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Stormwater Drainage Report

Washougal River Oaks
Camas, WA

October 2020

Prepared for: Desgrosellier Design & Construction
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Principal
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Navix Project 20.005.001

Table of Contents

Project Overview

Introduction

This stormwater report is prepared to discuss the proposed stormwater management system and to provide the documentation and the analysis showing that the proposed system is feasible and designed to address the jurisdictional requirements. All components of the stormwater management system were designed to meet the stormwater requirements of the Camas Stormwater Design Standards Manual, per the latest edition of Ecology's Stormwater Management Manual for Western Washington (2014 SWMMWW).

The project site is located at the northeast corner of the intersection of NE 3rd Ave and NE Wedgewood Ct in a portion of the Northwest ¼ and Southwest ¼ of the Northeast ¼ of Section 12, Township 1 North, Range 3 East of the Willamette Meridian, Camas, Clark County, Washington. A vicinity map is included in the Site Location section of this report.

The project site is located approximately 300 ft north of the Washougal River and approximately 3,900 ft north of the Columbia River. According to the FEMA Flood Insurance Rate Map Number 53011C0534E, effective January 19, 2018, the site is located within Zone X, described as areas of minimal flood hazard. See Appendix A-2 for the noted FEMA map.

Existing Conditions

The site is comprised of four (4) tax lots, consisting of approximately 2.95 acres. There are existing residential homes and associated driveway improvements on each lot, with miscellaneous outbuildings. The eastern and northern portions of the site are primarily unimproved, with dense tree and vegetation cover. It should be noted that the proposed development only covers the lower portion of the site – approximately 1.90 acres. The northern most portion of the site, approximately 1.05 acres, consists of steep slopes and dense vegetation, and will not be disturbed with this project. The site is located within a Wellhead Protection Area as shown by the Camas CARA Map (See Appendix A-3).

According to the Natural Resources Conservation Services (NCRS), the native soil underlying the site consists of Hillsboro Loam (HIC), Olympic Stony Clay (OmE), and Washougal Gravelly Loam (WgB), each with the following characteristics:

- Hillsboro Loam belongs to Soil Group (SG) 2, with a Hydrologic Soil Group (HSG) B designation.
- Olympic Stony Clay belongs to Soil Group (SG) 3, with a Hydrologic Soil Group (HSG) C designation.
- Washougal Gravelly Loam belongs to Soil Group (SG) 2, with a Hydrologic Soil Group (HSG) B designation.

Stormwater runoff of the site and surrounding streets are managed through a system of catch basins, field inlets, and storm pipes. Within the subject site, runoff from the existing homes daylights to grade, where it sheet flows downhill and infiltrates, or drains to NE 3rd Ave. Based on the geotechnical report prepared by Soil and Water Technologies, Inc, dated August 2018, the infiltration rate at the site was field-measured to be 4.0 inches per hour at 5.5 ft below ground surface. See Appendix C-2.

Re-Developed Conditions

The project proposes to develop the site into a 22-unit cottage style development, with common areas and shared drive access, as well as associated parking, landscaping, lighting, stormwater and utility improvements.

The project proposes to utilize an infiltration pond to manage and discharge all stormwater runoff onsite. Flow control is not required with this project since stormwater runoff is not proposed to be discharged to an offsite downstream conveyance system. The stormwater runoff from the developed site will conveyed to the infiltration pond through a system of curb and gutter and underground storm pipe.

The stormwater system for this project has been designed in accordance with regulatory criteria described above and is consistent with sound engineering practice. This system's design has incorporated stormwater treatment BMP's and infiltration facilities for the mitigation of stormwater runoff quantity and quality impacts.

Site Location

The project site is located at the northeast corner of the intersection of NE 3rd Ave and NE Wedgewood Ct in Camas, Washington (see Figure 1 below for Vicinity Map).

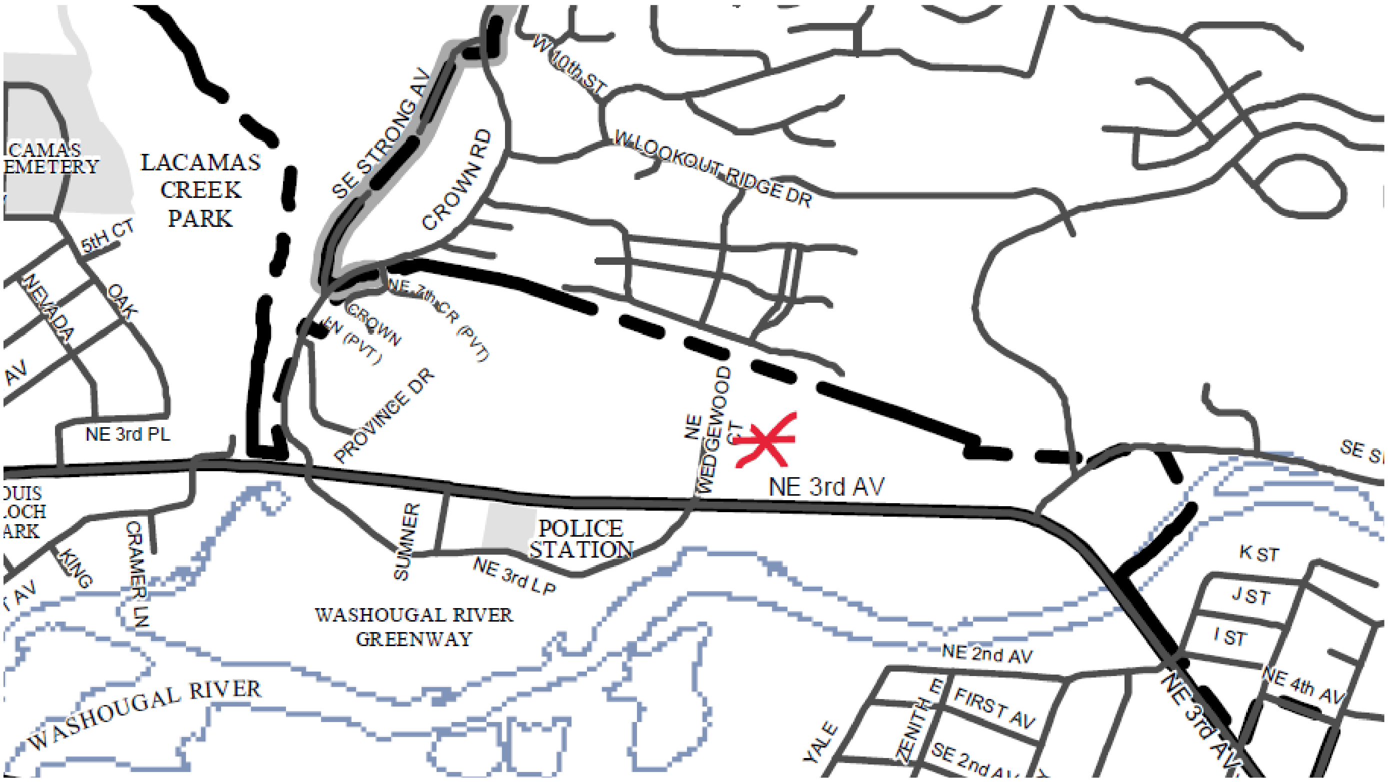


Figure 1: Site Location

- **Location:** 2531 NE 3rd Ave
- **Section, Township, Range:** NW ¼ & SW ¼ of NE ¼ of Section 12, T1N, R13E
- **Parcel/Tax Lot:** 89884000, 89883000, 89881000, 89875000
- **Size:** 128,629 SF (2.95 AC)
- **City, County, State:** City of Camas, Clark County, Washington State
- **Governing Agency:** City of Camas
- **Zoning:** MF-18 (with proposed Cottage overlay)

Minimum Requirements

The proposed site improvements will change the amount of impervious surface for the existing site. The total project disturbance area consists of approximately 4,760 sf of existing building/roof area (impervious), and approximately 4,570 sf of existing driveway (gravel) area, with approximately 76,318 sf of pervious area. All existing site improvements will be demolished as needed to accommodate the proposed development. The developed project area will consist of approximately 46,936 sf of total impervious area and 38,712 sf of landscape and stormwater pond area. Approximately 5,843 sf of the site will be dedicated to the NE Wedgewood Ct Right-of-Way.

Table 1 below on summarizes each land disturbing activity for the proposed development and provides a Total Effective Impervious Surface for the Threshold Drainage Area (TDA).

Table 1 - Project Disturbance Areas	
Existing Conditions (1.97 acres±)	***Area (SF)***
Existing Impervious Surface	9,330
Existing Landscaped Area	76,318
Proposed Conditions (1.97 acres±)*	***Area (SF)***
Site Replaced Impervious Area	40,430
Site Pervious Area	36,576
Off-site - Impervious Area	6,506
Off-site - Pervious Area	2,136
Total Land-Disturbing Activity	**85,648**
Total Effective Impervious Surface	**46,936**

** Proposed conditions account for tree credits*

The Minimum Requirements applicable for the site are determined by using Figure 2.3 found in Volume I of the Stormwater Management Manual for Western Washington (DOE Stormwater Manual). Based on the flowchart, Minimum Requirements #1 through #10 apply to the effective impervious surface.

Based on the project's proposal to infiltrate all stormwater runoff onsite, the Threshold Discharge Area, as defined by the DOE stormwater manual is not applicable to this project.

The Western Washington Hydrologic Model (WWHM2012) was used to size the infiltration pond proposed for the mitigated developed conditions. Results of the continuous runoff simulation are provided as part of the WWHM2012 Project Report in the appendix (See Appendix D).

Minimum Requirements that apply to the proposed development are as follows:

Minimum Requirement #1: Preparation of Stormwater Site Plans

The Stormwater Site Plan has been prepared in accordance with Volume I, Chapter 3 of the 2014 Stormwater Manual for Western Washington (SWMMWW).

Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP)

A SWPPP plan set will be developed and submitted with the site/building permit submittal after receipt of completion of the landuse entitlement process.

Minimum Requirement #3: Source Control of Pollution

Available and reasonable source control BMPs have been selected, designed, and maintained in accordance with Volume IV of the 2014 SWMMWW.

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

The existing drainage patterns of infiltrating stormwater runoff into the ground will be maintained. Runoff is not discharged from the project site and does not discharge directly to any offsite conveyance system, downstream receiving waters, and down gradient properties.

Minimum Requirement #5: On-site Stormwater Management

The proposed project will employ on-site stormwater management BMPs to infiltrate and retain stormwater runoff on-site to the maximum extent feasible without causing flooding and erosion.

Minimum Requirement #6: Runoff Treatment

Projects in which the total of effective, Pollution Generating Impervious Surfaces (PGIS) is 5,000 SF or more in a threshold discharge area shall be treated. Since runoff is not discharged to any natural drainage system, the subject site does not have a threshold discharge area as defined by the DOE stormwater manual. The project proposes to manage stormwater runoff by infiltration into the ground via an infiltration basin with emergency overflow to an existing storm drainage system located in NE 3rd Ave. Groundwater was not encountered in any of geotechnical borings completed on the site to depths of 12.5 ft below ground surface. Refer to geotechnical report in the Appendix C-2.

Pre-treatment of stormwater runoff will be provided by trapped catch basins located in the parking lot and drive aisle areas, to remove oils and sediment from runoff prior to entering the infiltration basin, in accordance with Volume 3, Section 3.3 of the DOE Stormwater Manual.

Minimum Requirement #7: Flow Control

This requirement does not apply since the proposed project will infiltrate stormwater runoff onsite and will not discharge to any offsite downstream conveyance system.

Minimum Requirement #8: Wetlands Protection

This requirement does not apply since the proposed project will not discharge to any wetlands directly or indirectly through a conveyance system.

Minimum Requirement #9: Basin/Watershed Planning

This requirement does not apply since the proposed project will infiltrate stormwater runoff onsite and will not discharge to any offsite downstream conveyance system.

Minimum Requirement #10: Operation and Maintenance

An operation and maintenance manual (O&M Manual) is included per provisions outlined in Volume V of the DOE Stormwater Manual, for the proposed stormwater infiltration facility (See Appendix E). The property owner will be responsible for the cost of installation, as well as operation and maintenance of the proposed stormwater facilities.

