DELVE
underground

503.227.1800
2000 SW First Avenue
Suite 410
Portland, OR 97201

July 26, 2023

Jesse Winterowd
Winterbrook Planning
610 SW Alder Street, Suite 810
Portland, OR 97205

Subject: Supplemental Information
Re: Land Use Permitting

Dear Jesse:

This letter provides additional information regarding expansive soils within the property upon which the Portland Water Bureau Filtration Facility is proposed (the "Filtration Facility Site") and the Filtration Facility Site septic system in response to comments on those issues included in a memorandum prepared by True North Geotechnical dated June 28, 2023 (Exhibit E.21).

Expansive Soils at Filtration Facility

Delve Underground performed an extensive geotechnical exploration program, consisting of 16 deep soils borings at and adjacent to the proposed structures on the Filtration Facility Site with all relevant soil layers identified with recommendations for design and construction provided to the Portland Water Bureau and design team. The location map and detailed logs of these 16 borings (FF-B-201, 202, 204 through 209, 212, 214 through 217, FF-SC-203, 213 and 218) are included in the attachment of this letter. The conclusion provided in Exhibit A.81 that "Based on the geotechnical investigations and evaluation performed for the project, the site is suitable for the intended development and the risks from the geologic and seismic hazards are low and can be mitigated with appropriate foundations and site developments." remains valid.

"Fat Clay", if composed of high content of expansive minerals, can be prone to large volume changes (expansion and shrinkage) that are directly related to changes in water content. The effects of the expansive soils are typically limited to at-grade, light-weight structure foundations and slabs for which moisture contents of the soils fluctuate drastically between seasons and the loads of the structures are not sufficient to counterbalance the swelling pressure from the expansive soil.

During the planning and design phases, the geotechnical and geologic studies did not identify that the existing structures in the surrounding area of the Bull Run Filtration Program have experienced expansive soil issues.

In particular for the Bull Run Filtration Facility geotechnical study, the "Fat Clay" is identified to be located generally from 15' to 35' deep within the proposed Filtration Facility structures, except for FF-SC-203 located at the southeast corner of the Flocculation and Sedimentation Basin (at approximately

15 to 20 feet deep structure) where the “Fat Clay” was noted from ground surface to 30’ deep. The “Fat Clay” is mainly in a moist condition.

”Fat Clay” will not affect the at-grade structures and shallow structures since it is well below their installation depths and the nature water content of the “Fat Clay” will not be affected. For deep structures (including the Flocculation and Sedimentation Basin), mat foundations will be situated on the “Fat Clay”, however, the groundwater and moisture conditions are also not expected to change because no significant dewatering efforts are anticipated, the clayey subgrade will be protected by a thick crushed rock working mat during construction and by well-compacted backfill and low-permeability cap layer at the surface after the construction. Furthermore, the deep structures are also heavy water-holding structures and their loads (weights) will likely be more than the swelling pressure if “Fat Clay” expands.

Additionally, the pipeline components connected to the Filtration Facility are installed at depths ranging from 10 to 30 feet deep. Their construction will not affect the nature moisture contents of the “Fat Clay” (if encountered) with the similar reasons for the deep structures mentioned above. Also, these welded steel pipes are very strong and flexible, and are expected to accommodate the swelling pressure even if the “Fat Clay” were to expand.

Therefore, we do not expect that the “Fat Clay” layer is a concern for the Filtration Facility. This is the reason why expansive index testing was not performed during the geotechnical evaluation.

Septic System

Prior geotechnical engineering analysis (identified that the slope stability concern at the site is from shallow landslides occurring at or near the surface of the slope (Geohazard Zone). The risk for deep seated landslides (a much larger global failure extending to Sandy River) is low as indicated by a high factor of safety of greater than 1.5. The drain field is located approximately 70 to 80 feet from the edge of the Geohazard Zone. At this distance and combined with the clayey/silty soils it will not increase the groundwater conditions at the Geohazard Zone and negatively affect the stability of the slopes within the Geohazard Zone. For the deep seated failure scenario, because of the high factor of safety, infiltration from drain field will not impact the deep seated failure mode. Therefore, the drain field is not anticipated to have a negative effect to the site slope stability.

Sincerely,

Yuxin Lang

Digitally signed by Yuxin Lang
Date: 2023.07.27 17:01:14 -07'00'

Yuxin “Wolfe” Lang, PE, GE, P.Eng
Principal Engineer

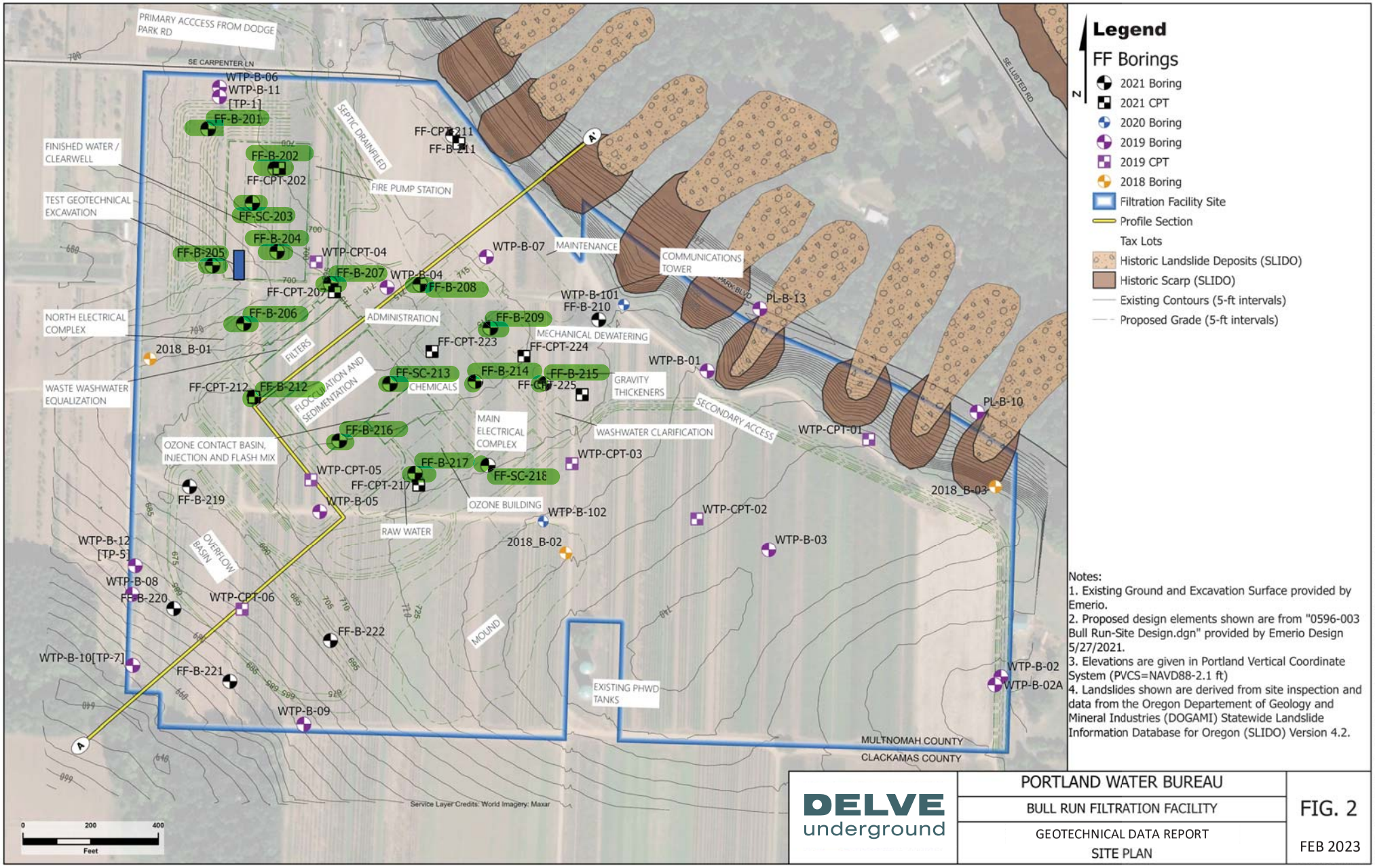
cc: File

Attachments

Bull Run Filtration Facility Geotechnical Data Report Site Plan
Logs of Borings*:

- FF-B-201
- FF-B-202
- FF-B-204
- FF-B-205
- FF-B-206
- FF-B-207
- FF-B-208
- FF-B-209
- FF-B-212
- FF-B-214
- FF-B-215
- FF-B-216
- FF-B-217
- FF-SC-203
- FF-SC-213
- FF-SC-218

* Locations of these borings are highlighted in green in the site plan.



Notes:
1. Existing Ground and Excavation Surface provided by Emerio.
2. Proposed design elements shown are from "0596-003 Bull Run-Site Design.dgn" provided by Emerio Design 5/27/2021.
3. Elevations are given in Portland Vertical Coordinate System (PVCS=NAVD88-2.1 ft)
4. Landslides shown are derived from site inspection and data from the Oregon Departement of Geology and Mineral Industries (DOGAMI) Statewide Landslide Information Database for Oregon (SLIDO) Version 4.2.

