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Righellis Inc.

Willow Grove

STORMWATER REPORT

December 2, 2022

Prepared For:

Sasha Frenkel
Access Architecture
500 W 8th Street, Ste. 115B
Vancouver, WA 98660-3051

ACS-01

Prepared By:

Harper Houf Peterson Righellis Inc.
1220 Main Street, Suite 150
Vancouver, WA 98660
P: 360-750-1131 F: 360-750-1141

Kelly Bachelder Johnson, PE

HHPR

ENGINEERS ◆ PLANNERS
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INTRODUCTION

This is the stormwater report for the Willow Grove Affordable Housing project. This report is submitted concurrently with the land use construction plan set that contains both the stormwater plan and the grading plan sheets.

The layout of this report conforms to the standardized format as described in Chapter 2 of the City of Kelso Engineering Design Manual (KEDM), dated May 2021.

PROJECT SUMMARY

The site is located west of Interstate 5 between Walnut St. and Willow St. in Kelso, Washington. Project improvements include the construction of two three-story apartment buildings, with community gardens, a playground area, bike parking, pedestrian paths, and parking areas. The project site will be constructed on a single parcel totaling 1.63 acres.

In association with the new building construction, the project will include public street improvements consisting of grading, storm drainage (collection, detention, treatment and disposal), public water extension, domestic water service, fire service connection, hydrants, and sanitary service.

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(b) Basin Map. See App. 1, Fig. 2 for the site Basin Map.

(c) Soils Map. See App. 1, Fig. 3 for the site Soil Map.

Section A – Project Overview

a) The project is located between Walnut St. and Willow St. in Kelso, Washington. The project is located on parcel #23655 and does not have an address at this point. The project site is zoned for Residential Multi-Family (RMF).

b)

c) The existing grade slopes from west to east. The parcel is undeveloped, consisting of mostly grasslands. The existing site stormwater systems consists of overland flow, and existing drainage on the site likely drains to the stream at the east side of the site. At the eastern side of the site, there is a riparian buffer zone that will be considered critical, and no improvements will be allowed within the buffer zone.

d) There does not appear to be an existing storm system on-site. The project will route the proposed stormwater into the existing system along Walnut St. by connecting to an existing 48" MH on the northern side of Walnut St.

e) Parameters influencing storm system design include the depth at which we will connect to the existing system along Walnut St., and the treatment of stormwater on-site.

f) There is a small stream at the east side of the site. The stream is protected by a riparian buffer zone, and this project will not encroach upon the existing buffer zone. All stormwater runoff created by the project will be captured and treated with a proposed water quality manhole before being routed north into the existing storm system along Walnut St. According to the FEMA Floodplain Map for this area, the project site is in an area with reduced flood risk (Zone X, refer to Figure 4, Appendix 1). The area surrounding the site is mostly residential, with some light commercial as well. Interstate 5 is to the east of the site. These adjacent properties will not be affected by the proposed project. The project will collect all runoff from the project site and no runoff will cross property lines.

g) The proposed project will consist of approximately 1.34 acres of building, asphalt parking lot, drive aisles, pedestrian areas, walkways, and landscaped areas. Stormwater runoff is proposed to be mitigated for water quality with the use of a water quality treatment manhole. There will be no required detention of stormwater for this project.

h) The proposed stormwater system was designed according to the SWMMWW, Vol III, Section 3.2 to minimize the project impacts. The proposed system is as far as possible from the existing riparian buffer zone, and the existing drainage patterns have been maintained to minimize impacts.

i) Xxx

Section B – Existing Conditions and Soils

a) The existing site area is undeveloped and consists of mostly grasslands.

b) Existing site drainage consists of mostly overland flow, and the site drains from west to east, with most of the existing runoff flowing towards the small stream as the east side of the property. Adjacent properties do not appear to contribute any considerable amount of runoff to the site.

c) Existing runoff from the site discharges into the small stream at the east side of the property. With the project improvements, the proposed runoff will be routed through a new system and into the existing stormwater system along Walnut St.

d) The proposed site is located within the Consolidated Diking District #3 (CDID #3).

e) The existing site has a small stream within a riparian buffer zone at the east side of the parcel. Existing slopes are roughly 25% within the riparian buffer zone, gradually flowing down into the stream. According to the geotechnical report provided by GeoDesign in November of 2018, the project site has a high risk of liquefaction during the design earthquake. The site also consists of various soil types, including undocumented fill of up to 7.5 feet depth throughout the site.

f) Critical areas within the site include the small stream at the east property boundary. All runoff created by the proposed improvements will be captured and routed away from the site, so there will be no impacts to the surrounding areas.

g) N/A

h) According to the geotechnical report provided by GeoDesign, the groundwater table was observed to be around 10.0’ below the surface.

i) N/A

j) The project site is at low risk of flooding according to the FEMA Floodplain Map for the area. The site is at high risk of liquefaction during an earthquake, however.

k) The site shares a property line to the north with an existing single-family residence. It is unclear whether the residence has a basement, or whether a septic tank or drain field exists for the residence.

l) A geotechnical report prepared by GeoDesign is included with this report (see Appendix 4). All relevant maps can be referenced within Appendix 1.

m) Soils within the project site consist of mostly Clato silty loams, ranging from 0 to 3% slopes. Refer to Figure 3, Appendix 1 for the complete soil report.

n) Infiltration testing has not been performed on the project site, but the proposed conditions do not utilize bioretention or permeable pavement and therefore infiltration information is not necessary.

o) N/A

p) N/A

Section C – Minimum Requirements Analysis

a) TABLE 1 – Impervious Surface Summary (Land-Disturbing Activities)

Post-Developed Conditions

Existing Impervious (acre)	New Impervious Surface (acre)	Replaced Impervious Surface (acre)	Native Vegetation converted to Lawn or Landscape (acre)	Total Land-Disturbing Activity (acre)	Total Site Area (acre)
0.00	0.81	0.00	0.57	1.71	1.71

b) Refer to Appendix 3 for hydrologic models of pre-developed to post-developed conditions.

c) N/A

d) The proposed project is within the Consolidated Diking District #3 (CDID #3) and therefore MR 5 will not be required.

Minimum Requirements

The minimum requirements for the subject project are as follows:

Minimum Requirement #1 - Preparation of Stormwater Site Plans – *included with this submittal.*

Minimum Requirement #2 - Construction Stormwater Pollution Prevention (SWPPP) – *A SWPPP will be included in the final submittal.*

Minimum Requirement #3 - Source Control Pollution –*The SWPPP and the Erosion Control Plan developed for this project provide short term source control during construction. All developed activities shall consult the Stormwater Manual for relevant BMP's. Source control BMP's that apply to the project could be BMP's for Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots and BMP's for Landscaping and Lawn/Vegetation Management.*

Minimum Requirement #4 - Preservation of Natural Drainage Systems and Outfalls –*The existing site drains to the small creek along the eastern property line. The proposed project will collect and treat stormwater runoff and will be routed to the existing stormwater system along Walnut St.*

Minimum Requirement #5 - On-Site Stormwater Management – *The project is within the Consolidated Diking District #3 (CDID #3) and therefore MR #5 will not be required.*

Minimum Requirement #6 - Runoff Treatment – *The pollution generating surfaces will be treated with the use of a water quality treatment manhole. Refer to the Stormwater Calculations within Appendix 3.*

Minimum Requirement #7 - Flow Control – *The project is within the Consolidated Diking District #3 (CDID #3) and therefore MR #7 will not be required.*

Minimum Requirement #8 - Wetlands Protection – *The surrounding wetland area will be protected with the use of BMP's outside of the riparian buffer zone. No disturbance will occur within the buffer zone.*

Minimum Requirement #9 - Basin/Watershed Planning – *N/A*

Minimum Requirement #10 - Operation and Maintenance – *An Operations and Maintenance Manual is included in this submittal.*

The project will provide runoff treatment for all of the new pollution generating impervious surface areas. See Appendix 3 for all calculations.

Section D – On-Site Stormwater Management Selection and Sizing (MR 5)

The project is within the Consolidated Diking District #3 (CDID #3) and therefore MR #5 will not be required.

Section E – Runoff Treatment Analysis and Design

See the Project Plans within Appendix 2 for the stormwater plan that shows the BMP's utilized for this site. Runoff treatment will be provided with the use of a water quality treatment manhole. Refer to Appendix 3 for stormwater calculations.

a) Refer to Appendix 3 for stormwater treatment calculations.
b) The following assumptions were made in the design of the stormwater system:

    a. Rainfall data in the WWHM2012 program accurately reflect the actual total precipitation for the design event.
    b. The topography of the site is accurately reflected in the topographic survey.
    c. The contractor will provide erosion control as necessary during construction to ensure that the infiltration trenches stay free of silt.
    d. Water quality treatment structures will be adequately maintained.
    e. Runoff from the proposed building and asphalt areas will be routed into the proposed system.

c) The proposed use of the water quality treatment manhole allows for the least amount of disturbance and provides a compact method for treating the proposed stormwater runoff from the project.

d) Refer to the project plans for the treatment manhole and accompanying details.

e) Refer to the project plans and the post-developed basin map for information on the runoff treatment plan.

f) Refer to the stormwater calculations in Appendix 3 for all water treatment calculations.

g) Refer to Appendix 3 for all stormwater models, hydrographs, and treatment calculations.

h) Results of the stormwater treatment calculations can be found in Appendix 3.

i) N/A

j) N/A

k) Refer to Appendix 3 for all stormwater models, hydrographs, and treatment calculations.

Section F – Flow Control Analysis and Design

The project is within the Consolidated Diking District #3 (CDID #3) and therefore MR #7 will not be required. Wetland areas protected within the riparian buffer zone will be protected with the use of erosion control measures and methods, and no work will occur within the riparian buffer zone. Refer to the Project Plans within Appendix 2 for more information.

Information regarding the stormwater plans can also be found within the Project Plans in Appendix 2. Stormwater calculations can be found in Appendix 3.

a) Refer to Appendix 3 for all figures and maps, including soil survey maps and pre-developed site conditions and topography.

b) Pre-Developed site conditions can be found within Appendix 3, and information regarding site groundwater tables and infiltration can be referenced within the geotechnical report in Appendix 4.

c) The following assumptions were made in the design of the stormwater system:

    i. Rainfall data in the WWHM2012 program accurately reflect the actual total precipitation for the design event.
    ii. The topography of the site is accurately reflected in the topographic survey.

iii. The contractor will provide erosion control as necessary during construction to ensure that the infiltration trenches stay free of silt.
iv. Water quality treatment structures will be adequately maintained.
v. Runoff from the proposed building and asphalt areas will be routed into the proposed system.

d) N/A

e) N/A

f) The project geotechnical report can be referenced in Appendix 4.

g) N/A

h) N/A

i) N/A

j) N/A

k) Refer to Appendix 1 for pre-developed and post-developed site conditions. Refer to Appendix 3 for all stormwater models and calculations.

i. Flow rates for the 2, 10, and 100-year, 24-hour storm return periods for pre and post-developed conditions can be referenced in Appendix 3.
ii. Table
iii. Refer to Appendix 3 for all hydrographs.
iv. N/A

l) N/A

m) Refer to Appendix 3 for all stormwater models and calculations.

n) Refer to Appendix 1 for all relevant maps.

o) N/A

p) N/A

q) N/A

r) All models, calculations, and hydrographs are included in Appendix 3.

Section G – Conveyance System Analysis and Design

a) Refer to the project plans in Appendix 2 for all conveyance design details. A summary of the existing stormwater pipe that will be utilized to convey the proposed flows can be found below. The existing system along Walnut St. is made up of a series of 18” concrete pipes, and the proposed project will convey flows via a 12” PVC pipe.

Table 2 – Pipe Capacity

Size (inches)	Slope (percent)	Peak Flow (cfs)	Capacity (cfs)	Capacity > Peak Flow?
18 (Existing)	0.06	0.24	2.79	Yes
12 (Proposed)	0.50	0.55	2.73	Yes

b) Off-Site Analysis

c) There are no contributing upstream basins from the proposed site that are not already routed into the existing storm system along Walnut St. From the proposed site, existing stormwater runoff flows West down Walnut St.

d) N/A

e) The existing storm system along Walnut St. consists of an 18” concrete pipe flowing east to west. The existing pipe has capacity to convey the proposed development.

f) Refer to Appendix 3 for all stormwater calculations.

g) N/A

Section H – Source Control

The minimum requirements stated in the KEDM have been applied. See the stormwater plan in Appendix 2. Applicable source control devices have been utilized. Refer to the Grading and ESC Plan for all short-term BMP measures that will be in place during construction.

Section I – Ongoing Operation and Maintenance

The proposed project is owned by the Kelso Housing Authority, and therefore all private on-site utilities will be maintained by the Kelso Housing Authority. The 12” PVC storm connection will be a public storm line, and therefore maintained by the city of Kelso. All water treatment devices on site shall be operated and maintained by the Kelso Housing Authority. Additional information regarding operations and maintenance can be found in Appendix 5.

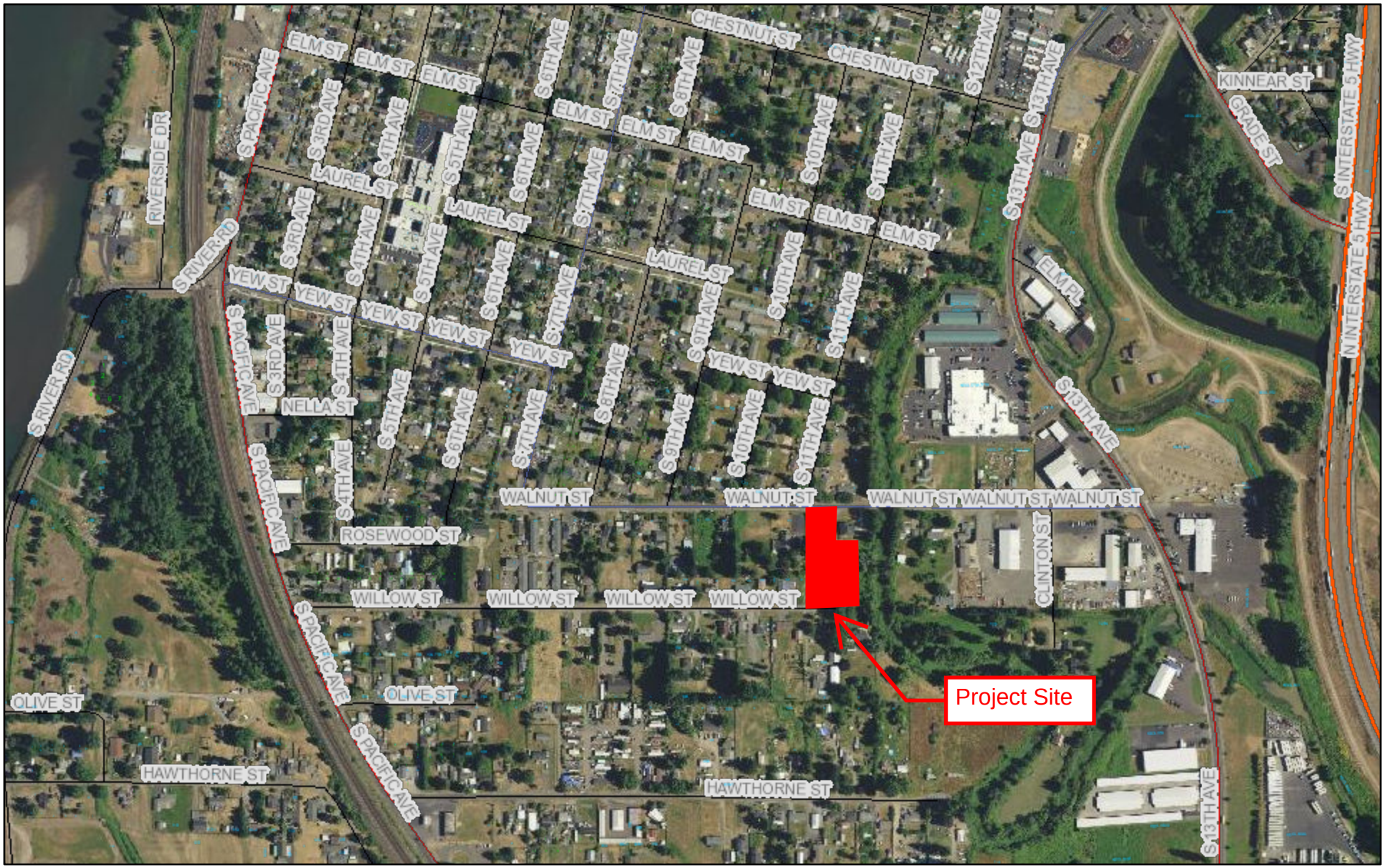
Section J – Groundwater Monitoring Program

City of Kelso to determine if a groundwater monitoring program shall be required for the proposed project.

Section K – Appendices

APPENDIX 1
MAPS

Vicinity Map



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Streets

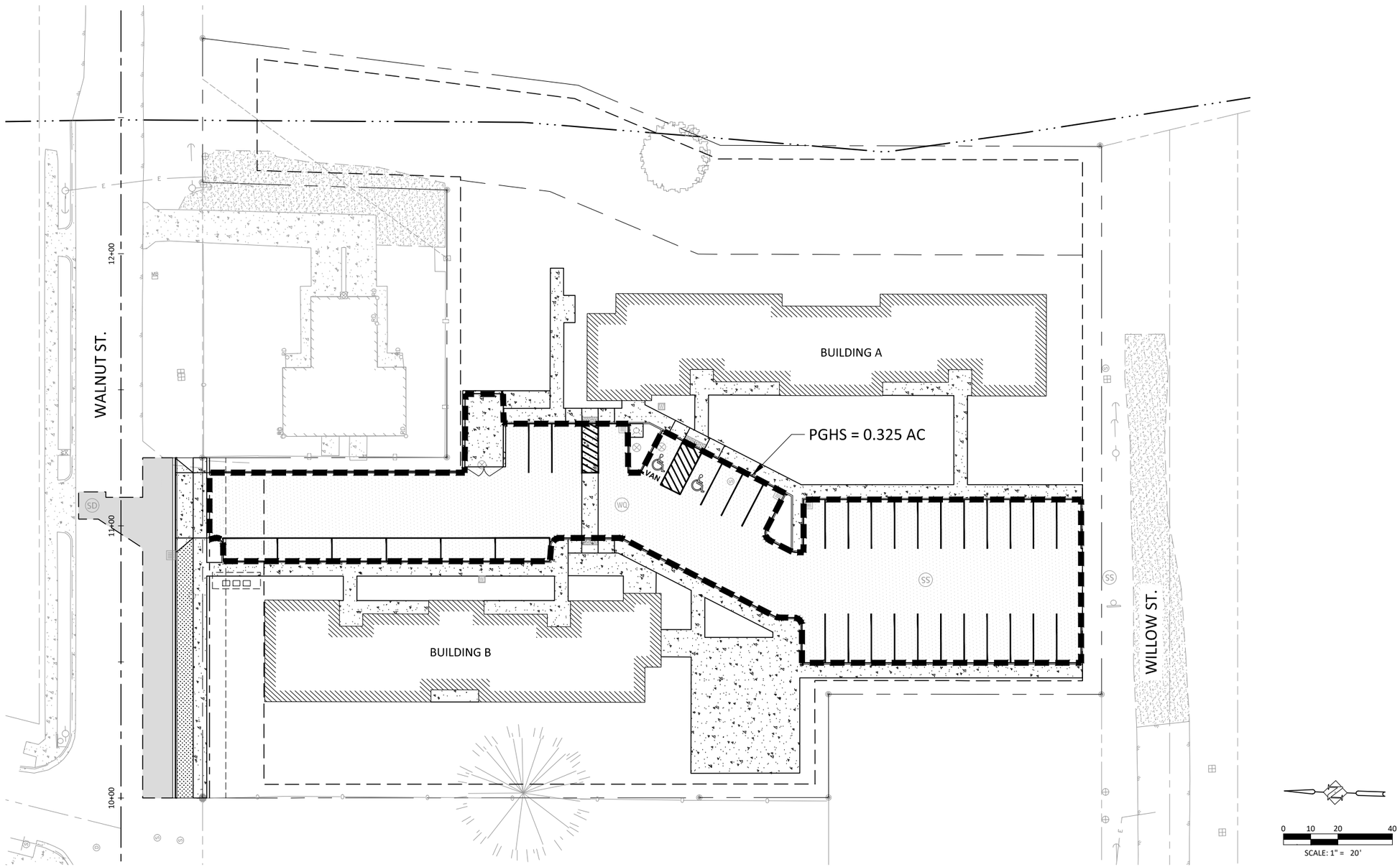
- 0 RURAL PRIVATE
- 1 INTERSTATE
- 2 RURAL PRINCIPAL ARTERIAL
- 6 RURAL MINOR ARTERIAL
- 7 RURAL MAJOR COLLECTOR
- 8 RURAL MINOR COLLECTOR
- 9 RURAL LOCAL ACCESS
- 12 PRINCIPAL ARTERIAL (HWY)

1:9,028

0 0.05 0.1 0.2 mi

0 0.07 0.15 0.3 km

Harper
Houf **P**eterson
Righellis **I**nc.
ENGINEERS♦PLANNERS
LANDSCAPE ARCHITECTS♦SURVEYORS
1220 Main Street, Suite 150, Vancouver, WA 98660
phone: 360.750.1131 www.hhpr.com fax: 360.750.1141



Access | Architecture

WILLOW GROVE
1106 WALNUT STREET
KELSO, WA 98626

LAND USE PERMIT

REV	DATE	FILE

PM:
JOB: 22012
DATE: 12/01/2022

Basin
Map

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

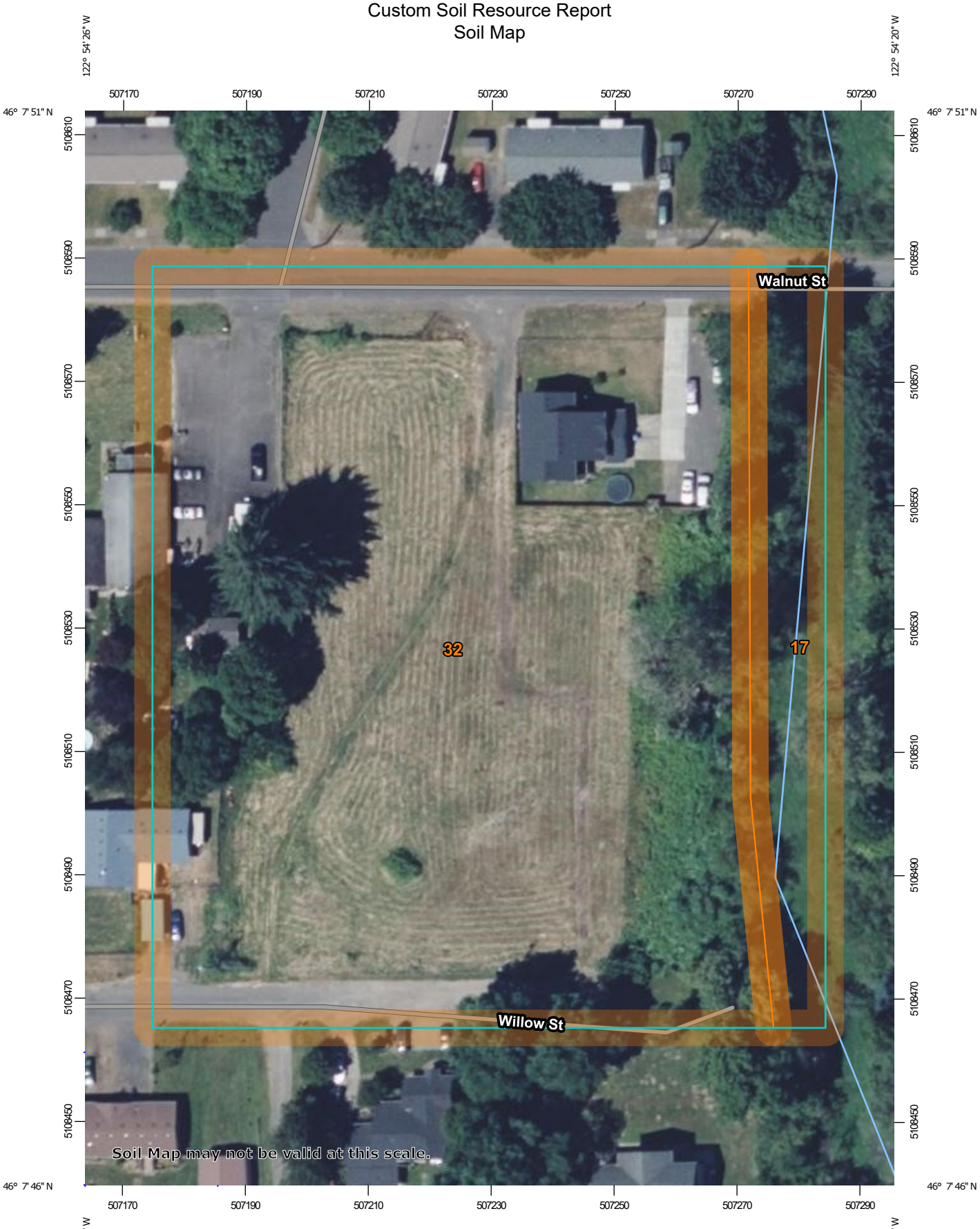
Custom Soil Resource Report for Cowlitz County, Washington

September 23, 2022

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:848 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 40 80 160 240

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 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 1:24,000.

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: Cowlitz County, Washington
Survey Area Data: Version 22, Aug 23, 2021

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

Date(s) aerial images were photographed: Nov 21, 2021—Nov 22, 2021

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
17	Caples silty clay loam, 0 to 3 percent slopes	0.4	10.7%
32	Clato silt loam, 0 to 3 percent slopes	3.0	89.3%
Totals for Area of Interest		**3.4**	**100.0%**

Map Unit Descriptions

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

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

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

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

onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

Cowlitz County, Washington

17—Caples silty clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2f4w
Elevation: 0 to 50 feet
Mean annual precipitation: 38 to 50 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 165 to 195 days
Farmland classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Caples, drained, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Caples, Drained

Setting

Landform: Flood plains
Parent material: Alluvium

Typical profile

H1 - 0 to 9 inches: silty clay loam
H2 - 9 to 39 inches: silty clay loam
H3 - 39 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 24 inches
Frequency of flooding: NoneRare
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Ecological site: F002XB007WA - Portland Basin Wet Forest
Forage suitability group: Seasonally Wet Soils (G002XV202WA)
Other vegetative classification: Seasonally Wet Soils (G002XV202WA)
Hydric soil rating: Yes

Minor Components

Caples, poorly drained

Percent of map unit: 10 percent
Landform: Flood plains
Hydric soil rating: Yes

32—Clato silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2fch
Elevation: 30 to 300 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 50 to 52 degrees F
Frost-free period: 160 to 180 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Clato and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Clato

Setting

Landform: Flood plains
Parent material: Alluvium derived from sedimentary rock

Typical profile

H1 - 0 to 11 inches: silt loam
H2 - 11 to 80 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneRare
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Ecological site: F002XB004WA - Portland Basin Forest
Forage suitability group: Soils with Few Limitations (G002XV502WA)
Other vegetative classification: Soils with Few Limitations (G002XV502WA)
Hydric soil rating: No

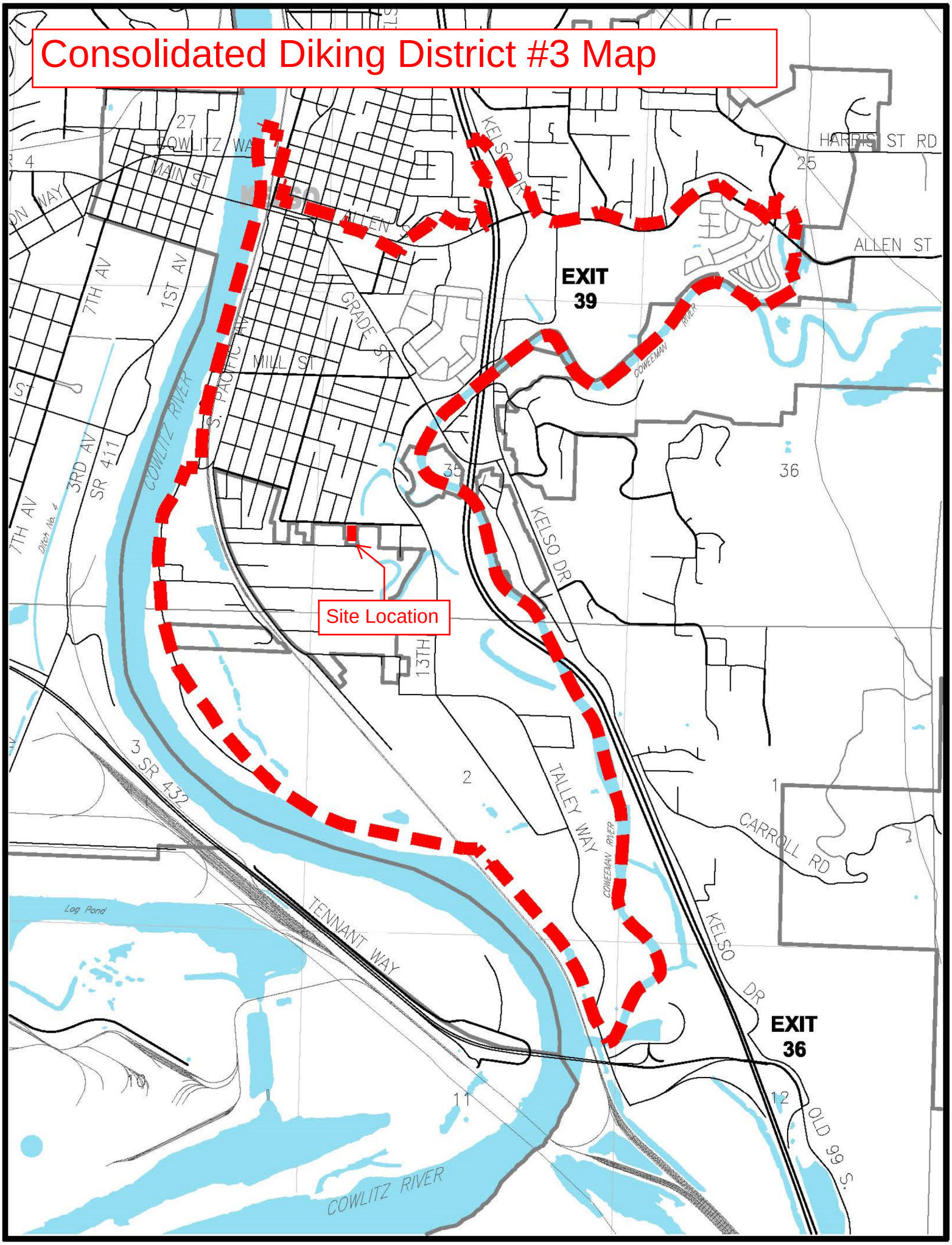
Minor Components

Newberg

Percent of map unit: 5 percent
Landform: Alluvial cones

Hydric soil rating: No

Consolidated Diking District #3 Map



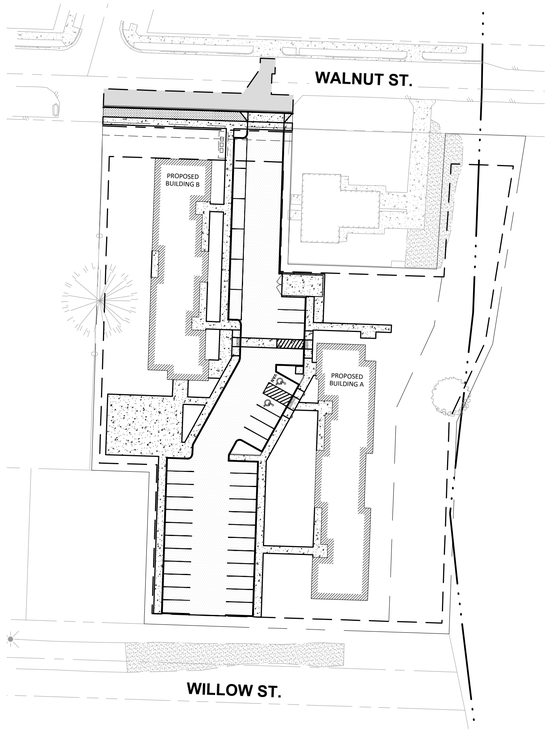
APPENDIX 2
PLAN REVIEW SET

WILLOW GROVE AFFORDABLE HOUSING

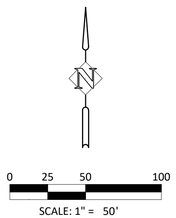
KELSO, WASHINGTON

PARCEL #23655

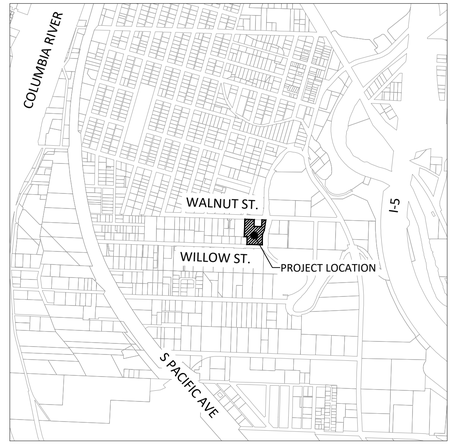
NO SITE ADDRESS



SITE MAP



SHEET INDEX



VICINITY MAP

N.T.S.

PROJECT OWNER

KELSO HOUSING AUTHORITY
1415 S 10TH AVE
KELSO, WA 98626
TEL: 360-423-3490

ARCHITECT

ACCESS ARCHITECTURE
CONTACT: BRENDAN SANCHEZ
500 W 8TH STREET, SUITE 115B
VANCOUVER, WA 98660
TEL: 360-326-1220
EMAIL: BRENDAN@ACCESS-ARCH.COM

CIVIL ENGINEER

HARPER HOUF PETERSON RIGHELLIS INC.
CONTACT: KELLY BACHELDER, P.E.
1220 MAIN STREET, SUITE 150
VANCOUVER, WA 98660
TEL: 360-750-1131
EMAIL: KELLYB@HHPR.COM

LANDSCAPE ARCHITECT

NAME: ECOTONE ENVIRONMENTAL
CONTACT: BRYAN BAILEY, RLA, LEEP AP
ADDRESS: 522 N THOMPSON ST #4
PORTLAND, OR 97227
TEL: 503-927-4180
EMAIL: BRYAN@ECOTONE-ENV.COM

TOPOGRAPHIC SURVEY BY S&F LAND SERVICES

HORIZONTAL DATUM:

THIS SURVEY UTILIZES THE WASHINGTON STATE PLANE COORDINATE SYSTEM - SOUTH ZONE. THE PROJECT WAS SCALED TO GROUND AROUND CONTROL POINT #1 WITH A SCALE FACTOR OF 1.0000515101. DISTANCES SHOWN ARE GROUND DISTANCES. TO OBTAIN GRID DISTANCES, DIVIDE BY THE SCALE FACTOR. CONTROL POINT #1 WAS OBSERVED WITH STATIC GPS PROCESSED THROUGH TRIMBLE RTX. NORTH AMERICAN DATUM OF NAD83/2011 (EPOCH 2010.0000). UNITS IN US SURVEY FEET.

VERTICAL DATUM:

NAVD88 BASED ON STATIC GPS OBSERVATIONS ON POINT 1, PROCESSED THROUGH TRIMBLE RTX.

BENCH MARK:

CONTROL POINT #1 WAS OBSERVED WITH STATIC GPS PROCESSED THROUGH THE TRIMBLE RTX.