Soils Evaluation

According to the Natural Resources Conservation Services (NCRS), the native soil underlying the site consists of Hillsboro Loam (HlC), Olympic Stony Clay (OmE), and Washougal Gravelly Loam (WgB), each with the following characteristics:

- Hillsboro Loam belongs to Soil Group (SG) 2, with a Hydrologic Soil Group (HSG) B designation.
- Olympic Stony Clay belongs to Soil Group (SG) 3, with a Hydrologic Soil Group (HSG) C designation.
- Washougal Gravelly Loam belongs to Soil Group (SG) 2, with a Hydrologic Soil Group (HSG) B designation.

A Web Soil Survey for the site is provided in the appendix (See Appendix A-1). The Clark County data map of the WWHM program includes five soils groups to represent the many soil types found within the county limits. See Appendix C-1. The majority of the developed site area is comprised of Hillsboro Loam and Washougal Gravelly Loam, which both fall within Soil Group 3.

As discussed in the geotechnical report, subgrade soils consist of 4 to 6 inches of organic topsoil, underlain by a mixture of silt, silty gravel, and sandy gravel. Subgrade soils in the upper portions of the site generally consist of native silt (ML), extending to a maximum explored depth of 10 ft below ground surface. Subgrade soils in the lower portion of the site, near the infiltration pond, generally consist of silty gravel to a maximum depth of 2 feet below ground surface, and sandy gravel to a maximum explored depth of 12.5 ft below ground surface. Further information about the on-site soil conditions and analysis is provided in the Geotechnical Report, prepared by Soil and Water Technologies, Inc, dated August 2018 (See Appendix C-2).

Source Control

Dust control and appropriate soil erosion control measures shall be implemented as needed during the construction phase of the proposed project. The proposed Stormwater infiltration facility shall be cleaned and maintained according to the applicable Source Control BMPs, as outlined in the DOE Stormwater Manual, for stormwater runoff from "pollution generating surfaces".

On-site Stormwater Management BMPs

The project proposes to employ the following on-site stormwater management BMPs to infiltrate, disperse, and retain stormwater runoff on-site to the maximum extent feasible: trapped catch basins, infiltration basin, and emergency overflow weir and pipe.

Selection and design criteria for the on-site stormwater management BMPs are found in Volume III, Chapter 3 and Volume V, Chapter 5 of the DOE Stormwater Manual. The stormwater management BMP locations are shown on the Preliminary Grading and Drainage Plan, Sheet C-2.0 (See Appendix B-3).

Runoff from the driveways, parking areas, and buildings will be collected with trapped catch basins for pre-treatment prior to discharge to an infiltration basin. Based on infiltration testing performed by Soil and Water Technologies, Inc. in the vicinity of the proposed stormwater facility, the infiltration rate was observed and calculated to be *4.0 inches per hour*.

The infiltration basin has been modeled using WWHM2012. The proposed infiltration basin has a bottom surface area of approximately 3,780 sf, with an overall length of approximately 153.5 ft. The bottom width varies between 11 ft at the narrowest to approximately 35' wide at the widest. For purposes of sizing the facility using the WWHM model, a bottom length of 170' and a bottom width of 24.6' was used, which is equivalent to a bottom area of 3,776 sf. As shown in the WWHM2012 analysis (See Appendix D), the proposed infiltration basin will infiltrate 100% of the required design storm event.

Runoff Treatment Analysis and Design

As noted, the project proposes to manage stormwater runoff by infiltration into the ground via an infiltration basin with emergency overflow to an existing storm drainage system. The Threshold Discharge Area (TDA) does not apply to this site since stormwater runoff is not proposed to be discharged to an offsite conveyance system or downstream receiving water body.

Pre-treatment of stormwater runoff will be provided by trapped catch basins located in the parking lot and drive aisle areas, to remove oils and sediment from runoff prior to entering the infiltration basin, in accordance with Volume 3, Section 3.3 of the DOE Stormwater Manual. The pollution generating surfaces for the proposed project that will be fully infiltrated on-site are summarized in Table 2.

Table 2 - Pollution Generating Surfaces

	Condition	Area (SF)
Site - Pollution Generating Impervious Surfaces (PGIS)	Pavement	18,567
Site - Pollution Generating Pervious Surfaces (PGPS)	Landscape	36,440
Off-site - PGIS Area	Pavement	6,506
Off-site - PGPS Area	Landscape	2,136

Flow Control Analysis and Design

Site Suitability for Stormwater Infiltration

Infiltration testing was performed by Soil and Water Technologies, Inc. in the vicinity of the proposed stormwater facility, to measure the infiltration rate of the soils. The testing was performed at a depth of 5.5' below the existing ground surface, and consisted of driving a six-inch diameter pipe six inches into the exposed ground surface at the bottom of the test pit. The pipe was filled with water and the soil around the bottom of the pipe was saturated for four hours. The pipe was then filled again and the amount of time required for the water to fall, per inch, for six inches, was recorded. This test was performed a minimum of three times, then the results are averaged. Based on these tests, the infiltration rate was observed and calculated to be *4.0 inches per hour*.

Based on Table 4-1 of the Camas Stormwater Design Standards Manual, a base correction factor of 2 shall be applied to the tested infiltration rate, to account for soil variability and long-term system degradation due to siltation, crusting, or other factors. Since the proposed impervious area is less than 2 acres, no system design correction factor is required. The geotechnical engineer did not recommend any additive correction factors as a result of the soil or groundwater conditions, but did recommend an overall correction factor ranging from 2 to 4, for use in design. Based on this, we chose the average and have sized the facility using an overall correction factor (CF) of 3. When using the WWHM, the infiltration reduction factor is inverted as 1/CF, or 1/3.

With the proposed stormwater facility, the rate obtained from these tests make the site suitable for 100% infiltration of all post-developed stormwater runoff; therefore, flow control is not applicable to this project. A hydrologic analysis, using WWHM2012 to demonstrate that the proposed facility has been sized to achieve 100% infiltration, is included in Appendix D.

Other Permits

An NPDES will be required for this site. An NOI will be submitted to Washington DOE for NPDES permit coverage.

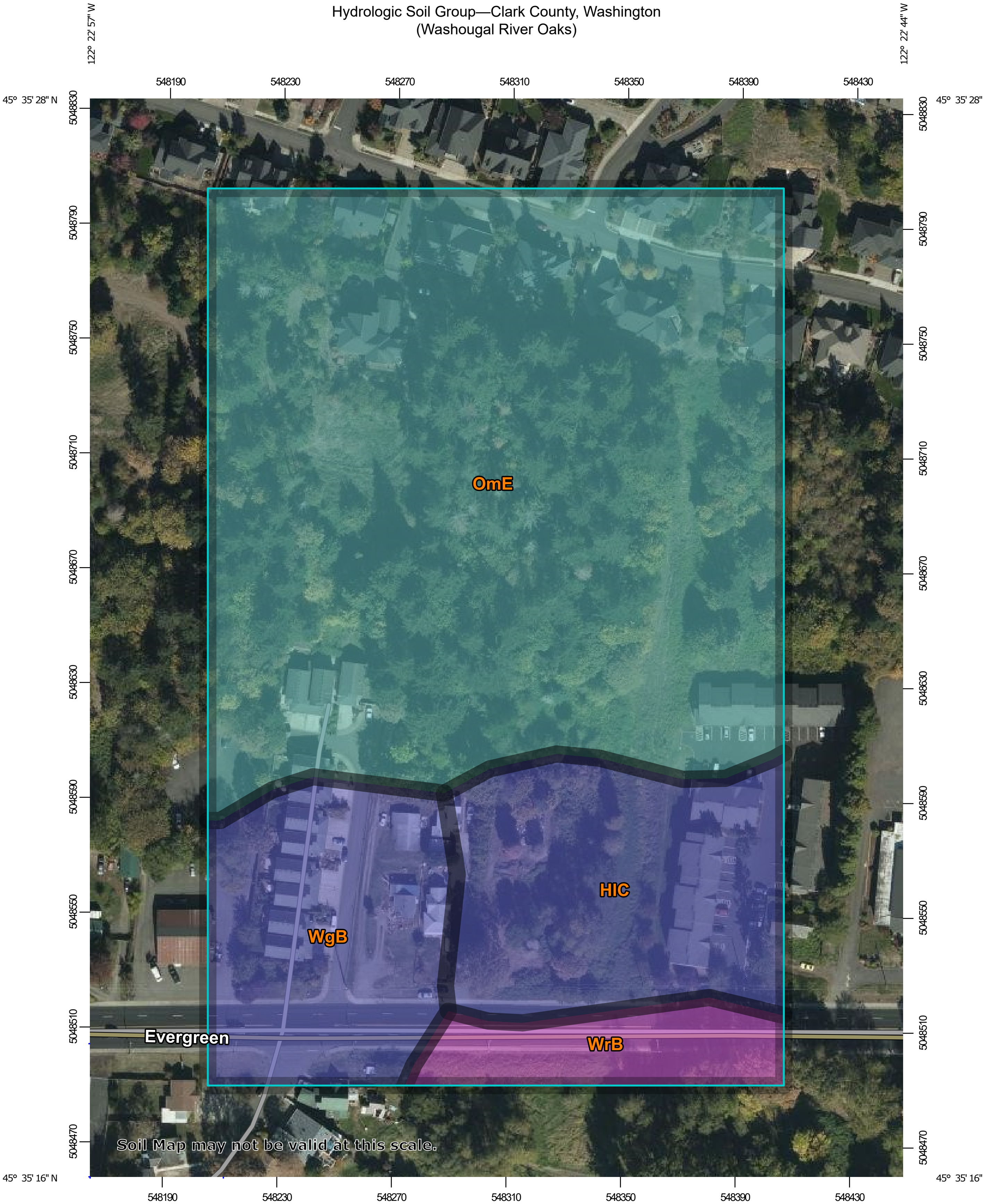
Appendices

APPENDIX A	MAPS A1 – WEB SOIL SURVEY A2 – FEMA/FIRMETTE MAP # 53011C0534E
APPENDIX B	SITE PLANS B1 – EXISTING CONDITIONS EXHIBIT B2 – PROPOSED CONDITIONS EXHIBIT B3 – PRELIMINARY GRADING & DRAINAGE PLAN
APPENDIX C	SOILS EVALUATION C1 – CLARK COUNTY WWHM SOIL GROUP MEMO C2 – SOIL & WATER TECHNOLOGIES, INC GEOTECHNICAL REPORT
APPENDIX D	WWHM2012 CONTINUOUS RUNOFF MODEL REPORT
APPENDIX E	OPERATIONS AND MAINTENANCE E1 – INFILTRATION BASIN INSPECTION & MAINTENANCE GUIDELINES

Appendix A

MAPS

Hydrologic Soil Group—Clark County, Washington
(Washougal River Oaks)



Map Scale: 1:1,830 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 18, Jun 4, 2020

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

Date(s) aerial images were photographed: Oct 15, 2018—Oct 18, 2018

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
HlC	Hillsboro loam, 8 to 15 percent slopes	B	2.4	15.7%
OmE	Olympic stony clay loam, 3 to 30 percent slopes	C	10.2	65.7%
WgB	Washougal gravelly loam, 0 to 8 percent slopes	B	2.1	13.5%
WrB	Wind River gravelly loam, 0 to 8 percent slopes	A	0.8	5.2%
Totals for Area of Interest			**15.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

