Huntington Ridge Apartments
Kelso, Washington

Preliminary Stormwater Management Report
February 6, 2020

Prepared for:
LA Hamilton, LLC
Contact: Jesse Brand
13203 SE 172nd Ave, Suite 166 #220
Happy Valley, OR 97086

Prepared by:
Tim Wines, P.E.
Three Rivers Land Services, PLLC
604 N 16th Ave
Kelso, WA 98626
(360) 431-9988

THREE RIVERS LAND SERVICES

TABLE OF CONTENTS

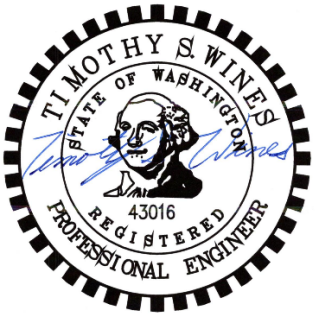
APPENDICES

CERTIFICATE OF ENGINEER

Huntington Ridge Apartments
Preliminary Drainage Report

The technical information and data contained in this report was prepared under the direction and supervision of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

This document was:

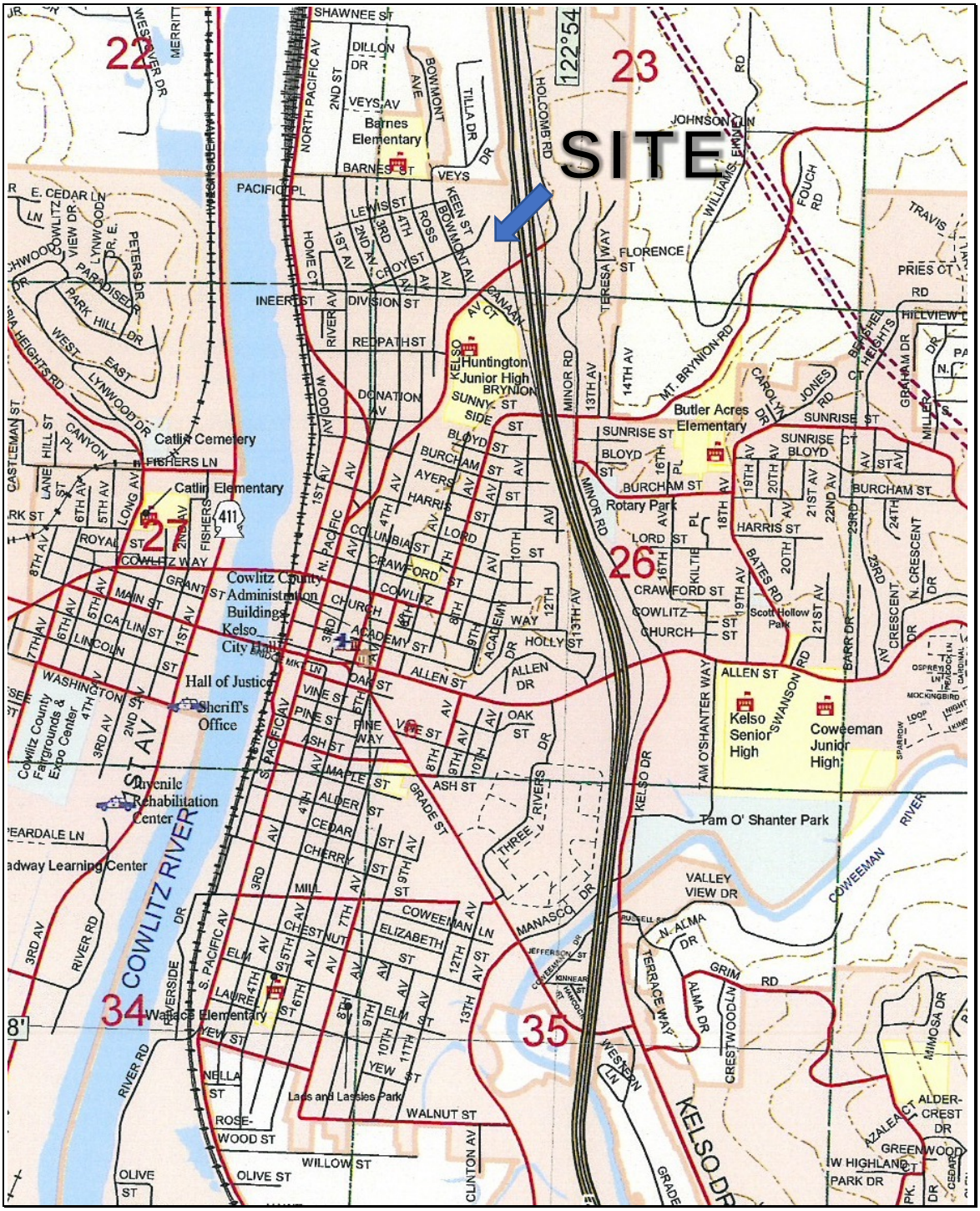


Approved by: _____

Timothy S. Wines, P.E.

1. VICINITY MAP

Kelso, Washington
Sec. 23, T. 8 N., R. 2 W., W.M.



2. SOILS MAP

USDA SCS Map
Site Soils include: Caples silty clay loam, 0 to 3 percent slopes (17) and Kelso silt loam, 15 to 30 percent slopes (102).

3. PROJECT DESCRIPTION

LA Hamilton, LLC is proposing to construct a 96 unit apartment complex on approximately 10.14 acres in Kelso. The project will be completed in a single phase. The site is currently zoned RMD (Residential Mixed Density). It is bounded by Interstate 5 (I-5) to the east, North Kelso Avenue to the south, single-family residences to the west, and vacant property zoned UR (Urban Residential) to the north.

The site is located at 906 Croy Street, Kelso, WA in the Southwest ¼ of Section 23, T8N, R2W of the Willamette Meridian, Cowlitz County, Washington. The Parcel Numbers are 23933 and 2393301.

Improvements proposed for the site include the construction of 96 apartment units, interior travel lanes and associated parking, various stormwater facilities, and all utilities necessary to serve the residents.

4. PRE-DEVELOPMENT CONDITIONS

The Huntington Ridge Apartments site is comprised of two parcels located directly west of the intersection of the southbound exit ramp of I-5 and North Kelso Avenue. Historical use of the site consisted of a building and a parking lot that was utilized as the juvenile detention facility for Cowlitz County. That structure has since been demolished; however, the parking lot and remnants of the building foundation are still in place. Access to the site will be obtained from North Kelso Avenue, which has a variable width Right-of-Way (ROW), and Croy Street which currently has a 50’ ROW. North Kelso Avenue is currently constructed with a pavement width of approximately 40’. It consists of northeast and southwest bound travel lanes with no curb and gutter or sidewalks. An access onto North Kelso Avenue will be constructed but no other road frontage improvements are proposed with this development.

Topography on the site is highly variable with slope ranging from 0% to upwards of 50%. The topography on the site generally slopes towards the west and to the south. The previously mentioned juvenile facility and parking area was located in the northeast portion of the property, which is abutting I-5. This area is generally flat. The topography south of the existing parking area slopes south towards North Kelso Avenue at slopes ranging between 1% to 33%. The slopes west of the parking lot range from 0% to 50%. There is an existing paved access driveway traversing from the southwest to the northeast that provides access to the site. This existing driveway is approximately 22’ wide with a maximum longitudinal slope of approximately 10%.

Currently, stormwater runoff from this site flows to the west and to the south. There are three separate mapped wetlands located along the western property line at the base of the slope. The majority of the stormwater runoff from this site flows into these wetlands where it ultimately discharges into an existing Drainage Improvement District #1 (DID#1) ditch that parallels the western property line. This ditch conveys the runoff to a catch basin located at the end of Croy Street where it enters the City of Kelso’s Municipal Separate Storm Sewer System (MS4).

On-Site Hydrologic Soil Groups

The NRCS Soil Survey of Cowlitz County maps the soils on the site as Caples silty clay loam, 0 to 3 percent slopes (Map Unit Symbol 17) and Kelso silt loam, 15 to 30 percent slopes (Map Unit Symbol 102). The NRCS designation for Caples soils is hydrological soil group (HSG) C/D and the NRCS designation for Kelso soils is HSG C. The NRCS soils map is included in Appendix A of this report.

5. POST-DEVELOPMENT CONDITIONS

Due to site constraints, most of the improvements proposed for this site will occur on the eastern half of the site. Development of this site will include the construction of 8 apartment buildings totaling 96 units. As part of the construction, the existing paved parking area, along with the remnants from the previously demolished building, will be removed. A portion of the vegetation on the west facing slope will be removed and the soils will be prepared to install fill. Approximately 6' of material from the northeast portion of the plateau will then be removed and either placed on the west facing slope or hauled to an approved dump site. Additional grading will occur to prepare the site for the apartment buildings along with the installation of the necessary utilities. Asphalt will then be installed to accommodate circulation throughout the site and provide the required parking area. Finally, site landscaping will be installed to meet the Kelso Municipal Code (KMC) requirements.

Because this project is creating more than 2,000 sf of new impervious surface, it is required to provide stormwater management per KMC 17.22.120. The provisions of this chapter require the project meet Minimum Requirements 1-9 of the Stormwater Management Manual for Western Washington (SWMMWW). The parking and maneuvering area has been designed to sheet flow the stormwater to individual bioretention facilities (BRF's) located in the parking landscaping islands or other landscaping areas. Curb cuts will be installed to allow the stormwater to efficiently enter the facilities. The BRF's will be sized to provide water quality treatment. However, it should be noted that due to the underlying soils and slope stability issues, the BRF's will be constructed with a restrictive layer beneath the 18" of bioretention soil mix (BSM) to minimize the potential for infiltration. As a result, an underdrain and overflow standpipe will be installed in each facility to allow for the stormwater to be routed into a system of centrally located conveyance pipes. These conveyance pipes with then route the stormwater to the DID #1 ditch located along the west property line where it will enter the City of Kelso's MS4. The city's MS4 system will convey the stormwater to a pump station that will lift the stormwater over the dike and discharge it into the Cowlitz River. The Cowlitz River is an exempted water body and therefore, this project will be exempt from the flow control requirement.

6. MINIMUM REQUIREMENTS

Determination of Applicable Minimum Requirements

The site is Redevelopment project that will create greater than 5,000 square feet of new hard surfaces with a valuation of the proposed improvements that will exceed 50% of the assessed value of the existing project site improvements. Based on these criteria, the project triggers all

minimum requirements (Minimum Requirements 1-9) according to the Kelso Engineering Design Manual (KEDM) Section 2.02.

Minimum Requirement 1: Preparation of Stormwater Site Plans
The information provided in this report, together with the associated drawings, satisfies the City's requirements regarding preparation of Stormwater Site Plans.

Minimum Requirement 2: Construction Stormwater Pollution Prevention
A Stormwater Pollution Prevention Plan for this project will be prepared with the final construction drawings.

Minimum Requirement 3: Source Control of Pollution
The Stormwater Pollution Prevention Plan and the Erosion Control Plan that will be developed for this project will provide for the short-term protection of the site and downstream areas from potential pollutants associated with the construction project. It is not anticipated that there will be any long-term pollution risks associated with this project.

It is anticipated that a substantial portion of this site will remain in its current vegetated state. By retaining the existing vegetation, disturbed surface area will be minimized reducing the need for additional site stabilization BMP's in these areas.

Finally, all landscaping areas will be constructed utilizing BMP T5.13 Post Construction Soil Quality & Depth procedures. A detail will be included in the construction plans to specify materials and minimum depths. It is not anticipated that the site will generate an average daily vehicle traffic (ADT) count greater than 100 vehicles per 1,000 square feet of gross building area nor will it have vehicle storage of more than 25 diesel vehicles that are over 10 tons gross weight. Therefore, the site does not meet the threshold vehicle traffic intensity level of a high-use site. As such, no oil removal system has been proposed with this design.

Minimum Requirement 4: Preservation of Natural Drainage Systems and Outfalls
The Stormwater Management Manual for Western Washington (SWMMWW) requires that natural drainage patterns shall be maintained and discharges from the project site shall occur at the natural location, to the maximum extent practicable. It also requires that the manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down-gradient properties. The completed stormwater system will discharge stormwater into the City of Kelso's MS4 through an entirely man made source. As a result, downstream properties will not be adversely impacted by the proposed project.

Minimum Requirement 5: Onsite Stormwater Management BMP's
The KEDM and the SWMMWW requires that flow control exempt projects located within the city limits that trigger MR's 1-9 use either "the LID BMPs from List #3" or "Use any Flow Control BMP's desired to achieve the LID Performance Standard and apply BMP T5.13". This site qualifies as a flow control exempt project. However, a geotechnical engineering investigation dated June 2018 was completed on the property by Seth Chandlee of Soil and Water Technologies, Inc. As part of that investigation, it was documented that

there are extremely steep slopes on the site, that there is a section of undocumented fill located throughout the site, and that there are layers of subsurface clay soils that with very low blow counts. As a result, it is not recommended to utilize infiltration as a stormwater Best Management Practice (BMP). The geotechnical report has been provided in Appendix D of this document. Since this site has potential slope stability issues, this project will be exempt from implementing the LID Performance Standards.

Minimum Requirement 6: Runoff Treatment Analysis and Design

As mentioned previously, water quality treatment will be accomplished via multiple stormwater bioretention facilities located in the parking landscape islands and other landscaping areas. The facilities will be of irregular shape. The BRF will provide between 0.5' and 1' of surface storage prior to reaching the elevation of the overflow inlets and will contain a minimum 18" BSM base.

Stormwater modeling for the water quality treatment facilities will be completed using the Western Washington Hydrology Model (WWHM). Representative calculations for the BRF's located in the landscape islands have been provided in Appendix B of this report. A total of 4,000 square feet of pavement, sidewalk, and landscaping area will drain to each individual BRF. Other methods of water quality treatment may be implemented during the final design depending on topography and other site conditions. It should be noted that the stormwater runoff from the roof has will bypass the water quality facilities.

The BRF's will have side slopes equal to or flatter than 3:1, or will utilize the back of the vertical curb as the sidewall, and will be sized for a depth of storage of between 0.5' and 1' for the water quality event, as previously stated. The infiltration rate of the BSM is assumed to be the standard SMMWW 12 in/hr rate that is built into the WWHM. The standard SMMWW soil type will be utilized for the soil material in the BRF and a safety factor of 2 has been applied to the infiltration rate since less than 5,000 square feet of pollution generating impervious surfaces will drain to the facility. As shown on page 6 of the WWHM report included in Appendix B, the BRF's will successfully filtrate 91.81% of all tributary runoff through the bioretention soil mix. This exceeds the SMMWW requirement that at least 91% of all runoff be infiltrated through the treatment soils.