Harper Houf Peterson Righellis Inc.
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LANDSCAPE ARCHITECTS • SURVEYORS
1220 Main Street, Suite 150, Vancouver, WA 98660
phone: 360.750.1131 www.hhpr.com fax: 360.750.1141

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WILLOW GROVE
1106 WALNUT STREET
KELSO, WA 98626

LAND USE PERMIT

REV	DATE	FILE

PM:

JOB: 22012

DATE: 12/01/2022

C1.0

COVER SHEET

GENERAL NOTES

1. ALL MATERIALS AND METHODS OF CONSTRUCTION AND INSTALLATION FOR WATER, SEWER, STORM WATER FACILITIES, AND EROSION CONTROL MEASURES, SHALL CONFORM TO CITY OF KELSO "ENGINEERING DESIGN MANUAL". CONSTRUCTION SHALL BE AS PER THE MOST CURRENT STANDARD DETAILS CONTAINED THEREIN.
2. TRANSPORTATION ELEMENTS OF THESE PLANS SHALL CONFORM TO THE STANDARDS AND DETAILS SPECIFIED IN THE CITY OF KELSO ENGINEERING DESIGN MANUAL.
3. STREET SIGNING AND STRIPING SHALL BE INSTALLED BY THE DEVELOPER. ALL STREET SIGNS AND STRIPING SHALL BE INSTALLED PER THE MUTCD.
4. STREET LIGHTING WILL BE INSTALLED BY THE DEVELOPER PER P.U.D. APPROVED STREET LIGHTING PLANS.
5. PRE-PAVING AS-BUILTS SHALL BE SUBMITTED TO THE CITY OF KELSO CONSTRUCTION OFFICE AND CITY INSPECTOR FOR BOTH SANITARY SEWER AND STORM SEWER, PRIOR TO PAVING.
6. PAVING WILL NOT BE ALLOWED DURING WET OR COLD WEATHER, PER WSDOT SPECIFICATIONS.
7. ANY SIGNIFICANT DEVIATIONS FROM THE PLANS WILL REQUIRE A REQUEST FROM THE APPLICANT'S ENGINEER AND APPROVAL FROM THE CITY'S ENGINEER AND CITY INSPECTOR.
8. ALL PAVEMENT SHALL BE STRAIGHT CUT PRIOR TO PAVING. EXISTING PAVEMENT SHALL BE REMOVED AS NECESSARY TO PROVIDE A SMOOTH TRANSITION FOR BOTH RIDE AND DRAINAGE.
9. SUBGRADE PREPARATION DURING WET OR WINTER TIME CONSTRUCTION IS USUALLY/OFTEN NOT FEASIBLE. A WET OR WINTER TIME PLAN SHALL BE SUBMITTED TO CITY OF KELSO, DEVELOPMENT ENGINEERING STAFF FOR REVIEW AND APPROVAL IF THE CONTRACTOR PLANS TO COMMENCE WITH CONSTRUCTION DURING WET WEATHER CONDITIONS. IF PAVING FROM OCTOBER 15TH TO MARCH 3OTH, A WET WEATHER SUBGRADE PREPARATION PLAN IS REQUIRED. THE SUBGRADE MUST BE OVER EXCAVATED AND A GEOTEXTILE LINER USED. THE INSPECTOR SHALL APPROVE A COMPLETE PROOF ROLL TEST ON BOTH SIDES OF THE STREET.

GRADING NOTES

1. CONTRACTOR SHALL REMOVE AND DISPOSE OF TREES, STUMPS, BRUSH, ROOTS, AND OTHER UNACCEPTABLE MATERIAL OFF-SITE. MATERIAL SHALL BE DISPOSED OF IN SUCH A MANNER AS TO MEET LOCAL REGULATIONS.
2. ALL CONSTRUCTION WITHIN CITY OF KELSO RIGHT-OF-WAY SHALL HAVE AN APPROVED TRAFFIC CONTROL PLAN AND RIGHT-OF-WAY PERMIT PRIOR TO ANY ON-SITE CONSTRUCTION.
3. TWO-WAY TRAFFIC MUST BE MAINTAINED AT ALL TIMES ON THE ADJACENT PUBLIC STREETS.
4. THE APPLICANT MAY BE REQUIRED TO PROVIDE FLAGGING, SIGNS, AND OTHER TRAFFIC CONTROL DEVICES FOR SAFE TRUCK ACCESS ONTO PUBLIC STREETS. ALL SUCH DEVICES SHALL CONFORM TO THE STANDARDS ESTABLISHED IN THE LATEST ADOPTED EDITION OF THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" (MUTCD) PUBLISHED BY THE U.S. DEPARTMENT OF TRANSPORTATION AND THE MODIFICATIONS TO THE MUTCD FOR STREETS AND HIGHWAYS FOR THE STATE OF WASHINGTON.
5. PRIOR TO BEGINNING CONSTRUCTION, ALL AREAS OF THE SITE THAT WILL RECEIVE FOUNDATIONS, STRUCTURAL FILL, FLOOR SLABS, OR PAVEMENT SHALL BE STRIPPED OF TOP SOIL, ROOTS, AND UNSUITABLE FILLS, I.E., EXCAVATED TO NON-ORGANIC, NATIVE UNDISTURBED SOIL OR COMPACTED STRUCTURAL FILL. REFER TO THE GEOTECH REPORT FOR OVER EXCAVATION REQUIREMENTS.
6. SEE GEOTECH REPORT FOR GENERAL SITE CONDITIONS AND INFORMATION.

EROSION CONTROL

1. THE CONTRACTOR IS RESPONSIBLE FOR EROSION CONTROL DURING AND AFTER INSTALLATION OF ALL UTILITY WORK ASSOCIATED WITH UTILITY TRENCHES.
2. SEDIMENT CONTROL SHALL BE ESTABLISHED PRIOR TO THE COMMENCEMENT OF WORK AND MAINTAINED THROUGH THE LIFE OF THE PROJECT, AS CALLED OUT ON THE PLANS.
3. ALL EXPOSED AND UNWORKED SOILS SHALL BE STABILIZED BY A SUITABLE APPLICATION OF AN APPROPRIATE BEST MANAGEMENT PRACTICE (BMP). DURING THE PERIOD FROM OCTOBER 1 TO APRIL 30 NO SOIL SHALL BE EXPOSED FOR MORE THAN TWO (2) DAYS. FROM MAY 1 TO SEPTEMBER 30 NO SOIL SHALL BE EXPOSED FOR MORE THAN SEVEN (7) DAYS.
4. PAVEMENT SWEEPING AND SHOVELING IS REQUIRED. WASHING THE PAVEMENT INTO THE EXISTING STORM SYSTEM WILL NOT BE PERMITTED.
5. THE CONTRACTOR SHALL MAINTAIN ON-SITE A WRITTEN DAILY LOG OF EROSION CONTROL PRACTICE MAINTENANCE.
6. IF THE CITY INSPECTOR OR ENGINEER(S) HAS EVIDENCE OF POOR CONSTRUCTION PRACTICES OR EROSION CONTROL TECHNIQUES, CITATIONS AND/OR A STOP WORK ORDER SHALL BE ISSUED UNTIL PROPER MEASURES HAVE BEEN TAKEN AND APPROVED BY CITY OF VANCOUVER. IF THE BMP'S APPLIED TO A SITE ARE INSUFFICIENT TO PREVENT SEDIMENT FROM REACHING WATER BODIES, ADJACENT PROPERTIES, OR PUBLIC RIGHT-OF-WAY, THEN THE DIRECTOR SHALL REQUIRE ADDITIONAL BMP'S.
7. EROSION CONTROL AS SHOWN ON THE PLANS ARE THE BASE RECOMMENDATIONS, AND ARE IN NO WAY INTENDED TO REPRESENT ALL OF THE POTENTIAL EROSION CONTROL MEASURES THAT MAY BE REQUIRED DURING CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR GRADING OF TEMPORARY CUT-OFF DITCHES, SEDIMENTATION PONDS, SUMPS, BAKER TANKS™, BYPASS PUMPING, AND/OR OTHER MEANS AS REQUIRED AND NECESSARY TO CONTROL STORM WATER RUNOFF DURING CONSTRUCTION SO THAT NO SILT-LADEN WATER LEAVES THE PROJECT SITE. ALL SUCH MEASURES SHALL BE AT CONTRACTOR'S EXPENSE.

STORM NOTES

1. TRACER WIRE SHALL BE INSTALLED ALONG THE TOP OF ALL PIPE. EXTEND THE TRACER WIRE INTO MANHOLES AND ALL OTHER STRUCTURES, THEN UP THE INSIDE WALL OF STRUCTURES AND ATTACH THE WIRE TO THE TOP INSIDE OF THE STRUCTURE. PROVIDE 3 FEET OF COILED TRACER WIRE SLACK ATTACHED TO THE TOP INSIDE OF THE STRUCTURE.
2. MANHOLES AND TYPE 2 CATCH BASINS SHALL BE ADJUSTED TO GRADE FOLLOWING PAVING. ADJUST TO GRADE USING AN APPROVED FOUR-POINT ADJUSTMENT SYSTEM SUCH AS THE RIMRISER SHIMLESS ADJUSTMENT SYSTEM, OR APPROVED EQUAL.
3. STORM SEWERS AND APPURTENANCES SHALL BE CLEANED, AIR TESTED AND DEFLECTION TESTED AFTER BACKFILLING. THE LOW PRESSURE AIR TEST METHOD SHALL BE USED. TV INSPECTION SHALL BE PERFORMED AFTER CLEANING, TESTING AND CORRECTIONS ARE COMPLETE. CLEANING, AIR TESTING, INFILTRATION TESTING, DEFLECTION TESTING, AND TV INSPECTION SHALL BE COMPLETED PRIOR TO PAVEMENT RESTORATION OF THE TRENCH. AN ELECTRONIC COPY OF THE TV INSPECTION VIDEO AND THE TV INSPECTION REPORT SHALL BE PROVIDED TO THE INSPECTOR. TOP LIFT OF PAVING SHALL NOT BE PLACED UNTIL THE INSPECTOR HAS APPROVED THE TV INSPECTION.
4. ALL MANHOLES SHALL BE WATERTIGHT. FOLLOWING BACKFILL AND PRIOR TO FINAL PAVING, PERFORM VACUUM TESTING ON MANHOLES PER THE REQUIREMENTS OF THE SUPPLEMENT TO STANDARD PLAN B-15.20-01.
5. AS-BUILT DRAWINGS AND TV REPORTS SHALL BE PROVIDED PRIOR TO FINAL ACCEPTANCE.

SANITARY SEWER NOTES

1. TRACER WIRE SHALL BE INSTALLED ALONG THE TOP OF ALL PIPE. EXTEND THE TRACER WIRE INTO MANHOLES AND ALL OTHER STRUCTURES, THEN UP THE INSIDE WALL OF STRUCTURES AND ATTACH THE WIRE TO THE TOP INSIDE OF THE STRUCTURE. PROVIDE 3 FEET OF COILED TRACER WIRE SLACK ATTACHED TO THE TOP INSIDE OF THE STRUCTURE.
2. MANHOLES SHALL BE ADJUSTED TO GRADE FOLLOWING PAVING. ADJUST USING AN APPROVED FOUR-POINT ADJUSTMENT SYSTEM SYSTEM SUCH AS THE RIMRISE SHIMLESS ADJUSTMENT SYSTEM, OR APPROVED EQUAL.
3. SANITARY SEWERS AND APPURTENANCES SHALL BE CLEANED, AIR TESTED AND DEFLECTION TESTED AFTER BACKFILLING. THE LOW PRESSURE AIR TEST METHOD SHALL BE USED. TV INSPECTION SHALL BE PERFORMED AFTER CLEANING, TESTING AND CORRECTIONS ARE COMPLETE. CLEANING, AIR TESTING, INFILTRATION TESTING, DEFLECTION TESTING, AND TV INSPECTION SHALL BE COMPLETED PRIOR TO PAVEMENT RESTORATION OF THE TRENCH. AN ELECTRONIC COPY OF THE TV INSPECTION VIDEO AND THE TV INSPECTION REPORT SHALL BE PROVIDED TO THE INSPECTOR. TOP LIFT OF PAVING SHALL NOT BE PLACED UNTIL THE INSPECTOR HAS APPROVED THE TV INSPECTION.
4. ALL MANHOLES SHALL BE WATERTIGHT. FOLLOWING BACKFILL AND PRIOR TO FINAL PAVING, PERFORM VACUUM TESTING ON MANHOLES PER THE REQUIREMENTS OF THE SUPPLEMENT TO STANDARD PLAN B-15.20-01.
5. AS-BUILT DRAWINGS AND TV REPORTS SHALL BE PROVIDED PRIOR TO FINAL ACCEPTANCE.

WATER NOTES

1. ALL WATERMAIN INSTALLATION, DISINFECTION AND TESTING SHALL COMPLY WITH WSDOT STANDARD SPECIFICATIONS. UNIFORM PLUMBING CODE, AND CITY OF KELSO WATER DESIGN AND CONSTRUCTION STANDARDS.

PROPOSED LEGEND

Symbol	Description
309	CONTOUR - 1'
310	CONTOUR - 5'
	SAWCUT
x x x	FENCE
SS	SANITARY CLEANOUT/MANHOLE
SAN	SANITARY LINE
SD	STORM CATCH BASIN/MANHOLE
	STORM LINE
WQ	STORMFILTER MANHOLE
	FDC/FIRE HYDRANT
	WATER VALVE/AIR RELEASE VALVE
W	WATER METER
W	WATER LINE
	TREE PROTECTION FENCING
x x x	SEDIMENT FENCE
	CONSTRUCTION ENTRANCE
	INLET PROTECTION

SURFACE LEGEND

- HMA PAVEMENT
- HMA PAVEMENT FOR DRIVE AISLE
- CONCRETE SIDEWALK/PATH
- LANDSCAPING AREA

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LANDSCAPE ARCHITECTS • SURVEYORS
1220 Main Street, Suite 150, Vancouver, WA 98660
phone: 360.750.1131 www.hhpr.com fax: 360.750.1141

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KELLY D. BACHELDER
STATE OF WASHINGTON
40581
REGISTERED
PROFESSIONAL ENGINEER
PRELIMINARY NOT FOR CONSTRUCTION

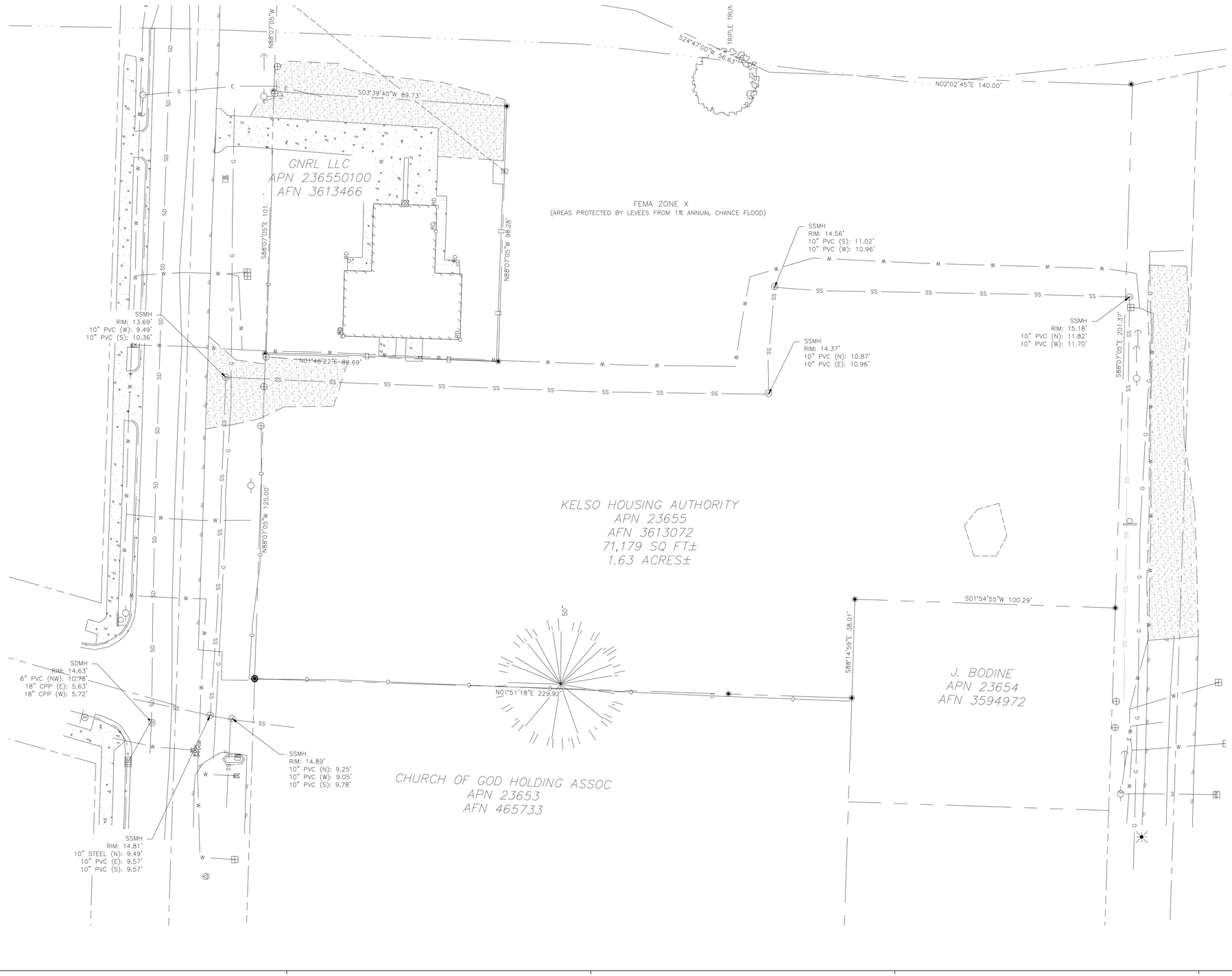
WILLOW GROVE
1106 WALNUT STREET
KELSO, WA 98626

LAND USE PERMIT

REV	DATE	FILE

PM:
JOB: 22012
DATE: 12/01/2022

C1.1
GENERAL NOTES



0 10 20 40

SCALE: 1" = 20'

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phone: 360.750.1131 www.hhpr.com fax: 360.750.1141

S&F Land Services

PORTLAND, VANCOUVER, BEND, SEASIDE

4858 SW SCHOLLS FERRY RD.
STE A, PORTLAND, OR 97225
(503) 345-0328

WWW.SFLANDS.COM EMAIL: INFO@SFLANDS.COM

LOCATED IN THE SW QUARTER OF SECTION 35, TOWNSHIP 8 NORTH, RANGE 2 WEST, WILLAMETTE MERIDIAN, IN THE CITY OF KELSO, COWLITZ COUNTY, WASHINGTON

HORIZONTAL DATUM (BASIS OF BEARINGS):

THIS SURVEY UTILIZES THE WASHINGTON STATE PLANE COORDINATE SYSTEM – SOUTH ZONE. THE PROJECT WAS SCALED TO GROUND AROUND CONTROL POINT #1 WITH A SCALE FACTOR OF 1.0000515101. DISTANCES SHOWN ARE GROUND DISTANCES. TO OBTAIN GRID DISTANCES, DIVIDE BY THE SCALE FACTOR. CONTROL POINT #1 WAS OBSERVED WITH STATIC GPS PROCESSED THROUGH TRIMBLE RTX. NORTH AMERICAN DATUM OF NAD83/2011 (EPOCH 2010.0000). UNITS IN US SURVEY FEET.

VERTICAL DATUM:

NAVD88 BASED ON STATIC GPS OBSERVATIONS ON POINT 1, PROCESSED THROUGH TRIMBLE RTX.

6. EASEMENT(S) FOR THE PURPOSE(S) SHOWN BELOW AND RIGHTS INCIDENTAL THERETO AS SET FORTH IN A DOCUMENT:

IN FAVOR OF: PUBLIC UTILITY DISTRICT NO. 1 OF COWLITZ COUNTY, WASHINGTON, A MUNICIPAL CORPORATION

PURPOSE: UNDERGROUND TRANSMISSION OF ELECTRIC ENERGY, INCLUDING ALL ASSOCIATED FACILITIES AND APPURTENANCES

RECORDING DATE: DECEMBER 29, 2000

RECORDING NO.: 3104207

AFFECTS:

–DESCRIBES A LINE RUNNING FROM A POINT 15 FEET WEST OF THE NORTHEAST PROPERTY CORNER, THENCE SOUTHWESTERLY APPROXIMATELY 110 FEET TO A TRANSFORMER.

–SAID APPROXIMATE LINE IS SHOWN.

–ALSO INCLUDES 'RIGHT TO MAKE FUTURE UNDERGROUND ELECTRIC LINE EXTENSIONS ROM SAID UNDERGROUND ELECTRIC LINE SYSTEM TO ACCOMMODATE FUTURE DEVELOPMENT WITHIN THE GRANTORS PROPERTY.'

–UNDERGROUND ELECTRIC LINE LOCATED BY UTILITY DIFFERS FROM APPROXIMATE DESCRIBED LOCATION AS SHOWN.

NOTES:

1) THE SUBJECT PROPERTY LIES WITHIN ZONE A, 1% ANNUAL CHANCE (100-YEAR FLOOD) FLOODPLAIN, NO BASE FLOOD ELEVATIONS DETERMINED, AND SHADED ZONE X, AREAS PROTECTED BY LEVEES FROM 1% ANNUAL CHANCE FLOOD, AS SHOWN PER FEMA FLOOD INSURANCE MAP NUMBERS 53015C0518G AND 53015C0519G, EFFECTIVE DATE DECEMBER 16, 2015.
   – SHADED ZONE X HAS THE FOLLOWING NOTE ON SAID MAPS: 'NOTE: THIS AREA IS SHOWN AS BEING PROTECTED FROM TEH 1-PERCENT-ANNUAL-CHANCE OR GREATER FLOOD HAZARD BY A LEVEE SYSTEM THAT HAS BEEN PROVISIONALLY ACCREDITIED. OVERTOPPING OR FAILURE OF ANY LEVEE SYSTEM IS POSSIBLE. FOR ADDITIONAL INFORMATION, SEE THE "PROVISIONALLY ACCREDITED LEVEE NOTE" IN NOTES TO USERS."

2) THE LOCATION OF EXISTING ABOVEGROUND UTILITY FACILITIES SHOWN HEREON ARE BASED ON FIELD OBSERVATIONS. A UTILITY LOCATE TICKET WAS SUBMITTED WITH NUMBER 2228988. THE SURVEYOR ASSUMES NO RESPONSIBILITY FOR THE EXISTING UNDERGROUND UTILITIES BY THE RESPECTIVE UTILITY OWNERS, NOR FOR THE EXISTENCE OF BURIED OBJECTS WHICH ARE NOT SHOWN ON THE PLAN. ALL UTILITY LOCATIONS SHOULD BE FIELD VERIFIED PRIOR TO CONSTRUCTION, AND A UTILITY LOCATE TICKET SHOULD BE SUBMITTED.

3) SEWER AND WATER LINES CROSS THE PROPERTY AS SHOWN. IT IS NOT KNOWN IF EASEMENTS FOR THESE UTILITIES EXIST. THE CHICAGO TITLE COMPANY OF WASHINGTON WAS CONTACTED REGARDING THIS MATTER, AND NO EASEMENT WAS FOUND. WE SEARCHED THE ONLINE DEED RECORDS BACK TO 1991, AND FOUND NO EASEMENTS. WE ALSO PLACED MULTIPLE VOICEMAILS AND EMAILS TO THE CITY OF KELSO ENGINEERING DEPARTMENT REGARDING THESE LINES, AND HAVE YET TO RECEIVE A RESPONSE. THE CITY UTILITY LOCATOR, NATHAN VORSE AT 360-957-8083, KNEW ABOUT THE LINES, BUT DIRECTED US BACK TO THE ENGINEERING DEPARTMENT FOR ANY QUESTIONS ABOUT EASEMENTS.

4) ONLY THE 2 TREES SHOWN WERE SURVEYED. OTHER SMALLER TREES MAY EXIST ON THE PROPERTY, MAINLY ALONG THE EASTERN BOUNDARY.

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WILLOW GROVE

1106 WALNUT STREET
KELSO, WA 98626

LAND USE PERMIT

REV	DATE	FILE

PM:

JOB: 22012

DATE: 12/01/2022

C2.0

EXISTING CONDITIONS PLAN

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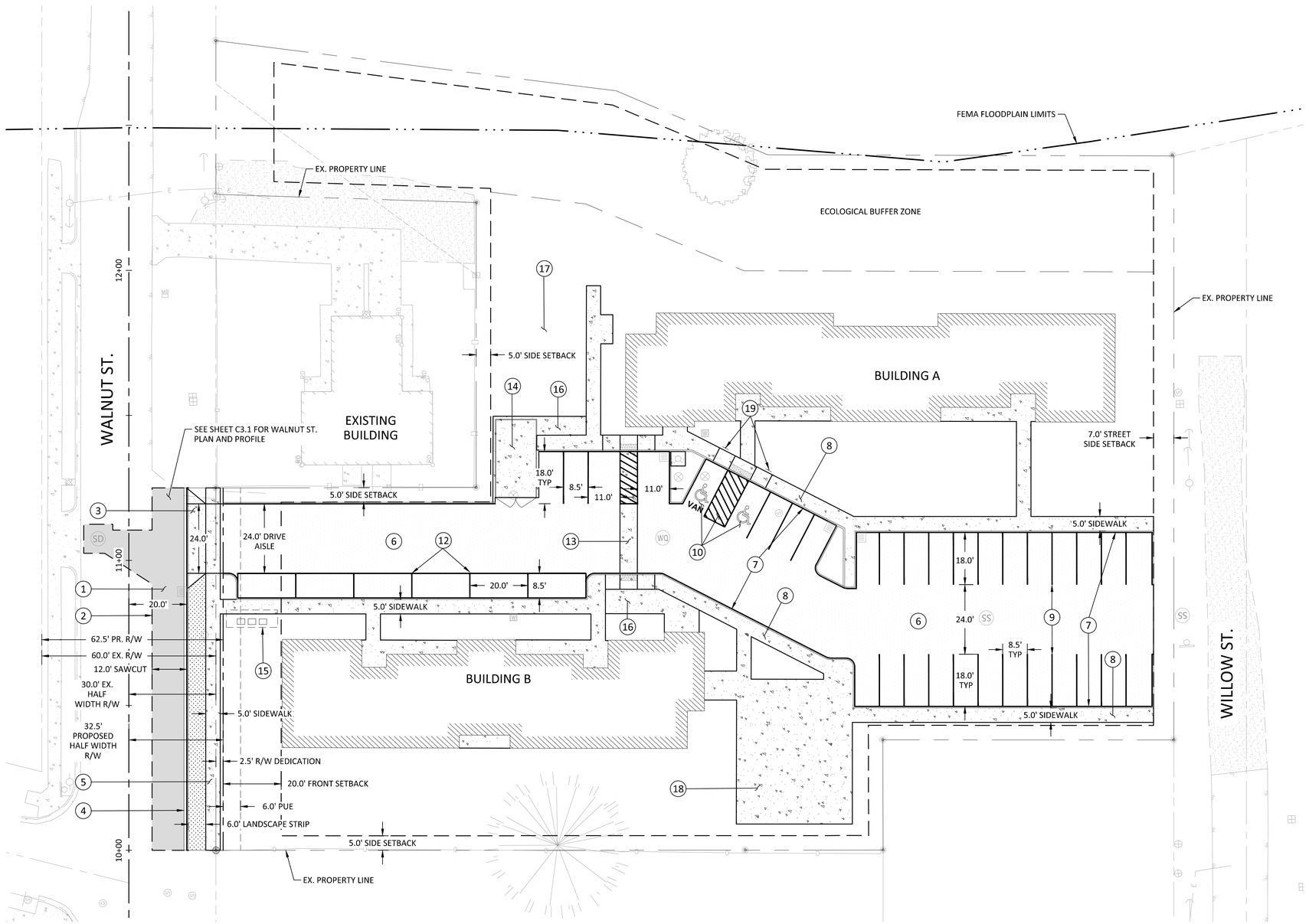

CONSTRUCTION NOTES:

1. PROPOSED PUBLIC HALF-STREET IMPROVEMENT. SEE SHEET C3.1 FOR DETAILS.
2. SAWCUT EXISTING PAVEMENT AND REMOVE AS NECESSARY.
3. CONSTRUCT CONCRETE DRIVEWAY APPROACH PER DETAIL ON SHEET C6.0.
4. CONSTRUCT CURB & GUTTER PER DETAIL ON SHEET C6.0.
5. CONSTRUCT CONCRETE SIDEWALK PER DETAIL ON SHEET C6.0.
6. CONSTRUCT AC PAVEMENT DRIVE AISLE PER SECTION ON SHEET C6.0.
7. CONSTRUCT PRIVATE STANDARD CURB PER DETAIL ON SHEET C6.0.
8. CONSTRUCT PRIVATE SIDEWALK PER SECTION ON SHEET C6.0.
9. INSTALL STANDARD PARKING STALL STRIPING PER DETAIL ON SHEET C6.0.
10. INSTALL ADA PARKING STALL AND VAN ACCESSIBLE LOADING STALL STRIPING PER DETAIL ON SHEET C6.0.
12. INSTALL PARALLEL PARKING STALL STRIPING PER DETAIL ON SHEET C6.0.
13. CONSTRUCT CONCRETE PEDESTRIAN CROSSWALK. SEE GRADING DETAILS ON SHEET C4.1 FOR ELEVATIONS.
14. TRASH & RECYCLING ENCLOSURE. REFER TO ARCHITECTURAL PLANS FOR DETAIL.
15. COVERED MAILBOX AREA. REFER TO ARCHITECTURAL PLANS FOR DETAIL.
16. COVERED BIKE PARKING AREA. REFER TO ARCHITECTURAL PLANS FOR DETAIL.
17. PLAYGROUND AREA. REFER TO LANDSCAPING PLANS FOR DETAIL.
18. COMMUNITY GARDEN AREA. REFER TO LANDSCAPING PLANS FOR DETAIL.
19. INSTALL ADA PARKING STALL SIGNAGE PER DETAIL ON SHEET C6.1.

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MELISSA D. BACA
STATE OF WASHINGTON
EXPIRES: 10/13/2023
PRELIMINARY NOT FOR CONSTRUCTION
PROFESSIONAL ENGINEER

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KELSO, WA 98626

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C3.0
SITE PLAN

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1220 Main Street, Suite 150, Vancouver, WA 98660
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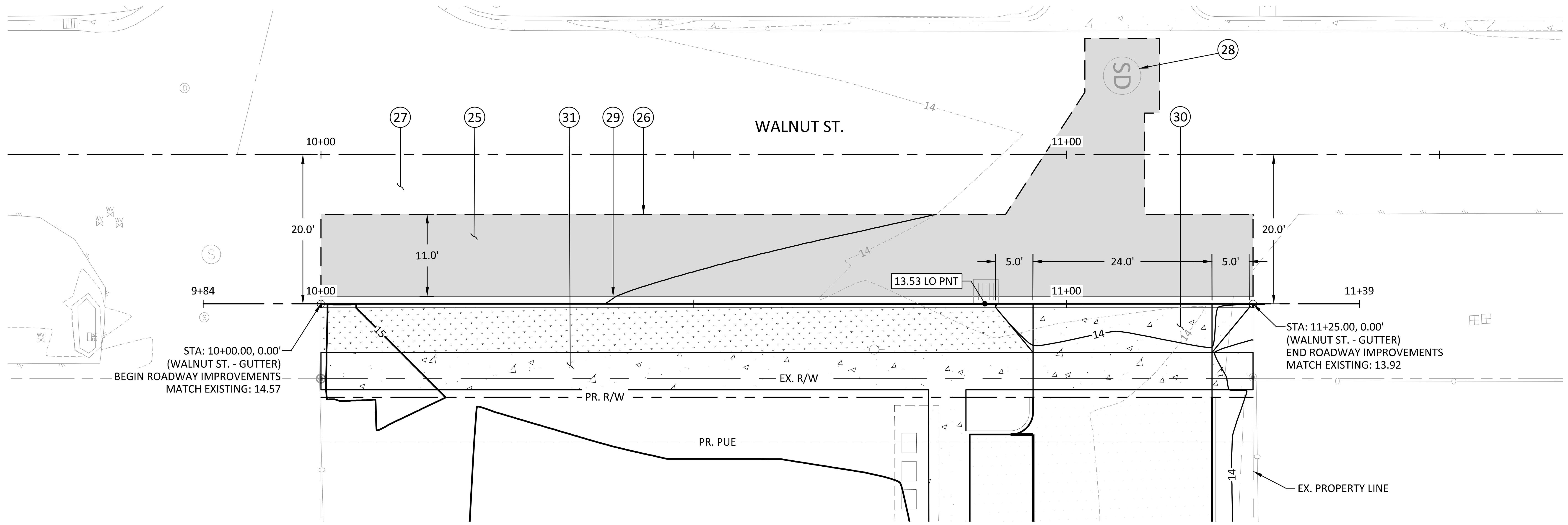
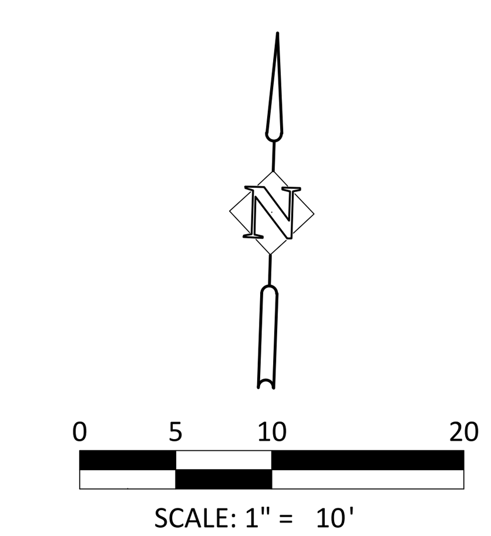
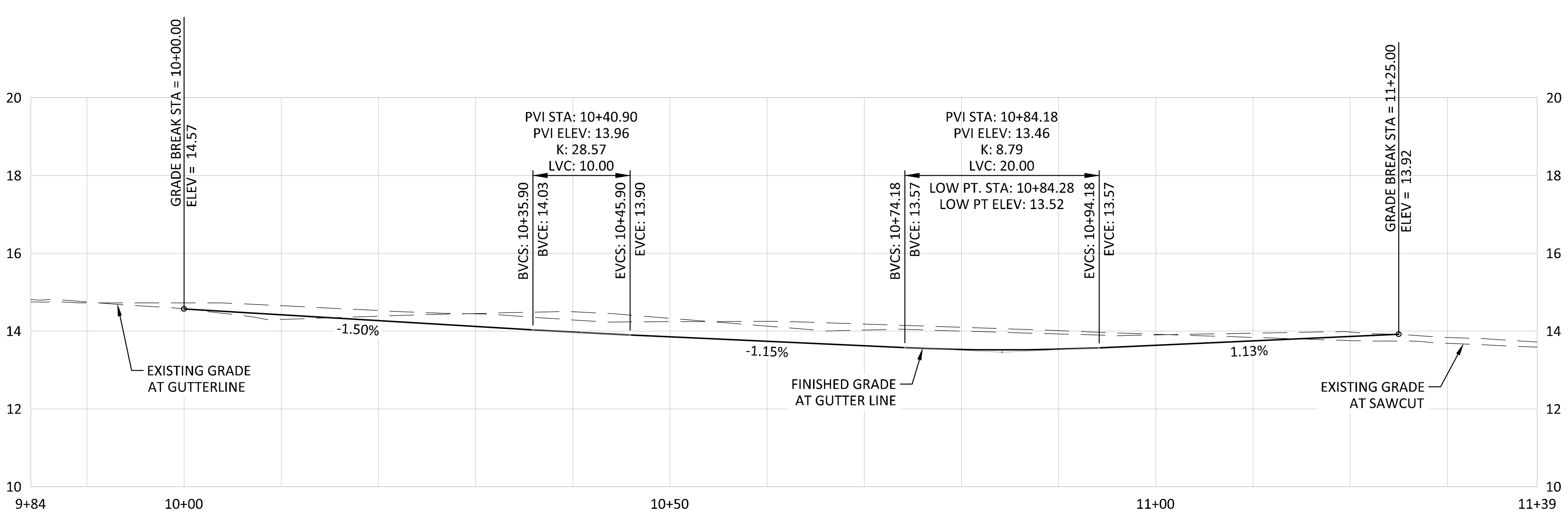


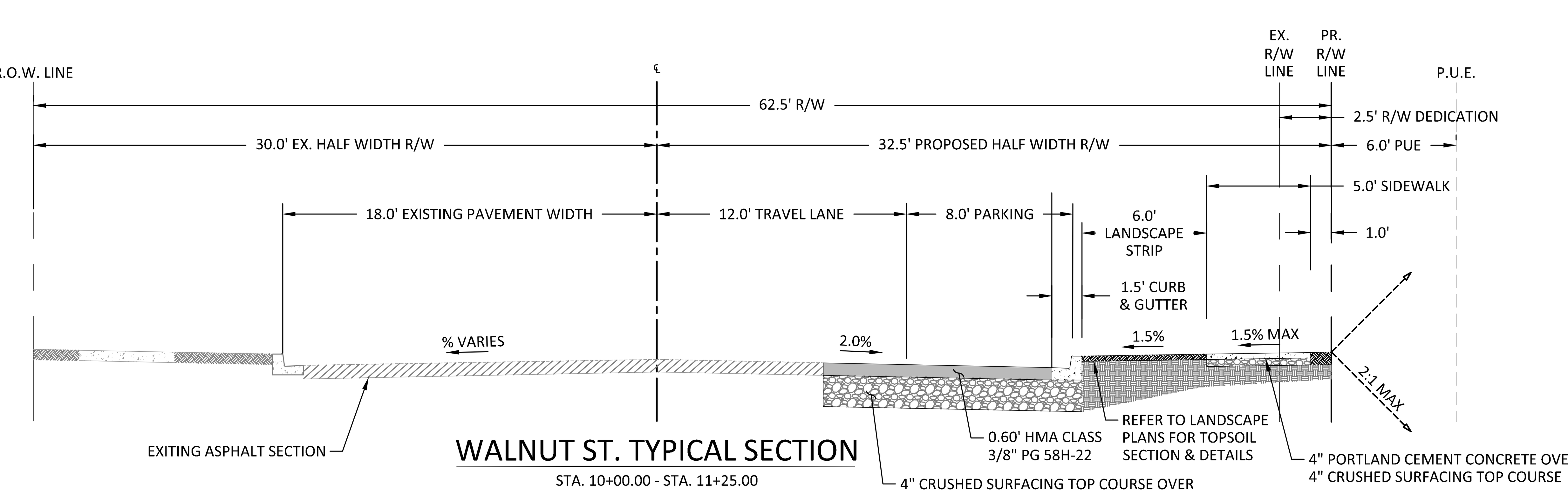
(25) CONSTRUCT HALF STREET IMPROVEMENT PER SECTION THIS SHEET.
(26) SAWCUT AND REMOVE EXISTING PAVEMENT AS NECESSARY.
(27) PROTECT EXISTING PAVEMENT.
(28) PROTECT EXISTING MANHOLE. ADJUST TO FINISH GRADE AS NECESSARY.
(29) CONSTRUCT CURB AND GUTTER PER DETAIL ON SHEET C6.0.
(30) CONSTRUCT CONCRETE DRIVEWAY PER DETAIL ON SHEET C6.0.
(31) CONSTRUCT SIDEWALK PER DETAIL ON SHEET C6.0.