National Flood Hazard Layer FIRMette

FEMA

122°23'9"W 45°35'33"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

122°22'31"W 45°35'8"N

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

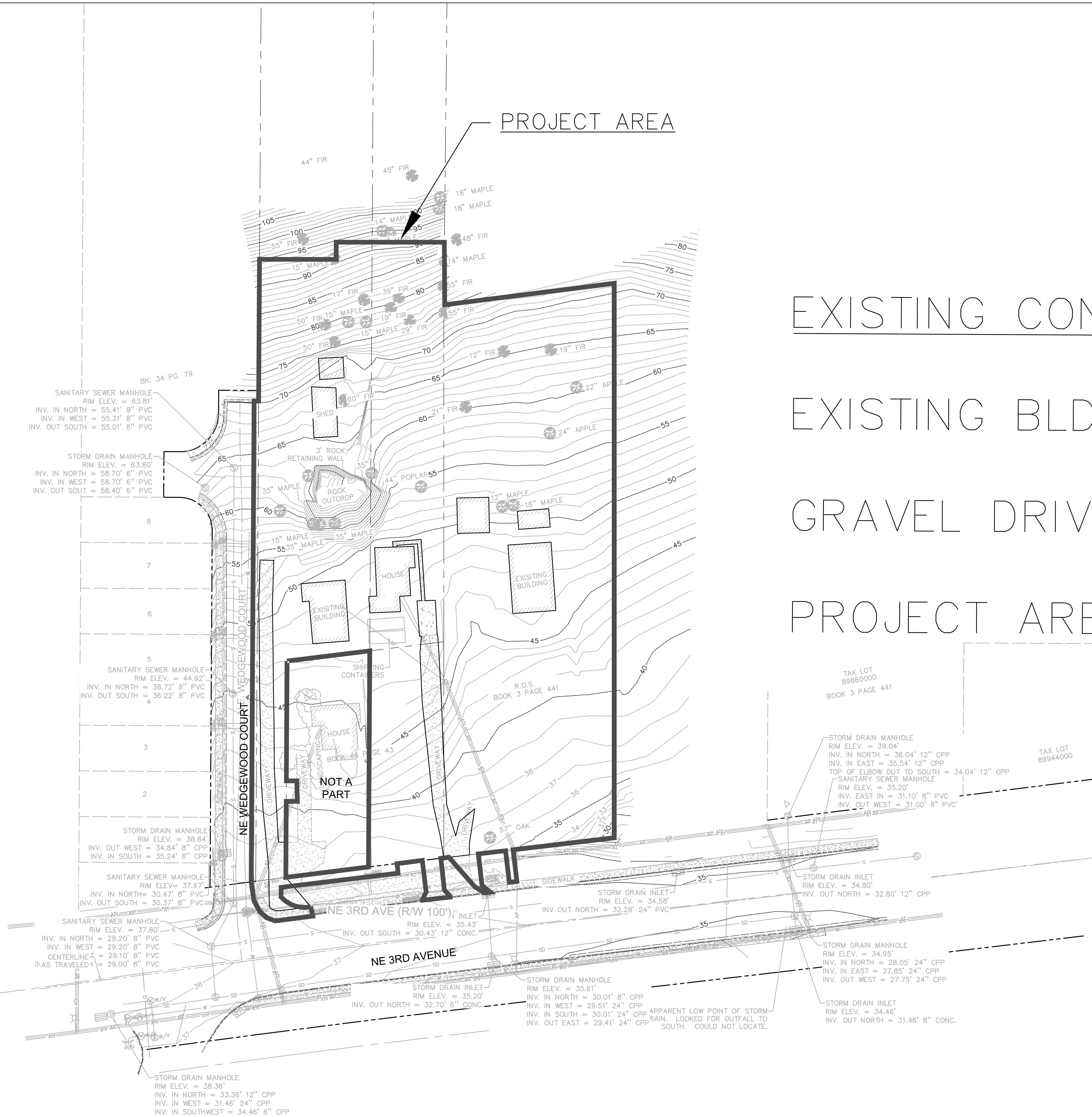
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/20/2020 at 5:50 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix B

SITE PLANS



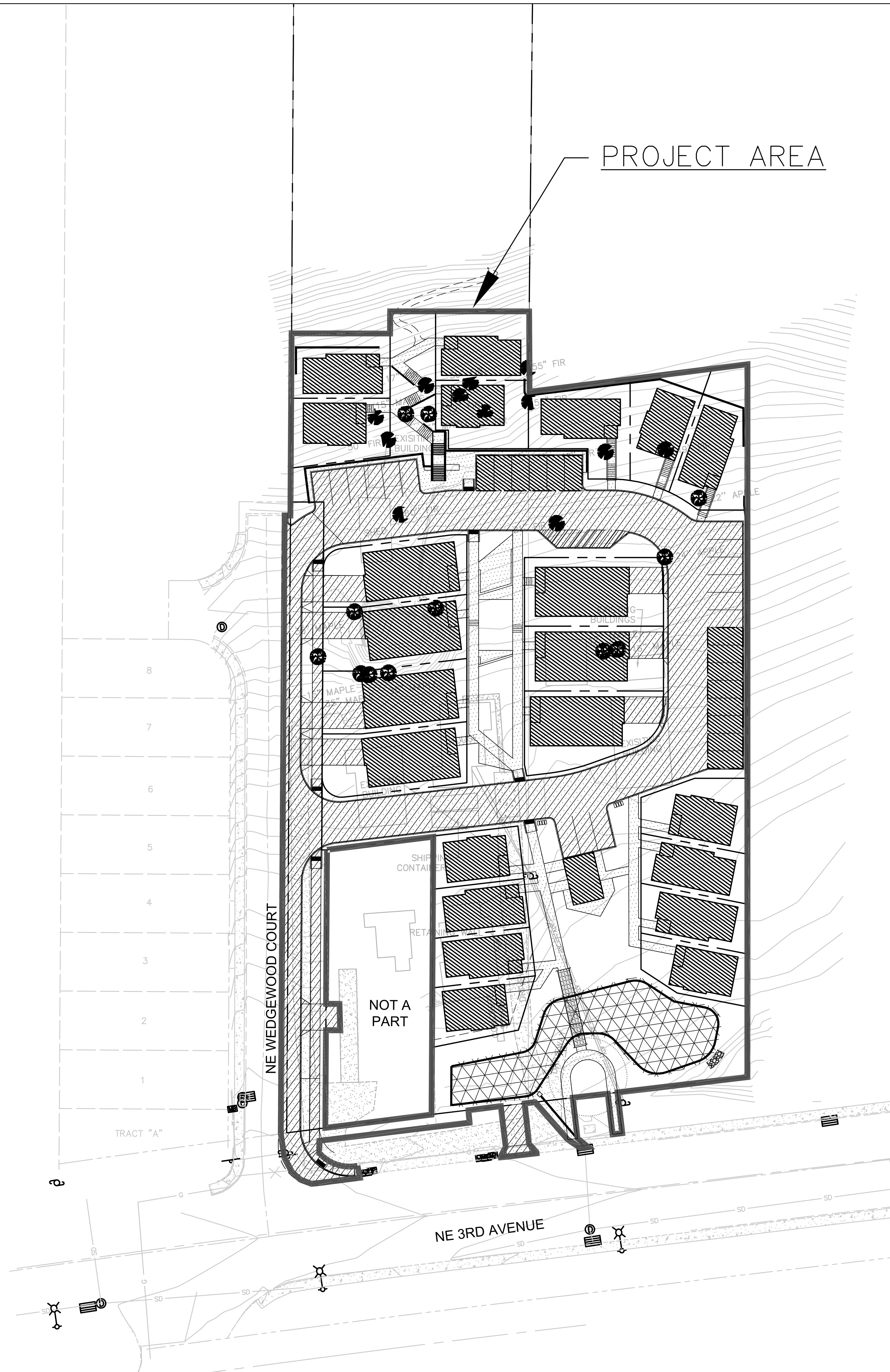
EXISTING CONDITIONS:

EXISTING BLDG = 4,760 SF

GRAVEL DRIVEWAY = 4,570 SF

PROJECT AREA = 1.97 ACRES

EXISTING CONDITIONS



DEVELOPED CONDITIONS:

TREE CREDIT =25 EVERGREEN X 50SF + 25 DECIDUOUS X 20SF= 1750SF
TREE CREDIT =5 DECIDUOUS TREES =20% CANOPY = 800 SF
TOTAL TREE CREDIT = 2,550 SF

ROOFTOP = 21,863 SF = 0.50 ACRES

PAVEMENT/CONC = 21,609 SF – 2,550 (TREE CREDIT) = 19,059 = 0.44 ACRES

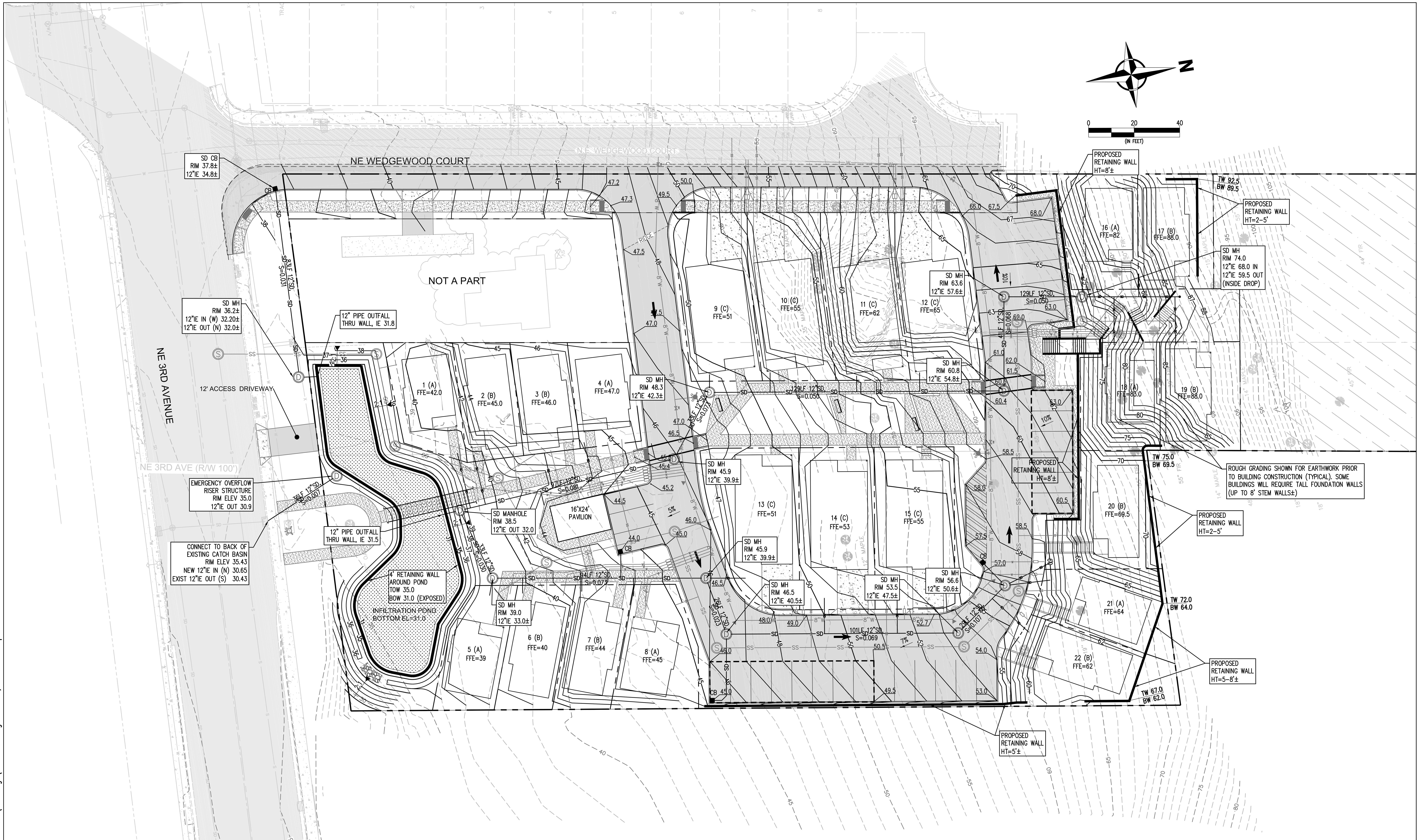
PEDESTRIAN WALKWAYS = 6,014 SF = 0.14 ACRES

DETENTION POND = 4,284 SF = 0.10 ACRES

PERVIOUS = 31,878 SF + 2,550 (TREE CREDIT) = 34,428 = 0.79 ACRES

TOTAL PROJECT AREA = 85,648 SF = 1.97 AC

POST-DEVELOPED CONDITIONS



LEGEND

—145—	PROPOSED MAJOR CONTOUR (5' INTERVAL)
—144—	PROPOSED MINOR CONTOUR (1' INTERVAL)
- -144- -	EXISTING CONTOUR
—SD—	PROPOSED STORM LINE
(D)	STORM DRAIN MANHOLE
(FC)	FLOW CONTROL MANHOLE
	SEDIMENT FENCE
☐	INLET PROTECTION
TW	TOP OF WALL
BW	BOTTOM OF WALL
TC	TOP OF CURB
BC	BOTTOM OF CURB
GT	GUTTER ELEV
TP	TOP OF PAVEMENT
EP	EDGE OF PAVEMENT
FG	FINISHED GRADE
DW	DRIVEWAY
SW	SIDEWALK

TC GT/TP SW PAVEMENT CURB & GUTTER SIDEWALK

\\PLPDX-FILE\Projects\Washington\Camas\3rd Ave Garden Houses\2Drawings\CMWA1206.dwg Oct 12, 2020 – 4:46pm

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www.navixeng.com

CLIENT/OWNER

DD&C, INC

PROJECT NAME

WASHOUGAL RIVER OAKS

NAVIX PROJECT NUMBER: 20-005-001

PROJECT ADDRESS

2531 NE 3RD AVE
CAMAS, WA 98607

STAMP

BRIAN S. DICKERSON, STATE OF WASHINGTON, 40314, REGISTERED PROFESSIONAL ENGINEER
PRELIMINARY

REVISIONS

REV	ISSUED FOR:	DATE
1	LAND USE	10.02.20

811

SECTION, TOWNSHIP, RANGE:

SECTION 12, TOWNSHIP 1 NORTH, RANGE 3 EAST, W.M.

