Bull Run TREATMENT PROJECTS | Pipelines

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Pipelines Project Stormwater Report

Bull Run Filtration Pipelines Project

September 2022

Prepared by: Jacobs

In association with EMERIO ENGINEERING • SURVEYING • DESIGN and other firms

Exhibit A.77

Pipelines Stormwater Management Report

Bull Run Filtration Pipelines Project
Multnomah County, Oregon

Emerio Project Number: 0545-006

City of Portland Permit Numbers: TBD

I hereby certify that this Stormwater Management Report for this project has been prepared by me or under my supervision and meets minimum standards of the Multnomah County Design and Construction Manual (MCDCM) and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me.

This report was prepared in support of the City of Portland Water Bureau's Bull Run Filtration Pipelines Project land use applications in Multnomah County and reflects the current status of the project design, which is approximately 60% complete as of the date of this report. This design is subject to change and has been prepared for the specific purpose of addressing conformance of the project to the Multnomah County land use requirements as expressed in the Multnomah County Code.

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Submittal #	Date	Returned	Comments

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1.0 Introduction

1.1 Project Overview and Description

The water supply for the City of Portland includes two sources: the Bull Run Watershed and the Columbia South Shore Wellfield (CSSWF). In addition to the City of Portland, the Water Bureau provides potable water to 19 wholesale customers. The Bull Run Watershed, located east of Portland in the Mount Hood National Forest, is the primary source of water. The 102 square mile, protected watershed is managed by the U.S. Forest Service in cooperation with the Water Bureau. There are two dam structures within the watershed that create two surface water reservoirs with a combined storage capacity of 16.5 billion gallons. This water is transported from the lower dam near the headworks site to the Portland metro area via three large-diameter pipelines.

The Bull Run supply is currently an unfiltered water supply and has consistently met the filtration avoidance criteria under the Surface Water Treatment Rule for source water quality, watershed management, and disinfection. Prior to distribution, the supply is treated with free chlorine for primary disinfection, ammonia to form chloramines as a residual disinfectant, and sodium hydroxide for corrosion control. The Water Bureau supplements the Bull Run source as needed with groundwater withdrawn from the CSSWF. The CSSWF is primarily used as an emergency backup, typically during turbidity events in the Bull Run Watershed and for summer supply augmentation.

In August 2017, the Portland City Council voted to build the Bull Run Filtration Facility to meet the U.S. Environmental Protection Agency (EPA) treatment requirements for *cryptosporidium*. As a part of the proposed plan, new raw water pipelines will intersect the existing conduits from the Bull Run Watershed and redirect the flow to the new Filtration Facility. New finished water pipelines will then convey water from the Filtration Facility and reconnect to the existing conduits. The three conduits currently in operation are referred to as Conduit 2 (C2), Conduit 3 (C3), and Conduit 4 (C4) in order from oldest to newest. Following completion of the Filtration Pipelines Project, much of the approximately 20 miles of existing conduit system from the Bull Run Watershed to the three conduits that deliver drinking water to the Portland Metropolitan Area will remain in service, with approximately 2.7 linear miles of the existing conduits being replaced with the new raw and finished water pipelines and Filtration Facility.

The Filtration Pipelines Project consists of five primary elements of work:

1. Two raw water pipelines:
    a. Lusted Raw Water Pipeline North and South (LRWP North and LRWP South)
    b. Two raw water tunnels and shaft system
2. Two finished water pipelines from the Filtration Facility to the Finished Water Intertie:
    a. Altman Finished Water Pipeline (AFWP), and
    b. Lusted Finished Water Pipeline (LFWP)
3. One intertie, flow control, and metering facility (Finished Water Intertie);

   a. and three finished water pipelines from the Finished Water Intertie to the existing conduit connections:
      i. Conduit 2 Finished Water Pipeline (C2FWP)
      ii. Conduit 3 Finished Water Pipeline (C3FWP), and
      iii. Conduit 4 Finished Water Pipeline (C4FWP).
4. The AFWP and LFWP include a trenchless crossing from the Filtration Facility south of Carpenter Lane to Dodge Park Boulevard.
5. A new small-diameter water distribution pipeline from AFWP and LFWP in SE Dodge Park Boulevard at the intersection of SE Cottrell Road, primarily installed via trenchless construction. The northerly terminus of this new Lusted Road Distribution Main connects to the existing SE Lusted Road Distribution Main located east of Lusted Hill Treatment Facility.

The purpose of this report is to evaluate the existing and proposed stormwater conditions along the length of the Filtration Pipelines Project limits. The report includes an analysis and discussion on the following:

- Existing conditions of the Project Area, including environmentally sensitive areas meeting the jurisdiction stormwater requirements (Multnomah County)
- Proposed stormwater quality treatment
- Analysis of offsite runoff conditions
- Additional regulatory triggers

A separate stormwater report addresses the individual site of the Finished Water Intertie, located on the Finished Water Pipeline alignment at SE Lusted Road east of SE Altman Road.

1.2 Project Location

See Appendix A for the Vicinity Map of the project limits. The project comprises a corridor of multiple parallel pipelines travelling a distance of 2.7 miles from end to end through right-of-way (ROW) and easement on private property within unincorporated Multnomah County. The project pipeline corridors are generally described by the following Segment Routes for the purpose of this report:

1. Project beginning on SE Lusted Road approximately one-half mile north of the intersection at SE Dodge Park Boulevard, connecting at existing pipelines in the SE Lusted Road ROW, then travelling westward through easements on private property, then;

2. Ending at the southeast corner of the new Filtration Facility (under separate contract), at which point the continued pipeline is continued under separate contract, then:

3. Beginning again at the northwest corner of the new Filtration Facility (under separate contract) and travelling northbound to SE Dodge Park Boulevard, then;

4. Travelling west within the SE Dodge Park Boulevard ROW, turning north at a point approximately 0.6 miles west of the intersection at SE Cottrell Road and continuing northward in easements on private property, then;

5. Turning at SE Lusted Road, travelling westward in the ROW of SE Lusted Road to the intersection at SE Altman Road, then;

6. Turning north at SE Altman Road, travelling north in the ROW of SE Altman Road to SE Oxbow Road.

Three connections to existing pipelines are made at the end of the project, one each at the intersections of:

- SE Lusted Road at SE Altman Road
- SE Altman Road at SE Pipeline Road
- SE Altman Road at SE Oxbow Drive

As referenced in this report, the limits of the project are the widths of corresponding ROW or the widths of easements on private property which comprise the corridor of the proposed pipelines.

1.3 Description of Existing Conditions

1.3.1 Drainage Basins

The project is located within the Beaver Creek-Sandy River Watershed. The pipeline corridors cross multiple drainage basins which discharge to separate reaches along Beaver Creek or lowland areas. The pipelines are primarily proposed within the roadway section, which is a crowned section. Drainage basins were delineated as the ultimate drainage basin to each waterbody, as opposed to only the proposed linear segment of pipeline.

A drainage basin map is shown in Appendix A Figure 2, with Table 1-1 showing the size of each drainage basin and its discharge location.

Table 1-1. Drainage Basin Area Summary		
Drainage Basin	**Area (Acres)**	**Discharge Location**
A	35.62	Middle Fork Beaver Creek (West of Altman Road)
B	17.83	Glendale Pond
C	67.16	Middle Fork Beaver Creek (West of Altman Road)
D	39.88	Sester Reservoir #1
E	32.53	Middle Fork Beaver Creek (West of Altman Road)
F	110.94	Surveyed Wetlands
G	65.80	North Fork Beaver Creek
H	57.13	North Fork Beaver Creek
I	68.40	North Fork Beaver Creek
J	11.68	Lusted Creek
K	10.66	Johnson Creek Tributary
L	90.26	Surveyed Wetlands
Total	**572.27**	**Beaver Creek-Sandy River Basin**

1.3.2 Existing Soil Characteristics

The project limits span multiple soil types identified by the National Resource Conservation Service (NRCS) Web Soil Maps:

- SE Altman Road:
  - Cornelius Silt Loam, 8 to 15 percent slopes.
  - Powell silt loam, 0 to 3 percent slopes, 3 to 8 percent slopes, 15 to 30 percent slopes.
  - Wollent silt loam.
- SE Lusted Road (Finished Water Pipelines scope)
  - Cornelius Silt Loam, 8 to 15 percent slopes.
  - Powell silt loam, 0 to 3 percent slopes, 3 to 8 percent slopes.
  - Wollent silt loam.
- Easement through Private Property (Finished Water Pipelines scope, between Dodge Park Blvd. and Lusted Rd.)
  - Cornelius Silt Loam, 8 to 15 percent slopes.
  - Mershon Silt Loam, 0 to 8 percent slopes, 8 to 15 percent slopes, 15 to 30 percent slopes.
  - Wollent silt loam.
- SE Dodge Park Blvd:
  - Cazadero Silty Clay Loam, 0 to 8 percent slopes, 8 to 15 percent slopes.

- Mershon Silt Loam, 0 to 8 percent slopes, 8 to 15 percent slopes, 15 to 30 percent slopes.
- Wollent silt loam, 0 to 8 percent slopes.

- Easement through Private Property (Raw Water Pipelines scope, west of SE Lusted Rd.)
  - Cazadero Silty Clay Loam, 0 to 8 percent slopes.
- SE Lusted Rd. (Raw Water Pipelines scope)
  - Cazadero Silty Clay Loam, 0 to 8 percent slopes.

The origin of all these soil types is from a mixed alluvium that has glacial silt and clay with small particle size. These soils have the following K_{sat} values (referring to the soils permeability to transmit water when saturated) and Hydrologic Soil Group (Rated A, B, C, D with A as highest permeability to D as lowest):

- Cornelius Silt Loam, K_{sat} of 0.64 inches per hour, Hydrologic Soil Group C.
- Powell silt loam, K_{sat} of 1.6 inched per hour, Hydrologic Soil Group D.
- Wollent silt loam, K_{sat} of 0.42 inches per hour, Hydrologic Soil Group C/D.
- Mershon Silt Loam, K_{sat} of 0.48 inches per hour, Hydrologic Soil Group C.
- Cazadero Silty Clay Loam, K_{sat} of 0.50 inches per hour, Hydrologic Soil Group C.

See Appendix C for NRCS Web Soil Survey Maps and more information.

Based on the Geotechnical Engineering Report, "Filtration Pipelines Project – Finished Water Pipeline" dated February 2022 by Jacobs Engineering Group, the soil investigations at soil boring logs along the pipeline alignments are consistent with the silty clay loam characteristics as noted in the NRCS Web Soil Maps. Infiltration testing was not performed at any locations along the pipeline alignment outside of the Filtration Facility site during investigations.

1.3.3 Environmentally Sensitive Areas

Wetlands

There are no County-mapped wetlands along the pipeline corridor. Potential wetland areas were identified by Winterbrook Planning during site observations, and overlay zones were applied to those areas along the pipeline corridors to minimize any impact. All County designated Significant Environmental Concern (SEC) areas and potential wetland areas are shown in Appendix B in the Stormwater Drawings, and will not be impacted by the pipeline project.

Waterbodies

Portions of the project limits drain to segments of North Fork Beaver Creek and Middle Fork Beaver Creek, specifically near the Bissel and Oxbow/Altman segments. Based on Oregon's Department of Fish and Wildlife (ODFW) Web Map, these segments are not considered fish

bearing streams or tributaries based on ODFW identified segments, however, extra precaution such as stormwater treatment Best Management Practices (BMPs) will be used upstream of these areas. See Appendix C for Fish Habitat Distribution and Barriers near the Project.

Floodplains

The project does not intersect any areas mapped within the Federal Emergency Management Areas (FEMA) mapped floodways for the 100-year flood, according to FEMA FIRMette Panel 41051C0427J, effective 2/1/2019.

1.4 Offsite Drainage Analysis

Offsite mixed agricultural and rural residential land drains into the ROW for most of the project limits. The ROW impacted by the proposed pipeline construction are primarily two-lane roadways with crowned prism sections where offsite drainage is currently collected or conveyed by the roadway ditch to culverts which cross the roadways.

There are existing culverts (hydraulic crossings) that connect these offsite drainage basins in the project area and have been reviewed for capacity of the 25-year storm in Section 3.1. Table 1-2 shows the existing hydraulic crossing drainage areas sizes, and Appendix A Figure 3 shows the drainage basin locations associated with the respective hydraulic crossings. Additional survey is being performed to identify existing crossings with unknown design parameters at this phase of the project design.

Table 1-2: Hydraulic Crossing Drainage Areas Summary

Hydraulic Crossing ID	Culvert Size and Type	Drainage Area (acres)
DA 1	12-inch Reinforced Concrete Pipe	28.29`
DA 2	18-inch Corrugated Plastic Pipe	33.11
DA 3	24-inch Corrugated Plastic Pipe	90.27
DA 4	72-inch concrete box culvert	12.82
DA 5	Unknown	24.37

1.5 Proposed Improvements

The project proposes the installation of over 30,000 linear feet of new large-diameter welded steel pipeline which conveys both unfiltered (raw) and filtered (finished) water to and from the proposed drinking water Filtration Facility. Construction of these large-diameter pipelines requires significant trench width in public ROW and, subsequently, reconstruction of existing roadways over the pipeline corridor. Existing culverts (hydraulics crossings) which convey stormwater across the ROW impacted by this project will be replaced to existing line and grade. Verification of hydraulic capacity of those existing crossings is included in Section 3 and Appendices.

1.6 Agency Stormwater Criteria and Permitting

Multnomah County is the governing agency for stormwater requirements within the pipeline project limits. With two exceptions, the project limits for pipeline construction are to be restored to pre-construction conditions. The first exception is the Finished Water Intertie site, addressed under a separate report cover, which will be improved with permanent stormwater facilities, pavement, a new electrical building, and a large, buried vault. The second exception is the improvement of existing dirt/gravel farm roads with new gravel roads with unchanged surface characteristics, which is not expected to change the runoff coefficient from the existing condition. The existing dirt/gravel farm roads are compacted, and will be improved with gravel with the same drainage direction. Otherwise, easements on private property are to be restored with in-situ topsoil and seeding, unpaved areas within ROW are to be restored to original line and grade and seeded with native grasses, and roadway pavement in ROW is to be repaved matching original line and grade. Though all new paved roadway is replacement of existing roadway, the project replaces over 500 square feet of impervious surface, and therefore stormwater flow control and stormwater quality treatment are required per Multnomah County Code (MCC) Section 39.6235, which states,

> *"(A) Persons creating new or replacing existing impervious surfaces exceeding 500 square feet shall install a stormwater drainage system as provided in this section…*
>
> *(C)The provisions of this section are in addition to and not in lieu of stormwater and drainage requirements in the Multnomah County Road Rules and Design and Construction Manual, including those requirements relating to impervious surfaces and proposals to discharge stormwater onto a county ROW.*
>
> *(D) The stormwater drainage system required in subsection (A) shall be designed to ensure that the rate of runoff for the 10-year 24- hour storm event is no greater than that which existed prior to development at the property line or point of discharge into a water body."*

The stormwater facilities shall be designed in accordance with Section 5 Drainage of the Multnomah County Design and Construction Manual (MCDCM). In the MCDCM Section 5.1.2, there is a contradictory statement to the MCC regarding flow control.

"Flow control and volume storage shall be analyzed for the 2, 5, 10, and 25 year storm events for the pre-development discharges, and the post development discharges. The post-developed discharge flow rate shall be controlled to the pre-development levels. In addition, initial discharge flow rate shall be controlled to one half the 2 year flow rate before any development."

The contradiction between the 10-year and 25-year storm in Multnomah's Code and the MCDCM is related to MCDCM's reference of the City of Portland's Stormwater Management Manual (SWMM), where the City of Portland uses urbanized stormwater practices, which have more stringent requirements and maintenance. Since this project is in rural Multnomah County and has similar project characteristics to a linear transportation project, the Oregon Department of Transportation (ODOT) Hydraulics Manual is proposed for drainage design guidance, which prioritizes dispersion as a stormwater BMP sized for water quality and the 10-year storm event.

In addition to stormwater requirements, the following regulatory district areas were considered that have stormwater impact requirements and may require additional permitting for this project:

- Oregon Department of Environmental Quality (DEQ)
    - 1200-C Construction Stormwater Permit
        - Per Oregon Department of Environmental Quality (DEQ), construction of the proposed pipelines will cumulatively disturb greater than one acre and will require a 1200-C Construction Stormwater Permit.
- Oregon Department of State Lands (DSL)
    - Joint Permit Application
        - Provide 50-foot buffers around all wetlands.

2.0 Methodology

To meet the Multnomah County Stormwater requirements, this project report follows the guidance of the ODOT stormwater requirements, which requires analysis and discussion of the infiltration and discharge hierarchy, along with the selection of Best Management Practices (BMP) for stormwater management.

2.1 BMP Selection

ODOT has an established hierarchy of stormwater treatment approaches and techniques that supports water quality goals and flow control. Per Section 14.9.1 in BMP Selection Prioritization of the Hydraulic Manual, the preference for stormwater treatment is to disperse treatment along the length of the project, using characteristics of the ROW to provide treatment. A

requirement to manage runoff for water quality does not mean that a treatment facility needs to be constructed—often the properties of the ROW provide excellent stormwater treatment without minimal enhancement.

ODOT's BMP Hierarchy has the following preference levels:

1. Use of the adjacent unaltered ROW as a treatment filter strip
2. Modification of the ROW (slopes, soils and/or vegetation) to provide treatment
3. Use of small, distributed treatment facilities along the length of the project
4. Use of large, consolidated treatment facilities.

This project will use preference levels 1 and 2 with the use of unaltered ROW as a treatment filter strip and modifications to the ROW to provide treatment as the appropriate BMPs for the linear characteristics of this project. Preference levels 3 and 4 are not considered as the underlying soils are not suitable for infiltration facilities, with a K_{sat} of less than 2 inches per hour.

2.1.1 Stormwater Quality Treatment

To meet the stormwater requirements for both stormwater quality treatment and flow control, the project proposes to use dispersion through native vegetation and enhancing the existing roadside shoulders with seeded vegetation and amended soils, referred to as Filter Strips in this report. The project discharges to environmentally sensitive areas, and per MCDCM Section 5.1.3 for water quality design standards,

> *"The quality of stormwater entering or leaving the ROW after a project shall be equal to or better than the quality of stormwater entering or leaving the ROW before the project."*

Stormwater runoff shall be treated to remove 70% of TSS for the water quality design storm per Multnomah County, which is based on a depth of 1.81 inches using the ODOT water quality region design factor 67% of the 2-year 24-hour design storm with, based on ODOT TransGIS isopluvial maps.

The proposed improvements requiring stormwater quality treatment are the replaced roadways, and the project proposes to use Filter Strips adjacent to the roadways. The ODOT dispersion requirements for stormwater quality treatment closely align with the BMP practices for rural Multnomah County, especially for linear projects. Dispersion is the preferred practice for treatment per Chapter 14 of the ODOT Hydraulics Manual,

> *"The preference for stormwater treatment approaches is to disperse treatment along the length of the project, using the characteristics of the right of way to provide treatment, using consolidated facilities only when that is not possible."*

Filter strips are a common and preferred BMP for ODOT for stormwater quality treatment and provide treatment through filtration and hydrologic attenuation through vegetated flow paths

through sheet flow. Filter strips are also easily maintained, affordable and accessible when compared to other BMPs. An operation and maintenance checklist has been established for the dispersion practices utilizing the ODOT Hydraulics Manual Sections 14.10.15, 14.11, as well as Chapter 4.

In addition to the water quality rates and TSS removal requirements, discharge from the project area eventually enters the waters of Beaver Creek-Sandy River Watershed. Per the Oregon 2018/2020 Integrated Report and the 2018/2020 Water Quality Report and List of Water Quality Limited Waters, dated April 2020 Beaver Creek has a TMDL and 303(d) listed.

Impairments:

- Bacteria
- Dissolved Oxygen
- Temperature
- DDT 4, 4'; DDD4, 4'; DDE 4,4'
- Dieldrin
- Heptachlor Epoxide

Amended soil and dispersion BMPs facilitate removal of the listed impairments through biofiltration of the amended soil and vegetation.

2.1.2 Stormwater Flow Control

As discussed in Section 1.6, this project shall provide flow control up to the 10-year storm per MCC Section 39.6235. Appropriately sized dispersion is considered to serve as a management technique for both water quality and flow control and is a recommended post-construction stormwater BMP. Filter strips will be designed per the ODOT Hydraulics Manual in order to meet flow control and water quality standards for Multnomah County. Since dispersion through filter strips can be used for both flow control and water quality, hydrologic modeling for flow control was not performed for each drainage basin as the existing and proposed condition does not change.

3.0 Analysis

3.1 Proposed Stormwater Flow Control and Water Quality

This project utilizes dispersion BMPs such as vegetated filter strips, native vegetation and seeding with soil amendment to manage the stormwater runoff from roadways by allowing stormwater to sheet flow across the shoulders and disperse into the vegetated areas located within the ROW.

Based on guidance from Chapter 14 Appendix B, Section 3.1in the ODOT Hydraulics Manual, filter strips for this project shall have the following criteria:

- The flow width of the filter strip must be equal to or greater than 5 feet

- The length of filter strips placed parallel to the road must be equal to the length of the contributing impervious or pavement area
- The lateral or cross-section of the filter strip must be equal to or greater than 1 percent and to not exceed 15 percent. The native existing slope is adequate if flow length exceeds
- The contributing impervious drainage area to filter strip shall have the following corresponding widths:
    - 2% sloped filter strip to treat 4 feet of pavement for every 1 foot of filter strip
    - 5% sloped filter strip to treat 3 feet of pavement for every 1 foot of filter strip
    - 10% sloped filter strip to treat 2 feet of pavement for every 1 foot of filter strip
    - 15% sloped filter strip to treat 1.5 feet of pavement for every 1 foot of filter strip

In addition to the filter strip geometry, all Filter Strips and impacted vegetation by the project shall be improved with amended soil. The native soil shall be amended with at least 3 inches of yard-debris compost and mixed to a depth of 12 inches before planting. The proposed dispersion areas and filter strip widths are shown in the Stormwater Drawings in Appendix B with the entire ROW proposed for soil amendment and seeding.

A key difference in the filter strips proposed for this project and the standard ODOT filter strip design criteria is that there is no 8-foot aggregate shoulder prior to discharging to the vegetated filter strip. The ODOT filter strip is intended for wider roadways and highways and needs larger shoulders for traffic-related design. The filter strip for this project starts at the existing aggregate roadway edge based on the standard local roadway cross-section in Multnomah County.

4.0 Engineering Conclusions

4.1 Dispersion Analysis

There are segments in which the ROW does not allow for the minimum dispersion widths to be met under the performance approach and general ODOT sizing guidance, for the following various reasons: limited ROW width; grade changes with an existing ditch; slopes steeper than 15% ; impacts to wetland buffers. However, along the entirety of the project, existing soil within the ROW will be amended and seeded with the appropriate seedings per soil and land use type along the ROW, as shown on the drawings in Appendix B. Some areas are shown as undisturbed as those areas are already heavily vegetated with native plantings or within a SEC buffer. Parts of Segment Route 6 as described in Section 1.2 in this report does not meet the ODOT Filter Strip criteria, but does provide some water quality and flow control benefit post-construction based on Multnomah County criteria:

- **SE Altman Road (West Side):** The roadside is steeper than 15% and ROW width only allows for 8 feet past road edge. Beyond the ROW line is agricultural crop land with native vegetation buffer between road and cropland. The contributing impervious

drainage of 12 feet of width does not increase flows from the existing condition, and the 8 feet of vegetation within the ROW will be improved with amended soil and seeding—which improves the existing compacted earthen shoulder. This is an improvement from the existing condition and meets the water quality enhancement criteria per Multnomah County.

- **SE Altman Road to SE Oxbow Drive Connection and Intersection:** This segment is an existing steep road grade (greater than 10%), with heavily vegetated ditches and trees on either side of the road. The proposed BMP here is to protect the native vegetation in place (in the SEC zone), as it is already providing a water quality benefit for the roadway prior to discharging to Beaver Creek.

4.2 Hydraulic Crossings

Multnomah County Design and Construction Manual Section 5 requires that all culverts and pipes,

> *"pipes shall be designed to the 25-year storm, full build out of the ROW, and all natural runoff that drains into the ROW. If area of concern has been studied for stormwater planning, the pipe shall be designed so as to accommodate the stormwater plan flows. "*

Culverts identified as impacted by this project need to meet the 25-year conveyance capacity. For this project, the 25-year 24-hour storm event depth is 3.8 inches, based on a Portland-modified NRCS 24-hour Type 1A rainfall distribution. The 25-year peak discharge for each hydraulic crossing was calculated using Santa Barbara Unit Hydrology (SBUH) method. The HY-8 Culvert Analysis Program was used to determine the minimum culvert size for each crossing to convey the 25-year peak discharge. Table 4-1 shows the proposed minimum size required to carry the 25-year storm or if the existing size is adequate. Based on the calculations, the project proposes to replace at least one culvert (DA-1) for a larger hydraulic opening. See Hydraulic Crossing Drainage Areas in Appendix D for calculations.

Table 4-1. Hydraulic Crossing Minimum Pipe Size

Hydraulic Crossing ID	25-year peak discharge(cfs)	Existing Culvert Size and Type	Proposed Minimum Culvert Size
DA 1	7.67	12-inch Reinforced Concrete Pipe	18-inch Corrugated Plastic Pipe
DA 2	11.13	18-inch Corrugated Plastic Pipe	Maintain hydraulic opening of the 18-inch Corrugated Plastic Pipe
DA 3	20.86	24-inch Corrugated Plastic Pipe	Maintain hydraulic opening of 24-inch Corrugated Plastic Pipe
DA 4	4.64	72-inch concrete box culvert	Maintain Existing 72-inch concrete box culvert

DA 5	7.86	Unknown	18-inch Corrugated Plastic Pipe

4.3 Conclusion

The proposed stormwater approach to the project meets the Multnomah County requirements for flow control and stormwater water quality treatment for the replaced impervious surfaces within the ROW. For each drainage basin, the dispersion provided by restored ROW unpaved area acting as vegetated filter strips matches or reduces the flow rates from existing conditions and provides water quality treatment prior to the runoff entering the downstream water body.

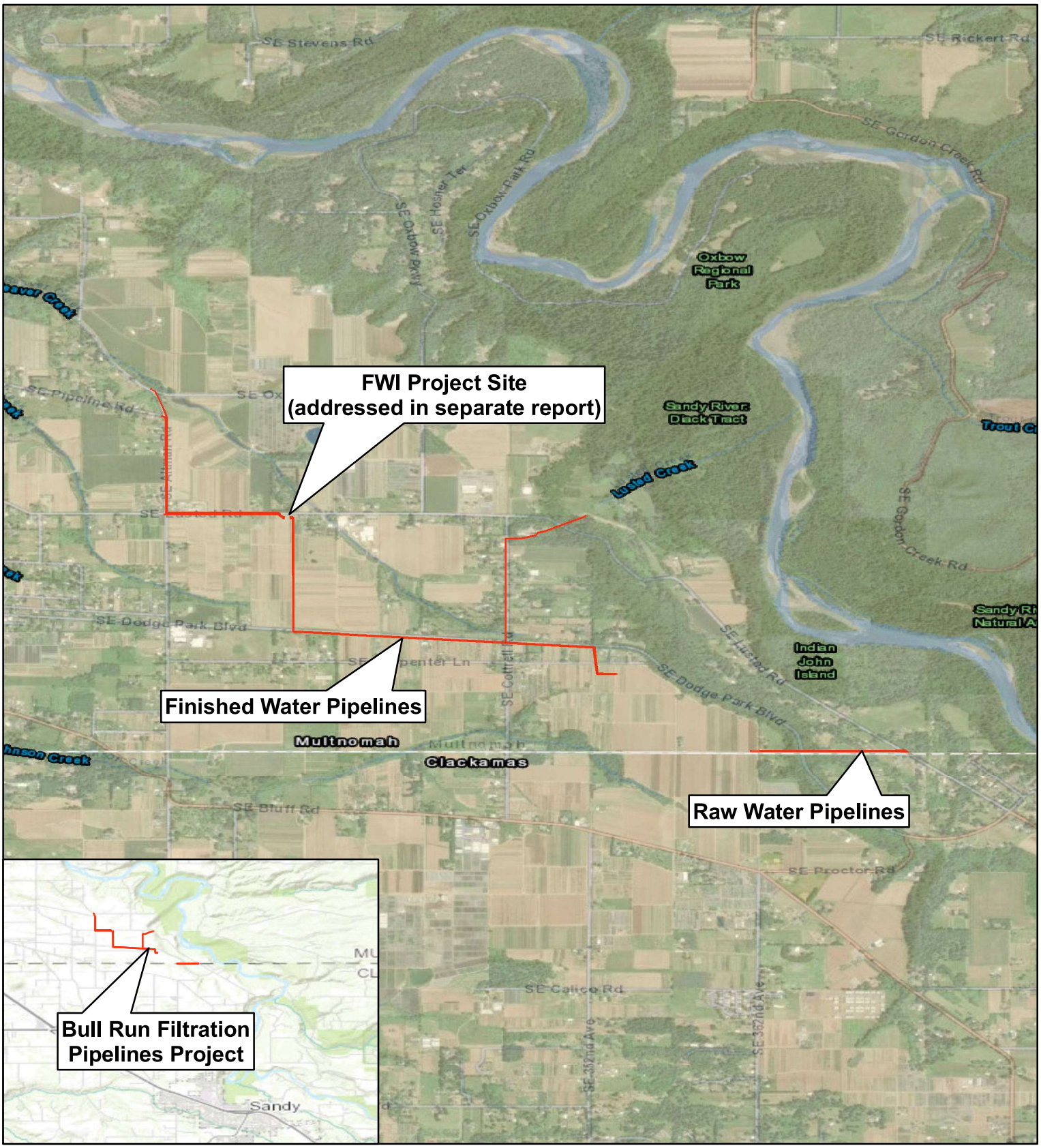
5.0 Operations & Maintenance

Multnomah County shall maintain all facilities within the ROW. Portland Water Bureau shall maintain all facilities on private property or easements. A copy of the City of Portland maintenance procedures listed in the SWMM will be used for the vegetated filter strips for this project, see Appendix E for City of Portland Operations & Maintenance procedures with Maintenance Log for the vegetated filter strips and maintenance components.