WALNUT ST. - GUTTER LINE

SCALE: 1" = 10' (HORIZ.)
1" = 2' (VERT.)



WALNUT ST. TYPICAL SECTION

STA. 10+00.00 - STA. 11+25.00

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C3.1

WALNUT ST. PLAN & PROFILE

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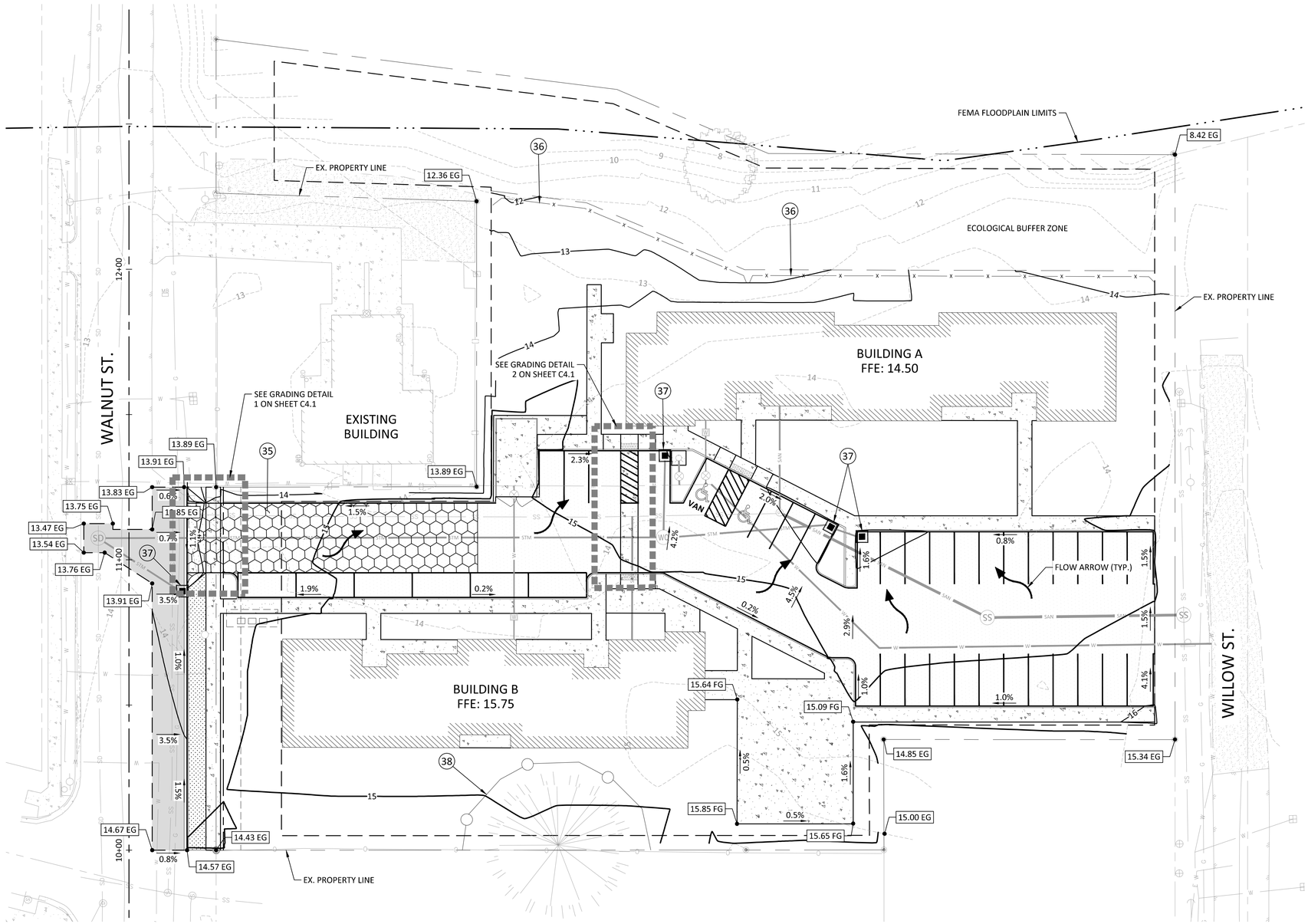
phone: 360.750.1131 www.hhpr.com fax: 360.750.1141

CONSTRUCTION NOTES:

35 INSTALL CONSTRUCTION ENTRANCE PER DETAIL ON SHEET C6.3.
36 INSTALL SEDIMENT FENCE PER DETAIL ON SHEET C6.3.
37 INSTALL INLET PROTECTION PER DETAIL ON SHEET C6.3.
38 INSTALL TREE PROTECTION FENCING PER DETAIL ON SHEET C6.3.



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C4.0
GRADING & ESC PLAN

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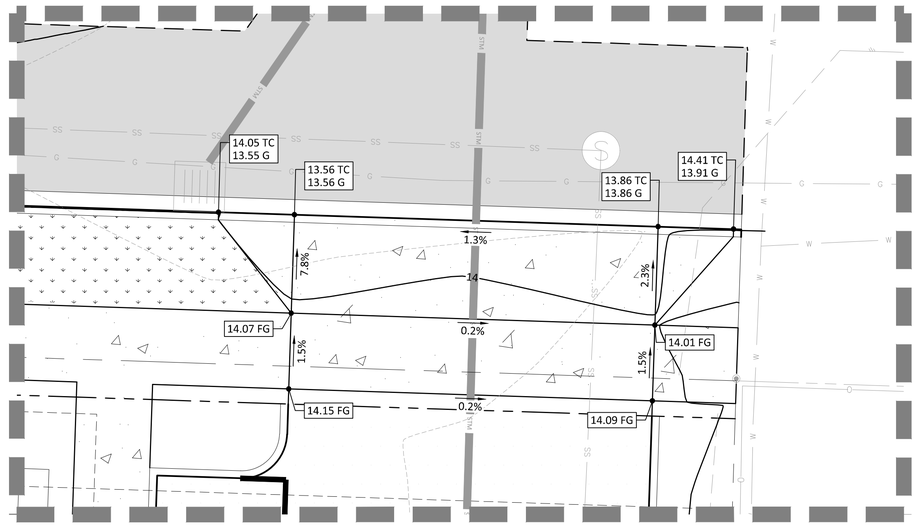
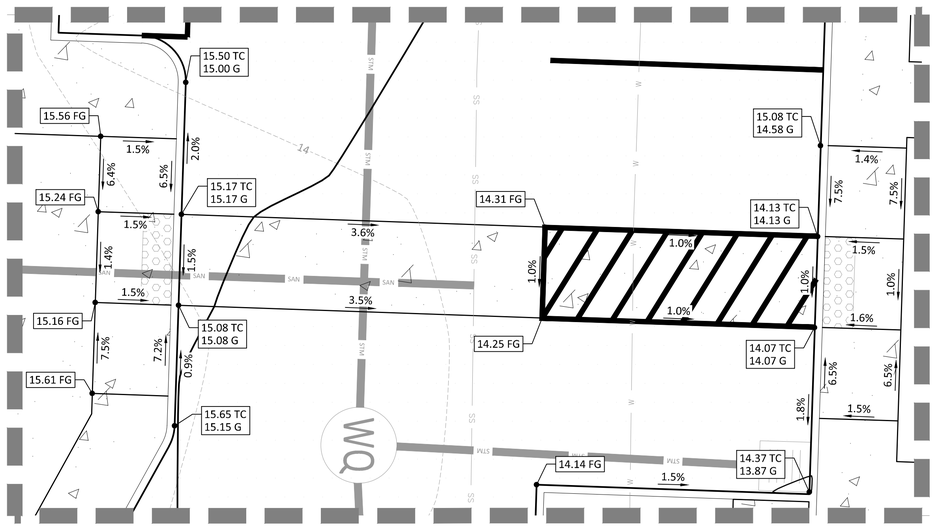


GRADING DETAIL 1
SCALE: 1" = 5'



GRADING DETAIL 2
SCALE: 1" = 5'

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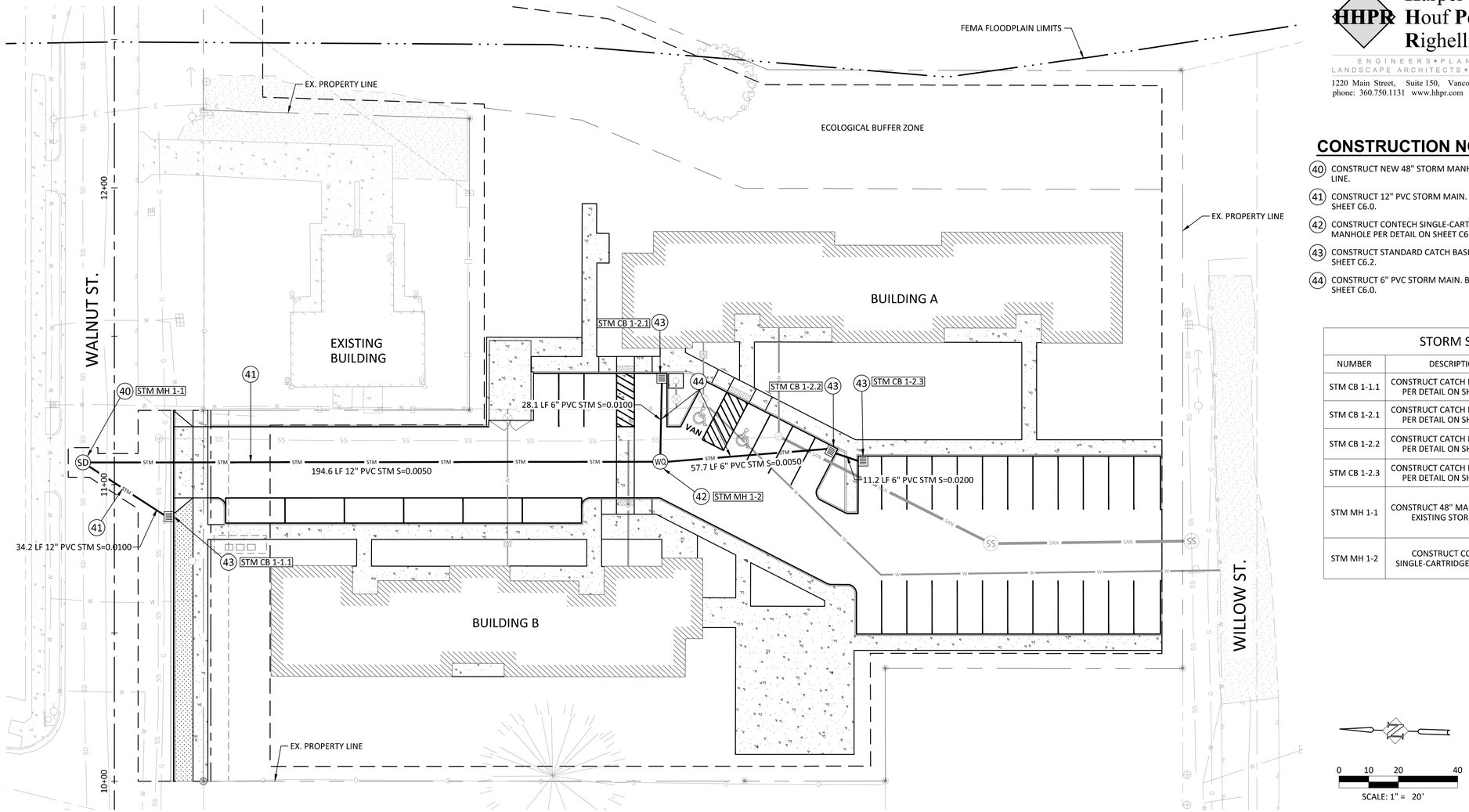
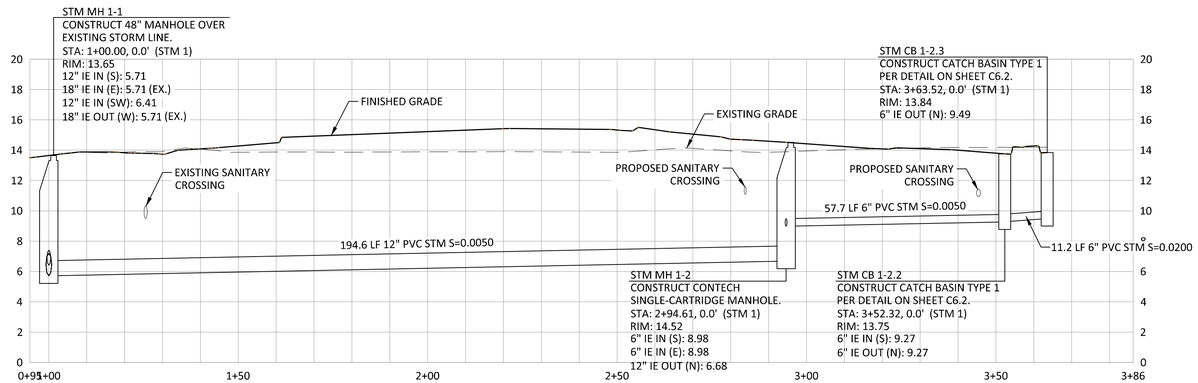
C4.1
GRADING DETAILS





STORM 1

SCALE: 1" = 20' (HORIZ.)
1" = 5' (VERT.)

CONSTRUCTION NOTES:

(40) CONSTRUCT NEW 48" STORM MANHOLE OVER EXISTING STORM LINE.

(41) CONSTRUCT 12" PVC STORM MAIN. BACKFILL PER DETAIL ON SHEET C6.0.

(42) CONSTRUCT CONTECH SINGLE-CARTRIDGE STORM FILTER MANHOLE PER DETAIL ON SHEET C6.1.

(43) CONSTRUCT STANDARD CATCH BASIN TYPE 1 PER DETAIL ON SHEET C6.2.

(44) CONSTRUCT 6" PVC STORM MAIN. BACKFILL PER DETAIL ON SHEET C6.0.

STORM STRUCTURE DATA			
NUMBER	DESCRIPTION	RIM ELEV.	INVERT ELEV.
STM CB 1-1.1	CONSTRUCT CATCH BASIN TYPE 1 PER DETAIL ON SHEET C6.2.	13.56	12" IE OUT (NE): 6.75
STM CB 1-2.1	CONSTRUCT CATCH BASIN TYPE 1 PER DETAIL ON SHEET C6.2.	13.78	6" IE OUT (W): 9.26
STM CB 1-2.2	CONSTRUCT CATCH BASIN TYPE 1 PER DETAIL ON SHEET C6.2.	13.75	6" IE IN (S): 9.27 6" IE OUT (N): 9.27
STM CB 1-2.3	CONSTRUCT CATCH BASIN TYPE 1 PER DETAIL ON SHEET C6.2.	13.84	6" IE OUT (N): 9.49
STM MH 1-1	CONSTRUCT 48" MANHOLE OVER EXISTING STORM LINE.	13.65	12" IE IN (S): 5.71 18" IE OUT (W): 5.71 18" IE IN (E): 5.71 12" IE IN (SW): 6.41
STM MH 1-2	CONSTRUCT CONTECH SINGLE-CARTRIDGE MANHOLE.	14.52	6" IE IN (S): 8.98 12" IE OUT (N): 6.68 6" IE IN (E): 8.98

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KELSO, WA 98626

LAND USE PERMIT

REV	DATE	FILE

PM:
JOB: 22012
DATE: 12/01/2022

C5.0
STORM DRAINAGE PLAN

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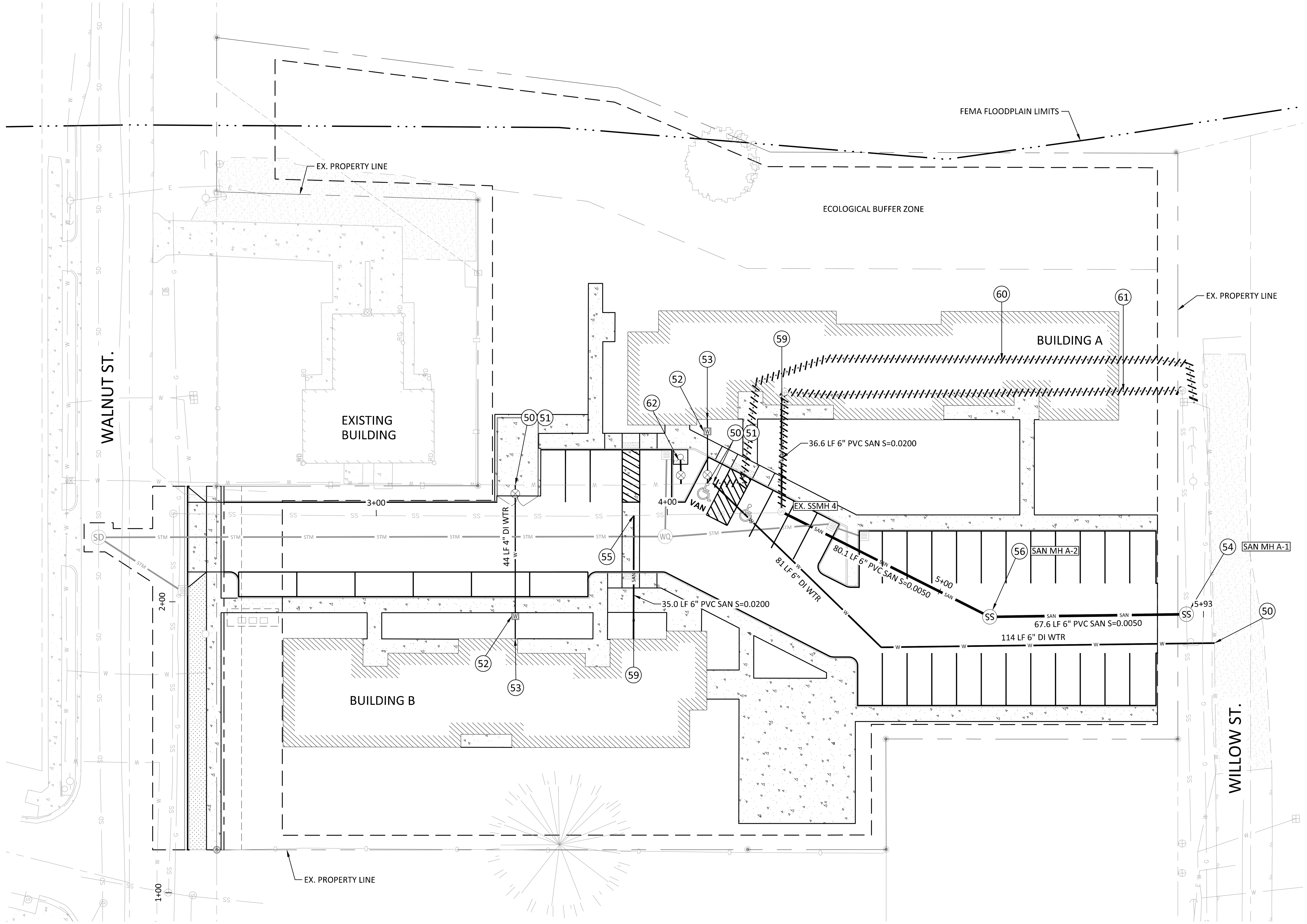


CONSTRUCTION NOTES:

- (50) CONNECT TO EXISTING WATER LINE PER DETAIL ON SHEET C6.2.
- (51) INSTALL 4" GATE VALVE.
- (52) INSTALL 2" DOMESTIC WATER METER PER DETAIL ON SHEET C6.2.
- (53) WATER SERVICE BUILDING POINT OF CONNECTION.
- (54) INSTALL NEW 48" SANITARY MANHOLE AND CONNECT EXISTING SANITARY LINE.
- (55) CONNECT TO EXISTING SANITARY LINE.
- (56) CONSTRUCT NEW 48" SANITARY MANHOLE PER DETAIL ON SHEET C6.1.
- (59) SANITARY SEWER BUILDING POINT OF CONNECTION.
- (60) REMOVE EXISTING WATER LINE.
- (61) REMOVE EXISTING SANITARY LINE.
- (62) INSTALL FIRE HYDRANT PER DETAIL ON SHEET C6.2.

SANITARY STRUCTURE DATA

NUMBER	LOCATION	RIM ELEV.	INVERT ELEV.
EX. SSMH 4	SAN A STA:4+39.20, 0.00	14.02	10" IE OUT (N): 10.87 (EX.) 6" IE IN (E): 11.37 (PLUG) 6" IE IN (SW): 10.87 10" IE IN (E): 10.96
SAN MH A-1	SAN A STA:5+86.92, 0.00	15.73	6" IE OUT (N): 11.61 (EX.) 10" IE IN (E): 11.61 10" IE OUT (W): 11.61(PLUG)
SAN MH A-2	SAN A STA:5+19.34, 0.00	14.62	6" IE OUT (NE): 11.27 6" IE IN (S): 11.27

0 10 20 40
SCALE: 1" = 20'

Access | Architecture

PRELIMINARY NOT FOR CONSTRUCTION

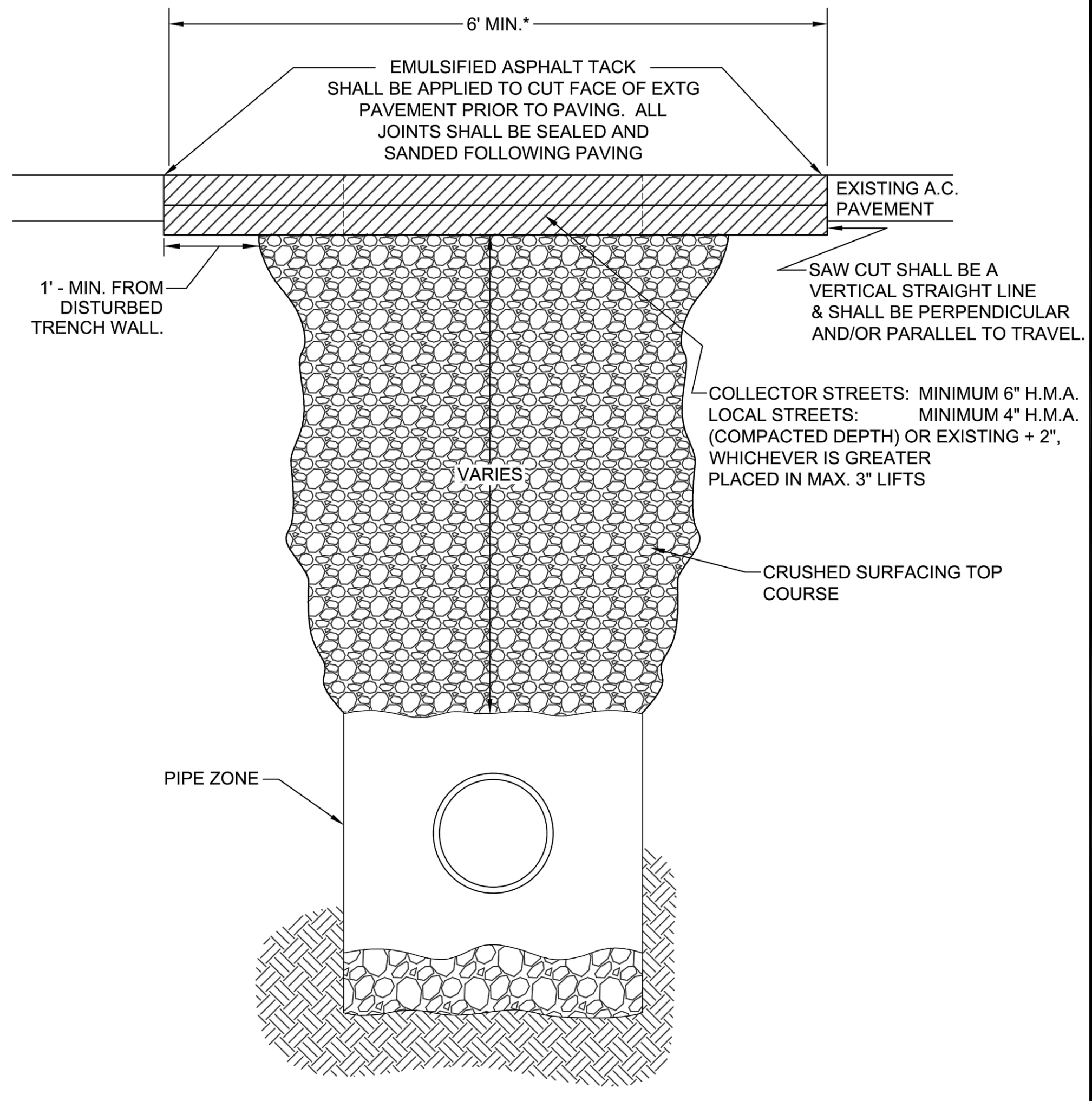
WILLOW GROVE
1106 WALNUT STREET
KELSO, WA 98626

LAND USE PERMIT

REV	DATE	FILE

PM:
JOB: 22012
DATE: 12/01/2022

C5.1
SANITARY & WATER PLAN



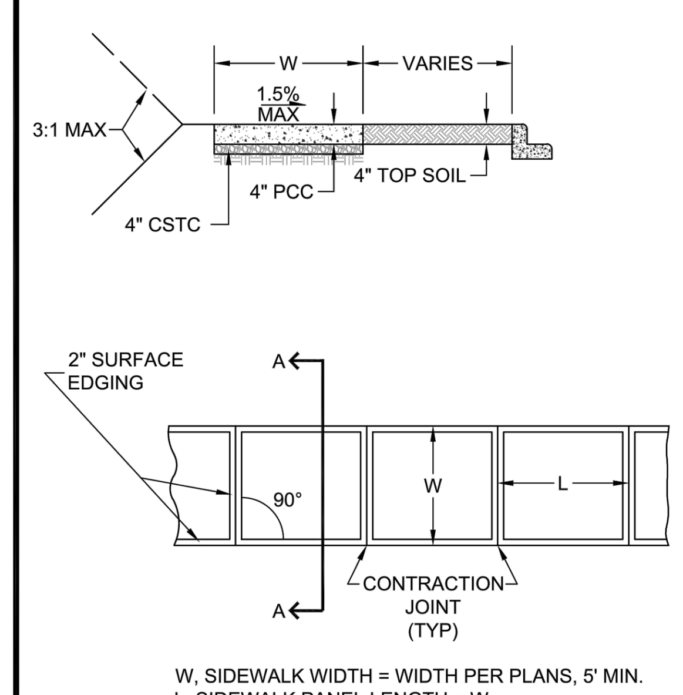
NOTES:

1. BACKFILL SHALL BE COMPACTED IN 6-INCH MAXIMUM LIFTS TO 95% DENSITY PER WSDOT T606.
2. TRENCH SHALL BE PLATED OR TEMPORARILY PAVED WITH COLD MIX, 1 1/2 INCHES THICK, UNTIL PAVED.
3. PLATE SHALL BE SECURED BY METHOD APPROVED BY ENGINEER.
4. PLACE ADVANCE WARNING SIGNS UNTIL PERMANENT PATCH IS COMPLETED.
5. RESTORE PAVEMENT MARKINGS.
6. SEAL FOR PAVEMENT JOINTS SHALL BE HOT POURED SEALANT FOR BITUMINOUS PAVEMENT, TYPE 1, PER WSDOT 9-04.2(1)A2

* RESTORATION WIDTH SHALL BE DOUBLED FOR STREETS THAT HAVE BEEN REHABILITATED WITHIN 5 YEARS. RESTORATION FOR TRENCHING CONDUCTED LONGITUDINAL TO THE STREET SHALL BE HALF STREET WIDTH. INCREASED RESTORATION WIDTH MAY BE REQUIRED WHEN MULTIPLE UTILITIES ARE PROPOSED.

N.T.S.

TRENCH BACKFILL AND RESTORATION LOCAL AND COLLECTOR STREETS		STANDARD PLAN NO. **KST-020-21**
CITY OF KELSO DEPARTMENT OF COMMUNITY DEVELOPMENT & ENGINEERING	**CITY ENGINEER APPROVAL: Michael Kardas, P.E.**	DATE: **MAY 2021**



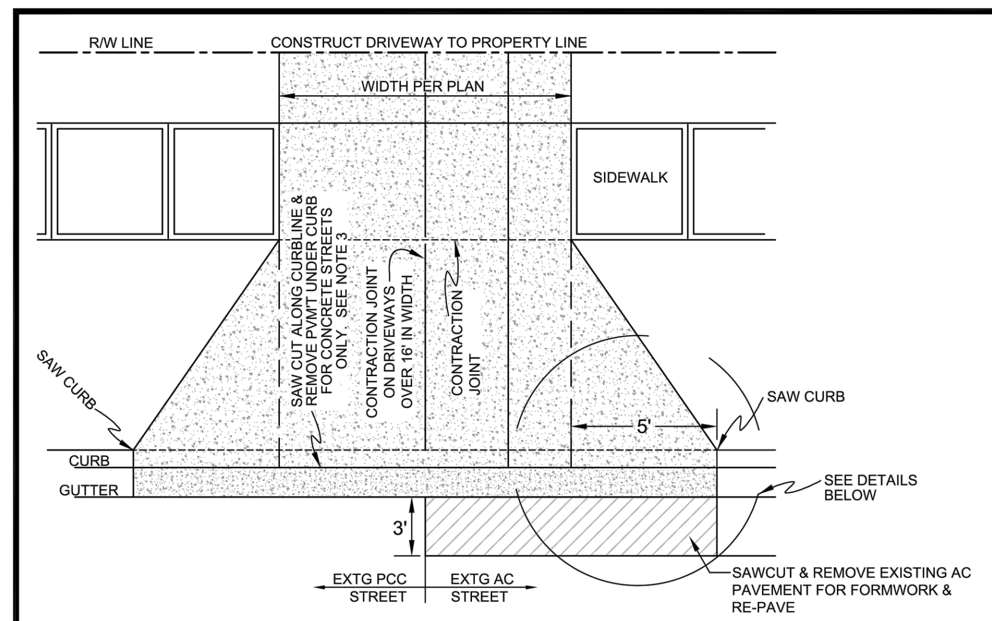
W, SIDEWALK WIDTH = WIDTH PER PLANS, 5' MIN.
L, SIDEWALK PANEL LENGTH = W

NOTES:

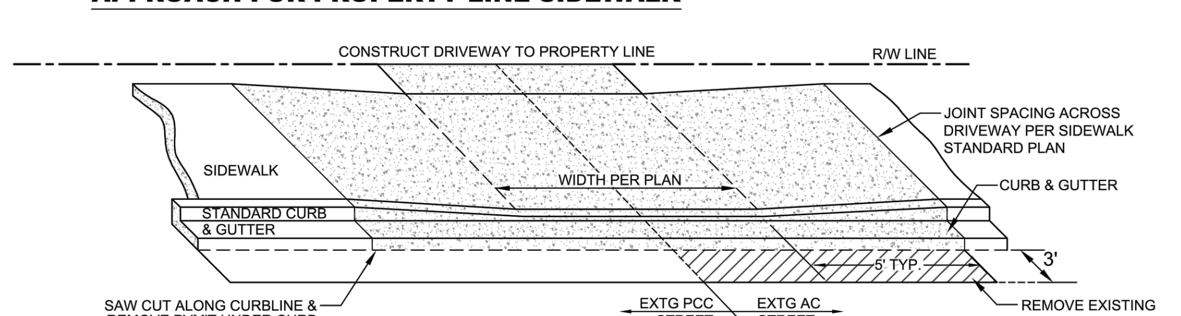
1. CONCRETE MIX SHALL BE 3000 PSI COMMERCIAL GRADE.
2. CLEAR CONCRETE SEALER SHALL BE APPLIED WITHIN (2) TWO HOURS AFTER FINISHING IS COMPLETE.
3. JOINTS IN SIDEWALK MUST ALIGN WITH JOINTS IN CURB.
4. PLACE TRANSVERSE CONTRACTION JOINTS AT INTERVALS EQUAL TO THE WIDTH OF THE SIDEWALK.
5. SURFACE EDGING (SHINER) SHALL BE 3" WIDE SMOOTH BORDERS EITHER FOLLOWING EXISTING PATTERN OR AS SHOWN . (ALSO USED ON ALL JOINTS).
6. MATCH EXISTING SCORE AND SHINER MARKS WITH SURROUNDING SIDEWALK IN AREA OR AS DIRECTED BY INSPECTOR.
7. FINISH SHALL BE BROOMED TRANSVERSE TO THE RUN OF THE SIDEWALK.
8. FOR WIDENING AROUND MAILBOXES AND OTHER OBSTRUCTIONS IN THE SIDEWALKS SEE ST-100.
9. FULL PANEL REPLACEMENT REQUIRED FOR ALL DAMAGED OR VANDILIZED CONCRETE. NO GRAFFITI DAMAGE OR REPAIRS WILL BE ACCEPTED.

N.T.S.