PROJECT TEAM

REVIEWED BY: B.DICKERSON
DESIGNED BY: S.NGUY

SHEET NAME

GRADING AND DRAINAGE PLAN

SHEET NUMBER

C-2.0

Appendix C

SOILS EVALUATION

Memorandum

otak

700 Washington Street
Suite 401.
Vancouver, WA 98660
Phone (360) 737-9613
Fax (360) 737-9651

To:	Rod Swanson, Clark County Environmental Services
From:	Tim Kraft
Copies:	File
Date:	December 21, 2010
Subject:	Clark County WWHM Soil Groupings

The Clark County version of the Western Washington Hydrology Model (WWHM) includes five soils groups to represent the many soil types found within the county limits. Although there are over 110 different soil types throughout Clark County, similarities between the soils allows them to be grouped into categories for modeling purposes.

Clark County soils are grouped into five categories largely based on their permeability and runoff potential. These categories include:

- Soil Group (SG) 1 – Excessively drained soils (hydrologic soil groups A & B)
- Soil Group (SG) 2 – Well drained soils (mostly hydrologic soil group B)
- Soil Group (SG) 3 – Moderately drained soils (hydrologic soil groups B & C)
- Soil Group (SG) 4 – Poorly drained soils (slowly infiltrating C soils, as well as D soils)
- Soil Group (SG) 5 – Wetland soils (mucks).

Soil Groups 1 and 2 are those most suitable for traditional infiltration facilities such as trenches and drywells, while Soil Group 3 may only be suitable for slower infiltrating facilities such as rain gardens and other Low Impact Development (LID) measures. Soil Groups 4 and 5 are those which are typically not suitable for infiltration.

For additional information on the classification of soils for use in the Clark County WWHM model, please see the report titled "Development of the Clark County Version of the Western Washington Hydrology Model", which can be found on the county's community development web site.

The following table lists the WWHM soil group for each NCRS soil type in Clark County.

Map Symbol	Soil Name	HSG
Soils Group (SG) 1		
LeB	LAUREN	B
LgB	LAUREN	B
LgD	LAUREN	B
LgF	LAUREN	B
LIB	LAUREN	B
Ro	ROUGH BROKEN LAND	A
SvA	SIFTON	B
WnB	WIND RIVER VARIANT	B
WnD	WIND RIVER VARIANT	B
WnG	WIND RIVER VARIANT	B
WrB	WIND RIVER VARIANT	B
WrF	WIND RIVER VARIANT	B
	PITS	A
	BONNEVILLE STONY SAND LOAM	A
Soils Group (SG) 2		
BpB	BEAR PRARIE	B
BpC	BEAR PRARIE	B
CnB	CINEBAR	B
CnD	CINEBAR	B
CnE	CINEBAR	B
CnG	CINEBAR	B
CrE	CINEBAR	B
CrG	CINEBAR	B
CsF	CISPUS	B
CtA	CLOQUATO	B
HlA	HILLSBORO	B
HlB	HILLSBORO	B
HlC	HILLSBORO	B
HlD	HILLSBORO	B
HlE	HILLSBORO	B

Map Symbol	Soil Name	HSG
HlF	HILLSBORO	B
Soils Group (SG) 2 (continued)		
KeC	KINNEY	B
KeE	KINNEY	B
KeF	KINNEY	B
KnF	KINNEY	B
LaE	LARCHMOUNT	B
LaG	LARCHMOUNT	B
LcG	LARCHMOUNT	B
MsB	MOSSYROCK	B
NbA	NEWBERG	B
NbB	NEWBERG	B
PhB	PILCHUCK	C
PuA	PUYALLUP	B
SaC	SALKUM	B
VaB	VADER	B
VaC	VADER	B
WaA	WASHOUGAL	B
WgB	WASHOUGAL	B
WgE	WASHOUGAL	B
WhF	WASHOUGAL	B
YaA	YACOLT	B
YaC	YACOLT	B
YcB	YACOLT	B

Soils Group (SG) 3

DoB	DOLLAR	C
HcB	HESSON	C
HcD	HESSON	C
HcE	HESSON	C
HcF	HESSON	C
HgB	HESSON	C
HgD	HESSON	C
HhE	HESSON	C
HoA	HILLSBORO	B

Map Symbol	Soil Name	HSG
HoB	HILLSBORO	B
Soils Group (SG) 3 (continued)		
HoC	HILLSBORO	B
HoD	HILLSBORO	B
HoE	HILLSBORO	B
HoG	HILLSBORO	B
HsB	HILLSBORO	B
McB	McBEE	C
MeA	McBEE	C
MIA	McBEE	C
OeD	OLEQUA	B
OeE	OLEQUA	B
OeF	OLEQUA	B
OlB	OLYMPIC	B
OID	OLYMPIC	B
OlE	OLYMPIC	B
OIF	OLYMPIC	B
OmE	OLYMPIC	B
OmF	OLYMPIC	B
OpC	OLYMPIC VARIANT	C
OpE	OLYMPIC VARIANT	C
OpG	OLYMPIC VARIANT	C
OrC	OLYMPIC VARIANT	C
PoB	POWELL	C
PoD	POWELL	C
PoE	POWELL	C
SmA	SAUVIE	B
SmB	SAUVIE	B
SnA	SAUVIE	D
SpB	SAUVIE	B

Soils Group (SG) 4

CvA	COVE	D
CwA	COVE	D
GeB	GEE	C

Map Symbol	Soil Name	HSG
GeD	GEE	C
Soils Group (SG) 4 (continued)		
GeE	GEE	C
GeF	GEE	C
GuB	GUMBOOT	D
HtA	HOCKINSON	D
HuB	HOCKINSON	D
HvA	HOCKINSON	D
LrC	LAUREN	C
LrF	LAUREN	C
MnA	MINNIECE	D
MnD	MINNIECE	D
MoA	MINNIECE VARIANT	D
OdB	ODNE	D
OhD	OLEQUA VARIANT	C
OhF	OLEQUA VARIANT	C
SlB	SARA	D
SlD	SARA	D
SlF	SARA	D

Soils Group (SG) 5

Sr	SEMIAHMOO	C
Su	SEMIAHMOO VARIANT	D
ThA	TISCH	D

GEOTECHNICAL ENGINEERING STUDY

Proposed 2531 NE 3rd Avenue Subdivision
2531 NE 3rd Avenue
Camas, Clark County, WA 98607

Prepared for:

DD&C, LLC
418 Date Street
Vancouver, WA 98660

Prepared By:

Seth A. Chandlee
Project Manager

Paul Williams, PE
Project Engineer

Project No. G0941800
{August 2018}

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Soil and Water Technologies, Inc.

Geotechnical & Environmental Consultants

DD&C, LLC.
418 Date Street
Vancouver, WA 98661

August 21st, 2018
G0941800

Attention: Bryan Desgrosellier

Hello Bryan,

We are pleased to submit our report titled "Geotechnical Engineering Study with Infiltration Testing, Proposed 2531 NE 3rd Avenue Subdivision located at 2531 NE 3rd Avenue, Camas, Clark County, Washington." This report presents the results of our field exploration, selective laboratory tests, and engineering analyses.

Based on the results of this study, it is our opinion that construction of the proposed residential development is feasible from a geotechnical standpoint, provided recommendations presented in this report are included in the project design.

We appreciate the opportunity to have been of service to you and look forward to working with you in the future. Should you have any questions about the content of this report, or if we can be of further assistance, please call.

Respectfully Submitted,
Soil and Water Technologies, Inc.

PAUL WILLIAMS
STATE OF WASHINGTON
43138
REGISTERED
PROFESSIONAL ENGINEER
8/21/18

Seth A. Chandlee
Project Manager

Paul Williams, PE
Project Engineer

TABLE OF CONTENTS

INTRODUCTION

General

This report presents the results of the geotechnical engineering study completed by Soil and Water Technologies, Inc. (SWT) for the proposed 2531 NE 3rd Avenue Subdivision located in Camas, Clark County, Washington. The general location of the site is shown on the *Vicinity Map, Figure 1.* Our approximate exploratory test pit locations are shown in relation to the site on the *Site Plan, Figure 2.*

The purpose of this study is to explore and evaluate subsurface conditions at the site and provide geotechnical recommendations for the proposed construction based on the soil conditions encountered. These recommendations include site specific geotechnical parameters for foundation support, earthwork grading, utility trench backfill, roadway construction, drainage, erosion control and a seismic hazard evaluation.

Project Description

Based on the preliminary site plan information provided by DD&C, LLC, it is our understanding that the approximate one-acre property will be developed into a total of twelve (12) residential building lots. The project will also include associated underground utilities, an asphalt paved roadway, stormwater management facilities and a park area. Although no specific grading plan was available at the time of our study, we anticipate that earthwork cuts/fills will range from approximately one to four feet (1-4') in thickness across the site. The proposed residences will most likely be constructed with wood frames, suspended floors and slab on grade garage floors.

At the time this report was written, specific structural design loads were not available. However, based on our experience with similar projects, we anticipate that wall loads will be approximately seven hundred to one thousand five hundred (700 -1,500) pounds per lineal foot. Slab-on-grade garage floor loads will most likely range from one hundred to one hundred and fifty pounds per square foot (100-150 psf).

If any of the above information is incorrect or changes, we should be consulted to review the recommendations contained in this report. In any case, it is recommended that Soil and Water Technologies perform a general review of the final design.

SITE CONDITIONS

Surface

The rectangular shaped property is located approximately one-tenth of a mile east of the intersection of NE 3rd Avenue and NE Wedgewood Court in Camas, Washington. The subject property is bordered on the north by forested land, to the east by high-density residential development, to the west by single family residences and on the south by NE 3rd Avenue.

The property slopes gently downwards from the north to the south at an approximately 10H:1V (horizontal: vertical) slope gradient. The maximum total elevation change across the site is approximately forty feet (40'). At the time of our field investigation the southern half of the property was vegetated with brambles and with native shrubs and trees at the northern half of the property. While onsite, we observed one partially demolished residence. It is our understanding that this building will be completely demolished prior to site construction.

Subsurface

On August 3rd, 2018 we observed the exploration of three test pits with an excavator, designated I-1 TP-2, and TP-3. All exploration locations were selected by SWT to determine subsurface conditions in the vicinity of the proposed building lots, pavement areas and stormwater facilities. The approximate locations are shown on the *Site Plan, Figure 2.*

All soil was classified in general accordance with the *Unified Soil Classification System (USCS).* Soil samples obtained from the test pits were returned to our office for additional evaluation and laboratory testing. Descriptions of field and laboratory procedures are included in Appendices A and B, respectively.

The following is a generalized description of the subsurface units encountered.

SURFACE MATERIALS: Surface materials encountered in the explorations consisted of 4 to 6 inches of organic topsoil in all test pit locations.

SILT: Native Silt (ML), was encountered below the surface materials in test pits TP-2 and TP-3, extending to a maximum explored depth of 10 feet below ground surface. In general, the Silt was brown, with medium plasticity and moist. The consistency of the Silt ranged from medium stiff to hard. The moisture content of samples from this unit ranged from 19 to 23 percent.

SILTY GRAVEL: Native silty Gravel (GM), was encountered below the surface materials in test pit I-1 and extended to a maximum depth of 2 feet below ground surface. In general, the silty Gravel was brown and moist. The consistency of the silty Gravel was medium dense and became cleaner with depth.