Minimum Requirement 7: Flow Control Analysis and Design

Since this project will be discharging into an MS4 it will be exempt from flow control requirements.

Minimum Requirement 8: Wetlands Protection

There are three separate Category IV wetlands located on the western boundary of the site. Wetland A and C have a habitat score of 3 and Wetland B has a habitat score of 4. Based off the SWMMWW flow chart in Figure I-3.5, the Wetland Protection Levels that apply to the TDA are General Protection and Protection from Pollutants. All points of the General Protection requirements will be adhered to and the Protection from Pollutants will be provided by addressing MR's 12,3,5, and 6 in the final design.

Minimum Requirement 9: Operations and Maintenance

A maintenance and operations manual will be prepared as part of the final design.

7. CONVEYANCE SYSTEM

The site conveyance system will be designed to convey runoff from the 25-year storm event under gravity flow conditions.

APPENDIX A

Soils Information
SCS Curve Numbers

Hydrologic Soil Group—Cowlitz County, Washington
(Huntington Ridge Apartments)

Map Scale: 1:2,070 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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 20, Sep 16, 2019

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

Date(s) aerial images were photographed: Apr 26, 2019—Jun 11, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
17	Caples silty clay loam, 0 to 3 percent slopes	C/D	6.3	54.8%
102	Kelso silt loam, 15 to 30 percent slopes	C	5.2	45.2%
Totals for Area of Interest			**11.4**	**100.0%**

Description

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

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

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

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

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

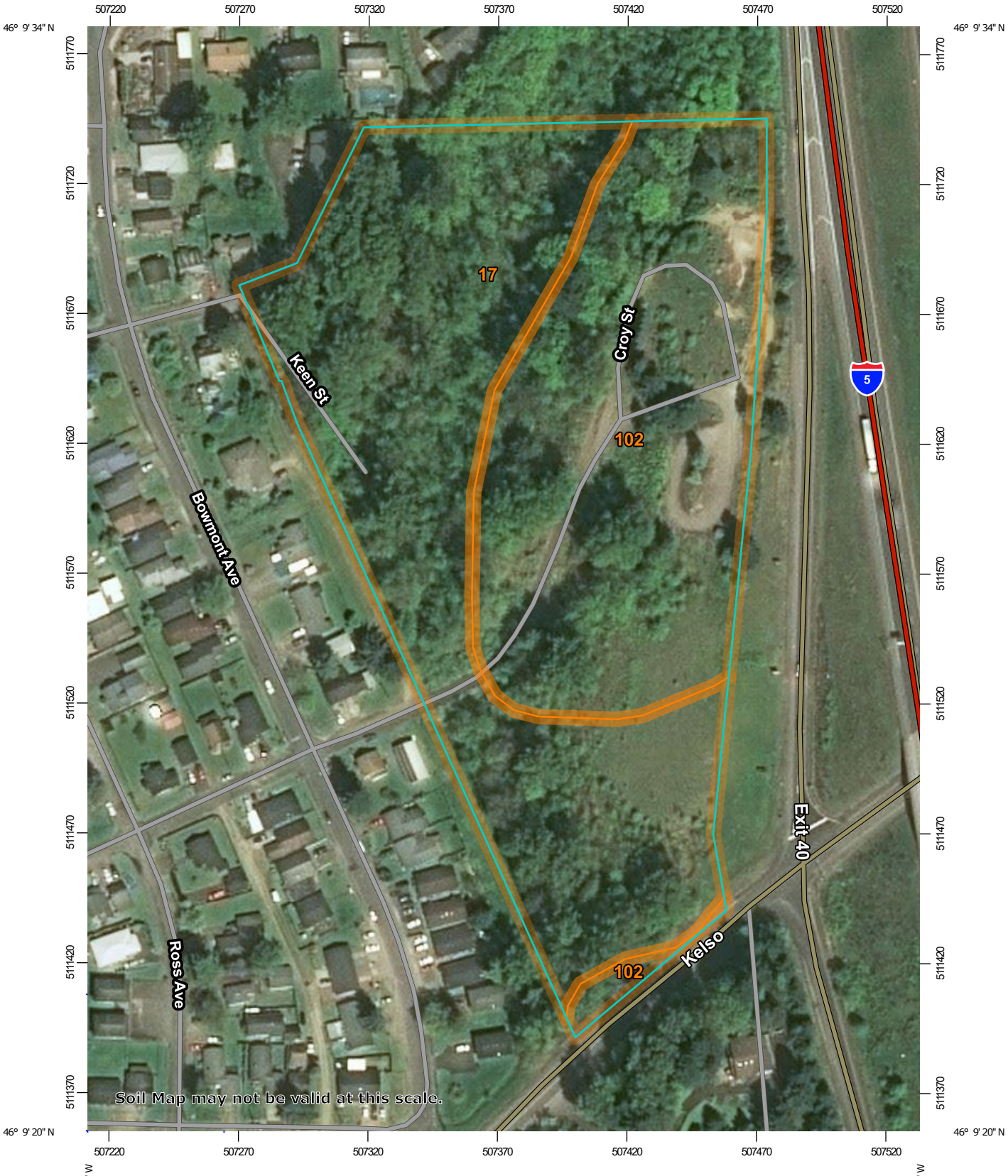
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over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

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

Rating Options

Aggregation Method: Dominant Condition

Soil Map—Cowlitz County, Washington
(Huntington Ridge Apartments)



Map Scale: 1:2,070 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

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 20, Sep 16, 2019

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

Date(s) aerial images were photographed: Apr 26, 2019—Jun 11, 2019

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	6.3	54.8%
102	Kelso silt loam, 15 to 30 percent slopes	5.2	45.2%
Totals for Area of Interest		**11.4**	**100.0%**

APPENDIX B

WWHM Bioretention Facility Sizing Calculations

WWHM2012

PROJECT REPORT

WWHM2012

File Edit View Help Summary Report

Basin Help

Schematic

SCENARIOS

Predeveloped

Mitigated

Run Scenario

Basic Elements

Pro Elements

LID Toolbox

Commercial Toolbox

Move Elements

Save x,y Load x,y

X 10

Y 0

Tue 2:42p - HRA - Finish Mitigated

Basin 1 Mitigated

Subbasin Name: Basin 1 Designate as Bypass for POC:

Flows To :	Surface	Interflow	Groundwater
	Surface retention 1	Surface retention 1	

Area in Basin

Show Only Selected

Available Pervious	Acres	Available Impervious	Acres
A/B, Forest, Flat	0	ROADS/FLAT	0
A/B, Forest, Mod	0	ROADS/MOD	0
A/B, Forest, Steep	0	ROADS/STEEP	0
A/B, Pasture, Flat	0	ROOF TOPS/FLAT	0
A/B, Pasture, Mod	0	DRIVEWAYS/FLAT	0
A/B, Pasture, Steep	0	DRIVEWAYS/MOD	.0918
A/B, Lawn, Flat	0	DRIVEWAYS/STEEP	0
A/B, Lawn, Mod	0	SIDEWALKS/FLAT	0
A/B, Lawn, Steep	0	SIDEWALKS/MOD	0
C, Forest, Flat	0	SIDEWALKS/STEEP	0
C, Forest, Mod	0	PARKING/FLAT	0
C, Forest, Steep	0	PARKING/MOD	0
C, Pasture, Flat	0	PARKING/STEEP	0
C, Pasture, Mod	0	POND	0
C, Pasture, Steep	0	Porous Pavement	0
C, Lawn, Flat	0		
C, Lawn, Mod	0		
C, Lawn, Steep	0		
SAT, Forest, Flat	0		
SAT, Forest, Mod	0		
SAT, Forest, Steep	0		

Pervious Total	0	Acres
Impervious Total	0.0918	Acres
Basin Total	0.0918	Acres

Deselect Zero Select By: GO

WWHM2012

File Edit View Help Summary Report

Bioswale Help

Schematic

SCENARIOS

Predeveloped

Mitigated

Run Scenario

Basic Elements

Pro Elements

LID Toolbox

Commercial Toolbox

Move Elements

Save x,y Load x,y

X 40
Y 60

Tue 2:42p - HRA - Finish Mitigated

Bioretention 1 Mitigated

Facility Name Bioretention 1

	Outlet 1	Outlet 2	Outlet 3
Downstream Connection	0	0	0

Facility Type Bioretention Swale

Use simple Bioretention | Quick Swale | Size Water Quality | Size Facility

Underdrain Used

Underdrain Diameter(ft) 1 **Offset(in)**

Orifice Diameter(in) 4 0

Bioretention Bottom Elevation 0

Flow Through Underdrain (ac-ft) 17.966

Total Outflow (ac-ft) 17.984

Percent Through Underdrain 99.9

WQ Percent Filtered 99.9

Facility Dimension Diagram

Bioretention Dimensions

Bioretention Length (ft)	13.000
Bioretention Bottom Width (ft)	6.000
Freeboard (ft)	0.500
Over-road Flooding (ft)	0.000
Effective Total Depth (ft)	3.5
Bottom slope of bioretention.(0-1)	0.000

Sidewall Invert Location

Front and Back side slope (H/V)	3.000
Left Side Slope (H/V)	3.000
Right Side Slope (H/V)	3.000

Riser Outlet Structure

Outlet Structure Data

Riser Height Above bioretention surface (ft) 0.5

Riser Diameter (in) 6

Riser Type Flat

Material Layers for

	Layer 1	Layer 2	Layer 3
Depth (ft)	1.500	1.000	0.000
Soil Layer 1	SMMWW 12 in/hr		
Soil Layer 2	GRAVEL		
Soil Layer 3	GRAVEL		

Edit Soil Types

KSat Safety Factor: None 2 4

Orifice Number	Diameter (in)	Height (ft)
1	0	0
2	0	0
3	0	0

Show Bioretention Open Table

Bioretention Volume at Riser Head (ac-ft) .024

Native Infiltration NO

Precipitation on Facility (acre-ft) 1.298

Evaporation from Facility (acre-ft) 0.448

General Model Information

Project Name:	HRA
Site Name:	Huntington Ridge Apartments
Site Address:	906 Croy Street
City:	Kelso
Report Date:	2/11/2020
Gage:	Longview
Data Start:	1955/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.14
Version Date:	2016/02/25
Version:	4.2.12

POC Thresholds

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

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
DRIVEWAYS MOD	0.0918
Impervious Total	0.0918
Basin Total	0.0918

Element Flows To:

Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

Mitigated Routing

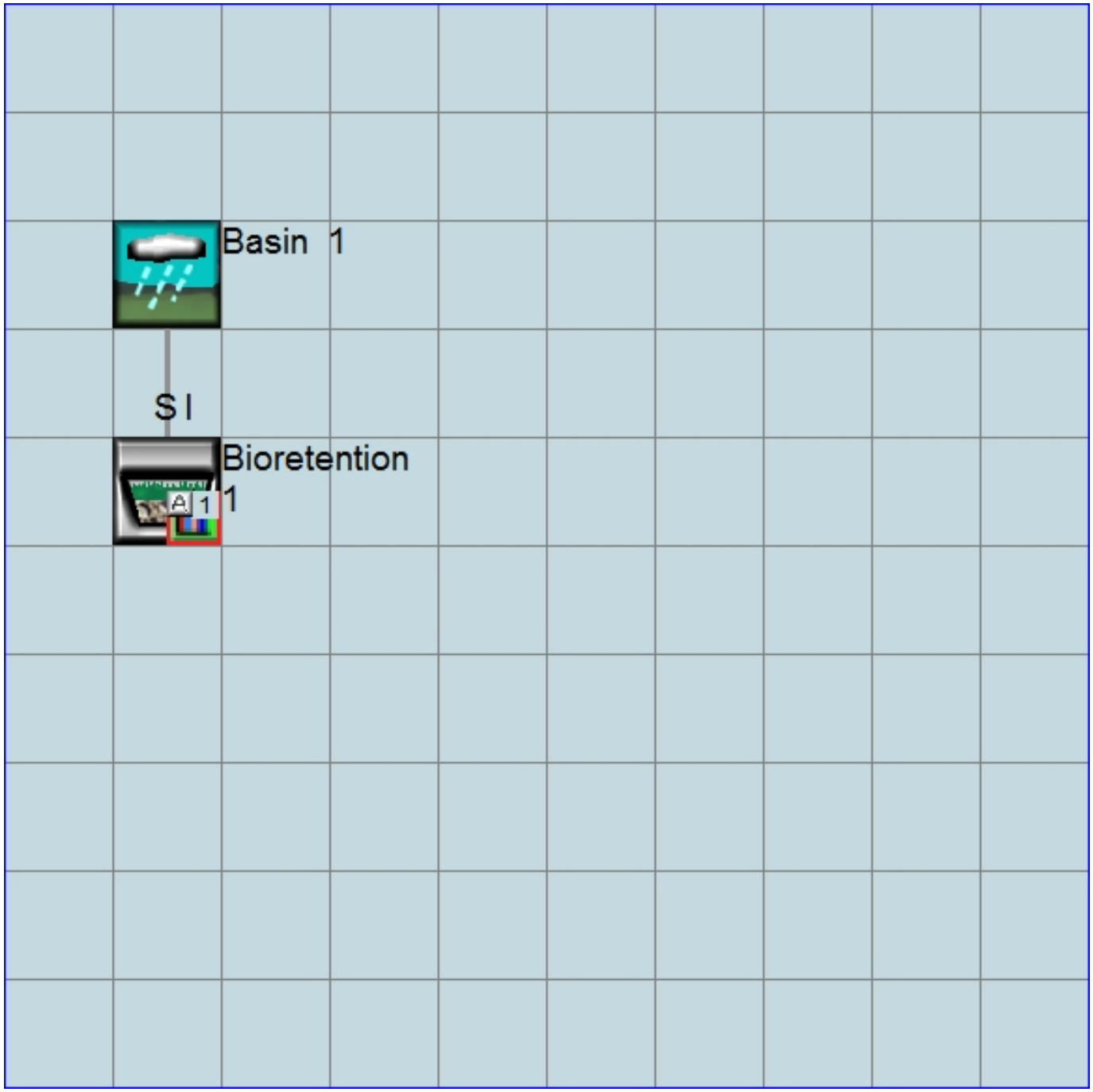
Bioretention 1

Bottom Length:	13.00 ft.
Bottom Width:	6.00 ft.
Material thickness of first layer:	1.5
Material type for first layer:	SMMWW 12 in/hr
Material thickness of second layer:	1
Material type for second layer:	GRAVEL
Material thickness of third layer:	0
Material type for third layer:	GRAVEL
Underdrain used	
Underdrain Diameter (feet):	1
Orifice Diameter (in.):	4
Offset (in.):	0
Flow Through Underdrain (ac-ft.):	17.966
Total Outflow (ac-ft.):	17.984
Percent Through Underdrain:	99.9
Discharge Structure	
Riser Height:	0.5 ft.
Riser Diameter:	6 in.
Element Flows To:	
Outlet 1	Outlet 2