SIDEWALKS		STANDARD PLAN NO. **KST-070-21**
CITY OF KELSO DEPARTMENT OF COMMUNITY DEVELOPMENT & ENGINEERING	**CITY ENGINEER APPROVAL: Michael Kardas, P.E.**	DATE: **MAY 2021**



APPROACH FOR PROPERTY LINE SIDEWALK



APPROACH FOR CURB LINE SIDEWALK

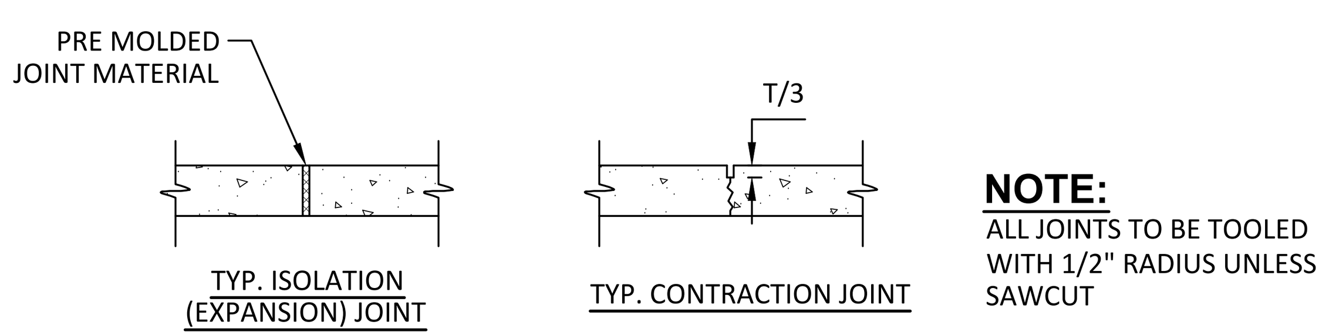
GENERAL INSTRUCTIONS:

1. SIDEWALK PORTION OF DRIVEWAY APPROACH SHALL COMPLY WITH SIDEWALK STANDARD DRAWING EXCEPT THICKNESS SHALL BE AS SPECIFIED BELOW.
2. REMOVE A 3' WIDE STRIP OF PAVEMENT AND BASE ROCK IN FRONT OF THE NEW GUTTER A MINIMUM OF 8" DEEP TO PROVIDE ROOM FOR FORMS. REPLACE BASE ROCK AND RE-PAVE AFTER THE CONCRETE HAS CURED SUFFICIENTLY TO ALLOW WORK BUT MITIGATE DAMAGE TO THE NEW CONCRETE. HMA PATCH SHALL MATCH EXISTING THICKNESS, BUT NOT LESS THAN 4" FOR LOCAL STREETS, AND NOT LESS THAN 6" FOR COLLECTORS AND ARTERIALS.
3. WHERE A DRIVEWAY APPROACH EXCEEDS 16' IN WIDTH, A CONTRACTION JOINT SHALL BE PLACED ALONG ITS CENTER LINE.
4. FOR ASPHALT STREETS, REMOVE EXISTING CURB & GUTTER SECTIONS, FOR CONCRETE STREETS, THE EXISTING STREET SHALL BE SAWED FULL DEPTH ALONG THE GUTTER LINE & THE CURB & ALL PAVEMENT UNDER THE CURB REMOVED.
5. A 1/2" MAXIMUM LIP SHALL BE PROVIDED AT THE GUTTER LINE OF THE APPROACH.
6. DRIVEWAY APPROACH WIDTHS:
   RESIDENTIAL: 10' MIN TO 24' MAX.
   MULTI-FAMILY:
   TWO WAY: 16' MIN TO 24' MAX.
   ONE WAY: 10' MIN TO 12' MAX.
   COMMERCIAL/INDUSTRIAL:
   TWO WAY: 24' MIN TO 32' MAX.
   ONE WAY: 12' MIN TO 16' MAX.
   ALLEY: WIDTH AS DIRECTED.
7. DRIVEWAY APPROACH SHALL BE CEMENT CONCRETE WHERE CURB AND GUTTER EXISTS. CONCRETE STRENGTH SHALL BE 4000 PSI FOR ALLEYS, COMMERCIAL, INDUSTRIAL AND MULTI-FAMILY UNITS, AND 3000 PSI FOR ALL OTHERS.
8. DRIVEWAY THICKNESS SHALL BE 8" FOR ALLEYS, COMMERCIAL, INDUSTRIAL AND MULTI-FAMILY 4 UNITS AND GREATER, AND 6" FOR ALL OTHERS.
9. BASE ROCK FOR DRIVEWAYS SHALL BE CSTC, 4" THICK, EXCEPT BASE ROCK FOR ALLEYS SHALL BE 8" THICK.

A PERMIT MUST BE OBTAINED FROM THE OFFICE OF THE CITY ENGINEER PRIOR TO CONSTRUCTION IN THE CITY RIGHT-OF-WAY. THE ENGINEERING OFFICE MUST BE NOTIFIED PRIOR TO BEGINNING CONSTRUCTION.

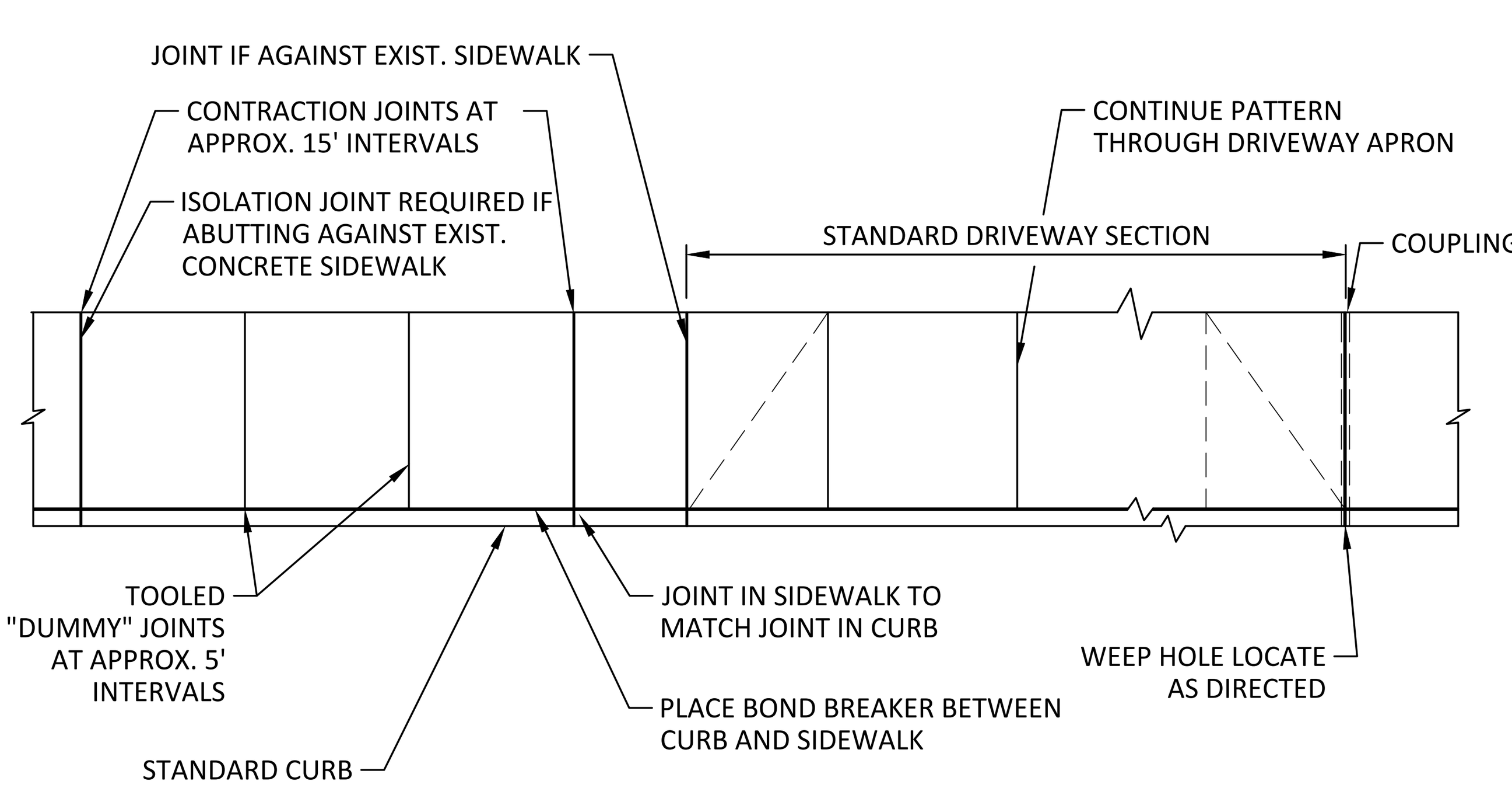
N.T.S.

CEMENT CONCRETE DRIVEWAY APPROACH		STANDARD PLAN NO. **KST-080-21**
CITY OF KELSO DEPARTMENT OF COMMUNITY DEVELOPMENT & ENGINEERING	**CITY ENGINEER APPROVAL: Michael Kardas, P.E.**	DATE: **MAY 2021**



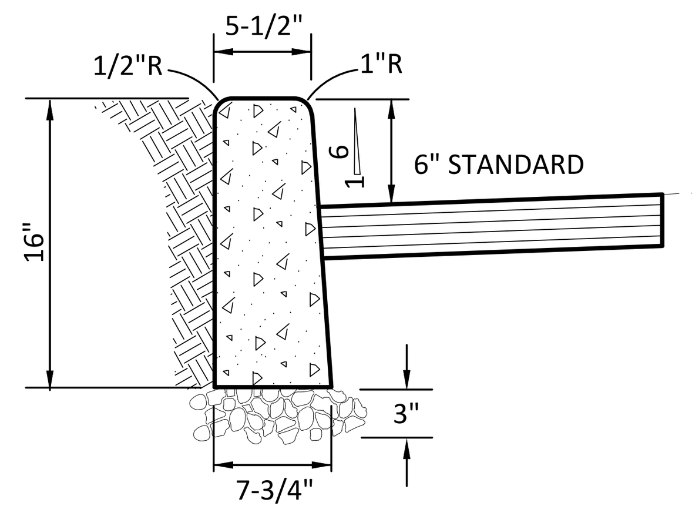
NOTE:
ALL JOINTS TO BE TOOLED WITH 1/2" RADIUS UNLESS SAWCUT

CONCRETE PAVEMENT JOINTS

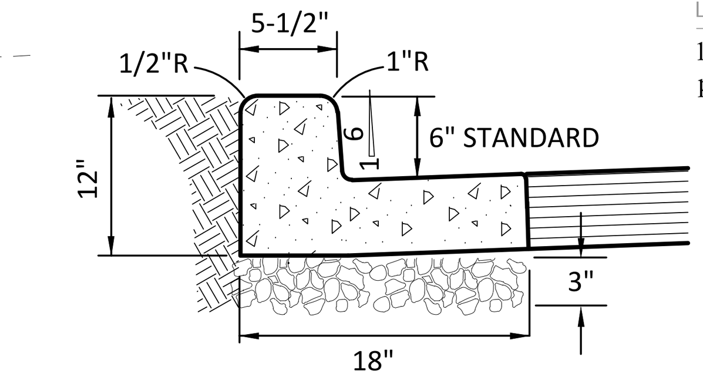


NOTE:
SIDEWALKS 8 FEET AND WIDER SHALL HAVE A LONGITUDINAL CONTRACTION JOINT AT THE MIDPOINT.

CONCRETE SIDEWALK
NTS



STD. CURB

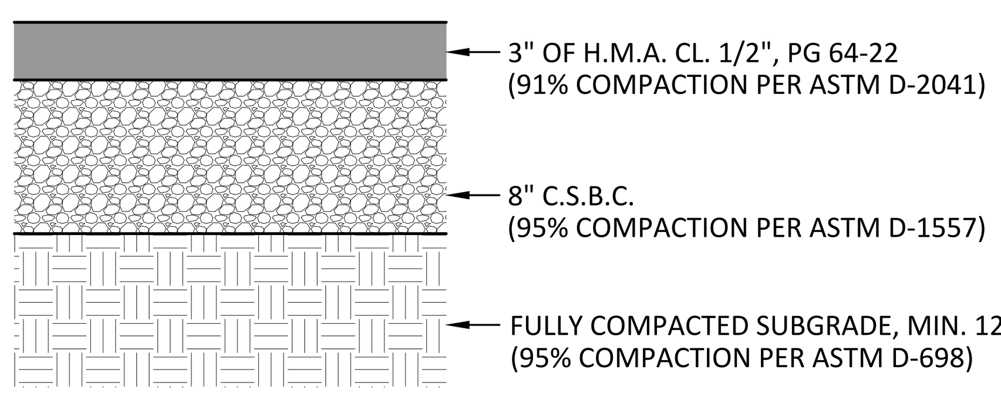


STD. CURB & GUTTER

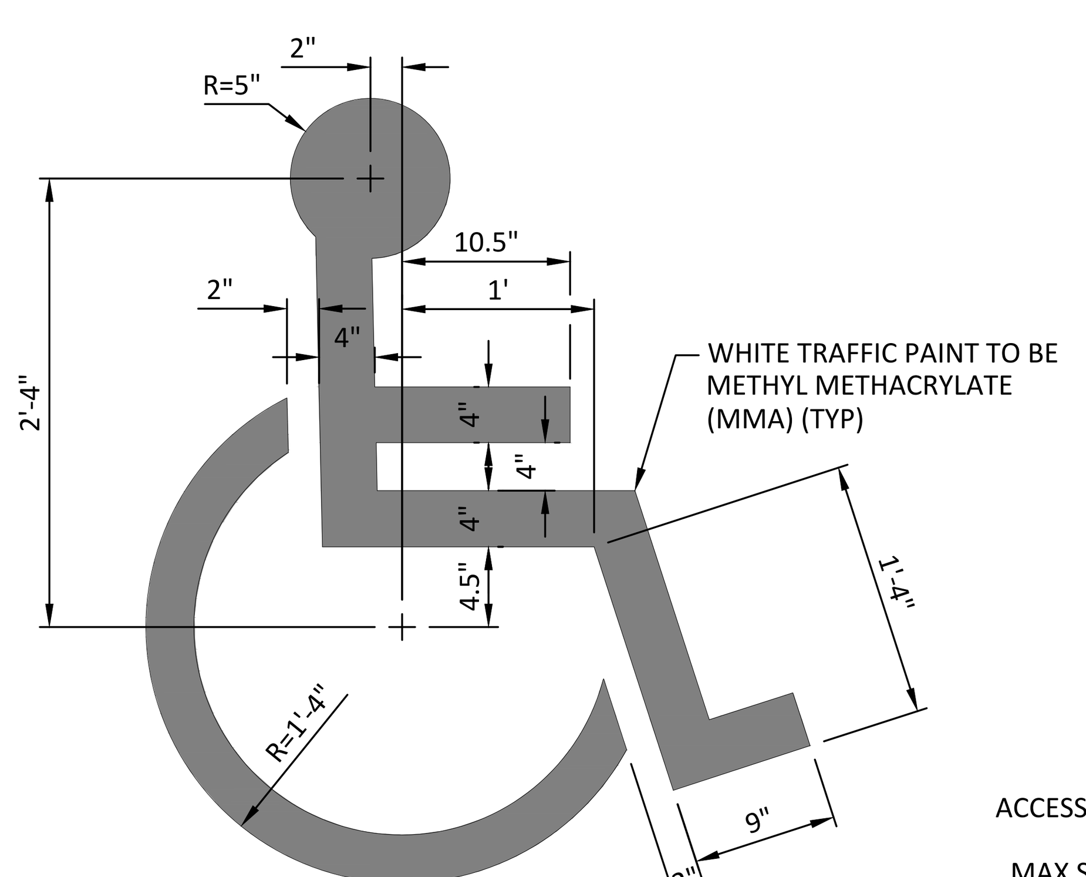
NOTES:

1. CONCRETE SHALL BE 4000 PSI MIN., 3-1/2" SLUMP (MAX.).
2. CURBS ADJACENT TO PAVEMENT OR SIDEWALK TO HAVE EXPANSION AND/OR CONSTRUCTION JOINTS TO MATCH EXISTING PATTERNS.
3. 3/8" EXPANSION JOINTS SHALL BE PLACED AT 45' MAXIMUM SPACING, ON BOTH SIDES OF CATCH BASINS, AT TOPS OF DRIVEWAYS, AND ALL CHANGES IN DIRECTION. 1 1/2" CUT JOINTS TO BE PLACED AT 15' MAXIMUM SPACING.
4. CURB SHALL BE PLACED ON 3" MIN. DEPTH 5/8"-0 CRUSHED AGGREGATE.
5. COMPACT SUBGRADE AND AGGREGATE TO 95% MAXIMUM DRY DENSITY.
6. CURB TO BE MEDIUM BROOM FINISHED.
7. WHERE MATCHING EXISTING CURBS, ALL EXISTING EDGES SHALL BE SAWCUT.

CURB DETAILS
N.T.S.



HMA DRIVE AISLE SECTION
N.T.S.



NOTES:

1. SYMBOL AND PAINT SHALL MEET CURRENT A.D.A. ACCESSIBILITY GUIDELINE AND OREGON TRANSPORTATION COMMISSION REQUIREMENTS.
2. SYMBOL SHALL HAVE A BACKGROUND MEETING CURRENT A.D.A. ACCESSIBILITY GUIDELINE AND OREGON TRANSPORTATION COMMISSION REQUIREMENTS.

ACCESSIBLE PARKING SYMBOL
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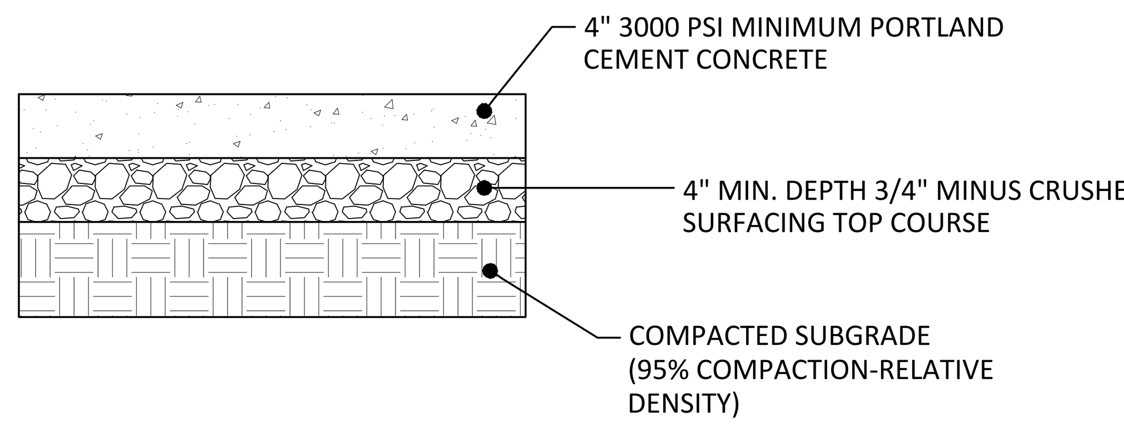
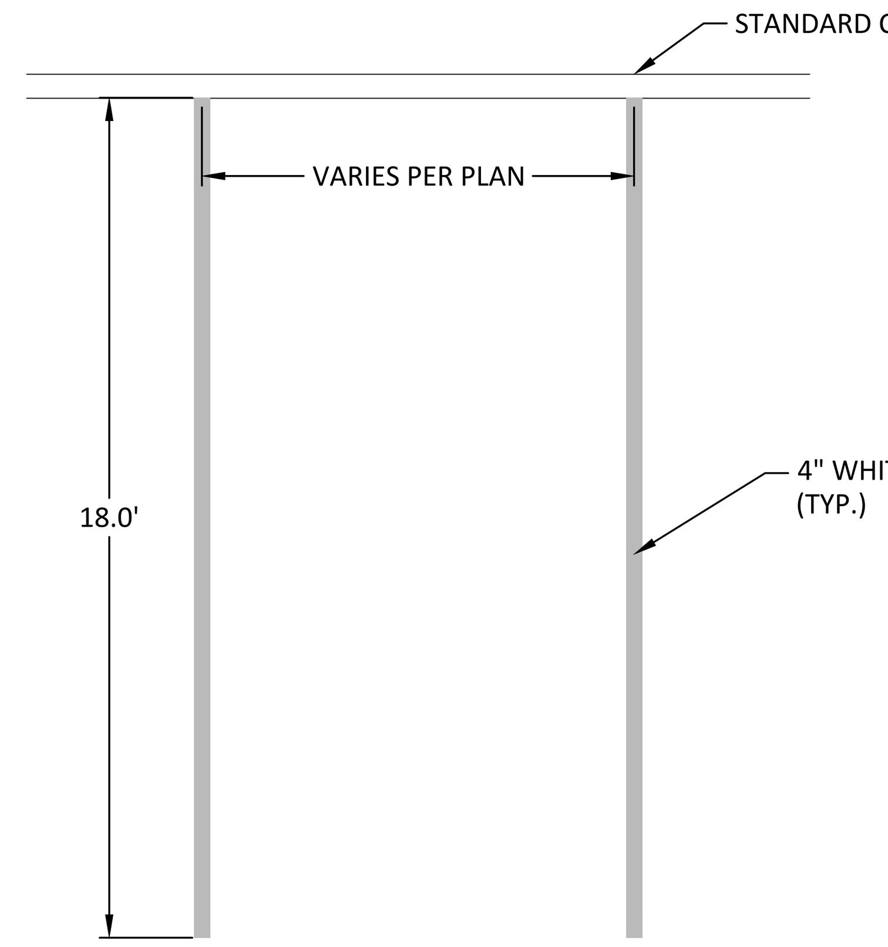
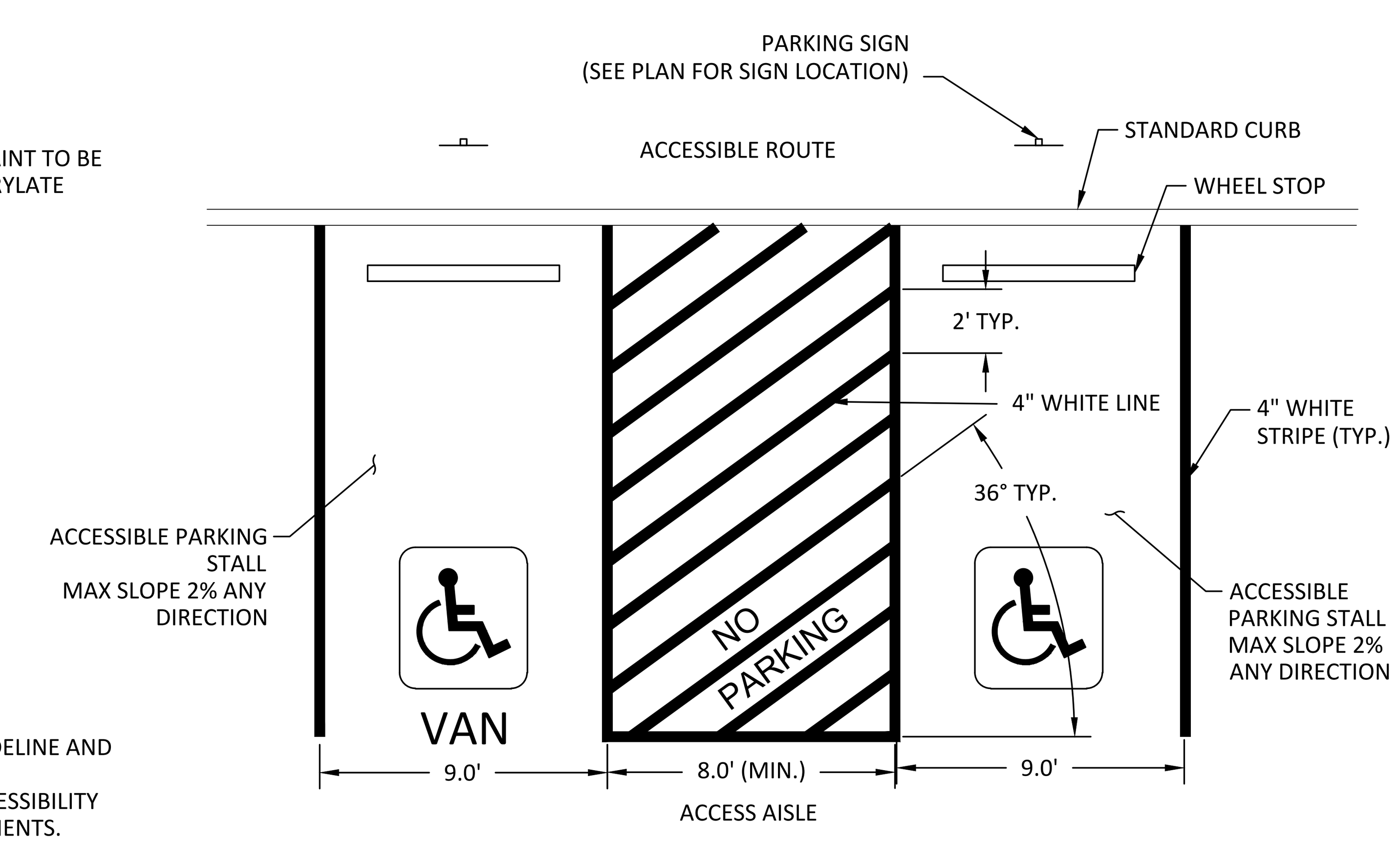


PRIVATE CONCRETE SIDEWALK/PATH SECTION
NTS



PARKING STALL STRIPING
NTS



VAN/STANDARD ACCESSIBLE PARKING STALL & AISLE STRIPING DETAIL
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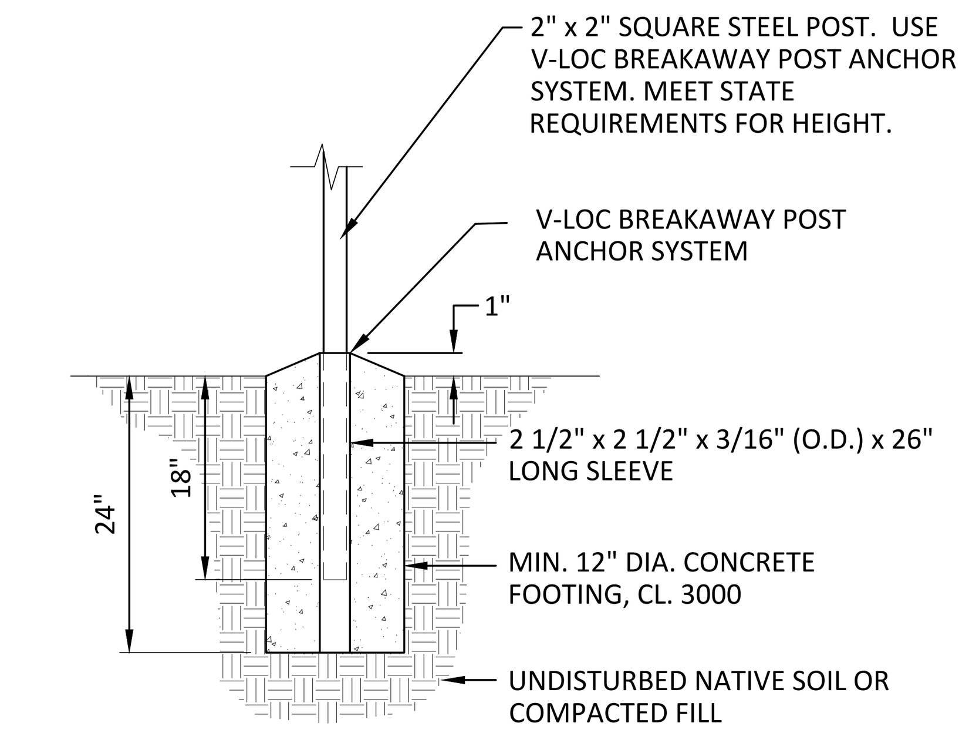
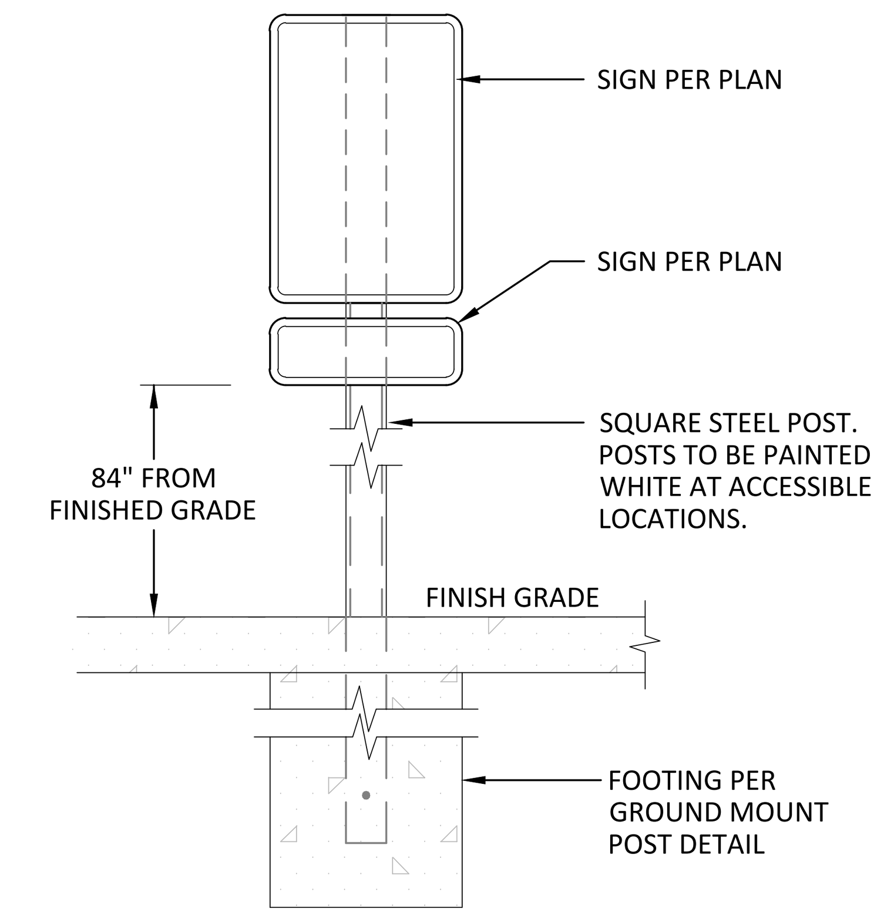
C6.0
DETAILS



GROUND MOUNT POST DETAIL

NTS



SIGNS SHALL MEET CURRENT MUTCD AND OREGON TRANSPORTATION REQUIREMENTS

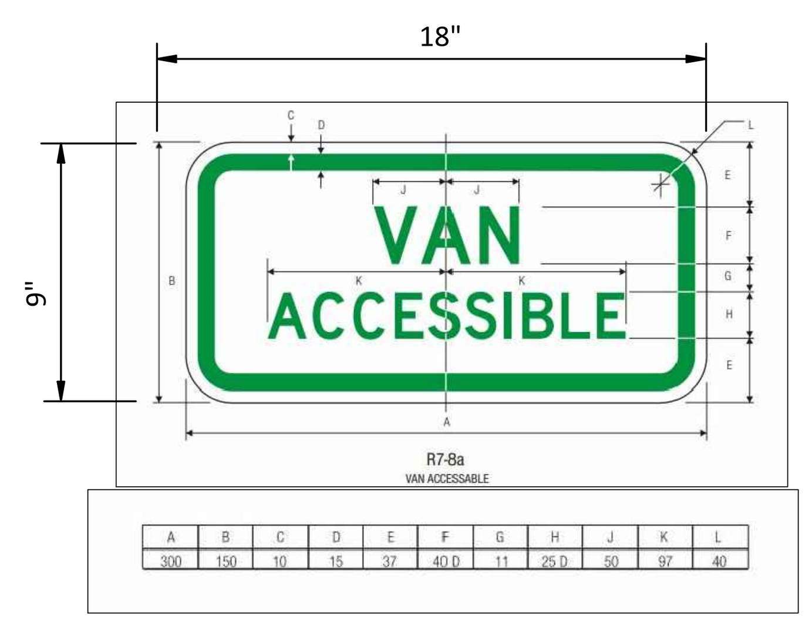
SIGN INSTALL DETAIL

NTS

NOTES:
SIGN BACKGOUND: WHITE, RETRO-REFLECTIVE SHEETING
SIGN LEGEND: GREEN, RETRO-REFLECTIVE
SYMBOL: WHITE ON BLUE BACKGROUND, RETRO-REFLECTIVE

RESERVED PARKING SIGN DETAIL

NTS



NOTES:
SIGN BACKGOUND: WHITE, RETRO-REFLECTIVE SHEETING
SIGN LEGEND: GREEN, RETRO-REFLECTIVE SHEETING

VAN ACCESSIBLE PARKING SIGN DETAIL

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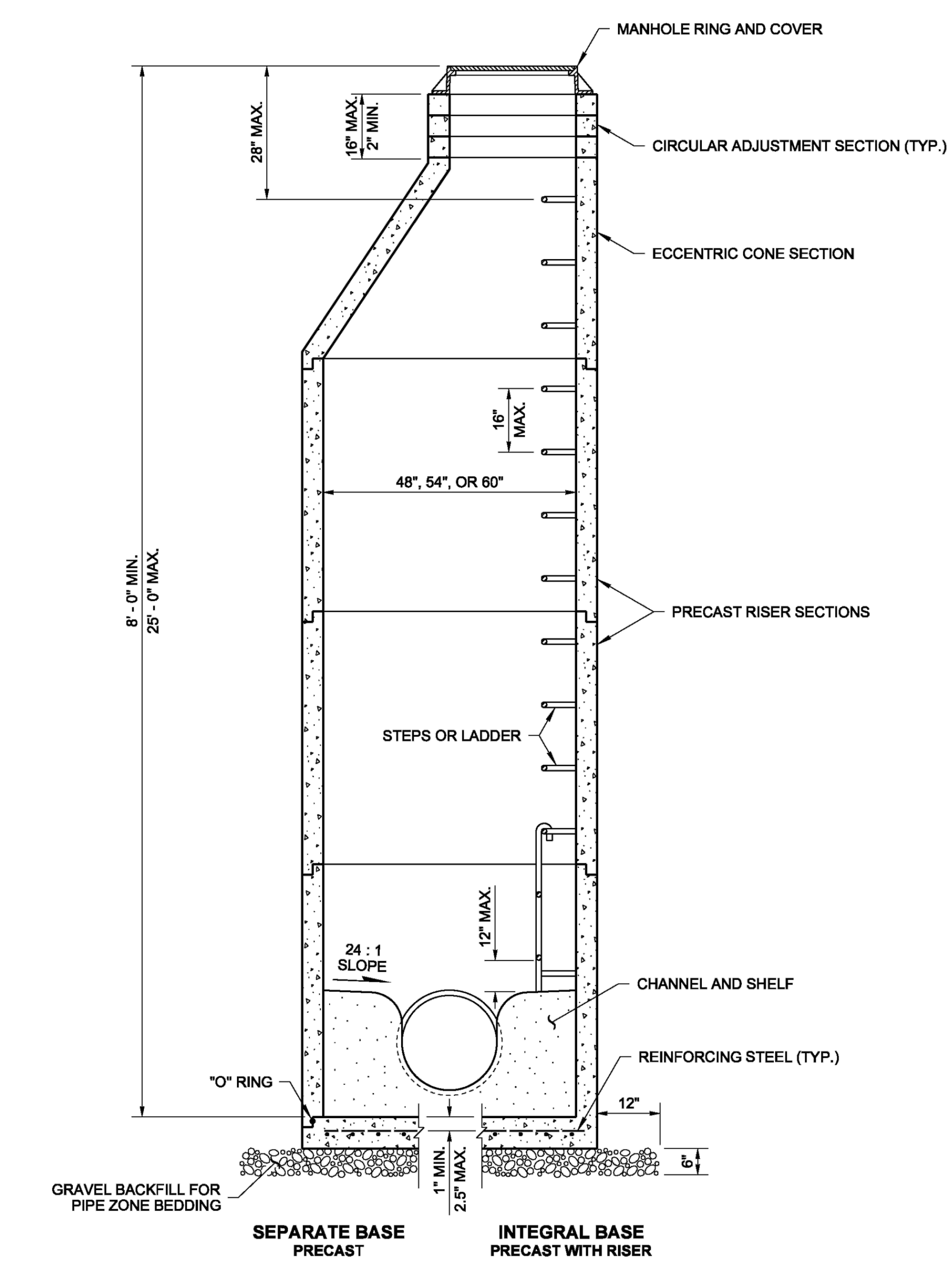
DRAWN BY: LISA CYFORD



NOTES

1. Knockouts shall have a wall thickness of 2" minimum to 2.5" maximum.
2. For pipe allowances, see **Standard Plan B-10.20.**

MANHOLE DIMENSION TABLE

DIAM.	MIN. WALL THICKNESS	MIN. BASE THICKNESS	MAXIMUM KNOCKOUT SIZE	MINIMUM DISTANCE BETWEEN KNOCKOUTS
48"	4"	6"	36"	8"
54"	4.5"	8"	42"	8"
60"	5"	8"	48"	8"