SANDY GRAVEL: Native sandy Gravel (GP), was encountered below the silty Gravel in test pit I-1 and extended to a maximum explored depth of 12.5 feet below ground surface. In general, the sandy Gravel was grayish brown and moist. The consistency of the sandy Gravel was dense. The moisture content of samples from this unit ranged from 4 to 12 percent. Fines content of samples ranged from 4 to 6 percent.

Please refer to our test pit logs, Plates A2 through A4 for a more detailed description of the conditions encountered at each location explored.

Infiltration Testing

Infiltration testing was performed in the vicinity of the proposed onsite stormwater tract. The approximate location of the infiltration test pit is shown on the *Site Plan, Figure 2.* It is our understanding that the proposed stormwater tract is to provide stormwater treatment and control for all onsite impervious surfaces. Infiltration testing was performed at a depth of five and one-half feet (5.5') below the existing ground surface at I-1, in accordance with the 2016 Clark County Stormwater Management Manual guidelines.

In general, the test consists of driving a six-inch diameter pipe six inches into the exposed ground surface at the bottom of the test pit. The pipe is filled with water and the soil around the bottom of the pipe is saturated for several hours. The pipe is filled again and the amount of time required for the water to fall, per inch, for six inches, is recorded. This step is performed a minimum of three times. The test results are averaged, recorded and the field infiltration rate is calculated in inches per hour. Infiltration testing was performed at the site on August 3rd, 2018.

All soil was classified following the *Unified Soil Classification System* (USCS) and the *AASHTO Soil Classification System (M145).* The following table provides the field infiltration test results and associated laboratory testing:

Location	USCS* Soil Type	AASHTO Soil Type	Depth (ft.)	% Passing #200 sieve	Moisture content	Field-Measured Infiltration Rate
I-1	**GP**	**A-1-a**	**5.5**	**4%**	**7%**	**4.0 iph**

* Unified Soil Classification System / iph - inches per hour

The infiltration rate presented is not a permeability/hydraulic conductivity, but an average field-measured rate and does not include correction factors related to long-term infiltration rates. It is recommended that the designer include correction factors to account for the level of maintenance, type of system, vegetation, siltation, etc. The rate is dependent on the percentage of fines in the soil (i.e., silt and clay), the degree of soil saturation and the relative density of the in-situ soil. Field measured infiltration rates are typically reduced by a minimum factor of 2 to 4 for use in design.

Due to the subsurface conditions encountered, rates of infiltration and our laboratory test results, it is our opinion that the on-site soils in the vicinity of the of I-1 at the lower, southern side of the property are suitable for the infiltration of stormwater.

Groundwater

No groundwater was encountered to the maximum depth of exploration at our test pits. Our review of water well logs from the Washington Department of Ecology database indicates that the static groundwater level in the area is greater than one-hundred feet (100') below the surface.

It is important to note that groundwater conditions are not static; fluctuations may be expected in the level and seepage of flow depending on the season, amount of rainfall, surface water runoff, and other factors. Generally, the groundwater level is higher and seepage rate is greater in the wetter winter months (typically October through May). The static groundwater level may approach the ground surface during these months.

General Regional Geology

General information about geologic conditions and soils in the vicinity of the site was obtained by reviewing the Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon (2008).

In the vicinity of the subject property, a low elevation bench slopes upwards and generally northeastward towards the Cascade Mountain Range. The underlying bedrock is poorly exposed Oligocene epoch (34 to 23 mya) basaltic andesite flows emplaced by eruptions from the nearby Elkhorn Mountain during the early formation of the regional segment of the Cascade volcanic arc. The bedrock's appearance is usually limited to steep slopes and cliff faces, landslide scarps, and streambeds and is overlain by Neogene-Quaternary period (23 to 2.5 mya) fine-grained Hillsboro soil series.

The material encountered in our test pits consists predominantly of basaltic andesite overlain by brown Silt, consistent with the fine-grained Hillsboro soil series, and Gravel (at I-1) which we interpret to represent weathered Late Pleistocene coarse-grained sedimentary flood deposits.

Geologic Hazards

The following provides a geologic hazard review for the subject site. The geologic hazard review as based on our site reconnaissance and explorations, as well as a review of publicly available published literature and maps.

Slope and Landslide Hazards:

A review of the Clark County Maps Online for the site indicates the slopes at the northernmost side of of the site exceed 15% and are mapped as areas of potential slope instability and subject to review prior to development. Title 40, Section 40.430.C.2 Geologic Hazard Areas, of the Clark County, Washington, Unified Development Code defines potential landslide hazard areas as areas meeting all three of the following characteristics: 1) slopes steeper than 15%; 2) Hillsides intersecting geologic contacts with permeable sediment overlying low permeable sediment or bedrock, and; 3) Any springs or groundwater seepage.

While we did observe slopes greater than 15%, we did not observe the other two necessary characteristics of potential landslide areas. Based upon the results of our site reconnaissance, our experience with localized soils in the area and definitions of a geologic hazard area provided by Clark County Unified Development Code, the subject building area does not meet Clark County's definition of a geologic hazard area. It is our opinion that the proposed development as planned will not create a risk of increased slope instability at the site.

Seismic Hazards:

The following seismic hazards have been considered as part of our geologic hazards review for the project site:

Ground Motion Amplification: Based on a review of Clark County Maps Online, the site is designated as seismic Site Class "B/C". However, based on our field explorations and recommendations below, it is our opinion that a Site Class "D" is appropriate for use at the site. Our seismic design criteria, which are partially based on the site class designation, are included in the Geotechnical Design Recommendations portion of this report.

Liquefaction: Structures are subject to damage from earthquakes due to direct and indirect action. Shaking represents direct action. Indirect action is represented by foundation failures and is typified by liquefaction. Liquefaction occurs when soil loses all shear strength for short periods of time during an earthquake. Ground shaking of sufficient duration then results in the loss of grain-to-grain contact as well as a rapid increase in pore water pressure. This causes the soil to assume the physical properties of a fluid.

To have potential for liquefaction a soil must be loose, cohesion-less (generally sands and silts), below the groundwater table, and must be subjected to sufficient magnitude and duration of ground shaking.

Based on the anticipated groundwater table depth, as well as the relative consistency of the exposed bedrock, we consider the potential for liquefaction within the site boundaries to be very low. Indeed, the site is mapped as having a "Bedrock" to "Very Low" liquefaction susceptibility based on the Liquefaction Susceptibility Layer of Clark County Maps Online.

GEOTECHNICAL DESIGN RECOMMENDATIONS

General

Based on the results of our study, it is our opinion the proposed residential subdivision can be constructed as planned, provided the geotechnical recommendations contained in this report are incorporated into the final design. The following sections present detailed recommendations and parameters pertaining to the geotechnical engineering design for this project.

Foundations

Based on the encountered subsurface soil conditions, preliminary building design criteria, and assuming compliance with the preceding *Site Earthwork and Grading* section, the proposed building foundations may be supported on conventional shallow spread footings bearing on undisturbed medium stiff to hard native Silt.

Individual spread footings or continuous wall footings providing support for the proposed building may be designed for a maximum allowable bearing value of 2,000 pounds per square foot (psf). Footings for one level structures should be at least 12 inches in width. Footings for two level structures should be at least 15 inches in width. Footings for three level structures should be at least 18 inches in width. All footings should extend to a depth of at least 12 inches below the lowest adjacent finished sub grade.

These basic allowable bearing values are for dead plus live loads and may be increased one-third for combined dead, live, wind, and seismic forces. It is estimated that total and differential footing settlements for the relatively light residential buildings will be approximately one and one-half inches, respectively.

Slab on Grade

If concrete floor slabs are desired, then any disturbed soils must be re-compacted prior to pouring concrete. Satisfactory subgrade support for lightly-loaded building floor slabs can be obtained on the undisturbed native soil or on engineered structural fill. A subgrade modulus of 125 pounds per cubic inch (pcf) may be used to design floor slabs.

A minimum 6-inch-thick layer of free draining fill should be placed and compacted over the prepared subgrade to assist as a capillary break and blanket drain.

It is also suggested that nominal reinforcement such as “6X6-10/10” welded wire mesh be employed, near midpoint, in new concrete slabs. In areas where slab moisture is undesirable, a vapor barrier such as a 6-mil plastic membrane should be placed beneath the slab.

Site Drainage

The site should be graded so that surface water is directed off the site. Water should not be allowed to stand in any area where buildings or foundations are to be constructed. Loose surfaces should be sealed at the end of each workday by compacting the surface to reduce the potential of moisture infiltrating into the soils. Final site grades should allow for drainage away from the building foundations.

The ground should be sloped at a gradient of three percent for a distance of at least ten feet away from the buildings. We recommend that a foundation footing drain be installed around the perimeter of the buildings. The drain should consist of a four-inch diameter perforated pipe with holes facing down and installed in an envelope of clean drain rock or pea gravel wrapped with free draining filter fabric. The drain should be a minimum of one-foot-wide and one-foot-deep with sufficient gradient to initiate flow. The drain should be routed to a suitable discharge area and rock spalls placed at the outlet to dissipate flow from the system. Details for the footing drain have been included as *Figure 3, Footing and Drainage Detail.*

Under no circumstances should the roof down spouts be connected to the perimeter building drain. We suggest that clean outs be installed at several accessible locations to allow for the periodic maintenance of the drain system.

Pavement Areas

Asphaltic Cement (AC) and Crushed Rock Base (CRB) materials should conform to WSDOT specifications. All pavement area subgrades should be compacted to at least 95 percent of the ASTM D1557 modified proctor laboratory test standard. We recommend that a minimum of 3 inches of AC underlain by 8 inches of compacted CRB in the vicinity of all paved roadway areas.

Exterior concrete slabs that are subject to vehicle traffic loads should be at least four inches in thickness. It is also suggested that nominal reinforcement such as “6x6-10/10” welded wire mesh be installed, near midpoint, in new exterior concrete slabs and paving. Fiber mesh concrete may be used in lieu of welded wire mesh.

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section.

AC and CRB materials should conform to WSDOT specifications. All CRB should be compacted to at least 95 percent of the modified proctor *ASTM D-1557* laboratory test standard.

Seismic Design Criteria:

Supportive foundation soils encountered at the site are classified as a type "D" soil in accordance with "Site Class Definitions (IBC 2006, Section 1613, Table 1613.5.2; page 303). For more detail regarding soil conditions refer to the soil logs in Appendix A of this report.

The seismic design criteria for this project found herein is based on the International Building Code (IBC) 2012/2015 and the USGS website. A summary of IBC seismic design criterion is below.

Table 1. 2012/2015 IBC Seismic Design Parameters

Location (Latitude: 45.588908°, Longitude: -122.380502°)	Short Period	1-Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.859 g	S_1 = 0.366 g
Site Class	D	
Site Coefficient	F_a = 1.156	F_v = 1.668
Adjusted Spectral Acceleration	S_{MS} = 0.993 g	S_{M1} = 0.611 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.662 g	S_{D1} = 0.407 g

g – acceleration due to gravity

CONSTRUCTION RECOMMENDATIONS

Site Earthwork and Grading

Clearing and Grubbing:

Prior to grading, the project area should be cleared of all rubble, trash, debris, etc. Any buried organic debris, undocumented fill or other unsuitable material encountered during subsequent excavation and grading work should also be removed. Excavations for removal of any existing footings, slabs, walls, utility lines, tanks, and any other subterranean structures should be processed and backfilled in the following manner:

- Clear the excavation bottom and side cuts of all loose and/or disturbed material.
- Once the organic topsoil has been adequately removed, the upper one foot of native soil shall be scarified to twelve (12) inches in depth and dried to within 2 percent of its optimal moisture content and re-compacted. Density testing shall be performed prior to placement of additional fill.
- Prior to placing backfill, the excavation bottom should be moisture conditioned to within 2 percent of the optimum moisture content and compacted to at least 95 percent of the ASTM D-1557 laboratory test standard.
- Backfill should be placed, moisture conditioned (i.e., watered and/or aerated as required and thoroughly mixed to a uniform, near optimum moisture content), and compacted by mechanical means in approximate 6-inch lifts. The degree of compaction obtained should be at least 95 percent of the ASTM D-1557 laboratory test standard, as applicable.

It is also critical that any surficial sub grade materials disturbed during initial demolition and clearing work be removed and/or re-compacted in the course of subsequent site preparation earthwork operations.

