date:	2/18/2026
Gage:	Troutdale
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.370
Version Date:	2025/10/07
Version:	4.3.2

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

Basin 1X

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Mod	6.41
Pervious Total	6.41
Impervious Land Use	acre
Impervious Total	0
Basin Total	6.41

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

Mitigated Land Use

IMPERVIOUS

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS FLAT	1.42
ROOF TOPS FLAT	1.74
SIDEWALKS FLAT	0.18
Impervious Total	3.34
Basin Total	3.34

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

Detention Pond	Detention Pond

PERVIOUS

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Field, Mod	3.07
Pervious Total	3.07
Impervious Land Use	acre
Impervious Total	0
Basin Total	3.07

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

Detention Pond	Detention Pond

Routing Elements
Predeveloped Routing

Mitigated Routing

Detention Pond

Bottom Length: 50.00 ft.
Bottom Width: 50.00 ft.
Depth: 6 ft.
Volume at riser head: 0.4171 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 5 ft.
Riser Diameter: 10 in.
Notch Type: Rectangular
Notch Width: 0.250 ft.
Notch Height: 1.500 ft.
Orifice 1 Diameter: 3.000 in. Elevation:0 ft.
Element Outlets:
Outlet 1 Outlet 2
Outlet Flows To:

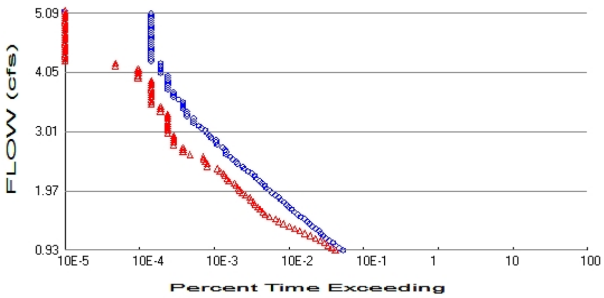
Pond Hydraulic Table

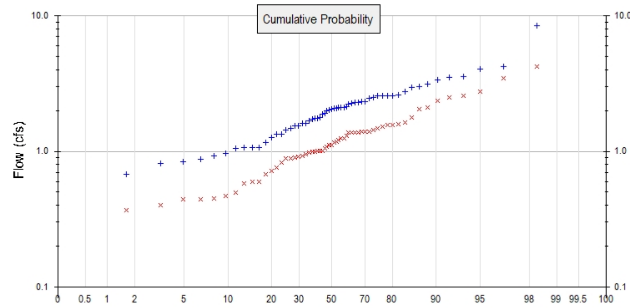
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.057	0.000	0.000	0.000
0.0667	0.058	0.003	0.013	0.000
0.1333	0.058	0.007	0.048	0.000
0.2000	0.059	0.011	0.093	0.000
0.2667	0.059	0.015	0.126	0.000
0.3333	0.060	0.019	0.141	0.000
0.4000	0.061	0.023	0.154	0.000
0.4667	0.061	0.027	0.166	0.000
0.5333	0.062	0.031	0.178	0.000
0.6000	0.063	0.036	0.189	0.000
0.6667	0.063	0.040	0.199	0.000
0.7333	0.064	0.044	0.209	0.000
0.8000	0.065	0.048	0.218	0.000
0.8667	0.065	0.053	0.227	0.000
0.9333	0.066	0.057	0.235	0.000
1.0000	0.066	0.062	0.244	0.000
1.0667	0.067	0.066	0.252	0.000
1.1333	0.068	0.071	0.260	0.000
1.2000	0.068	0.075	0.267	0.000
1.2667	0.069	0.080	0.274	0.000
1.3333	0.070	0.085	0.282	0.000
1.4000	0.071	0.089	0.289	0.000
1.4667	0.071	0.094	0.295	0.000
1.5333	0.072	0.099	0.302	0.000
1.6000	0.073	0.104	0.308	0.000
1.6667	0.073	0.109	0.315	0.000
1.7333	0.074	0.113	0.321	0.000
1.8000	0.075	0.118	0.327	0.000
1.8667	0.075	0.123	0.333	0.000
1.9333	0.076	0.129	0.339	0.000
2.0000	0.077	0.134	0.345	0.000

2.0667	0.077	0.139	0.351	0.000
2.1333	0.078	0.144	0.356	0.000
2.2000	0.079	0.149	0.362	0.000
2.2667	0.080	0.155	0.367	0.000
2.3333	0.080	0.160	0.373	0.000
2.4000	0.081	0.165	0.378	0.000
2.4667	0.082	0.171	0.383	0.000
2.5333	0.083	0.176	0.388	0.000
2.6000	0.083	0.182	0.393	0.000
2.6667	0.084	0.188	0.398	0.000
2.7333	0.085	0.193	0.403	0.000
2.8000	0.086	0.199	0.408	0.000
2.8667	0.086	0.205	0.413	0.000
2.9333	0.087	0.210	0.418	0.000
3.0000	0.088	0.216	0.423	0.000
3.0667	0.089	0.222	0.427	0.000
3.1333	0.089	0.228	0.432	0.000
3.2000	0.090	0.234	0.436	0.000
3.2667	0.091	0.240	0.441	0.000
3.3333	0.092	0.246	0.445	0.000
3.4000	0.092	0.253	0.450	0.000
3.4667	0.093	0.259	0.454	0.000
3.5333	0.094	0.265	0.464	0.000
3.6000	0.095	0.271	0.489	0.000
3.6667	0.096	0.278	0.522	0.000
3.7333	0.096	0.284	0.561	0.000
3.8000	0.097	0.291	0.604	0.000
3.8667	0.098	0.297	0.651	0.000
3.9333	0.099	0.304	0.701	0.000
4.0000	0.100	0.310	0.753	0.000
4.0667	0.100	0.317	0.807	0.000
4.1333	0.101	0.324	0.863	0.000
4.2000	0.102	0.331	0.919	0.000
4.2667	0.103	0.338	0.977	0.000
4.3333	0.104	0.344	1.036	0.000
4.4000	0.104	0.351	1.095	0.000
4.4667	0.105	0.358	1.154	0.000
4.5333	0.106	0.365	1.219	0.000
4.6000	0.107	0.373	1.292	0.000
4.6667	0.108	0.380	1.366	0.000
4.7333	0.109	0.387	1.443	0.000
4.8000	0.109	0.394	1.522	0.000
4.8667	0.110	0.402	1.602	0.000
4.9333	0.111	0.409	2.051	0.000
5.0000	0.112	0.417	2.161	0.000
5.0667	0.113	0.424	2.316	0.000
5.1333	0.114	0.432	2.589	0.000
5.2000	0.115	0.439	2.905	0.000
5.2667	0.115	0.447	3.200	0.000
5.3333	0.116	0.455	3.421	0.000
5.4000	0.117	0.463	3.555	0.000
5.4667	0.118	0.471	3.680	0.000
5.5333	0.119	0.478	3.787	0.000
5.6000	0.120	0.486	3.887	0.000
5.6667	0.121	0.494	3.982	0.000
5.7333	0.122	0.503	4.073	0.000
5.8000	0.123	0.511	4.159	0.000
5.8667	0.123	0.519	4.243	0.000

5.9333	0.124	0.527	4.323	0.000
6.0000	0.125	0.536	4.400	0.000
6.0667	0.126	0.544	4.475	0.000

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 6.41
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 3.07
Total Impervious Area: 3.34

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	1.863984
5 year	2.812514
10 year	3.487222
25 year	4.385963
50 year	5.086233
100 year	5.811144

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	1.08929
5 year	1.725525
10 year	2.194566
25 year	2.836023
50 year	3.346941
100 year	3.884686

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

Year	**Predeveloped**	**Mitigated**
1949	1.742	1.185
1950	1.534	1.058
1951	2.305	1.247
1952	2.480	1.212
1953	2.115	0.925
1954	2.136	1.089
1955	1.540	0.895
1956	3.123	2.578
1957	2.122	1.310
1958	1.904	1.564

1959	1.063	0.444
1960	1.155	0.596
1961	2.041	1.255
1962	1.728	0.948
1963	1.609	0.974
1964	2.120	0.993
1965	2.072	1.483
1966	2.582	1.163
1967	1.619	1.115
1968	2.594	1.428
1969	1.989	1.368
1970	8.463	4.227
1971	1.072	0.719
1972	1.480	0.917
1973	2.283	1.375
1974	2.766	2.491
1975	2.219	1.001
1976	3.536	1.568
1977	0.554	0.401
1978	2.556	2.115
1979	2.026	1.388
1980	1.431	0.677
1981	2.569	2.056
1982	3.004	1.626
1983	3.581	1.512
1984	2.323	0.881
1985	1.343	1.117
1986	1.060	0.441
1987	1.887	1.376
1988	0.820	0.580
1989	0.678	0.447
1990	0.870	0.466
1991	2.076	0.822
1992	1.673	0.598
1993	4.221	2.376
1994	1.758	1.768
1995	1.333	1.397
1996	4.036	3.453
1997	2.965	2.741
1998	2.489	0.987
1999	1.786	1.403
2000	0.924	0.369
2001	1.052	0.357
2002	3.377	1.009
2003	2.252	1.595
2004	0.836	0.497
2005	0.970	0.886
2006	2.560	1.013
2007	1.270	1.383
2008	2.343	0.762

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	8.4626	4.2267
2	4.2210	3.4533
3	4.0361	2.7409
4	3.5811	2.5781

5	3.5358	2.4909
6	3.3772	2.3755
7	3.1230	2.1147
8	3.0038	2.0560
9	2.9646	1.7683
10	2.7658	1.6256
11	2.5940	1.5951
12	2.5820	1.5682
13	2.5686	1.5644
14	2.5605	1.5117
15	2.5556	1.4832
16	2.4890	1.4277
17	2.4805	1.4028
18	2.3433	1.3965
19	2.3232	1.3883
20	2.3052	1.3833
21	2.2825	1.3764
22	2.2516	1.3753
23	2.2185	1.3676
24	2.1363	1.3104
25	2.1221	1.2546
26	2.1199	1.2472
27	2.1146	1.2116
28	2.0762	1.1851
29	2.0716	1.1630
30	2.0411	1.1171
31	2.0262	1.1153
32	1.9892	1.0887
33	1.9040	1.0585
34	1.8868	1.0129
35	1.7857	1.0086
36	1.7578	1.0011
37	1.7423	0.9931
38	1.7283	0.9874
39	1.6725	0.9743
40	1.6190	0.9480
41	1.6086	0.9252
42	1.5401	0.9168
43	1.5344	0.8951
44	1.4795	0.8855
45	1.4314	0.8809
46	1.3433	0.8220
47	1.3333	0.7624
48	1.2697	0.7186
49	1.1554	0.6770
50	1.0720	0.5981
51	1.0630	0.5959
52	1.0605	0.5802
53	1.0524	0.4969
54	0.9703	0.4660
55	0.9245	0.4467
56	0.8704	0.4435
57	0.8356	0.4415
58	0.8196	0.4012
59	0.6776	0.3685
60	0.5545	0.3572

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.9320	1121	877	78	Pass
0.9740	995	788	79	Pass
1.0159	895	696	77	Pass
1.0579	815	625	76	Pass
1.0998	724	551	76	Pass
1.1418	659	475	72	Pass
1.1838	614	407	66	Pass
1.2257	563	347	61	Pass
1.2677	527	293	55	Pass
1.3097	481	250	51	Pass
1.3516	436	213	48	Pass
1.3936	398	178	44	Pass
1.4355	369	154	41	Pass
1.4775	337	139	41	Pass
1.5195	301	115	38	Pass
1.5614	273	101	36	Pass
1.6034	249	94	37	Pass
1.6453	227	86	37	Pass
1.6873	207	80	38	Pass
1.7293	197	74	37	Pass
1.7712	182	71	39	Pass
1.8132	165	65	39	Pass
1.8552	152	63	41	Pass
1.8971	137	55	40	Pass
1.9391	125	50	40	Pass
1.9810	116	46	39	Pass
2.0230	106	44	41	Pass
2.0650	99	41	41	Pass
2.1069	92	39	42	Pass
2.1489	85	33	38	Pass
2.1909	77	31	40	Pass
2.2328	73	29	39	Pass
2.2748	67	28	41	Pass
2.3167	59	25	42	Pass
2.3587	53	23	43	Pass
2.4007	51	17	33	Pass
2.4426	43	17	39	Pass
2.4846	41	16	39	Pass
2.5265	37	15	40	Pass
2.5685	35	15	42	Pass
2.6105	30	10	33	Pass
2.6524	30	8	26	Pass
2.6944	29	8	27	Pass
2.7364	27	8	29	Pass
2.7783	23	6	26	Pass
2.8203	22	6	27	Pass
2.8622	22	6	27	Pass
2.9042	19	6	31	Pass
2.9462	18	6	33	Pass
2.9881	17	5	29	Pass
3.0301	16	5	31	Pass
3.0721	14	5	35	Pass
3.1140	13	5	38	Pass