Appendix A: Figures

Figure 1: Project Vicinity Map
Figure 2: Drainage Basins Map
Figure 2: Hydraulic Crossing Drainage Areas Map

Exhibit A.77.a



Legend

Pipeline Project Area Extents

Note:
1. Aerial imagery source: ESRI, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, AeroGRID, IGN, and the GIS User Community

0 0.25 0.5 1 Miles

N

Appendix A - Figure 1
Vicinity Map

Bull Run Pipeline Project

Multnomah County

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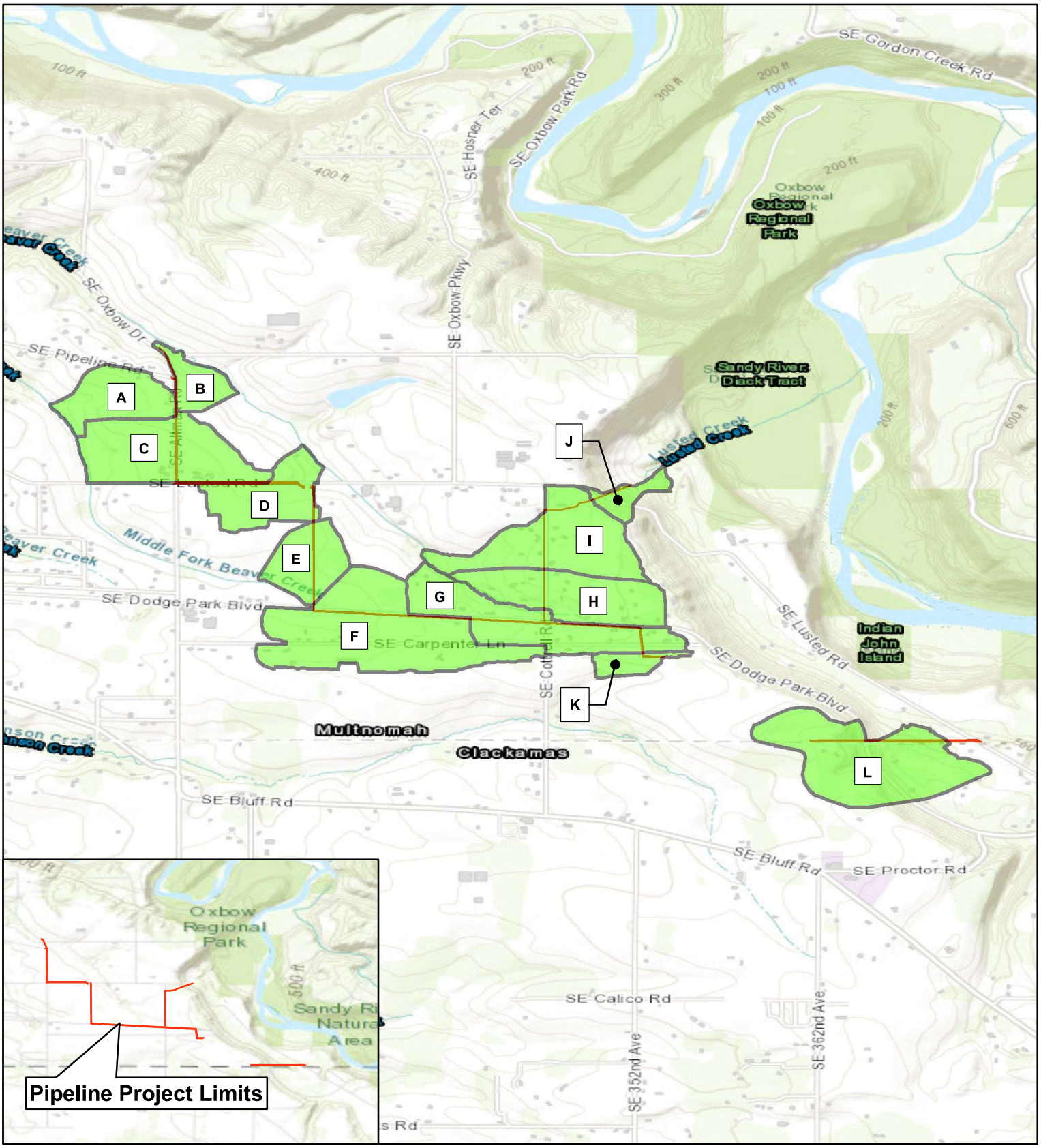

Legend

Pipeline Project Area Extents

Note:
1. Aerial imagery source: ESRI, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, AeroGRID, IGN, and the GIS User Community

N

0 0.25 0.5 1 Miles

Appendix A - Figure 2
Drainage Basins
Bull Run Pipeline Project
Multnomah County

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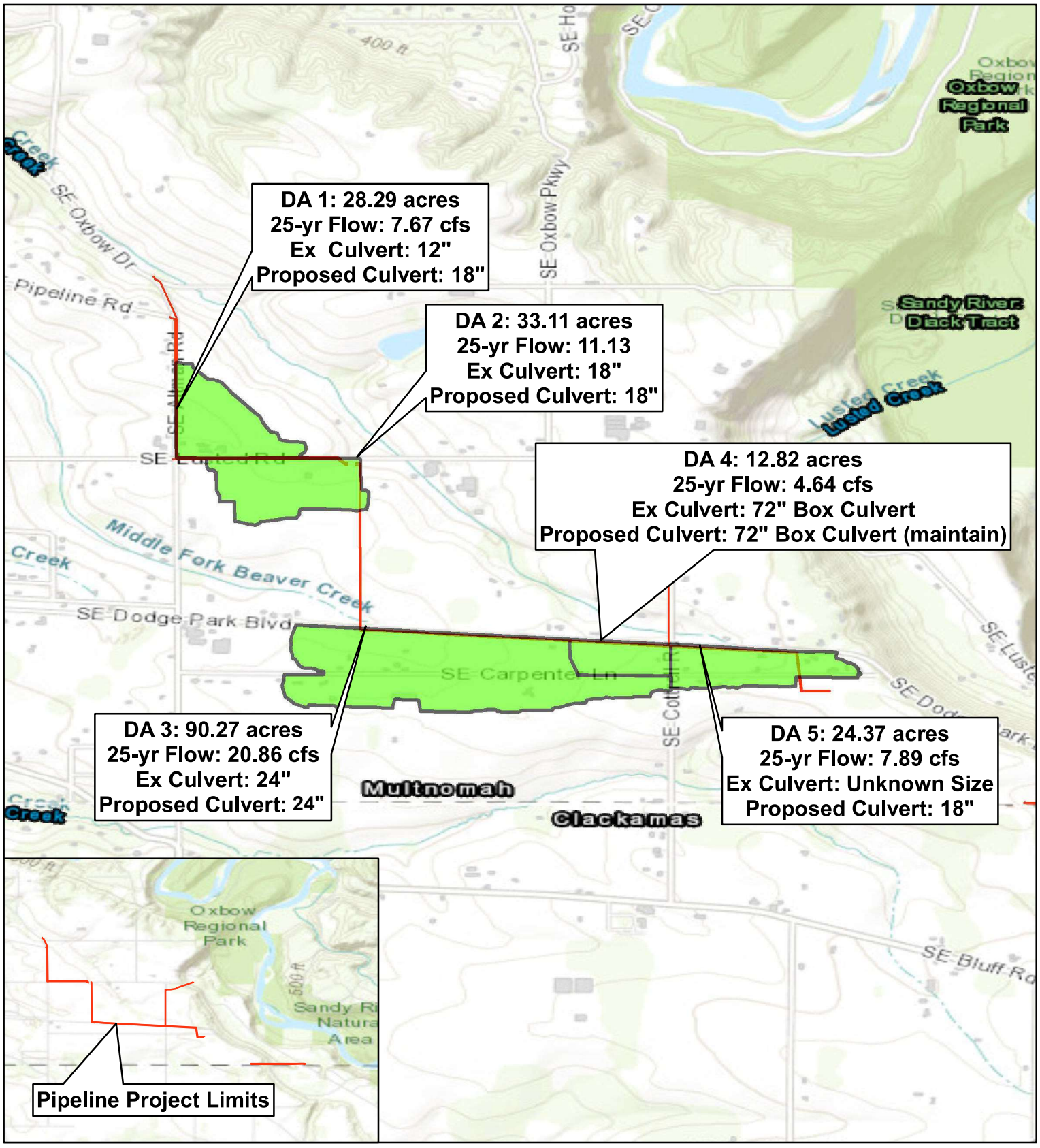

Legend

- Pipeline Project Area Extents
- Drainage Areas

Note:
1. Aerial imagery source: ESRI, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, AeroGRID, IGN, and the GIS User Community

N

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Appendix A - Figure 3
Hydraulic Crossings
Bull Run Pipeline Project
Multnomah County

Jacobs

Appendix B: Stormwater Drawings

Bull Run Filtration Project Pipelines Stormwater Plans

PORTLAND WATER BUREAU

FROM FOREST TO FAUCET

Portland Water Bureau

Bull Run Filtration Pipelines Project

Stormwater Exhibits

STORMWATER EXHIBITS SUBMITTAL PACKAGE		
SHEET NUMBER	SHEET NAME	PIPELINES DRAWINGS
PIPELINES DRAWINGS		
1	SW-001	COVER SHEET
2	SW-002	KEY PLAN
3	SW-101	RAW WATER PIPELINE GRID 1, GRID 2, GRID 3
4	SW-102	FINSIHED WATER PIPELINE GRID 4, GRID 5
5	SW-103	FINISHED WATER PIPELINE GRID 6, GRID 7
6	SW-104	FINISHED WATER PIPELINE GRID 8, GRID 9
7	SW-105	FINISHED WATER PIPELINE GRID 10, GRID 11
8	SW-106	FINISHED WATER PIPELINE GRID 12, GRID 13
9	SW-107	FINISHED WATER PIPELINE GRID 14, GRID 15
10	SW-108	FINISHED WATER PIPELINE GRID 16
11	SW-201	STORMWATER EXHIBITS DETAIL

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No	Date	Description	Appd
Revision			
Survey			

PRELIMINARY
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Designed By	TWL	Program Mgr		XXX
Drawn By	AP	Const Mgr		XXX
Checked By	SDA	Const Supvr		XXX
Project Mgr	XXX	Date	6/30/22	

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PORTLAND WATER BUREAU

FROM FOREST TO FAUCET

XXX XXX — Date

XXX XXX — Date

CITY OF PORTLAND OREGON 1851

Bull Run Filtration Pipelines

STORMWATER EXHIBITS

COVER SHEET

SAP Project No
W02563
1/4 Section

Sheet No
SW-001

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PIPELINE CONNECTS TO EXISTING CONDUIT IN R.O.W.

PIPELINE CONNECTS TO EXISTING CONDUIT IN R.O.W.

PIPELINES IN R.O.W.

PIPELINES IN R.O.W.

FINISHED WATER INTERTIE

LOCAL DISTRIBUTION MAIN CONNECTS TO EXISTING MAIN

PIPELINE CONNECTS TO EXISTING CONDUIT IN R.O.W.

PIPE IN R.O.W.

PIPELINES IN R.O.W.

PIPELINE EXITS FILTRATION FACILITY

FILTRATION FACILITY

PIPELINES EXIT TUNNEL AND ENTER FILTRATION FACILITY

PIPELINES ENTER TUNNEL

MULTNOMAH CONNECTION: PIPELINES CONNECT TO EXISTING CONDUITS

GRID 1
GRID 2
GRID 3
GRID 4
GRID 5
GRID 6
GRID 7
GRID 8
GRID 9
GRID 10
GRID 11
GRID 12
GRID 13
GRID 14
GRID 15
GRID 16

SE OXBOW RD
SE ALTMAN RD
SE LUSTED RD
SE HOSNER RD
SE DODGE PARK BLVD
SE CARPENTER LN
SE COTTRELL RD
SE LUSTED RD
SE DODGE PARK BLVD
SANDY RIVER

MULTNOMAH COUNTY
CLACKAMAS COUNTY

MULTNOMAH COUNTY
CLACKAMAS COUNTY

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Scale In Feet

CONFIDENTIAL

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No	Date	Description	Appd
		Revision	
Survey			

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PORTLAND WATER BUREAU
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XXX XXX — Date

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CITY OF PORTLAND, OREGON 1851

Bull Run Filtration Pipelines

KEY PLAN

SAP Project No W02563
1/4 Section
Sheet No SW-002

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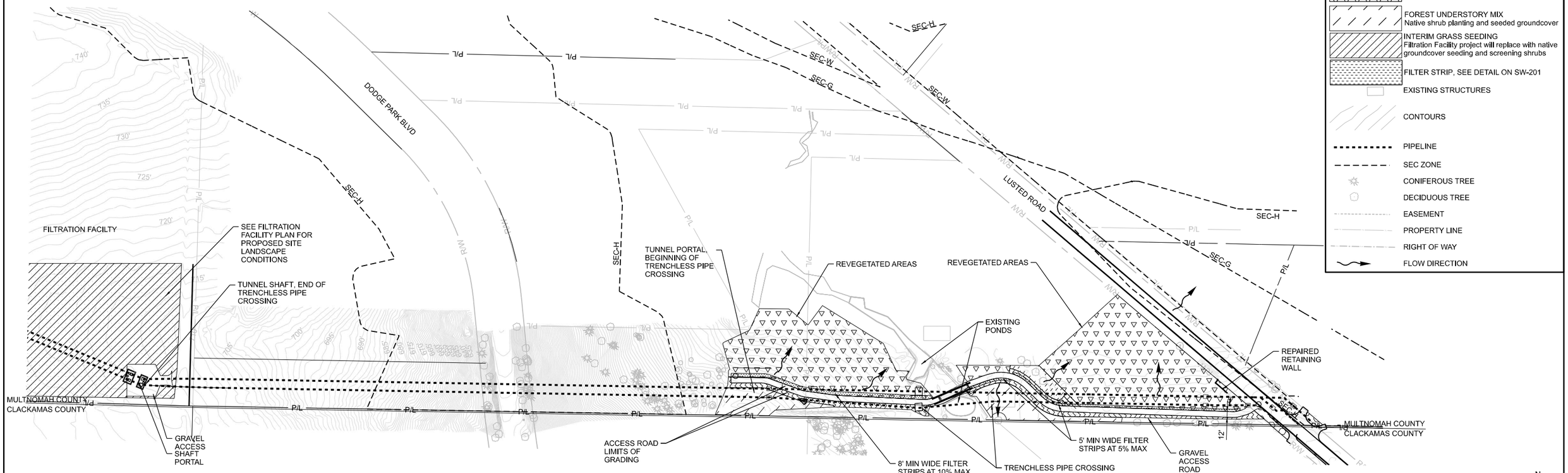
GENERAL SHEET NOTES

1. ALL WORK AREAS RESTORED TO EXISTING GRADE
2. NO PROPSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
3. SEE SPEC 32 92 00 FOR SEEDING INFORMATION.
4. ALL VEGETATED AREA WITHIN R/W TO BE RESOTRED WITH AMENDED SOIL TREATMENT. SEE VEGETAED FILTER STRIP DETAIL ON SHEET SW-201
5. REPLACED IMPERVIOUS AREA = 20,000 sf

LEGEND

- PASTURE SEEDING
- FOREST UNDERSTORY MIX — Native shrub planting and seeded groundcover
- INTERIM GRASS SEEDING — Filtration Facility project will replace with native groundcover seeding and screening shrubs
- FILTER STRIP, SEE DETAIL ON SW-201
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EASEMENT
- PROPERTY LINE
- RIGHT OF WAY
- FLOW DIRECTION



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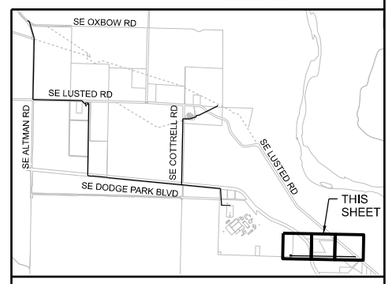

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		Revision	
Survey			

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Project Mgr	XXX	Date	6/30/22

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PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

XXX XXX — Date
XXX XXX — Date

Bull Run Filtration Pipelines

RAW WATER PIPELINE STORMWATER PLAN

GRID 1, GRID 2, GRID 3

SAP Project No	W02563
1/4 Section	3967
Sheet No	SW-101

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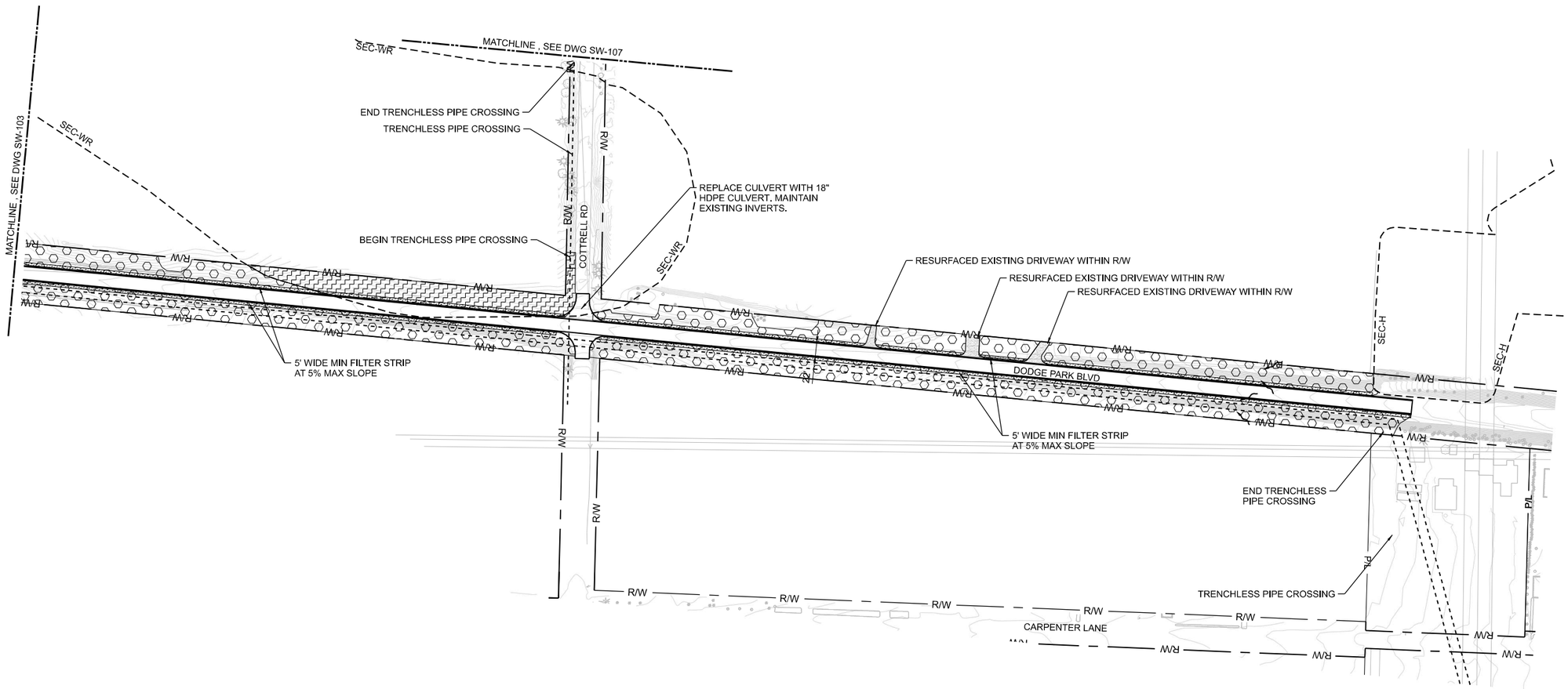
2. NO PROPOSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
3. SEE SPEC 32 92 00 FOR SEEDING INFORMATION.
4. ALL VEGETATED AREA WITHIN R/W TO BE RESOTRED WITH AMENDED SOIL TREATMENT.
5. SEE VEGETATED FILTER STRIP DETAIL ON SHEET SW-201.
6. REPLACED IMPERVIOUS AREA = 62,000 sf

LEGEND

- ROADSIDE SEEDING
- SEC ROADSIDE SEEDING
- FILTER STRIP, SEE DETAIL ON SW-201
- EXISTING TREES
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EL — EASEMENT
- P/L — PROPERTY LINE
- R/W — RIGHT OF WAY
- FLOW DIRECTION



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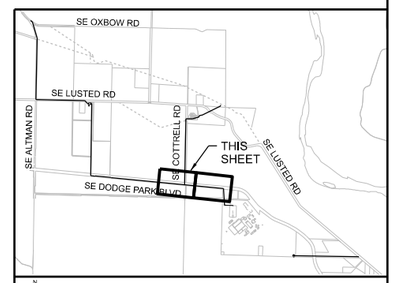

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Project Mgr	XXX	Date 6/30/22	

WARNING

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PORTLAND WATER BUREAU

FROM FOREST TO FAUCET

XXX XXX — Date

XXX XXX — Date

CITY OF PORTLAND OREGON 1851

Bull Run Filtration Pipelines

FINISH WATER PIPELINE STORMWATER PLAN

GRID 3, GRID 4

SAP Project No W02563

1/4 Section 3865

Sheet No SW-102

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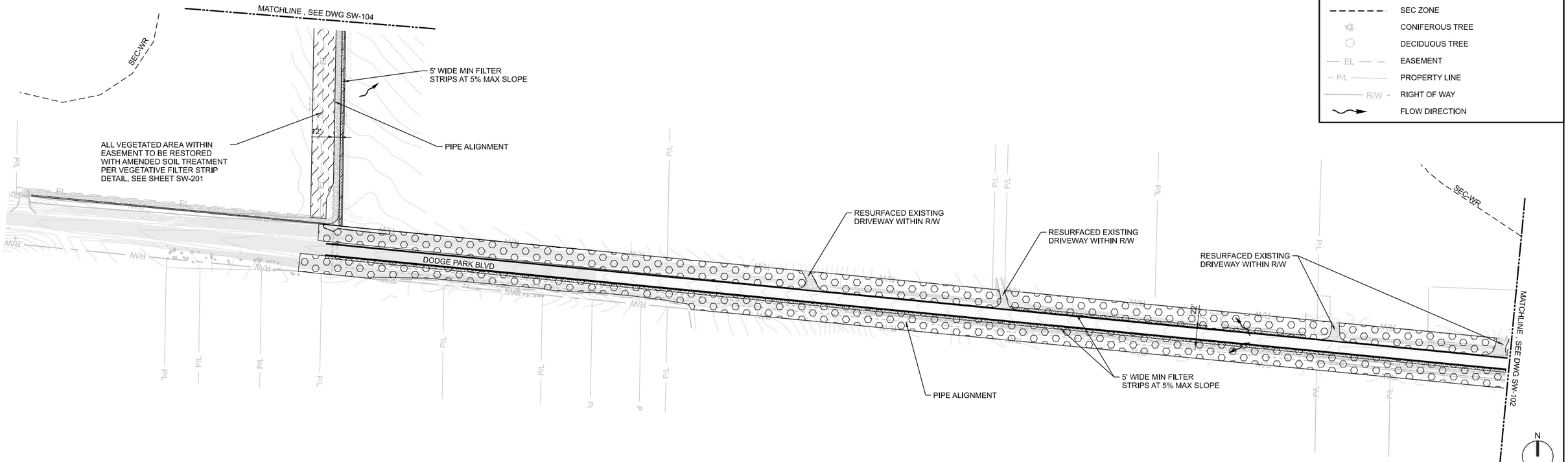
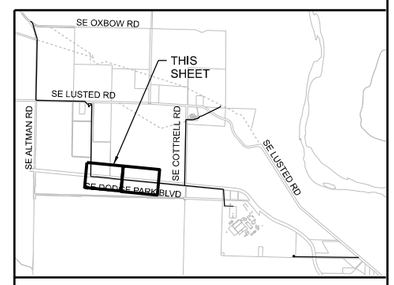
2. NO PROPOSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
3. SEE SPEC 32 92 00 FOR SEEDING INFORMATION.
4. ALL VEGETATED AREA WITHIN R/W TO BE RESTORED WITH AMENDED SOIL TREATMENT. SEE VEGETATED FILTER STRIP DETAIL ON SHEET SW-201.
5. REPLACED IMPERVIOUS AREA (DODGE PARK BOULEWARD AND DRIVEWAYS) = 70,000 sf
   GRAVEL ACCESS ROAD = 4,900 sf

LEGEND

- ROADSIDE SEEDING
- SEC ROADSIDE SEEDING
- FILTER STRIP, SEE DETAIL ON SW-201
- GRAVEL ACCESS ROAD
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EL — EASEMENT
- P/L — PROPERTY LINE
- R/W — RIGHT OF WAY
- FLOW DIRECTION





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Drawn By	DG	Const Mgr		XXX
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PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

XXX XXX — Date

XXX XXX — Date

CITY OF PORTLAND OREGON 1851

Bull Run Filtration Pipelines

FINISH WATER PIPELINE STORMWATER PLAN

GRID 6, GRID 7

SAP Project No	W02563
1/4 Section	3865
Sheet No	SW-103

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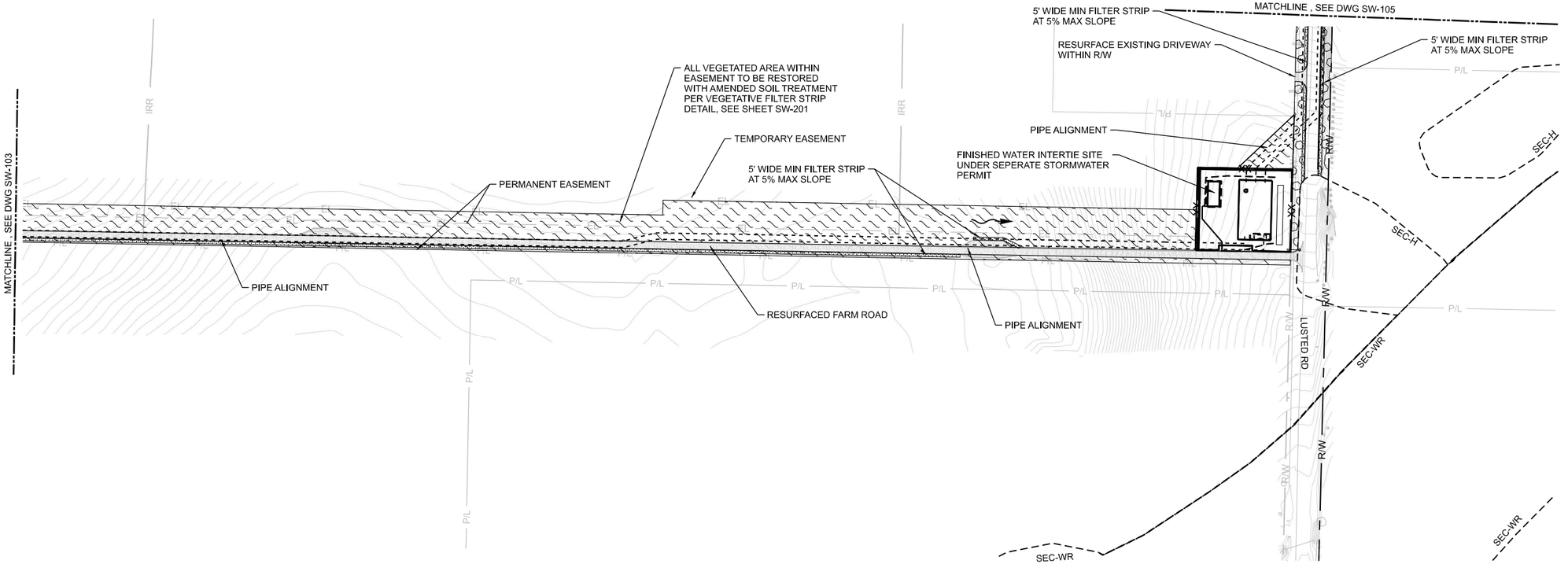
3. NO PROPOSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
4. ALL VEGETATED AREA WITHIN R/W TO BE RESTORED WITH AMENDED SOIL TREATMENT. SEE VEGETATED FILTER STRIP DETAIL ON SHEET SW-201.
5. REPLACED IMPERVIOUS AREA (LUSTED ROAD AND DRIVEWAYS) = 5,800 sf
   GRAVEL ACCESS ROAD = 24,500 sf

LEGEND

- ROADSIDE SEEDING
- SEC ROADSIDE SEEDING
- FILTER STRIP, SEE DETAIL ON SW-201
- GRAVEL ACCESS ROAD
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EL — EASEMENT
- P/L — PROPERTY LINE
- R/W — RIGHT OF WAY
- FLOW DIRECTION



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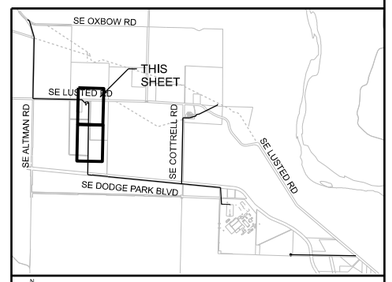

KEYPLAN

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No	Date	Description	Appd
		Revision	
Survey			

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Project Mgr	XXX	Date	6/30/22

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PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

XXX XXX — Date
XXX XXX — Date

Bull Run Filtration Pipelines

FINISH WATER PIPELINE STORMWATER PLAN

GRID 8, GRID 9

SAP Project No: W02563
1/4 Section: 3764
Sheet No: SW-104

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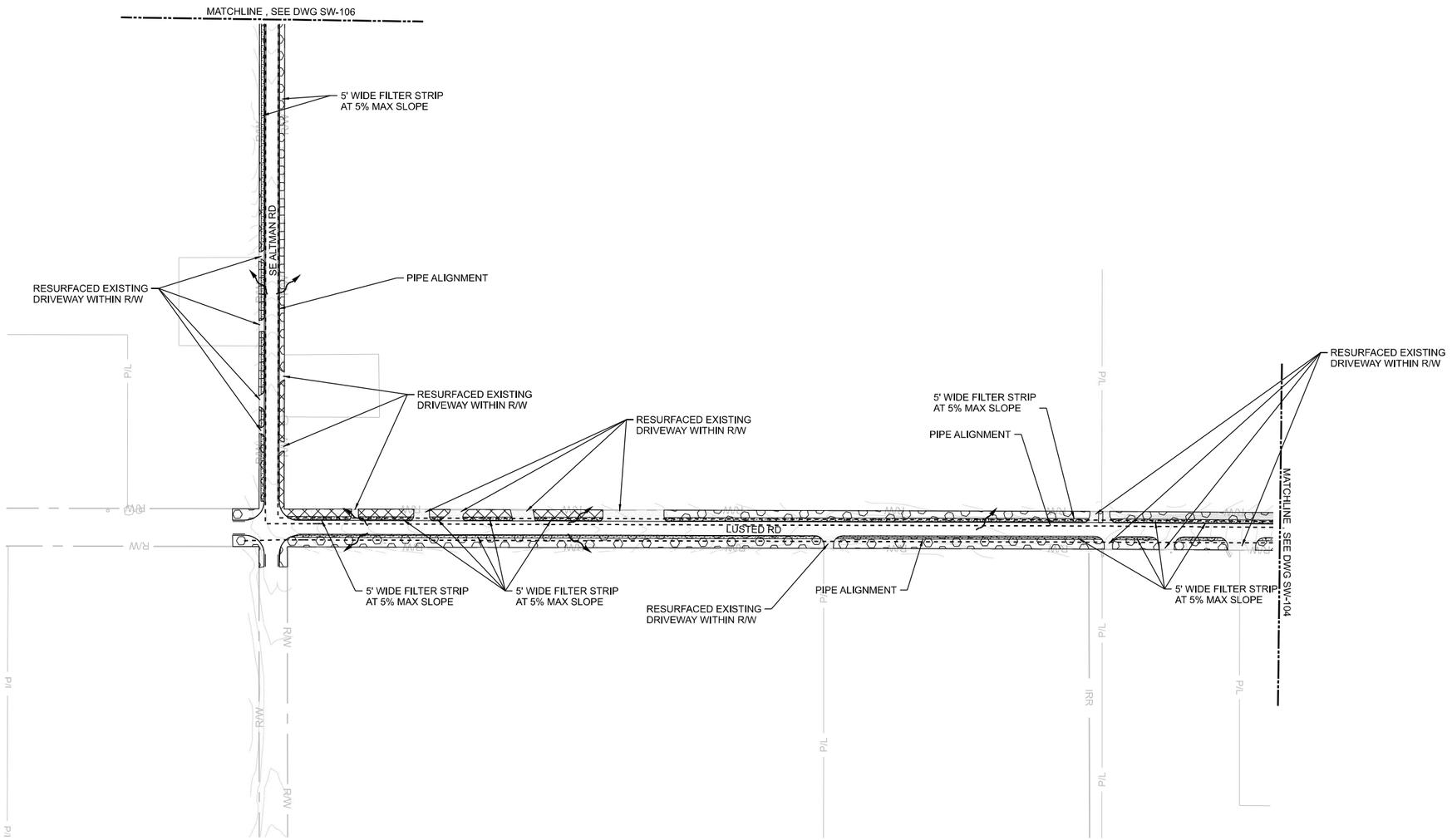
3. NO PROPOSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
4. ALL VEGETATED AREA WITHIN R/W TO BE RESTORED WITH AMENDED SOILT TREATMENT. SEE VEGETATED FILTER STRIP DETAIL ON SHEET SW-201
5. REPLACED IMPERVIOUS AREA (LUSTED ROAD AND ALTMAN ROAD) = 59,000 sf

LEGEND

- ROADSIDE SEEDING
- LAWN SEEDING
- FILTER STRIP, SEE DETAIL ON SW-201
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EASEMENT
- PROPERTY LINE
- RIGHT OF WAY
- FLOW DIRECTION



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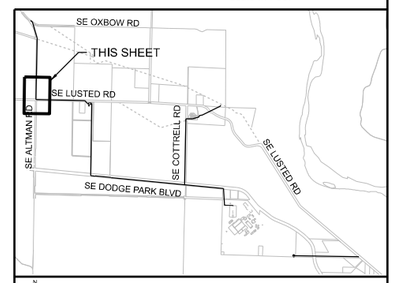

KEYPLAN

No	Date	Description	Appd
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Survey			

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Project Mgr	XXX	Date 6/30/22	

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PORTLAND WATER BUREAU

FROM FOREST TO FAUCET

XXX XXX — Date

XXX XXX — Date

CITY OF PORTLAND OREGON 1851

Bull Run Filtration Pipelines

FINISH WATER PIPELINE STORMWATER PLAN

GRID 10, GRID 11

SAP Project No	W02563
1/4 Section	3764
Sheet No	SW-105

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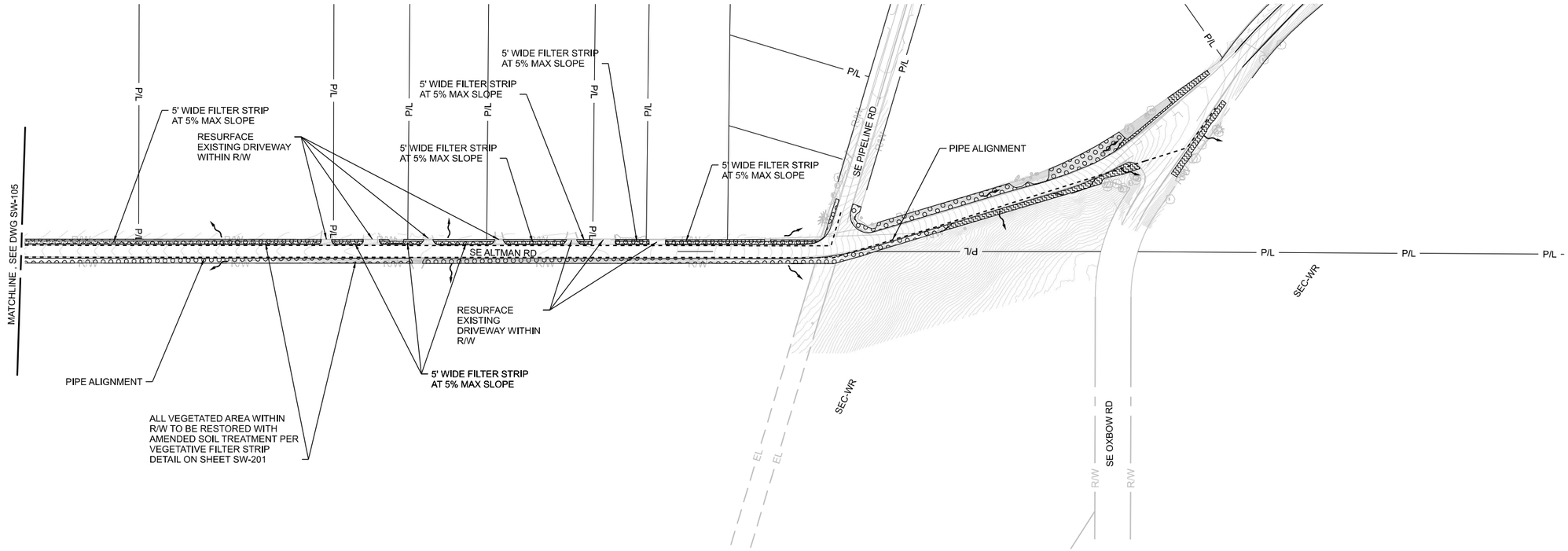
2. NO PROPOSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
3. SEE SPEC 32 92 00 FOR SEEDING INFORMATION
4. ALL VEGETATION AREA WITHIN R/W TO BE RESTORED WITH AMENDED SOIL TREATMENT. SEE VEGETATED FILTER STRIP DETAIL ON SHEET SW-201.
5. REPLACED IMPERVIOUS AREA (OXBOW ROAD AND ALTMAN ROAD) = 47,000 sf

LEGEND

- SEC ROADSIDE SEEDING
- ROADSIDE SEEDING
- FILTER STRIP, SEE DETAIL ON SW-201
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EL — EASEMENT
- P/L — PROPERTY LINE
- R/W — RIGHT OF WAY
- FLOW DIRECTION



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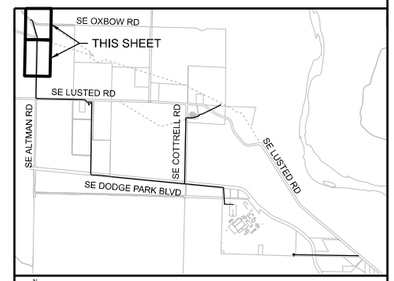

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24-SEP-2022

No	Date	Description	Appd
		Revision	
Survey			

PRELIMINARY NOT FOR CONSTRUCTION

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Drawn By	DG	Const Mgr	XXX
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Project Mgr	XXX	Date	6/30/22

WARNING

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PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

XXX XXX — Date

XXX XXX — Date

CITY OF PORTLAND OREGON 1851

Bull Run Filtration Pipelines

FINISH WATER PIPELINE STORMWATER PLAN

GRID 12, GRID 13

SAP Project No
W02563
1/4 Section
Sheet No
SW-106

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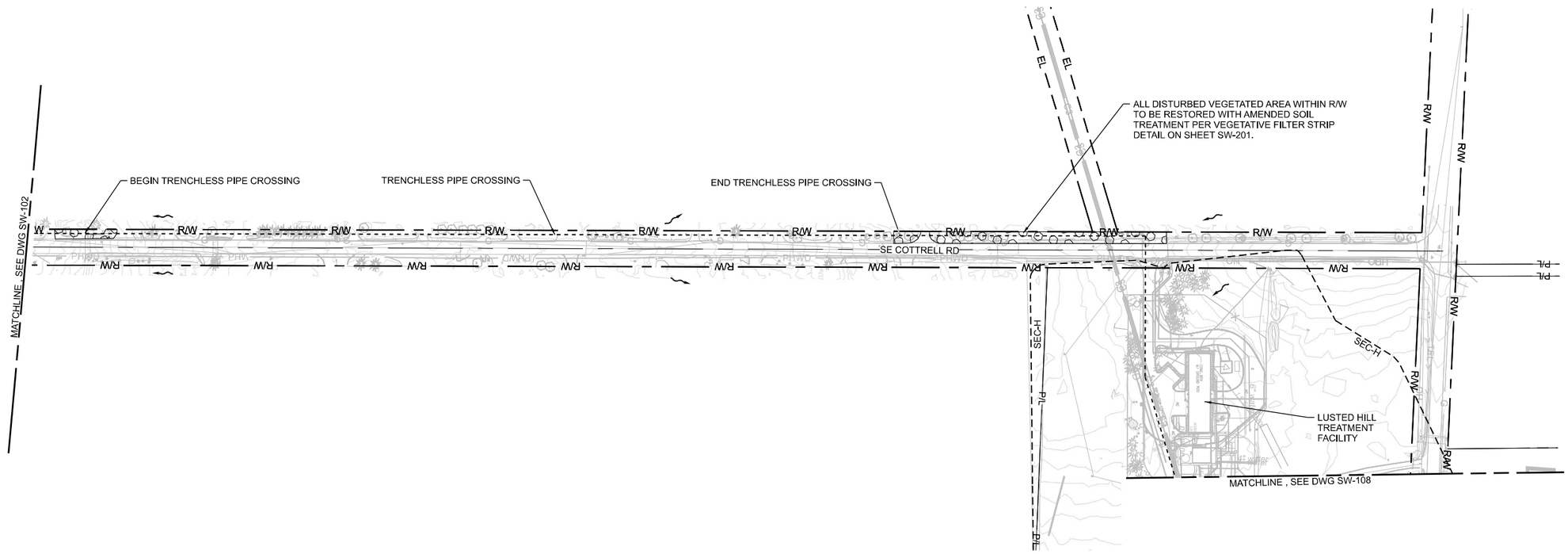
2. NO PROPOSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
3. SEE SPEC 32 92 00 FOR SEEDING INFORMATION
4. REPLACED VEGETATED AREAS SHALL HAVE 3-INCHES OF YARD-DEBRIS COMPOST INCORPORATED INTO THE 12-INCHES OF AMENDED SOIL.