If encountered, it is important that all soft, undocumented fill is to be over-excavated and replaced with suitable structural fill. Supporting the proposed buildings on homogeneous material will significantly decrease the potential for differential settlement across the foundation area. In order to create uniform sub grade support conditions, the following earthwork operations are recommended:

- Over-excavate existing soils to a competent native subgrade below the bottom of the proposed foundations. The excavations should extend at least one-half width laterally beyond the foundation footprint, or as constrained by existing structures.
- The fill soils placed shall consist of clean soils with an expansion index (EI) less than twenty (20), and be free of organic material, debris, and rocks greater than three inches in maximum diameter. Based on the field observations and laboratory testing, the existing native soil is suitable for use as structural fill so long as the material does not exceed three (3) inches in diameter and is within two percent (2%) of its optimum moisture content prior to compaction.
- The backfill shall consist of minimum ninety-five percent (95%) compacted fills (Note: ASTM D1557). In addition to the relative compaction requirements, all fills shall be compacted to a firm non-yielding condition.
- Import soils should be sampled, tested, and approved by SWT prior to arrival on site. Imported soils shall consist of clean soils (EI of 20 or less) free from vegetation, debris, or rocks larger than three inches in maximum dimension.

Subgrade Verification and Proof Rolling

After clearing and grading the site, it is possible that some localized areas of soft, wet or unstable sub grade may still exist. Before placement of any base rock, the sub grade should be scarified eight inches in depth and compacted with suitable compaction equipment. Yielding areas that are identified should be excavated to medium dense material and replaced with compacted two inch-minus clean crushed rock. All building and pavement areas should be compacted to a dense non-yielding condition with suitable compaction equipment. This phase of earthwork compaction shall be performed prior to the placement of any structural fill, at the bottom of all foundation excavations and along the roadway sub-grade, before the placement of base rock.

Wet Weather Construction & Moisture Sensitive Soils:

Field observations and laboratory testing indicates that Silt (ML) encountered at the site is a moisture sensitive material. As such, in an exposed condition, moisture sensitive soil can become disturbed during normal construction activity, especially when in a wet or saturated condition. Once disturbed, in a wet condition, these soils will be unsuitable for support of foundations, floor slabs and roadways.

Therefore, where soil is exposed and will support new construction, care must be taken not to disturb their condition. If disturbed soil conditions develop, the affected soil must be removed and replaced with structural fill. The depth of removal will be dependent on the depth of disturbance developed during construction. Covering the excavated area with plastic and refraining from excavation activities during rainfall will minimize the disturbance and decrease the potential degradation of supportive soils.

Utility Support and Backfill

Based on the conditions encountered, the soil to be exposed by utility trenches should provide adequate support for utilities. Utility trench backfill is a concern in reducing the potential for settlement along utility alignments, particularly in pavement areas. It is also important that each section of utility line be adequately supported in the bedding material. The backfill material should be hand tamped to ensure support is provided around the pipe haunches.

Fill should be carefully placed and hand tamped to about twelve inches above the crown of the pipe before any compaction equipment is used. The remainder of the trench back fill should be placed in lifts having a loose thickness of eight inches.

A typical trench backfill section and compaction requirements for load supporting and non-load supporting areas is presented on *Figure 4, Utility Trench Backfill Detail*.

Imported granular material or on-site native soil to be used as backfill should be submitted to our laboratory at least one week prior to construction so that we can provide a laboratory proctor for field density testing. If native soil is planned for use as backfill, additional testing will be required to determine the suitability of the material.

Temporary Excavations

The following information is provided solely as a service to our client. Under no circumstances should this information be interpreted to mean that SWT is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred. In no case should excavation slopes be greater than the limits specified in local, state and federal safety regulations.

Based on the information obtained from our field exploration and laboratory testing, the onsite soils expected to be encountered in excavations will most likely consist of native medium stiff to hard Silt (ML) and sandy Gravel (GP). These soils would be classified as a type "C" soil. Therefore, temporary excavations and cuts greater than four feet in height, should be sloped at an inclination no steeper than 1½ H:1V (horizontal to vertical).

If slopes of this inclination, or flatter, cannot be constructed, or if excavations greater than four feet in depth are required, temporary shoring may be necessary. This shoring would help protect against slope or excavation collapse and would provide protection to workmen in the excavation. If temporary shoring is required, we will be available to provide shoring design criteria, if requested.

LIMITATIONS

Our recommendations and conclusions are based on the site materials observed, selective laboratory testing, engineering analyses and other design information provided to Soil and Water Technologies as well as our experience and engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

The recommendations submitted in this report are based upon the data obtained from the test pits. Soil and groundwater conditions between the test pits may vary from those encountered. The nature and extent of variations may not become evident until construction. If variations do appear, Soil and Water Technologies should be requested to reevaluate the recommendations contained in this report and to modify or verify them in writing prior to proceeding with the proposed construction.

ADDITIONAL SERVICES & EARTHWORK MONITORING

Soil and Water Technologies will be available to provide consultation services related to review of the final design to verify that the recommendations within our purview have been properly interpreted and implemented in the approved construction plans and specifications. A representative from our office will be available to attend a pre-construction meeting to discuss and/or clarify all geotechnical issues related to the proposed project.

In addition, it is suggested that our office be retained to provide geotechnical services during construction to observe compliance with the design concepts and project specifications and to allow design changes in the event subsurface conditions differ from those anticipated. Our construction services would include monitoring and documenting the following:

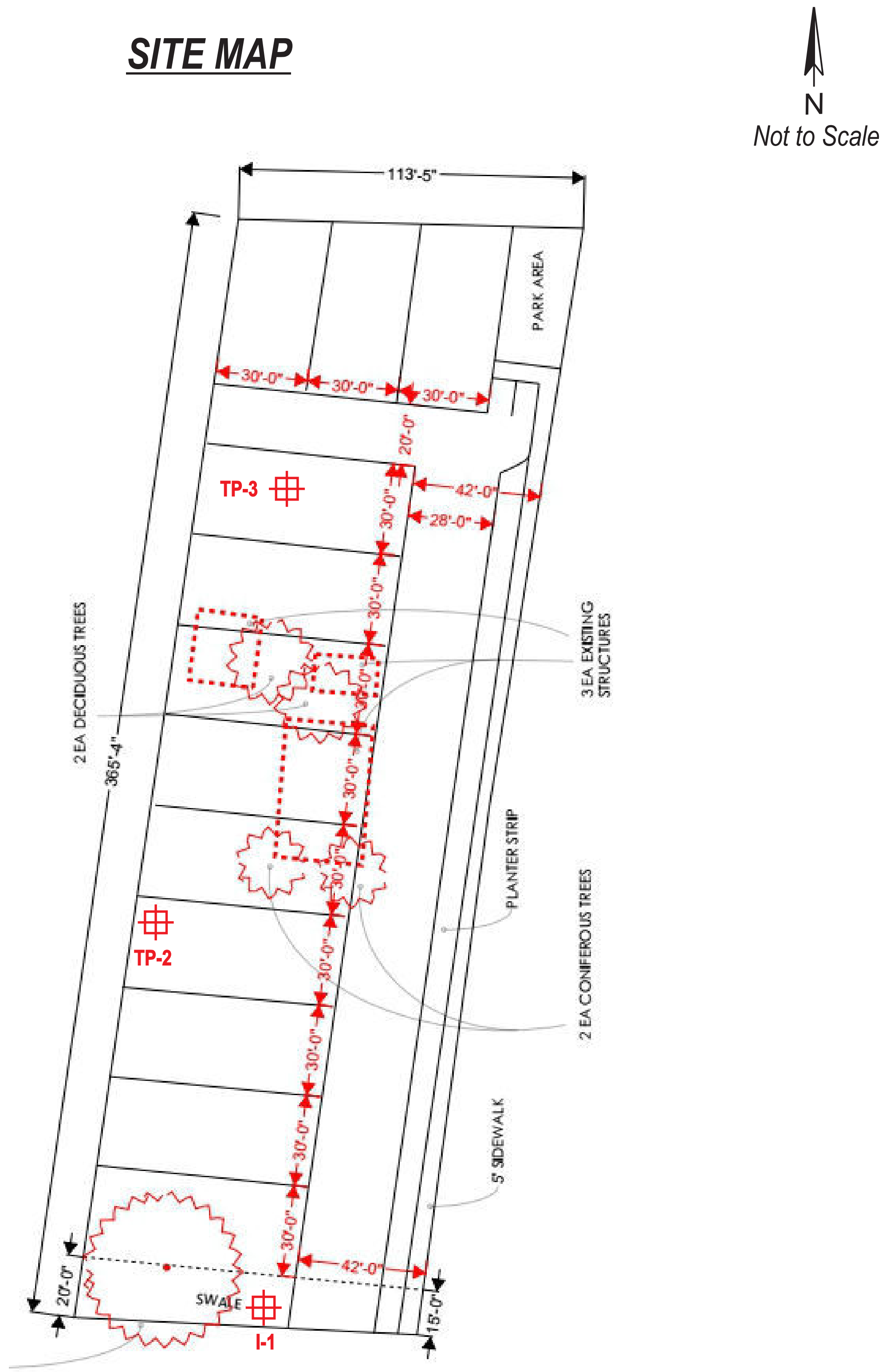
- Verify the removal of organic strippings and other deleterious material.
- Verify over-excavation and replacement of undocumented fills, where encountered.
- Observe the placement and compaction of structural fill at building areas, utility trenches and roadways.
- Perform laboratory tests on structural fill source and roadway base rock materials.
- Perform density tests on structural fill and utility trench backfill.
- Verify the field rate of infiltration.
- Monitor proof rolling of roadway subgrade and base rock.
- Perform density testing on roadway base rock and asphalt pavement.
- Concrete Testing (i.e. Temp., Slump, Air, Compressive Strength), if required.
- Provide certified erosion control design, monitoring and consulting.
- Provide written field reports and electronically submit to all associated parties.

VICINITY MAP

N
Not to Scale

Soil and Water Technologies, Inc PO Box 59 Vancouver, WA 98666 PH: 360 281-5406 www.swt.ski	*CLIENT:* DD&C, LLC	*DRAWN:*	JR
	PROJECT: 2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	*DATE:*	7/30/2018
		FIGURE:	1
		PRO. #:	G0941800

