EXHIBIT 10

Drainage Report: 100% Design

Deschutes Valley Trail – Segment C
City of Tumwater

Prepared For:
City of Tumwater

Prepared By:
SCJ Alliance
8730 Tallon Ln NE, Ste 200
Lacey, WA 98516
360.352.1465

June 2026

SCJ ALLIANCE
CONSULTING SERVICES

Drainage Report: 100% Design

Project Information

Project:	**Deschutes Valley Trail – Segment C**
Prepared for:	**City of Tumwater** Jared VerHey Capital Projects Manager

Reviewing Agency

Jurisdiction:	City of Tumwater

Project Representative

Prepared by:	SCJ Alliance 8730 Tallon Ln NE, Ste 200 Lacey, WA 98516 360.352.1465 scjalliance.com
Contact:	Whitney Holm, PE
Project Reference:	SCJ #23-000313
	Path: N:\Projects\0625 City of Tumwater\25-000313 Tumwater Deschutes Valley Trail\Design\Storm\Seg C Stormwater\2026-0220_SegC Storm Report.docx

Signature

I hereby state that this Drainage Control Plan for the Deschutes Valley Trail Project – Segment C has been prepared by me or under my supervision and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that the City of Tumwater does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

Whitney Holm, PE

Approved by Whitney Holm, PE

Table of Contents

1 Proposed Project Description....1

1.1 Summary of Requirements....2

2 Existing Conditions Description....2

2.1.1 Existing Soils....6

2.1.2 Critical Areas....7

3 Vicinity Analysis and Subbasin Description....8

3.1.1 Vicinity Analysis....8

3.1.2 Subbasin Description....10

4 Flow Control and Water Quality Facility Sizing....12

4.1.1 Minimum Requirements Overview....12

4.1.2 MR #1: Stormwater Site Planning....13

4.1.3 MR #2: Construction Stormwater Pollution Prevention Plan (SWPPP)....13

4.1.4 MR #3: Source Control of Pollution....13

4.1.5 MR #4: Preservation of Natural Drainage Systems and Outfalls....13

4.1.6 MR #5: On-Site Stormwater Management....14

4.1.7 MR #6: Runoff Treatment....15

4.1.8 MR #7: Flow Control....17

4.1.9 MR #8: Wetlands Protection....18

4.1.10 MR #9: Operation and Maintenance....19

4.1.11 MR #10: Financial Liability....19

4.1.12 MR #11: Off-Site Analysis and Mitigation....19

5 Aesthetic Considerations for Facilities....19

6 Covenants, Dedications, Easements....20

7 Agreements and Guarantees....20

8 Other Permits or Conditions Placed on the Project....21

List of Tables

Table 1. Existing Area Takeoffs for TDA 1 3
Table 2. Existing Area Takeoffs for TDA 2 3
Table 3. Existing Area Takeoffs for TDA 3 4
Table 4. Existing Area Takeoffs for TDA 4 5
Table 5. Existing Area Takeoffs for TDA 5 5
Table 6. Existing Area Takeoffs for TDA 6 6
Table 7. Proposed Area Takeoffs for TDA 1 10
Table 8. Proposed Area Takeoffs for TDA 2 10
Table 9. Proposed Area Takeoffs for TDA 3 11
Table 10. Proposed Area Takeoffs for TDA 4 11
Table 11. Proposed Area Takeoffs for TDA 5 12
Table 12. Proposed Area Takeoffs for TDA 6 12
Table 13. TDA and Project Site Areas 17
Table 14. Flow Control Exemption 18
Table 15. Anticipated Permits and Variances 21

List of Figures

Figure 1 – Site Vicinity Map 1

List of Appendices

Appendix 1 – Design Calculations 28
Appendix 2 – Soil Management Plan 132
Appendix 3 – Supplemental Reports and Information 134
Exhibit 3A – Critical Areas 135
Exhibit 3B – NRCS Soil Report 169
Exhibit 3C – Draft Geotechnical Report 194
Appendix 4 – Maps and Area Takeoffs 372
Exhibit 4A – Minimum Requirements Flow Chart 373
Exhibit 4B – Basin Map 377
Exhibit 4C – Work Map 379
Appendix 5 – Construction SWPPP 399
Appendix 6 – Wetlands Requirements 513

1 Proposed Project Description

The Deschutes Valley Trail Project will be approximately a 2-mile trail connecting from Tumwater Historical Park to Pioneer Park. The trail is broken into five segments, A1 has been constructed connecting Tumwater Historical Park to Brewery Park, A2, B, C, and D. This report focuses on Segment C, which begins east of the Valley Athletic Club and extends to Deschutes Valley Park. Segment C is located in Tumwater, Washington within the City of Tumwater property. The goal of Segment C is to complete a missing link in the existing trail by providing a paved, non-motorized trail along the edge of the existing Valley Golf Course. Project improvements include a 10-foot to 12-foot wide HMA trail with 2 foot gravel shoulders and the replacement of segments of existing cart paths. The Segment C trail alignment is approximately 5,150 LF and the Deschutes Valley Park Spur adds an additional 950 LF. The project site is located within the Budd/Deschutes Watershed and the Deschutes River Basin (See **Appendix 3, Exhibit 3A**).

See **Figure 1** below for the project location.

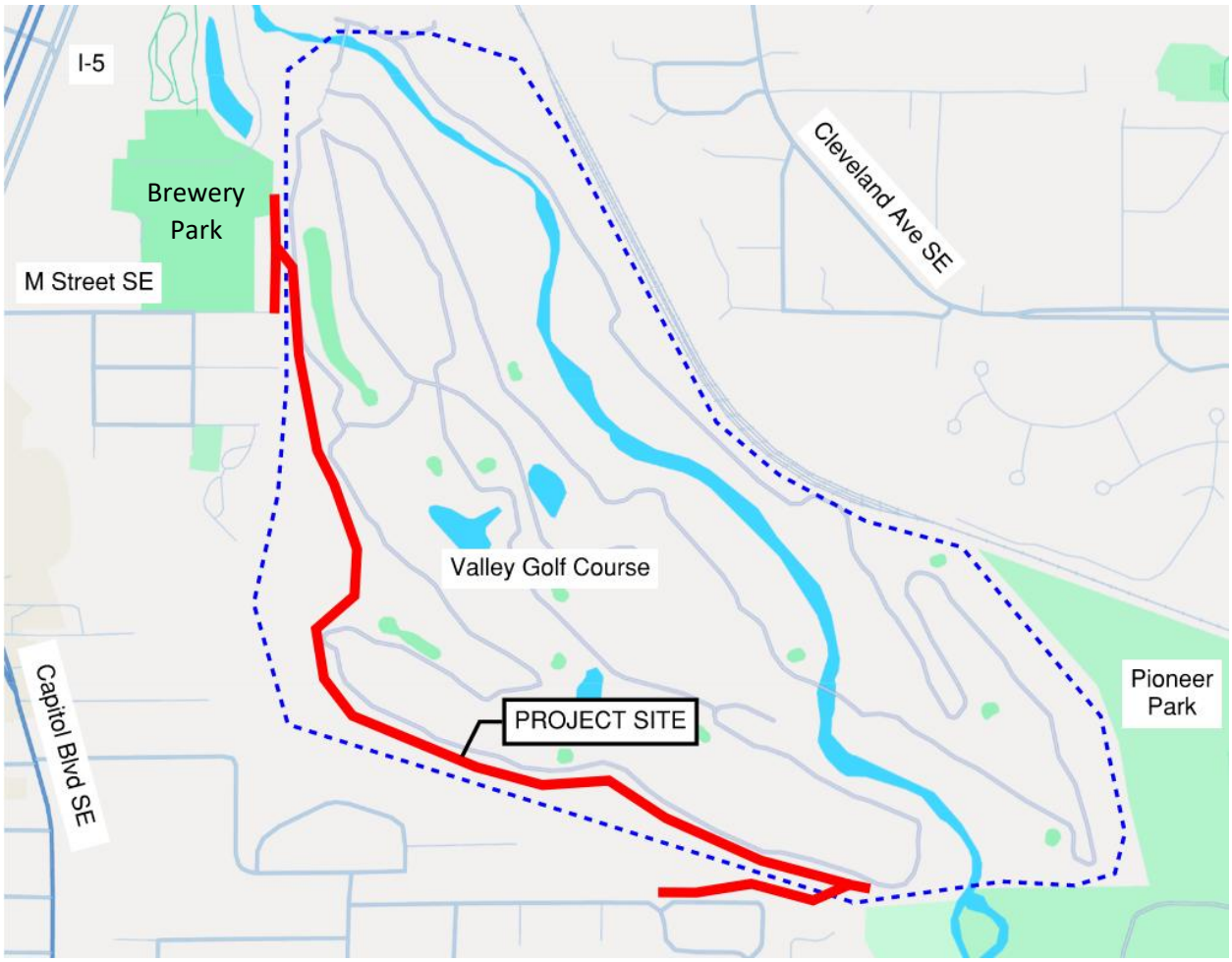


Figure 1 – Site Vicinity Map

1.1 Summary of Requirements

The stormwater design for this project meets the requirements outlined in the July 1, 2022 City of Tumwater Drainage Design and Erosion Control Manual (DDECM).

Per Figure 2.1 of the City of Tumwater DDECM, all minimum requirements apply to the new and replaced hard surfaces and converted vegetation areas (Refer to **Appendix 4, Exhibit 4A**). In addition, the requirements for redevelopment project sites in Section 2.3.2 of the City of Tumwater DDECM must be evaluated to determine if retrofitting existing surface is required. For a description of how each minimum requirement is being addressed, see **Sections 4.1.2 – 4.1.12** of this report.

2 Existing Conditions Description

The existing site consists of undeveloped land within the City of Tumwater property and portions of existing cart path near the boundary of the Tumwater Valley Golf Course, within City of Tumwater property. Surrounding land use includes parks/open space (Tumwater Valley Golf Course), General Commercial (The Valley Athletic Club, Serendipity Children's Center recently acquired by the City of Tumwater and Tumwater Valley Physical Therapy), and low-density single-family developments. Most of the existing surface on site consists of open grassy slopes or forested areas. For approximately 2,600 LF of the proposed trail footprint, the existing surface contains 8-foot-wide HMA cart paths and open grassy slopes to the north. In existing conditions, stormwater infiltrates in the grass and treed areas or sheet flows from the HMA cart path and infiltrates in nearby vegetation. The project site is composed of 6 Threshold Discharge Areas (TDAs) as shown in **Appendix 4, Exhibit 4C**. For a map of off-site drainage to the project site, refer to **Appendix 4, Exhibit 4B**.

TDA 1

TDA 1 is composed of two subbasins, Subbasin A, and Subbasin B:

- Subbasin A extends from the Valley Athletic Club parking lot to C 152+54 and M-line. The existing topography in this segment has a gradual downward slope from west to east.
- Subbasin B extends from C 153+38 to C 169+75. The grade is almost flat in this section of the project with a slight downward slope from east to west.

Surfaces that will be impacted by improvements in TDA 1 include existing pervious surface along the edge of the golf course, segments of existing cart paths, and undeveloped, forested areas. See **Table 1** below for the existing area takeoffs for TDA 1:

Table 1. Existing Area Takeoffs for TDA 1

TDA 1 EXISTING SURFACES IMPACTED BY THE PROJECT		
Surface Type	**Subbasin A Area (SF)**	**Subbasin B Area (SF)**
NPGIS	61	8,382
PGIS	0	0
Pervious	8,862	34,509
Impervious Total	61	8,382

Refer to **Appendix 4, Exhibit 4C for a breakdown of existing areas by subbasin.*

In TDA 1, stormwater currently flows into an existing wetland area between Palermo Valley Park and the Valley Golf Course. In Subbasin A, stormwater flows west into a stream located between the Valley Athletic Club and the golf course. The swale carries water south and discharges into the wetland. In Subbasin B, stormwater flows north through a buffer of trees and discharges into the same wetland. In Subbasin C, stormwater flows east into a stream located between the athletic center and the golf course. The stream carries water south and discharges into the category II wetland. Subbasins A, B and C are all part of TDA 1 because storm flows from the basins combine within one quarter mile downstream of the project site. Refer to **Appendix 4, Exhibit 4B** for a map of the flow path of existing stormwater from each basin area.

TDA 2

There is only one basin in TDA 2, Subbasin A:

- Subbasin A extends and is offset from C 166+50 – C 167+00. Existing topography in TDA 2 slopes downhill to the northeast.

Surfaces that will be impacted by improvements in TDA 2 consist of undeveloped, forested areas. See **Table 2** below for the existing area takeoffs for TDA 2:

Table 2. Existing Area Takeoffs for TDA 2

TDA 2 EXISTING SURFACES IMPACTED BY THE PROJECT	
Surface Type	**Area (SF)**
NPGIS	592
PGIS	0
Pervious	1,230
Impervious Total	592

In TDA 2, stormwater currently flows northeast through a forested area and across the golf course before entering a pond in the middle of the course. From the pond, stormwater flows southeast to another pond and eventually discharges into the Deschutes River near the east end of the project.

TDA 3

TDA 3 has one subbasin, Subbasin A :

- Subbasin A extends from C 182+75 – C 185+25. In Subbasin A, the existing grade slopes downward from west to east.

Surfaces that will be impacted by improvements in TDA 3 include existing pervious surface along the edge of the golf course, segments of existing cart paths, and undeveloped, forested areas. See **Table 3** below for the existing area takeoffs for TDA 3:

Table 3. Existing Area Takeoffs for TDA 3

TDA 3 EXISTING SURFACES IMPACTED BY THE PROJECT	
Surface Type	**Area (SF)**
NPGIS	1,648
PGIS	0
Pervious	5,291
Impervious Total	1,648

Refer to **Appendix 4, Exhibit 4C for a breakdown of existing areas by subbasin.*

In existing conditions, stormwater from TDA 3 flows to a pond in the golf course located southeast of the project site. The pond is within 1,000 feet of the Deschutes River. Any excess water that overtops the pond in a larger storm event follows the grade of the site to the east and discharges into the Deschutes River. In Subbasin A, stormwater flows southeast through a treed valley before it is captured in the pond. In Subbasin B, stormwater flows northeast across a grassy hillside before entering the pond. Subbasin A and Subbasin B are both part of TDA 3 because storm flows from the basins merge within one quarter mile downstream of the project site at a pond. Refer to **Appendix 4, Exhibit 4B** for a map of the flow path of existing stormwater from each basin area.

TDA 4

TDA 4 has two subbasins, Subbasin A and Subbasin B:

- Subbasin A is located between C 172+20 – C 182+75. The existing topography in this segment of the project slopes downhill from north to south to an existing valley that runs parallel to the project site.
- Subbasin B is located between C 185+25 – C 192+50. The existing grade in Subbasin B also slopes downhill from north to south.

Surfaces that will be impacted by the project in TDA 4 include existing pervious surface along the edge of the golf course and segments of existing cart paths. See **Table 4** below for the existing area takeoffs for TDA 4:

Table 4. Existing Area Takeoffs for TDA 4

TDA 4 EXISTING SURFACES IMPACTED BY THE PROJECT		
Surface Type	**Subbasin A Area (SF)**	**Subbasin B Area (SF)**
NPGIS	4,100	4,491
PGIS	0	0
Pervious	21,683	36,035
Impervious Total	4,100	4,491

Refer to **Appendix 4, Exhibit 4C for a breakdown of existing areas by subbasin.*

In TDA 4, Stormwater currently flows south to an existing valley running parallel to the project site. From the valley, the existing grade carries water southeast where it discharges into a category II wetland bordering the Tumwater Valley Golf Course. Subbasin A and Subbasin B are both part of TDA 4 because storm flows from the basins merge within one quarter mile downstream of the project site at the wetland. Refer to **Appendix 4, Exhibit 4B** for a map of the flow path of existing stormwater from each basin area.

TDA 5

TDA 5 is composed of 4 subbasins, Subbasin A, Subbasin B, Subbasin C, and Subbasin D:

- Subbasin A spans between C 192+50 – C 197+25. Existing topography in Subbasin A slopes downhill from south to north.
- Subbasin B spans between C 197+25 – C 200+90. In this segment, the existing topography is almost flat, with a slight downward slope from north to south.
- Subbasin C includes the Deschutes Valley Park Spur and spans between C 300+00 – C 308+64. Existing topography in Subbasin C slopes downhill from south to north.

Surfaces that will be impacted by the project in TDA 5 include existing pervious surface along the edge of the golf course, segments of existing cart paths, and undeveloped, forested areas. See **Table 5** below for the existing area takeoffs for TDA 5:

Table 5. Existing Area Takeoffs for TDA 5

TDA 5 EXISTING SURFACES IMPACTED BY THE PROJECT			
Surface Type	**Subbasin A Area (SF)**	**Subbasin B Area (SF)**	**Subbasin C Area (SF)**
NPGIS	3,995	1,304	168
PGIS	0	0	0
Pervious	11,682	9,627	64,918
Impervious Total	3,995	1,304	168

Refer to **Appendix 4, Exhibit 4C for a breakdown of existing areas by subbasin.*

In TDA 5, stormwater from Subbasin A currently flows northeast across the golf course and into the Deschutes River. In Subbasin B, stormwater flows southeast through an existing forested area before discharging into the Deschutes River. In Subbasin C, the stormwater is currently doing two things. The upper section near Deschutes Valley Park flows to the embankment where it is collected by a catch basin that connects to the golf course's stormwater pipes and the other portion of the site is sheet flowing through a forested area and across the golf course into the Deschutes River similar to Subbasin A. Subbasins A, B, and C are all part of TDA 5 because storm flows from the basins merge within one quarter mile downstream of the project site at the Deschutes River. Refer to **Appendix 4, Exhibit 4B** for a map of the flow path of existing stormwater from each basin area.

TDA 6

TDA 6 has one subbasin, Subbasin A:

- Subbasin A extends from C 169+75 – C 172+25. In Subbasin A, the existing grade slopes downward from west to east.

Surfaces that will be impacted by improvements in TDA 6 made up of undeveloped, forested areas. See **Table 6** below for the existing area takeoffs for TDA 6:

Table 6. Existing Area Takeoffs for TDA 6

TDA 6 EXISTING SURFACES IMPACTED BY THE PROJECT	
Surface Type	**Area (SF)**
NPGIS	0
PGIS	0
Pervious	5,847
Impervious Total	0

Refer to **Appendix 4, Exhibit 4C for a breakdown of existing areas by subbasin.*

In existing conditions, stormwater from TDA 6 flows to a depression between wetlands A and B. This depression is directly south of wetland A and northeast of wetland B. Any stormwater overtopping this depression is expected to flow into either of the wetlands. Refer to **Appendix 4, Exhibit 4B** for a map of the flow path of existing stormwater from each basin area.

2.1.1 Existing Soils

A draft geotechnical report evaluating soil and groundwater conditions was prepared by Sage Geotechnical on March 10th, 2026.

Based on the geology review completed by Sage Geotechnical, soils in Segment C are comprised of post-glaciation sand, silt, and gravel alluvium deposits from the Deschutes River. Recessional outwash was also found to be present given due to the significant fill material involved in grading the golf course. Subsurface conditions were analyzed based on 4 drilled borings and 40 hand augers. Soils discovered include sod/topsoil between depths of 0.15 and 2 feet, forest duff between depths of 0.7 and 1.4 feet in wooded areas, fill between depths of 0.25 and 4.5 feet in developed portions of the site, marsh deposits between depths of 1 and 10 feet in historic wetland areas, alluvium between depths of 2 and 5.1 feet, and recessional outwash between the surface soils and the full depth of exploration.

The existing groundwater level is located between 1.1 and 9.0 feet below the ground surface, including perched irrigation water and the groundwater table associated with the Deschutes River. Fill grading activities at the site created a complicated groundwater regime, trapping and perching groundwater along the west side of the golf course. It is anticipated that groundwater in the valley fluctuates seasonally and is near the ground surface over most of the project site during the winter. Refer to **Appendix 3, Exhibit 3C** for the draft geotechnical report.

Soil data from the NRCS web soil survey is consistent with findings from the geotechnical report, confirming that soils are composed primarily of Xerorthents fill material, Everett very gravelly sandy loam, Norma silt loam, Indianola loamy sand, and Puyallup silt loam. The groundwater data is also consistent with the geotechnical report, confirming a variable depth to the water table from 0-6.6 feet below the existing ground surface. Refer to **Appendix 3, Exhibit 3B** for the NRCS Soil Report.

The geotechnical report by Sage Geotechnical has yielded infiltration rates for TDA 5 and soil types for the entire project area; refer to **Appendix 3, Exhibit 3D**.

2.1.2 Critical Areas

There are no City of Tumwater maps for the following types of critical areas; the information provided below is based on Thurston County maps included as **Appendix 3, Exhibit 3A**.

- Geologic Hazard Areas
    - There are no known landslide and no volcanic hazard areas within the project site.

- Known Areas of Soil or Groundwater Concern
    - There are no known areas of soil or groundwater concern within the project site.

- High Groundwater Hazard Areas
    - There are three ponds north of the project improvements that have a high groundwater hazard. Construction activities will not affect these areas.

- Flood Zones
    - The northern section of the project is located within the 100-year flood zone.

- Critical Aquifer Recharge Areas
    - The project improvements are in a moderate-to-high class aquifer recharge area. Per the City of Tumwater DDECM and Section 16.24.050 of the Municipal Code, the project does not involve storage of hazardous materials and therefore does not trigger any additional requirements for the aquifer recharge area.

- Wetlands
    - The northern section of the project is adjacent to a designated category II wetland A. Along the central western portion of the trail category III wetland B resides. The southern section of the project is adjacent to a designated category II wetland C. Approximately half of the project improvements are within 300 feet of a wetland area.

  - The existing cart path stretches within these wetland boundaries, and the planned improvements are designed to follow the existing path closely. Additional impervious surface is expected to be minimal and stretched across the several basins on the project site. See *section 4.1.9* for further descriptions of each wetland.

- Wellhead Protection Areas
  - Wellhead No. 89700 is located west of the project site and project improvements are located within the 6-month - 5-year travel times. Since new impervious surfaces on the project are non-pollution-generating and the project does not fall under any of the prohibited uses listed in Section 16.26.040 of the City of Tumwater Municipal Code, no additional requirements are triggered.

- Washington State Department of Ecology Water Quality Atlas Map
  - The site is in the Budd/Deschutes Watershed, Water Resource Inventory Area (WRIA) 13 and the Deschutes River Basin (see **Appendix 3, Exhibit 3A**).
  - The Deschutes River is designated as a Category 5 Assessed Water - 303(d) (see **Appendix 3, Exhibit 3A**) specifically for:
    - Bacteria - fecal coliform, and
    - Benthic Macroinvertebrates Bioassessments.
  - At the time the City of Tumwater DDECM was written, a Water Quality Improvement Report and Implementation Plan (also known as a TMDL) had been developed for the Deschutes River, Percival Creek, and Budd Inlet Tributaries for Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load (see **Appendix 3, Exhibit 3A**). The plan lists nine specific actions the City of Tumwater implemented via additional water quality mitigation requirements included in City of Tumwater DDECM, Volume I, Section 4.3.5 to meet requirements of the TMDL.

3 Vicinity Analysis and Subbasin Description

3.1.1 Vicinity Analysis

A qualitative analysis of off-site tributary areas is included as **Appendix 4, Exhibit 4B**. Off-site tributary areas were delineated based on surface contours provided by the survey and Thurston County GIS. The downstream analysis was completed from upstream contributing areas to a minimum of ½ mile downstream of the project site for each TDA.

The following items were analyzed during development of the Basin and Work Maps included as **Appendix 4**:

- All areas pertinent to the analyses such as site boundaries, study area boundaries, streets and prominent features, downstream flow path, potential/existing problems, etc. shall be keyed to features shown on the Work Map.

  - Refer to **Appendix 4, Exhibit 4C** for the Work Map.

- Describe the drainage system between the site and the receiving surface waters (or pothole, regional detention facility, etc.). Provide information on pipe sizes, channel characteristics, and drainage structures. Describe emergency services located along the flow path (e.g., fire/police stations, hospitals). Describe environmentally sensitive areas, such as wetlands, etc.

    - In existing conditions, stormwater sheet flows across forested areas and the Valley Golf Course into wetlands, ponds, and the Deschutes River. There are no emergency services located along the flow path. Refer to **Section 2** of this report for a detailed description of the existing drainage path from each TDA and subbasin. Refer to **Section 4.1.9** of this report for a description of wetland areas.

- Describe off-site drainage tributary to the project. Describe any bypass drainage from the project that will not be controlled.

    - Refer to **Appendix 4, Exhibit 4B** for a map of off-site drainage tributary to the project. There is no bypass drainage from the project.
- Evaluate existing and potential impacts from conveyance system capacity issues, flooding or bank overtopping, upland erosion impacts, including slope stability and landslide hazards, stream channel erosion, violations of surface water quality standards or violations of groundwater standards in a wellhead protection area.

    - Per **Section 2.1.2** of this report, the only critical areas that impact the project are flood zones, critical aquifer recharge areas, wetlands, and wellhead protection areas. The project improvements are not anticipated to impact these critical areas. Wetland migration will be completed per the direction of Land Services Northwest (LSNW) report.

- Identify the existence of wellhead protection areas, drinking water wells, and septic systems both of record and others on the site and adjacent property within setback distance for stormwater retention/detention facilities identified in Volume V of the City of Tumwater DDECM.

    - Refer to **Section 2.1.2** of this report for a description of wellhead protection areas.

- Identify the existence of fuel tanks, in-use or abandoned.

    - No fuel tanks are located within the project site.

- Determine whether the project is within the potential flood hazard area as defined in TMC Title 18.38, show the 100-year flood hazard area on the plans.

    - The project falls under the special flood hazard area according to the FEMA Flood Map included in **Appendix 3, Exhibit 3A** and is therefore subject to a floodplain development permit per TMC Title 18.38. The project shall be designed and located to minimize the impact on flood flows, food storage, water quality, and habitat. Sheet flow dispersion shall be implemented to mimic predeveloped hydrologic conditions.

3.1.2 Subbasin Description

Below is a description of proposed surfaces in each TDA and subbasin. Project improvements generally include a 10-foot to 12-foot wide HMA shared-use path with 1-2-foot gravel shoulders and 8-foot to 7.25-foot cart path where practicable. Sections of trail canopy fence are included as needed to delineate the shared use path from the cart path in areas with both vehicular and pedestrian travel. The proposed HMA trail is graded at a 1.5% slope to the west, away from the existing golf course.

TDA 1

See **Table 6** below for a summary of proposed surfaces in TDA 1:

Table 7. Proposed Area Takeoffs for TDA 1

TDA 1 PROPOSED AREAS		
Surface Type	**Subbasin A Area (SF)**	**Subbasin B Area (SF)**
NPGIS (New)	6,311	24,147
PGIS (New)	0	0
New Hard Surface	6,311	24,147
Pervious	2,612	10,719
NPGIS (Replaced)	0	8,025
PGIS (Replaced)	0	0
Replaced Hard Surface	0	8,025

Refer to **Appendix 4, Exhibit 4C for a breakdown of proposed areas by subbasin.*

TDA 2

See **Table 7** below for a summary of proposed surfaces in TDA 2:

Table 8. Proposed Area Takeoffs for TDA 2

TDA 2 PROPOSED AREAS	
Surface Type	**Subbasin A Area (SF)**
NPGIS (New)	86
PGIS (New)	0
New Hard Surface	86
Pervious	1,148
NPGIS (Replaced)	588
PGIS (Replaced)	0
Replaced Hard Surface	588

Refer to **Appendix 4, Exhibit 4C for a breakdown of proposed areas by subbasin.*

TDA 3

See **Table 8** below for a summary of proposed surfaces in TDA 3:

Table 9. Proposed Area Takeoffs for TDA 3

TDA 3 PROPOSED AREAS	
Surface Type	**Subbasin A Area (SF)**
NPGIS (New)	3,921
PGIS (New)	0
New Hard Surface	3,921
Pervious	1,476
NPGIS (Replaced)	1,542
PGIS (Replaced)	0
Replaced Hard Surface	1,542

Refer to **Appendix 4, Exhibit 4C for a breakdown of proposed areas by subbasin.*

TDA 4

See **Table 9** below for a summary of proposed surfaces in TDA 4:

Table 10. Proposed Area Takeoffs for TDA 4

TDA 4 PROPOSED AREAS		
Surface Type	**Subbasin A Area (SF)**	**Subbasin B Area (SF)**
NPGIS (New)	16,109	12,254
PGIS (New)	0	0
New Hard Surface	16,109	12,254
Pervious	6,173	25,020
NPGIS (Replaced)	3,501	3,252
PGIS (Replaced)	0	0
Replaced Hard Surface	3,501	3,252

Refer to **Appendix 4, Exhibit 4C for a breakdown of proposed areas by subbasin.*

TDA 5

See **Table 10** below for a summary of proposed surfaces in TDA 5:

Table 11. Proposed Area Takeoffs for TDA 5

TDA 5 PROPOSED AREAS			
Surface Type	**Subbasin A Area (SF)**	**Subbasin B Area (SF)**	**Subbasin C Area (SF)**
NPGIS (New)	6,466	7,815	12,175
PGIS (New)	0	0	0
New Hard Surface	6,466	7,815	12,175
Pervious	5,269	3,086	52,911
NPGIS (Replaced)	3,942	30	0
PGIS (Replaced)	0	0	0
Replaced Hard Surface	3,942	30	0

Refer to **Appendix 4, Exhibit 4C for a breakdown of proposed areas by subbasin.*

TDA 6

See **Table 11** below for a summary of proposed surfaces in TDA 6:

Table 12. Proposed Area Takeoffs for TDA 6

TDA 6 PROPOSED AREAS	
Surface Type	**Subbasin A Area (SF)**
NPGIS (New)	3,397
PGIS (New)	0
New Hard Surface	3,397
Pervious	2,450
NPGIS (Replaced)	0
PGIS (Replaced)	0
Replaced Hard Surface	0

Refer to **Appendix 4, Exhibit 4C for a breakdown of proposed areas by subbasin.*

4 Flow Control and Water Quality Facility Sizing

4.1.1 Minimum Requirements Overview

The stormwater design for this project complies with applicable minimum requirements outlined in the City of Tumwater DDECM. See **Section 4.1.2 – 4.1.12** of this report for a description of how the project complies with each minimum requirement.

According to Figure 2.1 of the City of Tumwater DDECM, this project is classified as new development since the project site has less than 35% existing impervious surface coverage. The project also adds over 5,000 square feet of new plus replaced hard surfaces, so all minimum requirements apply to the new and replaced hard surfaces and converted vegetation areas. Since the site has existing impervious area,

the City of Tumwater DDECM also requires a review of additional requirements for redevelopment project sites which was determined to be required

This project results in 113,216 SF of new hard surface, which is approximately 360% of the existing hard surface. In addition, none of the new hard surfaces are pollution-generating. Refer to **Appendix 4, Exhibit 4A** for the minimum requirements flow chart.

4.1.2 MR #1: Stormwater Site Planning

Stormwater site plans are included as part of the Design Submittal Package. The stormwater design for this project retains native vegetation and minimizes impervious surfaces to the maximum extent feasible.

According to Chapter 3, Table 3.1 of the City of Tumwater DDECM, the following documents are required to meet Minimum Requirement #1:

- Stormwater Pollution Prevention Plan (SWPPP)
    - Refer to **Appendix 5**.

- Drainage Control Plan
    - This report along with the stormwater site plans included with the Design Submittal Package serve as the drainage control plan.

4.1.3 MR #2: Construction Stormwater Pollution Prevention Plan (SWPPP)

The Construction SWPPP addresses erosion and sediment control during site construction activities and demonstrate compliance with the 13 required elements per Volume II of the City of Tumwater DDECM. Refer to **Appendix 5** for the Construction SWPPP.

4.1.4 MR #3: Source Control of Pollution

All known available, and reasonable source control BMPs shall be applied to the project to prevent stormwater from coming into contact with pollutants on the developed site. Pollutants are not anticipated in developed conditions; pollutant sources are limited to construction activities.

The Source control BMPs are:

- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C153: Material Delivery, Storage, and Containment
- BMP C154: Concrete Washout Area
- BMP C250: Construction Stormwater Filtration
- BMP C252: Treating and Disposing of High pH Water

4.1.5 MR #4: Preservation of Natural Drainage Systems and Outfalls

Natural drainage patterns shall be maintained, and discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site shall not cause a significant adverse impact to downstream receiving waters and downgradient properties. All outfalls shall employ energy dissipation.

Throughout the project, the existing stormwater either flows across the existing golf course and collects at low points or is absorbed by native vegetation in forested areas. In the proposed C-Line conditions, stormwater shall continue to sheet flow from the path into surrounding vegetation and follow the natural topography of the site. In the proposed T-Line conditions, stormwater will flow along a ditch populated with check dams into a catch basin that pipes into an infiltration trench drain.

4.1.6 MR #5: On-Site Stormwater Management

Per Section 2.4.6 of the City of Tumwater DDECM, the BMPs from List #2 for all surfaces within each type of surface in List #2 shall be evaluated to meet Minimum Requirement 5. List #2 applies since the project triggers Minimum Requirements #1 – 11. BMPs shall be considered for each type of surface in the order listed and the first feasible BMP shall be implemented. Below are the List #2 BMPs for each surface type and explanations for why the BMPs were or were not implemented on this project.

Lawn and Landscaped Areas:

- **Postconstruction soil quality and depth (City of Tumwater DDECM Volume, Chapter 6) (Ecology BMP T5.13)** - This BMP is feasible and will be implemented onsite to the maximum extent feasible.

Roofs

- No roofs are proposed with this project.

Other Hard Surfaces:

- **Full Dispersion (City of Tumwater DDECM Volume V, Section 7.2) (Ecology BMP T5.30)** – This BMP is infeasible and will not be implemented onsite: a minimum forested or native vegetation flowpath length of 100 feet cannot be achieved.
- **Permeable Pavement (City of Tumwater DDECM Volume V, Chapter 11) (Ecology BMP T5.15)** – This BMP is infeasible and will not be implemented onsite. According to the NRCS web soil survey included in **Appendix 3, Exhibit 3B**, the depth to the water table is less than 3 feet for approximately half of the project area. The geotechnical report states that the water table varies due to perched groundwater and is at the ground surface throughout the winter months.
- **Bioretention (City of Tumwater DDECM Volume V, Chapter 9) (Ecology BMPs T5.14 and T7.30)** – This BMP is infeasible and will not be implemented onsite. According to the NRCS web soil survey included in **Appendix 3, Exhibit 3B**, the depth to the water table is less than 3 feet for approximately half of the project area. The geotechnical report states that the water table varies due to perched groundwater and is at the ground surface throughout the winter months.
- **Sheet Flow Dispersion (City of Tumwater DDECM Volume V, Sections 7.3) (Ecology BMP T5.12)** – This BMP is feasible and will be implemented onsite:
    - Site setbacks and design criteria provided in DDECM Volume V, Chapter 7.3.4 are achieved by proposing:
        - A 2-foot-wide transition zone to discourage channeling must be provided between the edge of the contributing surface (or building eaves) and the downslope vegetation.

        - A 10-foot-wide vegetated buffer for up to 20 feet of width of contributing surface.
    - The contributing surface is designed to meet ADA requirements with 1.5% max cross slope.
    - The dispersion area runs parallel to the proposed path, accepting sheet flow runoff.
    - The length of the dispersion area is equivalent to the length of the proposed path.
    - Positive drainage for sheet flow runoff is proposed:
        - The average longitudinal slope of the dispersion area is approximately 3%, ranging from 0% - 20% throughout the project.
    - Per City of Tumwater DDECM Volume V, Section 7.3.3 Modeling and Sizing: Where sheet flow dispersion is used to disperse runoff into an undisturbed native landscape area or an area that meets the requirements of Chapter 6, the impervious area may be modeled as grass/lawn area.

4.1.7 MR #6: Runoff Treatment

This project triggers Minimum Requirement 6 for new hard surfaces and converted vegetation areas since the improvements add more than 5,000 SF of new plus replaced hard surface at the project level (see **Appendix 4, Exhibit 4C** for area takeoffs). Per Section 2.4.7 of the City of Tumwater DDECM, the following thresholds for Minimum Requirement 6 are considered for each individual TDA, for new and replaced hard surfaces. If a TDA does not meet either of the following criteria, then Runoff Treatment is not required for that TDA:

- Projects in which the total pollution-generating hard surface (PGHS) is 5,000 square feet or more in a threshold discharge area of the project, or
- Projects in which the total pollution-generating pervious surface (PGPS) – not including permeable pavements – are 0.75 acre or more in a threshold discharge area, and from which there will be a surface water discharge in a natural or artificial conveyance system from the site.

Below is a summary of how each TDA complies with Minimum Requirement #6 according to the TDA thresholds listed above:

TDA 1

TDA 1 has 0 SF of new and replaced pollution-generating hard surface. TDA 1 also has no pollution-generating pervious surface. TDA 1 therefore falls below both thresholds and does not require runoff treatment BMPs.

TDA 2

TDA 2 has 0 SF of new and replaced pollution-generating hard surface. TDA 2 also has no pollution-generating pervious surface. TDA 2 therefore falls below both thresholds and does not require runoff treatment BMPs.

TDA 3

TDA 3 has 0 SF of new and replaced pollution-generating hard surface. TDA 3 also has no pollution-generating pervious surface. TDA 3 therefore falls below both thresholds and does not require runoff treatment BMPs.

TDA 4

TDA 4 has 0 SF of new and replaced pollution-generating hard surface. TDA 4 also has no pollution-generating pervious surface. TDA 4 therefore falls below both thresholds and does not require runoff treatment BMPs.

TDA 5

TDA 5 has 0 SF of new and replaced pollution-generating hard surface. TDA 5 also has no pollution-generating pervious surface. TDA 5 therefore falls below both thresholds and does not require runoff treatment BMPs.

Runoff Treatment is triggered for the project, but runoff treatment BMPs are not required for any of the TDAs because TDAs 1-5 fall below the TDA threshold criteria.

A flow control is required in Subbasin C. Stormwater running south will collect in a ditch with check dams and convey runoff into a catch basin that flows into an infiltration trench which is 6 feet wide and 50 feet long designed for 99.99% infiltration. Flow is designed to mimic existing drainage patterns into the Deschutes River.

TDA 6

TDA 6 has 0 SF of new and replaced pollution-generating hard surface. TDA 6 also has no pollution-generating pervious surface. TDA 6 therefore falls below both thresholds and does not require runoff treatment BMPs.

4.1.8 MR #7: Flow Control

Minimum Requirement 7 is triggered at a project-level for new hard surfaces and converted vegetation areas. Below is a summary of TDA and project site areas, along with a description of the types of surfaces within each TDA for reference.

Table 13. TDA and Project Site Areas

Surface Type	TDA 1 (SF)	TDA 2 (SF)	TDA 3 (SF)	TDA 4 (SF)	TDA 5 (SF)	TDA 6 (SF)	Project Area (SF)	Surface Description
New PGIS	0	0	0	0	0	0	0	
New NPGIS	30,458	86	3,921	28,363	26,456	3,397	92,681	HMA trail
New Hard Surface	30,458	86	3,921	28,363	26,456	3,397	92,681	360% of existing hard surface
Replaced PGIS	0	0	0	0	0	0	0	
Replaced NPGIS	8,025	588	1,542	6,753	3,972	0	20,880	HMA trail
Replaced Hard Surface	8,025	588	1,542	6,753	3,972	0	20,880	HMA trail
New + Replaced Impervious	38,483	674	5,463	35,116	30,428	3,397	113,561	HMA trail
Effective Impervious	38,483	674	5,463	35,116	30,428	3,397	113,561	HMA trail
Existing Impervious Surface	8,443	592	1,648	8,591	5,467	0	24,741	12% of total project area
Total Project Area*	51,814	1,822	6,939	66,309	91,694	5,847	224,425	

Project Area is defined as outlined in **Appendix 4, Exhibit 4C.*

Per City of Tumwater DDECM Volume I, Section 2.4.8 Minimum Requirement #7: Flow Control, Thresholds: the following circumstances require achievement of the standard flow control requirement for western Washington:

A. Projects in which the total of effective impervious surfaces is 10,000 square feet or more in a threshold discharge area.
B. Projects that convert 0.75 acre or more of native vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in a conveyance system (natural or man-made) from the site.
C. Projects that, through a combination of effective hard surfaces and converted vegetation areas, cause a 0.1 cubic feet per second increase in the 100-year recurrence interval flow frequency from a threshold discharge area, as estimated using the WWHM, or other approved model and 1-hour time steps (or a 0.15 cubic feet per second increase using 15-minute time steps).

Using WWHM at 15-minute time steps (with predeveloped land cover being existing condition and mitigated impervious area modeled as lawn), TDA 2, TDA 3, and TDA 6 are flow control exempt and do not require flow control BMPs:

Table 14. Flow Control Exemption

Threshold		TDA					
		1	2	3	4	5	6
A		Yes	No	No	Yes	Yes	No
B		No	No	No	No	Yes	No
C	100-year Peak Flow (cfs)						
	Predeveloped	0.364	0.009	0.036	0.228	0.207	0.051
	Developed	0.831	0.019	0.120	0.901	1.349	0.090
	Increase	0.467	0.010	0.084	0.673	1.142	0.039
	Increase > 0.15 cfs	Yes	No	No	Yes	Yes	No
Flow Control Exempt		No	Yes	Yes	No	No	Yes

TDA 1, TDA 4, and TDA 5 will utilize Sheet Flow Dispersion (City of Tumwater DDECM Volume V, Sections 7.3) (Ecology BMP T5.12) as described in Section 4.1.6 of this report.

TDA 5 will also utilize concentrated flow dispersion (Ecology BMP T5.11) in Subbasin C.

4.1.9 MR #8: Wetlands Protection

Minimum Requirement #8 states that discharges to wetlands shall maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated wetland uses and functions. Wetlands Protection applies to TDA 1, TDA 2, TDA 3, and TDA 4, all of which discharge into designated wetland areas. The following information went under investigation for all wetlands adjacent to the project site:

- Wetland A is Category II with a habitat score of seven
- Wetland B is Category III with a habitat score of seven

- Wetland C is Category II with a habitat score of six
- No known Presence/absence of endangered species currently
- No known Presence/absence of breeding native amphibians currently

Wetland protection requirements shall be determined per Figure 2.4 of the City of Tumwater DDECM included as **Appendix 6**.

4.1.10 MR #9: Operation and Maintenance

Sheet flow dispersion areas shall be maintained and managed by the City of Tumwater. An Operation and Maintenance plan is not provided as part of this report and shall be completed by the City of Tumwater as desired.

4.1.11 MR #10: Financial Liability

This project is located within the publicly owned property and shall be owned and maintained by the City of Tumwater.

4.1.12 MR #11: Off-Site Analysis and Mitigation

Refer to **Section 3.1.1** of this report for a qualitative downstream analysis. A quantitative analysis is not anticipated given that the stormwater management strategy is sheet flow dispersion.

5 Aesthetic Considerations for Facilities

The City of Tumwater DDECM states that stormwater facilities shall be designed to be aesthetically pleasing and meet the landscaping requirements of TMC 18.47 and of Volume V, Appendix V-E of the DDECM.

Aesthetic Considerations:

- **Post-Construction Soil Quality and Depth**
  - Any areas disturbed during construction shall be replaced with the appropriate soil section and re-seeded prior to final completion.
- **Sheet Flow Dispersion**
  - Designated dispersion areas shall be maintained as vegetation throughout the life of the project.

Landscaping Requirements (TMC 18.47):

- The Deschutes Valley Trail – Segment C Project site is located in a parks/open space zoning category. TMC 18.47 does not have any additional landscaping requirements for open space zones.

Landscaping Requirements (DDECM Volume V, Appendix V-E):

- Volume V, Appendix V-E of the City of Tumwater DDECM discusses the use of facility liners to minimize pollutant-laden runoff from treatment facilities. Runoff treatment BMPs are not required as part of this project, so this section does not apply to the project.

6 Covenants, Dedications, Easements

This project is located within the publicly owned property and is owned and maintained by the City of Tumwater. No covenants, dedications, or easements apply to the project.

7 Agreements and Guarantees

Maintenance and/or operational bonding or other financial guarantees shall be consistent with Minimum Requirement #10. Refer to **Section 4.1.11** of this report.

8 Other Permits or Conditions Placed on the Project

SCJ shall provide permit support as needed for the anticipated permits below along with any additional permits identified by the City of Tumwater:

Table 15. Anticipated Permits and Variances

Agency	Permit/Approval	Notes
City of Tumwater	Floodplain Development Permit	Required per TMC 18.38
City of Tumwater	Wetland Permit	Required per City permits dashboard
NEPA	*	Identified in Section 5.6 the scope of work
SEPA	*	Identified in Section 5.6 the scope of work
City of Tumwater	Sheet Flow Dispersion Variance	Required to comply with Minimum Requirement #7

** Permit requirements to be provided by the City of Tumwater*

Appendix 1
Design Calculations

WWHM Calcs
6/30/2026
NWS

Existing Area Calculations **	sf	ac	Slope: Flat (0-5%), Moderate (5-15%), Steep (>15%).	Sidewalk	Lawn	Pasture	Forest
				ac			
TDA 1							
Subbasin A			Flat	Hydrologic Soil Group C/D and B/D			
Pervious	8,862	0.20				0.20	
NPGIS	61	0.00		0.00			
Total	8,923	0.20		0.00	0.00	0.20	0.00
Subbasin B			Flat	Hydrologic Soil Group B/D			
Pervious	34,509	0.79					0.79
NPGIS	8,382	0.19		0.19			
Total	42,891	0.98		0.19	0.00	0.00	0.79
TDA 2							
Subbasin A			Flat	Hydrologic Soil Group A			
Pervious	1,230	0.03				0.03	
NPGIS	592	0.01		0.01			
Total	1,822	0.04		0.01	0.00	0.03	0.00
TDA 3							
Subbasin A			Flat	Hydrologic Soil Group B/D			
Pervious	5,291	0.12					0.12
NPGIS	1,648	0.04		0.04			
Total	6,939	0.16		0.04	0.00	0.00	0.12
TDA 4							
Subbasin A			Flat	Hydrologic Soil Group B/D			
Pervious	21,683	0.50					0.50
NPGIS	4,100	0.09		0.09			
Total	25,783	0.59		0.09	0.00	0.00	0.50
Subbasin B			Flat	Hydrologic Soil Group B/D			
Pervious	36,035	0.83				0.83	
NPGIS	4,491	0.10		0.10			
Total	40,526	0.93		0.10	0.00	0.83	0.00
TDA 5							
Subbasin A			Moderate	Hydrologic Soil Group B/D			
Pervious	11,682	0.27				0.27	
NPGIS	3,995	0.09		0.09			
Total	15,677	0.36		0.09	0.00	0.27	0.00
Subbasin B			Moderate	Hydrologic Soil Group A			
Pervious	9,627	0.22					0.22
NPGIS	1,304	0.03		0.03			
Total	10,931	0.25		0.03	0.00	0.00	0.22
Subbasin C (T-Line)			Steep	Hydrologic Soil Group A			
Pervious	64,918	1.49					1.49
NPGIS	168	0.00		0.00			
Total	65,086	1.49		0.00	0.00	0.00	1.49
TDA 6							
Subbasin A			Flat	Hydrologic Soil Group B/D			
Pervious	5,847	0.13					0.13
NPGIS	0	0.00		0.00			
Total	5,847	0.13		0.00	0.00	0.00	0.13

** MR7 Flow Control TDA threshold: pre-developed landcover is existing condition.

Developed Area Calculations	sf	ac	Slope: Flat (0-5%), Moderate (5-15%), Steep (>15%).	Sidewalk	Lawn	Pasture	Forest
				ac			
TDA 1							
Subbasin A			Flat	Hydrologic Soil Group C/D and B/D			
Pervious	2,612	0.06			0.06		
NPGIS (New)*	6,311	0.14			0.14		
NPGIS (Replaced)*	0	0.00			0.00		
Total	8,923	0.20		0.00	0.20	0.00	0.00
Subbasin B			Flat	Hydrologic Soil Group B/D			
Pervious	10,719	0.25			0.25		
NPGIS (New)*	24,147	0.55			0.55		
NPGIS (Replaced)*	8,025	0.18			0.18		
Total	42,891	0.98		0.00	0.98	0.00	0.00
TDA 2							
Subbasin A			Flat	Hydrologic Soil Group A			
Pervious	1,148	0.03			0.03		
NPGIS (New)*	86	0.00			0.00		
NPGIS (Replaced)*	588	0.01			0.01		
Total	1,822	0.04		0.00	0.04	0.00	0.00
TDA 3							
Subbasin A			Flat	Hydrologic Soil Group B/D			
Pervious	1,476	0.03			0.03		
NPGIS (New)*	3,921	0.09			0.09		
NPGIS (Replaced)*	1,542	0.04			0.04		
Total	6,939	0.16		0.00	0.16	0.00	0.00
TDA 4							
Subbasin A			Flat	Hydrologic Soil Group B/D			
Pervious	6,173	0.14			0.14		
NPGIS (New)*	16,109	0.37			0.37		
NPGIS (Replaced)*	3,501	0.08			0.08		
Total	25,783	0.59		0.00	0.59	0.00	0.00
Subbasin B			Flat	Hydrologic Soil Group B/D			
Pervious	25,020	0.57			0.57		
NPGIS (New)*	12,254	0.28			0.28		
NPGIS (Replaced)*	3,252	0.07			0.07		
Total	40,526	0.93		0.00	0.93	0.00	0.00
TDA 5							
Subbasin A			Moderate	Hydrologic Soil Group B/D			
Pervious	5,269	0.12			0.12		
NPGIS (New)*	6,466	0.15			0.15		
NPGIS (Replaced)*	3,942	0.09			0.09		
Total	15,677	0.36		0.00	0.36	0.00	0.00
Subbasin B			Moderate	Hydrologic Soil Group A			
Pervious	3,086	0.07			0.07		
NPGIS (New)*	7,815	0.18			0.18		
NPGIS (Replaced)*	30	0.00			0.00		
Total	10,931	0.25		0.00	0.25	0.00	0.00
Subbasin C			Steep	Hydrologic Soil Group A			
Pervious	52,911	1.21			1.21		0.00
NPGIS (New)*	12,175	0.28			0.28		
NPGIS (Replaced)*	0	0.00			0.00		
Total	65,086	1.49		0.00	1.49	0.00	0.00

TDA 6

Subbasin A			Flat	Hydrologic Soil Group B/D			
Pervious	2,450	0.06			0.06		0.00
NPGIS (New)*	3,397	0.08			0.08		
NPGIS (Replaced)*	0	0.00			0.00		
Total	5,847	0.13		0.00	0.13	0.00	0.00

** Per City of Tumwater DDECM Volume V, Section 7.3.3: Where sheet flow dispersion is used to disperse runoff into an undisturbed native landscape area or an area that meets the requirements of Chapter 6, the impervious area may be modeled as grass/lawn area.*

NEXT DOCUMENT

WWHM4

PROJECT REPORT

General Model Information

WWHM2012 Project Name: Flow Control Exemption

Site Name:	Flow Control Exemption
Site Address:	
City:	
Report Date:	7/1/2026
Gage:	Olympia Airport
Data Start:	1955/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	0.000 (adjusted)
Version Date:	2024/06/28

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year
Low Flow Threshold for POC3:	50 Percent of the 2 Year
High Flow Threshold for POC3:	50 Year
Low Flow Threshold for POC4:	50 Percent of the 2 Year
High Flow Threshold for POC4:	50 Year
Low Flow Threshold for POC5:	50 Percent of the 2 Year
High Flow Threshold for POC5:	50 Year
Low Flow Threshold for POC6:	50 Percent of the 2 Year
High Flow Threshold for POC6:	50 Year

Landuse Basin Data
Predeveloped Land Use

TDA 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Flat	0.2
C, Pasture, Flat	0.79
Pervious Total	0.99

Impervious Land Use	acre
SIDEWALKS FLAT	0.19
Impervious Total	0.19
Basin Total	1.18

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

TDA 2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Flat	0.03
Pervious Total	0.03

Impervious Land Use	acre
SIDEWALKS FLAT	0.01
Impervious Total	0.01
Basin Total	0.04

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

POC 2	POC 2

TDA 3

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Flat	0.12
Pervious Total	0.12

Impervious Land Use	acre
SIDEWALKS FLAT	0.04
Impervious Total	0.04
Basin Total	0.16

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

POC 3	POC 3

TDA 4

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Flat	0.5
A B, Pasture, Flat	0.83
Pervious Total	1.33

Impervious Land Use	acre
SIDEWALKS FLAT	0.19
Impervious Total	0.19
Basin Total	1.52

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 4	POC 4	

TDA 5

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Steep	1.49
A B, Pasture, Mod	0.27
A B, Forest, Mod	0.22
Pervious Total	1.98

Impervious Land Use	acre
SIDEWALKS FLAT	0.12
Impervious Total	0.12
Basin Total	2.1

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 5	POC 5	

TDA 6

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	0.13
Pervious Total	0.13
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.13

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

POC 6	POC 6

Mitigated Land Use

TDA 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.31
Pervious Total	0.31

Impervious Land Use	acre
SIDEWALKS FLAT	0.87
Impervious Total	0.87
Basin Total	1.18

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 1	POC 1	

TDA 2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.03
Pervious Total	0.03

Impervious Land Use	acre
SIDEWALKS FLAT	0.01
Impervious Total	0.01
Basin Total	0.04

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

POC 2	POC 2

TDA 3

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.03
Pervious Total	0.03

Impervious Land Use	acre
SIDEWALKS FLAT	0.13
Impervious Total	0.13
Basin Total	0.16

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 3	POC 3	

TDA 4

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.71
Pervious Total	0.71

Impervious Land Use	acre
SIDEWALKS FLAT	0.81
Impervious Total	0.81
Basin Total	1.52

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 4	POC 4	

TDA 5

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Steep	1.21
A B, Lawn, Mod	0.19
Pervious Total	1.4

Impervious Land Use	acre
SIDEWALKS MOD	0.42
SIDEWALKS STEEP	0.28
Impervious Total	0.7
Basin Total	2.1

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 5	POC 5	

TDA 6

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Steep	0.01
A B, Lawn, Flat	0.06
Pervious Total	0.07

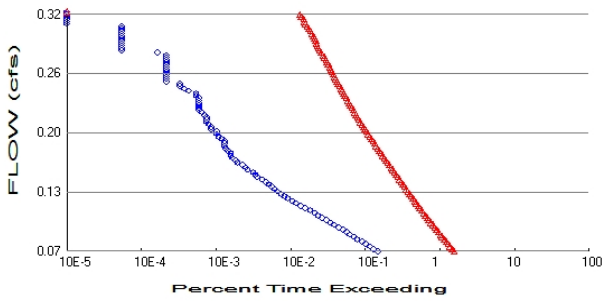
Impervious Land Use	acre
SIDEWALKS FLAT	0.08
Impervious Total	0.08
Basin Total	0.15

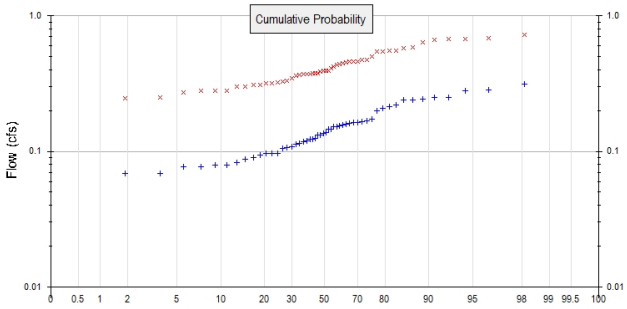
Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
POC 6	POC 6	

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.99
Total Impervious Area: 0.19

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.31
Total Impervious Area: 0.87

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.135413
5 year	0.191963
10 year	0.231276
25 year	0.282941
50 year	0.322827
100 year	0.363885

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.401883
5 year	0.516297
10 year	0.591812
25 year	0.687463
50 year	0.759111
100 year	0.831234

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1956	0.118	0.371
1957	0.219	0.584
1958	0.097	0.321
1959	0.123	0.379
1960	0.153	0.458
1961	0.115	0.362
1962	0.068	0.310
1963	0.240	0.660
1964	0.146	0.420
1965	0.123	0.374

1966	0.090	0.279
1967	0.107	0.309
1968	0.083	0.271
1969	0.079	0.281
1970	0.094	0.298
1971	0.108	0.302
1972	0.198	0.452
1973	0.096	0.280
1974	0.138	0.461
1975	0.249	0.499
1976	0.162	0.438
1977	0.167	0.555
1978	0.159	0.471
1979	0.215	0.544
1980	0.113	0.345
1981	0.207	0.544
1982	0.146	0.461
1983	0.169	0.722
1984	0.132	0.334
1985	0.077	0.317
1986	0.151	0.378
1987	0.279	0.678
1988	0.079	0.243
1989	0.131	0.390
1990	0.241	0.581
1991	0.283	0.641
1992	0.097	0.319
1993	0.064	0.248
1994	0.068	0.247
1995	0.105	0.373
1996	0.156	0.444
1997	0.119	0.391
1998	0.162	0.391
1999	0.174	0.472
2000	0.151	0.433
2001	0.077	0.327
2002	0.136	0.378
2003	0.087	0.395
2004	0.244	0.683
2005	0.125	0.368
2006	0.312	0.679
2007	0.250	0.555
2008	0.164	0.410

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.3118	0.7219
2	0.2831	0.6834
3	0.2792	0.6789
4	0.2501	0.6781
5	0.2487	0.6601
6	0.2445	0.6408
7	0.2409	0.5839
8	0.2397	0.5806
9	0.2188	0.5554
10	0.2145	0.5550
11	0.2067	0.5443

12	0.1978	0.5443
13	0.1740	0.4987
14	0.1686	0.4721
15	0.1667	0.4713
16	0.1643	0.4610
17	0.1623	0.4608
18	0.1616	0.4575
19	0.1589	0.4517
20	0.1561	0.4443
21	0.1535	0.4378
22	0.1511	0.4333
23	0.1511	0.4205
24	0.1464	0.4103
25	0.1462	0.3947
26	0.1377	0.3913
27	0.1356	0.3908
28	0.1324	0.3896
29	0.1313	0.3790
30	0.1247	0.3779
31	0.1231	0.3775
32	0.1229	0.3736
33	0.1194	0.3730
34	0.1182	0.3713
35	0.1151	0.3676
36	0.1127	0.3623
37	0.1077	0.3447
38	0.1070	0.3340
39	0.1052	0.3272
40	0.0972	0.3212
41	0.0970	0.3189
42	0.0962	0.3175
43	0.0937	0.3100
44	0.0895	0.3094
45	0.0872	0.3020
46	0.0828	0.2983
47	0.0795	0.2807
48	0.0794	0.2800
49	0.0773	0.2791
50	0.0767	0.2712
51	0.0682	0.2482
52	0.0682	0.2473
53	0.0643	0.2430

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0677	2725	28899	1060	Fail
0.0703	2407	27134	1127	Fail
0.0729	2132	25480	1195	Fail
0.0754	1881	23937	1272	Fail
0.0780	1671	22562	1350	Fail
0.0806	1448	21279	1469	Fail
0.0832	1295	19997	1544	Fail
0.0857	1159	18826	1624	Fail
0.0883	1049	17745	1691	Fail
0.0909	934	16758	1794	Fail
0.0935	815	15842	1943	Fail
0.0961	711	14933	2100	Fail
0.0986	631	14089	2232	Fail
0.1012	553	13232	2392	Fail
0.1038	491	12519	2549	Fail
0.1064	432	11807	2733	Fail
0.1089	387	11177	2888	Fail
0.1115	337	10588	3141	Fail
0.1141	291	10038	3449	Fail
0.1167	253	9478	3746	Fail
0.1192	222	8999	4053	Fail
0.1218	194	8519	4391	Fail
0.1244	169	8107	4797	Fail
0.1270	152	7688	5057	Fail
0.1296	138	7294	5285	Fail
0.1321	123	6925	5630	Fail
0.1347	115	6583	5724	Fail
0.1373	102	6246	6123	Fail
0.1399	94	5930	6308	Fail
0.1424	87	5639	6481	Fail
0.1450	77	5341	6936	Fail
0.1476	65	5048	7766	Fail
0.1502	62	4797	7737	Fail
0.1527	58	4546	7837	Fail
0.1553	49	4336	8848	Fail
0.1579	46	4103	8919	Fail
0.1605	42	3901	9288	Fail
0.1631	36	3702	10283	Fail
0.1656	34	3514	10335	Fail
0.1682	31	3338	10767	Fail
0.1708	29	3159	10893	Fail
0.1734	29	3003	10355	Fail
0.1759	27	2855	10574	Fail
0.1785	25	2708	10832	Fail
0.1811	24	2585	10770	Fail
0.1837	24	2475	10312	Fail
0.1862	24	2362	9841	Fail
0.1888	22	2236	10163	Fail
0.1914	20	2132	10660	Fail
0.1940	19	2033	10700	Fail
0.1966	19	1927	10142	Fail
0.1991	16	1842	11512	Fail
0.2017	16	1747	10918	Fail
0.2043	15	1668	11120	Fail

0.2069	14	1589	11350	Fail
0.2094	14	1511	10792	Fail
0.2120	14	1454	10385	Fail
0.2146	13	1395	10730	Fail
0.2172	12	1340	11166	Fail
0.2197	11	1285	11681	Fail
0.2223	11	1222	11109	Fail
0.2249	11	1172	10654	Fail
0.2275	11	1121	10190	Fail
0.2301	11	1080	9818	Fail
0.2326	11	1028	9345	Fail
0.2352	10	989	9890	Fail
0.2378	10	952	9520	Fail
0.2404	8	916	11450	Fail
0.2429	7	878	12542	Fail
0.2455	6	844	14066	Fail
0.2481	6	805	13416	Fail
0.2507	4	779	19475	Fail
0.2532	4	743	18575	Fail
0.2558	4	715	17875	Fail
0.2584	4	690	17250	Fail
0.2610	4	663	16575	Fail
0.2636	4	637	15925	Fail
0.2661	4	619	15475	Fail
0.2687	4	591	14775	Fail
0.2713	4	571	14275	Fail
0.2739	4	554	13850	Fail
0.2764	4	526	13150	Fail
0.2790	4	498	12450	Fail
0.2816	3	470	15666	Fail
0.2842	1	453	45300	Fail
0.2867	1	435	43500	Fail
0.2893	1	422	42200	Fail
0.2919	1	413	41300	Fail
0.2945	1	401	40100	Fail
0.2971	1	387	38700	Fail
0.2996	1	373	37300	Fail
0.3022	1	354	35400	Fail
0.3048	1	343	34300	Fail
0.3074	1	323	32300	Fail
0.3099	1	308	30800	Fail
0.3125	0	293	n/a	Fail
0.3151	0	284	n/a	Fail
0.3177	0	278	n/a	Fail
0.3203	0	256	n/a	Fail
0.3228	0	246	n/a	Fail

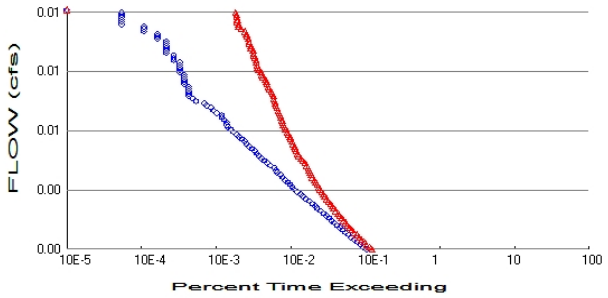
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

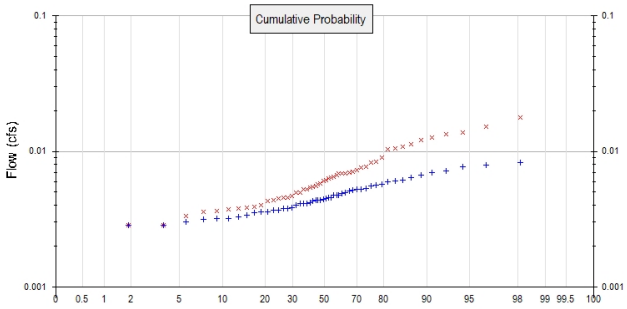
Water Quality

Water Quality BMP Flow and Volume for POC #1

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

POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 0.03
Total Impervious Area: 0.01

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.03
Total Impervious Area: 0.01

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.004491
5 year	0.005699
10 year	0.006488
25 year	0.00748
50 year	0.008219
100 year	0.00896

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.00602
5 year	0.008939
10 year	0.011135
25 year	0.014218
50 year	0.016744
100 year	0.01947

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1956	0.004	0.006
1957	0.006	0.011
1958	0.004	0.005
1959	0.004	0.005
1960	0.005	0.007
1961	0.004	0.006
1962	0.004	0.004
1963	0.007	0.013
1964	0.005	0.008
1965	0.004	0.007
1966	0.003	0.004

1967	0.004	0.005
1968	0.003	0.004
1969	0.003	0.004
1970	0.003	0.005
1971	0.003	0.004
1972	0.005	0.008
1973	0.003	0.003
1974	0.005	0.005
1975	0.006	0.007
1976	0.005	0.007
1977	0.006	0.006
1978	0.005	0.008
1979	0.006	0.010
1980	0.004	0.005
1981	0.006	0.011
1982	0.005	0.006
1983	0.008	0.008
1984	0.004	0.005
1985	0.004	0.004
1986	0.004	0.007
1987	0.008	0.015
1988	0.003	0.003
1989	0.004	0.005
1990	0.006	0.012
1991	0.007	0.013
1992	0.004	0.004
1993	0.003	0.003
1994	0.003	0.003
1995	0.004	0.004
1996	0.005	0.007
1997	0.004	0.007
1998	0.004	0.006
1999	0.005	0.009
2000	0.005	0.007
2001	0.004	0.004
2002	0.004	0.006
2003	0.005	0.005
2004	0.007	0.014
2005	0.004	0.004
2006	0.008	0.018
2007	0.006	0.010
2008	0.005	0.006

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	0.0083	0.0179
2	0.0079	0.0152
3	0.0077	0.0138
4	0.0072	0.0133
5	0.0070	0.0127
6	0.0067	0.0122
7	0.0064	0.0113
8	0.0061	0.0109
9	0.0060	0.0104
10	0.0059	0.0104
11	0.0057	0.0089
12	0.0056	0.0083

13	0.0056	0.0083
14	0.0054	0.0077
15	0.0053	0.0076
16	0.0052	0.0072
17	0.0052	0.0071
18	0.0051	0.0070
19	0.0050	0.0069
20	0.0049	0.0069
21	0.0048	0.0068
22	0.0048	0.0067
23	0.0047	0.0065
24	0.0046	0.0064
25	0.0045	0.0063
26	0.0045	0.0062
27	0.0044	0.0060
28	0.0044	0.0058
29	0.0044	0.0057
30	0.0043	0.0055
31	0.0043	0.0054
32	0.0042	0.0054
33	0.0041	0.0052
34	0.0041	0.0052
35	0.0041	0.0050
36	0.0040	0.0049
37	0.0038	0.0047
38	0.0038	0.0046
39	0.0038	0.0045
40	0.0037	0.0045
41	0.0037	0.0044
42	0.0036	0.0043
43	0.0036	0.0040
44	0.0036	0.0039
45	0.0034	0.0038
46	0.0033	0.0038
47	0.0032	0.0037
48	0.0032	0.0037
49	0.0032	0.0036
50	0.0030	0.0033
51	0.0029	0.0029
52	0.0028	0.0029
53	0.0028	0.0028

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0022	1948	2284	117	Fail
0.0023	1756	2098	119	Fail
0.0024	1597	1933	121	Fail
0.0024	1448	1774	122	Fail
0.0025	1329	1643	123	Fail
0.0025	1205	1533	127	Fail
0.0026	1115	1419	127	Fail
0.0027	1007	1319	130	Fail
0.0027	922	1227	133	Fail
0.0028	854	1148	134	Fail
0.0028	772	1071	138	Fail
0.0029	710	1009	142	Fail
0.0030	655	953	145	Fail
0.0030	608	894	147	Fail
0.0031	556	842	151	Fail
0.0032	510	799	156	Fail
0.0032	465	742	159	Fail
0.0033	418	700	167	Fail
0.0033	393	664	168	Fail
0.0034	363	635	174	Fail
0.0035	333	597	179	Fail
0.0035	293	559	190	Fail
0.0036	268	529	197	Fail
0.0036	254	506	199	Fail
0.0037	227	482	212	Fail
0.0038	207	462	223	Fail
0.0038	194	438	225	Fail
0.0039	182	421	231	Fail
0.0039	169	403	238	Fail
0.0040	156	382	244	Fail
0.0041	145	363	250	Fail
0.0041	134	351	261	Fail
0.0042	123	335	272	Fail
0.0042	117	327	279	Fail
0.0043	112	318	283	Fail
0.0044	99	306	309	Fail
0.0044	90	287	318	Fail
0.0045	82	270	329	Fail
0.0045	75	253	337	Fail
0.0046	69	240	347	Fail
0.0047	65	229	352	Fail
0.0047	61	219	359	Fail
0.0048	56	212	378	Fail
0.0048	51	208	407	Fail
0.0049	47	200	425	Fail
0.0050	45	192	426	Fail
0.0050	41	184	448	Fail
0.0051	38	181	476	Fail
0.0051	35	171	488	Fail
0.0052	32	167	521	Fail
0.0053	29	158	544	Fail
0.0053	27	154	570	Fail
0.0054	26	148	569	Fail
0.0054	26	145	557	Fail

0.0055	24	142	591	Fail
0.0056	22	136	618	Fail
0.0056	22	134	609	Fail
0.0057	19	130	684	Fail
0.0057	17	125	735	Fail
0.0058	16	121	756	Fail
0.0059	14	117	835	Fail
0.0059	13	114	876	Fail
0.0060	10	113	1130	Fail
0.0060	9	110	1222	Fail
0.0061	8	109	1362	Fail
0.0062	8	106	1325	Fail
0.0062	8	102	1275	Fail
0.0063	8	95	1187	Fail
0.0063	8	92	1150	Fail
0.0064	7	89	1271	Fail
0.0065	7	88	1257	Fail
0.0065	7	85	1214	Fail
0.0066	7	79	1128	Fail
0.0067	7	75	1071	Fail
0.0067	6	74	1233	Fail
0.0068	6	69	1150	Fail
0.0068	6	67	1116	Fail
0.0069	6	66	1100	Fail
0.0070	6	64	1066	Fail
0.0070	5	64	1280	Fail
0.0071	5	61	1220	Fail
0.0071	5	60	1200	Fail
0.0072	4	59	1475	Fail
0.0073	4	58	1450	Fail
0.0073	4	54	1350	Fail
0.0074	4	54	1350	Fail
0.0074	4	52	1300	Fail
0.0075	4	51	1275	Fail
0.0076	3	50	1666	Fail
0.0076	3	48	1600	Fail
0.0077	3	47	1566	Fail
0.0077	2	45	2250	Fail
0.0078	2	40	2000	Fail
0.0079	2	37	1850	Fail
0.0079	1	37	3700	Fail
0.0080	1	36	3600	Fail
0.0080	1	36	3600	Fail
0.0081	1	35	3500	Fail
0.0082	1	35	3500	Fail
0.0082	1	34	3400	Fail

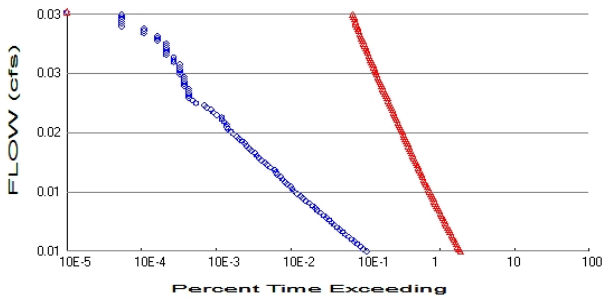
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

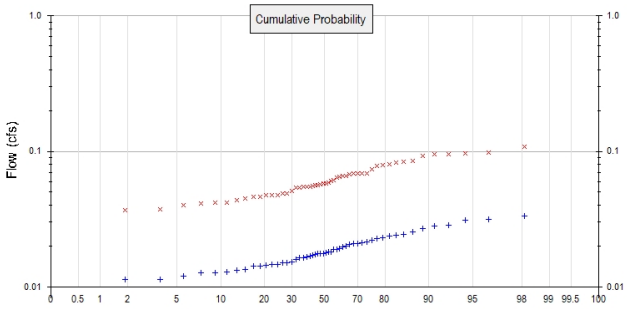
Water Quality

Water Quality BMP Flow and Volume for POC #2

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

POC 3





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3
Total Pervious Area: 0.12
Total Impervious Area: 0.04

Mitigated Landuse Totals for POC #3
Total Pervious Area: 0.03
Total Impervious Area: 0.13

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	**Flow(cfs)**
2 year	0.017966
5 year	0.022795
10 year	0.025951
25 year	0.029922
50 year	0.032878
100 year	0.035839

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**
2 year	0.059198
5 year	0.07543
10 year	0.086077
25 year	0.0995
50 year	0.109514
100 year	0.119563

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	**Predeveloped**	**Mitigated**
1956	0.017	0.055
1957	0.024	0.084
1958	0.014	0.047
1959	0.017	0.057
1960	0.021	0.068
1961	0.017	0.054
1962	0.014	0.046
1963	0.028	0.095
1964	0.019	0.061
1965	0.016	0.054
1966	0.013	0.041

1967	0.014	0.046
1968	0.012	0.040
1969	0.013	0.042
1970	0.013	0.044
1971	0.013	0.045
1972	0.019	0.066
1973	0.013	0.042
1974	0.021	0.069
1975	0.022	0.074
1976	0.019	0.064
1977	0.026	0.083
1978	0.020	0.069
1979	0.023	0.079
1980	0.015	0.051
1981	0.023	0.078
1982	0.021	0.069
1983	0.033	0.108
1984	0.015	0.049
1985	0.015	0.047
1986	0.016	0.055
1987	0.032	0.097
1988	0.011	0.036
1989	0.018	0.058
1990	0.024	0.083
1991	0.027	0.092
1992	0.015	0.048
1993	0.011	0.037
1994	0.011	0.037
1995	0.017	0.056
1996	0.020	0.065
1997	0.018	0.057
1998	0.018	0.058
1999	0.021	0.068
2000	0.020	0.065
2001	0.015	0.049
2002	0.017	0.056
2003	0.018	0.059
2004	0.029	0.098
2005	0.017	0.055
2006	0.031	0.095
2007	0.024	0.080
2008	0.018	0.060

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	Predeveloped	Mitigated
1	0.0332	0.1079
2	0.0316	0.0984
3	0.0309	0.0967
4	0.0287	0.0952
5	0.0279	0.0951
6	0.0268	0.0925
7	0.0255	0.0844
8	0.0244	0.0833
9	0.0241	0.0829
10	0.0238	0.0805
11	0.0229	0.0787
12	0.0226	0.0785

13	0.0222	0.0737
14	0.0214	0.0690
15	0.0211	0.0688
16	0.0210	0.0686
17	0.0208	0.0684
18	0.0205	0.0681
19	0.0199	0.0656
20	0.0196	0.0654
21	0.0191	0.0647
22	0.0190	0.0641
23	0.0190	0.0611
24	0.0182	0.0604
25	0.0181	0.0590
26	0.0179	0.0583
27	0.0177	0.0578
28	0.0175	0.0575
29	0.0175	0.0566
30	0.0174	0.0565
31	0.0171	0.0557
32	0.0168	0.0551
33	0.0165	0.0548
34	0.0165	0.0546
35	0.0164	0.0543
36	0.0160	0.0540
37	0.0153	0.0509
38	0.0151	0.0489
39	0.0151	0.0489
40	0.0146	0.0476
41	0.0146	0.0474
42	0.0143	0.0472
43	0.0142	0.0463
44	0.0142	0.0462
45	0.0134	0.0446
46	0.0132	0.0439
47	0.0128	0.0418
48	0.0127	0.0416
49	0.0126	0.0414
50	0.0121	0.0400
51	0.0114	0.0371
52	0.0114	0.0369
53	0.0113	0.0363

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0090	1946	34865	1791	Fail
0.0092	1755	33452	1906	Fail
0.0095	1597	32096	2009	Fail
0.0097	1448	30869	2131	Fail
0.0099	1327	29698	2237	Fail
0.0102	1211	28565	2358	Fail
0.0104	1115	27450	2461	Fail
0.0107	1007	26409	2622	Fail
0.0109	922	25387	2753	Fail
0.0112	854	24402	2857	Fail
0.0114	773	23510	3041	Fail
0.0116	711	22618	3181	Fail
0.0119	657	21818	3320	Fail
0.0121	607	20982	3456	Fail
0.0124	556	20202	3633	Fail
0.0126	510	19440	3811	Fail
0.0128	465	18733	4028	Fail
0.0131	418	18075	4324	Fail
0.0133	393	17397	4426	Fail
0.0136	363	16799	4627	Fail
0.0138	333	16206	4866	Fail
0.0141	293	15628	5333	Fail
0.0143	268	15068	5622	Fail
0.0145	254	14518	5715	Fail
0.0148	227	14004	6169	Fail
0.0150	207	13461	6502	Fail
0.0153	194	12968	6684	Fail
0.0155	183	12513	6837	Fail
0.0157	167	12054	7217	Fail
0.0160	156	11623	7450	Fail
0.0162	145	11247	7756	Fail
0.0165	134	10874	8114	Fail
0.0167	123	10519	8552	Fail
0.0169	117	10170	8692	Fail
0.0172	113	9831	8700	Fail
0.0174	99	9460	9555	Fail
0.0177	90	9168	10186	Fail
0.0179	83	8848	10660	Fail
0.0182	75	8573	11430	Fail
0.0184	69	8304	12034	Fail
0.0186	65	8032	12356	Fail
0.0189	61	7772	12740	Fail
0.0191	55	7512	13658	Fail
0.0194	51	7272	14258	Fail
0.0196	47	7047	14993	Fail
0.0198	45	6813	15139	Fail
0.0201	41	6603	16104	Fail
0.0203	38	6391	16818	Fail
0.0206	35	6189	17682	Fail
0.0208	32	5992	18725	Fail
0.0211	29	5795	19982	Fail
0.0213	27	5609	20774	Fail
0.0215	26	5419	20842	Fail
0.0218	26	5258	20223	Fail

0.0220	24	5059	21079	Fail
0.0223	22	4899	22268	Fail
0.0225	22	4735	21522	Fail
0.0227	19	4581	24110	Fail
0.0230	17	4444	26141	Fail
0.0232	16	4302	26887	Fail
0.0235	14	4157	29692	Fail
0.0237	13	4027	30976	Fail
0.0239	10	3903	39030	Fail
0.0242	9	3767	41855	Fail
0.0244	8	3654	45675	Fail
0.0247	8	3542	44275	Fail
0.0249	8	3423	42787	Fail
0.0252	8	3317	41462	Fail
0.0254	8	3189	39862	Fail
0.0256	7	3081	44014	Fail
0.0259	7	2998	42828	Fail
0.0261	7	2910	41571	Fail
0.0264	7	2808	40114	Fail
0.0266	7	2725	38928	Fail
0.0268	6	2637	43950	Fail
0.0271	6	2559	42650	Fail
0.0273	6	2490	41500	Fail
0.0276	6	2416	40266	Fail
0.0278	6	2353	39216	Fail
0.0281	5	2264	45280	Fail
0.0283	5	2189	43780	Fail
0.0285	5	2132	42640	Fail
0.0288	4	2070	51750	Fail
0.0290	4	2000	50000	Fail
0.0293	4	1942	48550	Fail
0.0295	4	1881	47025	Fail
0.0297	4	1829	45725	Fail
0.0300	4	1768	44200	Fail
0.0302	3	1712	57066	Fail
0.0305	3	1657	55233	Fail
0.0307	3	1615	53833	Fail
0.0309	2	1567	78350	Fail
0.0312	2	1519	75950	Fail
0.0314	2	1484	74200	Fail
0.0317	1	1444	144400	Fail
0.0319	1	1397	139700	Fail
0.0322	1	1370	137000	Fail
0.0324	1	1336	133600	Fail
0.0326	1	1300	130000	Fail
0.0329	1	1260	126000	Fail

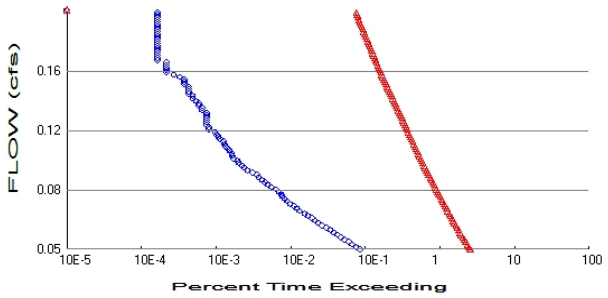
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

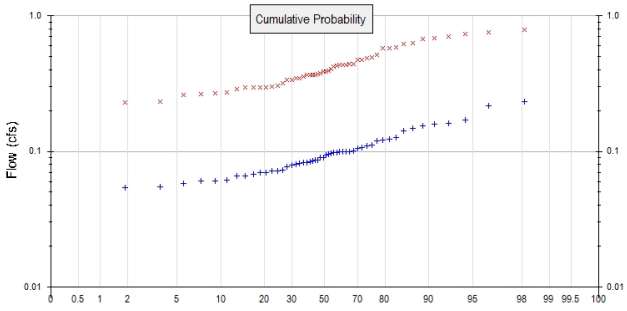
Water Quality

Water Quality BMP Flow and Volume for POC #3

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

POC 4





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #4
Total Pervious Area: 1.33
Total Impervious Area: 0.19

Mitigated Landuse Totals for POC #4
Total Pervious Area: 0.71
Total Impervious Area: 0.81

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #4

Return Period	**Flow(cfs)**
2 year	0.090898
5 year	0.12304
10 year	0.14607
25 year	0.17722
50 year	0.201952
100 year	0.228023

Flow Frequency Return Periods for Mitigated. POC #4

Return Period	**Flow(cfs)**
2 year	0.396951
5 year	0.526649
10 year	0.614363
25 year	0.727534
50 year	0.813661
100 year	0.901421

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #4

Year	**Predeveloped**	**Mitigated**
1956	0.090	0.369
1957	0.123	0.618
1958	0.076	0.319
1959	0.083	0.364
1960	0.099	0.432
1961	0.097	0.357
1962	0.068	0.289
1963	0.169	0.706
1964	0.109	0.436
1965	0.096	0.388
1966	0.061	0.272

1967	0.072	0.300
1968	0.058	0.265
1969	0.060	0.270
1970	0.066	0.296
1971	0.065	0.295
1972	0.093	0.470
1973	0.061	0.262
1974	0.100	0.431
1975	0.106	0.486
1976	0.098	0.443
1977	0.121	0.517
1978	0.099	0.474
1979	0.111	0.574
1980	0.073	0.337
1981	0.120	0.580
1982	0.100	0.436
1983	0.158	0.672
1984	0.079	0.337
1985	0.069	0.296
1986	0.090	0.386
1987	0.217	0.750
1988	0.053	0.226
1989	0.083	0.375
1990	0.154	0.629
1991	0.148	0.682
1992	0.070	0.298
1993	0.054	0.231
1994	0.054	0.231
1995	0.081	0.347
1996	0.100	0.439
1997	0.105	0.391
1998	0.085	0.366
1999	0.126	0.496
2000	0.095	0.420
2001	0.072	0.305
2002	0.083	0.366
2003	0.087	0.367
2004	0.160	0.731
2005	0.080	0.345
2006	0.234	0.793
2007	0.142	0.581
2008	0.086	0.405

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #4

Rank	Predeveloped	Mitigated
1	0.2338	0.7926
2	0.2173	0.7499
3	0.1693	0.7314
4	0.1603	0.7059
5	0.1576	0.6818
6	0.1545	0.6724
7	0.1476	0.6288
8	0.1421	0.6176
9	0.1261	0.5814
10	0.1234	0.5803
11	0.1213	0.5735
12	0.1198	0.5170

13	0.1114	0.4956
14	0.1095	0.4857
15	0.1060	0.4744
16	0.1048	0.4700
17	0.1003	0.4426
18	0.1000	0.4387
19	0.0996	0.4361
20	0.0990	0.4358
21	0.0990	0.4322
22	0.0976	0.4311
23	0.0975	0.4197
24	0.0963	0.4051
25	0.0946	0.3906
26	0.0935	0.3882
27	0.0904	0.3862
28	0.0895	0.3746
29	0.0865	0.3694
30	0.0863	0.3675
31	0.0852	0.3663
32	0.0833	0.3658
33	0.0831	0.3643
34	0.0829	0.3572
35	0.0815	0.3473
36	0.0800	0.3450
37	0.0786	0.3367
38	0.0765	0.3366
39	0.0731	0.3191
40	0.0718	0.3046
41	0.0716	0.2996
42	0.0695	0.2979
43	0.0695	0.2962
44	0.0681	0.2956
45	0.0655	0.2954
46	0.0654	0.2886
47	0.0610	0.2723
48	0.0605	0.2700
49	0.0602	0.2650
50	0.0583	0.2615
51	0.0544	0.2313
52	0.0540	0.2305
53	0.0534	0.2263

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0454	1590	47149	2965	Fail
0.0470	1397	45012	3222	Fail
0.0486	1236	43042	3482	Fail
0.0502	1110	41091	3701	Fail
0.0518	979	39288	4013	Fail
0.0534	882	37522	4254	Fail
0.0549	782	35943	4596	Fail
0.0565	699	34475	4932	Fail
0.0581	630	32932	5227	Fail
0.0597	559	31612	5655	Fail
0.0613	487	30349	6231	Fail
0.0628	429	29104	6784	Fail
0.0644	398	27896	7009	Fail
0.0660	358	26799	7485	Fail
0.0676	317	25740	8119	Fail
0.0692	286	24643	8616	Fail
0.0707	243	23714	9758	Fail
0.0723	223	22748	10200	Fail
0.0739	205	21911	10688	Fail
0.0755	182	21094	11590	Fail
0.0771	166	20239	12192	Fail
0.0786	157	19440	12382	Fail
0.0802	143	18696	13074	Fail
0.0818	138	17994	13039	Fail
0.0834	128	17295	13511	Fail
0.0850	117	16670	14247	Fail
0.0866	103	16079	15610	Fail
0.0881	91	15474	17004	Fail
0.0897	84	14877	17710	Fail
0.0913	77	14321	18598	Fail
0.0929	69	13754	19933	Fail
0.0945	65	13219	20336	Fail
0.0960	57	12710	22298	Fail
0.0976	49	12249	24997	Fail
0.0992	44	11799	26815	Fail
0.1008	41	11418	27848	Fail
0.1024	37	11002	29735	Fail
0.1039	36	10627	29519	Fail
0.1055	32	10262	32068	Fail
0.1071	31	9880	31870	Fail
0.1087	30	9519	31729	Fail
0.1103	28	9207	32882	Fail
0.1118	27	8883	32900	Fail
0.1134	25	8566	34264	Fail
0.1150	24	8302	34591	Fail
0.1166	23	8025	34891	Fail
0.1182	21	7746	36885	Fail
0.1197	20	7493	37465	Fail
0.1213	19	7241	38110	Fail
0.1229	18	7003	38905	Fail
0.1245	15	6780	45200	Fail
0.1261	15	6546	43640	Fail
0.1277	14	6334	45242	Fail
0.1292	14	6098	43557	Fail

0.1308	14	5902	42157	Fail
0.1324	14	5732	40942	Fail
0.1340	14	5533	39521	Fail
0.1356	14	5352	38228	Fail
0.1371	12	5135	42791	Fail
0.1387	12	4955	41291	Fail
0.1403	11	4802	43654	Fail
0.1419	11	4642	42200	Fail
0.1435	10	4497	44970	Fail
0.1450	9	4343	48255	Fail
0.1466	9	4196	46622	Fail
0.1482	8	4059	50737	Fail
0.1498	8	3929	49112	Fail
0.1514	8	3797	47462	Fail
0.1529	8	3672	45900	Fail
0.1545	7	3555	50785	Fail
0.1561	7	3436	49085	Fail
0.1577	7	3319	47414	Fail
0.1593	6	3206	53433	Fail
0.1609	5	3098	61959	Fail
0.1624	4	2998	74950	Fail
0.1640	4	2903	72575	Fail
0.1656	4	2816	70400	Fail
0.1672	4	2721	68025	Fail
0.1688	4	2630	65750	Fail
0.1703	3	2565	85500	Fail
0.1719	3	2485	82833	Fail
0.1735	3	2422	80733	Fail
0.1751	3	2347	78233	Fail
0.1767	3	2267	75566	Fail
0.1782	3	2206	73533	Fail
0.1798	3	2137	71233	Fail
0.1814	3	2074	69133	Fail
0.1830	3	2003	66766	Fail
0.1846	3	1951	65033	Fail
0.1861	3	1886	62866	Fail
0.1877	3	1825	60833	Fail
0.1893	3	1770	59000	Fail
0.1909	3	1725	57500	Fail
0.1925	3	1672	55733	Fail
0.1940	3	1621	54033	Fail
0.1956	3	1569	52300	Fail
0.1972	3	1527	50900	Fail
0.1988	3	1475	49166	Fail
0.2004	3	1439	47966	Fail
0.2020	3	1405	46833	Fail

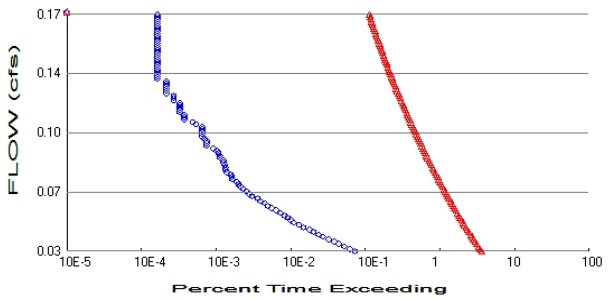
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

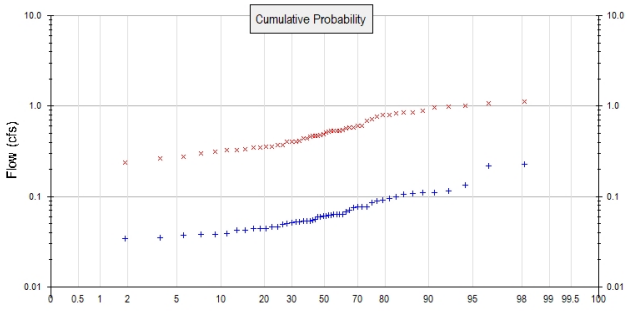
Water Quality

Water Quality BMP Flow and Volume for POC #4

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

POC 5





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #5
Total Pervious Area: 1.98
Total Impervious Area: 0.12

Mitigated Landuse Totals for POC #5
Total Pervious Area: 1.4
Total Impervious Area: 0.7

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #5

Return Period	**Flow(cfs)**
2 year	0.061045
5 year	0.089693
10 year	0.112486
25 year	0.146077
50 year	0.174874
100 year	0.207161

Flow Frequency Return Periods for Mitigated. POC #5

Return Period	**Flow(cfs)**
2 year	0.502844
5 year	0.712357
10 year	0.85793
25 year	1.049174
50 year	1.196767
100 year	1.348663

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #5

Year	**Predeveloped**	**Mitigated**
1956	0.060	0.474
1957	0.077	0.833
1958	0.049	0.405
1959	0.053	0.459
1960	0.064	0.532
1961	0.086	0.535
1962	0.044	0.324
1963	0.114	0.958
1964	0.090	0.602
1965	0.064	0.545
1966	0.038	0.359

1967	0.054	0.371
1968	0.037	0.347
1969	0.038	0.331
1970	0.042	0.405
1971	0.043	0.345
1972	0.077	0.762
1973	0.039	0.273
1974	0.063	0.471
1975	0.068	0.716
1976	0.062	0.537
1977	0.077	0.583
1978	0.063	0.587
1979	0.070	0.806
1980	0.046	0.405
1981	0.074	0.890
1982	0.063	0.473
1983	0.100	0.807
1984	0.061	0.443
1985	0.044	0.303
1986	0.059	0.508
1987	0.216	1.084
1988	0.035	0.228
1989	0.053	0.482
1990	0.110	0.851
1991	0.134	0.988
1992	0.044	0.324
1993	0.034	0.265
1994	0.034	0.239
1995	0.051	0.358
1996	0.089	0.610
1997	0.094	0.563
1998	0.054	0.526
1999	0.108	0.693
2000	0.060	0.531
2001	0.046	0.311
2002	0.052	0.436
2003	0.056	0.375
2004	0.106	1.006
2005	0.051	0.409
2006	0.228	1.122
2007	0.110	0.859
2008	0.055	0.495

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #5

Rank	Predeveloped	Mitigated
1	0.2283	1.1220
2	0.2164	1.0841
3	0.1342	1.0056
4	0.1144	0.9877
5	0.1100	0.9585
6	0.1096	0.8899
7	0.1083	0.8588
8	0.1063	0.8515
9	0.0996	0.8327
10	0.0943	0.8074
11	0.0905	0.8063
12	0.0891	0.7617

13	0.0861	0.7161
14	0.0774	0.6929
15	0.0773	0.6102
16	0.0768	0.6024
17	0.0745	0.5868
18	0.0701	0.5827
19	0.0675	0.5632
20	0.0638	0.5448
21	0.0636	0.5373
22	0.0634	0.5355
23	0.0629	0.5315
24	0.0626	0.5308
25	0.0616	0.5259
26	0.0610	0.5078
27	0.0602	0.4945
28	0.0598	0.4815
29	0.0593	0.4739
30	0.0555	0.4732
31	0.0545	0.4709
32	0.0540	0.4588
33	0.0537	0.4430
34	0.0533	0.4357
35	0.0527	0.4092
36	0.0524	0.4049
37	0.0515	0.4049
38	0.0506	0.4047
39	0.0490	0.3747
40	0.0462	0.3705
41	0.0462	0.3587
42	0.0443	0.3577
43	0.0440	0.3466
44	0.0440	0.3451
45	0.0426	0.3314
46	0.0424	0.3243
47	0.0386	0.3239
48	0.0382	0.3112
49	0.0380	0.3029
50	0.0371	0.2729
51	0.0346	0.2652
52	0.0344	0.2393
53	0.0341	0.2275

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0305	1345	67183	4995	Fail
0.0320	1140	63671	5585	Fail
0.0334	974	60567	6218	Fail
0.0349	820	57650	7030	Fail
0.0364	711	54973	7731	Fail
0.0378	604	52279	8655	Fail
0.0393	501	49788	9937	Fail
0.0407	442	47502	10747	Fail
0.0422	377	45291	12013	Fail
0.0436	329	43302	13161	Fail
0.0451	276	41425	15009	Fail
0.0466	240	39567	16486	Fail
0.0480	204	37894	18575	Fail
0.0495	185	36166	19549	Fail
0.0509	169	34567	20453	Fail
0.0524	153	33099	21633	Fail
0.0539	134	31687	23647	Fail
0.0553	117	30386	25970	Fail
0.0568	103	29141	28292	Fail
0.0582	91	27877	30634	Fail
0.0597	84	26762	31859	Fail
0.0611	72	25647	35620	Fail
0.0626	67	24606	36725	Fail
0.0641	56	23602	42146	Fail
0.0655	52	22673	43601	Fail
0.0670	47	21781	46342	Fail
0.0684	43	20926	48665	Fail
0.0699	39	20146	51656	Fail
0.0713	37	19421	52489	Fail
0.0728	35	18659	53311	Fail
0.0743	31	17906	57761	Fail
0.0757	30	17245	57483	Fail
0.0772	29	16576	57158	Fail
0.0786	26	15938	61300	Fail
0.0801	25	15358	61432	Fail
0.0816	25	14780	59120	Fail
0.0830	24	14249	59370	Fail
0.0845	23	13777	59900	Fail
0.0859	23	13240	57565	Fail
0.0874	21	12749	60709	Fail
0.0888	21	12299	58566	Fail
0.0903	20	11868	59340	Fail
0.0918	19	11482	60431	Fail
0.0932	17	11067	65100	Fail
0.0947	14	10677	76264	Fail
0.0961	14	10316	73685	Fail
0.0976	14	9963	71164	Fail
0.0991	13	9608	73907	Fail
0.1005	12	9294	77450	Fail
0.1020	12	8988	74900	Fail
0.1034	12	8685	72375	Fail
0.1049	12	8408	70066	Fail
0.1063	12	8118	67650	Fail
0.1078	10	7843	78430	Fail

0.1093	9	7566	84066	Fail
0.1107	7	7328	104685	Fail
0.1122	7	7086	101228	Fail
0.1136	7	6863	98042	Fail
0.1151	6	6663	111050	Fail
0.1166	6	6466	107766	Fail
0.1180	6	6256	104266	Fail
0.1195	6	6072	101200	Fail
0.1209	6	5865	97750	Fail
0.1224	5	5670	113400	Fail
0.1238	5	5490	109800	Fail
0.1253	5	5328	106560	Fail
0.1268	4	5165	129125	Fail
0.1282	4	4977	124425	Fail
0.1297	4	4849	121225	Fail
0.1311	4	4696	117400	Fail
0.1326	4	4551	113775	Fail
0.1340	4	4419	110475	Fail
0.1355	3	4304	143466	Fail
0.1370	3	4195	139833	Fail
0.1384	3	4064	135466	Fail
0.1399	3	3946	131533	Fail
0.1413	3	3836	127866	Fail
0.1428	3	3723	124100	Fail
0.1443	3	3618	120600	Fail
0.1457	3	3526	117533	Fail
0.1472	3	3436	114533	Fail
0.1486	3	3327	110900	Fail
0.1501	3	3258	108600	Fail
0.1515	3	3171	105700	Fail
0.1530	3	3094	103133	Fail
0.1545	3	3026	100866	Fail
0.1559	3	2946	98200	Fail
0.1574	3	2866	95533	Fail
0.1588	3	2780	92666	Fail
0.1603	3	2708	90266	Fail
0.1618	3	2624	87466	Fail
0.1632	3	2565	85500	Fail
0.1647	3	2496	83200	Fail
0.1661	3	2423	80766	Fail
0.1676	3	2377	79233	Fail
0.1690	3	2318	77266	Fail
0.1705	3	2256	75200	Fail
0.1720	3	2199	73300	Fail
0.1734	3	2150	71666	Fail
0.1749	3	2102	70066	Fail

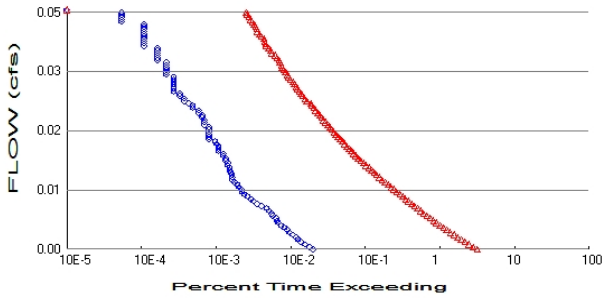
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

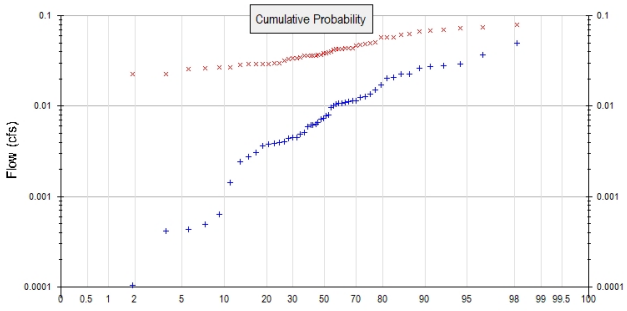
Water Quality

Water Quality BMP Flow and Volume for POC #5

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

POC 6





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #6
Total Pervious Area: 0.13
Total Impervious Area: 0

Mitigated Landuse Totals for POC #6
Total Pervious Area: 0.07
Total Impervious Area: 0.08

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #6

Return Period	**Flow(cfs)**
2 year	0.007538
5 year	0.019015
10 year	0.027568
25 year	0.037986
50 year	0.045007
100 year	0.051247

Flow Frequency Return Periods for Mitigated. POC #6

Return Period	**Flow(cfs)**
2 year	0.03946
5 year	0.052459
10 year	0.061263
25 year	0.072636
50 year	0.081299
100 year	0.090133

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #6

Year	**Predeveloped**	**Mitigated**
1956	0.007	0.037
1957	0.023	0.062
1958	0.006	0.032
1959	0.004	0.036
1960	0.011	0.043
1961	0.011	0.036
1962	0.000	0.029
1963	0.028	0.070
1964	0.014	0.044
1965	0.012	0.039
1966	0.005	0.027

1967	0.006	0.030
1968	0.004	0.026
1969	0.003	0.027
1970	0.006	0.030
1971	0.004	0.029
1972	0.015	0.047
1973	0.003	0.026
1974	0.007	0.043
1975	0.008	0.048
1976	0.011	0.044
1977	0.000	0.051
1978	0.011	0.047
1979	0.021	0.057
1980	0.005	0.033
1981	0.023	0.058
1982	0.004	0.043
1983	0.010	0.066
1984	0.008	0.034
1985	0.001	0.029
1986	0.011	0.039
1987	0.037	0.075
1988	0.000	0.022
1989	0.004	0.037
1990	0.027	0.062
1991	0.026	0.068
1992	0.001	0.029
1993	0.004	0.023
1994	0.000	0.023
1995	0.004	0.034
1996	0.010	0.044
1997	0.013	0.039
1998	0.010	0.036
1999	0.017	0.050
2000	0.011	0.042
2001	0.000	0.030
2002	0.006	0.036
2003	0.002	0.036
2004	0.029	0.073
2005	0.004	0.034
2006	0.050	0.079
2007	0.021	0.058
2008	0.007	0.040

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #6

Rank	Predeveloped	Mitigated
1	0.0495	0.0788
2	0.0366	0.0750
3	0.0294	0.0731
4	0.0282	0.0705
5	0.0272	0.0683
6	0.0263	0.0664
7	0.0228	0.0623
8	0.0227	0.0616
9	0.0206	0.0582
10	0.0206	0.0581
11	0.0173	0.0574
12	0.0152	0.0511

13	0.0137	0.0496
14	0.0127	0.0483
15	0.0124	0.0473
16	0.0114	0.0471
17	0.0114	0.0441
18	0.0112	0.0437
19	0.0110	0.0436
20	0.0108	0.0432
21	0.0107	0.0428
22	0.0105	0.0426
23	0.0101	0.0418
24	0.0096	0.0403
25	0.0079	0.0391
26	0.0079	0.0386
27	0.0073	0.0385
28	0.0071	0.0372
29	0.0066	0.0368
30	0.0063	0.0365
31	0.0062	0.0363
32	0.0062	0.0362
33	0.0059	0.0362
34	0.0051	0.0358
35	0.0049	0.0343
36	0.0045	0.0341
37	0.0045	0.0336
38	0.0044	0.0335
39	0.0041	0.0318
40	0.0040	0.0301
41	0.0039	0.0298
42	0.0038	0.0295
43	0.0037	0.0294
44	0.0031	0.0294
45	0.0027	0.0292
46	0.0024	0.0285
47	0.0014	0.0271
48	0.0006	0.0268
49	0.0005	0.0264
50	0.0004	0.0258
51	0.0004	0.0228
52	0.0001	0.0228
53	0.0001	0.0223

Duration Flows

The Duration Matching Failed

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0038	371	58802	15849	Fail
0.0042	330	51647	15650	Fail
0.0046	290	45570	15713	Fail
0.0050	252	40403	16032	Fail
0.0054	232	35850	15452	Fail
0.0059	218	31966	14663	Fail
0.0063	199	28620	14381	Fail
0.0067	179	25684	14348	Fail
0.0071	167	22989	13765	Fail
0.0075	153	20778	13580	Fail
0.0079	138	18678	13534	Fail
0.0084	127	16832	13253	Fail
0.0088	122	15256	12504	Fail
0.0092	117	13723	11729	Fail
0.0096	107	12376	11566	Fail
0.0100	102	11240	11019	Fail
0.0104	96	10235	10661	Fail
0.0109	88	9274	10538	Fail
0.0113	76	8471	11146	Fail
0.0117	66	7724	11703	Fail
0.0121	59	7081	12001	Fail
0.0125	54	6464	11970	Fail
0.0129	49	5895	12030	Fail
0.0133	44	5403	12279	Fail
0.0138	41	4910	11975	Fail
0.0142	40	4490	11225	Fail
0.0146	38	4115	10828	Fail
0.0150	36	3750	10416	Fail
0.0154	33	3436	10412	Fail
0.0158	31	3135	10112	Fail
0.0163	31	2869	9254	Fail
0.0167	30	2630	8766	Fail
0.0171	29	2448	8441	Fail
0.0175	28	2249	8032	Fail
0.0179	28	2074	7407	Fail
0.0183	27	1905	7055	Fail
0.0188	27	1756	6503	Fail
0.0192	25	1619	6476	Fail
0.0196	25	1492	5968	Fail
0.0200	23	1393	6056	Fail
0.0204	23	1296	5634	Fail
0.0208	20	1211	6055	Fail
0.0213	20	1129	5645	Fail
0.0217	20	1050	5250	Fail
0.0221	19	987	5194	Fail
0.0225	18	922	5122	Fail
0.0229	15	859	5726	Fail
0.0233	15	805	5366	Fail
0.0238	15	752	5013	Fail
0.0242	15	707	4713	Fail
0.0246	15	659	4393	Fail
0.0250	15	624	4160	Fail
0.0254	13	590	4538	Fail
0.0258	13	540	4153	Fail

0.0263	13	506	3892	Fail
0.0267	12	481	4008	Fail
0.0271	12	454	3783	Fail
0.0275	11	430	3909	Fail
0.0279	11	403	3663	Fail
0.0283	9	378	4200	Fail
0.0288	9	356	3955	Fail
0.0292	8	345	4312	Fail
0.0296	7	306	4371	Fail
0.0300	7	289	4128	Fail
0.0304	6	269	4483	Fail
0.0308	6	257	4283	Fail
0.0313	5	243	4860	Fail
0.0317	5	228	4560	Fail
0.0321	5	218	4360	Fail
0.0325	5	208	4160	Fail
0.0329	5	198	3959	Fail
0.0333	5	184	3680	Fail
0.0338	5	175	3500	Fail
0.0342	4	167	4175	Fail
0.0346	4	159	3975	Fail
0.0350	4	149	3725	Fail
0.0354	4	143	3575	Fail
0.0358	4	139	3475	Fail
0.0363	4	133	3325	Fail
0.0367	3	130	4333	Fail
0.0371	3	121	4033	Fail
0.0375	3	114	3800	Fail
0.0379	3	103	3433	Fail
0.0383	3	100	3333	Fail
0.0388	3	94	3133	Fail
0.0392	2	86	4300	Fail
0.0396	2	86	4300	Fail
0.0400	2	83	4150	Fail
0.0404	2	81	4050	Fail
0.0408	2	75	3750	Fail
0.0413	2	71	3550	Fail
0.0417	2	66	3300	Fail
0.0421	2	65	3250	Fail
0.0425	2	63	3150	Fail
0.0429	2	60	3000	Fail
0.0433	1	57	5700	Fail
0.0438	1	54	5400	Fail
0.0442	1	51	5100	Fail
0.0446	1	48	4800	Fail
0.0450	1	47	4700	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #6

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

Model Default Modifications

Total of 0 changes have been made.