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PORTLAND WATER BUREAU

BULL RUN FILTRATION FACILITY

GEOTECHNICAL DATA REPORT

SITE PLAN

FIG. 2

FEB 2023

C:\Users\roth\Box\Jobs\6084.0 Bull Run Filtration Facility\CADD\GIS\6084.0 Bull Run Filtration Facility.aprx Roth 3/4/2022 3:35 PM

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-201

Date(s) Drilled	04/12/2021 - 04/13/2021	Client	Portland Water Bureau	Final Depth	80.4 ft bgs
Coordinates	7740379.2 E, 661243.8 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	707.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
703 / 5		SPT_ 1	100	2-3-5 (N=8)			MH	Medium stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Grass-covered plowed field at ground surface.	
698 / 10		SPT_ 2	100	4-4-4 (N=8)						
693 / 15		SPT_ 3	100	4-6-9 (N=15)				*Becomes stiff at 15.0 feet.*	Lost 100 gallons of drilling mud at 15-20 feet likely due to clay "collar" blocking fluid return. Stiffer drilling at 17 feet.	
688 / 20		SPT_ 4	100	5-7-9 (N=16)				*Becomes very stiff at 20.0 feet.*		
		SPT_ 5	100	4-7-10 (N=17)						
683 / 25		SPT_ 6	100	4-6-9 (N=15)			CH	Very stiff, moist, gray, orange, and black, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation** *Becomes stiff at 25.0 feet.*		
		SPT_ 7	100	5-9-11 (N=20)				*Becomes very stiff at 27.5 feet.*	SPT_7: Oven Dried PI=50.1 (PL, LL = 25.7, 75.8).	
678										

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NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-201

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-201

Date(s) Drilled	04/12/2021 - 04/13/2021	Client	Portland Water Bureau	Final Depth	80.4 ft bgs
Coordinates	7740379.2 E, 661243.8 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	707.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40); WATER CONTENT (MC); ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_8	100	5-10-10 (N=20)			CH	Very stiff, moist, gray, orange, and black, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation** *Becomes stiff at 32.5 feet.*	Lost 300 gallons of drilling mud at 30 feet. Casing borehole to 10 feet stopped mud loss.	
673		SPT_9	100	3-5-8 (N=13)						
35		SPT_10	100	2-3-4 (N=7)			MH	Medium stiff, wet, gray, orange, red, brown, and black, ELASTIC SILT with sand (MH); high plasticity, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Becomes stiff at 37.5 feet.* *Becomes not sensitive at 40.0 feet.*	SPT_11: Oven Dried PI=11.5 (PL, LL = 33.0, 44.5).	
668		SPT_11	100	3-5-7 (N=12)						
40		SPT_12	100	4-3-11 (N=14)						
663		SPT_13	100	9-11-38 (N=49)			ML	Hard, moist, gray-brown, Sandy SILT (ML); low plasticity, fine to coarse sand, relict texture. **Less Weathered Springwater Formation**		
45		SPT_14	100	17-18-28 (N=46)			SM	Dense, moist to wet, gray-brown, Silty SAND with cobbles (SM); fine to coarse sand, few coarse gravel, low plasticity fines. **Less Weathered Springwater Formation**		
658										
50		SPT_15	100	29-41-36 (N=77)				*Becomes very dense and overconsolidated at 50.0 feet.*		
653										
55		SPT_16	200	50/3" (Refusal)					Small cobbles from 55 to 60 feet.	
648							CL	Stiff, moist, gray and orange, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**	Softer drilling at 59 feet.	

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NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-201

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-201

Date(s) Drilled	04/12/2021 - 04/13/2021	Client	Portland Water Bureau	Final Depth	80.4 ft bgs
Coordinates	7740379.2 E, 661243.8 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	707.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_17	100	4-5-9 (N=14)	■ ○		CL	Stiff, moist, gray and orange, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**		
643 65		SPT_18	120	15-22-50 /3" (Refusal)	○ ■		SM	Very dense, moist, gray and orange, Silty SAND (SM), fine to medium sand, low plasticity fines. **Less Weathered Springwater Formation**	Harder drilling at 64 feet. No cobbles from 65 to 70 feet.	
638 70		SPT_19	200	50/3" (Refusal)	■		SM	Very dense, moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**		
633 75		SPT_20	132	50/3" (Refusal)	■		GP	Very dense, moist, gray, Poorly Graded GRAVEL with sand (GP); fine to coarse gravel, fine to coarse sand, trace low plasticity fines. **Less Weathered Springwater Formation**	"Gravelly" drilling from 75 to 80 feet.	
628 80		SPT_21	119	50/5" (Refusal)			SP-SM	Very dense, moist, red-gray Poorly Graded SAND with silt (SP-SM); fine to medium sand, low plasticity fines. **Less Weathered Springwater Formation**	Borehole completed at 80.4 feet below ground surface (bgs). Boring backfilled with bentonite grout.	
623 85										
618										

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NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-201

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-202

Date(s) Drilled	04/19/2021 - 04/20/2021	Client	Portland Water Bureau	Final Depth	81.2 ft bgs
Coordinates	7740578.6 E, 661126.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55
Surface Elevation	710.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
706								Medium stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Flush-mount monument installed. VWP installed at 41 feet and grouted into borehole. S/N: 2113123 Plowed field at ground surface.
5		SPT_1	100	1-3-3 (N=6)	■ ○				
701								*Becomes stiff at 10.0 feet.*	
10		SPT_2	100	2-4-5 (N=9)	■ ○		MH		
696									
15		SPT_3	100	5-6-8 (N=14)	■ ○				
691									SH_4 advanced at 400 psi form 20 to 20.5 feet and at 750 psi from 20.5 to 20.83 feet.
20		SH_4	50						
		SPT_5	100	6-8-12 (N=20)	○ ■			*Becomes very stiff, orange-brown light brown, and dark brown at 22.5 feet.*	
686								Very stiff, moist, orange and gray, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**	Too stiff for Shelby tube.
25		SPT_6	100	5-8-11 (N=19)	■		CH		
		SPT_7	100	5-6-10 (N=16)	■ ○				
681									

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NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-202

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-202

Date(s) Drilled	04/19/2021 - 04/20/2021	Client	Portland Water Bureau	Final Depth	81.2 ft bgs
Coordinates	7740578.6 E, 661126.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55
Surface Elevation	710.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SH_8	80				CH	Very stiff, moist, orange and gray, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation** *Becomes stiff, gray and red at 32.0 feet.*		
676		SPT_9	100	3-4-5 (N=9)						
35		SH_10	42				MH	Wet, orange-brown and red, ELASTIC SILT (MH); with zones of FAT CLAY (CH); high plasticity, trace fine to medium sand, sensitive. **Sensitive Saprolite of the Springwater Formation**	SH_10 advanced at 300 psi from 35 to 36 feet and at 350 psi from 36 to 37 feet. Gravelly drilling at 38 feet.	
		SPT_11	100	3-4-9 (N=13)						
671							SM	Medium dense, wet, Silty SAND (SM); low plasticity, sensitive. **Sensitive Saprolite of the Springwater Formation** *Color becomes gray-brown, trace fine gravel at 40.0 feet.*	SPT_12: Oven Dried PI=4.6 (PL, LL = 27.4, 32.0).	
40		SPT_12	100	5-5-10 (N=15)						
		SPT_13	100	16-17-36 (N=53)				Very dense moist, gray-brown, Silty SAND (SM); fine to coarse sand, trace fine to coarse gravel, low plasticity fines. **Less Weathered Springwater Formation** *Grades to Silty SAND with gravel (SM) at 45.0 feet.*		
666										
45		SPT_14	73	32-50/5" (Refusal)						
661										
50		SPT_15	30	22-32-50 /5" (Refusal)			SM	*Becomes gray-brown and orange, Silty SAND (SM) with trace gravel at 50.0 feet.*		
656										
55		SPT_16		30-50/6" (Refusal)					Chattering on gravel at 55 feet.	
								Very stiff, moist, gray, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**	Soft drilling at 59 feet.	
651							CL			

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NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-202

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-202

Date(s) Drilled	04/19/2021 - 04/20/2021	Client	Portland Water Bureau	Final Depth	81.2 ft bgs
Coordinates	7740578.6 E, 661126.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55
Surface Elevation	710.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40); WATER CONTENT (MC); ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_17	100	3-7-11 (N=18)			CL	Very stiff, moist, gray, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**		
646 65		SPT_18	100	19-19-42 (N=61)			SM	Very dense, moist, gray-brown and orange, Silty SAND (SM); fine to medium sand, trace gravel, low plasticity fines. **Less Weathered Springwater Formation**	SPT_18: 49.8% fines by ASTM D1140	
641 70		SPT_19	106	28-40-50 /5" (Refusal)				*Becomes Silty SAND with gravel (SM); fine to coarse sand at 70.0 feet.*	Chattering on gravel at 70 feet.	
636 75		SPT_20	168	50/3" (Refusal)				*Becomes Silty SAND with gravel and cobbles (SM) at 75.0 feet.*	Cobbly and gravelly drilling 75 - 79 feet.	
631 80		SPT_21	114	17-42-50 /2" (Refusal)					Borehole completed at 81.2 feet below ground surface (bgs).	
626 85										
621										

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NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-202

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-204

Date(s) Drilled	04/09/2021	Client	Portland Water Bureau	Final Depth	80.4 ft bgs
Coordinates	7740583.9 E, 660880.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55
Surface Elevation	703.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
699 / 5		SPT_1	95	2-5-5 (N=10)			MH	Stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Plowed field at ground surface. SPT_1: Oven Dried PI=16.6 (PL, LL = 25.9, 42.5).	
694 / 10		SPT_2	100	4-6-8 (N=14)						
689 / 15		SPT_3	100	6-10-12 (N=22)				Very stiff, moist, gray and orange, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
684 / 20		SPT_4	100	5-8-13 (N=21)			CH	*Color changes to orange-brown and gray at 20.0 feet*		
		SPT_5	100	5-8-11 (N=19)				*Color changes to gray and red at 22.5 feet.*		
679 / 25		SPT_6	100	2-2-2 (N=4)				*Moisture become wet and color changes to gray and orange-brown at 25.0 feet.*		
		SPT_7	100	2-2-5 (N=7)			SM	Medium stiff, wet, orange, gray, and brown, ELASTIC SILT (MH) interbedded with loose Silty SAND (SM); fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		
674										

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NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-204

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-204

Date(s) Drilled	04/09/2021	Client	Portland Water Bureau	Final Depth	80.4 ft bgs
Coordinates	7740583.9 E, 660880.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55
Surface Elevation	703.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_8	100	2-2-2 (N=4)			SM	Loose, wet, orange, brown, and gray, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		
669	35	SPT_9	100	3-5-8 (N=13)			MH	Stiff, wet, gray-brown, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Minor sensitivity and trace gravel at 35.0 feet.*	Gravel at 34.0 feet. SPT_10: Oven Dried PI=4.9 (PL, LL = 24.9, 29.8). Harder drilling at 37.0 feet.	
		SPT_10	100	3-3-10 (N=13)						
664	40	SPT_11	88	16-36-50 /4" (Refusal)			ML	Hard, wet, gray-brown, Sandy SILT with gravel (ML); low plasticity, fine to coarse gravel, fine to coarse sand. **Less Weathered Springwater Formation** *Becomes moist at 40.0 feet.*		
		SPT_12	72	36-38-41 (N=79)						
659	45	SPT_13	142	25-35-50 /0" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**	SPT_13: 25.6% fines by ASTM D1140	
654	50	SPT_14	100	0-3-4 (N=7)			ML	Medium stiff, moist, gray and orange, SILT (ML); low plasticity. **Less Weathered Springwater Formation**	Soft drilling at 49.0 feet.	
649	55	SPT_15	100	28-15-23 (N=38)			MH	Hard, wet, gray and orange, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, trace fine to coarse gravel, relict texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	Hard drilling at 54.0 feet. SPT_15: Oven Dried PI=12.9 (PL, LL = 39.2, 52.1).	
644							ML	Hard, moist, gray-brown, Sandy SILT (ML); low plasticity, fine to coarse sand, trace gravel, overconsolidated. **Less Weathered Springwater Formation**	Large cobble at 59.0 feet.	