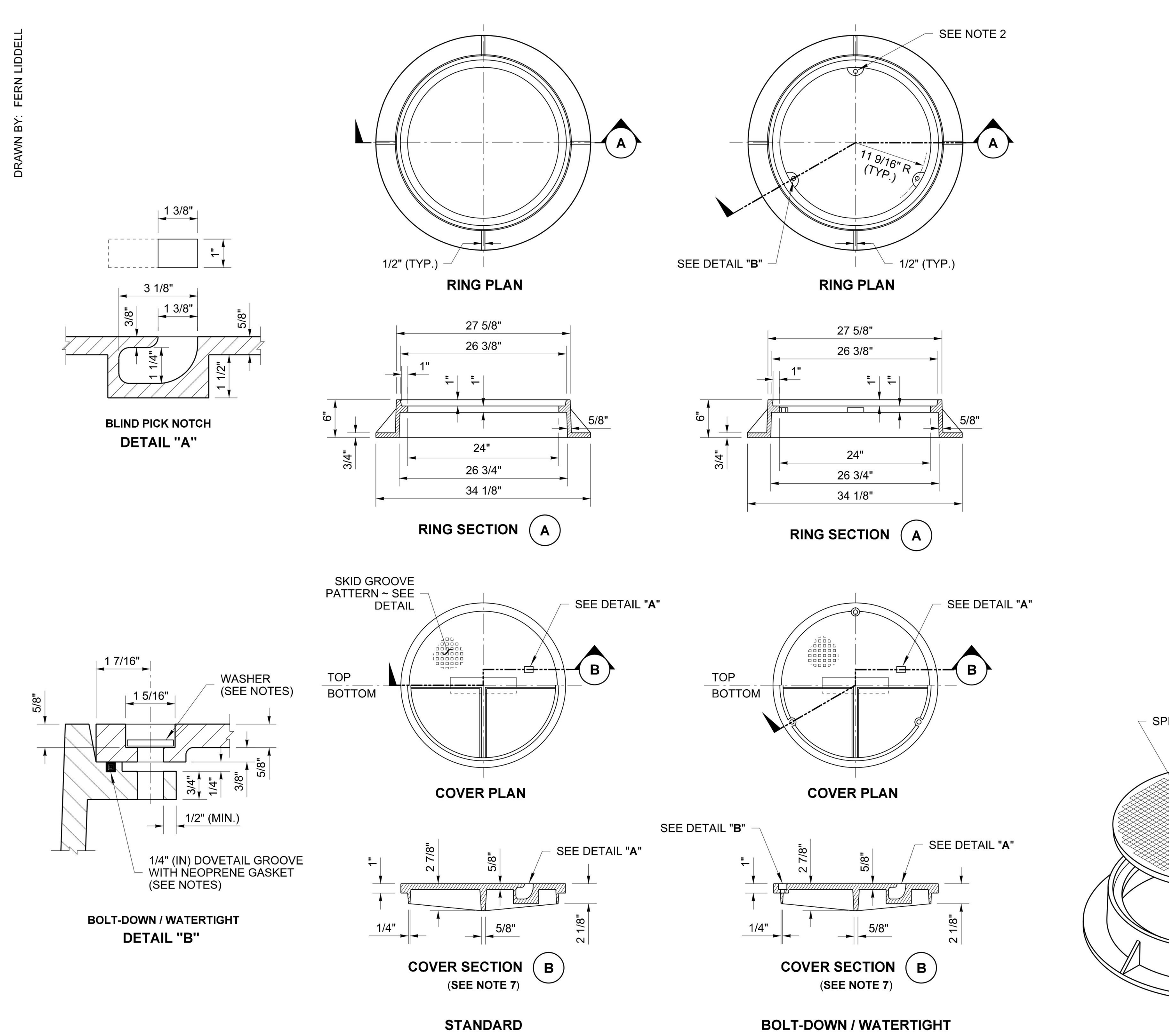
MANHOLE TYPE 1

STANDARD PLAN B-15.20-01

SHEET 1 OF 1 SHEET

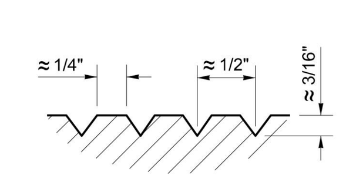
APPROVED FOR PUBLICATION
Pasco Bakotich III 02-07-12
STATE DESIGN ENGINEER DATE
Washington State Department of Transportation

DRAWN BY: FERN LIDDELL

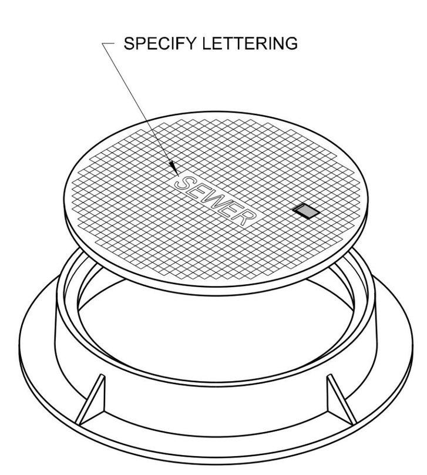


NOTES

1. The gasket and groove may be in the seat (frame) or in the underside of the cover. The gasket may be "T" shaped in section. The groove may be cast or machined.
2. Bolt-down capability is required on all frames, grates, and covers, unless specified otherwise in the Contract. Provide 3 holes in the frame that are vertically aligned with the grate or cover slots. The frame shall accept the 304 Stainless Steel (S.S) 5/8" - 11 NC x 2" (in) allen head cap screw by being tapped, or other approved mechanism. Location of bolt down holes varies by manufacturer.
3. For bolt-down manhole ring and covers that are not designated "Watertight," the neoprene gasket, groove, and washer are not required.
4. Washer shall be neoprene (Detail "B").
5. In lieu of blind pick notch for manhole covers, a single 1" (in) pick hole is acceptable. Hole location and number of holes may vary by manufacturer.
6. Alternative reinforcing designs are acceptable in lieu of the rib design.
7. For clarity, the vertical scale of the Cover Section has been exaggerated, it is 1.5 times the horizontal scale (1H:1.5V).



SKID GROOVE PATTERN DETAIL



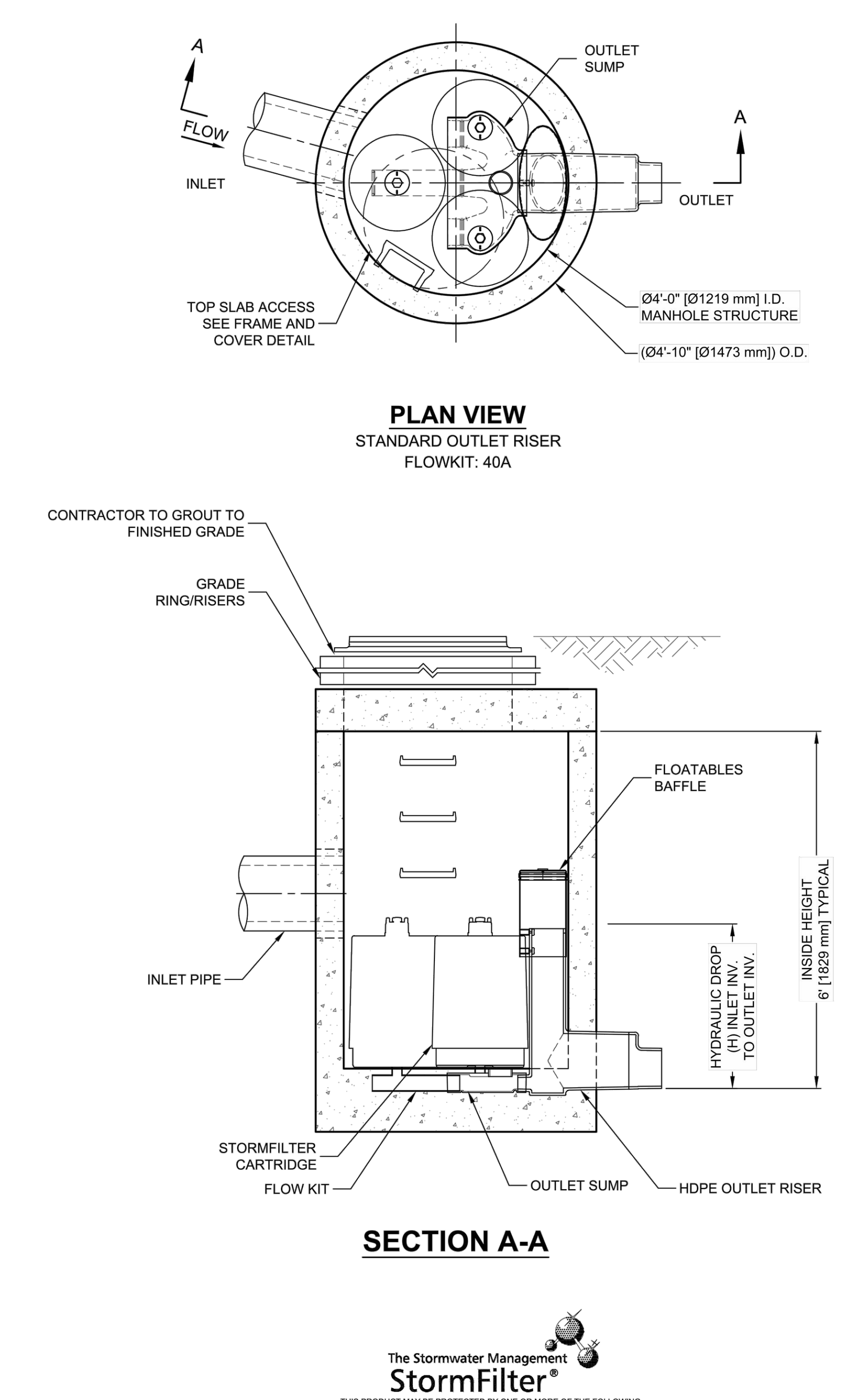
ISOMETRIC VIEW

CIRCULAR FRAME (RING) AND COVER

STANDARD PLAN B-30.70-04

SHEET 1 OF 1 SHEET

APPROVED FOR PUBLICATION
STATE DESIGN ENGINEER
Washington State Department of Transportation



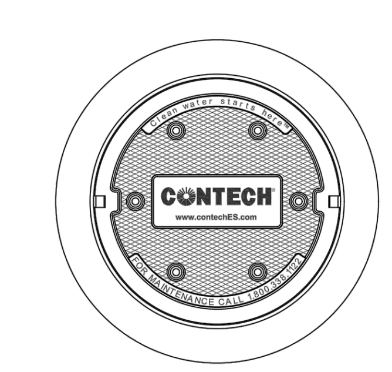
STORMFILTER DESIGN NOTES

STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD MANHOLE STYLE IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (3). VOLUME SYSTEM IS ALSO AVAILABLE WITH MAXIMUM 3 CARTRIDGES. Ø4 [1219 mm] MANHOLE STORMFILTER PEAK HYDRAULIC CAPACITY IS 1.0 CFS [28.3 L/s] . IF THE SITE CONDITIONS EXCEED 1.0 CFS [28.3 L/s] AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27" [686 mm]			18" [458 mm]			LOW DROP		
RECOMMENDED HYDRAULIC DROP (H)	3.05' [930 mm]			2.3' [700 mm]			1.8' [550 mm]		
SPECIFIC FLOW RATE (gpm/sf) [L/s/m²]	2 [1.30]	1.67* [1.08]	1 [0.65]	2 [1.30]	1.67* [1.08]	1 [0.65]	2 [1.30]	1.67* [1.08]	1 [0.65]
CARTRIDGE FLOW RATE (gpm) [L/s]	22.5 [1.42]	18.79 [1.19]	11.25 [0.71]	15 [0.95]	12.53 [0.79]	7.5 [0.44]	10 [0.63]	8.35 [0.54]	5 [0.32]

* 1.67 gpm/sf [1.08 L/s/m²] SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (cfs) [L/s]	0.017
PEAK FLOW RATE (cfs) [L/s]	<0.20
RETURN PERIOD OF PEAK FLOW (yrs)	25
CARTRIDGE HEIGHT (SEE TABLE ABOVE)	18"
NUMBER OF CARTRIDGES REQUIRED	2
CARTRIDGE FLOW RATE	12.53
MEDIA TYPE (PERLITE, ZPG, PSORB)	PSORB

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE #1	8.06	PVC	6"
INLET PIPE #2	8.06	PVC	6"
OUTLET PIPE	5.76	PVC	6"

RIM ELEVATION		*
ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR SITE SPECIFIC DRAWINGS WITH DETAILED VAULT DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS-20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' [1524 mm] AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES [178 mm]. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS.
7. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) [L/s] DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft)[m²].
8. STORMFILTER STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET PIPE(S).
E. CONTRACTOR TO PROVIDE AND INSTALL CONNECTOR TO THE OUTLET RISER STUB. STORMFILTER EQUIPPED WITH A DUAL DIAMETER HDPE OUTLET STUB AND SAND COLLAR. IF OUTLET PIPE IS LARGER THAN 8 INCHES [200 mm], CONTRACTOR TO REMOVE THE 8 INCH [200 mm] OUTLET STUB AT MOLDED-IN CUT LINE. COUPLING BY FERNCO OR EQUAL AND PROVIDED BY CONTRACTOR.
F. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

The Stormwater Management StormFilter®

CONTECH® ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

SFMH48
STORMFILTER
STANDARD DETAIL

Access | Architecture

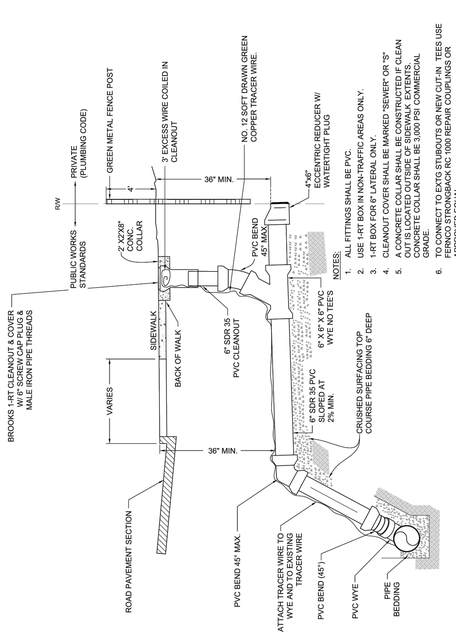
WILLOW GROVE
1106 WALNUT STREET
KELSO, WA 98626

LAND USE PERMIT

REV	DATE	FILE

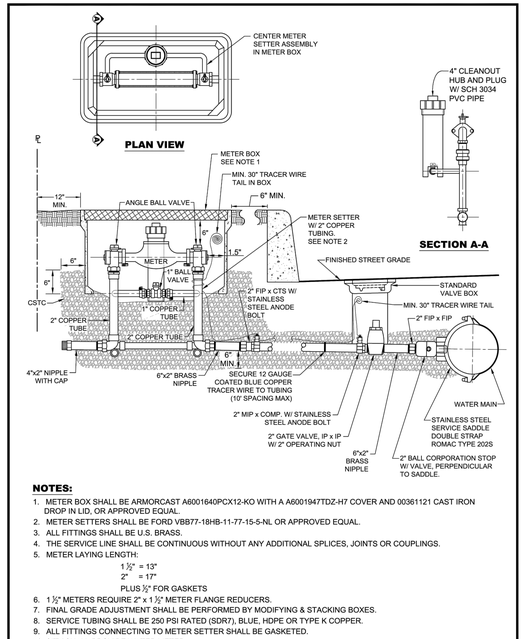
PM:
JOB: 22012
DATE: 12/01/2022

C6.1
DETAILS



N.T.S.

Kelso WASHINGTON	**6" SANITARY SIDE SEWER**	STANDARD PLAN NO. **KSS-020-21**
CITY OF KELSO DEPARTMENT OF COMMUNITY DEVELOPMENT & ENGINEERING	**CITY ENGINEER APPROVAL: Michael Kardas, P.E.**	DATE: **MAY 2021**



NOTES:

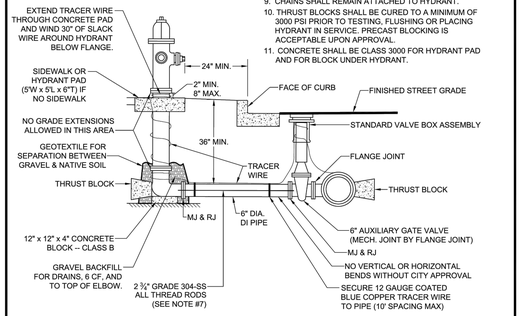
1. METER BOX SHALL BE ARMORCAST A6001640PCX12-KO WITH A A6001947TDZ-H7 COVER AND 00361121 CAST IRON DROP IN LID, OR APPROVED EQUAL.
2. METER SETTERS SHALL BE FORD VBB77-18HB-11-77-15-5-NL OR APPROVED EQUAL.
3. ALL FITTINGS SHALL BE U.S. BRASS.
4. THE SERVICE LINE SHALL BE CONTINUOUS WITHOUT ANY ADDITIONAL SPLICES, JOINTS OR COUPLINGS.
5. METER LAYING LENGTH:
   1 ½" = 13"
   2" = 17"
   PLUS ½" FOR GASKETS
6. 1 ½" METERS REQUIRE 2" x 1 ½" METER FLANGE REDUCERS.
7. FINAL GRADE ADJUSTMENT SHALL BE PERFORMED BY MODIFYING & STACKING BOXES.
8. SERVICE TUBING SHALL BE 250 PSI RATED (SDR7), BLUE, HDPE OR TYPE K COPPER.
9. ALL FITTINGS CONNECTING TO METER SETTER SHALL BE GASKETED.
10. CITY SHALL PROVIDE WATER METER.

N.T.S.

Kelso WASHINGTON	**1-½" AND 2" WATER SERVICE**	STANDARD PLAN NO. **KW-030-21**
CITY OF KELSO DEPARTMENT OF COMMUNITY DEVELOPMENT & ENGINEERING	**CITY ENGINEER APPROVAL: Michael Kardas, P.E.**	DATE: **MAY 2021**

NOTES:

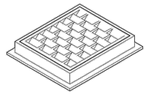
1. HYDRANTS SHALL BE 5 ¼" MUELLAR CENTURION, WATEROUS PACER 90, CLOW MEDALLION OR KENNEDY K81D GUARDIAN, WITH 16" TOP SECTION OR APPROVED EQUAL.
2. ALL HYDRANTS SHALL HAVE NATIONAL STANDARD THREAD OUTLETS, TWO 2 ½" PORTS AND SHALL BE EQUIPPED WITH ONE 4 ½" PUMPER CONNECTION WHICH FACES THE MAIN ROADWAY.
3. ALL HYDRANTS SHALL STAND PLUMB WITH THE LOWEST OUTLET OF THE HYDRANT NO LESS THAN 18" ABOVE FINISHED GRADE.
4. 10 MIL. PLASTIC SHEETING SHALL BE USED AS A BOND BREAKER BETWEEN CONCRETE BLOCKING AND PIPE FITTING AS WELL AS BETWEEN HYDRANT BARREL AND HYDRANT PAD.
5. INCLUDE VALVE BOX IN HYDRANT PAD WHEN BOX IS WITHIN 3' OR LESS OF HYDRANT OR BETWEEN SIDEWALK AND CURB.
6. ALL HYDRANTS SHALL BE BAGGED UNTIL SYSTEM IS APPROVED.
7. ASSEMBLY SHALL BE RODDED OR SHALL HAVE RESTRAINED JOINTS INCLUDING THRUST BLOCKS.
8. LOCATION OF HYDRANT SHALL COMPLY WITH ADA REQUIREMENTS.
9. CHAINS SHALL REMAIN ATTACHED TO HYDRANT.
10. THRUST BLOCKS SHALL BE CURED TO A MINIMUM OF 3000 PSI PRIOR TO TESTING, FLUSHING OR PLACING HYDRANT IN SERVICE. PRECAST BLOCKING IS ACCEPTABLE UPON APPROVAL.
11. CONCRETE SHALL BE CLASS 3000 FOR HYDRANT PAD AND FOR BLOCK UNDER HYDRANT.



N.T.S.

Kelso WASHINGTON	**HYDRANT ASSEMBLY**	STANDARD PLAN NO. **KW-080-21**
CITY OF KELSO DEPARTMENT OF COMMUNITY DEVELOPMENT & ENGINEERING	**CITY ENGINEER APPROVAL: Michael Kardas, P.E.**	DATE: **MAY 2021**

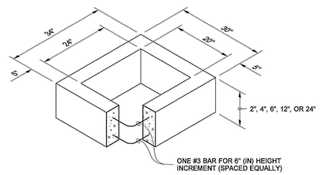
DRAWN BY: FERN LIDDELL



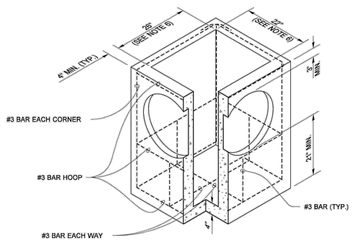
FRAME AND VANED GRATE

PIPE ALLOWANCES	
PIPE MATERIAL	**MAXIMUM INSIDE DIAMETER (INCHES)**
REINFORCED OR PLAIN CONCRETE	12"
ALL METAL PIPE	15"
CPSSB ✱ **(STD. SPEC. SECT. 9-05.20)**	12"
SOLID WALL PVC **(STD. SPEC. SECT. 9-05.12(1))**	15"
PROFILE WALL PVC **(STD. SPEC. SECT. 9-05.12(2))**	15"

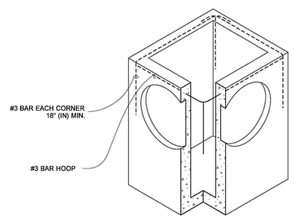
✱ CORRUGATED POLYETHYLENE STORM SEWER PIPE



RECTANGULAR ADJUSTMENT SECTION



PRECAST BASE SECTION



(SEE NOTE 1)

ALTERNATIVE PRECAST BASE SECTION

NOTES

1. As acceptable alternatives to the rebar shown in the **PRECAST BASE SECTION**, fibers (placed according to the Standard Specifications), or wire mesh having a minimum area of 0.12 square inches per foot shall be used with the minimum required rebar shown in the **ALTERNATIVE PRECAST BASE SECTION**. Wire mesh shall not be placed in the knockouts.
2. The knockout diameter shall not be greater than 20" (in). Knockouts shall have a wall thickness of 2" (in) minimum to 2.5" (in) maximum. Provide a 1.5" (in) minimum gap between the knockout wall and the outside of the pipe. After the pipe is installed, fill the gap with joint mortar in accordance with **Standard Specification Section 9-04.3**.
3. The maximum depth from the finished grade to the lowest pipe invert shall be 5' (ft).
4. The frame and grate may be installed with the flange down, or integrally cast into the adjustment section with flange up.
5. The Precast Base Section may have a rounded floor, and the walls may be sloped at a rate of 1 : 24 or steeper.
6. The opening shall be measured at the top of the **Precast Base Section**.
7. All pickup holes shall be grouted full after the basin has been placed.

JULIE HEILMAN STATE OF WASHINGTON 41810 REGISTERED PROFESSIONAL ENGINEER

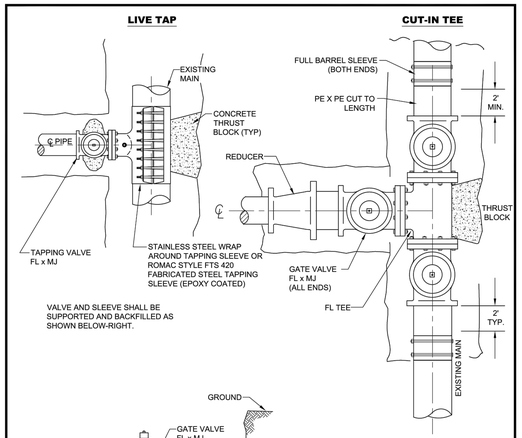
Julie Heilman 2020.09.01 07:52:50 -07'00'

CATCH BASIN TYPE 1

STANDARD PLAN B-5.20-03

SHEET 1 OF 1 SHEET

APPROVED FOR PUBLICATION
Roark, Steve Digitally signed by Roark, Steve Date: 2020.09.09 09:45:23 -07'00'
STATE DESIGN ENGINEER
Washington State Department of Transportation



NOTES:

1. 11 MIL PLASTIC OR CONSTRUCTION FABRIC SHALL BE WRAPPED AROUND PIPE AND FITTINGS BEFORE THRUST BLOCKS ARE POURED.
2. SUPPORT VALVE AND SLEEVE CONTINUOUSLY THROUGH INSTALLATION.
3. THRUST BLOCKS MAY BE PRECAST IF APPROVED.

N.T.S.

Kelso WASHINGTON	**CONNECTION TO EXISTING WATER MAIN**	STANDARD PLAN NO. **KW-130-21**
CITY OF KELSO DEPARTMENT OF COMMUNITY DEVELOPMENT & ENGINEERING	**CITY ENGINEER APPROVAL: Michael Kardas, P.E.**	DATE: **MAY 2021**

Harper
Houf **P**eterson
Righellis **I**nc.
ENGINEERS ✦ PLANNERS
LANDSCAPE ARCHITECTS ✦ SURVEYS
1220 Main Street, Suite 150, Vancouver, WA 98660
phone: 360.750.1131 www.hhpr.com fax: 360.750.1141

Access | Architecture

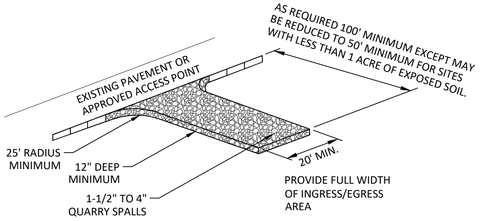
WILLOW GROVE
1106 WALNUT STREET
KELSO, WA 98626

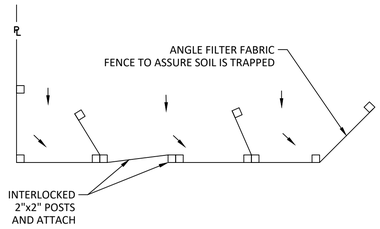
LAND USE PERMIT

REV.	DATE	FILE

PM:
JOB: 22012
DATE: 12/01/2022

C6.2
DETAILS

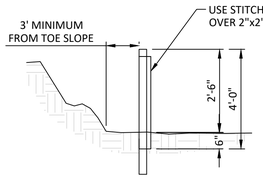




PLAN VIEW

NOTES:

1. IF THE ENTRANCE SITS ON A SLOPE, PLACE A FILTER FABRIC FENCE DOWN GRADIENT TO PREVENT SEDIMENT LADEN WATER FROM LEAVING THE SITE. WHEN THE CONSTRUCTION ENTRANCE BECOMES CLOGGED WITH SEDIMENTS, TOP DRESS THE PAD WITH CLEAN 3" MINUS ROCK.
2. ANY SEDIMENT CARRIED FROM THE SITE ONTO THE STREET SHALL BE CLEANED UP IMMEDIATELY.
3. IF EQUIPMENT TRAVELS EXTENSIVELY ON UNSTABILIZED ROADS ON THE SITE, A TIRE AND VEHICLE WHEEL WASH NEAR THE ENTRANCE WILL BE NEEDED. PERFORM WASHING ON CRUSHED ROCK. WASH WATER WILL REQUIRE TREATMENT IN A SEDIMENT POND OR TRAP.



NOTES:

1. BURY BOTTOM OF FILTER FABRIC 6" VERTICALLY BELOW FINISHED GRADE.
2. 2"x2" FIR, PINE OR STEEL FENCE POSTS.
3. POSTS TO BE INSTALLED ON UPHILL SIDE OF SLOPE.
4. COMPACT BOTH SIDES OF FILTER FABRIC TRENCH.
5. PANELS MUST BE PLACED ACCORDING TO SPACING ON DETAIL.

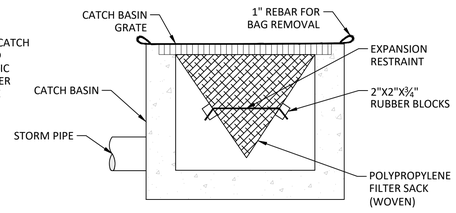
PROFILE

GRAVEL CONSTRUCTION ENTRANCE

NTS

NOTE:

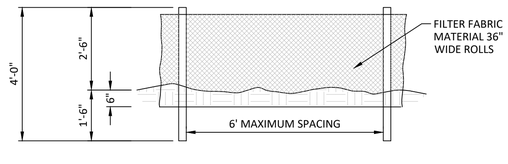
1. RECESSED CURB INLET CATCH BASINS MUST BE BLOCKED WHEN USING FILTER FABRIC INLET SACKS. SIZE OF FILTER FABRIC INLET SACKS TO BE DETERMINED BY MANUFACTURER.



INLET PROTECTION TYPE 5

WOVEN POLYPROPYLENE SACK

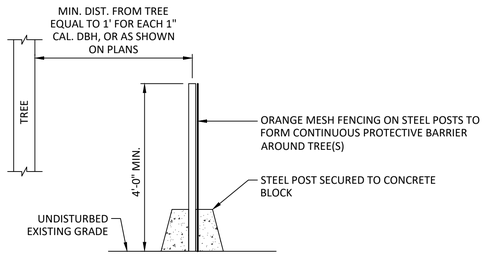
NTS



FRONT VIEW

SEDIMENT FENCE

NTS



TREE PROTECTION FENCING

NTS

Harper Houf Peterson Righellis Inc.
ENGINEERS • PLANNERS
LANDSCAPE ARCHITECTS • SURVEYORS
1220 Main Street, Suite 150, Vancouver, WA 98660
phone: 360.750.1131 www.hhpr.com fax: 360.750.1141

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LAND USE PERMIT

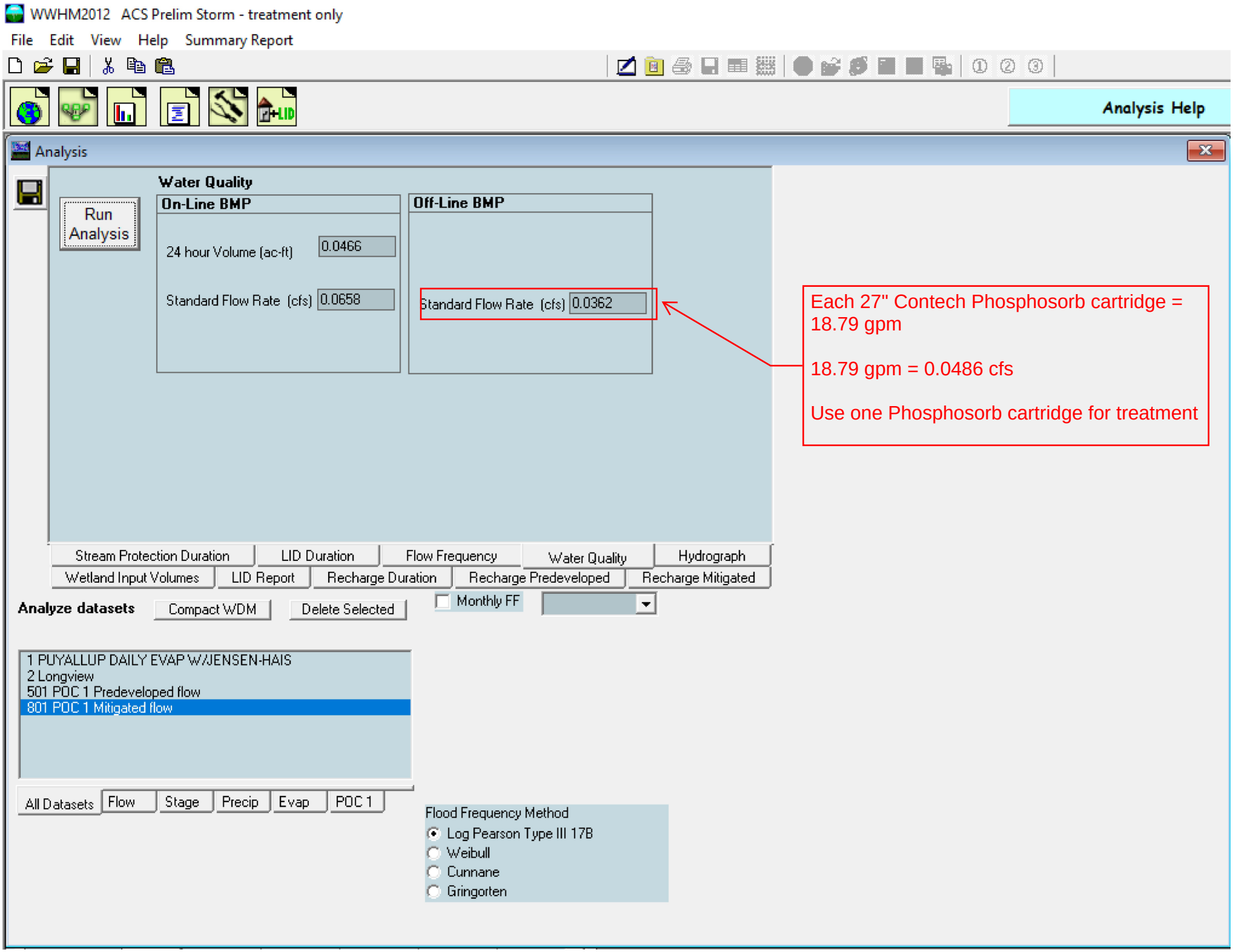
REV.	DATE	FILE

PM:
JOB: 22012
DATE: 12/01/2022

C6.3

DETAILS

APPENDIX 3
STORMWATER CALCULATIONS


WWHM2012 ACS Prelim Storm - treatment only
File Edit View Help Summary Report
Analysis Help
Analysis
Water Quality
Run Analysis
On-Line BMP
24 hour Volume (ac-ft) 0.0466
Standard Flow Rate (cfs) 0.0658
Off-Line BMP
Standard Flow Rate (cfs) 0.0362
Each 27" Contech Phosphosorb cartridge = 18.79 gpm
18.79 gpm = 0.0486 cfs
Use one Phosphosorb cartridge for treatment
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
1 PUYALLUP DAILY EVAP W/JENSEN-HAIS
2 Longview
501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow
All Datasets
Flow
Stage
Precip
Evap
POC 1
Flood Frequency Method
Log Pearson Type III 17B
Weibull
Cunnane
Gringorten

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	ACS Prelim Storm - treatment only
Site Name:	Willow Grove
Site Address:	
City:	
Report Date:	12/2/2022
Gage:	Longview
Data Start:	1955/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.143
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
Pervious Total	0
Impervious Land Use	acre
ROADS FLAT	0.325
Impervious Total	0.325
Basin Total	0.325

Element Flows To:

Surface	Interflow	Groundwater

Routing Elements
Predeveloped Routing

Mitigated Routing

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.

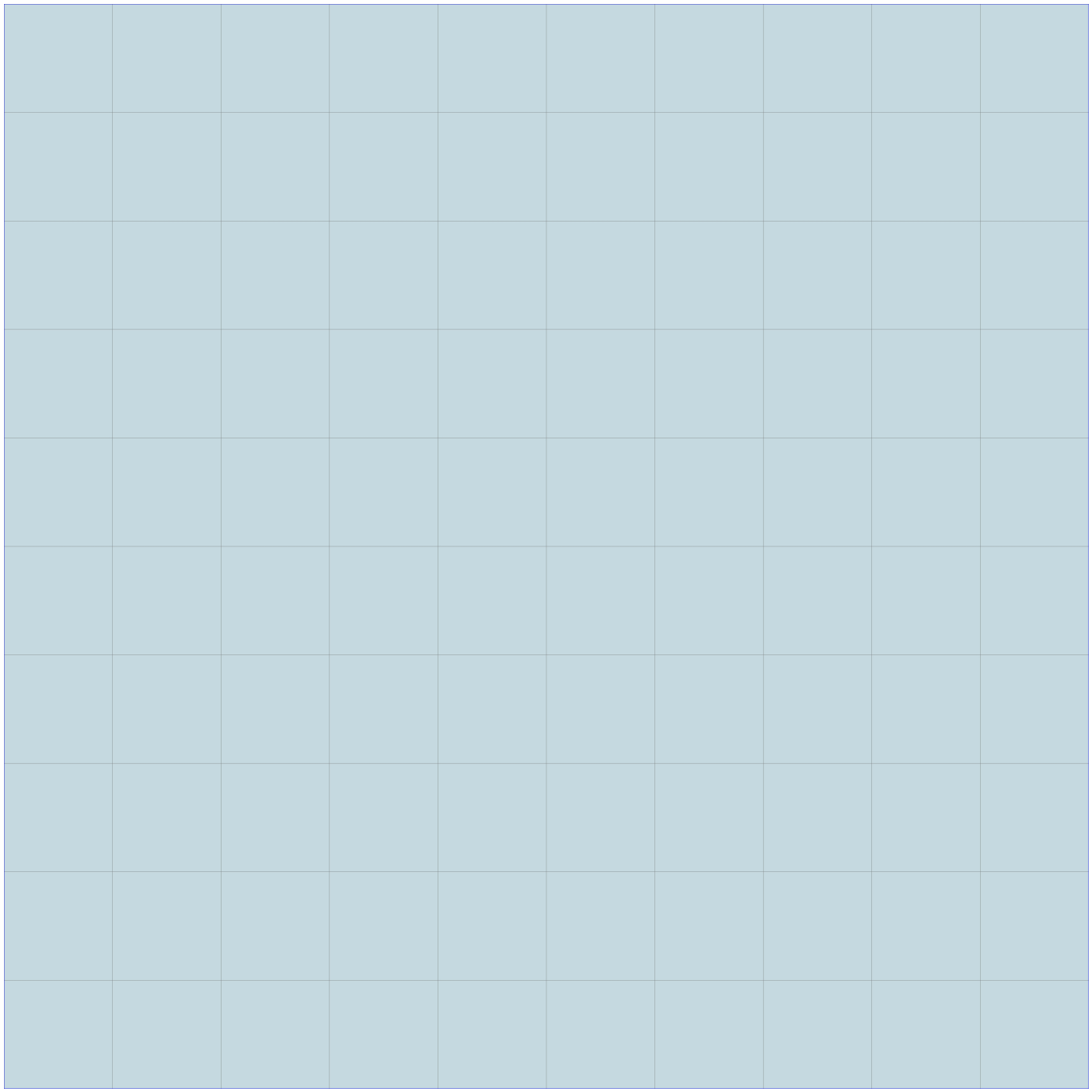
PERLND Changes

No PERLND changes have been made.