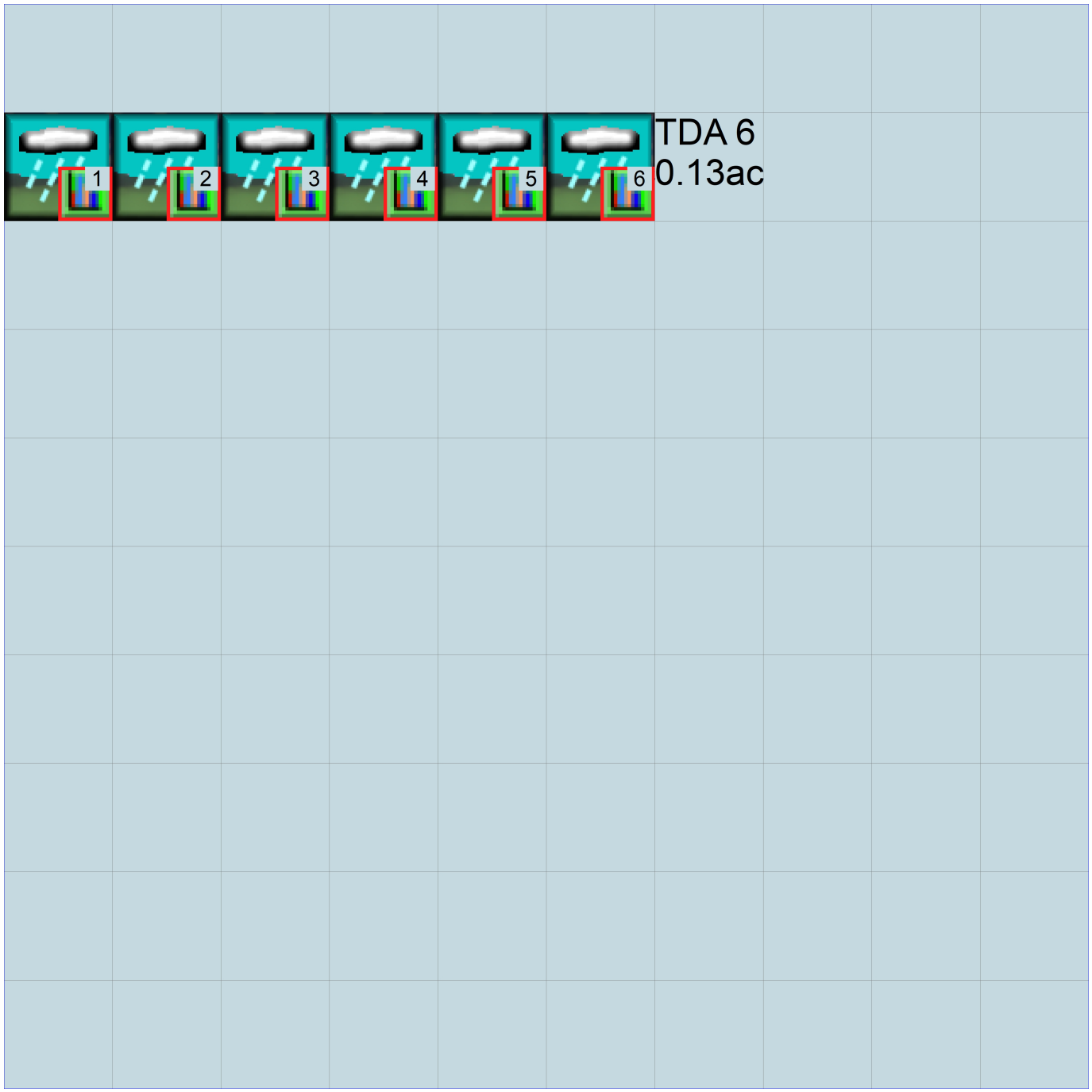
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Flow Control Exemption.wdm
MESSU       25   PreFlow Control Exemption.MES
            27   PreFlow Control Exemption.L61
            28   PreFlow Control Exemption.L62
            30   POCFlow Control Exemption1.dat
            31   POCFlow Control Exemption2.dat
            32   POCFlow Control Exemption3.dat
            33   POCFlow Control Exemption4.dat
            34   POCFlow Control Exemption5.dat
            35   POCFlow Control Exemption6.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND       1
      PERLND      13
      IMPLND       8
      PERLND       4
      PERLND       3
      PERLND       5
      PERLND       2
      PERLND       7
      COPY       501
      COPY       502
      COPY       503
      COPY       504
      COPY       505
      COPY       506
      DISPLY       1
      DISPLY       2
      DISPLY       3
      DISPLY       4
      DISPLY       5
      DISPLY       6
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        TDA 1                      MAX                    1    2   30    9
    2        TDA 2                      MAX                    1    2   31    9
    3        TDA 3                      MAX                    1    2   32    9
    4        TDA 4                      MAX                    1    2   33    9
    5        TDA 5                      MAX                    1    2   34    9
    6        TDA 6                      MAX                    1    2   35    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  503         1    1
  504         1    1
  505         1    1
```

```
  506         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                        in  out           ***
    1     A/B, Forest, Flat       1    1    1    1   27    0
   13     C, Pasture, Flat        1    1    1    1   27    0
    4     A/B, Pasture, Flat      1    1    1    1   27    0
    3     A/B, Forest, Steep      1    1    1    1   27    0
    5     A/B, Pasture, Mod       1    1    1    1   27    0
    2     A/B, Forest, Mod        1    1    1    1   27    0
    7     A/B, Lawn, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    1         0    0    1    0    0    0    0    0    0    0    0    0
   13         0    0    1    0    0    0    0    0    0    0    0    0
    4         0    0    1    0    0    0    0    0    0    0    0    0
    3         0    0    1    0    0    0    0    0    0    0    0    0
    5         0    0    1    0    0    0    0    0    0    0    0    0
    2         0    0    1    0    0    0    0    0    0    0    0    0
    7         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    1         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   13         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    4         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    3         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    5         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    2         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    1         0    0    0    0    0    0    0    0    0    0    0
   13         0    0    0    0    0    0    0    0    0    0    0
    4         0    0    0    0    0    0    0    0    0    0    0
    3         0    0    0    0    0    0    0    0    0    0    0
    5         0    0    0    0    0    0    0    0    0    0    0
    2         0    0    0    0    0    0    0    0    0    0    0
    7         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2          ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    1              0         5         2       400      0.05       0.3     0.996
   13              0       4.5      0.06       400      0.05       0.5     0.996
    4              0         5       1.5       400      0.05       0.3     0.996
    3              0         5         2       400      0.15       0.3     0.996
    5              0         5       1.5       400       0.1       0.3     0.996
```

```
    2              0         5         2       400       0.1       0.3     0.996
    7              0         5       0.8       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3          ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    1              0         0         2         2         0         0         0
   13              0         0         2         2         0         0         0
    4              0         0         2         2         0         0         0
    3              0         0         2         2         0         0         0
    5              0         0         2         2         0         0         0
    2              0         0         2         2         0         0         0
    7              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                  ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    1            0.2       0.5      0.35         0       0.7       0.7
   13           0.15       0.4       0.3         6       0.5       0.4
    4           0.15       0.5       0.3         0       0.7       0.4
    3            0.2       0.5      0.35         0       0.7       0.7
    5           0.15       0.5       0.3         0       0.7       0.4
    2            0.2       0.5      0.35         0       0.7       0.7
    7            0.1       0.5      0.25         0       0.7      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    1              0         0         0         0         3         1         0
   13              0         0         0         0       2.5         1         0
    4              0         0         0         0         3         1         0
    3              0         0         0         0         3         1         0
    5              0         0         0         0         3         1         0
    2              0         0         0         0         3         1         0
    7              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

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

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

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

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

  IWAT-PARM2
```

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

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
TDA 1***
PERLND   1                        0.2     COPY   501     12
PERLND   1                        0.2     COPY   501     13
PERLND  13                       0.79     COPY   501     12
PERLND  13                       0.79     COPY   501     13
IMPLND   8                       0.19     COPY   501     15
TDA 2***
PERLND   1                       0.03     COPY   502     12
PERLND   1                       0.03     COPY   502     13
IMPLND   8                       0.01     COPY   502     15
TDA 3***
PERLND   1                       0.12     COPY   503     12
PERLND   1                       0.12     COPY   503     13
IMPLND   8                       0.04     COPY   503     15
TDA 4***
PERLND   1                        0.5     COPY   504     12
PERLND   1                        0.5     COPY   504     13
PERLND   4                       0.83     COPY   504     12
PERLND   4                       0.83     COPY   504     13
IMPLND   8                       0.19     COPY   504     15
TDA 5***
PERLND   3                       1.49     COPY   505     12
PERLND   3                       1.49     COPY   505     13
PERLND   5                       0.27     COPY   505     12
PERLND   5                       0.27     COPY   505     13
PERLND   2                       0.22     COPY   505     12
PERLND   2                       0.22     COPY   505     13
IMPLND   8                       0.12     COPY   505     15
TDA 6***
PERLND   7                       0.13     COPY   506     12
PERLND   7                       0.13     COPY   506     13

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

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   48.4        DISPLY   3     INPUT  TIMSER 1
COPY   504 OUTPUT MEAN   1 1   48.4        DISPLY   4     INPUT  TIMSER 1
COPY   505 OUTPUT MEAN   1 1   48.4        DISPLY   5     INPUT  TIMSER 1
COPY   506 OUTPUT MEAN   1 1   48.4        DISPLY   6     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
```

```
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

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

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
COPY   503 OUTPUT MEAN   1 1     48.4      WDM    503 FLOW     ENGL      REPL
COPY   504 OUTPUT MEAN   1 1     48.4      WDM    504 FLOW     ENGL      REPL
COPY   505 OUTPUT MEAN   1 1     48.4      WDM    505 FLOW     ENGL      REPL
COPY   506 OUTPUT MEAN   1 1     48.4      WDM    506 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>           <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
```

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

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

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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   Flow Control Exemption.wdm
MESSU       25   MitFlow Control Exemption.MES
            27   MitFlow Control Exemption.L61
            28   MitFlow Control Exemption.L62
            30   POCFlow Control Exemption1.dat
            31   POCFlow Control Exemption2.dat
            32   POCFlow Control Exemption3.dat
            33   POCFlow Control Exemption4.dat
            34   POCFlow Control Exemption5.dat
            35   POCFlow Control Exemption6.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND       7
      IMPLND       8
      PERLND       9
      PERLND       8
      IMPLND       9
      IMPLND      10
      COPY       501
      COPY       502
      COPY       503
      COPY       504
      COPY       505
      COPY       506
      DISPLY       1
      DISPLY       2
      DISPLY       3
      DISPLY       4
      DISPLY       5
      DISPLY       6
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        TDA 1                      MAX                    1    2   30    9
    2        TDA 2                      MAX                    1    2   31    9
    3        TDA 3                      MAX                    1    2   32    9
    4        TDA 4                      MAX                    1    2   33    9
    5        TDA 5                      MAX                    1    2   34    9
    6        TDA 6                      MAX                    1    2   35    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  503         1    1
  504         1    1
  505         1    1
  506         1    1
  END TIMESERIES
```

```
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
    7     A/B, Lawn, Flat         1    1    1    1   27    0
    9     A/B, Lawn, Steep        1    1    1    1   27    0
    8     A/B, Lawn, Mod          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    7         0    0    1    0    0    0    0    0    0    0    0    0
    9         0    0    1    0    0    0    0    0    0    0    0    0
    8         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    9         0    0    4    0    0    0    0    0    0    0    0    0    1    9
    8         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    7         0    0    0    0    0    0    0    0    0    0    0
    9         0    0    0    0    0    0    0    0    0    0    0
    8         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR      KVARY     AGWRC
    7              0         5       0.8       400      0.05        0.3     0.996
    9              0         5       0.8       400      0.15        0.3     0.996
    8              0         5       0.8       400       0.1        0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    7              0         0         2         2         0         0         0
    9              0         0         2         2         0         0         0
    8              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    7          0.1       0.5      0.25         0       0.7      0.25
    9          0.1       0.5      0.25         0       0.7      0.25
    8          0.1       0.5      0.25         0       0.7      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
```

```
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS      GWVS
    7              0         0         0          0         3          1         0
    9              0         0         0          0         3          1         0
    8              0         0         0          0         3          1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    8      SIDEWALKS/FLAT         1    1    1   27    0
    9      SIDEWALKS/MOD          1    1    1   27    0
   10      SIDEWALKS/STEEP        1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    8         0    0    1    0    0    0
    9         0    0    1    0    0    0
   10         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    8         0    0    4    0    0    4    1    9
    9         0    0    4    0    0    0    1    9
   10         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    8         0    0    0    0    0
    9         0    0    0    0    0
   10         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    8            400      0.01       0.1       0.1
    9            400      0.05       0.1      0.08
   10            400       0.1       0.1      0.05
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    8              0         0
    9              0         0
   10              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    8              0         0
    9              0         0
   10              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
```

```
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
TDA 1***
PERLND   7                        0.31     COPY   501     12
PERLND   7                        0.31     COPY   501     13
IMPLND   8                        0.87     COPY   501     15
TDA 2***
PERLND   7                        0.03     COPY   502     12
PERLND   7                        0.03     COPY   502     13
IMPLND   8                        0.01     COPY   502     15
TDA 3***
PERLND   7                        0.03     COPY   503     12
PERLND   7                        0.03     COPY   503     13
IMPLND   8                        0.13     COPY   503     15
TDA 4***
PERLND   7                        0.71     COPY   504     12
PERLND   7                        0.71     COPY   504     13
IMPLND   8                        0.81     COPY   504     15
TDA 5***
PERLND   9                        1.21     COPY   505     12
PERLND   9                        1.21     COPY   505     13
PERLND   8                        0.19     COPY   505     12
PERLND   8                        0.19     COPY   505     13
IMPLND   9                        0.42     COPY   505     15
IMPLND  10                        0.28     COPY   505     15
TDA 6***
PERLND   9                        0.01     COPY   506     12
PERLND   9                        0.01     COPY   506     13
PERLND   7                        0.06     COPY   506     12
PERLND   7                        0.06     COPY   506     13
IMPLND   8                        0.08     COPY   506     15

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

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   48.4        DISPLY   3     INPUT  TIMSER 1
COPY   504 OUTPUT MEAN   1 1   48.4        DISPLY   4     INPUT  TIMSER 1
COPY   505 OUTPUT MEAN   1 1   48.4        DISPLY   5     INPUT  TIMSER 1
COPY   506 OUTPUT MEAN   1 1   48.4        DISPLY   6     INPUT  TIMSER 1