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-204

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-204

Date(s) Drilled	04/09/2021	Client	Portland Water Bureau	Final Depth	80.4 ft bgs
Coordinates	7740583.9 E, 660880.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55
Surface Elevation	703.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_ 16	113	8-23-50/ 4" (Refusal)				Hard, moist, gray-brown, Sandy SILT (ML); low plasticity, fine to coarse sand, trace gravel, overconsolidated. **Less Weathered Springwater Formation**		
639 65		SPT_ 17	200	50/3" (Refusal)				*Few gravel, cobbles, and boulders at 64.0 feet.*	Large cobble at 64.0 feet. Boulder from 66.0 to 68.0 feet.	
634 70		SPT_ 18	179	50/5" (Refusal)			ML	*Becomes Sandy SILT with gravel (ML) at 70.0 feet.*	Hard drilling from 70.0 to 75.0 feet.	
629 75		SPT_ 19	200	50/3" (Refusal)						
624 80		SPT_ 20	138	50/5" (Refusal)					Borehole completed at 80.4 feet below ground surface (bgs).	
619 85										
614										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-204

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-205

Date(s) Drilled	05/14/2021 - 05/15/2021	Client	Portland Water Bureau	Final Depth	80.7 ft bgs
Coordinates	7740391.6 E, 660838.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	692.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
688 / 5		SPT_ 1	100	2-4-4 (N=8)			MH	Medium stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Flush-mount monument installed. VWP installed at 20 feet and grouted into borehole. 350 kPa Rating S/N: 2113126 Grass-covered field at ground surface.	
683 / 10		SPT_ 2	100	3-5-5 (N=10)				*Becomes stiff at 10.0 feet.*		
678 / 15		SPT_ 3	100	0-1-2 (N=3)				Soft, wet, orange, gray, brown, and black, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	SPT_3: Oven Dried PI=27.3 (PL, LL = 35.6, 62.9).	
		SPT_ 4	100	1-2-1 (N=3)			MH			
673 / 20		SPT_ 5	61	1-1-3 (N=4)				*At 20.0 feet, becomes gray-brown, sand becomes fine to coarse.*		
		SPT_ 6	100	1-2-8 (N=10)				*Becomes stiff with trace gravel below 22.5 feet; color becomes gray-brown-yellow.*	SPT_6: Oven Dried PI=6.5 (PL, LL = 35.1, 41.6).	
668 / 25		SPT_ 7	22	26-21-25 (N=46)			GM	Dense, wet, gray, brown, and orange, Silty GRAVEL with sand and cobbles (GM); coarse gravel (broken), fine to medium sand, high plasticity fines, sensitive elastic silt matrix. **Sensitive Saprolite of the Springwater Formation** *Large cobbles from 27.5 to 30.0 feet.*	Bouncing on gravel at 25 feet.	
663										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-205

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-205

Date(s) Drilled	05/14/2021 - 05/15/2021	Client	Portland Water Bureau	Final Depth	80.7 ft bgs
Coordinates	7740391.6 E, 660838.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	692.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
658 / 35	SPT	SPT_8	120	26-50/4" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**	Hard, slow drilling in gravel from 30 to 39.5 feet.	
	SPT	SPT_9	161	36-50/2" (Refusal)						
653 / 40	SPT	SPT_10	100	1-7-10 (N=17)			CL	Very stiff, moist, gray, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**	Softer drilling at 39.5 feet. Switched to 4-inch tricone bit below 40 feet.	
648 / 45	SPT	SPT_11	100	7-10-29 (N=39)			MH	Hard, moist to wet, gray and orange, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	SPT_11: Oven Dried PI=18.0 (PL, LL = 29.5, 47.5).	
643 / 50	SPT	SPT_12	109	19-25-50 /5" (Refusal)			ML	Hard, moist, light brown, Sandy SILT (ML); low plasticity, fine to coarse sand. **Less Weathered Springwater Formation**	Rod "chatter" indicates gravel at 48.5 feet.	
638 / 55	SPT	SPT_13	141	24-50/4" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND (SM); fine to coarse sand, low plasticity fines; soil exhibits minor sensitivity. **Less Weathered Springwater Formation**		
633										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-205

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-205

Date(s) Drilled	05/14/2021 - 05/15/2021	Client	Portland Water Bureau	Final Depth	80.7 ft bgs
Coordinates	7740391.6 E, 660838.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	692.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
628 / 65		SPT_14	31	50/5" (Refusal)				Very dense, moist, light brown and gray, Silty SAND with gravel (SM); fine to coarse sand, trace fine to coarse gravel, low plasticity, overconsolidated fines. **Less Weathered Springwater Formation**	Rod "chatter" indicates gravel at 66 feet.	
		SPT_15	171	35-50/4" (Refusal)	○					
623 / 70		SPT_16	212	48-50/2" (Refusal)	○		SM	*No gravel at 70.0 feet.*	Lost drilling circulation and 50 gallons of drilling mud at 74 feet. SPT_17: 24.1% fines by ASTM D1140 Poor circulation; lost 100 gallons of drilling mud between 75 and 80 feet. Mud loss may be due to squeezing clay or clay collar forming around drill rods preventing circulation return.	
618 / 75		SPT_17	94	16-39-50 /5" (Refusal)	○			*Few coarse gravel at 75.0 feet.*		
613 / 80		SPT 18	95	41-50/3" (Refusal)	○				Borehole completed at 80.7 feet below ground surface (bgs).	
608 / 85										
603										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-205

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-206

Date(s) Drilled	04/15/2021 - 04/16/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7740484.3 E, 660667.1 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	702.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
698 / 5		SPT_ 1	100	1-2-3 (N=5)			MH	Medium stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Grass-covered plowed field at ground surface.	
693 / 10		SPT_ 2	100	2-2-3 (N=5)						
688 / 15		SPT_ 3	100	4-5-9 (N=14)				*Becomes stiff at 15.0 feet.*		
683 / 20		SPT_ 4	100	12-5-6 (N=11)			CH	Stiff, moist, gray and orange, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
		SPT_ 5	100	1-1-2 (N=3)			MH	Soft, wet, gray-brown-orange, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	SPT_5: Oven Dried PI=28.8 (PL, LL = 36.4, 65.2).	
678 / 25		SPT_ 6	100	2-1-2 (N=3)				*At 25.0 feet, becomes brown, orange, and black; sand becomes fine to coarse.*		
673		SPT_ 7	100	2-2-3 (N=5)				*At 27.5 feet, becomes medium stiff, orange and brown.*	Rod "chatter" indicating gravel at	

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-206

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-206

Date(s) Drilled	04/15/2021 - 04/16/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7740484.3 E, 660667.1 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	702.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_8	100	6-12-8 (N=20)			MH	Very stiff, wet, gray-brown-orange, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *At 32.5 feet, becomes stiff with trace fine to coarse gravel.*	29.5 feet.	
		SPT_9	100	3-4-8 (N=12)						
668	35									
		SPT_10	100	5-16-12 (N=28)			ML	Very stiff, wet, light brown and gray, Sandy SILT (ML); low plasticity, few fine to coarse gravel, fine to coarse sand. **Less Weathered Springwater Formation**	SPT_10: Oven Dried PI=3.3 (PL, LL = 22.4, 25.7).	
		SPT_11	100	21-24-28 (N=52)			SM	Very dense, moist, light brown and gray, Silty SAND with gravel (SM): fine to coarse gravel, fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**		
663	40									
		SPT_12	100	14-29-31 (N=60)			SM	Very dense, moist, light brown and gray, Silty SAND (SM); fine to coarse sand, low plasticity overconsolidated fines. **Less Weathered Springwater Formation**		
658	45									
		SPT_13	100	0-2-2 (N=4)			CL	Soft, moist to wet, gray, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**	Soft at 45 feet.	
653	50									
		SPT_14	100	2-3-5 (N=8)			ML	Medium stiff to hard, moist to wet, orange-brown, Sandy SILT (ML); low plasticity, fine to coarse sand, relict texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**		
648	55									
		SPT_15	100	9-17-40 (N=57)					SPT_15: Oven Dried PI=4.5 (PL, LL = 33.9, 38.4).	
							SM	Very dense, wet, gray and brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines, weakly cemented. **Less Weathered Springwater Formation**		
643										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-206

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-206

Date(s) Drilled	04/15/2021 - 04/16/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7740484.3 E, 660667.1 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	702.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
638 / 65		SPT_16	146	50/5" (Refusal)			SM	Very dense, wet, gray and brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines, weakly cemented. **Less Weathered Springwater Formation**		
633 / 70		SPT_17	100	50/3" (Refusal)			SW-SM	Very dense, wet, gray-brown, Well Graded SAND with silt and cobbles (SW-SM); fine to coarse sand, low plasticity fines, minor sensitivity. **Less Weathered Springwater Formation**		
628 / 75		SPT_18	120	50/2" (Refusal)					Rod "chatter" at 71.5 feet on gravel and cobbles.	
623 / 80		SPT_19	127	50/5" (Refusal)			SM	Very dense, moist to wet, gray and brown, Silty SAND (SM): fine to coarse sand, low plasticity fines, minor sensitivity. **Less Weathered Springwater Formation** *Trace gravel, weakly cemented at 80.0 feet.*	Dense "gravelly" drilling from about 76 to 79 feet.	
618 / 85 / 613		SPT_20	168	50/3" (Refusal)					Borehole completed at 80.3 feet below ground surface (bgs).	