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0135	0.0000	0.0000	0.0000
0.0385	0.0135	0.0000	0.0000	0.0000
0.0769	0.0132	0.0001	0.0000	0.0000
0.1154	0.0130	0.0001	0.0000	0.0000
0.1538	0.0127	0.0001	0.0004	0.0000
0.1923	0.0125	0.0002	0.0009	0.0000
0.2308	0.0122	0.0002	0.0013	0.0000
0.2692	0.0120	0.0003	0.0017	0.0000
0.3077	0.0117	0.0003	0.0029	0.0000
0.3462	0.0115	0.0004	0.0029	0.0000
0.3846	0.0113	0.0004	0.0044	0.0000
0.4231	0.0110	0.0005	0.0055	0.0000
0.4615	0.0108	0.0005	0.0064	0.0000
0.5000	0.0106	0.0006	0.0089	0.0000
0.5385	0.0103	0.0006	0.0091	0.0000
0.5769	0.0101	0.0007	0.0118	0.0000
0.6154	0.0099	0.0008	0.0138	0.0000
0.6538	0.0097	0.0008	0.0153	0.0000
0.6923	0.0094	0.0009	0.0194	0.0000
0.7308	0.0092	0.0010	0.0197	0.0000
0.7692	0.0090	0.0010	0.0240	0.0000
0.8077	0.0088	0.0011	0.0270	0.0000
0.8462	0.0086	0.0012	0.0292	0.0000
0.8846	0.0084	0.0013	0.0351	0.0000
0.9231	0.0082	0.0014	0.0356	0.0000
0.9615	0.0080	0.0015	0.0417	0.0000
1.0000	0.0078	0.0015	0.0458	0.0000
1.0385	0.0076	0.0016	0.0489	0.0000
1.0769	0.0074	0.0017	0.0568	0.0000

Mitigated Schematic



LID Report

POC 1

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
retention 1 POC	☐	16.37			☐	0.00			
Total Volume Infiltrated		16.37	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Export Close

APPENDIX C

Preliminary Site Plan

Huntington Ridge Apartments

Located in the SW ¼ of Section 23 T8N, R2W, W.M.
Kelso, Washington

Proposed Hatching Legend	
Proposed Asphalt Section	
Proposed Concrete	
Proposed Landscaping	

Scale 1" = 40'

40 20 0 40

SITE LOCATION:
Located at the northwest corner of the intersection of the Interstate 5 Exit 40 southbound offramp and North Kelso Avenue.
Latitude: N46°9'41"
Longitude: W123°0'33"

SITE ADDRESS:
906 Croy Street
Kelso, WA 98626

Parcel Numbers 23933 and 2393301
SW ¼ of Section 23, T8N, R2W, W.M. Kelso, WA

LOT AREA:
Minimum Req'd = None
Actual = 441,693 sq-ft
= 10.14 acres

DENSITY:
Maximum = 17 units/acre
Actual = 9.47 units/acre

LOT WIDTH:
Minimum Req'd = 25 ft

SETBACKS:
Minimum Front = 20 ft
Minimum Rear = 10 ft
Minimum Side = 5 ft
Minimum Street Side = 7 ft

BUILDING HEIGHT:
Maximum = 35 ft

PRESENT USE:
The site is a vacant parcel with remnants of a previous structure and parking lot.

EXISTING STREETS:
The site will access from Croy Street. The property is bordered on the north by a vacant timbered parcel, on the east by Interstate 5, on the south by North Kelso Avenue, and on the west by the Drainage Improvement District #1 Ditch and single family residential homes.

EXISTING ZONING:
Residential Mixed Density (RMD)

SANITARY SEWER SERVICE:
City of Kelso

WATER SERVICE:
City of Kelso

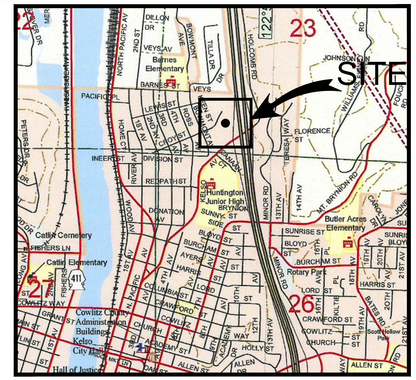
ELECTRICAL SERVICE:
Cowlitz PUD

LOT COVERAGE:
Maximum Impervious Cover = 75%

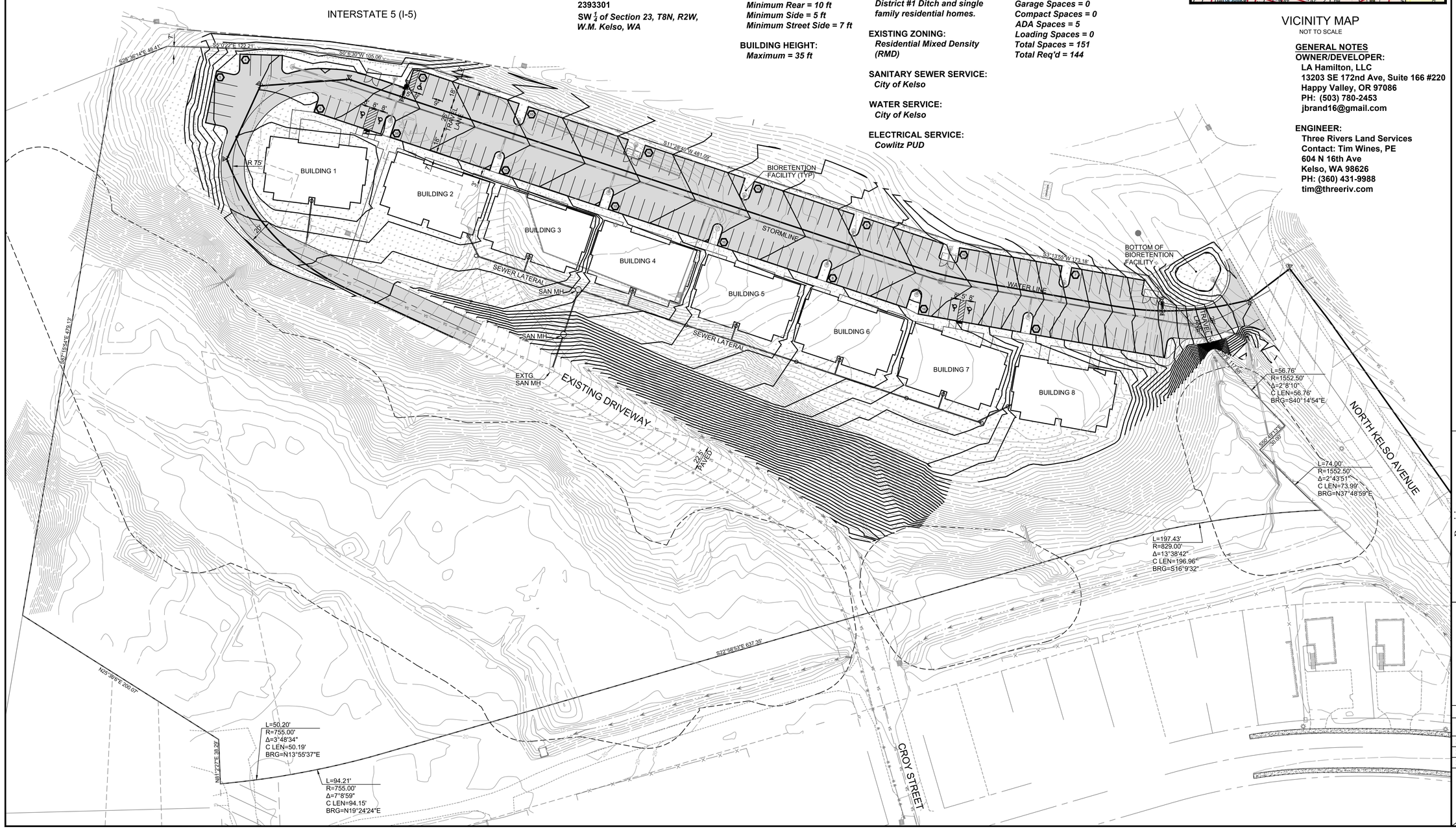
WELLS OR SEPTICS:
None Known

APARTMENT UNITS:
Total Units = 96
1 Bedroom Units = 24 (25.0%)
2 Bedroom Units = 60 (62.5%)
3 Bedroom Units = 12 (12.5%)

PARKING:
Standard Spaces = 146
Garage Spaces = 0
Compact Spaces = 0
ADA Spaces = 5
Loading Spaces = 0
Total Spaces = 151
Total Req'd = 144



VICINITY MAP
NOT TO SCALE



GENERAL NOTES

OWNER/DEVELOPER:
LA Hamilton, LLC
13203 SE 172nd Ave, Suite 166 #220
Happy Valley, OR 97086
PH: (503) 780-2453
jbrand16@gmail.com

ENGINEER:
Three Rivers Land Services
Contact: Tim Wines, PE
604 N 16th Ave
Kelso, WA 98626
PH: (360) 431-9988
tim@threeriv.com

THREE RIVERS LAND SERVICES

Conceptual Site Plan for:
Huntington Ridge Apartments
Located in Kelso, Washington

Three Rivers Land Services | Consulting Engineers & Planners | 604 N 16th Avenue, Kelso, WA 98626 | PH (360) 431-9988

Revisions			
			TSW
A	1/24/18	For Review	
B			
1			
2			
3			
4			

Project No.	1011
SCALE:	H: 1" = 40' V: N/A
DESIGNED BY:	TSW
DRAFTED BY:	TSW
REVIEWED BY:	TSW

1
1

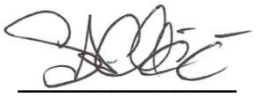
APPENDIX D

Geotechnical Report

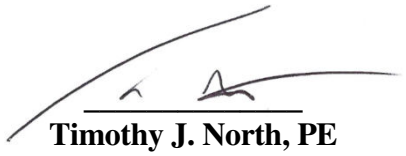
PRELIMINARY GEOTECHNICAL ENGINEERING STUDY

Proposed Huntington Ridge Apartments
906 Croy Road
Kelso, Cowlitz County, Washington

Prepared for:
Mr. Jesse Brand
13203 SE 172nd Avenue
Happy Valley, OR 97086
Prepared By:



Seth A. Chandlee
Project Manager



Timothy J. North, PE
Project Engineer

Project No. G0141800
{June 2018}

Soil and Water Technologies, Inc.
PO Box 59 / Vancouver, Washington 98666
(360) 281-5406
www.swt.ski

TABLE OF CONTENTS

INTRODUCTION

General

This report presents the results of the geotechnical engineering study completed by Soil and Water Technologies, Inc. (SWT) for the proposed Huntington Ridge Apartments located in Kelso, Cowlitz County, Washington. The general location of the site is shown on the *Vicinity Map, Figure 1.* Our approximate exploratory boring locations are shown in relation to the site on the *Site Plan, Figure 2.*

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

Project Description

It is SWT understanding that you plan to construct a total of eight, three-story wood-framed apartment buildings consisting of a total of ninety-six (96) living units. The project will also include associated underground utilities, asphalt paved roadways and parking areas at the approximate ten-acre parcel. Although no specific grading plan was available during the time of our study, we understand that the proposed grading plan for the site will include an approximate cut of five feet at the upper northwest portion of the site, and that the cut materials are planned to be used to fill and level out the lower southeastern portions of the site. In total, we anticipate that earthwork cuts and fills will not exceed approximately five feet in thickness across the site. Each of the proposed apartment buildings will be constructed close to proposed grade with slab on grade foundations.

Specific structural design loads for the proposed apartment buildings were not available at the time of the preparation of this report, and so our recommendations are based on the local experience with similar projects.

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

SITE CONDITIONS

Surface

The irregularly shaped property is located at the northwest corner of the intersection of the Interstate 5 (Exit 40) southbound off-ramp and North Kelso Avenue in Kelso, Washington. The subject property is bordered on the north by a forested parcel, on the east by Interstate 5, on the south by North Kelso Avenue and on the west by Drainage Improvement District No. 1 Ditch and by single family residences beyond.

The topography across the site consists of a bluff that formerly consisted of an ancient river terrace that was orphaned by the cutting of the adjacent hillsides to the east during the construction of Interstate 5. The proposed project site itself is relatively flat, sloping down moderately to the south at an approximately 20H:1V (horizontal: vertical) slope gradient. Steeper terrace slopes along the west side of the property boundary include average slope gradients around 30 to 40 percent, with a steeper portion along the northwest boundary, where slopes gradients up to 80 percent exist. The maximum

total elevation change across the site is approximately 40 to 50 feet. During the time of our site study the property was covered with pasture grass, blackberry brambles, native trees and shrubs.

Subsurface

On February 26th, 2018 the site was explored excavating a total of three mud-rotary borings, designated B-1 through B-3, that were drilled to depths ranging from 26.5 to 51.5 feet below the existing ground surface (bgs). On April 6th, 2018 we also observed the exploration of seven additional test pits with an excavator, designated TP-1 through TP-7. All exploration locations were selected by SWT to determine subsurface conditions in the vicinity of the proposed apartment buildings and pavement areas. The approximate locations are shown on the *Site Plan, Figure 2.*

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

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

SURFACE MATERIALS: Surface materials encountered in the explorations consisted of deteriorated gravel and asphalt pavements in the northern portion of the site, and 4 to 10 inches of organic topsoil in the southern portion of the site.