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

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

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

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

  HYDR-PARM1
```

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL       REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL       REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL       REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL       REPL
COPY     3 OUTPUT MEAN   1 1     48.4      WDM    703 FLOW     ENGL       REPL
COPY   503 OUTPUT MEAN   1 1     48.4      WDM    803 FLOW     ENGL       REPL
COPY     4 OUTPUT MEAN   1 1     48.4      WDM    704 FLOW     ENGL       REPL
COPY   504 OUTPUT MEAN   1 1     48.4      WDM    804 FLOW     ENGL       REPL
COPY     5 OUTPUT MEAN   1 1     48.4      WDM    705 FLOW     ENGL       REPL
COPY   505 OUTPUT MEAN   1 1     48.4      WDM    805 FLOW     ENGL       REPL
COPY     6 OUTPUT MEAN   1 1     48.4      WDM    706 FLOW     ENGL       REPL
COPY   506 OUTPUT MEAN   1 1     48.4      WDM    806 FLOW     ENGL       REPL
END EXT TARGETS

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

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

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

This program and accompanying documentation are provided 'as-is' without warranty of any kind. The entire risk regarding the performance and results of this program is assumed by End User. Clear Creek Solutions Inc. and the governmental licensee or sublicensees disclaim all warranties, either expressed or implied, including but not limited to implied warranties of program and accompanying documentation. In no event shall Clear Creek Solutions Inc. be liable for any damages whatsoever (including without limitation to damages for loss of business profits, loss of business information, business interruption, and the like) arising out of the use of, or inability to use this program even if Clear Creek Solutions Inc. or their authorized representatives have been advised of the possibility of such damages. Software Copyright © by : Clear Creek Solutions, Inc. 2005-2026; All Rights Reserved.

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

www.clearcreeksolutions.com

NEXT DOCUMENT

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: T-Line Infiltration Trench

Site Name:	DVT_T-Line
Site Address:	
City:	
Report Date:	7/1/2026
Gage:	Olympia Airport
Data Start:	1955/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2024/06/28
Version:	4.3.1

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Steep	1.49
Pervious Total	1.49
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.49

Element Flow Componants:

Surface	Interflow	Groundwater

Componant Flows To:

POC 1	POC 1

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Steep	1.21
Pervious Total	1.21

Impervious Land Use	acre
SIDEWALKS FLAT	0.28
Impervious Total	0.28
Basin Total	1.49

Element Flow Componants:

Surface	Interflow	Groundwater
Componant Flows To:		
Gravel Trench Bed 1	Gravel Trench Bed 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Gravel Trench Bed 1

Bottom Length:	50.00 ft.
Bottom Width:	6.00 ft.
Trench bottom slope 1:	1 To 1
Trench Left side slope 0:	1 To 1
Trench right side slope 2:	1 To 1
Material thickness of first layer:	4
Pour Space of material for first layer:	0.33
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	12
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	53.713
Total Volume Through Riser (ac-ft.):	0.002
Total Volume Through Facility (ac-ft.):	53.715
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	12 in.
Element Outlets:	
Outlet 1	Outlet 2
Outlet Flows To:	

Gravel Trench Bed Hydraulic Table

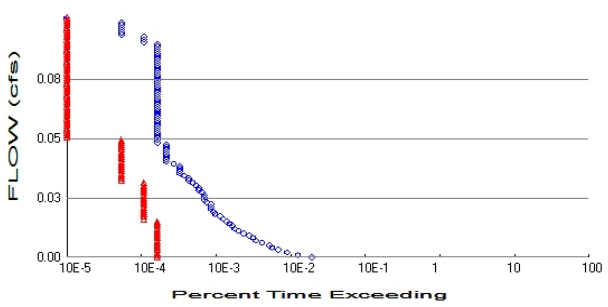
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.006	0.000	0.000	0.000
0.0444	0.007	0.000	0.000	0.083
0.0889	0.007	0.000	0.000	0.083
0.1333	0.007	0.000	0.000	0.083
0.1778	0.007	0.000	0.000	0.083
0.2222	0.007	0.000	0.000	0.083
0.2667	0.007	0.000	0.000	0.083
0.3111	0.007	0.000	0.000	0.083
0.3556	0.007	0.000	0.000	0.083
0.4000	0.007	0.001	0.000	0.083
0.4444	0.008	0.001	0.000	0.083
0.4889	0.008	0.001	0.000	0.083
0.5333	0.008	0.001	0.000	0.083
0.5778	0.008	0.001	0.000	0.083
0.6222	0.008	0.001	0.000	0.083
0.6667	0.008	0.001	0.000	0.083
0.7111	0.008	0.001	0.000	0.083
0.7556	0.008	0.002	0.000	0.083
0.8000	0.009	0.002	0.000	0.083
0.8444	0.009	0.002	0.000	0.083
0.8889	0.009	0.002	0.000	0.083
0.9333	0.009	0.002	0.000	0.083
0.9778	0.009	0.002	0.000	0.083

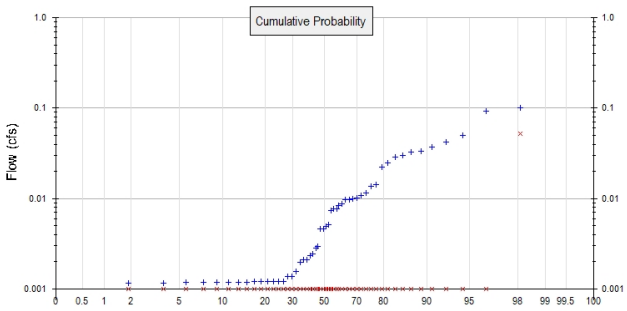
1.0222	0.009	0.002	0.000	0.083
1.0667	0.009	0.002	0.000	0.083
1.1111	0.009	0.003	0.000	0.083
1.1556	0.010	0.003	0.000	0.083
1.2000	0.010	0.003	0.000	0.083
1.2444	0.010	0.003	0.000	0.083
1.2889	0.010	0.003	0.000	0.083
1.3333	0.010	0.003	0.000	0.083
1.3778	0.010	0.004	0.000	0.083
1.4222	0.010	0.004	0.000	0.083
1.4667	0.010	0.004	0.000	0.083
1.5111	0.011	0.004	0.000	0.083
1.5556	0.011	0.004	0.000	0.083
1.6000	0.011	0.004	0.000	0.083
1.6444	0.011	0.004	0.000	0.083
1.6889	0.011	0.005	0.000	0.083
1.7333	0.011	0.005	0.000	0.083
1.7778	0.011	0.005	0.000	0.083
1.8222	0.011	0.005	0.000	0.083
1.8667	0.012	0.005	0.000	0.083
1.9111	0.012	0.006	0.000	0.083
1.9556	0.012	0.006	0.000	0.083
2.0000	0.012	0.006	0.000	0.083
2.0444	0.012	0.006	0.000	0.083
2.0889	0.012	0.006	0.000	0.083
2.1333	0.012	0.006	0.000	0.083
2.1778	0.012	0.007	0.000	0.083
2.2222	0.013	0.007	0.000	0.083
2.2667	0.013	0.007	0.000	0.083
2.3111	0.013	0.007	0.000	0.083
2.3556	0.013	0.007	0.000	0.083
2.4000	0.013	0.008	0.000	0.083
2.4444	0.013	0.008	0.000	0.083
2.4889	0.013	0.008	0.000	0.083
2.5333	0.014	0.008	0.000	0.083
2.5778	0.014	0.008	0.000	0.083
2.6222	0.014	0.009	0.000	0.083
2.6667	0.014	0.009	0.000	0.083
2.7111	0.014	0.009	0.000	0.083
2.7556	0.014	0.009	0.000	0.083
2.8000	0.014	0.009	0.000	0.083
2.8444	0.014	0.010	0.000	0.083
2.8889	0.015	0.010	0.000	0.083
2.9333	0.015	0.010	0.000	0.083
2.9778	0.015	0.010	0.000	0.083
3.0222	0.015	0.011	0.000	0.083
3.0667	0.015	0.011	0.000	0.083
3.1111	0.015	0.011	0.000	0.083
3.1556	0.015	0.011	0.000	0.083
3.2000	0.016	0.011	0.000	0.083
3.2444	0.016	0.012	0.000	0.083
3.2889	0.016	0.012	0.000	0.083
3.3333	0.016	0.012	0.000	0.083
3.3778	0.016	0.012	0.000	0.083
3.4222	0.016	0.013	0.000	0.083
3.4667	0.016	0.013	0.000	0.083
3.5111	0.017	0.013	0.000	0.083
3.5556	0.017	0.013	0.000	0.083

3.6000	0.017	0.014	0.000	0.083
3.6444	0.017	0.014	0.000	0.083
3.6889	0.017	0.014	0.000	0.083
3.7333	0.017	0.014	0.000	0.083
3.7778	0.017	0.015	0.000	0.083
3.8222	0.018	0.015	0.000	0.083
3.8667	0.018	0.015	0.000	0.083
3.9111	0.018	0.016	0.000	0.083
3.9556	0.018	0.016	0.000	0.083
4.0000	0.018	0.016	0.000	0.083

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.49
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 1.21
Total Impervious Area: 0.28

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.004737
5 year	0.015504
10 year	0.029966
25 year	0.062369
50 year	0.101841
100 year	0.16011

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.010	0.000
1957	0.001	0.000
1958	0.002	0.000
1959	0.002	0.000
1960	0.009	0.000
1961	0.029	0.000
1962	0.001	0.000
1963	0.014	0.000
1964	0.025	0.000
1965	0.008	0.000

1966	0.003	0.000
1967	0.010	0.000
1968	0.002	0.000
1969	0.001	0.000
1970	0.002	0.000
1971	0.011	0.000
1972	0.022	0.000
1973	0.001	0.000
1974	0.012	0.000
1975	0.005	0.000
1976	0.007	0.000
1977	0.001	0.000
1978	0.005	0.000
1979	0.001	0.000
1980	0.003	0.000
1981	0.010	0.000
1982	0.005	0.000
1983	0.002	0.000
1984	0.014	0.000
1985	0.001	0.000
1986	0.005	0.000
1987	0.093	0.000
1988	0.001	0.000
1989	0.001	0.000
1990	0.042	0.000
1991	0.050	0.000
1992	0.001	0.000
1993	0.001	0.000
1994	0.001	0.000
1995	0.008	0.000
1996	0.030	0.000
1997	0.032	0.000
1998	0.002	0.000
1999	0.033	0.000
2000	0.001	0.000
2001	0.001	0.000
2002	0.008	0.000
2003	0.001	0.000
2004	0.010	0.000
2005	0.001	0.000
2006	0.101	0.052
2007	0.037	0.000
2008	0.001	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1014	0.0521
2	0.0927	0.0000
3	0.0499	0.0000
4	0.0422	0.0000
5	0.0368	0.0000
6	0.0334	0.0000
7	0.0325	0.0000
8	0.0299	0.0000
9	0.0288	0.0000
10	0.0249	0.0000
11	0.0224	0.0000

12	0.0143	0.0000
13	0.0136	0.0000
14	0.0115	0.0000
15	0.0109	0.0000
16	0.0102	0.0000
17	0.0098	0.0000
18	0.0097	0.0000
19	0.0097	0.0000
20	0.0088	0.0000
21	0.0083	0.0000
22	0.0077	0.0000
23	0.0076	0.0000
24	0.0073	0.0000
25	0.0051	0.0000
26	0.0050	0.0000
27	0.0046	0.0000
28	0.0046	0.0000
29	0.0029	0.0000
30	0.0028	0.0000
31	0.0024	0.0000
32	0.0023	0.0000
33	0.0021	0.0000
34	0.0021	0.0000
35	0.0020	0.0000
36	0.0015	0.0000
37	0.0014	0.0000
38	0.0014	0.0000
39	0.0012	0.0000
40	0.0012	0.0000
41	0.0012	0.0000
42	0.0012	0.0000
43	0.0012	0.0000
44	0.0012	0.0000
45	0.0012	0.0000
46	0.0012	0.0000
47	0.0012	0.0000
48	0.0012	0.0000
49	0.0012	0.0000
50	0.0012	0.0000
51	0.0012	0.0000
52	0.0012	0.0000
53	0.0012	0.0000

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0024	357	3	0	Pass
0.0034	230	3	1	Pass
0.0044	167	3	1	Pass
0.0054	127	3	2	Pass
0.0064	104	3	2	Pass
0.0074	96	3	3	Pass
0.0084	77	3	3	Pass
0.0094	63	3	4	Pass
0.0104	58	3	5	Pass
0.0114	52	3	5	Pass
0.0124	43	3	6	Pass
0.0134	37	3	8	Pass
0.0144	33	3	9	Pass
0.0154	31	3	9	Pass
0.0164	28	3	10	Pass
0.0174	26	3	11	Pass
0.0184	23	2	8	Pass
0.0194	21	2	9	Pass
0.0205	18	2	11	Pass
0.0215	17	2	11	Pass
0.0225	16	2	12	Pass
0.0235	16	2	12	Pass
0.0245	16	2	12	Pass
0.0255	14	2	14	Pass
0.0265	13	2	15	Pass
0.0275	13	2	15	Pass
0.0285	13	2	15	Pass
0.0295	12	2	16	Pass
0.0305	11	2	18	Pass
0.0315	11	2	18	Pass
0.0325	10	2	20	Pass
0.0335	9	2	22	Pass
0.0345	8	1	12	Pass
0.0355	8	1	12	Pass
0.0365	7	1	14	Pass
0.0375	6	1	16	Pass
0.0385	6	1	16	Pass
0.0395	6	1	16	Pass
0.0405	6	1	16	Pass
0.0416	5	1	20	Pass
0.0426	4	1	25	Pass
0.0436	4	1	25	Pass
0.0446	4	1	25	Pass
0.0456	4	1	25	Pass
0.0466	4	1	25	Pass
0.0476	4	1	25	Pass
0.0486	4	1	25	Pass
0.0496	4	1	25	Pass
0.0506	3	1	33	Pass
0.0516	3	1	33	Pass
0.0526	3	0	0	Pass
0.0536	3	0	0	Pass
0.0546	3	0	0	Pass

0.0556	3	0	0	Pass
0.0566	3	0	0	Pass
0.0576	3	0	0	Pass
0.0586	3	0	0	Pass
0.0596	3	0	0	Pass
0.0606	3	0	0	Pass
0.0617	3	0	0	Pass
0.0627	3	0	0	Pass
0.0637	3	0	0	Pass
0.0647	3	0	0	Pass
0.0657	3	0	0	Pass
0.0667	3	0	0	Pass
0.0677	3	0	0	Pass
0.0687	3	0	0	Pass
0.0697	3	0	0	Pass
0.0707	3	0	0	Pass
0.0717	3	0	0	Pass
0.0727	3	0	0	Pass
0.0737	3	0	0	Pass
0.0747	3	0	0	Pass
0.0757	3	0	0	Pass
0.0767	3	0	0	Pass
0.0777	3	0	0	Pass
0.0787	3	0	0	Pass
0.0797	3	0	0	Pass
0.0807	3	0	0	Pass
0.0817	3	0	0	Pass
0.0828	3	0	0	Pass
0.0838	3	0	0	Pass
0.0848	3	0	0	Pass
0.0858	3	0	0	Pass
0.0868	3	0	0	Pass
0.0878	3	0	0	Pass
0.0888	3	0	0	Pass
0.0898	3	0	0	Pass
0.0908	3	0	0	Pass
0.0918	3	0	0	Pass
0.0928	2	0	0	Pass
0.0938	2	0	0	Pass
0.0948	2	0	0	Pass
0.0958	1	0	0	Pass
0.0968	1	0	0	Pass
0.0978	1	0	0	Pass
0.0988	1	0	0	Pass
0.0998	1	0	0	Pass
0.1008	1	0	0	Pass
0.1018	0	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

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

Model Default Modifications

Total of 0 changes have been made.

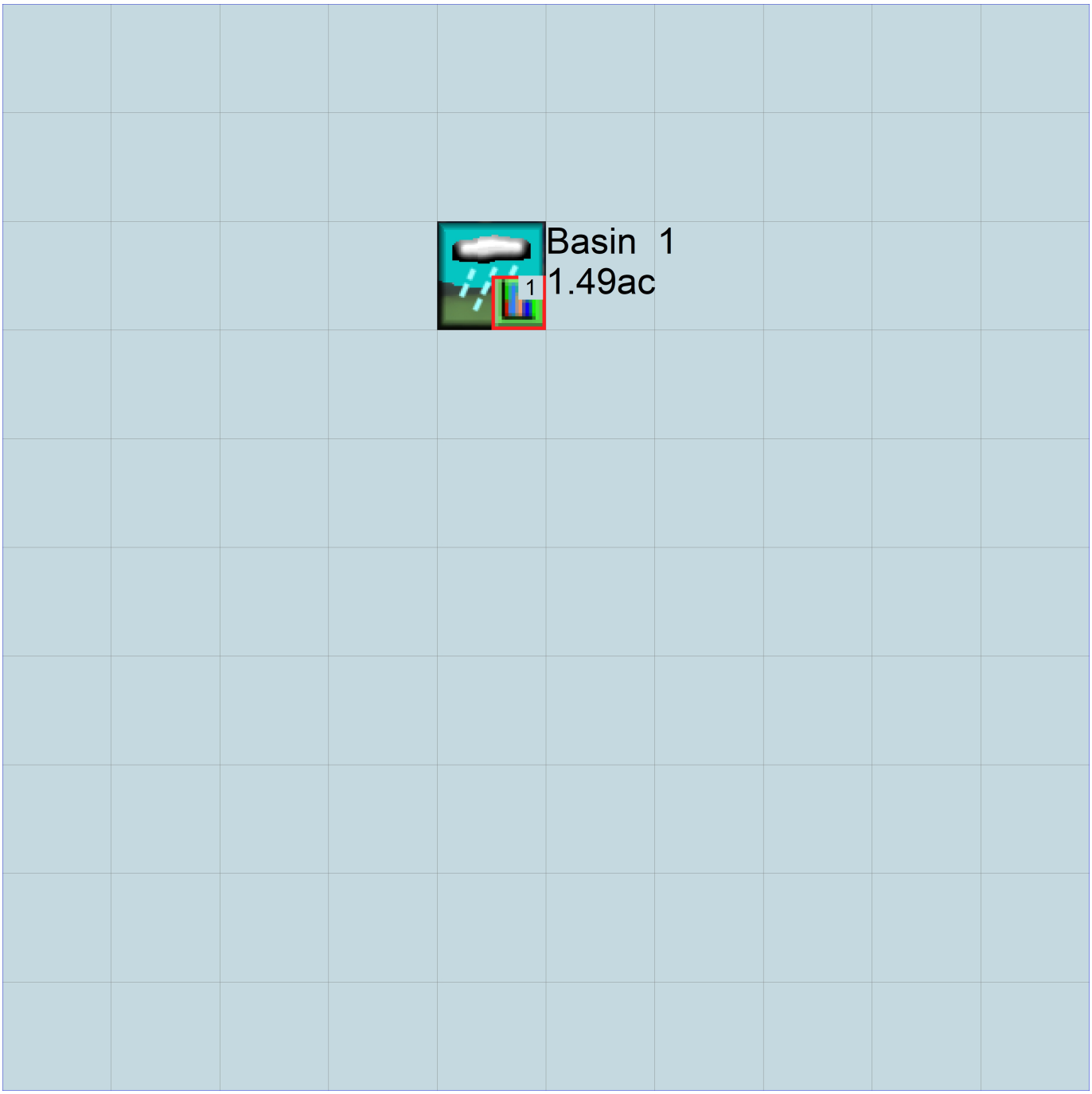
PERLND Changes

No PERLND changes have been made.

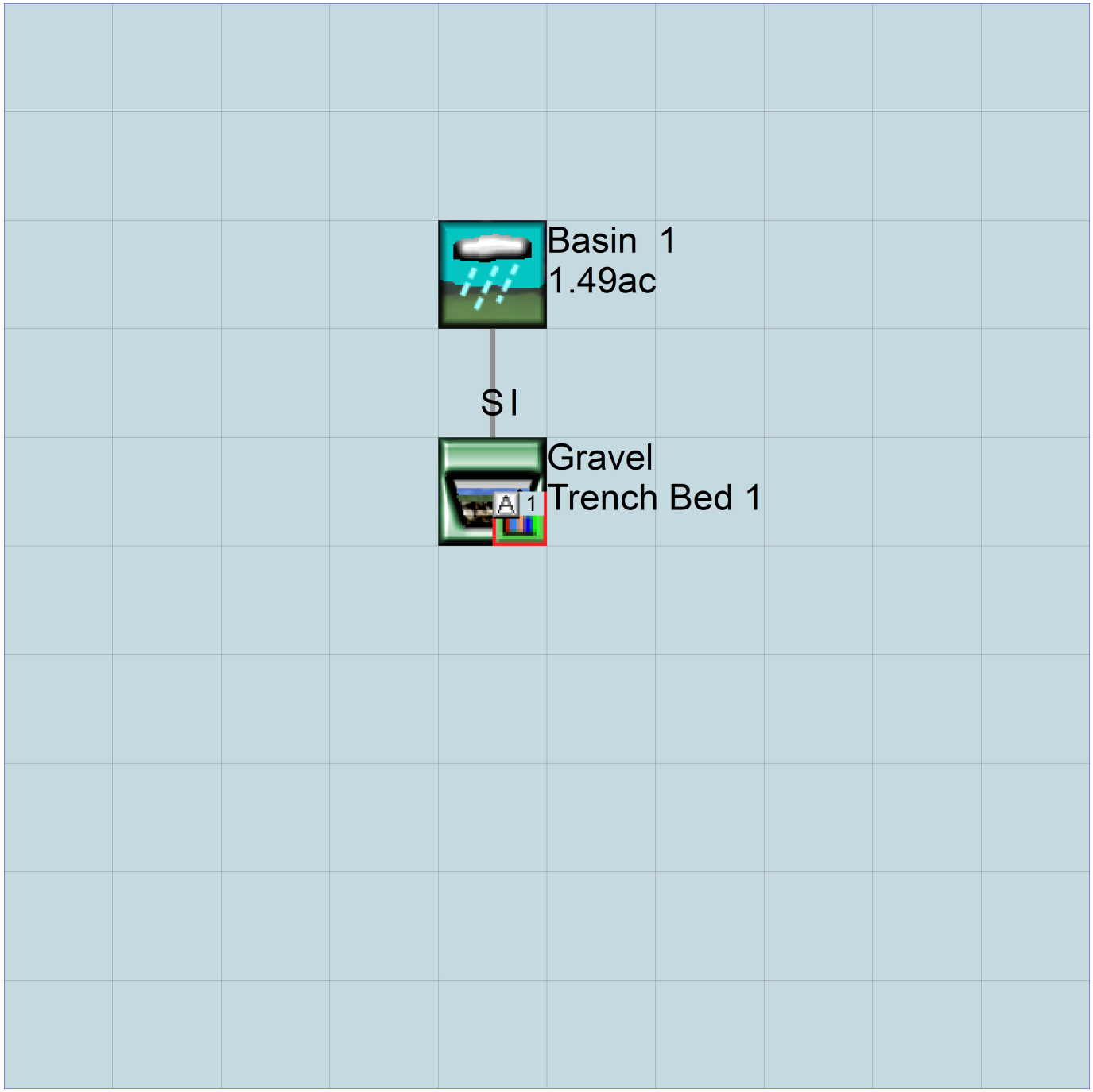
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

Mitigated UCI File

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

This program and accompanying documentation are provided 'as-is' without warranty of any kind. The entire risk regarding the performance and results of this program is assumed by End User. Clear Creek Solutions Inc. and the governmental licensee or sublicensees disclaim all warranties, either expressed or implied, including but not limited to implied warranties of program and accompanying documentation. In no event shall Clear Creek Solutions Inc. be liable for any damages whatsoever (including without limitation to damages for loss of business profits, loss of business information, business interruption, and the like) arising out of the use of, or inability to use this program even if Clear Creek Solutions Inc. or their authorized representatives have been advised of the possibility of such damages. Software Copyright © by : Clear Creek Solutions, Inc. 2005-2026; All Rights Reserved.

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

www.clearcreeksolutions.com

Appendix 2
Soil Management Plan

2/20/2026

Deschutes Valley Trail – Segment C
Soil Management Plan

The Deschutes Valley Trail – Segment C project utilizes the Postconstruction Soil Quality and Depth BMP. See below for compliance with the following requirements as outlined in the City of Tumwater DDECM:

- A site map showing areas to be fenced and left undisturbed during construction, and areas that will be amended at the turf or planting bed rates.
    - Any areas that are disturbed during construction and are not replaced with impervious surface shall employ Postconstruction Soil Quality and Depth and be reseeded. Refer to the civil engineering plans for the limits of grading associated with construction of the trail.
- Determination of soil conditions
    - Refer to Appendix 3: Exhibits 3B, 3C and 3D of the Drainage Report for information on existing site soil conditions.
- Identified soil quality implementation option
    - The soil section specified under Postconstruction Soil Quality and Depth shall be met by bringing in off-site soils that meet the BMP requirements.
- Calculations of the amounts of compost, compost amended topsoil, and mulch to be used on the site.
    - Refer to the civil engineering estimate for calculations of compost, compost amended topsoil, and mulch.

Appendix 3
Supplemental Reports and Information

Exhibit 3A - Critical Areas

Thurston County

Critical Aquifer Recharge Areas & McAllister Springs Geological Sensitive Area

Aquifer Recharge Classes*
- Extreme
- High
- Moderate

Geological Sensitive Area
- McAllister Springs

PROJECT SITE

Cities | Urban Growth Are

0 Miles

*Thurston County Critical Area Ordinance Chapter 24.10; Appendix B:
Table 24.10-3 Critical Aquifer Recharge Areas Geologic Features.
Table 24.10-4 Critical Aquifer Recharge Area soil series.

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The boun
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, complete
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, includin
not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misu
reliance of the information contained on this map. If any portion of this map or disclain
missing or altered, Thurston County removes itself from all responsibility from the map ar
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

Map Exported on 12/20/2025
PDP\Library\APRX\Environmental\Health\Water.aprx\AquiferRecharge(54x30)

Thurston County

Drainage Basins

- Military Bases
- Native American Reservations
- Public Forests
- Cities
- Urban Growth Areas

PROJECT SITE

TUMWATER

Miles

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The boun
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, complete
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, including
not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misu
reliance of the information contained on this map. If any portion of this map or disclaim
missing or altered, Thurston County removes itself from all responsibility from the map ar
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

Map Exported on 12/20/2025
PDF:Library/AP/RGI/Planning/NaturalResources.aprx!Basins(54x35)

Thurston County

100 Year & 500 Year Flood Zones
1996 Historical Flood

100 Year Flood Zone

500 Year Flood Zone

Flood of 1996

PROJECT SITE

Cities | Urban Growth Area

Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in the Surface not represented on this map. Orthorectified and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED "AS IS" AND WITH ALL FAULTS. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including but not limited to, lost revenues or lost profits, real or anticipated resulting from the use, misuse, or tolerance of the information contained on this map. If any portion of this map or chosen data is missing or altered, Thurston County removes itself from all responsibility from this map and data contained within. The burden for determining fitness for use lies entirely with the user. The user is solely responsible for understanding the accuracy limitations of the information contained in this map.

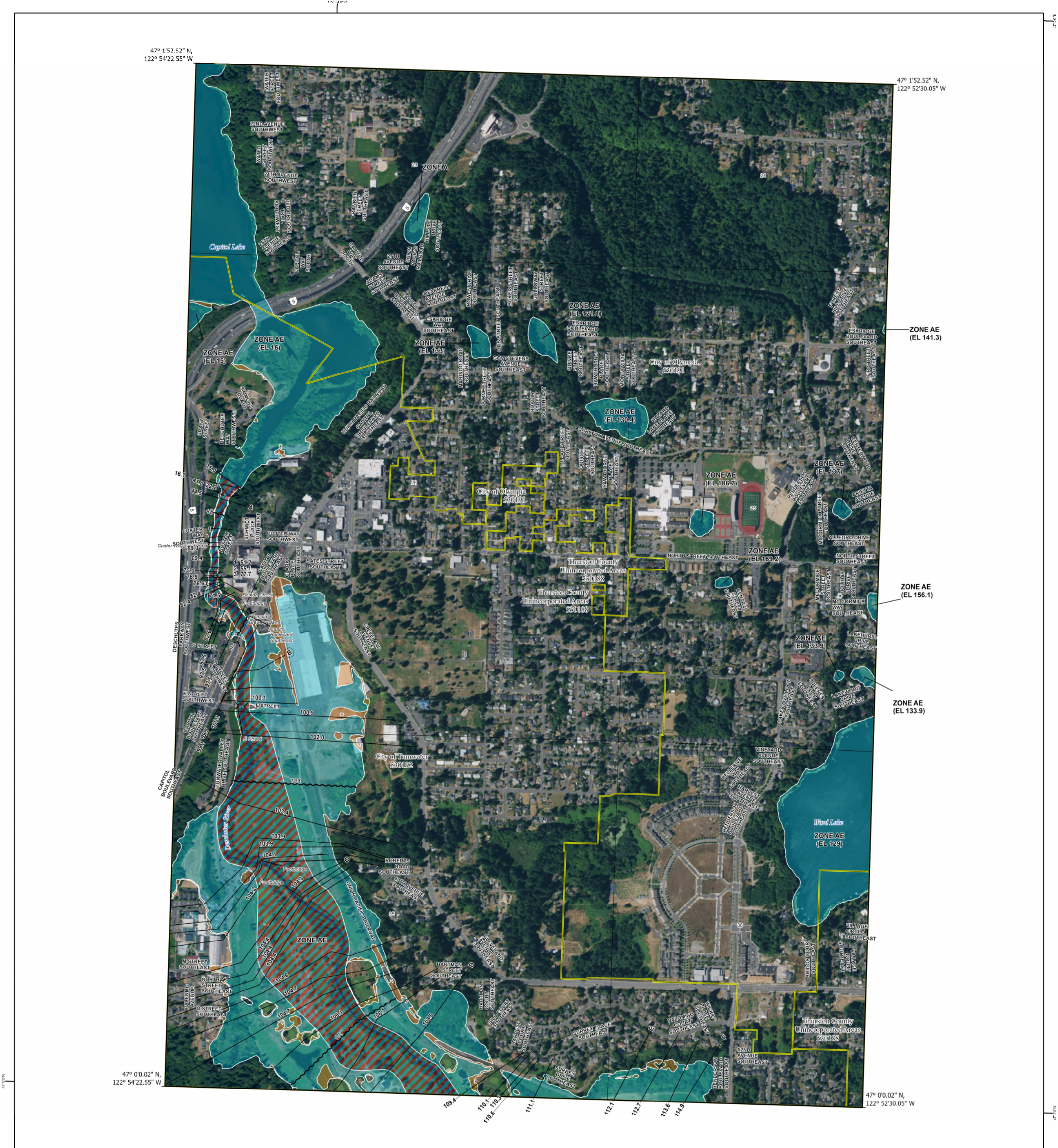
Updated on 11/14/2006

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

GEODATA

NORTH



FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
	20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	Base Flood Elevation Line (BFE)
OTHER FEATURES	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available effective flood hazard information for your community, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Mapping and Insurance eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be downloaded from the website. Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be acquired directly from the Flood Map Service Center at the website listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

Note: Some Special Flood Hazard Areas with elevations may not appear with elevation labels if the Base Flood Elevation or Cross-section line which communicates the elevation for the location appears on the adjacent panel. Please see the Panel Locator Diagram on this map panel to determine the adjacent panel and find the elevation feature there, or alternatively use the Flood Insurance Study report for detailed elevations by flood source.

SCALE

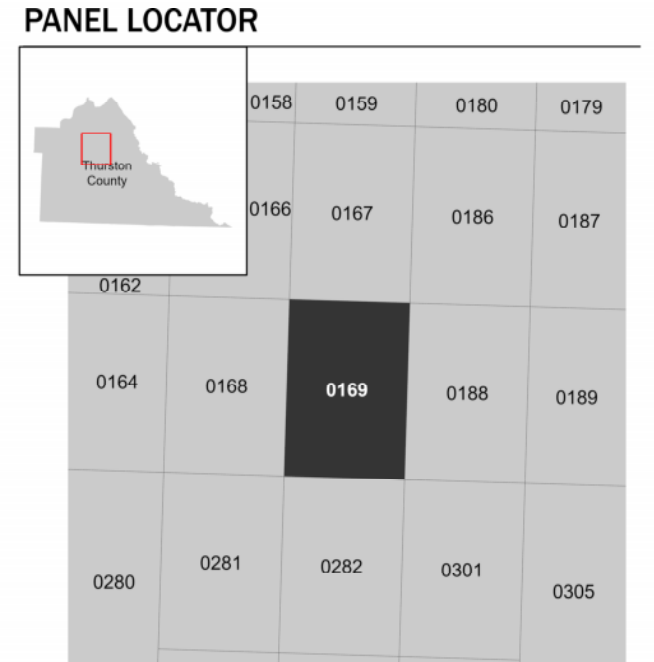
1 inch = 500 feet 1:6,000

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

0 50 100 200 300 400 meters

Map Projection:
NAD 1983 StatePlane Washington South FIPS 4602 Feet
Vertical Datum: NAVD88

PANEL LOCATOR



FEMA
National Flood Insurance Program

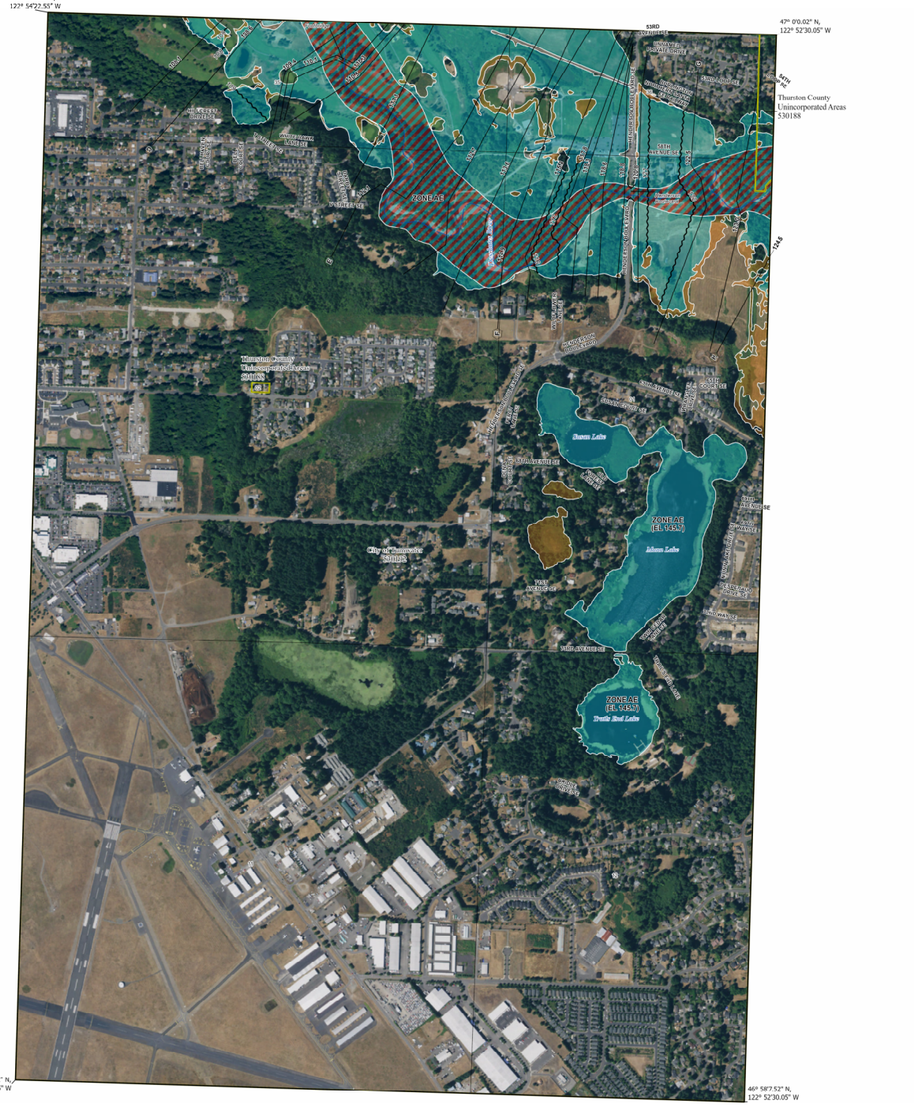
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

THURSTON COUNTY
WASHINGTON
AND INCORPORATED
AREAS

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
CITY OF OLYMPIA	530191	0169	H
THURSTON COUNTY UNINCORPORATED AREAS	530188	0169	H
CITY OF TUMWATER	530192	0169	H

MAP NUMBER
53067C0169H
EFFECTIVE DATE
May 08, 2024



FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

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

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

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard — Zone X
- Area of Undetermined Flood Hazard — Zone D

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

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

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available effective flood hazard information for your community, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Mapping and Insurance Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users should be aware that individual FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be acquired directly from the Flood Map Service Center at the website listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

Note: Some Special Flood Hazard Areas with elevations may not appear with elevation labels if the Base Flood Elevation or Cross-section line which communicates the elevation for the location appears on the adjacent panel. Please see the Panel Locator Diagram on this map panel to determine the adjacent panel and find the elevation feature there, or alternatively use the Flood Insurance Study report for detailed elevations by flood source.

SCALE

N

1 inch = 500 feet — 1:6,000

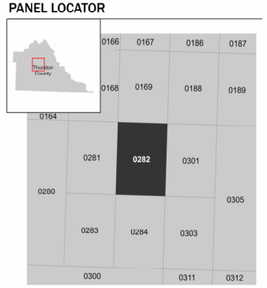
0 250 500 1,000 1,500 2,000 feet

0 50 100 200 300 400 meters

Map Projection:
NAD 1983 StatePlane Washington South FIPS 4602 Feet

Vertical Datum: NAVD88

PANEL LOCATOR





NATIONAL FLOOD INSURANCE PROGR

FLOOD INSURANCE RATE MAP

THURSTON COUNTY WASHINGTON AND INCORPORATED AREAS

Panel Contains:

COMMUNITY	NUMBER	PANEL	S
THURSTON COUNTY (UNINCORPORATED AREAS	530188	0282	G
CITY OF TUMWATER	530193	0282	G

MAP NUM
53067C02
EFFECTIVE
May 08, 2

Thurston County

Geologic Hazard Areas

Landslide Hazard Area

Volcanic Hazard Area - Case 1

PROJECT SITE

Cities **Urban Growth Areas**

0 5

Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness for use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

NORTH

Map Exported on 12/25/2025
PDP:\Library\APROX\Planning\CriticalAreas.aprx\Geologic Hazard(54x36)

Thurston County

High Groundwater Hazard Areas

- Salmon Creek Basin
- High Groundwater Hazard
- High Groundwater Hazard - 300' Buffer
- Salmon Creek Basin High Groundwater Hazard
- Salmon Creek High Groundwater Hazard - 300' Buffer

PROJECT SITE

- Cities
- Urban Growth Areas

0 5
Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness for use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY GEODATA CENTER

NORTH

Map Exported on 12/20/2025
P:\PLibrary\APRX\Planning\Critical\Areas aprx\HighGroundwater(54x36)

Thurston County

Known Areas of Soil or Groundwater Concern

THIS MAP IS BASED ON DATA THAT IS NOT ALWAYS FULLY CONCLUSIVE AND IS INTENDED MAINLY AS A GUIDE TO AREAS WHERE FURTHER MONITORING IS APPROPRIATE. IT IS A MAP OF SUSPECTED OR CONFIRMED GROUNDWATER QUALITY PROBLEMS.

AREAS OF PESTICIDE CONTAMINATION
Includes EDB, DBCP, 1,2 DCP and others

ELEVATED CHLORIDE AREAS
Areas containing significant numbers of wells with chloride levels exceeding 4 parts/million

ELEVATED NITRATE AREAS
Areas containing significant numbers of wells with nitrate levels exceeding 4 parts/million (1999-2003)

AREAS OF VERY LIMITED GROUNDWATER
Volcanic bedrock unlikely to produce enough water for any type of well

AREAS OF LIMITED GROUNDWATER
Sedimentary bedrock that may produce enough water for low-yield wells

SITES OF CONCERN

1 . EDB 1 Thurston County
2 . Restover Truck Stop
3 . Cascade Pole Inc McFarland
4 . The Ostrom Company
5 . Weyerhaeuser Co Box Plant
6 . Cedar Creek Corrections DNR
7 . Citflor Inc
8 . Puget Sound Power & Light
9 . Rhodes Chemical Co
10 . Rhodes Chemical Co Barn
11 . Pattison Lake EDB
12 . Lacey Valve Grinding
13 . Lacey Laundromat
14 . Black Lake Grocery
15 . West Olympia Landfill Former
16 . Warehouse One Port
17 . Industrial Petroleum Distributors
18 . US West Capitol Peak
19 . Unocal Service Station 0266
20 . Tumwater City N 5th & Bates
21 . Puget Power Eld Inlet Substation
22 . Olympia Dry Cleaners
23 . Boulevard Nursery
24 . Clarke Residence
25 . Franks Property
26 . Former Mervyns Westifeld Capital Mall
27 . Tumwater Falls Park Reclaimed Water Lines
28 . Former WSDOT Materials Testing Facility
29 . The Evergreen State College
30 . J & J Salvage Drums
31 . Faber & Sons Recycling Rochester
32 . Arrowood Subdivision Property
33 . Stacey Property
34 . Meridian Campus
35 . Chestnut Street ROW
36 . Pacific Pride Marvin Rd
37 . Tri Way Properties
38 . PSE ROW Lot 140 9101 Steilacoom Rd
39 . Port Of Olympia Texaco Bulk Storage Facility
40 . SR8, MP 18 Westbound Spill
41 . Kemp Property
42 . Steilacoom Ridge
43 . PSE Olympia Switching Substation
44 . LOTT Construction Project ROW Martin Way
45 . Vacant Property Rochester
46 . WA DFW Fishery Resource Management
47 . Lacey Gateway
48 . Peranzi Property
49 . WA State Dept Information Svcs Office Bldg
50 . Carlyon Beach Homeowners Assn Shop
51 . North Thurston Middle School #5
52 . WA Dept Of Fish & Wildlife Print Shop
53 . Old Sears Building
54 . Franklin Street Row
55 . WA Dept Of Fish & Wildlife Parking Lot
56 . 2040 Mottman Rd
57 . Capital City Studios
58 . Phoenix Inn
59 . Arco 4435
60 . Lacey Fuel
61 . Evergreen Sportsman Club
62 . WA DOT E I5 Milepost 87.5
63 . 1515 Division Nursery
64 . 318 State Ave NE Olympia
65 . Budd Inlet Sediment
66 . Taco Bell/Former Chevron 96801
67 . Haumann Property
68 . WA GA Olympia
69 . 8th & Capitol Investigation
70 . Gallagher Cove LLC
71 . 5th & Columbia St Parking Lot
72 . 7 Eleven Food Store 230325983H
73 . Gull Harbor Mercantile
74 . Diamond Parking/Chevron 9-0292
75 . East Bay Redevelopment
76 . Old Brewhouse Former Paint Shop
77 . WA DNR Triangle Pit
78 . PSE Blumauer Substation
79 . Buckeye Court Gasoline Spill
80 . Valentine Fyrst Property
81 . North Thurston School Dist Transp Dept
82 . 1203 Edison St NE
83 . City Of Olympia 4th & Sylvester Utility Corridor
84 . WA DNR Webster Nursery
85 . Eighth Avenue Park
86 . Lacey Market Square
87 . Handy Pantry
88 . WA Grange Parking Lot Chevron
89 . Jacks Auto Repair
90 . Zittle's Johnson Point
91 . Eastside Laundry/Allisons Norge Village
92 . WA DNR Marine Research Cntr
93 . Intercity Transit/Treasure Chest
94 . Low Ronts Wost Inc
95 . Howards Cleaners
96 . LOTT Wastewater Treatment Plant
97 . Tacoma Smelter Plume Thurston County
98 . Olympic Pipeline Co Olympia Station
99 . MJMG Group Llc
100 . Shell Oil Co Black Lake Blvd
101 . Port Of Olympia Warehouse 2
102 . City Of Olympia-Heritage Park
103 . Olympia City Sewer Pump Station
104 . Jackpot Station #371
105 . Olympia School District Bus Barn
106 . Shop Fast
107 . Briggs Nursery
108 . Littlerock Grocery
109 . Acme Fuel Bulk Plant 305
1'0 . Summit Lake BP
1'1 . Stop N Go
1'2 . Premier Auto Detail
1'3 . Performance Corner
1'4 . Intercity Transit
1'5 . 6110 Olympia Chevron
1'6 . Fast Fuel 1
1'7 . WA St CB&G Steamplant
1'8 . Circle K 5497/BP 01690
1'9 . Darigold Site Former
120 . Kens Tire
121 . Pearson Air Inc
122 . U S West Capital Peak Radio 070585
123 . Lacey Food Mart
124 . Palermo Wellfield
125 . Western Pacific Cleaners
126 . Secured Safe Storage
127 . Johns Auto Wrecking
128 . Evergreen Shores Grocery
129 . Northwest Pipeline GP Olympia M/S
130 . Olympia City Public Works 7th Ave
131 . Martin Way Shell
132 . PHO Olympia Restaurant Utility Pole
133 . Puget Power Olympia Serv Center
134 . McMahans Furniture
135 . Mos Mini Mart
136 . BMT Northwest AKA Reliable Steel
137 . Pit Stop Olympia
138 . Tenino Blumaer Substation
139 . Massoth Machine
140 . Tenino Corner Grocery
141 . Jackpot Station 372
142 . Tanglewilde Chevron
143 . Phil Wall & Sons Inc
144 . Great Western Soil
145 . Capital Plumbing And Heating
146 . 4th Ave Shell Texaco Station 120948
147 . Jack Wilmarth Triangle General Store
148 . Flintstone Fuel Inc
149 . Jiffy Lube 2071
150 . Olympia Fuel & Asphalt Inc Tumwater
151 . City Of Olympia-Miller Central
152 . US West Martin Way SOC
153 . Arnolds Texaco Service
154 . Columbia Square Properties
155 . West Bay Marina
156 . Solid Wood Inc
157 . Astro Western 617
158 . Old Tumwater City Hall/2nd Ave
159 . Union Oil Station

Downtown Olympia Inset

PROJECT SITE

Cities Urban Growth Are

0 Miles

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The boun
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, comple
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, includin
loss of profits, arising out of or in connection with the use of this map or data. Due to the
reliance of the information contained on this map, if any portion of this map or data
missing or altered, Thurston County removes itself from all responsibility from the map ar
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

Map Exported on 12/20/2025
PDP/Library/APPDE/Environmental Health/Water.apr/Hotspots(54x35)

Thurston County

Watersheds

- BLACK RIVER
- BUDD/DESCHUTES
- CHEHALIS RIVER
- ELD INLET
- HENDERSON INLET
- NISQUALLY RIVER
- SKOOKUMCHUCK RIVER
- TOTTEN INLET
- WEST CAPITOL FOREST

PROJECT SITE

Cities | Urban Growth Are

0

Miles

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The bound
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, complete
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, including
not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misu
reliance of the information contained on this map. If any portion of this map or disclai
missing or altered, Thurston County removes itself from all responsibility from the map an
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

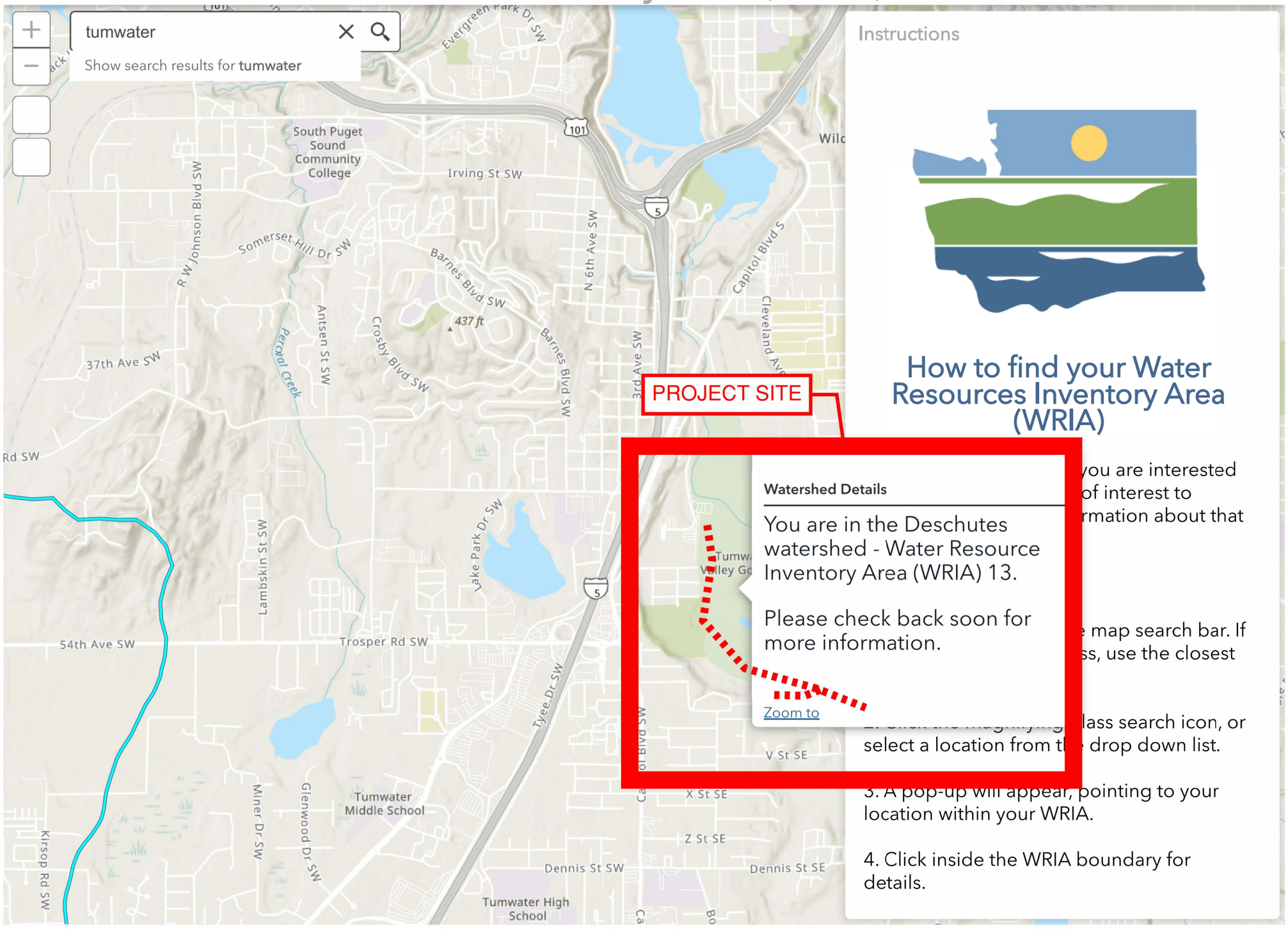
Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

Map Exported on 12/20/2025
PDF/Library/APRX\Planning\NaturalResources.aprx\Watersheds(54x36)

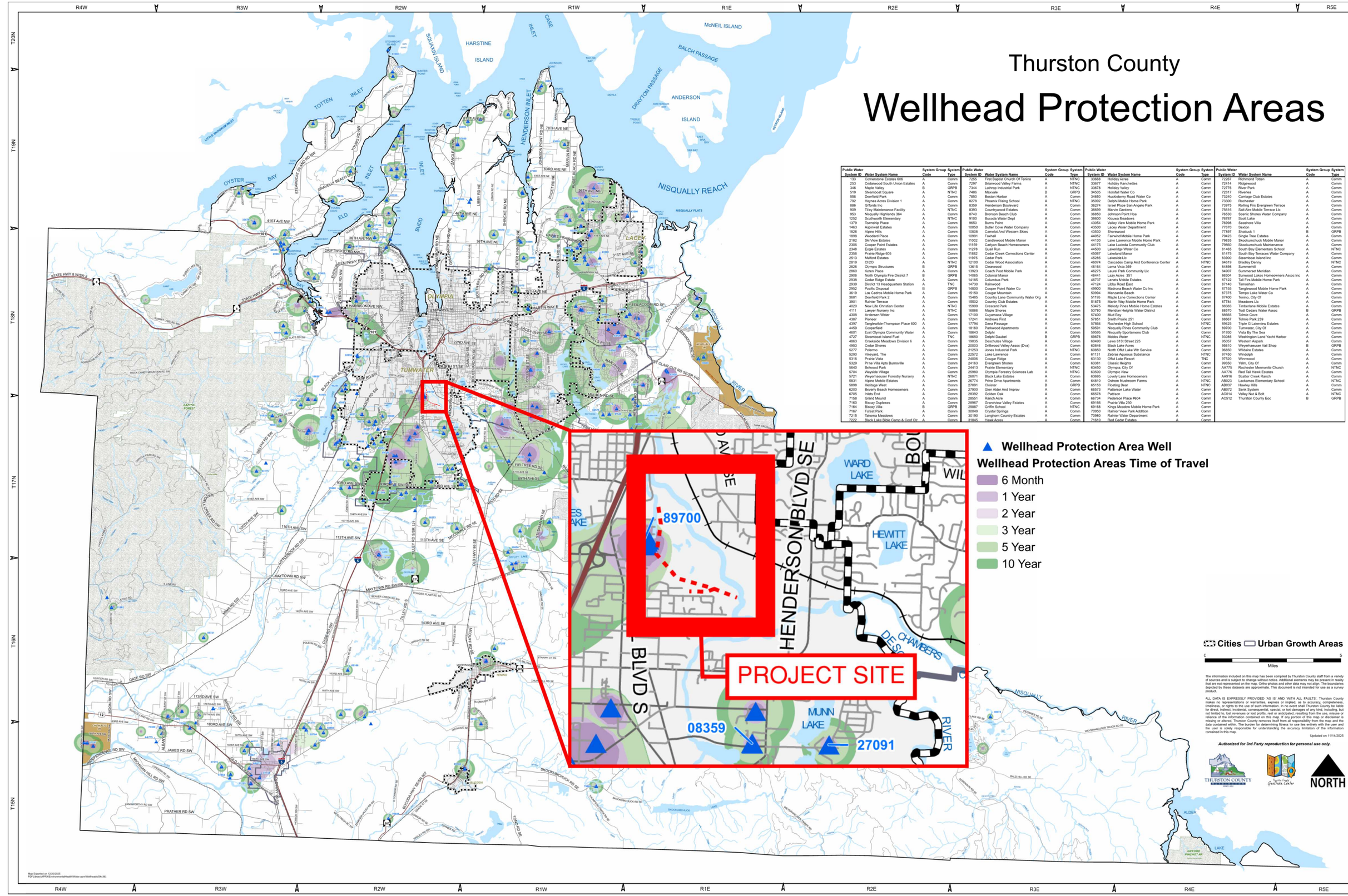
Find Your Water Resources Inventory Area (WRIA)



Thurston County

Wellhead Protection Areas

Public Water System ID	Water System Name	System Group Code	System Type
133	Cornerstone Estates 606	A	Comm
253	Cedarwood South Union Estates	A	Comm
346	Maple Valley	B	GRPB
519	Steamboat Square	A	NTNC
558	Deerfield Park	A	Comm
782	Haynes Acres Division 1	A	Comm
886	Giffords Inc	A	Comm
909	Tilley Maintenance Facility	A	NTNC
953	Nisqually Highlands 364	A	Comm
1252	Southworth Elementary	A	NTNC
1379	Township Place	A	Comm
1463	Aspinwall Estates	A	Comm
1826	Alpine Hills	A	Comm
1898	Woodard Place	A	Comm
2182	Ski-View Estates	A	Comm
2306	Cooper Point Estates	A	Comm
2348	Eagle Estates	A	Comm
2356	Prairie Ridge 605	A	Comm
2513	Mulford Estates	A	Comm
2819	CIQO	A	NTNC
2826	Olympic Structures	B	GRPB
2860	Koren Place	A	Comm
2906	North Olympia Fire District 7	B	GRPB
2938	Cedar Ridge Estate	A	Comm
2939	District 13 Headquarters Station	A	TNC
2952	Pacific Disposal	B	GRPB
3619	Los Cedros Mobile Home Park	A	Comm
3681	Deerfield Park 2	A	Comm
3901	Rainier Terrace	A	Comm
4020	New Life Christian Center	A	NTNC
4111	Lawyer Nursery Inc	A	NTNC
4308	Ar-bersen Water	A	Comm
4387	Pioneer	A	Comm
4397	Tanglewilde-Thompson Place 600	A	Comm
4459	Cooperfield	A	Comm
4601	East Olympia Community Water	A	Comm
4727	Steamboat Island Fuel	A	TNC
4863	Creekside Meadows Division Ii	A	Comm
4953	Cedar Shores	A	Comm
5277	Palermo	A	Comm
5290	Vineyard, The	A	Comm
5316	Prairie Vista	A	Comm
5329	Prine Villa Apts Burnsville	A	Comm
5640	Belwood Park	A	Comm
5704	Wayside Village	A	Comm
5721	Weyerhaeuser Forestry Nursery	A	NTNC
5831	Alpine Mobile Estates	A	Comm
5898	Heritage West	A	Comm
6200	Beverly Beach Homeowners	A	Comm
6705	Inlets End	A	Comm
7158	Grand Mound	A	Comm
7160	Biscay Duplexes	A	Comm
7164	Biscay Villa	B	GRPB
7167	Forest Park	A	Comm
7215	Tahoma Meadows	A	Comm
7222	Black Lake Bible Camp & Conf Ctr	A	Comm
7255	First Baptist Church Of Tenino	A	NTNC
7297	Briarwood Valley Farms	A	Comm
7344	Lathrop Industrial Park	A	NTNC
7486	Maxvale	B	GRPB
7850	Boston Harbor	A	Comm
8278	Phoenix Rising School	A	NTNC
8359	Henderson Boulevard	A	Comm
8393	Countrywood Estates	A	Comm
8740	Bronson Beach Club	A	Comm
9100	Bucoda Water Dept	A	Comm
9650	Burns Point	A	Comm
10050	Butler Cove Water Company	A	Comm
10808	Camelot And Western Skies	A	Comm
10991	Foxhall	A	Comm
11002	Castlewood Mobile Manor	A	Comm
11159	Carlyon Beach Homeowners	A	Comm
11278	Quail Run	A	Comm
11882	Cedar Creek Corrections Center	A	Comm
11975	Cedar Park	A	Comm
12100	Cedar Wood Association	A	Comm
13615	Clearwood	A	Comm
13923	Coach Post Mobile Park	A	Comm
14065	Colonial Manor	A	Comm
14185	Columbus Park	A	Comm
14730	Rainwood	A	Comm
14800	Cooper Point Water Co	A	Comm
15150	Cougar Mountain	A	Comm
15485	Country Lane Community Water Org	A	Comm
15502	Country Club Estates	A	Comm
15999	Crescent Park	A	Comm
16866	Maple Shores	A	Comm
17100	Cuyamaca Village	A	Comm
17241	Andrews First	A	Comm
17784	Dana Passage	A	Comm
18160	Parkwood Apartments	A	Comm
18643	Delphi Rd	A	Comm
18650	Delphi Daubel	B	GRPB
19035	Deschutes Village	A	Comm
20003	Driftwood Valley Assoc (Dva)	A	Comm
21253	Jones Industrial Park	A	NTNC
22572	Lake Lawrence	A	Comm
24006	Cougar Ridge	A	Comm
24163	Evergreen Shores	A	Comm
24413	Prairie Elementary	A	NTNC
25980	Olympia Forestry Sciences Lab	A	NTNC
26071	Black Lake Estates	A	Comm
26774	Prine Drive Apartments	A	Comm
27091	Cloister	B	GRPB
27900	Glen Alder And Improv	A	Comm
28392	Golden Oak	A	Comm
28551	Ranch Acre	A	Comm
28967	Grandview Valley Estates	A	Comm
29887	Griffin School	A	NTNC
30049	Crystal Springs	A	Comm
30190	Longhorn Country Estates	A	Comm
31845	Hawk Acres	A	Comm
33668	Holiday Acres	A	Comm
33677	Holiday Ranchettes	A	Comm
33678	Holiday Valley	A	Comm
34505	Horsfall Water Co	A	Comm
34650	Huckleberry Road Water Co	A	Comm
35092	Delphi Mobile Home Park	A	NTNC
36274	Israel Place San Angelo Park	A	Comm
36899	Marvin Gardens	A	Comm
36850	Johnson Point Hoa	A	Comm
38600	Kcuwa Meadows	A	Comm
43054	Valley View Mobile Home Park	A	Comm
43500	Lacey Water Department	A	Comm
43530	Shorewood	A	Comm
44052	Fairwind Mobile Home Park	A	Comm
44130	Lake Lawrence Mobile Home Park	A	Comm
44175	Lake Lucinda Community Club	A	Comm
44500	Lakeridge Water Co	A	Comm
45087	Lakeland Manor	A	Comm
45285	Lakeside Llc	A	Comm
46074	Cascades Camp And Conference Center	A	NTNC
46164	Loma Vista 369	A	Comm
46275	Laurel Park Community Llc	A	Comm
46441	Lazy Acres 351	A	Comm
46737	Lenets Mobile Estates	A	Comm
47124	Libby Road East	A	Comm
49900	Madrona Beach Water Co Inc	A	Comm
50994	Manzanita Beach	A	Comm
51195	Maple Lane Corrections Center	A	Comm
51875	Martin Way Mobile Home Park	A	Comm
53475	Melody Pines Mobile Home Estates	A	Comm
53780	Meridian Heights Water District	A	Comm
57400	Mud Bay	A	Comm
57851	Smith Prairie 251	A	Comm
57864	Rochester High School	A	NTNC
59591	Nisqually Pines Community Club	A	Comm
59595	Nisqually Sportsmens Club	A	Comm
59876	Mobbs Water	A	NTNC
60490	Lacey 6119 Street 225	A	Comm
60846	Black Lake Acres	A	Comm
60850	North Offut Lake Wtr Service	A	Comm
61131	Zebras Aqueous Substance	A	NTNC
63130	Offut Lake Resort	A	TNC
63381	Evergreen Shores	A	Comm
63450	Olympia, City Of	A	Comm
63500	Olympic View	A	Comm
63695	Lovely Lane Homeowners	A	Comm
64810	Oslrons Mushroom Farms	A	NTNC
65153	Floating Bear	A	NTNC
66573	Patterson Lake Water	A	Comm
66578	Pattison	A	Comm
66734	Pederson Place #604	A	Comm
69166	Prairie Villa 230	A	Comm
69168	Kings Meadow Mobile Home Park	A	Comm
70950	Rainier View Park Addition	A	Comm
70980	Rainier Water Department	A	Comm
71610	Red Cedar Estates	A	Comm
72267	Richmond Totten	A	Comm
72414	Ridgewood	A	Comm
72776	River Park	A	Comm
72817	Riverlea	A	Comm
73240	Carriage Club Estates	A	Comm
73300	Rochester	A	Comm
73975	Rolling Firs Evergreen Terrace	A	Comm
75616	Salt Aire Mobile Terrace Llc	A	Comm
76530	Scenic Shores Water Company	A	Comm
76787	Scott Lake	A	Comm
76998	Seashore Villa	A	Comm
77670	Sexton	A	Comm
77897	Shattuck 1	B	GRPB
79423	Single Tree Estates	A	Comm
79835	Skookumchuck Mobile Manor	A	Comm
79860	Skookumchuck Maintenance	A	Comm
81465	South Bay Elementary School	A	NTNC
81475	South Bay Terraces Water Company	A	Comm
83900	Steamboat Island Inc	A	Comm
84074	Deep Denny	A	NTNC
84898	Summerhill	A	Comm
84907	Summerset Meridian	A	Comm
86304	Sunwood Lakes Homeowners Assoc Inc	A	Comm
87122	Tall Firs Mobile Home Park	A	Comm
87140	Tamoshan	A	Comm
87155	Tanglewood Mobile Home Park	A	Comm
87375	Tempo Lake Water Co	A	Comm
87400	Tenino, City Of	A	Comm
87784	Meadows Llc	A	Comm
88383	Timberlane Mobile Estates	A	Comm
88570	Todt Cedars Water Assoc	B	GRPB
88665	Tolmie Cove	A	Comm
88667	Tolmie Park 239	A	Comm
89425	Tsjio Ci Lakeview Estates	A	Comm
89700	Tumwater, City Of	A	Comm
91930	Valley By The Sea	A	Comm
93085	Washington Land Yacht Harbor	A	Comm
95057	Western Airpark	A	Comm
95610	Weyerhaeuser Vail Shop	B	GRPB
96850	Wildaire Estates	A	Comm
97450	Windolph	A	Comm
97520	Winwood	A	Comm
99350	Yelm, City Of	A	Comm
AA775	Rochester Mennonite Church	A	NTNC
AA776	Red Tail Hawk Estates	A	Comm
AA916	Scatter Creek Ranch	A	Comm
AB023	Lackamas Elementary School	A	NTNC
AB037	Hawley Hills	A	Comm
AB072	Senk System	A	Comm
AC014	Valley Nut & Bolt	A	NTNC
AC512	Thurston County Eoc	B	GRPB



The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tot damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness 'or use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

Map Exported on 12/20/2025
PDF:Library/APRX/Environmental Health/Water.aprx\Wellheads(54x36)

Thurston County

Wetlands & 300 Foot Wetland Buffer

Wetlands

300 Foot Wetlands Buffer

PROJECT SITE

Cities **Urban Growth Areas**

0 5

Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness for use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY GEODATA CENTER

NORTH

Map Exported on 12/20/2025
PDFLibrary/APRX/Planning/CriticalAreas.aprx\Wetland(54x35)

February 27, 2026

Water Quality Atlas Map



WQ Improvement Projects

- TMDL - Approved
- 4B - Approved
- STI - Approved
- ARP - Approved
- TMDL - In Development
- STI - In Development
- ARP - In Development

Miles
0 0.1 0.2 0.4

Esri Community Maps Contributors, City of Olympia, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA,

https://apps.ecology.wa.gov/waterqualityatlas/wqa/map

Deschutes River, Percival Creek, & Budd Inlet tributaries

Parts of the Deschutes River and its tributary creeks do not meet state clean water standards. To return these waters to a healthy condition, we are working with local governments and other groups to implement a total maximum daily load (TMDL) project.

Water quality issues

The Deschutes River is under pressure from growth, resulting in many small, uncontrolled sources of pollution that enter the river. Local city, county, and state government agencies monitor and protect water quality. In the Deschutes, water quality monitoring revealed that levels of pH, dissolved oxygen, temperature, fine sediment, and fecal coliform did not meet state standards. We began the TMDL process to address these problems.

What is being done

With the help of an advisory group of affected stakeholders, special interest groups, and interested residents, we developed a TMDL plan to solve the river's pollution problems. The Deschutes River, Percival Creek, and Budd Inlet Tributaries Water Quality Improvement Plan (also known as a TMDL) assigns the amount of pollution the water bodies can receive and still meet water quality standards. Any additional amount needs to be eliminated to achieve clean water.

This plan provides a framework for how stakeholders will track, monitor, and implement the water cleanup plan. It outlines what is needed, establishes a schedule, and guides corrective actions with adaptive management practices.

We gathered public comments on the draft plan in 2015. We held two public meetings to provide a broad overview of the project and findings. In 2018, EPA approved some elements of the TMDL plan and disapproved others. See our 2018 Letter to Stakeholders for details.

On August 10, 2020, EPA finalized the replacement of the TMDL elements that were disapproved. They were open for public comment until October 7, 2020 and can be found on EPA's Deschutes River TMDLs web page.

We are also continuing to work with the Department of Enterprise Services on the Deschutes Estuary Restoration Project, which will clean and restore Capitol Lake by returning the Deschutes Estuary to a tidal salt marsh habitat.

Why this matters

Water must be of high quality to support fish and wildlife.

Dissolved oxygen — oxygen dissolved in healthy water — is vital for the survival of fish and aquatic life. It is more difficult to transfer oxygen from water to blood than it is to transfer oxygen from air to blood. Therefore, it is critical that an adequate amount of oxygen is maintained in the water for this transfer to take place efficiently and sustain aquatic life. Oxygen is also necessary to help decompose organic matter in the water and bottom sediments as well as for other biological and chemical processes.

Fecal coliform is a type of bacteria common in human and animal waste. It can make people sick and cause the closure of shellfish harvesting beds. Bacteria can get into waters from untreated or partially treated discharges from wastewater treatment plants, from improperly functioning septic systems, and from livestock, pets, and wildlife.

People can help keep bacteria out of the water. Properly collect, bag, and trash dog poop. Check your on-site sewage system to make sure it is maintained and working properly. Use proper storage, management, and disposal practices for livestock manure.

pH is a measure of the acidity or alkalinity of the water. pH can affect the solubility of nutrients and metal compounds. By affecting the solubility of nutrients, it can change the amount of nutrients available for plant growth. If too many nutrients are available, aquatic plants can grow out of control. When these plants decompose, they can deplete the water of oxygen. The solubility of many metal compounds also changes greatly with pH. When more metals are dissolved in the water, aquatic animals may absorb them faster. Therefore, a lower pH may make these metals more toxic to aquatic life.

Water temperature influences what types of organisms can live in a water body. Cooler water holds more dissolved oxygen that fish and other aquatic life need to breathe. Warmer water holds less dissolved oxygen. Threatened and endangered salmon need cold, clean water to survive. Removing streamside vegetation tends to raise water temperature to a level that may be harmful to fish, other aquatic animals, and insects.

Finally, too much **sediment** in the water can irritate fish gills and make it difficult for them to breathe.

DEPARTMENT OF ECOLOGY State of Washington http://www.ecy.wa.gov

Publication Summary

Our Ecology website has changed, which can cause broken links.
To report these, please *contact us* with the publication and broken link.

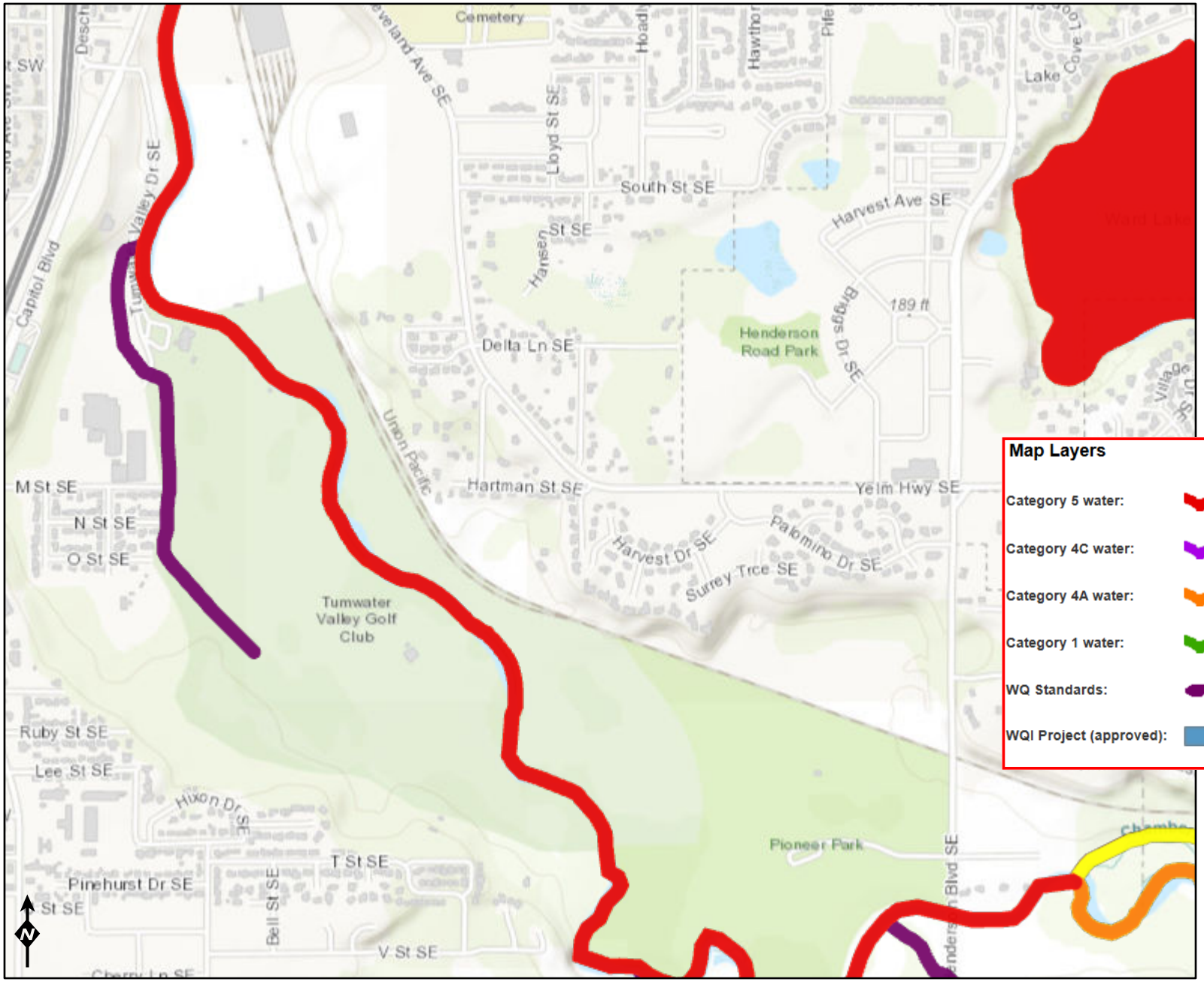
TITLE	**Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL: Water Quality Improvement Report and Implementation Plan**
	Publication number: 15-10-012 | Date Published: April 2015 | Date Revised: July 2018
VIEW NOW	Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL: Water Quality Improvement Report and Implementation Plan (Number of pages: 335) (Publication Size: 14292KB) Trouble viewing? Try these free options. • Get the latest Adobe Reader for PDFs. • For Excel or Word viewing get Open Office, Microsoft OneDrive, DropBox Basic or a mobile app at your favorite app store.
AUTHOR(S)	Wagner, Lydia, Bilhimer, Dustin
DESCRIPTION	Portions of the Deschutes River, Percival Creek, and Budd Inlet tributaries do not meet water quality standards and are on the Clean Water Act Section 303(d) list for one or more of the following parameters: fecal coliform bacteria, temperature, dissolved oxygen (DO), pH, or fine sediment. This Total Maximum Daily Load (TMDL) report sets the load and wasteload reductions needed to meet Washington State water quality standards, and describes implementation actions to achieve those reductions.
REQUEST A COPY	The mission of the Department of Ecology is to protect, preserve, and enhance Washington's environment. To help us meet that goal, please consider the environment before you print or request a copy. **ADA Accessibility** The Department of Ecology is committed to providing people with disabilities access to information and services by meeting or exceeding the requirements of the Americans with Disabilities Act (ADA), Section 504 and 508 of the Rehabilitation Act, and Washington State Policy #188. Visit Ecology's website for more information.

	• Water Quality Order Form
CONTACT	Leanne Weiss at 360-407-0243 or leanne.weiss@ecy.wa.gov
KEYWORDS	water quality improvement plan, Deschutes River, water cleanup plan, Total Maximum Daily Load
WEB PAGE	Deschutes River watershed area: Budd Inlet
WATERSHED	Water Resource Inventory Area 13 Deschutes
DATA	Environmental Information Management (EIM) #MROB0001
RELATED PUBLICATIONS	Title: Budd Inlet Total Maximum Daily Load for Dissolved Oxygen Deschutes River, Capitol Lake, and Budd Inlet Total Maximum Daily Load Study: Supplemental Modeling Scenarios Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Technical Report: Water Quality Study Findings Assessment of Surface Water / Groundwater Interactions and Associated Nutrient Fluxes in the Deschutes River and Percival Creek Watersheds, Thurston County Quality Assurance Project Plan: Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Study

Copyright © Washington State Department of Ecology. See https://ecology.wa.gov/About-us/Accountability-transparency/Our-website/Copyright-information.

February 27, 2026

Water Quality Atlas Map



Assessed Water/Sediment

Water
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Sediment
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Water Quality Standards

- All Standards

Map Layers

Category 5 water:	2 listings found
Category 4C water:	1 listing found
Category 4A water:	2 listings found
Category 1 water:	9 listings found
WQ Standards:	1 water quality standard found
WQI Project (approved):	Deschutes River, Percival Creek, and Budd Inlet Tributaries TMDL

Miles
0 0.1 0.2 0.4

Esri Community Maps Contributors, City of Olympia, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA,

https://apps.ecology.wa.gov/waterqualityatlas/wqa/map

Assessed Water/Sediment

Water

Category 5 - 303d

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 16722

Main Listing Information

Listing ID: 16722

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Bacteria - Fecal coliform

WQI Project: None

Designated Use: Recreation - Primary Contact

Current Category: 5

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value	Criterion 2	Aggregate 2	Calculated Value 2
2016	1	14	200 #col/100ml	Highest daily average	280	100 #col/100ml	Three-month geometric mean	137

Assessed Water/Sediment

Water

Category 5 - 303d

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 70194

Main Listing Information

Listing ID: 70194

Waterbody Name: DESCHUTES RIVER

Medium: Other

Parameter: Benthic Macroinvertebrates Bioassessments

WQI Project: None

Designated Use: Aquatic Life - General

Current Category: 5

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

sessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value	Fine Sediment Biotic Index Score	FSB Threshold	Hilsenhoff Biotic Index Score	HBI Threshold	Metals Tolerance Index Score	MTI Threshold
2012; 2015	3	3	65 (Puget Lowland)	Average BIBI score	56.7	46.2	89	4.84	>5.5	2.8	>4.0

Assessed Water/Sediment

Water

Category 4C

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 6195

Main Listing Information

Listing ID: 6195

Waterbody Name: DESCHUTES RIVER

Medium: Habitat

Parameter: Instream Flow

WQI Project: None

Designated Use: Aquatic Life - General

Current Category: 4C

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

See Basis Statement field.

Basis Statement

USGS flow data collected at RM 3.4 between 1990 and 1995 (submitted by Jeff Dickison on 2/27/96) are consistently below minimum flows established in WAC 173-513-030.

USGS and Thurston County flow data (submitted by Jeff Dickison on 2/27/96) show intensified peak flows likely due to silvicultural activities in the upper watershed (Thurston County, 1995).

The following references document characteristic uses: Squaxin Island Tribal data (submitted by Jeff Dickison on 2/27/96) show numbers of Coho salmon stock.

Baranski, 1996 SASSI Update shows that Coho are reclassified to depressed.

Remarks

This listing was on the 1998 303(d) list, but has been moved to the new Category 4C (impaired by a non-pollutant) based on EPA Guidance for preparing the 2004 Integrated Report.

Assessed Water/Sediment

Water

Category 4A

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 6576

Main Listing Information

Listing ID: 6576

Current Category: 4A

Waterbody Name: DESCHUTES RIVER

View Category History

Medium: Water

Parameter: Temperature

WQI Project: Deschutes River, Percival Creek and Budd Inlet Tributaries Multi-parameter TMDL

Designated Use: Aquatic Life - Salmonid Spawning, Rearing, and Migration

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

County: Thurston

Size: 4.855 Kilometers

WRIA: Deschutes

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	11	361	17.5 deg C	7-DADMax	19.71

Basis Statement

Location ID: 13A060 -- In 2010, between 1/1/2010 and 9/22/2010, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 26 of 265 days (10%); The maximum exceedance during this period was 18.74°C for the 7-day period centered on 8/15/2010; (External Data Source: Thurston County Health Database)

Location ID: 13A060 -- In 2009, between 10/10/2009 and 12/31/2009, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 0 of 83 days (0%); (External Data Source: Thurston County Health Database)

Location ID: 13A060 -- In 2008, between 7/14/2008 and 9/30/2008, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 14 of 79 days (18%); The maximum exceedance during this period was 18.46°C for the 7-day period centered on 8/15/2008; (External Data Source: Thurston County Health Database)

Assessed Water/Sediment

Water

Category 4A

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 10894

Main Listing Information

Listing ID: 10894

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Dissolved Oxygen

WQI Project: Deschutes River, Percival Creek and Budd Inlet Tributaries Multi-parameter TMDL

Designated Use: Aquatic Life - Salmonid Spawning, Rearing, and Migration

Current Category: 4A

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	12	8.0 mg/L	Daily Minimum	9.8

Basis Statement

HISTORICAL INFORMATION

Location ID [13A060] -- In 2005, 12 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-00.5] -- In 2004, 4 of 39 samples (10.3%) showed an excursion of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-02.7] -- In 2004, 24 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-00.5] -- In 2003, 9 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 10893

Main Listing Information

Listing ID: 10893

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Ammonia-N

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2016	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2015	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2014	0	9	Calculated	Toxic aquatic 4-day mean exceedance factor	
2013	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2012	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2011	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2010	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2009	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2008	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2007	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2006	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 53217

Main Listing Information

Listing ID: 53217

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Arsenic

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	190 ug/L	Toxic aquatic 4-day average	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 75944

Main Listing Information

Listing ID: 75944

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Silver

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 1-day exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 76380

Main Listing Information

Listing ID: 76380

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Lead

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 76689

Main Listing Information

Listing ID: 76689

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Chromium

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78277

Main Listing Information

Listing ID: 78277

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Copper

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060], [SRIW1301] -- In 2002, 5 of 5 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment
Water
Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78486

Main Listing Information

Listing ID: 78486
Waterbody Name: DESCHUTES RIVER
Medium: Water
Parameter: Zinc
WQI Project: None
Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001
Size: 4.855 Kilometers
Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston
WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060], [SRIW1301] -- In 2002, 5 of 5 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78873

Main Listing Information

Listing ID: 78873

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Nickel

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 79301

Main Listing Information

Listing ID: 79301

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Cadmium

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

DEPARTMENT OF ECOLOGY State of Washington

Water Quality Atlas Standards

Home

Water Quality Standards for Surface Waters of the State of Washington

Disclaimer: The Department of Ecology continues to improve the mapped depiction of the Surface Water Quality Standards. However, the map may contain errors and the information displayed does not replace the official rules available in Chapter 173-201A of the Washington Administrative Code.

USE DESIGNATIONS

WAC:	173-201A-600 (1)
Description:	All surface waters of the state not named in Table 602 are to be protected for the designated uses of: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.
Aquatic life use:	Salmonid spawning, rearing, and migration
Recreation use:	Primary contact recreation
Water supply uses:	Domestic, Industrial, Agricultural, Stock
Miscellaneous uses:	Wildlife Habitat, Harvesting, Commerce and Navigation, Boating, Aesthetics

CRITERION

Brackish Water Exceptions: None

Temperature: 17.5°C (63.5°F)

Supplemental spawning: None

Dissolved Oxygen (DO): 8.0 mg/L

pH: pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.5 units

Turbidity: 5 NTU over background when the background is 50 NTU or less; or

A 10 percent increase in turbidity when the background turbidity is more than 50 NTU

Bacteria: E. coli and fecal coliform criteria are expressed as colony forming units (CFU) or most probable number (MPN).

To protect recreational use:

- E.coli organism levels must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples(or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 320 CFU or MPN per 100 mL.
- Fecal coliform organism levels must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples(or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 CFU or MPN per 100 mL. (The use of fecal coliform organism levels to determine compliance will expire December 31, 2020.)

Other requirements:

- A minimum of three samples is required to calculate a geometric mean for comparison to the geometric mean criteria. Sample collection dates shall be well distributed throughout the averaging period so as not to mask noncompliance periods.
- When averaging bacteria sample values for comparison to the geometric mean criteria, it is preferable to average by season. The averaging period of bacteria sample data shall be ninety days or less.

Exhibit 3B – NRCS Soil Report

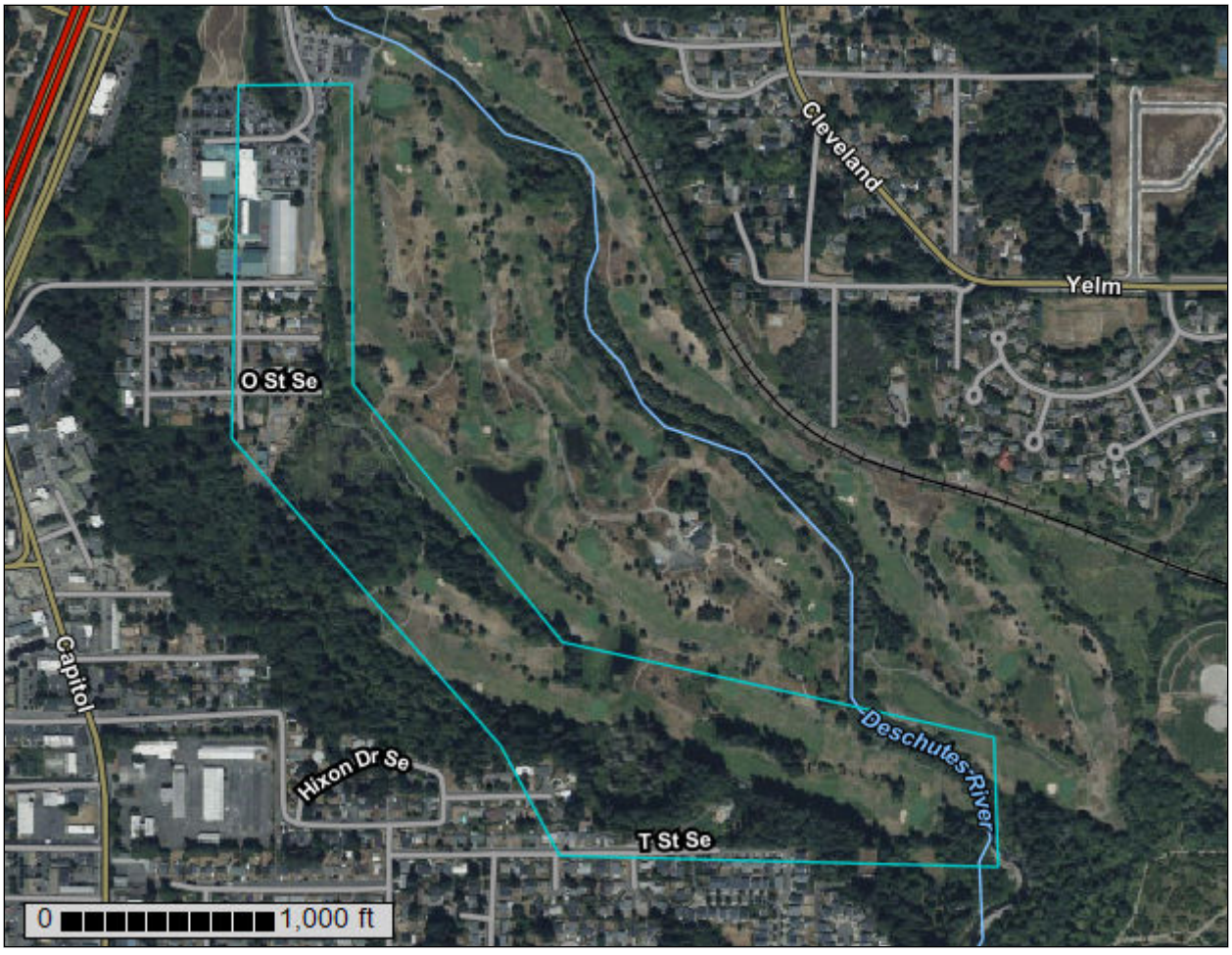
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Thurston County Area, Washington



December 26, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Thurston County Area, Washington.....13
20—Cagey loamy sand.....13
33—Everett very gravelly sandy loam, 8 to 15 percent slopes.....14
46—Indianola loamy sand, 0 to 5 percent slopes.....15
48—Indianola loamy sand, 15 to 30 percent slopes.....17
76—Norma silt loam.....18
89—Puyallup silt loam.....19
125—Xerorthents, 0 to 5 percent slopes.....21
129—Water.....21
References.....23

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Custom Soil Resource Report
Soil Map



Map Scale: 1:8,480 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Thurston County Area, Washington
Survey Area Data: Version 19, Aug 28, 2025

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

Date(s) aerial images were photographed: May 26, 2023—Aug 14, 2023

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
20	Cagey loamy sand	1.8	2.2%
33	Everett very gravelly sandy loam, 8 to 15 percent slopes	7.0	8.5%
46	Indianola loamy sand, 0 to 5 percent slopes	8.3	10.0%
48	Indianola loamy sand, 15 to 30 percent slopes	4.9	5.9%
76	Norma silt loam	25.5	30.9%
89	Puyallup silt loam	14.0	16.9%
125	Xerorthents, 0 to 5 percent slopes	17.4	21.0%
129	Water	3.8	4.6%
Totals for Area of Interest		**82.6**	**100.0%**

Map Unit Descriptions

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

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

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

mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

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

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

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

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

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

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

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

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

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

Thurston County Area, Washington

20—Cagey loamy sand

Map Unit Setting

National map unit symbol: 2nd8d
Elevation: 330 to 980 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 165 to 195 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Cagey

Setting

Landform: Terraces
Parent material: Sandy glacial drift

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 28 inches: loamy sand
H3 - 28 to 60 inches: fine sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A
Ecological site: F002XA005WA - Puget Lowlands Moist Forest
Forage suitability group: Seasonally Wet Soils (G002XS201WA)
Other vegetative classification: Seasonally Wet Soils (G002XS201WA)
Hydric soil rating: No

Minor Components

Mckenna

Percent of map unit: 5 percent
Landform: Depressions
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

33—Everett very gravelly sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t62b
Elevation: 30 to 900 feet
Mean annual precipitation: 35 to 91 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 180 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Everett and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Everett

Setting

Landform: Moraines, eskers, kames
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Base slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly glacial outwash

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: very gravelly sandy loam
Bw - 3 to 24 inches: very gravelly sandy loam
C1 - 24 to 35 inches: very gravelly loamy sand
C2 - 35 to 60 inches: extremely cobbly coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F002XA004WA - Puget Lowlands Forest
Forage suitability group: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XF403WA)

Other vegetative classification: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XF403WA)
Hydric soil rating: No

Minor Components

Alderwood
Percent of map unit: 10 percent
Landform: Hills, ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope, talf
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Indianola
Percent of map unit: 10 percent
Landform: Terraces, kames, eskers
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

46—Indianola loamy sand, 0 to 5 percent slopes

Map Unit Setting
National map unit symbol: 2t62k
Elevation: 0 to 980 feet
Mean annual precipitation: 30 to 81 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Indianola and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Indianola

Setting
Landform: Kames, terraces, eskers
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glacial outwash

Typical profile
Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: loamy sand
Bw1 - 6 to 17 inches: loamy sand

Bw2 - 17 to 27 inches: sand
BC - 27 to 37 inches: sand
C - 37 to 60 inches: sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F002XA004WA - Puget Lowlands Forest
Forage suitability group: Droughty Soils (G002XF403WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XS401WA), Droughty Soils (G002XV402WA)
Other vegetative classification: Droughty Soils (G002XF403WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XS401WA), Droughty Soils (G002XV402WA)
Hydric soil rating: No

Minor Components

Alderwood

Percent of map unit: 5 percent
Landform: Ridges, hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest, talf
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Everett

Percent of map unit: 5 percent
Landform: Eskers, moraines, kames
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

48—Indianola loamy sand, 15 to 30 percent slopes

Map Unit Setting

National map unit symbol: 2t639
Elevation: 0 to 980 feet
Mean annual precipitation: 30 to 81 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Indianola and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Indianola

Setting

Landform: Terraces, kames, eskers
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glacial outwash

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: loamy sand
Bw1 - 6 to 17 inches: loamy sand
Bw2 - 17 to 27 inches: sand
BC - 27 to 37 inches: sand
C - 37 to 60 inches: sand

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F002XA004WA - Puget Lowlands Forest

Forage suitability group: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA)
Other vegetative classification: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA)
Hydric soil rating: No

Minor Components

Alderwood
Percent of map unit: 8 percent
Landform: Hills, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope, side slope, talf
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Everett
Percent of map unit: 5 percent
Landform: Moraines, eskers, kames
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma
Percent of map unit: 2 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

76—Norma silt loam

Map Unit Setting
National map unit symbol: 2ndcc
Elevation: 0 to 1,000 feet
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Norma, silt loam, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Norma, Silt Loam

Setting

Landform: Depressions, drainageways
Parent material: Alluvium

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F002XA007WA - Puget Lowlands Wet Hemlock Forest
Forage suitability group: Wet Soils (G002XS101WA)
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

Minor Components

Norma, fine sandy loam

Percent of map unit: 5 percent
Landform: Depressions
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

Alderwood

Percent of map unit: 5 percent
Hydric soil rating: No

89—Puyallup silt loam

Map Unit Setting

National map unit symbol: 2nd9z
Elevation: 70 to 1,970 feet
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 170 to 200 days

Farmland classification: All areas are prime farmland

Map Unit Composition

Puyallup and similar soils: 85 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Puyallup

Setting

Landform: Terraces, flood plains
Parent material: Alluvium

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 19 inches: fine sandy loam
H3 - 19 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 14 to 20 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B
Ecological site: F002XA008WA - Puget Lowlands Riparian Forest
Forage suitability group: Droughty Soils (G002XS401WA)
Other vegetative classification: Droughty Soils (G002XS401WA)
Hydric soil rating: No

Minor Components

Newberg

Percent of map unit: 5 percent
Hydric soil rating: No

Semiahmoo, undrained

Percent of map unit: 3 percent
Landform: Depressions
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

Sultan

Percent of map unit: 2 percent
Hydric soil rating: No

125—Xerorthents, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2nd87
Elevation: 0 to 2,620 feet
Mean annual precipitation: 30 to 60 inches
Mean annual air temperature: 39 to 50 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Xerorthents and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerorthents

Setting

Landform: Tidal flats
Parent material: Sandy and loamy cut and fill material

Typical profile

H1 - 0 to 60 inches: variable

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Depth to water table: About 24 inches
Frequency of flooding: None
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydric soil rating: No

129—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Setting

Landform: Alluvial cones

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Exhibit 3C – Draft Geotechnical Report

TO: Patrick Holm, PE, Principal, SCJ Alliance

FROM: Calvin McCaughan, PE, and Lance Levine, PE

DATE: March 10, 2026

RE: Summary of Geotechnical Engineering Services
Tumwater Deschutes Valley Trail
Segment C and Deschutes Valley Park Spur
Tumwater, Washington
SCJ Project No. 25-000313, Phase 03
Sage Project No. 027019

INTRODUCTION

This memorandum summarizes the results of geotechnical engineering services provided by Sage Geotechnical, LLC (Sage), in support of the Deschutes Valley Trail project in Tumwater, Washington (site). The conclusions and recommendations herein apply specifically to Segment C and the Deschutes Valley Park Spur. Services were provided in accordance with the scope outlined in the October 7, 2025, subconsultant agreement between Sage and SCJ Alliance (civil engineer).

PROJECT UNDERSTANDING

Segment C of the City of Tumwater's (project owner) proposed Deschutes Valley Trail system will include an approximately 10-foot (ft)-wide pathway surfaced with asphalt concrete pavement. A fence canopy will be installed along the majority of the trail segment.

Much of the trail segment will wrap along the southern and western boundaries of the Tumwater Valley Golf Club, sharing an alignment with an existing cart path (Figure 1). Along the shared alignment (shared-use path), the total width of the trail will increase to approximately 20 ft.

The trail spur will branch off the southern portion of Segment C and climb a steep slope between the Tumwater Valley Golf Club and Deschutes Valley Park. Cut-and-fill grading will be required to achieve the proposed trail grade. The area that will require the largest cuts and fills is shown on Figure 5; with the exception of a few local low points, other portions of the trail will match existing grades.

A small pedestrian bridge will be constructed over the Palermo Waterway crossing (Bridge 1). Bridge 1 will be designed and constructed in general accordance with the seismic design requirements for single-span bridges in the *AASHTO* (American Association of State Highway and Transportation Officials) *LRFD* (Load and Resistance Factor Design) *Bridge Design*

Specifications (2024). Per AASHTO's simplified seismic design approach and Sage's discussions with the City of Tumwater, seismically induced bridge and abutment damage is acceptable, and the bridge may need to be rebuilt following a seismic event.

Sage understands that the trail will be designed and constructed in accordance with the shared-use path criteria in the Washington State Department of Transportation's (WSDOT) *Design Manual* (2024). Sage's geotechnical recommendations conform to the appropriate WSDOT standards.

SURFACE CONDITIONS

Trail Segment C runs along the southern and western boundaries of the Tumwater Valley Golf Club and is surfaced with grass and asphalt concrete pavement. Portions of the trail segment pass through wooded areas.