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-206

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-207

Date(s) Drilled	04/07/2021	Client	Portland Water Bureau	Final Depth	80.5 ft bgs
Coordinates	7740742.1 E, 660786.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	707.0 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
702 5		SPT_1	78	1-0-2 (N=2)			MH	Soft, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Dirt road at ground surface.	
697 10		SPT_2	100	3-4-5 (N=9)				*Becomes stiff at 10 feet.*		
692 15		SPT_3	100	3-5-6 (N=11)						
687 20		SPT_4	100	4-8-12 (N=20)			CH	Very stiff, moist, gray and orange, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
		SH_5	75					*Becomes gray, orange, and red.*	SH_5 advanced at 400 to 600 psi from 22.5 to 24.5 feet.	
682 25		SPT_6	100	2-2-2 (N=4)				Soft, wet, brown, gray, and black, ELASTIC SILT with sand (MH): high plasticity, fine sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		
		SH_7	66				MH / SM	Loose, wet, gray-brown, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	SH_7 advanced at 500 to 650 psi from 27.5 to 29.5 feet.	

DELVE underground

NOTES:
Location and Elevation Source: GPS (not surveyed)
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-207

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-207

Date(s) Drilled	04/07/2021	Client	Portland Water Bureau	Final Depth	80.5 ft bgs
Coordinates	7740742.1 E, 660786.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	707.0 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
				SPT_8	100	1-1-5 (N=6)	SM	Loose, wet, gray-brown, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	
				SH_9	75				SH_9 advanced at 300 to 900 psi from 32.5 to 34.5 feet.
672		35		SPT_10	100	3-3-12 (N=15)	ML	Stiff, wet, gray, brown, and orange, Sandy SILT (ML); low plasticity, fine to coarse sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	SPT_10: Oven Dried PI=10.8 (PL, LL = 28.8, 39.6).
				SPT_11	17	12-29-39 (N=68)	GP	Very dense, wet, gray-brown, Poorly Graded GRAVEL (GP); fine to coarse gravel, trace fine to coarse sand, trace low plasticity fines. **Less Weathered Springwater Formation**	Drilling action indicates gravel at 36.5 feet.
667		40		SPT_12	0	50/2" (Refusal)			
662		45		SPT_13	100	50/4" (Refusal)	GP-GM	Very dense, moist, tan-gray, Poorly Graded GRAVEL with silt, sand, and cobbles (GP-GM); fine to coarse gravel, fine to coarse sand, low plasticity fines, minor sensitivity. **Less Weathered Springwater Formation**	Drilling action indicates cobbles at 43 feet.
							CL	Hard, moist, gray and orange, LEAN CLAY (CL); low plasticity, overconsolidated. **Less Weathered Springwater Formation**	Soft drilling zone at 47.5 feet.
657		50		SPT_14	100	10-15-20 (N=35)			No gravel from 50 to 55 feet. SPT_14: Oven Dried PI=16.4 (PL, LL = 20.4, 36.8).
652		55		SPT_15	100	5-10-15 (N=25)	MH	Very stiff, moist, orange-brown, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	
							ML	Hard, moist, gray and brown, Sandy SILT (ML); low plasticity, fine to coarse sand, trace gravel, overconsolidated. **Less Weathered Springwater Formation**	Drilling action indicates gravel at 57 feet.

DELVE underground

NOTES:
Location and Elevation Source: GPS (not surveyed)
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-207

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-207

Date(s) Drilled	04/07/2021	Client	Portland Water Bureau	Final Depth	80.5 ft bgs
Coordinates	7740742.1 E, 660786.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	707.0 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_16	106	26-25-50/5" (Refusal)			ML	Hard, moist, gray and brown, Sandy SILT (ML); low plasticity, fine to coarse sand, trace gravel, overconsolidated. **Less Weathered Springwater Formation** *Becomes very hard, gray and brown, with trace gravel.*	Cobbles below 62 feet.	
642 65		SPT_17	100	50/3" (Refusal)			GM	Very dense, moist, gray-brown, Silty GRAVEL with cobbles (GM); fine to coarse gravel, few fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**		
637 70		SPT_18	146	50/5" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines. **Less Weathered Springwater Formation**	SPT_18: 23.9% fines by ASTM D1140	
632 75		SPT_19	181	50/5" (Refusal)						
627 80		SPT_20	109	50/5" (Refusal)			ML	Hard, moist, gray-brown, Sandy SILT with gravel and cobbles (ML); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines. **Less Weathered Springwater Formation**		
622 85									Borehole completed at 80.5 feet below ground surface (bgs).	

DELVE underground

NOTES:
Location and Elevation Source: GPS (not surveyed)
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-207

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-208

Date(s) Drilled	04/06/2021	Client	Portland Water Bureau	Final Depth	81.5 ft bgs
Coordinates	7741007.7 E, 660783.7 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	711.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
707 / 5		SPT_ 1	100	2-3-4 (N=7)			MH	Medium stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Borehole instrumented with a 2" ID standpipe piezometer with 010 slot and 10/20 sand; flush-mount monument at surface. Well ID #: L14170 Start Card #:1051383 Grass at ground surface.	
702 / 10		SPT_ 2	100	2-2-3 (N=5)						
697 / 15		SPT_ 3	100	3-5-7 (N=12)				*Becomes stiff at 15 feet.*		
692 / 20		SPT_ 4	100	6-9-13 (N=22)			CH	Very stiff, moist, orange, black, and gray, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
		SPT_ 5		5-8-11 (N=19)						
687 / 25		SPT_ 6	100	3-5-7 (N=12)				*Becomes stiff, gray, orange, and red.*		
		SPT_ 7	100	2-2-3 (N=5)			MH	Medium stiff, wet, gray, black, orange, yellow, and brown, ELASTIC SILT with sand (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	SPT_7: Oven Dried PI=39.6 (PL, LL = 36.9, 76.5).	
682										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-208

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-208

Date(s) Drilled	04/06/2021	Client	Portland Water Bureau	Final Depth	81.5 ft bgs
Coordinates	7741007.7 E, 660783.7 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	711.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_ 8	100	0-1-3 (N=4)			SM	Very loose, wet, brown, gray, orange, and black, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		
		SPT_ 9	83	1-5-7 (N=12)			MH	Stiff, wet, gray-brown, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Trace fine to coarse gravel at 35 feet.*		
677										
35		SPT_ 10	100	2-3-6 (N=9)					SPT_10: Oven Dried PI=3.6 (PL, LL = 37.6, 41.2).	
		SPT_ 11	50	7-11-14 (N=25)			ML	Very stiff, wet, gray-brown, Gravelly SILT with sand (ML); low plasticity, fine to coarse gravel, fine to coarse sand. **Less Weathered Springwater Formation**		
672										
40		SPT_ 12	100	3-26-19 (N=45)			SM	Dense, moist, gray and orange-brown, Silty SAND with cobbles (SM); fine to coarse sand, low plasticity fines, minor sensitivity. **Less Weathered Springwater Formation**	Hard, "cobbly" drilling from 40 to 50 feet. Cobbles of 4-5" diameter.	
							SP	Very dense, wet, gray, Poorly Graded SAND with cobbles (SP); fine to coarse sand, decomposed cobble. **Less Weathered Springwater Formation**		
667										
45		SPT_ 13	50	50/3" (Refusal)						
							GP	Very dense, Poorly Graded GRAVEL with cobbles (GP). **Less Weathered Springwater Formation**		
662										
50		SPT_ 14	100	50/1" (Refusal)						
							CL	Very stiff, moist, gray and orange, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**	Soft drilling from 52 to 55 feet.	
657										
55		SPT_ 15	100	7-10-17 (N=27)						
							SM	Very dense, moist becoming wet, orange-brown, Silty SAND with cobbles (SM); fine to coarse sand, trace fine to coarse gravel, low plasticity fines, oxidized. **Less Weathered Springwater Formation**	"Gravelly" drilling below 58 feet; hard and soft layered.	
652										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-208

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-208

Date(s) Drilled	04/06/2021	Client	Portland Water Bureau	Final Depth	81.5 ft bgs
Coordinates	7741007.7 E, 660783.7 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	711.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
647 / 65		SPT_16	144	18-50/3" (Refusal)				Very dense, moist becoming wet, orange-brown, Silty SAND with cobbles (SM); fine to coarse sand, trace fine to coarse gravel, low plasticity fines, oxidized. **Less Weathered Springwater Formation**		
		SPT_17	163	29-50/5" (Refusal)			SM	*Becomes red-gray and orange, overconsolidated at 65 feet.*	Cobbles are larger below 65 feet.	
642 / 70		SPT_18	120	24-39-50 /3" (Refusal)			ML	Hard, moist to wet, gray-brown, Sandy SILT with cobbles (ML); low plasticity, fine to coarse sand, few fine to coarse gravel, overconsolidated. **Less Weathered Springwater Formation**		
637 / 75		SPT_19	133	19-50/3" (Refusal)			SM	Very dense, moist to wet, gray-brown, Silty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, non-plastic overconsolidated fines. **Less Weathered Springwater Formation**	Easier drilling below 75 feet; cobbles and gravel still present.	
632 / 80		SPT_20	100	20-24-20 (N=44)			ML	Hard, moist, gray, SILT with cobbles (ML); low plasticity, few fine to coarse sand, trace fine gravel. **Less Weathered Springwater Formation**		
627 / 85									Borehole completed at 81.5 feet below ground surface (bgs).	
622										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-208

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-209

Date(s) Drilled	04/04/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7741215.4 E, 660653.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	713.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
709 / 5		SPT_1	100	2-2-4 (N=6)	MH	Medium stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Flush-mount monument installed. VWP installed at 31 feet and grouted into borehole. S/N: 2113125 Plowed field at ground surface.
704 / 10		SPT_2	100	3-3-4 (N=7)			
699 / 15		SPT_3	100	5-8-10 (N=18)		*Becomes very stiff, orange-brown and black at 15.0 feet.*	
694 / 20		SPT_4	100	5-7-9 (N=16)	CH	Very stiff, moist, gray and orange, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**	
		SPT_5	100	3-7-9 (N=16)			
689 / 25		SPT_6	100	3-5-7 (N=12)		*Becomes stiff at 25.0 feet.*	
684		SPT_7	100	2-3-3 (N=6)	MH	Medium stiff, wet, orange, dark brown, and gray, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	SPT_7: Oven Dried PI=28.8 (PL, LL = 34.9, 63.7).

