

August 1, 2023

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

**Subject:** Supplemental Information  
**Re:** Land Use Permitting

Dear Jesse:

Delve Underground was asked to provide additional information in regard to the “expansive soil” and “Fat Clay” layer identified in in response to comments on those issues included in a memorandum prepared by True North Geotechnical dated June 28, 2023 (Exhibit E.21). An extensive geotechnical exploration program was performed on the project site, all relevant soil layers were identified with recommendations for design and construction provided to the Portland Water Bureau and design team.

Expansive soils are clayey soils, generally Fat Clays containing specific clay minerals, that exhibit volume changes due to changes in water content. Fat Clay was not encountered in the explorations near the proposed shaft location. Fat Clay soils were identified in field explorations in eastern half of the raw water pipeline (RWP) alignment, within the upper 20 feet of the ground. Attached are the project site plan showing the exploration locations and logs of the borings completed by Delve Underground. Borings in which fat clay was identified are highlighted in green. The pipeline in this section of the alignment will be embedded in gravelly soils, below fat clay. Gravelly soils are not susceptible to expansion. The foundations of ancillary structures such as manholes or access way structures will also be constructed on gravelly soils. Therefore, presence of fat clay in this section of the alignment is not anticipated to impact the pipeline and associated structures.

The map of expansive soils in the U.S. by Olive, et al. (1989) identifies soils within eastern part of the Portland metro as “Little or no Swelling Clay”. Specific testing of the expansive potential of the Fat Clays was not performed because the design of the pipeline is not sensitive to the expansive properties on account of the pipeline being founded on material below the Fat Clay and because steel pipes, which will be utilized in this project, are flexible elements that can accommodate a moderate amount of deformation.



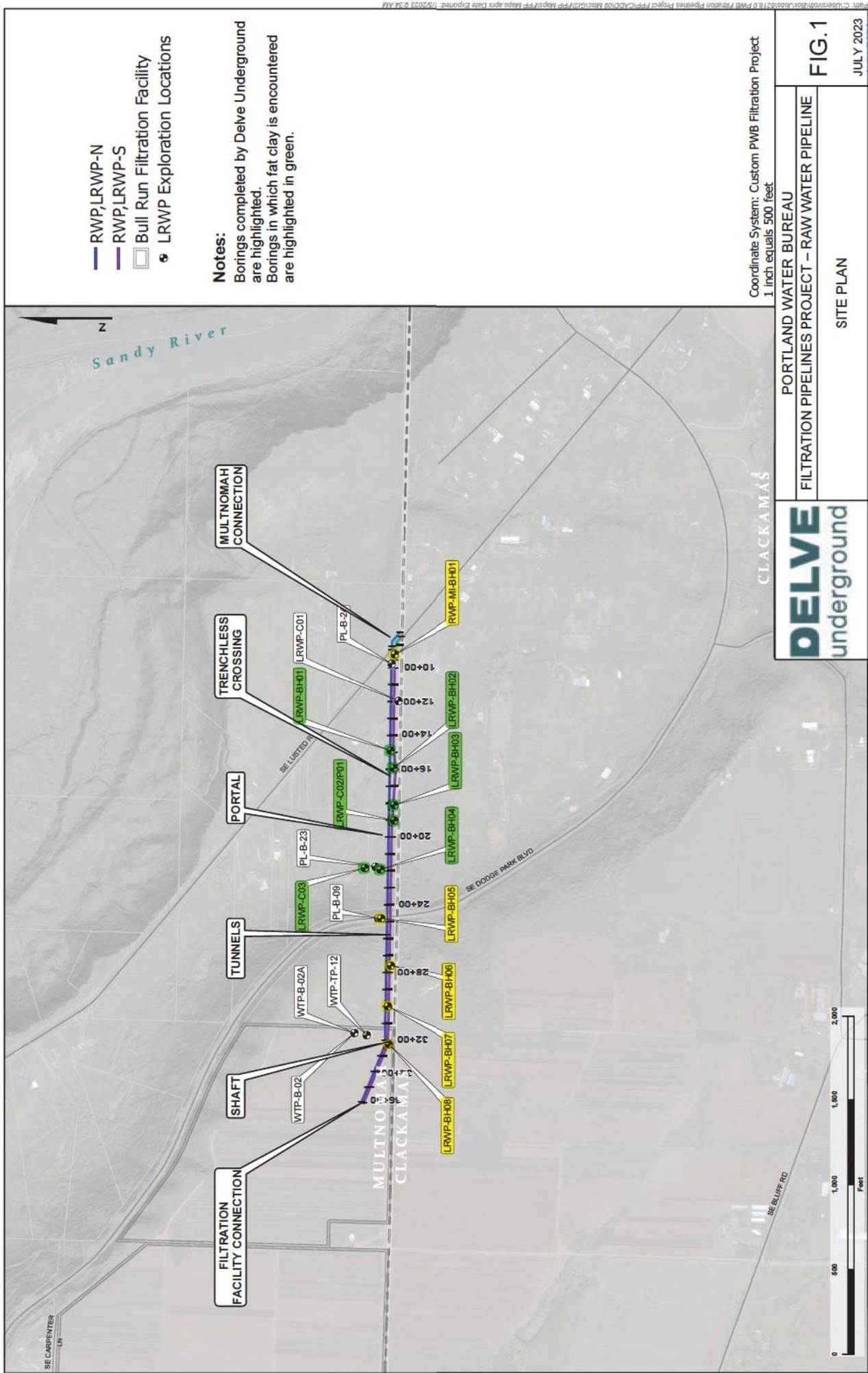
The conclusion provided in Exhibit A.82 that “Based on a review of published geologic and seismic hazard mapping and the explorations and analyses performed for the project as documented in this report, the location of the RWP section of the Pipelines project is suitable for the proposed development”, remains valid.