LEGEND

- ROADSIDE SEEDING
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EL — EASEMENT
- P/L — PROPERTY LINE
- R/W - RIGHT OF WAY
- FLOW DIRECTION



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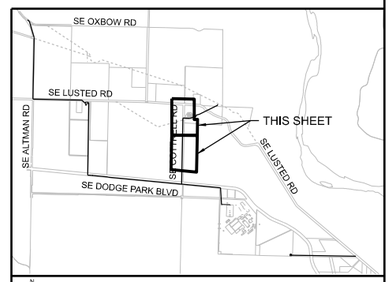

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24-SEP-2022

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		Revision	
Survey			

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Designed By	DG	Program Mgr	XXX
Drawn By	DG	Const Mgr	XXX
Checked By	BN	Const Supvr	XXX
Project Mgr	XXX	Date	6/30/22

WARNING
0 1"
If this bar does not measure 1" then the drawing is not to scale

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

XXX XXX — Date
XXX XXX — Date

CITY OF PORTLAND, OREGON 1851

Bull Run Filtration Pipelines

FINISH WATER PIPELINE STORMWATER PLAN

GRID 14, GRID 15

SAP Project No
W02563
1/4 Section
3664
Sheet No
SW-107

REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN ("DOCUMENTS"), AS AN INSTRUMENT OF PROFESSIONAL SERVICE, WAS PREPARED BY JACOBS SOLEY FOR THE PURPOSE OF THIS PROJECT AND DESIGN CRITERIA. JACOBS IS RELEASED FROM ANY AND ALL LIABILITY OF ANY KIND ARISING OUT OF OR RELATING TO THE RE-USE OF THE DOCUMENTS, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT OR EXTENSIONS OF THIS PROJECT.

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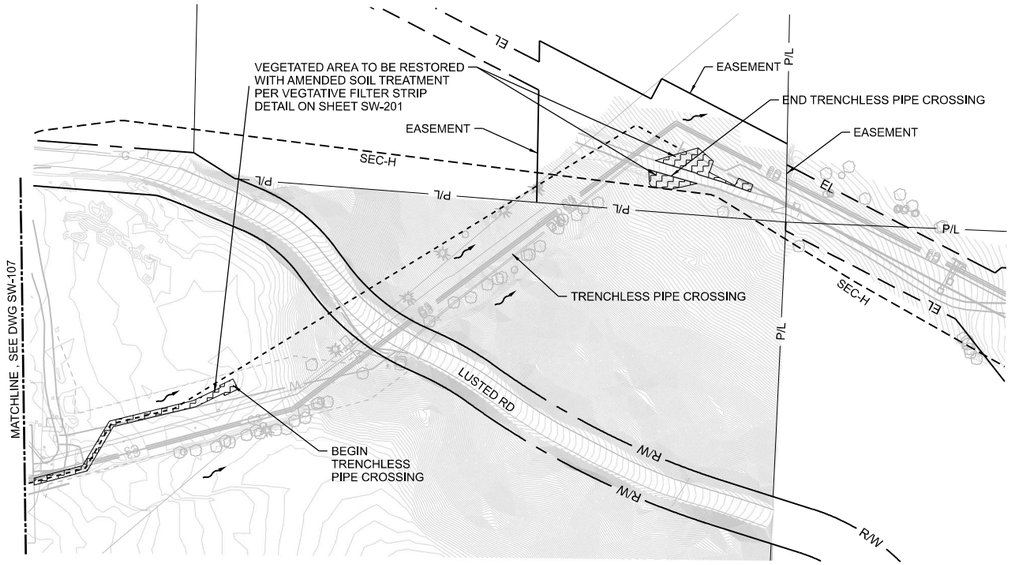
GENERAL SHEET NOTES

1. ALL WORK AREAS RESTORED TO EXISTING GRADE
2. NO PROPSED TREE REMOVAL, FILL OR GRADING WITHIN SEC-H ZONE. PROTECT EXISTING VEGETATION IN ALL SEC ZONES.
3. SEE SPEC 32 92 00 FOR SEEDING INFORMATION
4. DISPERSION AREA ADJACENT TO REPLACED IMPERVIOUS AREAS MUST BE 2 TIMES THE WIDTH OF THE IMPERVIOUS AREA DRAINING TO IT. SEE VEGEATED FILTER STRIP DETAIL ON SHEET SW-201.

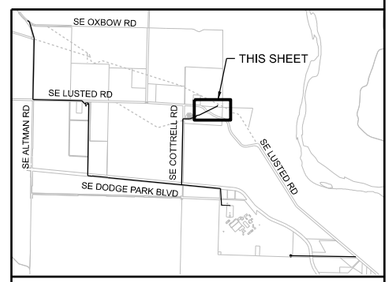
LEGEND

- SEC ROADSIDE SEEDING
- EXISTING STRUCTURES
- CONTOURS
- PIPELINE
- SEC ZONE
- CONIFEROUS TREE
- DECIDUOUS TREE
- EL — EASEMENT
- P/L — PROPERTY LINE
- R/W — RIGHT OF WAY
- FLOW DIRECTION



0 100 200 300
Scale In Feet

N



KEY PLAN

W02563_SW-108.dgn
24-SEP-2022 01:11

No	Date	Description	Appd
		Revision	
Survey			

PRELIMINARY NOT FOR CONSTRUCTION

Designed By	DG	Program Mgr	XXX
Drawn By	DG	Const Mgr	XXX
Checked By	BN	Const Supvr	XXX
Project Mgr	XXX	Date	6/30/22

WARNING
0 1"
If this bar does not measure 1" then the drawing is not to scale

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

XXX XXX — Date
XXX XXX — Date

CITY OF PORTLAND, OREGON 1851

Bull Run Filtration Pipelines

FINISH WATER PIPELINE STORMWATER PLAN

GRID 16

SAP Project No W02563
1/4 Section
Sheet No SW-108

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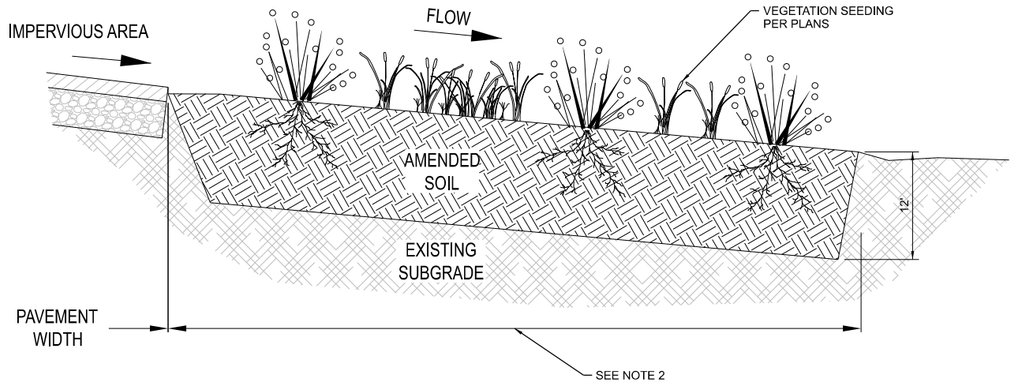
CONSTRUCTION REQUIREMENTS

DO NOT ALLOW TEMPORARY STORAGE OF CONSTRUCTION WASTE OR MATERIALS IN THE FILTER STRIP. DO NOT ALLOW VEHICULAR TRAFFIC, FOOT TRAFFIC, MATERIAL STORAGE, OR HEAVY EQUIPMENT WITHIN 10 FEET OF THE FILTER STRIP AREA AFTER SITE CLEARING AND GRADING HAVE BEEN COMPLETED, EXCEPT AS NEEDED TO EXCAVATE, GRADE, AND CONSTRUCT THE FILTER STRIP.



1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AS WELL AS FOOT TRAFFIC FOR PROPOSED INFILTRATION AREAS PRIOR TO AND DURING CONSTRUCTION.

2. MINIMUM FILTER STRIP FLOW PATH IS 5 FEET. FILTER STRIP WIDTH SHALL HAVE THE CORRESPONDING WIDTHS PER CONTRIBUTING IMPERVIOUS AREA:
   -2% SLOPED FILTER STRIP TO TREAT 4 FEET OF PAVEMENT FOR EVERY 1 FOOT OF FILTER STRIP
   -5% SLOPED FILTER STRIP TO TREAT 3 FEET OF PAVEMENT FOR EVERY 1 FOOT OF FILTER STRIP
   -10% SLOPED FILTER STRIP TO TREAT 2 FEET OF PAVEMENT FOR EVERY 1 FOOT OF FILTER STRIP
   -15% SLOPED FILTER STRIP TO TREAT 1.5 FEET OF PAVEMENT FOR EVERY 1 FOOT OF FILTER STRIP

3. THE LENGTH OF FILTER STRIPS PLACED PARRALLEL TO THE ROAD MUST BE EQUAL TO THE LENGTH OF THE CONTRIBUTING IMPERVIOUS OR PAVEMENT AREA.

4. AMENDED SOIL: IF AREA ISN'T ALREADY VEGETATED, AMEND NATIVE SOIL BY ADDING 3 INCHES OF YARD-DEBRIS COMPOST AND BLENDING TO A DEPTH OF 12 INCHES.

5. VEGETATION: THE FILTER STRIP MUST HAVE AT LEAST 90% COVERAGE BY NATIVE VEGETATION, GRASS OR TREE CANOPY.

VEGETATED FILTER STRIP

3125-300

W02563_SW-201.dgn
23-SEP-2022 21:05

No	Date	Description	Appd
		Revision	
Survey			

PRELIMINARY NOT FOR CONSTRUCTION

Designed By	XXX	Program Mgr	XXX
Drawn By	XXX	Const Mgr	XXX
Checked By	XXX	Const Supvr	XXX
Project Mgr	XXX	Date 6/30/22	

WARNING
0 1"
If this bar does not measure 1" then the drawing is not to scale

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

XXX XXX — Date
XXX XXX — Date

CONFIDENTIAL

Bull Run Filtration Pipelines

FINISHED WATER PIPELINE STANDARD DETAILS

SAP Project No W02563
1/4 Section
Sheet No SW-201

REUSE OF DOCUMENTS: THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN ("DOCUMENTS"), AS AN INSTRUMENT OF PROFESSIONAL SERVICE, WAS PREPARED BY JACOBS SOLELY FOR THE PURPOSE OF THIS PROJECT AND DESIGN CRITERIA. JACOBS IS RELEASED FROM ANY AND ALL LIABILITY OF ANY KIND ARISING OUT OF OR RELATING TO THE RE-USE OF THE DOCUMENTS, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT OR EXTENSIONS OF THIS PROJECT.

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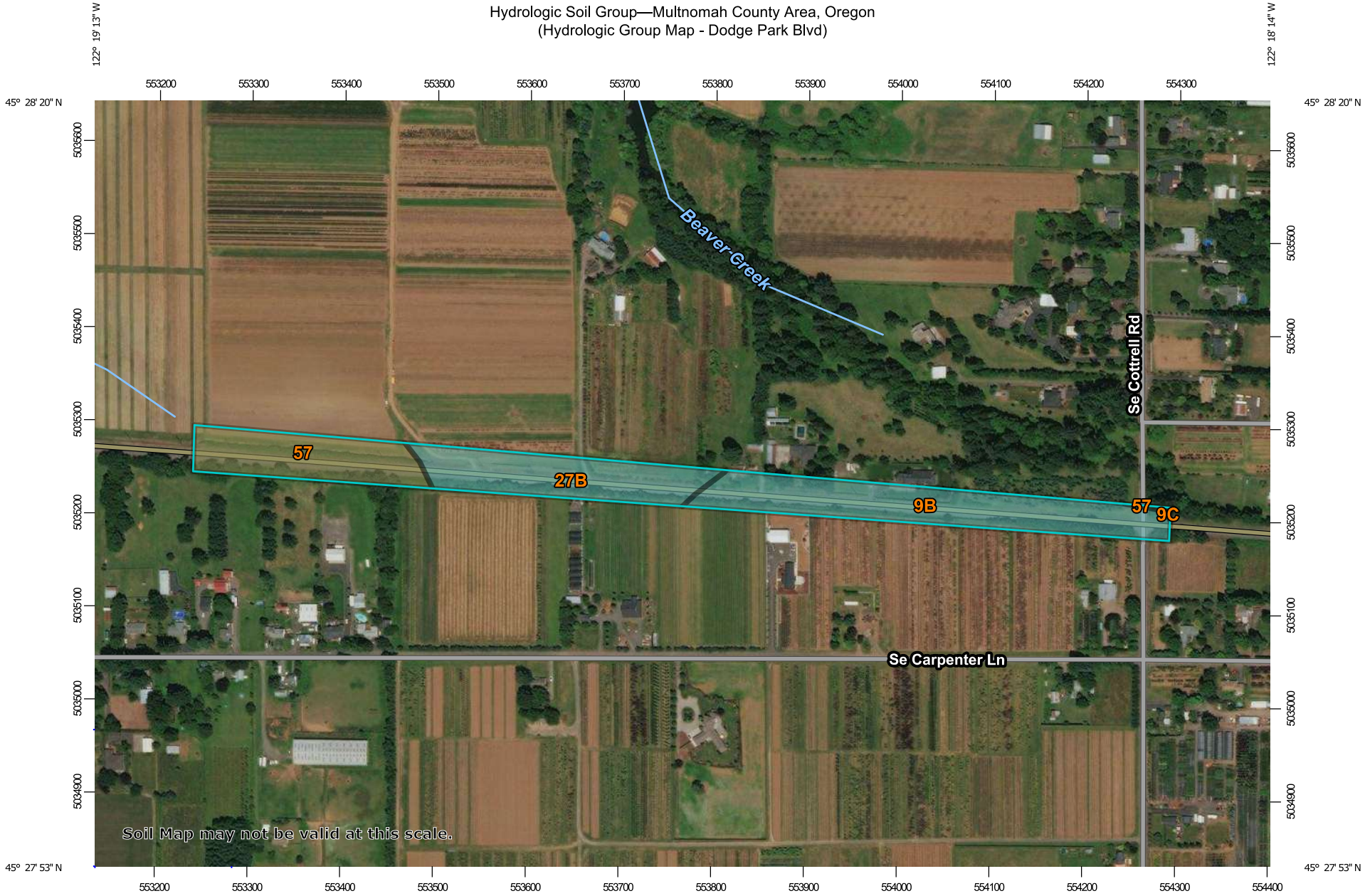
Appendix C: References

NCRS Soils Web Maps
TR-55 Table 2-2a Runoff Curve Numbers for Urban Areas
ODFW Fish Habitat and Barriers

Exhibit A.77.c

Hydrologic Soil Group—Multnomah County Area, Oregon
(Hydrologic Group Map - Dodge Park Blvd)



Map Scale: 1:5,790 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Multnomah County Area, Oregon
Survey Area Data: Version 20, Oct 27, 2021

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

Date(s) aerial images were photographed: Jul 2, 2015—Sep 21, 2016

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
9B	Cazadero silty clay loam, 0 to 8 percent slopes	C	4.9	43.4%
9C	Cazadero silty clay loam, 8 to 15 percent slopes	C	0.0	0.1%
27B	Mershon silt loam, 0 to 8 percent slopes	C	3.4	30.2%
57	Wollent silt loam	C/D	3.0	26.4%
Totals for Area of Interest			**11.2**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Hydrologic Soil Group—Multnomah County Area, Oregon
(Hydrologic Group Map - Private Property)

Map Scale: 1:4,780 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10C	Cornelius silt loam, 8 to 15 percent slopes	C	0.6	7.2%
27B	Mershon silt loam, 0 to 8 percent slopes	C	6.2	70.0%
27C	Mershon silt loam, 8 to 15 percent slopes	C	0.7	8.4%
57	Wollent silt loam	C/D	1.3	14.4%
Totals for Area of Interest			**8.9**	**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.

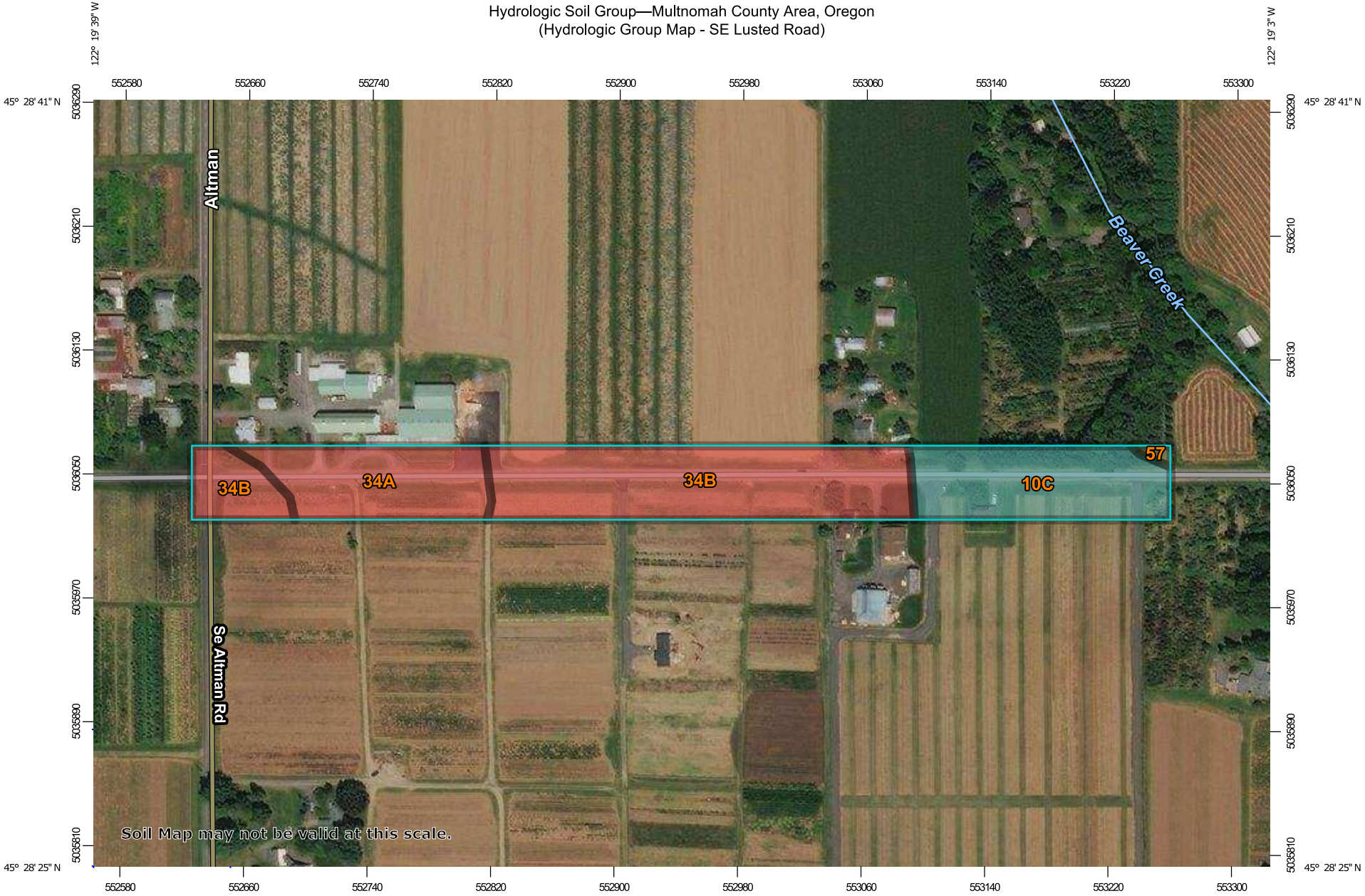
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Hydrologic Soil Group—Multnomah County Area, Oregon
(Hydrologic Group Map - SE Lusted Road)



Map Scale: 1:3,480 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10C	Cornelius silt loam, 8 to 15 percent slopes	C	1.9	25.8%
34A	Powell silt loam, 0 to 3 percent slopes	D	1.7	22.1%
34B	Powell silt loam, 3 to 8 percent slopes	D	3.9	51.4%
57	Wollent silt loam	C/D	0.1	0.7%
Totals for Area of Interest			**7.5**	**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.

Saturated Hydraulic Conductivity (Ksat)—Multnomah County Area, Oregon
(Hydraulic Conductivity (Ksat) - Private Property)

Map Scale: 1:4,740 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

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

Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
10C	Cornelius silt loam, 8 to 15 percent slopes	4.4908	0.4	6.7%
27B	Mershon silt loam, 0 to 8 percent slopes	3.3934	4.7	70.6%
27C	Mershon silt loam, 8 to 15 percent slopes	3.3934	0.6	8.4%
57	Wollent silt loam	3.0000	1.0	14.3%
Totals for Area of Interest			**6.7**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

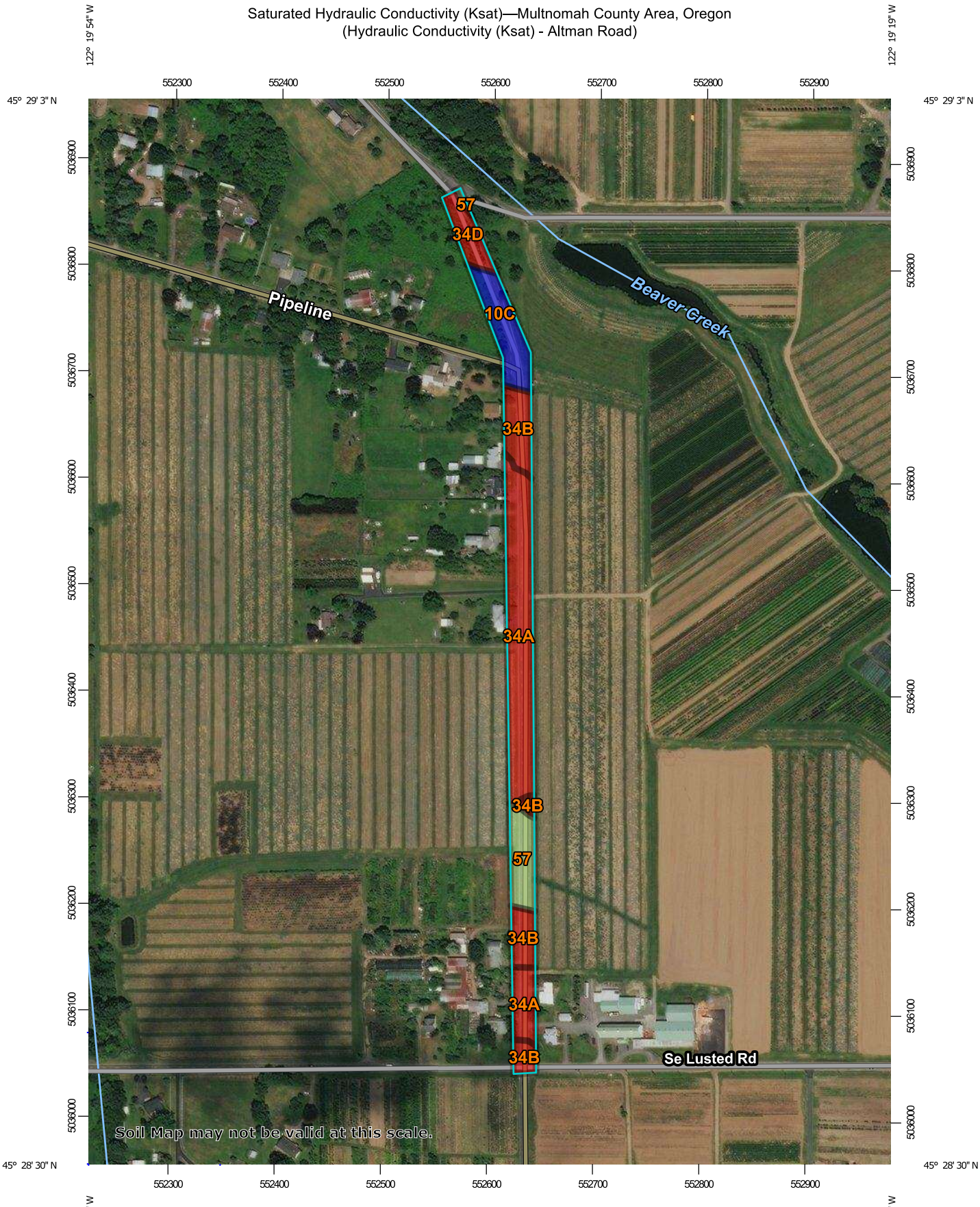
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 12

Bottom Depth: 60

Units of Measure: Inches

Saturated Hydraulic Conductivity (Ksat)—Multnomah County Area, Oregon
(Hydraulic Conductivity (Ksat) - Altman Road)



Map Scale: 1:4,870 if printed on A portrait (8.5" x 11") sheet.

N

Meters
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Feet
0 200 400 800 1200

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

Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
10C	Cornelius silt loam, 8 to 15 percent slopes	4.4908	0.7	14.9%
34A	Powell silt loam, 0 to 3 percent slopes	1.6394	2.3	46.0%
34B	Powell silt loam, 3 to 8 percent slopes	1.6394	1.0	20.1%
34D	Powell silt loam, 15 to 30 percent slopes	1.6394	0.4	7.8%
57	Wollent silt loam	3.0000	0.5	11.1%
Totals for Area of Interest			**4.9**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

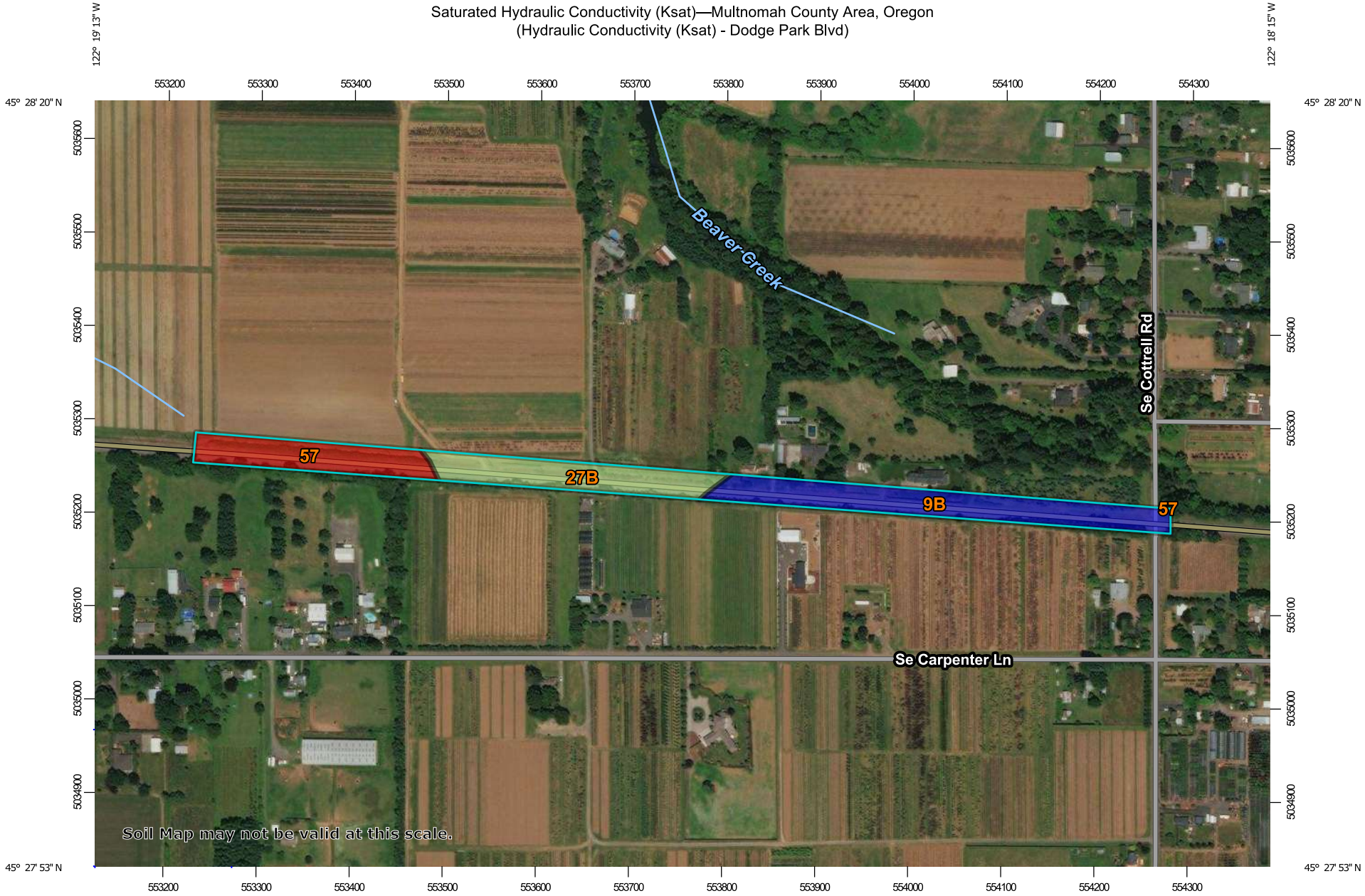
Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 12

Bottom Depth: 60

Saturated Hydraulic Conductivity (Ksat)—Multnomah County Area, Oregon
(Hydraulic Conductivity (Ksat) - Dodge Park Blvd)



Map Scale: 1:5,770 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

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

- <= 3.0000
- > 3.0000 and <= 3.3934
- > 3.3934 and <= 3.5410
- Not rated or not available

Soil Rating Lines

- <= 3.0000
- > 3.0000 and <= 3.3934
- > 3.3934 and <= 3.5410
- Not rated or not available

Soil Rating Points

- <= 3.0000
- > 3.0000 and <= 3.3934
- > 3.3934 and <= 3.5410
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Multnomah County Area, Oregon
Survey Area Data: Version 20, Oct 27, 2021

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

Date(s) aerial images were photographed: Jul 2, 2015—Sep 21, 2016

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.

Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
9B	Cazadero silty clay loam, 0 to 8 percent slopes	3.5410	3.4	44.3%
27B	Mershon silt loam, 0 to 8 percent slopes	3.3934	2.3	29.7%
57	Wollent silt loam	3.0000	2.0	25.9%
Totals for Area of Interest			**7.7**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

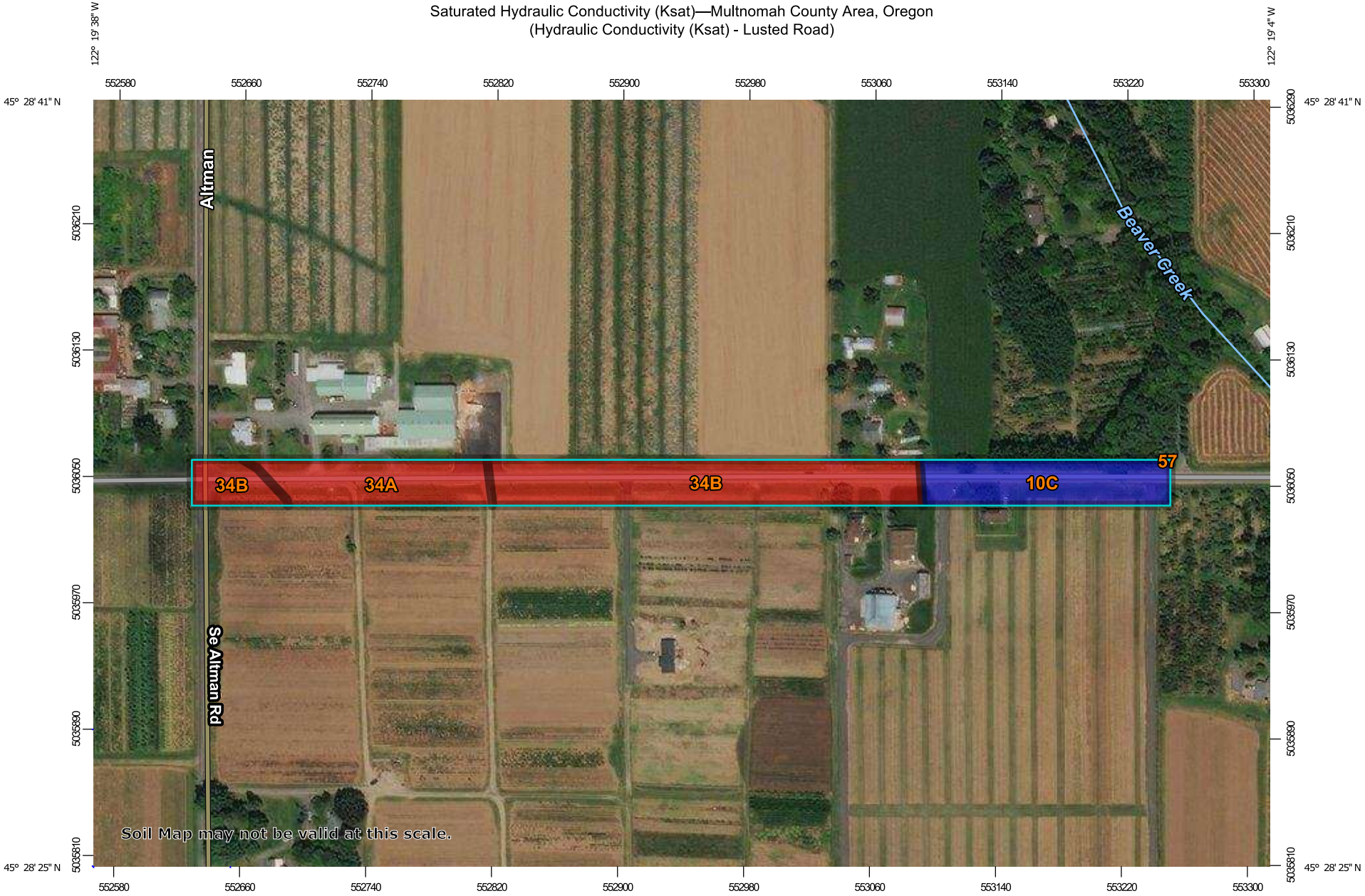
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 12

Bottom Depth: 60

Units of Measure: Inches

Saturated Hydraulic Conductivity (Ksat)—Multnomah County Area, Oregon
(Hydraulic Conductivity (Ksat) - Lusted Road)



Map Scale: 1:3,420 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

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

- <= 1.6394
- > 1.6394 and <= 3.0000
- > 3.0000 and <= 4.4908
- Not rated or not available

Soil Rating Lines

- <= 1.6394
- > 1.6394 and <= 3.0000
- > 3.0000 and <= 4.4908
- Not rated or not available

Soil Rating Points

- <= 1.6394
- > 1.6394 and <= 3.0000
- > 3.0000 and <= 4.4908
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Multnomah County Area, Oregon
Survey Area Data: Version 20, Oct 27, 2021

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

Date(s) aerial images were photographed: Jun 22, 2020—Jun 26, 2020

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.

Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
10C	Cornelius silt loam, 8 to 15 percent slopes	4.4908	1.1	25.5%
34A	Powell silt loam, 0 to 3 percent slopes	1.6394	1.0	22.5%
34B	Powell silt loam, 3 to 8 percent slopes	1.6394	2.3	52.0%
57	Wollent silt loam	3.0000	0.0	0.0%
Totals for Area of Interest			**4.5**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

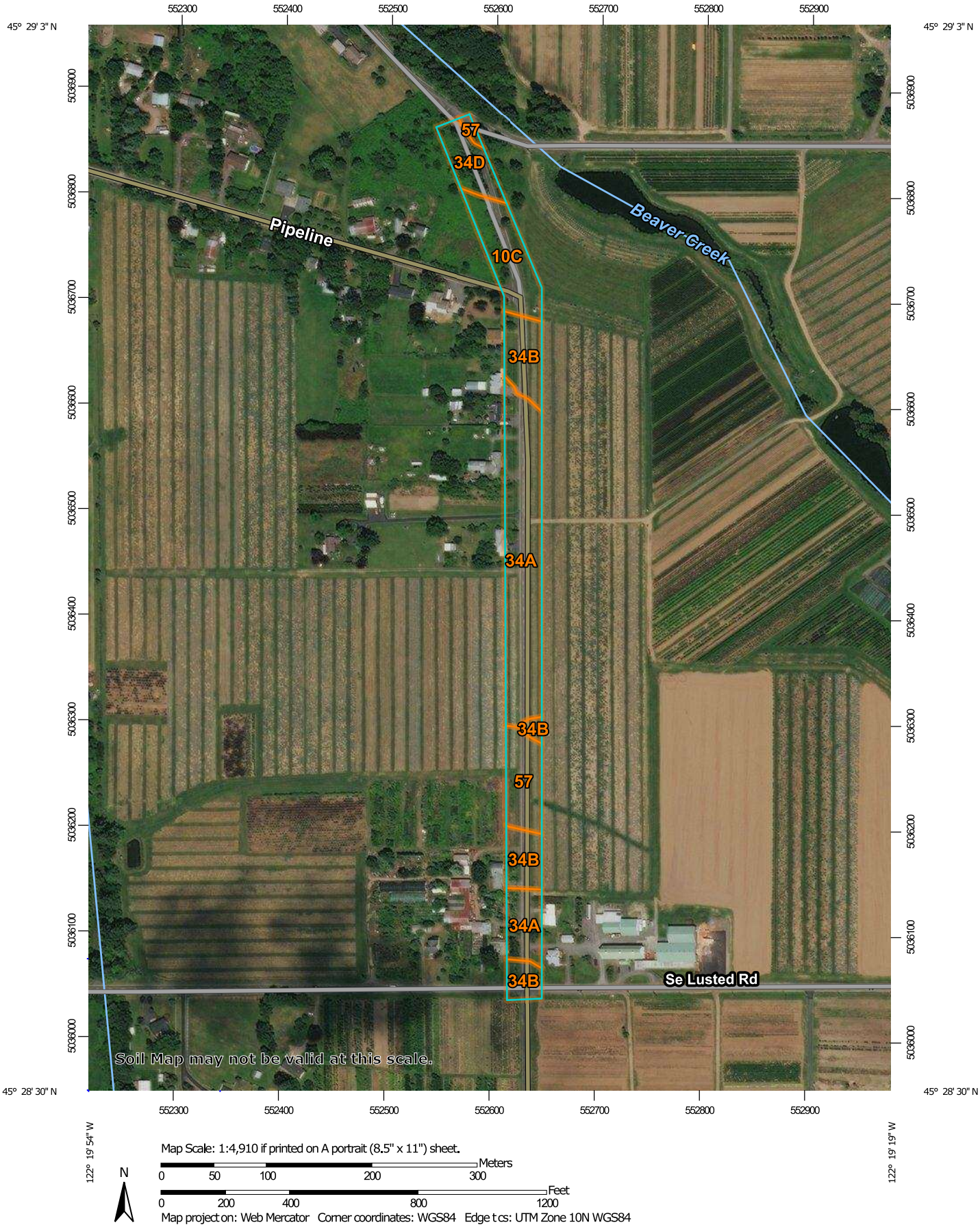
Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 12

Bottom Depth: 60

Units of Measure: Inches

Soil Map—Multnomah County Area, Oregon
(Soil Map - SE Altman Road)



Map Scale: 1:4,910 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

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 1:20,000.

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

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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)

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

Soil Survey Area: Multnomah County Area, Oregon
Survey Area Data: Version 20, Oct 27, 2021

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

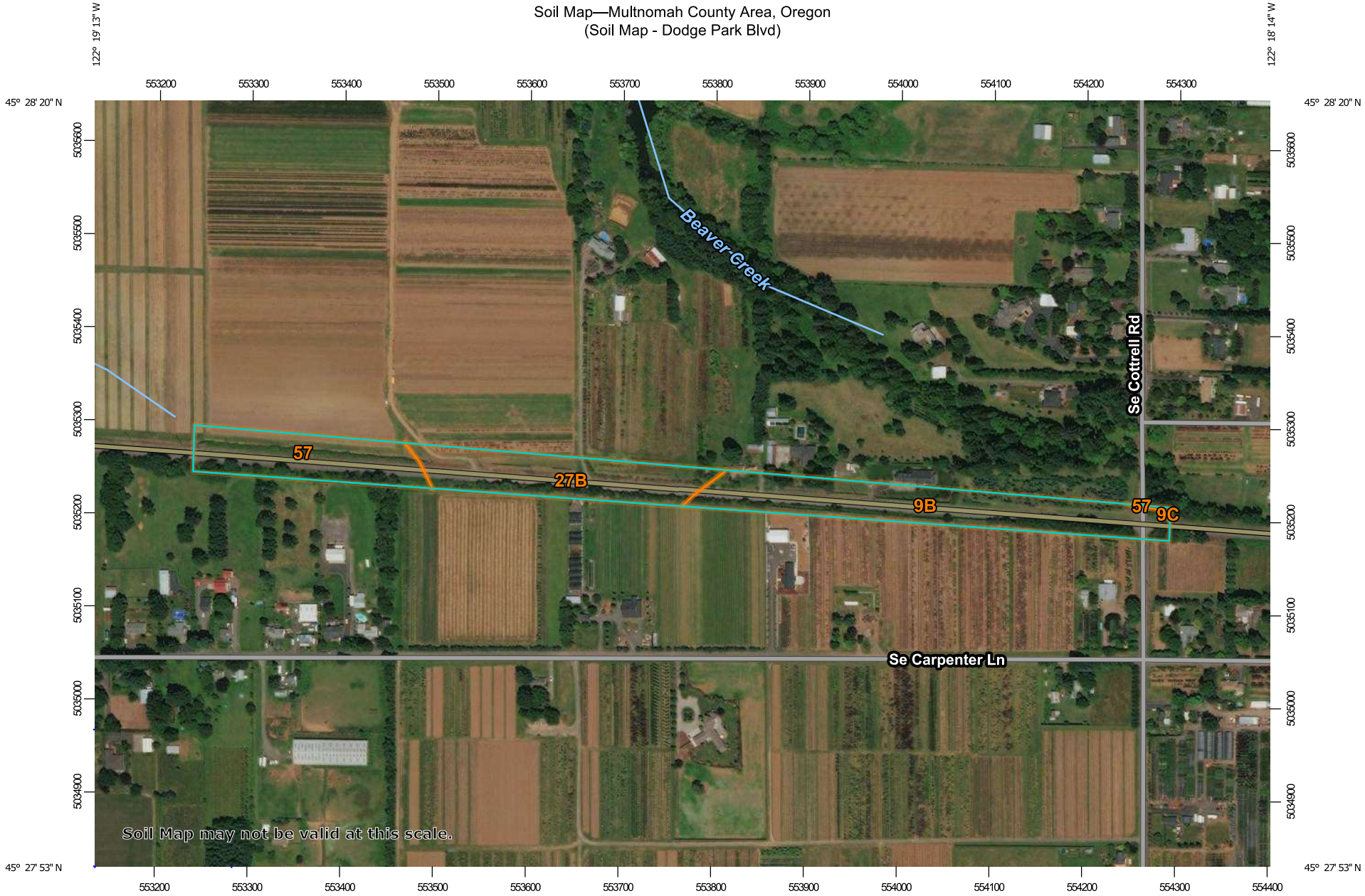
Date(s) aerial images were photographed: Jul 2, 2015—Sep 21, 2016

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
10C	Cornelius silt loam, 8 to 15 percent slopes	1.1	14.8%
34A	Powell silt loam, 0 to 3 percent slopes	3.2	44.8%
34B	Powell silt loam, 3 to 8 percent slopes	1.5	20.6%
34D	Powell silt loam, 15 to 30 percent slopes	0.6	8.2%
57	Wollent silt loam	0.8	11.6%
Totals for Area of Interest		**7.2**	**100.0%**

Soil Map—Multnomah County Area, Oregon
(Soil Map - Dodge Park Blvd)



Map Scale: 1:5,790 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

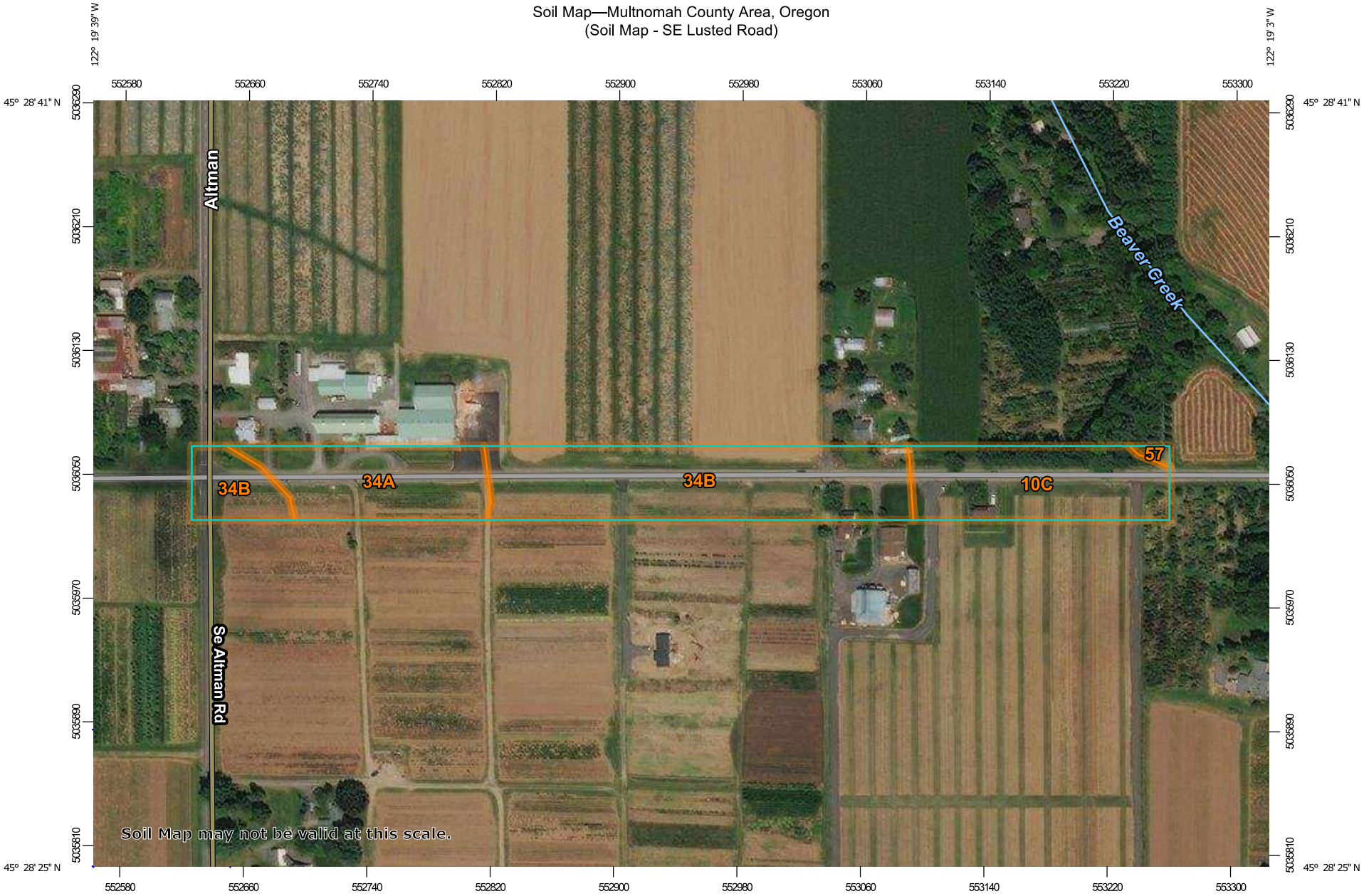
Feet
0 250 500 1000 1500

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
9B	Cazadero silty clay loam, 0 to 8 percent slopes	4.9	43.4%
9C	Cazadero silty clay loam, 8 to 15 percent slopes	0.0	0.1%
27B	Mershon silt loam, 0 to 8 percent slopes	3.4	30.2%
57	Wollent silt loam	3.0	26.4%
Totals for Area of Interest		**11.2**	**100.0%**

Soil Map—Multnomah County Area, Oregon
(Soil Map - SE Lusted Road)



Map Scale: 1:3,480 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10C	Cornelius silt loam, 8 to 15 percent slopes	1.9	25.8%
34A	Powell silt loam, 0 to 3 percent slopes	1.7	22.1%
34B	Powell silt loam, 3 to 8 percent slopes	3.9	51.4%
57	Wollent silt loam	0.1	0.7%
Totals for Area of Interest		**7.5**	**100.0%**

Soil Map—Multnomah County Area, Oregon
(Soil Map - Private Property)

Map Scale: 1:4,780 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

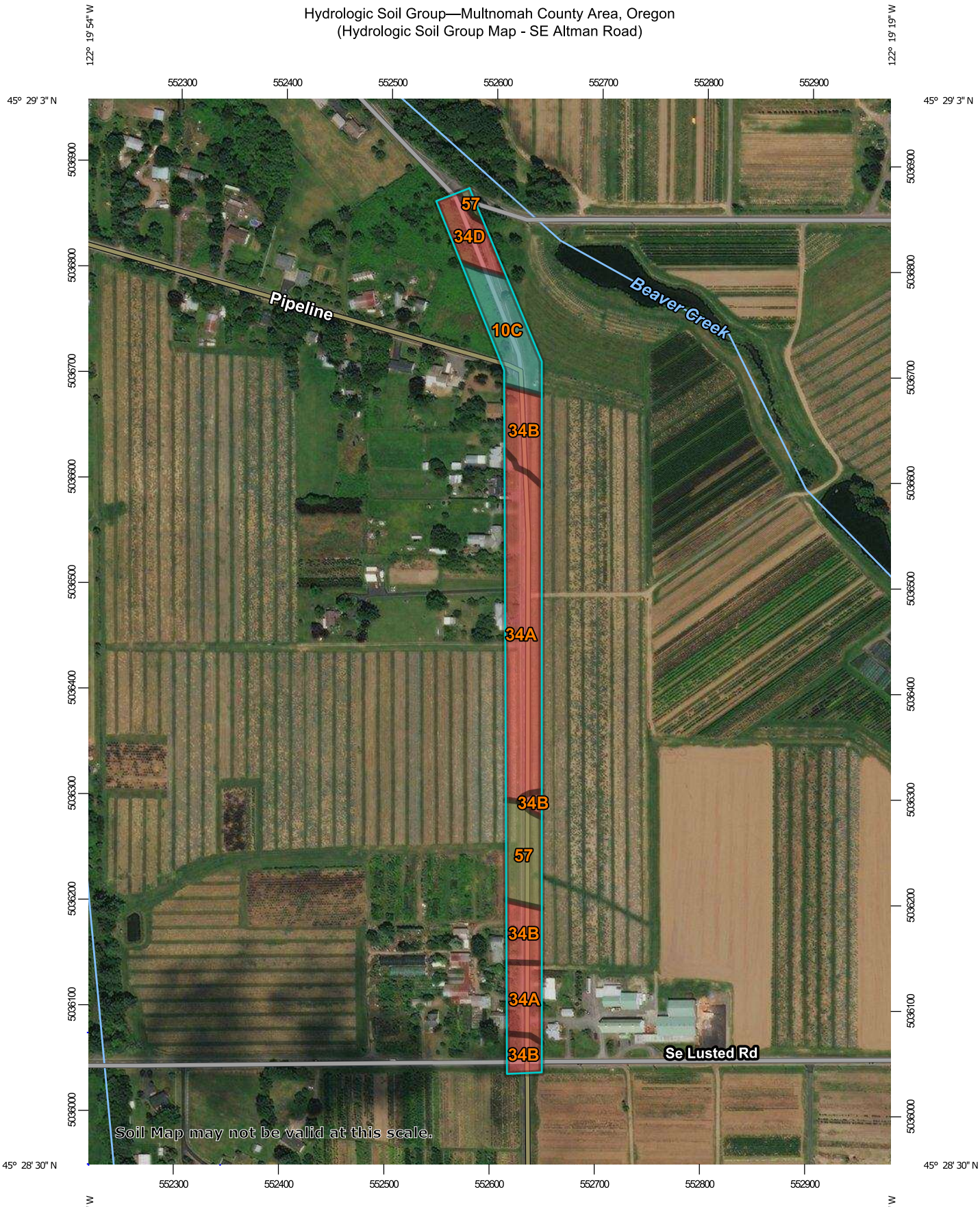
Feet
0 200 400 800 1200

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10C	Cornelius silt loam, 8 to 15 percent slopes	0.6	7.2%
27B	Mershon silt loam, 0 to 8 percent slopes	6.2	70.0%
27C	Mershon silt loam, 8 to 15 percent slopes	0.7	8.4%
57	Wollent silt loam	1.3	14.4%
Totals for Area of Interest		**8.9**	**100.0%**

Hydrologic Soil Group—Multnomah County Area, Oregon
(Hydrologic Soil Group Map - SE Altman Road)



Map Scale: 1:4,910 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

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

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

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Survey Area Data: Version 20, Oct 27, 2021

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

Date(s) aerial images were photographed: Jul 2, 2015—Sep 21, 2016

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
10C	Cornelius silt loam, 8 to 15 percent slopes	C	1.1	14.8%
34A	Powell silt loam, 0 to 3 percent slopes	D	3.2	44.8%
34B	Powell silt loam, 3 to 8 percent slopes	D	1.5	20.6%
34D	Powell silt loam, 15 to 30 percent slopes	D	0.6	8.2%
57	Wollent silt loam	C/D	0.8	11.6%
Totals for Area of Interest			**7.2**	**100.0%**

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

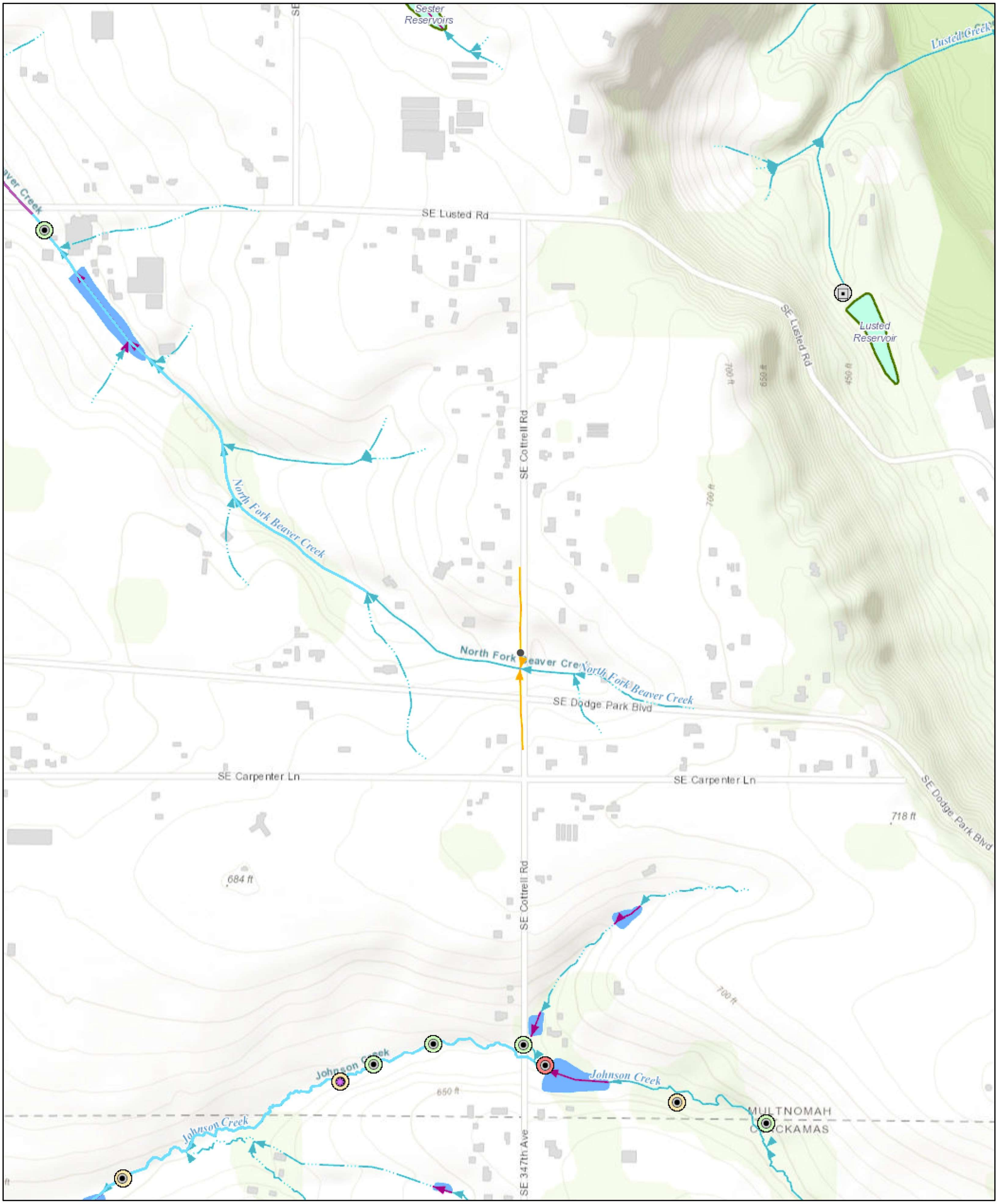
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Oregon Fish Habitat Distribution & Barriers



8/24/2022, 11:34:53 AM

Removed or Replaced Barriers
- Culvert
- Dam
- Tide gate
- Bridge
- Ford - road stream crossing
- Weir / sill
- Other (Ford, Weir, Debris Jam, Unknown)

- Unknown
- Cascades / gradient / velocity
- Natural waterfalls

Fish Passage Barriers by Passage Status
- Blocked
- Partial Passage
- Passable
- Unknown Passage

- Unknown Passage within Anadromy

Fish Passage Barriers by Type
- Culvert
- Dam
- Tide gate
- Bridge
- Ford - road stream crossing
- Weir / sill

1:9,028

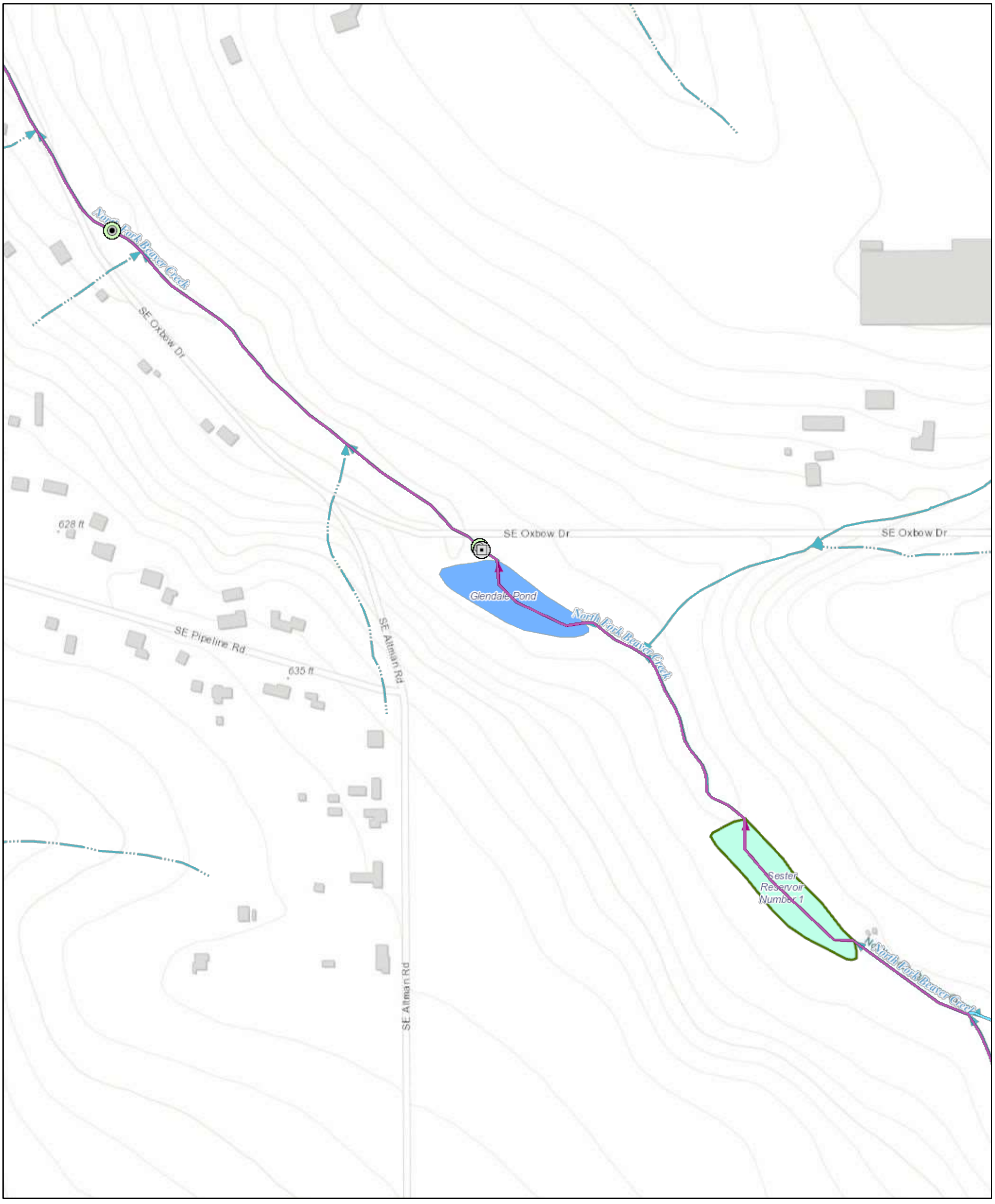
0 0.05 0.1 0.2 mi

0 0.1 0.2 0.4 km

ODFW, ODFW and multiple contributing state and federal agencies, USGS TNM – National Hydrography Dataset. Data Refreshed July, 2022., ODFW, numerous state and federal natural resource agencies including tribes have

ODFW Web Map
ODFW

Oregon Fish Habitat Distribution & Barriers



8/24/2022, 11:47:58 AM

Removed or Replaced Barriers
- Culvert
- Dam
- Tide gate
- Bridge
- Ford - road stream crossing
- Weir / sill
- Other (Ford, Weir, Debris Jam, Unknown)
- Unknown
- Cascades / gradient / velocity
- Natural waterfalls

Fish Passage Barriers by Passage Status
- Blocked
- Partial Passage
- Passable
- Unknown Passage
- Unknown Passage within Anadromy

Fish Passage Barriers by Type
- Culvert
- Dam
- Tide gate
- Bridge
- Ford - road stream crossing
- Weir / sill

1:4,514

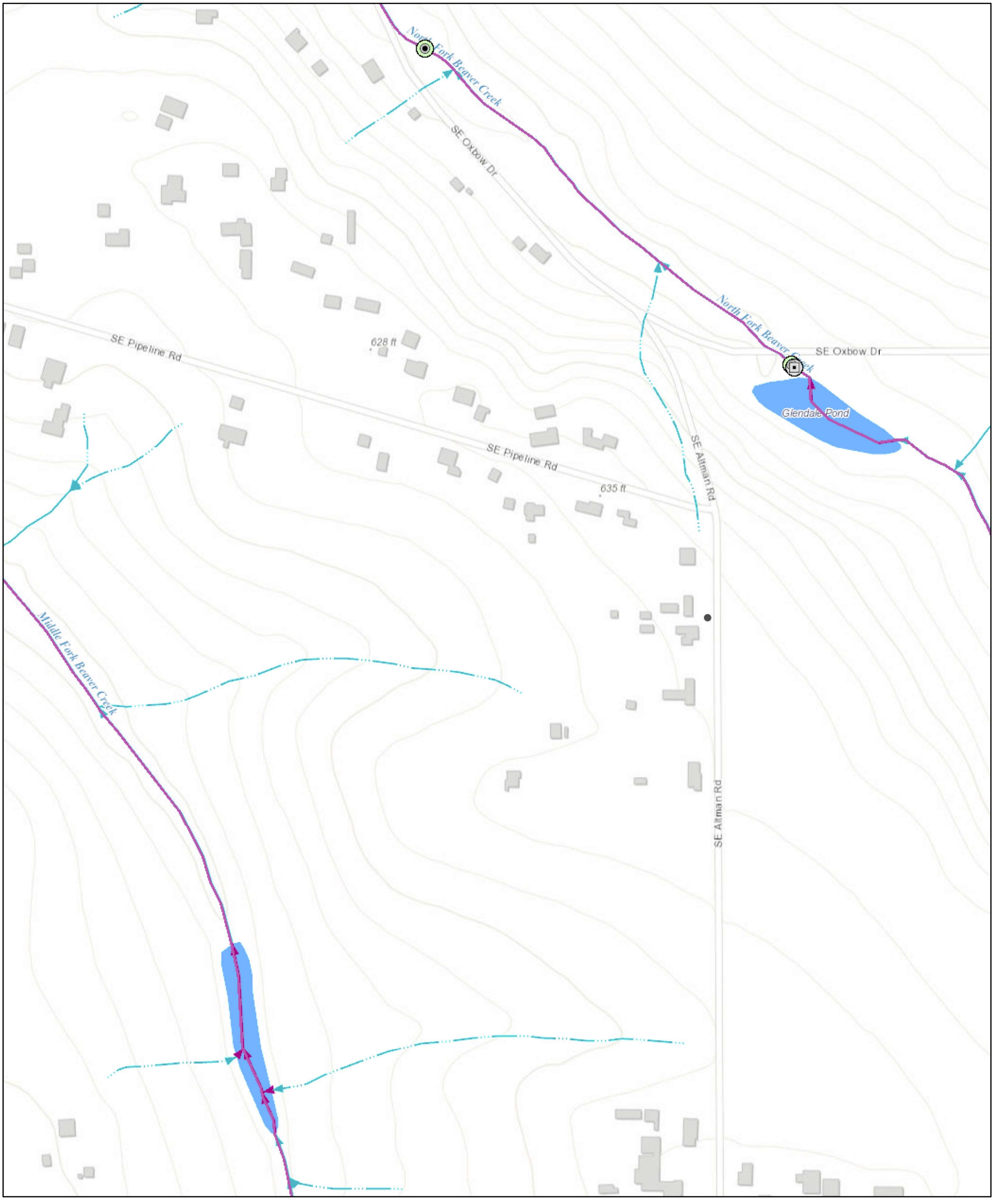
0 0.04 0.07 0.14 mi

0 0.05 0.1 0.2 km

Oregon Metro, Bureau of Land Management, State of Oregon, State of Oregon DOT, State of Oregon GEO, Esri Canada, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, EPA, USDA, ODFW, ODFW and multiple

ODFW Web Map
ODFW

Oregon Fish Habitat Distribution & Barriers



8/26/2022, 9:41:59 AM

Removed or Replaced Barriers
- Culvert
- Dam
- Tide gate
- Bridge
- Ford - road stream crossing
- Weir / sill
- Other (Ford, Weir, Debris Jam, Unknown)

- Unknown
- Cascades / gradient / velocity
- Natural waterfalls

Fish Passage Barriers by Passage Status
- Blocked
- Partial Passage
- Passable
- Unknown Passage

- Unknown Passage within Anadromy

Fish Passage Barriers by Type
- Culvert
- Dam
- Tide gate
- Bridge
- Ford - road stream crossing
- Weir / sill

1:4,514

0 0.04 0.07 0.14 mi

0 0.05 0.1 0.2 km

Oregon Metro, Bureau of Land Management, State of Oregon, State of Oregon DOT, State of Oregon GEO, Esri Canada, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, EPA, USDA, ODFW, ODFW and multiple

ODFW Web Map
ODFW

Appendix D: Calculations

SBUH Calculations for 25-year peak discharge for Hydraulic Crossings
HY-8 Calculations for Hydraulic Crossings