3.1560	11	5	45	Pass
3.1979	11	5	45	Pass
3.2399	11	5	45	Pass
3.2819	9	5	55	Pass
3.3238	9	5	55	Pass
3.3658	9	4	44	Pass
3.4078	8	4	50	Pass
3.4497	8	4	50	Pass
3.4917	8	3	37	Pass
3.5336	8	3	37	Pass
3.5756	7	3	42	Pass
3.6176	6	3	50	Pass
3.6595	6	3	50	Pass
3.7015	6	3	50	Pass
3.7434	5	3	60	Pass
3.7854	5	3	60	Pass
3.8274	5	3	60	Pass
3.8693	5	3	60	Pass
3.9113	5	3	60	Pass
3.9533	5	2	40	Pass
3.9952	5	2	40	Pass
4.0372	4	2	50	Pass
4.0791	4	2	50	Pass
4.1211	4	2	50	Pass
4.1631	4	1	25	Pass
4.2050	4	1	25	Pass
4.2470	3	0	0	Pass
4.2890	3	0	0	Pass
4.3309	3	0	0	Pass
4.3729	3	0	0	Pass
4.4148	3	0	0	Pass
4.4568	3	0	0	Pass
4.4988	3	0	0	Pass
4.5407	3	0	0	Pass
4.5827	3	0	0	Pass
4.6247	3	0	0	Pass
4.6666	3	0	0	Pass
4.7086	3	0	0	Pass
4.7505	3	0	0	Pass
4.7925	3	0	0	Pass
4.8345	3	0	0	Pass
4.8764	3	0	0	Pass
4.9184	3	0	0	Pass
4.9603	3	0	0	Pass
5.0023	3	0	0	Pass
5.0443	3	0	0	Pass
5.0862	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

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

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

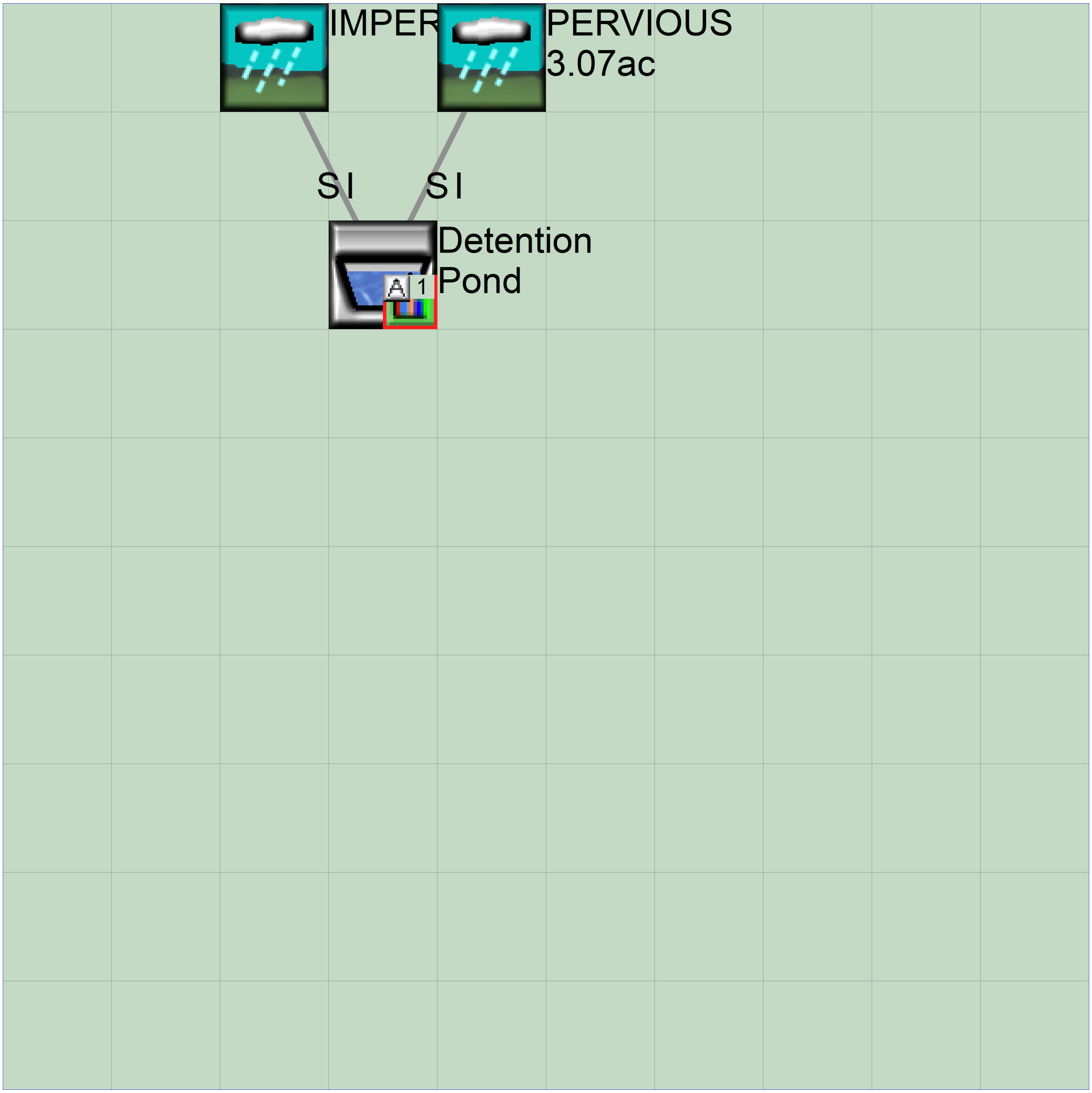
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   12533 Pond.wdm
MESSU      25   Pre12533 Pond.MES
           27   Pre12533 Pond.L61
           28   Pre12533 Pond.L62
           30   POC12533 Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      29
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1X                   MAX                      1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                              in  out        ***
   29     SG4, Forest, Mod        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   29         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   29         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   29         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   29              0         6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                     ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29            0.2       0.4      0.35         2       0.4       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   29              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                   <--Area-->     <-Target->   MBLK   ***
<Name>   #                   <-factor->     <Name>   #   Tbl#   ***
Basin  1X***
PERLND  29                         6.41     COPY   501     12
PERLND  29                         6.41     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                         in  out                             ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *        *  *  *  *  *        ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.37           PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.37           IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   12533 Pond.wdm
MESSU      25   Mit12533 Pond.MES
           27   Mit12533 Pond.L61
           28   Mit12533 Pond.L62
           30   POC12533 Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       1
      IMPLND       4
      IMPLND       8
      PERLND      32
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Detention Pond              MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   32     SG4, Field, Mod         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   32         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
```

```
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   32         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   32         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   32              0         6      0.03       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   32              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   32           0.15       0.4       0.3         2       0.4       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   32              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                      User  t-series Engl Metr ***
                                       in  out           ***
    1      ROADS/FLAT             1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    4         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    4    1    9
    4         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    4         0    0    0    0    0
    8         0    0    0    0    0
```

```
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
    4              0         0
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    4              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
IMPERVIOUS***
IMPLND   1                        1.42     RCHRES   1      5
IMPLND   4                        1.74     RCHRES   1      5
IMPLND   8                        0.18     RCHRES   1      5
PERVIOUS***
PERLND  32                        3.07     RCHRES   1      2
PERLND  32                        3.07     RCHRES   1      3

******Routing******
IMPLND   1                        1.42     COPY     1     15
IMPLND   4                        1.74     COPY     1     15
IMPLND   8                        0.18     COPY     1     15
PERLND  32                        3.07     COPY     1     12
PERLND  32                        3.07     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
    1     Detention Pond          1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
```

```
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                         ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *     *  *  *  *  *        *  *  *  *  *        ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50        ***
  <------><--------><--------><--------><--------><--------><-------->        ***
    1             1      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                            ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1          0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.057392  0.000000  0.000000
  0.066667  0.058006  0.003847  0.013499
  0.133333  0.058623  0.007734  0.048368
  0.200000  0.059243  0.011663  0.093664
  0.266667  0.059867  0.015633  0.126120
  0.333333  0.060494  0.019645  0.141007
  0.400000  0.061124  0.023699  0.154465
  0.466667  0.061757  0.027795  0.166842
  0.533333  0.062394  0.031934  0.178361
  0.600000  0.063034  0.036115  0.189181
  0.666667  0.063677  0.040338  0.199414
  0.733333  0.064324  0.044605  0.209147
  0.800000  0.064973  0.048915  0.218447
  0.866667  0.065626  0.053268  0.227367
  0.933333  0.066283  0.057665  0.235950
  1.000000  0.066942  0.062106  0.244231
  1.066667  0.067605  0.066591  0.252241
  1.133333  0.068271  0.071120  0.260004
  1.200000  0.068940  0.075694  0.267542
  1.266667  0.069613  0.080312  0.274873
  1.333333  0.070289  0.084976  0.282014
  1.400000  0.070968  0.089684  0.288978
  1.466667  0.071650  0.094438  0.295779
  1.533333  0.072336  0.099238  0.302426
  1.600000  0.073025  0.104083  0.308931
  1.666667  0.073717  0.108975  0.315301
  1.733333  0.074412  0.113912  0.321545
  1.800000  0.075111  0.118896  0.327671
  1.866667  0.075813  0.123927  0.333683
  1.933333  0.076518  0.129005  0.339590
  2.000000  0.077227  0.134130  0.345395
```

```
  2.066667  0.077939  0.139302  0.351105
  2.133333  0.078654  0.144522  0.356723
  2.200000  0.079372  0.149789  0.362253
  2.266667  0.080093  0.155105  0.367701
  2.333333  0.080818  0.160468  0.373069
  2.400000  0.081546  0.165881  0.378361
  2.466667  0.082278  0.171341  0.383580
  2.533333  0.083012  0.176851  0.388729
  2.600000  0.083750  0.182410  0.393811
  2.666667  0.084491  0.188018  0.398828
  2.733333  0.085236  0.193675  0.403783
  2.800000  0.085983  0.199383  0.408677
  2.866667  0.086734  0.205140  0.413514
  2.933333  0.087489  0.210947  0.418294
  3.000000  0.088246  0.216805  0.423021
  3.066667  0.089007  0.222714  0.427695
  3.133333  0.089771  0.228673  0.432319
  3.200000  0.090538  0.234683  0.436894
  3.266667  0.091309  0.240745  0.441422
  3.333333  0.092082  0.246858  0.445903
  3.400000  0.092860  0.253023  0.450340
  3.466667  0.093640  0.259239  0.454734
  3.533333  0.094423  0.265508  0.464118
  3.600000  0.095210  0.271829  0.489196
  3.666667  0.096000  0.278203  0.522424
  3.733333  0.096794  0.284629  0.561352
  3.800000  0.097590  0.291109  0.604680
  3.866667  0.098390  0.297641  0.651536
  3.933333  0.099194  0.304228  0.701268
  4.000000  0.100000  0.310867  0.753362
  4.066667  0.100810  0.317561  0.807390
  4.133333  0.101623  0.324309  0.862985
  4.200000  0.102439  0.331111  0.919830
  4.266667  0.103258  0.337967  0.977640
  4.333333  0.104081  0.344879  1.036161
  4.400000  0.104907  0.351845  1.095161
  4.466667  0.105737  0.358866  1.154424
  4.533333  0.106569  0.365943  1.219584
  4.600000  0.107405  0.373076  1.292175
  4.666667  0.108244  0.380264  1.366856
  4.733333  0.109086  0.387508  1.443565
  4.800000  0.109932  0.394809  1.522248
  4.866667  0.110781  0.402166  1.602852
  4.933333  0.111633  0.409580  2.051313
  5.000000  0.112489  0.417051  2.161449
  5.066667  0.113347  0.424578  2.316762
  5.133333  0.114209  0.432164  2.589369
  5.200000  0.115074  0.439806  2.905239
  5.266667  0.115943  0.447507  3.200546
  5.333333  0.116815  0.455266  3.421900
  5.400000  0.117690  0.463082  3.555523
  5.466667  0.118568  0.470958  3.680538
  5.533333  0.119449  0.478892  3.787174
  5.600000  0.120334  0.486884  3.887519
  5.666667  0.121222  0.494936  3.982594
  5.733333  0.122114  0.503047  4.073171
  5.800000  0.123008  0.511218  4.159848
  5.866667  0.123906  0.519449  4.243101
  5.933333  0.124807  0.527739  4.323318
  6.000000  0.125712  0.536090  4.400816
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.37           PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.37           IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP
```

```
END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO      1 1        1      WDM   1048 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE   1 1        1      WDM   1049 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN    1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN    1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16