CLAY FILL: Undocumented fill consisting of silty Clay (CL) with occasional rock fragments, trace sand and other variable debris, was encountered below the surface materials in borings B-2 and B-3, extending to depths 16 and 21 feet, respectively. The fill was also encountered in test pits TP-2 through TP-7, extending to the termination depth of all at 10 feet bgs, except TP-2 and TP-7, where it extended to depths of 2.5 in both. In general, the clay fill was light brown to blue-gray, low plasticity and moist. The consistency of the clay fill was highly variable, ranging from very soft to stiff, based on of SPT N-values ranging from 0 to 7. The moisture content of samples from this unit ranged from 22 to 34 percent.

SILTY SAND: Native silty sand (SM) was encountered at the surface in boring B-1, and below the clay fill in borings B-2 and B-3, and well as test pits TP-1, TP-2 and TP-7, to the termination depth of these explorations. In general, the silty sand was light brown to gray, fine grained, and loose to dense, based on SPT N-values ranging from 8 to 42, increasing in density and coarseness with depth. The percent fines content of tested samples of the silty sand ranged from 32 to 48. The moisture content of samples from this unit varied from 12 to 44 percent, however these moisture values in the looser portions of the unit are likely artificially high due to the mud rotary drilling technique used. In Test Pit TP-7, the silty sand became cleaner (fines content of 14 percent) below 7 feet bgs, and remained so to the termination depth at 10 feet bgs.

Please refer to our test pit logs, Plates A2 through A8 and boring logs, B1 through B3 for a more detailed description of the conditions encountered at each location explored.

Groundwater

No groundwater or groundwater seepage was encountered to the maximum depth of exploration at our test pits or borings. Our review of water well logs from the Washington Department of Ecology database indicates that the static groundwater level in the area is greater than fifty feet (50') below the surface.

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

General Regional Geology

General information about geologic conditions and soil in the vicinity of the site was obtained by reviewing the Washington Division of Geology and Earth Resources Geologic Map of the Mount St. Helens Quadrangle, Washington and Oregon, and the USDA web soil survey.

In the vicinity of the subject property, underlying bedrock is unexposed Oligocene epoch (34 to 23 mya) basalt and basaltic andesite flows emplaced by flood basalts that represent the early formation of the regional segment of the Cascade volcanic arc. The bedrock's appearance is usually limited to steep cliff faces, landslide scarps, and streambeds and is extensively overlain by Neogene-Quaternary period (23 to 2.5 mya) alluvial and glacial till.

In the Late Pleistocene (17 -13 kya), a series of floods caused by the failure of the ice dam at Glacial Lake Missoula in western Montana caused the deposition of suspended sediments from floodwaters throughout the lower Columbia River Basin

The native material encountered in our borings and test pits consists predominantly of native Sand and Silt consistent with Pleistocene-age terrace deposits of fine sand and silt formed from the sequence of undercutting and subsequent filling of the ancient alluvial Columbia River floodplain deposits.

Geologic Hazards

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

Slope and Landslide Hazards:

A review of the Cowlitz County Online Planning Clearance (EPIC) for the site and the "Digital Landslide Inventory of the Cowlitz County Urban Corridor" for the Kelso Quadrangle (Wegmann, 2006), do not indicate any identified active or inactive landslides at the subject property. However, Cowlitz County Code Section 19.15.150 defines any slopes taller than 10 feet with a gradient greater than 33 percent as potential landslide hazard areas, pending review by a qualified professional.

Seismic Hazards:

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

Ground Motion Amplification: Based on a review of the "Site Class Map of Cowlitz County, Washington" (Palmer et al. 2004), portions of the site are designated as both seismic Site Class "C" and "D". Based on our field explorations and recommendations below, it is our opinion that a Site Class "D" is appropriate for use at the site. Our seismic design criteria, which are partially based on the site class designation, are included in the Geotechnical Design Recommendations portion of this report.

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

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

Based on the anticipated groundwater table depth (greater than 50 feet bgs), as well as the relative density and fines content of the expected bearing soils, we consider the potential for liquefaction within the site boundaries to be low. Indeed, the site as mapped as having a "very low to low" liquefaction susceptibility based on the "Liquefaction Susceptibility Map of Cowlitz County, Washington" (Palmer et al., 2004).

Fault Rupture: There are no seismogenic faults mapped within thirty (30) miles of the property boundaries (WA Dept. of Natural Resources Geological Information Portal).

Volcanic Hazards:

According to the "Volcanic Hazard Zonation for Mount St. Helens, Washington" (Wolfe & Peterson, 1995), the site does not lie within a flowage-hazard zone resulting from a potential volcanic eruption.

Slope Stability Analysis

For the purposes of this study, we performed quantitative slope modeling and slope stability analysis of the steepest portions of the northwest slopes. The analysis was based on the geologic cross section A-A' shown in Figure 5. We used topography provided by you in the preliminary site plan and subsurface data compiled from our exploratory borings to create the cross section.

We used the software SLIDE 2018 version 8.011 developed by Rocscience Inc., of Toronto, Ontario, Canada to evaluate the cross section. The software uses Spencer's method of slices to evaluate the static equilibrium of the model for both force and moment equilibrium while assuming that resultant inter-slice forces are of constant orientation throughout the sliding mass. This method of analysis is valid for circular and non-circular failure surfaces.

The internal friction angles (phi), moist unit weights, and cohesions intercepts assigned to each unit are included with the results provided with the A-A' cross section in Figures 5a & 5b. The values were chosen conservatively based on generally accepted correlations with soil texture, and standard penetration tests conducted in the soil borings.

We used a pseudo-static analysis to evaluate slope stability under seismic conditions. Pseudo-static analysis represents the effects of earthquake shaking by accelerations that create inertial forces. We estimated the seismic coefficient based on a mean peak ground acceleration for the site of 0.2 g.

The limits of the static and pseudo-static analysis were adjusted until factors of safety were greater than the generally accepted minimum factors of safety of 1.5 and 1.1, respectively, for existing or engineered slopes. Failure planes at these minimum factors of safety were found to be located at a minimum distance of 25 feet from the top of the steepest northwest slope. The graphical output of the slope model analysis for static and pseudo-static (seismic) is provided with the A-A' cross sections in Figures 5a & 5b, respectively.

GEOTECHNICAL DESIGN RECOMMENDATIONS

General

Based on the results of our study, it is our opinion the proposed apartment buildings can be constructed as planned, provided the geotechnical recommendations contained in this report are incorporated into the final design. The primary geotechnical concerns at the site are steeper slopes along the northwest boundary of the proposed project site and soft undocumented fill within the southern portion of the site.

The following sections present detailed recommendations and parameters pertaining to the geotechnical engineering design for this project.

Limitation of structures

To reduce the risk of slope instability at the site, we recommend that residential structures be set back at least 25 feet from the top of slope break at steeper slopes in the northwest portion of the site, as indicated on the Site Plan, Figure 2. The limitation recommendation is intended to reduce potential for slope instability by limiting the dynamic and static loading resulting from construction and permanent structures.

The setback is based on the horizontal distance of the outside base of footings from the adjacent slope. With increased embedment depth of the footings, structures may be founded closer to the adjacent top of slope, providing the horizontal distance from the slope face is maintained.

To reduce the risk of slope instability, clearing, grading, soil stockpiling, utility installation and other major construction activities should not be permitted within the limitation area or along the slopes themselves. The probability for slope instability increases with disturbance or alteration of existing slope vegetation. The setback zone is not intended to be an undisturbed conservation area, and small disturbances such as minor landscaping or construction of decks or fences are acceptable. The recommendations provided are intended to address the geotechnical aspects of construction within the recommended limitation zones.

Foundations

Based on the encountered subsurface soil conditions, preliminary building design criteria, and assuming compliance with the preceding *Site Earthwork and Grading* section, the proposed building foundations may be supported on conventional shallow spread footings bearing either on undisturbed medium dense native silty sand, or in the case of the lower southern portion of the site where soft undisturbed fill is present, on 12-inch-thick geo-grid reinforced granular mat, as described below.

Individual spread footings or continuous wall footings providing support for the proposed building may be designed for a maximum allowable bearing value of 1,500 pounds per square foot (psf). Footings for one level structures should be at least 12 inches in width. Footings for two level structures should be at least 15 inches in width. Footings for three level structures should be at least 18 inches in width. All footings should extend to a depth of at least eighteen (18) inches below the lowest adjacent finished sub grade.

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

Geo-grid Reinforced Granular Mats:

Due to the soft soil conditions encountered within lower southern portion of the site and the potential for unrecognized softer zones within this are, we recommend that the building foundations in this portion of the site be supported on conventional shallow spread footings that bear upon a geo-grid reinforced "granular mat". This type of foundation system will reduce the potential for differential settlement and act to bridge softer areas below foundations. The mat should consist of an twelve-inch thick layer of granular material placed and compacted above a geo-textile grid such as Tensar TriAxial TX160 or equivalent. The mat should extend a minimum of two feet beyond the building footprint.

By constructing the proposed building on a geogrid-reinforced gravel mat, the potential for differential settlement will be significantly reduced. However, if no degree of differential settlement risk can be assumed by the owner then it will be necessary to support the entire building and floor slab on a deep foundation system. A deep pile foundation system design can be provided at the owner's request.

Slab on Grade

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

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

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

Site Drainage

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

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

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

Pavement Areas

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

In the area of the proposed onsite roadways and drive aisles, we recommend 3 inches of AC underlain by 12 inches of compacted CRB.

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

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

The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote drainage. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the base layer.

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

Seismic Design Criteria:

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

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

Table 1. 2012/2015 IBC Seismic Design Parameters

Location (Latitude:46.158052°, Longitude:-122.903561°)	Short Period	1-Second
Maximum Credible Earthquake Spectral Acceleration	S_s = 0.954g	S_1 = 0.439g
Site Class	D	
Site Coefficient	F_a = 1.119	F_v = 1.561
Adjusted Spectral Acceleration	S_{MS} = 1.067g	S_{M1} = 0.685g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.711g	S_{D1} = 0.457g

g – acceleration due to gravity

CONSTRUCTION RECOMMENDATIONS

Site Earthwork and Grading

Clearing and Grubbing:

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

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

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

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

- Over-excavate existing soils to a competent native subgrade below the bottom of the proposed foundations. The excavations should extend at least one-half width laterally beyond the foundation footprint, or as constrained by existing structures. In addition, native soil removal shall extend to a minimum depth so that a maximum 2:1 ratio of differential structural fill thickness is maintained below all building spread foundation systems.
- The fill soils placed shall consist of clean soils with an expansion index (EI) less than twenty (20), and be free of organic material, debris, and rocks greater than three inches in maximum diameter. Based on the field observations and laboratory testing, the existing native soil is suitable for use as structural fill so long as the material does not exceed three (3) inches in diameter and is within two percent (2%) of its optimum moisture content prior to compaction.
- The backfill shall consist of minimum ninety-five percent (95%) compacted fills (Note: ASTM D1557). In addition to the relative compaction requirements, all fills shall be compacted to a firm non-yielding condition.
- Import soils should be sampled, tested, and approved by SWT prior to arrival on site. Imported soils shall consist of clean soils (EI of 20 or less) free from vegetation, debris, or rocks larger than three inches in maximum dimension.

Subgrade Verification and Proof Rolling

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

Wet Weather Construction & Moisture Sensitive Soils:

Field observations and laboratory testing indicates that both native silty Sand (SM) and undocumented fill consisting of silty Clay (CL) encountered at the site are moisture sensitive materials. As such, in an exposed condition, moisture sensitive soil can become disturbed during normal construction activity, especially when in a wet or saturated condition. Once disturbed, in a wet condition, these soils will be unsuitable for support of foundations, floor slabs and roadways.

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

Utility Support and Backfill

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

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

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

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

Temporary Excavations

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

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

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

LIMITATIONS

Our recommendations and conclusions are based on the site materials observed, selective laboratory testing, engineering analyses and other design information provided to Soil and Water Technologies

as well as our experience and engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

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

ADDITIONAL SERVICES & EARTHWORK MONITORING

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

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

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

VICINITY MAP

N

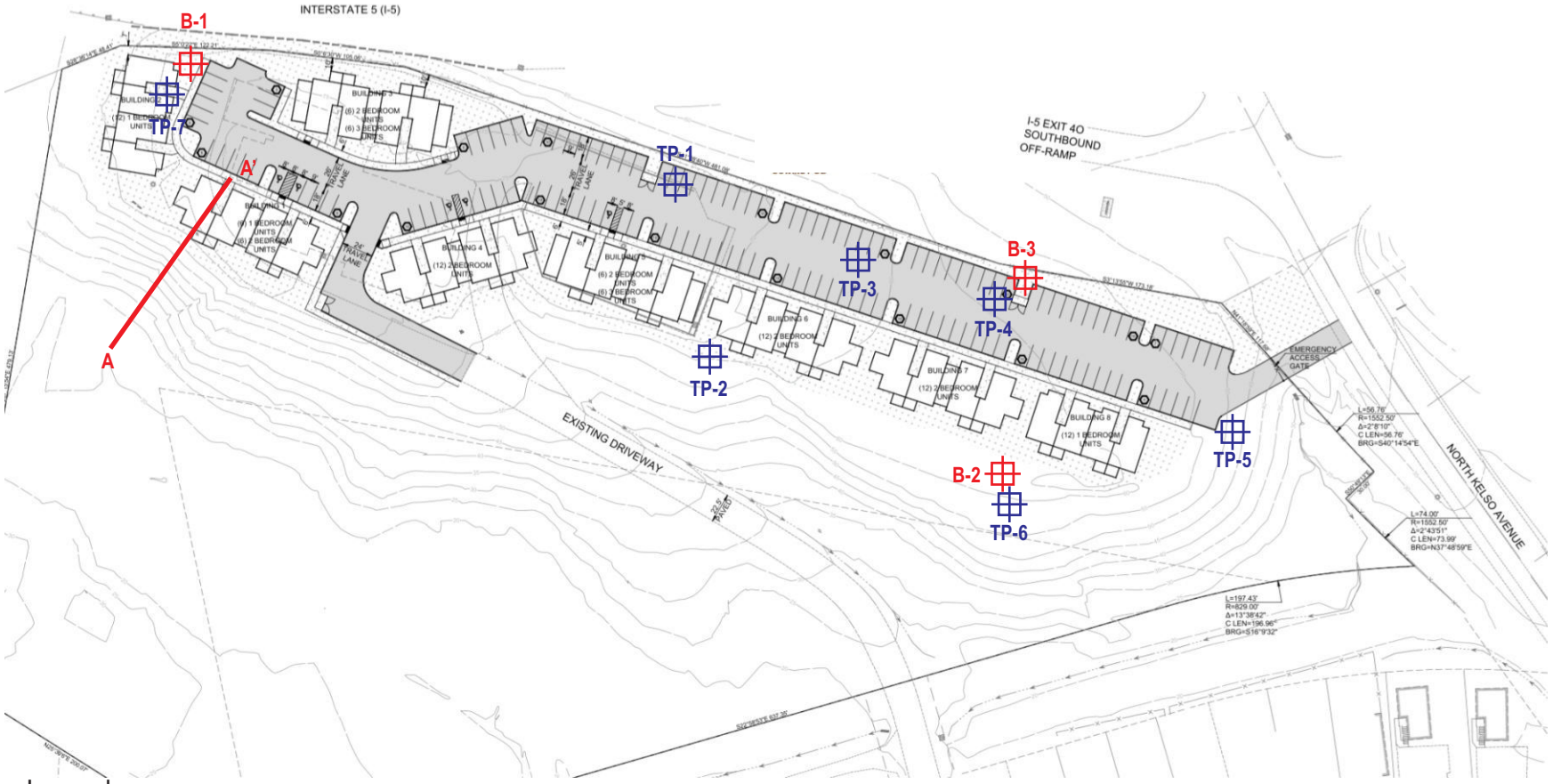
Not to Scale

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	JR
PROJECT:	Huntington Ridge Apts. 906 Croy Road Kelso, WA 98626	*DATE:*	3/14/2018
		FIGURE:	1
		PRO. #:	G0141800