The trail spur climbs a steep slope between the Tumwater Valley Golf Club and Deschutes Valley Park. This area is vegetated with coniferous trees that have reached maturation and with younger deciduous trees and brush. The slope is inclined between 25 and 30 degrees. Sage reconnoitered the slope and did not observe any indicators of instability, e.g., pistol-butted trees, landslide scarps, groundwater seepage, sloughing, or erosion. Additional details about the slope reconnaissance are provided in Attachment 1.

Wet Surface Conditions

A portion of trail Segment C will wrap along the southern and western boundaries of the golf club. Of this portion, approximately 80 percent[1] is too water saturated between November and April to support minor vehicle traffic, i.e., traffic from golf carts and mowing equipment.

Cart Path Conditions

The cart path was constructed in 1998 and consists of 0.17 ft of Class B asphalt concrete pavement and 0.50 ft of crushed surfacing base course (CSBC) over soil stabilization fabric.

GEOLOGIC REVIEW

Geologic information for the site and the surrounding area was obtained from the *Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington* (Walsh et al. 2003). Elevated portions of the site (Deschutes Valley Park Spur and vicinity) are underlain by Vashon-age recessional outwash, a unit that consists of sand, silt, gravel, and cobbles deposited during the Holocene glacial retreat. The valley is underlain by a thin veneer of alluvium, a unit that consists of silt, sand, and gravel deposited by the Deschutes River.

[1] This percentage does not include the existing cart path or an elevated area near Hole #14.

The subsurface conditions observed in Sage's explorations were generally consistent with the mapped geology; however, fill material, placed during construction of the Tumwater Valley Golf Club, was also observed in the explorations. Sage interprets the majority of the soils encountered in the valley to be recessional outwash rather than alluvium.

Critical areas are addressed in Attachment 1.

SUBSURFACE EXPLORATIONS

In November 2025 and January 2026, Sage's drilling subcontractor advanced ten geotechnical borings along the proposed trail/spur alignment. The boreholes extended 16.5 ft to 101.5 ft below ground surface (bgs). Groundwater monitoring wells were constructed in borings SB-6W and SB-13W. Summary boring logs are provided in Attachment 2.

Between 2012 and 2014, others explored subsurface conditions along the proposed alignment; copies of their exploration logs are provided in Attachment 3.

The locations of all explorations—current and historical—are shown on Figures 2 through 4.

Subsurface Soil Conditions

The materials encountered in the current and historical explorations were categorized as follows:

- **Pavement Section:** Explorations advanced along the edges of existing pavement sections encountered CSBC with occasional cobbles. Filter fabric was observed in low areas that are expected to be seasonally saturated.
- **Sod/Topsoil:** Explorations encountered a layer of sod over organic topsoil. The sod/topsoil layer was generally 0.15 to 2.0 ft thick.
- **Forest Duff:** Explorations in forested areas with limited ground cover encountered a layer of forest duff that included pine needles, leaf matter, roots, and other organics. The forest duff layer was generally 0.7 to 1.4 ft thick.
- **Fill:** Fill was encountered along the existing cart path and in other developed areas of the proposed trail alignment. The fill typically consisted of loose to medium dense, silty sand or of sand with silt and variable gravel and organic content. The fill layer was generally 1.0 to 10.0 ft thick.
- **Marsh Deposits:** Explorations encountered marsh deposits that typically consisted of loose, silty sand or of soft silt with sand and variable organic content. Sage interprets this material to derive from historical wetlands and/or floodplains that have since been infilled. The layer of marsh deposits was generally 1.5 to 4.2 ft.
- **Alluvium:** Alluvium was encountered in one exploration, historical hand auger boring HA-17. The alluvium extended from 2 to 5.1 ft bgs and consisted of medium dense, silty sand.

- **Recessional Outwash:** Explorations encountered recessional outwash that typically consisted of medium dense to dense[2] sand with variable silt and gravel content or of medium dense to dense gravel with silt and sand. Where observed, the recessional outwash extended to the maximum depth explored.

Groundwater Conditions – Lowland

A shallow water table was encountered in most of the explorations advanced in the valley, with groundwater levels ranging from 1.1 to 9.0 ft bgs.

Previous grading activities have created a complex groundwater system, in which trapped groundwater perches along the southern and western boundaries of the golf club.

Groundwater levels are likely influenced by perched irrigation water and the surface elevation of the nearby Deschutes River. Sage anticipates that groundwater levels will fluctuate seasonally, with the water table rising within 2 ft of ground surface during the wet season (mid-October to late April).

Groundwater Conditions – Upland

A deeper groundwater table was encountered in the upland portion of the site, along the Deschutes Valley Park Spur. Groundwater levels at the crest of the steep slope ranged from approximately 50 to 60 ft bgs,[3] while groundwater levels at the toe of the slope ranged from 12 to 15 ft bgs.[4]

Sage is collecting groundwater monitoring data using the wells installed in borings SB-6W and SB-13W. The final memorandum will be updated to include the additional groundwater data.

Seismic Survey

Global Geophysics, LLC, completed microtremor array measurement and multichannel analysis of surface waves (MASW) surveys of Bridge 1. A copy of the survey report is provided in Attachment 4.

Laboratory Testing

During the November 2025 and January 2026 field investigations, representative soil samples were collected from the boreholes and transported to Sage's geotechnical laboratory for further examination and testing. Test results are provided in Attachment 2.

The results of historical laboratory tests completed by others are provided in Attachment 3.

[2] With occasional loose layers.
[3] Approximate ground elevation 165 ft; groundwater elevation 115 to 105 ft (Figure 5).
[4] Approximate ground elevation 122 ft; groundwater elevation 110 to 107 ft (Figure 5).

CONCLUSIONS AND RECOMMENDATIONS

The soil conditions observed in the current and historical explorations are suitable for the proposed improvements. Sage does not anticipate any major design challenges related to site soils.

A shallow water table was observed in the valley; still, the cart path is located in the same general area and has performed well for more than 25 years.

Civil Design Input

The civil engineer may use the geotechnical design recommendations in the following sections to prepare the project plans and specifications.

Deschutes Valley Park Spur Cut-and-Fill Slopes

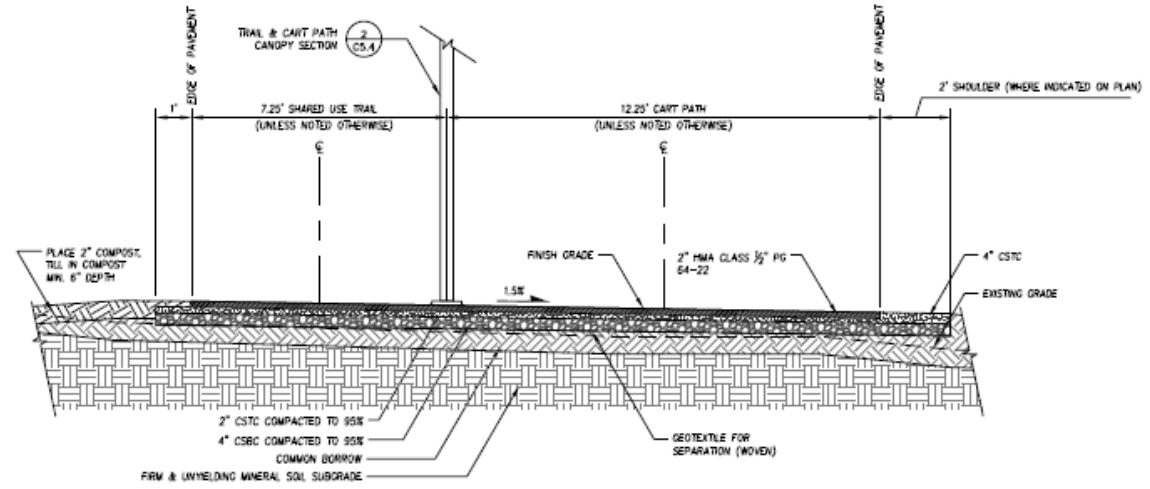
Sage recommends establishing 2 horizontal to 1 vertical (2H:1V) permanent slopes along the trail spur. To prevent erosion, the slopes should be covered with an 18-inch-thick layer of armor rock. Armor rock specifications and thickness will be updated in the final memorandum. Additional details are provided in Attachment 1.

Embankment Settlement

Provided that embankment fill is placed and compacted in accordance with the recommendations herein, Sage estimates that embankments will experience less than 2 inches of settlement. Settlement along the majority of the proposed trail alignment should be complete within about 2 weeks of embankment construction.

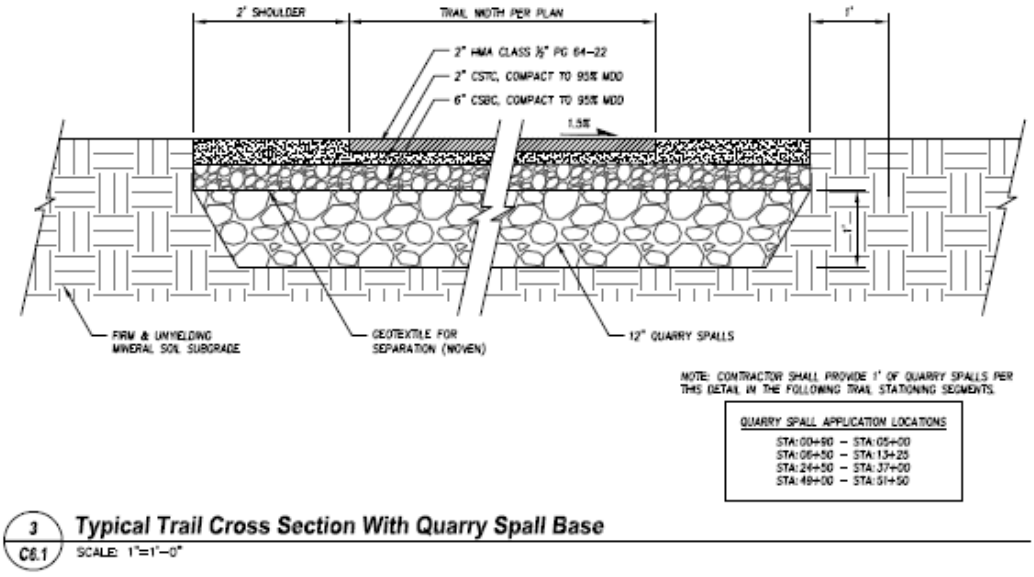
Pavement Design

WSDOT does not provide design criteria for a minimum pavement section for shared-use paths. The preliminary design drawings include a typical pavement section.



2 C6.1 **Typical Trail & Cart Path Cross Section**
SCALE: ½"=1'–0"

Areas of the proposed trail alignment are known to be underlain by wet or soft soils, the result of local drainage patterns. The pavement section for these areas includes an improved quarry spall subbase.



3 C8.1 **Typical Trail Cross Section With Quarry Spall Base**
SCALE: 1"=1'–0"

Sage concludes that the proposed pavement sections included in the preliminary design drawings are adequate for the proposed trail and shared-use path. Pavement design assumptions will be revisited during final design.

Stormwater Design

Stormwater infiltration facilities will be installed at the intersection of the Deschutes Valley Park Spur and trail Segment C. The intersection sits approximately 10 ft above the valley floor and is underlain by recessional outwash deposits. In Sage's opinion, stormwater in the area can be infiltrated using the preliminary rates provided in Table 1.

Table 1. Factored Infiltration Rates

Exploration	Depth Interval (ft)	Factored Infiltration (in/hr)	Soil Type	Depth to Groundwater (ft)
SB-06W	1.0–15.0	16.1	SP	14.26
SB-09	0.5–2.5	3.4	SP-SM	7.38
	2.5–5.5	0.1	ML	
	5.5–10.0	0.7	SM	

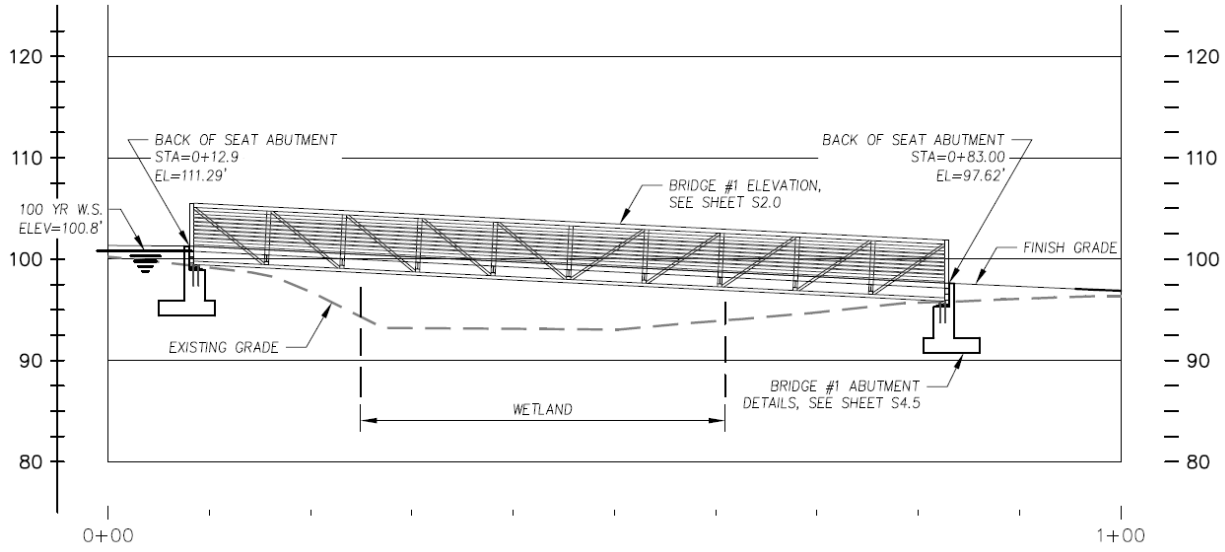
Exploration	Depth Interval (ft)	Factored Infiltration (in/hr)	Soil Type	Depth to Groundwater (ft)
SB-10	0.5–5.5	12.7	SP	8.31
	5.0–5.5	0.7	SM	
	5.5–6.5	0.1	ML	

ft = foot/feet
in/hr = inches per hour

The stormwater infiltration rates in Table 1 were developed in accordance with the grain size methods in the City of Tumwater's 2022 *Drainage Design and Erosion Control Manual*. During final design, the infiltration rates may be updated to account for the results of pilot infiltration tests or shape modification factors.

Structural Design Input

Bridge 1 should be supported on driven piles to limit excavation and dewatering quantities in an area of environmental concern.[5] Although the bridge layout has not been finalized, the preliminary design drawings indicate that the ends of the bridge will sit at different grades.



Pile Foundation Design

Sage evaluated the axial capacity of driven steel pipe piles in general accordance with the methods described in the *AASHTO LRFD Bridge Design Specifications* (2024). The

[5] The proposed bridge location is adjacent to a lagoon associated with the Palermo Wellfield Superfund Site.

Nordlund/Thurman method was used to estimate the axial pile capacity; recommendations are provided on the diagrams below.

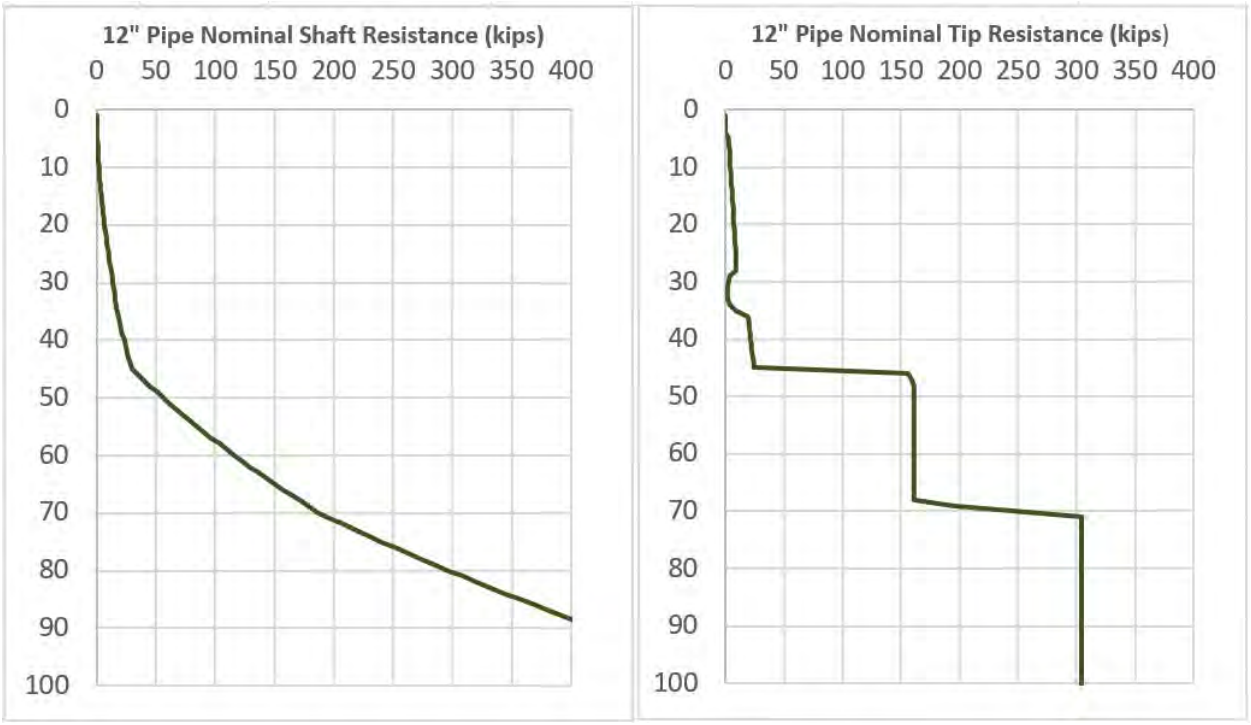


Diagram 1. Axial Resistance of 12-inch-diameter Driven Pipe Piles

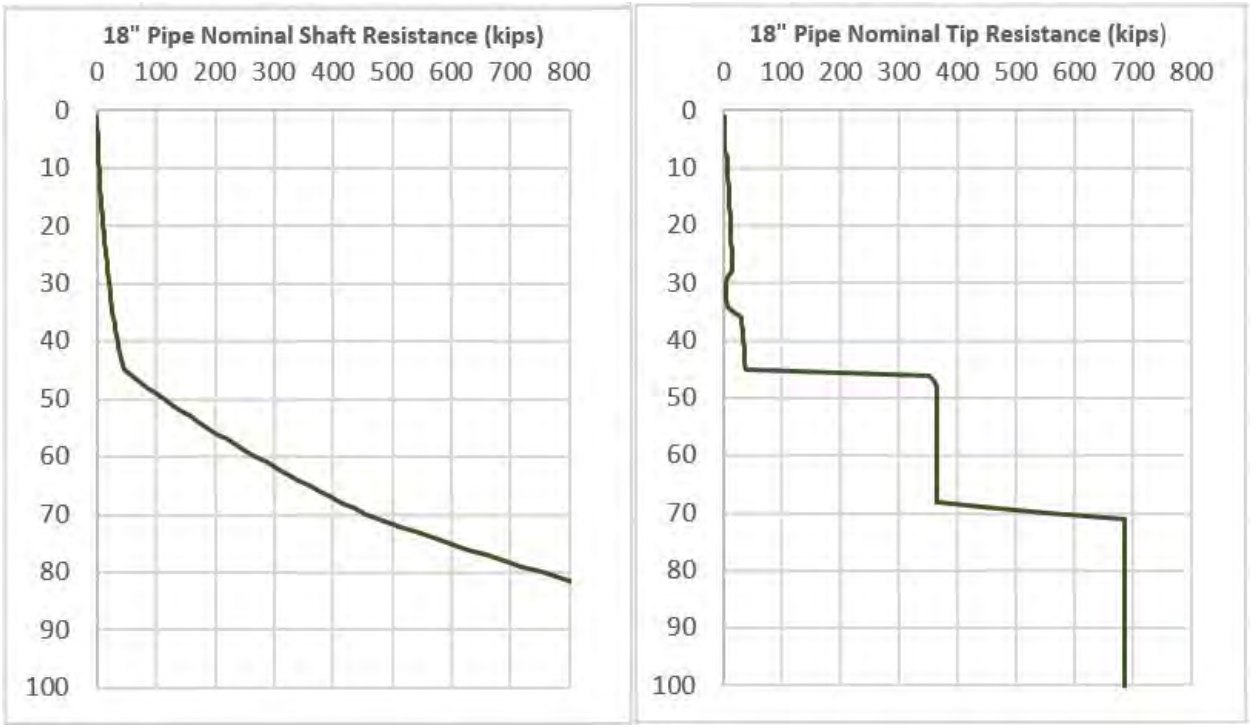


Diagram 2. Axial Resistance of 18-inch-diameter Driven Pipe Piles

The nominal bearing capacity is the sum of the shaft and tip resistances shown on Diagrams 1 and 2. Uplift resistance should be calculated using the shaft resistance diagrams only. The following resistance factors (RFs) should be applied in accordance with the *AASHTO LRFD Bridge Design Specifications* (2024):

- Nominal bearing of single piles (shaft and tip), RF = 0.45.
- Uplift resistance of single piles (shaft), RF = 0.35.
- Group uplift, RF = 0.5.

Lateral Design Parameters

The p-y springs in Table 2 should be used to design deep foundations.

Table 2. P-Y Springs for Deep Foundation Design

Elevation Range	P-Y Spring Model	Model Parameters
95–65 ft	Reese (Sand)	γ' = 62 pcf, φ = 32°, k = 25 pci
65–60 ft	Reese (Sand)	γ' = 43 pcf, φ = 28°, k = 15 pci
60–25 ft	Reese (Sand)	γ' = 67 pcf, φ = 34°, k = 50 pci
25–0 ft	Reese (Sand)	γ' = 73 pcf, φ = 36°, k = 75 pci

Reese, L.C., W.R. Cox, and F.D. Koop. 1974. “Analysis of Laterally Loaded Piles in Sand.” Offshore Technology in Civil Engineering Hall of Fame Papers from the Early Years. 95–10.5
φ = soil friction angle
ft = foot/feet
k = spring modulus
pcf = pounds per cubic foot
pci = pounds per cubic inch
γ' = effective unit weight

For piles spaced less than three diameters apart, P-multipliers should be used in accordance with the requirements in Section 8.12.2.3 of the *Geotechnical Design Manual* (WSDOT 2022). Lateral resistance can be provided by passive resistance acting along the opposite abutment, in accordance with Section 4.2.11.2.3 of the *Bridge Design Manual* (WSDOT 2025).

Abutment Wall Design

The soil parameters in Table 3 should be used to design the abutment walls for Bridge 1.

Table 3. Abutment Wall Design Parameters

Parameter	Value	
	Level Backslope	3H:1V Backslope
Backfill soil unit weight (pcf)	125	
Backfill soil submerged unit weight (pcf)	63	
Backfill soil internal angle of friction (degrees)	36	
Foundation soil internal angle of friction (degrees)	32	
Active earth pressure coefficient (K_a)	0.30	0.39
At-rest earth pressure coefficient (K_0)	0.48	0.57
Passive pressure coefficient (K_p)	3.85	
Ultimate coefficient of sliding	Cast-in-place: 0.57 Precast: 0.46	

H:V = horizontal to vertical
pcf = pounds per cubic foot

Pole Foundations

Pole foundations for the fence canopy may be designed using an average allowable soil bearing pressure of 1,500 pounds per square foot and a soil friction angle of 32 degrees. These recommendations are based on the average N-values collected across trail Segment C. Additional information is provided in Section 17.2.1 of the *Geotechnical Design Manual* (WSDOT 2022).

Structural Earth Walls

A final layout will be required to complete geotechnical design of the structural earth wall. The following information for typical lowland walls is included as a placeholder.

(January 3, 2011)
The following geotechnical design parameters shall be used for the design of the structural earth wall(s):

Wall Name or No.: Seg C Typical

Soil Properties	Wall Backfill	Retained Soil	Foundation Soil
Unit Weight (pcf)	135	125	125
Friction Angle (deg)	36	32	32
Cohesion (psf)	0	0	0

For the Service Limit State, the wall shall be designed to accommodate a differential settlement of 2 inches per 100 feet of wall length.

For the Extreme Event I Limit State, the wall shall be designed for a horizontal seismic acceleration coefficient k_h of 0.3 g and a vertical seismic acceleration coefficient k_v of 0.0 g.

Seismic Design

Sage understands that seismic design will be completed in accordance with the *AASHTO LRFD Bridge Design Specifications* (2024). Sage recommends using seismic Site Class D/E to develop the design response spectrum, in accordance with the results of the MASW survey. Seismic design parameters are provided in Attachment 4.

Earthwork Construction

The following key points should be considered when developing project plans and specifications:

- **Wet weather earthwork:** Site soils are moisture sensitive, and a shallow water table was encountered in the valley/lowlands of the site. To the extent possible, earthwork activities should be completed during the dry season. The golf club should pause or otherwise limit irrigation in areas adjacent to active construction.

  Disturbance of near-surface soils and increased construction costs should be expected if earthwork is completed during periods of wet weather.

- **Stripping:** Sod, topsoil, forest duff, vegetation, and other organics should be stripped from areas designated for development. Stripped soils are not suitable for reuse as structural fill.

- **Temporary excavations:** Temporary excavations should be completed in accordance with the requirements in Section 3-03 of WSDOT's 2026 *Standard Specifications for Road, Bridge, and Municipal Construction* (hereinafter, *2026 WSDOT Standard Specifications*). The contractor should be responsible for actual excavation configurations and the maintenance of safe working conditions, including temporary excavation stability.

  Temporary excavations in excess of 4 ft should be shored or sloped in accordance with the requirements in Safety Standards for Construction Work, Part N (Chapter 296-155 of the Washington Administrative Code). Type C soil is likely to be exposed in the excavation sidewalls. The maximum allowable excavation inclination in Type C soils is 1.5H:1V.

- **Dewatering:** Groundwater seepage and surface water encountered during construction should be managed with sumps, pumps, cutoff walls, and/or diversion systems. The contractor should select, design, and implement the dewatering system(s).

- **Subgrade preparation:** The subgrade should be scarified; moisture-conditioned; and compacted to a firm, unyielding condition. The prepared subgrade should be proof rolled in the presence of a qualified geotechnical engineer, who is familiar with the site and can check for soft/disturbed areas. Areas of limited access can be evaluated with a steel T-probe. If probing or proof-rolling reveals loose and/or disturbed subgrades, additional moisture conditioning and compaction should be completed to produce a firm, unyielding subgrade. Alternatively, unsuitable subgrade soils can be overexcavated and replaced with compacted structural fill or quarry spalls.

- **Hillside terrace:** Before rock armor is placed, subgrades along the 2H:1V cut-and-fill embankment slopes shall be prepared in accordance with the requirements for hillside terrace in Section 3-03.3(14) of the *2026 WSDOT Standard Specifications.*
- **Reuse of site soil:** The topsoil/sod, forest duff, and marsh deposit soils should not be reused as structural fill. All other materials encountered in the explorations may be considered for reuse as structural fill; such materials should only be reused during periods of dry weather.

  Recessional outwash sands and gravels will likely be used to construct the fill embankments along the Deschutes Valley Park Spur.
- **Import structural fill:** The following are suitable sources of import structural fill so long as they conform to the requirements in the *2026 WSDOT Standard Specifications:*
  - Gravel Borrow per Standard 9-03.14(1) – for use in sitewide earthwork.
  - Gravel Backfill for Walls per Standard 9-03.12(2) – for backfill of bridge abutment walls.
  - Gravel Borrow for Structural Earth Walls per Standard 9-03.14(4) – for backfill of structural earth walls.
  - Crushed Surfacing per Standard 9-03.9(3) – for pavement base course.
  - Quarry Spalls per Standard 9-13.1(5) – for armor rock placed on cut-and-fill slopes and for improvement of pavement subbase.
  - Foundation Material Class B per Standard 9-03.17 – for foundation improvement beneath walls, where required.
  - Rock for Erosion and Scour Protection, Class A per Standard 9-13.4(2) – alternate rock armor material for cut-and-fill slopes.
- **Fill placement and compaction:** Structural fill should be placed on approved subgrades and compacted in accordance with the requirements in Section 3-03.3(14)C of the *2026 WSDOT Standard Specifications.* Method B should be used for embankment construction. Method A should be used within the limits of structure excavations.
- **Embankments:** Trail embankments should be constructed in accordance with the requirements in Section 3-03 of the *2026 WSDOT Standard Specifications.* Sage recommends a maximum allowable inclination of 2H:1V and long-term erosion protection, e.g., armor or vegetation, for permanent slopes.
- **Pile driving:** Pile driving should be performed in accordance with the requirements in Section 6-05 of the *2026 WSDOT Standard Specifications.* The pile-driving hammer should have a rated energy that meets the requirements in Section 6-05.3(9)B. Driving criteria can be determined in accordance with the formula in Section 6-05.3(12). The criteria should be applied in end-of-driving conditions only; they are not appropriate for use after pile setup.

USE OF THIS TECHNICAL MEMORANDUM

Sage Geotechnical, LLC, has prepared this technical memorandum for the exclusive use of SCJ Alliance, the City of Tumwater, and their authorized representatives for specific application to the Tumwater Deschutes Valley Trail project (Segment C and the Deschutes Valley Spur) in Tumwater, Washington. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Sage Geotechnical. Reuse of the information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Sage Geotechnical, shall be at the user's sole risk.

Sage Geotechnical warrants that, within the limitations of scope, schedule, and budget, its services have been provided in a manner consistent with that level of skill and care ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. Sage Geotechnical makes no other warranty, either express or implied.

CLOSING

We trust that this memorandum provides you with the information needed to proceed with the project. If you have questions or comments, or if we can be of further service, please contact Calvin McCaughan at calvinm@sagegeotechnical.com.

SAGE GEOTECHNICAL, LLC

Calvin McCaughan, PE
Principal Engineer

Lance Levine, PE
Senior Engineer

CAM/LGL/MCS
[HTTPS://SAGEGEOTECHNICAL.SHAREPOINT.COM/SITES/SAGEGEOTECHNICAL/SHARED DOCUMENTS/PROJECTS/027 SCJ ALLIANCE/019 DESCHUTES VALLEY TRAIL/R/SEG C/DVT (SEG C AND DVP SPUR) DRAFT TECHNICAL MEMORANDUM 3.10.2026.DOCX]

Attachments: Figure 1. Vicinity Map
Figures 2–4. Site and Exploration Location Plans
Figure 5. DVP Spur Proposed Grading
Attachment 1. Critical Areas Assessment
Attachment 2. 2026 Subsurface and Laboratory Data
Attachment 3. Historical Subsurface and Laboratory Data
Attachment 4. Seismic Design Parameters and Survey Results

REFERENCES

AASHTO. 2024. *AASHTO LRFD Bridge Design Specifications.* 10th Edition. American Association of State Highway and Transportation Officials.

ASTM. 2023. Annual Book of ASTM Standards. In: *Soil and Rock (I).* West Conshohocken, PA: ASTM International.

City of Tumwater. 2022. *Drainage Design and Erosion Control Manual.* July.

LNI. 2025. Construction Work. Chapter 296-155 WAC; Part N. Excavation, Trenching, and Shoring. Washington State Department of Labor and Industries. Last updated September 5.

Reese, L.C., W.R. Cox, and F.D. Koop. 1974. "Analysis of Laterally Loaded Piles in Sand." Offshore Technology in Civil Engineering Hall of Fame Papers from the Early Years. 95–10.5.

Walsh, T.J., R.L. Logan, H.W. Schasse, and M. Polenz. 2003. *Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington.* Open File Report 2003-25. Washington State Department of Natural Resources. Division of Geology and Earth Resources.

WSDOT. 2024. *M 22-01.23: Design Manual.* Washington State Department of Transportation. Engineering and Regional Operations Division. Development Division, Design Office. September.

WSDOT. 2025. *M 23-50.24: Bridge Design Manual.* Washington State Department of Transportation. Engineering and Regional Operations Division. Bridge and Structures Office. June.

WSDOT. 2025. *M 41:10: Standard Specifications for Road, Bridge, and Municipal Construction.* 2026 Edition. Washington State Department of Transportation. Engineering and Regional Operations Division. Construction Administration Office.

WSDOT. 2022. *M 46-03: Geotechnical Design Manual.* Washington State Department of Transportation. Engineering and Regional Operations Division. Materials Laboratory. February.



Source: ESRI 2025

Vicinity Map

Deschutes Valley Trail - Segment C and DVP Spur

Tumwater, Washington

Figure 1

SAGE GEOTECHNICAL



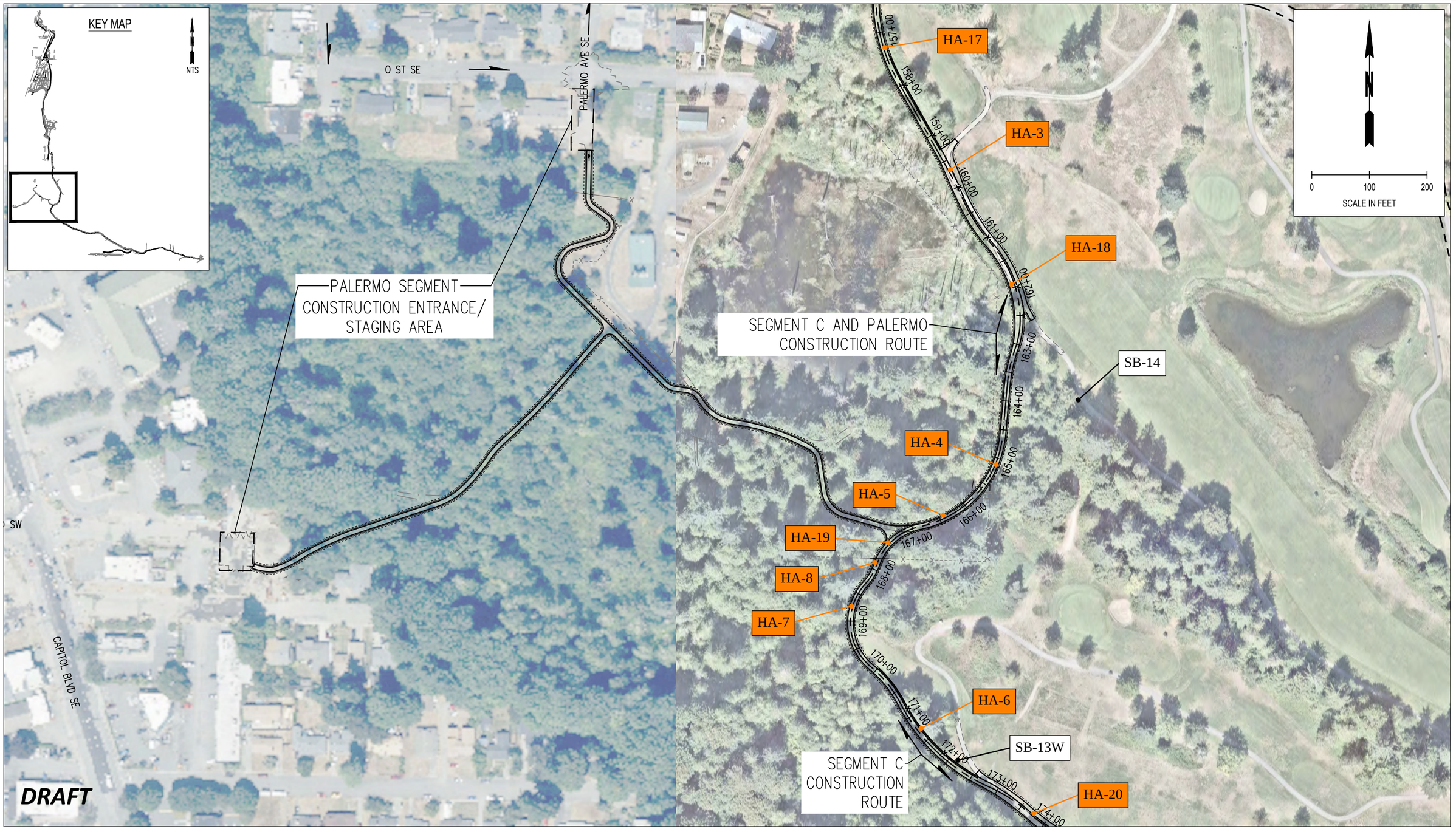
SB-17 — 2025 & 2026 Borings (see Attachment 2)

HA-2 — Historical Explorations by Others (See Attachment 3)

Source: SCJ Alliance 2026

SAGE GEOTECHNICAL

Site and Exploration Location Plan	
Deschutes Valley Trail - Segment C and DVP Spur	
Tumwater, Washington	Figure 2



SB-14 — 2025 & 2026 Borings (see Attachment 2)

HA-3 — Historical Explorations by Others (See Attachment 3)

Source: SCJ Alliance 2026

SAGE GEOTECHNICAL

Site and Exploration Location Plan	
Deschutes Valley Trail - Segment C and DVP Spur	
Tumwater, Washington	Figure 3

HA-9
HA-21
HA-10
SB-12
SB-11
HA-22
HA-11
HA-13
HA-14
HA-15
B-2
SB-8
SB-7
SB-10
SB-9
B-1
HA-23
SB-6W
HA-24
HA-12

400-ft stationing jump to be resolved in final memorandum, if needed.

SEGMENT C CONSTRUCTION ROUTE

SEGMENT D CONSTRUCTION INGRESS

BRIDGE 2

END OF SEGMENT C
START OF SEGMENT D

178+00 179+00 180+00 181+00 182+00 183+00 184+00 185+00 186+00 187+00 188+00 189+00 190+00 191+00 192+00 193+00 194+00 195+00 196+00 197+00 198+00 199+00 200+00 201+00 201+62 251+00 252+00 253+00 300+00 301+00 302+00 303+00 304+00 305+00 306+00 307+00 308+00

N

0 100 200
SCALE IN FEET

KEY MAP
NTS

DRAFT

SB-6W — 2025 & 2026 Borings (see Attachment 2)
B-1 — Historical Explorations by Others (See Attachment 3)

Source: SCJ Alliance 2026

SAGE GEOTECHNICAL

Site and Exploration Location Plan	
Deschutes Valley Trail - Segment C and DVP Spur	
Tumwater, Washington	Figure 4

DRAFT



Source: SCJ Alliance 2026

SAGE GEOTECHNICAL

DVP Spur Proposed Grading	
Deschutes Valley Trail - Segment C and DVP Spur	
Tumwater, Washington	Figure 5

ATTACHMENT 1

Critical Areas Assessment

ATTACHMENT 1.
CRITICAL AREAS ASSESSMENT

Slope Conditions

In November 2025, Sage reconnoitered the steep slope between the Tumwater Valley Golf Club and Deschutes Valley Park. The slope has a gradient of 47 to 58 percent and a vertical relief of approximately 50 feet (ft). During its reconnaissance, Sage did not observe any indicators of slope instability, e.g., pistol-butted trees, landslide scarps, groundwater seepage, sloughing, or erosion.

The slope and the surrounding area are vegetated with coniferous trees that have reached maturation and with younger deciduous trees and brush.

Critical Areas Assessment

Chapter 16.20 of the *Tumwater Municipal Code* outlines four categories of geologically hazardous areas: landslide hazards, erosion hazards, seismic hazards, and volcanic hazards. Sage assessed the site for each.

Landslide Hazard Area

Section 16.20.045.B of the *Tumwater Municipal Code* lists eight criteria for identifying landslide hazard areas (LHAs). Based on Sage's desktop review and slope reconnaissance, the site does not meet LHA criteria one through seven; however, most of the slope between Deschutes Valley Park and the Tumwater Valley Golf Club qualifies as an LHA, as it is more than 10 ft tall and steeper than 40 percent.

No current or historical landslides are mapped at, or in the immediate vicinity of, the site (DNR, accessed March 2, 2026), and no evidence of current or historical slope instability was observed during Sage's November 2025 reconnaissance. The slope consists of well-draining glacial outwash (sand and gravel). In Sage's opinion, there is a low risk that deep-seated landslides will occur at the site.

Erosion Hazard Area

Section 16.20.045.A of the *Tumwater Municipal Code* defines erosion hazard areas (EHAs) as areas where soil is at risk of erosion if disturbed, including areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service as "moderate to severe," "severe," or "very severe" erosion risks. Site soils do not meet these criteria; therefore, the site does not classify as an EHA (USDA NRCS, accessed March 6, 2026).

Seismic Hazard Area

Section 16.20.045.C of the *Tumwater Municipal Code* defines seismic hazard areas (SHAs) as "areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface faulting." In Sage's opinion, there is a moderate risk that soils in the valley or lowlands of the site will experience seismically induced soil liquefaction. There is also a moderate risk that the aforementioned steep slope will experience shallow instability following a design-level earthquake. Such hazards are common for trail projects that cross steep slopes and valleys. Sage concludes that there is not a severe risk of seismic damage; therefore, proposed trail Segment C and the Deschutes Valley Park Spur are not considered SHAs.

Volcanic Hazard Area

Section 16.20.045.D of the *Tumwater Municipal Code* defines volcanic hazard areas (VHAs) as "areas subject to pyroclastic flows, lava flows, debris avalanche, inundation by debris flows, lahars, mudflows, or related flooding resulting from volcanic activity." The site is not subject to any of these hazards and is not considered a VHA.

Conclusions

The proposed Deschutes Valley Park Spur crosses a landslide hazard area with a slope taller than 10 ft and steeper than 40 percent. The slope consists of well-draining sand and gravel outwash. No seeps, springs, or other indicators of recent or historical instability were observed.

Sage used the limit-equilibrium software Slide2 (Rocscience) to analyze the global stability of the proposed cuts and fills shown on Figure 5. Based on the results of its analysis, Sage concludes that the proposed 2 horizontal to 1 vertical cut-and-fill slopes will have a static factor of safety of 1.3 to 1.6. This exceeds the typical 1.25 factor of safety threshold used to design roadway and trail embankments.

The proposed cut-and-fill slopes in the LHA will be faced with rock armor to mitigate erosion potential. The project civil engineer is preparing grading and drainage plans intended to collect and control stormwater runoff. Sage recommends that disturbed areas outside of the rock armor and asphalt concrete-paved trail are revegetated in a manner appropriate to the surrounding topography and canopy.

Sage concludes that the project satisfies the "Alterations of Geologically Hazardous Areas" standards in Section 16.20.055 of the *Tumwater Municipal Code.* The proposed improvements will not increase the threat of the geological hazard to adjacent properties beyond predevelopment conditions and will not adversely impact other critical areas. The improvements are and will be designed so that any hazard is mitigated equal to predevelopment conditions. They are and will be certified as safe as designed and under anticipated conditions by a qualified engineer, licensed in the State of Washington.

References

City of Tumwater. 2025. *Tumwater Municipal Code.* Title 16. Environment. Chapter 16.20 Geologically Hazardous Areas. Last updated November 18.

DNR. "Washington Geologic Information Portal." Washington Department of Natural Resources. Accessed March 2, 2026. Available online at: https://geologyportal.dnr.wa.gov/.

USDA NRCS. "Web Soil Survey." U.S. Department of Agriculture Natural Resources Conservation Service. Accessed March 6, 2026. Available online at: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

ATTACHMENT 2

2026 Subsurface and Laboratory Data

Project: **Deschutes Valley Trail**
Project Location: **Tumwater, Washington**
Project Number: **027019**

Key to Boring Logs

Sheet 1 of 1

1 Elevation (feet)	2 Depth (feet)	3 Sample Type	4 Sample Number	5 Sampling Resistance, blows/ft	6 Material Type	7 Graphic Log	8 MATERIAL DESCRIPTION	9 REMARKS AND OTHER TESTS

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6 Material Type: Type of material encountered.
7 Graphic Log: Graphic depiction of the subsurface material encountered.
8 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
GS: Grain size analysis
w: Gravimetric water content
-200: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Silty GRAVEL (GM)
Poorly graded GRAVEL (GP)
Poorly graded GRAVEL with Silt (GP-GM)
SILT, SILT w/SAND, SANDY SILT (MH)
SILT, SILT w/SAND, SANDY SILT (ML)
Silty SAND (SM)
Poorly graded SAND (SP)
Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Drill-stem core barrel
3.25" OD split spoon (Dames & Moore) w/o liners
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bg4\Sage_Boring_35 ft_no well.tpl

Figure 2-1

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-6W **Sheet 1 of 2**

Date(s) Drilled **11/20/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **8 inches**	Total Depth of Borehole **33.0 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **15.15 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Approximate Location **46.99650, -122.89433**	

Depth (feet)	Sample Number	Sample Type	Recovery Length (in.)	Blows/6" **(blows/ft)**	Material Type	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
0	S-1a		12	WOH	SP-SM		12 inches of dark brown, silty, fine to medium SAND with organics and wood fragments (loose, moist)		Flush-mount monument
	S-1b			WOH	SP-SM		**(TOPSOIL)**		Well ID: BRF 243
				2 **(2)**					
				3	SP		Reddish-brown, fine to medium SAND with silt (loose, moist)		
	S-2		10	3			**(RECESSIONAL OUTWASH)**		GS
				6 **(9)**			Reddish-brown, fine to coarse SAND with gravel and wood fragments (loose, moist)		w = 8.5 %
5				2	SP-SM				
	S-3		18	3 **(6)**			Reddish-brown, fine to medium SAND with silt (loose, moist)		2-inch-diameter, schedule 40 PVC casing
	S-4		16	3 5 7 **(12)**			Light brown, with orange mottling, and medium dense		
10	S-5		10	3 5 9 **(14)**			Without mottling		
15	S-6		17	1 1 2 **(3)**	SM		Brown, silty, fine to coarse SAND (very loose, wet)		
20	S-7		18	4 8 10 **(18)**	SP-SM		Brown, fine to coarse SAND with silt (medium dense, moist to wet)		2-inch diameter, 0.020-slotted screen
25	S-8		18	2 6 12 **(18)**			Moist		12/20 sand pack
30									Threaded end cap

DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd[Sage_MW.tpl]

SAGE GEOTECHNICAL

Figure 2-2

Project: **Deschutes Valley Trail**
Project Location: **Tumwater, Washington**
Project Number: **027019**

Log of Boring SB-6W

Sheet 2 of 2

Depth (feet)	Sample Number	Sample Type	Recovery Length (in.)	Blows/6" **(blows/ft)**	Material Type	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
30	S-9		10	9 14 25 **(39)**			Dense		Bentonite chips
							Total Depth = 33.0 ft bgs Refusal due to heave		
35									
40									
45									
50									
55									
60									
65									

DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bg4[Sage_MW.tpl]

SAGE GEOTECHNICAL

Figure 2-2

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-7 **Sheet 1 of 2**

Date(s) Drilled **1/22/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **7 inches**	Total Depth of Borehole **56.5 ft bgs**
Drill Rig Type **Diedrich D50 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **51.2 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **46.99668, -122.89493**	

Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
0				SP-SM		20 inches of dark brown, fine to coarse SAND with silt, organics, and wood (loose, moist)	
				SP-SM		**(TOPSOIL)**	
		S-1	1 1 2 **(3)**			Brown, fine to coarse SAND with silt (loose, moist) **(RECESSIONAL OUTWASH)**	
5				SM		Light brown, with orange mottling, and very loose	
		S-2	1 1 WOH **(1)**			Light brown, silty, fine to coarse SAND (very loose, moist)	GS w = 19.7 %
		S-3	4 9 8 **(17)**			Medium dense and with orange mottling	
10		S-4	16 18 15 **(33)**	SP-SM		Brown, gravelly, fine to coarse SAND with silt (dense, moist)	GS w = 4.4 %
15		S-5	7 7 8 **(15)**	SP		Light brown, gravelly, fine to coarse SAND (medium dense, moist)	GS w = 2.0 %
20		S-6	6 9 12 **(21)**	SP-SM		Light brown, fine to coarse SAND with silt (medium dense, moist)	GS w = 5.3 %
25		S-7	8 9 21 **(30)**			With gravel	
30		S-8	9 16 21 **(37)**			Without gravel and dense	
35							

DRAFT

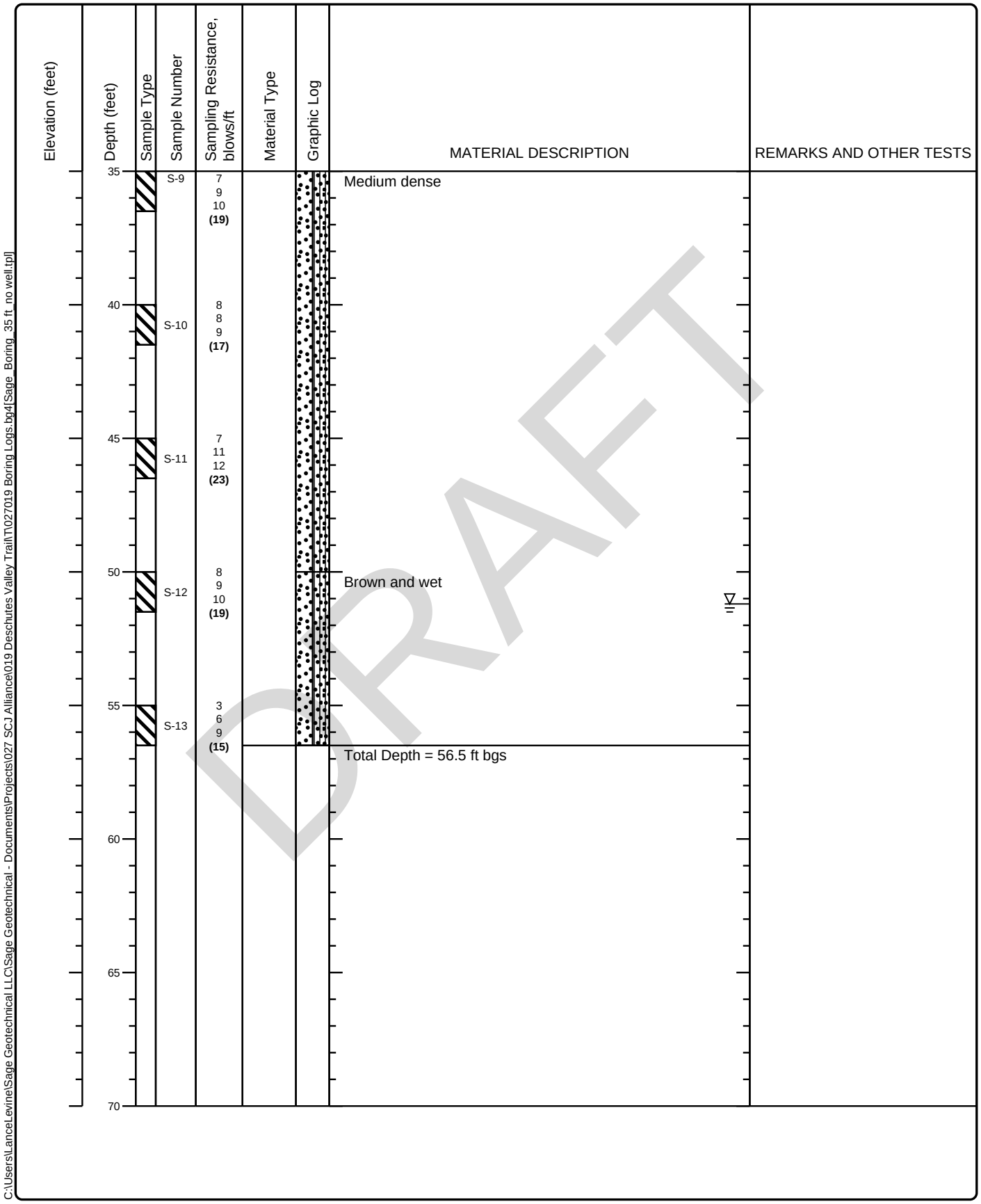
C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-3

Project: **Deschutes Valley Trail**
Project Location: **Tumwater, Washington**
Project Number: **027019**

Log of Boring SB-7

Sheet 2 of 2



C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bg4[Sage_Boring_35 ft_no well.tpl]

Figure 2-3

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-8 **Sheet 1 of 2**

Date(s) Drilled **1/22/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **7 inches**	Total Depth of Borehole **41.5 ft bgs**
Drill Rig Type **Diedrich D50 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **Not Observed**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **46.99659,-122.89332**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0				SP-SM		24 inches of dark brown, fine to coarse SAND with silt, organics, and wood (loose, moist) **(TOPSOIL)**	
			S-1	5 6 6 **(12)**	SP-SM		Brown, fine to coarse SAND with silt (loose, moist) **(RECESSIONAL OUTWASH)**	
	5		S-2	4 4 5 **(9)**	SM		Dark brown and medium dense Light brown, silty, fine to coarse SAND (loose, moist)	GS w = 11.0 %
			S-3	4 4 5 **(9)**				
	10		S-4	2 3 4 **(7)**				GS w = 26.7 %
	15		S-5	4 11 12 **(23)**	GP		Brown, sandy, fine to coarse GRAVEL (medium dense, moist)	GS w = 3.2 %
	20		S-6	3 4 3 **(7)**	SP		Brown, fine to coarse SAND (loose, moist)	GS w = 5.6 %
	25		S-7	3 3 4 **(7)**			Without gravel	
	30		S-8a S-8b	3 6 6 **(17)**			Gravelly and medium dense Light brown and without gravel	
	35							

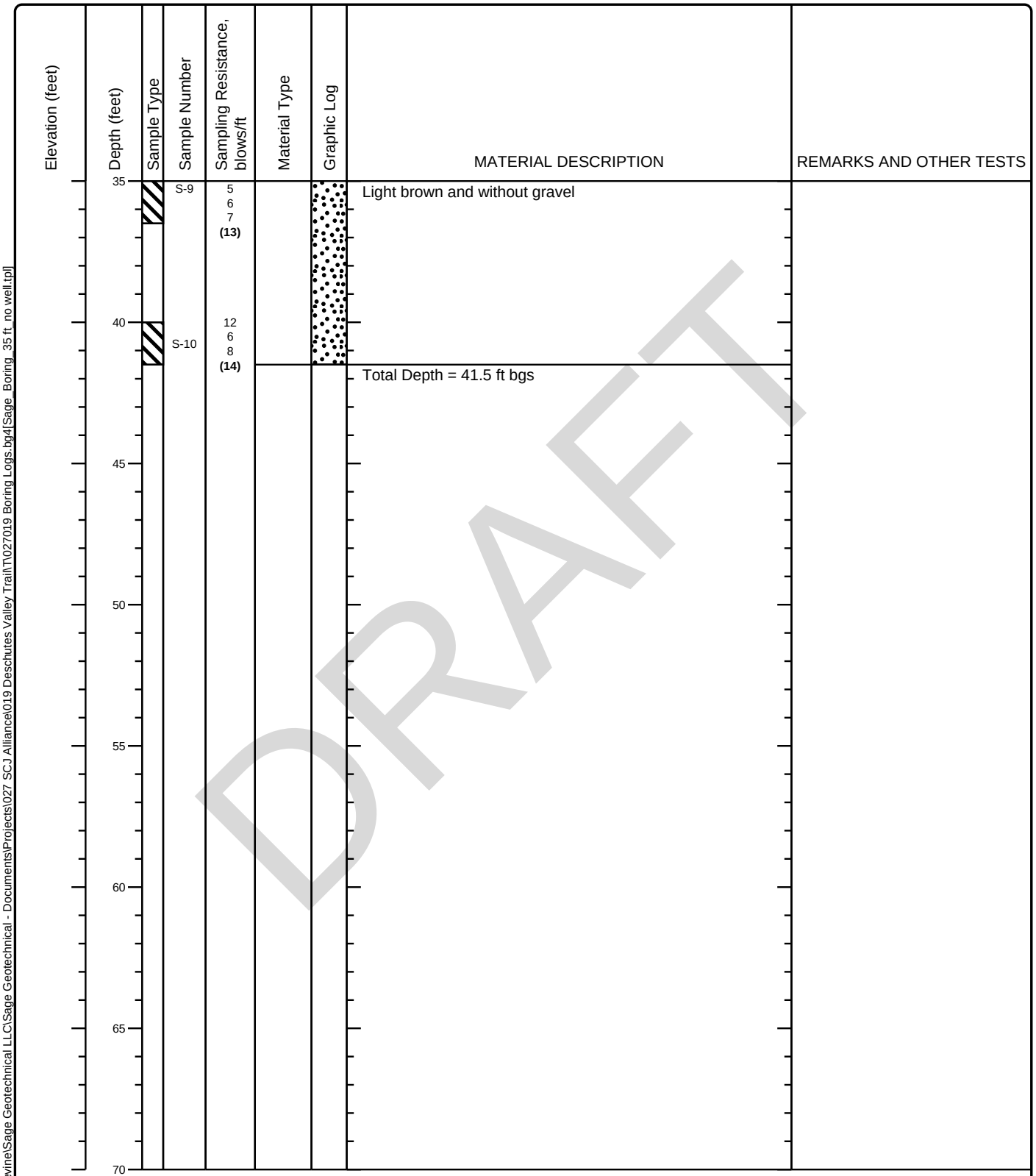
DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-4

Project: **Deschutes Valley Trail**
Project Location: **Tumwater, Washington**
Project Number: **027019**

Log of Boring SB-8
Sheet 2 of 2



DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bg4[Sage_Boring_35 ft_no well.tpl]

Figure 2-4

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-9 **Sheet 1 of 1**

Date(s) Drilled **11/20/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **8 inches**	Total Depth of Borehole **26.5 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **7.38 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **46.99667, -122.89302**	

Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
0		S-1	4 5 5 **(10)**	SM SP-SM		4 inches of dark brown, silty, fine to medium SAND with organics (loose, moist) **(TOPSOIL)**	
		S-2	1 WOH 1 **(1)**	ML		Brown, fine to coarse SAND with silt and gravel (loose, moist) **(RECESSIONAL OUTWASH)**	LL = 48 PI = 13 GS w = 55.8 %
5		S-3a	1			Gray, sandy SILT with charcoal (very soft, moist)	
		S-3b	1 5 **(6)**	SM		Medium stiff	-200 = 33.2 % w = 43.1 %
		S-4	3 6 10 **(16)**			Brown, silty, fine to coarse SAND with wood fragments and charcoal (loose, moist) Reddish-brown, gravelly, with orange mottling, without wood fragments and charcoal, and medium dense	
10		S-5	3 4 7 **(11)**	SP-SM		Brown, fine to coarse SAND with silt (medium dense, wet)	
15		S-6	6 9 9 **(18)**			Moist, light brown, and with orange mottling	
20		S-7	7 9 17 **(26)**			Brown	
25		S-8	3 10 17 **(27)**			Without orange mottling	
						Total Depth = 26.5 ft bgs	
30							
35							

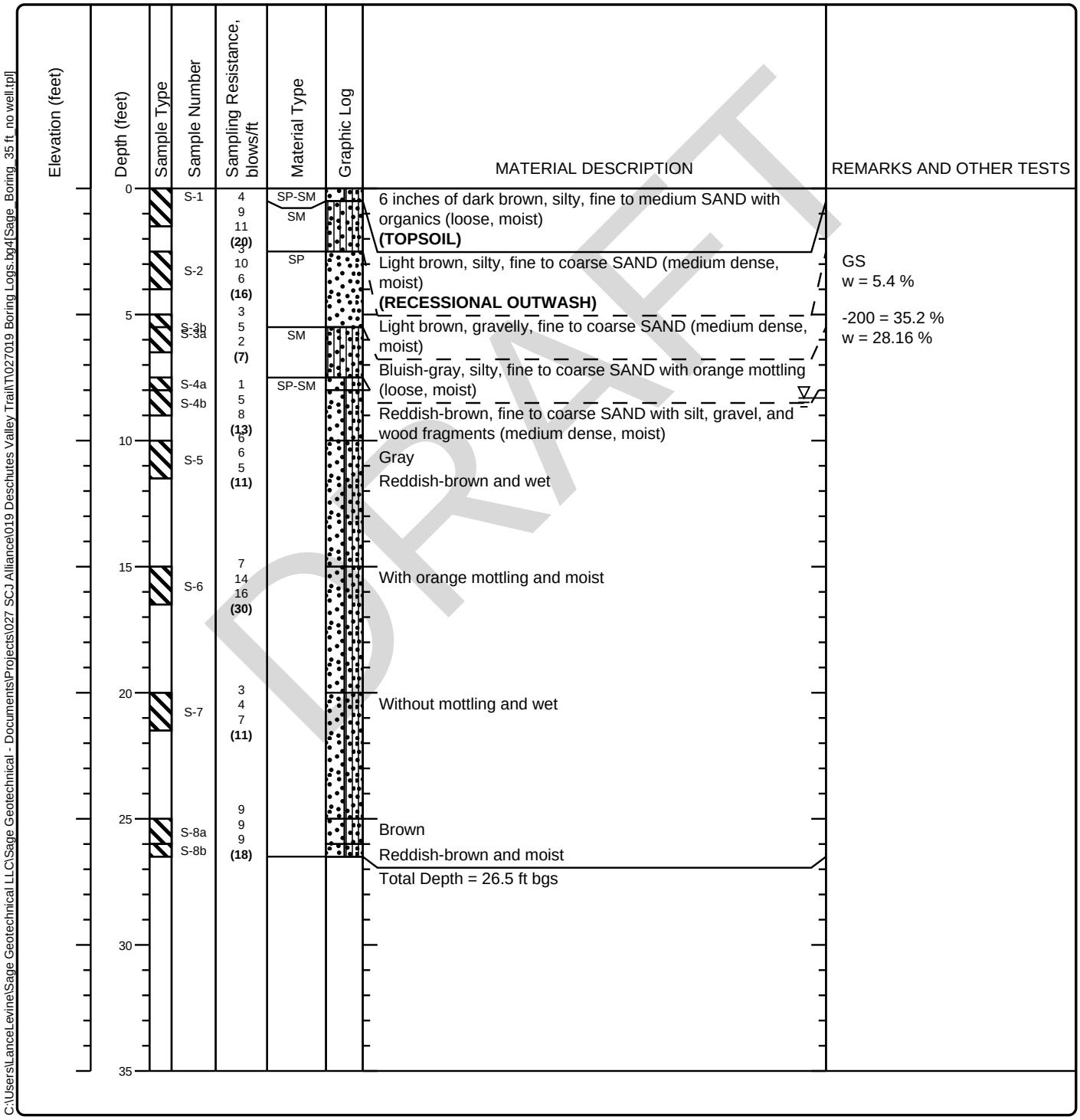
DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\TO27019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-5

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-10 **Sheet 1 of 1**

Date(s) Drilled **11/21/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **8 inches**	Total Depth of Borehole **26.5 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **8.31 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **46.996827, -122.893827**	



DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-6

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-11 **Sheet 1 of 1**

Date(s) Drilled **11/21/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **8 inches**	Total Depth of Borehole **26.5 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **17.65 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **46.99729, -122.89587**	

Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
0		S-1	7 7 7 **(14)**	SM SP-SM		4 inches of dark brown, silty, fine to medium SAND with organics (loose, moist) **(TOPSOIL)**	
		S-2	3 7 8 **(15)**			Reddish-brown, gravelly, fine to coarse SAND with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**	GS w = 9.0 %
5		S-3	5 7 6 **(13)**			Light brown and with orange mottling	
		S-4	4 4 5 **(9)**			Without gravel and loose	
10		S-5	3 3 5 **(8)**	SM		Light brown, silty, fine to coarse SAND with silt (loose, moist)	-200 = 24.0 % w = 21.0 %
15		S-6a S-6b	4 4 6 **(10)**	SP-SM		Wet Brown, fine to coarse SAND with silt (loose, wet)	
20		S-7	4 8 7 **(15)**			Medium dense and with red mottling	
25		S-8	6 9 15 **(24)**			Moist Total Depth = 26.5 ft bgs	
30							
35							

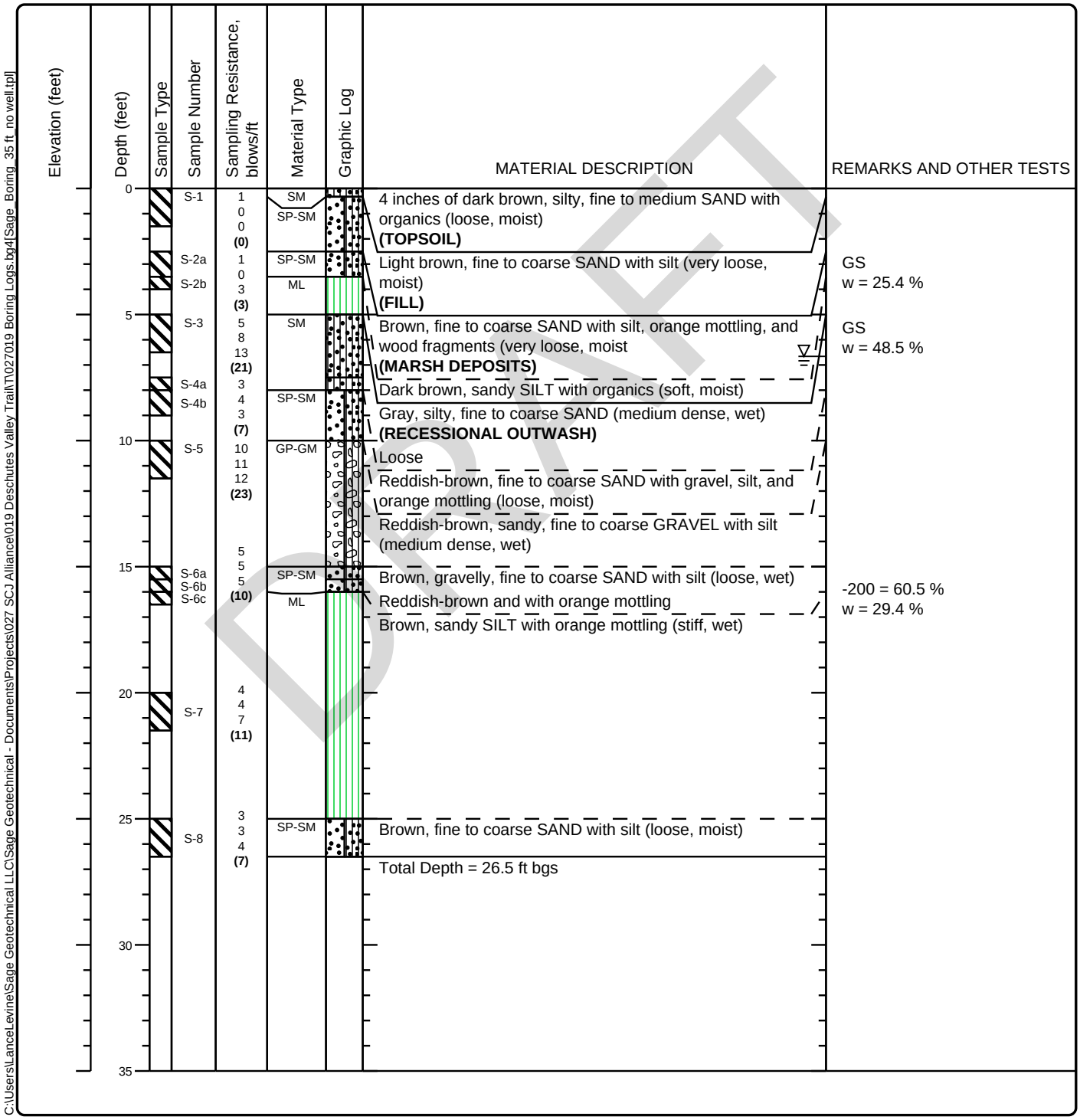
DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-7

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-12 **Sheet 1 of 1**

Date(s) Drilled **11/21/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **8 inches**	Total Depth of Borehole **26.5 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **6.66 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **46.99758, -122.89661**	



DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-8

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-13W **Sheet 1 of 1**

Date(s) Drilled **11/21/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **8 inches**	Total Depth of Borehole **16.5 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **6.02 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Approximate Location **46.99900, -122.90234**	

Depth (feet)	Sample Number	Sample Type	Recovery Length (in.)	Blows/6" **(blows/ft)**	Material Type	Graphic Log	MATERIAL DESCRIPTION	Well Log	REMARKS AND OTHER TESTS
0	S-1		14	1 4 4 **(8)**	SM SP-SM		4 inches of dark brown, silty, fine to medium SAND with organics (loose, moist) **(TOPSOIL)**		Flush-mount monument Well ID: BRF 244 2-inch-diameter, schedule 40 PVC casing GS w = 25.0 %
	S-2		18	1 2 1 **(3)**	SM		Brown, fine to coarse SAND with silt (loose, moist) **(FILL)** Brown, silty, fine to coarse SAND (very loose, moist)		
5	S-3a S-3b		18	WOH WOH WOH **(WOH)**	SP-SM		Brown, fine to coarse SAND with silt and wood fragments (very loose, wet) **(MARSH DEPOSITS)**		-200 = 10.1 % w = 31.3 %
	S-4		18	5 6 11 **(17)**	SP-SM		Grayish-brown and with organics Grayish-brown, fine to coarse SAND with silt and gravel (medium dense, wet) **(RECESSIONAL OUTWASH)**		2-inch diameter, 0.020-slotted screen
10	S-5		14	5 9 11 **(20)**			Brownish-gray		12/20 sand pack
15	S-6		18	5 7 9 **(16)**			Brown, moist, and with gravel and orange mottling		Threaded end cap Bentonite chips
							Total Depth = 16.5 ft bgs		
20									
25									
30									

DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bg4[Sage_MW.tpl]

SAGE GEOTECHNICAL

Figure 2-9

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-14 **Sheet 1 of 1**

Date(s) Drilled **11/21/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Hollow-Stem Auger**	Drill Bit Size/Type **8 inches**	Total Depth of Borehole **26.5 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **15.0 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **47.000715, -122.901633**	

Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
0		S-1	4 7 8 (15)	SM / SP-SM		6 inches of dark brown, silty, fine to medium SAND with organics and wood fragments (loose, moist) **(TOPSOIL)**	
		S-2	7 4 5 (9)	SM		Brown, gravelly, fine to medium SAND with silt, wood fragments, and orange mottling (medium dense, moist) **(FILL)**	GS w = 19.0 %
5		S-3a S-3b	1 1 1 (2)	MH		Brown, silty, fine to coarse SAND with gravel, wood fragments, and orange mottling (medium dense, moist)	LL = 61 PI = 20 w = 62.1 %
		S-4	1 0 5 (5)	SP-SM		Bluish-gray elastic SILT with sand and wood fragments (very soft, moist)	
10		S-5	WOH WOH 3 (3)	ML		Brown, fine to coarse SAND with silt and gravel (loose, moist)	
						Dark brown, sandy SILT with wood fragments and organics (soft, moist) **(MARSH DEPOSITS)**	PI = Non-plastic w = 53.2 %
15		S-6	1 2 5 (7)	SP-SM		Reddish-brown, fine to coarse SAND with silt (loose, wet) **(RECESSIONAL OUTWASH)**	
20		S-7a S-7b	7 9 10 (19)	GP-GM		Light brown, with orange mottling, and medium dense Reddish-brown, sandy, fine to coarse GRAVEL with silt (medium dense, moist)	
25		S-8	10 22 39 (61)			Very dense	
						Total Depth = 26.5 ft bgs	
30							
35							

DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-10

Project: **Deschutes Valley Trail** Project Location: **Tumwater, Washington** Project Number: **027019**	Log of Boring SB-17 **Sheet 1 of 3**

Date(s) Drilled **11/17/2025**	Logged By **KAM**	Checked By **LGL**
Drilling Method **Mud Rotary**	Drill Bit Size/Type **7 inches**	Total Depth of Borehole **101.5 ft bgs**
Drill Rig Type **Diedrich D90 Turbo**	Drilling Contractor **Holocene Acquisition Company, LLC**	Approximate Surface Elevation **Not Measured**
Groundwater Level and Date Measured **9.0 ft bgs**	Sampling Method(s) **SPT**	Hammer Data **140 lb./30 in. Drop**
Borehole Backfill **Bentonite**	Location **47.004099, -122.903517**	

Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
0		S-1	2 4 3 **(7)**	SP-SM		10 inches of dark brown, fine to medium SAND with silt, gravel, and organics (loose, moist) **(TOPSOIL)**	
		S-2	5 7 6 **(13)**	GP-GM		Reddish-brown, fine to medium SAND with silt and gravel (loose, moist) **(RECESSIONAL OUTWASH)**	GS w = 13.8 %
5		S-3	5 4 3 **(7)**	SP-SM		Brown, sandy, fine to coarse GRAVEL with silt and orange mottling (medium dense, wet)	
		S-4	7 2 3 **(5)**			Brown, fine to coarse SAND with gravel, silt, and orange mottling (loose, wet) Without orange mottling	
10		S-5	3 3 3 **(6)**				
15		S-6	2 3 4 **(7)**			Without gravel	
20		S-7	3 5 6 **(11)**			Medium dense and moist	
25		S-8	5 4 7 **(11)**				
30		S-9	9 10 8 **(18)**	SM		Gray, gravelly, silty, fine to coarse SAND (medium dense, moist)	
35							

DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd\Sage_Boring_35 ft_no well.tpl

Figure 2-11

Project: **Deschutes Valley Trail**
Project Location: **Tumwater, Washington**
Project Number: **027019**

Log of Boring SB-17
Sheet 2 of 3

Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
35		S-10	WOH WOH 2 **(2)**	ML		Gray, sandy SILT (soft, wet)	-200 = 65.9 % w = 42.7 %
40		S-11	5 5 7 **(12)**	SP-SM		Gray, fine to coarse SAND with silt (medium dense, moist)	
45		S-12	9 5 9 **(14)**				
50		S-13	11 12 14 **(26)**			Brown	
55		S-14	7 9 9 **(18)**				
60		S-15	11 12 14 **(26)**				No recovery with SPT, used CA to retrieve sample
65		S-16	8 9 12 **(21)**				
70							

DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bgd[Sage_Boring_35 ft_no well.tpl]

Figure 2-11

Project: **Deschutes Valley Trail**
Project Location: **Tumwater, Washington**
Project Number: **027019**

Log of Boring SB-17

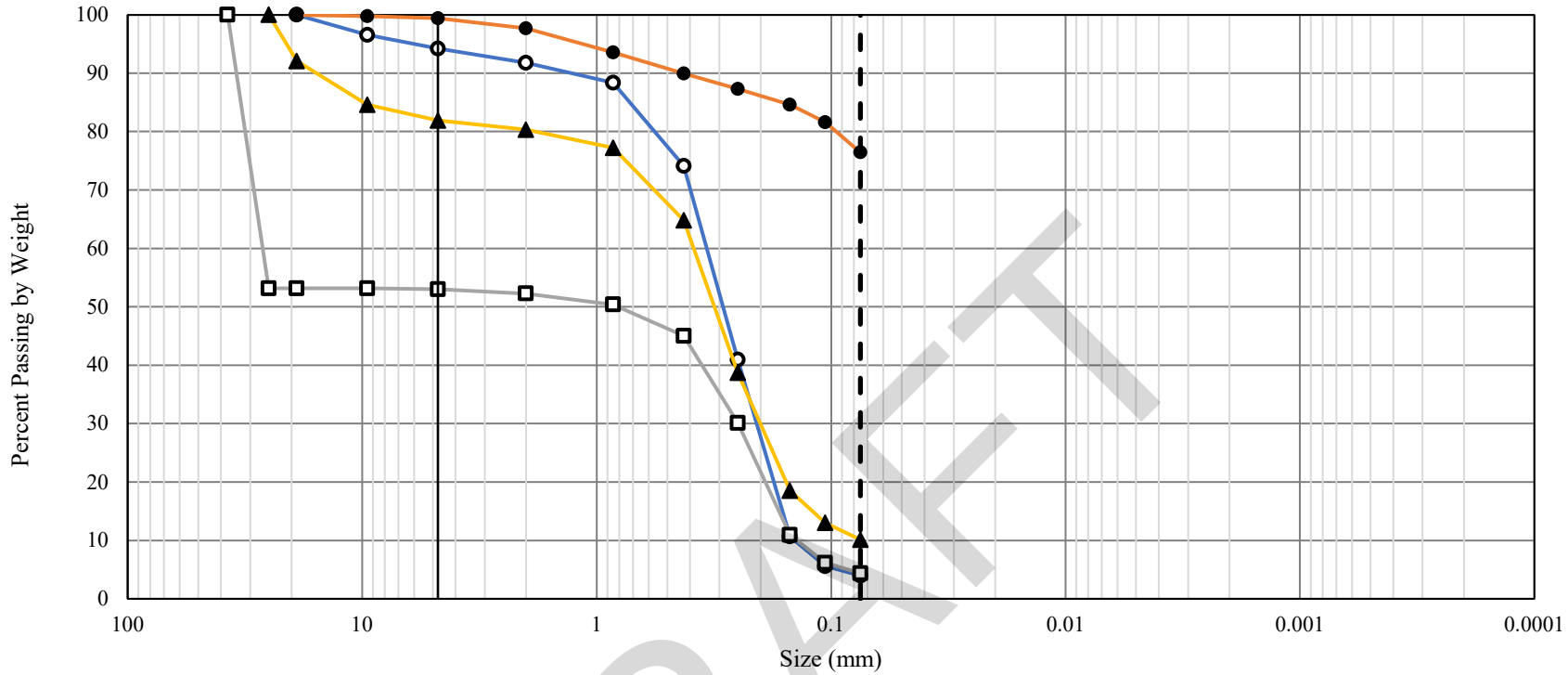
Sheet 3 of 3

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	70		S-17	8 7 8 **(15)**	SP-SM		Gray, fine to coarse SAND with silt (medium dense, moist)	
	75		S-18	10 12 15 **(27)**				
	80		S-19	15 12 18 **(30)**			With red mottling and 0.25-inch silt lens (medium dense, moist)	
	85		S-20	40 38 24 **(62)**			Very dense	
	90		S-21	14 14 16 **(30)**			Without rock fragments, without mottling, and medium dense	
	95		S-22	15 16 19 **(35)**			Dense	
	100		S-23	26 22 26 **(48)**			Gray	
							Total Depth = 101.5 ft bgs	
	105							

DRAFT

C:\Users\LanceLevine\Sage Geotechnical LLC\Sage Geotechnical - Documents\Projects\027 SCJ Alliance\019 Deschutes Valley Trail\T\027019 Boring Logs.bg4[Sage_Boring_35 ft_no well.tpl]

Figure 2-11



	Depth	w	D90	D60	D30	D10	Cu	Cc	% G	% S	% F	USCS
	(ft)	(%)	(mm)	(mm)	(mm)	(mm)	-	-	(%)	(%)	(%)	-
SB-06W S-2	2.5	8.5%	1.28	0.34	0.21	0.14	2.4	0.9	5.8	90.3	4.0	SP
SB-09 S-2	2.5	55.8%	0.43	-	-	-	-	-	0.6	23.0	76.4	ML
SB-10 S-2	2.5	5.4%	34.39	26.52	0.25	0.14	189.3	0.02	47.0	48.6	4.4	SP
SB-11 S-2	2.5	9.0%	15.69	0.39	0.20	-	-	-	18.1	71.8	10.1	SP-SM

DRAFT

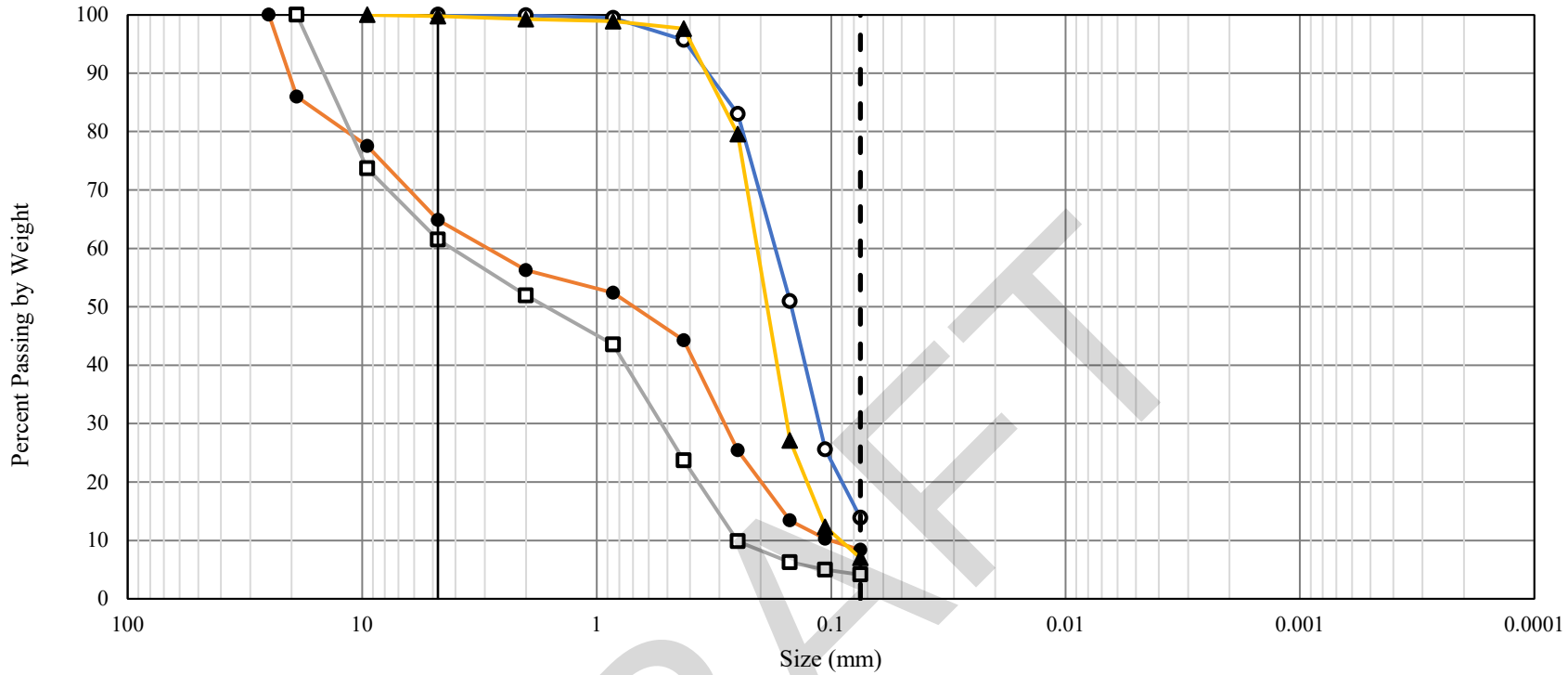
w = as-received moisture content
% G = percent gravel and larger
% S = percent sand
% F = percent fines
USCS = Unified Soil Classification System group symbol
To be well-graded: 1 < Cc < 3, Cu > 4 for GW, Cu > 6 for SW

SAGE GEOTECHNICAL

Grain Size Analysis Results
ASTM D422

Deschutes Valley Trail

Tumwater, Washington | Figure 2-12



	Depth	w	D90	D60	D30	D10	Cu	Cc	% G	% S	% F	USCS
	(ft)	(%)	(mm)	(mm)	(mm)	(mm)	-	-	(%)	(%)	(%)	-
SB-7 S-2	5.0	19.7%	0.33	0.17	0.11	-	-	-	0.0	86.1	13.9	SM
SB-7 S-4	10.0	4.4%	20.55	2.92	0.28	0.10	28.9	0.3	35.2	56.5	8.4	SP-SM
SB-7 S-5	15.0	2.0%	14.60	4.15	0.53	0.25	16.5	0.3	38.5	57.4	4.1	SP
SB-7 S-6	20.0	5.3%	0.34	0.21	0.15	0.09	2.3	1.3	0.3	92.7	7.0	SP-SM

DRAFT

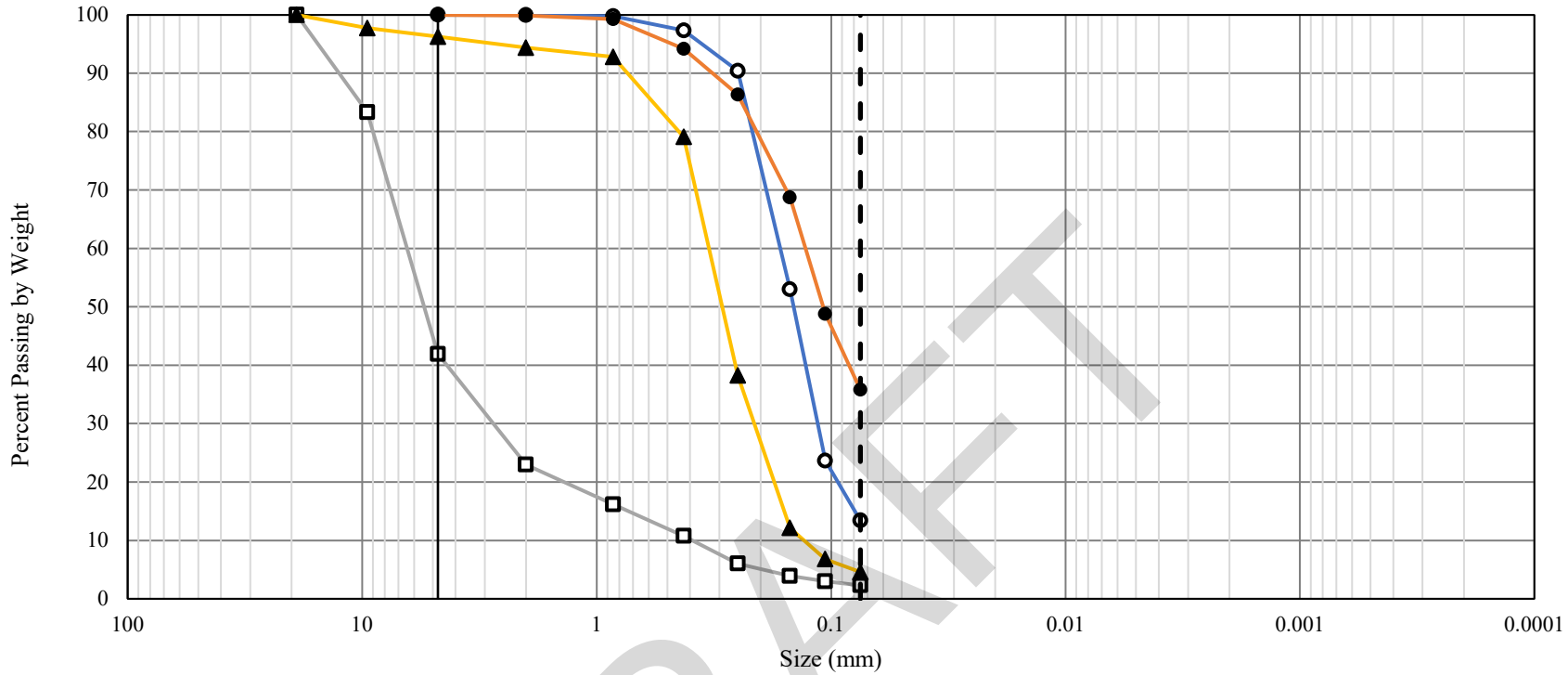
w = as-received moisture content
% G = percent gravel and larger
% S = percent sand
% F = percent fines
USCS = Unified Soil Classification System group symbol
To be well-graded: 1 < Cc < 3, Cu > 4 for GW, Cu > 6 for SW

SAGE GEOTECHNICAL

Grain Size Analysis Results
ASTM D422

Deschutes Valley Trail

Tumwater, Washington | Figure 2-13



	Depth	w	D90	D60	D30	D10	Cu	Cc	% G	% S	% F	USCS
	(ft)	(%)	(mm)	(mm)	(mm)	(mm)	-	-	(%)	(%)	(%)	-
SB-8 S-2	5.0	11.0%	0.25	0.17	0.11	-	-	-	0.0	86.6	13.4	SM
SB-8 S-4	10.0	26.7%	0.32	0.13	-	-	-	-	0.0	64.2	35.8	SM
SB-8 S-5	15.0	3.2%	12.53	6.43	2.76	0.39	16.5	3.03	58.1	39.6	2.3	GP
SB-8 S-6	20.0	5.6%	0.74	0.33	0.21	0.13	2.5	1.04	3.7	91.7	4.6	SP

DRAFT

w = as-received moisture content
% G = percent gravel and larger
% S = percent sand
% F = percent fines
USCS = Unified Soil Classification System group symbol
To be well-graded: 1 < Cc < 3, Cu > 4 for GW, Cu > 6 for SW

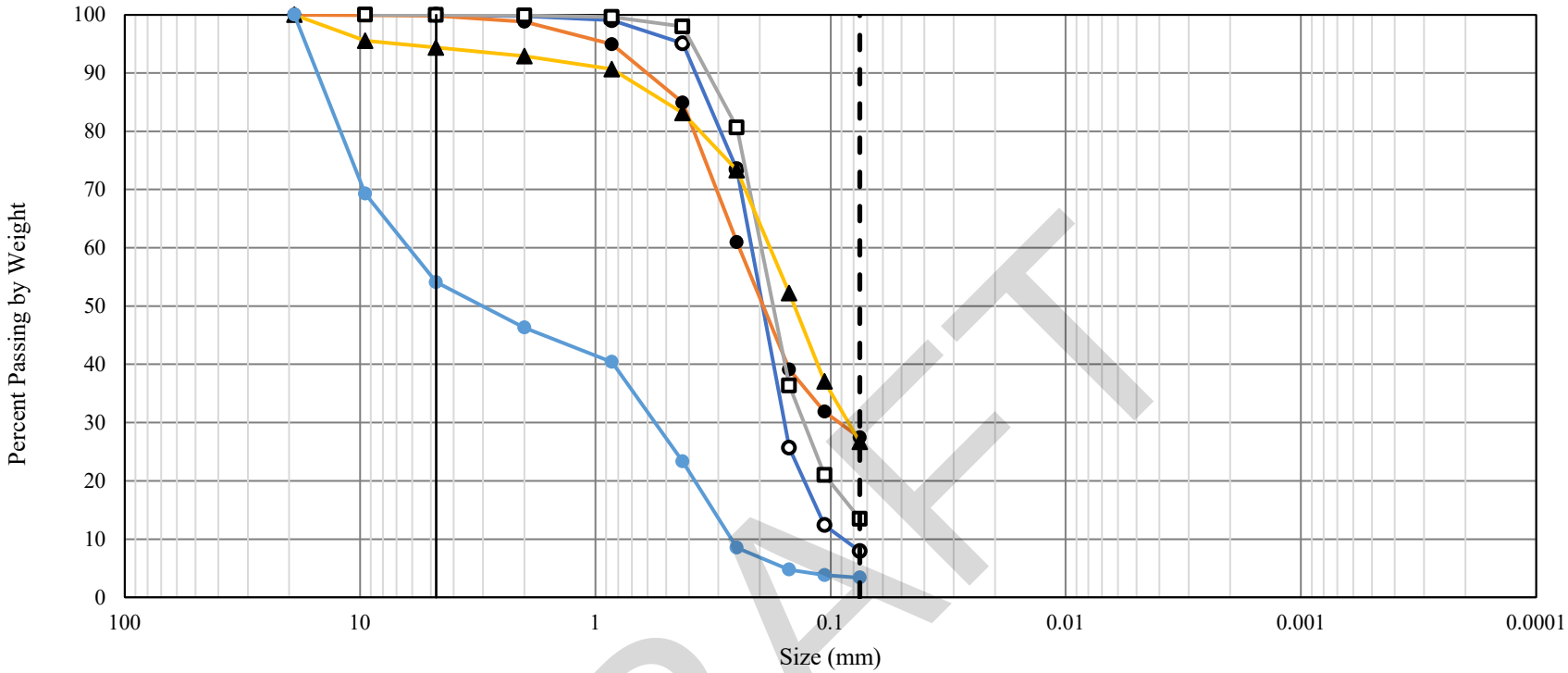
SAGE GEOTECHNICAL

Grain Size Analysis Results
ASTM D422

Deschutes Valley Trail

Tumwater, Washington

Figure 2-14



	Depth	w	D90	D60	D30	D10	Cu	Cc	% G	% S	% F	USCS
	(ft)	(%)	(mm)	(mm)	(mm)	(mm)	-	-	(%)	(%)	(%)	-
SB-12 S-2a	2.5	25.4%	0.38	0.22	0.16	0.09	2.5	1.3	0.0	92.1	7.9	SP-SM
SB-12 S-2b	3.5	48.5%	0.60	0.24	0.09	-	-	-	0.2	72.4	27.4	SM
SB-13W S-2	2.5	25.0%	0.33	0.20	0.13	-	-	-	0.0	86.5	13.5	SM
SB-14 S-2	2.5	19.0%	0.80	0.18	0.08	-	-	-	5.6	67.7	26.67	SM
SB-17 S-2	2.5	13.8%	15.16	6.22	0.56	0.26	23.6	0.2	45.9	50.7	3.4	SP

DRAFT

w = as-received moisture content
% G = percent gravel and larger
% S = percent sand
% F = percent fines
USCS = Unified Soil Classification System group symbol
To be well-graded: 1 < Cc < 3, Cu > 4 for GW, Cu > 6 for SW

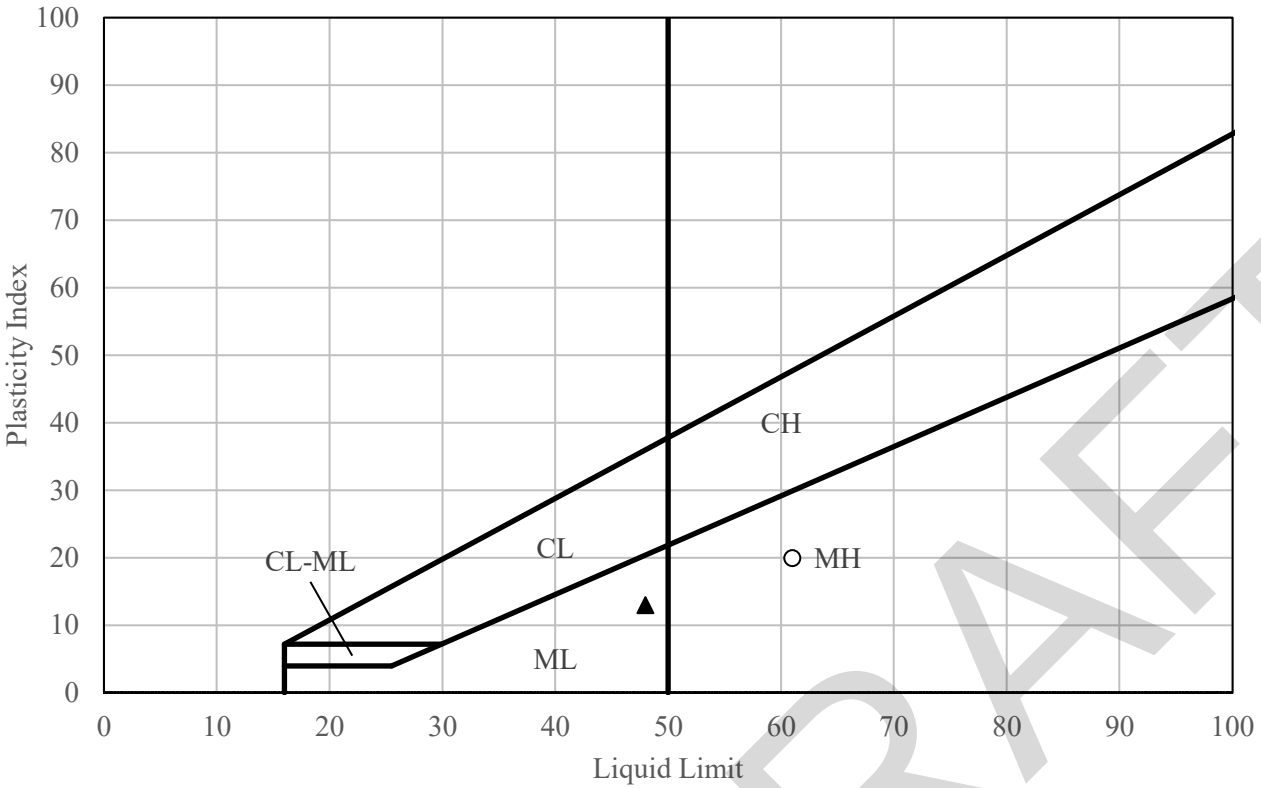
SAGE GEOTECHNICAL

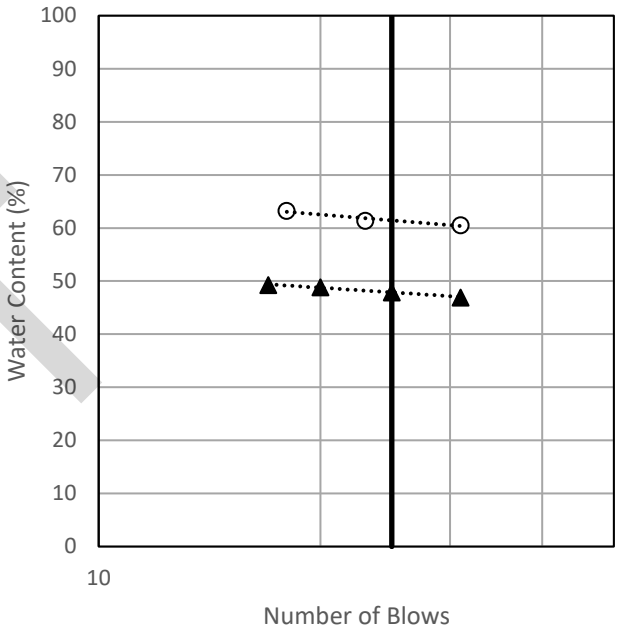
Grain Size Analysis Results
ASTM D422

Deschutes Valley Trail

Tumwater, Washington

Figure 2-15





	Depth	w	LL	PL	PI
	(ft)	(%)	( )	( )	( )
▲SB-09 S-2	2.5	55.8	48	35	13
○SB-14 S-3b	5.5	62.1	61	41	20

DRAFT

SAGE GEOTECHNICAL

w = as-received moisture content
LL = liquid limit
PL = plastic limit
PI = plasticity index

Atterberg Limits Results		
Deschutes Valley Trail		
Tumwater, Washington	Figure	2-16

ATTACHMENT 3

Historical Subsurface and Laboratory Data

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS [2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
	≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

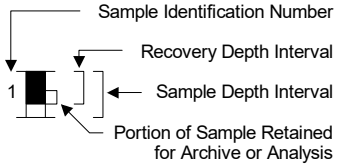
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽ Approximate water level at time of drilling (ATD)

▼ Approximate water level at time other than ATD

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Soil Classification System and Key

Figure A-1

B-1

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE** | Groundwater | Moisture Content (%) (Plastic Limit – Liquid Limit) 10 20 30 40 | ▲ SPT N-Value ▲ △ Non-Standard N-Value △ 10 20 30 40 | × Fines Content (%) × 10 20 30 40

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 165
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description
0	165	S-1	b2					14" of Forest Duff **(TOPSOIL/SOD/DUFF)**
							SP-SM	Brown, fine to medium SAND with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**
5	160	S-2	b2	12	-200 = 11 W = 8			
10	155	S-3	b2	16	-200 = 13 W = 9			-grades to gray
15	150	S-4	b2	14	GS -200 = 12 W = 9			
							SP	Gray, very gravelly SAND (very dense, moist)
20	145	S-5	b2	60	GS -200 = 4 W = 5			-density over stated due to rock in sampler tip
25	140	S-6	b2	28				-grades to medium dense
30	135	S-7	b2	24	W = 6			-gravel content decreases
							SP-SM	Gray, gravelly SAND with silt (dense, moist)
35	130							

60

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-1

Figure
A-2
(1 of 2)

B-1

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 165
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
35	130	S-8 3	b2		-200 = 12 W = 9		SP-SM	Gray, gravelly SAND with silt (dense, moist)	
							GP-GM	Gray, sandy GRAVEL with silt (dense, moist)	
40	125	S-9	b2	47					
45	120	S-10	b2	42				-grades to include fine to medium sand seams	
							SM	Brown, silty SAND (medium dense, moist)	
50	115	S-11	b2	27	-200 = 23 W = 13				
55	110	S-12	b2	32				-grades to dense, includes iron-stained lenses	▽ 59.2 ft ATD
60	105	S-13	b2	45	W = 28			-grades to wet	
65									
70									

Moisture Content (%)
Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Boring Completed 08/06/12
Total Depth of Boring = 61.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-1

Figure
A-2
(2 of 2)

B-2

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 170
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
0	170	S-1 4	b2				SM	11" of Forest Duff **(TOPSOIL/SOD/DUFF)**	Groundwater Not Encountered
								Brown, silty, fine to medium SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
5	165	S-2	b2	10					
10	160	S-3	b2	18	GS -200 = 13 W = 9			-grades to gray, includes silty sand seams	
15	155	S-4	b2	48				-grades to dense, includes trace gravel	
20	150	S-5	b2	16			GP-GM	Gray, sandy GRAVEL with silt (medium dense, moist)	
25	145	S-6	b2	32				-grades to dense	
30									
35									

Moisture Content (%)
Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Boring Completed 08/06/12
Total Depth of Boring = 26.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-2

Figure
A-3

B-3

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Mud Rotary
Ground Elevation (ft): 102
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
0	100	S-1	b2				SM	5" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Dark brown, silty SAND with organics (loose, moist) **(FILL)**	3.1 ft ATD
		S-2	b2	3	W = 44		MH/PT	Dark brown SILT with sand and peat (soft, wet) **(MARSH DEPOSITS)**	
5	95	S-3	b2	3	W = 65				
		S-4	b2	36			GM	Gray, silty, sandy GRAVEL (dense, wet) **(RECESSIONAL OUTWASH)**	
10	90	S-5	b2	19	-200 = 21 W = 15			-grades to medium dense	
15	85	S-6	b2	8			SM	Gray, silty SAND (loose, wet)	
20									
25									
30									
35									

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Boring Completed 08/06/12
Total Depth of Boring = 19.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-3

Figure
A-4

B-4

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Mud Rotary
Ground Elevation (ft): 95
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description
0	95	S-1	b2			PT / GP		3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**
								Brown, sandy GRAVEL (loose, moist) **(FILL)**
		S-2	b2	10				-grades to medium dense
5	90	S-3	b2	11	-200 = 7 W = 22		SP-SM	Gray, fine to medium SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**
		S-4	b2	12	-200 = 7 W = 27			-grades to wet
10	85	S-5	b2	8	-200 = 10 W = 33			-grades to loose
15	80	S-6	b2	13				-grades to medium dense
20	75	S-7	b2	20	-200 = 8 W = 28			-grades to trace gravel (medium dense, moist)
								-grades to gray-brown
25	70	S-8	b2	19				
30	65	S-9	b2	6	-200 = 94 W = 39		ML	Gray SILT with sand (medium stiff, moist to wet)
35	60							

Groundwater: ▽ 6.3 ft ATD

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-4

Figure
A-5
(1 of 2)

B-4

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE** | Groundwater | Moisture Content (%) (Plastic Limit – Liquid Limit) 10 20 30 40 | ▲ SPT N-Value ▲ △ Non-Standard N-Value △ 10 20 30 40 | × Fines Content (%) × 10 20 30 40

Drilling Method: Mud Rotary
Ground Elevation (ft): 95
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description
35	60						ML	Gray SILT with sand (medium stiff, moist to wet)
		S-10	b2					-grades to stiff
40	55						SM	Dark gray, very silty SAND (medium dense, wet)
		S-11	b2	20	-200 = 40 W = 30			
45	50							
		S-12	b2	35				-grades to dense
50	45							
		S-13	b2	27				-grades to gray-brown, medium dense
55	40							
		S-14	b2	31				-grades to dense
60								
65								
70								

Boring Completed 08/06/12
Total Depth of Boring = 59.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-4

Figure
A-5
(2 of 2)

HA-01

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	98			SP-		SM	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown-gray, fine to medium SAND with silt (medium dense, moist) **(FILL)**	Groundwater not encountered.
				-200 = 9 W = 5				
2	96							
				Hand Auger Boring Completed 07/30/12 Total Depth of Hand Auger Boring = 2.8 ft.				
4								
6								

HA-02

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 96 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	96						7" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
				-200 = 9 W = 4		SP-SM	Brown-gray, fine to medium SAND with silt (medium dense, moist) **(FILL)**	
2	94			W = 22		SM	Dark brown, silty SAND with organics (loose, moist) **(MARSH DEPOSITS)**	
				Hand Auger Boring Completed 07/30/12 Total Depth of Hand Auger Boring = 3.1 ft.			-grades to bright gray	
4								
6								

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-9

HA-03

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	98			AC			2" of Asphalt concrete pavement	
				W = 4		GW SM	Crushed surfacing base course (dense, moist) **(FILL)**	
2	96			GS -200 = 25 W = 20		SM	Filter fabric layer under CSBC Dark brown, very silty SAND with trace organics (loose, moist) **(MARSH DEPOSITS)**	
				W = 19			Bright gray, silty SAND with trace organics (loose, moist)	
4	94					SM	Dark gray, fine to medium SAND with silt (loose, wet)	▽ Groundwater seepage encountered at 4.1 ft.
6								

Hand Auger Boring Completed 07/30/12
Total Depth of Hand Auger Boring = 4.5 ft.

HA-04

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 109 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	108					SP-SM	Brown-gray, fine to medium sand with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2							-grades to gray, includes gravel	
	106							
4								
6								

Hand Auger Boring Completed 07/30/12
Total Depth of Hand Auger Boring = 3.4 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-10

HA-05

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 109 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	108			GW		SP-SM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Crushed surfacing base course (dense, moist) **(FILL)**	Groundwater not encountered.
2							Gray, fine to coarse SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
4								
6								

Hand Auger Boring Completed 07/31/12
Total Depth of Hand Auger Boring = 2.1 ft.

HA-06

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	114			W = 39		SM	Brown, silty SAND with trace organics (loose, moist) **(MARSH DEPOSITS)**	▽ Groundwater seepage encountered at 1.3 ft.
2	112			-200 = 31 W = 30		SM	Gray, very silty, fine to medium SAND (loose, wet) **(RECESSIONAL OUTWASH)**	
4								
6								

Hand Auger Boring Completed 07/31/12
Total Depth of Hand Auger Boring = 3.1 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-11

HA-07

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 110 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	110						14" of Forest Duff **(TOPSOIL/SOD/DUFF)**	
				SP-		SM	Gray, fine to medium SAND with silt (medium dense, moist to wet) **(RECESSIONAL OUTWASH)**	▽ Groundwater seepage encountered at 1.9 ft.
2	108							
							Hand Auger Boring Completed 07/31/12 Total Depth of Hand Auger Boring = 2.4 ft.	
4								
6								

HA-08

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 109 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							16" of Forest Duff **(TOPSOIL/SOD/DUFF)**	
	108							
						SP-SM	Gray, fine to medium SAND with silt (medium dense, moist to wet) **(RECESSIONAL OUTWASH)**	▽ Groundwater seepage encountered at 2.1 ft.
2								
							Hand Auger Boring Completed 07/31/12 Total Depth of Hand Auger Boring = 2.6 ft.	
4								
6								

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-12

HA-09

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 116 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	116						6" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	
				SM			Gray, silty SAND (medium dense, moist) **(FILL)**	▽ Groundwater seepage encountered at 1.5 ft.
2	114			-200 = 22 W = 22		SM	Gray, silty, fine to medium SAND (medium dense, wet) **(RECESSIONAL OUTWASH)**	
4				Hand Auger Boring Completed 07/31/12 Total Depth of Hand Auger Boring = 3.6 ft.				
6								

HA-10

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 108 Excavated By: Bay Townes Geotechnical Logged By: CAM
0	108					AC	2" of Asphalt concrete pavement
						GW	
						SP-SM	Crushed surfacing base course, includes small uncrushed cobble (dense, moist) **(FILL)**
2	106			-200 = 7 W = 9			Filter fabric layer under CSBC Brown, fine to medium SAND with silt (medium dense, moist to wet)
						MH/PT	Bright gray SILT with sand and peat lenses (soft, wet) **(MARSH DEPOSITS)**
4	104			W = 45			▽ Groundwater seepage encountered at 3.4 ft.
						SP-SM	Dark gray, fine to medium SAND with silt (loose, wet) **(RECESSIONAL OUTWASH)**
6				Hand Auger Boring Completed 08/07/12 Total Depth of Hand Auger Boring = 5.5 ft.			

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-13

HA-11

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	
	114			SP- -200 = 10 W = 7		SM	Orange-brown, fine to coarse SAND with silt, gravel and cobble (medium dense, moist) **(RECESSIONAL OUTWASH)**	Groundwater not encountered.
2								

Hand Auger Boring Completed 08/07/12
Total Depth of Hand Auger Boring = 2.8 ft.

4

6

HA-12

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 106 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	106					AC	2" of Asphalt concrete pavement	
				-200 = 8 W = 6		GW SP-SM	Crushed surfacing base course, includes round cobble (dense, moist) **(FILL)**	Groundwater not encountered.
2	104						Orange-brown, fine to coarse SAND with silt, gravel and cobble (medium dense, moist) **(RECESSIONAL OUTWASH)**	

Hand Auger Boring Completed 08/07/12
Total Depth of Hand Auger Boring = 2.7 ft.

4

6

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-14

HA-13

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 174 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	174						10" of Forest Duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
				SP- -200 = 8 W = 6		SM	Brown, fine SAND with silt and trace gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
2	172							
4								
6								

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 3.1 ft.

HA-14

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 174 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	174						11" of Forest duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
						SP- SM	Brown, fine SAND with silt and trace gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
				-200 = 8 W = 8				
2	172							
4	170							
6								

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-15

HA-15

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 173 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							10" of Forest Duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	172			SP-		SM	Brown, fine SAND with silt and trace gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
2				-200 = 8 W = 8				
	170							
4								

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.2 ft.

6

HA-16

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	98						3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
						SP-SM	Brown, fine SAND with silt (loose, moist) **(FILL)**	
2	96							
				-200 = 17 W = 17		SM	Brown-gray, silty SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
4	94							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.9 ft.

6

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-16

HA-17

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 99 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0				SP-			4" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	98					SM	Brown, fine to medium SAND with silt (loose, moist) **(FILL)**	
2						SM	Gray, silty SAND (medium dense, moist) **(ALLUVIUM)**	
	96			-200 = 19 W = 20				
4								
	94							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.1 ft.

6

HA-18

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	98						4" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	
						SP-SM		▽ Groundwater seepage encountered at 1.1 ft.
						MH/PT	Brown, fine to medium SAND with silt and trace gravel (medium dense, moist) **(FILL)**	
2	96						Dark brown PEAT with silt seams (soft, wet) **(MARSH DEPOSITS)**	
				W = 72				
4	94					SM	Bright gray, silty fine SAND with peat seams (very loose, wet)	

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.2 ft.

6

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-17

HA-19

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 109 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							11" of Forest Duff **(TOPSOIL/SOD/DUFF)**	
	108			SP- GS -200 = 8 W = 21		SM	Brown, fine to medium SAND with silt and trace gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2								
	106					SM	Orange-brown and gray, silty SAND with trace gravel (medium dense, wet)	▽ Groundwater seepage encountered at 3.1 ft.
4								
	104							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.1 ft.

6

HA-20

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							3" of Topsoil **(TOPSOIL/SOD/DUFF)**	
	114			GS -200 = 11 W = 15		SP- SM	Brown, fine to medium SAND with silt (medium dense, moist) **(FILL)**	
2								
	112					SM	Gray-black, silty SAND with trace organics (loose, moist to wet) **(MARSH DEPOSITS)**	
4				W = 21				▽ Groundwater seepage encountered at 4.2 ft.
	110							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.0 ft.

6

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-18

HA-21

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0				SM			3" of Topsoil **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	114						Brown, silty SAND (loose, moist) **(FILL)**	
2								
	112					ML	Gray, sandy SILT with organics (loose, moist) **(MARSH DEPOSITS)**	
4				W = 70				
	110							
	Hand Auger Boring Completed 08/20/12 Total Depth of Hand Auger Boring = 5.0 ft.							
6								

HA-22

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 105 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	104					SP-SM	Brown, fine to medium SAND with silt (loose, moist) **(FILL)**	
2								
	102					MH/PT	Dark brown SILT with sand and peat lenses (soft, moist) **(MARSH DEPOSITS)**	
4				W = 64				
	100							
	Hand Auger Boring Completed 08/20/12 Total Depth of Hand Auger Boring = 5.2 ft.							
6								

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-19

HA-23

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 130 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	130						9" of Forest duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
				SP- -200 = 6 W = 9		SM	Brown, fine to medium SAND with silt and gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