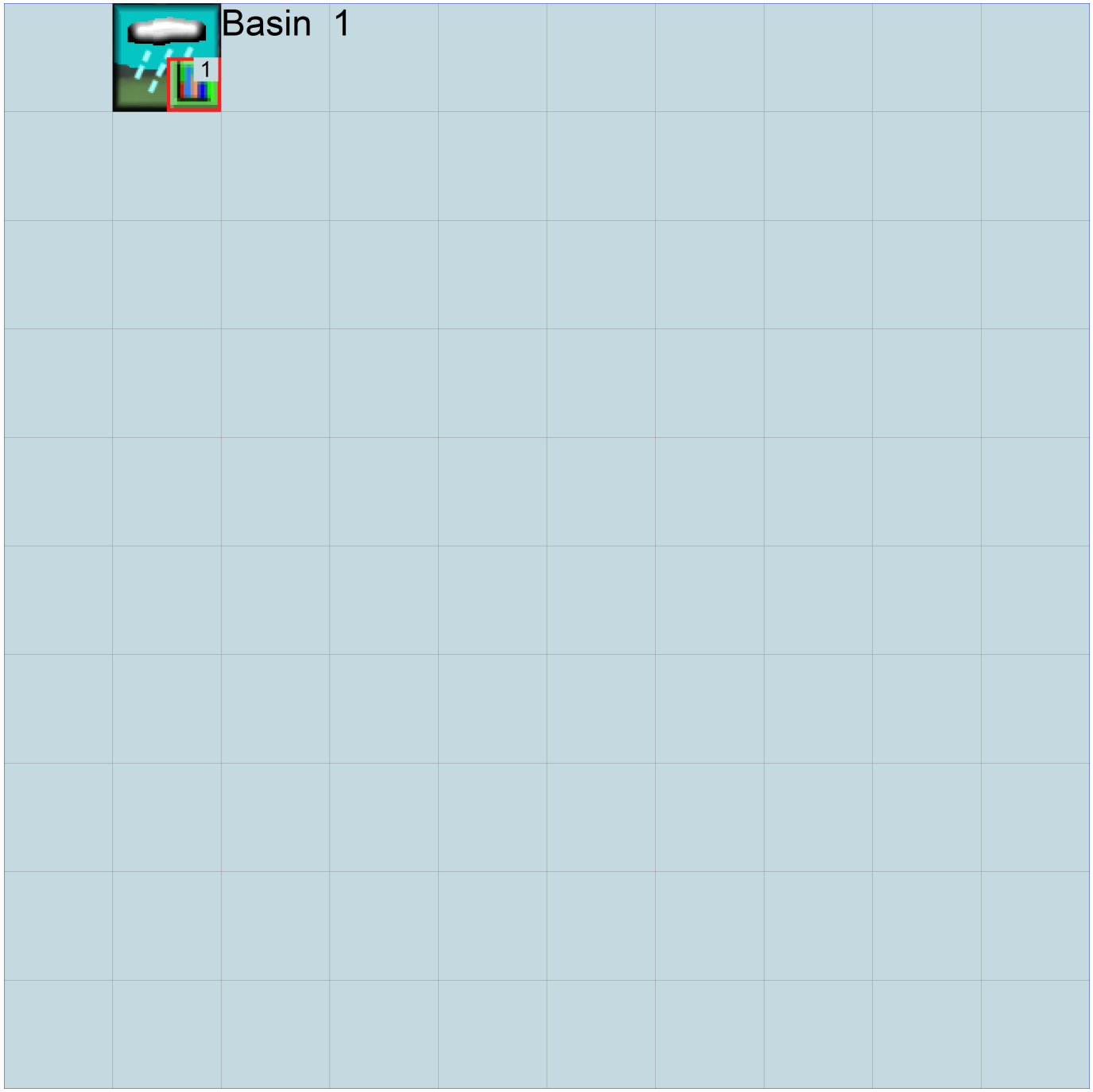
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2009 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   ACS Prelim Storm - treatment only.wdm
MESSU       25   PreACS Prelim Storm - treatment only.MES
            27   PreACS Prelim Storm - treatment only.L61
            28   PreACS Prelim Storm - treatment only.L62
            30   POCACS Prelim Storm - treatment only1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  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           ***
  END GEN-INFO
  *** Section PWATER***

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

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

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

```
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  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
  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
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    ***
    1         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    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
  END IWAT-PARM1

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

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

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

END IMPLND
```

```
SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
IMPLND   1                       0.325     COPY   501     15

******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    1.143          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.143          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           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       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2009 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   ACS Prelim Storm - treatment only.wdm
MESSU       25   MitACS Prelim Storm - treatment only.MES
            27   MitACS Prelim Storm - treatment only.L61
            28   MitACS Prelim Storm - treatment only.L62
            30   POCACS Prelim Storm - treatment only1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  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           ***
  END GEN-INFO
  *** Section PWATER***

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

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

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

```
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  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
  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
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         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    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
  END IWAT-PARM1

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

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

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

END IMPLND
```

```
SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
IMPLND   1                       0.325     COPY   501     15

******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    1.143          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.143          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           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     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       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

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

www.clearcreeksolutions.com

WASHINGTON STATE DEPARTMENT OF ECOLOGY

April 2017

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS) AND PHOSPHORUS TREATMENT
For
CONTECH Engineered Solutions
Stormwater Management StormFilter®
with PhosphoSorb® media

Ecology's Decision:

1. **Based on Contech Engineered Solutions application, Ecology hereby issues the following use level designation for the Stormwater Management StormFilter® using PhosphoSorb® media cartridges:**

   - **General Use Level Designation (GULD) for Basic Treatment (total suspended solids) and for Phosphorus (total phosphorus) treatment.**
     - **Sized at a hydraulic loading rate of no greater than 1.67 gallon per minute (gpm) per square foot (sq ft.) of media surface, per Table 1.**
     - **Using Contech's PhosphoSorb media. Specifications for the media shall match the specifications provided by the manufacturer and approved by Ecology.**

Table 1. StormFilter cartridge design flow rates for 18-inch diameter cartridges with PhosphoSorb media operating at 1.67 gpm/sq ft.

Effective cartridge height (in)	Cartridge flow rate (gpm/cartridge)
12	8.35
18	12.53
27	18.79

18.79 gpm = 0.0419 cfs

2. **Ecology approves StormFilter systems containing PhosphoSorb media for treatment at the cartridge flow rate shown in Table 1, and sized based on the water quality design flow rate for an off-line system. Contech designs their StormFilter systems to maintain treatment of the water quality design flow while routing excess flows around the treatment chamber during periods of peak bypass. Calculate the water quality design flow rates using the following procedures:**
    - **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.**
    - **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**
    - **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**
3. **The GULD designation has no expiration date but it may be amended or revoked by Ecology and is subject to the conditions specified below.**

Ecology's Conditions of Use:

StormFilter systems containing PhosphoSorb media shall comply with these conditions:

1. **Design, assemble, install, operate, and maintain StormFilter systems containing PhosphoSorb media in accordance with applicable Contech Engineered Solutions manuals, documents, and the Ecology Decision.**
2. **Use sediment loading capacity, in conjunction with the water quality design flow rate, to determine the target maintenance interval.**
3. **Owners shall install StormFilter systems in such a manner that bypass flows exceeding the water quality treatment rate or flows through the system will not re-suspend captured sediments.**
4. **Pretreatment of TSS and oil and grease may be necessary, and designers shall provide pre-treatment in accordance with the most current versions of the CONTECH *Product Design Manual* or the applicable Ecology Stormwater Manual. Design pre-treatment using the performance criteria and pretreatment practices provided in the Stormwater Management Manual for Western Washington (SWMMWW), the Stormwater Management Manual for Eastern Washington (SWMMEW), or on Ecology's "Evaluation of Emerging Stormwater Treatment Technologies" website.**
5. **Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.**
    - **Typically, CONTECH designs StormFilter systems for a target filter media replacement interval of 12 months. Maintenance includes removing accumulated**

sediment from the vault, and replacing spent cartridges with recharged cartridges.

- **Indications of the need for maintenance include the effluent flow decreasing to below the design flow rate, as indicated by the scumline above the shoulder of the cartridge.**
- **Owners/operators must inspect StormFilter with PhosphoSorb media for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the *SWMMWW,* the wet season in western Washington is October 1 to April 30. According to *SWMMEW,* the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.**
- **Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.**
- **When inspections are performed, the following findings typically serve as maintenance triggers:**
    - **Accumulated vault sediment depths exceed an average of 2 inches, or**
    - **Accumulated sediment depths on the tops of the cartridges exceed an average of 0.5 inches, or**
    - **Standing water remains in the vault between rain events, or**
    - **Bypass during storms smaller than the design storm.**
- **Note: If excessive floatables (trash and debris) are present, perform a minor maintenance consisting of gross solids removal, not cartridge replacement.**

6. **Discharges from the StormFilter systems containing PhosphoSorb media shall not cause or contribute to water quality standards violations in receiving waters.**

Applicant:	CONTECH Engineered Solutions
Applicant's Address:	11835 NE Glenn Widing Dr. Portland, OR 97220

Application Documents:

- The Stormwater Management StormFilter, PhosphoSorb at a Specific Flow Rate of 1.67 gpm/ft^2, Conditional Use Level Designation Application. August 2012.
- Quality Assurance Project Plan The Stormwater Management StormFilter® PhosphoSorb® at a Specific Flow Rate of 1.67 gpm/ft^2 Performance Evaluation. August 2012.
- The Stormwater Management StormFilter® PhosphoSorb® at a Specific Flow Rate of 1.67 gpm/ft^2, General Use Level Designation, Technical Evaluation Report. October 2015.

Applicant's Use Level Request:

- General use level designation as a basic (TSS) and phosphorus (total phosphorus) treatment device in accordance with Table 2 of Ecology's 2011 *Technical Guidance Manual for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE).*

Applicant's Performance Claims:

Based on results from laboratory and field-testing, the applicant claims:

- The Stormwater Management StormFilter® with PhosphoSorb® media operating at 1.67 gpm/ft^2 is able to remove 80% of Total Suspended Solids (TSS) for influent concentrations greater than 100 mg/L, is able to remove greater than 80% TSS for influent concentrations greater than 200 mg/L, and achieve a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- The StormFilter with PhosphoSorb media is able to remove 50% or greater total phosphorus for influent concentrations between 0.1 to 0.5 mg/L.

Recommendations:

Ecology finds that:

- CONTECH Engineered Solutions has shown Ecology, through laboratory and field testing, that the Stormwater Management StormFilter® with PhosphoSorb® media is capable of attaining Ecology's Basic and Total Phosphorus treatment goals.

Findings of Fact:

Laboratory testing

- A Phosphosorb StormFilter cartridge test unit, operating at 28 L/min (equivalent to 1.0 gpm/ sq. ft.), and subject to SSC with a silt loam texture (25% sand, 65% silt, and 10% clay by mass) originating from SCS 106 provides a mean SSC removal efficiency of 88%;
- A Phosphosorb StormFilter cartridge test unit, operating at 56 L/min (equivalent to 2.0 gpm/sq. ft.), and subject to SSC with a silt loam texture (25% sand, 65% silt, and 10% clay by mass) originating from SCS 106 provides a mean turbidity reduction of 82%;

- Laboratory testing of PhosphoSorb media in a Horizontal Flow Column (HFC; a 1/24th scale of a full cartridge) resulted in 50 percent dissolved phosphorus removal for the first 1,000 bed volumes. Granular activated carbon (GAC) tested under the same conditions resulted in 30 percent removal of dissolved phosphorus.

Field testing

- Contech conducted monitoring of a StormFilter® with PhosphoSorb® media at a site along Lolo Pass Road in Zigzag, Oregon between February 2012 and February 2015. The manufacturer collected flow-weighted influent and effluent composite samples during 17 separate storm events. The system treated approximately 96 percent of the flows recorded during the monitoring period. The applicant sized the system at 1.67 gpm/sq. ft.
    - Influent TSS concentrations for qualifying sampled storm events ranged from 40 to 780 mg/L. For influent concentrations less than 100 mg/L (n=2) the effluent concentration was less than 10 mg/L. For influent concentrations greater than 100 mg/L the bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean TSS reduction was 85%.
    - Total phosphorus removal for 16 events with influent TP concentrations in the range of 0.1 to 0.5 mg/L averaged 75 percent. A bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus reduction was 67 percent.

Other StormFilter system with PhosphoSorb media items the Company should address:

1. Conduct testing to obtain information about maintenance requirements in order to come up with a maintenance cycle.
2. Conduct loading tests on the filter to determine maximum treatment life of the system.

Technology Description: Download at: http://www.conteches.com/Products/Stormwater-Management/Treatment/Stormwater-Management-StormFilter®.aspx

Contact Information:

Applicant: Jeremiah Lehman
Contech Engineered Solutions
11815 NE Glenn Widing Drive
Portland, OR, 97220
503-258-3136
jlehman@conteches.com

Applicant website: www.conteches.com

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Revision History

Date	Revision
December 2012	Original use-level-designation document: CULD for basic and phosphorus treatment.
January 2013	Revised document to match standard formatting
August 2014	Revised TER and expiration dates
November 2015	Approved GULD designation for Basic and Phosphorus treatment
November 2016	Revised Contech contact information
April 2017	Revised sizing language to note sizing based on Off-line calculations

APPENDIX 4
GEOTECHNICAL REPORT

GEODESIGN INC

REPORT OF GEOTECHNICAL ENGINEERING SERVICES

Proposed Walnut Street Apartment Complex
1100 Walnut Street
Kelso, Washington

For
Kelso Housing Authority
November 19, 2018

GeoDesign Project: KelsoHA-1-02

GeoDesign Inc

November 19, 2018

Kelso Housing Authority
1415 S 10th Avenue
Kelso, WA 98626

Attention: Joleen Reece c/o Suzanna Mainor

Report of Geotechnical Engineering Services
Proposed Walnut Street Apartment Complex
1100 Walnut Street
Kelso, Washington
GeoDesign Project: KelsoHA-1-02

GeoDesign, Inc. is pleased to present this report of geotechnical engineering services for the proposed Kelso Housing Authority apartment complex located at 1100 Walnut Street in Kelso, Washington. Our services have been provided in accordance with our proposal dated October 18, 2018.

We appreciate the opportunity to be of service to you. Please contact us if you have questions regarding this report.

Sincerely,

GeoDesign, Inc.

Shawn M. Dimke, P.E.
Principal Engineer

cc: Pam Haynes, Vancouver Housing Authority (via email only)

SMD:kt
Attachments
One copy submitted (via email only)
Document ID: KelsoHA-1-02-111918-geor.docx

EXECUTIVE SUMMARY

We understand a roughly 30-unit apartment complex is planned for the site. The buildings will be two to three stories high and will have standard, wood-frame construction. We anticipate the following geotechnical factors will have an impact on design and construction of the proposed development:

- There is a high risk of liquefaction during the design earthquake. Our analysis indicates up to 7 inches of liquefaction-induced settlement potential at the ground surface under design levels of ground shaking.
- Spread footings bearing on minimum 18-inch-thick granular pads can be used to support foundation loads provided the structures can tolerate the total estimated liquefaction-induced settlement of 7 inches and estimated differential settlement of 3.5 inches over a distance of approximately 50 feet.
- Mat foundations can be constructed instead of shallow spread foundations to limit differential settlement due to liquefaction. The potential for differential settlement will depend on the strength and continuity of the mat foundations; however, liquefaction-induced differential settlement for buildings supported on continuously reinforced mat foundations bearing on a minimum 18-inch-thick layer of imported granular fill are expected to be limited to 2 inches or less over a distance of approximately 50 feet.
- If the structures cannot tolerate the anticipated liquefaction-induced settlement, mitigation will be necessary. In our opinion, the most suitable mitigation method is ground improvement, such as stone columns or RAPs. Specialty contractors should be contacted to recommend the most suitable option for this site. Pile foundations are also possible for support of the foundation loads but are expected to be less cost effective to ground improvement methods considering the depth of liquefaction and anticipated building loads.
- Liquefaction mitigation will likely need to extend to depths of at least 35 feet BGS to limit total settlement to less than 2 inches and differential settlement to 1 inch. Mitigation can extend to shallower depths if the buildings can tolerate greater settlements.
- We encountered undocumented fill ranging in depth up to 7.5 feet BGS at the site. The undocumented fill generally consists of medium stiff silt and loose to medium dense sand with silt to silty sand with trace organics. Reliable strength properties are extremely difficult to predict for undocumented fill; therefore, we recommend improving the upper 12 inches of subgrade in structural areas by scarifying and re-compacting the on-site soil to structural fill requirements, removing and replacing with granular structural fill, or cement treatment. Scarifying and re-compacting on-site soil will only be possible during dry weather. If soft, very loose, or deleterious materials are encountered in the undocumented fill, greater over-excavation depths and granular backfill could be required for foundations.
- Fine-grained soil present on this site may be easily disturbed during the wet season. If not carefully executed, site earthwork can create extensive soft areas and significant repair costs can result. Subgrade protection should be employed as-needed during the wet season.

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ACRONYMS AND ABBREVIATIONS

AC	asphalt concrete
AOS	apparent opening size
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BGS	below ground surface
CPT	cone penetrometer test
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
MCE	maximum considered earthquake
OSHA	Occupational Safety and Health Administration
pcf	pounds per cubic foot
pci	pounds per cubic inch
PG	performance grade
psf	pounds per square foot
psi	pounds per square inch
RAP	rammed aggregate pier
WSS	Washington Standard Specifications for Road, Bridge, and Municipal Construction (2018)

1.0 INTRODUCTION

GeoDesign, Inc. is pleased to present this report of geotechnical engineering services for the proposed Kelso Housing Authority apartment complex located at 1100 Walnut Street in Kelso, Washington. Figure 1 shows the site relative to existing physical features and streets. Figure 2 shows the approximate locations of our explorations. Acronyms and abbreviations used herein are defined above, immediately following the Table of Contents.

1.1 PROJECT UNDERSTANDING

We understand a roughly 30-unit apartment complex is planned for the currently vacant site located south of Walnut Street in Kelso, Washington. The buildings will be two to three stories high and will have standard, wood-frame construction. Foundation loading is expected to be typical for wood-frame construction. The site is relatively flat, so cuts and fills for grading are expected to be less than a few feet each.

1.2 BACKGROUND

GeoDesign recently prepared a Phase I Environmental Site Assessment (GeoDesign, 2018) and the associated review of historical sources from 1919 through 2018 indicates the site was initially vacant marsh land. Between 1921 and 1943 the site appears to have been graded with undocumented fill. By 1970 the site was occupied by multiple residences located on the western and eastern portions of the site. By 2006 the residential structures were removed from the site and it has remained vacant since.

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 performed the following scope of services for this phase of work:

- Coordinated and managed the field explorations, including utility locates and scheduling subcontractors and GeoDesign field staff.
- Completed the following subsurface explorations at the site:
  - One CPT to a depth of approximately 70.4 feet BGS with a pore pressure dissipation test at a depth of 21.5 feet BGS
  - Five test pit explorations to depths between 4.0 and 11.0 feet BGS
- Collected disturbed soil samples for laboratory testing at select depths from the test pits. Classified the material encountered in the test pits.
- Maintained a detailed log of each test pit. Observed groundwater conditions in the test pits.
- Completed the following laboratory testing on select soil samples collected from the test pits:
  - Twelve natural moisture content determinations
  - Two moisture density determinations
  - Two particle-size analyses
  - One Atterberg limits test

- Prepared this report summarizing the results of our geotechnical evaluation and recommendations for the proposed development, including the following:
  - Provided recommendations for site preparation, 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
  - Provided recommendations for design and construction of shallow spread foundations and mat foundations, including allowable design bearing pressure, minimum footing depth and width, passive resistance capacity, and coefficient of friction
  - Performed a liquefaction analysis and provided recommendations for liquefaction mitigation
  - Provided recommendations for preparation of floor slab subgrade
  - Provided design criteria recommendations for retaining walls, including lateral earth pressures, backfill, compaction, and drainage
  - Provided recommendations for the management of identified groundwater conditions that may affect the performance of structures
  - Provided recommendations for new AC pavements for on-site parking/driveways
  - Provided recommendations for IBC seismic coefficients and evaluated the risk of liquefaction and lateral spreading at the site

3.0 SITE CONDITIONS

3.1 GEOLOGIC SETTING

Kelso and Longview are located along the boundary between the Willamette Valley lowland and the Puget Sound lowland, which together compose the Puget Sound-Willamette Valley physiographic province (Orr and Orr, 1999). The province is a tectonically active forearc basin bordered by the Coast Range physiographic province on the west and by the Cascade Mountains physiographic province on the east. The Longview/Kelso metropolitan area is located near the southern end of a constriction in the Puget Sound-Willamette Valley Province, where rocks of the Coast Range province meet rocks associated with the Cascade Mountains. Basement rocks in the Longview/Kelso area consist of Eocene to Oligocene basalts and other volcanics and marine sedimentary rocks (approximately 40 million to 30 million years old), which are related to rocks exposed in the Coast Ranges. Basalt flows of the Miocene Columbia River Basalt Group (erupted between approximately 17 million to 8 million years ago) overlie the older volcanic and marine sedimentary rocks to the west, and these units together constitute the hills visible on the western side of the Cowlitz and Columbia rivers. The hills to the east of Kelso consist of older volcanic and marine sedimentary rocks overlain by andesitic volcanics and associated volcaniclastic/sedimentary deposits from the Cascade Mountains, most recently from eruptions at Mount St. Helens. Basement rocks in the vicinity of the Longview/Kelso area are overlain by alluvium, which has been deposited for several million years along the Cowlitz, Coweeman, and Columbia rivers. The deposits consist of silt, sand, and gravel deposited as fans and river terraces along the banks.

3.1.1 Faults and Seismicity

Oblique subduction of the Juan de Fuca Plate beneath the North American Plate is occurring along the plate margin and represents a variety of earthquake hazards to the Pacific Northwest. Many bedrock faults have been mapped in the Coast Ranges west of the site (Phillips, 1987;

Walsh, 1987; Walker and MacLeod, 1991). The dominant trend of these faults is northwesterly. The faulting exhibited in the Coast Ranges is associated with uplift of the region from convergent tectonics along the Pacific Northwest. Ground shaking should be expected during earthquakes on the Cascadia Subduction Zone or other faults within the regional system.

Volcanic activity at Mount St. Helens, approximately 35 miles to the east of the site, can also produce shallow earthquakes that may affect the site. In April and May 1980, 13 earthquakes of magnitude 5.0 and greater occurred in the vicinity of Mount St. Helens prior to and during the eruption on May 18, 1980 (ANSS, 2003).

3.2 SURFACE CONDITIONS

The approximately 1.6-acre vacant site is located south of Walnut Street and north of Willow Street in Kelso, Washington. The site wraps around the east and west sides of a lot occupied by a residential duplex off of Walnut Street. Most of the site is a field with tall grasses and some weeds. Trees and thicker vegetation are located along the east edge of the site adjacent to an unnamed slough of the Coweeman River. The ground surface is relatively flat and is situated at an elevation of approximately 15 feet. Based on a review of Google Earth photographs and elevations, the unnamed slough bordering the east edge of the site is dry during summers and relatively shallow with a bottom elevation of approximately 7 feet. A 15-foot-wide utility easement runs from north to south through the site with a jog in the alignment near the middle of the site.

3.3 SUBSURFACE CONDITIONS

3.3.1 General

We explored the subsurface conditions at the site by excavating five test pits (TP-1 through TP-5) to depths between 4.0 and 11.0 feet BGS and advancing one CPT probe (CPT-1) to a depth of approximately 70.4 feet BGS. The approximate exploration locations are shown on Figure 2. Descriptions of our test pit exploration and laboratory testing programs, the test pit logs, and results of laboratory testing are presented in Appendix A. A description of the CPT explorations and logs of the CPT probe are presented in Appendix B.

The shallow subsurface conditions at the site generally consist of a topsoil zone and/or undocumented fill consisting of medium stiff silt with trace organics to depths of 0.7 foot to 2.0 feet BGS underlain by undocumented fill consisting of loose to medium dense sand with variable amounts of silt and trace organics to depths of 5.0 to 7.5 feet BGS. Soft to medium stiff silt and/or clay with trace organics was generally encountered below the fill to depths of 10.0 to 10.5 feet BGS in the test pits and to a depth of 13.1 feet BGS in CPT-1. The silt and clay is generally underlain by sand with variable amounts of silt to the depths explored. The sand is generally medium dense and becomes dense at 54.0 feet BGS. Laboratory testing on select samples indicates moistures contents ranging from 28 to 56 percent for the silt and clay and 3 to 40 percent for the sand. One Atterberg limits test indicates the silt is non-plastic.

3.3.2 Groundwater

We observed groundwater seepage at depths below to 10 to 10.5 feet BGS in test pits TP-1 through TP-4. Test pit TP-5 was only excavated to 4.0 feet BGS due to concern of a utility conflict. A pore water pressure dissipation test performed in the CPT probe indicated a

groundwater level of 6.4 feet BGS. The depth to groundwater may fluctuate in response to prolonged rainfall, seasonal changes, changes in surface topography, and other factors not observed during this study.

4.0 DESIGN RECOMMENDATIONS

4.1 SEISMIC CONSIDERATIONS

4.1.1 Liquefaction

Liquefaction is a phenomenon caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles to near zero. The excessive buildup of pore water pressure results in the sudden loss of shear strength in a soil. Granular soil, which relies on interparticle friction for strength, is susceptible to liquefaction until the excess pore pressures can dissipate. Sand boils and flows observed at the ground surface after an earthquake are the result of excess pore pressures dissipating upwards, carrying soil particles with the draining water. In general, loose, saturated sand soil with low silt and clay content is the most susceptible to liquefaction. Low plasticity, silty sand may be moderately susceptible to liquefaction under relatively higher levels of ground shaking.

Based on the CPT results and our analysis, there is a high risk of liquefaction during the design earthquake. Our analysis indicates up to 7 inches of liquefaction-induced settlement at the ground surface under design levels of ground shaking for an MCE event (ground acceleration = 0.42 g). We expect differential settlement may range up to one-half the total over a distance of approximately 50 feet.

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, seawall, or pond. Liquefied soil adjacent to an open face can flow toward the open face, resulting in lateral ground displacement as the soil liquefies during the design earthquake. The primary difference between a conventional slope stability failure and lateral spreading is that a distinct failure plane is not formed during a lateral spreading event. Liquefied soil flows downslope or to an exposed bank similar to the behavior of a viscous fluid. Considering the shallow depth of the adjacent slough channel, groundwater depth, and shallow native fine-grained soil below the undocumented fill, it is our opinion that lateral displacement will be less than 1 inch for buildings at the site.

4.1.2 Seismic Design Parameters

Due to liquefaction potential, the site is classified as Site Class F according to the 2015 IBC and ASCE 7-10. ASCE 7-10 indicates a site response analysis is not required for structures with a fundamental period of vibration equal to or less than 0.5 second and the site class without liquefaction can be used for design. Accordingly, the seismic design parameters provided in Table 1 for Site Class D can be used for design.

Table 1. Seismic Design Parameters

Parameter	Short Period (T_s = 0.2 second)	1 Second Period (T_1 = 1.0 second)
MCE Spectral Acceleration, S	S_s = 0.949 g	S_1 = 0.438 g
Site Class	D*	
Site Coefficient, F	F_a = 1.120	F_v = 1.562
Adjusted Spectral Acceleration, S_M	S_{MS} = 1.064 g	S_{M1} = 0.684 g
Design Spectral Response Acceleration Parameters, S_D	S_{DS} = 0.709 g	S_{D1} = 0.456 g

*Based on the explorations and our analyses, the site is classified as Site Class F; however, provided the fundamental period of vibration for the structure will be less than 0.5 second, the structure can be design using Site Class D seismic parameters.

4.2 LIQUEFACTION MITIGATION

The following sections provide options for liquefaction mitigation. In our opinion, ground improvement will be the most effective mitigation option for the site. Ground improvement methods typically densify soil or provide a stiff matrix within liquefiable zones, resulting in an overall reduction in liquefaction settlement magnitudes across the improved area.

In order to limit liquefaction-induced settlement to less than 1 inch at the ground surface, we recommend mitigation be performed to a depth of at least 35 feet BGS. If the buildings can tolerate more than 1 inch of settlement, mitigation can be performed to shallower depths. The actual depth of ground improvement should be determined by the design-build contractor based on the allowable settlement tolerances.

Mitigation can also be performed below site utilities. If ground improvement is not used for both utilities and buildings, we recommend flexible utility connections to buildings to prevent shearing of the utility lines due to differential settlement.

4.2.1 Ground Improvement

Ground improvement methods, such as stone columns, RAPs, and dynamic compaction, can be employed to mitigate liquefaction. Stone columns are constructed by inserting a vibrating probe into the subsurface to the desired depth. When the probe is extracted, the void is backfilled with crushed rock aggregate. Stone columns densify the surrounding matrix soil, significantly reducing the potential for liquefaction. RAPs are installed by excavating columns of soil and replacing it with compacted gravel. This system is typically limited to depths of 20 to 30 feet BGS. Dynamic compaction is a technique that densifies soil by dropping a large weight from a crane or using a large pneumatic tamper. This method produces significant vibration and is typically effective to depths of 15 to 20 feet BGS. Considering the shallow silt and clay soil and adjacent residential duplex, dynamic compaction is not considered a viable ground improvement

method for the site. There are a number of other proprietary methods for densifying soil or alleviating the development of excess pore pressures that are available to ground improvement contactors.

Ground improvement is typically designed and constructed by a specialty contractor. GeoDesign can provide the names of several specialty contractors, who can be consulted on the best and least expensive options for liquefaction mitigation. The specialty contractor will also provide design and construction services. We recommend that GeoDesign review ground improvement designs.

4.2.2 Deep Foundations

Deep foundations are possible for support of the anticipated foundation loads. However, liquefied soil will impose large downdrag forces along the shaft of piles and require greater embedment depths than ground improvement methods. In our opinion, ground improvement will be more suitable and likely less expensive than piles for this site.

4.3 FOUNDATION SUPPORT

4.3.1 General

Based on the results of our explorations and analysis, structures that can tolerate the estimated liquefaction-induced settlement discussed in the "Seismic Considerations" section can be supported by conventional spread footings constructed on 18-inch-thick gravel pads. Differential settlement for shallow spread footings is expected to be less than one-half of the total settlement magnitude. Mat foundations can be constructed instead of shallow spread foundations to limit differential settlement from seismic-induced liquefaction. While the total liquefaction-induced settlement will not change, we expect differential settlement for a sufficiently reinforced mat foundation can be limited to 2 inches over approximately 50 feet. Recommendations for mat foundations are included in the following sections.

Structures that cannot tolerate the estimated liquefaction-induced settlement should be established on shallow foundations/grade beams on improved ground per the "Liquefaction Mitigation" section. Gravel pads are not required for structures established on improved ground or piles.

4.3.2 Gravel Pads

Gravel pads should extend 6 inches beyond footing perimeters for each 12 inches of depth and should consist of imported granular material as described in the "Structural Fill" section. The imported granular material should be compacted to not less than 95 percent of the 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 before placing granular pads as well.

4.3.3 Mat Foundations

Mat foundations can be used to support columns and walls under the planned structural loads. Mats should be founded on an 18-inch-thick gravel pad as discussed in the previous sections. We estimate that post-construction consolidation-induced settlement of the mat foundation will be less than 1 inch. We estimate liquefaction-induced settlement of up to 7 inches during the

design earthquake is expected as discussed in the "Seismic Considerations" and "Liquefaction Mitigation" sections. We estimate that liquefaction-induced differential settlement for mat foundations will be limited to 2 inches over approximately 50 feet.

A subgrade reaction modulus of 150 pci can be used to design mat foundation underlain by a minimum 18-inch-thick zone of crushed rock. The subgrade modulus should be reduced to 75 pci for seismic loading. Lateral loads can be resisted by passive earth pressure on the sides of the mat foundations and by friction on the bearing surface as discussed in the following sections.

4.3.4 Dimensions and Design Parameters

If constructed, continuous wall and isolated spread footings should be at least 16 and 20 inches wide, respectively. The bottom of exterior footings should be at least 18 inches below the lowest adjacent exterior grade. The bottom of interior footings should be established at least 12 inches below the base of the slab. Footings established on on-site soil or structural fill soil and prepared as recommended above should be sized based on an allowable bearing pressure of 1,500 psf. This is a net bearing pressure; the weight of the footing and overlying backfill can be ignored in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads and can be increased by one-half for short-term loads such as those resulting from wind or seismic forces.

Based on our analysis and experience with similar soil, total post-construction consolidation-induced settlement under static conditions should be less than 1 inch, with differential settlement of less than ½ inch between footings. This does not include liquefaction-induced settlement that may occur during the design earthquake.

4.3.5 Resistance to Sliding

Lateral loads on shallow foundations and grade beams can be resisted by passive earth pressure on the sides of the structure and by friction on the base. Our analysis indicates that the available passive earth pressure for footings confined by on-site soil and structural fill is 325 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 pressure of 250 pcf equivalent fluid pressure. Adjacent floor slabs, pavements, or the upper 12-inch depth of adjacent unpaved areas should not be considered when calculating passive resistance. In addition, in order to rely on passive resistance, a minimum of 10 feet of horizontal clearance must exist between the face of the footings and any adjacent downslopes.

For foundations/grade beams in contact with imported granular material, a coefficient of friction equal to 0.40 may be used when calculating resistance to sliding. This value should be reduced to 0.35 for structural elements established over the native sand.

4.3.6 Footing Subgrade Evaluation

We recommend that all footing and floor subgrades be evaluated by the project geotechnical engineer or their representative to confirm suitable bearing conditions. Observations should also confirm that all loose or soft material, organics, unsuitable fill, prior topsoil zones, and softened subgrades (if present) have been removed. Localized deepening of footing excavations

may be required to penetrate debris, fill, or deleterious material. Foundation-bearing surfaces should not be exposed to standing water. Should water infiltrate and pool in the excavation, the water and any damaged subgrade should be removed before placing reinforcing steel or concrete.

4.4 FLOOR SLABS

Satisfactory subgrade support for building floor slabs supporting floor loads up to 100 psf areal loading can be obtained provided the subgrade is prepared in accordance with the "Site Preparation" section. We recommend a minimum 6-inch-thick layer of aggregate base be placed and compacted over the prepared soil subgrade. Imported granular material placed beneath building floor slabs should meet the requirements in the "Structural Fill" and "Fill Placement and Compaction" sections.