END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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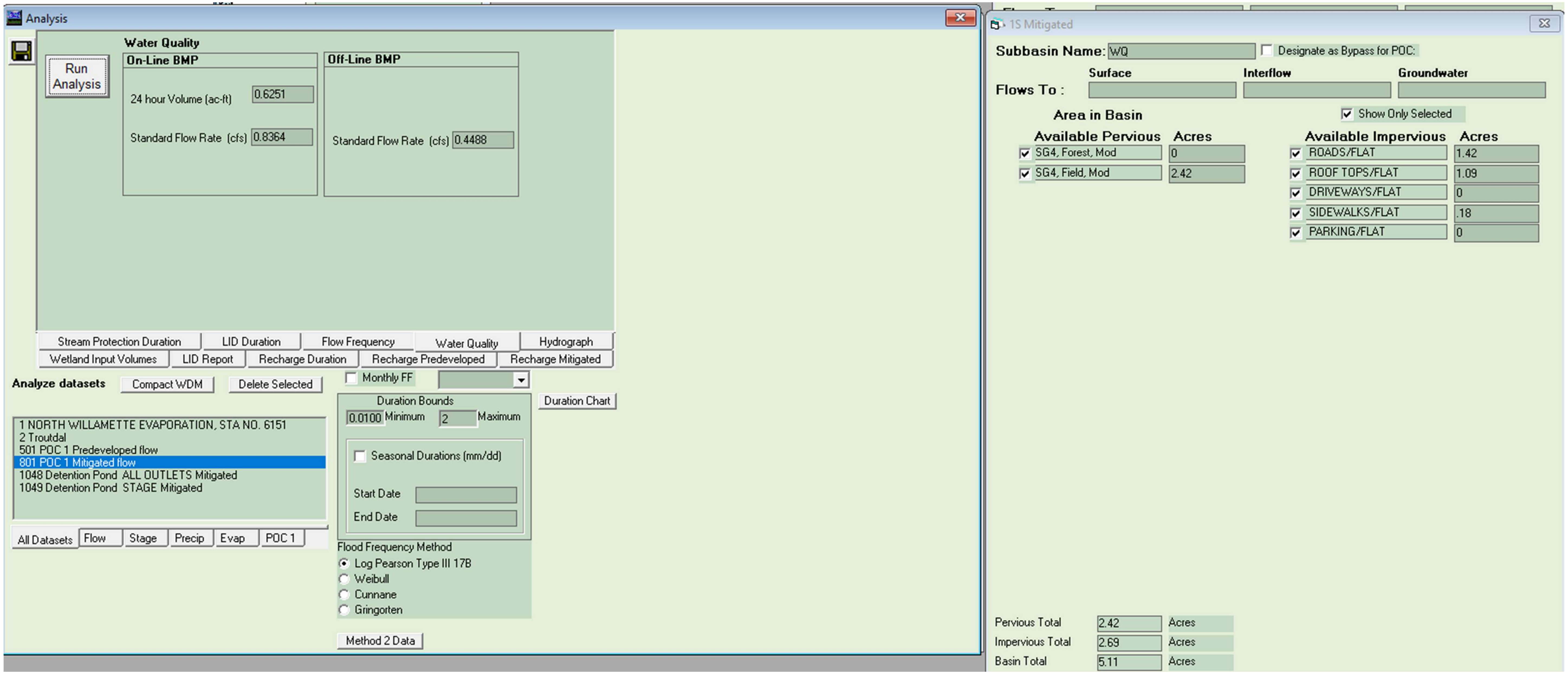
Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Appendix F


Analysis
Run Analysis
Water Quality
On-Line BMP
24 hour Volume (ac-ft) 0.6251
Standard Flow Rate (cfs) 0.8364
Off-Line BMP
Standard Flow Rate (cfs) 0.4488
Stream Protection Duration
LID Duration
Flow Frequency
Water Quality
Hydrograph
Wetland Input Volumes
LID Report
Recharge Duration
Recharge Predeveloped
Recharge Mitigated
Analyze datasets
Compact WDM
Delete Selected
Monthly FF
Duration Bounds
0.0100 Minimum
2 Maximum
Duration Chart
1 NORTH WILLAMETTE EVAPORATION, STA NO. 6151
2 Troutdal
501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow
1048 Detention Pond ALL OUTLETS Mitigated
1049 Detention Pond STAGE Mitigated
Seasonal Durations (mm/dd)
Start Date
End Date
All Datasets
Flow
Stage
Precip
Evap
POC 1
Flood Frequency Method
Log Pearson Type III 17B
Weibull
Cunnane
Gringorten
Method 2 Data
1S Mitigated
Subbasin Name: WQ
Designate as Bypass for POC:
Surface
Interflow
Groundwater
Flows To :
Area in Basin
Show Only Selected
Available Pervious
Acres
SG4, Forest, Mod 0
SG4, Field, Mod 2.42
Available Impervious
Acres
ROADS/FLAT 1.42
ROOF TOPS/FLAT 1.09
DRIVEWAYS/FLAT 0
SIDEWALKS/FLAT .18
PARKING/FLAT 0
Pervious Total 2.42 Acres
Impervious Total 2.69 Acres
Basin Total 5.11 Acres

Appendix G

Report of Geotechnical Engineering Services

Uhacz Development

Camas, Washington

June 17, 2025

Geotechnical ■ Environmental ■ Special Inspections

Columbia West Engineering, Inc




www.columbia-west.com

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West Engineering, Inc

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

June 17, 2025

Romano Development, Inc.
4660 NE 77th Avenue, Suite 200
Vancouver, WA 98662

Attn: Stacey Shields and Dominic Maiello

Re: Report of Geotechnical Engineering Services
Uhacz Development
27429 SE 15th Street
Camas, Washington
CWE Project: Romano-8-01-1

Columbia West Engineering, Inc. (Columbia West) is pleased to present this geotechnical report for the proposed Uhacz Development in Camas, Washington. Our services were conducted in accordance with the Annual Master Services Agreement dated June 16, 2023, and the Work Order for Environmental Services dated May 5, 2025, between Romano Development, Inc. and Columbia West.

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

Sincerely,

Nick Paveglio, PE
Principal Engineer

NICHOLAS N. PAVEGLIO
STATE OF WASHINGTON
45872
REGISTERED
PROFESSIONAL ENGINEER

Signed 06/17/2025

NNP:kat
Attachments
Document ID: Romano-8-01-1-061725-geor.docx

EXECUTIVE SUMMARY

This section provides a summary of the geotechnical considerations associated with the proposed Uhacz Development 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 herein is presented in respective sections of the report.

- Structures associated with the development can be supported on conventional spread footings bearing on firm, native soil or structural fill overlying firm, native soil.

- Based on the soil and groundwater conditions at the site, seismic settlement and lateral spreading are not design considerations for the project.

- The on-site soil will generally provide poor support for construction equipment during the wet construction season. Subgrade protection during construction will be important. Granular haul roads and working pads should be employed if earthwork occurs during the wet season or when the subgrade is wet of optimum moisture content.

- Moisture conditioning will be required to use the on-site soil as structural fill. Accordingly, extended dry weather will be required to adequately condition and place the silt 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.

- Due to the sloping topography, silty subsurface soil, and perched groundwater encountered in our test pits, perimeter building foundation drains are recommended for all structures at the site.

- Dewatering may be required in portions of the site, particularly in cut areas.

- Based on the soil and groundwater conditions, infiltration systems are not feasible at the site.

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
ESAL	equivalent single axle load
g	gravitational acceleration (32.2 feet/second^2)
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
NGVD	National Geodetic Vertical Datum
pcf	pounds per cubic foot
pci	pounds per cubic inch
PG	performance grade
psf	pounds per square foot
psi	pounds per square inch
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSS	Washington Standard Specifications for Road, Bridge, and Municipal Construction (2024)
WWHM	Western Washington Hydrology Model

REPORT OF GEOTECHNICAL ENGINEERING SERVICES
UHACZ DEVELOPMENT
CAMAS, WASHINGTON

1.0 INTRODUCTION

Columbia West is pleased to submit this geotechnical report for the proposed Uhacz Development in Camas, Washington. The approximately 6.8-acre site is located at 27429 SE 15th Street and is currently occupied by a single-family residence and several outbuildings. The site is shown relative to surrounding physical features on Figure 1. Figure 2 shows the existing conditions of the site. Abbreviations and acronyms used herein are defined immediately following the Table of Contents.

Development consists of a residential subdivision with approximately 30 lots. Associated infrastructure, including utilities, private roadways, and stormwater detention, will also be constructed as part of the development. Structures will be of wood-framed construction and lightly loaded. We estimate that column and wall loads will not exceed 20 kips and 4 kips per lineal foot, respectively. Slab loads are not expected to exceed 150 psf.

Based on topography at the site, we anticipate cuts and fills could be moderate and up to 10 feet each and retaining walls may be constructed in portions of the development. Based on our experience in the area and results of testing, infiltration of stormwater will not be feasible due to the fine-grained nature of the near-surface soil.

2.0 PURPOSE AND SCOPE

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

- Reviewed information available in Columbia West's files for the site vicinity.
- Coordinated and managed the field exploration program, which included locating utilities, coordinating site access, and scheduling subcontractors and Columbia West field staff.
- Excavated eight test pits to depths between 12 and 13.5 feet BGS.
- Performed infiltration testing in select test pits to evaluate on-site infiltration potential.
- Observed subsurface conditions, maintained continuous logs of the explorations, and collected soil samples at representative intervals.
- Performed a laboratory testing program using select soil samples collected from the explorations, which included the following:
  - Six moisture content determinations in general accordance with ASTM D2216
  - Five particle-size analyses in general accordance with ASTM D1140
  - Two Atterberg limits tests in general accordance with ASTM D4318
- Prepared this geotechnical report that summarizes our explorations, laboratory testing, and analyses and provides geotechnical design criteria and construction recommendations for the development, including information relating to the following:
  - Summary of soil and groundwater conditions at the site
  - Laboratory testing results
  - Settlement potential

- Seismic hazards
- Recommendations for shallow spread footings
- 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
- Recommendations for pavement sections and construction
- Code-based seismic design parameters in accordance with currently accepted design codes

3.0 SITE CONDITIONS

3.1 GEOLOGY

The near-surface geology at the site is mapped as Oligocene-aged basaltic andesite of Elkhorn Mountain. The unit is described as a sequence of lava flows and flow breccia composed of dark gray to brown, porphyritic to seriate to aphyric tholeiitic basaltic andesite and basalt. Individual flows are generally 15 to 25 feet thick and exhibit platy to blocky to columnar jointing. The unit locally includes minor volcaniclastic rocks too thin or poorly exposed to map (Evarts and O'Connor 2008).

The Web Soil Survey indicates that the surficial soil at the site consists of Olympic clay loam and Olympic stony loam generally consisting of 3 to 4 feet of clay loam underlain by gravelly clay loam (USDA 2025).

3.2 SURFACE CONDITIONS

The approximately 6.8-acre site is located at 27429 SE 15th Street in the north portion of Camas, Washington. The property is a "flag" lot with a narrow access road off of SE 15th Street. The property is generally open with the exception of a single-family residence and several outbuildings in the central portion. Vegetation generally consists of grass with occasional mature trees near the residence and along NE Woodburn Drive at the southern site boundary.

Topography at the site slopes downward to the north and south from a topographic high in the middle of the property near the residence. Elevations at the site range between approximately 430 and 460 (NGVD 29 (47)). The slope gradient in the north portion of the site is less than approximately 5 percent while maximum slopes in the south portion of the site approach 20 percent in isolated areas.

3.3 SUBSURFACE CONDITIONS

3.3.1 General

Subsurface conditions at the site were explored by excavating eight test pits (TP-1 through TP-8) to depths between 12 and 13.5 feet BGS. The exploration locations are shown on Figure 2. A description of the 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. A summary of the subsurface conditions is presented below.

3.3.2 Subsurface Conditions

3.3.2.1 Topsoil and Root Zones

A 3- to- 4-inch-thick root zone within an approximately 8- to 12-inch-thick topsoil zone was encountered in all of the test pits completed at the site.

3.3.2.2 Low to Medium Plasticity Silt

Underlying the topsoil at the site is low to medium plasticity silt. The silt is typically medium stiff with some clay and variable proportions of sand. It is orange-brown-gray and moist. The low to medium plasticity silt generally extends to the maximum depths explored of 13.5 feet BGS in the north portion of the site and 7 to 10 feet BGS in the south portion of the site.

Laboratory testing indicates the moisture content of the low to medium plasticity silt ranged between 27 and 50 percent at the time of exploration.

3.3.2.3 High Plasticity Silt

High plasticity silt with is present below the low to medium plasticity silt in the south portion of the site. The silt is generally stiff and sandy with cobbles and boulders and some clay. The silt is orange-brown and moist. We interpret the silt to be highly decomposed Elkhorn Mountain basalt as described in Section 3.1 (Geology). The high plasticity silt extends to the maximum depth explored of up to 13 feet BGS, where encountered.

Laboratory testing indicates the moisture content of the high plasticity silt ranged between 40 and 45 percent at the time of exploration.