2	128							
4	126							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.1 ft.

6

HA-24

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 121 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	120						8" of Forest Duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
				GS -200 = 4 W = 6		SP-SM	Brown, very gravelly SAND (loose, moist) **(RECESSIONAL OUTWASH)** -grades to medium dense	
2	118							
4								

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.2 ft.

6

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-20

HA-25

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 96 Excavated By: Landau Associates Logged By: BJF	
0	96	S-1		GP W = 2			3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, sandy GRAVEL with cobbles (quarry spalls) and organics (medium dense, moist) **(FILL)**	
2	94	S-2				SP	Brown, gravelly fine to coarse SAND (medium dense, moist)	
4	92	S-3				SP	Brown, fine to medium SAND (loose, wet) **(RECESSIONAL OUTWASH)**	▽ Groundwater seepage encountered at 5.0 ft.
6	90							

Hand Auger Boring Completed 06/25/14

Refusal at 6.5 ft on Possible Bedrock

HA-26

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 95 Excavated By: Landau Associates Logged By: JTM	
0	95							
	94	S-1		W = 8 -200 = 2		GP	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, sandy GRAVEL with trace organics (medium dense, moist) **(FILL)**	Groundwater not encountered.
2	93	S-2				SP-SM	Brown, fine to medium SAND with silt (medium dense, moist) **(RECESSIONAL OUTWASH)** -grades to brown-gray with mottling, moist to wet -gray sand layer	
4	92						**Refusal at 3.2 ft on Possible Bedrock**	
6								

Hand Auger Boring Completed 06/24/14
Total Depth of Hand Auger Boring = 3.2 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-21

HA-27

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 95 Excavated By: Landau Associates Logged By: BJF	
0							12" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	94			SM			Orange/brown, silty SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2		S-1		W = 19 -200 = 27			-Charcoal/burnt wood at 2.5' to 2.8'	
	92	S-2		W = 20 -200 = 28			-grades to brown (medium dense, moist)	
		S-3		W = 18 -200 = 14		SP-SM	Brown gravelly SAND with silt (medium dense, moist to wet)	
4							**Refusal at 4.0 ft on Possible Bedrock**	
6								

Hand Auger Boring Completed 06/24/14
Total Depth of Hand Auger Boring = 4.0 ft.

HA-28

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 110 Excavated By: Landau Associates Logged By: BJF	
0	110	S-1		W = 13 -200 = 12		SM	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
		S-2		W = 4 -200 = 3		SP	Brown, silty SAND (medium dense, moist) **(FILL)**	
2	108						Orange/brown, fine to medium SAND with gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
		S-3		W = 8 -200 = 3		SP	Brown, fine to coarse SAND with gravel (medium dense, wet)	
4	106						**Refusal at 4.0 ft on Possible Bedrock**	
6								

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 4.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-22

HA-29

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 113 Excavated By: Landau Associates Logged By: BJF	
0				SP			3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	
	112	S-1		W = 4 -200 = 3			Orange/brown, gravelly, fine to medium SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2								
	110	S-2						
4								▽ Groundwater seepage encountered at 4.5 ft.
	108	S-3		W = 21 -200 = 31		SM	Orange/brown, very silty, fine to medium SAND (medium dense, wet)	
		S-4					-grades to with gravel (medium dense, wet)	
6								

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 6.0 ft.

HA-30

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 107 Excavated By: Landau Associates Logged By: JTM	
0						SP-SM	Brown, fine to medium SAND with silt and gravel (medium dense, moist)	
	106					SP-SM	**(FILL)**	
		S-1		W = 15 -200 = 9			Brown, fine to medium SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2								
	104	S-2						
4		S-3					-grades to wet	▽ Groundwater seepage encountered at 3.8 ft.
							Refusal at 4.3 ft on Possible Bedrock	
6								

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 4.2 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-23

HA-31

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 101 Excavated By: Landau Associates Logged By: BJF	
0	101						2" of Organic Topsoil **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	100	S-1		SP- W = 8 -200 = 9		SM	Brown, fine to medium SAND with silt and trace organics (medium dense, moist) **(FILL)**	
2							-grades to without organics	
	98	S-2						
		S-3					-grades to orange/brown	
4								
	96							
		S-4					-grades to brown	
6							**Refusal at 5.7 ft on Possible Bedrock**	

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 5.7 ft.

HA-32

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 106 Excavated By: Landau Associates Logged By: BJF	
0	106						3" of Organic Topsoil **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
		S-1				SP-SM	Brown, fine to medium SAND with silt and trace organics (loose, moist) **(FILL)**	
2	104	S-2					-grades to medium dense, without organics	
4	102							
		S-3						
6	100						**Refusal at 6.1 ft on Weathered Bedrock**	

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 6.1 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-24

HA-33

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Landau Associates Logged By: BJF	
0	98						4" of Organic Topsoil **(TOPSOIL/SOD/DUFF)**	
		S-1		W = 33		SM	Brown, silty SAND with trace organics (medium dense, moist) **(FILL)**	
2	96							▽ Groundwater seepage encountered at 2.8 ft.
		S-2		W = 30		SM	Orange/brown, silty, fine to medium SAND (medium dense, wet) **(RECESSIONAL OUTWASH)**	
4							**Refusal at 3.9 ft on Weathered Bedrock**	
6								

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 3.9 ft.

HA-34

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 110 Excavated By: Landau Associates Logged By: BJF	
0	110					SP-SM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
		S-1				SP-SM	Brown, fine to coarse SAND with silt, gravel, and organics (dense, moist) **(FILL)**	
		S-2				GP	Brown, fine to medium SAND with gravel and trace organics (medium dense, moist)	
2	108	S-3					Brown, cobbly GRAVEL with sand (dense, moist)	
4							**Refusal on Roadway Ballast at 3.1 ft**	
6								

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 3.1 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-25

HA-35

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0		S-1		W = 9P-		SM	Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF 2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
2							Brown, gravelly, fine to medium SAND with silt (medium dense, moist) **(RECESSIONAL OUTWASH)** -becoming cobbly at 1.2 ft **Refusal on Weathered Bedrock at 1.2 ft**	
4								
6								

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 1.2 ft.

HA-36

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0							Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF 9" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
2		S-1				SP-SM	Brown, fine to medium SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
4							**Refusal on Bedrock or Possible Utility at 3.5 ft**	
6								

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 3.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-26

HA-37

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
0	S-1		SP- W = 9		SM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt, gravel, and trace organics (medium dense, moist) **(FILL)**	Groundwater not encountered.
2							
						Hand Auger Boring Completed 06/25/14 Total Depth of Hand Auger Boring = 3.0 ft.	**Refusal at 3.0 ft on Bedrock**
4							
6							

HA-38

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
0					SP- SM	3" of Organic Topsoil **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	S-1					Brown, fine to medium SAND with silt, gravel, and trace organics (medium dense, moist) **(FILL)**	
2	S-2		W = 25 -200 = 39		SM	Mottled gray/brown, very silty, fine to medium SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
	S-3					-grades to with gravel	
4							
						Hand Auger Boring Completed 06/26/14 Total Depth of Hand Auger Boring = 4.3 ft.	**Refusal at 4.3 ft on Bedrock**
6							

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-27

HA-39

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0							Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
		S-1		GP- W = 6		GM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, sandy GRAVEL with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**	Groundwater not encountered.
2		S-2				SP	Brown, fine to medium SAND with gravel (medium dense, moist)	
4								
							Hand Auger Boring Completed 06/26/14 Total Depth of Hand Auger Boring = 4.7 ft.	**Refusal at 4.7 ft on Bedrock**
6								

HA-40

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0							Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
						SP- SM	2" of Organic Topsoil **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt and gravel (medium dense, moist) **(FILL)**	Groundwater not encountered.
2								
		S-1						
4								
							Hand Auger Boring Completed 06/26/14 Total Depth of Hand Auger Boring = 5.1 ft.	
6								

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-28

APPENDIX B
PHYSICAL SOIL TESTING

Soil samples obtained from the geotechnical borings were taken to our laboratory for further examination and testing. Laboratory tests were performed on representative soil samples to characterize certain engineering and index properties of the site soil. The laboratory testing program included visual inspection to confirm our field soil descriptions, determination of natural moisture content, grain size analysis, and determination of fines fraction (percent passing the U.S. Standard No. 200 sieve). A description of the testing performed is presented below.

NATURAL MOISTURE CONTENT

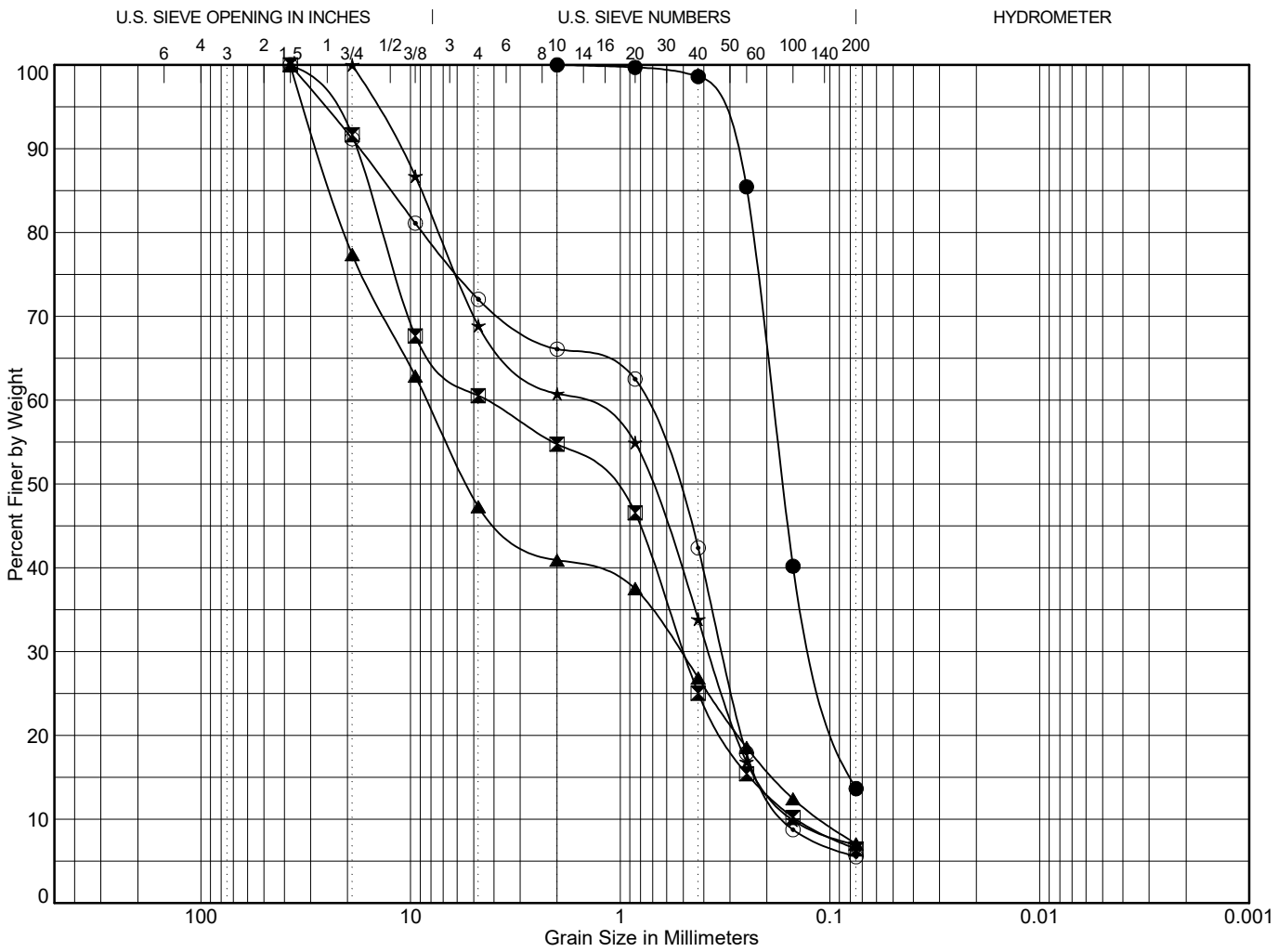
The natural moisture contents of selected soil samples obtained from the explorations were determined in general accordance with International ASTM (ASTM) D 2216 test method. The results from the moisture content determinations are indicated on the summary logs presented in Appendix A, adjacent to the corresponding sample.

GRAIN SIZE ANALYSES

Sieve analyses were conducted on representative soil samples obtained from the explorations in accordance with ASTM test method D422 to provide an indication of the grain size distribution of the onsite soil. Samples selected for grain size analyses are designated with a "GS" in the column labeled "Test Data" on the summary boring logs in Appendix A. The results of the grain size analyses are presented in the form of grain size distribution curves on Figures B-1 through B-4 in this appendix.

FINES FRACTION

The fines fraction (percent passing the U.S. Standard No. 200 sieve) of select soil samples was determined in general accordance with ASTM D 422 test procedures. The test results are indicated on the summary logs presented in Appendix A, adjacent to the corresponding sample.



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point		Depth	Classification	LL	PL	PI	C_c	C_u
●	B-5	3.0	Fine, SAND with silt (SP-SM)					
⊠	B-5	8.0	Very gravelly, SAND with silt (SP-SM)				0.39	30.46
▲	B-5	10.0	Very sandy, GRAVEL with silt (GP-GM)				0.30	76.35
★	B-5	35.5	Very gravelly, SAND with silt (SP-SM)				0.52	11.80
⊙	B-5	40.5	Gravelly, SAND with silt (SP-SM)				0.84	4.85

Point		Depth	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	B-5	3.0	2	0.188	0.168	0.115		0.0	0.0	0.0	1.4	85.0	13.7
⊠	B-5	8.0	37.5	4.382	1.218	0.499	0.144	8.3	31.1	5.8	29.7	18.6	6.4
▲	B-5	10.0	37.5	8.362	5.36	0.522	0.11	22.6	30.1	6.4	14.1	19.8	7.1
★	B-5	35.5	19	1.787	0.723	0.377	0.151	0.0	31.1	8.1	26.9	26.9	6.9
⊙	B-5	40.5	37.5	0.779	0.552	0.325	0.161	8.8	19.2	5.9	23.7	36.8	5.5

$C_c = D_{30}^2/(D_{60} * D_{10})$
$C_u = D_{60}/D_{10}$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

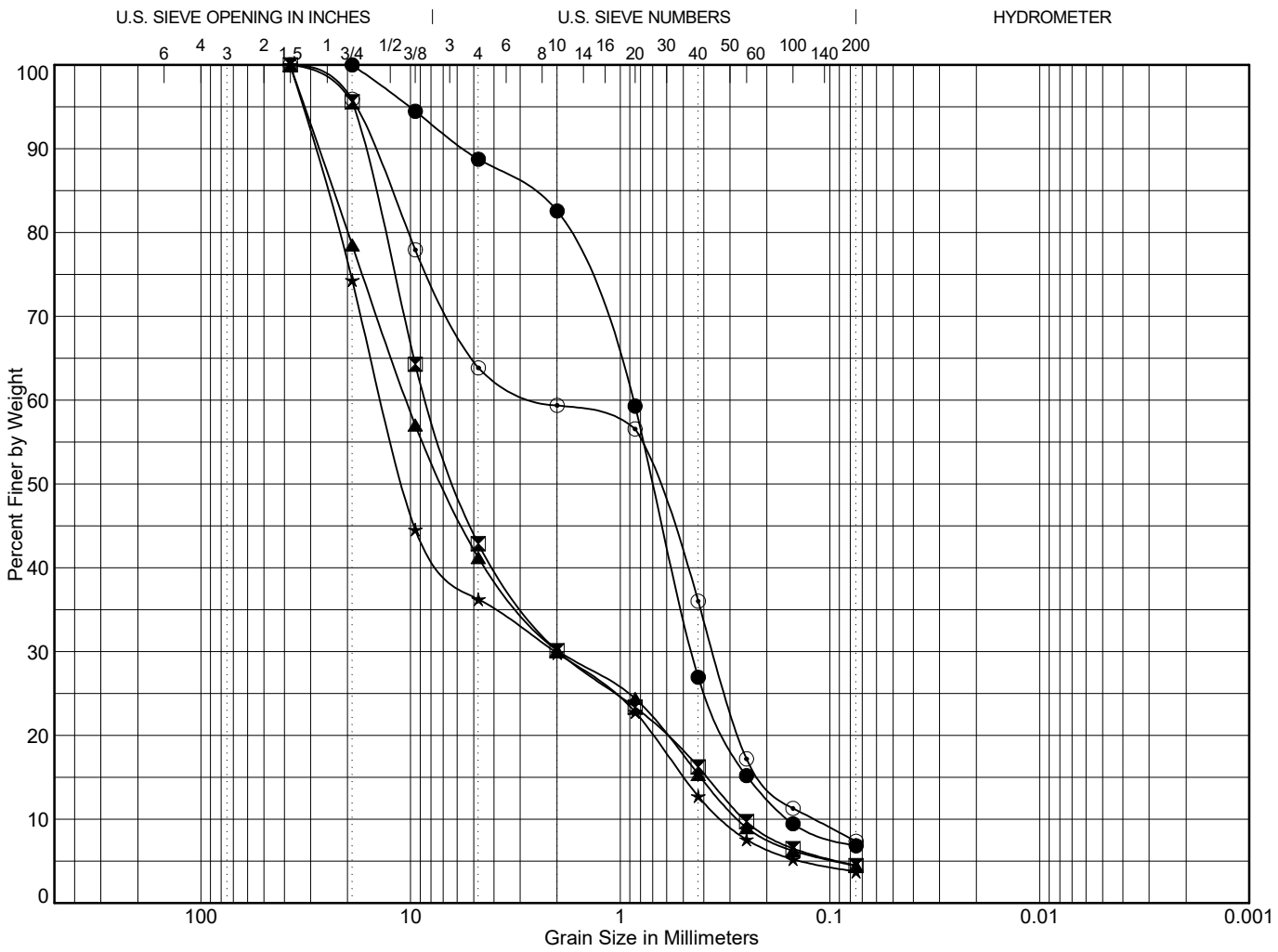
1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ GRAIN SIZE W/STATS

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Grain Size Test Data

Figure
B-1



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point		Depth	Classification	LL	PL	PI	C_c	C_u
●	B-5	50.5	SAND with silt and gravel (SP-SM)				1.50	5.54
⧓	B-6	8.0	Very sandy GRAVEL (GP)				1.85	32.30
▲	B-6	10.0	Very sandy GRAVEL (GP)				1.35	38.49
★	B-7	30.0	Very sandy GRAVEL (GP)				0.96	42.44
⊙	B-7	80.0	Very gravelly, fine to medium SAND with silt (SP-SM)				0.48	18.90

Point		Depth	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	B-5	50.5	19	0.872	0.697	0.454	0.157	0.0	11.3	6.2	55.6	20.1	6.8
⧓	B-6	8.0	37.5	8.271	5.984	1.977	0.256	4.4	52.7	12.8	13.8	11.8	4.5
▲	B-6	10.0	37.5	10.452	6.979	1.957	0.272	21.5	37.3	11.1	14.8	10.9	4.4
★	B-7	30.0	37.5	13.613	10.785	2.049	0.321	25.7	38.1	6.4	17.1	9.0	3.7
⊙	B-7	80.0	37.5	2.258	0.681	0.359	0.119	4.1	32.1	4.5	23.4	28.7	7.4

$C_c = D_{30}^2/(D_{60} * D_{10})$ To be well graded: $1 < C_c < 3$ and

$C_u = D_{60}/D_{10}$ $C_u > 4$ for GW or $C_u > 6$ for SW

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ GRAIN SIZE W/STATS

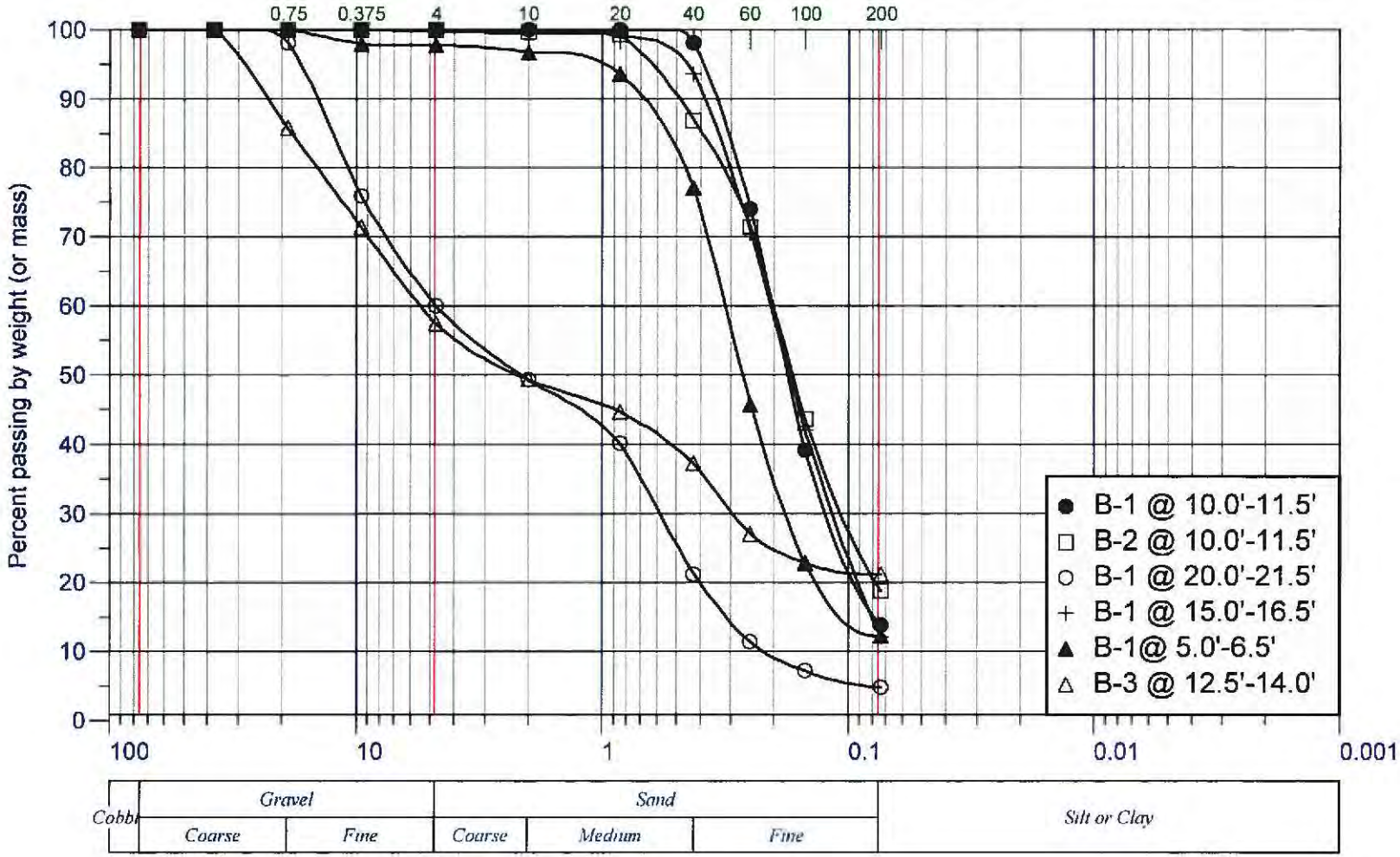
LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Grain Size Test Data

Figure
B-2

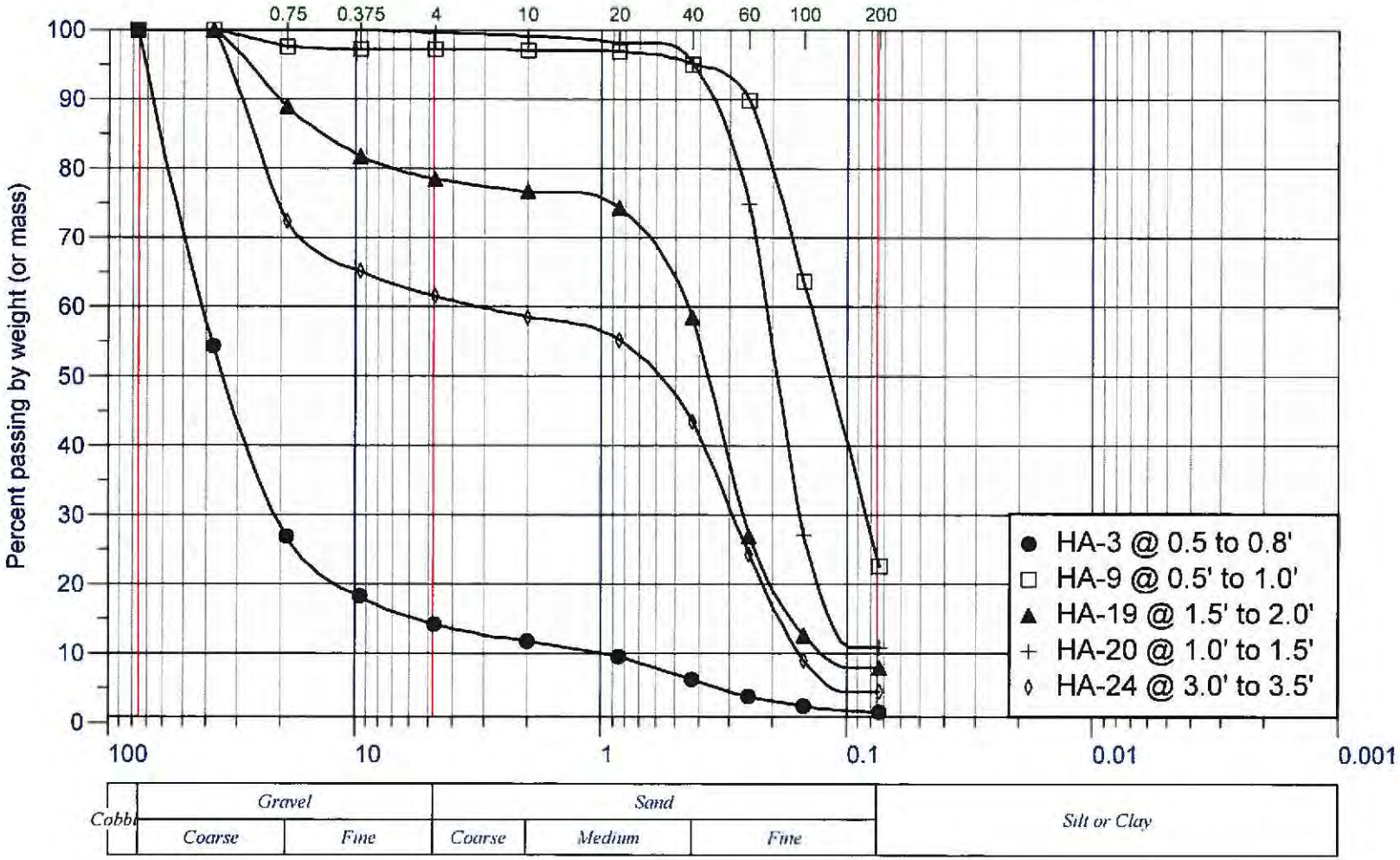
Grain Size Distribution (ASTM D422)



LANDAU ASSOCIATES	Deschutes Valley Trail Tumwater, WA	**Grain Size Profile**

Figure
B-3

Grain Size Distribution (ASTM D422)



LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Grain Size Profile**	Figure B-4

ATTACHMENT 4

Seismic Design Parameters and Survey Results

Seismic Design Parameters
***AASHTO LRFD Bridge Design Specifications* (10th Edition)**

Period (s)	Spectral Acceleration (g)
0	0.608
0.01	0.609
0.02	0.623
0.03	0.642
0.05	0.689
0.075	0.841
0.1	1.04
0.15	1.23
0.2	1.33
0.25	1.34
0.3	1.38
0.4	1.37
0.5	1.26
0.75	1.01
1	0.804
1.5	0.586
2	0.449
3	0.29
4	0.213
5	0.164
7.5	0.0964
10	0.0733

Abbreviations and Acronyms:

AASHTO = American Association of State Highway and Transportation Officials

LRFD = Load and Resistance Factor Design

g = force of gravity

s = seconds

Global Geophysics

P. O. Box 2229
Redmond, WA, 98073-2229
Tel: 425-890-4321

Report on 1D MASW and MAM Surveys

4833 Tumwater Valley Dr SE, Olympia, WA 98501

Global Geophysics Project No. 116-0112.000

Prepared for
Kate Masterson
Sage Geotechnical
2840 Crites St SW STE 104
Tumwater, WA 98512

Prepared by
Global Geophysics LLC
P.O. Box 2229
Redmond, WA 98073-2229

January 20, 2026

CONTENTS

1. Objective 3
2. Introduction 3
3. Methodology and Instrumentation 4
3.1 Microtremor Array Measurements (MAM) Method 4
3.2 Surface Wave Dispersion Curve Modeling 5
4. Instruments and Equipment 5
4.1 MAM 5
5. Procedures 7
5.1 Field Deployment 7
5.2 Quality Control and Data Processing 7
5.2.1 Quality Control 7
5.2.2 Data Processing 7
6. Results 8
7. Analysis 12
8. Limitations of the Geophysical Method 13
9. References 14

1. OBJECTIVE

Global Geophysics, LLC conducted two passive MAM surveys near 4833 Tumwater Valley Dr SE, Olympia, WA 98501 on January 16, 2026. The goal of this investigation was to determine the average shear wave velocity to a depth of 100 feet. This report provides the methods, instrumentation, data collection and processing procedures, results, and analysis of this investigation.

2. INTRODUCTION

Surface waves are a special type of seismic wave whose propagation is confined to the near surface medium. The depth of subsurface penetration of a surface wave is directly proportional to its wavelength. In a non-homogeneous medium, surface waves are dispersive, i.e. each wavelength has a characteristic velocity stemming from subsurface variations in the soils and rocks. The velocity that the surface waves' wavelengths propagate through the subsurface is related to the shear wave (S-Wave) velocity of the subsurface. If the S-Wave velocity varies with depth, so will the surface wave's wavelength velocity. Analysis of how the wavelength varies, or dispersion, allows us to estimate the S-Wave velocity as it passes through the subsurface. The S-Wave velocity of the subsurface can then be used to infer useful characteristics such as the rock/soil type, stratigraphy, and soil conditions.

Average S-Wave velocities to a depth of 100ft (30m) are known as V_{S100} (V_{S30}) and are sorted into classes by the International Building Code (IBC) to provide valuable earthquake engineering design information. These classes are shown here:

Class Name	**Ground Description**	**V_{S100}**	**V_{S30}**
A	Hard Rock	>5000ft/s	>1500m/s
B	Rock	5000ft/s to 2500ft/s	1500m/s to 760m/s
C	Dense Soil or Soft Rock	2500ft/s to 1200ft/s	760m/s to 360m/s
D	Stiff Soil	1200ft/s to 600ft/s	360m/s to 180m/s
E	Soft Soil	<600ft/s	<360m/s
F	Needs site specific evaluation	NA	NA

Surface waves can be utilized in both active and passive deployments. Multichannel Analysis of Surface Waves (MASW) comprises most active deployments while Microtremor Array Measurements (MAM) are the primary method to collect passive data. MASW arrays are typically linear while MAM arrays can be linear (often known as refraction microtremor, or ReMi, when linear) but generally perform better when deployed in 2D orientations (triangular, circular, T-shaped, or L-shaped arrays). Another passive method employed is the Horizontal over Vertical Spectral Ratio (HVSR) which utilizes a single geophone sensitive to motion in three directions (vertical, east-west, and north-south).

For this project, seismic surveys were deployed at each of the locations shown on Fig. 1.



Figure 1. Site Plan

3. METHODOLOGY AND INSTRUMENTATION

3.1 Microtremor Array Measurements (MAM) Method

A detailed description of the MAM method can be found in Okada, 2003. MAM arrays generally have a greater degree of flexibility with their design and in addition to linear arrays, can be deployed in 2D arrays such as the circular, triangular, T and L arrays. Since this is a passive survey, the ambient vibrations of the surroundings are utilized rather than deliberately generated. These passive sources can come from all directions and include traffic, ocean waves, cultural noise, and construction. MAM arrays should utilize an array size equal to or greater than the depth of investigation (Geometrics, 2009) and record the ambient vibrations for a minimum of 30 seconds and collect a minimum of 10 minutes of data.

Wireless sensors, such as the SmartSolo IGU-16 or the Geometrics Atom enable passive arrays to be deployed to sizes much larger than wired arrays. Wireless MAM arrays can span several hundred, or even several thousand feet; enabling much deeper investigations into the subsurface.

3.2 Surface Wave Dispersion Curve Modeling

Dispersion curves are useful for determining S-Wave velocities of the subsurface and are generated with the help of specialized software. Data files are added to the software and their traces displayed by location versus time, showing the seismic waves that arrive at each geophone over the course of the record.

For MAM surveys, the data are transformed with a fast Fourier transform to the frequency domain. Then the coherence (or similarity between traces or waveforms) is calculated. If the coherences are averaged over a long period of time or over many data blocks, the data are considered to be Spatially Auto-Correlated (SPAC) ((Aki, 1957). From here, the phase velocity can be calculated from each frequency and fundamental and higher modes can be picked. From the fundamental mode, the dispersion curve can be created and edited (Roesset, 1991). The dispersion curve is used to create an inversion model that displays the S-Wave velocities at the desired range of depths (Xia, Miller, & Park, 1999). Theoretical dispersion curves are generated via a matrix method (Saito & Kabasawa, 1993) and compared against the observed dispersion curve. The model is updated until the observed and theoretical dispersion curves converge. The resulting model is the delivered S-Wave velocity model for the array.

4. INSTRUMENTS AND EQUIPMENT

4.1 MAM

For this investigation, Global Geophysics used 24 4.5 Hz SmartSolo IGU-16 wireless sensors (Figure 2). Data were downloaded via the Smartsolo All-in-One (AIO) box (Figure 3). Data processing was done with Geometrics SeisImager software package.



Figure 2. SmartSolo IGU-16 wireless sensor



Figure 3. SmartSolo All-in-One (AIO) box

5. PROCEDURES

5.1 Field Deployment

MAM Sounding

The MAM Soundings were linear 10 ft spaced 24 sensor long arrays. Sensor deployments can be found in Figure 4. Data were recorded for approximately 20 min.

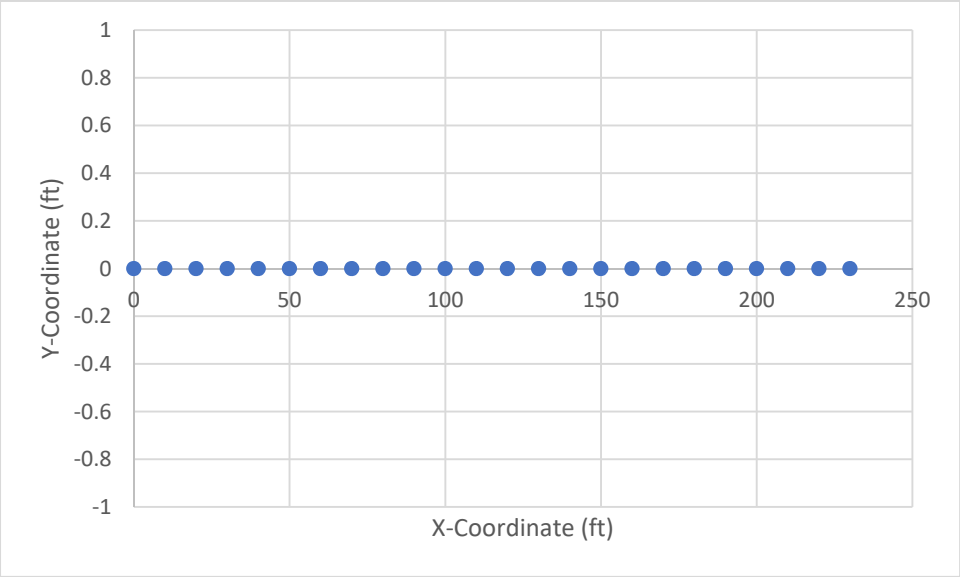


Figure 4. S-1 MAM Sounding Wireless Sensor Deployment

5.2 Quality Control and Data Processing

5.2.1 Quality Control

Wireless MAM Arrays

Data were recorded for 20 minutes to record enough vibrations at various frequencies.

5.2.2 Data Processing

Wireless MAM Arrays

Data were opened in the Surface Wave Analysis Wizard within SeisImager using the Passive Source (Microtremor) tool. A dispersion curve is generated from the data and the fundamental mode is picked with the assistance of the software. Uncertain data at high and low frequencies are clipped. The dispersion curve is inverted with the Wave EQ program within SeisImager and an initial model is generated. The model is improved by using a Least Square Method inversion with at least 5 iterations.

6. RESULTS

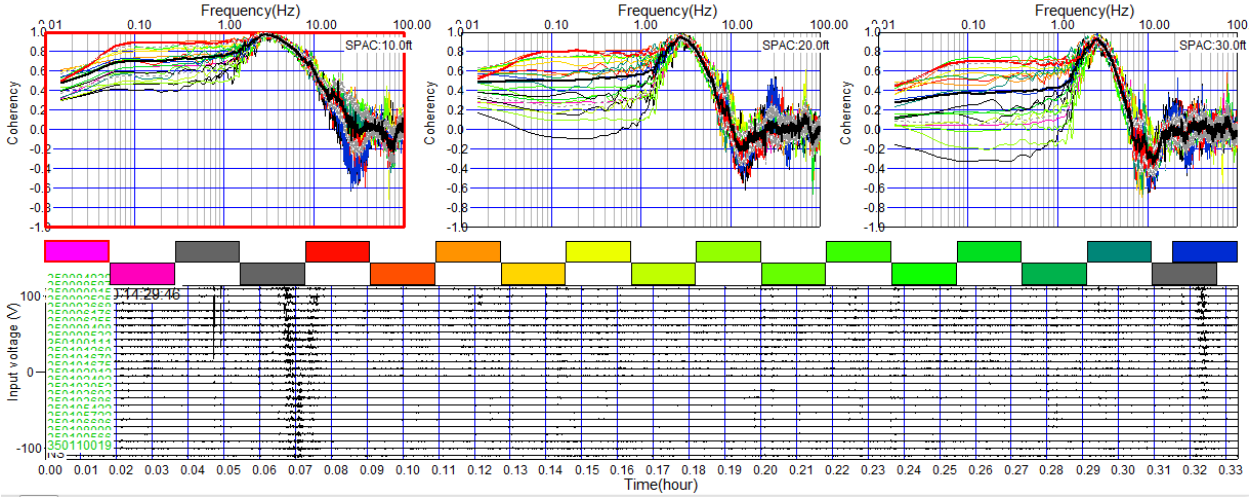


Figure 5. S-1 MAM Sounding Coherency

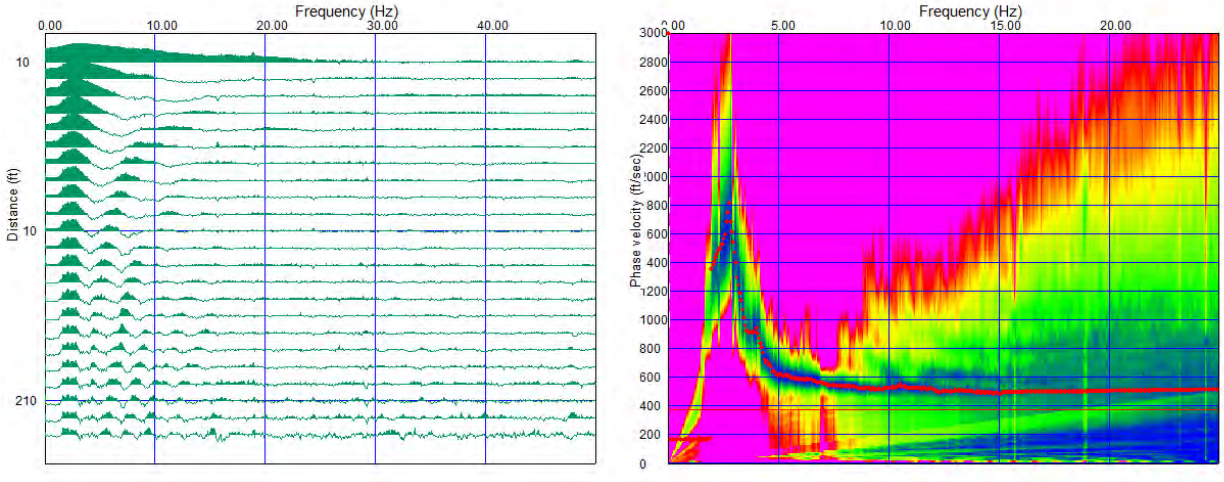


Figure 6. S-1 MAM Sounding Dispersion Curve

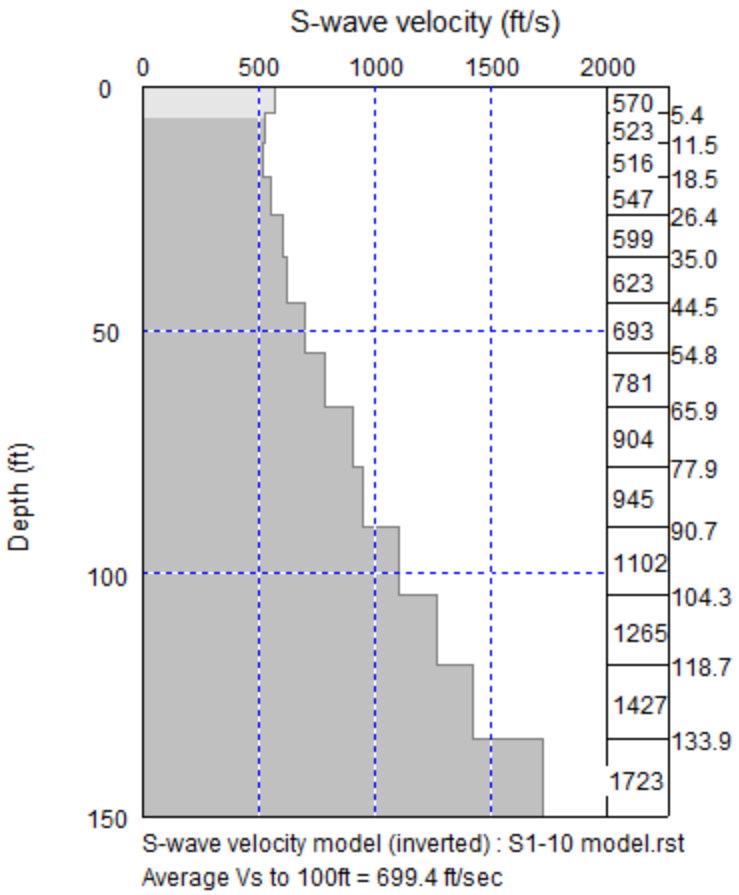


Figure 7. S-1 MAM S-Wave Model

Depth(ft)	S-wave velocity (ft/sec)
0	571
5	524
12	516
19	548
26	599
35	623
45	694
55	781
66	904
78	946
91	1103
104	1266
119	1427
134	1724
150	1723

Table 1. S-1 S-Wave Velocities at Specific Depths

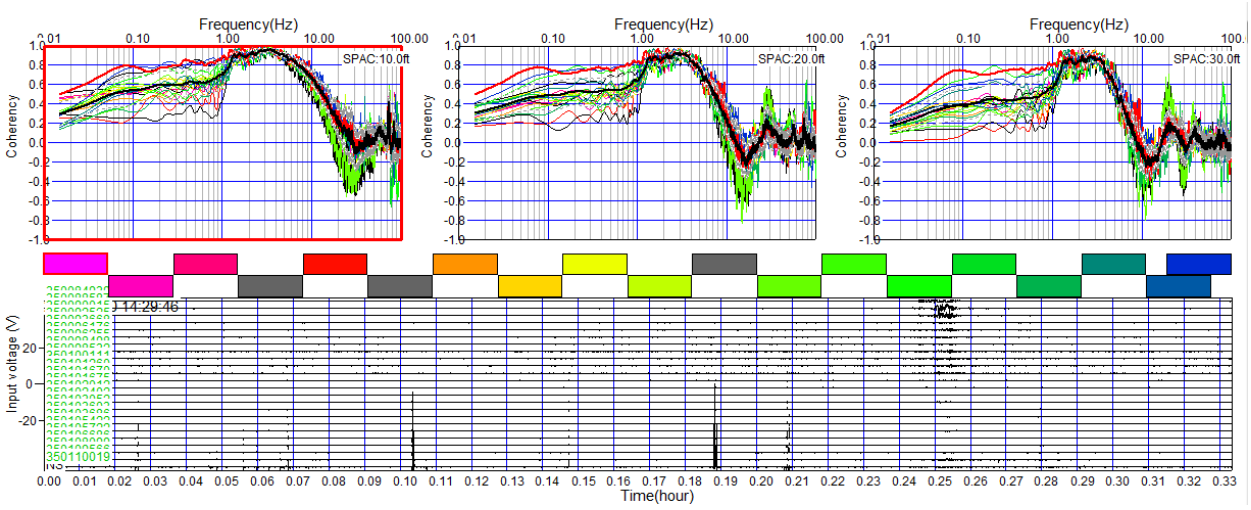


Figure 8. S-2 MAM Sounding Coherency

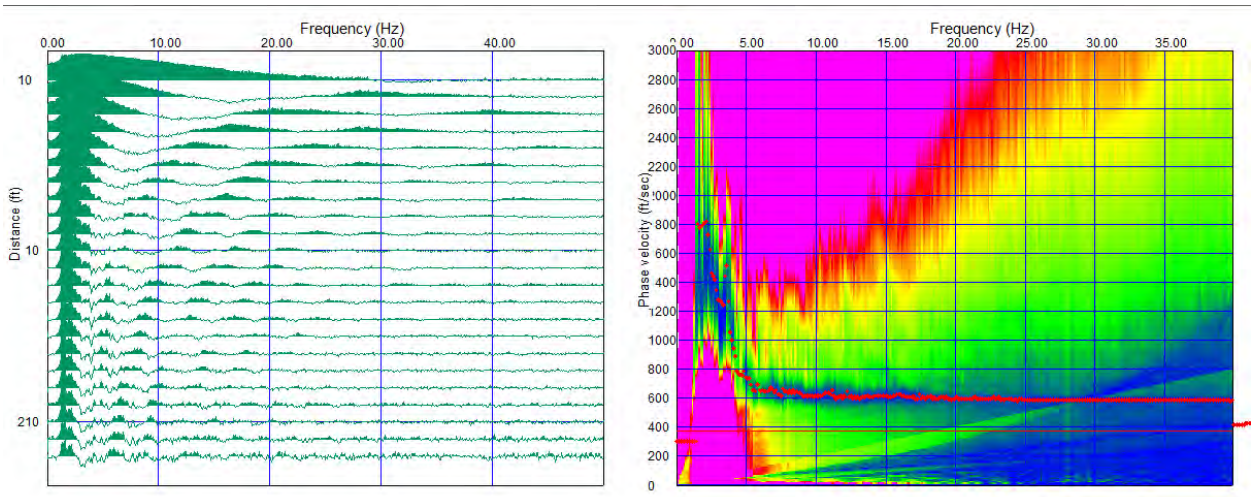


Figure 9. S-2 MAM Sounding Dispersion Curve

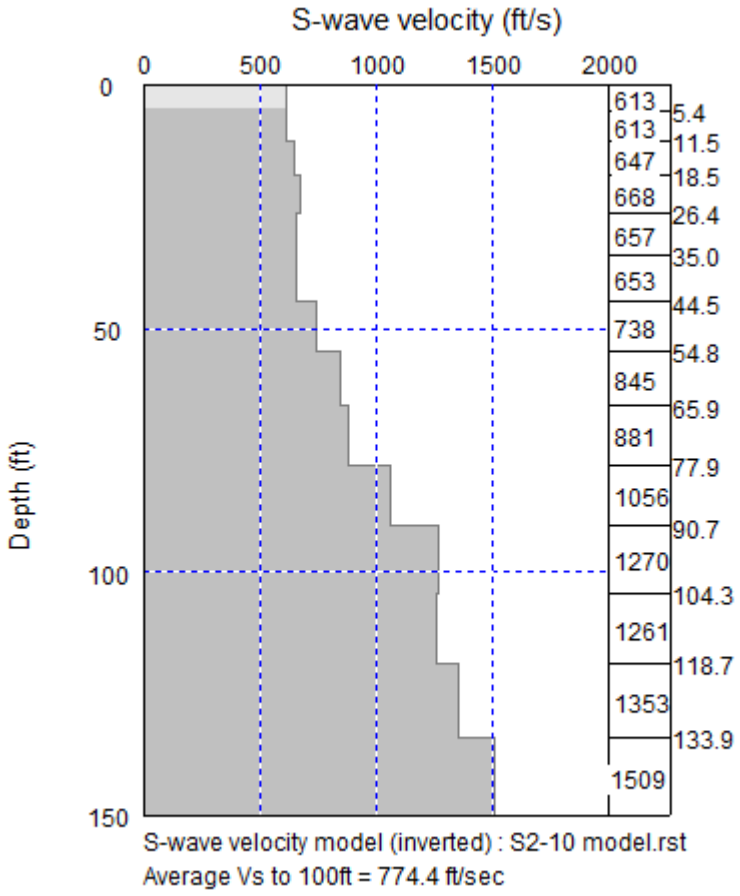


Figure 10. S-2 MAM S-Wave Model

Depth(ft)	S-wave velocity (ft/sec)
0	613
5	614
12	648
19	668
26	657
35	653
45	738
55	846
66	882
78	1057
91	1271
104	1261
119	1354
134	1510
150	1509

Table 2. S-2 S-Wave Velocities at Specific Depths

7. ANALYSIS

Figure 5 shows the S-1 sounding coherency. Figure 6 shows the S-1 sounding dispersion curve with the fundamental mode picked in red. Figure 7 shows the S-1 shear wave velocity profiles for the MAM sounding. Table 1 shows the modeled shear wave velocities of the subsurface at specific depths for S-1. Figure 8 shows the S-2 sounding coherency. Figure 9 shows the S-21 sounding dispersion curve with the fundamental mode picked in red. Figure 10 shows the S-2 shear wave velocity profiles for the MAM sounding. Table 2 shows the modeled shear wave velocities of the subsurface at specific depths for S-2.

The V_{S100} value for S-1 is 699.4 ft/s.

The V_{S100} value for S-2 is 774.4 ft/s.

8. LIMITATIONS OF THE GEOPHYSICAL METHOD

Global Geophysics' services are conducted in a manner consistent with the level of care and skill ordinarily exercised by other members of the geophysical community currently practicing under similar conditions and are subject to the time limits, financial and physical constraints applicable to the services. MAM and 1D MASW are remote sensing geophysical methods that may not detect all subsurface conditions due to the limitations of the method, soil conditions, size of features, and their depths.

Sincerely,

Global Geophysics, LLC.

Evangeline Johnston
Field Operation Manager

John Liu, Ph.D., R.G.
Principal Geophysicist

9. REFERENCES

Aki, K. (1957). Space and time spectra of stationary stochastic waves, with special reference to microtremors. *Earthquake Res. Inst. Univ. Tokyo*(25), 415-457.

Geometrics. (2009, October). *SeisImager/SW Manual*. Retrieved from Geometrics.com: https://geometrics.com/wp-content/uploads/2019/04/SeisImagerSW_Manual_v3.0.pdf

Nakamura, Y. (1989). A method for dynamic characteristics estimation of subsurface using microtremor on the ground surface. *Quarterly Report of Railway Technical Research Institute*, 30(1), 25-33.

Okada, H. (2003). The Microtremor Survey Method. *Society of Exploration Geophysics Geophysical Monograph Series, 12*, 135.

Park C, M. R. (1999). Multichannel Analysis of Surface Waves. *Geophysics, 64*(3), 800-808.

Park, C. B, Miller, R. D., Xia, J., Ivanov, J. (2007 Jan). Multichannel analysis of surface waves (MASW) – active and passive methods. *The Leading Edge*, 60-64.

Roesset, J. (1991). Comparison of 2-D and 3-D Models for Analysis of Surface Wave Tests. *5th International Conference on Soil Dynamics and Earthquake Engineering.* Karlsruhe, Germany.

Saito, M., & Kabasawa, H. (1993). Computation of reflectivity and surface wave dispersion curves; Rayleigh wave calculations. *Butsuri-tansa*, 283-298.

Taipodia, J., & Babu, K. (2013). Subsurface Characterization using MASW: Preliminary Experimentation and analysis. *International Journal of Innovative Research in Science, Engineering and Technology*, 129-138.

Xia, J., Miller, R., & Park, C. (1999). Estimation of near-surface shear-wave velocity by inversion of Rayleigh waves. *Geophysics*, 691-700.

NEXT DOCUMENT

Draft
Geotechnical Engineering Report
Deschutes Valley Trail
Tumwater, Washington

July 9, 2014

Prepared for

Robert W. Droll
Landscape Architect, PS

LANDAU ASSOCIATES
1115 West Bay Drive NW, Suite 201
Olympia, WA 98502
(360) 791-3178

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1-1
	1.1 PROJECT UNDERSTANDING	1-1
	1.2 SCOPE OF SERVICES	1-2
2.0	SITE CONDITIONS	2-1
	2.1 SURFACE CONDITIONS	2-1
	2.1.1 WET SURFACE CONDITIONS	2-2
	2.1.2 CART PATH CONDITIONS	2-2
	2.2 GEOLOGY REVIEW	2-2
	2.3 SUBSURFACE EXPLORATIONS	2-3
	2.3.1 SUBSURFACE CONDITIONS	2-3
	2.3.1.1 General	2-3
	2.3.2 Valley Subsurface Conditions Summary	2-4
	2.3.3 Upland Subsurface Condition Summary	2-5
	2.3.4 Groundwater Conditions	2-5
	2.4 LABORATORY TESTING	2-6
3.0	ENGINEERING STUDIES AND RECOMMENDATIONS	3-1
	3.1 GENERAL	3-1
	3.2 STABILITY ANALYSES OF PROPOSED CUT SLOPES AND FILL EMBANKMENTS	3-1
	3.3 EMBANKMENT SETTLEMENT	3-2
	3.4 PAVEMENT DESIGN	3-3
	3.5 SEISMIC DESIGN CONSIDERATIONS	3-4
	3.5.1 Spectral Acceleration Parameters	3-4
	3.5.2 Soil Liquefaction	3-4
	3.5.3 Lateral Spreading	3-5
	3.6 BRIDGE ABUTMENT SHALLOW FOUNDATION SUPPORT	3-5
	3.6.1 General	3-5
	3.6.2 Deschutes River Bridge Shallow Foundation Seismic Design Considerations	3-5
	3.6.3 Shallow Foundation Design Parameters	3-6
	3.7 BRIDGE ABUTMENT DEEP FOUNDATION SUPPORT	3-7
	3.7.1 General	3-7
	3.7.2 Axial Capacity	3-7
	3.7.3 Lateral Spreading Loads	3-8
	3.7.4 Lateral Capacity	3-9
4.0	EARTHWORK AND CONSTRUCTION RECOMMENTATIONS	4-1
	4.1 GENERAL	4-1
	4.2 CLEARING AND STRIPPING	4-1
	4.3 SUBGRADE PREPARATION	4-1
	4.3.1 General	4-1
	4.3.2 Bridge Abutments	4-2
	4.4 TEMPORARY EXCAVATIONS	4-2
	4.5 DEEP FOUNDATION INSTALLATION	4-3

DRAFT

	4.5.1	Driven Piles	4-3
	4.5.2	Drilled Shafts	4-3
4.6		GROUNDWATER HANDLING	4-4
4.7		WET WEATHER EARTHWORK	4-4
4.8		STRUCTURAL FILL	4-5
	4.8.1	General	4-5
	4.8.2	Onsite Soil	4-5
	4.8.3	Placement and Compaction	4-5
5.0		OUTSTANDING FINAL DESIGN ISSUES	5-1
6.0		REFERENCES	6-1

FIGURES

Figure	Title
1	Site Map
2	Vicinity Map
3	Site and Exploration Plan
4	Site and Exploration Plan
5	Site and Exploration Plan
6	Site and Exploration Plan
7	Geologic Profile A-A'
8	Axial Shaft Capacity Service and Strength Limit States
9	Axial Shaft Capacity Extreme Event Limit State
10	Axial Pile Capacity Service and Strength Limit States
11	Axial Pile Capacity Extreme Event Limit State

TABLES

Table	Title
1	Slope Stability Analyses Results
2	AASHTO Seismic Parameters
3	Resistance Factors for Single Shafts
4	Resistance Factors for Driven Piles
5	L-Pile Soil Parameters
6	P-Multipliers for Group Effects

APPENDICES

Appendix	Title
A	Subsurface Explorations
B	Laboratory Test Results

DRAFT

1.0 INTRODUCTION

Landau Associates is pleased to present this report of our geotechnical engineering services in support of the proposed Deschutes Valley Trail project located in Tumwater, Washington. Our services have been completed in general accordance with our July 31, 2012 and February 26, 2014 signed agreements for the project. Our 2012 services were provided by Bay Townes Geotechnical (now Landau Associates). This standalone report incorporates the 2012 Bay Townes Geotechnical findings under the name Landau Associates.

1.1 PROJECT UNDERSTANDING

Our project understanding is based on conversations with Robert W. Droll Landscape Architect, PS personnel and information provided. The proposed trail extends from Tumwater Historical Park to Pioneer Park. The overall project location is shown on the Site Map on Figure 1. Additional details are provided on Figures 2 through 6.

We understand that the trail will be approximately 19 feet (ft) wide and paved with asphalt concrete pavement (ACP). A significant portion of the trail alignment is common with the existing golf cart path (cart path) along the west side of the Tumwater Valley Golf Course. We understand that the cart path pavement surface will likely be removed, and the base course materials left in place will be incorporated into the new pavement section. The northern-most portion of the proposed trail will utilize an existing paved trail.

Trail Spur #3 ascends a steep slope prior to connecting to T Street. We understand that significant cut and fill grading will be required in this area to meet 5 percent trail grade requirements. The larger cut and fill sections could be as thick as 20 ft. We understand that proposed grades for the remaining portions of the project will typically match existing grades, with the exception of regrading a few local low points.

The proposed trail includes three new bridge crossings: 1) the Palermo Waterway Bridge, 2) the Deschutes River Bridge and 3) the Deschutes River Slough Bridge. Preliminary estimates for the maximum bridge span are 60 ft, 120 ft, and 80 ft, respectively. The City of Tumwater has requested shallow foundation support for the Palermo Waterway Bridge. Based on our experience, we also anticipate that shallow foundations will be utilized for the Deschutes River Slough Bridge. These are both simple span pedestrian structures, and we anticipate that the structural bridge design will follow the simplified seismic design requirements for single span bridges presented in the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications. Under this simplified seismic design approach, bridge and abutment damage is acceptable as the result of a seismic event.

DRAFT

The Deschutes River Bridge will include a span of approximate 120 ft to cross the Deschutes River (River), as well as approach structures or embankments. However, embankments could be unfeasible due to permitting limitations on grading within floodplains. At this preliminary design level, both shallow and deep foundations are being considered for support of the Deschutes River Bridge. The final selection on foundation type for this structure will need to consider the City of Tumwater's seismic performance expectations and collapse prevention objectives as determined by the structural engineer (MC-Squared) utilizing the information presented in this report. Preliminary loading information presented by MC-Squared includes a maximum of 50 kips live load and 120 kips dead load at each abutment.

We understand that the trail will be designed as a shared-use path in general accordance with the criteria presented in Chapter 1515 of the Washington State Department of Transportation (WSDOT) Design Manual M 22-01.09. Accordingly, our geotechnical recommendations in this report are presented in general accordance with the appropriate WSDOT standards.

1.2 SCOPE OF SERVICES

The objective of our scope of services was to explore the subsurface site conditions as a basis for developing geotechnical recommendations for the proposed trail development. Our specific scope of services included the following tasks:

- Review available information for the site, including geologic maps and previous geotechnical information provided by others.
- Walk the trail alignment with Tumwater Valley Golf Course personnel to help establish an understanding of the site conditions during the wetter times of the year.
- Coordinate the location and clearance of underground utilities in the area of our proposed subsurface explorations.
- Explore the subsurface site conditions using a combination of drilled borings and hand augers. Our exploration program included:
  - Eight drilled borings to depths of between 19.0 and 101.5 ft BGS in the area of the proposed bridges and along the top of the steep slope at Trail Spur #3. The purpose of the borings was to assess bridge foundation support and site slope stability.
  - Forty hand augers to depths of not more than 6.1 ft below ground surface (BGS) along the proposed trail alignment. The purpose of the hand augers was to assess pavement support characteristics and identify areas of soft or organic soils.
    - The borings were completed with track- and truck-mounted drilling equipment under subcontract to Landau Associates. Standard Penetration Test samples were taken at intervals of 5 ft or less during drilling. Landau Associates' personnel completed the hand augers and monitored the borings on a full-time basis.

DRAFT

- Perform geotechnical laboratory testing on selected samples. Our laboratory testing program consisted of grain-size distribution analyses (sieves), moisture content determinations, and fines content determinations (percent passing the No. 200 sieve).
- Provide geotechnical construction recommendations for earthwork and grading of the trail. Our recommendations include estimated stripping depth, subgrade preparation, structural fill and placement and compaction, temporary and permanent cut and fill slope inclinations, the potential for reuse of on-site materials as structural fill and design pavement sections.
- Provide seismic design parameters (spectral acceleration coefficients and Site Class) for the proposed bridge structure using map-based methods in accordance with AASHTO criteria. We also evaluate the potential risk for seismically-induced soil liquefaction, lateral spreading, slope instability, and surface rupture.
- Provide a slope stability assessment for the southernmost portion of the trail alignment
- Provide geotechnical recommendations for shallow foundation support of the bridge structures. We provide recommendations for foundation subgrade preparation, allowable soil bearing capacity, minimum footing width and depth, lateral pressures acting on abutment walls, and lateral resistance criteria. We also provide short-term, long-term and seismic settlement estimates.
- Provide preliminary recommendations for deep foundation support of the Deschutes River Bridge. We provide axial pile capacity recommendations and a lateral pile support soil profile for driven steel pipe piles and drilled shafts.
- Provide a discussion of bridge foundation support construction considerations.
- Prepare a geotechnical engineering report that presents our conclusions and recommendations along with supporting data.

DRAFT

2.0 SITE CONDITIONS

The following sections describe the existing surface conditions observed during completion of field explorations, a description of the geologic setting, a brief description of the field explorations, a summary of the subsurface soil and groundwater conditions observed in the borings, and the laboratory testing program.

2.1 SURFACE CONDITIONS

Trail Segment A extends from E Street to the Capitol Lake Trail. This segment is typically located 20 to 40 ft in elevation above the River. The majority of Segment A will be common with existing grades. A portion of Segment A is on a historical railroad grade that is situated along a steep eastern facing slope. Bedrock (Basalt) is exposed on the steep slopes on either side of the railroad grade. The ground surface in Segment A is typically covered by pavement, grass, or grass and moss overlying railroad ballast. One portion of Segment A is within a fenced, abandoned Puget Sound Energy right of way that is covered by concrete slabs. Details of the Segment A alignment are shown on Figure 3.

Trail Segment B extends from Tumwater Valley Drive to E Street, generally paralleling Tumwater Valley Drive. The Segment B alignment is typically vegetated with grass and brush outside of the existing pavement areas. A small portion of Segment B will require cut and fill grading to situate the trail into an existing side slope. Segment B details are shown on Figure 4.

Trail Segments C and D run along the west side of the Tumwater Valley Golf Course (Golf Course). The proposed trail alignment within these segments is typically surfaced by grass and the cart path. The cart path is surfaced with ACP. Small portions of Segments C and D cut through wooded areas. The wooded areas typically include mature conifer trees and brush. Horsetails and other plants indicative of excess moisture in the soil are periodically present along the western side of the cart path and in the general area of the trail through the golf course. Details of Segments C and D are provided on Figures 4 through 6.

Trail Spur #3 ascends a steep slope located between the golf course and upland neighborhoods along T Street. Trail Spur #3 is typically vegetated with mature conifer trees and smaller deciduous trees and brush. The section of the steep slope that the trail ascends is typically inclined at between 24 and 29 degrees. We did not observe any slope instability indicators during our reconnaissance of the slope. The slope instability indicators we investigated for included pistol-butt trees, landslide scarps, groundwater seepage, and sloughing and erosion. Trail Spur 3 is shown on Figure 6.

Trail Segment E connects Pioneer Park to the Golf Course. This segment is typically flat and surfaced with grass and brush. Trail Segment E also crosses a potential wetland near the location of the

DRAFT

Deschutes River Slough Bridge. The wetland area and banks of the Deschutes River are vegetated with blackberries, small conifer trees, horsetails, and other plants indicative of excess moisture in the soil. Trail Segment E is shown on Figure 6.

2.1.1 WET SURFACE CONDITIONS

On August 16, 2012, we traveled the proposed trail alignment with the Golf Course Superintendent Dwayne Erich. The purpose of this meeting was to help us gain an understanding of the seasonal wet surface conditions along the Golf Course.

During the meeting, Mr. Erich identified areas alongside the existing cart path that are seasonally saturated, areas that typically include ponding water, and areas that are not mowed due to soft ground conditions in the winter. A summary of the information gained through our meeting with Mr. Erich is as follows: excluding an elevated portion of Hole #14, about 80 percent of the trail alignment within the Golf Course is typically too saturated for cart traffic or mowing equipment between the months of November and April. This excludes the cart path itself.

2.1.2 CART PATH CONDITIONS

Based on conversations with the City of Tumwater, we understand that the existing cart path was constructed in 1998. During the field reconnaissance, it was generally observed that the cart path pavement was in a fair to good condition. We understand from conversations with the City of Tumwater, that the cart path has not experienced any damage from maintenance vehicle traffic, including occasional wintertime traffic. We also understand that the path has not experienced any damage related to freeze-thaw cycles.

We were provided with a set of drawings entitled "City of Tumwater – Typical Path Sections." These drawings show the typical cart path pavement section to comprise:

- 0.17 ft of ACP Class B
- 0.50 ft crushed surfacing base course (CSBC)
- Soil stabilization fabric when required
- Undisturbed "native" soil.

We understand from conversations with the City of Tumwater that this design pavement section was used for the construction of the existing path.

2.2 GEOLOGY REVIEW

Our geology review included The Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington (Walsh et al. 2003) and The Geologic Map of the Maytown 7.5-minute

DRAFT

Quadrangle, Thurston County, Washington (Logan et al. 2009). Our geology review indicates that the upland portions of the site (Segment A, the north half of Segment B, and Trail Spur #3) is mapped as Vashon-age recessional outwash (soil units Qgos and Qgok). Both of these soil units were deposited during the retreat of the most recent glaciation period in the Puget Sound and are not glacially consolidated. The portion of Trail Segment A within Tumwater Falls Park and Tumwater Historical Park is mostly mapped as Crescent formation basalt (soil unit Evc). This soil unit is described as basalt with local inclusions of diabase and gabbro.

Our geology review indicates that the valley portion of the site (southern portion of Segment B and Segments C through E) is mapped as alluvium (soil unit Qa). This unit is described as silt, sand and/or gravel deposited by streams. In the case of this site, the alluvium was mostly deposited by the Deschutes River. The alluvium unit post-dates glaciation in the area and is not glacially consolidated.

In general, we consider our geology review to be consistent with the findings in our subsurface explorations. However, we understand from conversations with City of Tumwater personnel that grading activities to build the Golf Course in the late 1960s included significant fill grading. Based on density and grain size, we interpret the majority of the soils encountered in our borings within the valley to be recessional outwash rather than alluvium. We did not observe an appreciable thickness of loose to very loose soils that would be consistent with post glacial alluvium. With the exception of a groundwater table, the observed density of the soils at depth in the valley is relatively consistent with that observed in the borings in the upland areas.

2.3 SUBSURFACE EXPLORATIONS

We explored the subsurface site conditions between July 30 and August 20, 2012, and again between June 2 and June 27, 2014 by advancing 8 drilled borings and 40 hand augers. Our exploration locations are shown on Figures 3 through 6.

2.3.1 SUBSURFACE CONDITIONS

This section provides a summary of the subsurface soil and groundwater conditions encountered in our explorations. More detailed information, including summary exploration logs and laboratory test results, are provided in Appendix A and B.

2.3.1.1 General

We characterize the materials encountered in our explorations into eight general groups:

- **Pavement Section** – Three of our explorations were advanced along the edge of the cart path to expose the existing pavement section. The pavement section we observed is similar to the

DRAFT

design pavement section described in Section 2.1.2 of this report. We observed that filter fabric was included in most low areas of the pavement section. These are areas that we wouldexpect to be seasonally saturated. We also note that there were occasional cobbles mixed in with the CSBC material.

- **Sod/Topsoil** – Typically consists of sod overlying organic topsoil. The thickness at our exploration locations is generally between 0.15 and 0.6 ft.
- **Forest Duff** – Typically consists of pine needles, leaf matter, roots and other organics. Duff was encountered within the wooded portions of the site where ground cover is limited. The thickness at our exploration locations is generally between 0.7 and 1.4 ft.
- **Fill** – Typically consists of loose to medium dense, silty sand, or sand with silt with variable gravel and organic content. We did not observe appreciable debris or organics within the fill. In general, the fill is granular soil that likely derived from nearby recessional outwash sources. The thickness at our exploration locations is generally between 1.0 and 4.0 ft. Fill was typically present at ground surface along the existing cart path and other developed portions of the trail alignment.
- **Marsh Deposits** – Typically consists of loose, silty sand, or soft silt with sand, with variable organic content. In some instances, abundant peat layers are present. We interpret this material to derive from historic wetlands and/or floodplains that have since been filled over. The thickness at our exploration locations is typically between 1.5 to 4.2 ft. However, explorations HA-2, HA-18, HA-20 and HA-22 were terminated within the marsh deposits. We consider the marsh deposits to be compressible when subjected to new loading. Laboratory test results indicate that the moisture content of this soil unit is typically between 25 and 70 percent.
- **Alluvium** – Typically consists of loose to medium dense sand with variable silt and gravel content deposited by the River. Where present, alluvium is typically located in the upper 10 ft of the soil profile and underlies fill soils or marsh deposits.
- **Recessional Outwash** – Typically consists of medium dense to dense sand with variable silt and gravel content. Occasional loose layers are present. Recessional outwash also includes medium dense to dense gravel with silt and sand. All explorations that encountered recessional outwash were terminated within the material. Below near surface soils, we interpret the majority of the project area to be underlain by recessional outwash.
- **Bedrock** – Typically consists of weathered to unweathered basalt. Where weathered, the bedrock is orange-brown and is silty/clayey. Where unweathered, bedrock is gray to black and difficult to break using a breaker bar. Several hand auger explorations were terminated on bedrock within Trail Segment A and the northern portion of Trail Segment B. Where encountered in our explorations, depth to bedrock is 1.2 to 6.5 ft.

2.3.2 VALLEY SUBSURFACE CONDITIONS SUMMARY

Underlying the surficial topsoil/sod, forest duff, or the cart path pavement section, our explorations in the valley generally encountered near-surface granular soil consisting of fine to medium sand with silt, or silty, fine sand. The gradation of the near-surface soils in the valley is relatively consistent, even though the materials can come from three different deposition processes (fill, alluvium,

or recessional outwash). At depths greater than 5 to 15 ft, our explorations generally encountered recessional outwash extending to the maximum depth explored at 101.5 ft BGS.

Marsh deposits were encountered in explorations B-3, and HA-2, HA-3, HA-6, HA-10, HA-18, HA-20, HA-21, and HA-22. The marsh deposits were typically buried beneath granular fill soils. Exploration HA-6 exposed marsh deposits at ground surface. We note that the area around HA-6 included abundant horsetail vegetation. Marsh deposits were not encountered in borings at the proposed abutment locations for the Deschutes River Bridge or Deschutes River Slough Bridge.

2.3.3 Upland Subsurface Condition Summary

Our explorations along Trail Spur #3 typically encountered recessional outwash underlying forest duff, and extending to the depths explored. Our explorations along Segment A and the northern portion of Segment B typically encountered fill or recessional outwash to the depths explored, or were terminated on bedrock underlying those materials.

2.3.4 Groundwater Conditions

Groundwater was encountered in the majority of our explorations in the valley at depths ranging between 1.1 and 9.0 feet BGS. We interpret the groundwater conditions in our explorations to comprise both perched irrigation water and the groundwater table associated with the River. In general, it appears that previous filling activity at the site created a complicated groundwater regime, where groundwater becomes trapped and perched along the west side of the Golf Course. We anticipate that the groundwater in the valley will fluctuate seasonally and be essentially at ground surface over much of the project area in the valley during the winter.

Groundwater was encountered in the upland portion of the site at Trail Spur #3 at approximately 59.2 ft BGS in exploration B-1. We interpret the groundwater encountered in B-1 to be the regional groundwater table within the recessional outwash soil. Based on our experience with groundwater fluctuation in upland portions of Tumwater, we estimate that the upland groundwater table fluctuation is on the order of a few feet or less.

Perched groundwater was encountered at the contact between soil and bedrock at several of our upland explorations within Segment A and Segment B. We anticipate perched groundwater will be present at this geologic contact throughout most of the wet season and after significant precipitation events.

DRAFT

2.4 LABORATORY TESTING

We completed gradation analyses consisting of moisture content determinations, percent passing the No. 200 sieve, and grain size distribution analysis. A detailed description of our laboratory testing program is contained in Appendix B.

DRAFT

3.0 ENGINEERING STUDIES AND RECOMMENDATIONS

The following sections present the results of our engineering studies and recommendations in support of corresponding project elements. Construction recommendations are presented in Section 4.0 of this report.

3.1 GENERAL

We completed engineering studies to develop geotechnical recommendations in support of the design and construction of the proposed trail and bridge structures. Our recommendations were developed in general accordance with the guidance provided in the WSDOT Geotechnical Design Manual (GDM) M-46 03 (WSDOT GDM). Our engineering studies were completed to address the following issues:

- Cut slopes and fill embankments
- Embankment settlement
- Pavement design section
- Seismic design considerations
- Shallow foundation support of the three bridges
- Deep foundation support considerations for the Deschutes River Bridge.

3.2 STABILITY ANALYSES OF PROPOSED CUT SLOPES AND FILL EMBANKMENTS

We preformed limit equilibrium slope stability analyses to determine the factor of safety (FS) against slope failure for cut and fill areas along Trail Spur #3. Based on site grading plans, we anticipate that the soils that will be exposed/used in cut and fill areas will mostly include recessional outwash sand with silt and silty sand. This conceptual grading concept is illustrated on Figure 7.

We completed deep-seated slope stability analyses using the computer program SLIDE 6.0 (Rocscience, Inc. 2010). SLIDE 6.0 evaluates the stability of numerous trial failure surfaces using a vertical slice limit-equilibrium method. We selected the Spencer method for computation of our safety factors. We also completed analyses of shallow, surficial slides using the infinite slope method described in Chapter 7 of the WSDOT GDM.

The WSDOT GDM requires a FS of 1.25 for permanent cut and fill slopes under static conditions. The FS reflects the ratio of driving forces to resisting forces within a slope. For example, a FS of 1.0 indicates a marginally unstable slope. Seismic design criteria are not considered for slopes associated with non-critical structures (such as the proposed trail and bridge). The results of our slope stability analyses are provided on Table 1.

DRAFT

TABLE 1
SLOPE STABILITY ANALYSES RESULTS

Slope Condition	Shallow Slides FS	Deep Slides FS
Existing Slope (2H:1V)	1.32	1.60
Cut 2H:1V	1.32	1.60
Cut 1.9H:1V	1.28	1.55
Cut 1.8H:1V	1.21	1.51
Fill 2H:1V	1.32	1.60
Fill 1.9H:1V	1.28	1.55
Fill 1.8H:1V	1.21	1.51

Based on information presented in Chapter 7 of the WSDOT GDM, if the FS for shallow slides is near or below 1.15, severe erosion or shallow slumping is likely. On this basis, and considering the results of our analyses presented in Table 1, we recommend a maximum cut slope inclination of 1.8H:1V (horizontal to vertical). We also recommend a maximum fill embankment slope inclination of 1.8H:1V. Temporary erosion protection should be provided on the slopes until new vegetation is established. Using 2H:1V slopes for design would provide a slight advantage over 1.8H:1V slopes from an erosion control perspective.

3.3 EMBANKMENT SETTLEMENT

The most significant fill embankment for the project is the bottom section, Trail Spur #3 (schematically shown on Figure 7). We anticipate that this embankment fill could be up to about 20 ft thick. Based on our understanding of grading plans, this embankment would land on sand and gravel recessional outwash soils; compressible soils are not present at this location. Provided that this embankment fill is compacted in accordance with the recommendations of this report, we anticipate that the embankment settlement will be less than 2 inches. We also anticipate that settlement would be complete within about two weeks of the embankment construction and that the overall effect of this settlement would be negligible.

We understand that some of the low areas along the existing cart path will likely be raised to meet trail grade requirements. In areas where marsh deposits are present, the placement of fill will likely result in settlement. Based on the organic and moisture content of the marsh deposits encountered in our explorations, we estimate that about 1 to 2 inches of long-term settlement could be encountered for each foot of fill placed in some areas of the site. Landau Associates should review the final grading plans to determine if this will be a relevant design issue. We anticipate that settlement mitigation techniques could entail: 1) waiting one season after initial earthwork construction to pave in certain fill areas or 2) soil preloading certain fill areas at the beginning of construction.

DRAFT

3.4 PAVEMENT DESIGN

WSDOT 1515 does not provide recommendations for a minimum pavement section for shared-use paths; rather, the publication recommends that paths be designed in the same manner as highways, considering the specific traffic loading conditions. WSDOT 1515 also states, "design the pavement structural section as recommended by the Region Materials Engineer." Specific traffic loading information was not available at the time this report was prepared. In general, we understand that the traffic conditions will include foot and bicycle traffic, with occasional maintenance and emergency vehicles.

We completed an initial pavement design analysis using the AASHTO 91 Flexible Pavement Design methodology. However, because the vehicle loading conditions were essentially insignificant, minimum thickness pavement sections resulted from our analyses. We contacted several pavement engineers at WSDOT to discuss the minimum pavement thickness that would typically be acceptable for a shared-use path. Based on these discussions, we understand that the minimum acceptable pavement section is typically between 0.18 and 0.25 ft of AC overlying 0.33 ft of CSBC.

Based on our experience and judgment, our discussions with WSDOT, and our understanding of the existing cart path performance, we recommend the following pavement sections for a 20-year design life:

Standard-duty AC Pavement (Upland Areas and Elevated Portion of Hole 14).

- 2 inches of hot mix asphalt [(HMA) Class ½'', PG 64-22, WSDOT Section 5-04].
- 4 inches of CSBC (WSDOT Standard Specification 9-03.9(3)).
- A woven geotextile that meets the requirements for Soil Separation provided in Table 3 of Section 9-33 of the 2010 WSDOT *Standard Specification.* Please note that the woven geotextile is not required on the portion of the trail that follows the existing railroad grade in Segment A.
- Approved subgrade prepared as described.

Heavy-duty AC Pavement (Valley Areas)

- 2.5 inches of HMA (HMA Class ½'', PG 64-22, WSDOT Section 5-04)
- 6 inches of CSBC (WSDOT Standard Specification 9-03.9(3))
- A woven geotextile that meets the requirements for Soil Separation provided in Table 3 of Section 9-33 of the 2010 WSDOT *Standard Specifications*
- Approved subgrade prepared as described.

We understand that the cart path base course materials are proposed for reuse in-kind. It is our opinion that the majority of these materials will be suitable for reuse.

DRAFT

3.5 SEISMIC DESIGN CONSIDERATIONS

3.5.1 SPECTRAL ACCELERATION PARAMETERS

AASHTO bridge design parameters for seismic design category, site class, acceleration coefficient, and spectral acceleration coefficients are presented in Table 2 below. These parameters are in accordance with the Fifth Edition of the AASHTO LRFD Bridge Design Specifications (2010). The specification recommends a 7 percent probability of exceedance in 75 years (nominal 1,000-year earthquake) design event for development of a design spectrum for bridges.

TABLE 2
AASHTO SEISMIC PARAMETERS

AASHTO Seismic Parameter	Recommended Value
Site Class	D
Effective Peak Ground Acceleration Coefficient $A_s = F_{pga}PGA = (1.116)(0.384)$	0.429
Design Spectral Acceleration Coefficient at 0.2 second period $S_{DS} = F_aS_s = (1.164)(0.840)$	0.978
Design Spectral Acceleration Coefficient at 1.0 second period $S_{D1} = F_vS_1 = (1.776)(0.312)$	0.554

3.5.2 SOIL LIQUEFACTION

Liquefaction refers to the condition by which vibration or shaking of the ground, usually from earthquake forces, results in the development of excess pore pressures in saturated soils, with subsequent loss of strength. In general, soils that are susceptible to liquefaction include saturated, very loose to medium dense, clean to silty sands and some non-plastic silts.

Liquefaction can result in a temporary reduction of bearing capacity, which can cause settlement of structures that are supported on foundations within or above the liquefied soils. Liquefaction can also cause a temporary reduction of lateral support for structures supported on deep foundations.

We evaluated the liquefaction potential of the site soil using the Simplified Procedure (Youd et al. 2001). Based on our liquefaction analyses, we estimate that there is the potential for up to about 5 inches of liquefaction settlement at the proposed Palermo Waterway Bridge as the result of an AASHTO design level earthquake. Our analyses indicate that there is the potential for 3 to 4 inches of liquefaction settlement at the proposed Deschutes River Bridge and Deschutes River Slough Bridge as the result of a design level earthquake. The potentially liquefiable soil zones are discontinuous and inconsistent in depth across our exploration locations. Potentially liquefiable soil zones are typically 5 ft or less in thickness and most commonly encountered in the upper 25 ft across the bridge sites. The deepest soil zone was encountered around 70 ft BGS in exploration B-7.

DRAFT

We interpret the soil conditions underlying the project site at depth as recessional outwash. Based on its depositional history, we consider the liquefaction risk of these soils to be low to moderate when compared to areas with a severe to high risk, such as the Port of Olympia, Port of Tacoma, and other local areas with widespread deposits of very loose to loose recent alluvium. We understand that mitigating (with piles) for 4 to 5 inches of potential liquefaction settlement is not likely within the design objectives of the Palermo Waterway Bridge or the Deschutes River Slough Bridge.

3.5.3 LATERAL SPREADING

Lateral spreading involves the lateral displacement of surficial blocks of non-liquefied soil when an underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground or significant grade changes are present. Based on the risk for soil liquefaction at the project site, it is our opinion that there is a slight risk for lateral spreading at the bridge sites. We understand that mitigating for lateral spreading is not likely within the design objectives of the Palermo Waterway Bridge or the Deschutes River Slough Bridge.

3.6 BRIDGE ABUTMENT SHALLOW FOUNDATION SUPPORT

3.6.1 GENERAL

It is our opinion that the proposed bridge abutments can be supported on shallow foundations from a static loading perspective. The pedestrian bridge structures are relatively lightly loaded and deep or widespread compressible soils were not encountered in our explorations. To reduce the potential for post-construction differential settlement, we recommend an overexcavation and replacement of organic marsh deposits that were encountered at the location of the eastern abutment of the Palermo Waterway Bridge (exploration B-3). We estimate that the required overexcavation depth will be about 7 ft. Because the exact abutment locations for the Deschutes River Bridge and Deschutes River Slough Bridge have not been defined, we recommend that the project plans allow for a contingency for 2 ft of overexcavation and replacement of unsuitable soil for these abutments, even though unsuitable soils were not encountered in our explorations in these areas. Additional information is provided in Section 5.0.

3.6.2 DESCHUTES RIVER BRIDGE SHALLOW FOUNDATION SEISMIC DESIGN CONSIDERATIONS

If the Deschutes River Bridge can be structurally isolated from approach structures or embankments, we anticipate the simplified seismic design requirements for single span bridges presented in AASHTO LRFD could be applicable. This should be verified by the structural engineer. Under this seismic design approach, bridge and abutment damage is acceptable, within limits, as the result of a

design level earthquake. This design approach is allowed because there is typically a low probability of occupancy during a design level earthquake for this type of recreational/pedestrian use structure. However, it is also possible that the City of Tumwater would like a specific level of seismic performance for the design level earthquake (possibly because of bridge construction cost and/or difficult access for post-earthquake repairs).

Based on our analysis, we recommend the following conditions be used by the structural engineer for initial seismic evaluations related to soil deformation and loading:

- Liquefaction induced settlement – 4 inches (total and differential over short distances)
- Lateral spreading loads – an equivalent fluid density of 325 pounds per cubic foot (pcf) acting on each bridge abutment for foundation depths of 7 ft BGS or less. Under this scenario, an ultimate passive resistance of the same amount is available along the opposite abutment if the bridge can be rigidly designed to transfer the load. A resistance factor of 1.0 should be used for this extreme limit state.

We anticipate additional discussions between the design team and the City of Tumwater on this topic after the initial structural evaluation of the bridge has been completed.

3.6.3 SHALLOW FOUNDATION DESIGN PARAMETERS

Our recommendations for soil loading conditions, soil resistance parameters, and resistance factors for the structural design of the bridge abutment foundations are provided below. Our recommendations are in accordance with the Fifth Edition of the AASHTO LRFD Bridge Design Specifications (2010).

- **Bearing Resistance** - Ultimate bearing resistance of 7 kips per square foot (ksf) for a 2-ft-wide footing, 9 ksf for a 4-ft-wide footing and 11 ksf for an 8-ft-wide footing. Resistance factors of 0.45 and 1.0 should be used for the strength and extreme limit states, respectively. For the service limit state, we recommend bearing resistances of 5 ksf, 4 ksf, and 3 ksf for a 2-ft-wide, 4-ft-wide, and 8-ft-wide footings, respectively. Service limit state is for 1-inch or less of foundation settlement under static loading. Intermediate capacities/footing sizes can be interpolated.
- **Active Lateral Earth Pressure** - 81 pounds per cubic foot (pcf) (includes hydrostatic)
- **At-rest Lateral Earth Pressure** - 100 pcf (includes hydrostatic)
- **Rectangular Seismic Surcharge Pressure** - If required, 9H pounds per square foot (psf), where H is the height of the wall. This pressure is based on the Mononobe-Okabe procedure using ½ of the peak ground acceleration for the site.
- **Coefficient of Base Friction** - Ultimate values of 0.60 and 0.49 for cast-in-place and precast concrete, respectively. For the strength limit state, resistance factors of 0.8 and 0.9 should be used for cast-in-place and precast concrete, respectively. A resistance factor of 0.9 should be used for the extreme limit state.
- **Passive Resistance** - Ultimate passive resistance of 195 pcf (assumes submerged conditions). For the strength limit state, a resistance factor of 0.5 should be used when calculating the

passive portion of the sliding resistance. A resistance factor of 1.0 should be used for the extreme limit state.

3.7 BRIDGE ABUTMENT DEEP FOUNDATION SUPPORT

3.7.1 GENERAL

We anticipate that deep foundations would be utilized if the design approach/objectives discussed in Section 3.62 cannot be achieved using shallow foundations. Based on our experience and conversations with the structural engineer, we anticipate that driven steel pipe piles or drilled shafts would be the preferred deep foundation type.

It is our opinion that friction piles or shafts could be used to reduce the potential magnitude of liquefaction induced settlement at the bridge abutments to about 2 inches or less. Based on our experience, we anticipate that applicable foundation diameters include 12-inch and 18-inch driven piles and 24-inch drilled shafts. Friction piles or shafts would need to extend below the minimum depth for lateral fixity. For planning and discussion purposes, we recommend this embedment depth be assumed at 40 ft. Under seismic design conditions (Extreme Limit State), we also recommend that the upper 25 ft of soil resistance be ignored to account for isolated zones of soil liquefaction that are more common in the upper 25 ft than at depth; we also recommend the use of a downdrag load along the upper 25 ft of the pile.