The near-surface native soil is fine grained and will tend to maintain high moisture content. In areas where moisture-sensitive floor slab and flooring will be installed, the installation of a vapor barrier is warranted in order to reduce the potential for moisture transmission through and efflorescence growth on the slab and flooring. In addition, flooring manufacturers often require vapor barriers to protect flooring and flooring adhesives and will warrant their product only if a vapor barrier is installed according to their recommendations.

If the project includes moisture-sensitive flooring, we recommend that 10- or 15-mil Stego Wrap be considered for this project. The recommended procedures for installing Stego Wrap are to pour the floor slab concrete directly over the vapor barrier. We recommend that the structural engineer be contacted to determine if the mix design for the concrete should be modified assuming the above-referenced construction sequence. Actual selection and design of an appropriate vapor barrier, if needed, should be based on discussions among members of the design team.

Concrete slabs may be designed assuming a modulus of subgrade reaction, k, of 150 psi per inch, provided the subgrade is prepared in accordance with the "Site Preparation" section.

4.5 RETAINING STRUCTURES

4.5.1 Assumptions

Our retaining wall design recommendations are based on the following assumptions: (1) the walls consist of conventional, cantilevered retaining walls, (2) the walls are less than 8 feet in height, (3) the backfill is drained and consists of imported granular materials, and (4) the backfill has a slope flatter than 4H: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

For unrestrained retaining walls, an active pressure of 35 pcf equivalent fluid pressure should be used for design. Where retaining walls are restrained from rotation (such as basement walls), a pressure of 55 pcf equivalent fluid pressure should be used for design. A superimposed seismic lateral force should be calculated based on a dynamic force of $7H^2$ pounds per lineal foot of wall, where H is the height of the wall in feet, and applied as a distributed load with the centroid located at a distance of 0.6H from the base of the wall.

If surcharges (e.g., retained slopes, structure foundations, vehicles, steep slopes, terraced walls, etc.) are located within a horizontal distance from the back of a wall equal to the height of the wall, additional pressures will need to be accounted for in the wall design. Our office should be contacted for appropriate wall surcharges based on the actual magnitude and configuration of the applied loads. The base of the wall footing excavations should extend a minimum of 12 inches below the lowest adjacent grade. The wall footings should be designed in accordance with the "Foundation Support" section.

4.5.3 Wall Drainage and Backfill

The above design parameters have been provided assuming back-of-wall drains will be installed to prevent buildup of hydrostatic pressures behind all walls. If a drainage system is not installed, our office should be contacted for revised design forces.

Backfill material placed behind retaining walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of select granular wall backfill meeting the requirements described in the "Structural Fill" section. Alternatively, the native soil can be used as backfill material provided a minimum 2-foot-wide column of angular drain rock wrapped in a geotextile is placed against the wall and the native soil can be adequately moisture conditioned for compaction. The rock column should extend from the perforated drainpipe or foundation drains to within approximately 1 foot of the ground surface. The angular drain rock should meet the requirements provided in the "Structural Fill" section. All wall backfill should be placed and compacted as recommended for select granular wall backfill in the "Structural Fill" section.

Perforated collector pipes should be placed at the base of the granular backfill behind the walls. The pipe should be embedded in a minimum 2-foot-wide zone of angular drain rock. The drain rock should meet specifications provided in the "Structural Fill" section. The drain rock should be wrapped in a drainage geotextile fabric meeting the requirements in the "Materials" section. The collector pipes should discharge at an appropriate location away from the base of the wall. Unless measures are taken to prevent backflow into the wall's drainage system, the discharge pipe should not be tied directly into stormwater drain systems.

Settlement of up to 1 percent of the wall height commonly occurs immediately adjacent to the wall as the wall rotates and develops active lateral earth pressures. Consequently, we recommend that construction of flatwork adjacent to retaining walls be 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 DESIGN

Pavements should be installed on prepared subgrade or new engineered fill prepared in conformance with the "Construction" section. Subgrade improvement should be performed as discussed in the "Site Preparation" section. Our pavement recommendations are based on the following assumptions:

- The top 12 inches of soil subgrade below the pavement section is compacted to at least 92 percent of its maximum density, per ASTM D1557, or observations indicate that it is in a firm, unyielding condition.
- Resilient moduli of 4,000 psi and 20,000 psi were estimated for the compacted subgrade and base rock, respectively.
- Initial and terminal serviceability indices of 4.2 and 2.5, respectively.
- Reliability of 75 percent and standard deviation of 0.45.
- Structural coefficients of 0.42 and 0.10 for the AC and base rock, respectively.
- A 20-year design life.
- Heavy traffic generally consists of two-axle trucks, such as delivery trucks or garbage trucks.

We do not have specific information on the frequency of vehicles expected at the site. We performed pavement design for two assumed traffic scenarios. The assumed traffic breakdown and recommended pavement sections are provided in Table 2. The design team can select the appropriate pavement section for different areas of the site based on the anticipated traffic levels. The required base rock thicknesses can be reduced to 4.0 inches if the subgrade is cement treated. Both recommended pavement sections with subgrades prepared as recommended are suitable to support an occasional 80,000-pound fire truck.

Table 2. Minimum Pavement Thicknesses

Traffic Levels			Pavement Thicknesses[1] (inches)	
Cars per Day	Trucks per Day	ESALs	AC	Base Rock
100	0	1,000	2.5	6.0
100	5	13,000	3.0	8.0

1. All thicknesses are intended to be the minimum acceptable values

The AC and aggregate base should meet the requirements outlined in the "Materials" section. Construction traffic should be limited to non-building, unpaved portions of the site or haul roads. Construction traffic should not be allowed on new pavements. 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. The aggregate base thickness does not account for construction traffic, and haul roads and staging areas should be used as described in the "Construction" section.

4.7 DRAINAGE

Where possible, the finished ground surface around the buildings should be sloped away from the structures at a minimum 2 percent gradient for a distance of at least 5 feet. Downspouts or roof scuppers should discharge into a storm drain system that carries the collected water to an appropriate stormwater system. Trapped planter areas should not be created adjacent to the buildings without providing means for positive drainage (e.g., swales or catch basins). Embedded walls should include drainage, as discussed in the "Retaining Structures" section.

4.8 PERMANENT SLOPES

Permanent cut and fill slopes should not exceed 2H:1V. Slopes within stormwater facilities should not exceed 3H:1V. Access roads and pavements should be located at least 5 feet from the top of cut and fill slopes. The setback should be increased to 10 feet for buildings. The slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face of the slope.

5.0 CONSTRUCTION

5.1 SITE PREPARATION

5.1.1 Stripping and Grubbing

Trees and shrubs should be removed from planned improvement 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 the root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend that soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with structural fill. Grass and root zones should be stripped and removed from all development areas. We estimate that the root zone associated with grasses will be 3 to 6 inches thick. Stripped material should be transported off site for disposal or used in landscaped areas.

5.1.2 Demolition

Demolition should include complete removal of existing structures, foundations, and pavements within 5 feet of areas to receive new pavements, buildings, retaining walls, or engineered fills. Underground utility lines, vaults, or tanks encountered in areas of new improvements should be completely removed or grouted full if left in place.

Old basement/crawlspace areas or voids resulting from removal of improvements or loose soil in utility lines should be backfilled with compacted structural fill, as discussed in the "Structural Fill" section. The bottom of such excavations should be excavated to expose a firm subgrade before filling and their sides sloped at a minimum of 1H:1V to allow for more uniform compaction at the edges of the excavations.

Material generated during demolition should be transported off site for disposal or stockpiled in areas designated by the owner. In general, this material will not be suitable for re-use as engineered fill.

5.1.3 Subgrade Improvement and Evaluation

We encountered variable undocumented fill with trace organics in all our test pit explorations. Reliable strength properties are extremely difficult to predict for undocumented fill; therefore, we recommend improving the subgrade by scarifying and re-compacting the on-site soil to structural fill requirements, removing and replacing with granular structural fill, or cement treatment. Scarifying and re-compacting on-site soil will only be possible during dry weather. Improvement should occur to a depth of at least 12 inches and before structural fill or structures are placed. A qualified geotechnical engineer should evaluate the subgrade as described in the

following section to determine if there are areas where deeper improvement will be necessary. The cost of improving significant amounts of subgrade should be included in the project budget.

As discussed in the "Structural Fill" section, the native soil can be sensitive to small changes in moisture content and will be difficult, if not impossible, to compact adequately during wet weather. While scarification and compaction of the subgrade is the least expensive option for subgrade improvement, it will likely only be possible during extended dry periods and following moisture conditioning of the soil.

After improvement, the exposed subgrade should be evaluated by proof rolling with a fully loaded dump truck or similarly heavy, rubber tire construction equipment. A member of our geotechnical staff should observe proof rolling to evaluate yielding of the ground surface. During wet weather, subgrade evaluation should be performed by probing with a foundation probe rather than proof rolling.

5.2 SUBGRADE PROTECTION

The on-site fine-grained soil is moisture sensitive and may be disturbed when wet. Trafficability on exposed subgrades may be difficult during or after extended wet periods or when the moisture content of the surface soil is more than a few percentage points above optimum. Granular haul roads or staging areas should be used for support of construction traffic during wet conditions. The base rock thicknesses recommended in the "Pavement Design" and "Floor Slabs" sections are intended to support post-construction design traffic/floor loads and are not intended to support repeated heavy construction traffic.

The thickness of the granular material for haul roads and staging areas will depend on the amount and type of construction traffic. Generally, a 6- to 12-inch-thick mat of imported granular material is sufficient for staging areas for the building pad. The granular mat for haul roads and areas with repeated heavy construction traffic typically needs to be increased to 12 to 16 inches. The actual thickness of haul roads and staging areas should be based on the contractor's approach to site development and the amount and type of construction traffic.

The granular material should consist of imported granular material or stabilization material as described in the "Structural Fill" section. In addition, we recommend that a geotextile be placed as a barrier between the subgrade and imported granular material in areas of repeated construction traffic. The geotextile should have a minimum Mullen burst strength of 250 psi for puncture resistance and an AOS between U.S. Standard No. 70 and No. 100 sieves.

5.3 EXCAVATION

5.3.1 Trench Cuts and Shoring

The near-surface soil is generally loose to medium dense sand with variable silt fractions. Trench cuts will likely experience caving and raveling at shallow depths. Excavations above the groundwater depth should be cut at a slope of 1.5H:1V in accordance with OSHA guidelines for Type C soil. In lieu of large and open cuts, approved temporary shoring may be used for excavation support. A wide variety of shoring and dewatering systems are available. Consequently, we recommend that 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. Box shoring will be difficult to install because caving of the sidewalls will occur after short periods of time. 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 that 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. All excavations should be made in accordance with applicable OSHA and state regulations.

5.3.2 Temporary Dewatering

Groundwater seepage was encountered at 10 to 10.5 feet BGS in our test pit explorations. Groundwater may also be encountered in excavations depending on the required depths and season they are completed. Dewatering using sump pumps may be possible for excavations proceeding less than 2 feet below groundwater. Excavations below groundwater in the sand and sandy soil at the site will be prone to sloughing, caving, and "running sand". More intensive dewatering methods, such as well points, and shoring may be necessary if excavations extend below groundwater.

If groundwater is present at the base of utility trench excavations, we recommend placing up to 12 inches of stabilization material at the base of the excavations. Trench stabilization material should meet the requirements provided in the "Structural Fill" section.

We note that these recommendations are for guidance only. Dewatering of excavations is the sole responsibility of the contractor, as the contractor is in the best position to select these systems based on their means and methods.

5.3.3 Safety

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

5.4 MATERIALS

5.4.1 Structural Fill

5.4.1.1 General

Fill should be placed on subgrade that has been prepared in conformance with the "Site Preparation" section. A variety of material may be used as structural fill at the site. However, all material used as structural fill should be free of organic matter or other unsuitable material and should generally meet the specifications provided in WSS 9-03 – Aggregates, depending on the

application. A brief characterization of some of the acceptable materials and our recommendations for their use as structural fill is provided below. Fill should be compacted as described in the "Fill Placement and Compaction" section.

5.4.1.2 On-Site Soil

The on-site material is suitable for use as general structural fill, provided it is properly moisture conditioned and free of debris, organic material, and particles over 6 inches in diameter. On-site soil will be difficult, if not impossible, to compact during or shortly after the wet season and should only be used as structural fill during the dry season. Moisture conditioning (drying) will likely be required to use on-site soil for structural fill during most times of the year. Soil should be spread over a broad area and frequently turned/tilled in order to adequately dry it.

5.4.1.3 Imported Granular Material

Imported granular material used during periods of wet weather, for building pad subgrades, and for staging areas should be pit- or quarry-run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in WSS 9-03.9(1) – Ballast, WSS 9-03.14(1) – Gravel Borrow, or WSS 9-03.14(2) – Select Borrow. The imported granular material should be fairly well graded between coarse and fine material, have less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve, and have a minimum of two mechanically fractured faces. Imported granular material should be placed in lifts with a maximum uncompacted thickness of 8 to 12 inches and compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557. During the wet season or when wet subgrade conditions exist, the initial lift should be approximately 18 inches in uncompacted thickness and should be compacted with a smooth-drum roller without using vibratory action.

Where imported granular material is placed over wet or soft soil subgrades, we recommend a geotextile be placed as a barrier between the subgrade and imported granular material. Depending on site conditions, the geotextile should meet the specifications provided in WSS 9-33.2(1) – Geotextile Properties (Table 3) for soil separation or stabilization. The geotextile should be installed in conformance with WSS 2-12 – Construction Geosynthetic.

5.4.1.4 Stabilization Material

Stabilization material used to create haul roads for construction traffic or at the base of unstable trench subgrade should consist of pit- or quarry-run rock or crushed rock. The material should have a maximum particle size of 6 inches and less than 5 percent by dry weight passing the U.S. Standard No. 4 sieve, have at least two mechanically fractured faces, and be free of organic matter and other deleterious material. Material meeting the specifications provided in WSS 9-27.3(6) – Stone is generally acceptable for use. Stabilization material should be placed in lifts between 12 and 18 inches thick and compacted to a firm condition with a smooth-drum roller without using vibratory action.

5.4.1.5 Trench Backfill

Trench backfill placed beneath, adjacent to, and for at least 2 feet above utility lines (i.e., the pipe zone) should consist of well-graded, granular material with a maximum particle size of 1½ inches and less than 7 percent by dry weight passing the U.S. Standard No. 200 sieve and meet the specifications provided in WSS 9 03.12(3) – Gravel Backfill for Pipe Zone Bedding. The

pipe zone backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

Within roadway alignments or beneath proposed or future building pads, the remainder of the trench backfill should consist of well-graded, granular material with a maximum particle size of 2½ inches and less than 7 percent by dry weight passing the U.S. Standard No. 200 sieve and meet the specifications provided in WSS 9-03.19 – Bank Run Gravel for Trench Backfill. This material should be compacted to at least 92 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department. The upper 2 feet of the trench backfill should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

Outside of structural improvement areas (e.g., roadway alignments or building pads), trench backfill placed above the pipe zone may consist of general fill material that is free of organics and material over 6 inches in size and meets the specifications provided in WSS 9-03.14(3) – Common Borrow and WSS 9-03.15 – Native Material for Trench Backfill. This general trench backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

5.4.1.6 Drain Rock

Backfill for subsurface drains should consist of drain rock meeting the specifications provided in WSS 9-03.9(1) – Ballast or WSS 9 03.12(4) – Gravel Backfill for Drains and have at least two angular faces. The drain rock should be wrapped in a geotextile separation fabric meeting the specifications provided in this section.

5.4.1.7 Aggregate Base Rock

Imported granular material used as base rock for building floor slabs and pavements should consist of ¾- or 1½-inch-minus material (depending on the application) and meet the requirements in WSS 9-03.9(3) – Crushed Surfacing and WSS 9-03.10 – Aggregate for Gravel Base. In addition, the aggregate should have less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve. The aggregate base should be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557.

5.4.1.8 Retaining Wall Select Backfill

Backfill material 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. We recommend the select granular 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 the 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 the 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 pavements) will be placed atop the wall backfill, we recommend that the upper 2 feet of material be compacted to 95 percent of the maximum dry density, as determined by ASTM D1557.

5.4.2 Geotextile Fabric

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

5.4.3 AC

The AC pavement should conform to WSS 5-04 - Hot Mix Asphalt. AC should consist of ½-inch HMA. The asphalt cement binder should be PG 64-22 Performance Grade Asphalt Cement conforming to WSS 9-02.1(4) – Performance Graded Asphalt Binder. The layer thickness should be 2.0 to 3.5 inches. The job mix formula should meet the requirements for non-statistical ½-inch HMA (WSS 5-04 – Hot Mix Asphalt and WSS 9-03.8 – Aggregates for Hot Mix Asphalt) and be compacted to 91 percent of the maximum specific gravity or as required by the local jurisdiction in public right-of-way areas.

5.4.3.1 Cold Weather Paving Considerations

In general, AC paving is not recommended during the 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. 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 2.0 and 2.5 inches.

If paving activities must take place during cold-weather construction as defined above, the project team should be consulted and a site meeting should be held to discuss ways to lessen low compaction risks.

5.4.4 Soil Amendment With Cement

5.4.4.1 General

As an alternative to the use of imported granular material for wet weather structural fill and/or to provide subgrade protection during wet weather, an experienced contractor may be able to amend the on-site silty/sandy soil with portland cement to obtain suitable support properties. Successful use of soil amendment depends on the use of correct mixing techniques, soil moisture content, and amendment quantities. The amount of cement used during treatment should be based on an assumed soil dry unit weight of 100 pcf.

5.4.4.2 Subbase Stabilization

Specific recommendations based on exposed site conditions for soil amending 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 80 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. Generally, 6 percent cement by weight of dry soil can be used when the soil moisture content does not exceed approximately 23 percent. If the soil moisture content is in the range of 25 to 35 percent, 7 to 9 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 cement-spreading equipment be equipped with balloon tires to reduce rutting and disturbance of the fine-grained soil. A static 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. 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 the achievable dry density at the moisture content of the material, as defined in ASTM D 1557.

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

Treatment depths for building/pavement, haul roads, and staging areas are typically on the order of 12, 16, and 12 inches, respectively. Treatment to depths up to 24 inches may be necessary in isolated areas where soft to very soft soils exist. 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 amending should not be attempted when 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.

5.4.4.3 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 the "Site Preparation" section. The cement ratio for general cement-amended fill can generally be reduced by 1 percent (by dry weight). Typically, a minimum curing of four days is required between treatment and construction traffic access. Consecutive lifts of fill may be treated 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 for the final lift of cement-amended soil.

5.4.4.4 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 (if any).

5.4.4.5 Specification Recommendations

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

- In general, cement amending is not recommended during the cold weather (temperatures less than 40 degrees Fahrenheit) or during 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/treatment depth shall extend the full depth of the disturbance.
  - Multiple "passes" of the tiller may be required to adequately blend the cement and soil mixture.
- 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/treatment 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.

5.5 FILL PLACEMENT AND COMPACTION

Fill soil should be compacted at a moisture content that is within 3 percent of optimum. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction. Fill and backfill material should be placed in uniform, horizontal lifts and compacted with appropriate equipment. The maximum lift thickness will vary depending on the

material and compaction equipment used but should generally not exceed the loose thicknesses provided in Table 3. Fill material should be compacted in accordance with the compaction criteria provided in Table 4.

Table 3. Recommended Uncompacted Lift Thickness

Compaction Equipment	Recommended Uncompacted Lift Thickness (inches)		
	Silt/Clay Soil	Granular and Crushed Rock Maximum Particle Size ≤ 1½ Inches	Crushed Rock Maximum Particle Size > 1½ Inches
Hand Tools: Plate Compactor and Jumping Jack	4 to 8	4 to 8	Not Recommended
Rubber Tire Equipment	6 to 8	10 to 12	6 to 8
Light Roller	8 to 10	10 to 12	8 to 10
Heavy Roller	10 to 12	12 to 18	12 to 16
Hoe Pack Equipment	12 to 16	18 to 24	18 to 24

The table above is based on our experience and is intended to serve only as a guideline. The information provided in this table should not be included in the project specifications.

Table 4. Compaction Criteria

Fill Type	Compaction Requirements in Structural Zones		
	Percent Maximum Dry Density Determined by ASTM D1557		
	0 to 2 Feet Below Subgrade (percent)	Greater Than 2 Feet Below Subgrade (percent)	Pipe Zone (percent)
Area Fill (Granular)	95	95	-----
Area Fill (Fine Grained)	92	92	-----
Aggregate Bases	95	95	-----
Trench Backfill[1,2]	95	92	90[1,2]
Retaining Wall Backfill	95[3]	92[3]	-----

1. Trench backfill above the pipe zone in non-structural areas should be compacted to 85 percent.
2. Or as recommended by the pipe manufacturer.
3. Should be reduced to 90 percent within a horizontal distance of 3 feet from the retaining wall.

5.6 EROSION CONTROL

The fine-grained soil at this site is eroded easily by wind and water; therefore, erosion control measures should be carefully planned and in place before construction begins. 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. During earthwork at the site, the contractor should be responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion at the working surface.

6.0 OBSERVATION OF CONSTRUCTION

Satisfactory earthwork and foundation performance depends to a large degree on the quality of construction. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions often requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated. In addition, 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.

7.0 LIMITATIONS

We have prepared this report for use by the Kelso Housing Authority and members of their design and construction teams for the proposed project. The data and report can be used for estimating purposes, but our report, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions and are not applicable to other sites.

Soil explorations indicate soil conditions only at specific locations and only to the depths penetrated. The soil explorations do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during the course of excavation and construction, re-evaluation will be necessary. In addition, if design changes are made, we should be retained to review our conclusions and recommendations and to provide a written evaluation or modification.

The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

♦ ♦ ♦

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

Sincerely,

GeoDesign, Inc.

Shawn M. Dimke, P.E.
Principal Engineer

Signed 11/19/2018

REFERENCES

Advanced National Seismic System (ANSS), 2003, *ANSS/CNSS Worldwide Earthquake Catalog*, http://www.anss.org, Accessed November 17, 2003.

GeoDesign, Inc., 2018. *Phase I Environmental Site Assessment; Proposed Walnut Street Apartment Complex Site; 1106 Walnut Street; Kelso, Washington,* dated November 7, 2018. GeoDesign Project: KelsoHA-1-01.

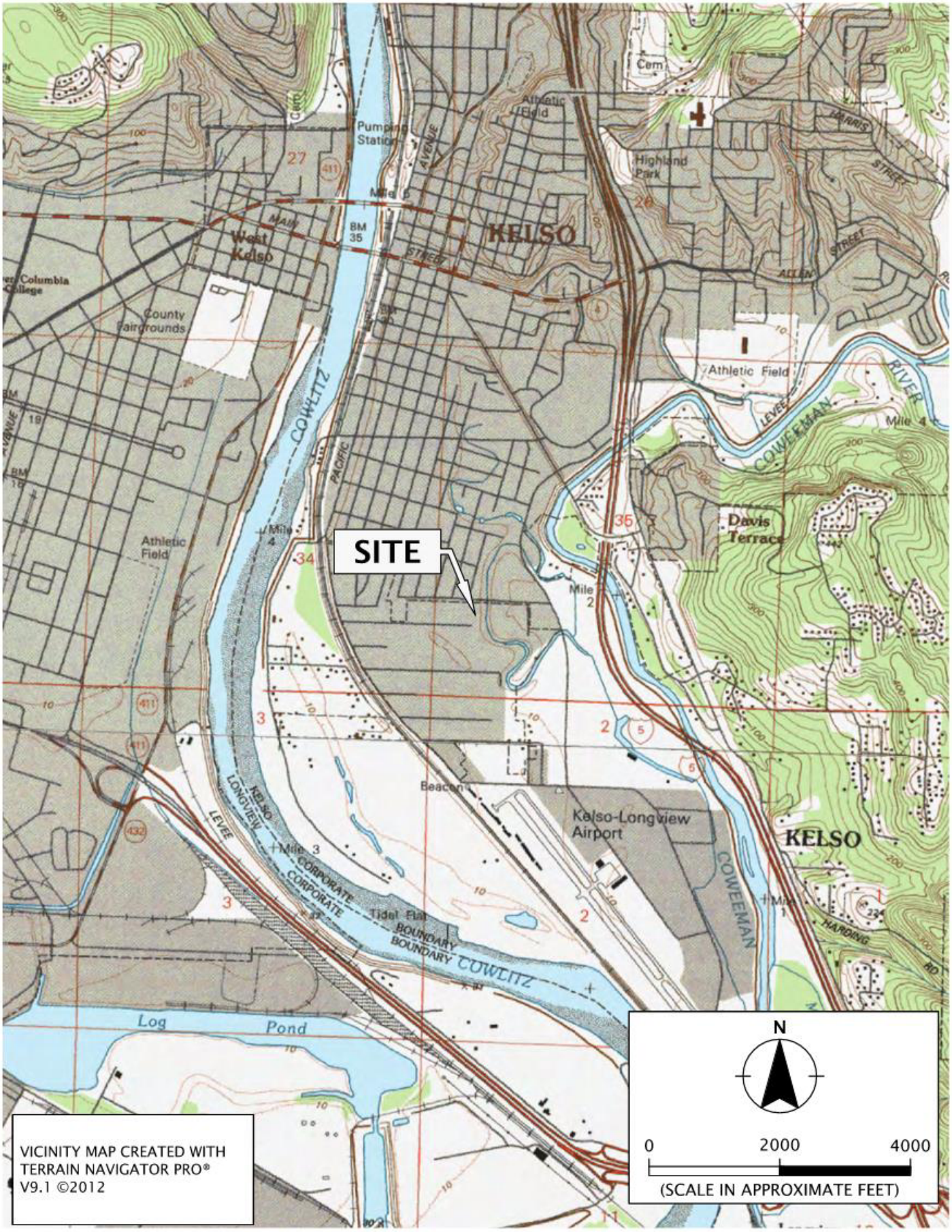
Orr, Elizabeth L. and Orr, William N., 1999, *Geology of Oregon*: Kendall/Hunt Publishing Company, Dubuque, IA; 254p.

Phillips, William M., 1987, *Geologic Map of the Mount St. Helens Quadrangle, Washington and Oregon*: Washington Division of Geology and Earth Resources, Open File Report 87-4, scale 1:100,000; 1 sheet and 63 p. text.

Walker, G.W., and MacLeod, N.S., 1991, *Geologic Map of Oregon*: United States Geological Survey, scale 1:500,000; 2 sheets.

Walsh, Timothy J., 1987, *Geologic Map of the Astoria and Ilwaco Quadrangles, Washington and Oregon*: Washington Division of Geology and Earth Resources, Open File Report 87-2, scale 1:100,000; 1 sheet and 30 p. text.

FIGURES



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KELSOHA-1-02	**VICINITY MAP**	
NOVEMBER 2018	PROPOSED WALNUT STREET APARTMENT COMPLEX KELSO, WA	**FIGURE 1**

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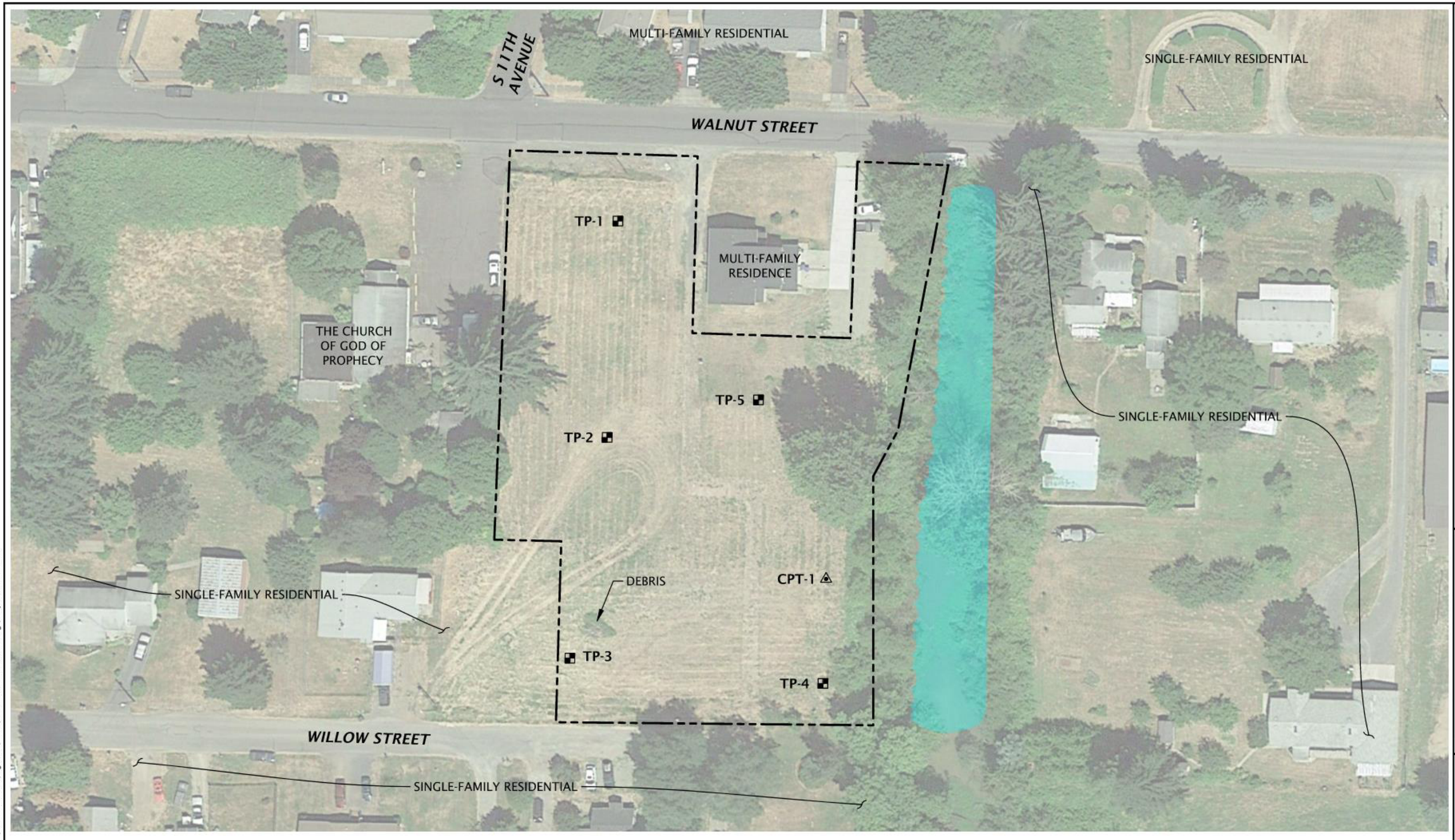
File Name: J:\E-L\KelsoHA\kelsoha-1\kelsoha-1-02\Figures\CAD\KelsoHA-1-02-VM01.dwg | Layout: FIGURE 1



LEGEND:

- APPROXIMATE SITE BOUNDARY
- TP-1 TEST PIT
- STREAM
- CPT-1 CONE PENETRATION TEST

SITE PLAN BASED ON AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO OCTOBER 24, 2018

N

0 60 120

(SCALE IN FEET)

SITE PLAN

PROPOSED WALNUT STREET APARTMENT COMPLEX
KELSO, WA

FIGURE 2

KELSOHA-1-02

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APPENDIX A

APPENDIX A

TEST PIT EXPLORATIONS

GENERAL

Our subsurface exploration program included excavating five test pits (TP-1 through TP-5) to depths between 4.0 and 11.0 feet BGS at the approximate locations shown on Figure 2. The exploration logs are presented in this appendix. The test pits were excavated using a John Deere 35C tracked excavator by Dan J. Fischer Excavating, Inc. on October 31, 2018. The locations of the explorations were determined by pacing from existing site features. This information should be considered accurate to the degree implied by the methods used.

SOIL SAMPLING

Grab samples were collected from the test pit walls and/or base using the excavator bucket. Higher quality, relatively undisturbed samples were collected using a standard Shelby tube in general accordance with ASTM D 1587. Sampling methods and intervals are shown on the exploration logs.

SOIL CLASSIFICATION

The soil samples were classified in accordance with the "Exploration Key" (Table A-1) and "Soil Classification System" (Table A-2), which are presented in this appendix. The exploration logs indicate the depths at which the soils or their characteristics change, although the change actually could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications are shown on the exploration logs.

LABORATORY TESTING

CLASSIFICATION

The soil samples were classified in the laboratory to confirm field classifications. The laboratory classifications are shown on the exploration logs if those classifications differed from the field classifications.

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 soil in a test sample and is expressed as a percentage. The test results are presented in this appendix.

PARTICLE-SIZE ANALYSIS

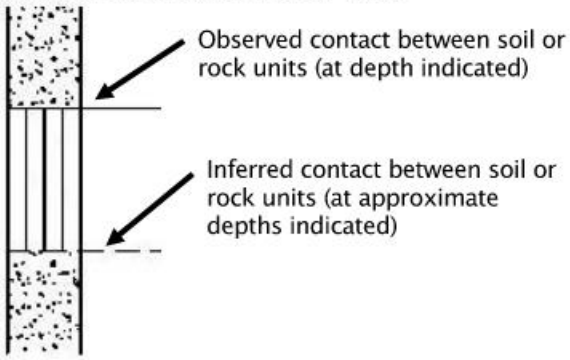
We completed particle-size analysis on select soil samples in accordance with ASTM D1140. The tests determined percent fines (passing a U.S. Standard No. 200 sieve) only. The test results are presented in this appendix.

ATTERBERG LIMITS TESTING

Atterberg limits (plastic and liquid limits) testing was performed on a select soil sample in general accordance with ASTM D 4318. 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. The test results are presented in this appendix.

SYMBOL	SAMPLING DESCRIPTION
	Location of sample obtained in general accordance with ASTM D 1586 Standard Penetration Test with recovery
	Location of sample obtained using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D 1587 with recovery
	Location of sample obtained using Dames & Moore sampler and 300-pound hammer or pushed with recovery
	Location of sample obtained using Dames & Moore and 140-pound hammer or pushed with recovery
	Location of sample obtained using 3-inch-O.D. California split-spoon sampler and 140-pound hammer
	Location of grab sample
	Rock coring interval
	Water level during drilling
	Water level taken on date shown

Graphic Log of Soil and Rock Types



GEOTECHNICAL TESTING EXPLANATIONS

ATT	Atterberg Limits	P	Pushed Sample
CBR	California Bearing Ratio	PP	Pocket Penetrometer
CON	Consolidation	P200	Percent Passing U.S. Standard No. 200 Sieve
DD	Dry Density		
DS	Direct Shear	RES	Resilient Modulus
HYD	Hydrometer Gradation	SIEV	Sieve Gradation
MC	Moisture Content	TOR	Torvane
MD	Moisture-Density Relationship	UC	Unconfined Compressive Strength
NP	Nonplastic	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal

ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
		MS	Moderate Sheen
ppm	Parts per Million	HS	Heavy Sheen

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EXPLORATION KEY

TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOIL

Relative Density	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)
Very Loose	0 – 4	0 - 11	0 - 4
Loose	4 – 10	11 - 26	4 - 10
Medium Dense	10 – 30	26 - 74	10 - 30
Dense	30 – 50	74 - 120	30 - 47
Very Dense	More than 50	More than 120	More than 47

CONSISTENCY - FINE-GRAINED SOIL

Consistency	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)	Unconfined Compressive Strength (tsf)
Very Soft	Less than 2	Less than 3	Less than 2	Less than 0.25
Soft	2 - 4	3 – 6	2 - 5	0.25 - 0.50
Medium Stiff	4 - 8	6 – 12	5 - 9	0.50 - 1.0
Stiff	8 - 15	12 – 25	9 - 19	1.0 - 2.0
Very Stiff	15 - 30	25 – 65	19 – 31	2.0 - 4.0
Hard	More than 30	More than 65	More than 31	More than 4.0

PRIMARY SOIL DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOIL (more than 50% retained on No. 200 sieve)	GRAVEL (more than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (< 5% fines)	GW or GP	GRAVEL
		GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)	GW-GM or GP-GM	GRAVEL with silt
			GW-GC or GP-GC	GRAVEL with clay
		GRAVEL WITH FINES (> 12% fines)	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND (50% or more of coarse fraction passing No. 4 sieve)	CLEAN SAND (<5% fines)	SW or SP	SAND
		SAND WITH FINES (≥ 5% and ≤ 12% fines)	SW-SM or SP-SM	SAND with silt
			SW-SC or SP-SC	SAND with clay
		SAND WITH FINES (> 12% fines)	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOIL (50% or more passing No. 200 sieve)	SILT AND CLAY	Liquid limit less than 50	ML	SILT
			CL	CLAY
			CL-ML	silty CLAY
			OL	ORGANIC SILT or ORGANIC CLAY
		Liquid limit 50 or greater	MH	SILT
			CH	CLAY
			OH	ORGANIC SILT or ORGANIC CLAY
HIGHLY ORGANIC SOIL			PT	PEAT

MOISTURE CLASSIFICATION

Term	Field Test
dry	very low moisture, dry to touch
moist	damp, without visible moisture
wet	visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Secondary granular components or other materials such as organics, man-made debris, etc.