3.3.3 Groundwater

Slow to moderate groundwater seepage was encountered in several of the test pits at depths between 7 and 11 feet BGS. We anticipate the observed groundwater is perched and static groundwater will be more than 50 feet BGS.

Perched groundwater levels are subject to seasonal variation and may rise during extended periods of increased precipitation. Perched groundwater may also be present in localized areas and not consistently across the site. Seepage from perched groundwater may become evident during site grading, primarily along slopes or in areas cut below existing grade.

3.4 INFILTRATION TESTING

Infiltration testing was completed in three of the test pits to assist in the evaluation of stormwater management facilities for the project. The infiltration testing was conducted in general accordance with the recommendations for the encased falling head method per the *Clark County Stormwater Manual* (Clark County 2021). Table 1 summarizes our infiltration testing results and fines content determinations. The exploration logs and the laboratory testing results are presented in Appendices A and B, respectively.

Table 1. Infiltration Testing Results

Location	Depth (feet BGS)	Soil Type	Fines Content[1] (percent)	Unfactored Infiltration Rate (in/hr)
TP-2	4	Silt	85	Negligible
TP-5	4	Silt with sand	73	Negligible
TP-7	4	Sandy Silt	54	Negligible

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

As indicated in Table 1, near-surface infiltration rates were negligible in the tested locations. Based on review of Table 7-2 of the USDA hydrologic soil group criteria (USDA 2009), Appendix 2-A of the 2021 *Clark County Stormwater Manual*, and the *Clark County WWHM Soil Groupings* memorandum (Otak, Inc. 2010), the near-surface native soil meets the classification criteria for WWHM Soil Group 4. Based on the near-surface soil at the site and the results of testing, on-site infiltration systems are not feasible.

3.5 GEOLOGIC HAZARDS

3.5.1 Seismic Setting

3.5.1.1 Earthquake Sources

Three scenario earthquakes were considered for this study consistent 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.

3.5.1.2 Regional Events

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 study:

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.

3.5.1.3 Local 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 2 provides the closest mapped faults to the site.

Table 2. Nearest Mapped Crustal Faults[1]

Source	Closest Mapped Distance (km)	Mapped Length (km)	Slip Rate (mm/yr)
Lacamas Lake fault	1.2	24	<0.02
Grant Butte fault	14.2	10	<0.02

1. Based on mapping by USGS (2025)

3.5.2 Seismic Settlement
Liquefaction is caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles. Granular soil, which relies on interparticle friction for strength, undergoes a loss of strength until the excess pore pressures dissipate. In general, loose, saturated sand soil with low silt and clay content is the most susceptible to liquefaction. Silty soil with low plasticity can be susceptible to strain softening under relatively higher levels of ground shaking. Strain-softened soil has volumetric strains much smaller than liquefiable soil due to matrix effects.

Based on the soil and groundwater conditions observed in the explorations and geology mapping, liquefaction and seismic settlement are not design considerations at the site.

3.5.3 Lateral Spreading
Lateral spreading is a liquefaction-related seismic hazard and occurs on gently sloping or flat sites underlain by liquefiable sediment adjacent to an open face, such as a riverbank. Liquefied soil adjacent to an open face can flow toward the open face, resulting in lateral ground displacement.

Because liquefiable soil is not present at the site and there is no open face at or adjacent to the site, lateral spreading is not a design consideration at the site.

3.5.4 Fault Rupture
Based on USGS mapping, the nearest mapped fault is approximately 1 km away from the site (USGS 2025). As such, fault rupture is not considered a hazard at the site.

4.0 DESIGN
4.1 STATIC SETTLEMENT CONSIDERATIONS
Subsurface conditions at the site consist of silt with varying proportions of sand, clay, cobbles, and boulders. Areal loading from placement of fill can result in settlement that can be detrimental to structural elements at the site. In general, residential structures are constructed at least several months after grading and fill-induced settlement is not a consideration. Roadways and, particularly, utilities are typically constructed shortly after fill placement. If areal fills at the site

exceed 10 feet, we should be contacted to review the grading plan to determine if settlement monitoring points should be installed to monitor settlement and determine when it is appropriate to construct settlement-sensitive improvements.

4.2 FOUNDATION SUPPORT

4.2.1 General

Based on the foundation loads in Section 1.0 (Introduction), the proposed buildings can be supported by conventional spread footings bearing on firm, native soil or engineered structural fill underlain by firm, native soil.

Footings should not be supported on topsoil or undocumented fill. All topsoil or undocumented fill should be removed from under footings and replaced with compacted crushed rock. Over excavation should extend 6 inches beyond the margins of the footings for every foot excavated below the base grades of the footings. Crushed rock should consist of imported granular material, as defined in Section 5.5.1 (Structural Fill). Imported granular material should be compacted to not less than 95 percent of maximum dry density as determined by ASTM D1557 or until well-keyed as determined by one of our geotechnical staff. We recommend that a member of our geotechnical staff observe the prepared footing subgrade.

4.2.2 Dimensions and Capacities

Continuous perimeter wall and isolated spread footings should have minimum widths of 16 and 20 inches, respectively. The bases of exterior footings should bear at least 18 inches below the lowest adjacent exterior grade. The bases of interior footings should bear at least 12 inches below the base of the floor slab.

Footings bearing on subgrade prepared as recommended above should be sized based on an allowable bearing pressure of 2,000 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 is typically increased by one-third for transient lateral forces such as seismic or wind.

If footings are constructed after fill-induced settlement is complete, total post-construction consolidation settlement is expected to be less than 1.0 inch, with differential settlement less than 0.5 inch over a 50-foot span.

4.2.3 Resistance to Sliding

Lateral loads on footings can be resisted by passive earth pressure on the sides of structures and by friction on the bases of footings. Our analysis indicates that the available passive earth pressure for footings confined by native soil and structural fill is 300 pcf, modeled as an equivalent fluid pressure. Typically, the movement required to develop the available passive resistance may be relatively large; therefore, we recommend using a reduced passive equivalent fluid pressure of 250 pcf. Adjacent floor slabs, pavement, or the upper 12-inch depth of unpaved areas should not be considered when calculating passive resistance. In addition, in order to rely on passive resistance, a minimum of 5 feet of horizontal clearance must exist between the faces of the footings and any adjacent down slopes.

An allowable coefficient of friction equal to 0.30 can be used for footings supported on native soil. If a minimum of 6 inches of gravel are placed at the base of a footing, the coefficient of friction can be increased to 0.45.

4.2.4 Subgrade Observation and Preparation

All footing subgrade should be evaluated by a representative of Columbia West to confirm suitable bearing conditions. Observations should also confirm that loose or soft material, organic material, unsuitable fill, prior topsoil zones, and softened subgrade (if present) have been removed. Localized deepening of footing excavations may be required to penetrate any deleterious or soft material, particularly during wet weather conditions.

4.2.5 Foundation Drainage

Foundation drains should be installed for structures associated with the development as described in Section 4.7 (Drainage).

4.3 FLOOR SLABS

Floor slabs supporting loading of up to 150 psf can be supported on firm soil, provided the subgrade is prepared as described in Section 4.1 (Static Settlement Considerations) and Section 5.1 (Site Preparation). A modulus of subgrade reaction of 100 pci can be used to design slabs. A minimum 6-inch-thick layer of imported granular material should be placed and compacted over the prepared subgrade to assist as a capillary break. The floor slab base rock should be crushed rock or crushed gravel and sand meeting the requirements outlined in Section 5.5.1 (Structural Fill). The imported granular material should be placed in one lift and compacted to not less than 95 percent of maximum dry density as determined by ASTM D1557. Floor slab base rock contaminated with excessive fines (greater than 5 percent by dry weight passing the U.S. Standard No. 200 sieve) should be replaced.

Flooring manufacturers often require vapor barriers to protect flooring and flooring adhesives. Many flooring manufacturers will warrant their product only if a vapor barrier is installed according to their recommendations. Selection and design of an appropriate vapor barrier, if needed, should be based on discussions among members of the design team. We can provide additional information to assist you with your decision.

4.4 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 geologic mapping, our explorations, and review of well logs for the area, 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

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} = 0.571 g
Design spectral response acceleration, S_D	S_{DS} = 0.630 g	S_{D1} = 0.345 g

4.5 RETAINING STRUCTURES

4.5.1 Assumptions

Our retaining wall design recommendations are based on the following assumptions: (1) the walls are cantilevered walls, (2) the walls are less than 10 feet in height, (3) drainage is provided behind the walls, (4) the retained soil has a slope flatter than 4H:1V, and (5) the ground surface at the toes of the walls has an inclination of flatter than 5H:1V. Re-evaluation of our recommendations will be required if the retaining wall design criteria for the project varies from these assumptions.

4.5.2 Wall Design Parameters

Permanent retaining structures free to rotate slightly around the base should be designed for active earth pressures using an equivalent fluid unit pressure of 35 pcf. If retaining walls are restrained against rotation during backfilling, they should be designed for an at-rest earth pressure of 55 pcf.

Seismic lateral forces can be calculated using a dynamic force equal to $7H^2$ pounds per linear foot of wall, where H is the wall height. The seismic force should be applied as a distributed load with the centroid located at 0.5H from the wall base. Footings for retaining walls should be designed as recommended for shallow foundations.

The design equivalent fluid pressure should be increased for walls that retain sloping soil. We recommend the above lateral earth pressures be increased using the factors presented in Table 4 when designing walls that retain sloping soil.

Table 4. Lateral Earth Pressure Increase Factors for Sloping Soil

Slope of Retained Soil (degrees)	Lateral Earth Pressure Increase Factor
0	1.00
5	1.06
10	1.12
20	1.33
25	1.52
30	2.27

A vertical live load of 250 psf should be applied where roadways are located within 1H of the backs of the walls, where H is the exposed height of the wall. Figure 3 should be used if other surcharges are located near the backs of the walls.

Foundations for walls can be designed in accordance with Section 4.2 (Foundation Support).

4.5.3 Wall Drainage and Backfill

The above design parameters have been provided assuming drains will be installed behind walls to prevent hydrostatic pressure from developing. If a drainage system is not installed, our office should be contacted for revised design forces.

Backfill placed behind walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of retaining wall select backfill placed and compacted in conformance with Section 5.5.1 (Structural Fill).

A minimum 6-inch-diameter, perforated collector pipe should be placed at the bases of 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 the finished grade. The drain rock and drainage geotextile fabric should meet the specifications in Section 5.5 (Materials). Perforated collector pipes should discharge at an appropriate location away from the bases of walls. Discharge pipes should not be tied directly into stormwater drain systems, unless measures are taken to prevent backflow into the wall's drainage system.

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 construction of flatwork adjacent to retaining walls be postponed at least four weeks after backfilling of the wall, unless survey data indicates that settlement is complete prior to that time.

4.6 PAVEMENT

4.6.1 General

New private roadways will be installed as part of the project. All pavement should be installed on subgrade prepared in conformance with Section 5.1 (Site Preparation) and Section 5.5 (Materials). Our pavement design recommendations are based on the following assumptions:

- The top 12 inches of soil subgrade are compacted to at least 92 percent of maximum dry density as determined by ASTM D1557 or until proof rolling with heavy equipment indicates that is it firm and unyielding.
- Resilient moduli of 4,500 psi and 20,000 psi were assumed for the subgrade soil and aggregate base, respectively.
- The design manual provided for the project specifies pavement recommendations based on a design life of 20 years.
- Initial and terminal serviceability indices of 4.2 and 2.5, respectively.
- Reliability of 85 percent and standard deviation of 0.45.
- Fire access will consist of an imposed fire apparatus load of 75,000 pounds on an infrequent basis.
- No growth.

If any of our assumptions are incorrect, we should be contacted to provide alternative recommendations.

4.6.2 Traffic Loading Assumptions

We anticipate vehicle traffic will primarily consist of passenger cars and up to five semi-trucks per day. If any of these assumptions are incorrect, our office should be contacted with the appropriate information so that the pavement designs can be revised.

4.6.3 AC Pavement Design

Our AC pavement design recommendations are presented in Table 5.

Table 5. Recommended AC Pavement Sections Constructed over Native Soil or Engineered Fill

Traffic	ESALs	AC Thickness (inches)	Aggregate Base Thickness[1] (inches)
Drive aisles with limited trucks (up to five trucks per day)	25,000	3	10
Automobile parking (no trucks)	5,000	2.5	8

1. Aggregate base thickness can be decreased to 4 inches if the subgrade is cement amended to a minimum depth of 12 inches with a minimum unconfined compressive strength of 100 psi.

4.6.4 Construction Considerations

All thicknesses are intended to be the minimum acceptable. Design of the recommended sections assumes that construction will be completed during an extended period of dry weather. Wet weather construction could require an increased thickness of aggregate base.

Construction traffic should be limited to non-building, unpaved portions of the site or haul roads. Construction traffic should not be allowed on new pavement. If construction traffic is to be allowed on newly constructed road sections, an allowance for this additional traffic will need to be made in the design pavement section.