PENETRATION RESISTANCE BLOWS/FT: 10 20 30 40
WATER CONTENT (MC)
ATTERBERG LL/PL: 20 40 60 80

BACKFILL/INSTALL.

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-209

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-209

Date(s) Drilled	04/04/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7741215.4 E, 660653.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	713.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_ 8	100	2-2-3 (N=5)			MH	Medium stiff, wet, orange, dark brown, and gray, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Trace gravel at 30.0 feet.*	SPT_9: Oven Dried PI=2.1 (PL, LL = 34.0, 36.1). "Cobbly" drilling from 33 to 49.5 feet.	
679		SPT_ 9	100	4-7-4 (N=11)			ML	Stiff, wet, gray with minor orange, Sandy SILT with cobbles (ML); low plasticity, fine to coarse sand, trace fine to coarse gravel, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		
35		SPT_ 10	100	6-8-11 (N=19)			ML			
		SPT_ 11	100	15-20-38 (N=58)			SM	Very stiff, gray-brown and orange, Sandy SILT with gravel and cobbles (ML); low plasticity, fine to coarse gravel, fine to coarse sand, relict texture. **Less Weathered Springwater Formation**		
674										
40		SPT_ 12	100	13-15-30 (N=45)				Very dense, moist, gray-brown, Silty SAND with cobbles (SM); fine to coarse sand, few fine to coarse gravel, low plasticity to non-plastic fines. **Less Weathered Springwater Formation** *Becomes dense, gravel content grades to trace at 40.0 feet.*	Slightly softer drilling at 43 feet.	
669										
45		SPT_ 13	100	39-50/3" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines. **Less Weathered Springwater Formation**		
664										
50		SPT_ 14	100	4-11-9 (N=20)			CL	Very stiff, moist, gray, orange, and brown, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation** *Large cobble from 49.0 to 49.5 feet.*	Soft drilling at 49.5 feet.	
659										
55		SPT_ 15	100	12-8-8 (N=16)			MH	Very stiff, wet, light brown and orange, ELASTIC SILT with sand (MH); low plasticity, fine to coarse sand, trace fine gravel, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	"Soft" from 54 to 64 feet; lower sensitive soil zone.	
654										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-209

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-209

Date(s) Drilled	04/04/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7741215.4 E, 660653.9 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 75
Surface Elevation	713.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_16	100	13-12-37 (N=49)			MH	Hard, moist, gray-brown-orange, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, trace fine gravel, minor sensitivity. **Sensitive Saprolite within Less Weathered Springwater Formation**		
649									"Cobbly" drilling from 64 to 70 feet.	
65		SPT_17	128	22-36-50 /2" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND with cobbles (SM); fine to coarse sand, few fine to coarse gravel, low plasticity overconsolidated fines. **Less Weathered Springwater Formation** *6" diameter cobble at 66.0 feet.*		
644										
70		SPT_18	64	36-39-50 /0" (Refusal)			ML	Hard, moist, light brown-gray, Sandy SILT with gravel and cobbles (ML); low plasticity, fine to coarse gravel, fine to coarse sand, overconsolidated. **Less Weathered Springwater Formation** *Cobble at 69.0 feet.*	Hard, slow drilling from 70 to 75; no cobbles.	
639										
75		SPT_19	232	50/3" (Refusal)			SM	Very dense, moist, light brown-gray, Silty SAND (SM); fine to coarse sand, low plasticity overconsolidated fines. **Less Weathered Springwater Formation** *Large cobble/small boulder from 77.0 to 78.0 feet.* *Few fine to coarse gravel below 80.0 feet.*	No cobbles below 78.	
634										
80		SPT_20	227	50/4" (Refusal)					Borehole completed at 80.3 feet below ground surface (bgs).	
629										
85										
624										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-209

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-212

Date(s) Drilled	04/20/2021 - 04/21/2021	Client	Portland Water Bureau	Final Depth	80.2 ft bgs
Coordinates	7740516.2 E, 660449.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	711.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
707 / 5		SPT_1	95	2-3-5 (N=8)			MH	Medium stiff, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Flush-mount monument installed. VWP installed at 28.5 feet and grouted into borehole. S/N: 2113122 Plowed field at ground surface.	
702 / 10		SPT_2	100	3-4-6 (N=10)				*Becomes stiff at 10.0 feet.*		
697 / 15		SPT_3	100	15-7-11 (N=18)			CH	Very stiff, moist, red-brown, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
692 / 20		SH_4	114						SH_4 advanced at 600 psi from 20 to 21 feet and at 800 psi to refusal at 21 to 21.3 feet.	
		SH_5	54					*Becomes orange-brown at 22.5 feet.*	SH_5 advanced at 500 psi from 22.5 to 23.5 feet and at 700 psi from 23.5 to 24.5 feet.	
687 / 25		SPT_6	100	4-5-6 (N=11)				*Becomes stiff at 25.0 feet.* Medium stiff, wet, orange-brown, gray, and black, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, relict texture, sensitive.		
682		SPT_7	100	2-2-3 (N=5)			MH	**Sensitive Saprolite of the Springwater Formation** *Becomes orange and gray at 27.5 feet.*		

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-212

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-212

Date(s) Drilled	04/20/2021 - 04/21/2021	Client	Portland Water Bureau	Final Depth	80.2 ft bgs
Coordinates	7740516.2 E, 660449.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	711.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SH_8	100					Medium stiff, wet, orange-brown, gray, and black, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Grades to ELASTIC SILT with sand (MH) at 32.0 feet, becomes gray, brown, and yellow.* *Grades to Sandy ELASTIC SILT (MH) at 35.0 feet, becomes gray-brown.* *Becomes very stiff, gray-brown, red, green, and black, with trace fine to coarse gravel at 36.75 feet.*	SH_8 advanced at 400 psi from 30 to 31 feet and at 500 psi from 31 to 32 feet. SPT_9: Oven Dried PI=12.5 (PL, LL = 34.3, 46.8). SH_10 advanced at 450 psi from 35 to 36 feet and at 450 to 750 from 36 to 36.75 feet.	
		SPT_ 9	100	2-2-3 (N=5)						
677										
	35	SH_1 0	100				MH			
		SPT_ 11	100	2-5-11 (N=16)						
672										
	40	SPT_ 12	100	5-8-18 (N=26)				Very stiff, moist, gray-brown, Sandy SILT (ML); low plasticity, fine to coarse sand. **Less Weathered Springwater Formation**	SPT_12: Oven Dried PI=3.8 (PL, LL = 31.7, 35.5).	
		SPT_ 13	100	5-37-50/ 4" (Refusal)			ML	*Becomes hard, moist, with few gravel at 42.5 feet.* *Cobble at 44.0 feet.*		
667										
	45	SPT_ 14	149	31-50/2" (Refusal)			SM	Very dense, moist to wet, gray-brown, Silty SAND (SM); fine to coarse sand, trace fine to coarse gravel, low plasticity fines. **Less Weathered Springwater Formation**	Rod chatter on gravel below 45 feet.	
662										
	50	SPT_ 15	100	11-4-4 (N=8)				*Becomes gray, orange, and brown at 50.0 feet.* Medium stiff, moist, light brown and orange, ELASTIC SILT (MH); high plasticity, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	Softer drilling from 50 to 55 feet.	
657							MH			
	55	SPT_ 16	100	3-3-10 (N=13)				Stiff, moist to wet, gray-light brown, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, relict clastic texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	SPT_16: Oven Dried PI=5.3 (PL, LL = 43.2, 48.5).	
652							MH			

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-212

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-212

Date(s) Drilled	04/20/2021 - 04/21/2021	Client	Portland Water Bureau	Final Depth	80.2 ft bgs
Coordinates	7740516.2 E, 660449.2 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	711.3 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
647		SPT_ 17	17	15-20-17 (N=37)			GM	Dense, wet, gray-brown, Silty GRAVEL with sand (GM); fine to coarse gravel, fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**		
65		SPT_ 18	123	38-50/3" (Refusal)				Very dense, moist to wet, gray, Silty SAND (SM); fine to medium sand, low plasticity fines, relict texture. **Less Weathered Springwater Formation**		
642										
70		SPT_ 19	100	50/4" (Refusal)			SM	*Becomes moist, no relict texture below 70.0 feet.*	Stiff drilling with some gravel from 70 to 75 feet.	
637										
75		SPT_ 20	100	50/3" (Refusal)					"Concrete"-like drilling at approximately 78 feet; likely mudflow deposit.	
632										
80		SPT_ 21	47	50/2" (Refusal)				*Non-plastic fines below 80.0 feet.*	Borehole completed at 80.2 feet below ground surface (bgs).	
627										
85										
622										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-212

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-214

Date(s) Drilled	05/07/2021	Client	Portland Water Bureau	Final Depth	80.1 ft bgs
Coordinates	7741171.8 E, 660494.8 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	714.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
710 / 5		SPT_ 1	100	2-1-3 (N=4)	■ ○		MH	Soft, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Plowed field at ground surface.	
705 / 10		SPT_ 2	100	2-3-4 (N=7)	■ ⊖			*Becomes medium stiff at 10.0 feet.*		
700 / 15		SPT_ 3	100	4-6-7 (N=13)	■ ○			*Becomes stiff at 15.0 feet.*		
695 / 20		SPT_ 4	100	5-8-9 (N=17)	■ ○		CH	Very stiff, moist, gray-brown and orange, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
690 / 25		SPT_ 5	100	4-6-10 (N=16)	■ ○			*Becomes gray, orange, and red at 22.5 feet.*		
		SPT_ 6	100	4-6-8 (N=14)	■ ○			*Becomes stiff, gray and orange at 25.0 feet.*		
685		SPT_ 7	100	3-2-2 (N=4)	■ ○		MH	Soft, wet, brown and orange, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-214