Site Plan

N
Not to Scale



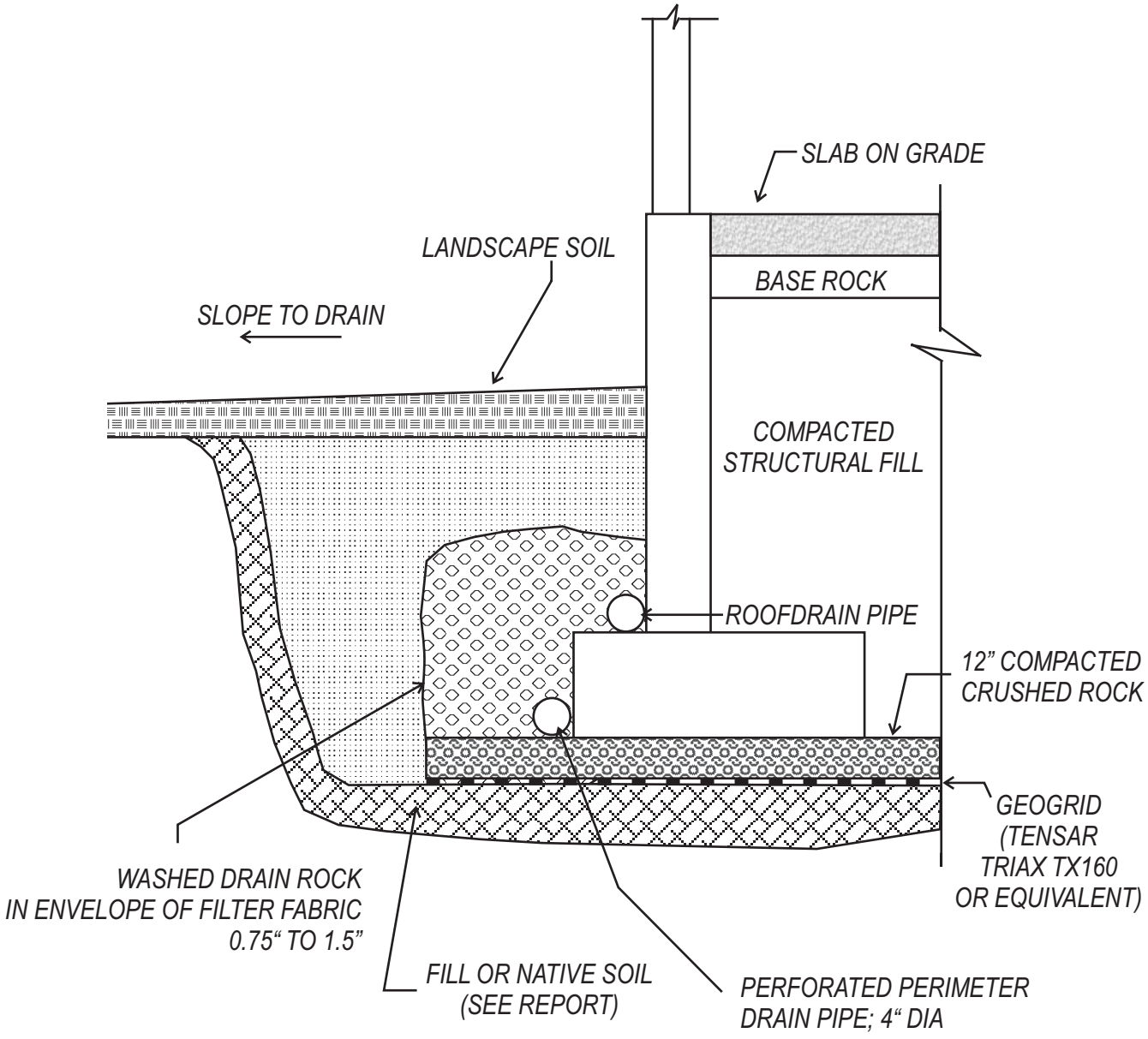
Legend

B-1 Boring Location

TP-1 Test Pit Location

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	6/6/2018
		FIGURE:	2
		PRO. #:	G0141800



NOTES:

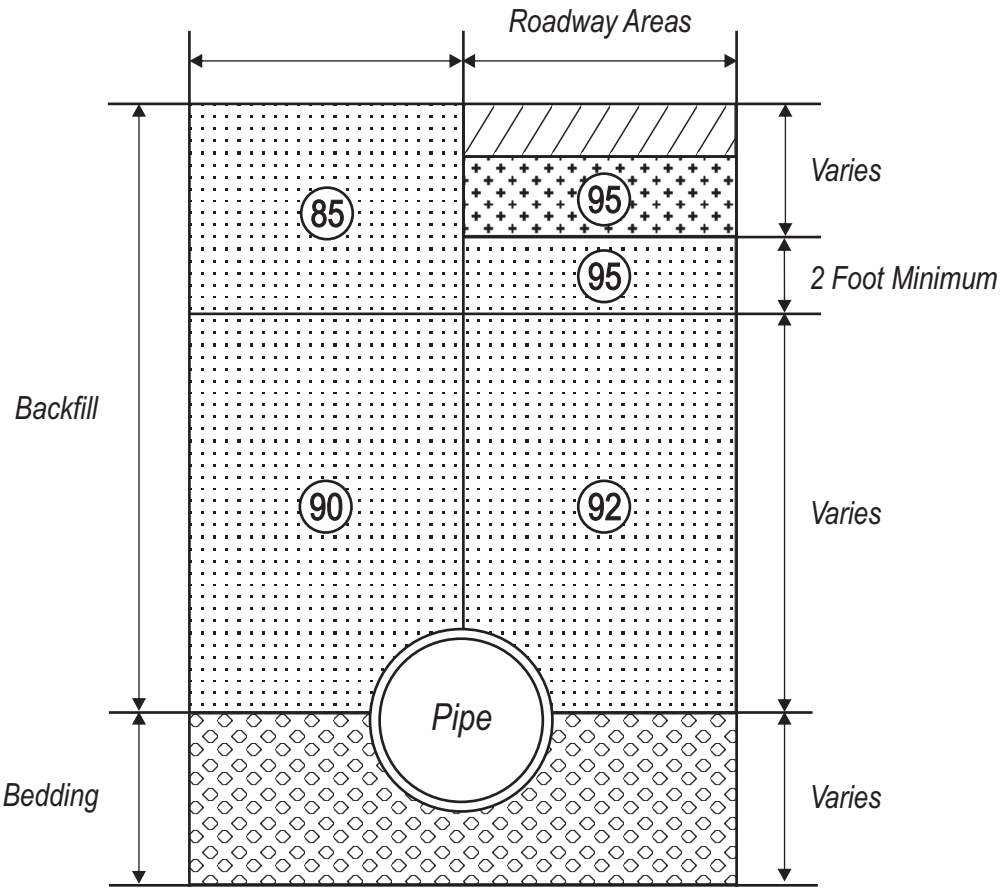
1. PERFORATED OR SLOTTED RIGID PVC PIPE WITH A POSITIVE DRAINAGE GRADIENT
2. FILTER SAND - FINE AGGREGATE FOR PORTLAND CEMENT; SECTION 9=03.1(2)
3. FILTER FABRIC OPTIONAL IF FILTER SAND USED
4. TWELVE INCHES OF COMPACTED CRUSHED ROCK BASE ABOVE A GEOTEXTILE GRID (SEE REPORT)

GRANULAR MAT SYSTEM & SUBDRAIN DETAIL

Not to Scale

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apts. 906 Croy Road Kelso, WA 98626	DATE:	3/14/2018
		FIGURE:	3
		PRO. #:	G0141800



LEGEND

Asphalt or Concrete Pavement

Roadway Base Material or Base Rock

Backfill: Compacted on-site soil or imported select fill material as described in the site preparation of the general Earthwork Section of the attached report text.

92 — Minimum percentage of maximum Laboratory Dry Density as determined by ASTM Test Method D1557 (Modified Proctor),unless otherwise specified in the attached report text.

Bedding Material: Material type depends on type of pipe and laying conditions. Bedding should conform to the manufacturer's recommendations for the type of pipe selected.

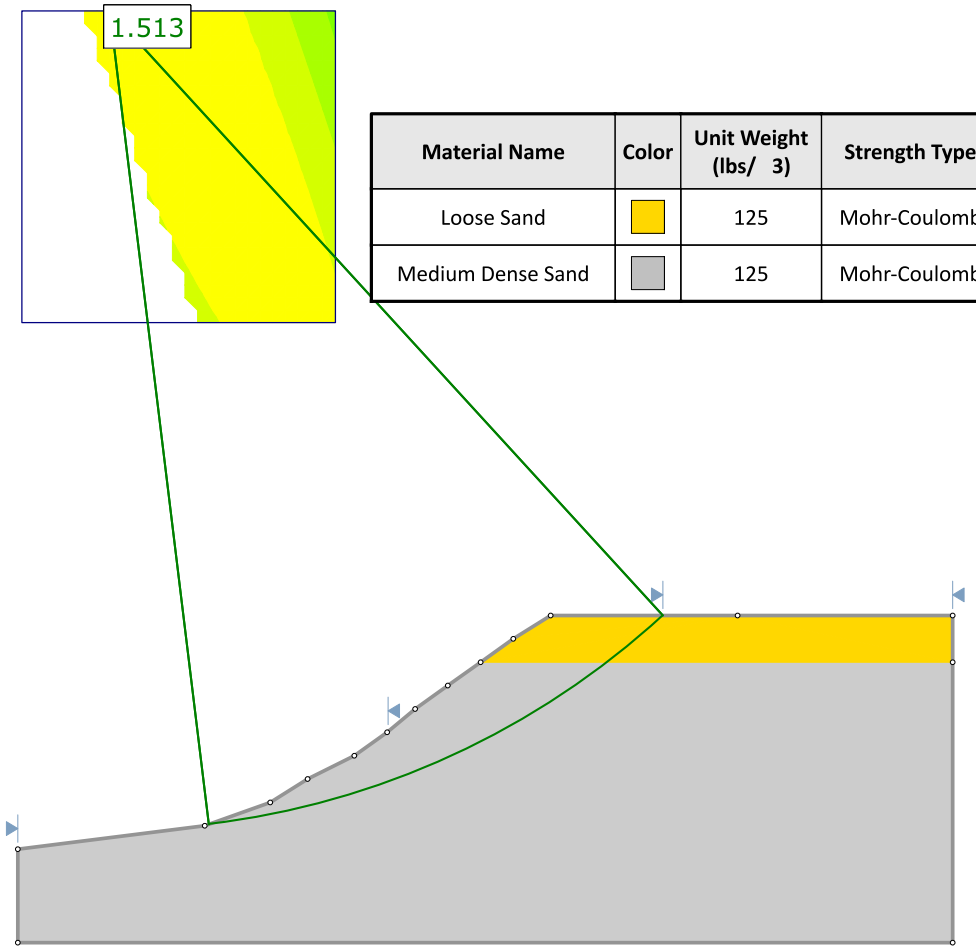
UTILITY TRENCH BACKFILL DETAIL

Not to Scale

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apts. 906 Croy Road Kelso, WA 98626	DATE:	3/14/2018
		FIGURE:	4
		PRO. #:	G0141800