If piles or shafts are designed to mitigate for liquefaction induced settlement in strict accordance with AASHTO and the WSDOT GDM (the same approach that would be used for a highway bridge), these foundation elements would need to extend below the deepest liquefiable layer that is located within the upper 80 ft BGS (70 ft BGS in the case of this project) in order to overcome downdrag loads. For cost and construction feasibility purposes, we recommend that this depth be assumed at 100 ft if using the AASHTO WSDOT GDM approach. Detailed geotechnical recommendations for 100 ft deep foundations are not provided in this draft report. We recommend that the minimum diameter of a 100-ft shaft be 3-ft and the minimum diameter of a 100-ft driven pile be 24-inches. These diameters are based on constructability and slenderness considerations, and should be verified by the structural engineer.

We also discussed a concept with the structural engineer that includes designing the bridge abutments on shallow foundations sized for the anticipated static loading, but then adding piles as an extra safety measure to qualitatively reduce the risk for liquefaction settlement. Although this foundation design approach is not specifically described by AASHTO or WSDOT, we believe it is a practical approach for a pedestrian bridge.

3.7.2 AXIAL CAPACITY

We evaluated axial capacity of driven steel pipe piles and drilled shafts in general accordance with the methods described in the 2012 AASHTO LRFD Bridge Design Specifications and the WSDOT

GDM. We used the Nordlund/Thurman method to estimate axial capacity of driven piles and the O'Neill and Reese method to estimate the capacity of drilled shafts. We used a generalized soil profile for our analysis that considers the profile across the Deschutes River Bridge and Deschutes River Slough Bridge sites. Slight revisions could be required if deep foundations are selected for final design.

The results of our drilled shaft static and seismic analyses (24-inch-diameter shafts) are presented on Figures 8 and 9, respectively. The resistance factors presented in Table 3 should be used along with these figures. Please note that downdrag load are listed on Figure 9.

TABLE 3
RESISTANCE FACTORS FOR SINGLE SHAFTS

Loading	Service Limit	Strength Limit(a)	Extreme Limit
Compression	1.0	0.55 (Side) 0.50 (Tip)	1.0
Uplift	1.0	0.45 (Side)	0.8

(a) O'Neill and Reese 1999

The results of our static and seismic driven pile analysis (12-inch and 18-inch-diameter steel pipe piles) are presented on Figures 10 and 11, respectivly. The resistance factors presented in Table 4 should be used along with these figures. Please note that downdrag loads are provided on Figure 11.

TABLE 4
RESISTANCE FACTORS FOR DRIVEN PILES

Loading	Service Limit		Strength Limit			Extreme Limit
		Dynamic Testing	WSDOT Driving Formula	Wave Equation Analysis	Nominal Resistance (a)	
Compression	1.0	0.65 (Single Piles or Pile Groups)	0.55 (Single Piles or Pile Groups)	0.50 (Single Piles or Pile Groups)	0.45 (Single Piles or Pile Groups)	1.0
Uplift[1]	1.0	0.50 (Single Piles) 0.50 (Pile Groups)	0.35 (Single Piles) 0.50 (Pile Groups)	0.35 (Single Piles) 0.50 (Pile Groups)	0.35 (Single Piles) 0.50 (Pile Groups)	0.8

(a) Nordlund/Thurman

3.7.3 LATERAL SPREADING LOADS

We recommend that pile supported bridge abutments consider the following lateral spreading loads:

- 0 to 7 ft BGS: 325 pcf

DRAFT

- 7 to 15 ft BGS: 20H, where H is the depth BGS.

If the bridge can be designed as a ridged structure, equivalent lateral resistance is available at the opposite abutment. Lateral spreading loads should be applied over the full abutment/pile cap width and over 2 pile diameters below the cap.

3.7.4 LATERAL CAPACITY

The lateral response of a pile or shaft will depend on the density and composition of the soil, the ground slope inclination, the pile spacing, the flexural stiffness of the pile, the structural loads, and other factors. Table 5 provides our recommended soil profile (L-PILE parameters), in terms of embedment depth, to be used in lateral pile capacity evaluations for the project. These parameters are based on our experience and on published sources.

TABLE 5
L-PILE SOIL PARAMETERS

Soil Unit	Model Type	Effective Unit Weight (pci)	k (pci)	Friction Angle, □ (deg)	P-multiplier	
					Static	Seismic
0 to 25 ft BGS Loose to Medium Dense SAND and GRAVEL	SAND[(a)]	0.028	20	32	1.0	0.3
25 ft to 50 ft BGS Medium Dense SAND and GRAVEL	SAND[(a)]	0.031	50	33	1.0	0.7
Deeper than 50 ft BGS Medium Dense to Dense SAND and GRAVEL	SAND[(a)]	0.034	75	34	1.0	1.0

(a) = (Reese et al. 1974)
pci = pounds per cubic inch

For static loading conditions, L-PILE parameters should be modified to account for group effects. Our recommendations for P-multipliers to account for group effects are provided in Table 6.

TABLE 6
P-MULTIPLIERS FOR GROUP EFFECTS

Pile Spacing (in direction of loading)	Row 1	Row 2	Row 3 (and higher)
2D	0.45	0.33	0.25
3D	0.80	0.40	0.30
5D	1.00	0.85	0.70

DRAFT

4.0 EARTHWORK AND CONSTRUCTION RECOMMENTATIONS

4.1 GENERAL

We anticipate that site development earthwork will include stripping and clearing, preparing subgrades, excavating for the trail, excavating for the bridge abutments, possibly driving piles or installing drilled shafts, and placing and compacting structural fill. We expect that the majority of site grading can be accomplished with conventional earthmoving equipment in proper working order. However, bedrock (basalt) is present at a shallow depth along much of Segment A and the northern half/upland portion of Segment B.

We understand that site grading plans will be developed to avoid cutting into bedrock. The depth at which our hand auger explorations were refused on bedrock is provided on the bottom of the exploration logs in Appendix A.

4.2 CLEARING AND STRIPPING

Clearing and stripping should consist of removing surface and subsurface deleterious materials including the existing pavement, sod/topsoil, forest duff, trees, brush, debris, and any other unsuitable loose/soft or organic materials. Stripping and clearing should extend at least 5 ft beyond all structures and areas to receive structural fill.

We estimate that an average stripping depth of about 0.4 ft will be required to remove sod/topsoil from the portions of the trail that are within developed areas. We estimate that an average stripping depth of about 1.0 ft will be required to remove the forest duff from the wooded areas. Additional stripping will be required in areas where trees are removed. We recommend that trees be removed by overturning so that a majority of the roots are removed.

4.3 SUBGRADE PREPARATION

4.3.1 GENERAL

After stripping and excavating to the proposed subgrade elevation, and before placing structural fill or foundation concrete, the exposed subgrade should be thoroughly compacted to a firm and uniformly unyielding condition. The upper 12 inches should be compacted to a soil density of at least 95 percent of the ASTM International D1557 Modified Proctor maximum dry density (MDD). The exposed subgrade should then be proof-rolled using loaded, rubber-tired, heavy equipment. An experienced geotechnical professional should observe the proof-rolling prior to placement of structural fill or foundation concrete. Areas of limited access that cannot be proof-rolled can be evaluated using a steel probe rod. If soft or otherwise unsuitable areas are revealed during proof-rolling or probing that cannot be compacted to a

DRAFT

stable and uniformly firm condition, we generally recommend that: 1) the subgrade soils be scarified (e.g., with a ripper or farmer's disc), aerated, and recompacted; or 2) the unsuitable soils be overexcavated and replaced with structural fill.

Subgrade preparation in areas of sloping ground should include constructing level keyways or benches. We recommend that the keyways or benches be completed in accordance with Section 1-03.3(14) of the 2012 WSDOT *Standard Specifications,* with the exception that we recommend a maximum step height of 3 ft.

4.3.2 BRIDGE ABUTMENTS

Our explorations encountered organic marsh deposits at the eastern Palermo Waterway Slough Bridge abutment extending to approximately 7.0 ft BGS. We consider the marsh deposits to be unsuitable foundation material due to their consolidation settlement potential. Accordingly, we recommend that the marsh deposits be overexcavated and replaced with structural fill at the location of the eastern bridge abutment.

Our explorations for the Deschutes River Bridge and Deschutes River Slough Bridge did not encounter unsuitable foundation material. Still, we recommend a minimal contingency be included in the project cost estimates to allow for 2 ft of overexcavation and replacement at the other bridge abutments. This is because the abutment locations have not been finalized.

Removal and replacement of unsuitable foundation material should be completed in accordance with Section 7-08.3(1)A of the 2012 WSDOT *Standard Specifications*. A woven geotextile should be placed in the bottom of the overexcavation and extended up the excavation sidewalls. We recommend a woven geotextile that meets the requirements for Soil Separation provided in Table 3 of Section 9-33 of the 2012 WSDOT *Standard Specifications*. The foundation replacement material should meet the requirements of Foundation Material Class A presented in Section 9-03.17 of the 2012 WSDOT *Standard Specifications*. Quarry Spalls as described in Section 9-13 of the 2012 WSDOT *Standard Specifications* is an acceptable alternative material, provided that the surface is fine-graded with Foundation Material Class A to allow for placement of foundation concrete.

4.4 TEMPORARY EXCAVATIONS

We anticipate that temporary excavations for the project will be mostly limited to the bridge abutment foundation excavations. We recommend that the bridge abutment excavations be completed in accordance with Section 2-09 of the 2012 WSDOT *Standard Specifications*. Actual excavation trench configurations and the maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. Temporary excavations in excess of 4 ft should be shored or sloped

in accordance with Safety Standards for Construction Work, Part N, located in Chapter 296-115 of the Washington Administrative Code (WAC). The soil conditions that will be exposed in the bridge abutment excavations should be considered Type C soils.

4.5 DEEP FOUNDATION INSTALLATION

The following sections present geotechnical construction considerations for driven piles and drilled shafts, if selected for bridge foundation support.

4.5.1 DRIVEN PILES

We anticipate that open-ended steel pipe piles can be driven to depths of 40 to 100 ft BGS using an impact hammer. The minimum pile wall thickness, minimum hammer energy, and preliminary refusal criteria should be selected during final design, based on the results of our pile drivability and wave equation analysis for piles that will be specific to the selected pile diameters and lengths. Based on our experience, we estimate that a ½ inch wall could be appropriate for shallow friction piles, whereas a ¾ inch wall could be required to drive piles to 100 ft without damage.

For planning purposes, piles should be driven to the estimated design tip elevations determined by the structural engineer and shown on project plans. Actual pile embedment/tip elevations will be based on driving criteria, which are dependent upon the driving hammer characteristics, resistance required, group action, and other factors. The geotechnical engineer should review the contractor's hammer submittal and develop refusal criteria prior to pile installation. We expect that the actual pile lengths will vary and the contractor should be prepared to furnish longer piles in the event that actual pile penetrations exceed the estimates shown on plans. The contractor should also be prepared to cut and remove sections of the piles that are below minimum embedment for fixity, but meet practical refusal short of the estimated tip embedment

4.5.2 DRILLED SHAFTS

We interpret the soils at the site to have a high to severe potential for caving during drilled shaft installation. Caving soils should be anticipated. We recommend the use of a temporary steel casing in order to reduce the potential for caving. Since the shafts would be installed below the groundwater table, a positive head (water or drilling mud) should be maintained in the casing as the shaft is advanced in order to limit the potential for heave in the base of the shaft excavation, and loss of ground around the shaft perimeter during installation.

4.6 GROUNDWATER HANDLING

The project site includes high groundwater throughout most of the valley. We did not observe appreciable groundwater within the upland portions of the site except where perched on top of shallow bedrock. We anticipate that groundwater will be essentially at ground surface in the valley throughout much of the wet season. Based on our understanding of the proposed grading plans, we do not recommend performing earthwork construction in the valley during the wet season; controlling groundwater, as required to prepare firm and unyielding subgrades, would likely be cost-prohibitive.

We anticipate that any shallow, perched groundwater encountered during construction can be handled adequately with sumps, pumps, and/or diversion ditches. Groundwater handling needs will be lower during the late summer and early fall months. We recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered during construction.

4.7 WET WEATHER EARTHWORK

The near surface soils at the site typically contain between 5 and 20 percent fines. When the moisture content of this soil is more than a few percent above the optimum moisture content, the soil will become unstable, and it will be difficult to meet the required compaction criteria. Disturbance of near surface soils should be expected if earthwork is completed during periods of wet weather.

The wet weather season in this area generally begins in October and continues through May. However, our conversations with Golf Course personnel suggest that much of the proposed trail area in the valley is wet between November and April. If wet weather earthwork is unavoidable, we recommend that:

- The ground surface is sloped so that surface water is collected and directed away from the work area to an approved collection/dispersion point
- Earthwork activities not take place during periods of heavy precipitation
- Measures are taken to prevent onsite soil and soil stockpiles from becoming wet or unstable
- Sealing the surficial soil by rolling with a smooth-drum roller prior to periods of precipitation to reduce the extent that the soil becomes wet or unstable
- Construction traffic is restricted to specific areas of the site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance
- A minimum 1-ft-thick layer of quarry spalls be used to protect subgrade soils from disturbance in high traffic areas
- Contingencies are included in the project schedule and budget to allow for the above elements.

DRAFT

4.8 STRUCTURAL FILL

4.8.1 GENERAL

Any inorganic material with a maximum particle size of 3 inches can be considered for use as structural fill provided that it can be moisture conditioned and compacted as recommended. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve. Gravel Borrow, as described in Section 9-03.14(1) of the 2012 WSDOT *Standard Specifications*, is a suitable source for structural fill during periods of wet weather, provided that the percent passing a U.S. Standard No. 200 sieve is less than 5 percent based on the minus ¾-inch fraction.

4.8.2 ONSITE SOIL

The topsoil/sod, forest duff, and marsh deposit soil units should not be considered for reuse as structural fill. All other materials encountered in our explorations may be considered for reuse as structural fill during periods of extended dry weather. We note that the onsite soils typically consist of silty, fine sand and fine sand with silt. These materials are typically poorly-graded and difficult to compact to the specified MDD; thin lifts and significant moisture conditioning can be required to meet the specified compaction criteria.

4.8.3 PLACEMENT AND COMPACTION

Structural fill should be placed on an approved subgrade that consists of uniformly firm and unyielding, inorganic, native soils or compacted structural fill. Structural fill should be compacted at moisture content near optimum. The optimum moisture content varies with the soil gradation and should be evaluated during construction.

Structural fill should be placed in uniform, horizontal lifts and uniformly densified with vibratory compaction equipment. The maximum lift thickness will vary depending on the material and compaction equipment used, but should generally not exceed 4 inches for hand operated equipment and 8 inches for heavy equipment. We recommend that structural fill in the proposed trail areas be compacted as described in Section 2-03.3(14)C, Method B, of the 2012 WSDOT *Standard Specifications*. In general, this method specifies 95 percent compaction within 2 ft of pavement surfaces and 90 percent compaction below. Recommendations for structural fill placement beneath the bridge abutments are presented in Section 4.3.2 of this report.

DRAFT

5.0 OUTSTANDING FINAL DESIGN ISSUES

The flowing geotechnical related items are anticipated after the date of this draft report, prior to the design being finalized:

- Complete a deep boring at the western Deschutes River Bridge Abutment
- Complete hand augers for any approachment structures associated with the Deschutes River Bridge, after their configuration has been established, to evaluate the potential presence of compressible soil
- Provide support to R.W. Droll on Helical anchor supported walkway concepts for the E Street undercrossing, if applicable.

* * * * *

We appreciate the opportunity to be of service to you on this project. Please contact us if you have questions or require additional information.

LANDAU ASSOCIATES, INC.

Calvin A. McCaughan, P.E.
Senior Associate

CAM/bar

DRAFT

6.0 REFERENCES

WSDOT. 2012. *Standard Specifications for Road, Bridge, and Municipal Construction.* Washington State Department of Transportation.

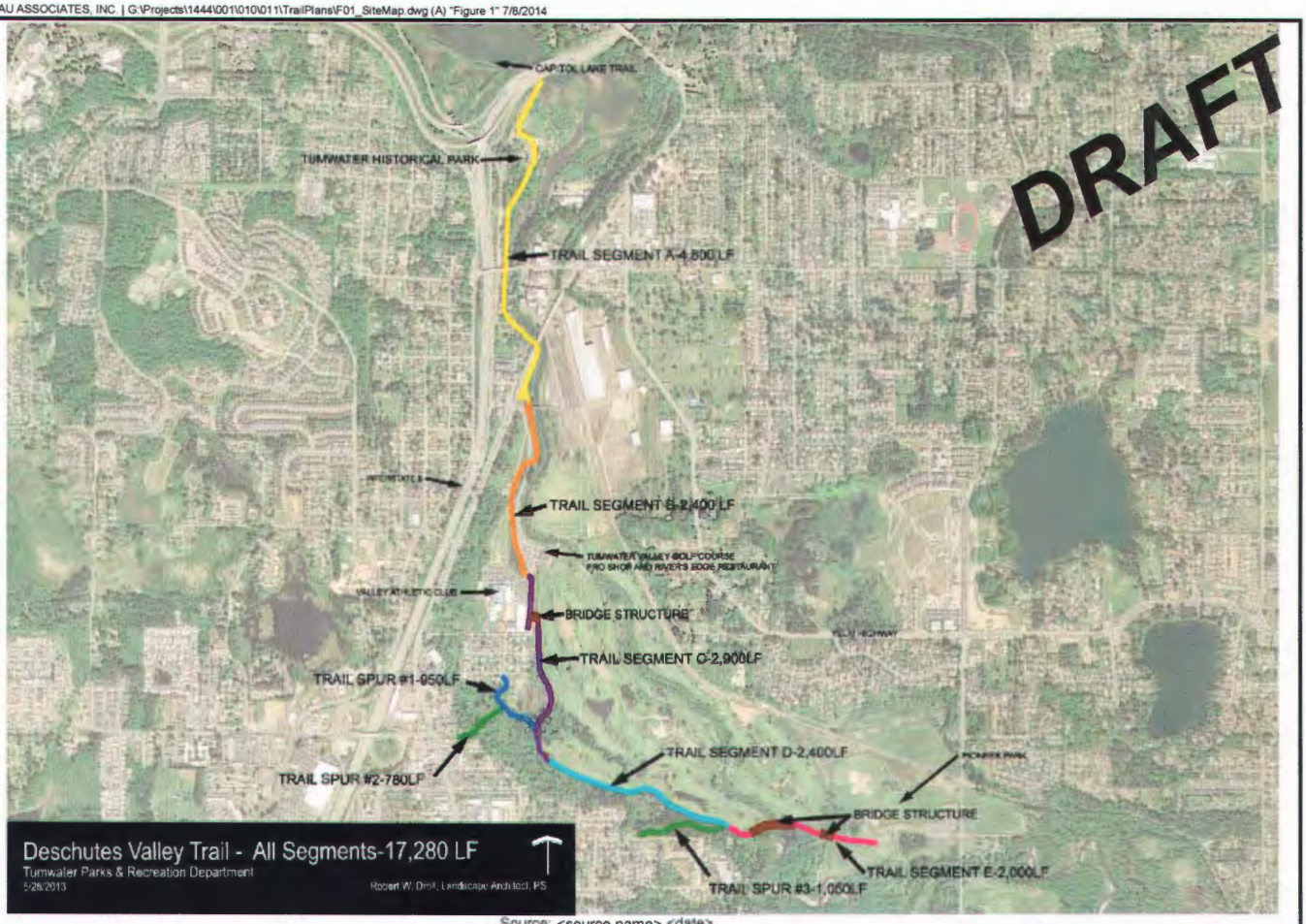
WSDOT. 2012. *Design Manual M 22-01.09.* Washington State Department of Transportation.

WSDOT. 2010. *Geotechnical Design Manual M 46-03.02.* Washington State Department of Transportation.

Rocscience Inc. 2012. Engineering Drawing: *Cross section of Deschutes Valley Trail.* Slide 6.018. August 30.

DRAFT

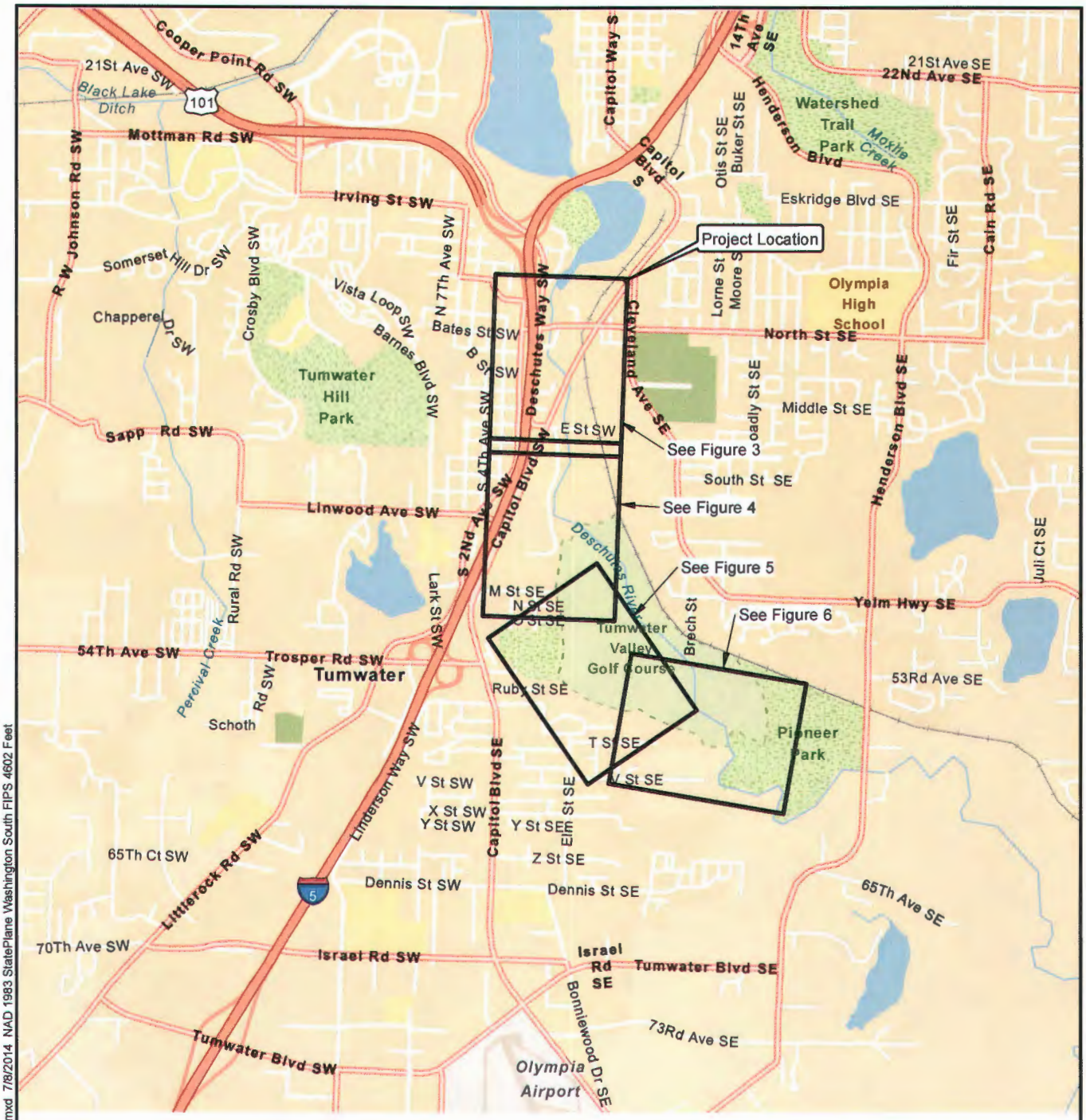
LANDAU ASSOCIATES, INC. | G:\Projects\1444\001\010\011\TrailPlans\F01_SiteMap.dwg (A) "Figure 1" 7/8/2014



Source: <source name> <date>

LANDAU ASSOCIATES	Deschutes Valley Trail Tumwater, WA	**Site Map**

Figure
1

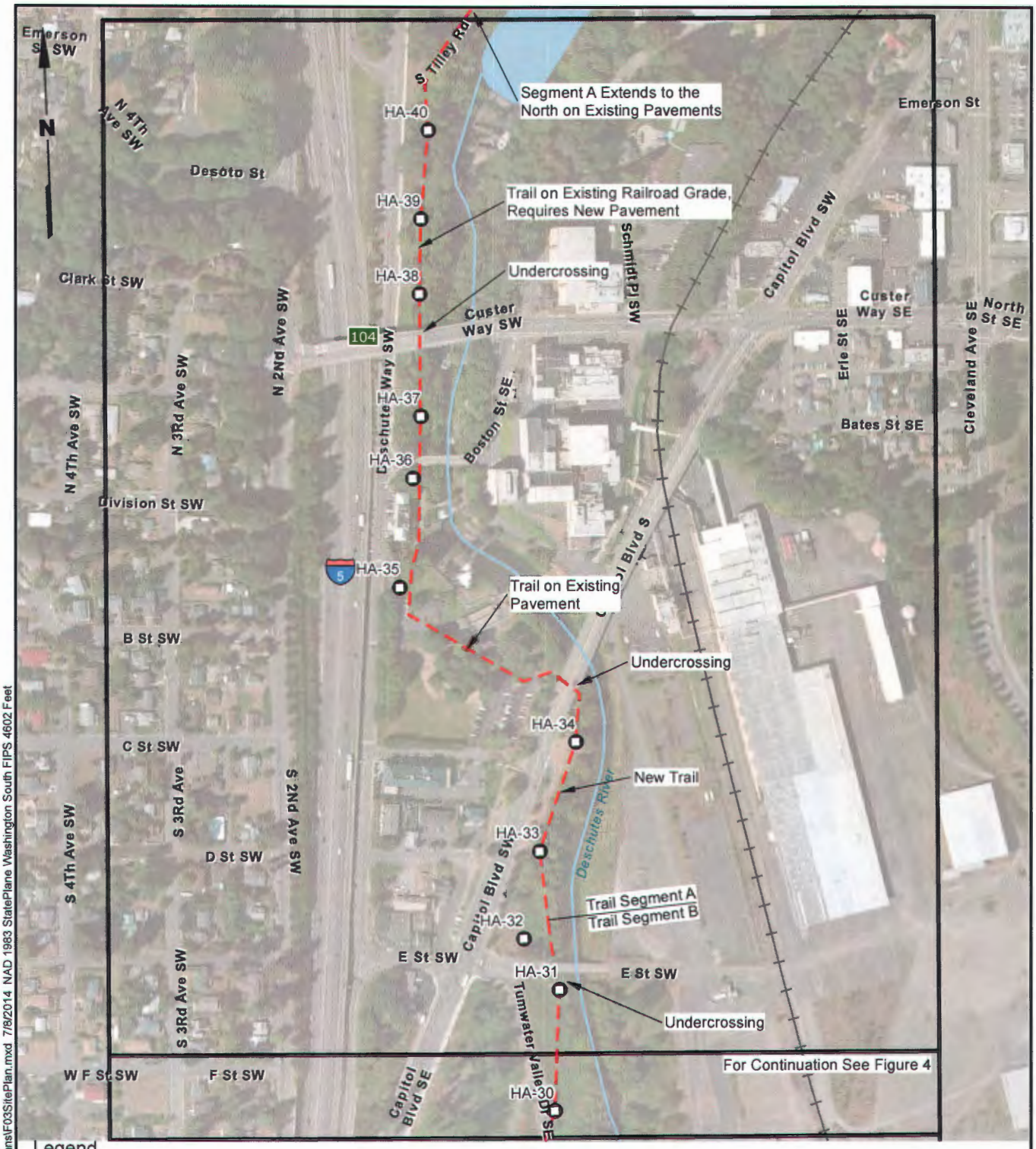


Data Source: Esri 2012

G:\Projects\1444\001\010\011\TrailPlans\F02\VicMap.mxd 7/8/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet

LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Vicinity Map**	Figure 2



Legend

- Boring Number and Approximate Location
- Hand Auger Number and Approximate Location
- Approximate Trail Alignment (See Project Plans for Actual Alignment)

0 400 800

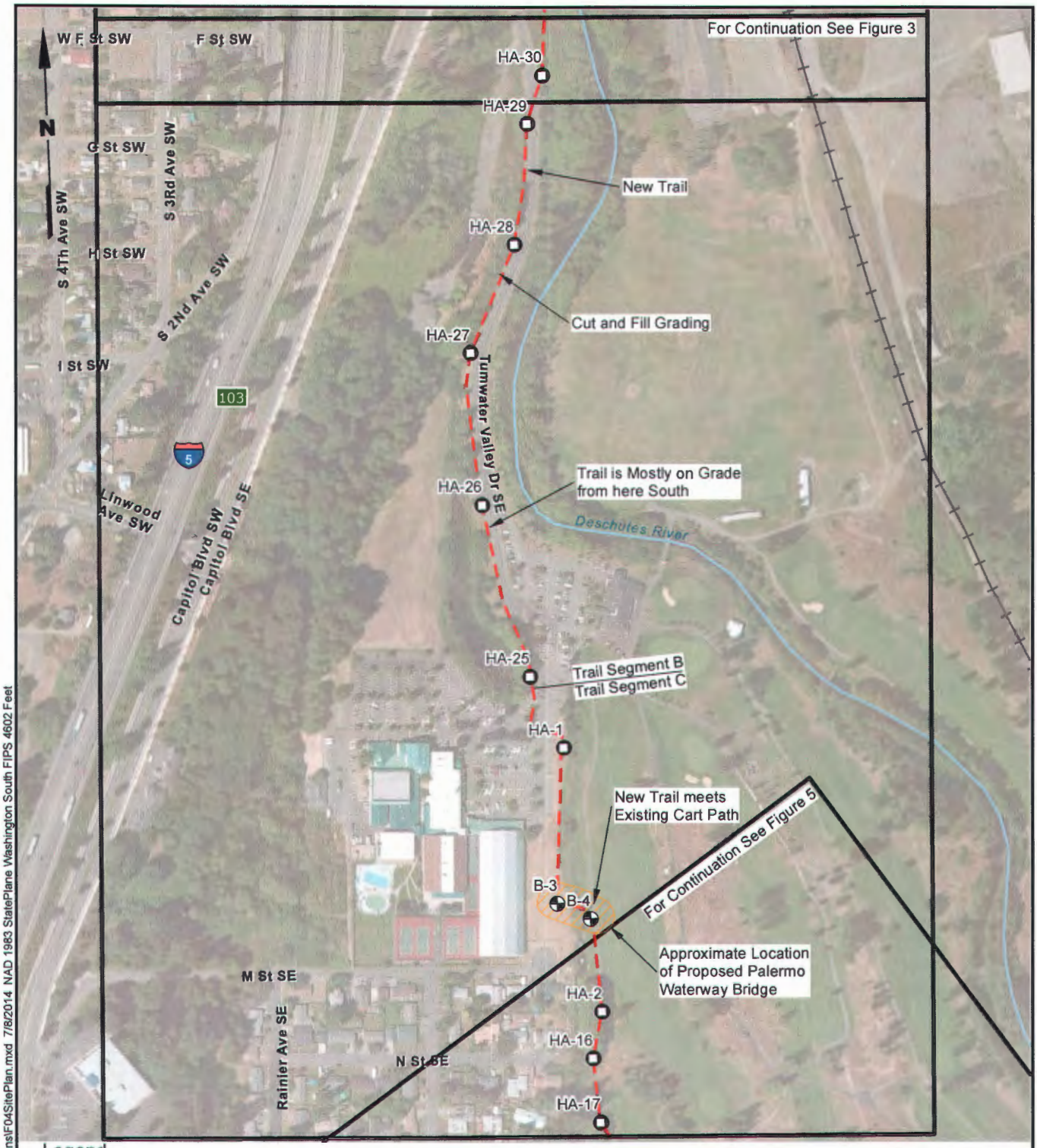
Feet

Data Source: Esri 2012

G:\Projects\1444\001\010\011\TrailPlans\F03SitePlan.mxd 7/8/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet

LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Site and Exploration Plan**	Figure 3



Legend

- Boring Number and Approximate Location
- Hand Auger Number and Approximate Location
- Approximate Trail Alignment (See Project Plans for Actual Alignment)

0 400 800

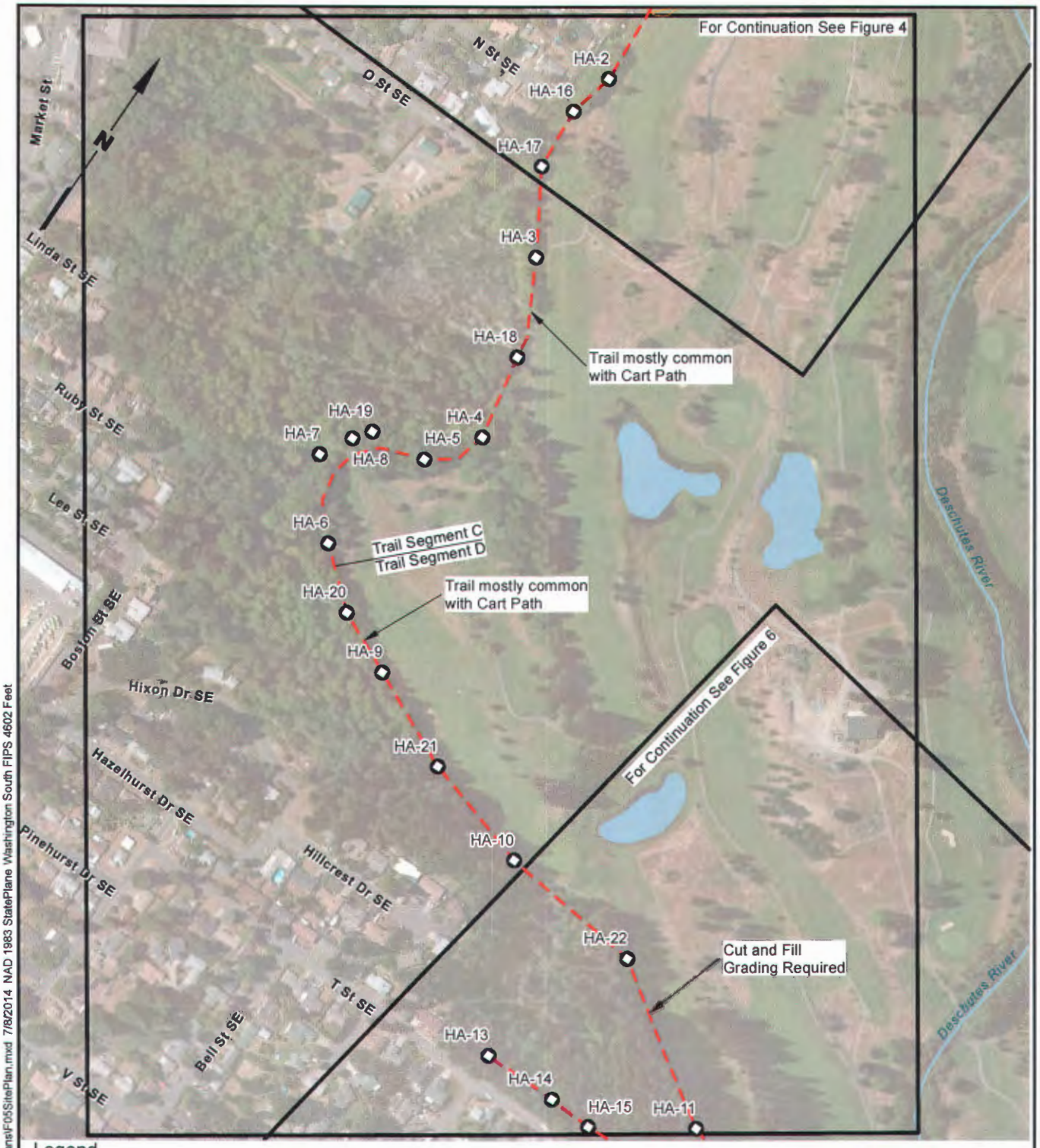
Feet

Data Source: Esri 2012

G:\Projects\144400101010\11\TrailPlans\F04SitePlan.mxd 7/8/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet

LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Site and Exploration Plan**	Figure 4



Legend

- Boring Number and Approximate Location
- Hand Auger Number and Approximate Location
- Approximate Trail Alignment (See Project Plans for Actual Alignment)

0 400 800

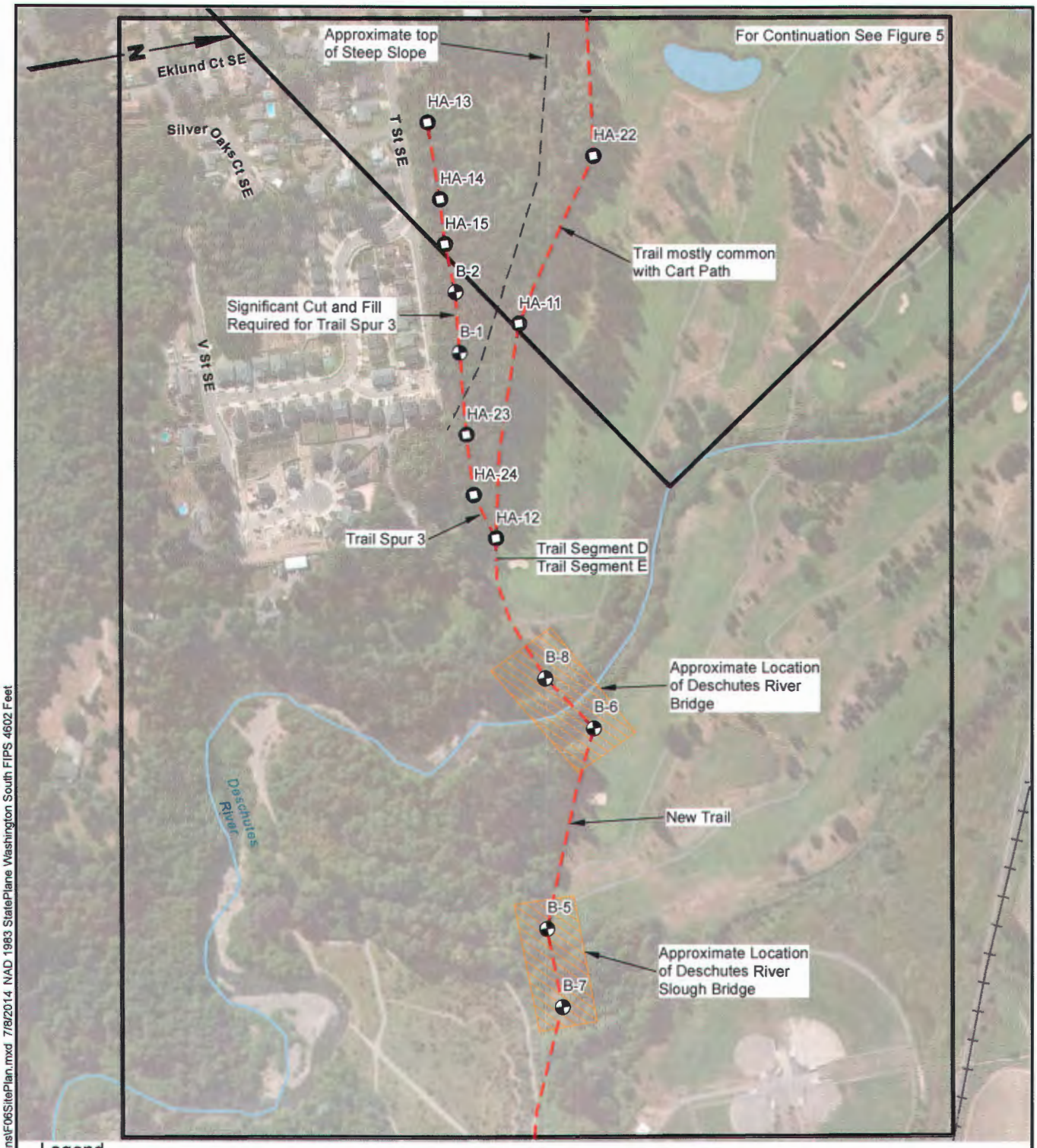
Feet

Data Source: Esri 2012

G:\Projects\1444\001\010\011\TrailPlans\F05SitePlan.mxd 7/8/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet

LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Site and Exploration Plan**	Figure 5



Legend

- Boring Number and Approximate Location
- Hand Auger Number and Approximate Location
- Approximate Trail Alignment (See Project Plans for Actual Alignment)

0 400 800

Feet

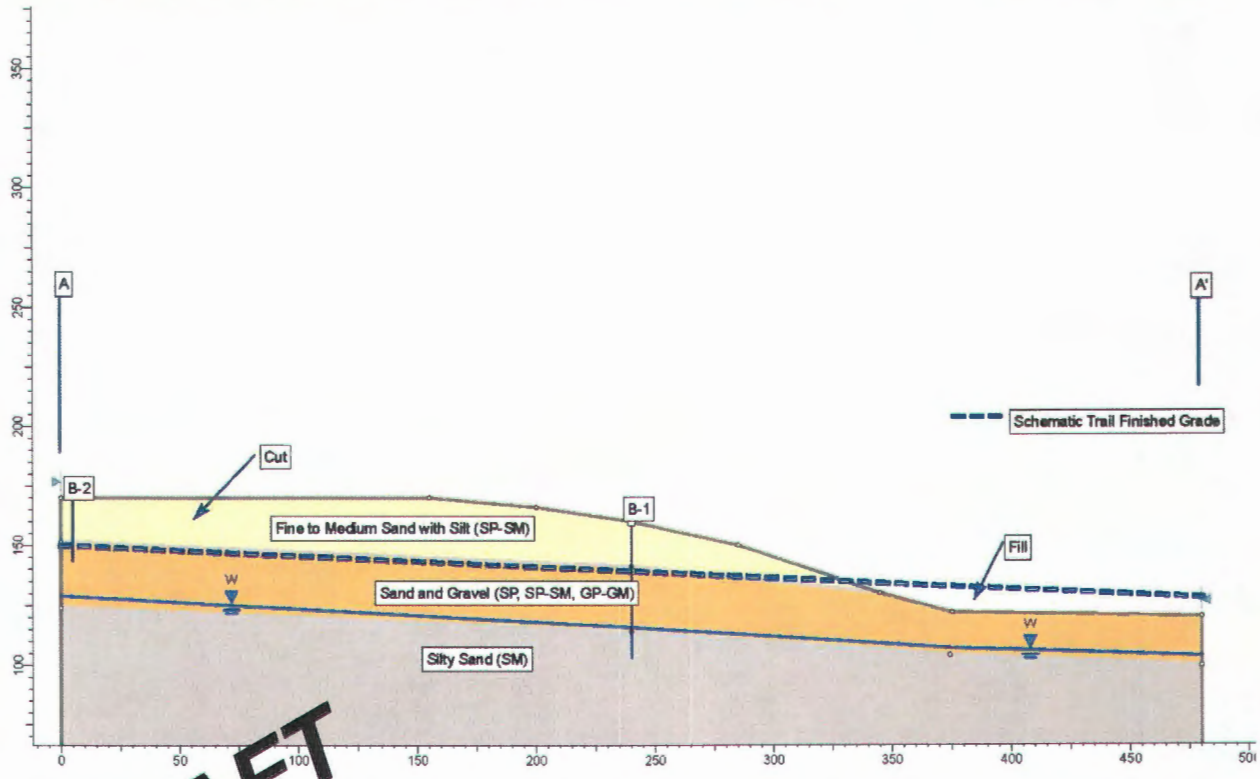
Data Source: Esri 2012

G:\Projects\1444\001\010\011\TrailPlans\F06SitePlan.mxd 7/8/2014 NAD 1983 StatePlane Washington South FIPS 4602 Feet

LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Site and Exploration Plan**	Figure 6

LANDAU ASSOCIATES, INC. | G:\Projects\1444\001\010\011\TrailPlans\F07Section.dwg (A) "Figure 7" 7/8/2014



DRAFT

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

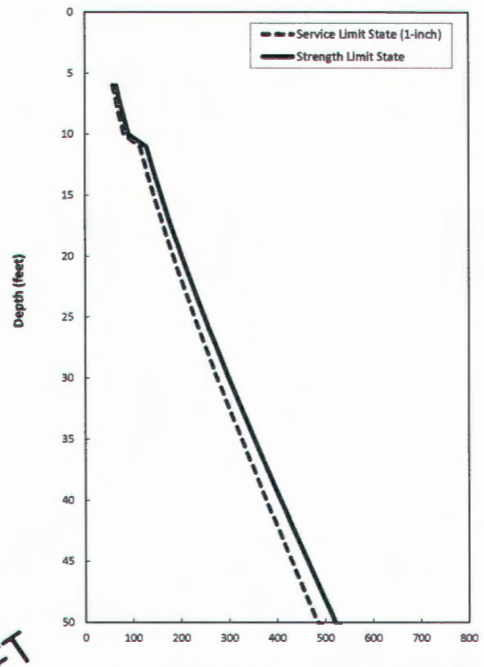
0 60 100
Horizontal Scale in Feet

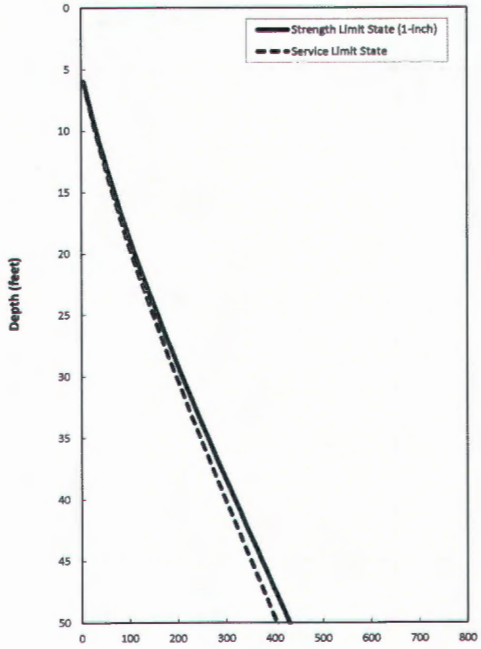
Deschutes Valley Trail
Tumwater, Washington

Geologic Profile A-A'

Figure
7

2-ft Diameter Drilled Shafts





DRAFT

Notes:

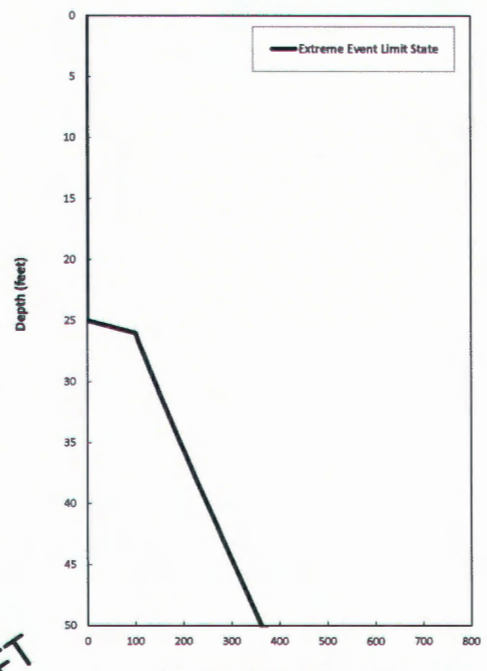
1. Unfactored axial capacity estimates are based upon O'Neill and Reese method (1999), as discussed in 2012 AASHTO LRFD Bridge Design Specifications and upon local geotechnical engineering experience. Factored load resistance should be computed using appropriate resistance factors for side friction and end-bearing, which may differ.
2. The net weight of the shaft should be treated as a load applied to the top of the shaft. This load is not accounted for in these charts.
3. Recommended resistance factors are shown in the report text.
4. Capacities computed are for single drilled shafts.

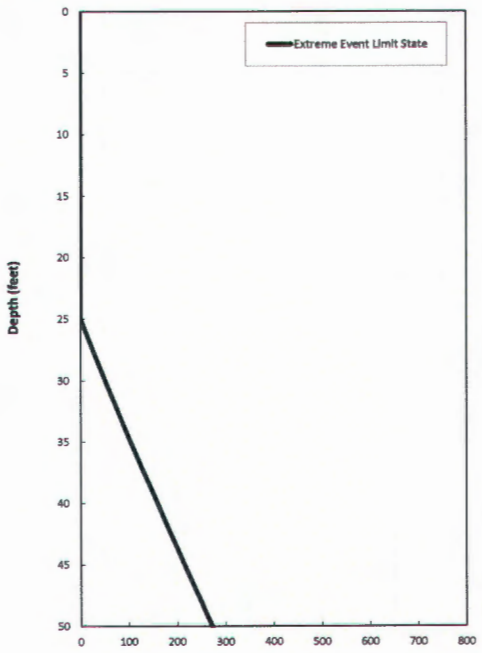
LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, Washington	**Axial Shaft Capacity Service and Strength Limit States**	Figure 8

Y:\1444\001.01\DR\Figures\Figures 8 and 9 7/8/2014

2-ft Diameter Drilled Shafts





DRAFT

Notes:

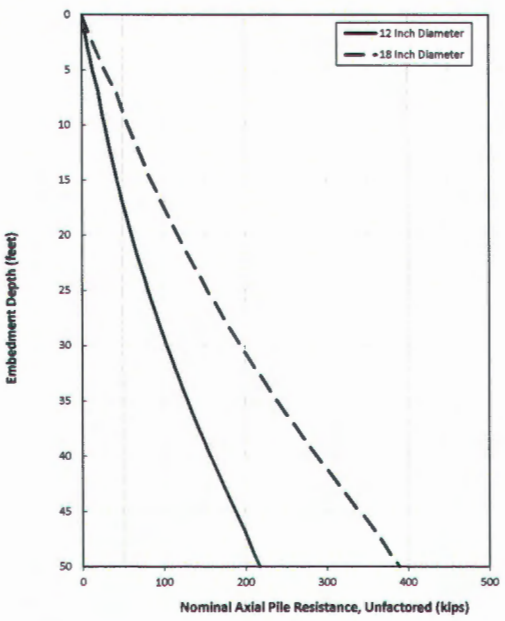
1. Unfactored axial capacity estimates are based upon O'Neill and Reese method (1999), as discussed in 2012 AASHTO LRFD Bridge Design Specifications and upon local geotechnical engineering experience. Factored load resistance should be computed using appropriate resistance factors for side friction and end-bearing, which may differ. The net weight of the shaft should be treated as a load applied to the top of the shaft. This load is not accounted for in these charts.
2. The net weight of the shaft should be treated as a load applied to the top of the shaft. This load is not accounted for in these charts.
3. Liquefaction-induced downdrag loads are 150 kips for the 2-ft diameter shafts.
4. Recommended resistance factors are shown in the report text.

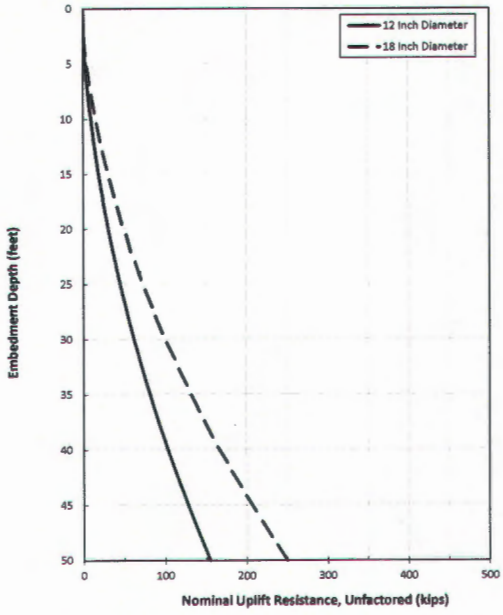
LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, Washington	**Axial Shaft Capacity** **Extreme Event Limit State**	Figure 9

Y:\1444\001.010\R\Figures\Figures 8 and 9 7/9/2014

Open-end Steel Pipe Piles (Service and Strength Limit States)





Notes:

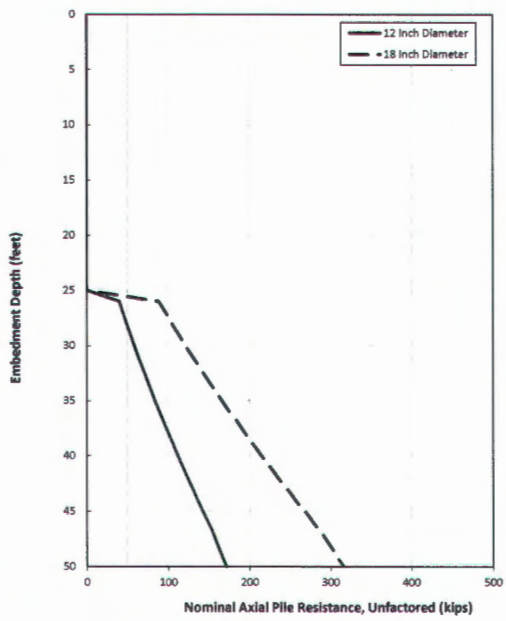
1. The plots above present the nominal resistance as determined by the Nordlund/Thurman Method as described in 2012 AASHTO LRFD Bridge Design Specifications.
2. Nominal pile axial pile resistance assumes the piles are impact driven
3. Resistance Factors must be applied to the values above based upon the Limit State under consideration. Please see the main text of the report for the resistance factors.
4. A group reduction factor may be appropriate depending upon group geometry and pile loading considerations, as discussed in the text of the report.

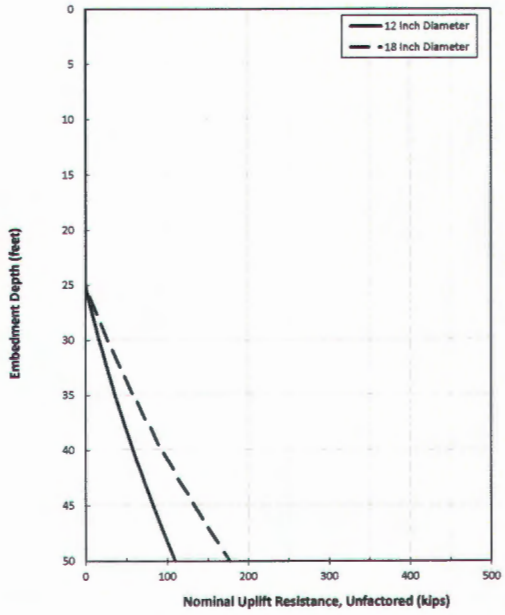
LANDAU ASSOCIATES

Y:\1444\001.010\R\Figures\Figure 10 7/9/2014

Deschutes Valley Trail Tumwater, Washington	**Axial Pile Capacity Service and Strength Limit States**	Figure 10

Open-end Steel Pipe Piles (Extreme Event Limit State)





Notes:

1. The plots above present the nominal resistance as determined by the Nordlund/Thurman Method as described in 2012 AASHTO LRFD Bridge Design Specifications.
2. Nominal pile axial pile resistance assumes the piles are impact driven.
3. Resistance Factors must be applied to the values above based upon the Limit State under consideration. Please see the main text of the report for the resistance factors.
4. A group reduction factor may be appropriate depending upon group geometry and pile loading considerations, as discussed in the text of the report.
5. Liquefaction-induced downdrag loads are 45 kips and 75 kips for the12-inch and 18-inch diameter pipe piles, respectively.

LANDAU ASSOCIATES

Y:\1444\001.010\R\Figures\Figure 11 7/9/2014

Deschutes Valley Trail Tumwater, Washington	**Axial Pile Capacity Extreme Event Limit State**	Figure 11

APPENDIX A

Subsurface Explorations

APPENDIX A
SUBSURFACE EXPLORATIONS

This appendix provides information about the subsurface exploration methods employed for the Deschutes Valley Trail project. Results of our subsurface exploration program and interpretation of the subsurface data is discussed in the main text of this report. The field exploration program consisted of seven borings advanced using truck- and track-mounted drilling equipment (designated B-1 through B-7) and 40 hand-auger borings (designated HA-1 through HA-40).

The field explorations were coordinated and monitored by representatives from our firmwho also obtained representative soil samples, maintained a detailed record of observed subsurface soil and groundwater conditions, and described the soil encountered by visual and textural examination. Each representative soil type observed was described using the soil classification system shown on Figure A-1, in general accordance with ASTM International D 2488, *Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)*. Logs of our explorations are presented on Figures A-2 through A-28. These logs represent our interpretation of subsurface conditions identified during the geotechnical explorations. The stratigraphic contacts shown on the individual logs represent the approximate boundaries between soil types; actual transitions may be more gradual. Information presented on the summary logs depicts subsurface conditions only at the specified location on the date designated on the logs. Soil and groundwater conditions at other locations may differ from conditions observed at the exploration locations.

The explorations were located in the field by hand taping and pacing from existing physical features. The ground surface elevations shown on the logs were interpreted from topographic contours indicated on the site survey by MTN2COAST Surveying. The reported elevations should be considered approximate.

Disturbed samples of the soil in the borings were obtained at selected intervals using a 2.0-inch outside diameter split-spoon sampler. The sampler was driven into the undisturbed soil ahead of the auger bit with a 140-pound automatic hammer falling a distance of about 30 inches. The number of blows required to drive the sampler for the final 1 foot of soil penetration, or part thereof, is noted in the boring logs adjacent to the appropriate sample notation. Disturbed grab samples were obtained from the hand-auger borings either by hand or from the blades of the auger.

DRAFT

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS[2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
	≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

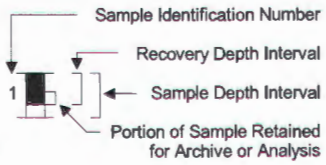
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽ Approximate water level at time of drilling (ATD)

▼ Approximate water level at time other than ATD

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Soil Classification System and Key

Figure A-1

B-1

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 165
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Groundwater	Moisture Content (%) / SPT N-Value / Fines Content (%)
0	165	S-1	b2	4					14" of Forest Duff **(TOPSOIL/SOD/DUFF)**
							SP-SM		Brown, fine to medium SAND with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**
5	160	S-2	b2	12	-200 = 11 W = 8				
10	155	S-3	b2	16	-200 = 13 W = 9				-grades to gray
15	150	S-4	b2	14	GS -200 = 12 W = 9				
							SP		Gray, very gravelly SAND (very dense, moist)
20	145	S-5	b2	60	GS -200 = 4 W = 5				-density over stated due to rock in sampler tip
25	140	S-6	b2	28					-grades to medium dense
30	135	S-7	b2	24	W = 6				-gravel content decreases
							SP-SM		Gray, gravelly SAND with silt (dense, moist)
35	130								

Moisture Content (%): Plastic Limit — Liquid Limit; 10 20 30 40
▲ SPT N-Value ▲ / △ Non-Standard N-Value △; 10 20 30 40
× Fines Content (%) ×; 10 20 30 40

60

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

DRAFT

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-1

Figure A-2 (1 of 2)

B-1

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 165
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
35	130	S-8	b2	38	-200 = 12 W = 9		SP-SM	Gray, gravelly SAND with silt (dense, moist)	
							GP-GM	Gray, sandy GRAVEL with silt (dense, moist)	
40	125	S-9	b2	47					
45	120	S-10	b2	42				-grades to include fine to medium sand seams	
							SM	Brown, silty SAND (medium dense, moist)	
50	115	S-11	b2	27	-200 = 23 W = 13				
55	110	S-12	b2	32				-grades to dense, includes iron-stained lenses	▽ 59.2 ft ATD
60	105	S-13	b2	45	W = 28			-grades to wet	
65									
70									

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Boring Completed 08/06/12
Total Depth of Boring = 61.5 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-1

Figure A-2 (2 of 2)

B-2

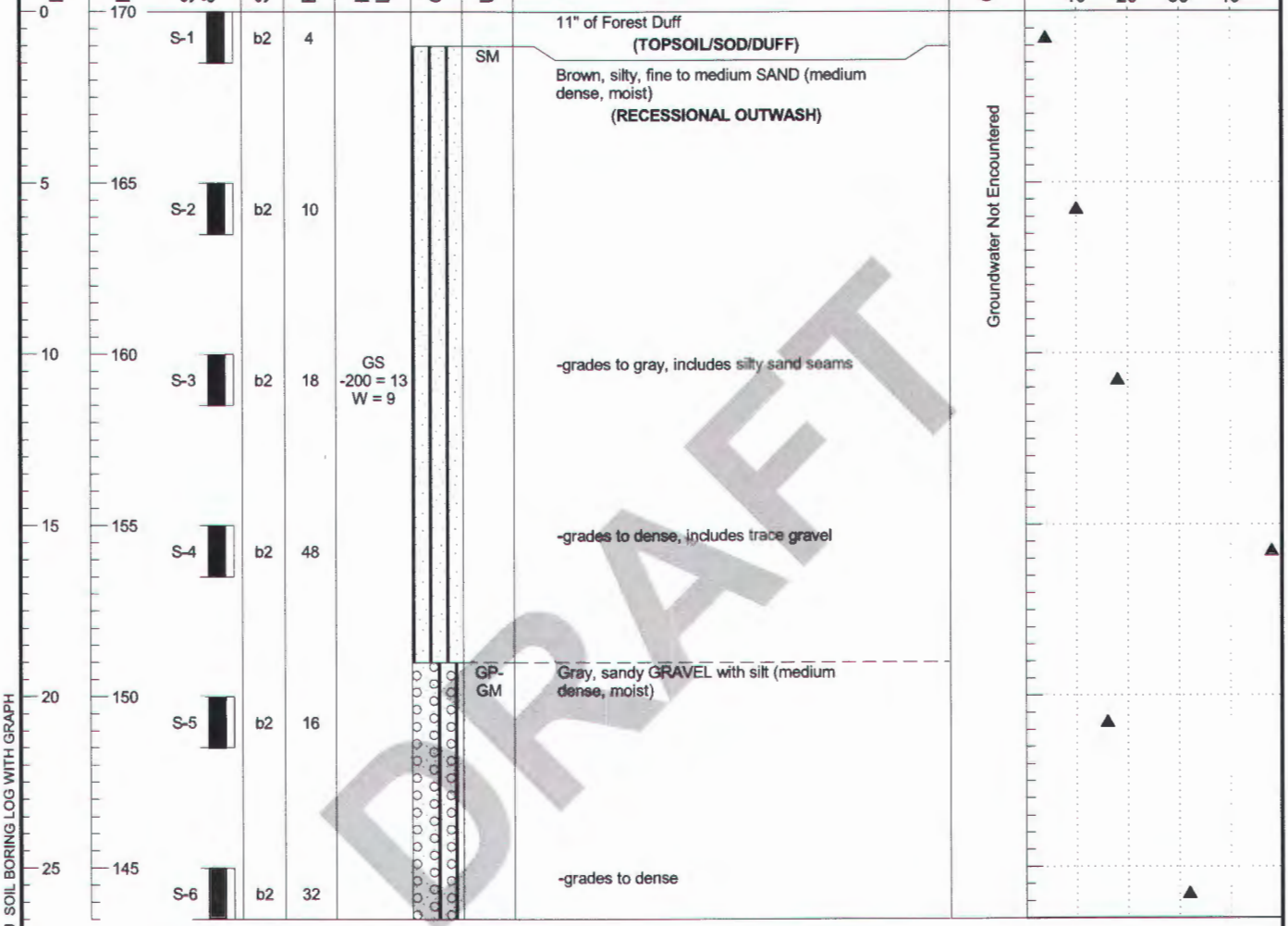
LAI Project No: 1444001.010

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	SOIL PROFILE	Groundwater
0	170	S-1	b2	4			SM	Drilling Method: Hollow-Stem Auger Ground Elevation (ft): 170 Drilled By: Holocene Drilling Inc. Logged By: CAM Date: 08/06/12 11" of Forest Duff **(TOPSOIL/SOD/DUFF)** Brown, silty, fine to medium SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	Groundwater Not Encountered
5	165	S-2	b2	10					
10	160	S-3	b2	18	GS -200 = 13 W = 9			-grades to gray, includes silty sand seams	
15	155	S-4	b2	48				-grades to dense, includes trace gravel	
20	150	S-5	b2	16			GP-GM	Gray, sandy GRAVEL with silt (medium dense, moist)	
25	145	S-6	b2	32				-grades to dense	
30									
35									

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40



Boring Completed 08/06/12
Total Depth of Boring = 26.5 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, Washington	Log of Boring B-2	Figure A-3

B-3

LAI Project No: 1444001.010

SAMPLE DATA / SOIL PROFILE

Drilling Method: Mud Rotary
Ground Elevation (ft): 102
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
0	100	S-1	b2	3			SM	5" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	
		S-2	b2	3	W = 44			Dark brown, silty SAND with organics (loose, moist) **(FILL)**	
5	95	S-3	b2	3	W = 65		MH/ PT	Dark brown SILT with sand and peat (soft, wet) **(MARSH DEPOSITS)**	
		S-4	b2	36			GM	Gray, silty, sandy GRAVEL (dense, wet) **(RECESSIONAL OUTWASH)**	
10	90	S-5	b2	19	-200 = 21 W = 15			-grades to medium dense	
15	85						SM	Gray, silty SAND (loose, wet)	
		S-6	b2	8					
20									3.1 ft ATD
25									
30									
35									

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Boring Completed 08/06/12
Total Depth of Boring = 19.0 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-3

Figure A-4

B-4

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

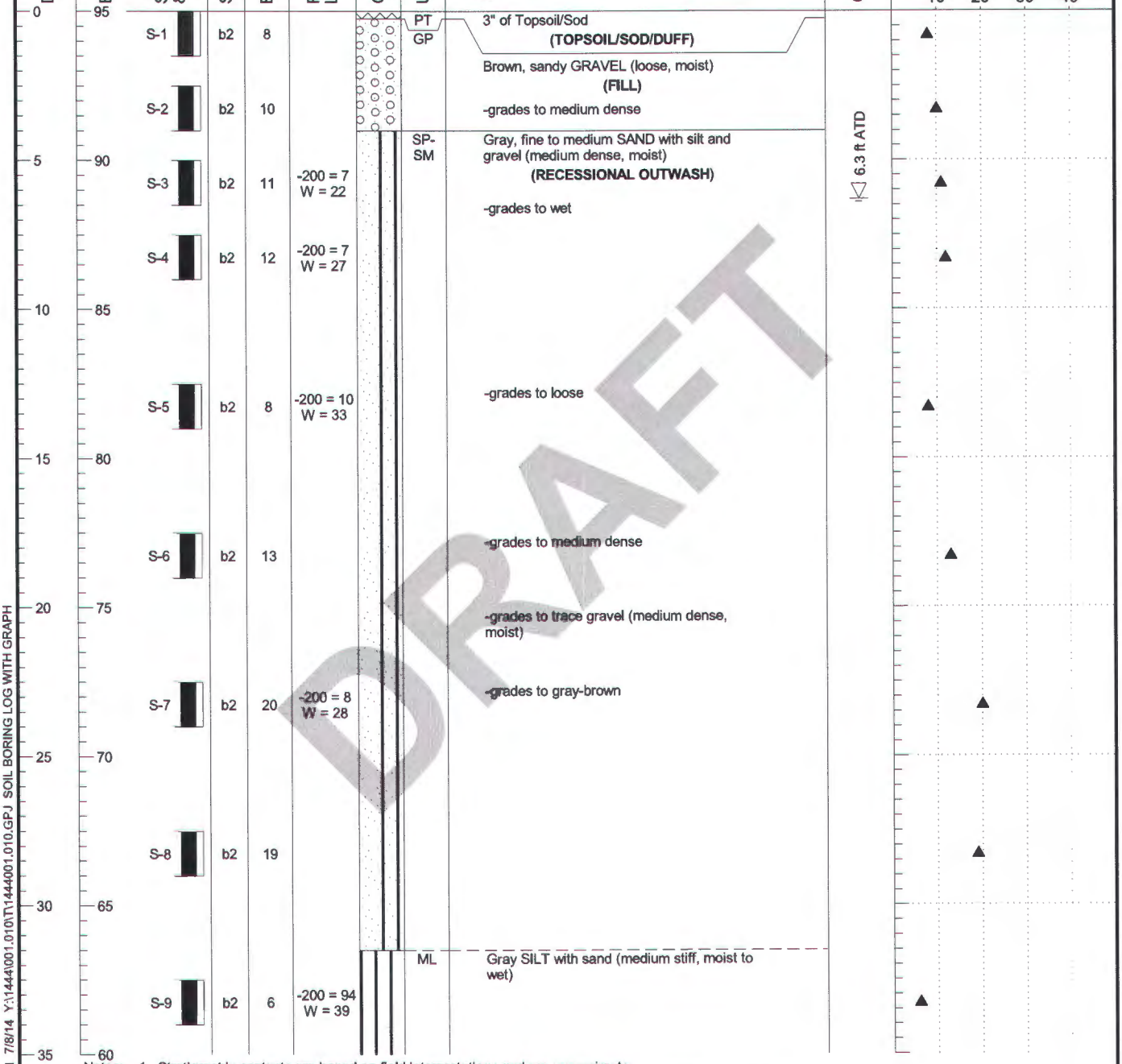
Drilling Method: Mud Rotary
Ground Elevation (ft): 95
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
0	95	S-1	b2	8			PT GP	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, sandy GRAVEL (loose, moist) **(FILL)**	
		S-2	b2	10				-grades to medium dense	
5	90	S-3	b2	11	-200 = 7 W = 22		SP-SM	Gray, fine to medium SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	▽ 6.3 ft ATD
		S-4	b2	12	-200 = 7 W = 27			-grades to wet	
10	85								
		S-5	b2	8	-200 = 10 W = 33			-grades to loose	
15	80								
		S-6	b2	13				-grades to medium dense	
20	75							-grades to trace gravel (medium dense, moist)	
		S-7	b2	20	-200 = 8 W = 28			-grades to gray-brown	
25	70								
		S-8	b2	19					
30	65								
							ML	Gray SILT with sand (medium stiff, moist to wet)	
35	60	S-9	b2	6	-200 = 94 W = 39				

Moisture Content (%)
Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40



DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, Washington	Log of Boring B-4	Figure A-5 (1 of 2)

B-4

LAI Project No: 1444001.010

SAMPLE DATA

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests
35	60				
		S-10	b2	10	
40	55				
		S-11	b2	20	-200 = 40 W = 30
45	50				
		S-12	b2	35	
50	45				
		S-13	b2	27	
55	40				
		S-14	b2	31	
60					
65					
70					

SOIL PROFILE

Drilling Method: Mud Rotary
Ground Elevation (ft): 95
Drilled By: Holocene Drilling Inc.
Logged By: CAM Date: 08/06/12

Graphic Symbol	USCS Symbol	
	ML	Gray SILT with sand (medium stiff, moist to wet)
		-grades to stiff
	SM	Dark gray, very silty SAND (medium dense, wet)
		-grades to dense
		-grades to gray-brown, medium dense
		-grades to dense

Groundwater

Moisture Content (%)
Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Boring Completed 08/06/12
Total Depth of Boring = 59.0 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-4

Figure
A-5
(2 of 2)

B-5

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 110
Drilled By: Holocene Drilling Inc.
Logged By: DAR Date: 06/02/14

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
0	110						SP	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	
								Brown, fine to medium SAND (loose, moist) **(FILL)**	
		S-1	b2	9	W = 13 GS		SP-SM	Brown, fine SAND with silt (loose, moist) **(ALLUVIUM)**	
5	105	S-2	b2	8	W = 22 -200 = 14				▽ 7.0 ft ATD
		S-3	b2	14	W = 11 GS		SP-SM	Brown, very gravelly SAND with silt (medium dense, wet) **(RECESSIONAL OUTWASH)**	
10	100	S-4	b2	14	W = 12 GS		GP-GM	Brown, very sandy GRAVEL with silt (medium dense, wet)	
15	95	S-5	b2	23			GP	Gray, fine to coarse GRAVEL with sand (medium dense, wet)	
20	90	S-6	b2	25			SM	Gray, silty SAND (medium dense, wet)	
25	85	S-7	b2	21	W = 31 -200 = 26		SP-SM	Gray, very gravelly SAND with silt (medium dense, wet)	
30	80	S-8	b2	24	W = 8 -200 = 6				
35	75								

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40
▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40
× Fines Content (%) ×
10 20 30 40

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-5

Figure A-6 (1 of 3)

B-5

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 110
Drilled By: Holocene Drilling Inc.
Logged By: DAR Date: 06/02/14

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
35	75	S-9	b2	24	W = 13 GS		SP-SM	Gray, very gravelly SAND with silt (medium dense, wet)	
							SP-SM	Gray, gravelly SAND with silt (dense, wet)	
40	70	S-10	b2	39	W = 13 GS				
45	65	S-11	b2	25				-grades to medium dense	
50	60	S-12	b2	27	W = 16 GS			-grades to with gravel	
55	55	S-13	b2	42				-grades to dense	
60	50	S-14	b2	48					
65	45	S-15	b2	57				-grades to very dense	
70	40								

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

57

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-5

Figure
A-6
(2 of 3)

B-5

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Hollow-Stem Auger
Ground Elevation (ft): 110
Drilled By: Holocene Drilling Inc.
Logged By: DAR Date: 06/02/14

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
70	40	S-16	b2	28	W = 23 -200 = 6		SP-SM	Gray, gravelly SAND with silt (dense, wet) -grades to medium dense	
75	35	S-17	b2	40				-grades to dense	

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40
▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40
× Fines Content (%) ×
10 20 30 40

Boring Completed 06/02/14
Total Depth of Boring = 76.5 ft.

80 85 90 95 100 105

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-5

Figure A-6 (3 of 3)

B-6

LAI Project No: 1444001.010

SAMPLE DATA

SOIL PROFILE

Drilling Method: Mud Rotary
Ground Elevation (ft): 105.5
Drilled By: Holocene Drilling Inc.
Logged By: DAR Date: 06/03/14

Groundwater: ▽ 8.0 ft ATD

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	105						PT	7" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**
							SP-SM	Brown, fine to medium SAND with silt (loose, moist) **(FILL)**
		S-1	b2	2	W = 15 -200 = 10			
5	100	S-2	b2	26	W = 8 -200 = 5		GP-GM	Brown, sandy GRAVEL with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**
		S-3	b2	28	W = 8 GS		GW	Gray, very sandy GRAVEL (medium dense, wet)
10	95	S-4	b2	41	W = 11 GS			-grades to gray, dense
		S-5	b2	32				
15	90						SP	Gray, fine to medium SAND with gravel (medium dense, wet)
		S-6	b2	22				
20	85							-grades to loose, without gravel
		S-7	b2	7				
25	80							
		S-8	b2	9				
30	75							-grades to medium dense, with gravel
		S-9	b2	19				
35								

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-6

Figure
A-7
(1 of 2)

B-6

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Mud Rotary
Ground Elevation (ft): 105.5
Drilled By: Holocene Drilling Inc.
Logged By: DAR Date: 06/03/14

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Groundwater
35	70						GP	Gray, sandy GRAVEL (medium dense, wet)
		S-10	b2	28				
40	65						SP	Gray, gravelly SAND (medium dense, wet)
		S-11	b2	23				
45								
50								
55								
60								
65								
70								

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

Boring Completed 06/03/14
Total Depth of Boring = 44.0 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-6

Figure
A-7
(2 of 2)

B-7

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Mud Rotary
Ground Elevation (ft): 107.5
Drilled By: Holocene Drilling Inc.
Logged By: JTM Date: 06/26/14

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
0	105						SM	Brown, silty SAND with organics (medium dense, moist) **(FILL)**	
5	100	S-1	b2	24	W = 8 -200 = 4		GP	Gray-Brown, sandy GRAVEL (medium dense, wet) **(RECESSIONAL OUTWASH)**	▽ 9.0 ft ATD
10	95		b2	16			SP	Gray, fine to medium SAND (dense, wet)	
15	90	S-2 S-3	b2	51			GP	Gray, sandy GRAVEL (dense, wet)	
20	85	S-4	b2	12			GP	Gray, very sandy GRAVEL (medium dense, wet)	
25	80	S-5	b2	16					
30	75	S-6	b2	41	W = 11 GS			-grades to dense	
35									

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

51

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-7

Figure
A-8
(1 of 3)

B-7

LAI Project No: 1444001.010

SAMPLE DATA | **SOIL PROFILE**

Drilling Method: Mud Rotary
Ground Elevation (ft): 107.5
Drilled By: Holocene Drilling Inc.
Logged By: JTM Date: 06/26/14

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Description	Groundwater
35	70						SP	Gray, gravelly SAND (medium dense to dense, wet)	
40	65							-gravel content decreases per driller	
45	60		b2	50/ 3"					
50	55							-gravel content increases per driller	
55	50								
60	45							-mostly sand per driller	
65	40								
70									

Moisture Content (%) — Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

50/ 3" ▲

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-7

Figure
A-8
(2 of 3)

B-7

LAI Project No: 1444001.010

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Soil Profile	Groundwater
								Drilling Method: Mud Rotary Ground Elevation (ft): 107.5 Drilled By: Holocene Drilling Inc. Logged By: JTM Date: 06/26/14	
70	35	S-7	b2	13			SP	Gray, gravelly SAND (medium dense to dense, wet) -grades to fine to medium SAND with gravel (medium dense, wet) -grades to very gravelly, very dense	
75	30	S-8	b2	52					
80	25	S-9	b2	45	W = 13 GS				
							SP	Gray, fine to medium SAND (dense, wet)	
85	20	S-10	b2	47					
90	15	S-11	b2	40					
95	10	S-12	b2	54				-grades to very dense	
100		S-13	b2	37				-grades to dense	
105									

Moisture Content (%)
Plastic Limit — Liquid Limit
10 20 30 40

▲ SPT N-Value ▲
△ Non-Standard N-Value △
10 20 30 40

× Fines Content (%) ×
10 20 30 40

52

54

DRAFT

Boring Completed 06/26/14
Total Depth of Boring = 101.5 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Boring B-7

Figure
A-8
(3 of 3)

HA-01

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	98					SP-SM	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
				-200 = 9 W = 5			Brown-gray, fine to medium SAND with silt (medium dense, moist) **(FILL)**	
2	96							
							Hand Auger Boring Completed 07/30/12 Total Depth of Hand Auger Boring = 2.8 ft.	
4								
6								

HA-02

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 96 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	96						7" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
				-200 = 9 W = 4		SP-SM	Brown-gray, fine to medium SAND with silt (medium dense, moist) **(FILL)**	
2	94			W = 22		SM	Dark brown, silty SAND with organics (loose, moist) **(MARSH DEPOSITS)**	
							-grades to bright gray	
							Hand Auger Boring Completed 07/30/12 Total Depth of Hand Auger Boring = 3.1 ft.	
4								
6								

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-9

HA-03

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	98					AC	2" of Asphalt concrete pavement
				W = 4		GW	
						SM	Crushed surfacing base course (dense, moist) **(FILL)**
2	96			GS -200 = 25 W = 20		SM	Filter fabric layer under CSBC Dark brown, very silty SAND with trace organics (loose, moist) **(MARSH DEPOSITS)**
				W = 19			Bright gray, silty SAND with trace organics (loose, moist)
4	94					SM	Dark gray, fine to medium SAND with silt (loose, wet)
6							

Excavation Method: Hand Auger
Ground Elevation (ft): 98
Excavated By: Bay Townes Geotechnical
Logged By: CAM

▽ Groundwater seepage encountered at 4.1 ft.

Hand Auger Boring Completed 07/30/12
Total Depth of Hand Auger Boring = 4.5 ft.

HA-04

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	108					SP-SM	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**
2	106						Brown-gray, fine to medium sand with silt (medium dense, moist) **(RECESSIONAL OUTWASH)** -grades to gray, includes gravel
4							
6							

Excavation Method: Hand Auger
Ground Elevation (ft): 109
Excavated By: Bay Townes Geotechnical
Logged By: CAM

Groundwater not encountered.

Hand Auger Boring Completed 07/30/12
Total Depth of Hand Auger Boring = 3.4 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-10

HA-05

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 109 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	109					GW	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	108					SP-SM	Crushed surfacing base course (dense, moist) **(FILL)**	
2							Gray, fine to coarse SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
							Hand Auger Boring Completed 07/31/12 Total Depth of Hand Auger Boring = 2.1 ft.	
4								
6								

HA-06

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	115			W = 39		SM	Brown, silty SAND with trace organics (loose, moist) **(MARSH DEPOSITS)**	▽ Groundwater seepage encountered at 1.3 ft.
	114			-200 = 31 W = 30		SM	Gray, very silty, fine to medium SAND (loose, wet) **(RECESSIONAL OUTWASH)**	
2	112						Hand Auger Boring Completed 07/31/12 Total Depth of Hand Auger Boring = 3.1 ft.	
4								
6								

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-11

HA-07

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 110 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	110						14" of Forest Duff **(TOPSOIL/SOD/DUFF)**	
2	108					SP-SM	Gray, fine to medium SAND with silt (medium dense, moist to wet) **(RECESSIONAL OUTWASH)**	▽ Groundwater seepage encountered at 1.9 ft.
4								
6								

Hand Auger Boring Completed 07/31/12
Total Depth of Hand Auger Boring = 2.4 ft.

HA-08

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 109 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	109						16" of Forest Duff **(TOPSOIL/SOD/DUFF)**	
2	107					SP-SM	Gray, fine to medium SAND with silt (medium dense, moist to wet) **(RECESSIONAL OUTWASH)**	▽ Groundwater seepage encountered at 2.1 ft.
4								
6								

Hand Auger Boring Completed 07/31/12
Total Depth of Hand Auger Boring = 2.6 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-12

HA-09

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	116						Excavation Method: Hand Auger Ground Elevation (ft): 116 Excavated By: Bay Townes Geotechnical Logged By: CAM
							6" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**
						SM	Gray, silty SAND (medium dense, moist) **(FILL)**
2	114			-200 = 22 W = 22		SM	Gray, silty, fine to medium SAND (medium dense, wet) **(RECESSIONAL OUTWASH)**
							▽ Groundwater seepage encountered at 1.5 ft.
4							Hand Auger Boring Completed 07/31/12 Total Depth of Hand Auger Boring = 3.6 ft.
6							

HA-10

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	108						Excavation Method: Hand Auger Ground Elevation (ft): 108 Excavated By: Bay Townes Geotechnical Logged By: CAM
						AC	2" of Asphalt concrete pavement
						GW	Crushed surfacing base course, includes small uncrushed cobble (dense, moist) **(FILL)**
						SP-SM	Filter fabric layer under CSBC
2	106			-200 = 7 W = 9			Brown, fine to medium SAND with silt (medium dense, moist to wet)
						MH/PT	Bright gray SILT with sand and peat lenses (soft, wet) **(MARSH DEPOSITS)**
4	104			W = 45			▽ Groundwater seepage encountered at 3.4 ft.
						SP-SM	Dark gray, fine to medium SAND with silt (loose, wet) **(RECESSIONAL OUTWASH)**
6							Hand Auger Boring Completed 08/07/12 Total Depth of Hand Auger Boring = 5.5 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-13

HA-11

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	114			-200 = 10 W = 7		SP-SM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Orange-brown, fine to coarse SAND with silt, gravel and cobble (medium dense, moist) **(RECESSIONAL OUTWASH)**	Groundwater not encountered.
2								
4								
6								

Hand Auger Boring Completed 08/07/12
Total Depth of Hand Auger Boring = 2.8 ft.

HA-12

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 106 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	106			-200 = 8 W = 6		AC	2" of Asphalt concrete pavement	Groundwater not encountered.
						GW	Crushed surfacing base course, includes round cobble (dense, moist) **(FILL)**	
2	104					SP-SM	Orange-brown, fine to coarse SAND with silt, gravel and cobble (medium dense, moist) **(RECESSIONAL OUTWASH)**	
4								
6								

Hand Auger Boring Completed 08/07/12
Total Depth of Hand Auger Boring = 2.7 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-14

HA-13

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 174 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	174						10" of Forest Duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
2	172			-200 = 8 W = 6		SP-SM	Brown, fine SAND with silt and trace gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
4							Hand Auger Boring Completed 08/20/12 Total Depth of Hand Auger Boring = 3.1 ft.	
6								

HA-14

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 174 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	174						11" of Forest duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
2	172			-200 = 8 W = 8		SP-SM	Brown, fine SAND with silt and trace gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
4	170						Hand Auger Boring Completed 08/20/12 Total Depth of Hand Auger Boring = 4.0 ft.	
6								

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-15

HA-15

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 173 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							10" of Forest Duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	172					SP-SM	Brown, fine SAND with silt and trace gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
2				-200 = 8 W = 8				
	170							
4								

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.2 ft.

6

HA-16

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	98					SP-SM	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
							Brown, fine SAND with silt (loose, moist) **(FILL)**	
2	96					SM	Brown-gray, silty SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
				-200 = 17 W = 17				
4	94							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.9 ft.

6

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-16

HA-17

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	98					SP-SM	Groundwater not encountered.
2	96			-200 = 19 W = 20		SM	
4	94						
6							

Excavation Method: Hand Auger
Ground Elevation (ft): 99
Excavated By: Bay Townes Geotechnical
Logged By: CAM

4" of Topsoil/Sod
(TOPSOIL/SOD/DUFF)

Brown, fine to medium SAND with silt (loose, moist)
(FILL)

Gray, silty SAND (medium dense, moist)
(ALLUVIUM)

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.1 ft.

HA-18

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	98					SP-SM	▽ Groundwater seepage encountered at 1.1 ft.
2	96			W = 72		MH/PT	
4	94					SM	
6							

Excavation Method: Hand Auger
Ground Elevation (ft): 98
Excavated By: Bay Townes Geotechnical
Logged By: CAM

4" of Topsoil/Sod
(TOPSOIL/SOD/DUFF)

Brown, fine to medium SAND with silt and trace gravel (medium dense, moist)
(FILL)

Dark brown PEAT with silt seams (soft, wet)
(MARSH DEPOSITS)

Bright gray, silty fine SAND with peat seams (very loose, wet)

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.2 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-17

HA-19

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	SOIL PROFILE	GROUNDWATER
							Excavation Method: Hand Auger Ground Elevation (ft): 109 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0							11" of Forest Duff **(TOPSOIL/SOD/DUFF)**	
	108			GS -200 = 8 W = 21		SP-SM	Brown, fine to medium SAND with silt and trace gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2								
	106					SM	Orange-brown and gray, silty SAND with trace gravel (medium dense, wet)	▽ Groundwater seepage encountered at 3.1 ft.
4								
	104							
				Hand Auger Boring Completed 08/20/12 Total Depth of Hand Auger Boring = 5.1 ft.				
6								

HA-20

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	SOIL PROFILE	GROUNDWATER
							Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0						SP-SM	3" of Topsoil **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt (medium dense, moist) **(FILL)**	
	114			GS -200 = 11 W = 15				
2						SM	Gray-black, silty SAND with trace organics (loose, moist to wet) **(MARSH DEPOSITS)**	
	112							
4				W = 21				▽ Groundwater seepage encountered at 4.2 ft.
	110							
				Hand Auger Boring Completed 08/20/12 Total Depth of Hand Auger Boring = 5.0 ft.				
6								

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-18

HA-21

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 115 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	115					SM	3" of Topsoil **(TOPSOIL/SOD/DUFF)** Brown, silty SAND (loose, moist) **(FILL)**	Groundwater not encountered.
2	113					ML	Gray, sandy SILT with organics (loose, moist) **(MARSH DEPOSITS)**	
4	111			W = 70				
6	109							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.0 ft.

HA-22

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 105 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	105					SP-SM	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt (loose, moist) **(FILL)**	Groundwater not encountered.
2	103					MH/PT	Dark brown SILT with sand and peat lenses (soft, moist) **(MARSH DEPOSITS)**	
4	101			W = 64				
6	99							

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 5.2 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-19

HA-23

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 130 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	130						9" of Forest duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
2	128			-200 = 6 W = 9		SP-SM	Brown, fine to medium SAND with silt and gravel (loose, moist) **(RECESSIONAL OUTWASH)**	
4	126							
6								

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.1 ft.

HA-24

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 121 Excavated By: Bay Townes Geotechnical Logged By: CAM	
0	120						8" of Forest Duff **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
2	118			GS -200 = 4 W = 6		SP-SM	Brown, very gravelly SAND (loose, moist) **(RECESSIONAL OUTWASH)** -grades to medium dense	
4								
6								

Hand Auger Boring Completed 08/20/12
Total Depth of Hand Auger Boring = 4.2 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-20

HA-25

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	96	S-1		W = 2		GP	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**
2	94	S-2				SP	Brown, sandy GRAVEL with cobbles (quarry spalls) and organics (medium dense, moist) **(FILL)**
4	92	S-3				SP	Brown, gravelly fine to coarse SAND (medium dense, moist)
6	90						Brown, fine to medium SAND (loose, wet) **(RECESSIONAL OUTWASH)**

Excavation Method: Hand Auger
Ground Elevation (ft): 96
Excavated By: Landau Associates
Logged By: BJF

▽ Groundwater seepage encountered at 5.0 ft.

Hand Auger Boring Completed 06/25/14

Refusal at 6.5 ft on Possible Bedrock

HA-26

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	
0	95	S-1		W = 8 -200 = 2		GP	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**
2	93	S-2				SP-SM	Brown, sandy GRAVEL with trace organics (medium dense, moist) **(FILL)**
4	91						Brown, fine to medium SAND with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**
6							-grades to brown-gray with mottling, moist to wet
							-gray sand layer

Excavation Method: Hand Auger
Ground Elevation (ft): 95
Excavated By: Landau Associates
Logged By: JTM

Groundwater not encountered.

Hand Auger Boring Completed 06/24/14
Total Depth of Hand Auger Boring = 3.2 ft.

Refusal at 3.2 ft on Possible Bedrock

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-21

HA-27

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 95 Excavated By: Landau Associates Logged By: BJF	
0						12" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
	94				SM	Orange/brown, silty SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2		S-1	W = 19 -200 = 27			-Charcoal/burnt wood at 2.5' to 2.8'	
	92	S-2	W = 20 -200 = 28			-grades to brown (medium dense, moist)	
		S-3	W = 18 -200 = 14		SP-SM	Brown gravelly SAND with silt (medium dense, moist to wet)	
4						**Refusal at 4.0 ft on Possible Bedrock**	
		Hand Auger Boring Completed 06/24/14 Total Depth of Hand Auger Boring = 4.0 ft.					
6							

HA-28

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 110 Excavated By: Landau Associates Logged By: BJF	
0	110	S-1	W = 13 -200 = 12		SM	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
		S-2	W = 4 -200 = 3		SP	Brown, silty SAND (medium dense, moist) **(FILL)**	
2	108					Orange/brown, fine to medium SAND with gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
		S-3	W = 8 -200 = 3		SP	Brown, fine to coarse SAND with gravel (medium dense, wet)	
4	106					**Refusal at 4.0 ft on Possible Bedrock**	
		Hand Auger Boring Completed 06/25/14 Total Depth of Hand Auger Boring = 4.0 ft.					
6							

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-22

HA-29

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0							Excavation Method: Hand Auger Ground Elevation (ft): 113 Excavated By: Landau Associates Logged By: BJF	
						SP	3" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	
	112	S-1		W = 4 -200 = 3			Orange/brown, gravelly, fine to medium SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2	110	S-2						
4		S-3		W = 21 -200 = 31		SM	Orange/brown, very silty, fine to medium SAND (medium dense, wet) -grades to with gravel (medium dense, wet)	▽ Groundwater seepage encountered at 4.5 ft.
	108	S-4						
6								

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 6.0 ft.

HA-30

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0							Excavation Method: Hand Auger Ground Elevation (ft): 107 Excavated By: Landau Associates Logged By: JTM	
						SP-SM	Brown, fine to medium SAND with silt and gravel (medium dense, moist) **(FILL)**	
	106	S-1		W = 15 -200 = 9		SP-SM	Brown, fine to medium SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2	104	S-2						
4		S-3					-grades to wet **Refusal at 4.3 ft on Possible Bedrock**	▽ Groundwater seepage encountered at 3.8 ft.
6								

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 4.2 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-23

HA-31

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 101 Excavated By: Landau Associates Logged By: BJF	
0	100	S-1	W = 8 -200 = 9		SP-SM	2" of Organic Topsoil **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt and trace organics (medium dense, moist) **(FILL)** -grades to without organics	Groundwater not encountered.
2	98	S-2					
4	96	S-3				-grades to orange/brown	
6		S-4				-grades to brown **Refusal at 5.7 ft on Possible Bedrock**	

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 5.7 ft.

HA-32

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 106 Excavated By: Landau Associates Logged By: BJF	
0	106	S-1			SP-SM	3" of Organic Topsoil **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt and trace organics (loose, moist) **(FILL)**	Groundwater not encountered.
2	104	S-2				-grades to medium dense, without organics	
4	102						
6	100	S-3				**Refusal at 6.1 ft on Weathered Bedrock**	

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 6.1 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-24

HA-33

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 98 Excavated By: Landau Associates Logged By: BJF	
0	98						4" of Organic Topsoil **(TOPSOIL/SOD/DUFF)**	
		S-1		W = 33		SM	Brown, silty SAND with trace organics (medium dense, moist) **(FILL)**	
2	96							▽ Groundwater seepage encountered at 2.8 ft.
		S-2		W = 30		SM	Orange/brown, silty, fine to medium SAND (medium dense, wet) **(RECESSIONAL OUTWASH)**	
4							**Refusal at 3.9 ft on Weathered Bedrock**	
6								

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 3.9 ft.

HA-34

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): 110 Excavated By: Landau Associates Logged By: BJF	
0	110					SP-SM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
		S-1				SP-SM	Brown, fine to coarse SAND with silt, gravel, and organics (dense, moist) **(FILL)**	
		S-2						
2	108					GP	Brown, fine to medium SAND with gravel and trace organics (medium dense, moist)	
		S-3					Brown, cobbly GRAVEL with sand (dense, moist)	
4							**Refusal on Roadway Ballast at 3.1 ft**	
6								

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 3.1 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-25

HA-35

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
0		S-1		W = 9		SP-SM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
							Brown, gravelly, fine to medium SAND with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2							-becoming cobbly at 1.2 ft	
							Refusal on Weathered Bedrock at 1.2 ft	
4								
6								

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 1.2 ft.

HA-36

SAMPLE DATA					SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
0							9" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)**	Groundwater not encountered.
						SP-SM	Brown, fine to medium SAND with silt and gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
2		S-1						
4							**Refusal on Bedrock or Possible Utility at 3.5 ft**	
6								

Hand Auger Boring Completed 06/27/14
Total Depth of Hand Auger Boring = 3.5 ft.

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure
A-26

HA-37

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
0	S-1		W = 9		SP-SM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt, gravel, and trace organics (medium dense, moist) **(FILL)**	Groundwater not encountered.
2							
4							
6							

Hand Auger Boring Completed 06/25/14
Total Depth of Hand Auger Boring = 3.0 ft.

Refusal at 3.0 ft on Bedrock

HA-38

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol	Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
0					SP-SM	3" of Organic Topsoil **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt, gravel, and trace organics (medium dense, moist) **(FILL)**	Groundwater not encountered.
2	S-1						
	S-2		W = 25 -200 = 39		SM	Mottled gray/brown, very silty, fine to medium SAND (medium dense, moist) **(RECESSIONAL OUTWASH)**	
4	S-3					-grades to with gravel	
6							

Hand Auger Boring Completed 06/26/14
Total Depth of Hand Auger Boring = 4.3 ft.

Refusal at 4.3 ft on Bedrock

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-27

HA-39

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0							Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
		S-1		W = 6		GP-GM	2" of Topsoil/Sod **(TOPSOIL/SOD/DUFF)** Brown, sandy GRAVEL with silt (medium dense, moist) **(RECESSIONAL OUTWASH)**	Groundwater not encountered.
2		S-2				SP	Brown, fine to medium SAND with gravel (medium dense, moist)	
4								
							Hand Auger Boring Completed 06/26/14 Total Depth of Hand Auger Boring = 4.7 ft.	**Refusal at 4.7 ft on Bedrock**
6								

HA-40

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Remarks and Laboratory Tests	Graphic Symbol	USCS Symbol		
0							Excavation Method: Hand Auger Ground Elevation (ft): Not Measured Excavated By: Landau Associates Logged By: BJF	
						SP-SM	2" of Organic Topsoil **(TOPSOIL/SOD/DUFF)** Brown, fine to medium SAND with silt and gravel (medium dense, moist) **(FILL)**	Groundwater not encountered.
2								
		S-1						
4								
							Hand Auger Boring Completed 06/26/14 Total Depth of Hand Auger Boring = 5.1 ft.	
6								

DRAFT

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ TEST PIT LOG W/ ELEVATION

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Log of Hand Auger Borings

Figure A-28

APPENDIX B

Physical Soil Testing

APPENDIX B
PHYSICAL SOIL TESTING

Soil samples obtained from the geotechnical borings were taken to our laboratory for further examination and testing. Laboratory tests were performed on representative soil samples to characterize certain engineering and index properties of the site soil. The laboratory testing program included visual inspection to confirm our field soil descriptions, determination of natural moisture content, grain size analysis, and determination of fines fraction (percent passing the U.S. Standard No. 200 sieve). A description of the testing performed is presented below.

NATURAL MOISTURE CONTENT

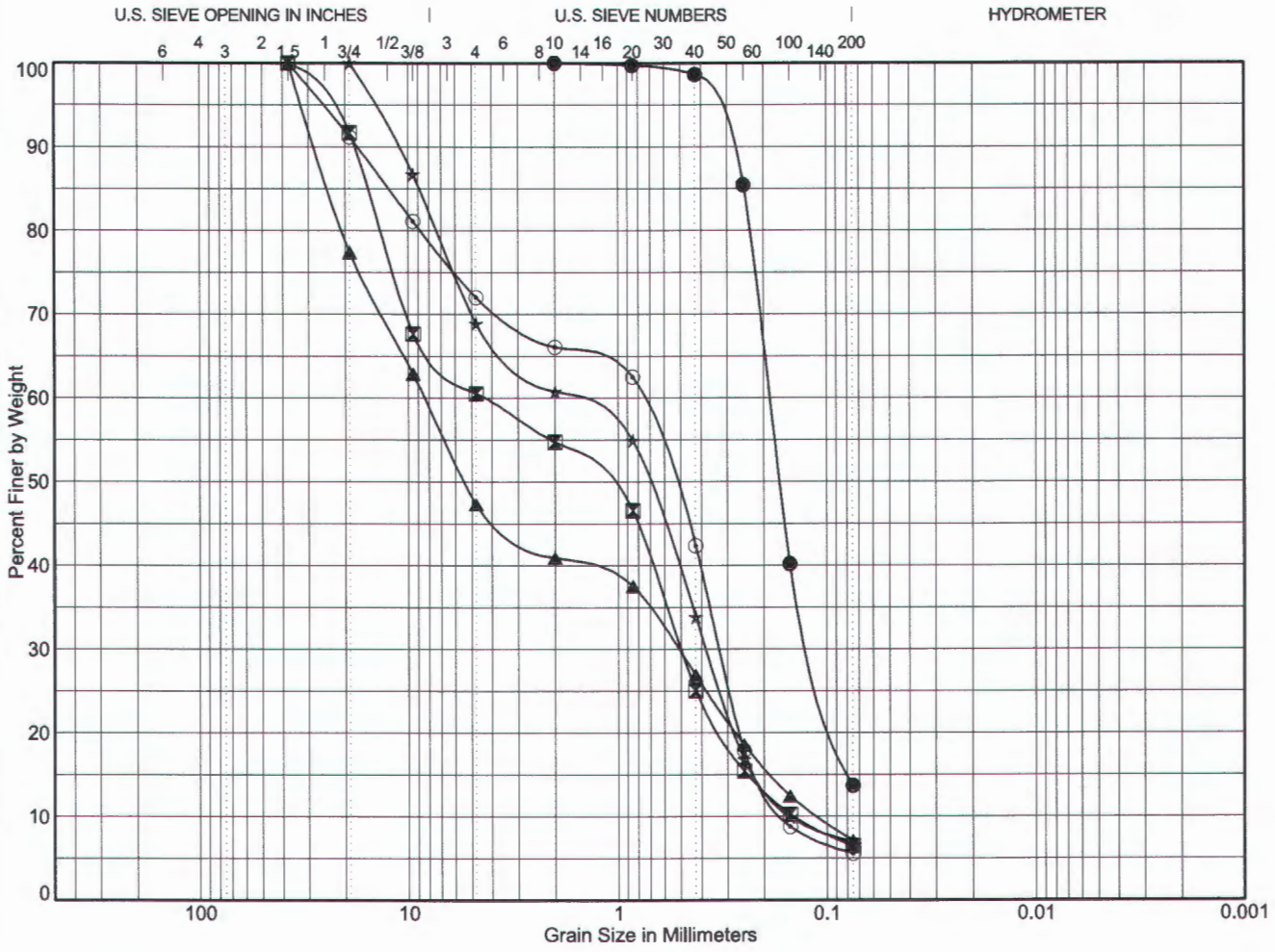
The natural moisture contents of selected soil samples obtained from the explorations were determined in general accordance with International ASTM (ASTM) D 2216 test method. The results from the moisture content determinations are indicated on the summary logs presented in Appendix A, adjacent to the corresponding sample.

GRAIN SIZE ANALYSES

Sieve analyses were conducted on representative soil samples obtained from the explorations in accordance with ASTM test method D422 to provide an indication of the grain size distribution of the onsite soil. Samples selected for grain size analyses are designated with a "GS" in the column labeled "Test Data" on the summary boring logs in Appendix A. The results of the grain size analyses are presented in the form of grain size distribution curves on Figures B-1 through B-4 in this appendix.

FINES FRACTION

The fines fraction (percent passing the U.S. Standard No. 200 sieve) of select soil samples was determined in general accordance with ASTM D 422 test procedures. The test results are indicated on the summary logs presented in Appendix A, adjacent to the corresponding sample.



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Point	Depth	Classification	LL	PL	PI	C_c	C_u
●	B-5	3.0	Fine, SAND with silt (SP-SM)					
⊠	B-5	8.0	Very gravelly, SAND with silt (SP-SM)				0.39	30.46
▲	B-5	10.0	Very sandy, GRAVEL with silt (GP-GM)				0.30	76.35
★	B-5	35.5	Very gravelly, SAND with silt (SP-SM)				0.52	11.80
⊙	B-5	40.5	Gravelly, SAND with silt (SP-SM)				0.84	4.85

	Point	Depth	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	B-5	3.0	2	0.188	0.168	0.115		0.0	0.0	0.0	1.4	85.0	13.7
⊠	B-5	8.0	37.5	4.382	1.218	0.499	0.144	8.3	31.1	5.8	29.7	18.6	6.4
▲	B-5	10.0	37.5	8.362	5.36	0.522	0.11	22.6	30.1	6.4	14.1	19.8	7.1
★	B-5	35.5	19	1.787	0.723	0.377	0.151	0.0	31.1	8.1	26.9	26.9	6.9
⊙	B-5	40.5	37.5	0.779	0.552	0.325	0.161	8.8	19.2	5.9	23.7	36.8	5.5

$C_c = D_{30}^2/(D_{60} * D_{10})$
$C_u = D_{60}/D_{10}$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

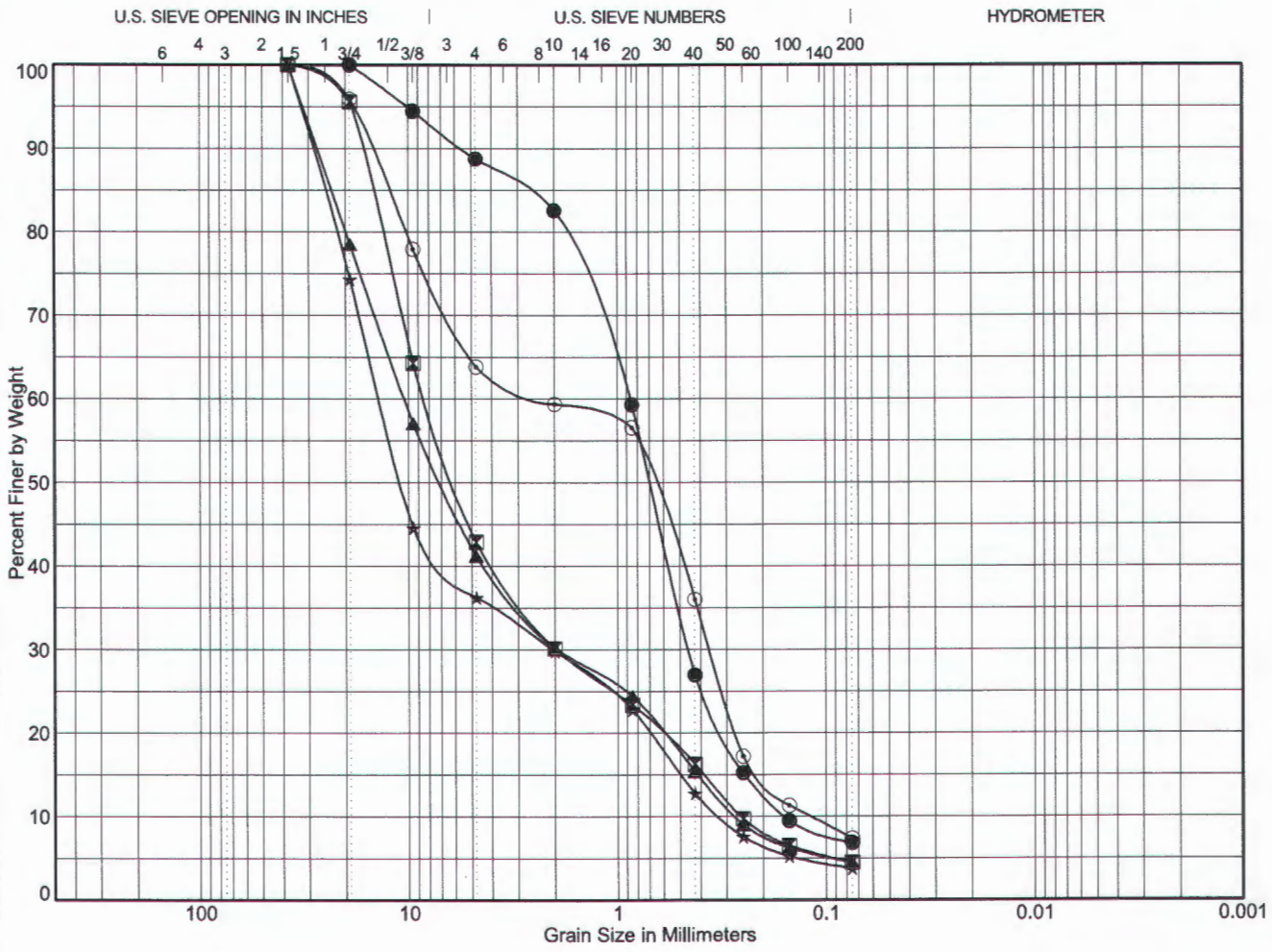
1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ GRAIN SIZE W/STATS

LANDAU ASSOCIATES

Deschutes Valley Trail
Tumwater, Washington

Grain Size Test Data

Figure
B-1



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Point	Depth	Classification	LL	PL	PI	C_c	C_u
●	B-5	50.5	SAND with silt and gravel (SP-SM)				1.50	5.54
⊠	B-6	8.0	Very sandy GRAVEL (GP)				1.85	32.30
▲	B-6	10.0	Very sandy GRAVEL (GP)				1.35	38.49
★	B-7	30.0	Very sandy GRAVEL (GP)				0.96	42.44
⊙	B-7	80.0	Very gravelly, fine to medium SAND with silt (SP-SM)				0.48	18.90

	Point	Depth	D_{100}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	B-5	50.5	19	0.872	0.697	0.454	0.157	0.0	11.3	6.2	55.6	20.1	6.8
⊠	B-6	8.0	37.5	8.271	5.984	1.977	0.256	4.4	52.7	12.8	13.8	11.8	4.5
▲	B-6	10.0	37.5	10.452	6.979	1.957	0.272	21.5	37.3	11.1	14.8	10.9	4.4
★	B-7	30.0	37.5	13.613	10.785	2.049	0.321	25.7	38.1	6.4	17.1	9.0	3.7
⊙	B-7	80.0	37.5	2.258	0.681	0.359	0.119	4.1	32.1	4.5	23.4	28.7	7.4

$C_c = D_{30}^2/(D_{60} * D_{10})$

$C_u = D_{60}/D_{10}$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

1444001.01 7/8/14 Y:\1444\001.010\T\1444001.010.GPJ GRAIN SIZE W/STATS

LANDAU ASSOCIATES

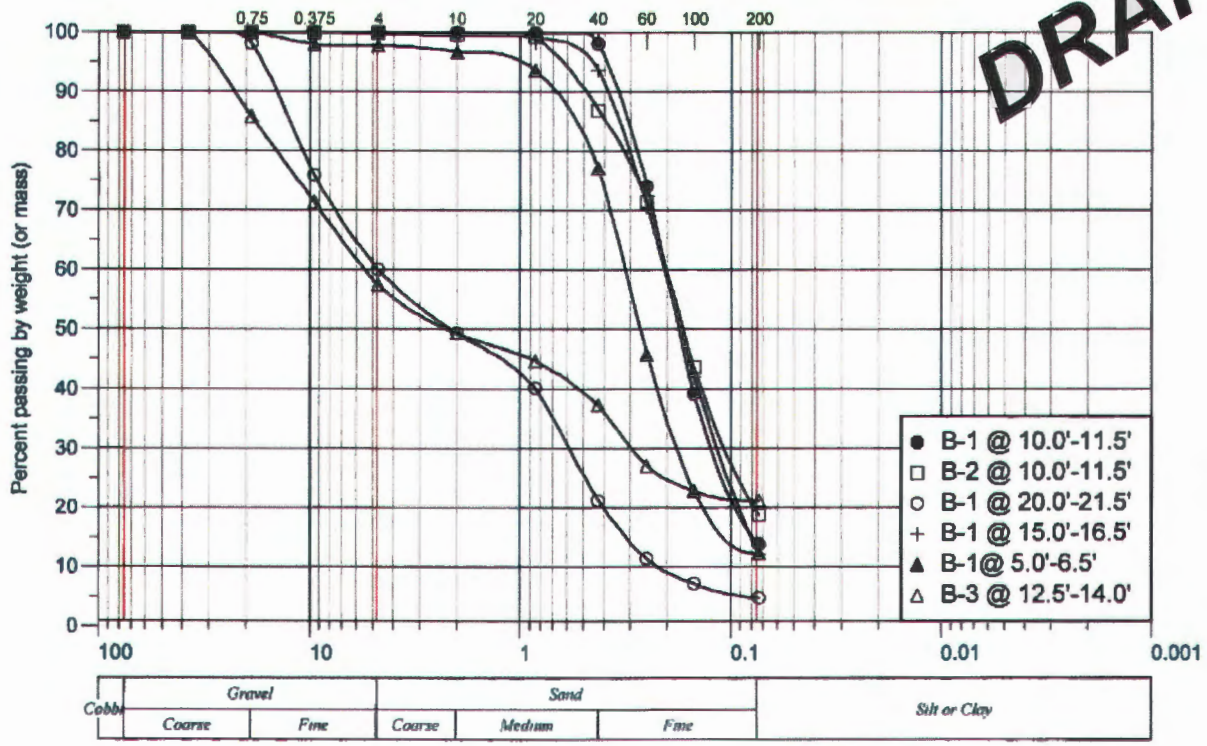
Deschutes Valley Trail
Tumwater, Washington

Grain Size Test Data

Figure
B-2

DRAFT

Grain Size Distribution (ASTM D422)



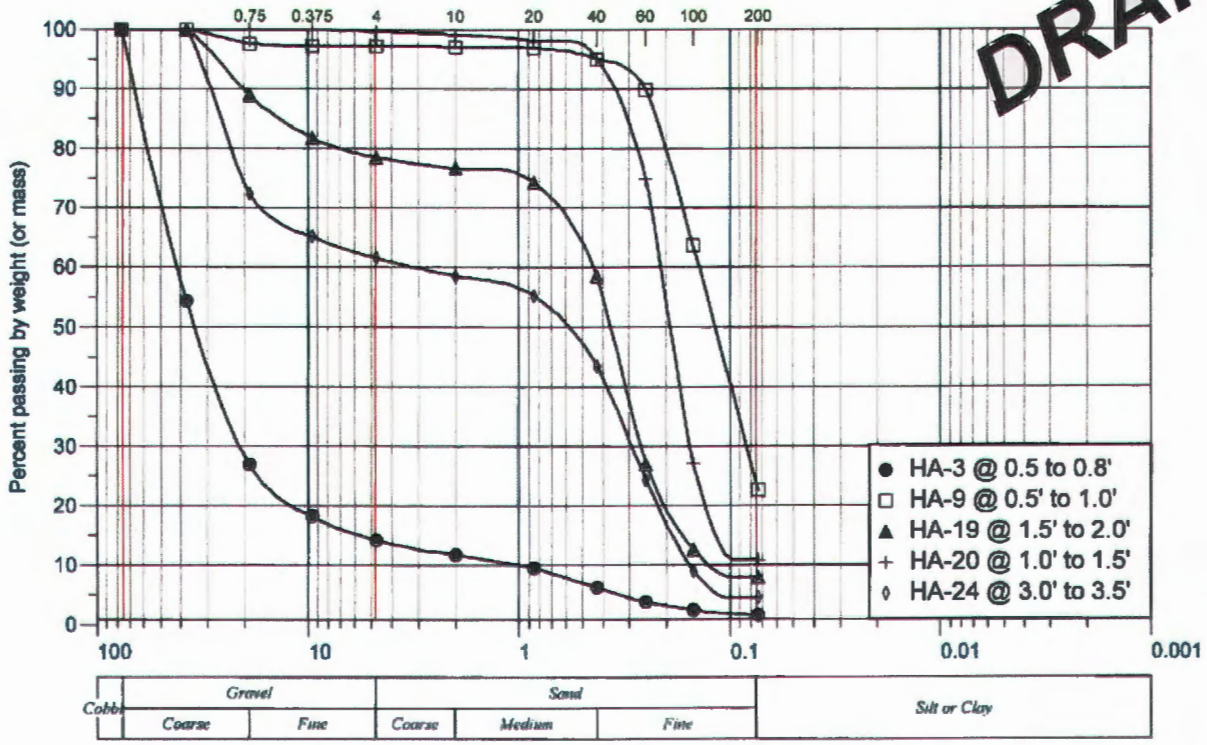
LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Grain Size Profile**	Figure B-3

LANDAU ASSOCIATES, INC. | G:\Projects\1444\001\010\011\TrailPlans\Appendix B3_B4 GrainSize.dwg (A) "Figure B-4" 7/8/2014

DRAFT

Grain Size Distribution (ASTM D422)



LANDAU ASSOCIATES

Deschutes Valley Trail Tumwater, WA	**Grain Size Profile**	Figure B-4

Appendix 4
Maps and Area Takeoffs

Exhibit 4A – Minimum Requirements Flow Chart

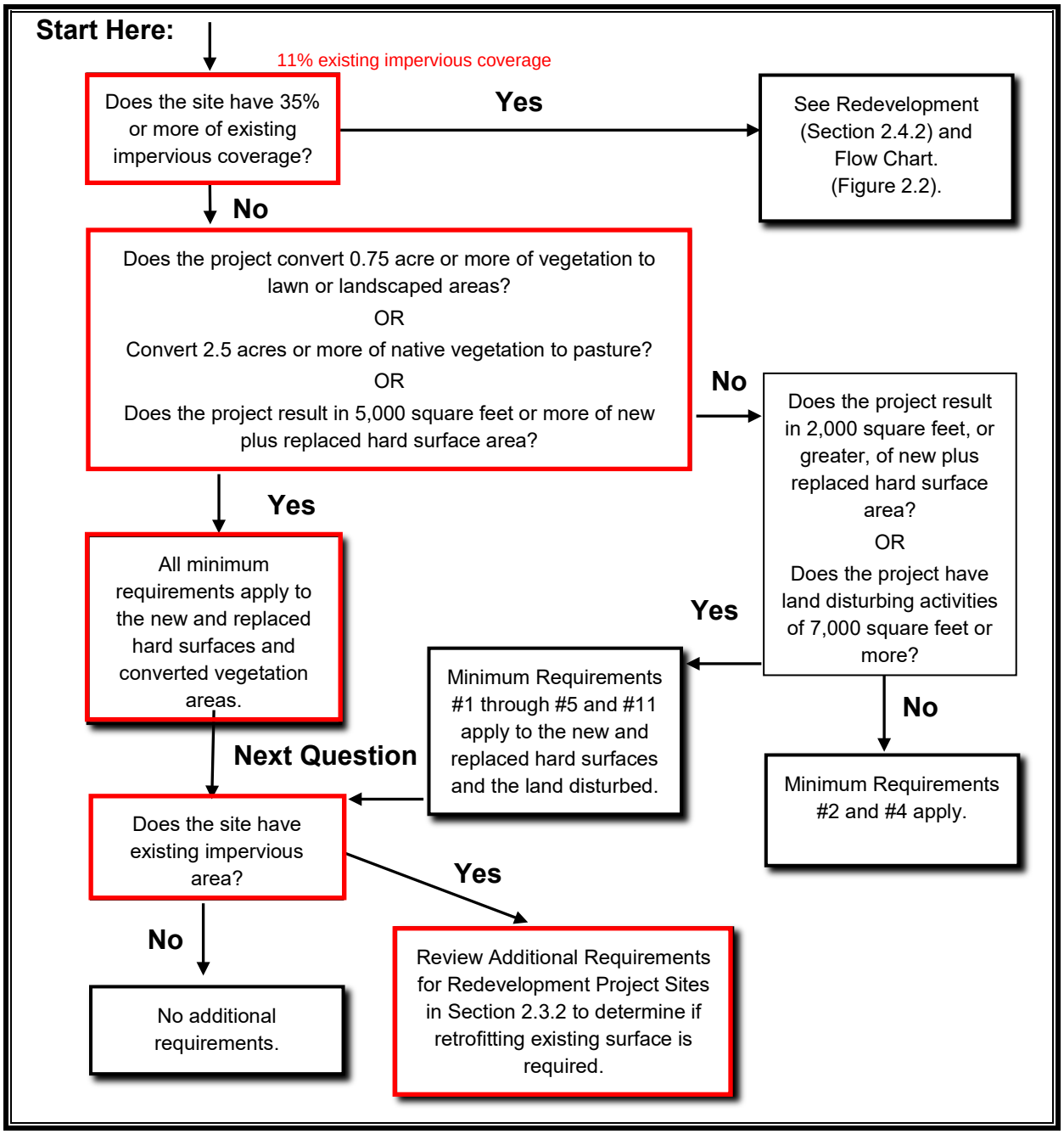


Figure 2.1. Flow Chart for Determining Requirements for New Development.

NEXT DOCUMENT

Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment

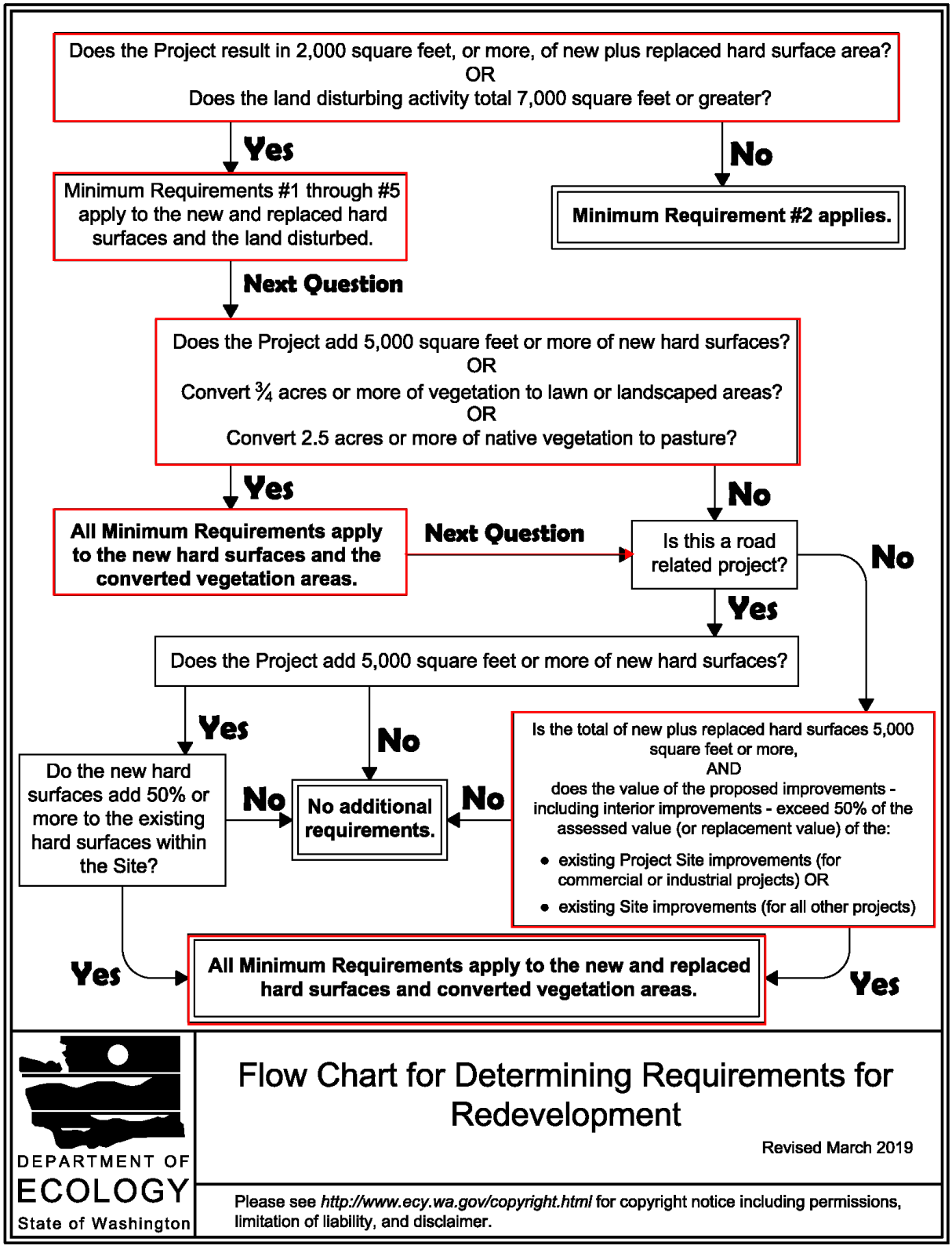
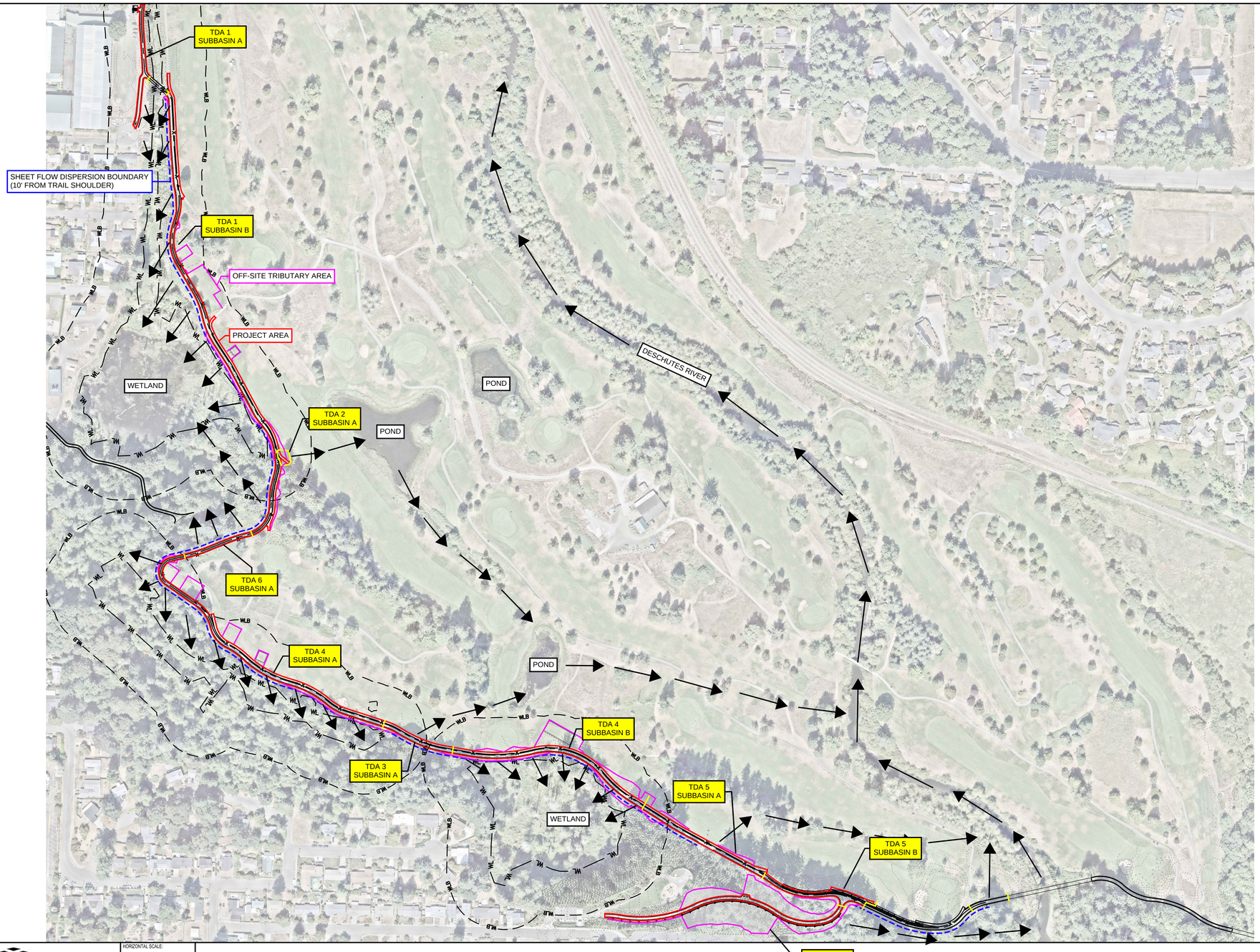


Exhibit 4B – Basin Map



SCJ ALLIANCE
CONSULTING SERVICES

HORIZONTAL SCALE:	AS SHOWN
DATE:	MARCH 2026