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-214

Date(s) Drilled	05/07/2021	Client	Portland Water Bureau	Final Depth	80.1 ft bgs
Coordinates	7741171.8 E, 660494.8 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	714.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
680 / 35		SPT_8	100	2-3-4 (N=7)			SM	Loose, wet, orange-brown, gray, and black, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Becomes gray-orange, Silty SAND with gravel (SM) at 32.0 feet.*	SPT_8: Oven Dried PI=15.2 (PL, LL = 36.5, 51.7). SPT_9: 42.1% fines by ASTM D1140 Gravelly drilling at 32.5 feet. SPT_10: Oven Dried PI=1.1 (PL, LL = 24.6, 25.7). SPT_11: 27.1% fines by ASTM D1140	
		SPT_9	100	2-3-5 (N=8)						
		SPT_10	100	10-15-22 (N=37)			SM	Dense, moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly cemented. **Less Weathered Springwater Formation**		
675		SPT_11	100	17-17-31 (N=48)						
40		SPT_12	144	15-50/3" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND with boulders (SM); fine to coarse sand, few fine gravel, low plasticity fines. **Less Weathered Springwater Formation**	Bouncing on boulder from 41 to 43 feet. Softer drilling at 43 feet.	
								Boulder from 41.0 to 43.0 feet. **Less Weathered Springwater Formation**		
670								Very dense, moist to wet, gray-brown, orange, and dark brown, Silty SAND (SM); fine to coarse sand, few fine gravel, low plasticity fines. **Less Weathered Springwater Formation**		
45		SPT_13	120	6-19-50/ 3" (Refusal)			SM			
665										
50		SPT_14	100	3-3-11 (N=14)				Medium dense, wet, brown, Silty SAND (SM); fine to medium sand, high plasticity fines, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**		
660										
55		SPT_15	22	7-7-7 (N=14)			SM			
655										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-214

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-214

Date(s) Drilled	05/07/2021	Client	Portland Water Bureau	Final Depth	80.1 ft bgs
Coordinates	7741171.8 E, 660494.8 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	714.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
650 / 65		SPT_16	100	10-13-14 (N=27)			SM	Medium dense, wet, brown, Silty SAND (SM); fine to medium sand, low plasticity fines. **Less Weathered Springwater Formation** *Becomes gray-brown and orange with trace fine gravel at 60.0 feet.*	SPT_16: Oven Dried PI=NP (PL, LL = 29.7, NP).	
		SPT_17	0	50/0" (Refusal)				Very dense, wet, dark gray, Poorly Graded GRAVEL (GP). **Less Weathered Springwater Formation**	Hard drilling from 65 to 70 feet.	
645 / 70		SPT_18	100	50/1" (Refusal)			GP		Chattering on gravel at 70 feet.	
640 / 75		SPT_19	68	50/3" (Refusal)			GP-GM	Very dense, wet, gray, Poorly Graded GRAVEL with silt and sand (GP-GC); fine gravel, fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**		
635 / 80		SPT_20	212	50/1" (Refusal)			SM	Very dense, moist, red-gray, Silty SAND (SM); fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**	Borehole completed at 80.1 feet below ground surface (bgs).	
630 / 85										
625										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-214

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-215

Date(s) Drilled	04/29/2021 - 04/30/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7741377.9 E, 660488.4 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	717.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
713 / 5		SPT_ 1	100	1-2-1 (N=3)				Soft, moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Plowed field at ground surface.	
708 / 10		SPT_ 2	100	2-2-2 (N=4)			MH	*Becomes soft at 10.0 feet.*		
703 / 15		SPT_ 3	100	2-3-7 (N=10)				*Becomes stiff at 15.0 feet.*		
698 / 20		SPT_ 4	100	4-5-5 (N=10)				Stiff, moist, gray and orange, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
693 / 25		SPT_ 5	100	4-6-7 (N=13)			CH			
		SPT_ 6	100	4-6-8 (N=14)						
688		SPT_ 7	100	5-4-4 (N=8)			SM	Very loose, wet, orange-brown, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-215

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-215

Date(s) Drilled	04/29/2021 - 04/30/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7741377.9 E, 660488.4 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	717.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_ 8	100	1-1-3 (N=4)			SM	Very loose, wet, orange-brown, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Becomes loose, gray-brown, with trace gravel at 32.5 feet.* *Becomes medium dense at 35.0 feet.*	SPT_8: 48.3% fines by ASTM D1140 SPT_8: Oven Dried PI=16.8 (PL, LL = 34.8, 51.6).	
		SPT_ 9	100	1-2-4 (N=6)						
683										
35		SPT_ 10	100	3-4-12 (N=16)						
		SPT_ 11	100	8-7-17 (N=24)			SM	Medium dense, moist, gray-brown, Silty SAND (SM); fine to coarse sand, low plasticity fines, relict clastic texture. **Less Weathered Springwater Formation**	Chatter on gravel below 37.5 feet.	
678										
40		SPT_ 12	128	12-12-50 /2" (Refusal)			ML	Hard, wet when worked, gray-brown, Sandy SILT (ML); low plasticity, fine to coarse sand, trace fine to coarse gravel, relict clastic texture. **Less Weathered Springwater Formation**	Gravel from 40 to 42.5 feet. SPT_12: Oven Dried PI=3.6 (PL, LL = 29.0, 32.6). Gravel from 43.5 to 45 feet.	
673										
45		SPT_ 13	0	50/0" (Refusal)				Boulder from 45.0 to 47.0 feet. **Less Weathered Springwater Formation**	Boulder from 45 to 47 feet.	
							GP	Gravel from 47.0 to 48.0 feet. **Less Weathered Springwater Formation**	Soft drilling at 48 feet.	
668								Very stiff, moist, orange-brown, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**		
50		SPT_ 14	100	7-8-16 (N=24)			CL			
								Medium dense, wet, orange-brown and dark brown, Silty SAND (SM); fine to coarse sand, trace gravel, low plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	
663										
55		SPT_ 15	100	2-6-10 (N=16)			SM	Very stiff, wet when worked, brown, gray, and red, Sandy SILT (ML); low plasticity, fine to coarse sand, relict clastic texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**		
658							ML			

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-215

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-215

Date(s) Drilled	04/29/2021 - 04/30/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7741377.9 E, 660488.4 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	717.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_16	100	6-8-18 (N=26)			MH	Very stiff, moist to wet, brown, gray, and red, ELASTIC SILT (MH); high plasticity, fine to coarse sand, relict clastic texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**	SPT_16: Oven Dried PI=4.8 (PL, LL = 35.2, 40.0).	
653									Gravel at 63 feet.	
65		SPT_17	132	50/3" (Refusal)				Very dense, moist, gray-red, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines, moderately cemented. **Less Weathered Springwater Formation**		
648										
70		SPT_18	201	50/5" (Refusal)			SM	*Becomes gray-brown at 70.0 feet.*	Layered hard and less hard drilling from 70 to 75 feet.	
643										
75		SPT_19	198	50/5" (Refusal)				*Becomes Silty SAND (SM) at 75.0 feet.*	Very dense, gravelly drilling from 75 to 80 feet.	
638										
80		SPT_20	168	50/3" (Refusal)				*Becomes red-brown, SIlty SAND with gravel (SM) at 80.0 feet.*	Borehole completed at 80.3 feet below ground surface (bgs).	
633										
85										
628										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-215

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-216

Date(s) Drilled	04/21/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7740768.6 E, 660320.0 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	715.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40); WATER CONTENT (MC); ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
711 / 5		SPT_ 1	100	2-3-4 (N=7)				Medium stiff, moist, red-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Dirt road at ground surface.	
706 / 10		SPT_ 2	100	3-3-5 (N=8)			MH	*Becomes medium stiff, orange-brown at 10.0 feet.*		
701 / 15		SPT_ 3	100	4-5-7 (N=12)				*Becomes stiff at 15.0 feet.*		
696 / 20		SPT_ 4	100	4-5-8 (N=13)				Very stiff, moist, gray, FAT CLAY (CH); high plasticity, interlayered with orange and dark brown, LEAN CLAY (CL); low plasticity. **Residual Soil of the Springwater Formation**		
		SPT_ 5	100	6-8-10 (N=18)						
691 / 25		SPT_ 6	100	5-7-10 (N=17)			CH			
		SPT_ 7	100	4-6-10 (N=16)				*Not interlayered with lean clay below 27.5 feet.*		
686										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-216

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-216

Date(s) Drilled	04/21/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7740768.6 E, 660320.0 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	715.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_ 8	100	3-1-3 (N=4)			CH	Very stiff, moist, gray, FAT CLAY (CH); high plasticity **Residual Soil of the Springwater Formation**		
681 35		SPT_ 9	100	2-2-2 (N=4)			MH	Soft, wet, orange and gray, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, relict clastic texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Becomes orange-gray-dark brown at 32.5 feet.* *Becomes medium stiff, gray-brown and black at 35.0 feet.*	SPT_9: Oven Dried PI=23.0 (PL, LL = 40.2, 63.2).	
		SPT_ 10	100	1-2-3 (N=5)						
		SPT_ 11	100	2-3-8 (N=11)			SM	Medium dense, wet, gray-brown, Silty SAND (SM); fine to coarse sand, trace fine gravel, high plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite of the Springwater Formation**	Gravelly drilling at 39 feet.	
676 40		SPT_ 12	0	8-11-13 (N=24)						
		SPT_ 13	100	7-18-49 (N=67)			SM	Very dense, moist to wet, gray-brown, Silty SAND with cobbles (SM); fine to coarse sand, trace fine to coarse gravel, low plasticity fines. **Less Weathered Springwater Formation**	Cobbles and gravel from 45 to 50 feet.	
671 45		SPT_ 14	120	26-33-50 /3" (Refusal)						
666 50		SPT_ 15	100	25-39-36 (N=75)			SM	Very dense, moist, gray-brown, Silty SAND with cobbles (SM); fine to coarse sand, trace gravel, low plasticity overconsolidated fines. **Less Weathered Springwater Formation** *Becomes moderately cemented at 55.0 feet.*		
661 55		SPT_ 16	114	50/3" (Refusal)						
656							CL	Very stiff, moist, gray, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**	Softer drilling from 57 to 65 feet.	