SLOPE STABILITY ANALYSIS RESULTS - STATIC

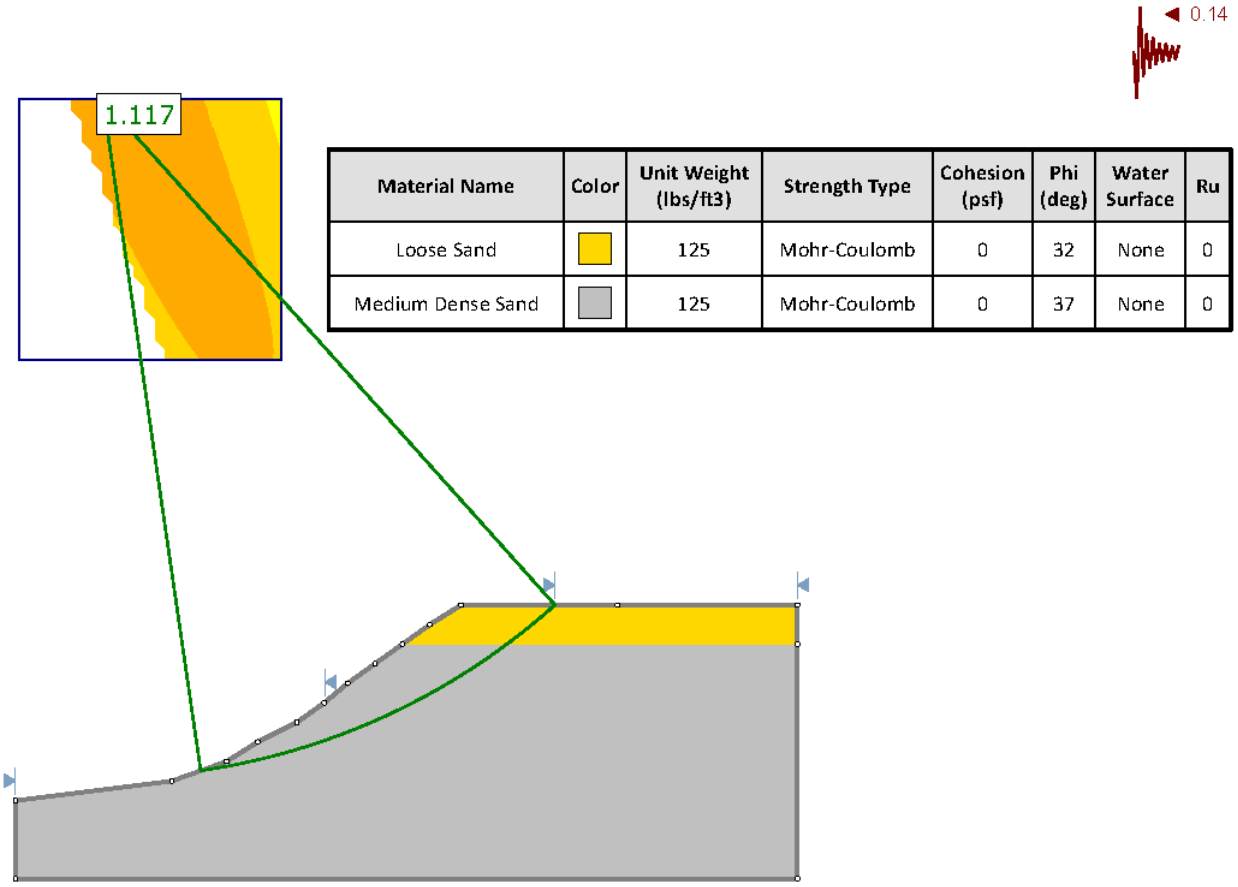


Material Name	Color	Unit Weight (lbs/ 3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Loose Sand		125	Mohr-Coulomb	0	32	None	0
Medium Dense Sand		125	Mohr-Coulomb	0	37	None	0

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	6/6/2018
		FIGURE:	5a
		PRO. #:	G0141800

SLOPE STABILITY ANALYSIS RESULTS - PSEUDO-STATIC



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Loose Sand		125	Mohr-Coulomb	0	32	None	0
Medium Dense Sand		125	Mohr-Coulomb	0	37	None	0

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	6/6/2018
		FIGURE:	5b
		PRO. #:	G0141800

APPENDIX A

(FIELD EXPLORATION)

FIELD EXPLORATION

We explored the subsurface conditions at the site by advancing three borings on February 26th and excavating seven test pits on April 6th, 2018. The borings were advanced to depths ranging from 26.5 to 51.5 feet below the ground surface (bgs) with a track-mounted drill rig provided and operated by Holt Drilling of Vancouver, Washington. The test pits were excavated by the use of a Kubota 121 track hoe to the maximum depth of 11 feet bgs.

Disturbed soil samples were taken in the borings at selected depth intervals. The samples were obtained using a standard 2-inch outside diameter (OD), split-spoon sampler following procedures prescribed for the SPT. Using the SPT, the sampler is driven 18 inches into the soil using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is defined as the standard penetration resistance (N-value). The N-value provides a measure of the relative density of granular soils such as sands and gravels, and the consistency of cohesive soils such as clays and plastic silts.

The approximate test pit and boring locations were determined by pacing from existing site features. The locations should be considered accurate only to the degree implied by the method used. These approximate locations are shown on the *Site Plan, Figure 2.*

The field exploration was monitored by two Soil and Water Technologies representatives, who classified the soil encountered and maintained a log of each test pit, obtained representative samples, and observed pertinent site features. Representative soil samples were placed in closed containers and returned to the laboratory for further examination and testing.

All samples were visually classified in accordance with the Unified Soil Classification System (USCS), which is presented on Plate A1. Logs of the test pits and borings are presented in Appendix A. The final logs represent our interpretations of the field logs and the results of the laboratory tests on field samples. The stratification lines on the logs represent the approximate boundaries between soil types. In fact, the transitions may be more gradual.

UNIFIED SOIL CLASSIFICATION SYSTEM
LEGEND

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTION
Coarse Grained Soils	Gravel and Gravelly Soils More Than 50% Coarse Fraction Retained on No 4 Sieve	Clean Gravels (little or no fines)		GW gw	Well-Graded Gravels, Gravel-Sand Mixtures Little or no Fines
				GP gp	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
		Gravels with Fines (appreciable amount of fines)		GM gm	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC gc	Clayey Gravels, Gravel-Sand-Clay Mixtures
More Than 50% Material Larger Than No 200 Sieve Size	Sand and Sandy Soils More Than 50% Coarse Fraction Passing No 4 Sieve	Clean Sand (little or no fines)		SW sw	Well-graded Sands, Gravelly Sands Little or no Fines
				SP sp	Poorly-Graded Sands, Gravelly Sands Little or no Fines
		Sands with Fines (appreciable amount of fines)		SM sm	Silty Sands, Sand-Silt Mixtures
				SC sc	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils	Silts and Clays	Liquid Limit Less than 50		ML ml	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands; Clayey Silts w/ slight Plasticity
				CL cl	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
				OL ol	Organic Silts and Organic Silty Clays of Low Plasticity
More Than 50% Material Smaller Than No 200 Sieve Size	Silts and Clays	Liquid Limit Greater than 50		MH mh	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils
				CH ch	Inorganic Clays of High Plasticity, Fat Clays
				OH oh	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils				PT pt	Peat, Humus, Swamp Soils with High Organic Contents

Topsoil		Humus and Duff Layer
Fill		Highly Variable Constituents

SAMPLING DESCRIPTIONS

- Grab Sample
- SPT Drive Sampler (ASTM D1586)
- Shelby Tube Push Sampler (ASTM D1587)
- Dames and Moore Drive Sampler (ASTM D3550)

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apts. 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	A1
		PRO. #:	G0141800

LOG OF TEST PIT — TP-1

ELEVATION: **+/- 71 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **4/6/2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
0		~ 10" Soft, dark brown, Organic Topsoil, wet				
2	●	Firm, gray, **sandy Silt (ML)** moist		20	-	{Orange Mottling}
4–10	●	Dense, gray **silty Sand (SM)** fine-grained, moist (Native)		20	-	

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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

CLIENT:	Mr. Jesse Brand	DRAWN:	RN
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	4/13/2018
		PLATE:	A2
		PRO. #:	G0141800

LOG OF TEST PIT — TP-2

ELEVATION: **+/- 65 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **4/6/2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 8" Soft, dark brown, Organic Topsoil, wet				
1–2	●	*Soft, gray,* **Undocumented Fill Silt, Clay & Concrete/Gravels** *moist* (Fill)		16	-	
3–4	●	*Firm, brown,* **sandy Silt (ML)** *moist* (Native)		18	-	
5–7	●	Dense, brown gray **silty Sand (SM)** *fine-grained, moist* {Orange Mottling}		29	-	{Orange Mottling}
8–10						

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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

CLIENT:	Mr. Jesse Brand	DRAWN:	RN
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	4/13/2018
		PLATE:	A3
		PRO. #:	G0141800

LOG OF TEST PIT **TP-3**

ELEVATION: ***+/- 65 feet***
EXPLORATORY EQUIPMENT: ***TRACK HOE***
DATE: ***4/6/2018***

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 8" Soft, dark brown, Organic Topsoil, wet				
1–10	●	*Stiff, brown gray,* **silty Clay (CL)** *wet* *{Mottling}* *(Fill)*		30	-	

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	RN
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	4/13/2018
		PLATE:	A4
		PRO. #:	G0141800

LOG OF TEST PIT **TP-4**

ELEVATION: ***+/- 60 feet***
EXPLORATORY EQUIPMENT: ***TRACK HOE***
DATE: ***4/6/2018***

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 6" Soft, dark brown, Organic Topsoil, wet				
1–10	●	*Soft to firm, brown gray,* **silty Clay (CL)** *some sand, wet* *(Fill)*		25	-	*{Perched water}* *{Rock @ ~ 2.5 ft bgs}*

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	RN
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	4/13/2018
		PLATE:	A5
		PRO. #:	G0141800

LOG OF TEST PIT — TP-5

ELEVATION: **+/- 50 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **4/6/2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 2" Soft, dark brown, Organic Topsoil, wet				
1–10	●	*Soft to firm, brown,* **sandy Silt (ML)** *moist* (Fill)		22	-	

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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

CLIENT:	Mr. Jesse Brand	DRAWN:	RN
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	4/13/2018
		PLATE:	A6
		PRO. #:	G0141800

LOG OF TEST PIT — TP-6

ELEVATION: **+/- 60 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **4/6/2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 8" Soft, dark brown, Organic Topsoil, wet				
1						
2	●	Soft, light brown, **silty Clay (CL)** some sand, wet		31	-	{Rocks, gravel, cobbles, concrete @ ~2.5 ft. bgs}
3						
4	●			26	-	
5						
6						
7						
8						
9						
10		(Fill)				

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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

CLIENT:	Mr. Jesse Brand	DRAWN:	RN
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	4/13/2018
		PLATE:	A7
		PRO. #:	G0141800

LOG OF TEST PIT — TP-7

ELEVATION: **+/- 72 feet**
EXPLORATORY EQUIPMENT: **TRACK HOE**
DATE: **4/6/2018**

DEPTH IN FEET	SAMPLES	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
		~ 4" Soft, dark brown, Organic Topsoil, wet				
1	●	Loose, gray, **Undocumented Fill Silt, Clay & Gravels,** *moist*		11	12	
2	●	Soft to firm, brown, **sandy Silt (ML),** *moist* (Fill)		25	73	
3		Loose, brown gray, **silty Sand (SM)** *fine-grained, wet*				
4						
5						
6	●			37	38	
7						
8	●	Loose, gray, **clean Sand (SP)** *fine-grained, wet* (Native)		31	14	
9						
10						

Bottom of test pit at 10.0 feet below existing ground surface.
No groundwater or groundwater seepage encountered

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

CLIENT:	Mr. Jesse Brand	DRAWN:	RN
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	4/13/2018
		PLATE:	A8
		PRO. #:	G0141800

LOG OF BORING B-1

DRIVING WEIGHT: **140 lb / 30" drop**
ELEVATION: **~75 feet**
DRILLING EQUIPMENT: **TRACK MOUNTED RIG**
DATE: **2/26/2018**

DEPTH IN FEET	SAMPLES	BLOWS PER FOOT	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
1–4	X	9	*Loose, light brown,* **silty Sand (SM)** *fine-grained, wet*		35	44	
5–6	X	6			35	-	
7–9	X	5	*{Sand becomes coarser}*		34	32	
10–11	X	6			30	-	
12–14	X	11	*Med. dense, gray,* **silty Sand (SM)** *fine-grained, moist*		21	32	
15–16	X	11			23	-	
17–19							

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	B1-1
		PRO. #:	G0141800

LOG OF BORING B-1

DRIVING WEIGHT: **140 lb / 30" drop**
ELEVATION: **~75 feet**
DRILLING EQUIPMENT: **TRACK MOUNTED RIG**
DATE: **2/26/2018**

DEPTH IN FEET	SAMPLES	BLOWS PER FOOT	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
20–21	X	10	Med. dense, gray, **silty Sand (SM)** fine-grained, moist		22	42	
22			harder drilling				
23–26	X	20	Med. dense, gray, **silty Sand (SM)** med.-grained, moist		29	-	
27–29			harder drilling				
30–31	X	31	Dense, gray, **silty Sand (SM)** med.-grained, moist		18	-	
32–35							
36	X	29			19	36	
37–38							

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	B1-2
		PRO. #:	G0141800

LOG OF BORING **B-1**

DRIVING WEIGHT: ***140 lb / 30" drop***
ELEVATION: ***~75 feet***
DRILLING EQUIPMENT: ***TRACK MOUNTED RIG***
DATE: ***2/26/2018***

DEPTH IN FEET	SAMPLES	BLOWS PER FOOT	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
40							
41		30	*Dense, gray,* **silty Sand (SM)** *med.-grained, moist*		20	-	
42							
43							
44							
45							
46		40	*{Coarser}*		12	-	
47							
48							
49							
50							
51		42			26	48	

Bottom of boring @ 51.5 feet below existing ground surface.
No groundwater or groundwater seepage encountered.

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	3/19/2018
		PLATE:	B1-3
		PRO. #:	G0141800

LOG OF BORING B-2

DRIVING WEIGHT: **140 lb / 30" drop**
ELEVATION: **~55 feet**
DRILLING EQUIPMENT: **TRACK MOUNTED RIG**
DATE: **2/26/2018**

DEPTH IN FEET	SAMPLES	BLOWS PER FOOT	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
1–6	X	2	*Soft to firm, brown,* **silty Clay (CL)** *{trace sand, rock fragments}, moist to wet*		32	-	
	X	5			26	-	
7–10	X	3	*Very soft to firm, blue gray,* **silty Clay (CL)** *{trace sand}, moist*		26	-	
		6			24	-	*Dames & Moore sample collected at 9.0 feet* *Atterberg Limits: (LL-23 PL-14 PI-9)*
11–14	X	0			25	-	
15–16	X	5	*(Fill)*		28	-	
17–19			*Loose, light brown,* **silty Sand (SM)** *fine-grained, moist*				

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	B2-1
		PRO. #:	G0141800

LOG OF BORING B-2

DRIVING WEIGHT: **140 lb / 30" drop**
ELEVATION: **~55 feet**
DRILLING EQUIPMENT:
DATE: **2/26/2018**

DEPTH IN FEET	SAMPLES	BLOWS PER FOOT	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
20–21	X	4	Loose to med. dense, light brown, **silty Sand (SM)** fine-grained, moist to wet			35	-
22–24							
25–26		8				30	- Dames & Moore sample collected at 25.0 feet
27–28			harder drilling				
29–30							
31	X	19				25	-

Bottom of boring @ 31.5 feet below existing ground surface.
No groundwater or groundwater seepage encountered.