JOB No.:	SCJ #25-000313
DRAWING FILE No.:	-

BASIN MAP

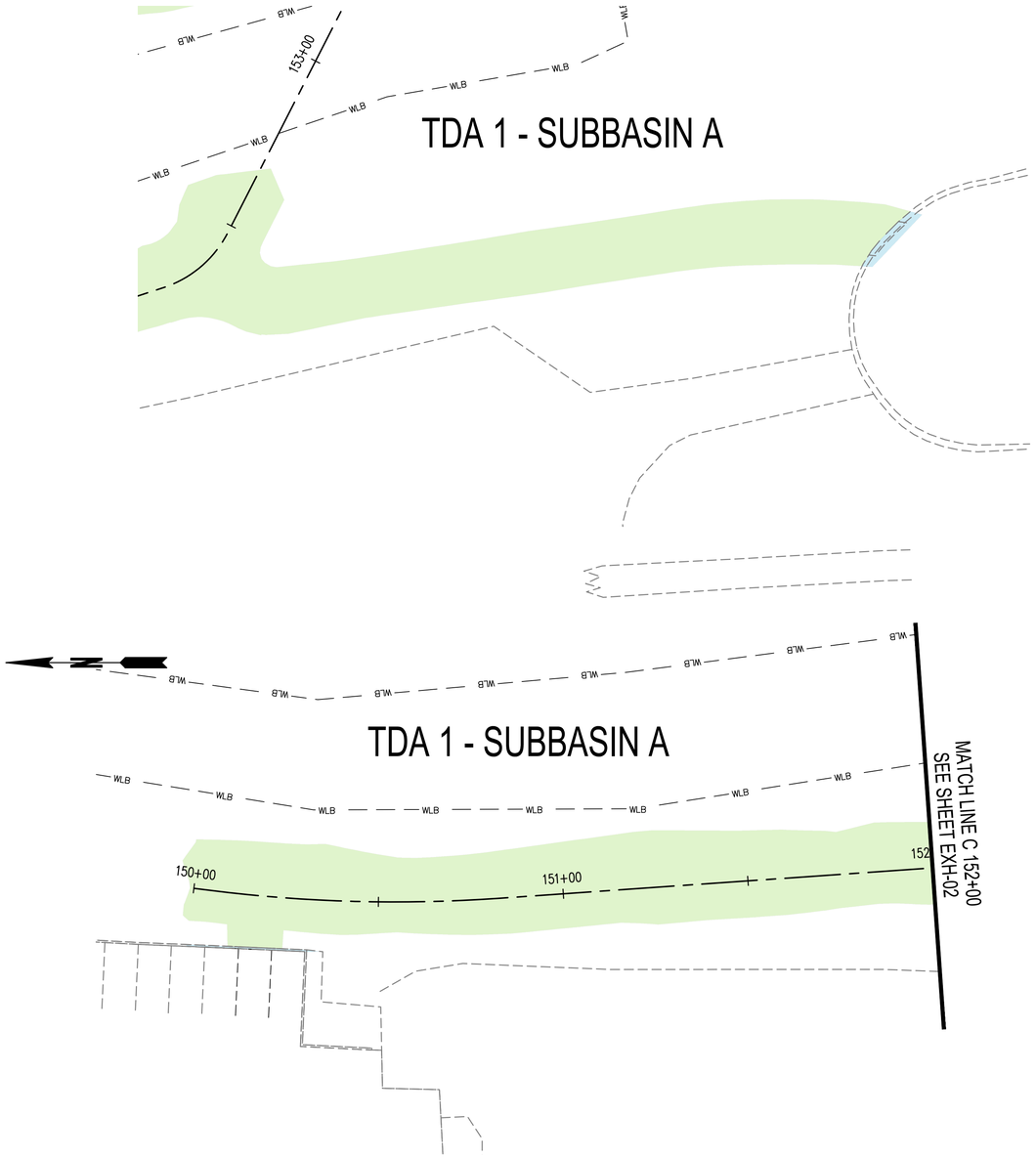
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: EX-01

SHEET No: 01

Apr 30, 2026 - 2:20:59pm - User nick.ulberg
N:\PROJECTS\2025\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4B - BASIN MAP_25-000313-BASIN MAP.DWG

Exhibit 4C – Work Map



TDA 1 EXISTING BASIN AREAS:

	SUBBASIN A	SUBBASIN B
PERVIOUS:	8862 SF	34509 SF
NPGIS:	61 SF	8382 SF
TOTAL:	8923 SF	42891 SF

0 20 40
SCALE IN FEET

TDA 2 EXISTING BASIN AREAS:

	SUBBASIN A
PERVIOUS:	1230 SF
NPGIS:	592 SF
TOTAL:	1822 SF

TDA 3 EXISTING BASIN AREAS:

	SUBBASIN A
PERVIOUS:	5291 SF
NPGIS:	1648 SF
TOTAL:	6939 SF

TDA 4 EXISTING BASIN AREAS:

	SUBBASIN A	SUBBASIN B
PERVIOUS:	21683 SF	36035 SF
NPGIS:	4100 SF	4491 SF
TOTAL:	25783 SF	40526 SF

TDA 5 EXISTING BASIN AREAS:

	SUBBASIN A	SUBBASIN B	SUBBASIN C
PERVIOUS:	11682 SF	9627 SF	64918 SF
NPGIS:	3995 SF	1304 SF	168 SF
TOTAL:	15677 SF	10931 SF	65086 SF

TDA 6 EXISTING BASIN AREAS:

	SUBBASIN A
PERVIOUS:	5847 SF
NPGIS:	0 SF
TOTAL:	5847 SF

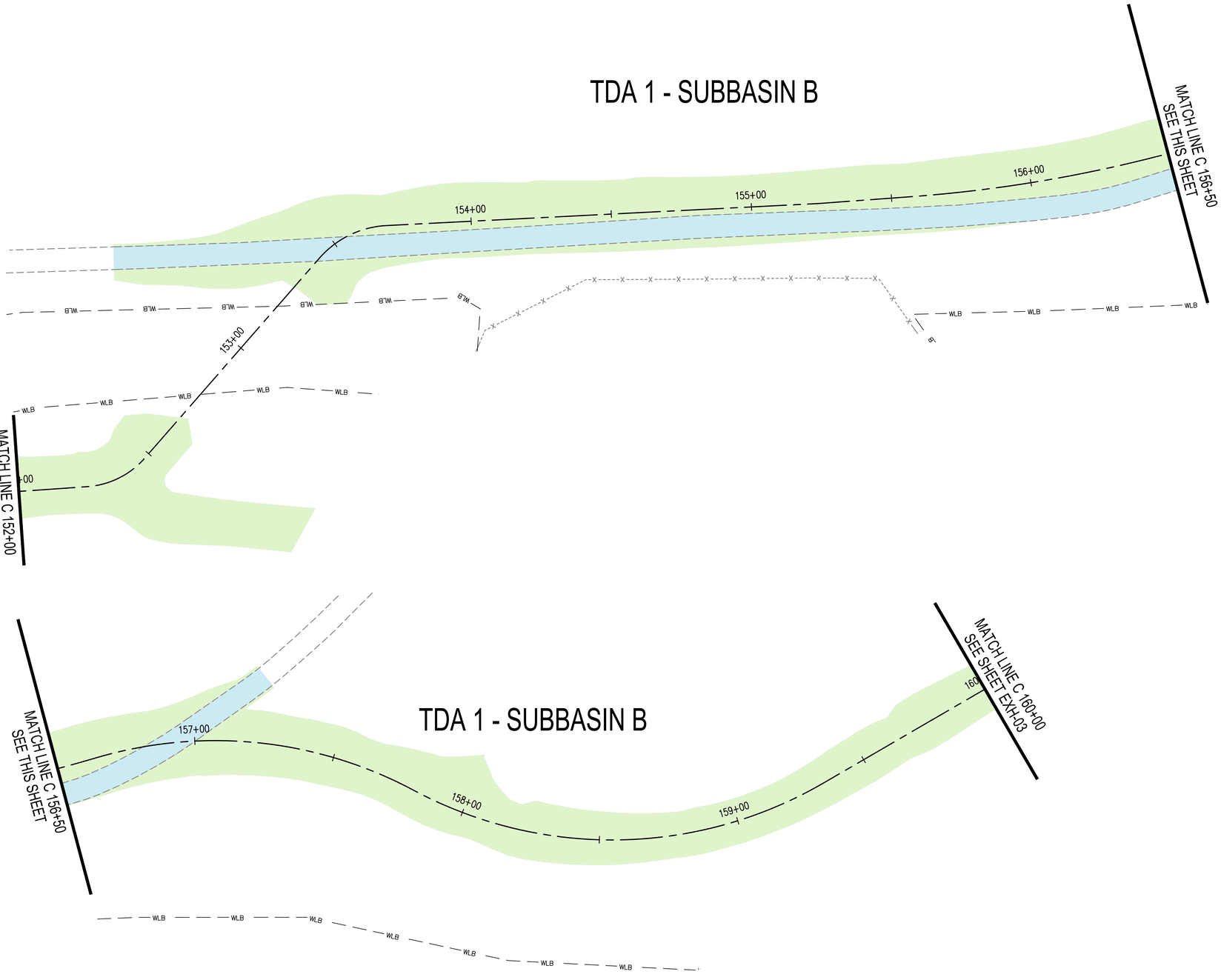
SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

HORIZONTAL SCALE: AS SHOWN
DATE: JUNE 2026
JOB No.: 25-000313
DRAWING FILE No.: AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-01**
SHEET No: **01**

Jul 01, 2026 9:46:04am - User: nick.eatherly
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEC C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG



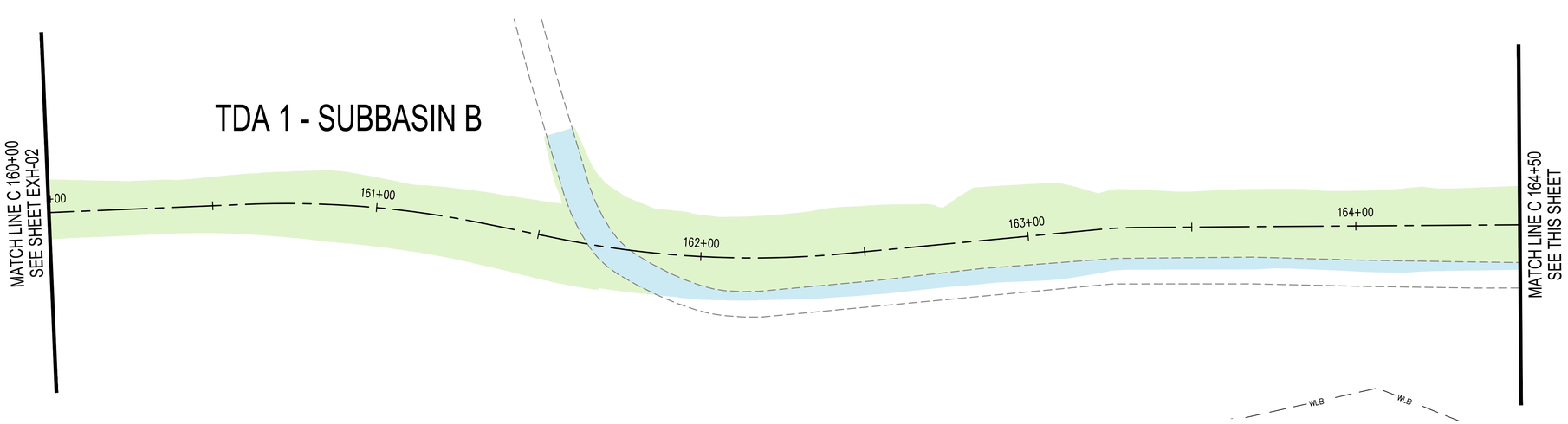
SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

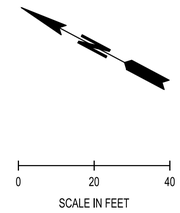
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

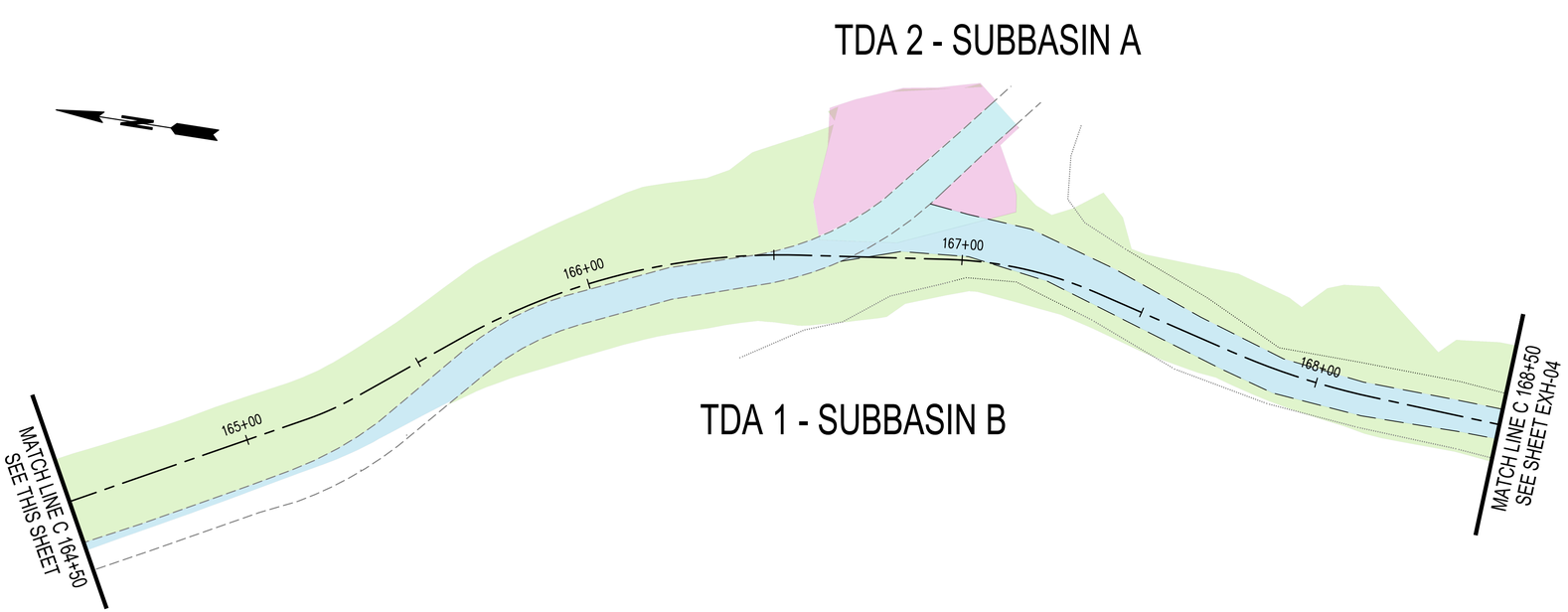
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-02**
SHEET No: **02**

Jul 01, 2026 - 9:46:06am - User rick.seiberg
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG







SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

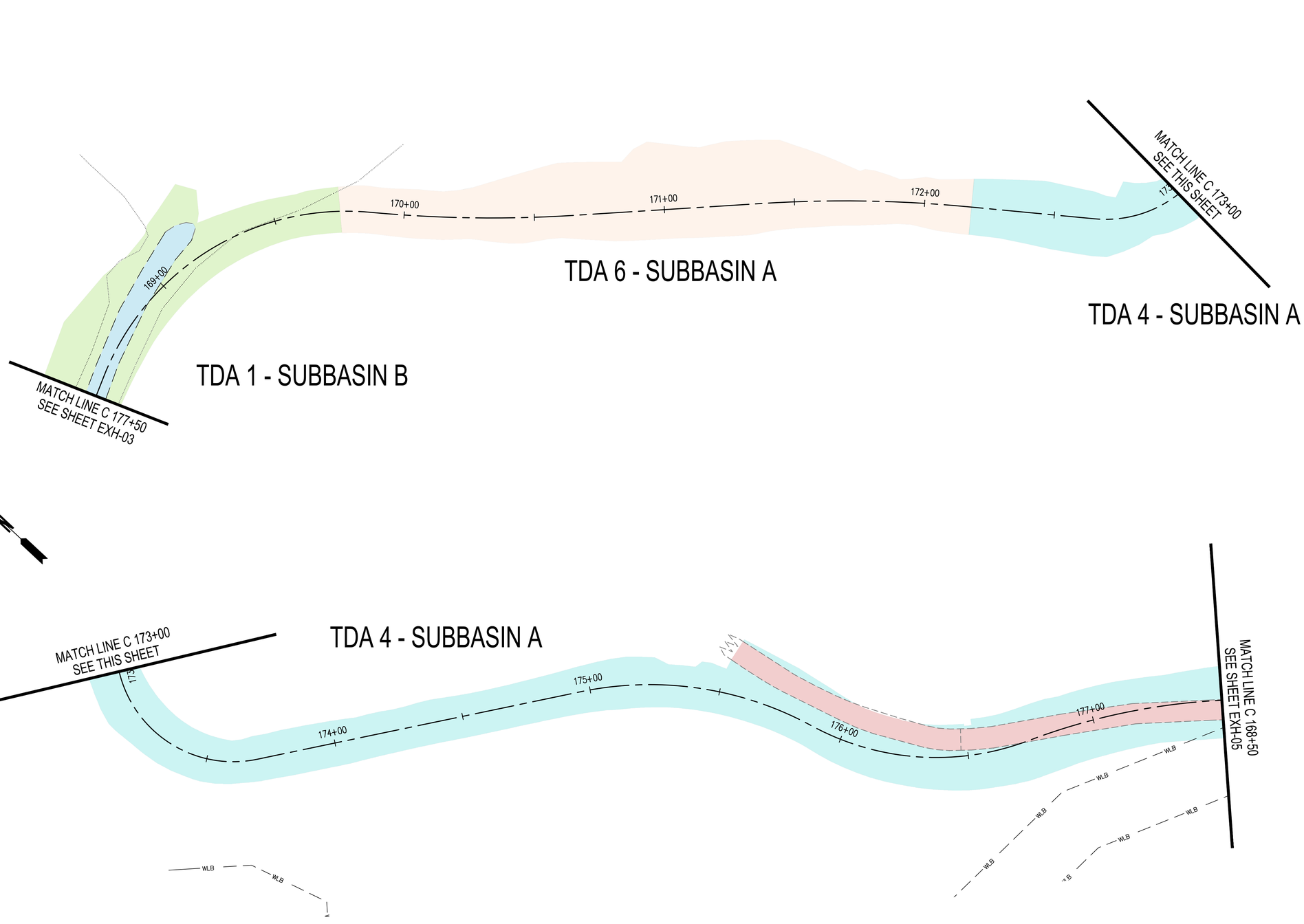
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-03**

SHEET No: **03**

Jul 01, 2026 - 9:46:24am - User: nick.ostberg
N:\PROJECTS\26\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG



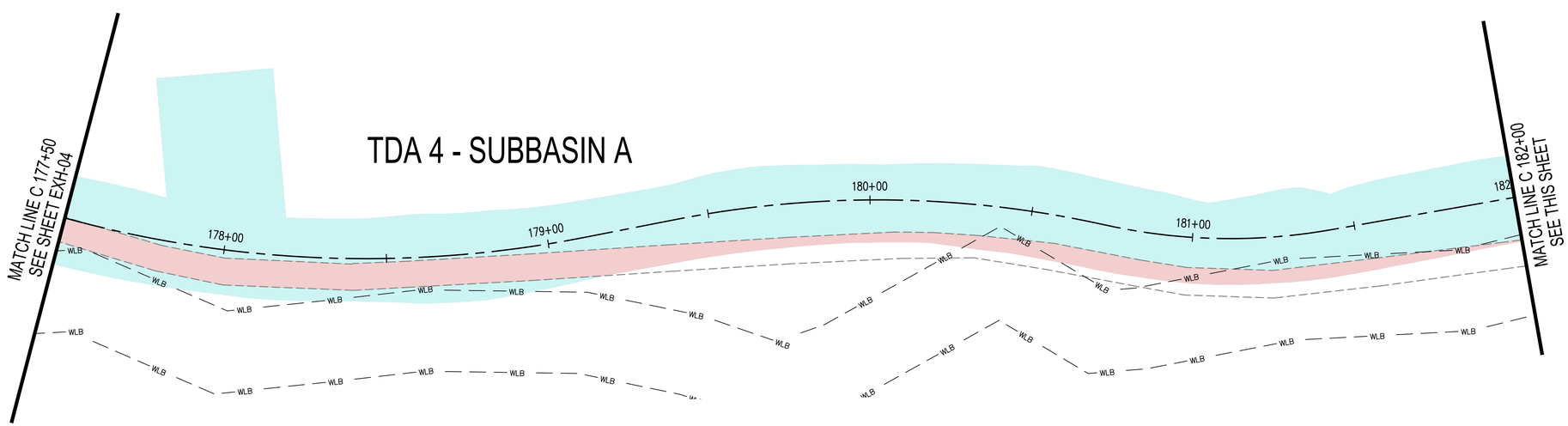
SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

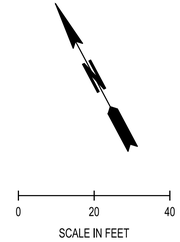
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

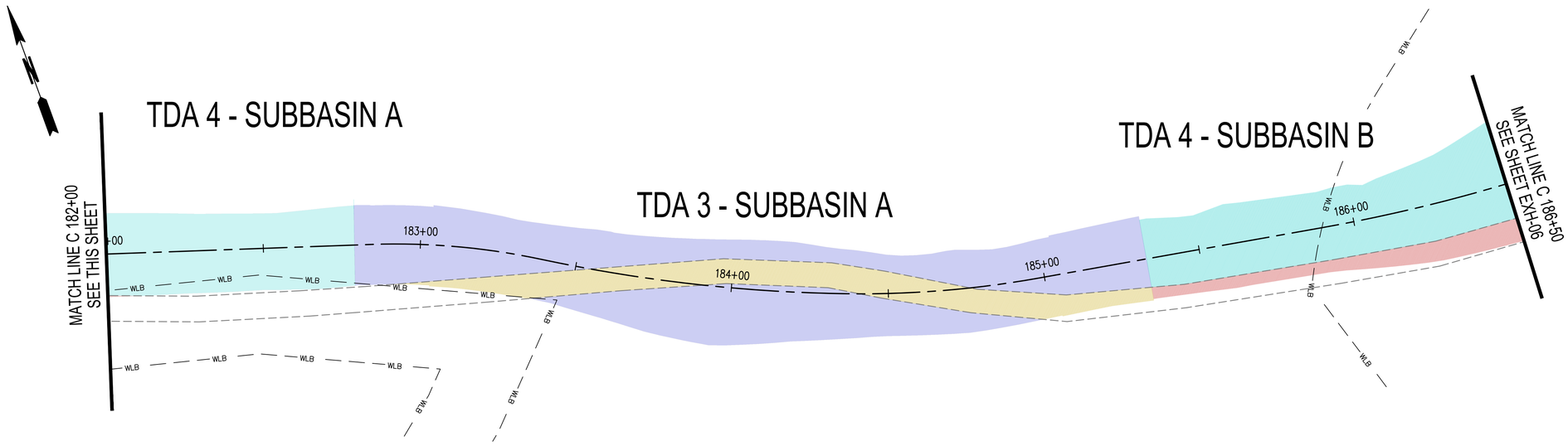
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-04**
SHEET No: **04**

Jul 01, 2026 9:46:16am – User: nick.eatherly
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEC C STORMWATER\APPENDICES\4 – MAPS AND AREA TAKEOFFS\4C – WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG







SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

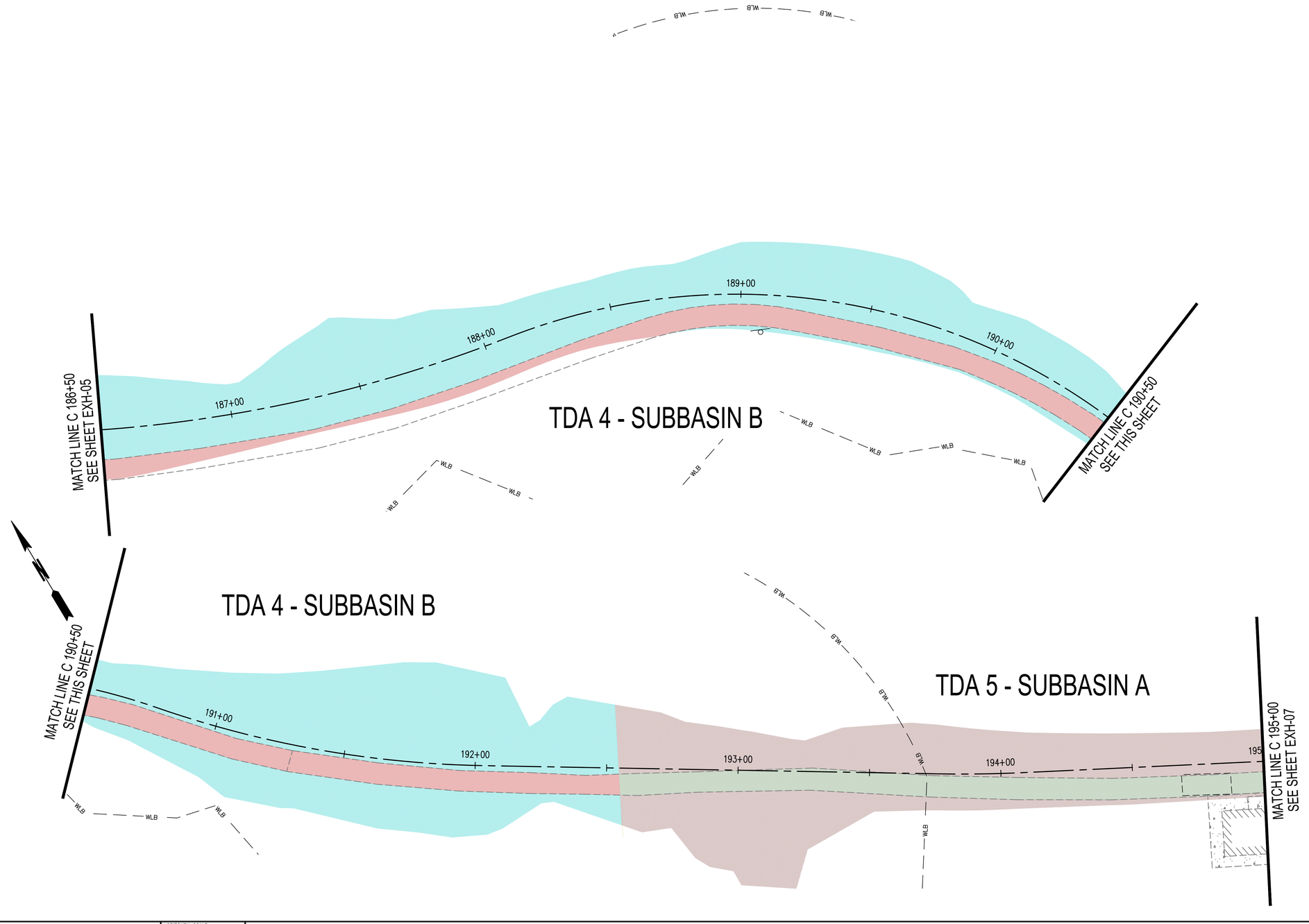
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-05**

SHEET No: **05**

Jul 01, 2026 - 8:46:25am - User: nick.wilberg
N:\PROJECTS\25 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4c - WORK MAPS\CADD\AREA TAKEOFFS EXHIBIT.DWG



SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

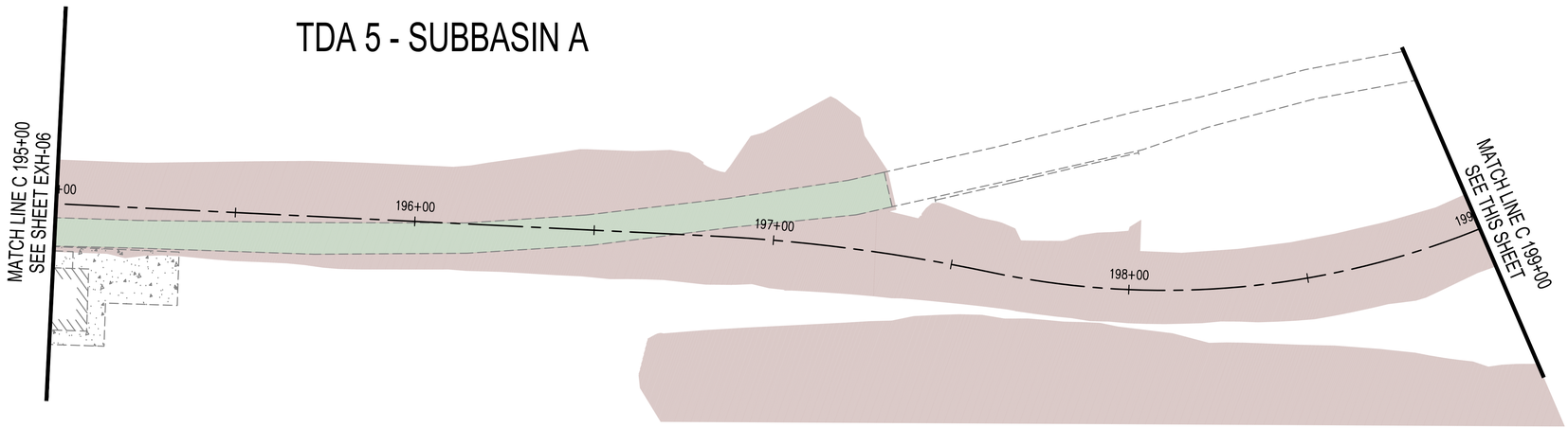
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

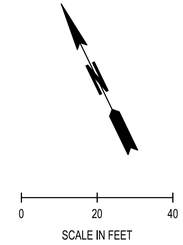
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

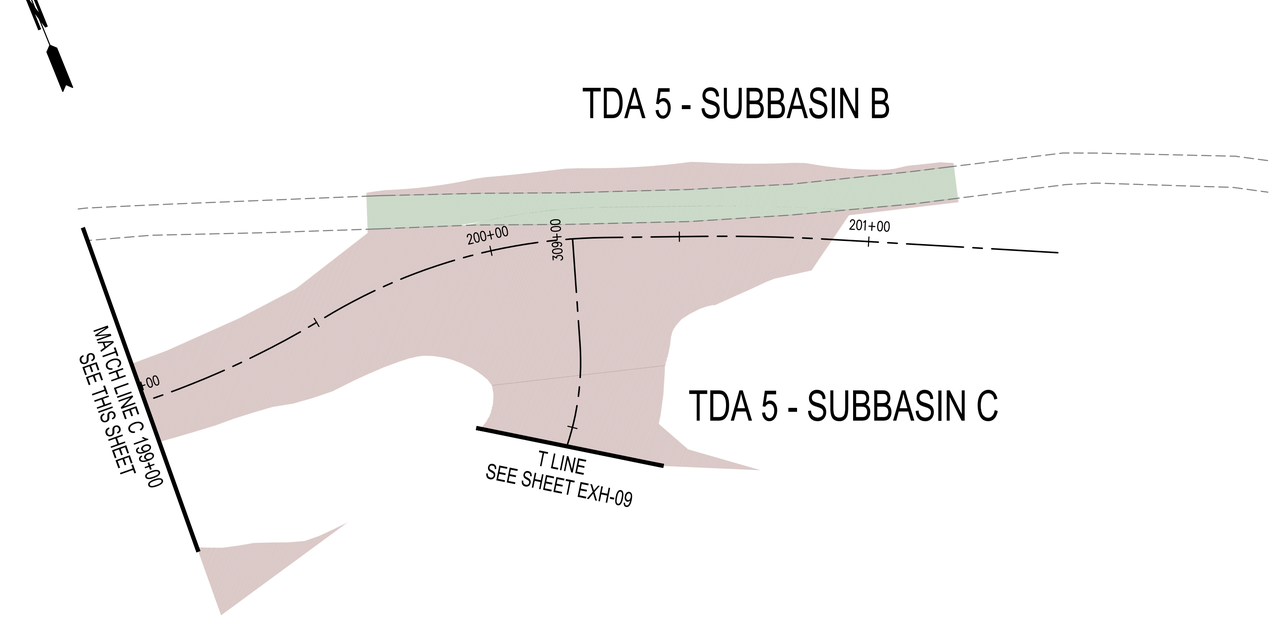
EXHIBIT No: **EXH-06**

SHEET No: **06**

Jul 01, 2026 - 9:46:34am - User: rick.selberg
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\V4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG







SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

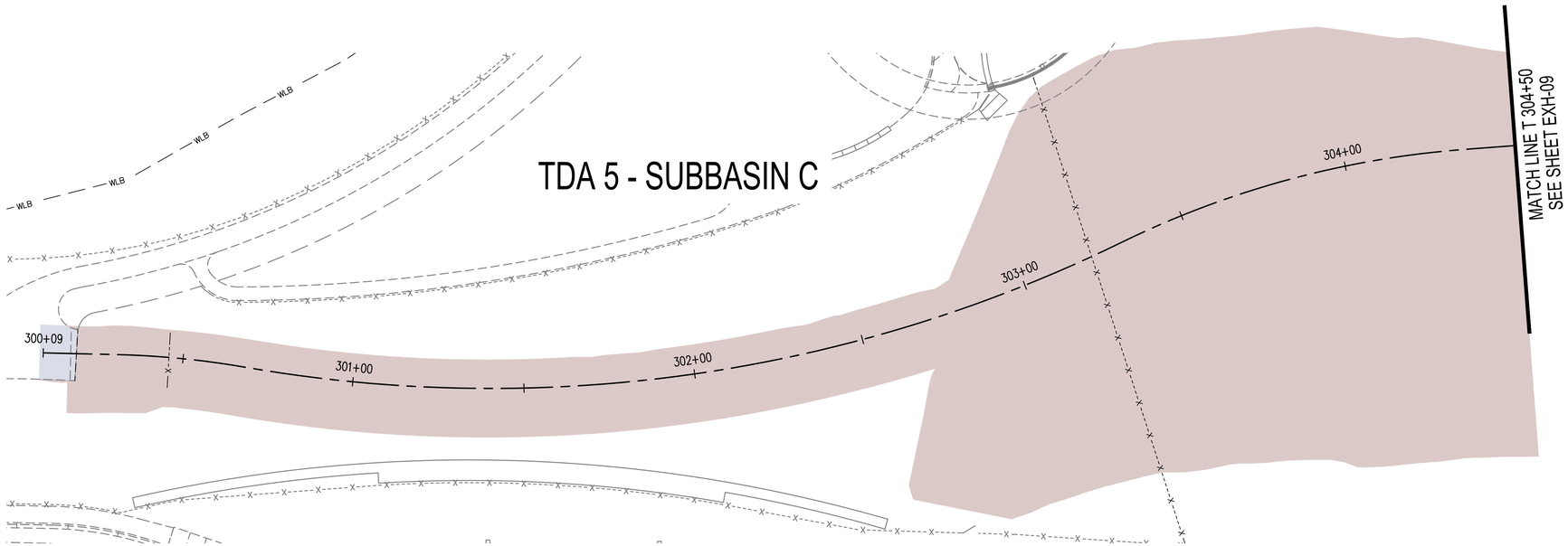
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

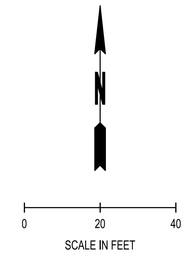
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-07**

SHEET No: **07**

Jul 01, 2026 9:46:44am - User rick.selberg
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG





SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

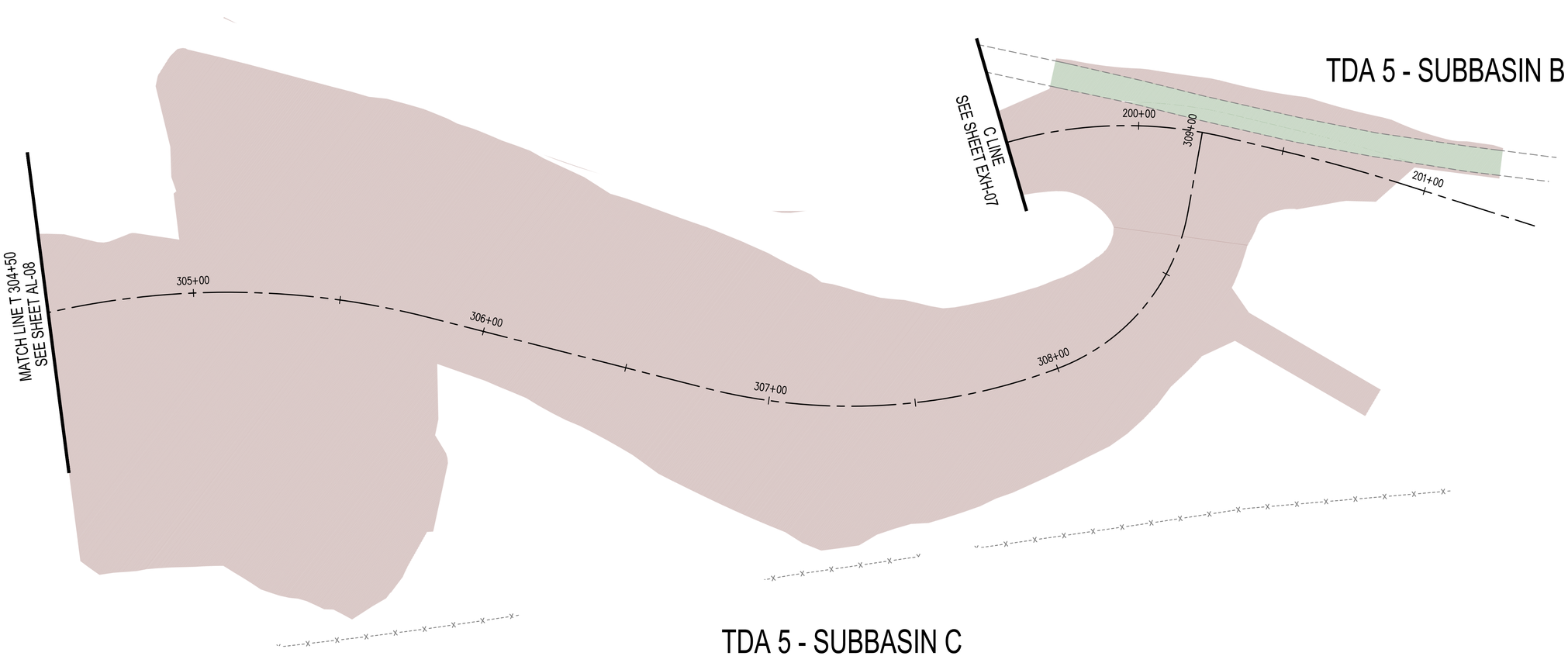
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-08**

SHEET No: **08**

Jul 01, 2026 - 9:46:33am - User: nick.seiberg
N:\PROJECTS\25 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CAD\AREA TAKEOFFS EXHIBIT.DWG



SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

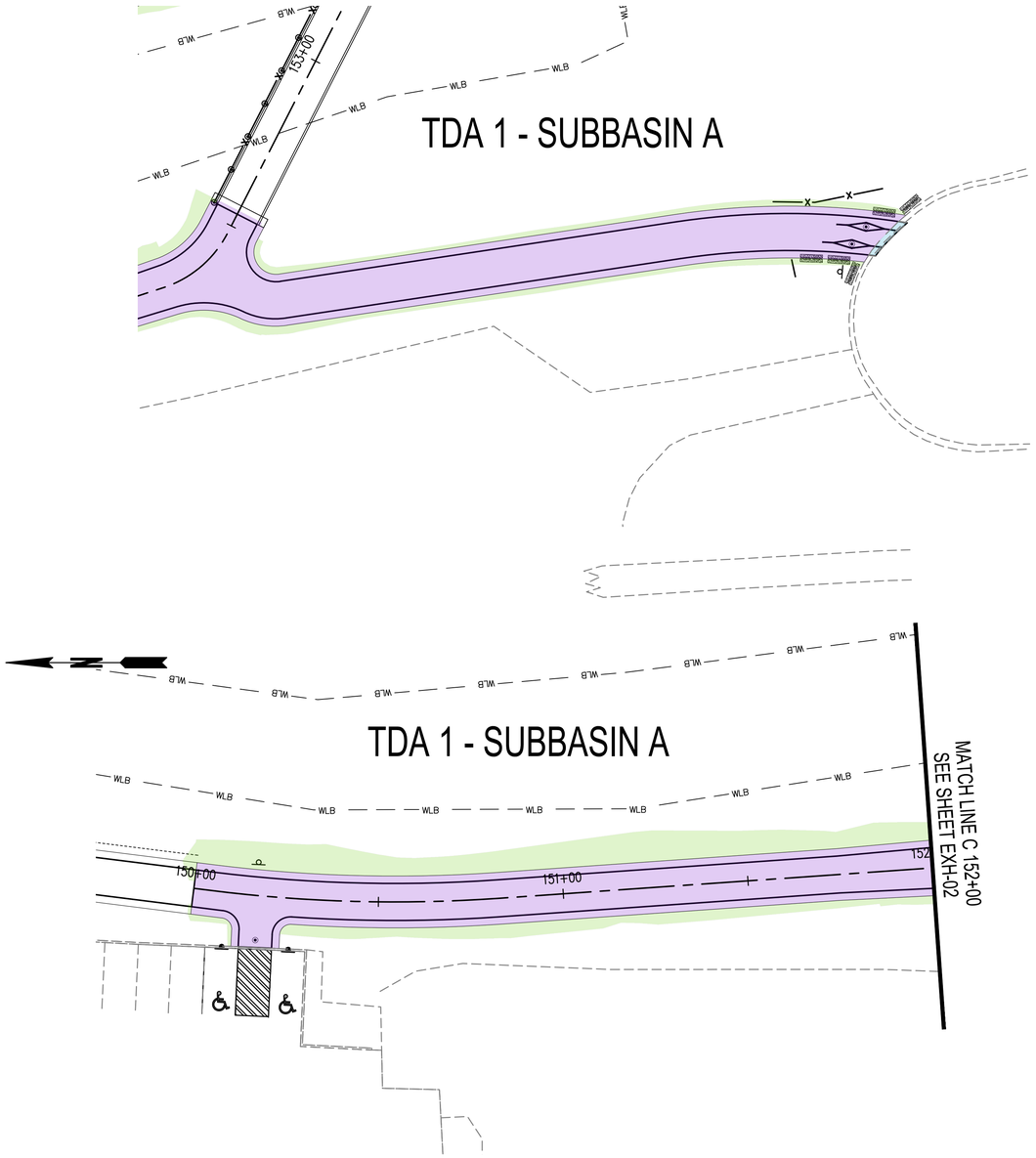
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-09**

SHEET No: **09**

Jul 01, 2026 9:46:13am - User:rick.selberg
N:\PROJECTS\25 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CAD\AREA TAKEOFFS EXHIBIT.DWG

NEXT DOCUMENT



TDA 1 PROPOSED BASIN AREAS:

	SUBBASIN A	SUBBASIN B
PERVIOUS:	2612 SF	10719 SF
NPGIS (NEW)	6311 SF	24147 SF
NPGIS (REPLACED)	0 SF	8025 SF
TOTAL:	8923 SF	42891 SF

0 20 40
SCALE IN FEET

TDA 2 PROPOSED BASIN AREAS:

	SUBBASIN A
PERVIOUS:	1148 SF
NPGIS (NEW):	86 SF
NPGIS (REPLACED):	588 SF
TOTAL	1822 SF

TDA 3 PROPOSED BASIN AREAS:

	SUBBASIN A
PERVIOUS:	1476 SF
NPGIS (NEW):	3921 SF
NPGIS (REPLACED):	1542 SF
TOTAL:	6939 SF

TDA 4 PROPOSED BASIN AREAS:

	SUBBASIN A	SUBBASIN B
PERVIOUS:	6173 SF	25020 SF
NPGIS (NEW):	16109 SF	12254 SF
NPGIS (REPLACED):	3501 SF	3252 SF
TOTAL:	25783 SF	40526 SF

TDA 5 PROPOSED BASIN AREAS:

	SUBBASIN A	SUBBASIN B	SUBBASIN C
PERVIOUS:	5269 SF	3086 SF	52911 SF
NPGIS (NEW):	6466 SF	7815 SF	12175 SF
NPGIS (REPLACED):	3942 SF	30 SF	0 SF
TOTAL:	15677 SF	10931 SF	65086 SF

TDA 6 PROPOSED BASIN AREAS:

	SUBBASIN A
PERVIOUS:	2450 SF
NPGIS (NEW):	3397 SF
NPGIS (REPLACED):	0 SF
TOTAL	5847 SF

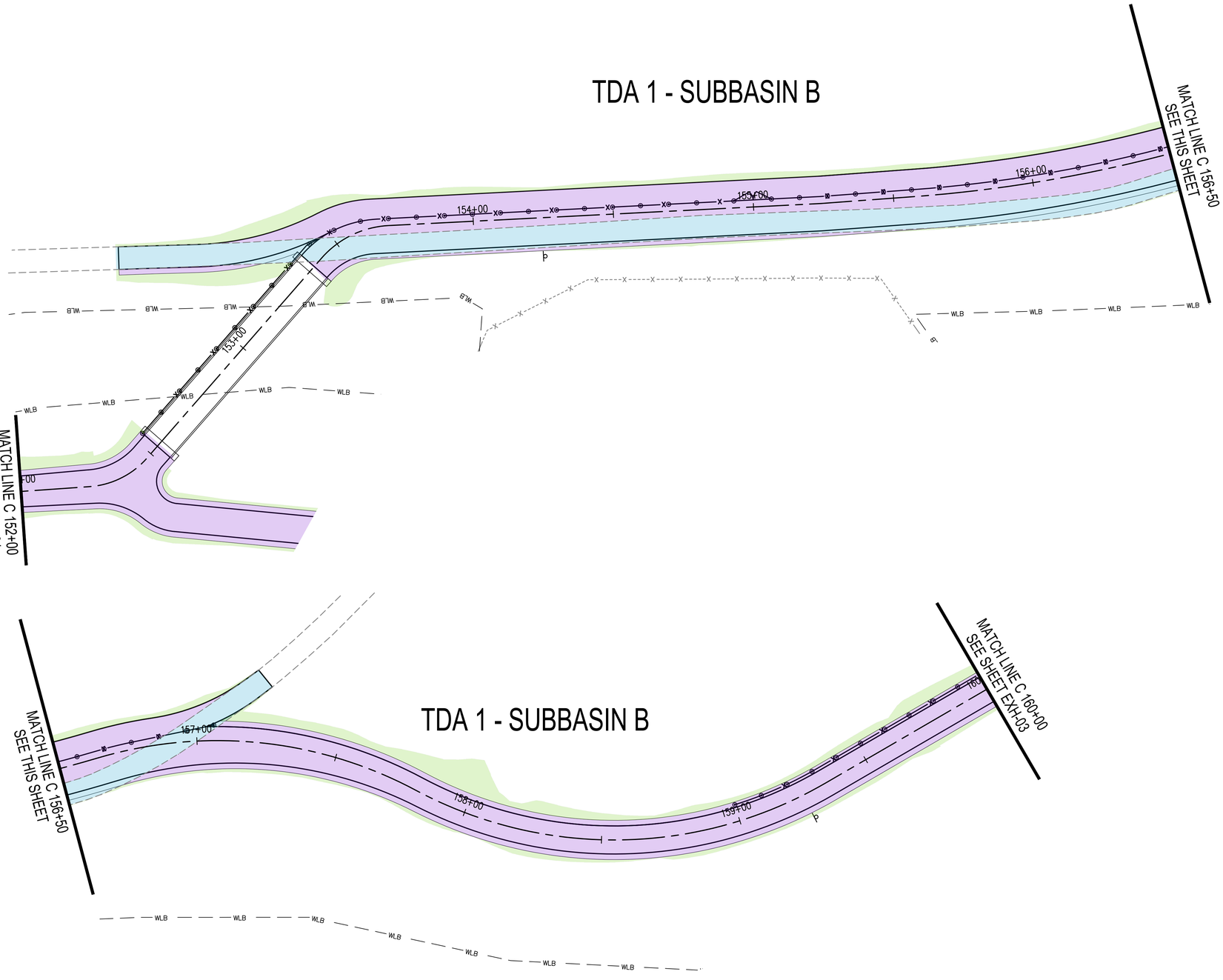
SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

HORIZONTAL SCALE: AS SHOWN
DATE: JUNE 2026
JOB No.: 25-000313
DRAWING FILE No.: AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: EXH-01
SHEET No: 01

Jul 01, 2026 9:32:06am - User nick.eatherly
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEC C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG



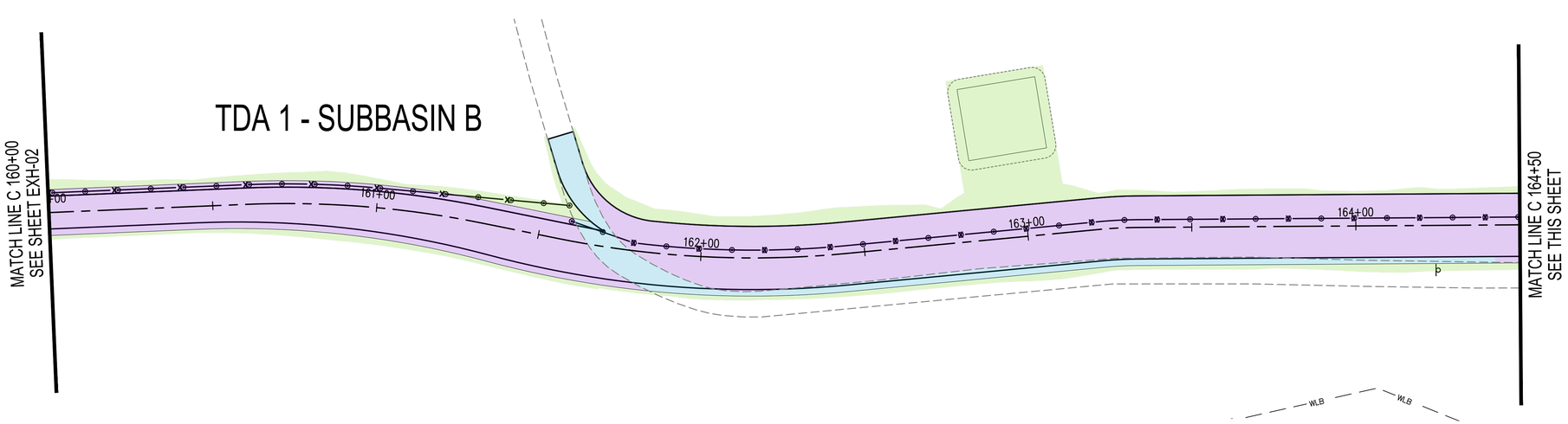
SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

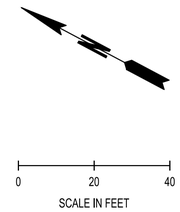
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

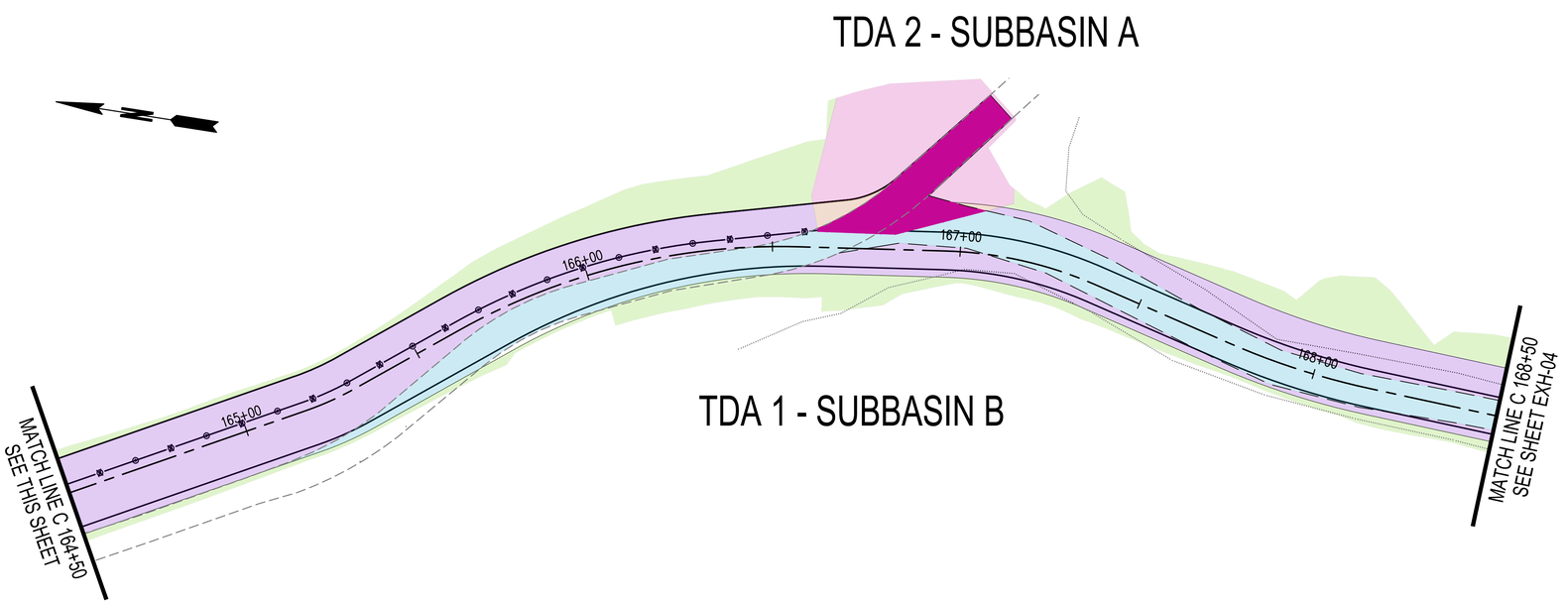
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-02**
SHEET No: **02**

Jul 01, 2026 - 9:32:08am - User rick.seiberg
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CAD\AREA TAKEOFFS EXHIBIT.DWG







SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

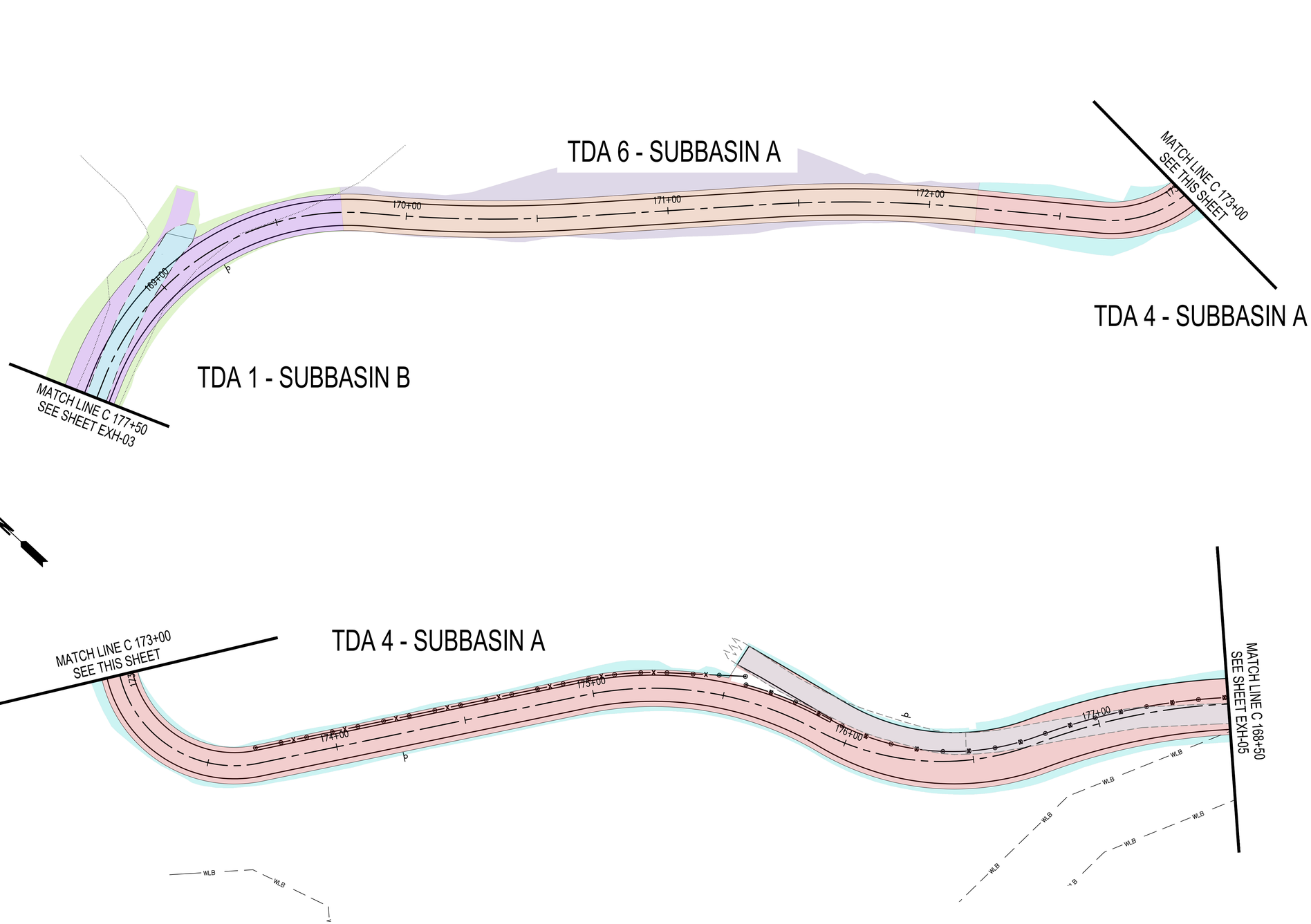
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-03**

SHEET No: **03**

Jul 01, 2026 - 9:32:31am - User: nick.wilberg
N:\PROJECTS\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAPS\CADD\AREA TAKEOFFS EXHIBIT.DWG



SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

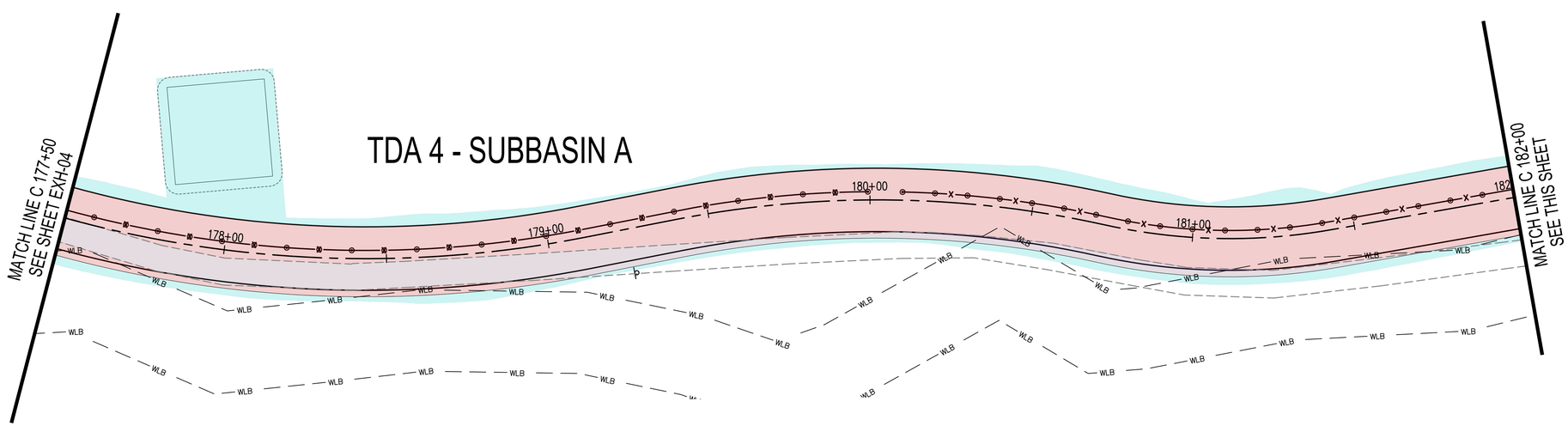
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

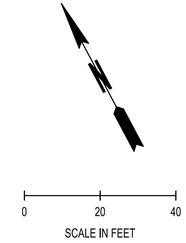
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

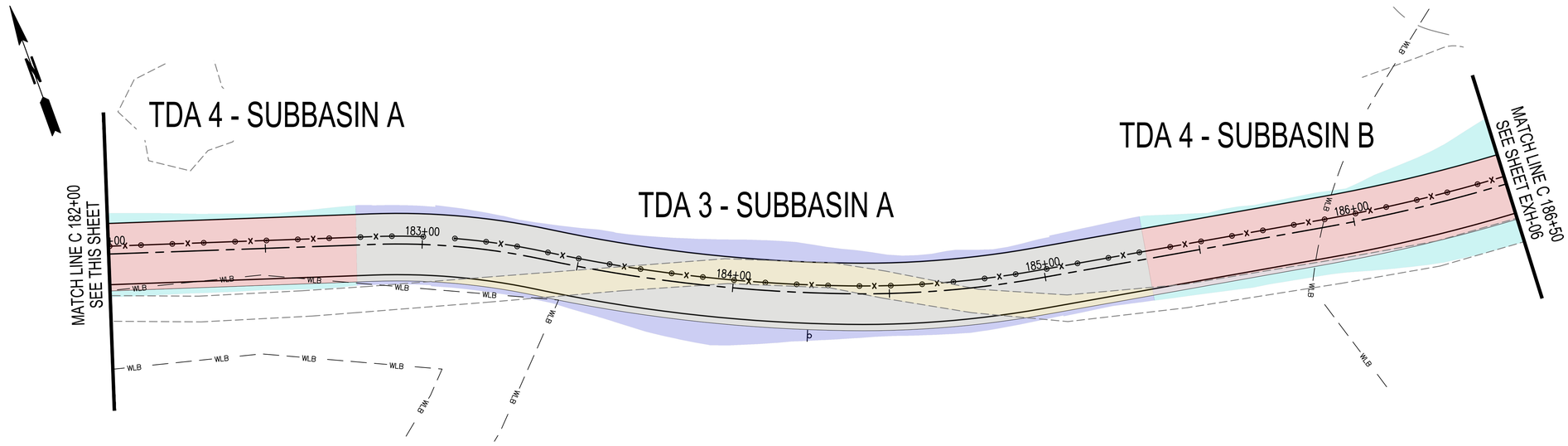
EXHIBIT No: **EXH-04**

SHEET No: **04**

Jul 01, 2026 9:32:29am – User: nick.eatherly
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 – MAPS AND AREA TAKEOFFS\4C – WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG







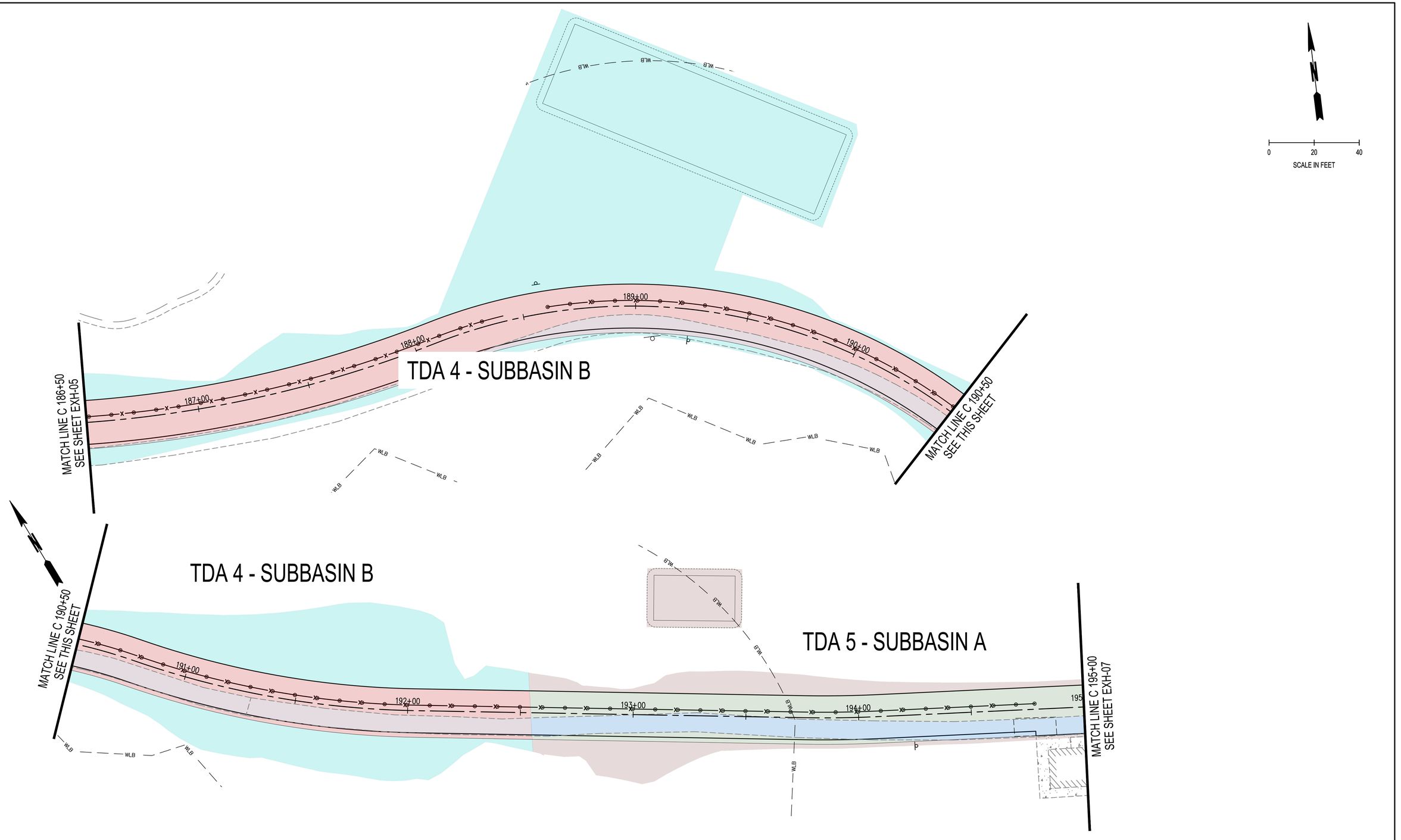
SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No:	EXH-05
SHEET No:	05

Jul 01, 2026 - 8:32:19am - User: nick.eatherly
N:\PROJECTS\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4c - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG



SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

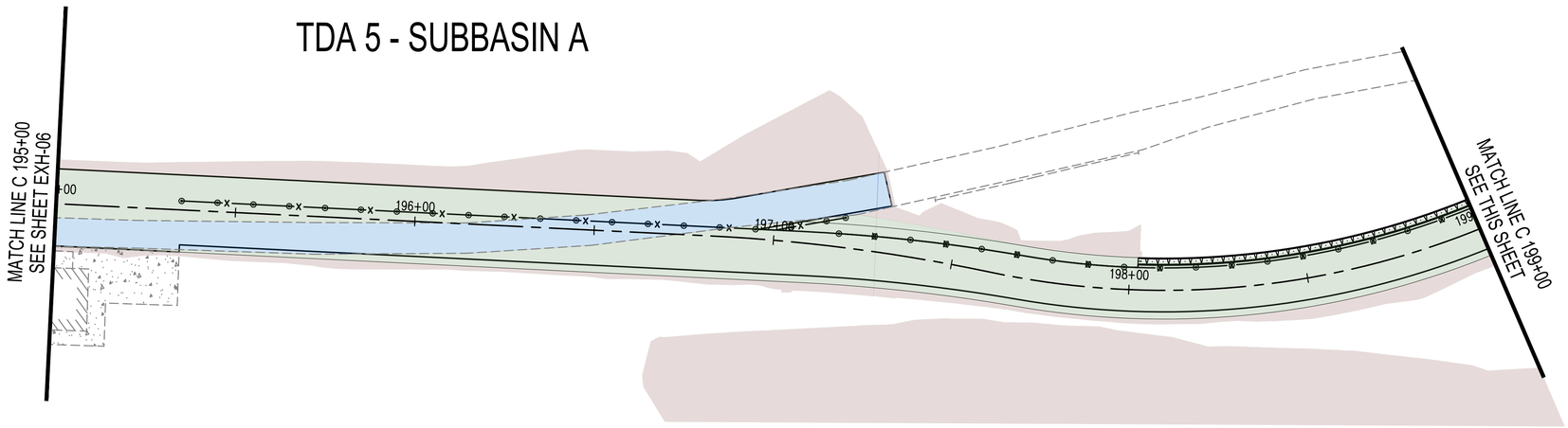
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

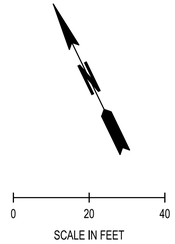
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

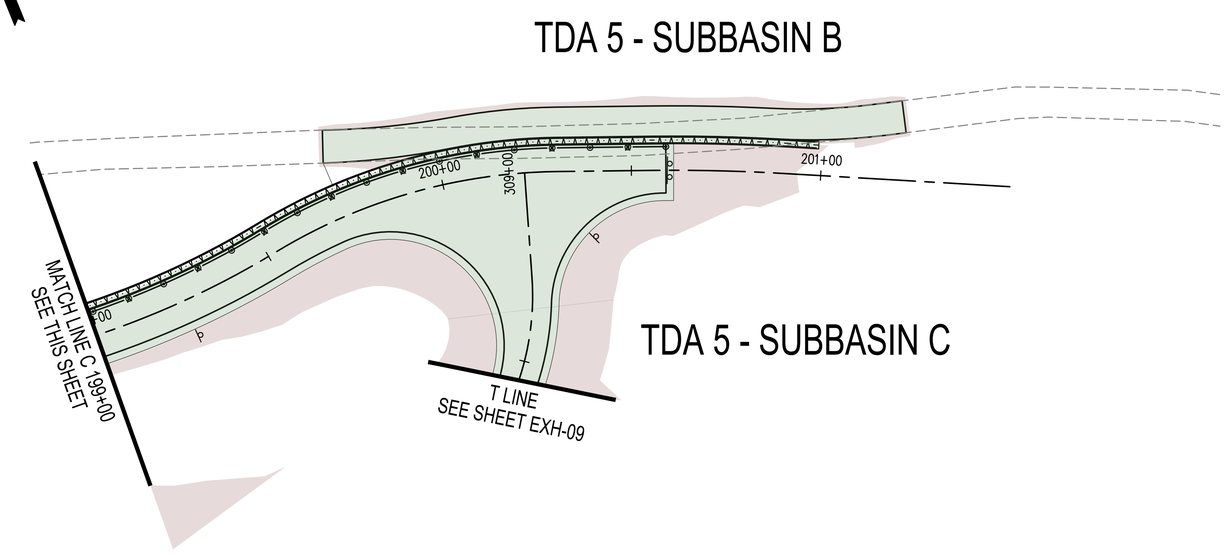
EXHIBIT No: **EXH-06**

SHEET No: **06**

Jul 01, 2026 - 9:32:44am - User: rick.sellberg
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\V4 - MAPS AND AREA TAKEOFFS\V4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG







SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

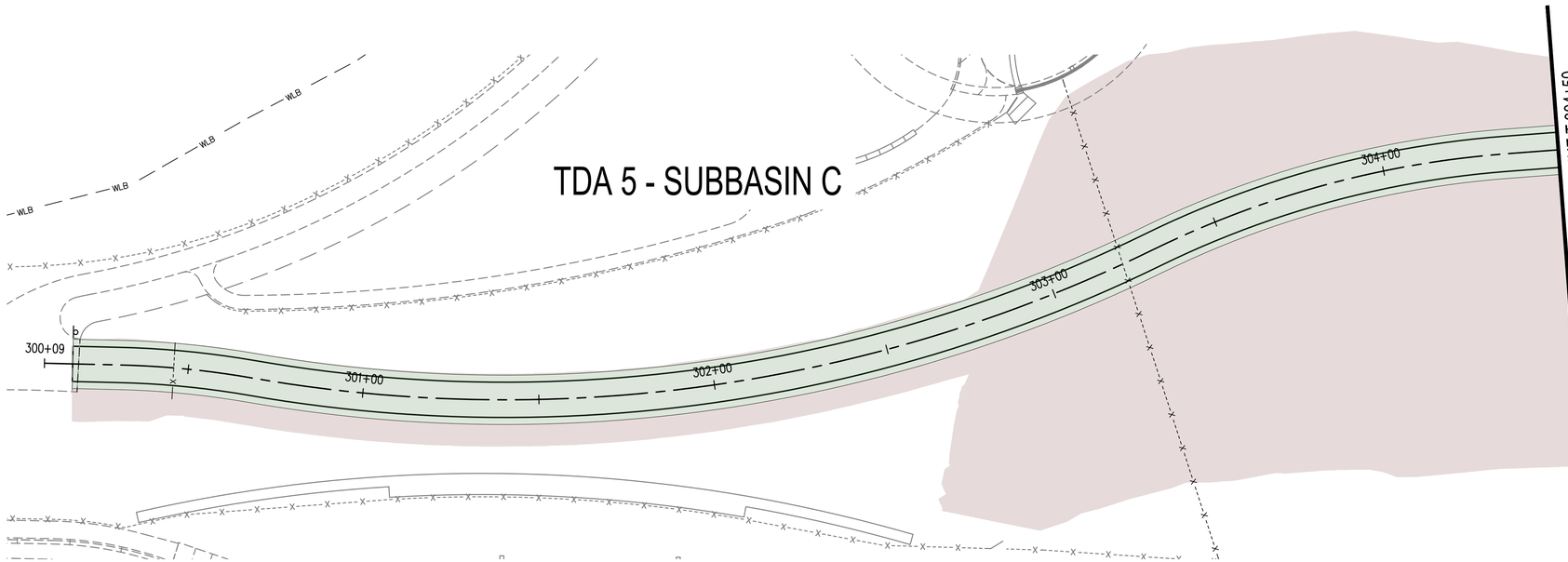
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

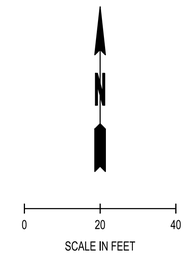
STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-07**

SHEET No: **07**

Jul 01, 2026 - 9:32:42am - User: rick.selberg
N:\PROJECTS\0625 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CADD\AREA TAKEOFFS EXHIBIT.DWG





SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

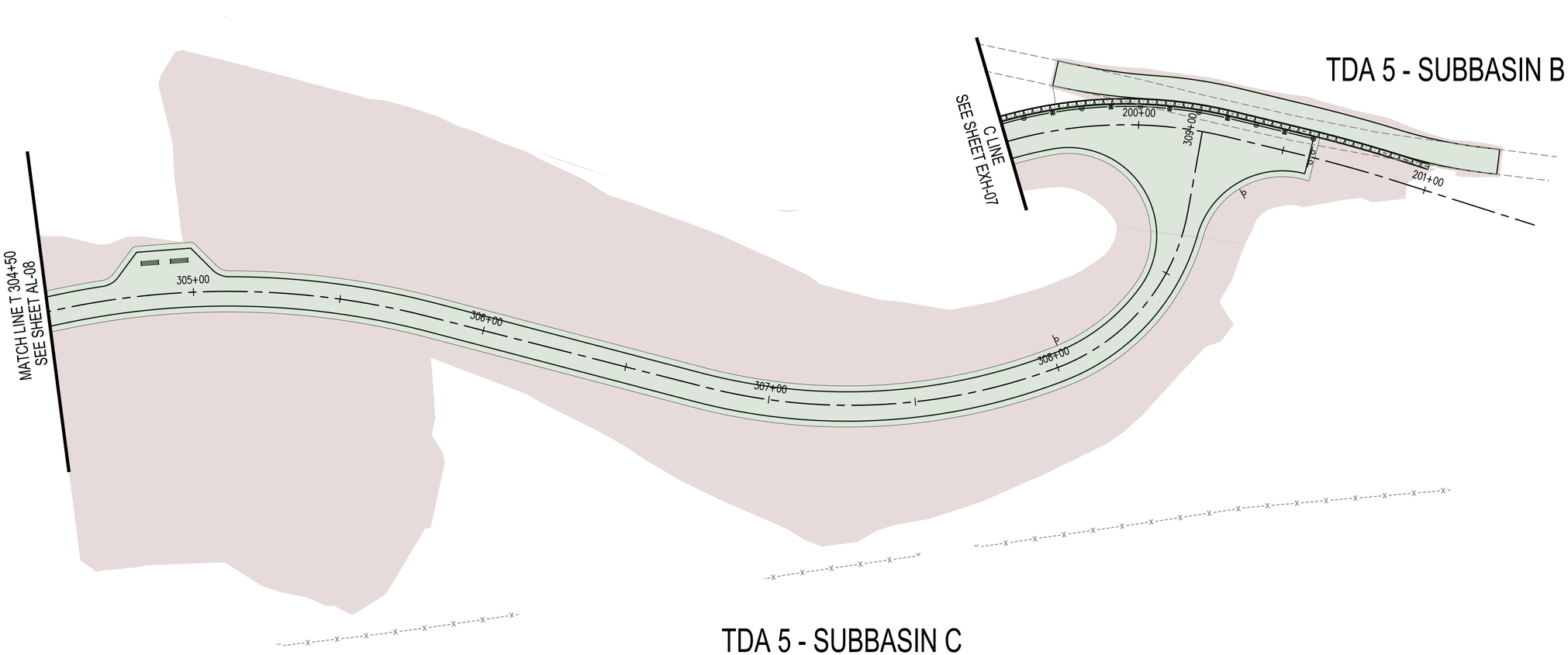
HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-08**

SHEET No: **08**

Jul 01, 2026 - 9:32:52am - User: nick.seiberg
N:\PROJECTS\25 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CAD\AREA TAKEOFFS EXHIBIT.DWG



SCJ ALLIANCE
CONSULTING SERVICES
8730 TALLON LANE NE, SUITE 200, LACEY, WA 98516
P: 360.352.1465
SCJALLIANCE.COM

HORIZONTAL SCALE:	AS SHOWN
DATE:	JUNE 2026
JOB No.:	25-000313
DRAWING FILE No.:	AREA TAKEOFFS EXHIBIT

STORMWATER AREA TAKEOFFS
DESCHUTES VALLEY TRAIL - SEGMENT C

EXHIBIT No: **EXH-09**

SHEET No: **09**

Jul 01, 2026 - 9:32:17am - User rick.selberg
N:\PROJECTS\25 CITY OF TUMWATER\25-000313 TUMWATER DESCHUTES VALLEY TRAIL\DESIGN\STORM\SEG C STORMWATER\APPENDICES\4 - MAPS AND AREA TAKEOFFS\4C - WORK MAP\CAD\AREA TAKEOFFS EXHIBIT.DWG

Appendix 5
Construction SWPPP

Construction Stormwater Pollution Prevention Plan (SWPPP)

Deschutes Valley Trail – Segment C
City of Tumwater

Prepared For:
City of Tumwater

Prepared By:
SCJ Alliance
8730 Tallon Ln NE, Ste 200
Lacey, WA 98516
360.352.1465

May 2026

SCJ ALLIANCE
CONSULTING SERVICES

Project Information

Project:	Deschutes Valley Trail – Segment C
Prepared for:	City of Tumwater Jared VerHey Capital Projects Manager

Reviewing Agency

Jurisdiction:	City of Tumwater

Project Representative

Prepared by:	SCJ Alliance 8730 Tallon Ln NE, Ste 200 Lacey, WA 98516 360.352.1465 scjalliance.com
Contact:	Whitney Holm, PE whitney.holm@scjalliance.com
Project Reference:	SCJ #23-000313

Signature

I hereby state that this Construction Stormwater Pollution Prevention Plan for Deschutes Valley Trail – Segment C has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that the City of Tumwater does not and will not assume liability for the sufficiency, suitability, or performance of Construction SWPPP BMPs prepared by me.

Tova Beck

Prepared by Tova Beck, EIT

Whitney Holm, PE

Approved by Whitney Holm, PE

This SWPPP shall be on site at all times and shall be updated as necessary.

Certified Erosion and Sediment Control Lead (CESCL)

Name	Organization	Contact Phone Number
TBD	TBD	TBD

SWPPP Preparation Date

April / 10 / 2026

Project Construction Dates

Activity / Phase	Start Date	End Date
-	TBD	TBD

Prepared for:

The Washington State Department of Ecology

Olympic Region

Permittee / Owner	Developer	Operator / Contractor
City of Tumwater	City of Tumwater	TBD

Table of Contents

1 General Information 1

1.1 Project Contacts 1
1.2 Project Description 1
1.3 Existing Site Conditions 3
1.4 Adjacent Areas 3
1.5 Critical Areas 3
1.6 Soil 3
1.7 Potential Erosion Problem Areas 4

2 Thirteen Elements 5

2.1 Element 1: Preserve Vegetation / Mark Clearing Limits 5
2.2 Element 2: Establish Construction Access 6
2.3 Element 3: Control Flow Rates 6
2.4 Element 4: Install Sediment Controls 7
2.5 Element 5: Stabilize Soils 8
2.6 Element 6: Protect Slopes 9
2.7 Element 7: Protect Drain Inlets 10
2.8 Element 8: Stabilize Channels and Outlets 10
2.9 Element 9: Control Pollutants 11
2.10 Element 10: Control Dewatering 12
2.11 Element 11: Maintain BMPs 13
2.12 Element 12: Manage the Project 13
2.13 Element 13: Protect Low Impact Development BMPs 15

3 Construction Phasing 15

4 Construction Schedule 16

5 Engineering Calculations 16

6 Pollution Prevention Team 16

6.1 Roles and Responsibilities 16
6.2 Team Members 17

7 Site Inspections and Monitoring 17

7.1 Site Inspection 17
7.2 Site Inspection Frequency 18
7.3 Site Inspection Documentation 18

Table of Contents

8 Stormwater Quality Monitoring 18

8.1 Turbidity 18
8.2 pH 19

9 Recordkeeping 19

9.1 Site Log Book 19
9.2 Records Retention 19
9.3 Access to Plans and Records 19
9.4 Updating the SWPPP 19

10 Reporting 20

10.1 Notification of Noncompliance 20

List of Figures

Figure 1 Site Vicinity Map..... **Error! Bookmark not defined.**

List of Appendices

Appendix A – Upstream Tributaries

Appendix B – Critical Areas

Appendix C – Soil Information

Appendix D – Site Log Book

1 General Information

1.1 Project Contacts

Table 1. Team Members

Title	Name(s)	Organization	Phone Number
Consultant Engineer	Whitney Holm, PE Patrick Holm, PE	SCJ Alliance	360-352-1465
Owner Contact / City Engineer	Jared Verhey, PE	City of Tumwater	360-754-4140
Contractor	TBD		

1.2 Project Description

The Deschutes Valley Trail Project – Segment C is located in Tumwater, Washington within the public right-of-way. The Deschutes Valley Trail Project begins at the recently completed Deschutes Valley Trail Segment A1 at Brewery Park and runs southeast along the perimeter of the Tumwater Valley Golf Course for 2 miles to Pioneer Park. Segment C begins at the Valley Athletic Club parking lot and extends to the Deschutes Valley Spur. The goal of Segment C is to complete a missing link in the existing trail by providing a paved, non-motorized trail along the edge of the existing Valley Golf Course. Project improvements include a 10-foot to 12-foot wide HMA trail with 1-2 foot gravel shoulders and the replacement of segments of existing cart paths. The Segment C trail alignment is approximately 5,150 LF and the Deschutes Valley Park Spur adds an additional 950 LF. See **Table 2** for a description of project areas and **Figure 1** for a map of the project area.

Table 2. Project Areas

Description	Area/Volume	Notes
Total Project Area	6.88 ACRES	Includes project improvements and clearing and grubbing areas, extending to the limits of the full dispersion area.
New NPGIS	113,216 SF	Trail, shoulder, and cart path.
New PGIS	0 SF	
Effective Impervious Surface	0 SF	Impervious surface that is not 100% infiltrated through full dispersion.
Area Disturbed	5.01 ACRES	Includes project improvements, extending to the clearing and grubbing limits.
Total Cut	6,892 CY	Significant cut volumes along the Deschutes Valley spur due to steep grades.
Total Fill	3,415 CY	Significant fill volumes at the South end of the project and along the Deschutes Valley Spur due to steep grades.

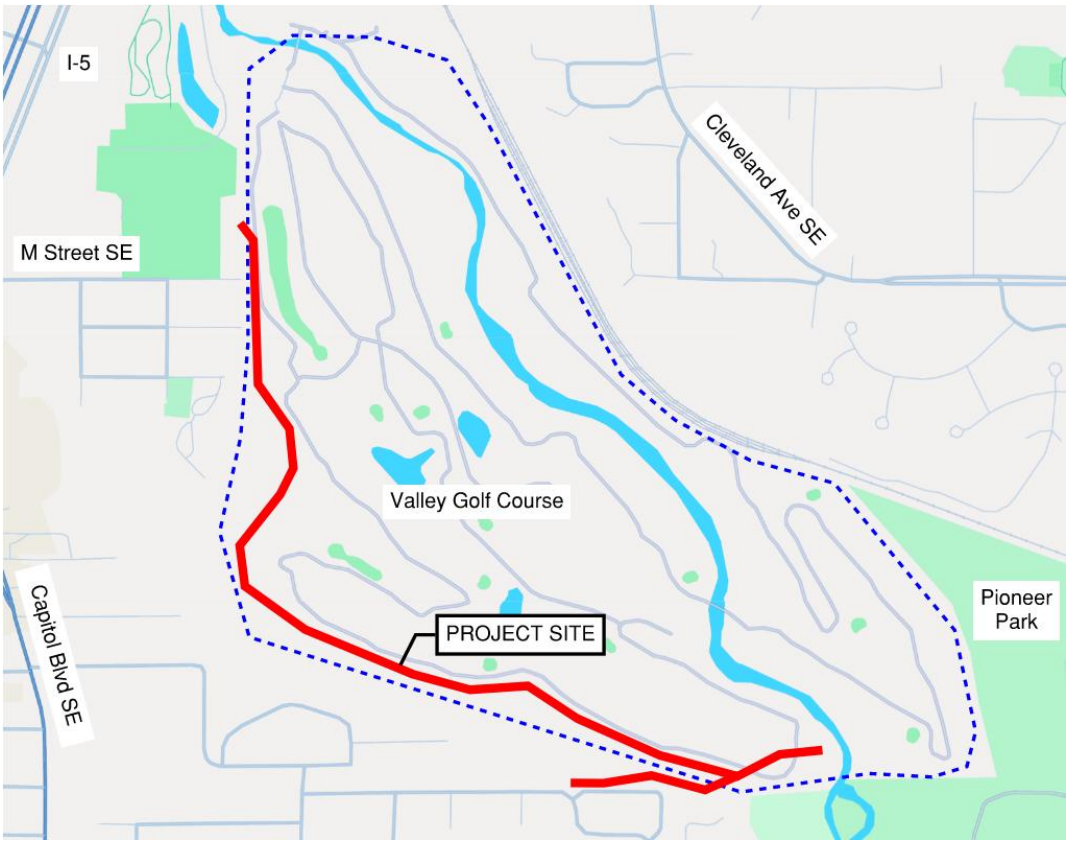


Figure 1 – Site Vicinity Map

1.3 Existing Site Conditions

The existing site consists of undeveloped land within the City of Tumwater property and portions of existing cart path near the boundary of the Valley Golf Course. Most of the surfaces within the project area consist of open grassy slopes and forested areas. However, there are 8-foot-wide HMA cart paths for approximately 2,600 LF of the proposed trail footprint. The area of existing hard surface is approximately 24,800 SF.

In existing conditions, stormwater infiltrates in the grass and treed areas or sheet flows from the HMA cart path and infiltrates in nearby vegetation. The site is composed of five distinct threshold discharge areas (TDAs). In TDA 1, stormwater flows through native vegetation to a low point on the west side of the proposed trail and discharges into a wetland. In TDA 2, stormwater flows east across the golf course and enters a pond. In TDA 3, stormwater flows east across the golf course and enters a second pond. In TDA 4, stormwater flows west and discharges into a wetland. In TDA 5, stormwater flows east and northeast across the golf course before discharging into the Deschutes River, and on the south side of the proposed path stormwater will flow eastward into a flow dispersion trench. In TDA 6, stormwater flows north to a depression where it will infiltrate in the forest floor.

1.4 Adjacent Areas

Land use surrounding the project site includes parks/open space (Valley Golf Course), General Commercial (The Valley Athletic Club, Serendipity Children's Center, and Tumwater Valley Physical Therapy), and low-density single-family developments. Wetland areas are located on the west side of the improvements and there are three ponds east of the improvements that collect site stormwater. The Deschutes River runs south to north along the east side of the Valley Golf Course, east of the project site. Storm flows from the site eventually make their way to the Deschutes River and are conveyed north to Capitol Lake and Puget Sound. Upstream areas tributary to the project site are minor because the improvements are located along the top of a grassy slope, with downward sloping topography on either side of the site. See **Appendix A** for a map of upstream tributary areas and a graphic of downstream drainage leading to the Deschutes River.

1.5 Critical Areas

There are no City of Tumwater maps for the following types of critical areas; the information provided below is based on Thurston County maps included as **Appendix B**.

- Geologic Hazard Areas
    - There are no known landslide and no volcanic hazard areas within the project site.

- Known Areas of Soil or Groundwater Concern
    - There are no known areas of soil or groundwater concern within the project site.

- High Groundwater Hazard Areas
    - There are three ponds north of the project improvements that have a high groundwater hazard. Construction activities will not affect these areas.

- Flood Zones

- The northern section of the project is located within the 100-year flood zone.

- Critical Aquifer Recharge Areas
  - The project improvements are in a moderate-to-high class aquifer recharge area. Per the City of Tumwater DDECM and Section 16.24.050 of the Municipal Code, the project does not involve storage of hazardous materials and therefore does not trigger any additional requirements for the aquifer recharge area.

- Wetlands
  - The northern section of the project is adjacent to a designated category II wetland A. Along the central western portion of the trail category III wetland B resides. The southern section of the project is adjacent to a designated category II wetland C. Approximately half of the project improvements are within 300 feet of a wetland area.
  - The existing cart path stretches within these wetland boundaries, and the planned improvements are designed to follow the existing path closely. Additional impervious surface is expected to be minimal and stretched across the several basins on the project site. See *section 4.1.9* for further descriptions of each wetland.

- Wellhead Protection Areas
  - Wellhead No. 89700 is located west of the project site and project improvements are located within the 6-month - 5-year travel times. Since new impervious surfaces on the project are non-pollution-generating and the project does not fall under any of the prohibited uses listed in Section 16.26.040 of the City of Tumwater Municipal Code, no additional requirements are triggered.

- Washington State Department of Ecology Water Quality Atlas Map
  - The site is in the Budd/Deschutes Watershed, Water Resource Inventory Area (WRIA) 13 and the Deschutes River Basin (see **Appendix B**).
  - The Deschutes River is designated as a Category 5 Assessed Water - 303(d) (see **Appendix B**) specifically for:
    - Bacteria - fecal coliform, and
    - Benthic Macroinvertebrates Bioassessments.
  - At the time the City of Tumwater DDECM was written, a Water Quality Improvement Report and Implementation Plan (also known as a TMDL) had been developed for the Deschutes River, Percival Creek, and Budd Inlet Tributaries for Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load (see **Appendix B**). The plan lists nine specific actions the City of Tumwater implemented via additional water quality mitigation requirements included in City of Tumwater DDECM, Volume I, Section 4.3.5 to meet requirements of the TMDL.

1.6 Soil

A draft geotechnical report evaluating soil and groundwater conditions was prepared by Sage Geotechnical on March 10th, 2026.

Based on the geology review completed by Sage Geotechnical, soils in Segment C are comprised of post-glaciation sand, silt, and gravel alluvium deposits from the Deschutes River. Recessional outwash was also found to be present given due to the significant fill material involved in grading the golf course. Subsurface conditions were analyzed based on 4 drilled borings and 40 hand augers. Soils discovered include sod/topsoil between depths of 0.15 and 2 feet, forest duff between depths of 0.7 and 1.4 feet in wooded areas, fill between depths of 0.25 and 4.5 feet in developed portions of the site, marsh deposits between depths of 1 and 10 feet in historic wetland areas, alluvium between depths of 2 and 5.1 feet, and recessional outwash between the surface soils and the full depth of exploration.

The existing groundwater level is located between 1.1 and 9.0 feet below the ground surface, including perched irrigation water and the groundwater table associated with the Deschutes River. Fill grading activities at the site created a complicated groundwater regime, trapping and perching groundwater along the west side of the golf course. It is anticipated that groundwater in the valley fluctuates seasonally and is near the ground surface over most of the project site during the winter. Refer to **Appendix C** for the draft geotechnical report.

Soil data from the NRCS web soil survey is consistent with findings from the geotechnical report, confirming that soils are composed primarily of Xerorthents fill material, Everett very gravelly sandy loam, Norma silt loam, Indianola loamy sand, and Puyallup silt loam. The groundwater data is also consistent with the geotechnical report, confirming a variable depth to the water table from 0-6.6 feet below the existing ground surface. Refer to **Appendix C** for the NRCS Soil Report.

The geotechnical report by Sage Geotechnical has yielded infiltration rates for TDA 5 and soil types for the entire project area; refer to **Appendix C**.

1.7 Potential Erosion Problem Areas

Per Section 1.5 of this report, there are no erosion hazard areas within the project site.

2 Thirteen Elements

The following section explains measures to be taken on site to control erosion and sedimentation problems. The SWPPP is a guideline to follow during construction to prevent erosion and sedimentation. Erosion control measures are not limited to those shown in this SWPPP. Measures shall be installed as necessary to meet the Department of Ecology's (DOE) and the City of Tumwater's guidelines for stormwater pollution prevention and the requirements of the DOE National Pollutant Discharge Elimination System (NPDES) permit. The SWPPP shall be updated by the contractor as necessary.

2.1 Element 1: Preserve Vegetation / Mark Clearing Limits

- Before beginning any land-disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area to prevent damage and offsite impacts. Mark clearing limits both in the field and on the plans.
- Retain the duff layer, native topsoil, and natural vegetation in an undisturbed state to the maximum degree practicable.
- Plastic, metal, fabric fence, or other physical barriers may be used to mark the clearing limits.

The BMP(s) proposed to meet this element are:

☒ BMP C101: Preserving Natural Vegetation
☒ BMP C102: Buffer Zones
☒ BMP C103: High-Visibility Fence
☒ BMP C233: Silt Fence
☐ Other:

2.2 Element 2: Establish Construction Access

- Limit construction vehicle ingress and egress to one route, if possible.
- Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent BMPs to minimize tracking of sediment.
- Locate wheel wash or tire baths on site if other measures fail to control sediment from leaving the site.
- No tracking of sediment offsite is allowed. If sediment is tracked offsite, offsite areas (including roadways) shall be thoroughly and immediately cleaned by shoveling or pickup sweeping.
- Keep streets clean at ALL times. Clean tracked sediment immediately.
- Washing of sediment into the stormwater system is not allowed.

The BMP(s) proposed to meet this element are:

☒ BMP C105: Stabilized Construction Access
☒ BMP C106: Wheel Wash
☐ BMP C107: Construction Road/Parking Area Stabilization
☐ Other:

2.3 Element 3: Control Flow Rates

- Protect downstream properties, receiving waters, and conveyance systems from erosion and other damage due to increases in the velocity and peak volumetric flowrate of stormwater from the project site. A quantitative downstream analysis may be required to ensure no damage to the downstream conveyance system during construction.
- Where necessary, construct flow control facilities as one of the first steps in grading.
- Flow control facilities shall be functional prior to construction of site improvements (e.g., impervious surfaces). It may be necessary to install temporary flow control facilities to meet flow control requirements during construction.
- Control structures designed for permanent flow control BMPs are not appropriate for use during construction without modification. If used during construction, modify the control structure to allow for long-term storage of runoff and enable sediments to settle. Verify that the BMP is sized appropriately for this purpose. Restore BMPs to their original design dimensions, remove sediment, and install a final control structure at completion of the project.
- Velocity of water leaving the site shall not exceed 3 feet/second if the discharge is to a stream or ditch.

- Permanent infiltration facilities shall not be used for flow control during construction unless lined. The bottom of the facility shall be scarified to ensure any compaction that occurred during construction is mitigated.

The BMP(s) proposed to meet this element are:

☐ BMP C203: Water Bars
☐ BMP C207: Check Dams
☐ BMP C209: Outlet Protection
☐ BMP C235: Wattles
☐ BMP C240: Sediment Trap
☐ BMP C241: Temporary Sediment Pond
☐ Other:

2.4 Element 4: Install Sediment Controls

- Design, install, and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.
- Construct sediment control BMPs as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.
- Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater, and soil characteristics, including the range of soil particle sizes expected to be present on the site.
- Prior to leaving a construction site or prior to discharge into an infiltration facility, stormwater from disturbed areas shall pass through a sediment removal BMP.
- Locate BMPs in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or conveyance channels.
- Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal and maximize infiltration, where feasible.
- Seed and mulch earthen structures such as dams, dikes, and diversions according to the timing indicated in Element 5.
- Design outlet structures to withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column. If installing a floating pump structure, include a stopper to prevent the pump basket from hitting the bottom of the pond.
- Full stabilization includes concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetative cover in a manner that will fully prevent soil erosion.

The BMP(s) proposed to meet this element are:

☐ BMP C231: Brush Barrier
☐ BMP C232: Gravel Filter Berm
☒ BMP C233: Silt Fence

☐ BMP C234: Vegetated Strip
☐ BMP C235: Wattles
☐ BMP C240: Sediment Trap
☐ BMP C241: Sediment Pond (Temporary)
☐ BMP C250: Construction Stormwater Chemical Treatment
☐ BMP C251: Construction Stormwater Filtration
☐ Other:

2.5 Element 5: Stabilize Soils

- Stabilize exposed and unworked soils by application of effective BMPs that prevent erosion. Soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on the weather forecast.
    - From October 1 through April 30, no soils shall remain exposed and unworked for more than 2 days.
    - From May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days.
- Select appropriate soil stabilization measures for the time of year, site conditions, estimated duration of use, and the potential water quality impacts that stabilization agents may have on downstream waters or groundwater.
- Control stormwater volume and velocity on site to minimize soil erosion.
- Control stormwater discharges, including peak volumetric flowrates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.
- Minimize the amount of soil exposed during construction activity.
- Minimize the disturbance of steep slopes.
- Minimize soil compaction and, unless infeasible, preserve topsoil.
- Ensure the gravel base used for stabilization is clean and does not contain fines or sediment.

The BMP(s) proposed to meet this element are:

☒ BMP C120: Temporary and Permanent Seeding
☒ BMP C121: Mulching
☐ BMP C122: Nets and Blankets
☐ BMP C123: Plastic Covering
☐ BMP C124: Sodding
☐ BMP C125: Topsoiling / Composting
☐ BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection
☒ BMP C130: Surface Roughening
☐ BMP C131: Gradient Terraces
☒ BMP C140: Dust Control
☐ Other:

2.6 Element 6: Protect Slopes

- Design and construct cut-and-fill slopes in a manner to minimize erosion. Applicable practices include, but are not limited to, reducing the continuous lengths of slopes with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).
- Divert offsite stormwater, run-on, or groundwater away from slopes and disturbed areas with interceptor dikes and/or swales. Manage offsite stormwater separately from stormwater generated on the site.
- At the top of the slopes, collect stormwater in pipe slope drains or protected channels to prevent erosion. Size temporary pipe slope drains to convey either:
    - The peak volumetric flowrate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm using a single event model, or
    - The 10-year peak flow rate, indicated by an Ecology-approved continuous simulation model with a 15-minute time step.
- Use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, use the temporary or permanent project land cover condition, whichever will produce the highest flow rate. If using a continuous simulation model, model bare soils as landscaped areas.
- Provide temporary or permanent conveyance to remove groundwater seepage from the slope surface of exposed soil areas.
- Place excavated material on the uphill side of trenches, consistent with safety and space considerations.
- Place check dams at regular intervals within channels that are cut down a slope.
- Stabilize soils on slopes, as specified in Element 5.

The BMP(s) proposed to meet this element are:

☒ BMP C120: Temporary and Permanent Seeding
☒ BMP C121: Mulching
☐ BMP C122: Nets and Blankets
☐ BMP C123: Plastic Covering
☐ BMP C124: Sodding
☒ BMP C130: Surface Roughening
☐ BMP C131: Gradient Terraces
☐ BMP C200: Interceptor Dike and Swale
☐ BMP C201: Grass-Lined Channels
☐ BMP C203: Water Bars
☐ BMP C204: Pipe Slope Drains
☐ BMP C205: Subsurface Drains
☐ BMP C206: Level Spreader
☐ BMP C207: Check Dams
☐ BMP C208: Triangular Silt Dike (TSD)
☒ Other: Grading tie-in slopes shall be 3H:1V where practicable.

2.7 Element 7: Protect Drain Inlets

- Protect all stormwater system inlets that are operable during construction so that stormwater does not enter the conveyance system without first being filtered or treated to remove sediment.
- Clean or remove and replace inlet protection devices when sediment has filled 1/3 of the available storage (unless a different standard is specified by the product manufacturer).
- Keep all approach roads clean. Do not allow sediment and street wash water to enter storm drains without prior and adequate treatment, unless treatment is provided before the storm drain discharges to waters of the State.
- Storm drain inlets should be inspected weekly at a minimum and daily during storm events.

The BMP(s) proposed to meet this element are:

☒ BMP C220: Stormwater System Inlet Protection

☐ Other:

2.8 Element 8: Stabilize Channels and Outlets

- Design, construct, and stabilize all temporary conveyance channels on site to prevent erosion from either:
  - The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm using a single event model, or
  - The 10-year return period flow rate, indicated by an Ecology-approved continuous simulation model with a 15-minute time step.
- Use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, use the temporary or permanent project land cover condition, whichever will produce the highest flow rate. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "lawn" area.
- Provide stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes, and downstream reaches at the outlets of all conveyance systems.

The BMP(s) proposed to meet this element are:

☐ BMP C122: Nets and Blankets

☐ BMP C202: Riprap Channel Lining

☐ BMP C207: Check Dams

☐ BMP C209: Outlet Protection

☒ Other: This element is not applicable to the project because the stormwater management strategy is full dispersion. There are no outlets of concentrated flow on the project.

2.9 Element 9: Control Pollutants

- Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants. The project proponent must:
    - Handle and dispose of all pollutants, including waste materials and demolition debris that occur on site in a manner that does not cause contamination of stormwater.
    - Provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health and the environment. Provide secondary containment for tanks holding pollutants including on site fueling tanks. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest tank within the containment structure. Double-walled tanks do not require additional secondary containment.
    - Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident.
    - Conduct oil changes, hydraulic system drain down, solvent and degreasing cleaning operations, fuel tank drain down and removal, and other activities, which may result in discharge or spillage of pollutants to the ground or into stormwater using spill prevention measures, such as drip pans.
    - Discharge wheel wash or tire bath wastewater to a separate on site treatment system that prevents discharge to surface water. Alternatively, discharge wheel wash or tire bath wastewater to the wastewater system (only allowed with local sewer district approval).
    - Apply fertilizers and pesticides in a manner and at application rates that will not result in loss of chemicals to stormwater. Follow manufacturer recommendations for application rates and procedures.
    - Use BMPs to prevent or treat contamination of stormwater by pH-modifying sources. These sources include, but are not limited to, recycled concrete stockpiles, bulk cement, kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, dewatering concrete vaults, and concrete pumping and mixer washout waters.
    - Adjust the pH of stormwater if necessary to prevent violations of water quality standards.
    - Manage concrete washout appropriately. Washout concrete truck drums or concrete handling equipment in on site or offsite designated concrete washout areas only. Do not washout concrete truck drums or concrete handling equipment onto streets, the stormwater system, receiving waterbodies, or the ground.
        - Washout of small concrete handling equipment may be disposed of in formed areas awaiting concrete where it will not contaminate stormwater and surface water or groundwater.
        - Do not use upland land applications for discharging wastewater from concrete washout areas.
        - Do not dump excess concrete on site, except in designated concrete washout areas.
        - Do not washout anything contaminated with concrete into formed areas awaiting infiltration BMPs.

    - Concrete spillage or concrete discharge directly to groundwater or surface waters of the state is prohibited.
- Written approval from the Department of Ecology is required prior to using chemical treatment other than CO2, dry ice, or food grade vinegar to adjust pH.
- Clean contaminated surfaces immediately following any discharge or spill incident.
- Uncontaminated water from water-only based shaft drilling for construction of building, road, and bridge foundations may be infiltrated provided the wastewater is managed in a way that prohibits discharge to surface waters. Prior to infiltration, water from water-only based shaft drilling that comes into contact with curing concrete must be neutralized until pH is in the range of 6.5 to 8.5.

The BMP(s) proposed to meet this element are:

☒ BMP C151: Concrete Handling
☒ BMP C152: Sawcutting and Surfacing Pollution Prevention
☒ BMP C153: Material Delivery, Storage, and Containment
☒ BMP C154: Concrete Washout Area
☐ BMP C250: Construction Stormwater Chemical Treatment
☐ BMP C251: Construction Stormwater Filtration
☐ BMP C252: Treating and Disposing of High pH Water
☐ Other

2.10 Element 10: Control Dewatering

- Discharge foundation, vault, and trench dewatering water that has similar characteristics to stormwater runoff at the site, into a controlled conveyance system prior to discharge to a sediment trap or temporary sediment pond. Stabilize channels as specified in Element 8.
- Clean, non-turbid dewatering water, such as well-point groundwater, can be discharged to systems tributary to state surface waters, as specified in Element 8, provided the dewatering flow does not cause erosion or flooding of receiving waters. Do not route clean dewatering water through TESC BMPs.
- Handle highly turbid or contaminated dewatering water separately from stormwater.

The BMP(s) proposed to meet this element are:

☐ BMP C203: Water Bars
☐ BMP C236: Vegetative Filtration
☒ Other: Dewatering shall be transported off site in a vehicle for legal disposal in a manner that does not pollute state waters. Other options include Ecology-approved on-site chemical treatment or other suitable treatment technologies, or sanitary or combined sewer discharge with local sewer district approval. Infiltration is not an option.

2.11 Element 11: Maintain BMPs

- Maintain and repair as needed all temporary and permanent erosion and sediment control BMPs to assure continued performance of their intended function. Conduct maintenance and repairs in accordance with BMP specifications.
- Remove temporary erosion and sediment control BMPs within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Permanently stabilize disturbed soil resulting from removal of BMPs or vegetation.

The BMP(s) proposed to meet this element are:

☐ BMP C150: Materials on Hand
☒ BMP C160: Erosion and Sediment Control Lead
☐ Other:

2.12 Element 12: Manage the Project

Phasing of Construction:

- Phase projects to prevent soil erosion and the transport of sediment from the project site during construction, unless the Erosion and Sediment Control Lead can demonstrate that construction phasing is infeasible. Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.

Seasonal Work Limitations:

- From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the City that silt-laden stormwater will be prevented from leaving the site through a combination of the following:
  - Site conditions (including existing vegetative coverage, slope, soil type, and proximity to receiving waters)
  - Limitations on activities and the extent of disturbed areas
  - Proposed erosion and sediment control measures
- Based on the information provided and local weather conditions, the City may expand or restrict the seasonal limitation on site disturbance. The following activities are exempt from the seasonal clearing and grading limitations:
  - Routine maintenance and necessary repair of erosion and sediment control BMPs
  - Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil.
  - Activities where there is one hundred percent infiltration of stormwater within the site in approved and installed erosion and sediment control facilities.

Inspection and Monitoring:

- Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. Projects regulated under the Construction Stormwater General Permit (CSWGP) must conduct site inspections and monitoring in accordance with Special Condition S4 of the CSWGP.
- Projects that disturb one or more acres must have site inspections conducted by a Certified Erosion and Sediment Control Lead (CESCL) or Certified Professional in Erosion and Sediment Control (CPESC).
- Projects disturbing less than one acre must have an Erosion Sediment Control (ESC) Lead conduct inspections. The ESC Lead does not have to have CESCL or CPESC certification.
- The CESCL, CPESC, or ESC Lead shall be identified in the SWPPP and shall be on site or on call at all times.
- The CESCL, CPESC, or ESC Lead must examine stormwater visually for the presence of suspended sediment, turbidity, discoloration, and oil sheen and evaluate the effectiveness of BMPs to determine if it is necessary to install, maintain, or repair BMPs.
- The CESCL, CPESC, or ESC Lead must inspect all areas disturbed by construction activities, all BMPs, and all locations where stormwater leaves the site at least once every calendar week and within 24 hours of any discharge from the site. (Individual discharge events that last more than one day do not require daily inspections). The CESCL, CPESC, or ESC Lead may reduce the inspection frequency for temporary stabilized, inactive sites to once every calendar month.
- Construction site operators must correct any problems identified by the CESCL, CPESC, or ESC Lead by:
    - Reviewing the SWPPP for compliance with the 13 construction SWPPP elements and making appropriate revisions within 7 days of the inspection.
    - Fully implementing and maintaining appropriate source control and/or treatment BMPs as soon as possible but correcting the problem within 10 days.
    - Documenting BMP implementation and maintenance in the site log book. (Required for sites larger than 1 acre but recommended for all sites).
    - Sampling and analysis of the stormwater discharges from a construction site may be necessary on a case-by-case basis to ensure compliance with standards. Ecology or the City will establish these monitoring and associated reporting requirements.
- Responsible Party – For all projects, a 24-hour responsible party shall be listed in the SWPPP, along with that person's telephone number and email address.

Maintaining an Updated Construction SWPPP:

- Keep the Construction SWPPP on site or within reasonable access to the site. Modify the SWPPP whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
- Modify the SWPPP if, during inspections or investigations conducted by the owner/operator, City staff, or by local or state officials, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. Modify the SWPPP as necessary to include additional or modified BMPs designed to correct problems identified. Complete revisions to the SWPPP within seven (7) days following the inspection.

The BMP(s) proposed to meet this element are:

☐ BMP C150: Materials on Hand
☒ BMP C160: Erosion and Sediment Control Lead
☒ BMP C162: Scheduling
☐ Other:

2.13 Element 13: Protect Low Impact Development BMPs

- Protect all permanent, or LID BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain to the BMPs. Restore all BMPs to their fully functioning condition if they accumulate sediment during construction. Sediment-impacting Best Management Practices shall be removed before system start-up. Restoring the BMP shall include removal of all sediment and full replacement of treatment media.
- Prevent compacting infiltration facilities by excluding construction equipment and foot traffic.
- Keep all heavy equipment away from native soils under infiltration BMPs that have been excavated to final grade to retain the infiltration rate of the soils.
- Protect lawn and landscaped areas from compaction due to construction equipment and material stockpiles.
- Do not allow muddy construction equipment on the base material of permeable pavement or on the permeable pavement section.
- Do not allow sediment-laden runoff onto permeable pavements or base materials of permeable pavements.
- Permeable pavements fouled with sediment or that can no longer pass an initial infiltration test must be cleaned prior to final acceptance.

The BMP(s) proposed to meet this element are:

☐ BMP C102: Buffer Zones
☒ BMP C103: High-Visibility Fence
☐ BMP C200: Interceptor Dike and Swale
☐ BMP C201: Grass-Lined Channels
☐ BMP C207: Check Dams
☐ BMP C208: Triangular Silt Dike (TSD)
☐ BMP C231: Brush Barrier
☒ BMP C233: Silt Fence
☐ BMP C234: Vegetated Filter Strip
☐ Other:

3 Construction Phasing

Describe the intended sequence and timing of construction activities, as well as any proposed construction phasing.

The construction schedule has not yet been determined. When the construction schedule is developed, it shall adhere to the following requirements unless approval is granted by the appropriate local authority:

- No soils exposed and unworked for more than two (2) days from October 01 through April 30
- No soils exposed and unworked for more than seven (7) days from May 01 to September 30
- Clearing, grading, and other soil disturbing activities are prohibited from November 01 to February 28

4 Construction Schedule

Describe the construction schedule. If the schedule extends into the wet season, describe what activities will continue during the wet season and how the transport of sediment from the construction site to receiving waters will be prevented. Describe the intended sequence and timing of construction activities and any proposed construction phasing. Refer to Element #12 for seasonal work considerations that should be reflected in the Construction SWPPP.

The construction schedule has not yet been determined.

5 Engineering Calculations

Engineering calculations relating to the design of swales, dispersions, waterways, and stormwater detention were not applicable to this project and therefore are not included in this document.

6 Pollution Prevention Team

6.1 Roles and Responsibilities

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead – Primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Project Engineer – For projects with engineered structures only (sediment pond/traps, sand filters, etc.): site representative for the owner that is the project's supervising engineer responsible for inspections and issuing instructions and drawings to the contractor's site supervisor or representative.
- Emergency Owner Contact – Individual that is the site owner or representative of the site owner to contacted in the case of an emergency.
- Monitoring Personnel – Personnel responsible for conducting water quality monitoring; for most sites this person is also the CESCL.

6.2 Team Members

Title	Name (s)	Phone Number
Certified Erosion and Sedimentation Control Lead (CESCL)	TBD	
General Contractor	TBD	
Project Engineer	Whitney Holm – SCJ Alliance	360.352.1465
Emergency Owner Contact	TBD	
Emergency Ecology Contact	Southwest Regional Office	360.407.6300
Non-Emergency Ecology Contact	Jacob Neuharth	360.742.9751
Monitoring Personnel	See CESCL	

7 Site Inspections and Monitoring

Monitoring includes visual inspection, monitoring for water quality parameters of concern and documentation of the inspection and monitoring findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book. This SWPPP may function as the site log book if desired, or the forms may be separated and included in a separate site log book. However, if separated, the site log book must be maintained on site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

7.1 Site Inspection

All BMPs will be inspected, maintained, and repaired as needed to ensure continued performance of their intended function. The inspector will be a CESCL per BMP C160. The name and contact information for the CESCL is provided in Section 6.2 of this SWPPP.

Site inspection will occur in all areas disturbed by construction activities and at all potential stormwater discharge points. Stormwater will be examined for the presence of suspended sediment, turbidity, discoloration, and oily sheen.

The site inspector will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs to improve the quality of the stormwater discharges.

All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible.

7.2 Site Inspection Frequency

Site inspected will be conducted at least once a week and within 24 hours following any discharge from the site. For sites with temporary stabilization measures, the site inspection frequency will be reduced to once every month.

7.3 Site Inspection Documentation

The site inspector will record each site inspection using the site log inspection forms provided in **Appendix D**. The site inspection log forms may be separated from this SWPPP document, but will be maintained on site or within reasonable access to the site and be made available upon request to Ecology, the local jurisdiction and the Engineer.

8 Stormwater Quality Monitoring

8.1 Turbidity

Turbidity sampling and monitoring will be conducted during the entire construction phase of the project. Samples will be collected weekly at the discharge point nearest the current phase of the project work. If there is no flow at the discharge point, the attempt to sample will be recorded in the site log book and reported to Ecology in the monthly Discharge Monitoring Report (DMR) as “No Discharge”. Samples will be analyzed for turbidity using the Hach 2100Q Turbidimeter.

The key benchmark turbidity value is 25 nephelometric turbidity units (NTU) for the downstream receiving water body. If the 25 NTU benchmark is exceeded in any sample collected, the following steps will be conducted:

1. Ensure all BMPs specified in this SWPPP are installed and functioning as intended.
2. Assess whether additional BMPs should be implemented, and document modified BMPs in the SWPPP as necessary.
3. Sample discharge daily until the discharge is 25 NTU or lower.

If the turbidity exceeds 250 NTU at any time, the following steps will be conducted:

1. Notify ecology by phone within 24 hours of analysis (see Section 6.2 of this SWPPP for contact information).
2. Continue sampling daily until the discharge is 25 NTU or lower. Initiate additional treatment BMPs such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours, and implement those additional treatment BMPs as soon as possible, but within a minimum of 7 days.
3. Describe inspection results and remedial actions taken in the site log book and in monthly discharge monitoring reports described in Section 9 of this SWPPP.

8.2 pH

Sampling and monitoring of pH occurs if significant concrete work (> 1,000 cubic yards throughout the life of the project) or use of engineered soils (e.g., cement-treated base) is anticipated. No significant concrete work or engineered soils is planned for this project; therefore , no pH testing will be conducted.

9 Recordkeeping

9.1 Site Log Book

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form included in this SWPPP include the required information for the site log book.

9.2 Records Retention

Records of all monitoring information (site log book, inspection reports/checklists, etc.), this Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements will be retained during the life of the construction project and for a minimum of three years following the termination of permit coverage in accordance with permit condition S5.C.

9.3 Access to Plans and Records

All applicable documentation, including but not limited to the SWPPP, General Permit, Notice of Authorization letter, and Site Log Book will be retained on site or within reasonable access to the site and will be made immediately available upon request to Ecology or the local jurisdiction. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of written request for the SWPPP from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with the general permit condition S5.G.

9.4 Updating the SWPPP

In accordance with conditions S3, S4.B, and S.B.3 of the General Permit, this SWPPP will be modified if the SWPPP is ineffective in eliminating of significantly minimizing pollutants in stormwater discharges from the site or there has been a change in design, construction, operation, or maintenance at the site that has a significant effect on the discharge, or potential for discharge, of pollutants to the waters of the State. The SWPPP will be modified within seven days of determination based on inspection(s) that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

10 Reporting

10.1 Notification of Noncompliance

If any of the terms and conditions of this permit are not met, and it causes a threat to human health or the environment, the following steps will be taken in accordance with permit section S5.F:

1. Ecology will be immediately notified of the failure to comply.
2. Immediate action will be taken to control the noncompliance issue and to correct the problem. If applicable, sampling and analysis of any noncompliance will be repeated immediately and submitted to Ecology within five days of becoming aware of the violation.
3. A detailed report describing the noncompliance will be submitted to Ecology within five days, unless requested earlier by Ecology.

Appendix A
Upstream Tributaries

February 27, 2026

Water Quality Atlas Map



WQ Improvement Projects

- TMDL - Approved
- 4B - Approved
- STI - Approved
- ARP - Approved
- TMDL - In Development
- STI - In Development
- ARP - In Development

Miles
0 0.1 0.2 0.4

Esri Community Maps Contributors, City of Olympia, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA,

https://apps.ecology.wa.gov/waterqualityatlas/wqa/map

Deschutes River, Percival Creek, & Budd Inlet tributaries

Parts of the Deschutes River and its tributary creeks do not meet state clean water standards. To return these waters to a healthy condition, we are working with local governments and other groups to implement a total maximum daily load (TMDL) project.

Water quality issues

The Deschutes River is under pressure from growth, resulting in many small, uncontrolled sources of pollution that enter the river. Local city, county, and state government agencies monitor and protect water quality. In the Deschutes, water quality monitoring revealed that levels of pH, dissolved oxygen, temperature, fine sediment, and fecal coliform did not meet state standards. We began the TMDL process to address these problems.

What is being done

With the help of an advisory group of affected stakeholders, special interest groups, and interested residents, we developed a TMDL plan to solve the river's pollution problems. The Deschutes River, Percival Creek, and Budd Inlet Tributaries Water Quality Improvement Plan (also known as a TMDL) assigns the amount of pollution the water bodies can receive and still meet water quality standards. Any additional amount needs to be eliminated to achieve clean water.

This plan provides a framework for how stakeholders will track, monitor, and implement the water cleanup plan. It outlines what is needed, establishes a schedule, and guides corrective actions with adaptive management practices.

We gathered public comments on the draft plan in 2015. We held two public meetings to provide a broad overview of the project and findings. In 2018, EPA approved some elements of the TMDL plan and disapproved others. See our 2018 Letter to Stakeholders for details.

On August 10, 2020, EPA finalized the replacement of the TMDL elements that were disapproved. They were open for public comment until October 7, 2020 and can be found on EPA's Deschutes River TMDLs web page.

We are also continuing to work with the Department of Enterprise Services on the Deschutes Estuary Restoration Project, which will clean and restore Capitol Lake by returning the Deschutes Estuary to a tidal salt marsh habitat.

Why this matters

Water must be of high quality to support fish and wildlife.

Dissolved oxygen — oxygen dissolved in healthy water — is vital for the survival of fish and aquatic life. It is more difficult to transfer oxygen from water to blood than it is to transfer oxygen from air to blood. Therefore, it is critical that an adequate amount of oxygen is maintained in the water for this transfer to take place efficiently and sustain aquatic life. Oxygen is also necessary to help decompose organic matter in the water and bottom sediments as well as for other biological and chemical processes.

Fecal coliform is a type of bacteria common in human and animal waste. It can make people sick and cause the closure of shellfish harvesting beds. Bacteria can get into waters from untreated or partially treated discharges from wastewater treatment plants, from improperly functioning septic systems, and from livestock, pets, and wildlife.

People can help keep bacteria out of the water. Properly collect, bag, and trash dog poop. Check your on-site sewage system to make sure it is maintained and working properly. Use proper storage, management, and disposal practices for livestock manure.

pH is a measure of the acidity or alkalinity of the water. pH can affect the solubility of nutrients and metal compounds. By affecting the solubility of nutrients, it can change the amount of nutrients available for plant growth. If too many nutrients are available, aquatic plants can grow out of control. When these plants decompose, they can deplete the water of oxygen. The solubility of many metal compounds also changes greatly with pH. When more metals are dissolved in the water, aquatic animals may absorb them faster. Therefore, a lower pH may make these metals more toxic to aquatic life.

Water temperature influences what types of organisms can live in a water body. Cooler water holds more dissolved oxygen that fish and other aquatic life need to breathe. Warmer water holds less dissolved oxygen. Threatened and endangered salmon need cold, clean water to survive. Removing streamside vegetation tends to raise water temperature to a level that may be harmful to fish, other aquatic animals, and insects.

Finally, too much **sediment** in the water can irritate fish gills and make it difficult for them to breathe.

DEPARTMENT OF ECOLOGY State of Washington http://www.ecy.wa.gov

Publication Summary

Our Ecology website has changed, which can cause broken links.
To report these, please *contact us* with the publication and broken link.

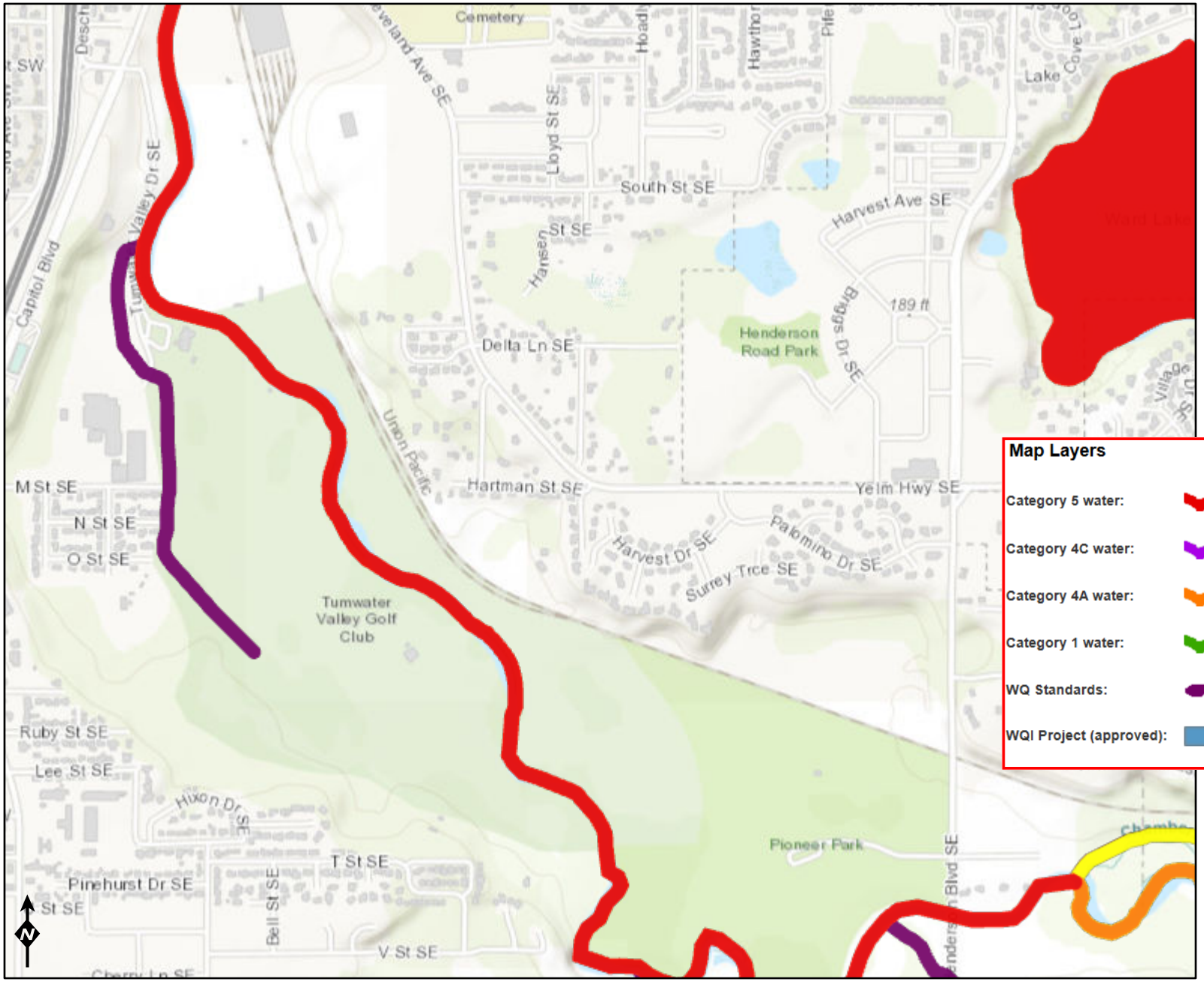
TITLE	**Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL: Water Quality Improvement Report and Implementation Plan**
	Publication number: 15-10-012 | Date Published: April 2015 | Date Revised: July 2018
VIEW NOW	Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL: Water Quality Improvement Report and Implementation Plan (Number of pages: 335) (Publication Size: 14292KB) Trouble viewing? Try these free options. • Get the latest Adobe Reader for PDFs. • For Excel or Word viewing get Open Office, Microsoft OneDrive, DropBox Basic or a mobile app at your favorite app store.
AUTHOR(S)	Wagner, Lydia, Bilhimer, Dustin
DESCRIPTION	Portions of the Deschutes River, Percival Creek, and Budd Inlet tributaries do not meet water quality standards and are on the Clean Water Act Section 303(d) list for one or more of the following parameters: fecal coliform bacteria, temperature, dissolved oxygen (DO), pH, or fine sediment. This Total Maximum Daily Load (TMDL) report sets the load and wasteload reductions needed to meet Washington State water quality standards, and describes implementation actions to achieve those reductions.
REQUEST A COPY	The mission of the Department of Ecology is to protect, preserve, and enhance Washington's environment. To help us meet that goal, please consider the environment before you print or request a copy. **ADA Accessibility** The Department of Ecology is committed to providing people with disabilities access to information and services by meeting or exceeding the requirements of the Americans with Disabilities Act (ADA), Section 504 and 508 of the Rehabilitation Act, and Washington State Policy #188. Visit Ecology's website for more information.

	• Water Quality Order Form
CONTACT	Leanne Weiss at 360-407-0243 or leanne.weiss@ecy.wa.gov
KEYWORDS	water quality improvement plan, Deschutes River, water cleanup plan, Total Maximum Daily Load
WEB PAGE	Deschutes River watershed area: Budd Inlet
WATERSHED	Water Resource Inventory Area 13 Deschutes
DATA	Environmental Information Management (EIM) #MROB0001
RELATED PUBLICATIONS	Title: Budd Inlet Total Maximum Daily Load for Dissolved Oxygen Deschutes River, Capitol Lake, and Budd Inlet Total Maximum Daily Load Study: Supplemental Modeling Scenarios Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Technical Report: Water Quality Study Findings Assessment of Surface Water / Groundwater Interactions and Associated Nutrient Fluxes in the Deschutes River and Percival Creek Watersheds, Thurston County Quality Assurance Project Plan: Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Study

Copyright © Washington State Department of Ecology. See https://ecology.wa.gov/About-us/Accountability-transparency/Our-website/Copyright-information.

February 27, 2026

Water Quality Atlas Map



Assessed Water/Sediment

Water
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Sediment
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Water Quality Standards

- All Standards

Map Layers

Category 5 water:	2 listings found
Category 4C water:	1 listing found
Category 4A water:	2 listings found
Category 1 water:	9 listings found
WQ Standards:	1 water quality standard found
WQI Project (approved):	Deschutes River, Percival Creek, and Budd Inlet Tributaries TMDL

Miles
0 0.1 0.2 0.4

Esri Community Maps Contributors, City of Olympia, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA,

https://apps.ecology.wa.gov/waterqualityatlas/wqa/map

Assessed Water/Sediment

Water

Category 5 - 303d

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 16722

Main Listing Information

Listing ID: 16722

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Bacteria - Fecal coliform

WQI Project: None

Designated Use: Recreation - Primary Contact

Current Category: 5

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value	Criterion 2	Aggregate 2	Calculated Value 2
2016	1	14	200 #col/100ml	Highest daily average	280	100 #col/100ml	Three-month geometric mean	137

Assessed Water/Sediment

Water

Category 5 - 303d

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 70194

Main Listing Information

Listing ID: 70194

Waterbody Name: DESCHUTES RIVER

Medium: Other

Parameter: Benthic Macroinvertebrates Bioassessments

WQI Project: None

Designated Use: Aquatic Life - General

Current Category: 5

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

sessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value	Fine Sediment Biotic Index Score	FSB Threshold	Hilsenhoff Biotic Index Score	HBI Threshold	Metals Tolerance Index Score	MTI Threshold
2012; 2015	3	3	65 (Puget Lowland)	Average BIBI score	56.7	46.2	89	4.84	>5.5	2.8	>4.0

Assessed Water/Sediment

Water

Category 4C

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 6195

Main Listing Information

Listing ID: 6195

Waterbody Name: DESCHUTES RIVER

Medium: Habitat

Parameter: Instream Flow

WQI Project: None

Designated Use: Aquatic Life - General

Current Category: 4C

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

See Basis Statement field.

Basis Statement

USGS flow data collected at RM 3.4 between 1990 and 1995 (submitted by Jeff Dickison on 2/27/96) are consistently below minimum flows established in WAC 173-513-030.

USGS and Thurston County flow data (submitted by Jeff Dickison on 2/27/96) show intensified peak flows likely due to silvicultural activities in the upper watershed (Thurston County, 1995).

The following references document characteristic uses: Squaxin Island Tribal data (submitted by Jeff Dickison on 2/27/96) show numbers of Coho salmon stock.

Baranski, 1996 SASSI Update shows that Coho are reclassified to depressed.

Remarks

This listing was on the 1998 303(d) list, but has been moved to the new Category 4C (impaired by a non-pollutant) based on EPA Guidance for preparing the 2004 Integrated Report.

Assessed Water/Sediment

Water

Category 4A

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 6576

Main Listing Information

Listing ID: 6576

Current Category: 4A

Waterbody Name: DESCHUTES RIVER

View Category History

Medium: Water

Parameter: Temperature

WQI Project: Deschutes River, Percival Creek and Budd Inlet Tributaries Multi-parameter TMDL

Designated Use: Aquatic Life - Salmonid Spawning, Rearing, and Migration

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

County: Thurston

Size: 4.855 Kilometers

WRIA: Deschutes

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	11	361	17.5 deg C	7-DADMax	19.71

Basis Statement

Location ID: 13A060 -- In 2010, between 1/1/2010 and 9/22/2010, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 26 of 265 days (10%); The maximum exceedance during this period was 18.74°C for the 7-day period centered on 8/15/2010; (External Data Source: Thurston County Health Database)

Location ID: 13A060 -- In 2009, between 10/10/2009 and 12/31/2009, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 0 of 83 days (0%); (External Data Source: Thurston County Health Database)

Location ID: 13A060 -- In 2008, between 7/14/2008 and 9/30/2008, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 14 of 79 days (18%); The maximum exceedance during this period was 18.46°C for the 7-day period centered on 8/15/2008; (External Data Source: Thurston County Health Database)

Assessed Water/Sediment

Water

Category 4A

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 10894

Main Listing Information

Listing ID: 10894

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Dissolved Oxygen

WQI Project: Deschutes River, Percival Creek and Budd Inlet Tributaries Multi-parameter TMDL

Designated Use: Aquatic Life - Salmonid Spawning, Rearing, and Migration

Current Category: 4A

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	12	8.0 mg/L	Daily Minimum	9.8

Basis Statement

HISTORICAL INFORMATION

Location ID [13A060] -- In 2005, 12 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-00.5] -- In 2004, 4 of 39 samples (10.3%) showed an excursion of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-02.7] -- In 2004, 24 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-00.5] -- In 2003, 9 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 10893

Main Listing Information

Listing ID: 10893