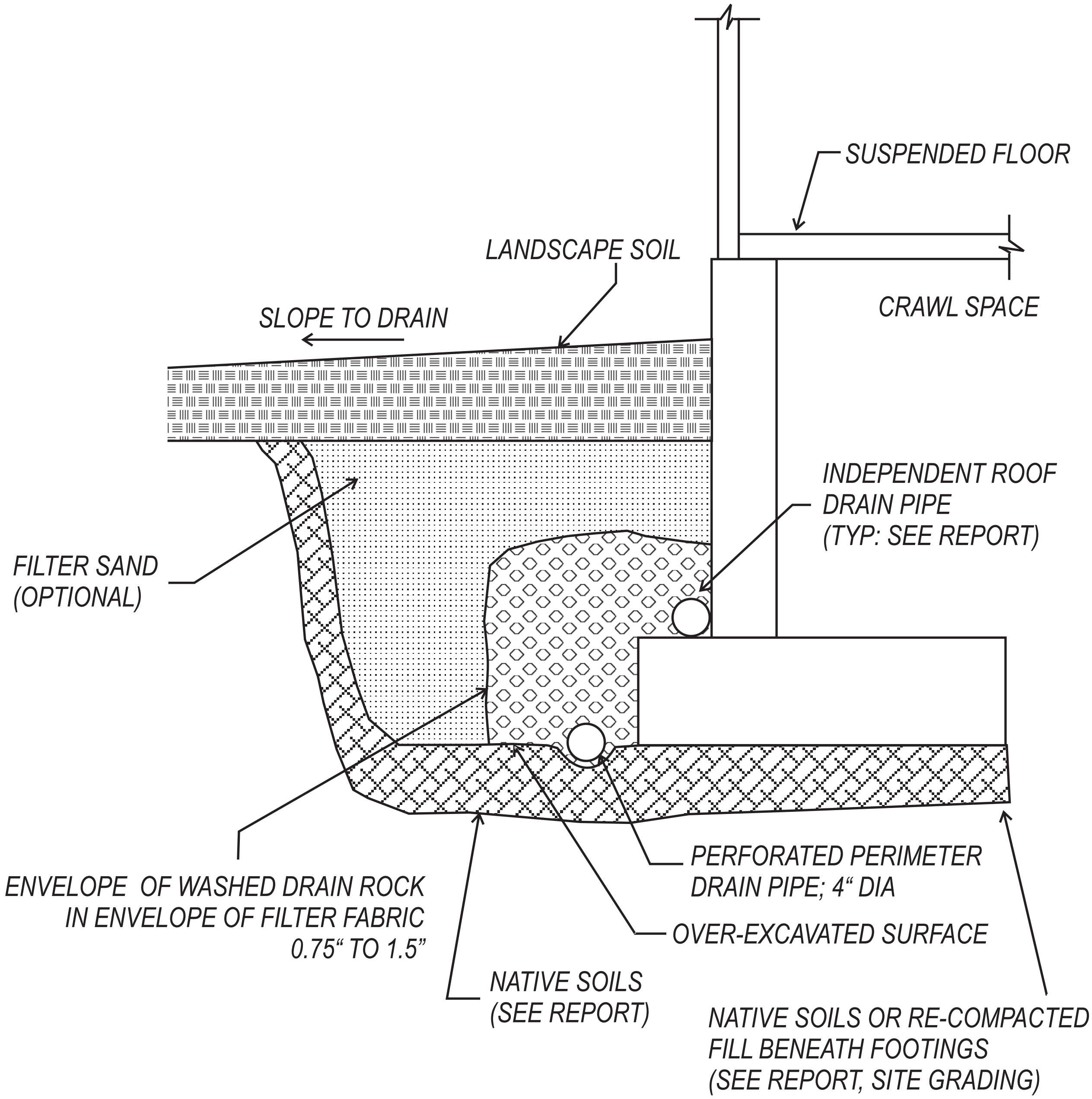
SITE MAP



Legend

TP-2 Approximate Test Pit Location

Soil and Water Technologies, Inc PO Box 59 Vancouver, WA 98666 PH: 360 281-5406 www.swt.ski	*CLIENT:*	DD&C, LLC	*DRAWN:*	JR
	PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	*DATE:*	7/30/2018
			FIGURE:	2
			PRO. #:	G0941800



NOTES:

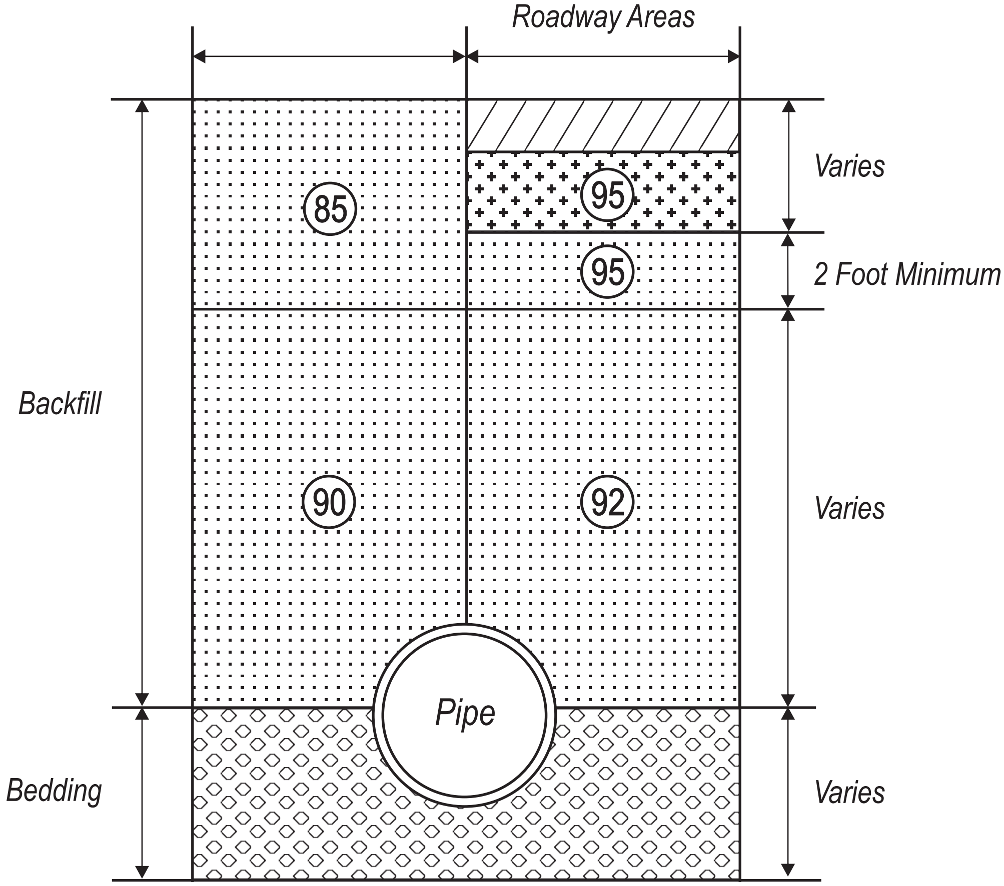
1. FILTER SAND - FINE AGGREGATE FOR PORTLAND CEMENT; SECTION 9=03.1(2)
2. PERFORATED OR SLOTTED RIGID PVC PIPE WITH A POSITIVE DRAINAGE GRADIENT
3. NATIVE SOIL COMPACTED TO 95% (STANDARD PROCTOR ASTM D698)

FOOTING DRAINAGE DETAIL

Not to Scale

Soil and Water Technologies, Inc
PO Box 59
Vancouver, WA 98666
PH: 360 281-5406
www.swt.ski

CLIENT:	DD&C, LLC	DRAWN:	JR
PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	DATE:	7/30/2018
		FIGURE:	3
		PRO. #:	G0941800



LEGEND

(diagonal hatch)	*Asphalt or Concrete Pavement*
(plus pattern)	*Roadway Base Material or Base Rock*
(dot pattern)	*Backfill: Compacted on-site soil or imported select fill material as described in the site preparation of the general Earthwork Section of the attached report text.*
(92)	*Minimum percentage of maximum Laboratory Dry Density as determined by ASTM Test method D1557 (Modified Proctor),unless otherwise specified in the attached report text.*
(diamond pattern)	*Bedding Material: Material type depends on type of pipe and laying conditions. Bedding should conform to the manufacturer's recommendations for the type of pipe selected.*

UTILITY TRENCH BACKFILL DETAIL

Not to Scale

Soil and Water Technologies, Inc
PO Box 59
Vancouver, WA 98666
PH: 360 281-5406
www.swt.ski

CLIENT:	DD&C, LLC	*DRAWN:*	JR
PROJECT:	2531 NE 3rd Subdivision 2531 NE 3rd Avenue Camas, WA 98607	*DATE:*	7/30/2018
		FIGURE:	4
		PRO. #:	G0941800

Appendix D

WWHM2012 CONTINUOUS RUNOFF MODEL REPORT

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Camas_10052020
Site Name:	
Site Address:	
City:	
Report Date:	10/5/2020
Gage:	Troutdale
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.370
Version Date:	2019/09/13
Version:	4.2.17

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

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Pasture, Steep	0.79
Pervious Total	0.79
Impervious Land Use	acre
ROADS MOD	0.44
ROOF TOPS FLAT	0.5
SIDEWALKS MOD	0.14
POND	0.1
Impervious Total	1.18
Basin Total	1.97

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1		

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	153.50 ft.	
Bottom Width:	24.60 ft.	
Depth:	5 ft.	
Volume at riser head:	0.4343 acre-feet.	
Infiltration On		
Infiltration rate:	4	
Infiltration safety factor:	0.333	
Total Volume Infiltrated (ac-ft.):		250.306
Total Volume Through Riser (ac-ft.):		0
Total Volume Through Facility (ac-ft.):		250.306
Percent Infiltrated:		100
Total Precip Applied to Facility:		0
Total Evap From Facility:		0
Side slope 1:	0.75 To 1	
Side slope 2:	0.75 To 1	
Side slope 3:	0.75 To 1	
Side slope 4:	6.5 To 1	
Discharge Structure		
Riser Height:	4 ft.	
Riser Diameter:	24 in.	
Element Flows To:		
Outlet 1	Outlet 2	

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.086	0.000	0.000	0.000
0.0556	0.087	0.004	0.000	0.116
0.1111	0.087	0.009	0.000	0.116
0.1667	0.088	0.014	0.000	0.116
0.2222	0.088	0.019	0.000	0.116
0.2778	0.089	0.024	0.000	0.116
0.3333	0.089	0.029	0.000	0.116
0.3889	0.090	0.034	0.000	0.116
0.4444	0.090	0.039	0.000	0.116
0.5000	0.091	0.044	0.000	0.116
0.5556	0.092	0.049	0.000	0.116
0.6111	0.092	0.054	0.000	0.116
0.6667	0.093	0.059	0.000	0.116
0.7222	0.093	0.065	0.000	0.116
0.7778	0.094	0.070	0.000	0.116
0.8333	0.094	0.075	0.000	0.116
0.8889	0.095	0.080	0.000	0.116
0.9444	0.095	0.086	0.000	0.116
1.0000	0.096	0.091	0.000	0.116
1.0556	0.096	0.096	0.000	0.116
1.1111	0.097	0.102	0.000	0.116
1.1667	0.098	0.107	0.000	0.116
1.2222	0.098	0.113	0.000	0.116
1.2778	0.099	0.118	0.000	0.116
1.3333	0.099	0.124	0.000	0.116
1.3889	0.100	0.129	0.000	0.116
1.4444	0.100	0.135	0.000	0.116

1.5000	0.101	0.140	0.000	0.116
1.5556	0.101	0.146	0.000	0.116
1.6111	0.102	0.152	0.000	0.116
1.6667	0.103	0.157	0.000	0.116
1.7222	0.103	0.163	0.000	0.116
1.7778	0.104	0.169	0.000	0.116
1.8333	0.104	0.175	0.000	0.116
1.8889	0.105	0.181	0.000	0.116
1.9444	0.105	0.186	0.000	0.116
2.0000	0.106	0.192	0.000	0.116
2.0556	0.107	0.198	0.000	0.116
2.1111	0.107	0.204	0.000	0.116
2.1667	0.108	0.210	0.000	0.116
2.2222	0.108	0.216	0.000	0.116
2.2778	0.109	0.222	0.000	0.116
2.3333	0.109	0.228	0.000	0.116
2.3889	0.110	0.235	0.000	0.116
2.4444	0.111	0.241	0.000	0.116
2.5000	0.111	0.247	0.000	0.116
2.5556	0.112	0.253	0.000	0.116
2.6111	0.112	0.259	0.000	0.116
2.6667	0.113	0.266	0.000	0.116
2.7222	0.114	0.272	0.000	0.116
2.7778	0.114	0.278	0.000	0.116
2.8333	0.115	0.285	0.000	0.116
2.8889	0.115	0.291	0.000	0.116
2.9444	0.116	0.298	0.000	0.116
3.0000	0.117	0.304	0.000	0.116
3.0556	0.117	0.311	0.000	0.116
3.1111	0.118	0.317	0.000	0.116
3.1667	0.118	0.324	0.000	0.116
3.2222	0.119	0.330	0.000	0.116
3.2778	0.120	0.337	0.000	0.116
3.3333	0.120	0.344	0.000	0.116
3.3889	0.121	0.350	0.000	0.116
3.4444	0.122	0.357	0.000	0.116
3.5000	0.122	0.364	0.000	0.116
3.5556	0.123	0.371	0.000	0.116
3.6111	0.123	0.378	0.000	0.116
3.6667	0.124	0.385	0.000	0.116
3.7222	0.125	0.391	0.000	0.116
3.7778	0.125	0.398	0.000	0.116
3.8333	0.126	0.405	0.000	0.116
3.8889	0.126	0.412	0.000	0.116
3.9444	0.127	0.420	0.000	0.116
4.0000	0.128	0.427	0.000	0.116
4.0556	0.128	0.434	0.277	0.116
4.1111	0.129	0.441	0.784	0.116
4.1667	0.130	0.448	1.438	0.116
4.2222	0.130	0.455	2.205	0.116
4.2778	0.131	0.463	3.059	0.116
4.3333	0.132	0.470	3.979	0.116
4.3889	0.132	0.477	4.939	0.116
4.4444	0.133	0.485	5.917	0.116
4.5000	0.134	0.492	6.887	0.116
4.5556	0.134	0.500	7.826	0.116
4.6111	0.135	0.507	8.711	0.116
4.6667	0.135	0.515	9.523	0.116