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

SBUH DESIGN WORKSHEET - 25-yr **POST-PROJECT**

					ZONE 8		
PROJECT:	FPP - Bull Run				**Event**	**24-hour precip (in ODOT Transgis**	
BASIN	DA 5				WQ	1.61	https //gis.odot state or.us/transgis/
OUTFALL:	Culvert (Unknown Size)				2-yr	2.40	
TREATMENT FACILITY:	N/A				5-yr	2.9	
FACILITY NAME:	N/A				10-year	3.4	
TOTAL IMPERVIOUS AREA	118,862	sq ft			25-yr	3.8	
Total Drainage Area	24.37	acre			100-yr	4.7	

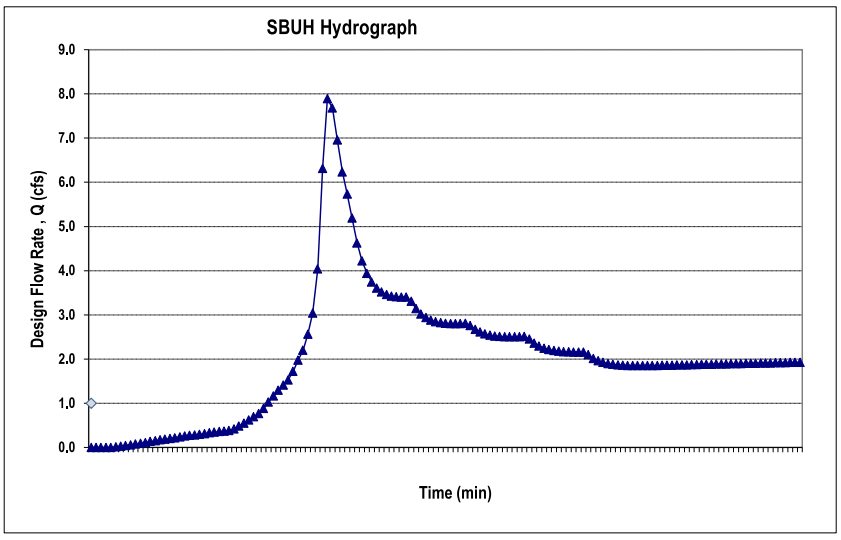
Parameters		**Units**			**Comments**			
Total length of Flow	1720	ft			Total length of sheet flow, concentrated flow and pipe flow segments			
Sheet Flow Segment								
Length	200	ft						
Slope of hydraulic Grid Line - S_o	0.02	ft/ft						
n_s - Sheet flow Manning' Effective roughness coeff.	0.15				*table III-1.4 from 1992 Puget Sound SWMM*			
Travel time (sheet Flow Segment) T_1 = $0.42\ (n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	23.0	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Shallow Concentrated Flow Segment								
Length	940	ft			Through Bioretention Basin to outlet			
S_o	0.0220	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Velocity V = 20.3282(S_o)^0.5	3.02	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
T_2 = L/(60*V)	5.2	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Ditch Flow Segment								
Length	580	ft			Assume sheet flows empty into inlets connected to pipes.			
T_3 = L/(60*V)	3.2	min			Assume pipe flow velocity of 3fps			
Given Area	2.73	acres						
P_1 Depth of Rainfall	3.80	in			25-yr			
					^change based on IDR event values.			
d_t	10	min			Time Interval			
T_c	31.4	min						
Routing Constant w= $d_t/(2T_c+d_t)$	0.137							
Pervious Area (acres)	21.64		CN	79	S = (1000/CN)-10	2.6582278	0.2*S	0.531646
Impervious Area (acres)	2.73		CN	98	S = (1000/CN)-10	0.2040816	0.2*S	0.040816

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

DEVELOPED - Upper End (25 yr)

Peak Design Flow Rate	**7.89**	**cfs**
Total Runoff	**18.18**	**in**
Total Runoff Volume	**180,089**	**cf**



	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
						Pervious Area		Impervious Area					
	Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
	1	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	10	0.004	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	20	0.004	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	30	0.004	0.015	0.046	0.000	0.000	0.000	0.000	0.000	0.002	0.000	1.085
	5	40	0.004	0.015	0.061	0.000	0.000	0.002	0.002	0.002	0.028	0.004	16.569
	6	50	0.004	0.015	0.076	0.000	0.000	0.005	0.003	0.003	0.056	0.015	33.593
	7	60	0.004	0.015	0.091	0.000	0.000	0.010	0.005	0.005	0.079	0.029	47.566

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
8	70	0.004	0.015	0.106	0.000	0.000	0.016	0.006	0.006	0.099	0.046	59.177
9	80	0.004	0.015	0.122	0.000	0.000	0.023	0.007	0.007	0.115	0.062	68.929
10	90	0.004	0.015	0.137	0.000	0.000	0.031	0.008	0.008	0.129	0.079	77.199
11	100	0.004	0.015	0.152	0.000	0.000	0.039	0.009	0.009	0.140	0.094	84.273
12	110	0.005	0.019	0.171	0.000	0.000	0.051	0.011	0.011	0.190	0.114	113.818
13	120	0.005	0.019	0.190	0.000	0.000	0.063	0.012	0.012	0.203	0.136	121.819
14	130	0.005	0.019	0.209	0.000	0.000	0.076	0.013	0.013	0.214	0.156	128.595
15	140	0.005	0.019	0.228	0.000	0.000	0.090	0.014	0.014	0.224	0.173	134.384
16	150	0.005	0.019	0.247	0.000	0.000	0.104	0.014	0.014	0.232	0.189	139.368
17	160	0.005	0.019	0.266	0.000	0.000	0.118	0.015	0.015	0.239	0.202	143.691
18	170	0.006	0.023	0.289	0.000	0.000	0.136	0.018	0.018	0.296	0.220	177.367
19	180	0.006	0.023	0.312	0.000	0.000	0.154	0.018	0.018	0.303	0.242	182.022
20	190	0.006	0.023	0.334	0.000	0.000	0.173	0.019	0.019	0.310	0.259	186.037
21	200	0.006	0.023	0.357	0.000	0.000	0.192	0.019	0.019	0.316	0.274	189.524
22	210	0.006	0.023	0.380	0.000	0.000	0.212	0.019	0.019	0.321	0.286	192.572
23	220	0.006	0.023	0.403	0.000	0.000	0.231	0.020	0.020	0.325	0.296	195.252
24	230	0.007	0.027	0.429	0.000	0.000	0.255	0.023	0.023	0.385	0.313	230.768
25	240	0.007	0.027	0.456	0.000	0.000	0.278	0.024	0.024	0.389	0.333	233.578
26	250	0.007	0.027	0.483	0.000	0.000	0.302	0.024	0.024	0.393	0.349	236.041
27	260	0.007	0.027	0.509	0.000	0.000	0.326	0.024	0.024	0.397	0.362	238.211
28	270	0.007	0.027	0.536	0.000	0.000	0.350	0.024	0.024	0.401	0.372	240.643
29	280	0.007	0.027	0.562	0.000	0.000	0.375	0.024	0.027	0.448	0.386	268.963
30	290	0.008	0.030	0.593	0.001	0.001	0.403	0.028	0.036	0.598	0.424	358.648
31	300	0.008	0.030	0.623	0.003	0.002	0.431	0.028	0.042	0.686	0.484	411.431
32	310	0.008	0.030	0.654	0.005	0.002	0.460	0.028	0.047	0.771	0.551	462.343
33	320	0.008	0.030	0.684	0.008	0.003	0.488	0.029	0.052	0.852	0.623	511.485
34	330	0.008	0.030	0.714	0.012	0.003	0.517	0.029	0.056	0.932	0.697	558.949
35	340	0.008	0.030	0.745	0.016	0.004	0.546	0.029	0.061	1.008	0.772	604.819
36	350	0.010	0.038	0.783	0.022	0.006	0.582	0.036	0.083	1.364	0.885	818.227
37	360	0.010	0.038	0.821	0.028	0.007	0.618	0.036	0.089	1.475	1.032	884.732
38	370	0.010	0.038	0.859	0.036	0.007	0.655	0.036	0.096	1.581	1.168	948.595
39	380	0.010	0.038	0.897	0.044	0.008	0.691	0.037	0.102	1.683	1.296	1009.961
40	390	0.010	0.038	0.935	0.053	0.009	0.728	0.037	0.108	1.782	1.416	1068.969
41	400	0.010	0.038	0.973	0.063	0.010	0.765	0.037	0.114	1.876	1.529	1125.742
42	410	0.013	0.049	1.022	0.076	0.014	0.812	0.048	0.156	2.575	1.721	1544.872
43	420	0.013	0.049	1.072	0.091	0.015	0.860	0.048	0.165	2.721	1.975	1632.868
44	430	0.013	0.049	1.121	0.107	0.016	0.909	0.048	0.173	2.861	2.200	1716.764
45	440	0.018	0.068	1.189	0.130	0.024	0.975	0.067	0.253	4.181	2.563	2508.449
46	450	0.018	0.068	1.258	0.156	0.025	1.042	0.067	0.268	4.421	3.040	2652.500
47	460	0.034	0.129	1.387	0.208	0.052	1.169	0.127	0.542	8.955	4.043	5373.141
48	470	0.054	0.205	1.592	0.302	0.094	1.371	0.202	0.949	15.671	6.315	9402.321
49	480	0.027	0.103	1.695	0.354	0.052	1.472	0.101	0.510	8.425	7.890	5054.755
50	490	0.018	0.068	1.763	0.390	0.036	1.540	0.068	0.352	5.813	7.678	3488.038
51	500	0.013	0.049	1.813	0.417	0.027	1.589	0.049	0.260	4.291	6.957	2574.636
52	510	0.013	0.049	1.862	0.444	0.027	1.638	0.049	0.264	4.365	6.234	2619.219
53	520	0.013	0.049	1.911	0.471	0.028	1.687	0.049	0.269	4.437	5.731	2662.157
54	530	0.009	0.034	1.946	0.491	0.020	1.720	0.034	0.189	3.112	5.193	1867.359
55	540	0.009	0.034	1.980	0.511	0.020	1.754	0.034	0.190	3.144	4.626	1886.689
56	550	0.009	0.034	2.014	0.531	0.020	1.788	0.034	0.192	3.176	4.223	1905.538
57	560	0.009	0.034	2.048	0.551	0.020	1.822	0.034	0.194	3.207	3.940	1923.921
58	570	0.009	0.034	2.082	0.571	0.020	1.856	0.034	0.196	3.236	3.742	1941.854
59	580	0.009	0.034	2.117	0.592	0.021	1.890	0.034	0.198	3.266	3.607	1959.352
60	590	0.009	0.034	2.151	0.613	0.021	1.924	0.034	0.200	3.294	3.517	1976.429
61	600	0.009	0.034	2.185	0.634	0.021	1.958	0.034	0.201	3.322	3.460	1993.097
62	610	0.009	0.034	2.219	0.655	0.021	1.992	0.034	0.203	3.349	3.426	2009.371
63	620	0.009	0.034	2.253	0.677	0.022	2.026	0.034	0.204	3.375	3.408	2025.261
64	630	0.009	0.034	2.288	0.699	0.022	2.060	0.034	0.206	3.401	3.403	2040.782
65	640	0.009	0.034	2.322	0.720	0.022	2.094	0.034	0.208	3.427	3.406	2055.942
66	650	0.007	0.027	2.348	0.738	0.017	2.120	0.026	0.162	2.682	3.309	1609.325
67	660	0.007	0.027	2.375	0.755	0.017	2.147	0.026	0.163	2.697	3.139	1618.126
68	670	0.007	0.027	2.402	0.772	0.017	2.173	0.026	0.164	2.711	3.019	1626.772
69	680	0.007	0.027	2.428	0.790	0.017	2.199	0.026	0.165	2.725	2.937	1635.265
70	690	0.007	0.027	2.455	0.807	0.018	2.226	0.026	0.166	2.739	2.881	1643.610
71	700	0.007	0.027	2.481	0.825	0.018	2.252	0.026	0.167	2.753	2.844	1651.811
72	710	0.007	0.027	2.508	0.843	0.018	2.279	0.026	0.168	2.766	2.821	1659.869
73	720	0.007	0.027	2.535	0.861	0.018	2.305	0.026	0.168	2.780	2.808	1667.790
74	730	0.007	0.027	2.561	0.879	0.018	2.332	0.026	0.169	2.793	2.802	1675.575
75	740	0.007	0.027	2.588	0.897	0.018	2.358	0.026	0.170	2.805	2.801	1683.228
76	750	0.007	0.027	2.614	0.915	0.018	2.384	0.026	0.171	2.818	2.804	1690.752
77	760	0.007	0.027	2.641	0.933	0.018	2.411	0.026	0.171	2.830	2.809	1698.149
78	770	0.006	0.023	2.664	0.949	0.016	2.434	0.023	0.148	2.436	2.761	1461.351
79	780	0.006	0.023	2.687	0.965	0.016	2.456	0.023	0.148	2.444	2.673	1466.619
80	790	0.006	0.023	2.709	0.981	0.016	2.479	0.023	0.149	2.453	2.611	1471.812
81	800	0.006	0.023	2.732	0.997	0.016	2.502	0.023	0.149	2.462	2.569	1476.932
82	810	0.006	0.023	2.755	1.013	0.016	2.524	0.023	0.150	2.470	2.541	1481.981
83	820	0.006	0.023	2.778	1.029	0.016	2.547	0.023	0.150	2.478	2.522	1486.958
84	830	0.006	0.023	2.801	1.045	0.016	2.570	0.023	0.151	2.486	2.511	1491.866
85	840	0.006	0.023	2.823	1.061	0.016	2.592	0.023	0.151	2.495	2.506	1496.707
86	850	0.006	0.023	2.846	1.077	0.016	2.615	0.023	0.152	2.502	2.504	1501.481
87	860	0.006	0.023	2.869	1.094	0.016	2.638	0.023	0.152	2.510	2.504	1506.189
88	870	0.006	0.023	2.892	1.110	0.016	2.661	0.023	0.153	2.518	2.507	1510.832
89	880	0.006	0.023	2.915	1.126	0.016	2.683	0.023	0.153	2.526	2.511	1515.413
90	890	0.005	0.019	2.934	1.140	0.014	2.702	0.019	0.128	2.110	2.458	1266.299
91	900	0.005	0.019	2.953	1.154	0.014	2.721	0.019	0.128	2.116	2.363	1269.401
92	910	0.005	0.019	2.972	1.168	0.014	2.740	0.019	0.128	2.121	2.296	1272.469
93	920	0.005	0.019	2.991	1.182	0.014	2.759	0.019	0.129	2.126	2.249	1275.503

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
94	930	0.005	0.019	3.010	1.195	0.014	2.778	0.019	0.129	2.131	2.215	1278.503
95	940	0.005	0.019	3.029	1.209	0.014	2.797	0.019	0.129	2.136	2.193	1281.470
96	950	0.005	0.019	3.048	1.223	0.014	2.816	0.019	0.130	2.141	2.178	1284.404
97	960	0.005	0.019	3.067	1.237	0.014	2.835	0.019	0.130	2.146	2.168	1287.305
98	970	0.005	0.019	3.086	1.251	0.014	2.854	0.019	0.130	2.150	2.163	1290.175
99	980	0.005	0.019	3.105	1.266	0.014	2.872	0.019	0.131	2.155	2.160	1293.014
100	990	0.005	0.019	3.124	1.280	0.014	2.891	0.019	0.131	2.160	2.159	1295.821
101	1000	0.005	0.019	3.143	1.294	0.014	2.910	0.019	0.131	2.164	2.160	1298.599
102	1010	0.004	0.015	3.158	1.305	0.011	2.925	0.015	0.105	1.735	2.102	1040.858
103	1020	0.004	0.016	3.174	1.317	0.012	2.941	0.016	0.111	1.825	2.014	1094.777
104	1030	0.004	0.016	3.190	1.329	0.012	2.957	0.016	0.111	1.828	1.962	1096.682
105	1040	0.004	0.016	3.206	1.341	0.012	2.973	0.016	0.111	1.831	1.926	1098.569
106	1050	0.004	0.016	3.222	1.353	0.012	2.989	0.016	0.111	1.834	1.900	1100.439
107	1060	0.004	0.016	3.238	1.365	0.012	3.005	0.016	0.111	1.837	1.882	1102.293
108	1070	0.004	0.016	3.254	1.377	0.012	3.021	0.016	0.111	1.840	1.870	1104.130
109	1080	0.004	0.016	3.270	1.389	0.012	3.037	0.016	0.112	1.843	1.862	1105.951
110	1090	0.004	0.016	3.285	1.401	0.012	3.053	0.016	0.112	1.846	1.858	1107.755
111	1100	0.004	0.016	3.301	1.413	0.012	3.069	0.016	0.112	1.849	1.855	1109.544
112	1110	0.004	0.016	3.317	1.426	0.012	3.084	0.016	0.112	1.852	1.854	1111.317
113	1120	0.004	0.016	3.333	1.438	0.012	3.100	0.016	0.112	1.855	1.854	1113.075
114	1130	0.004	0.016	3.349	1.450	0.012	3.116	0.016	0.113	1.858	1.855	1114.817
115	1140	0.004	0.016	3.365	1.462	0.012	3.132	0.016	0.113	1.861	1.856	1116.543
116	1150	0.004	0.016	3.381	1.474	0.012	3.148	0.016	0.113	1.864	1.858	1118.255
117	1160	0.004	0.016	3.397	1.487	0.012	3.164	0.016	0.113	1.867	1.860	1119.952
118	1170	0.004	0.016	3.413	1.499	0.012	3.180	0.016	0.113	1.869	1.862	1121.634
119	1180	0.004	0.016	3.429	1.511	0.012	3.196	0.016	0.113	1.872	1.864	1123.302
120	1190	0.004	0.016	3.445	1.523	0.012	3.212	0.016	0.114	1.875	1.867	1124.955
121	1200	0.004	0.016	3.461	1.536	0.012	3.228	0.016	0.114	1.878	1.869	1126.594
122	1210	0.004	0.016	3.477	1.548	0.012	3.244	0.016	0.114	1.880	1.872	1128.219
123	1220	0.004	0.016	3.493	1.561	0.012	3.259	0.016	0.114	1.883	1.875	1129.831
124	1230	0.004	0.016	3.509	1.573	0.012	3.275	0.016	0.114	1.886	1.877	1131.428
125	1240	0.004	0.016	3.525	1.585	0.012	3.291	0.016	0.114	1.888	1.880	1133.012
126	1250	0.004	0.016	3.541	1.598	0.012	3.307	0.016	0.115	1.891	1.883	1134.583
127	1260	0.004	0.016	3.557	1.610	0.012	3.323	0.016	0.115	1.894	1.885	1136.140
128	1270	0.004	0.016	3.573	1.623	0.012	3.339	0.016	0.115	1.896	1.888	1137.684
129	1280	0.004	0.016	3.589	1.635	0.012	3.355	0.016	0.115	1.899	1.891	1139.216
130	1290	0.004	0.016	3.605	1.648	0.013	3.371	0.016	0.115	1.901	1.893	1140.734
131	1300	0.004	0.016	3.621	1.660	0.013	3.387	0.016	0.115	1.904	1.896	1142.240
132	1310	0.004	0.016	3.637	1.673	0.013	3.403	0.016	0.115	1.906	1.898	1143.733
133	1320	0.004	0.016	3.653	1.685	0.013	3.419	0.016	0.116	1.909	1.901	1145.214
134	1330	0.004	0.016	3.669	1.698	0.013	3.434	0.016	0.116	1.911	1.903	1146.683
135	1340	0.004	0.016	3.684	1.711	0.013	3.450	0.016	0.116	1.914	1.906	1148.139
136	1350	0.004	0.016	3.700	1.723	0.013	3.466	0.016	0.116	1.916	1.908	1149.584
137	1360	0.004	0.016	3.716	1.736	0.013	3.482	0.016	0.116	1.918	1.911	1151.016
138	1370	0.004	0.016	3.732	1.749	0.013	3.498	0.016	0.116	1.921	1.913	1152.437
139	1380	0.004	0.016	3.748	1.761	0.013	3.514	0.016	0.116	1.923	1.916	1153.847
140	1390	0.004	0.016	3.764	1.774	0.013	3.530	0.016	0.117	1.925	1.918	1155.245
141	1400	0.004	0.016	3.780	1.787	0.013	3.546	0.016	0.117	1.928	1.920	1156.631
142	1410	0.004	0.016	3.796	1.799	0.013	3.562	0.016	0.117	1.930	1.923	1158.007
143	1420	0.004	0.016	3.812	1.812	0.013	3.578	0.016	0.117	1.932	1.925	1159.371
144	1430	0.004	0.016	3.828	1.825	0.013	3.594	0.016	0.117	1.935	1.927	1160.724
145	1440	0.004	0.016	3.844	1.838	0.013	3.610	0.016	0.117	1.937	1.930	1162.066
Total		**1.0**							**18.181**		**7.890**	**180088.859**

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

SBUH DESIGN WORKSHEET - 25-yr **POST-PROJECT**

PROJECT:	FPP- Bull Run			**ZONE 8**		
BASIN	DA 4			**Event**	**24-hour precip (in ODOT Transgis**	
OUTFALL:	Culvert (Unknown Size)			WQ	1.61	https //gis.odot state or.us/transgis/
TREATMENT FACILITY:	N/A			2-yr	2.40	
FACILITY NAME:	N/A			5-yr	2.9	
TOTAL IMPERVIOUS AREA	37,795	sq ft		10-year	3.4	
Total Drainage Area	12.82	acre		25-yr	3.8	
				100-yr	4.7	

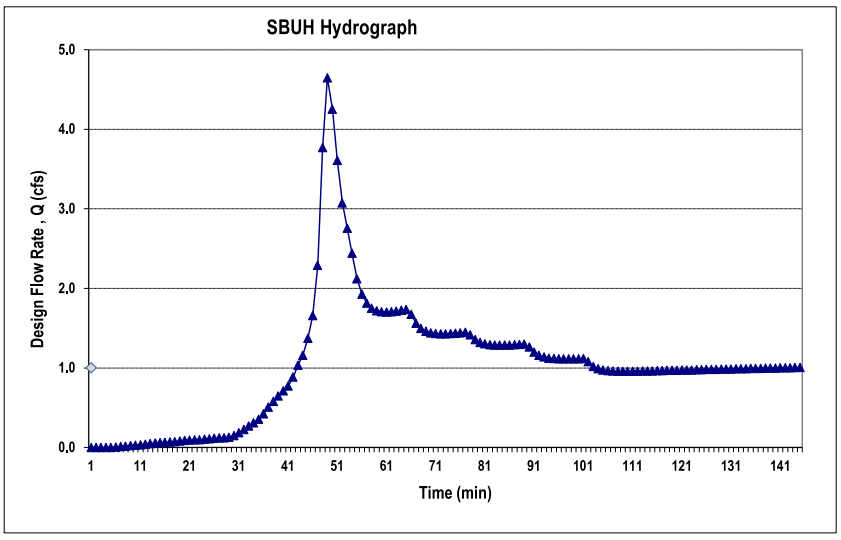
Parameters		**Units**			**Comments**
Total length of Flow	1540	ft			Total length of sheet flow, concentrated flow and pipe flow segments
Sheet Flow Segment					
Length	90	ft			
Slope of hydraulic Grid Line - S_o	0.02	ft/ft			
n_s - Sheet flow Manning' Effective roughness coeff.	0.15				*table III-1.4 from 1992 Puget Sound SWMM*
Travel time (sheet Flow Segment) T_1 = $0.42\ (n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	12.1	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Shallow Concentrated Flow Segment					
Length	940	ft			
S_o	0.0150	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Velocity V = 20.3282(S_o)^0.5	2.49	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*
T_2 = L/(60*V)	6.3	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*
Ditch Flow Segment					
Length	510	ft			
T_3 = L/(60*V)	2.8	min			
Given Area	0.87	acres			
P_1 Depth of Rainfall	3.80	in			25-yr
					^change based on IDR event values.
d_t	10	min			Time Interval
T_c	21.3	min			
Routing Constant w= $d_t/(2T_c+d_t)$	0.190				
Pervious Area (acres)	11.96		CN	79	S = (1000/CN)-10 2.6582278 0.2*S 0.531646
Impervious Area (acres)	0.87		CN	98	S = (1000/CN)-10 0.2040816 0.2*S 0.040816

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

DEVELOPED - Upper End (25 yr)

Peak Design Flow Rate	**4.64**	**cfs**
Total Runoff	**28.93**	**in**
Total Runoff Volume	**91,123**	**cf**



[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
1	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	10	0.004	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	20	0.004	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	30	0.004	0.015	0.046	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.345
5	40	0.004	0.015	0.061	0.000	0.000	0.002	0.002	0.002	0.009	0.002	5.268
6	50	0.004	0.015	0.076	0.000	0.000	0.005	0.003	0.003	0.018	0.006	10.682
7	60	0.004	0.015	0.091	0.000	0.000	0.010	0.005	0.005	0.025	0.012	15.125

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
8	70	0.004	0.015	0.106	0.000	0.000	0.016	0.006	0.006	0.031	0.018	18.817
9	80	0.004	0.015	0.122	0.000	0.000	0.023	0.007	0.007	0.037	0.024	21.918
10	90	0.004	0.015	0.137	0.000	0.000	0.031	0.008	0.008	0.041	0.030	24.547
11	100	0.004	0.015	0.152	0.000	0.000	0.039	0.009	0.009	0.045	0.035	26.796
12	110	0.005	0.019	0.171	0.000	0.000	0.051	0.011	0.011	0.060	0.041	36.191
13	120	0.005	0.019	0.190	0.000	0.000	0.063	0.012	0.012	0.065	0.049	38.735
14	130	0.005	0.019	0.209	0.000	0.000	0.076	0.013	0.013	0.068	0.056	40.890
15	140	0.005	0.019	0.228	0.000	0.000	0.090	0.014	0.014	0.071	0.061	42.730
16	150	0.005	0.019	0.247	0.000	0.000	0.104	0.014	0.014	0.074	0.065	44.315
17	160	0.005	0.019	0.266	0.000	0.000	0.118	0.015	0.015	0.076	0.069	45.690
18	170	0.006	0.023	0.289	0.000	0.000	0.136	0.018	0.018	0.094	0.075	56.398
19	180	0.006	0.023	0.312	0.000	0.000	0.154	0.018	0.018	0.096	0.083	57.878
20	190	0.006	0.023	0.334	0.000	0.000	0.173	0.019	0.019	0.099	0.088	59.155
21	200	0.006	0.023	0.357	0.000	0.000	0.192	0.019	0.019	0.100	0.093	60.264
22	210	0.006	0.023	0.380	0.000	0.000	0.212	0.019	0.019	0.102	0.096	61.233
23	220	0.006	0.023	0.403	0.000	0.000	0.231	0.020	0.020	0.103	0.099	62.085
24	230	0.007	0.027	0.429	0.000	0.000	0.255	0.023	0.023	0.122	0.104	73.378
25	240	0.007	0.027	0.456	0.000	0.000	0.278	0.024	0.024	0.124	0.111	74.272
26	250	0.007	0.027	0.483	0.000	0.000	0.302	0.024	0.024	0.125	0.116	75.055
27	260	0.007	0.027	0.509	0.000	0.000	0.326	0.024	0.024	0.126	0.120	75.745
28	270	0.007	0.027	0.536	0.000	0.000	0.350	0.024	0.024	0.128	0.123	76.638
29	280	0.007	0.027	0.562	0.000	0.000	0.375	0.024	0.029	0.153	0.129	91.885
30	290	0.008	0.030	0.593	0.001	0.001	0.403	0.028	0.042	0.221	0.151	132.899
31	300	0.008	0.030	0.623	0.003	0.002	0.431	0.028	0.051	0.269	0.187	161.651
32	310	0.008	0.030	0.654	0.005	0.002	0.460	0.028	0.060	0.316	0.227	189.415
33	320	0.008	0.030	0.684	0.008	0.003	0.488	0.029	0.069	0.360	0.270	216.240
34	330	0.008	0.030	0.714	0.012	0.003	0.517	0.029	0.077	0.404	0.312	242.173
35	340	0.008	0.030	0.745	0.016	0.004	0.546	0.029	0.085	0.445	0.355	267.254
36	350	0.010	0.038	0.783	0.022	0.006	0.582	0.036	0.117	0.614	0.422	368.105
37	360	0.010	0.038	0.821	0.028	0.007	0.618	0.036	0.128	0.674	0.506	404.523
38	370	0.010	0.038	0.859	0.036	0.007	0.655	0.036	0.140	0.733	0.581	439.517
39	380	0.010	0.038	0.897	0.044	0.008	0.691	0.037	0.150	0.789	0.650	473.164
40	390	0.010	0.038	0.935	0.053	0.009	0.728	0.037	0.161	0.843	0.713	505.535
41	400	0.010	0.038	0.973	0.063	0.010	0.765	0.037	0.170	0.894	0.772	536.694
42	410	0.013	0.049	1.022	0.076	0.014	0.812	0.048	0.236	1.237	0.884	742.403
43	420	0.013	0.049	1.072	0.091	0.015	0.860	0.048	0.251	1.318	1.034	790.743
44	430	0.013	0.049	1.121	0.107	0.016	0.909	0.048	0.266	1.395	1.157	836.850
45	440	0.018	0.068	1.189	0.130	0.024	0.975	0.067	0.391	2.052	1.372	1230.953
46	450	0.018	0.068	1.258	0.156	0.025	1.042	0.067	0.416	2.184	1.656	1310.184
47	460	0.034	0.129	1.387	0.208	0.052	1.169	0.127	0.849	4.457	2.290	2674.468
48	470	0.054	0.205	1.592	0.302	0.094	1.371	0.202	1.500	7.876	3.767	4725.875
49	480	0.027	0.103	1.695	0.354	0.052	1.472	0.101	0.812	4.263	4.644	2557.717
50	490	0.018	0.068	1.763	0.390	0.036	1.540	0.068	0.562	2.950	4.249	1770.279
51	500	0.013	0.049	1.813	0.417	0.027	1.589	0.049	0.416	2.182	3.608	1309.121
52	510	0.013	0.049	1.862	0.444	0.027	1.638	0.049	0.423	2.223	3.073	1333.694
53	520	0.013	0.049	1.911	0.471	0.028	1.687	0.049	0.431	2.262	2.756	1357.363
54	530	0.009	0.034	1.946	0.491	0.020	1.720	0.034	0.303	1.589	2.440	953.124
55	540	0.009	0.034	1.980	0.511	0.020	1.754	0.034	0.306	1.606	2.119	963.781
56	550	0.009	0.034	2.014	0.531	0.020	1.788	0.034	0.309	1.624	1.927	974.173
57	560	0.009	0.034	2.048	0.551	0.020	1.822	0.034	0.313	1.641	1.815	984.310
58	570	0.009	0.034	2.082	0.571	0.020	1.856	0.034	0.316	1.657	1.751	994.198
59	580	0.009	0.034	2.117	0.592	0.021	1.890	0.034	0.319	1.673	1.719	1003.847
60	590	0.009	0.034	2.151	0.613	0.021	1.924	0.034	0.322	1.689	1.704	1013.263
61	600	0.009	0.034	2.185	0.634	0.021	1.958	0.034	0.325	1.704	1.701	1022.456
62	610	0.009	0.034	2.219	0.655	0.021	1.992	0.034	0.327	1.719	1.705	1031.430
63	620	0.009	0.034	2.253	0.677	0.022	2.026	0.034	0.330	1.734	1.713	1040.194
64	630	0.009	0.034	2.288	0.699	0.022	2.060	0.034	0.333	1.748	1.724	1048.754
65	640	0.009	0.034	2.322	0.720	0.022	2.094	0.034	0.336	1.762	1.736	1057.116
66	650	0.007	0.027	2.348	0.738	0.017	2.120	0.026	0.263	1.380	1.673	827.860
67	660	0.007	0.027	2.375	0.755	0.017	2.147	0.026	0.264	1.388	1.563	832.714
68	670	0.007	0.027	2.402	0.772	0.017	2.173	0.026	0.266	1.396	1.498	837.483
69	680	0.007	0.027	2.428	0.790	0.017	2.199	0.026	0.267	1.404	1.460	842.168
70	690	0.007	0.027	2.455	0.807	0.018	2.226	0.026	0.269	1.411	1.440	846.772
71	700	0.007	0.027	2.481	0.825	0.018	2.252	0.026	0.270	1.419	1.431	851.295
72	710	0.007	0.027	2.508	0.843	0.018	2.279	0.026	0.272	1.426	1.428	855.741
73	720	0.007	0.027	2.535	0.861	0.018	2.305	0.026	0.273	1.434	1.428	860.110
74	730	0.007	0.027	2.561	0.879	0.018	2.332	0.026	0.274	1.441	1.432	864.405
75	740	0.007	0.027	2.588	0.897	0.018	2.358	0.026	0.276	1.448	1.436	868.627
76	750	0.007	0.027	2.614	0.915	0.018	2.384	0.026	0.277	1.455	1.442	872.778
77	760	0.007	0.027	2.641	0.933	0.018	2.411	0.026	0.278	1.461	1.448	876.859
78	770	0.006	0.023	2.664	0.949	0.016	2.434	0.023	0.240	1.258	1.414	754.790
79	780	0.006	0.023	2.687	0.965	0.016	2.456	0.023	0.241	1.263	1.356	757.697
80	790	0.006	0.023	2.709	0.981	0.016	2.479	0.023	0.241	1.268	1.321	760.562
81	800	0.006	0.023	2.732	0.997	0.016	2.502	0.023	0.242	1.272	1.302	763.387
82	810	0.006	0.023	2.755	1.013	0.016	2.524	0.023	0.243	1.277	1.291	766.172
83	820	0.006	0.023	2.778	1.029	0.016	2.547	0.023	0.244	1.282	1.287	768.919
84	830	0.006	0.023	2.801	1.045	0.016	2.570	0.023	0.245	1.286	1.286	771.627
85	840	0.006	0.023	2.823	1.061	0.016	2.592	0.023	0.246	1.290	1.287	774.298
86	850	0.006	0.023	2.846	1.077	0.016	2.615	0.023	0.247	1.295	1.289	776.932
87	860	0.006	0.023	2.869	1.094	0.016	2.638	0.023	0.248	1.299	1.292	779.529
88	870	0.006	0.023	2.892	1.110	0.016	2.661	0.023	0.248	1.303	1.296	782.092
89	880	0.006	0.023	2.915	1.126	0.016	2.683	0.023	0.249	1.308	1.299	784.619
90	890	0.005	0.019	2.934	1.140	0.014	2.702	0.019	0.208	1.093	1.262	655.756
91	900	0.005	0.019	2.953	1.154	0.014	2.721	0.019	0.209	1.096	1.198	657.468
92	910	0.005	0.019	2.972	1.168	0.014	2.740	0.019	0.209	1.099	1.160	659.161
93	920	0.005	0.019	2.991	1.182	0.014	2.759	0.019	0.210	1.101	1.137	660.835