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Ammonia-N

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2016	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2015	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2014	0	9	Calculated	Toxic aquatic 4-day mean exceedance factor	
2013	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2012	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2011	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2010	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2009	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2008	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2007	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2006	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 53217

Main Listing Information

Listing ID: 53217

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Arsenic

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	190 ug/L	Toxic aquatic 4-day average	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 75944

Main Listing Information

Listing ID: 75944

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Silver

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 1-day exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 76380

Main Listing Information

Listing ID: 76380

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Lead

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 76689

Main Listing Information

Listing ID: 76689

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Chromium

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78277

Main Listing Information

Listing ID: 78277

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Copper

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060], [SRIW1301] -- In 2002, 5 of 5 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment
Water
Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78486

Main Listing Information

Listing ID: 78486
Waterbody Name: DESCHUTES RIVER
Medium: Water
Parameter: Zinc
WQI Project: None
Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001
Size: 4.855 Kilometers
Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston
WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060], [SRIW1301] -- In 2002, 5 of 5 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78873

Main Listing Information

Listing ID: 78873

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Nickel

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 79301

Main Listing Information

Listing ID: 79301

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Cadmium

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

DEPARTMENT OF ECOLOGY State of Washington

Water Quality Atlas Standards

Home

Water Quality Standards for Surface Waters of the State of Washington

Disclaimer: The Department of Ecology continues to improve the mapped depiction of the Surface Water Quality Standards. However, the map may contain errors and the information displayed does not replace the official rules available in Chapter 173-201A of the Washington Administrative Code.

USE DESIGNATIONS

WAC:	173-201A-600 (1)
Description:	All surface waters of the state not named in Table 602 are to be protected for the designated uses of: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.
Aquatic life use:	Salmonid spawning, rearing, and migration
Recreation use:	Primary contact recreation
Water supply uses:	Domestic, Industrial, Agricultural, Stock
Miscellaneous uses:	Wildlife Habitat, Harvesting, Commerce and Navigation, Boating, Aesthetics

CRITERION

Brackish Water Exceptions: None

Temperature: 17.5°C (63.5°F)

Supplemental spawning: None

Dissolved Oxygen (DO): 8.0 mg/L

pH: pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.5 units

Turbidity: 5 NTU over background when the background is 50 NTU or less; or

A 10 percent increase in turbidity when the background turbidity is more than 50 NTU

Bacteria: E. coli and fecal coliform criteria are expressed as colony forming units (CFU) or most probable number (MPN).

To protect recreational use:

- E.coli organism levels must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples(or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 320 CFU or MPN per 100 mL.
- Fecal coliform organism levels must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples(or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 CFU or MPN per 100 mL. (The use of fecal coliform organism levels to determine compliance will expire December 31, 2020.)

Other requirements:

- A minimum of three samples is required to calculate a geometric mean for comparison to the geometric mean criteria. Sample collection dates shall be well distributed throughout the averaging period so as not to mask noncompliance periods.
- When averaging bacteria sample values for comparison to the geometric mean criteria, it is preferable to average by season. The averaging period of bacteria sample data shall be ninety days or less.

Appendix B
Critical Areas

Thurston County

Critical Aquifer Recharge Areas & McAllister Springs Geological Sensitive Area

Aquifer Recharge Classes*
- Extreme
- High
- Moderate

Geological Sensitive Area
- McAllister Springs

PROJECT SITE

Cities | Urban Growth Are

0 Miles

*Thurston County Critical Area Ordinance Chapter 24.10; Appendix B:
Table 24.10-3 Critical Aquifer Recharge Areas Geologic Features.
Table 24.10-4 Critical Aquifer Recharge Area soil series.

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The boun
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, complete
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, includin
not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misu
reliance of the information contained on this map. If any portion of this map or disclain
missing or altered, Thurston County removes itself from all responsibility from the map ar
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

Map Exported on 12/20/2025
PDP\Library\APRX\Environmental\Health\Water.aprx\AquiferRecharge(54x30)

Thurston County

Drainage Basins

- Military Bases
- Native American Reservations
- Public Forests
- Cities
- Urban Growth Areas

PROJECT SITE

TUMWATER

Miles

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The boun
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, complete
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, including
not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misu
reliance of the information contained on this map. If any portion of this map or disclaim
missing or altered, Thurston County removes itself from all responsibility from the map ar
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

Map Exported on 12/20/2025
PDF:Library/AP/RGI/Planning/NaturalResources.aprx!Basins(54x35)

Thurston County

100 Year & 500 Year Flood Zones
1996 Historical Flood

100 Year Flood Zone

500 Year Flood Zone

Flood of 1996

PROJECT SITE

Cities | Urban Growth Area

Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in the Surface not represented on this map. Orthorectified and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED "AS IS" AND WITH ALL FAULTS. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including but not limited to, lost revenues or lost profits, real or anticipated resulting from the use, misuse, or tolerance of the information contained on this map. If any portion of this map or chosen data is missing or altered, Thurston County removes itself from all responsibility from this map and data contained within. The burden for determining fitness for use lies entirely with the user. The user is solely responsible for understanding the accuracy limitations of the information contained in this map.

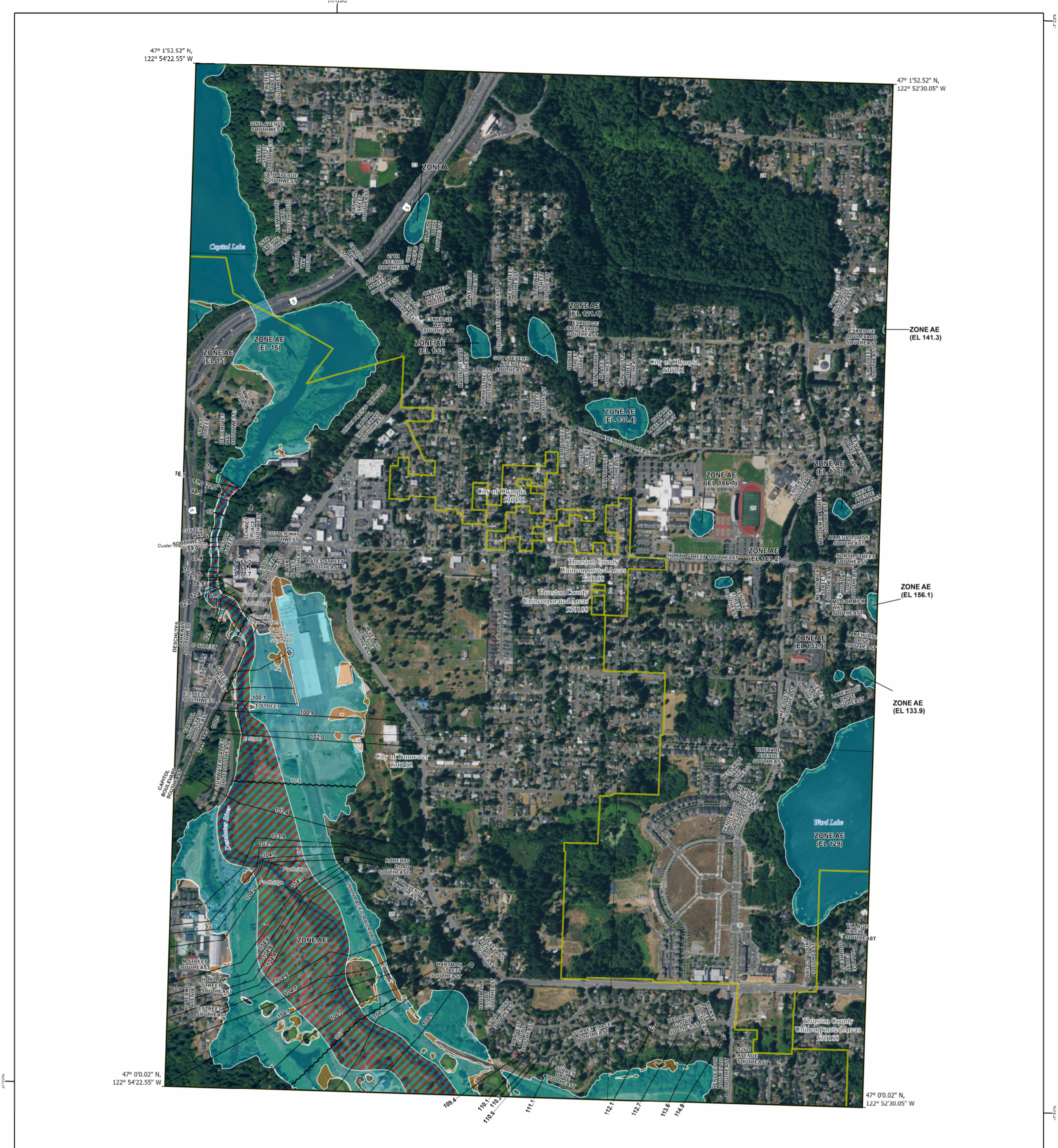
Updated on 11/14/2006

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

GEODATA

NORTH



FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

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

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

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

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

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

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available effective flood hazard information for your community, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Mapping and Insurance Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be downloaded from the website. Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be acquired directly from the Flood Map Service Center at the website listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

Note: Some Special Flood Hazard Areas with elevations may not appear with elevation labels if the Base Flood Elevation or Cross-section line which communicates the elevation for the location appears on the adjacent panel. Please see the Panel Locator Diagram on this map panel to determine the adjacent panel and find the elevation feature there, or alternatively use the Flood Insurance Study report for detailed elevations by flood source.

SCALE

1 inch = 500 feet 1:6,000

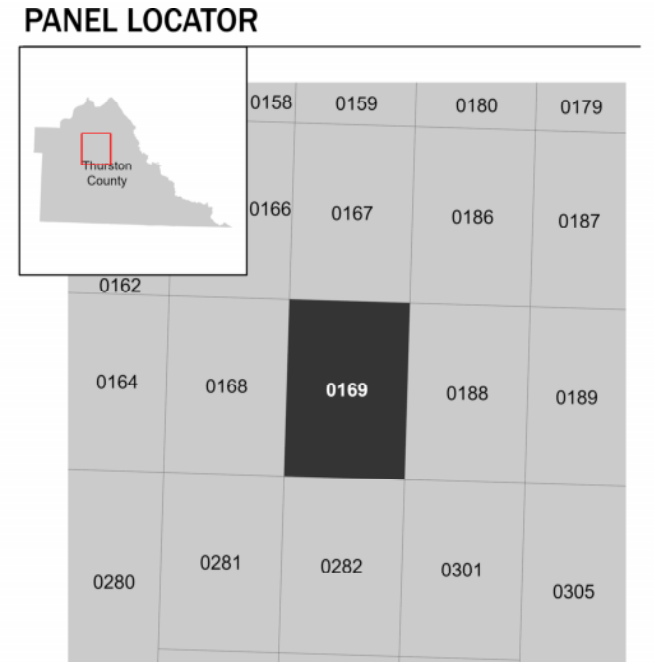
0 250 500 1,000 1,500 2,000 feet

0 50 100 200 300 400 meters

Map Projection:
NAD 1983 StatePlane Washington South FIPS 4602 Feet

Vertical Datum: NAVD88

PANEL LOCATOR



FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

THURSTON COUNTY
WASHINGTON
AND INCORPORATED
AREAS

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
CITY OF OLYMPIA	530191	0169	H
THURSTON COUNTY UNINCORPORATED AREAS	530188	0169	H
CITY OF TUMWATER	530192	0169	H

MAP NUMBER
53067C0169H
EFFECTIVE DATE
May 08, 2024



FLOOD HAZARD INFORMATION

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

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	(B) 20.2 Cross Sections with 1% Annual Chance
	17.5 Water Surface Elevation
	(8) Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available effective flood hazard information for your community, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Mapping and Insurance Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be downloaded from the website. Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be acquired directly from the Flood Map Service Center at the website listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

Note: Some Special Flood Hazard Areas with elevations may not appear with elevation labels if the Base Flood Elevation or Cross-section line which communicates the elevation for the location appears on the adjacent panel. Please see the Panel Locator Diagram on this map panel to determine the adjacent panel and find the elevation feature there, or alternatively use the Flood Insurance Study report for detailed elevations by flood source.

SCALE

1 inch = 500 feet 1:6,000

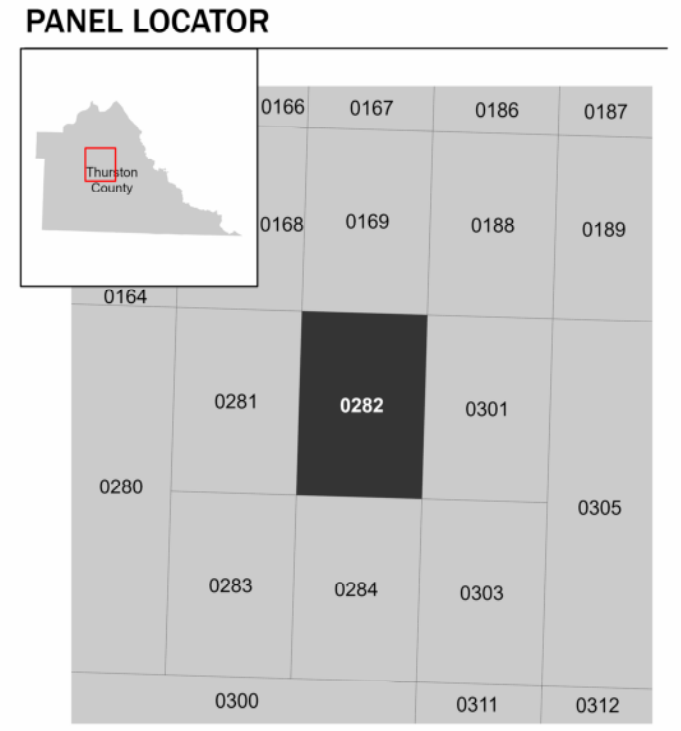
0 250 500 1,000 1,500 2,000 feet

0 50 100 200 300 400 meters

Map Projection:
NAD 1983 StatePlane Washington South FIPS 4602 Feet

Vertical Datum: NAVD88

PANEL LOCATOR



FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROG

FLOOD INSURANCE RATE MAP

**THURSTON COUNTY
WASHINGTON
AND INCORPORATED
AREAS**

FEM

Panel Contains:

COMMUNITY	NUMBER	PANEL	S
THURSTON COUNTY UNINCORPORATED AREAS	530188	0282	(
CITY OF TUMWATER	530192	0282	(

MAP NUM
53067C02
EFFECTIVE I
May 08, 2

Thurston County

Geologic Hazard Areas

Landslide Hazard Area

Volcanic Hazard Area - Case 1

PROJECT SITE

Cities **Urban Growth Areas**

0 5

Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness for use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

NORTH

Map Exported on 12/25/2025
PDP:\Library\APROX\Planning\CriticalAreas.aprx\Geologic Hazard(54x36)

Thurston County

High Groundwater Hazard Areas

- Salmon Creek Basin
- High Groundwater Hazard
- High Groundwater Hazard - 300' Buffer
- Salmon Creek Basin High Groundwater Hazard
- Salmon Creek High Groundwater Hazard - 300' Buffer

PROJECT SITE

- Cities
- Urban Growth Areas

0 5
Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness for use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY GEODATA CENTER

NORTH

Map Exported on 12/20/2025
P:\PLibrary\APRX\Planning\Critical\Areas aprx\HighGroundwater(54x36)

Thurston County

Known Areas of Soil or Groundwater Concern

THIS MAP IS BASED ON DATA THAT IS NOT ALWAYS FULLY CONCLUSIVE AND IS INTENDED MAINLY AS A GUIDE TO AREAS WHERE FURTHER MONITORING IS APPROPRIATE. IT IS A MAP OF SUSPECTED OR CONFIRMED GROUNDWATER QUALITY PROBLEMS.

AREAS OF PESTICIDE CONTAMINATION
Includes EDB, DBCP, 1,2 DCP and others

ELEVATED CHLORIDE AREAS
Areas containing significant numbers of wells with chloride levels exceeding 4 parts/million

ELEVATED NITRATE AREAS
Areas containing significant numbers of wells with nitrate levels exceeding 4 parts/million (1999-2003)

AREAS OF VERY LIMITED GROUNDWATER
Volcanic bedrock unlikely to produce enough water for any type of well

AREAS OF LIMITED GROUNDWATER
Sedimentary bedrock that may produce enough water for low-yield wells

SITES OF CONCERN

1 . EDB 1 Thurston County
2 . Restover Truck Stop
3 . Cascade Pole Inc McFarland
4 . The Ostrom Company
5 . Weyerhaeuser Co Box Plant
6 . Cedar Creek Corrections DNR
7 . Citflor Inc
8 . Puget Sound Power & Light
9 . Rhodes Chemical Co
10 . Rhodes Chemical Co Barn
11 . Pattison Lake EDB
12 . Lacey Valve Grinding
13 . Lacey Laundromat
14 . Black Lake Grocery
15 . West Olympia Landfill Former
16 . Warehouse One Port
17 . Industrial Petroleum Distributors
18 . US West Capitol Peak
19 . Unocal Service Station 0266
20 . Tumwater City N 5th & Bates
21 . Puget Power Eld Inlet Substation
22 . Olympia Dry Cleaners
23 . Boulevard Nursery
24 . Clarke Residence
25 . Franks Property
26 . Former Mervyns Westifeld Capital Mall
27 . Tumwater Falls Park Reclaimed Water Lines
28 . Former WSDOT Materials Testing Facility
29 . The Evergreen State College
30 . J & J Salvage Drums
31 . Faber & Sons Recycling Rochester
32 . Arrowood Subdivision Property
33 . Stacey Property
34 . Meridian Campus
35 . Chestnut Street ROW
36 . Pacific Pride Marvin Rd
37 . Tri Way Properties
38 . PSE ROW Lot 140 9101 Steilacoom Rd
39 . Port Of Olympia Texaco Bulk Storage Facility
40 . SR8, MP 18 Westbound Spill
41 . Kemp Property
42 . Steilacoom Ridge
43 . PSE Olympia Switching Substation
44 . LOTT Construction Project ROW Martin Way
45 . Vacant Property Rochester
46 . WA DFW Fishery Resource Management
47 . Lacey Gateway
48 . Peranzi Property
49 . WA State Dept Information Svcs Office Bldg
50 . Carlyon Beach Homeowners Assn Shop
51 . North Thurston Middle School #5
52 . WA Dept Of Fish & Wildlife Print Shop
53 . Old Sears Building
54 . Franklin Street Row
55 . WA Dept Of Fish & Wildlife Parking Lot
56 . 2040 Mottman Rd
57 . Capital City Studios
58 . Phoenix Inn
59 . Arco 4435
60 . Lacey Fuel
61 . Evergreen Sportsman Club
62 . WA DOT E I5 Milepost 87.5
63 . 1515 Division Nursery
64 . 318 State Ave NE Olympia
65 . Budd Inlet Sediment
66 . Taco Bell/Former Chevron 96801
67 . Haumann Property
68 . WA GA Olympia
69 . 8th & Capitol Investigation
70 . Gallagher Cove LLC
71 . 5th & Columbia St Parking Lot
72 . 7 Eleven Food Store 230325983H
73 . Gull Harbor Mercantile
74 . Diamond Parking/Chevron 9-0292
75 . East Bay Redevelopment
76 . Old Brewhouse Former Paint Shop
77 . WA DNR Triangle Pit
78 . PSE Blumauer Substation
79 . Buckeye Court Gasoline Spill
80 . Valentine Fyrst Property
81 . North Thurston School Dist Transp Dept
82 . 1203 Edison St NE
83 . City Of Olympia 4th & Sylvester Utility Corridor
84 . WA DNR Webster Nursery
85 . Eighth Avenue Park
86 . Lacey Market Square
87 . Handy Pantry
88 . WA Grange Parking Lot Chevron
89 . Jacks Auto Repair
90 . Zittle's Johnson Point
91 . Eastside Laundry/Allisons Norge Village
92 . WA DNR Marine Research Cntr
93 . Intercity Transit/Treasure Chest
94 . Low Ronts Wost Inc
95 . Howards Cleaners
96 . LOTT Wastewater Treatment Plant
97 . Tacoma Smelter Plume Thurston County
98 . Olympic Pipeline Co Olympia Station
99 . MJMG Group Llc
100 . Shell Oil Co Black Lake Blvd
101 . Port Of Olympia Warehouse 2
102 . City Of Olympia-Heritage Park
103 . Olympia City Sewer Pump Station
104 . Jackpot Station #371
105 . Olympia School District Bus Barn
106 . Shop Fast
107 . Briggs Nursery
108 . Littlerock Grocery
109 . Acme Fuel Bulk Plant 305
1'0 . Summit Lake BP
1'1 . Stop N Go
1'2 . Premier Auto Detail
1'3 . Performance Corner
1'4 . Intercity Transit
1'5 . 6110 Olympia Chevron
1'6 . Fast Fuel 1
1'7 . WA St CB&G Steamplant
1'8 . Circle K 5497/BP 01690
1'9 . Darigold Site Former
120 . Kens Tire
121 . Pearson Air Inc
122 . U S West Capital Peak Radio 070585
123 . Lacey Food Mart
124 . Palermo Wellfield
125 . Western Pacific Cleaners
126 . Secured Safe Storage
127 . Johns Auto Wrecking
128 . Evergreen Shores Grocery
129 . Northwest Pipeline GP Olympia M/S
130 . Olympia City Public Works 7th Ave
131 . Martin Way Shell
132 . PHO Olympia Restaurant Utility Pole
133 . Puget Power Olympia Serv Center
134 . McMahans Furniture
135 . Mos Mini Mart
136 . BMT Northwest AKA Reliable Steel
137 . Pit Stop Olympia
138 . Tenino Blumaer Substation
139 . Massoth Machine
140 . Tenino Corner Grocery
141 . Jackpot Station 372
142 . Tanglewilde Chevron
143 . Phil Wall & Sons Inc
144 . Great Western Soil
145 . Capital Plumbing And Heating
146 . 4th Ave Shell Texaco Station 120948
147 . Jack Wilmarth Triangle General Store
148 . Flintstone Fuel Inc
149 . Jiffy Lube 2071
150 . Olympia Fuel & Asphalt Inc Tumwater
151 . City Of Olympia-Miller Central
152 . US West Martin Way SOC
153 . Arnolds Texaco Service
154 . Columbia Square Properties
155 . West Bay Marina
156 . Solid Wood Inc
157 . Astro Western 617
158 . Old Tumwater City Hall/2nd Ave
159 . Union Oil Station

Downtown Olympia Inset

PROJECT SITE

Cities Urban Growth Are

0 Miles

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The boun
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, comple
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, includin
loss of profits, arising out of or in connection with the use of this map or data. Due to the
reliance of the information contained on this map, if any portion of this map or data
missing or altered, Thurston County removes itself from all responsibility from the map ar
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

Map Exported on 12/20/2025
PDP/Library/APPDE/Environmental Health/Water.apr/Hotspots(54x35)

Thurston County

Watersheds

- BLACK RIVER
- BUDD/DESCHUTES
- CHEHALIS RIVER
- ELD INLET
- HENDERSON INLET
- NISQUALLY RIVER
- SKOOKUMCHUCK RIVER
- TOTTEN INLET
- WEST CAPITOL FOREST

PROJECT SITE

Cities | Urban Growth Are

0

Miles

The information included on this map has been compiled by Thurston County staff from a v
of sources and is subject to change without notice. Additional elements may be present in
that are not represented on the map. Ortho-photos and other data may not align. The bound
depicted by these datasets are approximate. This document is not intended for use as a s
product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston C
makes no representations or warranties, express or implied, as to accuracy, complete
timeliness, or rights to the use of such information. In no event shall Thurston County be
for direct, indirect, incidental, consequential, special, or tort damages of any kind, including
not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misu
reliance of the information contained on this map. If any portion of this map or disclai
missing or altered, Thurston County removes itself from all responsibility from the map an
data contained within. The burden for determining fitness for use lies entirely with the use
the user is solely responsible for understanding the accuracy limitation of the inform
contained in this map.

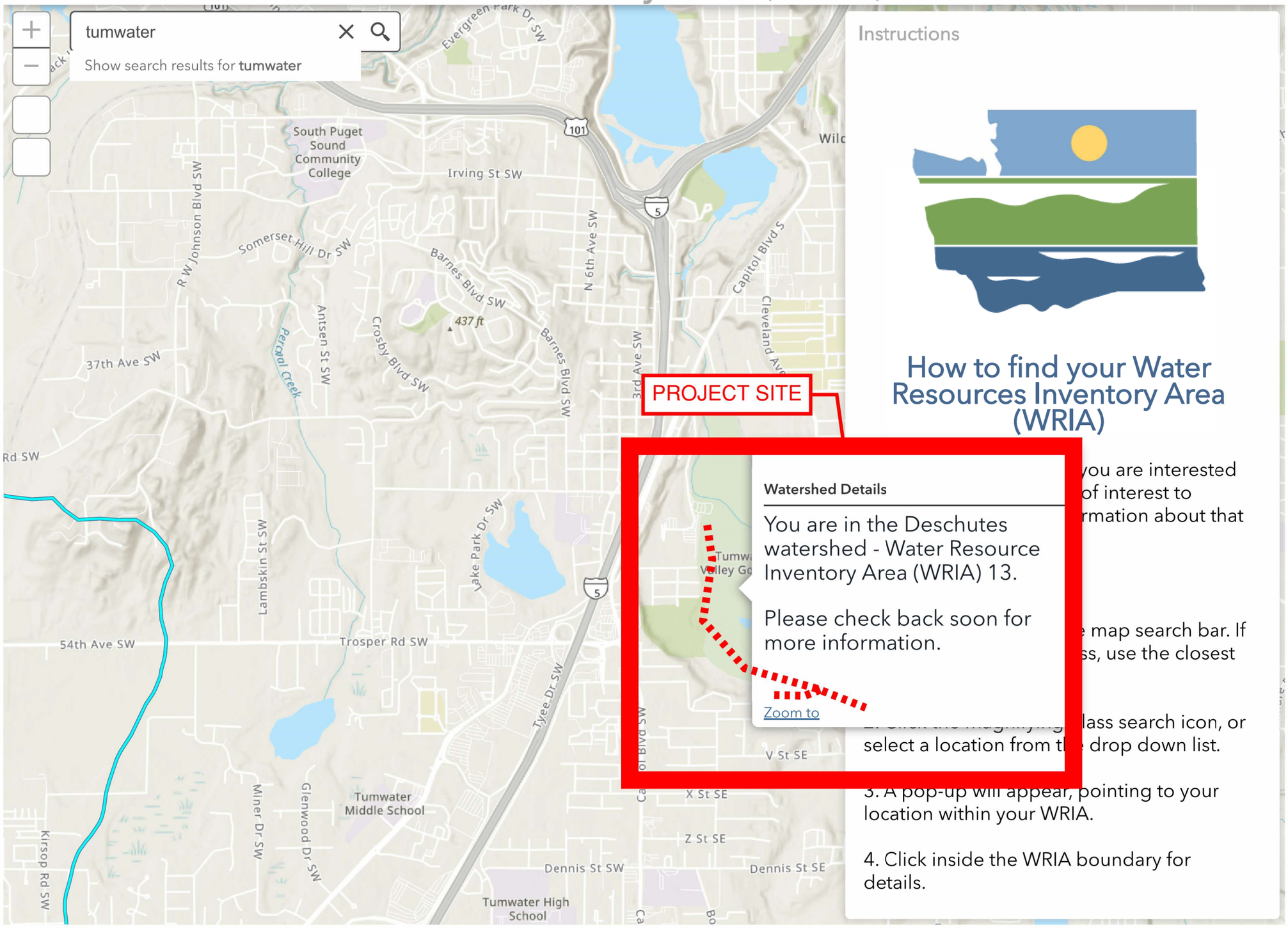
Updated on 11/14

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

Map Exported on 12/20/2025
PDF/Library/APRX\Planning\NaturalResources.aprx\Watersheds(54x36)

Find Your Water Resources Inventory Area (WRIA)



Thurston County

Wellhead Protection Areas

Public Water System ID	Water System Name	System Group Code	System Type
133	Cornerstone Estates 606	A	Comm
253	Cedarwood South Union Estates	A	Comm
346	Maple Valley	B	GRPB
519	Steamboat Square	A	NTNC
558	Deerfield Park	A	Comm
782	Haynes Acres Division 1	A	Comm
886	Giffords Inc	A	Comm
909	Tilley Maintenance Facility	A	NTNC
953	Nisqually Highlands 364	A	Comm
1252	Southworth Elementary	A	NTNC
1379	Township Place	A	Comm
1463	Aspinwall Estates	A	Comm
1826	Alpine Hills	A	Comm
1898	Woodard Place	A	Comm
2182	Ski-View Estates	A	Comm
2306	Cooper Point Estates	A	Comm
2348	Eagle Estates	A	Comm
2356	Prairie Ridge 605	A	Comm
2513	Mulford Estates	A	Comm
2819	CIQO	A	NTNC
2826	Olympic Structures	B	GRPB
2860	Koren Place	A	Comm
2906	North Olympia Fire District 7	B	GRPB
2938	Cedar Ridge Estate	A	Comm
2939	District 13 Headquarters Station	A	TNC
2952	Pacific Disposal	B	GRPB
3619	Los Cedros Mobile Home Park	A	Comm
3681	Deerfield Park 2	A	Comm
3901	Rainier Terrace	A	Comm
4020	New Life Christian Center	A	NTNC
4111	Lawyer Nursery Inc	A	NTNC
4308	Ar-bersen Water	A	Comm
4387	Pioneer	A	Comm
4397	Tanglewilde-Thompson Place 600	A	Comm
4459	Cooperfield	A	Comm
4601	East Olympia Community Water	A	Comm
4727	Steamboat Island Fuel	A	TNC
4863	Creekside Meadows Division Ii	A	Comm
4953	Cedar Shores	A	Comm
5277	Palermo	A	Comm
5290	Vineyard, The	A	Comm
5316	Prairie Vista	A	Comm
5329	Prine Villa Apts Burnsville	A	Comm
5640	Belwood Park	A	Comm
5704	Wayside Village	A	Comm
5721	Weyerhaeuser Forestry Nursery	A	NTNC
5831	Alpine Mobile Estates	A	Comm
5898	Heritage West	A	Comm
6200	Beverly Beach Homeowners	A	Comm
6705	Inlets End	A	Comm
7158	Grand Mound	A	Comm
7160	Biscay Duplexes	A	Comm
7164	Biscay Villa	B	GRPB
7167	Forest Park	A	Comm
7215	Tahoma Meadows	A	Comm
7222	Black Lake Bible Camp & Conf Ctr	A	Comm
7255	First Baptist Church Of Tenino	A	NTNC
7297	Briarwood Valley Farms	A	Comm
7344	Lathrop Industrial Park	A	NTNC
7486	Maxvale	B	GRPB
7850	Boston Harbor	A	Comm
8278	Phoenix Rising School	A	NTNC
8359	Henderson Boulevard	A	Comm
8393	Countrywood Estates	A	Comm
8740	Bronson Beach Club	A	Comm
9100	Bucoda Water Dept	A	Comm
9650	Burns Point	A	Comm
10050	Butler Cove Water Company	A	Comm
10808	Camelot And Western Skies	A	Comm
10991	Foxhall	A	Comm
11002	Castlewood Mobile Manor	A	Comm
11159	Carlyon Beach Homeowners	A	Comm
11278	Quail Run	A	Comm
11882	Cedar Creek Corrections Center	A	Comm
11975	Cedar Park	A	Comm
12100	Cedar Wood Association	A	Comm
13615	Clearwood	A	Comm
13923	Coach Post Mobile Park	A	Comm
14065	Colonial Manor	A	Comm
14185	Columbus Park	A	Comm
14730	Rainwood	A	Comm
14800	Cooper Point Water Co	A	Comm
15150	Cougar Mountain	A	Comm
15485	Country Lane Community Water Org	A	Comm
15502	Country Club Estates	A	Comm
15999	Crescent Park	A	Comm
16866	Maple Shores	A	Comm
17100	Cuyamaca Village	A	Comm
17241	Andrews First	A	Comm
17784	Dana Passage	A	Comm
18160	Parkwood Apartments	A	Comm
18643	Delphi Rd	A	Comm
18650	Delphi Daubel	B	GRPB
19035	Deschutes Village	A	Comm
20003	Driftwood Valley Assoc (Dva)	A	Comm
21253	Jones Industrial Park	A	NTNC
22572	Lake Lawrence	A	Comm
24006	Cougar Ridge	A	Comm
24163	Evergreen Shores	A	Comm
24413	Prairie Elementary	A	NTNC
25980	Olympia Forestry Sciences Lab	A	NTNC
26071	Black Lake Estates	A	Comm
26774	Prine Drive Apartments	A	Comm
27091	Cloister	B	GRPB
27900	Glen Alder And Improv	A	Comm
28392	Golden Oak	A	Comm
28551	Ranch Acre	A	Comm
28967	Grandview Valley Estates	A	Comm
29887	Griffin School	A	NTNC
30049	Crystal Springs	A	Comm
30190	Longhorn Country Estates	A	Comm
31845	Hawk Acres	A	Comm
33668	Holiday Acres	A	Comm
33677	Holiday Ranchettes	A	Comm
33678	Holiday Valley	A	Comm
34505	Horsfall Water Co	A	Comm
34650	Huckleberry Road Water Co	A	Comm
35092	Delphi Mobile Home Park	A	NTNC
36274	Israel Place San Angelo Park	A	Comm
36899	Marvin Gardens	A	Comm
36850	Johnson Point Hoa	A	Comm
38600	Kcuwa Meadows	A	Comm
43054	Valley View Mobile Home Park	A	Comm
43500	Lacey Water Department	A	Comm
43530	Shorewood	A	Comm
44052	Fairwind Mobile Home Park	A	Comm
44130	Lake Lawrence Mobile Home Park	A	Comm
44175	Lake Lucinda Community Club	A	Comm
44500	Lakeridge Water Co	A	Comm
45087	Lakeland Manor	A	Comm
45285	Lakeside Llc	A	Comm
46074	Cascades Camp And Conference Center	A	NTNC
46164	Loma Vista 369	A	Comm
46275	Laurel Park Community Llc	A	Comm
46441	Lazy Acres 351	A	Comm
46737	Lenets Mobile Estates	A	Comm
47124	Libby Road East	A	Comm
49900	Madrona Beach Water Co Inc	A	Comm
50994	Manzanita Beach	A	Comm
51195	Maple Lane Corrections Center	A	Comm
51875	Martin Way Mobile Home Park	A	Comm
53475	Melody Pines Mobile Home Estates	A	Comm
53780	Meridian Heights Water District	A	Comm
57400	Mud Bay	A	Comm
57851	Smith Prairie 251	A	Comm
57864	Rochester High School	A	NTNC
59591	Nisqually Pines Community Club	A	Comm
59595	Nisqually Sportsmens Club	A	Comm
59876	Mobbs Water	A	NTNC
60490	Lacey 6119 Street 225	A	Comm
60846	Black Lake Acres	A	Comm
60850	North Offut Lake Wtr Service	A	Comm
61131	Zebras Aqueous Substance	A	NTNC
63130	Offut Lake Resort	A	TNC
63381	Evergreen Shores	A	Comm
63450	Olympia, City Of	A	Comm
63500	Olympic View	A	Comm
63695	Lovely Lane Homeowners	A	Comm
64810	Oslrons Mushroom Farms	A	NTNC
65153	Floating Bear	A	NTNC
66573	Patterson Lake Water	A	Comm
66578	Pattison	A	Comm
66734	Pederson Place #604	A	Comm
69166	Prairie Villa 230	A	Comm
69168	Kings Meadow Mobile Home Park	A	Comm
70950	Rainier View Park Addition	A	Comm
70980	Rainier Water Department	A	Comm
71610	Red Cedar Estates	A	Comm
72267	Richmond Totten	A	Comm
72414	Ridgewood	A	Comm
72776	River Park	A	Comm
72817	Riverlea	A	Comm
73240	Carriage Club Estates	A	Comm
73300	Rochester	A	Comm
73975	Rolling Firs Evergreen Terrace	A	Comm
75616	Salt Aire Mobile Terrace Llc	A	Comm
76530	Scenic Shores Water Company	A	Comm
76787	Scott Lake	A	Comm
76998	Seashore Villa	A	Comm
77670	Sexton	A	Comm
77897	Shattuck 1	B	GRPB
79423	Single Tree Estates	A	Comm
79835	Skookumchuck Mobile Manor	A	Comm
79860	Skookumchuck Maintenance	A	Comm
81465	South Bay Elementary School	A	NTNC
81475	South Bay Terraces Water Company	A	Comm
83900	Steamboat Island Inc	A	Comm
84074	Deep Denny	A	NTNC
84898	Summerhill	A	Comm
84907	Summerset Meridian	A	Comm
86304	Sunwood Lakes Homeowners Assoc Inc	A	Comm
87122	Tall Firs Mobile Home Park	A	Comm
87140	Tamoshan	A	Comm
87155	Tanglewood Mobile Home Park	A	Comm
87375	Tempo Lake Water Co	A	Comm
87400	Tenino, City Of	A	Comm
87784	Meadows Llc	A	Comm
88383	Timberlane Mobile Estates	A	Comm
88570	Todt Cedars Water Assoc	B	GRPB
88665	Tolmie Cove	A	Comm
88667	Tolmie Park 239	A	Comm
89425	Tojie G Lakeview Estates	A	Comm
89700	Tumwater, City Of	A	Comm
91930	Valley By The Sea	A	Comm
93085	Washington Land Yacht Harbor	A	Comm
95057	Western Airpark	A	Comm
95610	Weyerhaeuser Vail Shop	B	GRPB
96850	Wildaire Estates	A	Comm
97450	Windolph	A	Comm
97520	Winwood	A	Comm
99350	Yelm, City Of	A	Comm
AA775	Rochester Mennonite Church	A	NTNC
AA776	Red Tail Hawk Estates	A	Comm
AA916	Scatter Creek Ranch	A	Comm
AB023	Lackamas Elementary School	A	NTNC
AB037	Hawley Hills	A	Comm
AB072	Senk System	A	Comm
AC014	Valley Nut & Bolt	A	NTNC
AC512	Thurston County Eoc	B	GRPB

Wellhead Protection Area Well

Wellhead Protection Areas Time of Travel

- 6 Month
- 1 Year
- 2 Year
- 3 Year
- 5 Year
- 10 Year

Cities **Urban Growth Areas**

0 5 Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tot damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness 'or use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY

NORTH

PROJECT SITE

89700

08359

27091

Map Exported on 12/20/2025
PDFLibrary/APRXExports/environmentalHealthWater.aprx\WellHeads(54x36)

Thurston County

Wetlands & 300 Foot Wetland Buffer

Wetlands

300 Foot Wetlands Buffer

PROJECT SITE

Cities **Urban Growth Areas**

0 5

Miles

The information included on this map has been compiled by Thurston County staff from a variety of sources and is subject to change without notice. Additional elements may be present in reality that are not represented on the map. Ortho-photos and other data may not align. The boundaries depicted by these datasets are approximate. This document is not intended for use as a survey product.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. Thurston County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. In no event shall Thurston County be liable for direct, indirect, incidental, consequential, special, or tort damages of any kind, including, but not limited to, lost revenues or lost profits, real or anticipated, resulting from the use, misuse or reliance of the information contained on this map. If any portion of this map or disclaimer is missing or altered, Thurston County removes itself from all responsibility from the map and the data contained within. The burden for determining fitness for use lies entirely with the user and the user is solely responsible for understanding the accuracy limitation of the information contained in this map.

Updated on 11/14/2025

Authorized for 3rd Party reproduction for personal use only.

THURSTON COUNTY GEODATA CENTER

NORTH

Map Exported on 12/20/2025
PDFLibrary/APRX/Planning/CriticalAreas.aprx\Wetland(54x35)

February 27, 2026

Water Quality Atlas Map



WQ Improvement Projects

- TMDL - Approved
- 4B - Approved
- STI - Approved
- ARP - Approved
- TMDL - In Development
- STI - In Development
- ARP - In Development

Miles
0 0.1 0.2 0.4

Esri Community Maps Contributors, City of Olympia, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA,

https://apps.ecology.wa.gov/waterqualityatlas/wqa/map

Deschutes River, Percival Creek, & Budd Inlet tributaries

Parts of the Deschutes River and its tributary creeks do not meet state clean water standards. To return these waters to a healthy condition, we are working with local governments and other groups to implement a total maximum daily load (TMDL) project.

Water quality issues

The Deschutes River is under pressure from growth, resulting in many small, uncontrolled sources of pollution that enter the river. Local city, county, and state government agencies monitor and protect water quality. In the Deschutes, water quality monitoring revealed that levels of pH, dissolved oxygen, temperature, fine sediment, and fecal coliform did not meet state standards. We began the TMDL process to address these problems.

What is being done

With the help of an advisory group of affected stakeholders, special interest groups, and interested residents, we developed a TMDL plan to solve the river's pollution problems. The Deschutes River, Percival Creek, and Budd Inlet Tributaries Water Quality Improvement Plan (also known as a TMDL) assigns the amount of pollution the water bodies can receive and still meet water quality standards. Any additional amount needs to be eliminated to achieve clean water.

This plan provides a framework for how stakeholders will track, monitor, and implement the water cleanup plan. It outlines what is needed, establishes a schedule, and guides corrective actions with adaptive management practices.

We gathered public comments on the draft plan in 2015. We held two public meetings to provide a broad overview of the project and findings. In 2018, EPA approved some elements of the TMDL plan and disapproved others. See our 2018 Letter to Stakeholders for details.

On August 10, 2020, EPA finalized the replacement of the TMDL elements that were disapproved. They were open for public comment until October 7, 2020 and can be found on EPA's Deschutes River TMDLs web page.

We are also continuing to work with the Department of Enterprise Services on the Deschutes Estuary Restoration Project, which will clean and restore Capitol Lake by returning the Deschutes Estuary to a tidal salt marsh habitat.

Why this matters

Water must be of high quality to support fish and wildlife.

Dissolved oxygen — oxygen dissolved in healthy water — is vital for the survival of fish and aquatic life. It is more difficult to transfer oxygen from water to blood than it is to transfer oxygen from air to blood. Therefore, it is critical that an adequate amount of oxygen is maintained in the water for this transfer to take place efficiently and sustain aquatic life. Oxygen is also necessary to help decompose organic matter in the water and bottom sediments as well as for other biological and chemical processes.

Fecal coliform is a type of bacteria common in human and animal waste. It can make people sick and cause the closure of shellfish harvesting beds. Bacteria can get into waters from untreated or partially treated discharges from wastewater treatment plants, from improperly functioning septic systems, and from livestock, pets, and wildlife.

People can help keep bacteria out of the water. Properly collect, bag, and trash dog poop. Check your on-site sewage system to make sure it is maintained and working properly. Use proper storage, management, and disposal practices for livestock manure.

pH is a measure of the acidity or alkalinity of the water. pH can affect the solubility of nutrients and metal compounds. By affecting the solubility of nutrients, it can change the amount of nutrients available for plant growth. If too many nutrients are available, aquatic plants can grow out of control. When these plants decompose, they can deplete the water of oxygen. The solubility of many metal compounds also changes greatly with pH. When more metals are dissolved in the water, aquatic animals may absorb them faster. Therefore, a lower pH may make these metals more toxic to aquatic life.

Water temperature influences what types of organisms can live in a water body. Cooler water holds more dissolved oxygen that fish and other aquatic life need to breathe. Warmer water holds less dissolved oxygen. Threatened and endangered salmon need cold, clean water to survive. Removing streamside vegetation tends to raise water temperature to a level that may be harmful to fish, other aquatic animals, and insects.

Finally, too much **sediment** in the water can irritate fish gills and make it difficult for them to breathe.

DEPARTMENT OF ECOLOGY State of Washington http://www.ecy.wa.gov

Publication Summary

Our Ecology website has changed, which can cause broken links.
To report these, please *contact us* with the publication and broken link.

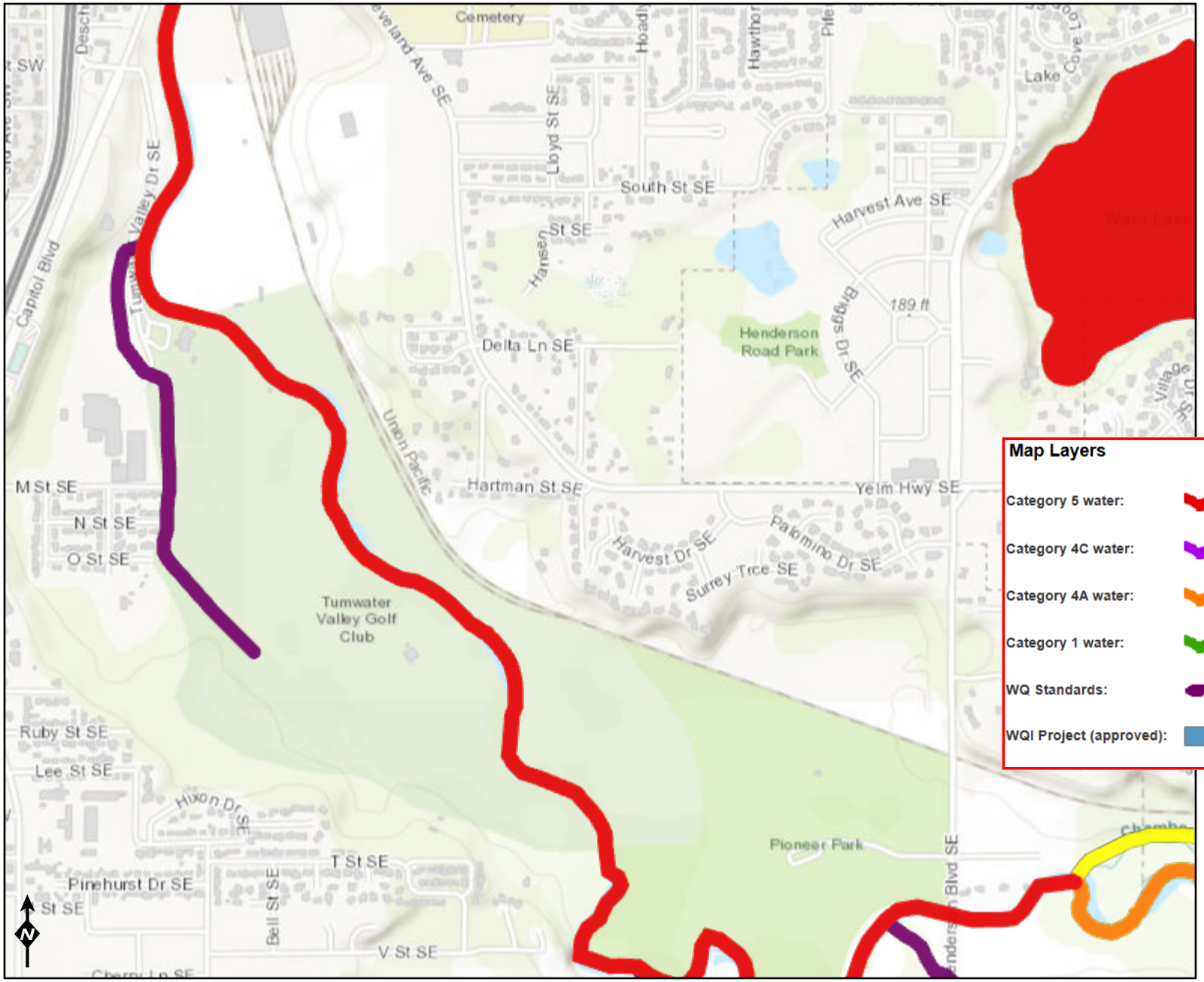
TITLE	**Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL: Water Quality Improvement Report and Implementation Plan**
	Publication number: 15-10-012 | Date Published: April 2015 | Date Revised: July 2018
VIEW NOW	Deschutes River, Percival Creek, and Budd Inlet Tributaries Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment TMDL: Water Quality Improvement Report and Implementation Plan (Number of pages: 335) (Publication Size: 14292KB) Trouble viewing? Try these free options. • Get the latest Adobe Reader for PDFs. • For Excel or Word viewing get Open Office, Microsoft OneDrive, DropBox Basic or a mobile app at your favorite app store.
AUTHOR(S)	Wagner, Lydia, Bilhimer, Dustin
DESCRIPTION	Portions of the Deschutes River, Percival Creek, and Budd Inlet tributaries do not meet water quality standards and are on the Clean Water Act Section 303(d) list for one or more of the following parameters: fecal coliform bacteria, temperature, dissolved oxygen (DO), pH, or fine sediment. This Total Maximum Daily Load (TMDL) report sets the load and wasteload reductions needed to meet Washington State water quality standards, and describes implementation actions to achieve those reductions.
REQUEST A COPY	The mission of the Department of Ecology is to protect, preserve, and enhance Washington's environment. To help us meet that goal, please consider the environment before you print or request a copy. **ADA Accessibility** The Department of Ecology is committed to providing people with disabilities access to information and services by meeting or exceeding the requirements of the Americans with Disabilities Act (ADA), Section 504 and 508 of the Rehabilitation Act, and Washington State Policy #188. Visit Ecology's website for more information.

	• Water Quality Order Form
CONTACT	Leanne Weiss at 360-407-0243 or leanne.weiss@ecy.wa.gov
KEYWORDS	water quality improvement plan, Deschutes River, water cleanup plan, Total Maximum Daily Load
WEB PAGE	Deschutes River watershed area: Budd Inlet
WATERSHED	Water Resource Inventory Area 13 Deschutes
DATA	Environmental Information Management (EIM) #MROB0001
RELATED PUBLICATIONS	Title: Budd Inlet Total Maximum Daily Load for Dissolved Oxygen Deschutes River, Capitol Lake, and Budd Inlet Total Maximum Daily Load Study: Supplemental Modeling Scenarios Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Technical Report: Water Quality Study Findings Assessment of Surface Water / Groundwater Interactions and Associated Nutrient Fluxes in the Deschutes River and Percival Creek Watersheds, Thurston County Quality Assurance Project Plan: Deschutes River, Capitol Lake, and Budd Inlet Temperature, Fecal Coliform Bacteria, Dissolved Oxygen, pH, and Fine Sediment Total Maximum Daily Load Study

Copyright © Washington State Department of Ecology. See https://ecology.wa.gov/About-us/Accountability-transparency/Our-website/Copyright-information.

February 27, 2026

Water Quality Atlas Map



Assessed Water/Sediment

Water
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Sediment
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Water Quality Standards

- All Standards

Map Layers

Category 5 water:	2 listings found
Category 4C water:	1 listing found
Category 4A water:	2 listings found
Category 1 water:	9 listings found
WQ Standards:	1 water quality standard found
WQI Project (approved):	Deschutes River, Percival Creek, and Budd Inlet Tributaries TMDL

Miles
0 0.1 0.2 0.4

Esri Community Maps Contributors, City of Olympia, WA State Parks GIS, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA,

https://apps.ecology.wa.gov/waterqualityatlas/wqa/map

Assessed Water/Sediment

Water

Category 5 - 303d

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 16722

Main Listing Information

Listing ID: 16722

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Bacteria - Fecal coliform

WQI Project: None

Designated Use: Recreation - Primary Contact

Current Category: 5

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value	Criterion 2	Aggregate 2	Calculated Value 2
2016	1	14	200 #col/100ml	Highest daily average	280	100 #col/100ml	Three-month geometric mean	137

Assessed Water/Sediment

Water

Category 5 - 303d

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 70194

Main Listing Information

Listing ID: 70194

Waterbody Name: DESCHUTES RIVER

Medium: Other

Parameter: Benthic Macroinvertebrates Bioassessments

WQI Project: None

Designated Use: Aquatic Life - General

Current Category: 5

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

sessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value	Fine Sediment Biotic Index Score	FSB Threshold	Hilsenhoff Biotic Index Score	HBI Threshold	Metals Tolerance Index Score	MTI Threshold
2012; 2015	3	3	65 (Puget Lowland)	Average BIBI score	56.7	46.2	89	4.84	>5.5	2.8	>4.0

Assessed Water/Sediment

Water

Category 4C

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 6195

Main Listing Information

Listing ID: 6195

Waterbody Name: DESCHUTES RIVER

Medium: Habitat

Parameter: Instream Flow

WQI Project: None

Designated Use: Aquatic Life - General

Current Category: 4C

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

See Basis Statement field.

Basis Statement

USGS flow data collected at RM 3.4 between 1990 and 1995 (submitted by Jeff Dickison on 2/27/96) are consistently below minimum flows established in WAC 173-513-030.

USGS and Thurston County flow data (submitted by Jeff Dickison on 2/27/96) show intensified peak flows likely due to silvicultural activities in the upper watershed (Thurston County, 1995).

The following references document characteristic uses: Squaxin Island Tribal data (submitted by Jeff Dickison on 2/27/96) show numbers of Coho salmon stock.

Baranski, 1996 SASSI Update shows that Coho are reclassified to depressed.

Remarks

This listing was on the 1998 303(d) list, but has been moved to the new Category 4C (impaired by a non-pollutant) based on EPA Guidance for preparing the 2004 Integrated Report.

Assessed Water/Sediment

Water

Category 4A

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 6576

Main Listing Information

Listing ID: 6576

Current Category: 4A

Waterbody Name: DESCHUTES RIVER

View Category History

Medium: Water

Parameter: Temperature

WQI Project: Deschutes River, Percival Creek and Budd Inlet Tributaries Multi-parameter TMDL

Designated Use: Aquatic Life - Salmonid Spawning, Rearing, and Migration

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

County: Thurston

Size: 4.855 Kilometers

WRIA: Deschutes

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	11	361	17.5 deg C	7-DADMax	19.71

Basis Statement

Location ID: 13A060 -- In 2010, between 1/1/2010 and 9/22/2010, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 26 of 265 days (10%); The maximum exceedance during this period was 18.74°C for the 7-day period centered on 8/15/2010; (External Data Source: Thurston County Health Database)

Location ID: 13A060 -- In 2009, between 10/10/2009 and 12/31/2009, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 0 of 83 days (0%); (External Data Source: Thurston County Health Database)

Location ID: 13A060 -- In 2008, between 7/14/2008 and 9/30/2008, the 7-day mean of daily maximum values (7DADmax) exceeded the criterion for this waterbody (17.5°C) on 14 of 79 days (18%); The maximum exceedance during this period was 18.46°C for the 7-day period centered on 8/15/2008; (External Data Source: Thurston County Health Database)

Assessed Water/Sediment

Water

Category 4A

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 10894

Main Listing Information

Listing ID: 10894

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Dissolved Oxygen

WQI Project: Deschutes River, Percival Creek and Budd Inlet Tributaries Multi-parameter TMDL

Designated Use: Aquatic Life - Salmonid Spawning, Rearing, and Migration

Current Category: 4A

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	12	8.0 mg/L	Daily Minimum	9.8

Basis Statement

HISTORICAL INFORMATION

Location ID [13A060] -- In 2005, 12 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-00.5] -- In 2004, 4 of 39 samples (10.3%) showed an excursion of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-02.7] -- In 2004, 24 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Location ID [13-DES-00.5] -- In 2003, 9 samples showed no excursions of the criterion for this waterbody, (criterion = 8.0 mg/L).

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 10893

Main Listing Information

Listing ID: 10893

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Ammonia-N

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2016	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2015	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2014	0	9	Calculated	Toxic aquatic 4-day mean exceedance factor	
2013	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2012	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2011	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	
2010	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2009	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2008	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2007	0	12	Calculated	Toxic aquatic 4-day mean exceedance factor	
2006	0	11	Calculated	Toxic aquatic 4-day mean exceedance factor	

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 53217

Main Listing Information

Listing ID: 53217

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Arsenic

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	190 ug/L	Toxic aquatic 4-day average	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 75944

Main Listing Information

Listing ID: 75944

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Silver

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 1-day exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute criterion.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 76380

Main Listing Information

Listing ID: 76380

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Lead

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 76689

Main Listing Information

Listing ID: 76689

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Chromium

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78277

Main Listing Information

Listing ID: 78277

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Copper

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060], [SRIW1301] -- In 2002, 5 of 5 sample event(s) did not exceed Washingtons Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment
Water
Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78486

Main Listing Information

Listing ID: 78486
Waterbody Name: DESCHUTES RIVER
Medium: Water
Parameter: Zinc
WQI Project: None
Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001
Size: 4.855 Kilometers
Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston
WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060], [SRIW1301] -- In 2002, 5 of 5 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 78873

Main Listing Information

Listing ID: 78873

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Nickel

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Assessed Water/Sediment

Water

Category 1

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment 303(d)/305(b) List

Approved WQ Assessment | Candidate List | Contact Us | WQ Atlas

Back To Results

Water Quality Listing Policy

Listing ID: 79301

Main Listing Information

Listing ID: 79301

Waterbody Name: DESCHUTES RIVER

Medium: Water

Parameter: Cadmium

WQI Project: None

Designated Use: Aquatic Life - Toxics

Current Category: 1

View Category History

Assessment Unit

Assessment Unit ID: 17110016000007_001_001

Size: 4.855 Kilometers

Associated Components(s): Reach: 17110016000007 0% - 100%, Type: Rivers/Streams

County: Thurston

WRIA: Deschutes

Basis Table

Assessment Year

2018

Sampling Year	Excursion Count	Sample Count	Criterion/Threshold	Aggregate	Calculated Value
2017	0	4	Calculated	Toxic aquatic 4-day mean exceedence factor	

Basis Statement

HISTORICAL INFORMATION

Location ID(s) [13A060] -- In 2005, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2004, 6 of 6 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2003, 2 of 2 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

Location ID(s) [13A060] -- In 2002, 4 of 4 sample event(s) did not exceed Washington's Aquatic Life Acute and Chronic criteria.

DEPARTMENT OF ECOLOGY State of Washington

Water Quality Atlas Standards

Home

Water Quality Standards for Surface Waters of the State of Washington

Disclaimer: The Department of Ecology continues to improve the mapped depiction of the Surface Water Quality Standards. However, the map may contain errors and the information displayed does not replace the official rules available in Chapter 173-201A of the Washington Administrative Code.

USE DESIGNATIONS

WAC:	173-201A-600 (1)
Description:	All surface waters of the state not named in Table 602 are to be protected for the designated uses of: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.
Aquatic life use:	Salmonid spawning, rearing, and migration
Recreation use:	Primary contact recreation
Water supply uses:	Domestic, Industrial, Agricultural, Stock
Miscellaneous uses:	Wildlife Habitat, Harvesting, Commerce and Navigation, Boating, Aesthetics

CRITERION

Brackish Water Exceptions: None

Temperature: 17.5°C (63.5°F)

Supplemental spawning: None

Dissolved Oxygen (DO): 8.0 mg/L

pH: pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.5 units

Turbidity: 5 NTU over background when the background is 50 NTU or less; or

A 10 percent increase in turbidity when the background turbidity is more than 50 NTU

Bacteria: E. coli and fecal coliform criteria are expressed as colony forming units (CFU) or most probable number (MPN).

To protect recreational use:

- E.coli organism levels must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples(or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 320 CFU or MPN per 100 mL.
- Fecal coliform organism levels must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples(or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 CFU or MPN per 100 mL. (The use of fecal coliform organism levels to determine compliance will expire December 31, 2020.)

Other requirements:

- A minimum of three samples is required to calculate a geometric mean for comparison to the geometric mean criteria. Sample collection dates shall be well distributed throughout the averaging period so as not to mask noncompliance periods.
- When averaging bacteria sample values for comparison to the geometric mean criteria, it is preferable to average by season. The averaging period of bacteria sample data shall be ninety days or less.

Appendix C
Soil Information

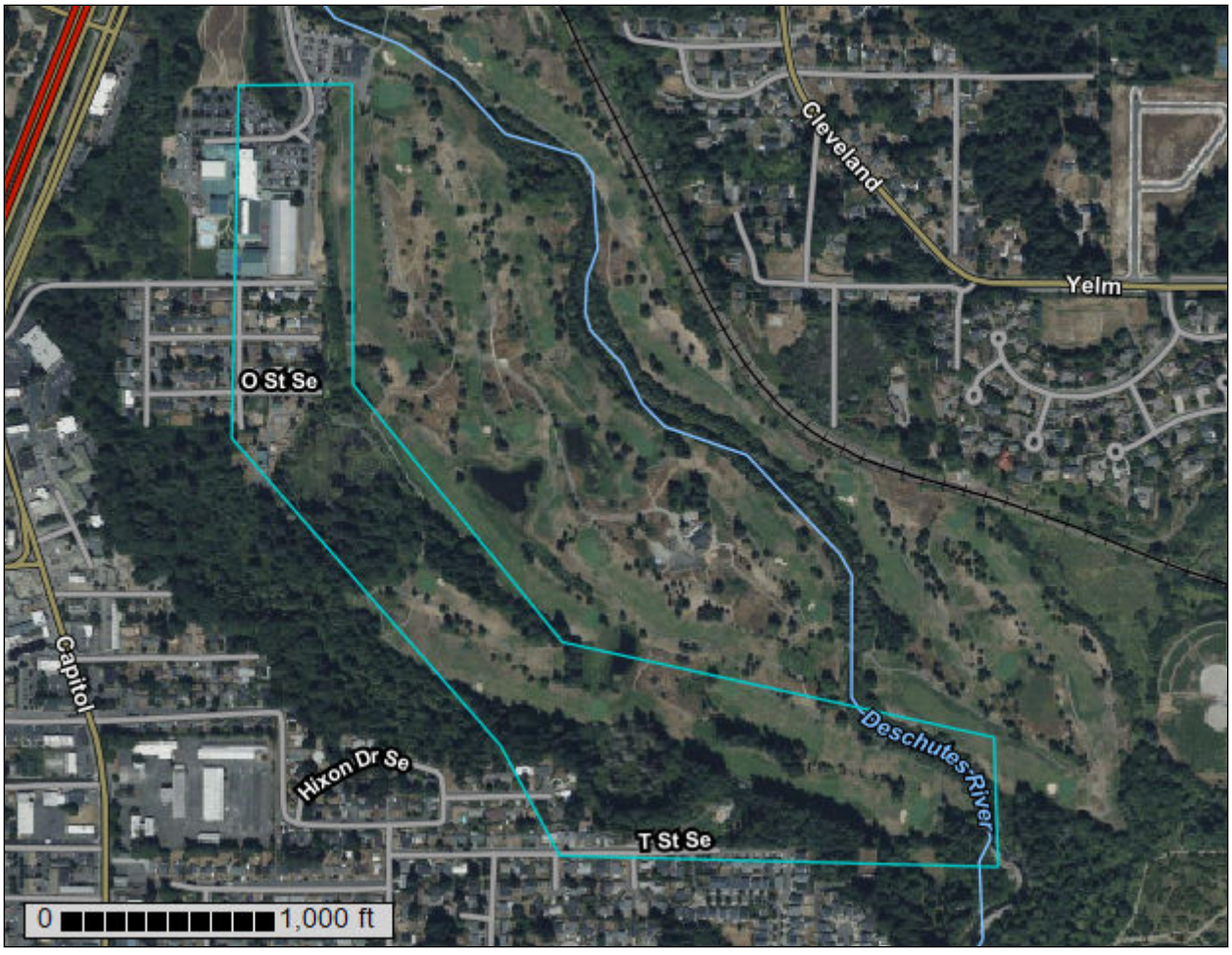
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Thurston County Area, Washington



December 26, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Thurston County Area, Washington.....13
20—Cagey loamy sand.....13
33—Everett very gravelly sandy loam, 8 to 15 percent slopes.....14
46—Indianola loamy sand, 0 to 5 percent slopes.....15
48—Indianola loamy sand, 15 to 30 percent slopes.....17
76—Norma silt loam.....18
89—Puyallup silt loam.....19
125—Xerorthents, 0 to 5 percent slopes.....21
129—Water.....21
References.....23

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Custom Soil Resource Report
Soil Map



Map Scale: 1:8,480 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Thurston County Area, Washington
Survey Area Data: Version 19, Aug 28, 2025

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

Date(s) aerial images were photographed: May 26, 2023—Aug 14, 2023

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
20	Cagey loamy sand	1.8	2.2%
33	Everett very gravelly sandy loam, 8 to 15 percent slopes	7.0	8.5%
46	Indianola loamy sand, 0 to 5 percent slopes	8.3	10.0%
48	Indianola loamy sand, 15 to 30 percent slopes	4.9	5.9%
76	Norma silt loam	25.5	30.9%
89	Puyallup silt loam	14.0	16.9%
125	Xerorthents, 0 to 5 percent slopes	17.4	21.0%
129	Water	3.8	4.6%
Totals for Area of Interest		**82.6**	**100.0%**

Map Unit Descriptions

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

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

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

mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

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

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

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

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

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

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

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

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

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

Thurston County Area, Washington

20—Cagey loamy sand

Map Unit Setting

National map unit symbol: 2nd8d
Elevation: 330 to 980 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 165 to 195 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Cagey

Setting

Landform: Terraces
Parent material: Sandy glacial drift

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 28 inches: loamy sand
H3 - 28 to 60 inches: fine sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A
Ecological site: F002XA005WA - Puget Lowlands Moist Forest
Forage suitability group: Seasonally Wet Soils (G002XS201WA)
Other vegetative classification: Seasonally Wet Soils (G002XS201WA)
Hydric soil rating: No

Minor Components

Mckenna

Percent of map unit: 5 percent
Landform: Depressions
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

33—Everett very gravelly sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t62b
Elevation: 30 to 900 feet
Mean annual precipitation: 35 to 91 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 180 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Everett and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Everett

Setting

Landform: Moraines, eskers, kames
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Base slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly glacial outwash

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: very gravelly sandy loam
Bw - 3 to 24 inches: very gravelly sandy loam
C1 - 24 to 35 inches: very gravelly loamy sand
C2 - 35 to 60 inches: extremely cobbly coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F002XA004WA - Puget Lowlands Forest
Forage suitability group: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XF403WA)

Other vegetative classification: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XF403WA)
Hydric soil rating: No

Minor Components

Alderwood
Percent of map unit: 10 percent
Landform: Hills, ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope, talf
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Indianola
Percent of map unit: 10 percent
Landform: Terraces, kames, eskers
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

46—Indianola loamy sand, 0 to 5 percent slopes

Map Unit Setting
National map unit symbol: 2t62k
Elevation: 0 to 980 feet
Mean annual precipitation: 30 to 81 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Indianola and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Indianola

Setting
Landform: Kames, terraces, eskers
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glacial outwash

Typical profile
Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: loamy sand
Bw1 - 6 to 17 inches: loamy sand

Bw2 - 17 to 27 inches: sand
BC - 27 to 37 inches: sand
C - 37 to 60 inches: sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F002XA004WA - Puget Lowlands Forest
Forage suitability group: Droughty Soils (G002XF403WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XS401WA), Droughty Soils (G002XV402WA)
Other vegetative classification: Droughty Soils (G002XF403WA), Droughty Soils (G002XN402WA), Droughty Soils (G002XS401WA), Droughty Soils (G002XV402WA)
Hydric soil rating: No

Minor Components

Alderwood

Percent of map unit: 5 percent
Landform: Ridges, hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest, talf
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Everett

Percent of map unit: 5 percent
Landform: Eskers, moraines, kames
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

48—Indianola loamy sand, 15 to 30 percent slopes

Map Unit Setting

National map unit symbol: 2t639
Elevation: 0 to 980 feet
Mean annual precipitation: 30 to 81 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Indianola and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Indianola

Setting

Landform: Terraces, kames, eskers
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy glacial outwash

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: loamy sand
Bw1 - 6 to 17 inches: loamy sand
Bw2 - 17 to 27 inches: sand
BC - 27 to 37 inches: sand
C - 37 to 60 inches: sand

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: F002XA004WA - Puget Lowlands Forest

Forage suitability group: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA)
Other vegetative classification: Droughty Soils (G002XS401WA), Droughty Soils (G002XN402WA)
Hydric soil rating: No

Minor Components

Alderwood
Percent of map unit: 8 percent
Landform: Hills, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope, side slope, talf
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Everett
Percent of map unit: 5 percent
Landform: Moraines, eskers, kames
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma
Percent of map unit: 2 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

76—Norma silt loam

Map Unit Setting
National map unit symbol: 2ndcc
Elevation: 0 to 1,000 feet
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Norma, silt loam, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Norma, Silt Loam

Setting

Landform: Depressions, drainageways
Parent material: Alluvium

Typical profile

H1 - 0 to 8 inches: silt loam
H2 - 8 to 30 inches: sandy loam
H3 - 30 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F002XA007WA - Puget Lowlands Wet Hemlock Forest
Forage suitability group: Wet Soils (G002XS101WA)
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

Minor Components

Norma, fine sandy loam

Percent of map unit: 5 percent
Landform: Depressions
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

Alderwood

Percent of map unit: 5 percent
Hydric soil rating: No

89—Puyallup silt loam

Map Unit Setting

National map unit symbol: 2nd9z
Elevation: 70 to 1,970 feet
Mean annual precipitation: 35 to 60 inches
Mean annual air temperature: 50 degrees F
Frost-free period: 170 to 200 days

Farmland classification: All areas are prime farmland

Map Unit Composition

Puyallup and similar soils: 85 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Puyallup

Setting

Landform: Terraces, flood plains
Parent material: Alluvium

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 19 inches: fine sandy loam
H3 - 19 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 14 to 20 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: B
Ecological site: F002XA008WA - Puget Lowlands Riparian Forest
Forage suitability group: Droughty Soils (G002XS401WA)
Other vegetative classification: Droughty Soils (G002XS401WA)
Hydric soil rating: No

Minor Components

Newberg

Percent of map unit: 5 percent
Hydric soil rating: No

Semiahmoo, undrained

Percent of map unit: 3 percent
Landform: Depressions
Other vegetative classification: Wet Soils (G002XS101WA)
Hydric soil rating: Yes

Sultan

Percent of map unit: 2 percent
Hydric soil rating: No

125—Xerorthents, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2nd87
Elevation: 0 to 2,620 feet
Mean annual precipitation: 30 to 60 inches
Mean annual air temperature: 39 to 50 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Xerorthents and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Xerorthents

Setting

Landform: Tidal flats
Parent material: Sandy and loamy cut and fill material

Typical profile

H1 - 0 to 60 inches: variable

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Depth to water table: About 24 inches
Frequency of flooding: None
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydric soil rating: No

129—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Setting

Landform: Alluvial cones

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Appendix D
Site Log Book

Construction Stormwater Site Inspection Form

Project Name _____ Permit # _____ Inspection Date _____ Time _____

Name of Certified Erosion Sediment Control Lead (CESCL) or qualified inspector if *less than one acre*
Print Name: _____

Approximate rainfall amount since the last inspection (in inches): _____

Approximate rainfall amount in the last 24 hours (in inches): _____

Current Weather Clear ☐ Cloudy ☐ Mist ☐ Rain ☐ Wind ☐ Fog ☐

A. Type of inspection: Weekly ☐ Post Storm Event ☐ Other ☐

B. Phase of Active Construction (*check all that apply*):

Pre Construction/installation of erosion/sediment controls	☐	Clearing/Demo/Grading	☐	Infrastructure/storm/roads	☐
Concrete pours	☐	Vertical Construction/buildings	☐	Utilities	☐
Offsite improvements	☐	Site temporary stabilized	☐	Final stabilization	☐

C. Questions:

1. Were all areas of construction and discharge points inspected? Yes ___ No ___
2. Did you observe the presence of suspended sediment, turbidity, discoloration, or oil sheen Yes ___ No ___
3. Was a water quality sample taken during inspection? (*refer to permit conditions S4 & S5*) Yes ___ No ___
4. Was there a turbid discharge 250 NTU or greater, or Transparency 6 cm or less?* Yes ___ No ___
5. If yes to #4 was it reported to Ecology? Yes ___ No ___
6. Is pH sampling required? pH range required is 6.5 to 8.5. Yes ___ No ___

If answering yes to a discharge, describe the event. Include when, where, and why it happened; what action was taken, and when.

_____

_____

_____

_____

*If answering yes to # 4 record NTU/Transparency with continual sampling daily until turbidity is 25 NTU or less/ transparency is 33 cm or greater.

Sampling Results: Date: _____

Parameter	Method (circle one)	Result			Other/Note
		NTU	cm	pH	
Turbidity	tube, meter, laboratory				
pH	Paper, kit, meter				

Construction Stormwater Site Inspection Form

D. Check the observed status of all items. Provide "Action Required "details and dates.

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
1 Clearing Limits	Before beginning land disturbing activities are all clearing limits, natural resource areas (streams, wetlands, buffers, trees) protected with barriers or similar BMPs? (high visibility recommended)						
2 Construction Access	Construction access is stabilized with quarry spalls or equivalent BMP to prevent sediment from being tracked onto roads?						
	Sediment tracked onto the road way was cleaned thoroughly at the end of the day or more frequent as necessary.						
3 Control Flow Rates	Are flow control measures installed to control stormwater volumes and velocity during construction and do they protect downstream properties and waterways from erosion?						
	If permanent infiltration ponds are used for flow control during construction, are they protected from siltation?						
4 Sediment Controls	All perimeter sediment controls (e.g. silt fence, wattles, compost socks, berms, etc.) installed, and maintained in accordance with the Stormwater Pollution Prevention Plan (SWPPP).						
	Sediment control BMPs (sediment ponds, traps, filters etc.) have been constructed and functional as the first step of grading.						
	Stormwater runoff from disturbed areas is directed to sediment removal BMP.						
5 Stabilize Soils	Have exposed un-worked soils been stabilized with effective BMP to prevent erosion and sediment deposition?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
5 Stabilize Soils Cont.	Are stockpiles stabilized from erosion, protected with sediment trapping measures and located away from drain inlet, waterways, and drainage channels?						
	Have soils been stabilized at the end of the shift, before a holiday or weekend if needed based on the weather forecast?						
6 Protect Slopes	Has stormwater and ground water been diverted away from slopes and disturbed areas with interceptor dikes, pipes and or swales?						
	Is off-site storm water managed separately from stormwater generated on the site?						
	Is excavated material placed on uphill side of trenches consistent with safety and space considerations?						
	Have check dams been placed at regular intervals within constructed channels that are cut down a slope?						
7 Drain Inlets	Storm drain inlets made operable during construction are protected.						
	Are existing storm drains within the influence of the project protected?						
8 Stabilize Channel and Outlets	Have all on-site conveyance channels been designed, constructed and stabilized to prevent erosion from expected peak flows?						
	Is stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream conveyance systems?						
9 Control Pollutants	Are waste materials and demolition debris handled and disposed of to prevent contamination of stormwater?						
	Has cover been provided for all chemicals, liquid products, petroleum products, and other material?						
	Has secondary containment been provided capable of containing 110% of the volume?						
	Were contaminated surfaces cleaned immediately after a spill incident?						
	Were BMPs used to prevent contamination of stormwater by a pH modifying sources?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
9 Cont.	Wheel wash wastewater is handled and disposed of properly.						
10 Control Dewatering	Concrete washout in designated areas. No washout or excess concrete on the ground.						
	Dewatering has been done to an approved source and in compliance with the SWPPP.						
	Were there any clean non turbid dewatering discharges?						
11 Maintain BMP	Are all temporary and permanent erosion and sediment control BMPs maintained to perform as intended?						
12 Manage the Project	Has the project been phased to the maximum degree practicable?						
	Has regular inspection, monitoring and maintenance been performed as required by the permit?						
	Has the SWPPP been updated, implemented and records maintained?						
13 Protect LID	Is all Bioretention and Rain Garden Facilities protected from sedimentation with appropriate BMPs?						
	Is the Bioretention and Rain Garden protected against over compaction of construction equipment and foot traffic to retain its infiltration capabilities?						
	Permeable pavements are clean and free of sediment and sediment laden-water runoff. Muddy construction equipment has not been on the base material or pavement.						
	Have soiled permeable pavements been cleaned of sediments and pass infiltration test as required by stormwater manual methodology?						
	Heavy equipment has been kept off existing soils under LID facilities to retain infiltration rate.						

E. Check all areas that have been inspected. ✔

All in place BMPs ☐ All disturbed soils ☐ All concrete wash out area ☐ All material storage areas ☐
All discharge locations ☐ All equipment storage areas ☐ All construction entrances/exits ☐

F. Elements checked "Action Required" (section D) describe corrective action to be taken. List the element number; be specific on location and work needed. Document, initial, and date when the corrective action has been completed and inspected.

Element #	Description and Location	Action Required	Completion Date	Initials

Attach additional page if needed

Sign the following certification:

"I certify that this report is true, accurate, and complete, to the best of my knowledge and belief"

Inspected by: (print) _____ (Signature) _____ Date: _____

Title/Qualification of Inspector: _____

Appendix 6
Wetlands Requirements

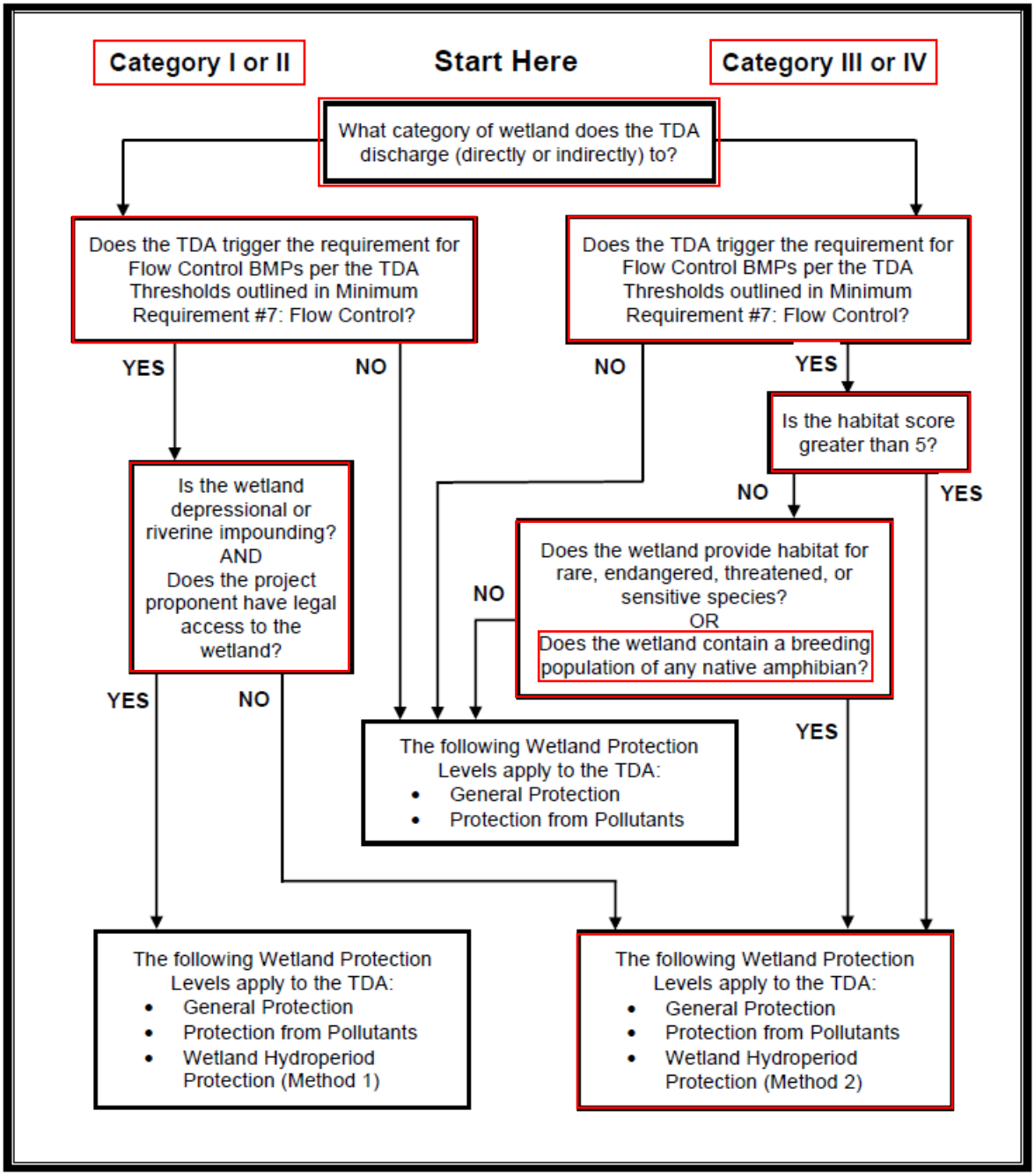


Figure 2.4. Flow Chart for Determining Wetland Protection Level Requirements

Additional Requirements

Stormwater treatment and flow control facilities shall not be built within a natural vegetated buffer, except for:

- Necessary conveyance systems as approved by the City of Tumwater.