If cement amendment is completed, the amendment subgrade should be allowed to cure for at least four days prior to construction traffic or placing the base rock to avoid strength loss. Lastly, the amended subgrade should be protected with a minimum of 4 inches of base rock prior to construction traffic access.

The aggregate base thicknesses do not account for construction traffic, and haul roads and staging areas should be used as described in Section 5.2 (Construction Traffic and Staging).

4.7 DRAINAGE

4.7.1 Temporary

During work at the site, the contractor should be made responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion at the working surface. During rough and finished grading of the site, the contractor should keep all pads and subgrade free of ponding water.

4.7.2 Surface

The ground surface at finished pads should be sloped away from their edges at a minimum 2 percent gradient for a distance of at least 5 feet. Roof drainage from buildings should be directed into solid, smooth-walled drainage pipes that carry the collected water to the storm drain system.

4.7.3 Subsurface

Based on the soil and groundwater conditions at the site and sloping topography at the site, we recommend perimeter footing drains for structures in the proposed development. Perimeter foundation drains should consist of a filter fabric-wrapped, drain rock-filled trench that extends at least 12 inches below the lowest adjacent grade (i.e., slab subgrade elevation). A perforated pipe should be placed at the base to collect water that gathers in the drain rock. The drain rock and filter fabric should meet specifications in Section 5.5 (Materials). Discharge for footing drains should not be tied directly into the stormwater drainage system, unless mechanisms are installed to prevent backflow.

4.7.4 Stormwater Infiltration Systems

Based on the measured rates in Table 1 and discussion in Section 3.4 (Infiltration Testing), the near-surface native soil meets the classification criteria for WWHM Soil Group 4 and on-site infiltration systems are not viable at the site.

4.8 PERMANENT SLOPES

Permanent cut and fill slopes should not exceed 2H:1V. Slopes that will be maintained by mowing should not be constructed steeper than 3H:1V. Access roads and pavement should be located at least 5 feet from the top of cut and fill slopes. The horizontal setback should be increased to 10 feet for buildings. Note that the setback recommendations pertain to engineered cut and fill slopes only.

Concentrated drainage or water flow over the faces of slopes should be prohibited as described in this report 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.

5.0 CONSTRUCTION

5.1 SITE PREPARATION

5.1.1 General

Site grading activities 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.

5.1.2 Demolition
Demolition includes removal of structural features that may be at the site. Abandoned foundations and utilities 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 5.5 (Materials).

5.1.3 Stripping and Grubbing
Where encountered, existing root and topsoil zones should be stripped and removed from all areas to receive new structural improvements. Based on test pit explorations at the site, we anticipate average stripping depths will range between 8 and 12 inches. Deeper stripping depths may be anticipated in areas with thicker vegetation and shrubs. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported offsite for disposal or used in landscaped areas.

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 soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with structural fill.

5.1.4 Undocumented Fill
5.1.4.1 General
Undocumented fill was not observed at the site; however, isolated areas of fill may be present at the site, particularly near existing structures. Due to the variable composition of fill and the unknown methods of placement and compaction, reliable strength properties for undocumented fill are difficult to predict.

5.1.4.2 Foundation Areas
Undocumented fill should be removed from under new building foundations and footings supported on crushed rock as discussed in the Section 4.2 (Foundation Support) and Section 5.5 (Materials).

5.1.4.3 Pavement Areas
There is a small risk for poor performance of pavement established directly over undocumented fill. If undocumented fill is present after site grading, removal and replacement of undocumented fill would eliminate all risk. Pavement can be constructed on fill, provided a small risk of distress is accepted and it is evaluated as described in Section 5.1.5 (Subgrade Evaluation).

5.1.5 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.

5.2 CONSTRUCTION TRAFFIC AND STAGING

The near-surface soil at the site contains silt and 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 and haul roads with increased thicknesses of base rock will be required. The amount of staging and haul road areas, 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 road areas. 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 5.5 (Materials).

As an alternative to thickened crushed rock sections, haul roads and utility work zones may be constructed using cement-amended subgrade overlain by a crushed rock wearing surface. If this approach is used, the thickness of granular material in staging areas and along haul roads can typically be reduced to between 6 and 9 inches. This recommendation is based on an assumed minimum unconfined compressive strength of 100 psi for subgrade amended to a depth of 12 to 16 inches. The actual thickness of the amended material and imported granular material will depend on the contractor's means and methods and should be the contractor's responsibility. Cement amendment is discussed in Section 5.5 (Materials).

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.

5.3 EXCAVATION

Excavations will be required for the installation of foundations, utilities, and other earthwork activities. Conventional earthmoving equipment in proper working condition should be capable of making the necessary excavations.

Temporary excavation sidewalls should stand vertical to a depth of approximately 4 feet, provided groundwater seepage does not occur in the sidewalls. Open excavation techniques may be used to excavate trenches with depths between 4 and 8 feet BGS, provided the walls of the excavation are cut at a slope of 1H:1V or flatter and groundwater seepage does not occur. Excavations should be flattened to 1.5H:1V or flatter if excessive sloughing occurs.

Given the relatively shallow groundwater, temporary shoring and dewatering will likely be required. Use of approved temporary shoring is recommended where the slopes cannot be cut back, within the influence area of structural elements, and for cuts below the water table. The influence area can be defined as a 1H:1V slope extending down from a 5-foot setback from the edge of a foundation element. A wide variety of shoring and dewatering systems are available. Consequently, we recommend the contractor be responsible for selecting the appropriate shoring and dewatering systems.

If box shoring is used, it should be understood that box shoring is a safety feature used to protect workers and does not prevent caving. If excavations are left open for extended periods of time, caving of the sidewalls may occur. The presence of caved material will limit the ability to properly backfill and compact the 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.

If shoring is used, we recommend the type and design of the shoring system be the responsibility of the contractor, who is in the best position to choose a system that fits the overall plan of operation

5.4 CONSTRUCTION DEWATERING

5.4.1 General

Perched groundwater was generally observed between depths of 7 and 11 feet BGS in the test pits at the site. Based on experience in the area, perched groundwater could be present within a few feet of the ground surface during the wet season. Groundwater should be expected in excavations during mass grading and temporary dewatering systems may be required, particularly in cut slope areas.

The contractor should be responsible for temporary drainage of surface water, perched water, and groundwater as necessary to prevent standing water and/or erosion at the working surface. Because of the instability of saturated soil, sloughing and “running” conditions can occur if excavations extend below groundwater seepage levels. Positive control of groundwater will be required to maintain stable trench sides and base. The proposed dewatering plan should be capable of maintaining groundwater levels at least 2 feet below the base of the trench excavation (including the depth required for trench bedding and stabilization material). In addition to safety considerations, running soil, caving, or other loss of ground will increase backfill volumes and can result in damage to adjacent structures or utilities.

Flow rates for dewatering are likely to vary depending on location, soil type, and the season in which excavation occurs. Dewatering systems should be capable of adapting to variable flows. Because of the tendency of saturated, low plasticity silt with sand to “run,” we recommend dewatering wells or well points be considered if trench excavations extend below groundwater levels. Tight-joint driven sheets in conjunction with a scaled-down dewatering program can also be an effective way to control groundwater seepage, provided the sheets are driven deep enough to control heaving conditions at the base of the excavation.

Trench dewatering will be required to maintain dry working conditions if the invert elevations of the proposed utilities encounter groundwater. Pumping from sumps located within the trench may result in excessive sloughing, caving, or running conditions, and dewatering by well points may be required. If groundwater is present at the base of utility excavations, we recommend placing 1.5 to 2 feet of stabilization material at the base of the excavation. The use of a subgrade geotextile fabric may reduce the amount of stabilization material required. The actual thickness should be based on field observations during construction. Trench stabilization material and the subgrade geotextile fabric should meet the requirements described in Section 5.5 (Materials). Trench stabilization material should be placed in one lift and compacted until well keyed.

While we have described certain approaches to excavation dewatering, it is the contractor's responsibility to select the dewatering methods.

5.4.2 Cut Slopes

Subdrains should also be considered if portions of the site are cut below surrounding grades. Shallow groundwater, springs, or seeps should be conveyed via drainage channels 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. A typical perforated drainpipe trench detail and cut and fill slope cross sections are provided on Figures 4 and 5.

Drains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seeps become evident, the drainage provisions may require modification or additional drains. Columbia West should be consulted to provide appropriate recommendations.

5.5 MATERIALS

5.5.1 Structural Fill

5.5.1.1 General

Areas proposed for fill placement should be appropriately prepared as described in Section 5.1 (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 and 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. All structural fill should be free of organic material and have a particle size of less than 6 inches.

5.5.1.2 On-Site Soil

The on-site soil is suitable for use as general fill, provided it is free of particles over 6 inches in diameter. Based on laboratory testing, the moisture content of the on-site soil will 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 on-site silt during the rainy season or during prolonged periods of rainfall. In addition, the soil at the site will be “blocky” and will need to be broken up or pulverized to adequate dry it.

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 92 percent of maximum dry density as determined by ASTM D1557.

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.

5.5.1.3 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.

5.5.1.4 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.

5.5.1.5 Trench Backfill

Trench backfill placed beneath, adjacent to, and for at least 12 inches above utility lines (i.e., the pipe zone) should consist of durable, well-graded granular material with a maximum particle size of 1½ inches, should have less than 7 percent fines by dry weight, and should have at least two mechanically fractured faces. The 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 pipe manufacturer or local building department.

Within roadway alignments, the remainder of the trench backfill up to the subgrade elevation should consist of durable, well-graded granular material with a maximum particle size of 2½ inches, should have less than 7 percent fines by dry weight, and should have at least two mechanically fractured faces. This material should be compacted to at least 92 percent of maximum dry density as determined by ASTM D1557 or as required by the pipe manufacturer or local building department. The upper 3 feet of the trench backfill should be compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

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.

5.5.1.6 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.

The 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 (such as a 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.

5.5.1.7 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.

5.5.1.8 Floor Slab and Pavement Aggregate Base

Imported granular material used as base rock for building floor slabs and pavement should consist of ¾- or 1½-inch-minus material (depending on the application). In addition, the aggregate should have less than 5 percent fines by dry weight and have at least two mechanically fractured faces. The aggregate base should be compacted to not less than 95 percent of maximum dry density as determined by ASTM D1557.

5.5.1.9 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.

5.5.1.10 Existing AC and Aggregate Base Material
The existing crushed aggregate base course material may be reused for engineered structural fill, provided it is well graded, clean, and free from deleterious material; has a maximum particle size of 3 inches; and is evaluated by Columbia West during construction when conditions are exposed. In addition, the existing AC pavement may be pulverized and blended into engineered structural fill in accordance with the requirements outlined in WSS 9-03.21 – Recycled Material. The specification for reuse of recycled material requires pulverized asphalt to be completely blended and mixed into the source material and places limits on the maximum amount of recycled asphalt (by weight) that can be added.

5.5.2 Geotextile Fabric
5.5.2.1 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 provided in WSS 9-33.2(1) – Geotextile Properties (Table 3) for soil separation. The geotextile should be installed in conformance with the specifications provided in WSS 2-12 – Construction Geosynthetic.

5.5.2.2 Drainage Geotextile
Subgrade 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.

5.5.3 Pavement
5.5.3.1 AC
The AC should conform to the specifications provided in WSS 5-04 – Hot Mix Asphalt and WSS 9-03.8 – Aggregates for Hot Mix Asphalt. The asphalt cement binder should be PG 58-22 Performance Grade Asphalt Cement meeting WSS 9-02.1(4) – Performance Graded (PG) Asphalt Binder. The AC should be ½-inch HMA. The lift thicknesses should be 2 to 3 inches. The AC should be compacted to 91 percent of maximum specific gravity of the mix as determined by ASTM D2041.

5.5.3.2 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.

5.5.4 Soil Amendment with Cement

5.5.4.1 General

The on-site soil can be amended with portland cement to obtain suitable properties for use as wet weather structural fill, subbase for pavement, or to limit potential expansion of the near-surface soil. 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 site soil.

Due to the plasticity of the near-surface soil, two passes with the tiller may be required for the project.

5.5.4.2 Subbase Stabilization

Specific recommendations based on exposed site conditions for soil amendment can be provided if necessary. However, for preliminary design purposes, we recommend a target strength for cement-amended subgrade for building and pavement subbase (below aggregate base) soil of 100 psi. The amount of cement used to achieve this target generally varies with moisture content and soil type. It is difficult to predict field performance of soil to cement amendment due to variability in soil response, and we recommend laboratory testing to confirm expectations. In general, 5 percent cement by weight of dry soil can be used when the soil moisture content does not exceed approximately 20 percent. If the soil moisture content is in the range of 25 to 35 percent, 6 to 8 percent by weight of dry soil is recommended. The amount of cement added to the soil may need to be adjusted based on field observations and performance. Moreover, depending on the time of year and moisture content levels during amendment, water may need to be applied during tilling to appropriately condition the soil moisture content. We recommend assuming a minimum cement ratio of 6 percent by dry weight; however, the cement amendment contractor should be responsible for selecting the cement content. If the soil moistures are in excess of 30 percent, a cement ratio of 7 percent may be needed.