4.7222	0.136	0.522	10.24	0.116
4.7778	0.137	0.530	10.86	0.116
4.8333	0.137	0.538	11.38	0.116
4.8889	0.138	0.545	11.81	0.116
4.9444	0.139	0.553	12.16	0.116
5.0000	0.139	0.561	12.46	0.116
5.0556	0.140	0.568	12.94	0.116

Analysis Results

POC 1

POC #1 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

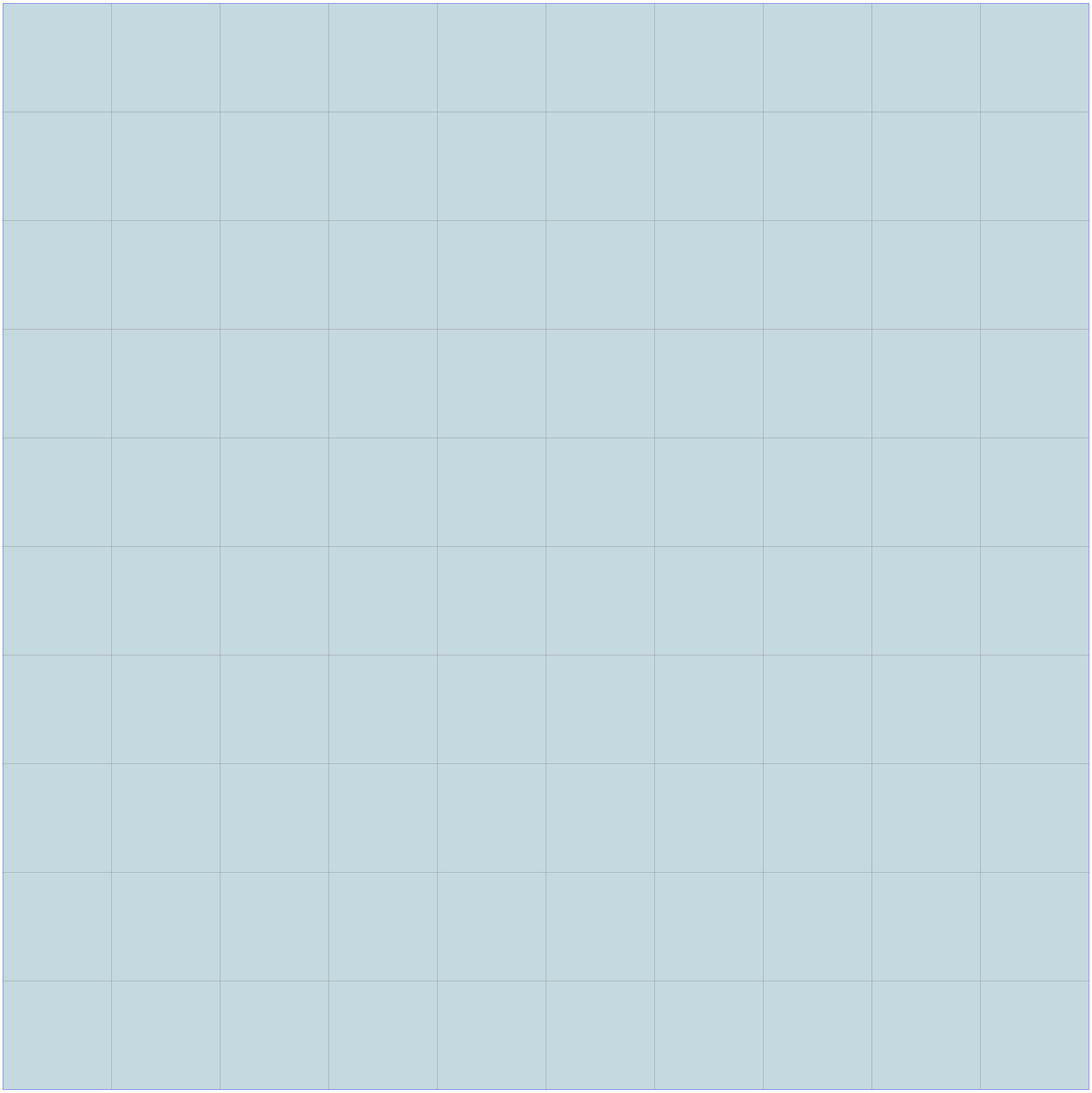
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

Mitigated UCI File

```
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   Camas_10052020.wdm
MESSU      25   MitCamas_10052020.MES
           27   MitCamas_10052020.L61
           28   MitCamas_10052020.L62
           30   POCCamas_100520201.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       6
      IMPLND       2
      IMPLND       4
      IMPLND       9
      IMPLND      14
      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        Trapezoidal Pond  1         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             ***
    6     A/B, Pasture, Steep     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 ***
    6         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  *********
    6         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 ***
    6         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
    6               0         5       1.5       400      0.15       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    6               0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    6           0.15       0.5       0.3         0       0.7       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
    6               0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

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

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    9         0    0    1    0    0    0
   14         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
   14         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     ***
    2        0    0    0    0    0
    4        0    0    0    0    0
    9        0    0    0    0    0
   14        0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
    9            400      0.05       0.1      0.08
   14            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
    9              0         0
   14              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
    9              0         0
   14              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   6                        0.79     RCHRES   1      2
IMPLND   2                        0.44     RCHRES   1      5
IMPLND   4                         0.5     RCHRES   1      5
IMPLND   9                        0.14     RCHRES   1      5
IMPLND  14                         0.1     RCHRES   1      5

******Routing******
PERLND   6                        0.79     COPY     1     12
IMPLND   2                        0.44     COPY     1     15
IMPLND   4                         0.5     COPY     1     15
IMPLND   9                        0.14     COPY     1     15
IMPLND  14                         0.1     COPY     1     15
RCHRES   1                           1     COPY   501     17
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     Trapezoidal Pond-015    2    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  5  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      0.03       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  5.0  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    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)     (cfs)     (cfs)  (ft/sec)    (Minutes)***
  0.000000  0.086687  0.000000  0.000000  0.000000
  0.055556  0.087209  0.004830  0.000000  0.116430
  0.111111  0.087733  0.009690  0.000000  0.116430
  0.166667  0.088258  0.014579  0.000000  0.116430
  0.222222  0.088784  0.019496  0.000000  0.116430
  0.277778  0.089312  0.024444  0.000000  0.116430
  0.333333  0.089842  0.029420  0.000000  0.116430
  0.388889  0.090373  0.034426  0.000000  0.116430
  0.444444  0.090906  0.039462  0.000000  0.116430
  0.500000  0.091440  0.044527  0.000000  0.116430
  0.555556  0.091976  0.049622  0.000000  0.116430
  0.611111  0.092513  0.054746  0.000000  0.116430
  0.666667  0.093052  0.059901  0.000000  0.116430
  0.722222  0.093592  0.065085  0.000000  0.116430
  0.777778  0.094134  0.070300  0.000000  0.116430
  0.833333  0.094678  0.075545  0.000000  0.116430
  0.888889  0.095223  0.080820  0.000000  0.116430
  0.944444  0.095769  0.086125  0.000000  0.116430
  1.000000  0.096317  0.091461  0.000000  0.116430
  1.055556  0.096867  0.096827  0.000000  0.116430
  1.111111  0.097418  0.102224  0.000000  0.116430
  1.166667  0.097971  0.107651  0.000000  0.116430
  1.222222  0.098525  0.113109  0.000000  0.116430
  1.277778  0.099081  0.118598  0.000000  0.116430
```

1.333333	0.099638	0.124118	0.000000	0.116430
1.388889	0.100197	0.129669	0.000000	0.116430
1.444444	0.100757	0.135251	0.000000	0.116430
1.500000	0.101319	0.140865	0.000000	0.116430
1.555556	0.101883	0.146509	0.000000	0.116430
1.611111	0.102448	0.152185	0.000000	0.116430
1.666667	0.103014	0.157892	0.000000	0.116430
1.722222	0.103583	0.163631	0.000000	0.116430
1.777778	0.104152	0.169402	0.000000	0.116430
1.833333	0.104723	0.175204	0.000000	0.116430
1.888889	0.105296	0.181038	0.000000	0.116430
1.944444	0.105870	0.186903	0.000000	0.116430
2.000000	0.106446	0.192801	0.000000	0.116430
2.055556	0.107024	0.198731	0.000000	0.116430
2.111111	0.107603	0.204693	0.000000	0.116430
2.166667	0.108183	0.210687	0.000000	0.116430
2.222222	0.108765	0.216713	0.000000	0.116430
2.277778	0.109349	0.222772	0.000000	0.116430
2.333333	0.109934	0.228863	0.000000	0.116430
2.388889	0.110520	0.234987	0.000000	0.116430
2.444444	0.111108	0.241143	0.000000	0.116430
2.500000	0.111698	0.247332	0.000000	0.116430
2.555556	0.112289	0.253554	0.000000	0.116430
2.611111	0.112882	0.259809	0.000000	0.116430
2.666667	0.113476	0.266096	0.000000	0.116430
2.722222	0.114072	0.272417	0.000000	0.116430
2.777778	0.114670	0.278771	0.000000	0.116430
2.833333	0.115269	0.285158	0.000000	0.116430
2.888889	0.115869	0.291579	0.000000	0.116430
2.944444	0.116471	0.298033	0.000000	0.116430
3.000000	0.117075	0.304520	0.000000	0.116430
3.055556	0.117680	0.311041	0.000000	0.116430
3.111111	0.118286	0.317596	0.000000	0.116430
3.166667	0.118895	0.324184	0.000000	0.116430
3.222222	0.119504	0.330806	0.000000	0.116430
3.277778	0.120116	0.337462	0.000000	0.116430
3.333333	0.120728	0.344152	0.000000	0.116430
3.388889	0.121343	0.350877	0.000000	0.116430
3.444444	0.121959	0.357635	0.000000	0.116430
3.500000	0.122576	0.364428	0.000000	0.116430
3.555556	0.123195	0.371255	0.000000	0.116430
3.611111	0.123816	0.378116	0.000000	0.116430
3.666667	0.124438	0.385012	0.000000	0.116430
3.722222	0.125061	0.391942	0.000000	0.116430
3.777778	0.125686	0.398908	0.000000	0.116430
3.833333	0.126313	0.405908	0.000000	0.116430
3.888889	0.126941	0.412943	0.000000	0.116430
3.944444	0.127571	0.420012	0.000000	0.116430
4.000000	0.128202	0.427117	0.000000	0.116430
4.055556	0.128835	0.434257	0.277796	0.116430
4.111111	0.129470	0.441432	0.784769	0.116430
4.166667	0.130106	0.448643	1.438492	0.116430
4.222222	0.130743	0.455888	2.205262	0.116430
4.277778	0.131382	0.463170	3.059929	0.116430
4.333333	0.132023	0.470486	3.979211	0.116430
4.388889	0.132665	0.477839	4.939668	0.116430
4.444444	0.133308	0.485227	5.917238	0.116430
4.500000	0.133954	0.492651	6.887532	0.116430
4.555556	0.134600	0.500111	7.826549	0.116430
4.611111	0.135249	0.507607	8.711714	0.116430
4.666667	0.135898	0.515139	9.523132	0.116430
4.722222	0.136550	0.522707	10.24504	0.116430
4.777778	0.137203	0.530311	10.86741	0.116430
4.833333	0.137857	0.537951	11.38772	0.116430
4.888889	0.138513	0.545628	11.81283	0.116430
4.944444	0.139170	0.553342	12.16099	0.116430
5.000000	0.139830	0.561092	12.46394	0.116430

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   1022 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1023 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      2 1        1      WDM   1024 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1025 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        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       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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Appendix E

OPERATIONS AND MAINTENANCE

INFILTRATION BASIN INSPECTION AND MAINTENANCE GUIDELINES.

Infiltration Basin			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Trash and Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with Clark County Weed Management department). Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with Clark County Maintenance and Operations department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet).
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted Clark County Maintenance and Operations policies.
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (If Applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.

Infiltration Basin (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
Emergency Overflow/ Spillway and Berms Over 4 Feet in Height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Rock Missing	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced)	Rocks and pad depth are restored to design standards.
Emergency Overflow/ Spillway	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Pre-settling Ponds and Vaults	Facility or Sump Filled With Sediment and/or Debris	6" or designed sediment trap depth of sediment.	Sediment is removed.