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	B2-2
		PRO. #:	G0141800

LOG OF BORING **B-3**

DRIVING WEIGHT: **140 lb / 30" drop**
ELEVATION: **~50 feet**
DRILLING EQUIPMENT: **TRACK MOUNTED RIG**
DATE: **2/26/2018**

DEPTH IN FEET	SAMPLES	BLOWS PER FOOT	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
1–4		7	*Firm, brown,* **silty Clay (CL)** *{trace sand}, moist*			25	-	*Dames & Moore sample collected at 2.5 feet* *Atterberg Limits: (LL-36 PL-21 PI-15)*
5–6		7	*Soft to firm, blue gray,* **silty Clay (CL)** *{trace sand and gravel}, moist to wet*			23	-	*{Orange mottling}*
7–9		6				25	-	
10–11		3				33	-	
12–13		4				29	-	
14–16		4				29	-	
17–19			*(Fill)*					

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	B3-1
		PRO. #:	G0141800

LOG OF BORING **B-3**

DRIVING WEIGHT: **140 lb / 30" drop**
ELEVATION: **~50 feet**
DRILLING EQUIPMENT:
DATE: **2/26/2018**

DEPTH IN FEET	SAMPLES	BLOWS PER FOOT	SOILS CLASSIFICATION	GRAPHIC LITHOLOGY (USGS)	MOISTURE CONTENT % OF DRY WEIGHT	PERCENT PASS NUMBER 200	NOTES
20–21	X	11	Stiff, blue gray, **silty Clay (CL)** {trace sand and gravel}, moist (Fill)		29	-	
22–24			Med. dense, light brown, **silty Sand (SM)** fine-grained, moist				
25–26	X	10			27	-	

Bottom of boring @ 26.5 feet below existing ground surface.
No groundwater or groundwater seepage encountered.

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	B3-2
		PRO. #:	G0141800

APPENDIX B

(LABORATORY TESTING)

LABORATORY TESTING

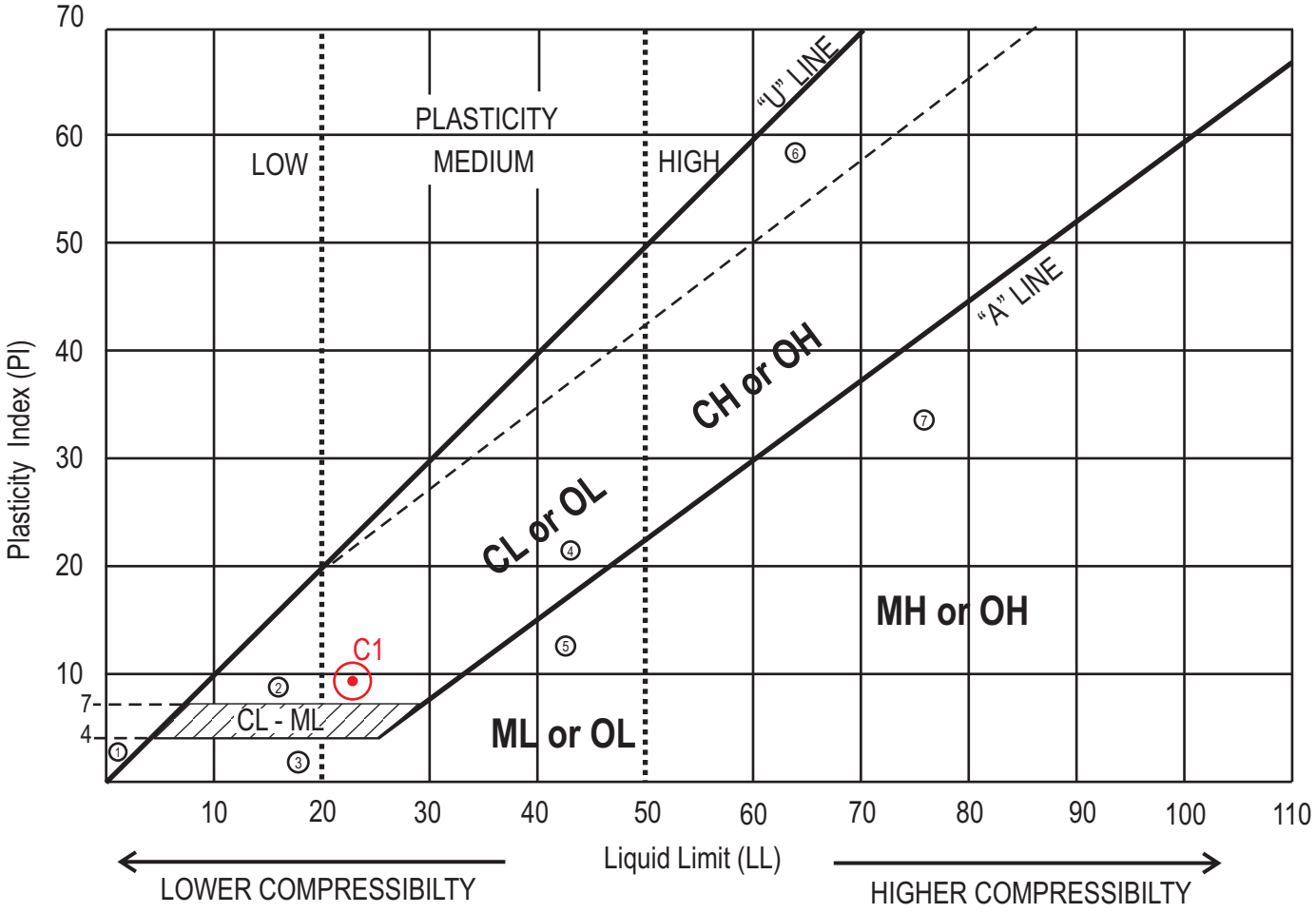
Laboratory tests were conducted on representative soil samples to verify or modify field soil classifications, and to evaluate the general physical properties and engineering characteristics of the soils encountered.

The following provides information about the testing procedures performed on representative soil samples:

- Moisture Content Tests (ASTM-D2216) were performed on representative samples.
- Atterberg Limits Testing (ASTM-D4318) was performed on two representative samples of undocumented fill materials to determine the "water-plasticity" ratio of in-situ soil. This test also provides an indication of relative soil strength as well as the potential for soil volume changes with variation in moisture content. Please refer to our Atterberg Limits Charts, Plates C1 & C2.
- In-Situ Soil Density (ASTM-D4564) by the sleeve method was performed on representative samples to determine the wet and dry density of native soil. The in-situ density provides a relative indication of soil support characteristics.
- Grain Size Analyses & Minus 200 Washes (ASTM-C136/C117) were performed on representative samples collected from the proposed infiltration zones.

The results of laboratory tests performed on specific samples are provided at the appropriate sample depth on the individual test pit logs. However, it is important to note that some variation of subsurface conditions may exist. Our geotechnical recommendations are based on our interpretation of these test results.

ATTERBERG LIMITS
(ASTM D4318)



Legend

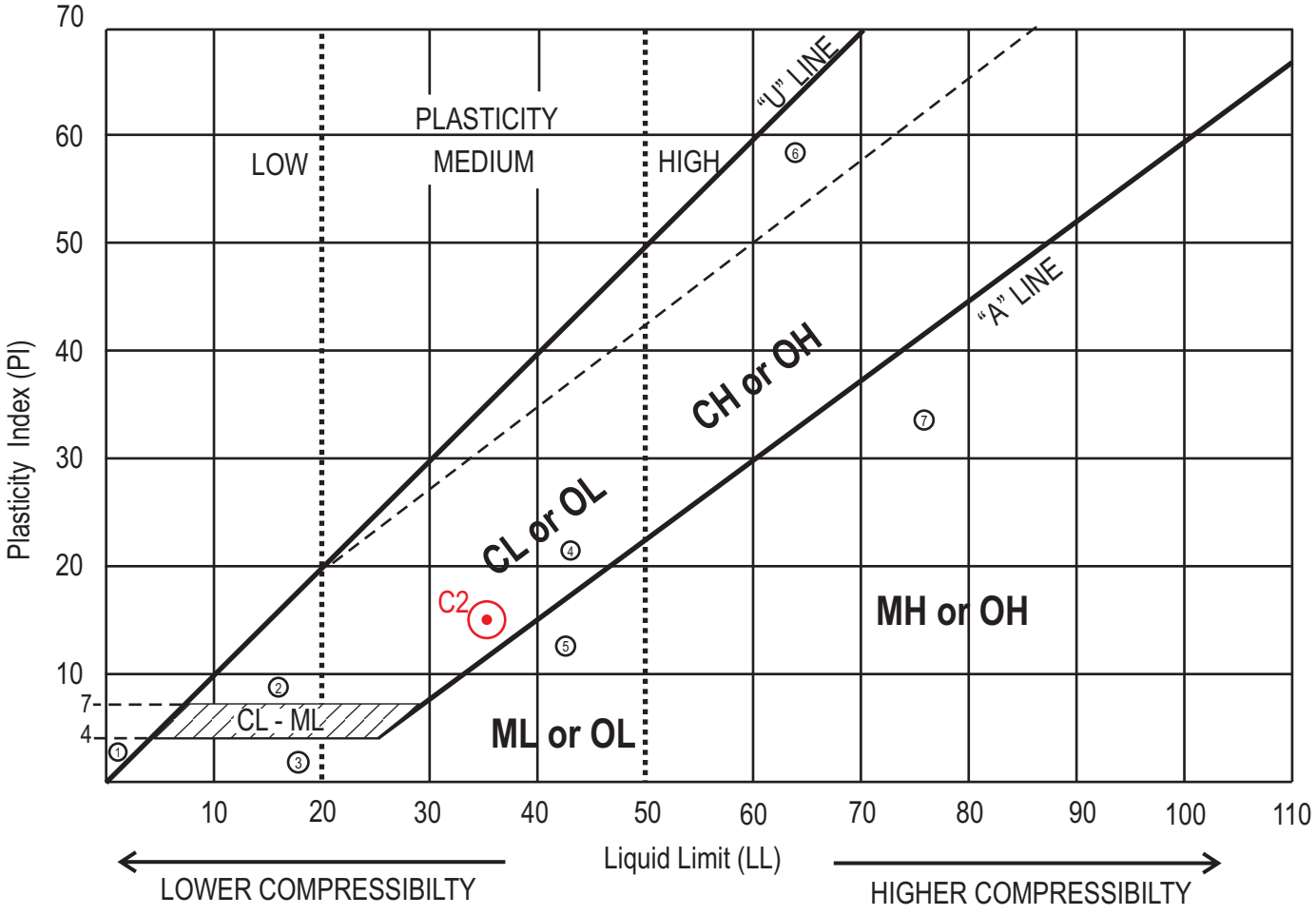
C1 — B2 at 9.0 feet - **silty Clay (CL)**
(LL-23 PL-14 PI-9)

1. COHESIONLESS SOILS
2. INORGANIC CLAYS, LOW PLASTICITY
3. INORGANIC SILTS, LOW COMPRESSIBILTY
4. INORGANIS CLAYS, MEDIUM PLASTICITY
5. INORGANIC SILTS AND ORGANIC CLAYS, MEDIUM COMPRESSIBILITY
6. INORGANIC CLAYS, HIGH PLASTISICTY
7. INORGANIC SILTS AND ORGANIC CLAYS, HIGH COMPRESSIBILTY

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	4/17/2018
		PLATE:	C1
		PRO. #:	G0141800

ATTERBERG LIMITS
(ASTM D4318)



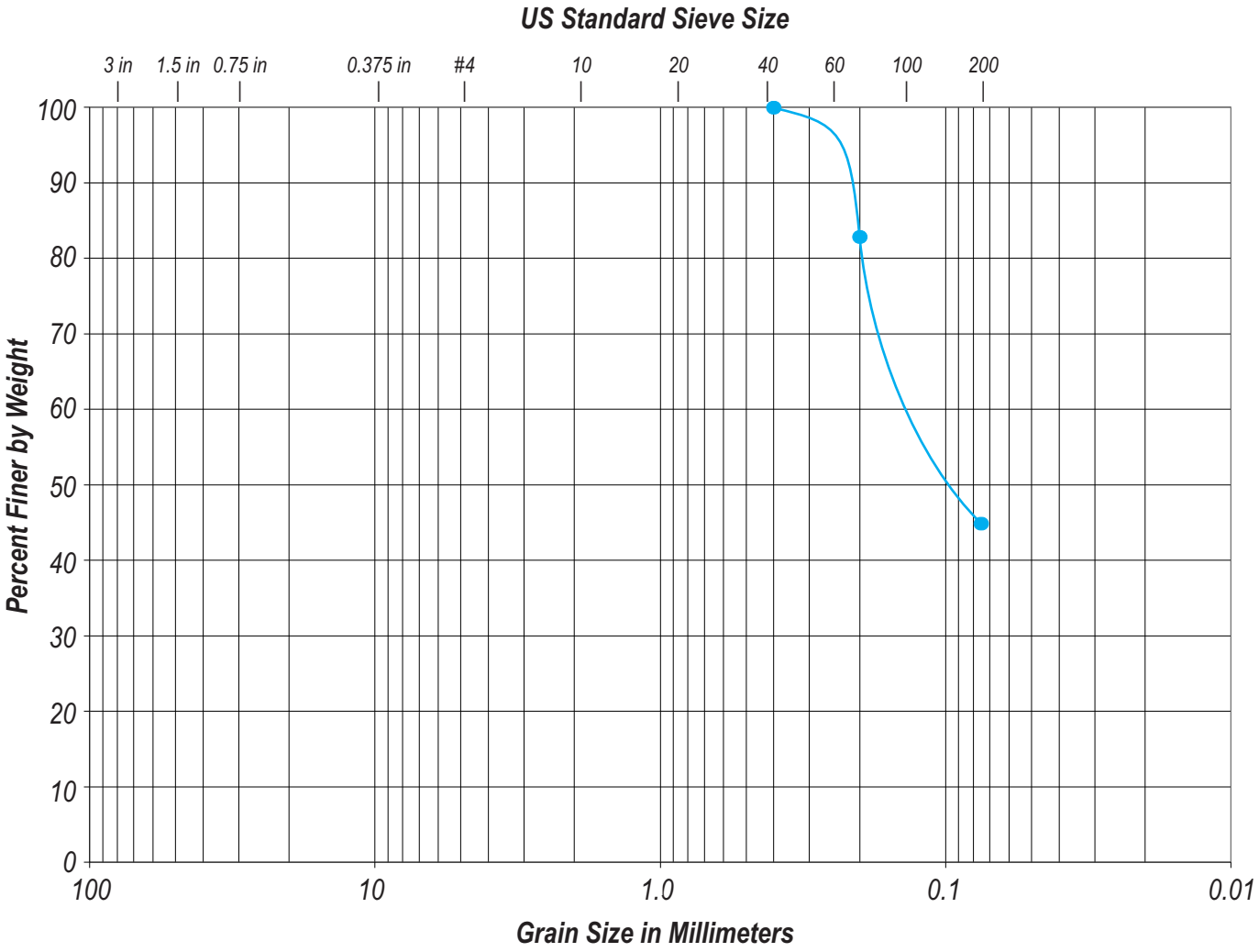
Legend

C2 — B3 at 2.5 feet - **silty Clay (CL)**
(LL-36 PL-21 PI-15)