We recommend cement amendment equipment be equipped with balloon tires to reduce rutting and disturbance of the fine-grained soil. A sheepsfoot or segmented pad roller with a minimum static weight of 40,000 pounds should be used for initial compaction of the fine-grained soil without the use of vibratory action. A smooth-drum roller with a minimum applied linear force of 700 pounds per inch should be used for final compaction. The amended soil should be compacted to at least 92 percent of maximum dry density as determined by ASTM D1557.

A minimum curing time of four days is required between amendment and construction traffic access. Construction traffic should not be allowed on unprotected, cement-amended subgrade. To protect the cement-amended surfaces from abrasion or damage, the finished surface should be covered with 4 to 6 inches of imported granular material.

Amendment depths for subgrade beneath buildings and pavement, haul roads, and staging areas are typically on the order of 12, 16, and 12 inches, respectively. The crushed rock typically becomes contaminated with soil during construction. Contaminated base rock should be removed and replaced with clean rock in pavement areas. The actual thickness of the amended material and imported granular material for haul roads and staging areas will depend on the anticipated traffic, as well as the contractor's means and methods and, accordingly, should be the contractor's responsibility.

Cement amendment should not be attempted when the air temperature is below 40 degrees Fahrenheit or during moderate to heavy precipitation. Cement should not be placed when the ground surface is saturated or standing water exists.

5.5.4.3 Cement-Amended Structural Fill

On-site soil that would not otherwise be suitable for structural fill may be amended and placed as fill over a subgrade prepared in conformance with Section 5.1 (Site Preparation). The cement ratio for general cement-amended fill can generally be reduced by 1 percent (by dry weight). Typically, a minimum curing time of four days is required between amendment and construction traffic access. Consecutive lifts of fill may be amended immediately after the previous lift has been amended and compacted (e.g., the four-day wait period does not apply). However, where the final lift of fill is a building or roadway subgrade, the four-day wait period is in effect.

5.5.4.4 Other Considerations

Portland cement-amended soil is hard and has low permeability. This soil does not drain well and it is not suitable for planting. Future planted areas should not be cement amended, if practical, or accommodations should be made for drainage and planting. Moreover, cement amending soil within building areas must be done carefully to avoid trapping water under floor slabs. We should be contacted if this approach is considered. Cement amendment should not be used if runoff during construction cannot be directed away from adjacent wetlands.

5.5.4.5 Specific Recommendations

We recommend the following comments be included in the specifications for the project:

- In general, cement amendment is not recommended during the cold weather (temperatures less than 40 degrees Fahrenheit) or during steady rainfall.
- Mixing Equipment
  - Use a pulverizer/mixer capable of uniformly mixing the cement into the soil to the design depth. Blade mixing will not be allowed.
  - Pulverize the soil-cement mixture such that 100 percent by dry weight passes a 1-inch sieve and a minimum of 70 percent passes a No. 4 sieve, exclusive of gravel or stone retained on these sieves. If water is required, the pulverizer should be equipped to inject water to a tolerance of ¼ gallon per square foot of surface area.
  - Use machinery that will not disturb the subgrade, such as using low-pressure "balloon" tires on the pulverizer/mixer vehicle. If subgrade is disturbed, the tilling/amendment depth shall extend the full depth of the disturbance.
  - Multiple passes of the tiller will likely be required to adequately blend the cement and soil mixture, particularly if a high frequency of cobbles and boulders are encountered.

- Spreading Equipment
  - Use a spreader capable of distributing the cement uniformly on the ground to within 5 percent variance of the specified application rate.
  - Use machinery that will not disturb the subgrade, such as using low-pressure balloon tires on the spreader vehicle. If subgrade is disturbed, the tilling/amendment depth shall extend the full depth of the disturbance.
- Compaction Equipment
  - Use a static, sheepsfoot or segmented pad roller with a minimum static weight of 40,000 pounds for initial compaction of fine-grained soil (silt and clay) or an alternate approved by the geotechnical engineer.

5.6 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.

6.0 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.

7.0 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 C.

♦ ♦ ♦

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,

Nick Paveglio, PE
Principal Engineer

REFERENCES

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FIGURES

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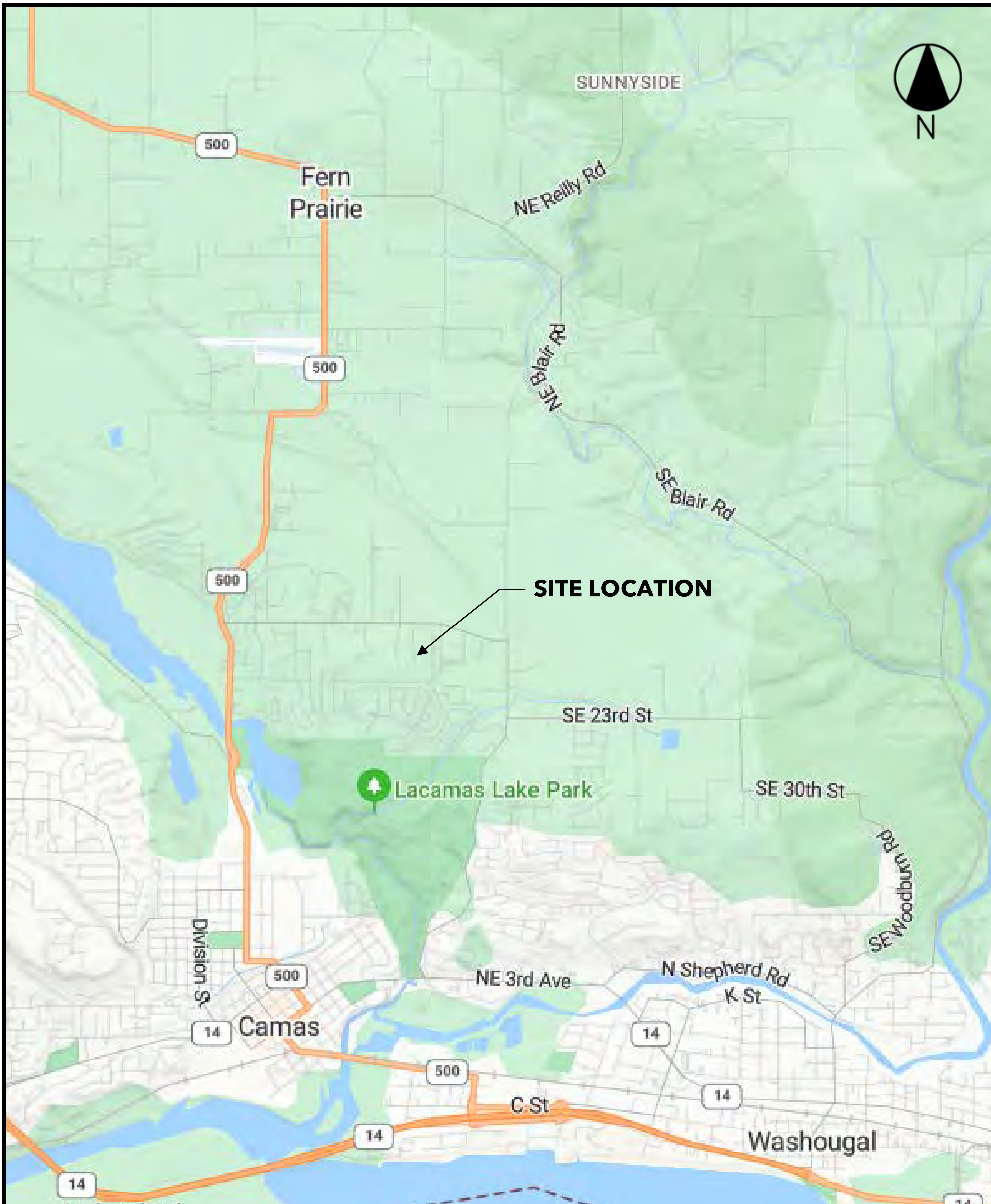

Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	PROJECT NO.: ROMANO-8-01-1 JUNE 2025	VICINITY MAP UHACZ DEVELOPMENT CAMAS, WASHINGTON	FIGURE 1

LEGEND

SITE BOUNDAR

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NOTES:
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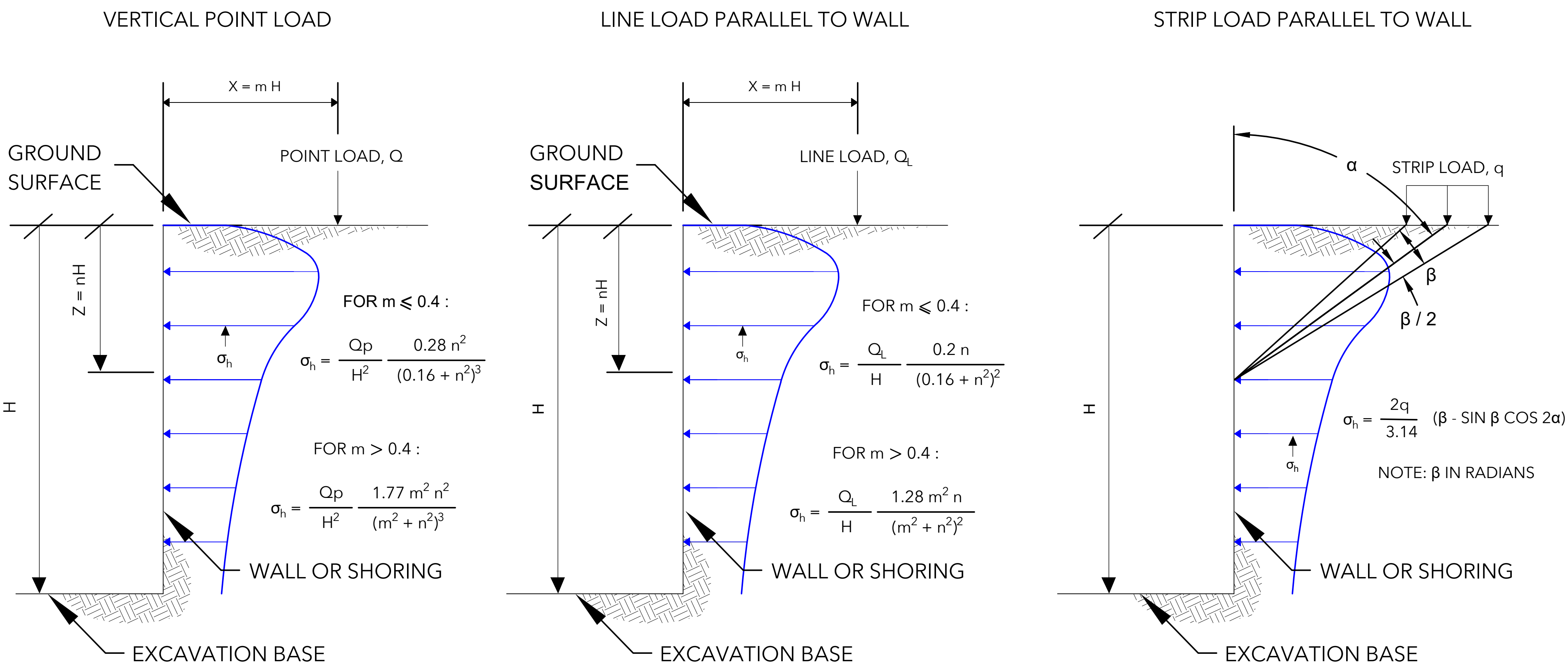

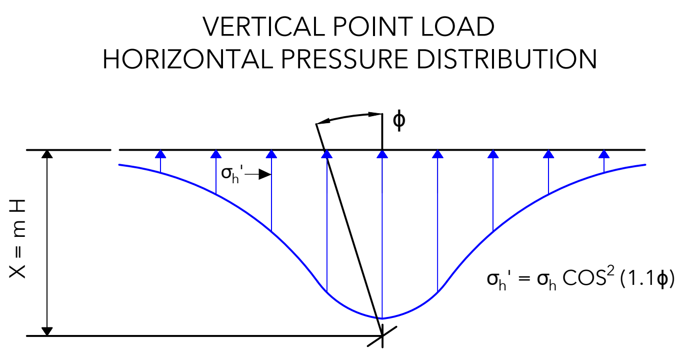

NOTES:

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.