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-216

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-216

Date(s) Drilled	04/21/2021	Client	Portland Water Bureau	Final Depth	80.3 ft bgs
Coordinates	7740768.6 E, 660320.0 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 55 Track Mounted
Surface Elevation	715.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SPT_ 17	100	8-10-19 (N=29)			CL	Very stiff, moist, gray, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**		
651 65		SPT_ 18	100	8-16-17 (N=33)			SM	Dense, wet, gray, yellow, red, and brown, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**		
							SM	Dense, moist, gray, yellow, red, and brown, Silty SAND (SM); fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**	Harder drilling at 68 feet.	
646 70		SPT_ 19	160	50/5" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**		
641 75		SPT_ 20	186	47-50/1" (Refusal)			SM	Very dense, moist, gray-brown, Silty SAND (SM); fine to coarse sand, overconsolidated fines, moderately cemented. **Less Weathered Springwater Formation**		
636 80		SPT_ 21	114	50/3" (Refusal)					Borehole completed at 80.3 feet below ground surface (bgs).	
631 85										
626										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-216

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-217

Date(s) Drilled	04/22/2021 - 04/23/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740994.0 E, 660223.3 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	719.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
715 / 5		SPT_ 1	100	2-2-4 (N=6)				Medium stiff, moist, red-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Flush-mount monument installed. VWP installed at 38 feet and grouted into borehole. S/N: 2113124 Plowed field at ground surface.	
710 / 10		SPT_ 2	100	3-5-6 (N=11)			MH	*Becomes stiff at 10.0 feet.*		
705 / 15		SPT_ 3	100	3-4-8 (N=12)						
700 / 20		SPT_ 4	100	4-4-8 (N=12)						
		SPT_ 5	100	4-6-9 (N=15)						
695 / 25		SH_6	128				CH	Stiff, moist, orange and gray, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation** *Becomes gray, orange, and black with trace fine to coarse sand at 25.0 feet.* *Becomes very stiff at 27.5 feet.*	SH_6 advanced at 450 psi from 25 to 26 feet and at 800 psi from 26 to 26.5 feet.	
		SPT_ 7	100	6-8-10 (N=18)						
690										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-217

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-217

Date(s) Drilled	04/22/2021 - 04/23/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740994.0 E, 660223.3 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	719.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		SH_8	84				CH	Stiff, moist, orange and gray, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation** *Becomes gray and red at 30.0 feet.*	SH_8 advanced at 500 psi from 30 to 31 feet and at 750 psi from 21 to 32 feet.	
		SPT_ 9	100	2-4-6 (N=10)			MH	Stiff, wet, gray, red, and light brown, ELASTIC SILT (MH); high plasticity, sensitive. **Sensitive Saprolite of the Springwater Formation**		
685	35									
		SH_10	116					Stiff, wet, orange-brown and gray, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, sensitive.	SH_10 advanced at 350 psi from 35 to 36 feet and at 600 psi from 36 to 37 feet.	
		SPT_ 11	100	2-3-6 (N=9)			MH	**Sensitive Saprolite of the Springwater Formation**	SPT_11: Oven Dried PI=4.7 (PL, LL = 41.5, 46.2).	
680	40									
		SH_12	212						SH_12 advanced at 800 psi for 1".	
		SPT_ 13	100	8-10-13 (N=23)			ML	Very stiff, moist, gray-brown and red, Sandy SILT (ML); low plasticity, fine to coarse sand. **Less Weathered Springwater Formation**	SPT_13: Oven Dried PI=3.7 (PL, LL = 34.2, 37.9).	
		SPT_ 14	55	13-17-12 (N=29)			SM	Medium dense, wet, gray-brown, Silty SAND (SM); fine to medium sand, trace fine gravel, low plasticity fines, relict clastic texture, sensitive.	Gravelly drilling at 42.5 feet.	
675	45							**Less Weathered Springwater Formation**	Cobbles encountered between 45 and 48 feet.	
		SPT_ 15	123	25-50/3" (Refusal)				Very dense, wet, gray-brown, Silty SAND with gravel and cobbles (SM); coarse gravel, fine to medium sand, low plasticity fines, relict texture. **Less Weathered Springwater Formation** *No cobbles below 48.0 feet.*		
670	50									
		SPT_ 16	159	27-50/1" (Refusal)			SM		Gravelly drilling from 50 to 57 feet.	
665	55									
		SPT_ 17	200	50/3" (Refusal)				*Becomes Silty SAND (SM); few gravel at 55.0 feet; overconsolidated fines, moderately cemented.*		
							CL	Hard, moist, light gray, LEAN CLAY (CL); low plasticity, overconsolidated. **Less Weathered Springwater Formation**	Clayey drilling at 57 feet.	
660										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-217

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-B-217

Date(s) Drilled	04/22/2021 - 04/23/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740994.0 E, 660223.3 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Mud Rotary/CME 800 Track
Surface Elevation	719.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT) / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
655 / 65		SPT_18	100	7-14-21 (N=35)	CL	Hard, moist, light gray, LEAN CLAY (CL); low plasticity, overconsolidated. **Less Weathered Springwater Formation**		
650 / 70		SPT_19	156	9-50/3" (Refusal)	SM	Very dense, moist and wet, Silty SAND with Cobbles (SM); fine to medium sand, layered high plasticity and low plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation** *Two cobbles at 67.0 feet.*	Gravels at 64.5 feet.	
645 / 75		SPT_20	128	21-41-50 /2" (Refusal)	SM	Very dense, moist, gray-brown, Silty SAND with Gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines, weakly cemented. **Less Weathered Springwater Formation**	Hard cemented drilling from 70 to 75 feet.	
640 / 80		SPT_21	227	50/4" (Refusal)			Hard gravels from 75 to 80 feet.	
635 / 85		SPT_22	0	50/0" (Refusal)			Borehole completed at 80 feet below ground surface (bgs).	
630								

PENETRATION RESISTANCE BLOWS/FT: 10 20 30 40
WATER CONTENT (MC)
ATTERBERG LL/PL: 20 40 60 80

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-B-217

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-203

Date(s) Drilled	05/03/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740510.5 E, 661024.3 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	706.8 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		C_1	100					Moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**	Borehole instrumented with a 2" ID standpipe piezometer with 010 slot and 10/20 sand; flush-mount monument at surface. Well ID #: L142278 Start Card #:1051771 Driller used water to reduce friction on drill casing during installation.	
		GS_1	100							
702	5									
		C_2	100							
		GS_2	87							
697	10						MH			
		C_3	87							
692	15	GS_3	100							
		C_4	97							
687	20	GS_4	100					*Becomes orange-brown and black at 19.0 feet.*		
		C_5	100					Moist, gray and brown, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**	Fat clay swelling; sample recovery over 100% from 20 to 30 feet.	
		GS_5	103				CH			
682	25							*Becomes gray, red, and orange below 25.0 feet.*		
		C_6	127					Moist, orange-brown, gray, and black, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, relict texture, sensitive.		
		GS_6	100				MH	**Sensitive Saprolite of the Springwater Formation**	GS_6: Oven Dried PI=21.4	

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-203

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-203

Date(s) Drilled	05/03/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740510.5 E, 661024.3 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	706.8 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		GS_7	200				CH	Moist, gray and orange, FAT CLAY (CH); high plasticity. **Sensitive Saprolite of the Springwater Formation**	(PL, LL = 37.9, 59.3). Driller did not use water to drill from 30 to 40 feet.	
		C_7	100				MH			
							SM	Wet, brown, gray, and yellow, Sandy ELASTIC SILT (MH), high plasticity, fine to coarse sand, relict clastic texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		
672 35									Clay swells up into rods at 35 feet.	
		C_8	100				SM	Wet, brown, gray, and yellow, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, high plasticity fines, sensitive. **Sensitive Saprolite of the Springwater Formation**	Sonic drilling disturbs relict clastic texture in soil.	
667 40		GS_8	100							
		GS_9	100				SM	Wet, gray-brown, Silty SAND (SM); fine to coarse sand, few fine to coarse gravel, high plasticity fines, sensitive. **Sensitive Saprolite of the Springwater Formation**	GS_9: Oven Dried PI=2.2 (PL, LL = 26.4, 28.6).	
		C_9	100							
							SM	Wet, gray-brown, Silty SAND with gravel (SM); fine to coarse sand, low plasticity fines. **Less Weathered Springwater Formation**		
662 45								Two 4-5" diameter cobbles between 42 and 43 feet. (Broken by drilling.) **Less Weathered Springwater Formation**	Swelling of overconsolidated clayey soil rubbing on casing likely contributing to issues drilling in Less Weathered Springwater Formation. Hard drilling at 50 feet; very difficult to advance casing to 50 feet.	
		C_10	108							
657 50		GS_10	100				SM	Moist, gray-brown, Silty SAND with cobbles (SM); fine to coarse sand, trace fine to coarse gravel, low plasticity fines. **Less Weathered Springwater Formation** *6" diameter cobble at 44.5 feet.*		
		C_11	103					Moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly to moderately cemented. **Less Weathered Springwater Formation** *At 50.0 feet becomes gray-brown and orange-brown.*		
652 55		GS_11	100				CL	Moist to wet, gray and orange, LEAN CLAY (CL); low plasticity, overconsolidated. **Less Weathered Springwater Formation**		
		C_12	108							
							ML	Moist to wet, gray and orange, Sandy SILT (ML); low plasticity, fine to medium sand. **Less Weathered Springwater Formation**		

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-203

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-203

Date(s) Drilled	05/03/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740510.5 E, 661024.3 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	706.8 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		C_13	100				SM	Moist, orange, brown, and gray, Silty SAND (SM); fine to coarse sand, few fine to coarse gravel, high plasticity fines, relict clastic texture, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**		
642 65		C_14	100				SM	Moist, gray-brown and orange, Silty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly to moderately cemented, oxidized, weathered. **Less Weathered Springwater Formation** *6" diameter andesite cobble at 65.0 feet.*		
637 70		GS_12	100		○					
		C_15	70				SM	Moist, orange-brown becoming gray, Silty SAND (SM); fine to coarse sand, few fine to coarse gravel, low plasticity fines, weakly to moderately cemented, oxidized/weathered zones. **Less Weathered Springwater Formation**		
632 75		GS_13	100		○					
		C_16	100				SM	Moist, gray becoming brown and orange, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly to moderately cemented. **Less Weathered Springwater Formation** *Dry zone from 79.0 to 80.0 feet; dessicated by sonic drilling.*		
627 80									Borehole completed at 80 feet below ground surface (bgs).	
622 85										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-203