1. COHESIONLESS SOILS
2. INORGANIC CLAYS, LOW PLASTICITY
3. INORGANIC SILTS, LOW COMPRESSIBILTY
4. INORGANIS CLAYS, MEDIUM PLASTICITY
5. INORGANIC SILTS AND ORGANIC CLAYS, MEDIUM COMPRESSIBILITY
6. INORGANIC CLAYS, HIGH PLASTISICTY
7. INORGANIC SILTS AND ORGANIC CLAYS, HIGH COMPRESSIBILTY

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

CLIENT:	Mr. Jesse Brand	*DRAWN:*	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	*DATE:*	4/17/2018
		PLATE:	C2
		PRO. #:	G0141800



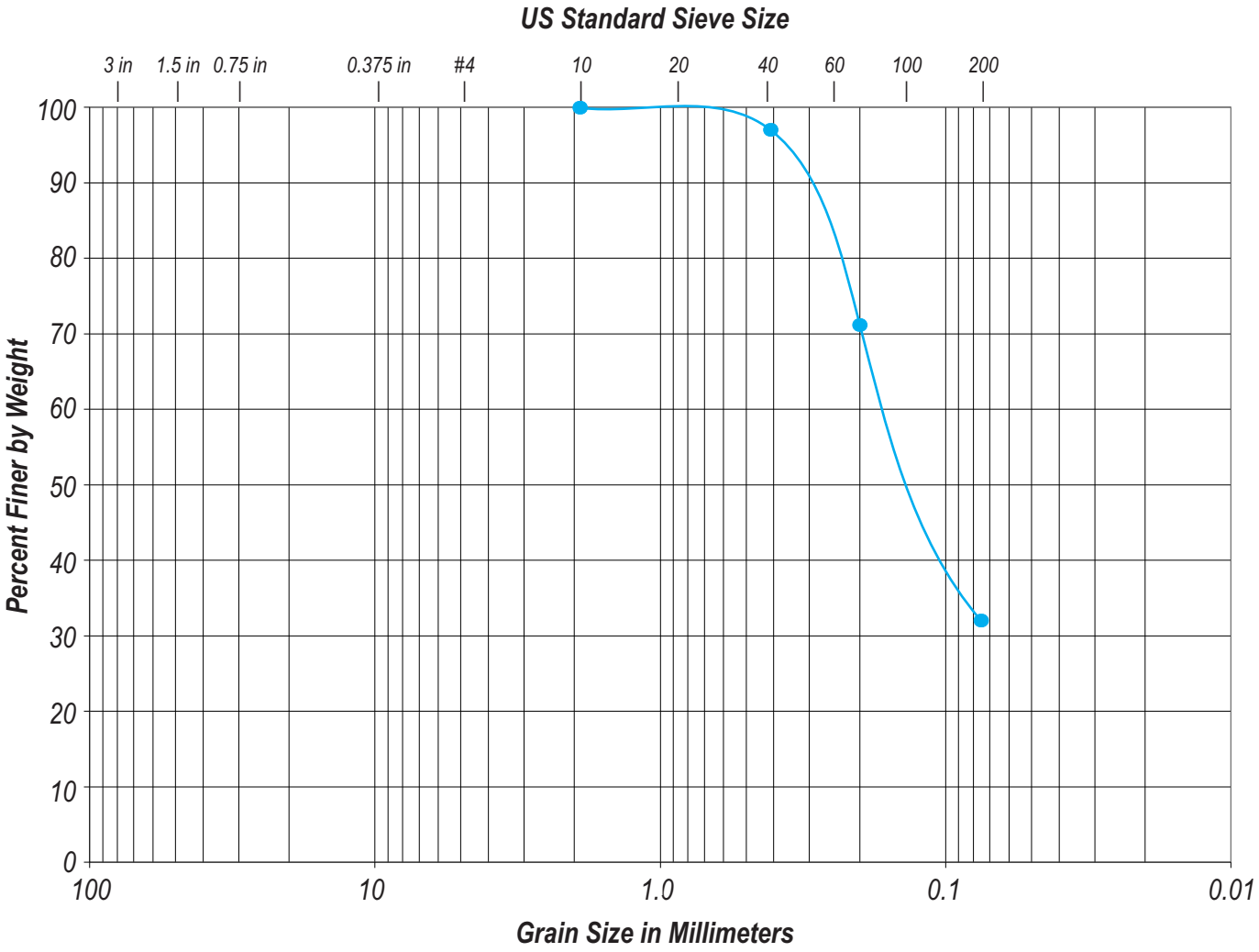
Gravel		Sand			Silt & Clay
Coarse	Fine	Coarse	Medium	Fine	---

GRAIN SIZE DISTRIBUTION

B-1 at 2.5 feet
Native fine silty Sand (SM)
with 44% passing the #200 Sieve

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	D1
		PRO. #:	G0141800



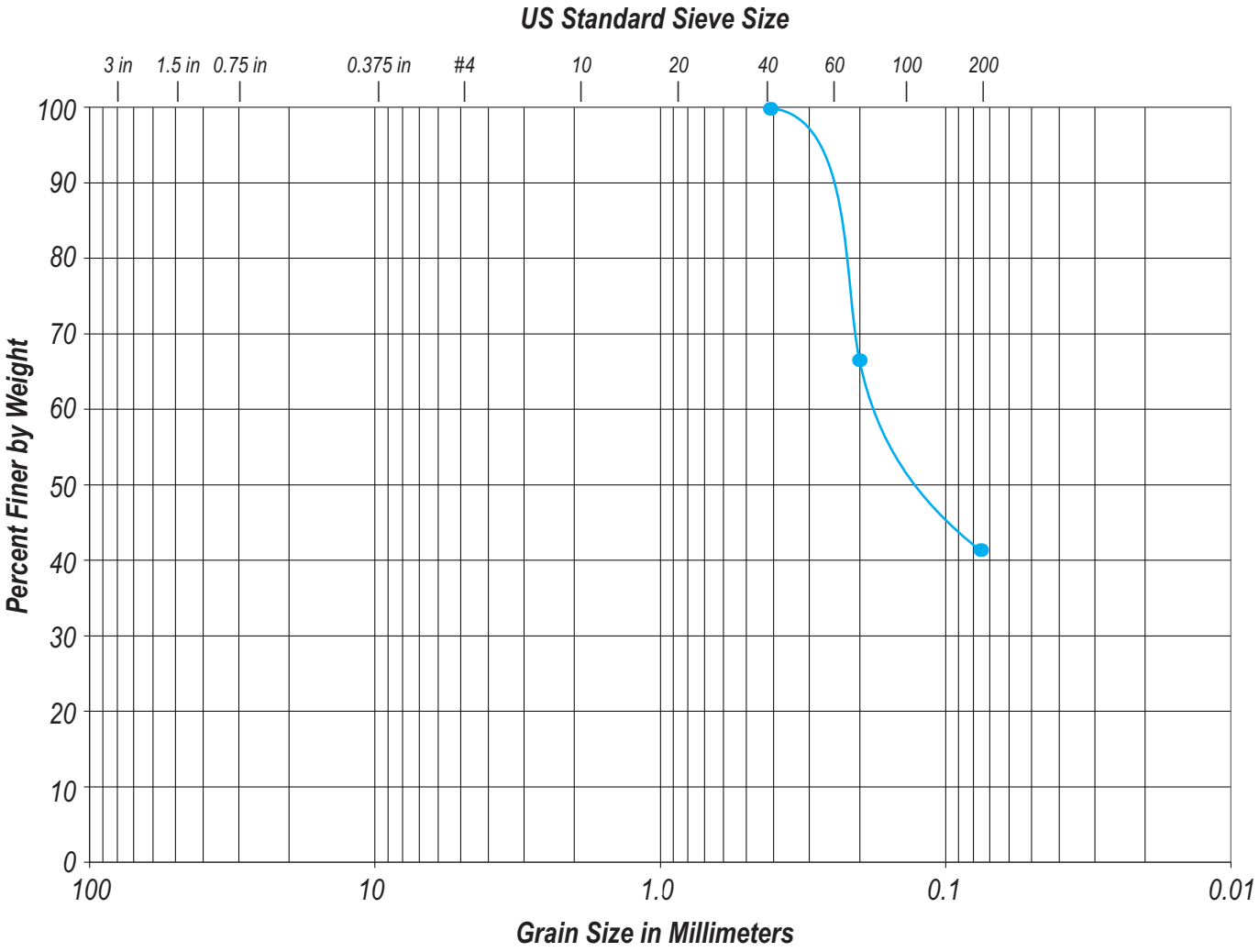
Gravel		Sand			Silt & Clay
Coarse	Fine	Coarse	Medium	Fine	---

GRAIN SIZE DISTRIBUTION

B-1 at 7.5 feet
Native fine silty Sand (SM)
with 32% passing the #200 Sieve

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	D2
		PRO. #:	G0141800



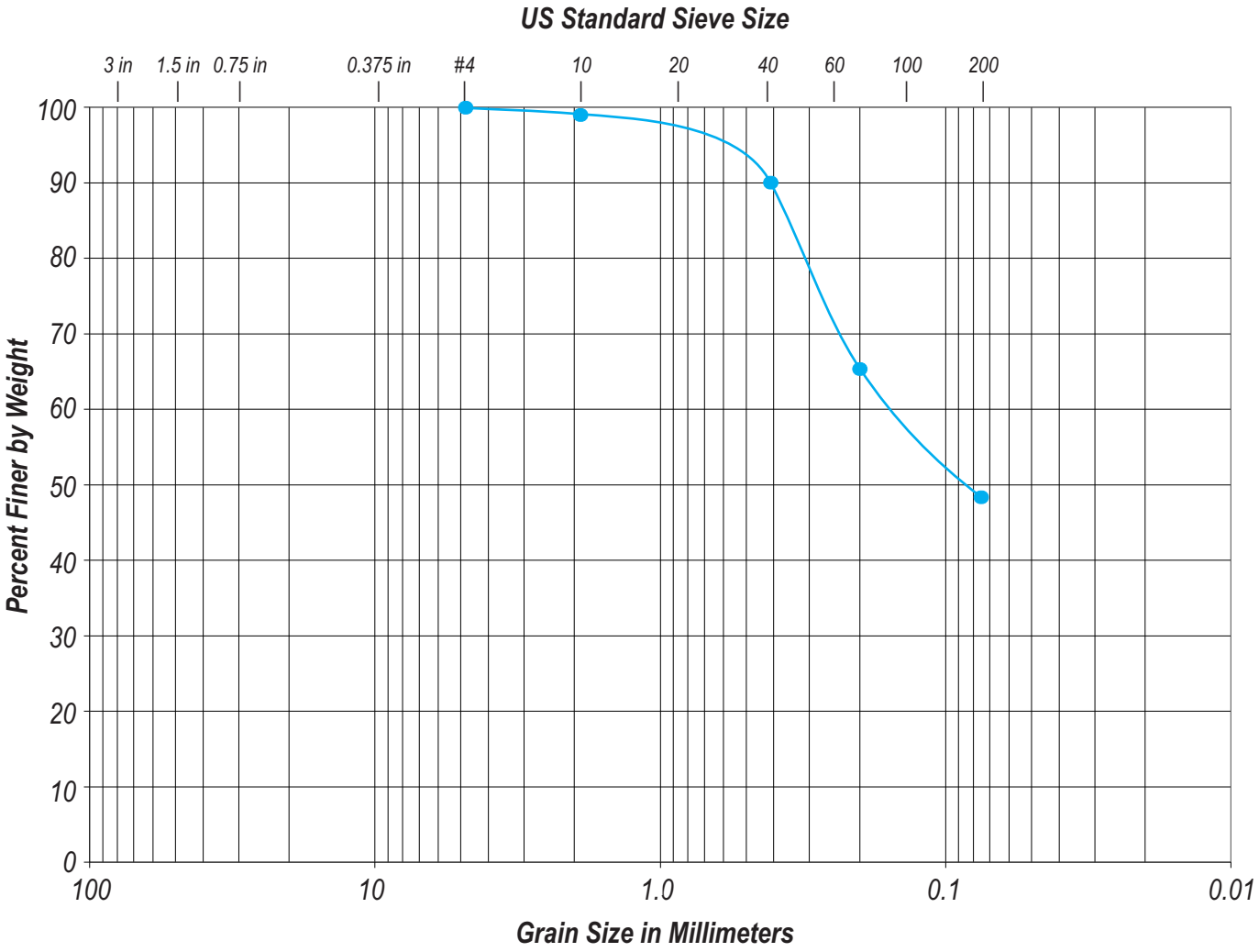
Gravel		Sand			Silt & Clay
Coarse	Fine	Coarse	Medium	Fine	---

GRAIN SIZE DISTRIBUTION

B-1 at 20 feet
Native fine silty Sand (SM)
with 42% passing the #200 Sieve

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	D3
		PRO. #:	G0141800



Gravel		Sand			Silt & Clay
Coarse	Fine	Coarse	Medium	Fine	---

GRAIN SIZE DISTRIBUTION

B-1 at 50 feet
Native fine silty Sand (SM)
with 48% passing the #200 Sieve

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

CLIENT:	Mr. Jesse Brand	DRAWN:	JR
PROJECT:	Huntington Ridge Apartments 906 Croy Road Kelso, WA 98626	DATE:	3/19/2018
		PLATE:	D4
		PRO. #:	G0141800

DISTRIBUTION

1 Copy

Mr. Jesse Brand
13203 SE 172nd Avenue
Happy Valley, OR 97086

Attention: Mr. Jesse Brand