Percent	Silt and Clay In: Fine-Grained Soil	Silt and Clay In: Coarse-Grained Soil	Percent	Sand and Gravel In: Fine-Grained Soil	Sand and Gravel In: Coarse-Grained Soil
< 5	trace	trace	< 5	trace	trace
5 – 12	minor	with	5 – 15	minor	minor
> 12	some	silty/clayey	15 – 30	with	with
			> 30	sandy/gravelly	Indicate %

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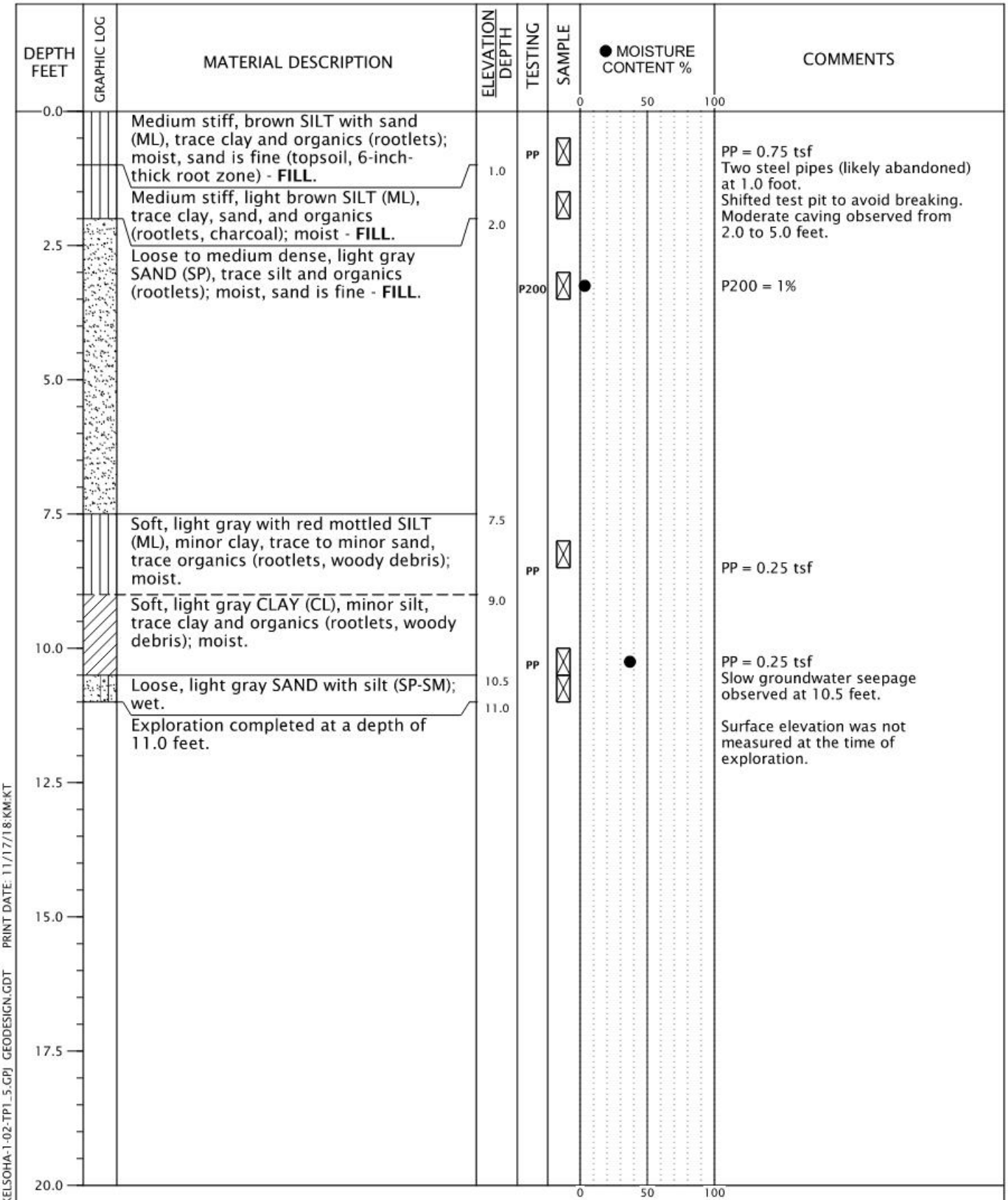
SOIL CLASSIFICATION SYSTEM

TABLE A-2



EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Hook

COMPLETED: 10/31/18

EXCAVATION METHOD: trackhoe (see document text)

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KELSOHA-1-02

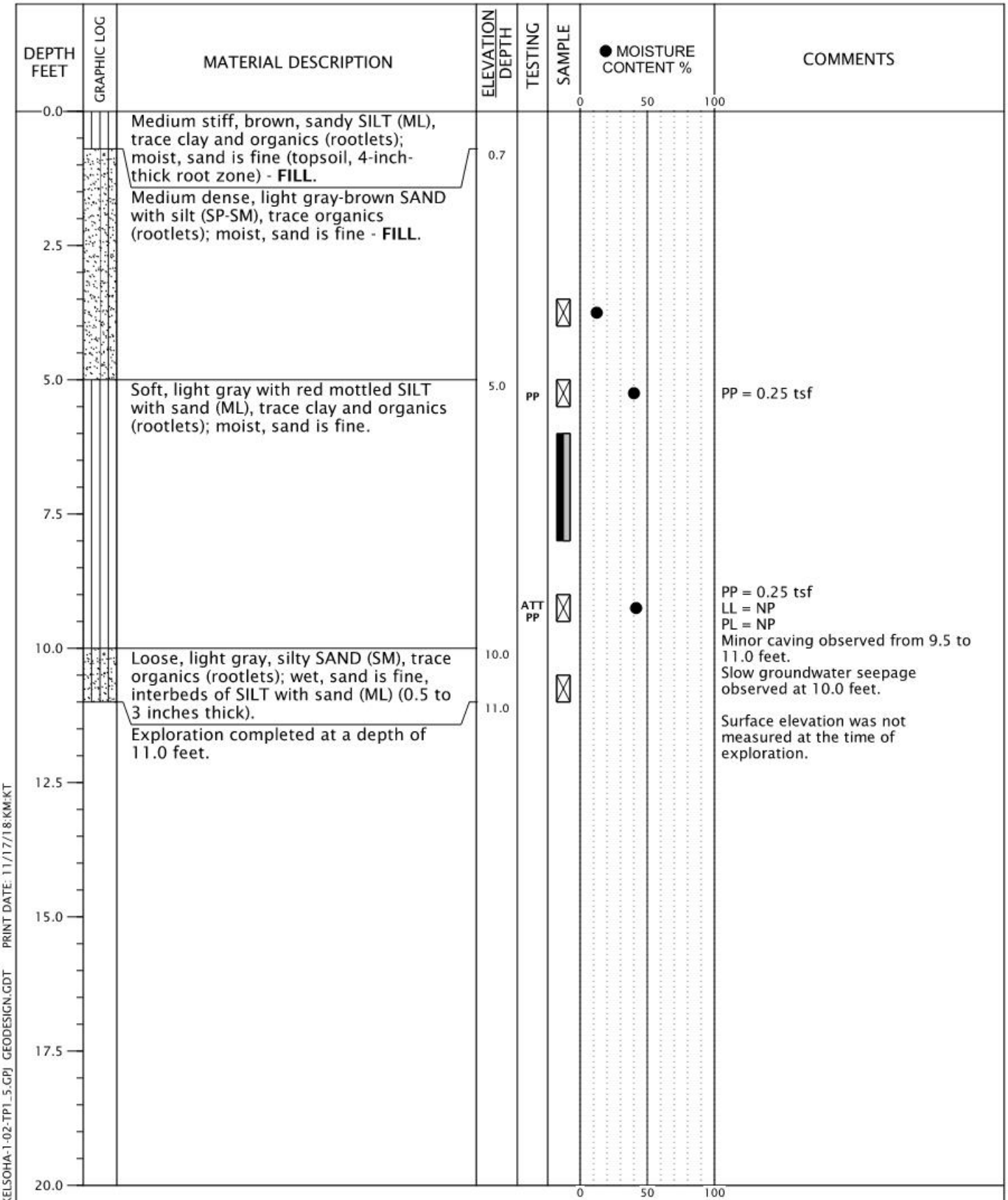
NOVEMBER 2018

TEST PIT TP-1

PROPOSED WALNUT STREET APARTMENT COMPLEX
KELSO, WA

FIGURE A-1

TEST PIT LOG - 1 PER PAGE KELSOHA-1-02-TP1_5.GPJ GEODESIGN.GDT PRINT DATE: 11/17/18:KM:KT



EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Hook

COMPLETED: 10/31/18

EXCAVATION METHOD: trackhoe (see document text)

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360.693.8416 www.geodesigninc.com

KELSOHA-1-02

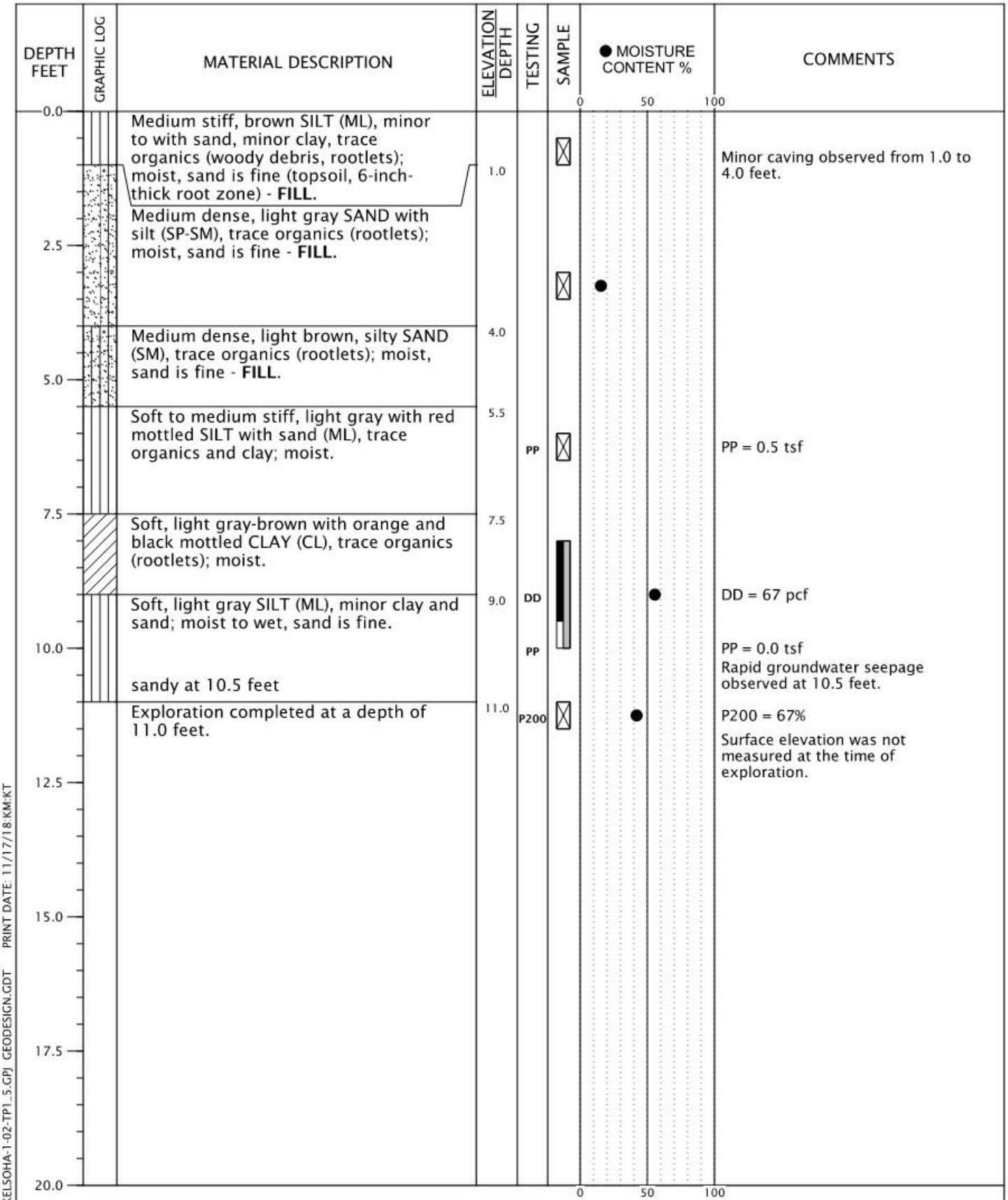
NOVEMBER 2018

TEST PIT TP-2

PROPOSED WALNUT STREET APARTMENT COMPLEX
KELSO, WA

FIGURE A-2

TEST PIT LOG - 1 PER PAGE KELSOHA-1-02-TP1_5.GPJ GEODESIGN.GDT PRINT DATE: 11/17/18:KM:KT



EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Hook

COMPLETED: 10/31/18

EXCAVATION METHOD: trackhoe (see document text)

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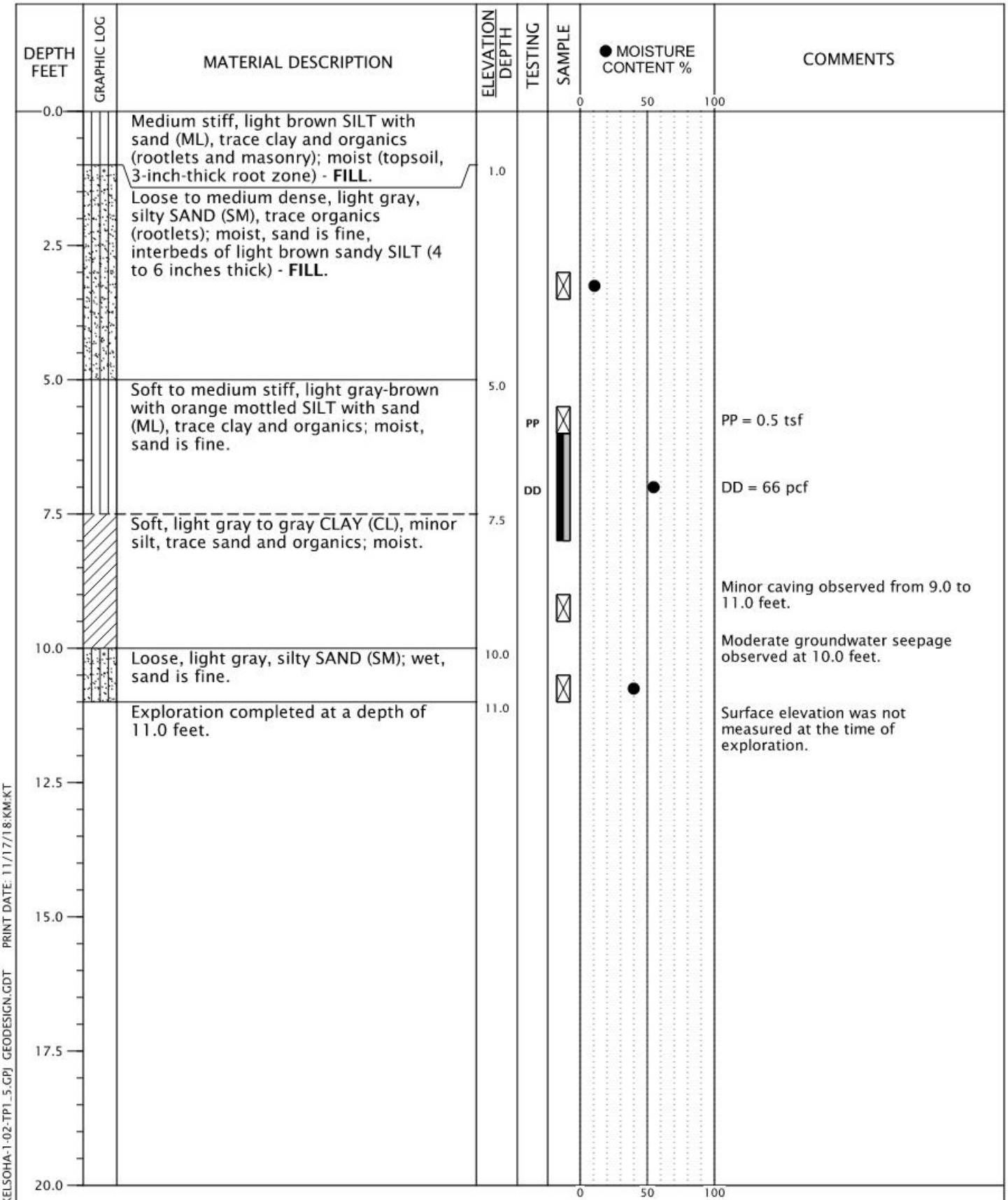
TEST PIT TP-3

PROPOSED WALNUT STREET APARTMENT COMPLEX
KELSO, WA

FIGURE A-3

TEST PIT LOG - 1 PER PAGE KELSOHA-1-02-TP1_5.GPJ GEODESIGN.GDT PRINT DATE: 11/17/18:KM:KT



EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Hook

COMPLETED: 10/31/18

EXCAVATION METHOD: trackhoe (see document text)

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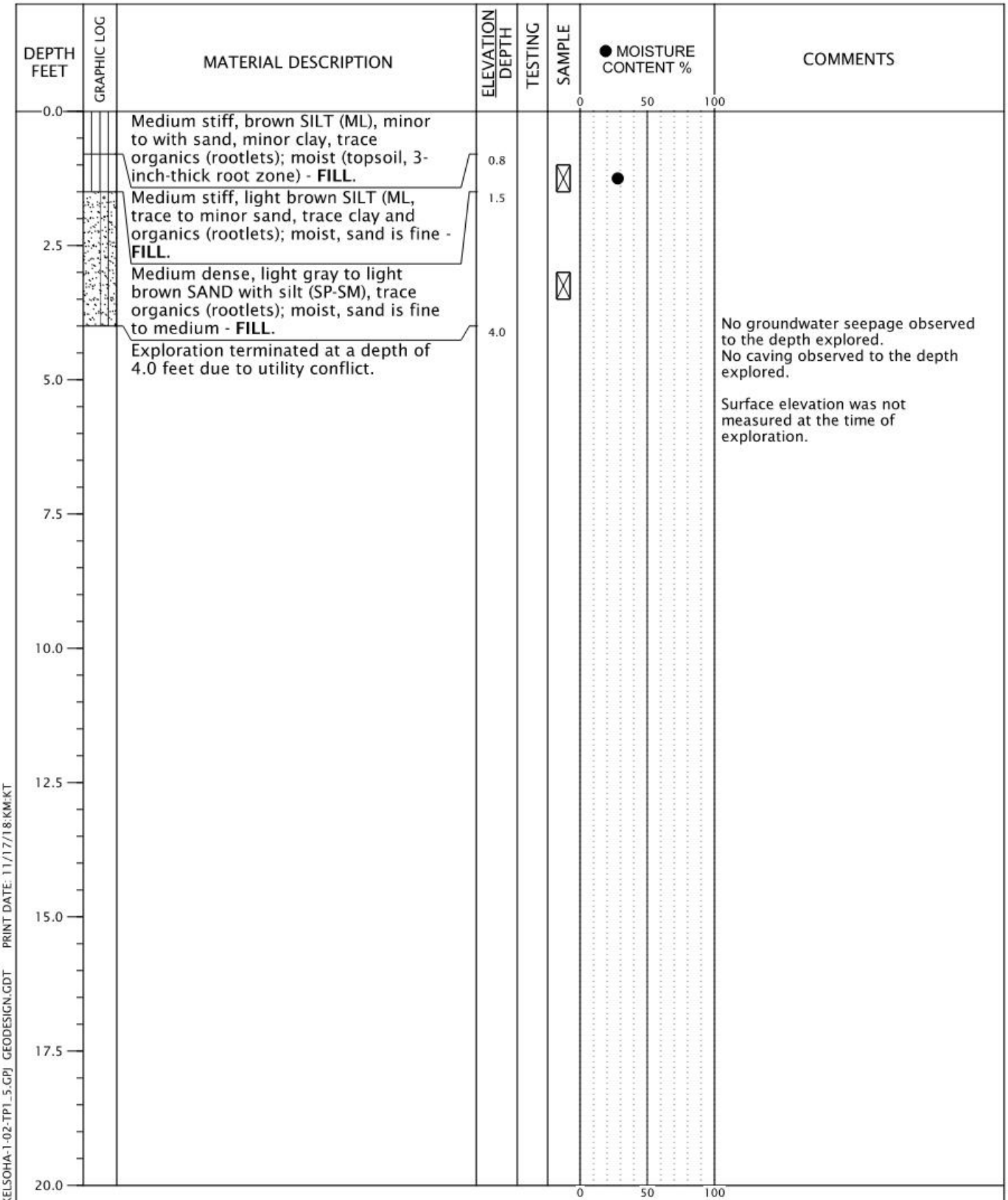
TEST PIT TP-4

PROPOSED WALNUT STREET APARTMENT COMPLEX
KELSO, WA

FIGURE A-4

TEST PIT LOG - 1 PER PAGE KELSOHA-1-02-TP1_5.GPJ GEODESIGN.GDT PRINT DATE: 11/17/18:KM:KT



EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Hook

COMPLETED: 10/31/18

EXCAVATION METHOD: trackhoe (see document text)

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TEST PIT TP-5

PROPOSED WALNUT STREET APARTMENT COMPLEX
KELSO, WA

FIGURE A-5

TEST PIT LOG - 1 PER PAGE KELSOHA-1-02-TP1_5.GPJ GEODESIGN.GDT PRINT DATE: 11/17/18:KM:KT

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
TP-1	3.0		3				1			
TP-1	10.0		37							
TP-2	3.5		12							
TP-2	5.0		40							
TP-2	9.0		42					NP	NP	NP
TP-3	3.0		15							
TP-3	8.0		56	67						
TP-3	11.0		42				67			
TP-4	3.0		11							
TP-4	6.0		55	66						
TP-4	10.5		40							
TP-5	1.0		28							

LAB SUMMARY KELSOHA-1-02-TP1_5.GPJ GEODESIGN.GDT PRINT DATE: 11/17/18.KT

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NOVEMBER 2018

SUMMARY OF LABORATORY DATA

PROPOSED WALNUT STREET APARTMENT COMPLEX
KELSO, WA

FIGURE A-6

APPENDIX B

APPENDIX B

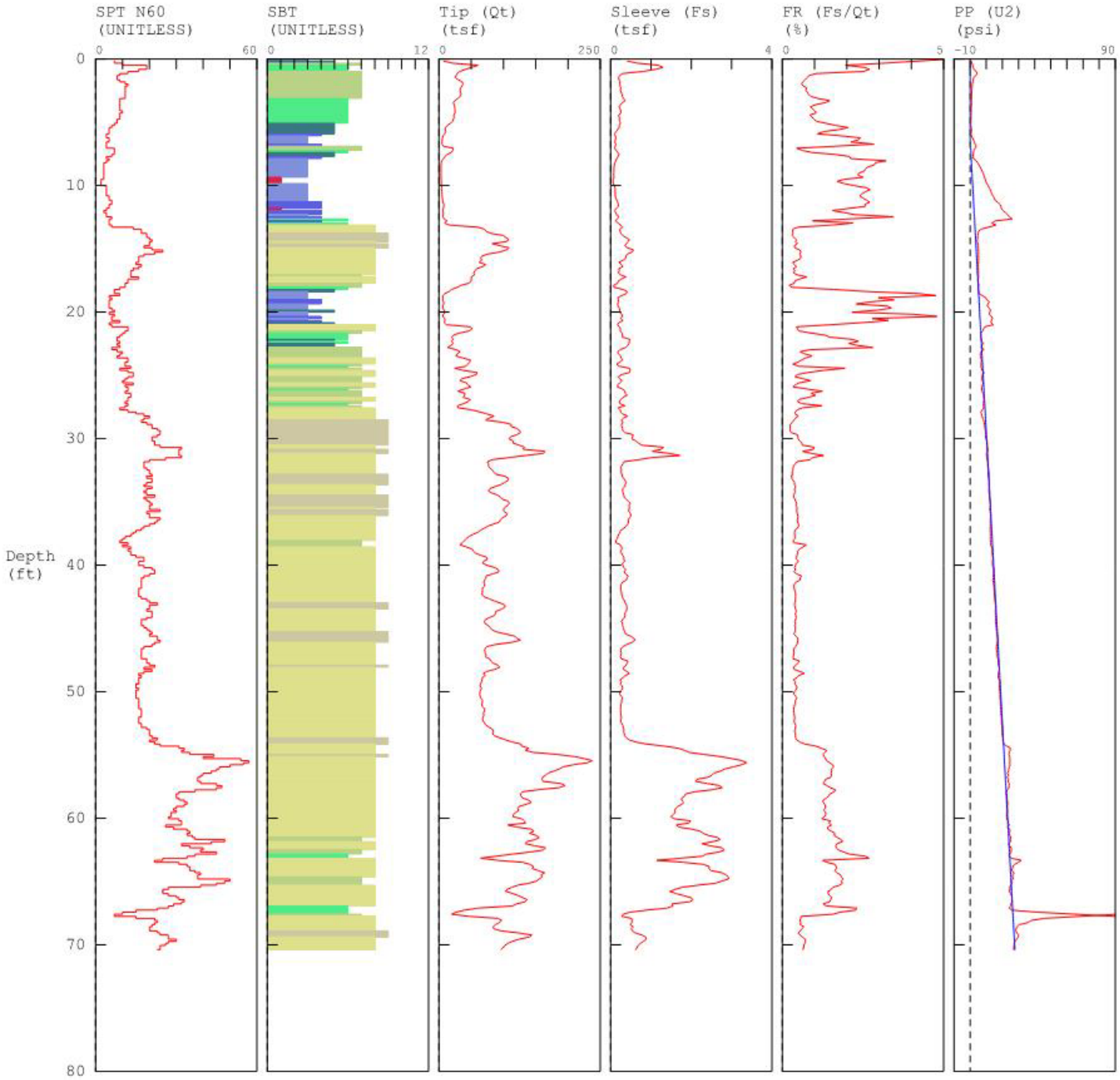
CONE PENETROMETER TESTING

Our subsurface exploration program included one CPT probe (CPT-1) to a depth of approximately 70.4 feet BGS. Figure 2 shows the location of the CPT probe relative to proposed site features. The CPT probe was performed in general accordance with ASTM D5778 by Oregon Explorations, Inc. on November 1, 2018. The result of the CPT probe is presented in this appendix.

The CPT is an in situ test that characterizes subsurface stratigraphy. The testing includes advancing a 35.6-millimeter-diameter cone and friction sleeve through the soil profile. The cone is advanced at a rate of approximately 2 centimeters per second. Tip resistance, sleeve friction, and pore pressure are typically recorded at 0.1-meter intervals. At a selected depth, the cone advancement was suspended and pore water dissipation rate was measured.

GeoDesign / CPT-1 / 1100 Walnut St Kelso

OPERATOR: OGE DMM
CONE ID: DDG1467
HOLE NUMBER: CPT-1
TEST DATE: 11/1/2018 9:51:32 AM
TOTAL DEPTH: 70.374 ft



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty cl
6 sandy silt to clayey si
7 silty sand to sandy si
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

APPENDIX 5
OPERATIONS AND MAINTENANCE

General O&M Requirements and Performance Measures

O&M Activity

System Component	Remove Sediment, Trash, Debris, and Vegetation	Clean Out/ Control pollution	Manage Vegetation
Structural Storm Sewer Devices Sedimentation Compartment/ Catch Basin	Sediment Accumulation does Not exceed 1 foot deep or exceed design specifications for sediment storage.	No flammable Chemicals or vapors are present in amounts that would present a fire hazard, exceed pollution control requirements presented in this table, or produce vapors that exceed 10% of the lower explosive limit for that chemical.	
Inlets/Outlets	No trash/debris/ Sediment obstructs more than 25% of the inlet/outlet structure. Flow is not restricted or impounded.		

Maintenance and Inspection Procedures

Catch Basin and Inlet Inspection/Cleaning

Inspection of catch basins and ditch inlets to be performed no less than annually or in the event of system failure.

	Action	Response/Remark
1.	Check the amount of trash, debris, and other material at the catch basin/ditch inlet.	Make note of the amount of trash and other material at the catch basin. Measure the sediment (in inches) in the catch basin or ditch inlet. Note significant evidence of pollution (oil grease, foam, odors, etc.)
2.	Remove accessible trash, debris, sediment, etc. from the catch basin/ditch inlet.	Place the debris on a truck so that it can be hauled to disposal.
3.	Inspect the catch basin/ditch inlet, checking that the grate and cover are in place and in good condition.	Check that: • The frame is even with the curb and the top slab is free of holes and cracks. • The frame is sitting flush on the top slab. • The inlet grate is in place and is undamaged.
4.	Check for cracks in the catch basin/ditch inlet structure	Check the basin walls, bottom, and at the joints of the inlet/outlet pipes. Look for dirt entering the catch basin or ditch inlet through cracks.
5.	Check for settling and/or misalignment of the catch basin/ditch inlet.	Check if: • The frame has settled more than 1 inch. • The frame has rotated more than 2 inches out of alignment.
6.	Make notes for machine cleaning, major repair, or replacement of the catch basin/ditch inlet.	Note any particular problems at the catch basin.

Drywells/Manholes Inspection/Cleaning

Inspection of manholes to be performed no less that annually or in the event of system failure.

Inspection

	Action	Response/Remark
1.	Test the manholes or flow structure for a hazardous atmosphere.	
2.	Inspect the manhole or flow structure frame and cover.	Check that: • The cover is accessible. • The manhole cover is in place and in good working condition. • All bolts and locks are in place. • The cover locks properly. • The cover is not difficult to remove.
3.	Check the amount of sediment in the manhole or structure.	Measure the depth of sediment. Record the depth of sediment. Remove sediment when depths exceeds 1/3 the sump depth.
4.	Check for plugging of the manhole or control structure inlet.	
5.	Make notes for cleaning and repair of the manhole or flow structure.	Note any particular structural problems at the manhole or flow structure. Note visual evidence of pollution or unusual odors. Report all problems immediately for follow-up action.
6.	Report the work completed.	Record: • Quantity of debris removed. • Significant evidence of pollution. • Types of defects observed.

Cleaning

	Action	Response/Remark
1.	Test the manhole or flow structure manhole for a hazardous atmosphere.	
2.	Follow vactor manufacturer guidelines to pump water and debris from the manhole or flow structure. Closely monitor the level of accumulation material.	Note any significant signs of pollution, such as oil and grease, foam and unusual odors.
3.	Make notes for repairs to manhole or flow structure.	The manhole cover or flow control frame should be in place and in good condition.
4.	Report the work completed	Record: • Amount of debris removed in CY. • Significant signs of pollution.

CONTECH®
ENGINEERED SOLUTIONS

StormFilter Inspection and Maintenance Procedures

The Stormwater Management StormFilter®

Maintenance Guidelines

The primary purpose of the Stormwater Management StormFilter® is to filter and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is a good practice to inspect the system after major storm events.

Maintenance Procedures

Although there are many effective maintenance options, we believe the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended::

1. **Inspection**
   - Inspection of the vault interior to determine the need for maintenance.
2. **Maintenance**
   - Cartridge replacement
   - Sediment removal

Inspection and Maintenance Timing

At least one scheduled inspection should take place per year with maintenance following as warranted.

First, an inspection should be done before the winter season. During the inspection the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, a maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather.

In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/ maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine as-needed basis, in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs..

Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

Warning: In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct an inspection:

Important: Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit and the unit's role, relative to detention or retention facilities onsite.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as Regulatory Requirements, may need to be considered).

Please note Stormwater Management StormFilter devices installed downstream of, or integrated within, a stormwater storage facility typically have different operational parameters (i.e. draindown time). In these cases, the inspector must understand the relationship between the retention/detention facility and the treatment system by evaluating site specific civil engineering plans, or contacting the engineer of record, and make adjustments to the below guidance as necessary. Sediment deposition depths and patterns within the StormFilter are likely to be quite different compared to systems without upstream storage and therefore shouldn't be used exclusively to evaluate a need for maintenance.

1. Sediment loading on the vault floor.
   a. If >4" of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
   a. If >1/4" of accumulation, maintenance is required.
3. Submerged cartridges.
   a. If >4" of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.
   a. While not required in all cases, inspection of the media within the cartridge may provide valuable additional information.
   b. If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
   a. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
6. Hazardous material release.
   a. If hazardous material release (automotive fluids or other) is reported, maintenance is required.
7. Pronounced scum line.
   a. If pronounced scum line (say ≥ 1/4" thick) is present above top cap, maintenance is required.

Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

Warning: In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

Method 1:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

   Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

B. Remove the used cartridges (up to 250 lbs. each) from the vault.

Important: Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

C. Set the used cartridge aside or load onto the hauling truck.

D. Continue steps a through c until all cartridges have been removed.

Method 2:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

B. Unscrew the cartridge cap.

C. Remove the cartridge hood and float.

D. At location under structure access, tip the cartridge on its side.

E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.

F. Set the empty, used cartridge aside or load onto the hauling truck.

G. Continue steps a through e until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used **empty** cartridges to Contech Engineered Solutions.

Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

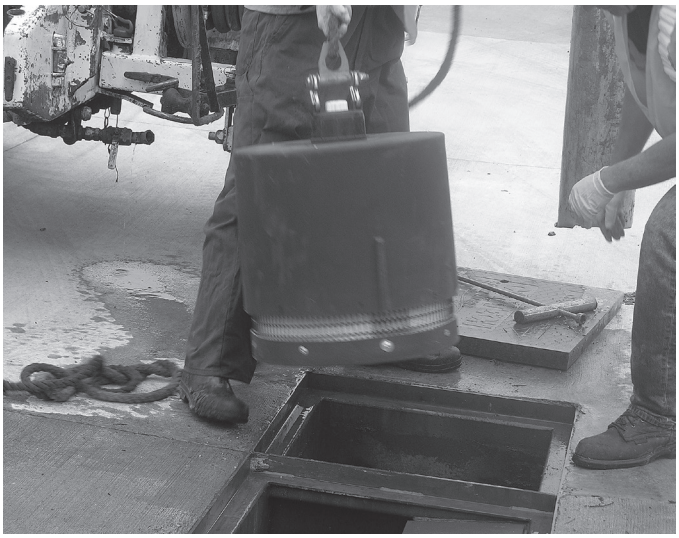
Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

Related Maintenance Activities - Performed on an as-needed basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.



Inspection Report

Date: _____ Personnel: _____

Location: _____ System Size: _____ Months in Service: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

Sediment Thickness in Forebay: _____ Date: _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Estimated Flow from Drainage Pipes (if available): _____

Cartridges Submerged: Yes ☐ No ☐ Depth of Standing Water: _____

StormFilter Maintenance Activities (check off if done and give description)

☐ Trash and Debris Removal: _____

☐ Minor Structural Repairs: _____

☐ Drainage Area Report _____

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

Items Needing Further Work: _____

Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals.

Other Comments:

_____

_____

_____

_____

_____

_____

_____

_____

Review the condition reports from the previous inspection visits.

StormFilter Maintenance Report

Date: _____ Personnel: _____

Location: _____ System Size: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

List Safety Procedures and Equipment Used: _____

_____

_____

System Observations

Months in Service: _____

Oil in Forebay (if present): Yes ☐ No ☐

Sediment Depth in Forebay (if present): _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Drainage Area Report

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

StormFilter Cartridge Replacement Maintenance Activities

Remove Trash and Debris: Yes ☐ No ☐ Details: _____

Replace Cartridges: Yes ☐ No ☐ Details: _____

Sediment Removed: Yes ☐ No ☐ Details: _____

Quantity of Sediment Removed (estimate?):

Minor Structural Repairs: Yes ☐ No ☐ Details: _____

Residuals (debris, sediment) Disposal Methods: _____

Notes:

_____

_____

_____

_____

_____

_____

_____

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Support

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- Site-specific design support is available from our engineers.