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-213

Date(s) Drilled	05/04/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740918.7 E, 660489.4 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	713.9 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		C_1	100					Moist, orange-brown, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**	Installed drill casing to 20 feet.	
		GS_1	100							
709 5										
		C_2	80							
704 10		GS_2	100							
		C_3	100							
		GS_3	100							
699 15							CH		Driller requires water to drill due to squeezing clay and high friction.	
		C_4	100							
		GS_4	100							
694 20								*Becomes gray and brown at 20.0 feet.*	20 - 21 feet: soil is wet from drilling water.	
		C_5	100							
		GS_5	105							
689 25										
		C_6	102							
		GS_6	100				SM	Wet, orange-brown, gray, and brown, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		

DELVE underground

NOTES:
Location and Elevation Source: USGS Topo Map
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-213

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-213

Date(s) Drilled	05/04/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740918.7 E, 660489.4 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	713.9 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		C_7	100				SM	Wet, orange-brown, gray, and brown, Silty SAND (SM); fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation** *Below 30.0 feet becomes orange-brown, red, gray, and yellow.* *Scattered gravel below 32.5 feet.*	Soil texture disturbed by auger bit used to retain soil in sonic core barrel. GS_7: Oven Dried PI=19.3 (PL, LL = 36.9, 56.2). 35 to 36 feet; soil is wet from drilling. Hard drilling from 36 to 37 feet.	
		GS_7	100							
679	35						SM	Wet, gray-brown, Silty SAND with gravel and boulders (SM); fine to coarse gravel, fine to coarse sand, high plasticity fines, relict texture, sensitive. **Sensitive Saprolite of the Springwater Formation**		
		C_8	107							
		GS_8	100				SM			
674	40							Weathered boulder from 36.0 to 37.0 feet; broken by drilling. **Less Weathered Springwater Formation**		
		C_9	100				SM	Moist, gray-brown, Silty SAND with gravel and boulders (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, relict texture. **Less Weathered Springwater Formation**		
		GS_9	100							
669	45							Moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, moderately cemented, minor oxidation. **Less Weathered Springwater Formation**		
		C_10	100							
664	50						SM	Moist, gray-brown, Silty SAND with gravel and cobbles (SM); fine to coarse gravel fine to coarse sand, low plasticity fines, moderately cemented. **Less Weathered Springwater Formation** *One 4" diameter cobble at 45.5 feet.* *Trace cobbles at 50.0 feet.* *One 5" diameter cobble at 52.0 feet.* *One 3.5" diameter cobble at 54.6 feet.*	Switched to 10-foot runs at 50 feet.	
		C_11	100							
659	55							Moist, gray-brown, SILT (ML); low plasticity, trace gravel, overconsolidated. **Less Weathered Springwater Formation**		
		GS_1	100				ML			
		0	100					Moist, gray-brown, Silty SAND with gravel (SM): fine to coarse gravel, fine to coarse sand, low plasticity fines, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation**		
		C_12					SM			

DELVE underground

NOTES:
Location and Elevation Source: USGS Topo Map
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-213

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-213

Date(s) Drilled	05/04/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7740918.7 E, 660489.4 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	713.9 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
649 65		C_13	100					Moist, brown, Silty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, low plasticity overconsolidated fines, weakly cemented. **Less Weathered Springwater Formation** *One 4" diameter cobble at 63.6 feet.* *At 65.0 feet, becomes weakly to moderately cemented.* *One 6" diameter broken cobble at 65.0 feet.* *One 3.5" cobble at 67.0 feet.*		
		C_14	100		○		SM			
		GS_1 1	100							
644 70								*One 3.5" diameter cobble at 69.5 feet.* *At 70.0 feet becomes gray-brown and gray, uncemented to weakly cemented.*		
		C_15	100							
639 75								*One large broken cobble at 74.5 feet.* *12" diameter broken, weathered boulder from 75.0 to 76.0 feet.* Moist, gray-brown and red-gray, Silty SAND with gravel, cobbles, and boulders (SM); fine to coarse sand, low plasticity fines, weakly to moderately cemented. **Less Weathered Springwater Formation** *One 4" diameter cobble at 77.0 feet.*		
		C_16	100				SM			
		GS-1 2	100		○					
634 80									Borehole completed at 80 feet below ground surface (bgs).	
629 85										

DELVE underground

NOTES:
Location and Elevation Source: USGS Topo Map
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-213

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-218

Date(s) Drilled	05/05/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7741208.6 E, 660246.6 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	719.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
715 / 5		C_1	100		○		MH	Moist, orange-brown, ELASTIC SILT (MH); high plasticity. **Residual Soil of the Springwater Formation**		
		GS_1	87							
		C_2	72					*Becomes brown to orange-brown at 5.0 feet.*		
710 / 10		GS_2	100		○					
		C_3	100							
		GS_3	100		⊣○⊢					
705 / 15		C_4	100							
		GS_4	100		○					
700 / 20		C_5	115					*Becomes orange-brown and black at 20.0 feet.*	Driller used water below 20 feet. Swelling clay from 20 to 30 feet; driller removed extra 9" before core box photo was taken.	
		GS_5	100		○					
695 / 25		C_6	100		○		CH	Moist, gray, orange, and red, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**		
		GS_6	120							
690										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-218

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-218

Date(s) Drilled	05/05/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7741208.6 E, 660246.6 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	719.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
		C_7	100				CH	Moist, gray, orange, and red, FAT CLAY (CH); high plasticity. **Residual Soil of the Springwater Formation**	C_7 30 to 35 feet: three attempts required to capture sample. Sample is very disturbed. Very soft drilling from 30 to 40 feet; Small amount of added water. GS_7: Oven Dried PI=13.8 (PL, LL = 38.1, 51.9).	
		GS_7	100				MH	Wet, gray, orange, and brown, Sandy ELASTIC SILT (MH); high plasticity, fine to coarse sand, few fine to coarse gravel, sensitive. **Sensitive Saprolite of the Springwater Formation**		
685	35									
		C_8	80				SM	Wet, gray-brown, Silty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, sensitive. **Sensitive Saprolite of the Springwater Formation** *One 3.5" diameter cobble at 39.5 feet.*		
		GS_8	100							
680	40						MH	Wet, gray-brown, Sandy ELASTIC SILT (MH); high plasticity, fine to medium sand, sensitive. **Sensitive Saprolite of the Springwater Formation**		
		C_9	103				SM			
		GS_9	100					Moist to wet, gray-brown and orange, Silty SAND (SM); fine to coarse sand, few fine to coarse gravel, low plasticity fines. **Less Weathered Springwater Formation**		
675	45									
		C_10	105				SM	Moist, gray-brown, Silty SAND with gravel and cobbles (SM); fine to coarse sand, low plasticity fines, moderately cemented. **Less Weathered Springwater Formation** *One cobble at 44.0 feet.* *At 45.0 feet becomes gray-brown and orange, no cementation to moderately cemented, oxidized.* *One 3.5" diameter cobble at 46.0 feet.* *Two 4" diameter cobbles between 50.0 and 51.0 feet.*		
670	50									
		C_11	100				GM	Moist, gray-brown and orange, Silty GRAVEL with sand and cobbles (GM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly to moderately cemented, minor oxidation. **Less Weathered Springwater Formation** *One 6" diameter cobble at 53.0 feet.*		
665	55									
		C_12	100				CL	Moist, gray and orange, LEAN CLAY (CL); low plasticity. **Less Weathered Springwater Formation**		
660										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-218

Project: Bull Run Filtration Facility
Project Location: Multnomah County, OR
Project Number: 6084.0

Log of Boring

FF-SC-218

Date(s) Drilled	05/05/2021	Client	Portland Water Bureau	Final Depth	80.0 ft bgs
Coordinates	7741208.6 E, 660246.6 N	Geotechnical Consultant	Lacamas Consulting	Method/ Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	719.6 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	6.00 in
Location	Carpenter Lane Nursery	Logged by/ Checked by	Susan Bednarz / Susan Bednarz	Hammer Type	N/A

ELEV. (FT) / WATER LEVEL / DEPTH (FT)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (%)	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT (10 20 30 40) / WATER CONTENT (MC) / ATTERBERG LL/PL (20 40 60 80)	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
655 / 65		GS_10 C_13	100 107				SM	Moist, orange-brown and gray, SIlty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, sensitive. **Sensitive Saprolite within Less Weathered Springwater Formation** *One 4" diameter cobble at 60.0 feet.* *Minor sensitivity from 62.0 to 65.0 feet.*	GS_10: Oven Dried PI=2.0 (PL, LL = 34.0, 36.0).	
650 / 70		GS_11 C_14	100 100				SM	Moist, orange, brown, and gray, Silty SAND with gravel and cobbles (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly to moderately cemented. **Less Weathered Springwater Formation** *One 5+" diameter cobble at 67.5 feet.*		
645 / 75		C_15	103				SM	Moist, gray-brown, Silty SAND with gravel (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly to moderately cemented. **Less Weathered Springwater Formation**	1.5' diameter andesite boulder from 77.5 to 79 feet; broken during coring.	
640 / 80		GS_12 C_16	100 103				SM	Moist, gray-brown, Silty SAND with gravel and boulders (SM); fine to coarse gravel, fine to coarse sand, low plasticity fines, weakly to moderately cemented. **Less Weathered Springwater Formation** *1.5' diameter andesite boulder from 77.5 to 79.0 feet; broken during coring.*		
635 / 85									Borehole completed at 80 feet below ground surface (bgs).	
630										

DELVE underground

NOTES:
Location and Elevation Source: PWB Survey 5-13-2021
Vertical Datum: Portland Vertical
Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring FF-SC-218