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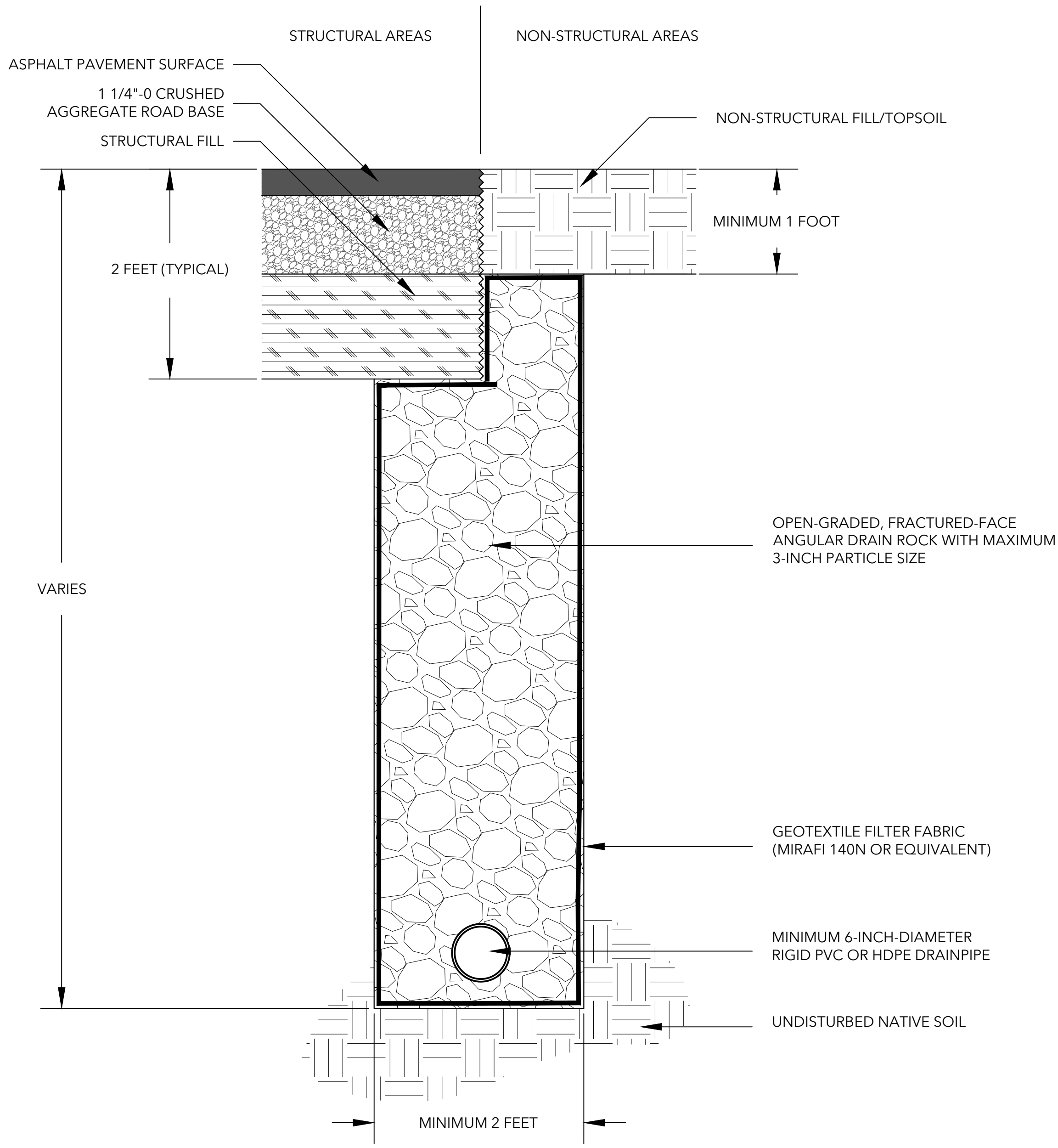
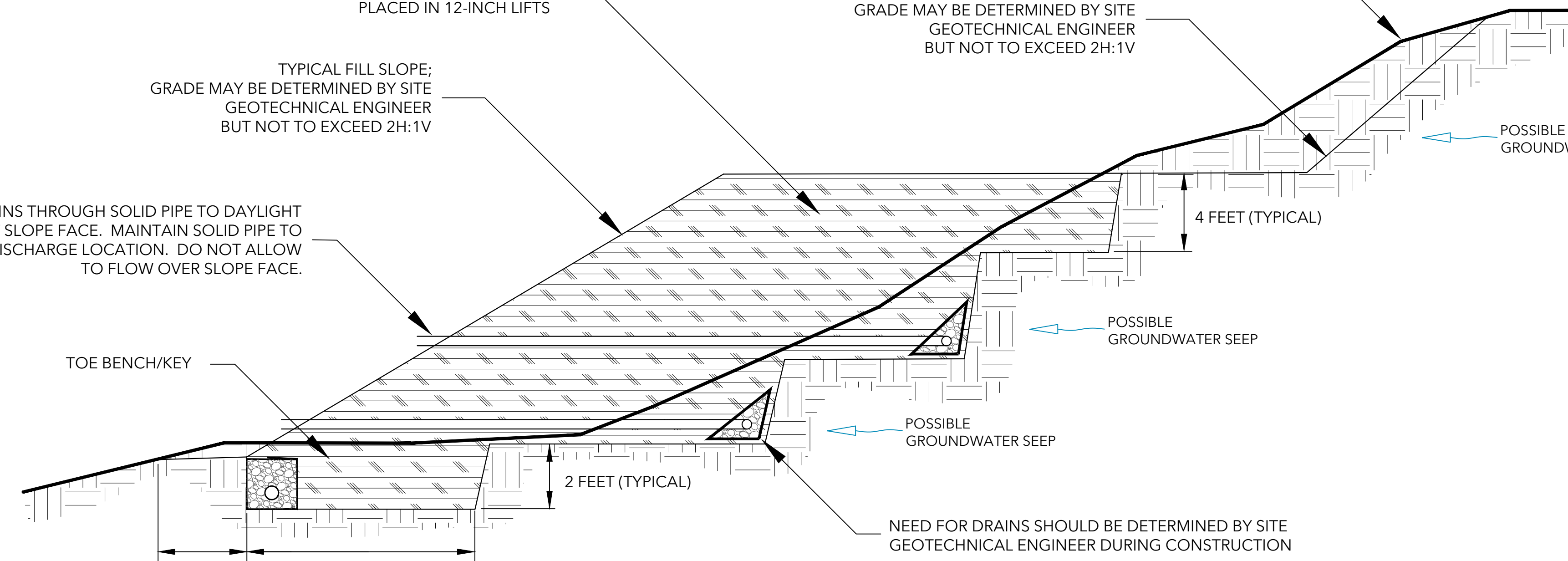
SURCHARGE-INDUCED LATERAL EARTH PRESSURES

FIGURE 3

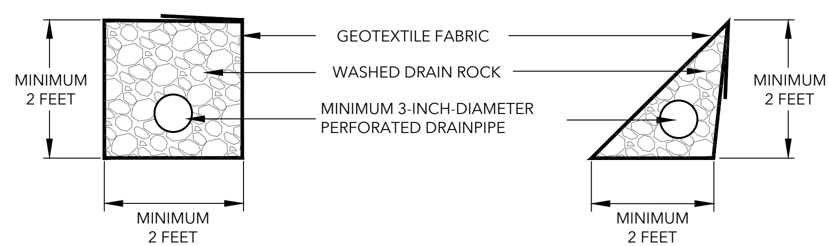


NOTE: LOCATION, INVERT ELEVATION, DEPTH OF TRENCH, AND EXTENT OF PERFORATED PIPE REQUIRED MAY BE MODIFIED BY THE SITE GEOTECHNICAL ENGINEER DURING CONSTRUCTION BASED UPON FIELD OBSERVATION AND SITE-SPECIFIC SOIL CONDITIONS.

Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	TYPICAL PERFORATED DRAINPIPE TRENCH DETAIL	NOTES: 1. DRAWING IS NOT TO SCALE. 2. DRAWING REPRESENTS TYPICAL PERFORATED DRAINPIPE TRENCH DETAIL AND MAY NOT BE SITE-SPECIFIC.	FIGURE 4



TYPICAL DRAIN SECTION DETAIL



DRAIN SPECIFICATIONS

GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN U.S. STANDARD NO. 70 AND NO. 100 SIEVES.

WASHED DRAIN ROCK SHALL BE OPEN-GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE U.S. STANDARD NO. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

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TYPICAL CUT AND FILL SLOPE CROSS SECTION

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL CUT AND FILL SLOPE CROSS SECTION AND MAY NOT BE SITE-SPECIFIC.

FIGURE 5

APPENDIX A

APPENDIX A
FIELD EXPLORATIONS

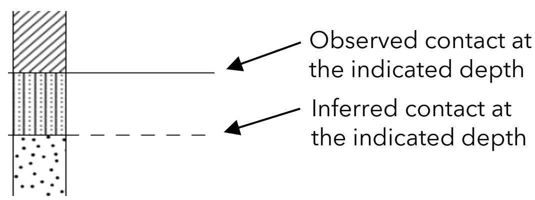
GENERAL
Subsurface conditions at the site were explored by excavating eight test pits (TP-1 through TP-8) to depths between 12 and 13.5 feet BGS. Excavation services were completed by L&S Contracting LLC of Yacolt, Washington. The exploration logs are presented in this appendix.

The exploration locations are shown on Figure 2. The exploration locations were determined in the field by pacing or measuring from existing site features. This information should be considered accurate only to the degree implied by the methods used.

SOIL SAMPLING
Representative grab samples of the soil observed in the test pits were collected from the walls and/or base of the test pits using the excavator bucket.

SOIL CLASSIFICATION
The soil samples were classified in the field in accordance with the "Exploration Legend" and "Soil Classification System," which are presented in this appendix. The exploration logs indicate the depths at which the soil characteristics change, although the change could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications are shown on the exploration logs.

EXPLORATION LEGEND

SAMPLER TYPE	DESCRIPTION	
SPT	Sample collected from the indicated depth in general accordance with ASTM D1586, *Standard Test Method Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils,* using an SPT sampler and 140-pound hammer	
SH	Sample collected from the indicated depth in general accordance with ASTM D1587, *Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes,* using a thin-walled Shelby tube, or in general accordance with ASTM D6519, *Standard Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler,* using a thin-walled tube	
D&M	Sample collected from the indicated depth in general accordance with ASTM D3550, *Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils,* using a Dames & Moore sampler and 140-pound hammer or pushed	
CSS	Sample collected from the indicated depth in general accordance with ASTM D3550, *Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils,* using a 3-inch-outside diameter California split-spoon sampler and 140-pound hammer	
DP	Sample collected from the indicated depth in general accordance with ASTM D6282, *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations,* using a direct-push soil sampler	
GRAB	Grab sample collected from the indicated depth	
CORE	Pavement or rock core interval at the indicated depth	

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

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		

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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-1

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/30/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 9:40 AM
LOGGED BY J. Wright
TIME COMPLETED 10:10 AM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (LL-PL-PI)	REMARKS
0–1.0					Medium stiff, brown SILT, moist (12 inches of topsoil, 4-inch-thick root zone). 1.0				
1.0–13.5			ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist. 13.5				
5	Grab	TP1.1						50-30-20	
	Grab	TP1.2							
	Grab	TP1.3							
10									

Exploration completed at 13.5 feet.

GROUNDWATER: Slow seepage at 10 feet

CAVING: Not observed

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TEST PIT NUMBER: TP-2

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/30/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 9:00 AM
LOGGED BY J. Wright
TIME COMPLETED 9:30 AM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
0–0.7					Medium stiff, brown SILT, moist (8 inches of topsoil, 3-inch-thick root zone). 0.7				
0.7–12.0			ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist. 12.0				
~3	Grab	TP2.1							
~4									Infiltration test at 4 feet.
5	Grab	TP2.2					29	85	
~11	Grab	TP2.3							

Exploration completed at 12 feet.

GROUNDWATER: Moderate seepage at 10 feet

CAVING: Not observed

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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-3

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/30/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 10:15 AM
LOGGED BY J. Wright
TIME COMPLETED 10:45 AM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
0–1.0					Medium stiff, brown SILT, moist (12 inches of topsoil, 4-inch-thick root zone). 1.0			
1.0–13.0	Grab	TP3.1	ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist.			
5								
10	Grab	TP3.2			13.0			
					Exploration completed at 13 feet.			

GROUNDWATER: Moderate seepage at 11 feet

CAVING: Not observed

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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-4

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/30/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 11:00 AM
LOGGED BY J. Wright
TIME COMPLETED 11:30 AM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	REMARKS
0–1.0					Medium stiff, brown SILT, moist (12 inches of topsoil, 4-inch-thick root zone). 1.0			
1.0	Grab	TP4.1	ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist.		27	
5	Grab	TP4.2						
10	Grab	TP4.3			13.0			

Exploration completed at 13 feet.