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
94	930	0.005	0.019	3.010	1.195	0.014	2.778	0.019	0.210	1.104	1.124	662.490
95	940	0.005	0.019	3.029	1.209	0.014	2.797	0.019	0.211	1.107	1.117	664.127
96	950	0.005	0.019	3.048	1.223	0.014	2.816	0.019	0.211	1.110	1.114	665.746
97	960	0.005	0.019	3.067	1.237	0.014	2.835	0.019	0.212	1.112	1.113	667.348
98	970	0.005	0.019	3.086	1.251	0.014	2.854	0.019	0.212	1.115	1.113	668.931
99	980	0.005	0.019	3.105	1.266	0.014	2.872	0.019	0.213	1.117	1.114	670.498
100	990	0.005	0.019	3.124	1.280	0.014	2.891	0.019	0.213	1.120	1.116	672.047
101	1000	0.005	0.019	3.143	1.294	0.014	2.910	0.019	0.214	1.123	1.118	673.580
102	1010	0.004	0.015	3.158	1.305	0.011	2.925	0.015	0.171	0.900	1.077	539.956
103	1020	0.004	0.016	3.174	1.317	0.012	2.941	0.016	0.180	0.947	1.019	567.989
104	1030	0.004	0.016	3.190	1.329	0.012	2.957	0.016	0.181	0.948	0.992	569.040
105	1040	0.004	0.016	3.206	1.341	0.012	2.973	0.016	0.181	0.950	0.975	570.082
106	1050	0.004	0.016	3.222	1.353	0.012	2.989	0.016	0.181	0.952	0.966	571.114
107	1060	0.004	0.016	3.238	1.365	0.012	3.005	0.016	0.182	0.954	0.961	572.137
108	1070	0.004	0.016	3.254	1.377	0.012	3.021	0.016	0.182	0.955	0.959	573.151
109	1080	0.004	0.016	3.270	1.389	0.012	3.037	0.016	0.182	0.957	0.958	574.156
110	1090	0.004	0.016	3.285	1.401	0.012	3.053	0.016	0.183	0.959	0.958	575.152
111	1100	0.004	0.016	3.301	1.413	0.012	3.069	0.016	0.183	0.960	0.958	576.139
112	1110	0.004	0.016	3.317	1.426	0.012	3.084	0.016	0.183	0.962	0.959	577.117
113	1120	0.004	0.016	3.333	1.438	0.012	3.100	0.016	0.184	0.963	0.961	578.087
114	1130	0.004	0.016	3.349	1.450	0.012	3.116	0.016	0.184	0.965	0.962	579.049
115	1140	0.004	0.016	3.365	1.462	0.012	3.132	0.016	0.184	0.967	0.963	580.002
116	1150	0.004	0.016	3.381	1.474	0.012	3.148	0.016	0.184	0.968	0.965	580.946
117	1160	0.004	0.016	3.397	1.487	0.012	3.164	0.016	0.185	0.970	0.967	581.883
118	1170	0.004	0.016	3.413	1.499	0.012	3.180	0.016	0.185	0.971	0.968	582.811
119	1180	0.004	0.016	3.429	1.511	0.012	3.196	0.016	0.185	0.973	0.970	583.732
120	1190	0.004	0.016	3.445	1.523	0.012	3.212	0.016	0.186	0.974	0.971	584.644
121	1200	0.004	0.016	3.461	1.536	0.012	3.228	0.016	0.186	0.976	0.973	585.549
122	1210	0.004	0.016	3.477	1.548	0.012	3.244	0.016	0.186	0.977	0.974	586.446
123	1220	0.004	0.016	3.493	1.561	0.012	3.259	0.016	0.186	0.979	0.976	587.335
124	1230	0.004	0.016	3.509	1.573	0.012	3.275	0.016	0.187	0.980	0.977	588.217
125	1240	0.004	0.016	3.525	1.585	0.012	3.291	0.016	0.187	0.982	0.979	589.091
126	1250	0.004	0.016	3.541	1.598	0.012	3.307	0.016	0.187	0.983	0.980	589.958
127	1260	0.004	0.016	3.557	1.610	0.012	3.323	0.016	0.188	0.985	0.982	590.818
128	1270	0.004	0.016	3.573	1.623	0.012	3.339	0.016	0.188	0.986	0.983	591.670
129	1280	0.004	0.016	3.589	1.635	0.012	3.355	0.016	0.188	0.988	0.984	592.515
130	1290	0.004	0.016	3.605	1.648	0.013	3.371	0.016	0.188	0.989	0.986	593.353
131	1300	0.004	0.016	3.621	1.660	0.013	3.387	0.016	0.189	0.990	0.987	594.185
132	1310	0.004	0.016	3.637	1.673	0.013	3.403	0.016	0.189	0.992	0.989	595.009
133	1320	0.004	0.016	3.653	1.685	0.013	3.419	0.016	0.189	0.993	0.990	595.826
134	1330	0.004	0.016	3.669	1.698	0.013	3.434	0.016	0.189	0.994	0.991	596.637
135	1340	0.004	0.016	3.684	1.711	0.013	3.450	0.016	0.190	0.996	0.993	597.441
136	1350	0.004	0.016	3.700	1.723	0.013	3.466	0.016	0.190	0.997	0.994	598.238
137	1360	0.004	0.016	3.716	1.736	0.013	3.482	0.016	0.190	0.998	0.996	599.029
138	1370	0.004	0.016	3.732	1.749	0.013	3.498	0.016	0.190	1.000	0.997	599.813
139	1380	0.004	0.016	3.748	1.761	0.013	3.514	0.016	0.191	1.001	0.998	600.591
140	1390	0.004	0.016	3.764	1.774	0.013	3.530	0.016	0.191	1.002	1.000	601.363
141	1400	0.004	0.016	3.780	1.787	0.013	3.546	0.016	0.191	1.004	1.001	602.128
142	1410	0.004	0.016	3.796	1.799	0.013	3.562	0.016	0.191	1.005	1.002	602.887
143	1420	0.004	0.016	3.812	1.812	0.013	3.578	0.016	0.192	1.006	1.003	603.640
144	1430	0.004	0.016	3.828	1.825	0.013	3.594	0.016	0.192	1.007	1.005	604.387
145	1440	0.004	0.016	3.844	1.838	0.013	3.610	0.016	0.192	1.009	1.006	605.128
Total		**1.0**							**28.932**		**4.644**	**91123.365**

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

SBUH DESIGN WORKSHEET - 25-yr **POST-PROJECT**

				ZONE 8		
PROJECT:	FPP- Bull Run			**Event**	**24-hour precip (in ODOT Transgis**	
BASIN	DA 3			WQ	1.61	https //gis.odot state or.us/transgis/
OUTFALL:	24" CPP			2-yr	2.40	
TREATMENT FACILITY:	N/A			5-yr	2.9	
FACILITY NAME:	N/A			10-year	3.4	
TOTAL IMPERVIOUS AREA	122,155	sq ft		25-yr	3.8	
Total Drainage Area	90.27	acre		100-yr	4.7	

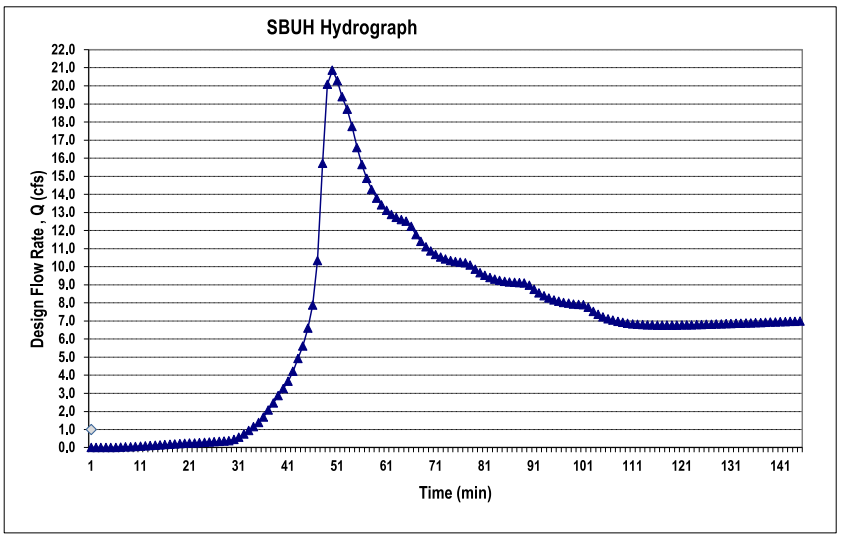
Parameters		**Units**			**Comments**			
Total length of Flow	4270	ft			Total length of sheet flow, concentrated flow and pipe flow segments			
Sheet Flow Segment								
Length	200	ft						
Slope of hydraulic Grid Line - S_o	0.01	ft/ft						
n_s - Sheet flow Manning' Effective roughness coeff.	0.15				*table III-1.4 from 1992 Puget Sound SWMM*			
Travel time (sheet Flow Segment) T_1 = $0.42\ (n_sL)^{0.8}/((1.58*(S_o)^{0.4})$	30.3	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Shallow Concentrated Flow Segment								
Length	100	ft						
S_o	0.0100	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Velocity V = 20.3282(S_o)^0.5	2.03	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
T_2 = L/(60*V)	0.8	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Pipe Flow Segment								
Length	3970	ft						
T_3 = L/(60*V)	22.1	min						
Given Area	2.80	acres						
P_1 Depth of Rainfall	3.80	in			25-yr			
					^change based on IDR event values.			
d_t	10	min			Time Interval			
T_c	53.2	min						
Routing Constant w= $d_t/(2T_c+d_t)$	0.086							
Pervious Area (acres)	87.46		CN	79	S = (1000/CN)-10	2.6582278	0.2*S	0.531646
Impervious Area (acres)	2.80		CN	98	S = (1000/CN)-10	0.2040816	0.2*S	0.040816

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

DEVELOPED - Upper End (25 yr)

Peak Design Flow Rate	**20.86**	**cfs**
Total Runoff	**60.93**	**in**
Total Runoff Volume	**620,204**	**cf**



	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
						Pervious Area		Impervious Area					
	Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
	1	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	10	0.004	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	20	0.004	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	30	0.004	0.015	0.046	0.000	0.000	0.000	0.000	0.000	0.002	0.000	1.115
	5	40	0.004	0.015	0.061	0.000	0.000	0.002	0.002	0.002	0.028	0.003	17.028
	6	50	0.004	0.015	0.076	0.000	0.000	0.005	0.003	0.003	0.058	0.010	34.523
	7	60	0.004	0.015	0.091	0.000	0.000	0.010	0.005	0.005	0.081	0.020	48.884

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
8	70	0.004	0.015	0.106	0.000	0.000	0.016	0.006	0.006	0.101	0.032	60.816
9	80	0.004	0.015	0.122	0.000	0.000	0.023	0.007	0.007	0.118	0.046	70.838
10	90	0.004	0.015	0.137	0.000	0.000	0.031	0.008	0.008	0.132	0.059	79.338
11	100	0.004	0.015	0.152	0.000	0.000	0.039	0.009	0.009	0.144	0.073	86.607
12	110	0.005	0.019	0.171	0.000	0.000	0.051	0.011	0.011	0.195	0.089	116.972
13	120	0.005	0.019	0.190	0.000	0.000	0.063	0.012	0.012	0.209	0.109	125.194
14	130	0.005	0.019	0.209	0.000	0.000	0.076	0.013	0.013	0.220	0.127	132.158
15	140	0.005	0.019	0.228	0.000	0.000	0.090	0.014	0.014	0.230	0.144	138.107
16	150	0.005	0.019	0.247	0.000	0.000	0.104	0.014	0.014	0.239	0.159	143.229
17	160	0.005	0.019	0.266	0.000	0.000	0.118	0.015	0.015	0.246	0.174	147.672
18	170	0.006	0.023	0.289	0.000	0.000	0.136	0.018	0.018	0.304	0.191	182.281
19	180	0.006	0.023	0.312	0.000	0.000	0.154	0.018	0.018	0.312	0.211	187.065
20	190	0.006	0.023	0.334	0.000	0.000	0.173	0.019	0.019	0.319	0.229	191.191
21	200	0.006	0.023	0.357	0.000	0.000	0.192	0.019	0.019	0.325	0.245	194.774
22	210	0.006	0.023	0.380	0.000	0.000	0.212	0.019	0.019	0.330	0.259	197.907
23	220	0.006	0.023	0.403	0.000	0.000	0.231	0.020	0.020	0.334	0.272	200.661
24	230	0.007	0.027	0.429	0.000	0.000	0.255	0.023	0.023	0.395	0.288	237.161
25	240	0.007	0.027	0.456	0.000	0.000	0.278	0.024	0.024	0.400	0.307	240.049
26	250	0.007	0.027	0.483	0.000	0.000	0.302	0.024	0.024	0.404	0.323	242.580
27	260	0.007	0.027	0.509	0.000	0.000	0.326	0.024	0.024	0.408	0.337	244.811
28	270	0.007	0.027	0.536	0.000	0.000	0.350	0.024	0.024	0.415	0.350	248.845
29	280	0.007	0.027	0.562	0.000	0.000	0.375	0.024	0.035	0.597	0.377	358.165
30	290	0.008	0.030	0.593	0.001	0.001	0.403	0.028	0.060	1.018	0.451	610.931
31	300	0.008	0.030	0.623	0.003	0.002	0.431	0.028	0.080	1.365	0.578	818.974
32	310	0.008	0.030	0.654	0.005	0.002	0.460	0.028	0.100	1.700	0.742	1020.048
33	320	0.008	0.030	0.684	0.008	0.003	0.488	0.029	0.119	2.024	0.935	1214.477
34	330	0.008	0.030	0.714	0.012	0.003	0.517	0.029	0.138	2.338	1.149	1402.561
35	340	0.008	0.030	0.745	0.016	0.004	0.546	0.029	0.156	2.641	1.379	1584.583
36	350	0.010	0.038	0.783	0.022	0.006	0.582	0.036	0.219	3.713	1.688	2227.888
37	360	0.010	0.038	0.821	0.028	0.007	0.618	0.036	0.245	4.154	2.074	2492.480
38	370	0.010	0.038	0.859	0.036	0.007	0.655	0.036	0.270	4.578	2.468	2746.862
39	380	0.010	0.038	0.897	0.044	0.008	0.691	0.037	0.294	4.986	2.866	2991.562
40	390	0.010	0.038	0.935	0.053	0.009	0.728	0.037	0.317	5.378	3.264	3227.074
41	400	0.010	0.038	0.973	0.063	0.010	0.765	0.037	0.339	5.756	3.660	3453.857
42	410	0.013	0.049	1.022	0.076	0.014	0.812	0.048	0.473	8.026	4.215	4815.463
43	420	0.013	0.049	1.072	0.091	0.015	0.860	0.048	0.508	8.613	4.920	5167.529
44	430	0.013	0.049	1.121	0.107	0.016	0.909	0.048	0.541	9.172	5.603	5503.442
45	440	0.018	0.068	1.189	0.130	0.024	0.975	0.067	0.800	13.578	6.595	8146.610
46	450	0.018	0.068	1.258	0.156	0.025	1.042	0.067	0.857	14.540	7.878	8724.205
47	460	0.034	0.129	1.387	0.208	0.052	1.169	0.127	1.762	29.892	10.342	17935.237
48	470	0.054	0.205	1.592	0.302	0.094	1.371	0.202	3.141	53.290	15.712	31974.163
49	480	0.027	0.103	1.695	0.354	0.052	1.472	0.101	1.710	29.014	20.084	17408.683
50	490	0.018	0.068	1.763	0.390	0.036	1.540	0.068	1.187	20.135	20.856	12081.289
51	500	0.013	0.049	1.813	0.417	0.027	1.589	0.049	0.879	14.914	20.283	8948.693
52	510	0.013	0.049	1.862	0.444	0.027	1.638	0.049	0.897	15.214	19.386	9128.128
53	520	0.013	0.049	1.911	0.471	0.028	1.687	0.049	0.914	15.502	18.694	9300.968
54	530	0.009	0.034	1.946	0.491	0.020	1.720	0.034	0.642	10.895	17.750	6537.070
55	540	0.009	0.034	1.980	0.511	0.020	1.754	0.034	0.650	11.025	16.583	6614.900
56	550	0.009	0.034	2.014	0.531	0.020	1.788	0.034	0.657	11.151	15.639	6690.799
57	560	0.009	0.034	2.048	0.551	0.020	1.822	0.034	0.665	11.275	14.878	6764.830
58	570	0.009	0.034	2.082	0.571	0.020	1.856	0.034	0.672	11.395	14.269	6837.055
59	580	0.009	0.034	2.117	0.592	0.021	1.890	0.034	0.679	11.513	13.785	6907.531
60	590	0.009	0.034	2.151	0.613	0.021	1.924	0.034	0.685	11.627	13.405	6976.315
61	600	0.009	0.034	2.185	0.634	0.021	1.958	0.034	0.692	11.739	13.109	7043.461
62	610	0.009	0.034	2.219	0.655	0.021	1.992	0.034	0.698	11.848	12.883	7109.020
63	620	0.009	0.034	2.253	0.677	0.022	2.026	0.034	0.705	11.955	12.714	7173.041
64	630	0.009	0.034	2.288	0.699	0.022	2.060	0.034	0.711	12.059	12.593	7235.573
65	640	0.009	0.034	2.322	0.720	0.022	2.094	0.034	0.717	12.161	12.510	7296.662
66	650	0.007	0.027	2.348	0.738	0.017	2.120	0.026	0.562	9.528	12.224	5716.518
67	660	0.007	0.027	2.375	0.755	0.017	2.147	0.026	0.565	9.587	11.765	5751.985
68	670	0.007	0.027	2.402	0.772	0.017	2.173	0.026	0.568	9.645	11.396	5786.826
69	680	0.007	0.027	2.428	0.790	0.017	2.199	0.026	0.572	9.702	11.100	5821.057
70	690	0.007	0.027	2.455	0.807	0.018	2.226	0.026	0.575	9.758	10.864	5854.690
71	700	0.007	0.027	2.481	0.825	0.018	2.252	0.026	0.578	9.813	10.679	5887.741
72	710	0.007	0.027	2.508	0.843	0.018	2.279	0.026	0.582	9.867	10.535	5920.222
73	720	0.007	0.027	2.535	0.861	0.018	2.305	0.026	0.585	9.920	10.425	5952.147
74	730	0.007	0.027	2.561	0.879	0.018	2.332	0.026	0.588	9.973	10.342	5983.528
75	740	0.007	0.027	2.588	0.897	0.018	2.358	0.026	0.591	10.024	10.283	6014.377
76	750	0.007	0.027	2.614	0.915	0.018	2.384	0.026	0.594	10.075	10.243	6044.707
77	760	0.007	0.027	2.641	0.933	0.018	2.411	0.026	0.597	10.124	10.218	6074.529
78	770	0.006	0.023	2.664	0.949	0.016	2.434	0.023	0.514	8.717	10.081	5230.098
79	780	0.006	0.023	2.687	0.965	0.016	2.456	0.023	0.516	8.752	9.850	5251.336
80	790	0.006	0.023	2.709	0.981	0.016	2.479	0.023	0.518	8.787	9.664	5272.274
81	800	0.006	0.023	2.732	0.997	0.016	2.502	0.023	0.520	8.822	9.516	5292.917
82	810	0.006	0.023	2.755	1.013	0.016	2.524	0.023	0.522	8.855	9.400	5313.271
83	820	0.006	0.023	2.778	1.029	0.016	2.547	0.023	0.524	8.889	9.309	5333.340
84	830	0.006	0.023	2.801	1.045	0.016	2.570	0.023	0.526	8.922	9.240	5353.131
85	840	0.006	0.023	2.823	1.061	0.016	2.592	0.023	0.528	8.954	9.188	5372.648
86	850	0.006	0.023	2.846	1.077	0.016	2.615	0.023	0.530	8.986	9.151	5391.896
87	860	0.006	0.023	2.869	1.094	0.016	2.638	0.023	0.532	9.018	9.125	5410.881
88	870	0.006	0.023	2.892	1.110	0.016	2.661	0.023	0.533	9.049	9.109	5429.607
89	880	0.006	0.023	2.915	1.126	0.016	2.683	0.023	0.535	9.080	9.102	5448.078
90	890	0.005	0.019	2.934	1.140	0.014	2.702	0.019	0.447	7.590	8.970	4553.995
91	900	0.005	0.019	2.953	1.154	0.014	2.721	0.019	0.449	7.611	8.735	4566.507
92	910	0.005	0.019	2.972	1.168	0.014	2.740	0.019	0.450	7.631	8.543	4578.879
93	920	0.005	0.019	2.991	1.182	0.014	2.759	0.019	0.451	7.652	8.388	4591.113

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
94	930	0.005	0.019	3.010	1.195	0.014	2.778	0.019	0.452	7.672	8.263	4603.212
95	940	0.005	0.019	3.029	1.209	0.014	2.797	0.019	0.453	7.692	8.164	4615.176
96	950	0.005	0.019	3.048	1.223	0.014	2.816	0.019	0.455	7.712	8.084	4627.009
97	960	0.005	0.019	3.067	1.237	0.014	2.835	0.019	0.456	7.731	8.022	4638.711
98	970	0.005	0.019	3.086	1.251	0.014	2.854	0.019	0.457	7.750	7.974	4650.286
99	980	0.005	0.019	3.105	1.266	0.014	2.872	0.019	0.458	7.770	7.937	4661.734
100	990	0.005	0.019	3.124	1.280	0.014	2.891	0.019	0.459	7.788	7.910	4673.059
101	1000	0.005	0.019	3.143	1.294	0.014	2.910	0.019	0.460	7.807	7.890	4684.260
102	1010	0.004	0.015	3.158	1.305	0.011	2.925	0.015	0.369	6.259	7.743	3755.392
103	1020	0.004	0.016	3.174	1.317	0.012	2.941	0.016	0.388	6.585	7.516	3950.727
104	1030	0.004	0.016	3.190	1.329	0.012	2.957	0.016	0.389	6.597	7.357	3958.409
105	1040	0.004	0.016	3.206	1.341	0.012	2.973	0.016	0.390	6.610	7.228	3966.021
106	1050	0.004	0.016	3.222	1.353	0.012	2.989	0.016	0.390	6.623	7.123	3973.565
107	1060	0.004	0.016	3.238	1.365	0.012	3.005	0.016	0.391	6.635	7.038	3981.042
108	1070	0.004	0.016	3.254	1.377	0.012	3.021	0.016	0.392	6.647	6.970	3988.452
109	1080	0.004	0.016	3.270	1.389	0.012	3.037	0.016	0.393	6.660	6.915	3995.797
110	1090	0.004	0.016	3.285	1.401	0.012	3.053	0.016	0.393	6.672	6.872	4003.076
111	1100	0.004	0.016	3.301	1.413	0.012	3.069	0.016	0.394	6.684	6.839	4010.292
112	1110	0.004	0.016	3.317	1.426	0.012	3.084	0.016	0.395	6.696	6.813	4017.443
113	1120	0.004	0.016	3.333	1.438	0.012	3.100	0.016	0.395	6.708	6.794	4024.532
114	1130	0.004	0.016	3.349	1.450	0.012	3.116	0.016	0.396	6.719	6.780	4031.559
115	1140	0.004	0.016	3.365	1.462	0.012	3.132	0.016	0.397	6.731	6.771	4038.525
116	1150	0.004	0.016	3.381	1.474	0.012	3.148	0.016	0.397	6.742	6.765	4045.430
117	1160	0.004	0.016	3.397	1.487	0.012	3.164	0.016	0.398	6.754	6.762	4052.276
118	1170	0.004	0.016	3.413	1.499	0.012	3.180	0.016	0.399	6.765	6.762	4059.062
119	1180	0.004	0.016	3.429	1.511	0.012	3.196	0.016	0.399	6.776	6.763	4065.789
120	1190	0.004	0.016	3.445	1.523	0.012	3.212	0.016	0.400	6.787	6.766	4072.459
121	1200	0.004	0.016	3.461	1.536	0.012	3.228	0.016	0.401	6.798	6.771	4079.072
122	1210	0.004	0.016	3.477	1.548	0.012	3.244	0.016	0.401	6.809	6.777	4085.628
123	1220	0.004	0.016	3.493	1.561	0.012	3.259	0.016	0.402	6.820	6.783	4092.128
124	1230	0.004	0.016	3.509	1.573	0.012	3.275	0.016	0.403	6.831	6.790	4098.573
125	1240	0.004	0.016	3.525	1.585	0.012	3.291	0.016	0.403	6.842	6.798	4104.963
126	1250	0.004	0.016	3.541	1.598	0.012	3.307	0.016	0.404	6.852	6.807	4111.299
127	1260	0.004	0.016	3.557	1.610	0.012	3.323	0.016	0.404	6.863	6.815	4117.582
128	1270	0.004	0.016	3.573	1.623	0.012	3.339	0.016	0.405	6.873	6.824	4123.812
129	1280	0.004	0.016	3.589	1.635	0.012	3.355	0.016	0.406	6.883	6.834	4129.990
130	1290	0.004	0.016	3.605	1.648	0.013	3.371	0.016	0.406	6.894	6.843	4136.116
131	1300	0.004	0.016	3.621	1.660	0.013	3.387	0.016	0.407	6.904	6.853	4142.192
132	1310	0.004	0.016	3.637	1.673	0.013	3.403	0.016	0.408	6.914	6.862	4148.216
133	1320	0.004	0.016	3.653	1.685	0.013	3.419	0.016	0.408	6.924	6.872	4154.191
134	1330	0.004	0.016	3.669	1.698	0.013	3.434	0.016	0.409	6.934	6.882	4160.117
135	1340	0.004	0.016	3.684	1.711	0.013	3.450	0.016	0.409	6.943	6.891	4165.993
136	1350	0.004	0.016	3.700	1.723	0.013	3.466	0.016	0.410	6.953	6.901	4171.821
137	1360	0.004	0.016	3.716	1.736	0.013	3.482	0.016	0.410	6.963	6.911	4177.602
138	1370	0.004	0.016	3.732	1.749	0.013	3.498	0.016	0.411	6.972	6.921	4183.335
139	1380	0.004	0.016	3.748	1.761	0.013	3.514	0.016	0.412	6.982	6.930	4189.022
140	1390	0.004	0.016	3.764	1.774	0.013	3.530	0.016	0.412	6.991	6.940	4194.662
141	1400	0.004	0.016	3.780	1.787	0.013	3.546	0.016	0.413	7.000	6.950	4200.256
142	1410	0.004	0.016	3.796	1.799	0.013	3.562	0.016	0.413	7.010	6.959	4205.806
143	1420	0.004	0.016	3.812	1.812	0.013	3.578	0.016	0.414	7.019	6.969	4211.310
144	1430	0.004	0.016	3.828	1.825	0.013	3.594	0.016	0.414	7.028	6.978	4216.770
145	1440	0.004	0.016	3.844	1.838	0.013	3.610	0.016	0.415	7.037	6.987	4222.187
Total		**1.0**							**60.926**		**20.856**	**620204.173**

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

SBUH DESIGN WORKSHEET - 25-yr **POST-PROJECT**

					ZONE 8		
PROJECT:	FPP- Bull Run				**Event**	**24-hour precip (in ODOT Transgis**	
BASIN	DA 1				WQ	1.61	https //gis.odot state or.us/transgis/
OUTFALL:	12" CPP				2-yr	2.40	
TREATMENT FACILITY:	N/A				5-yr	2.9	
FACILITY NAME:	N/A				10-year	3.4	
TOTAL IMPERVIOUS AREA	32,500	sq ft			25-yr	3.8	
Total Drainage Area	28.29	acre			100-yr	4.7	

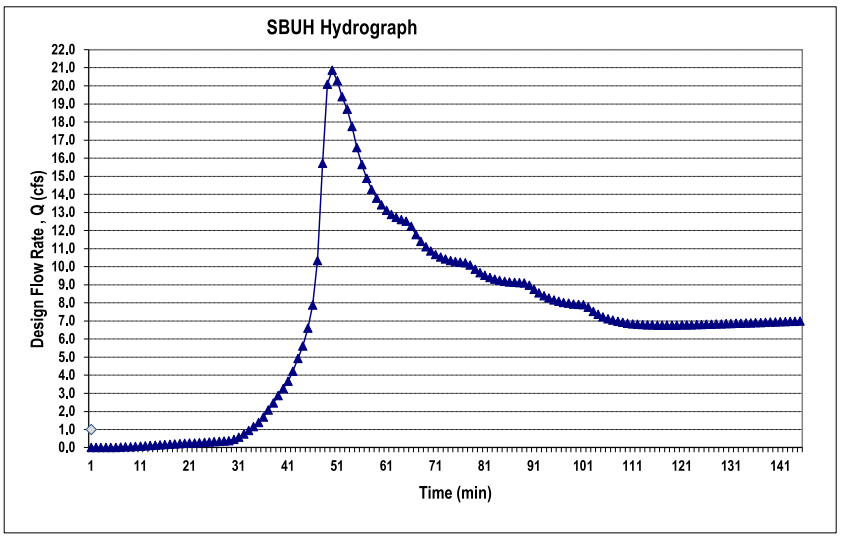
Parameters		**Units**			**Comments**			
Total length of Flow	1100	ft			Total length of sheet flow, concentrated flow and pipe flow segments			
Sheet Flow Segment								
Length	200	ft						
Slope of hydraulic Grid Line - S_o	0.01	ft/ft						
n_s - Sheet flow Manning' Effective roughness coeff.	0.15				*table III-1.4 from 1992 Puget Sound SWMM*			
Travel time (sheet Flow Segment) T_1 = $0.42\ (n_s L)^{0.8}/((1.58*(S_o)^{0.4})$	30.3	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Shallow Concentrated Flow Segment								
Length	550	ft						
S_o	0.0110	ft/ft			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Velocity V = 20.3282(S_o)^0.5	2.13	ft/s			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
T_2 = L/(60*V)	4.3	min			*[City of Portland Stormwater Management Manual 2004 page C-2]*			
Pipe Flow Segment								
Length	350	ft						
T_3 = L/(60*V)	1.9	min						
Given Area	0.75	acres						
P_1 Depth of Rainfall	3.80	in			25-yr			
					^change based on IDR event values.			
d_t	10	min			Time Interval			
T_c	36.6	min						
Routing Constant w= $d_t/(2T_c+d_t)$	0.120							
Pervious Area (acres)	27.55		CN	79	S = (1000/CN)-10	2.6582278	0.2*S	0.531646
Impervious Area (acres)	0.75		CN	98	S = (1000/CN)-10	0.2040816	0.2*S	0.040816

Summary Results

Santa Barbara Urban Hydrograph (SBUH) Method Using SCS Type 1A Storm Distribution

DEVELOPED - Upper End (25 yr)

Peak Design Flow Rate	**7.67**	**cfs**
Total Runoff	**71.46**	**in**
Total Runoff Volume	**193,528**	**cf**



[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
1	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	10	0.004	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	20	0.004	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	30	0.004	0.015	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.297
5	40	0.004	0.015	0.061	0.000	0.000	0.002	0.002	0.002	0.008	0.001	4.530
6	50	0.004	0.015	0.076	0.000	0.000	0.005	0.003	0.003	0.015	0.004	9.185
7	60	0.004	0.015	0.091	0.000	0.000	0.010	0.005	0.005	0.022	0.007	13.006

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
8	70	0.004	0.015	0.106	0.000	0.000	0.016	0.006	0.006	0.027	0.011	16.180
9	80	0.004	0.015	0.122	0.000	0.000	0.023	0.007	0.007	0.031	0.016	18.847
10	90	0.004	0.015	0.137	0.000	0.000	0.031	0.008	0.008	0.035	0.020	21.108
11	100	0.004	0.015	0.152	0.000	0.000	0.039	0.009	0.009	0.038	0.024	23.042
12	110	0.005	0.019	0.171	0.000	0.000	0.051	0.011	0.011	0.052	0.029	31.121
13	120	0.005	0.019	0.190	0.000	0.000	0.063	0.012	0.012	0.056	0.035	33.309
14	130	0.005	0.019	0.209	0.000	0.000	0.076	0.013	0.013	0.059	0.040	35.161
15	140	0.005	0.019	0.228	0.000	0.000	0.090	0.014	0.014	0.061	0.045	36.744
16	150	0.005	0.019	0.247	0.000	0.000	0.104	0.014	0.014	0.064	0.049	38.107
17	160	0.005	0.019	0.266	0.000	0.000	0.118	0.015	0.015	0.065	0.053	39.289
18	170	0.006	0.023	0.289	0.000	0.000	0.136	0.018	0.018	0.081	0.058	48.497
19	180	0.006	0.023	0.312	0.000	0.000	0.154	0.018	0.018	0.083	0.064	49.770
20	190	0.006	0.023	0.334	0.000	0.000	0.173	0.019	0.019	0.085	0.068	50.867
21	200	0.006	0.023	0.357	0.000	0.000	0.192	0.019	0.019	0.086	0.073	51.821
22	210	0.006	0.023	0.380	0.000	0.000	0.212	0.019	0.019	0.088	0.076	52.654
23	220	0.006	0.023	0.403	0.000	0.000	0.231	0.020	0.020	0.089	0.079	53.387
24	230	0.007	0.027	0.429	0.000	0.000	0.255	0.023	0.023	0.105	0.083	63.098
25	240	0.007	0.027	0.456	0.000	0.000	0.278	0.024	0.024	0.106	0.089	63.866
26	250	0.007	0.027	0.483	0.000	0.000	0.302	0.024	0.024	0.108	0.093	64.540
27	260	0.007	0.027	0.509	0.000	0.000	0.326	0.024	0.024	0.109	0.097	65.133
28	270	0.007	0.027	0.536	0.000	0.000	0.350	0.024	0.024	0.111	0.100	66.307
29	280	0.007	0.027	0.562	0.000	0.000	0.375	0.024	0.037	0.168	0.109	100.650
30	290	0.008	0.030	0.593	0.001	0.001	0.403	0.028	0.066	0.297	0.139	178.426
31	300	0.008	0.030	0.623	0.003	0.002	0.431	0.028	0.090	0.406	0.190	243.857
32	310	0.008	0.030	0.654	0.005	0.002	0.460	0.028	0.113	0.512	0.255	307.104
33	320	0.008	0.030	0.684	0.008	0.003	0.488	0.029	0.136	0.614	0.329	368.266
34	330	0.008	0.030	0.714	0.012	0.003	0.517	0.029	0.158	0.712	0.409	427.437
35	340	0.008	0.030	0.745	0.016	0.004	0.546	0.029	0.179	0.808	0.494	484.705
36	350	0.010	0.038	0.783	0.022	0.006	0.582	0.036	0.252	1.139	0.609	683.650
37	360	0.010	0.038	0.821	0.028	0.007	0.618	0.036	0.283	1.278	0.754	766.908
38	370	0.010	0.038	0.859	0.036	0.007	0.655	0.036	0.313	1.412	0.896	846.959
39	380	0.010	0.038	0.897	0.044	0.008	0.691	0.037	0.341	1.540	1.035	923.968
40	390	0.010	0.038	0.935	0.053	0.009	0.728	0.037	0.369	1.663	1.172	998.089
41	400	0.010	0.038	0.973	0.063	0.010	0.765	0.037	0.395	1.782	1.304	1069.466
42	410	0.013	0.049	1.022	0.076	0.014	0.812	0.048	0.551	2.488	1.504	1492.740
43	420	0.013	0.049	1.072	0.091	0.015	0.860	0.048	0.592	2.673	1.763	1603.557
44	430	0.013	0.049	1.121	0.107	0.016	0.909	0.048	0.631	2.849	2.003	1709.295
45	440	0.018	0.068	1.189	0.130	0.024	0.975	0.067	0.935	4.221	2.372	2532.438
46	450	0.018	0.068	1.258	0.156	0.025	1.042	0.067	1.002	4.524	2.853	2714.265
47	460	0.034	0.129	1.387	0.208	0.052	1.169	0.127	2.062	9.309	3.831	5585.372
48	470	0.054	0.205	1.592	0.302	0.094	1.371	0.202	3.681	16.615	6.028	9969.260
49	480	0.027	0.103	1.695	0.354	0.052	1.472	0.101	2.006	9.054	7.666	5432.213
50	490	0.018	0.068	1.763	0.390	0.036	1.540	0.068	1.392	6.285	7.667	3771.189
51	500	0.013	0.049	1.813	0.417	0.027	1.589	0.049	1.032	4.657	7.138	2793.950
52	510	0.013	0.049	1.862	0.444	0.027	1.638	0.049	1.052	4.751	6.553	2850.447
53	520	0.013	0.049	1.911	0.471	0.028	1.687	0.049	1.073	4.841	6.130	2904.869
54	530	0.009	0.034	1.946	0.491	0.020	1.720	0.034	0.754	3.403	5.647	2041.901
55	540	0.009	0.034	1.980	0.511	0.020	1.754	0.034	0.763	3.444	5.112	2066.407
56	550	0.009	0.034	2.014	0.531	0.020	1.788	0.034	0.772	3.484	4.715	2090.305
57	560	0.009	0.034	2.048	0.551	0.020	1.822	0.034	0.780	3.523	4.424	2113.615
58	570	0.009	0.034	2.082	0.571	0.020	1.856	0.034	0.789	3.561	4.211	2136.357
59	580	0.009	0.034	2.117	0.592	0.021	1.890	0.034	0.797	3.598	4.059	2158.548
60	590	0.009	0.034	2.151	0.613	0.021	1.924	0.034	0.805	3.634	3.953	2180.207
61	600	0.009	0.034	2.185	0.634	0.021	1.958	0.034	0.813	3.669	3.880	2201.349
62	610	0.009	0.034	2.219	0.655	0.021	1.992	0.034	0.820	3.703	3.833	2221.992
63	620	0.009	0.034	2.253	0.677	0.022	2.026	0.034	0.828	3.737	3.806	2242.152
64	630	0.009	0.034	2.288	0.699	0.022	2.060	0.034	0.835	3.770	3.793	2261.842
65	640	0.009	0.034	2.322	0.720	0.022	2.094	0.034	0.842	3.802	3.792	2281.077
66	650	0.007	0.027	2.348	0.738	0.017	2.120	0.026	0.660	2.979	3.695	1787.188
67	660	0.007	0.027	2.375	0.755	0.017	2.147	0.026	0.664	2.997	3.525	1798.355
68	670	0.007	0.027	2.402	0.772	0.017	2.173	0.026	0.668	3.016	3.400	1809.326
69	680	0.007	0.027	2.428	0.790	0.017	2.199	0.026	0.672	3.034	3.310	1820.105
70	690	0.007	0.027	2.455	0.807	0.018	2.226	0.026	0.676	3.051	3.245	1830.696
71	700	0.007	0.027	2.481	0.825	0.018	2.252	0.026	0.680	3.069	3.201	1841.103
72	710	0.007	0.027	2.508	0.843	0.018	2.279	0.026	0.684	3.086	3.171	1851.331
73	720	0.007	0.027	2.535	0.861	0.018	2.305	0.026	0.687	3.102	3.152	1861.384
74	730	0.007	0.027	2.561	0.879	0.018	2.332	0.026	0.691	3.119	3.142	1871.265
75	740	0.007	0.027	2.588	0.897	0.018	2.358	0.026	0.695	3.135	3.139	1880.979
76	750	0.007	0.027	2.614	0.915	0.018	2.384	0.026	0.698	3.151	3.140	1890.530
77	760	0.007	0.027	2.641	0.933	0.018	2.411	0.026	0.702	3.167	3.144	1899.920
78	770	0.006	0.023	2.664	0.949	0.016	2.434	0.023	0.604	2.726	3.097	1635.859
79	780	0.006	0.023	2.687	0.965	0.016	2.456	0.023	0.606	2.738	3.009	1642.546
80	790	0.006	0.023	2.709	0.981	0.016	2.479	0.023	0.609	2.749	2.945	1649.139
81	800	0.006	0.023	2.732	0.997	0.016	2.502	0.023	0.611	2.759	2.899	1655.640
82	810	0.006	0.023	2.755	1.013	0.016	2.524	0.023	0.614	2.770	2.867	1662.049
83	820	0.006	0.023	2.778	1.029	0.016	2.547	0.023	0.616	2.781	2.845	1668.369
84	830	0.006	0.023	2.801	1.045	0.016	2.570	0.023	0.618	2.791	2.831	1674.601
85	840	0.006	0.023	2.823	1.061	0.016	2.592	0.023	0.621	2.801	2.822	1680.746
86	850	0.006	0.023	2.846	1.077	0.016	2.615	0.023	0.623	2.811	2.818	1686.808
87	860	0.006	0.023	2.869	1.094	0.016	2.638	0.023	0.625	2.821	2.818	1692.786
88	870	0.006	0.023	2.892	1.110	0.016	2.661	0.023	0.627	2.831	2.820	1698.682
89	880	0.006	0.023	2.915	1.126	0.016	2.683	0.023	0.629	2.841	2.824	1704.499
90	890	0.005	0.019	2.934	1.140	0.014	2.702	0.019	0.526	2.375	2.772	1424.802
91	900	0.005	0.019	2.953	1.154	0.014	2.721	0.019	0.528	2.381	2.677	1428.742
92	910	0.005	0.019	2.972	1.168	0.014	2.740	0.019	0.529	2.388	2.607	1432.638
93	920	0.005	0.019	2.991	1.182	0.014	2.759	0.019	0.530	2.394	2.555	1436.491

HYDRAULIC CROSSINGS
SANTA BARBARA UNIT HYDROGRAPH METHOD

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
					Pervious Area		Impervious Area					
Time Incr.	Time (min)	Rainfal Distrib. (fraction)	Incre. Rainfall (in)	Accumul. Rainfall (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Accumul. Runoff (in)	Incre. Runoff (in)	Total Runoff (in)	Instant Flowrate (cfs)	Design Flowrate (cfs)	Instant Vol. (ft^3)
94	930	0.005	0.019	3.010	1.195	0.014	2.778	0.019	0.532	2.401	2.517	1440.300
95	940	0.005	0.019	3.029	1.209	0.014	2.797	0.019	0.533	2.407	2.490	1444.068
96	950	0.005	0.019	3.048	1.223	0.014	2.816	0.019	0.535	2.413	2.470	1447.794
97	960	0.005	0.019	3.067	1.237	0.014	2.835	0.019	0.536	2.419	2.457	1451.479
98	970	0.005	0.019	3.086	1.251	0.014	2.854	0.019	0.537	2.425	2.449	1455.124
99	980	0.005	0.019	3.105	1.266	0.014	2.872	0.019	0.539	2.431	2.444	1458.729
100	990	0.005	0.019	3.124	1.280	0.014	2.891	0.019	0.540	2.437	2.442	1462.295
101	1000	0.005	0.019	3.143	1.294	0.014	2.910	0.019	0.541	2.443	2.441	1465.822
102	1010	0.004	0.015	3.158	1.305	0.011	2.925	0.015	0.434	1.959	2.383	1175.172
103	1020	0.004	0.016	3.174	1.317	0.012	2.941	0.016	0.456	2.061	2.293	1236.313
104	1030	0.004	0.016	3.190	1.329	0.012	2.957	0.016	0.457	2.065	2.238	1238.732
105	1040	0.004	0.016	3.206	1.341	0.012	2.973	0.016	0.458	2.069	2.197	1241.129
106	1050	0.004	0.016	3.222	1.353	0.012	2.989	0.016	0.459	2.073	2.166	1243.505
107	1060	0.004	0.016	3.238	1.365	0.012	3.005	0.016	0.460	2.076	2.144	1245.859
108	1070	0.004	0.016	3.254	1.377	0.012	3.021	0.016	0.461	2.080	2.128	1248.193
109	1080	0.004	0.016	3.270	1.389	0.012	3.037	0.016	0.462	2.084	2.117	1250.505
110	1090	0.004	0.016	3.285	1.401	0.012	3.053	0.016	0.463	2.088	2.110	1252.798
111	1100	0.004	0.016	3.301	1.413	0.012	3.069	0.016	0.463	2.092	2.105	1255.070
112	1110	0.004	0.016	3.317	1.426	0.012	3.084	0.016	0.464	2.096	2.102	1257.322
113	1120	0.004	0.016	3.333	1.438	0.012	3.100	0.016	0.465	2.099	2.101	1259.554
114	1130	0.004	0.016	3.349	1.450	0.012	3.116	0.016	0.466	2.103	2.101	1261.767
115	1140	0.004	0.016	3.365	1.462	0.012	3.132	0.016	0.467	2.107	2.102	1263.960
116	1150	0.004	0.016	3.381	1.474	0.012	3.148	0.016	0.467	2.110	2.104	1266.135
117	1160	0.004	0.016	3.397	1.487	0.012	3.164	0.016	0.468	2.114	2.106	1268.290
118	1170	0.004	0.016	3.413	1.499	0.012	3.180	0.016	0.469	2.117	2.108	1270.427
119	1180	0.004	0.016	3.429	1.511	0.012	3.196	0.016	0.470	2.121	2.111	1272.546
120	1190	0.004	0.016	3.445	1.523	0.012	3.212	0.016	0.471	2.124	2.114	1274.646
121	1200	0.004	0.016	3.461	1.536	0.012	3.228	0.016	0.471	2.128	2.117	1276.729
122	1210	0.004	0.016	3.477	1.548	0.012	3.244	0.016	0.472	2.131	2.120	1278.793
123	1220	0.004	0.016	3.493	1.561	0.012	3.259	0.016	0.473	2.135	2.123	1280.840
124	1230	0.004	0.016	3.509	1.573	0.012	3.275	0.016	0.474	2.138	2.126	1282.870
125	1240	0.004	0.016	3.525	1.585	0.012	3.291	0.016	0.474	2.141	2.129	1284.882
126	1250	0.004	0.016	3.541	1.598	0.012	3.307	0.016	0.475	2.145	2.133	1286.877
127	1260	0.004	0.016	3.557	1.610	0.012	3.323	0.016	0.476	2.148	2.136	1288.856
128	1270	0.004	0.016	3.573	1.623	0.012	3.339	0.016	0.477	2.151	2.139	1290.818
129	1280	0.004	0.016	3.589	1.635	0.012	3.355	0.016	0.477	2.155	2.143	1292.763
130	1290	0.004	0.016	3.605	1.648	0.013	3.371	0.016	0.478	2.158	2.146	1294.692
131	1300	0.004	0.016	3.621	1.660	0.013	3.387	0.016	0.479	2.161	2.149	1296.605
132	1310	0.004	0.016	3.637	1.673	0.013	3.403	0.016	0.479	2.164	2.152	1298.502
133	1320	0.004	0.016	3.653	1.685	0.013	3.419	0.016	0.480	2.167	2.156	1300.384
134	1330	0.004	0.016	3.669	1.698	0.013	3.434	0.016	0.481	2.170	2.159	1302.250
135	1340	0.004	0.016	3.684	1.711	0.013	3.450	0.016	0.482	2.174	2.162	1304.100
136	1350	0.004	0.016	3.700	1.723	0.013	3.466	0.016	0.482	2.177	2.165	1305.936
137	1360	0.004	0.016	3.716	1.736	0.013	3.482	0.016	0.483	2.180	2.168	1307.756
138	1370	0.004	0.016	3.732	1.749	0.013	3.498	0.016	0.484	2.183	2.171	1309.561
139	1380	0.004	0.016	3.748	1.761	0.013	3.514	0.016	0.484	2.186	2.174	1311.352
140	1390	0.004	0.016	3.764	1.774	0.013	3.530	0.016	0.485	2.189	2.177	1313.128
141	1400	0.004	0.016	3.780	1.787	0.013	3.546	0.016	0.485	2.191	2.180	1314.890
142	1410	0.004	0.016	3.796	1.799	0.013	3.562	0.016	0.486	2.194	2.183	1316.638
143	1420	0.004	0.016	3.812	1.812	0.013	3.578	0.016	0.487	2.197	2.186	1318.371
144	1430	0.004	0.016	3.828	1.825	0.013	3.594	0.016	0.487	2.200	2.189	1320.090
145	1440	0.004	0.016	3.844	1.838	0.013	3.610	0.016	0.488	2.203	2.192	1321.796
Total		1.0							71.457		7.667	193528.291

Bull Run Pipelines: Drainage Area 1 (DA1)

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 7.67 cfs

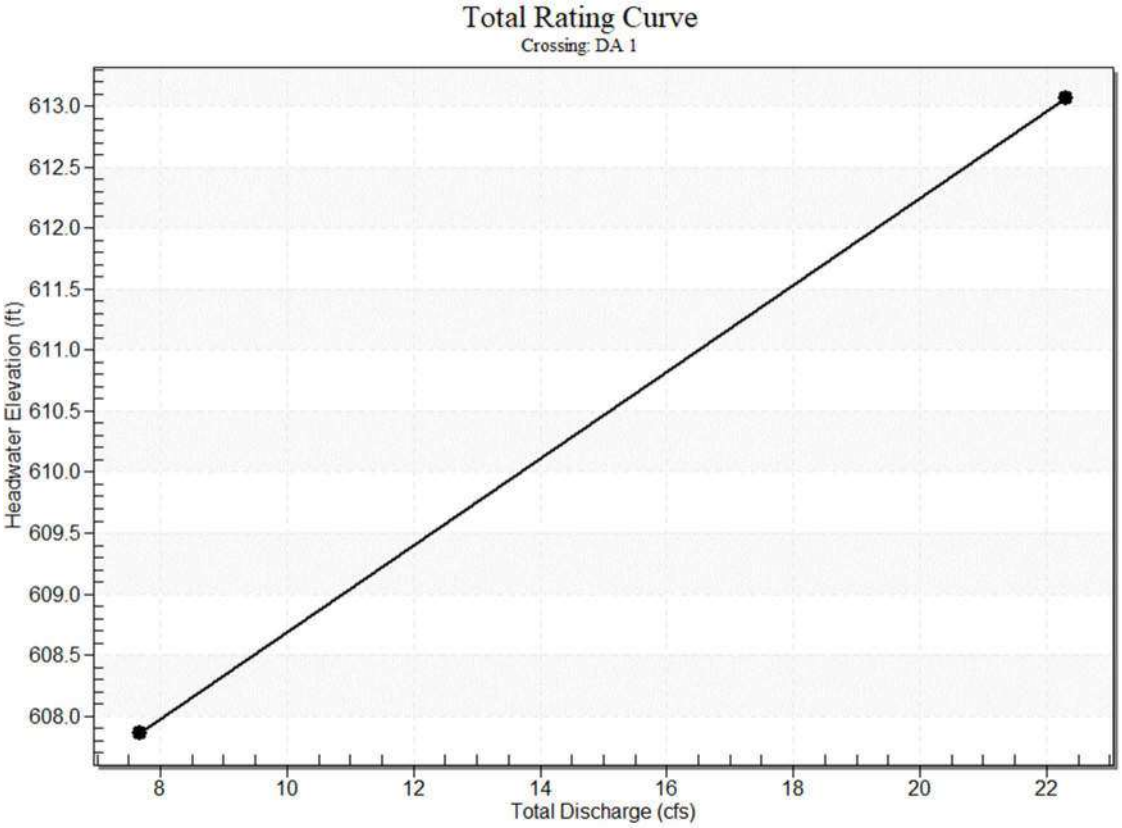
Design Flow: 7.67 cfs

Maximum Flow: 7.67 cfs

Table 1 - Summary of Culvert Flows at Crossing: DA 1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
607.86	7.67	7.67	0.00	1
613.00	21.27	21.27	0.00	Overtopping

Rating Curve Plot for Crossing: DA 1



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97

7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97
7.67 cfs	7.67 cfs	607.86	1.73	0.0*	5-S2n	0.60	1.07	0.65	0.35	10.42	4.97

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

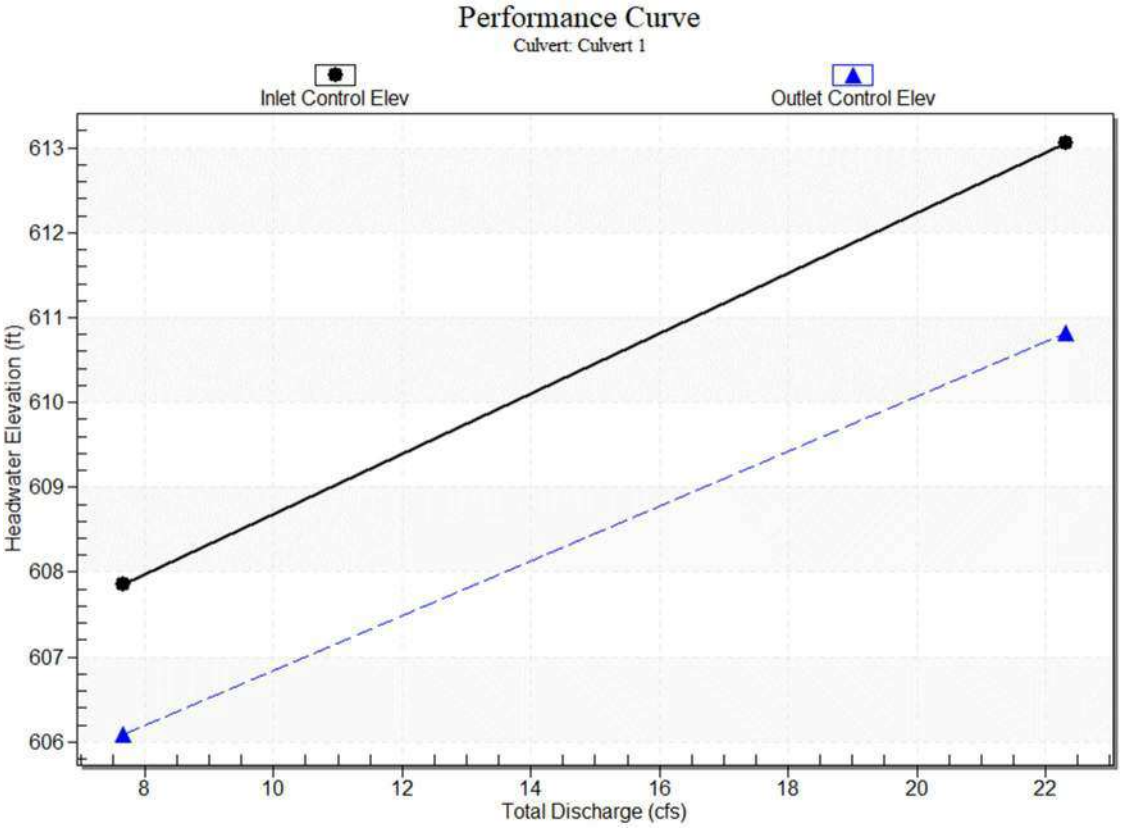
Inlet Elevation (invert): 606.13 ft,

Outlet Elevation (invert): 604.37 ft

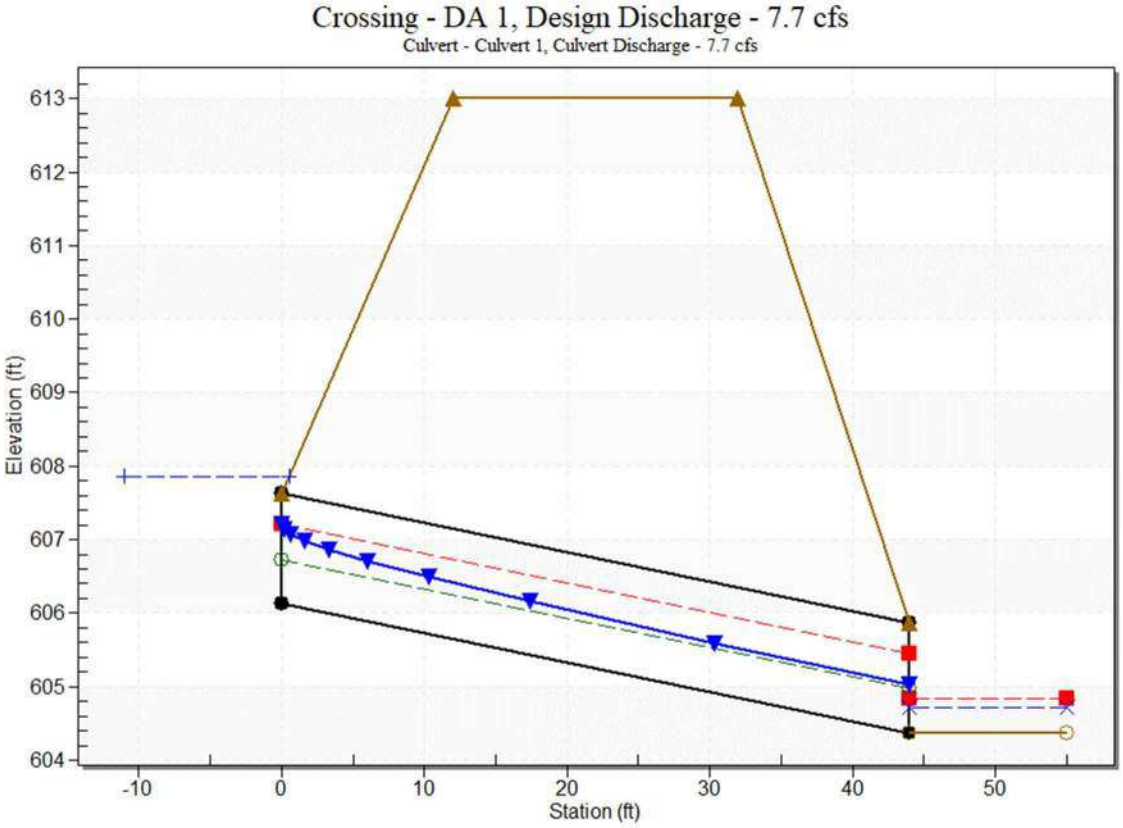
Culvert Length: 44.04 ft,

Culvert Slope: 0.0400

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 606.13 ft

Outlet Station: 44.00 ft

Outlet Elevation: 604.37 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: DA 1

Table 3 - Downstream Channel Rating Curve (Crossing: DA 1)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70
7.67	604.72	0.35	4.97	1.31	1.70

Tailwater Channel Data - DA 1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0600

Channel Manning's n: 0.0300

Channel Invert Elevation: 604.37 ft

Roadway Data for Crossing: DA 1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 613.00 ft

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

Bull Run Pipelines: Drainage Area 2 (DA2)

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 11.13 cfs

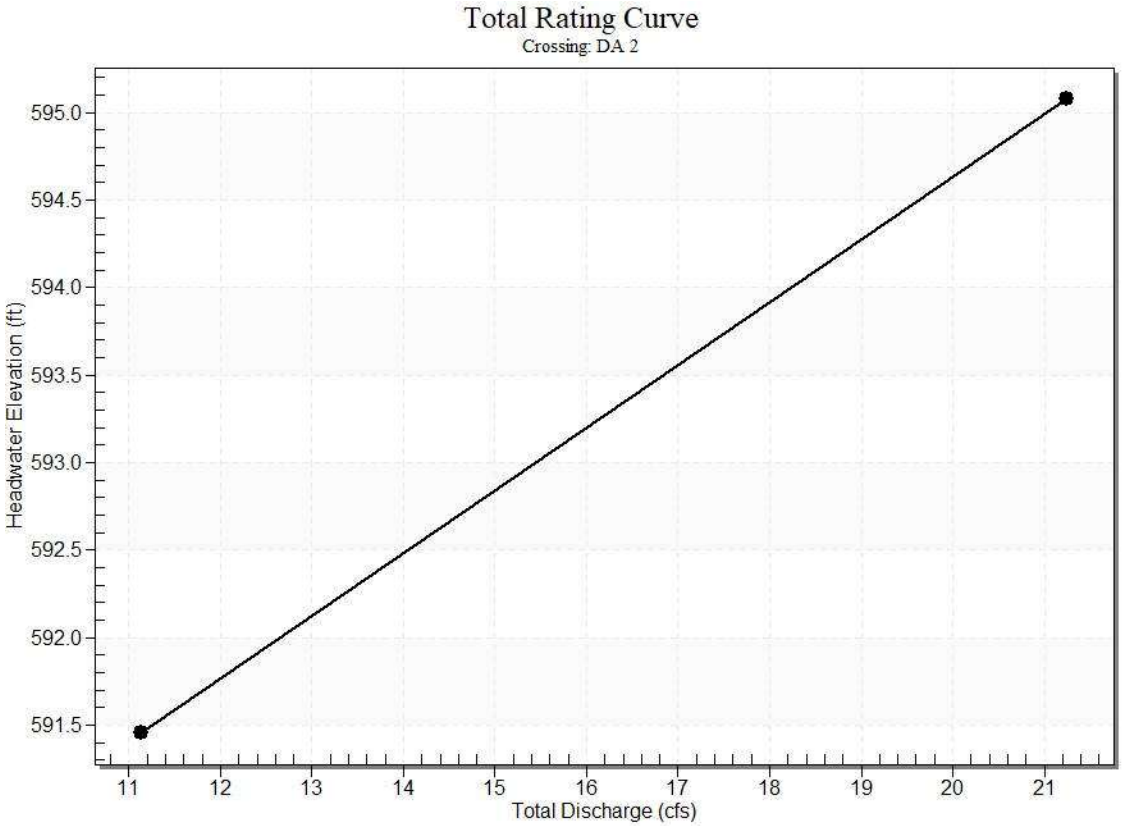
Design Flow: 11.13 cfs

Maximum Flow: 11.13 cfs

Table 1 - Summary of Culvert Flows at Crossing: DA 2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
591.46	11.13	11.13	0.00	1
595.00	19.86	19.86	0.00	Overtopping

Rating Curve Plot for Crossing: DA 2



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76

11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76
11.13 cfs	11.13 cfs	591.46	2.53	0.361	5-S2n	0.68	1.28	0.75	0.28	12.50	9.76

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

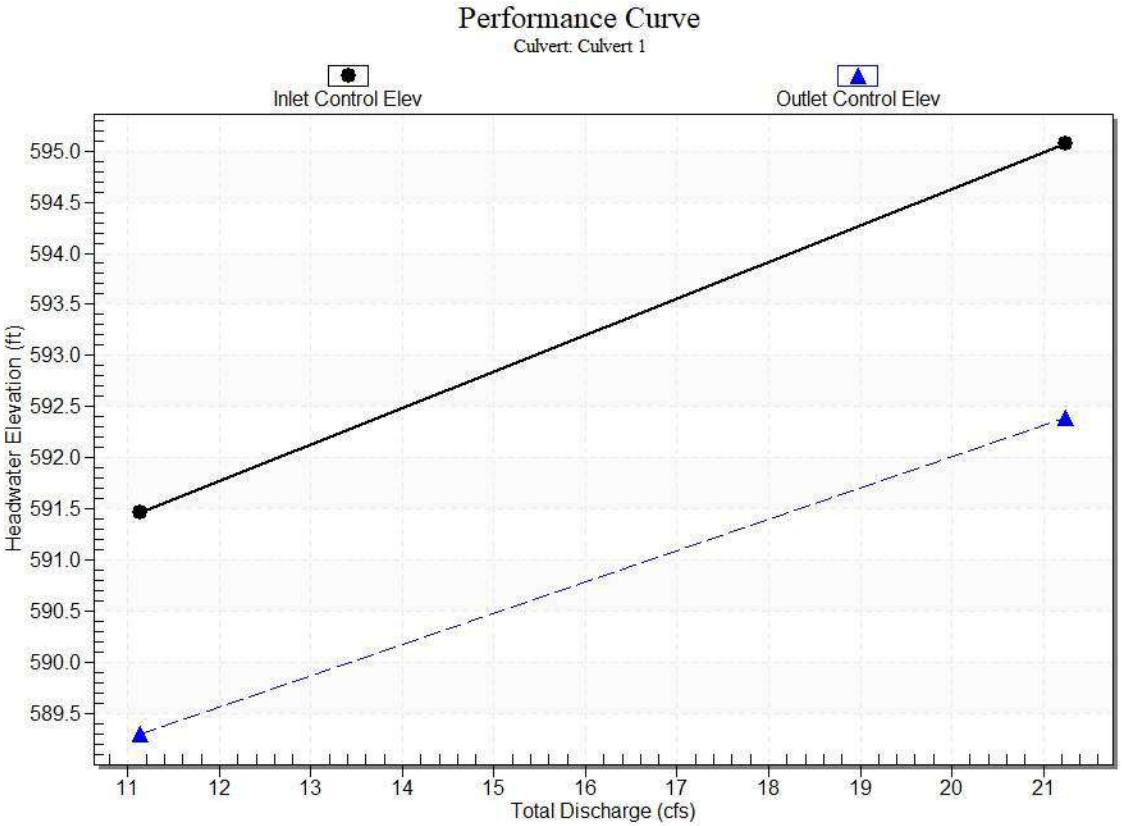
Inlet Elevation (invert): 588.93 ft,

Outlet Elevation (invert): 586.56 ft

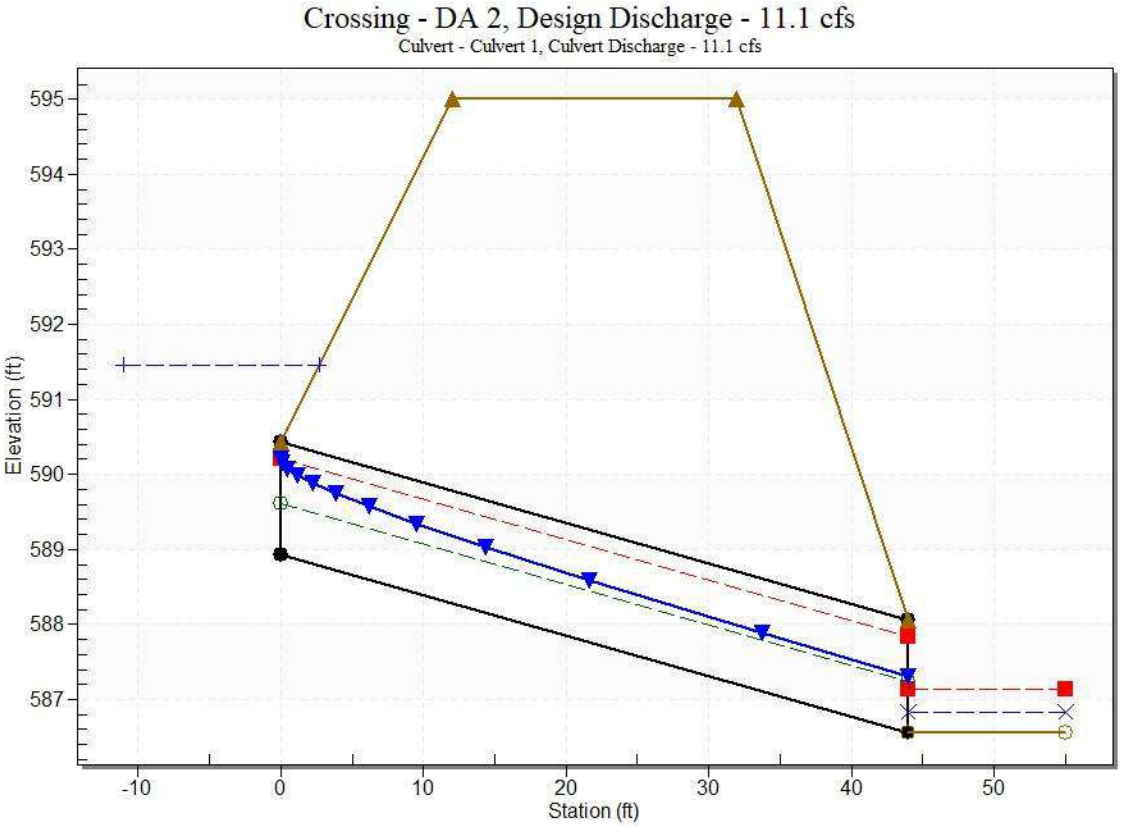
Culvert Length: 44.06 ft,

Culvert Slope: 0.0539

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 588.93 ft

Outlet Station: 44.00 ft

Outlet Elevation: 586.56 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: DA 2

Table 3 - Downstream Channel Rating Curve (Crossing: DA 2)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68
11.13	586.84	0.28	9.76	5.19	3.68

Tailwater Channel Data - DA 2

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.3000

Channel Manning's n: 0.0300

Channel Invert Elevation: 586.56 ft

Roadway Data for Crossing: DA 2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 595.00 ft

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

Bull Run Pipelines: Drainage Area 3 (DA3)

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 20.86 cfs

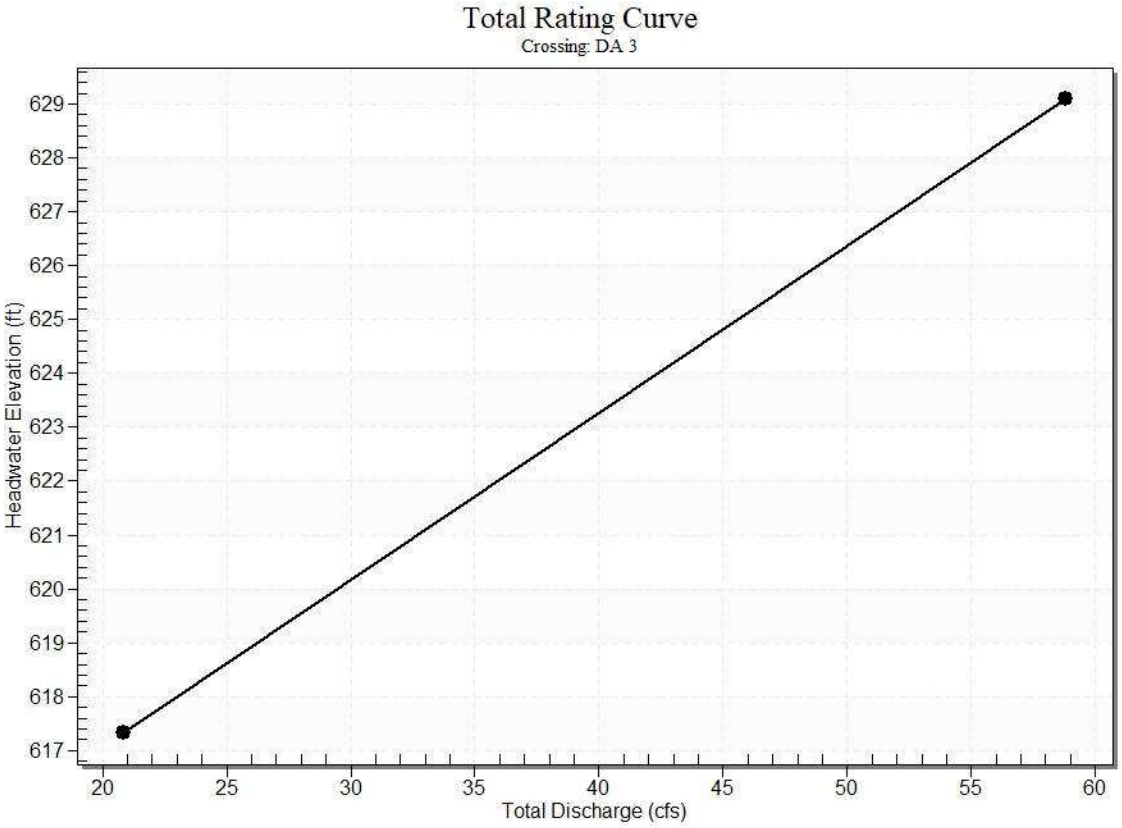
Design Flow: 20.86 cfs

Maximum Flow: 20.86 cfs

Table 1 - Summary of Culvert Flows at Crossing: DA 3

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
617.34	20.86	20.86	0.00	1
629.00	56.52	56.52	0.00	Overtopping