GROUNDWATER: Not observed

CAVING: Not observed

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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-5

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/30/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 11:35 AM
LOGGED BY J. Wright
TIME COMPLETED 12:05 PM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
0.7					Medium stiff, brown SILT, moist (8 inches of topsoil, 4-inch-thick root zone).				
			ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist.				
	Grab	TP5.1			With sand at 4 feet.		32	73	Infiltration test at 4 feet.
5									
	Grab	TP5.2			Trace gravel at 7 feet.				
10.0									
10			MH		Stiff, orange-brown sandy SILT with cobbles and boulders, some clay, moist.				
12.5	Grab	TP5.3							
					Exploration completed at 12.5 feet.				

GROUNDWATER: Not observed

CAVING: Not observed

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Columbia West Engineering, Inc

TEST PIT NUMBER: TP-6

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/30/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 12:15 PM
LOGGED BY J. Wright
TIME COMPLETED 12:45 PM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
0–1.0					Medium stiff, brown SILT, moist (12 inches of topsoil, 4-inch-thick root zone). 1.0				
1.0–7.0			ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist. 7.0				
4	Grab	TP6.1							
7.0–13.0			MH		Stiff, orange-brown sandy SILT with cobbles and boulders, some clay, moist. 13.0				
7	Grab	TP6.2							
10	Grab	TP6.3					45	57	

Exploration completed at 13 feet.

GROUNDWATER: Slow seepage at 7 feet

CAVING: Not observed

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TEST PIT NUMBER: TP-7

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/31/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 1:00 PM
LOGGED BY J. Wright
TIME COMPLETED 1:30 PM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (LL-PL-PI)	FINES (%)	REMARKS
0–0.7					Medium stiff, brown SILT, moist (8 inches of topsoil, 3-inch-thick root zone). 0.7					
0.7–8.0			ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist.					
	Grab	TP7.1								Infiltration test at 4 feet.
5	Grab	TP7.2			Sandy at 5 feet. 8.0		50		54	
8.0–13.0			MH		Stiff, orange-brown sandy SILT with cobbles and boulders, some clay, moist.					
10										
	Grab	TP7.3			13.0			61-48-13		

Exploration completed at 13 feet.

GROUNDWATER: Not observed

CAVING: Not observed

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TEST PIT NUMBER: TP-8

PROJECT NAME Uhacz Development
CLIENT Romano Development, Inc.
PROJECT NO. Romano-8-01-1
PROJECT CITY, STATE Camas, Washington
CONTRACTOR L&S Contractors
DATE COMPLETED 05/31/2025
EQUIPMENT CAT 307E2, 5-foot with tooth
TIME STARTED 1:45 PM
LOGGED BY J. Wright
TIME COMPLETED 2:15 PM

DEPTH (ft)	SAMPLE TYPE	SAMPLE ID	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	POCKET PEN (tsf)	MOISTURE CONTENT (%)	FINES (%)	REMARKS
0–0.7					Medium stiff, brown SILT, moist (8 inches of topsoil, 3-inch-thick root zone). 0.7				
0.7–8.0			ML		Medium stiff, orange-brown SILT, some clay, minor sand, moist. 8.0				
5	Grab	TP8.1							
8.0–13.0	Grab	TP8.2	MH		Stiff, orange-brown SILT with cobbles and boulders, some clay, minor sand, moist. 13.0		40	88	
					Exploration completed at 13 feet.				

GROUNDWATER: Not observed

CAVING: Not observed

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 and strength characteristics. 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 the testing results are presented in this appendix.

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.

PARTICLE-SIZE ANALYSIS

Particle-size analyses were completed 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.

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.

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MOISTURE CONTENT, PERCENT PASSING NO. 200 SIEVE BY WASHING

PROJECT	CLIENT	PROJECT NO.	
Uhacz Property 27429 SE 15th Street Camas, Washington	Romano Development, Inc. 4660 NE 77th Avenue, Ste. 200 Vancouver, WA 98662	Romano-8-01-1	
		ISSUE DATE: 06/11/25	PAGE: 1 of 1
		DATE SAMPLED: 05/30/25	SAMPLED BY: J. Wright

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
S25-1158	568.53	831.04	771.37	598.18	TP2.2	5	29%	85%
S25-1159	87.22	287.60	244.70	-	TP4.1	1	27%	-
S25-1160	1,036.42	1,925.04	1,708.91	1,217.17	TP5.1	4	32%	73%
S25-1161	995.65	2,181.21	1,815.90	1,345.58	TP6.3	10	45%	57%
S25-1162	975.04	2,174.30	1,773.48	1,341.90	TP7.2	5	50%	54%
S25-1164	556.31	840.07	759.50	580.12	TP8.2	8	40%	88%

NOTES:
Sample weights received for Lab ID: S25-1160, 1161, and 1162 did not meet the minimum size requirements; entire sample used for analysis.

DATE TESTED	TESTED BY
06/06/25	M. Scherette

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	
Uhacz Property 27429 SE 15th Street Camas, Washington	Romano Development, Inc. 4660 NE 77th Avenue, Ste. 200 Vancouver, WA 98662	Romano-8-01-1	
		ISSUE DATE: 06/11/25	PAGE: 1 of 1
		LAB ID: S25-1157	FIELD ID: TP1.1
		DATE SAMPLED: 05/30/25	SAMPLED BY: J. Wright

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
SILT	Test Pit TP-1 depth = 5 feet	no data provided

LABORATORY TEST DATA

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

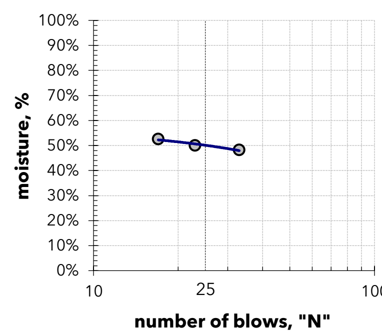
ATTERBERG LIMITS

liquid limit =	50
plastic limit =	30
plasticity index =	20

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	34.69	32.08	31.50	
dry soil + pan weight, g =	30.18	28.19	27.68	
pan weight, g =	20.82	20.42	20.42	
N (blows) =	33	23	17	
moisture, % =	48.2 %	50.1 %	52.6 %	

LIQUID LIMIT



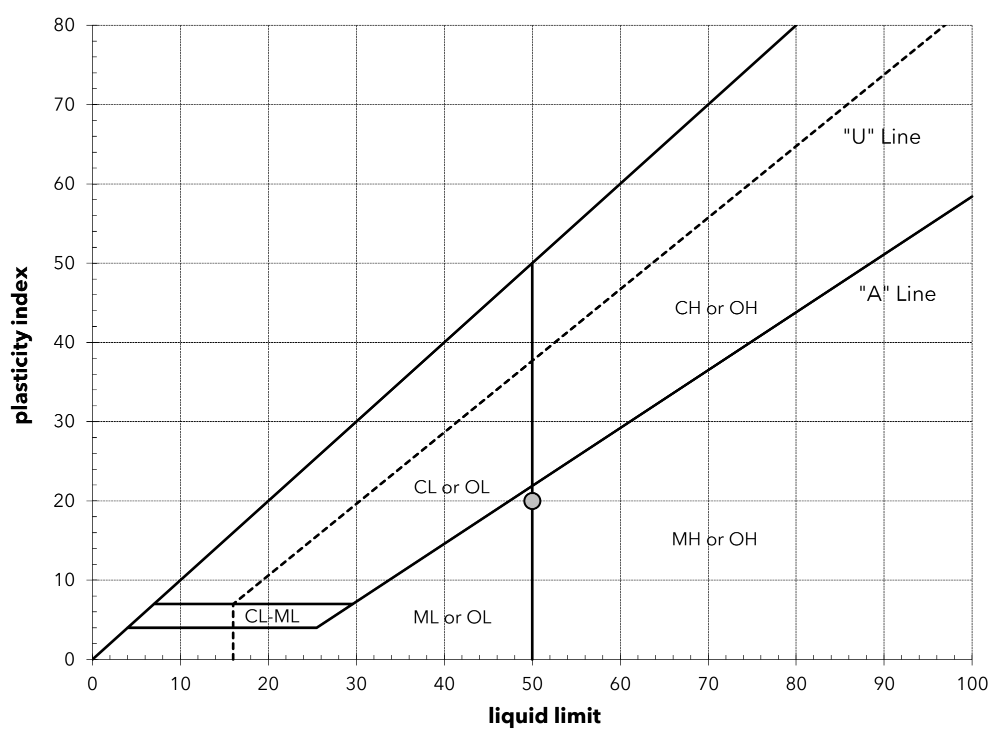
SHRINKAGE

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

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	28.32	27.66		
dry soil + pan weight, g =	26.61	26.00		
pan weight, g =	20.93	20.41		
moisture, % =	30.1 %	29.7 %		

PLASTICITY CHART



ADDITIONAL DATA

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

DATE TESTED	TESTED BY
06/09/25	M. Scherette

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	
Uhacz Property 27429 SE 15th Street Camas, Washington	Romano Development, Inc. 4660 NE 77th Avenue, Ste. 200 Vancouver, WA 98662	Romano-8-01-1	
		ISSUE DATE 06/11/25	PAGE 1 of 1
		LAB ID S25-1163	FIELD ID TP7.3
		DATE SAMPLED 05/30/25	SAMPLED BY J. Wright

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
SILT	Test Pit TP-7 depth = 11 feet	no data provided

LABORATORY TEST DATA

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

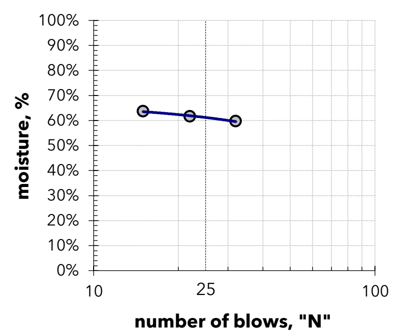
ATTERBERG LIMITS

liquid limit = 61
plastic limit = 48
plasticity index = 13

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	34.40	33.02	33.01	
dry soil + pan weight, g =	29.37	28.26	28.21	
pan weight, g =	20.94	20.54	20.67	
N (blows) =	32	22	15	
moisture, % =	59.7 %	61.7 %	63.7 %	

LIQUID LIMIT



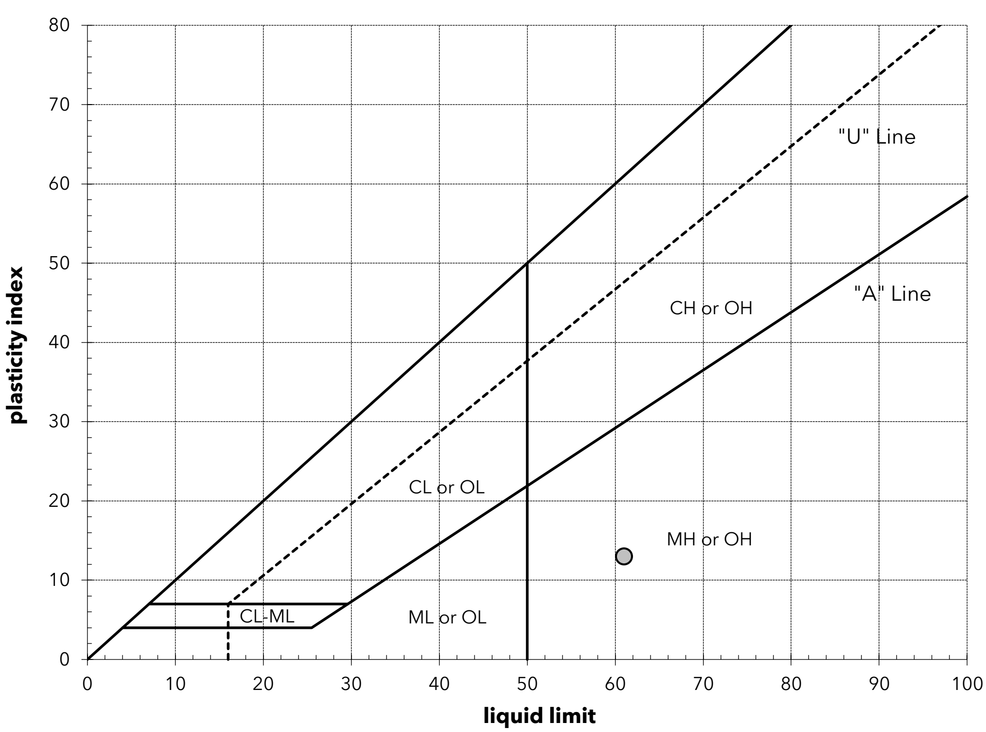
SHRINKAGE

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

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.12	27.34		
dry soil + pan weight, g =	25.06	25.26		
pan weight, g =	20.77	20.93		
moisture, % =	48.0 %	48.0 %		

PLASTICITY CHART



ADDITIONAL DATA

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

DATE TESTED	TESTED BY
06/09/25	M. Scherette

COLUMBIA WEST ENGINEERING, INC. authorized signature

APPENDIX C

APPENDIX C
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 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. 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

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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.