Rating Curve Plot for Crossing: DA 3



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03

20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03
20.86 cfs	20.86 cfs	617.34	3.06	1.128	5-S2n	1.03	1.64	1.08	0.36	11.99	13.03

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

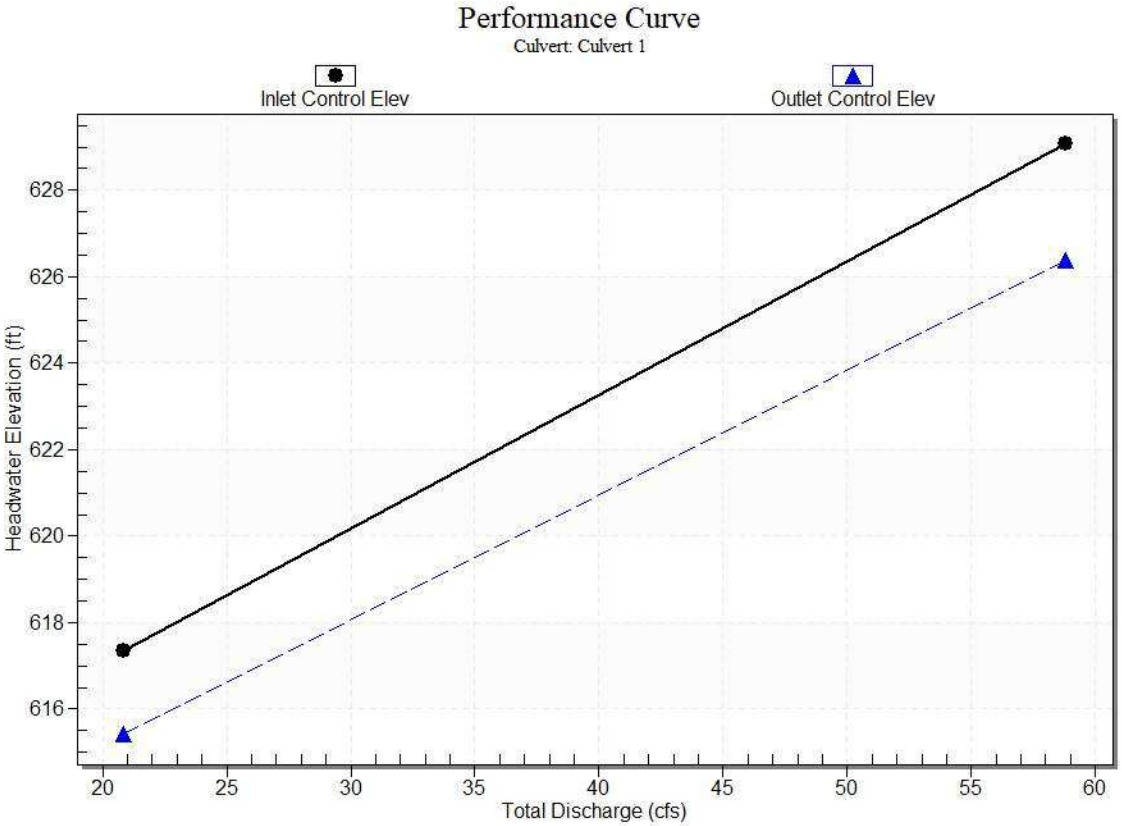
Inlet Elevation (invert): 614.28 ft,

Outlet Elevation (invert): 611.90 ft

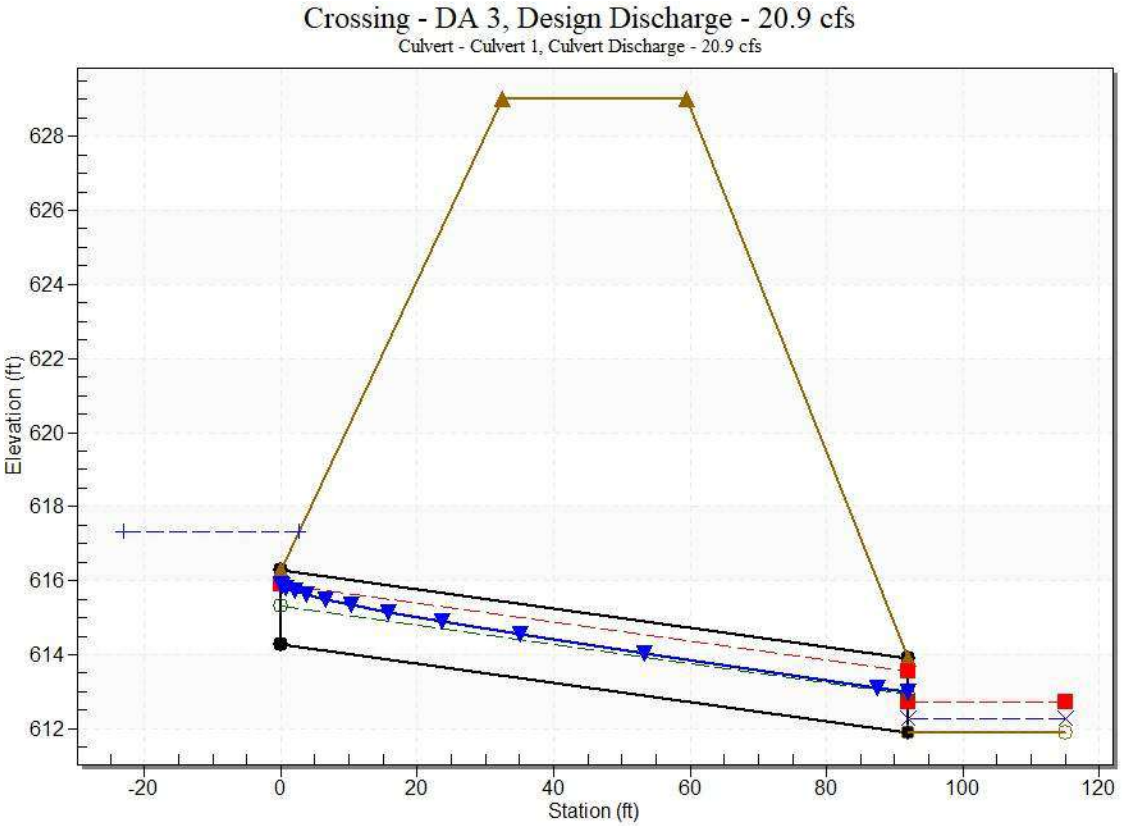
Culvert Length: 92.03 ft,

Culvert Slope: 0.0259

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 614.28 ft

Outlet Station: 92.00 ft

Outlet Elevation: 611.90 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: DA 3

Table 3 - Downstream Channel Rating Curve (Crossing: DA 3)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40
20.86	612.26	0.36	13.03	9.00	4.40

Tailwater Channel Data - DA 3

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.4000

Channel Manning's n: 0.0300

Channel Invert Elevation: 611.90 ft

Roadway Data for Crossing: DA 3

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 27.00 ft

Crest Elevation: 629.00 ft

Roadway Surface: Paved

Roadway Top Width: 27.00 ft

Bull Run Pipelines: Drainage Area 4 (DA4)

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 4.64 cfs

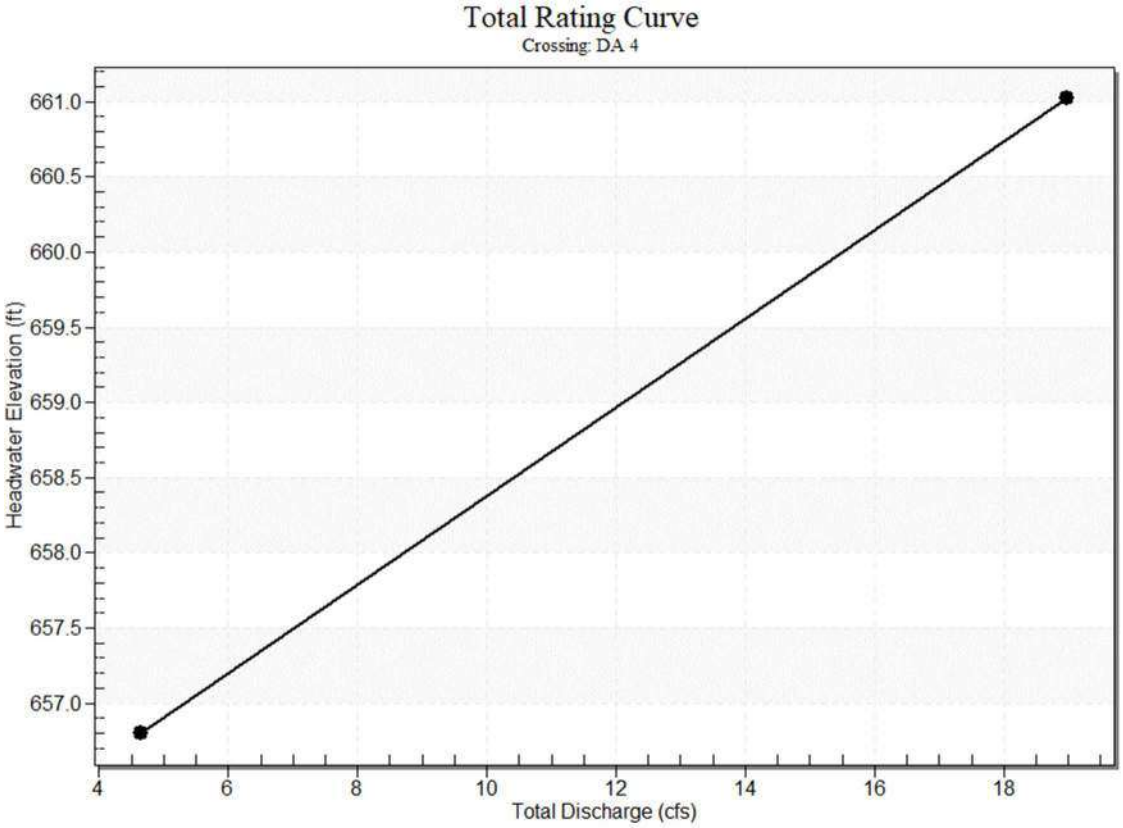
Design Flow: 4.64 cfs

Maximum Flow: 4.64 cfs

Table 1 - Summary of Culvert Flows at Crossing: DA 4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
656.80	4.64	4.64	0.00	1
661.00	18.68	18.68	0.00	Overtopping

Rating Curve Plot for Crossing: DA 4



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40

4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40
4.64 cfs	4.64 cfs	656.80	1.24	1.313	2-M2c	1.03	0.83	0.83	0.17	4.64	7.40

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

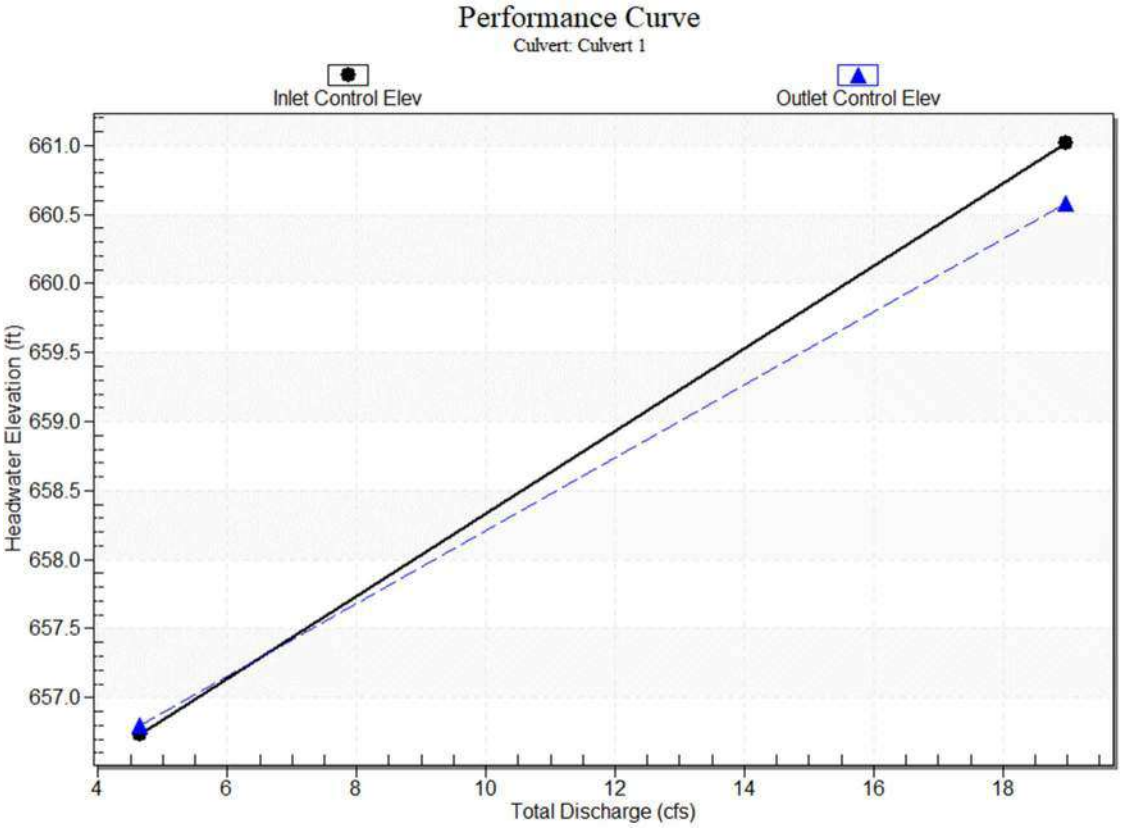
Inlet Elevation (invert): 655.49 ft,

Outlet Elevation (invert): 655.39 ft

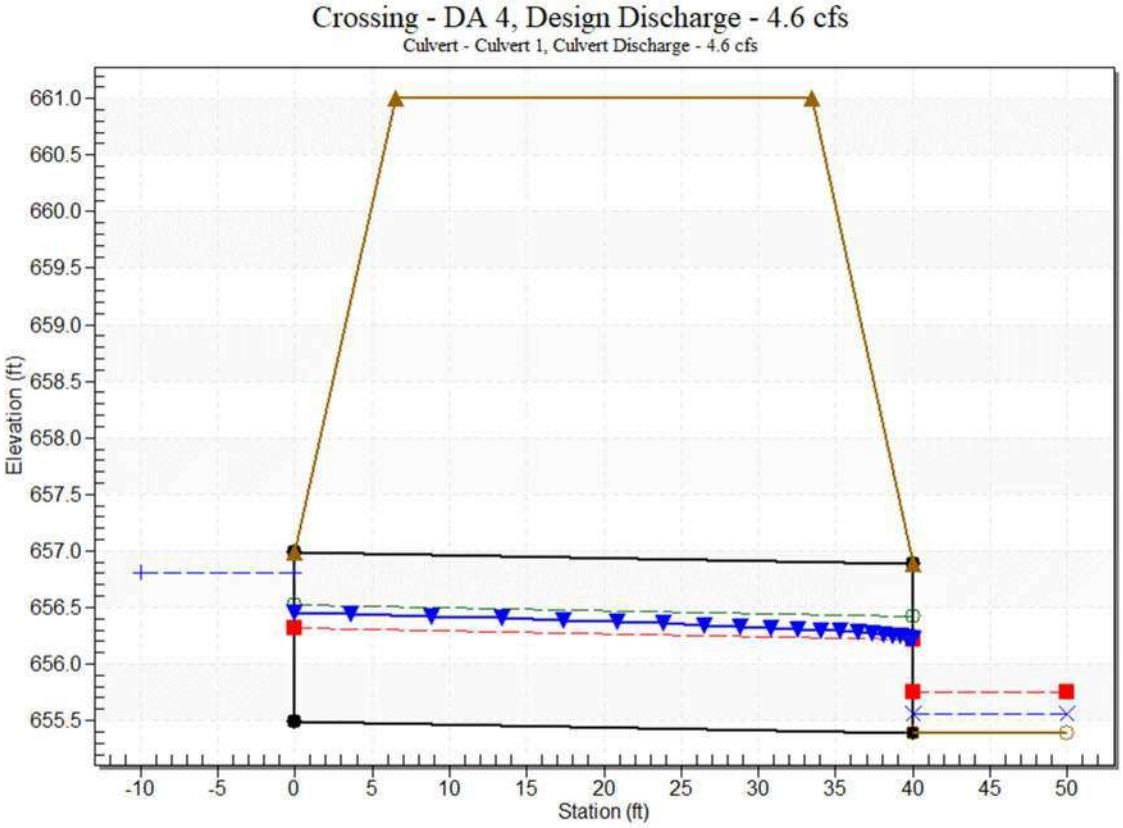
Culvert Length: 40.00 ft,

Culvert Slope: 0.0025

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 655.49 ft

Outlet Station: 40.00 ft

Outlet Elevation: 655.39 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: DA 4

Table 3 - Downstream Channel Rating Curve (Crossing: DA 4)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44
4.64	655.56	0.17	7.40	3.19	3.44

Tailwater Channel Data - DA 4

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.3000

Channel Manning's n: 0.0300

Channel Invert Elevation: 655.39 ft

Roadway Data for Crossing: DA 4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 27.00 ft

Crest Elevation: 661.00 ft

Roadway Surface: Paved

Roadway Top Width: 27.00 ft

Bull Run Pipelines: Drainage Area 5 (DA5)

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 8.42 cfs

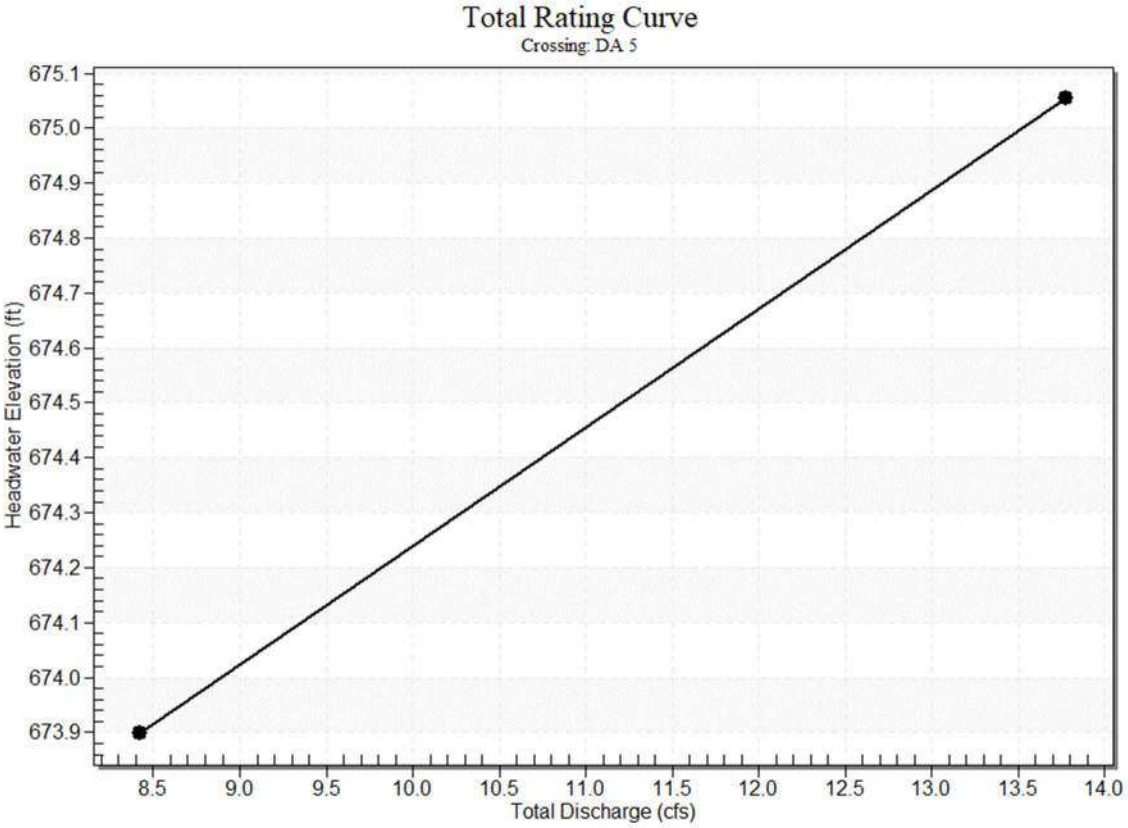
Design Flow: 8.42 cfs

Maximum Flow: 8.42 cfs

Table 1 - Summary of Culvert Flows at Crossing: DA 5

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
673.90	8.42	8.42	0.00	1
675.00	12.61	12.61	0.00	Overtopping

Rating Curve Plot for Crossing: DA 5



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79

8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79
8.42 cfs	8.42 cfs	673.90	1.90	0.979	5-S2n	0.81	1.12	0.84	0.39	8.30	4.79

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

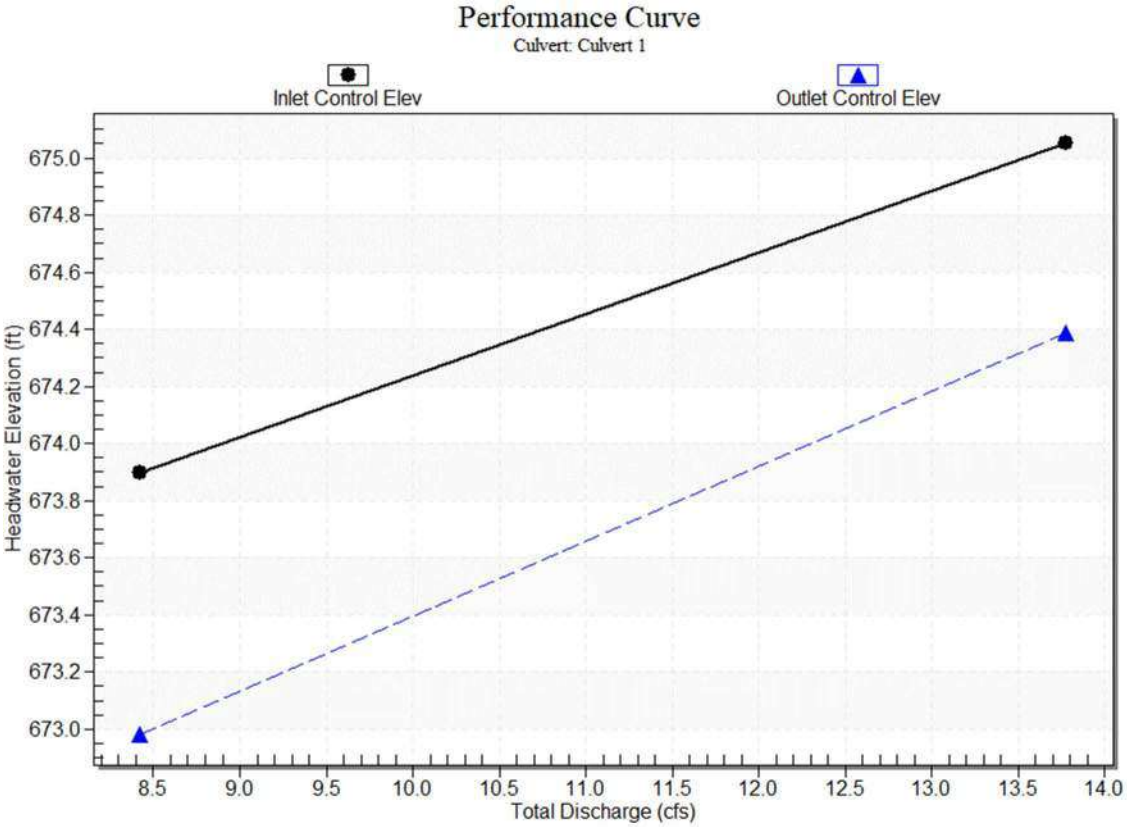
Inlet Elevation (invert): 672.00 ft,

Outlet Elevation (invert): 671.00 ft

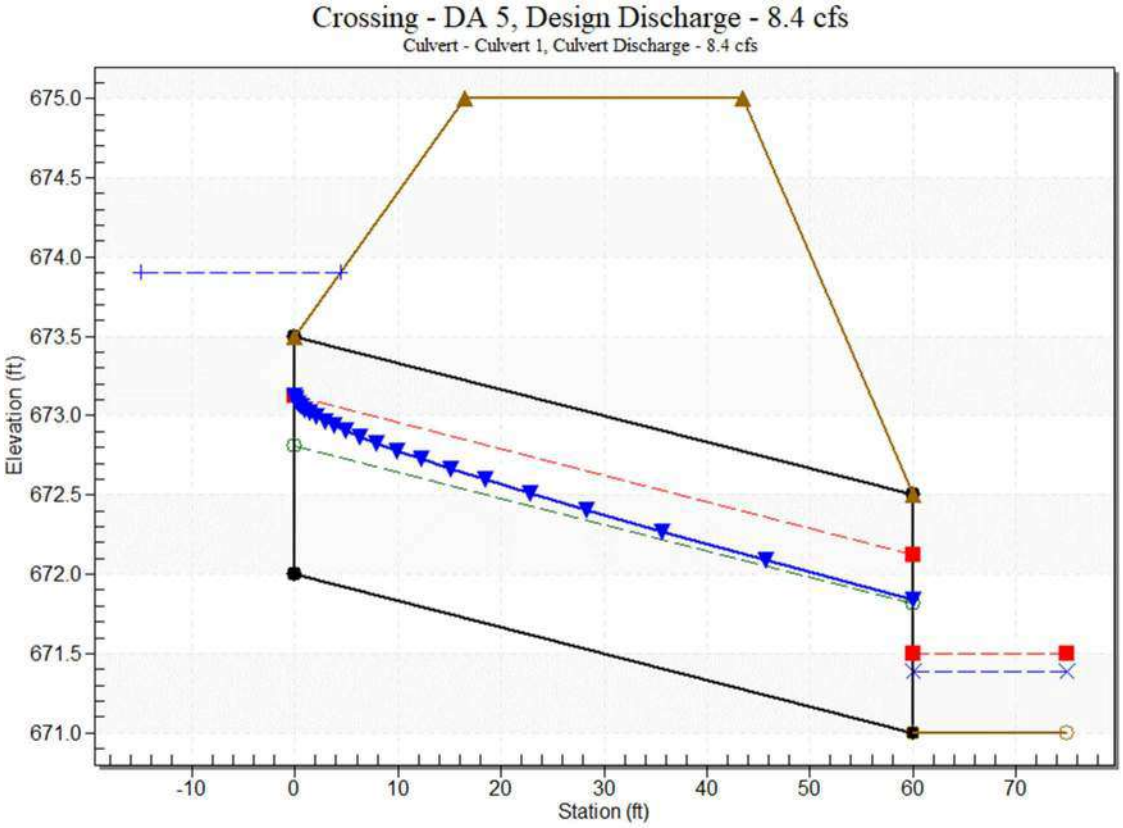
Culvert Length: 60.01 ft,

Culvert Slope: 0.0167

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 672.00 ft

Outlet Station: 60.00 ft

Outlet Elevation: 671.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: DA 5

Table 3 - Downstream Channel Rating Curve (Crossing: DA 5)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57
8.42	671.39	0.39	4.79	1.21	1.57

Tailwater Channel Data - DA 5

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0300

Channel Invert Elevation: 671.00 ft

Roadway Data for Crossing: DA 5

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 27.00 ft

Crest Elevation: 675.00 ft

Roadway Surface: Paved

Roadway Top Width: 27.00 ft

Appendix E: Operations & Maintenance

Exhibit A.77.e

STANDARD O&M PLAN FOR THE SIMPLIFIED APPROACH

Filter Strips

Runoff from impervious surface must enter filter strip as sheet flow		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Runoff isn't entering as sheet flow	Remove debris dams or other impediments to sheet flow
Vegetation must cover at least 90% of the facility at maturity.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Dead or stressed vegetation	Replant per planting plan, or substitute from BES plant list (see Section 3.5).
	Dry grass or other plants	Irrigate and mulch as needed; trim tall grasses and remove clippings. Maintain grass height at 6"-9".
	Tall grass and vegetation	Prune to allow sight lines.
	Weeds	Manually remove weeds.
Growing medium must sustain healthy plant cover.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Gullies, erosion, or exposed soils	Fill in and lightly compact areas of erosion and replant according to planting plan or substitute from BES plant list (see SWMM Section 3.8). Erosion deeper than 2 inches must be addressed.
	Slope slippage	Stabilize slopes with plantings from the plant list in SWMM Section 3.8.

Annual Maintenance Schedule

Summer	Remove any build-up of weeds or organic debris.
Fall	Replant exposed soil and replace dead plants. Remove sediment and plant debris.
Spring	Remove sediment and plant debris. Replant exposed soil and replace dead plants.
All seasons	Weed as necessary.

Maintenance Records: All facility operators are required to keep an inspection and maintenance log. Record date, description, and contractor (if applicable) for all repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Fertilizers: Their use is strongly discouraged because of the potential for negative environmental impacts. Never apply fertilizer before testing the fertility of the growing medium to determine whether fertilizer is needed and appropriate application rates. Use only organic, slow-release fertilizers. See SWMM Section 3.2.2.1 for more information.

Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or facility discharge points. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

Vectors (Mosquitoes and Rats): Stormwater facilities must not harbor mosquito larvae or rodents that pose a threat to public health or that undermine the facility structure. Record the time/date, weather, and site conditions when vector activity observed. Record when vector abatement started and ended.

Access: Maintain ingress/egress per design standards, maintaining access to the entirety of the facility for inspection & maintenance.

Operations and Maintenance Log

Date	Work Performed By	Type of Work Performed				Notes	Initials
		Sediment and Trash Removal	Plant Replacement type, location	Structural Repairs – type, location	Other		

Appendix F: Stormwater Certification Form

Land Use Planning Division
1600 SE 190th Ave.
Portland OR 97233
Phone: 503-988-3043
land.use.planning@multco.us
https://multco.us/landuse/

STORMWATER DRAINAGE CONTROL CERTIFICATE
>500 SQUARE FEET OF NEW / REPLACED IMPERVIOUS SURFACES

NOTE TO PROPERTY OWNER/APPLICANT: Please have an Oregon Licensed Professional Engineer fill out this Certificate and attach a signed site plan, stamped and signed storm water system details, and stamped and signed storm water calculations used to support the conclusion. Please note that replacement of existing structures does not provide a credit to the square footage threshold.

Property Address or Legal Description: SE Lusted Road, SE Dodge Park Blvd , SE Altman Rd, and SE Cottrell, Gresham

Description of Project: Bull Run Filtration - Filtration Pipelines

The following stormwater drainage control system will be required:

- ☐ **Use of Gutter, downspout, and splash block drainage control system;**
- ☐ **Natural Infiltration Process; or**
- ☒ **Construction of an on-site storm water drainage control system.**

The rate of stormwater runoff attributed to the new/replaced development for a 10-year/24-hour storm event will be no greater than that which existed prior to any development as measured from the property line or from the point of discharge into a water body with the use of the designated system [MCC 39.6235].

I certify the attached signed site plan showing the areas needed for the chosen system type, stamped and signed storm water system design details, and stamped and signed calculations dated 9/23/2022 **will meet the requirements listed above.**

Signature: _____

Print Name: Patrick Tortora

Business Name: Emerio Design, LLC

Address: 6445 SW Fallbrook Pl., Beaverton, OR 97008

Phone #: 503.746.8812

Date: 9/23/2022

Engineer's Stamp Below:

NOTE TO ENGINEER: Please check one box above. Multnomah County does not use the City of Portland's storm water ordinance. As part of your review, MCC 39.6235 requires that you must consider all new, replaced, and existing structures and impervious areas and determine that the newly generated stormwater from the new or replaced impervious surfaces is in compliance with Multnomah County Code for a 10-year/24-hour storm event. This Storm Water Drainage Control Certificate does not apply to shingle or roof replacement on lawfully established structures.

§ 39.6235 STORMWATER DRAINAGE CONTROL.

(A) Persons creating new or replacing existing impervious surfaces exceeding 500 square feet shall install a stormwater drainage system as provided in this section. This subsection (A) does not apply to shingle or roof replacement on lawful structures.

(B) The provisions of this section are in addition to and not in lieu of any other provision of the code regulating stormwater or its drainage and other impacts and effects, including but not limited to regulation thereof in the SEC overlay.

(C) The provisions of this section are in addition to and not in lieu of stormwater and drainage requirements in the Multnomah County Road Rules and Design and Construction Manual, including those requirements relating to impervious surfaces and proposals to discharge stormwater onto a county right-of-way.

(D) The stormwater drainage system required in subsection (A) shall be designed to ensure that the rate of runoff for the 10-year 24-hour storm event is no greater than that which existed prior to development at the property line or point of discharge into a water body.

(E) At a minimum, to establish satisfaction of the standards in this section and all other applicable stormwater-related regulations in this code, the following information must be provided to the planning director:

(1) A site plan drawn to scale, showing the property line locations, ground topography (contours), boundaries of all ground disturbing activities, roads and driveways, existing and proposed structures and buildings, existing and proposed sanitary tank and drainfields (primary and reserve), location of stormwater disposal, trees and vegetation proposed for both removal and planting and an outline of wooded areas, water bodies and existing drywells;

(2) Documentation establishing approval of any new stormwater surcharges to a sanitary drainfield by the City of Portland Sanitarian and/or any other agency authorized to review waste disposal systems;

(3) Certified statement, and supporting information and documentation, by an Oregon licensed Professional Engineer that the proposed or existing stormwater drainage system satisfies all standards set forth in this section and all other stormwater drainage system standards in this code; and

(4) Any other report, information, plan, certification or documentation necessary to establish satisfaction of all standards set forth in this section and all other applicable stormwater-related regulations in this code, such as, but not limited to, analyses and explanations of soil characteristics, engineering solutions, and proposed stream and upland environmental protection measures.