Sincerely,



Farid Sariosseiri, PE  
Lead Associate

cc: File



- RWP,LRWP-N
- RWP,LRWP-S
- Bull Run Filtration Facility
- LRWP Exploration Locations

**Notes:**

Borings completed by Delve Underground are highlighted.  
 Borings in which fat clay is encountered are highlighted in green.

Coordinate System: Custom PWB Filtration Project  
 1 inch equals 500 feet

PORTLAND WATER BUREAU  
 FILTRATION PIPELINES PROJECT – RAW WATER PIPELINE  
 SITE PLAN

**FIG.1**  
 JULY 2023



MOISTURE CONTENT

DESCRIPTION	CONDITION
Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp, but no visible water.
Wet	Visible free water, typically below water table.

ABBREVIATIONS

SYMBOL	DEFINITION
H	Atterberg Limits
○	Moisture Content
■	Blows per foot (N)

FINE-GRAINED SOIL  
CONSISTENCY

RELATIVE CONSISTENCY	N, SPT <i>Blows/foot</i>
Very Soft	0 to 1
Soft	2 to 4
Medium stiff	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	> 30

COARSE-GRAINED SOIL DENSITY

Relative Density	N, SPT <i>Blows/foot</i>
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	> 50

PERCENTAGE RANGE TERMS<sup>1,2</sup>

DESCRIPTION	RANGE
Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

1. Gravel, Sand and fines are estimated by mass. Other constituents such as organics, cobbles, and boulders are estimated by volume.

2. Percentages per ASTM D2488.

SOIL CONSTITUENCY DEFINITIONS

CONSTITUENT	COARSE-GRAINED	FINE-GRAINED
Major	Less than 50% fines: SAND or GRAVEL	More than 50% fines: SILT, ELASTIC SILT, LEAN CLAY, FAT CLAY, ORGANIC SOIL
Secondary	12% <sup>1</sup> or more fine-grained: Silty or Clayey	30% or more coarse-grained: Sandy or Gravelly
Minor	5 to 12% <sup>1</sup> fine-grained: with Silt or with Clay	15 to 30% coarse-grained: with Sand or with Gravel
	15% or more of a second coarse-grained constituent: with Sand or with Gravel	30% or more total coarse-grained and the lesser coarse constituent is 15% or more: with Sand or with Gravel

1. ASTM D2488 specifies more than 15% fines

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE SIZE <i>PER ASTM D2488</i>	
<b>FINES</b>		
	< #200 (0.075 mm)	
<b>SAND</b>	<i>Fine</i>	#200 to #40 (0.075 to 0.4 mm)
	<i>Medium</i>	#40 to #10 (0.4 to 2 mm)
	<i>Coarse</i>	#10 to #4 (0.4 to 4.75 mm)
<b>GRAVEL</b>	<i>Fine</i>	#4 to ¾ in. (4.75 to 19 mm)
	<i>Medium</i>	¾ to 3 in. (19 to 76 mm)
<b>COBBLES</b>		
	3 to 12 in. (76 to 305 mm)	
<b>BOULDERS</b>		
	> 12 in. (305 mm)	

# UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)<sup>1</sup>

MAJOR DIVISIONS		SYMBOL	TYPICAL DESCRIPTION	ALTERNATE DESCRIPTIONS			
<b>COARSE-GRAINED SOILS</b> (50% OR MORE RETAINED BY NO. 200 SIEVE)	<b>GRAVELS</b> (MORE THAN 50% RETAINED ON NO. 4 SIEVE)	<b>CLEAN GRAVELS</b> (≤ 5% FINES)	<b>GW</b> 	WELL-GRADED GRAVEL	WELL-GRADED GRAVEL WITH SAND		
		<b>GP</b> 	POORLY GRADED GRAVEL	POORLY GRADED GRAVEL WITH SAND			
		<b>GRAVELS<sup>2,4</sup></b> (5 – 12 % FINES)	<b>GW-GM</b> 	WELL-GRADED GRAVEL WITH SILT	WELL-GRADED GRAVEL WITH SILT AND SAND		
			<b>GW-GC</b> 	WELL-GRADED GRAVEL WITH CLAY	WELL-GRADED GRAVEL WITH CLAY AND SAND		
			<b>GP-GM</b> 	POORLY GRADED GRAVEL WITH SILT	POORLY GRADED GRAVEL WITH SILT AND SAND		
			<b>GP-GC</b> 	POORLY GRADED GRAVEL WITH CLAY	POORLY GRADED GRAVEL WITH CLAY AND SAND		
	<b>GRAVELS WITH FINES<sup>2</sup></b> (≥ 12% FINES)	<b>GM</b> 	SILTY GRAVEL	SILTY GRAVEL WITH SAND			
		<b>GC</b> 	CLAYEY GRAVEL	CLAYEY GRAVEL WITH SAND			
	<b>SANDS</b> (LESS THAN 50% RETAINED ON NO. 4 SIEVE)	<b>CLEAN SANDS</b> (≤ 5% FINES)	<b>SW</b> 	WELL-GRADED SAND	WELL-GRADED SAND WITH GRAVEL		
			<b>SP</b> 	POORLY GRADED SAND	POORLY GRADED SAND WITH GRAVEL		
		<b>SANDS<sup>2,4</sup></b> (5 – 12 % FINES)	<b>SW-SM</b> 	WELL-GRADED SAND WITH SILT	WELL-GRADED SAND WITH SILT AND GRAVEL		
			<b>SW-SC</b> 	WELL-GRADED SAND WITH CLAY	WELL-GRADED SAND WITH CLAY AND GRAVEL		
			<b>SP-SM</b> 	POORLY GRADED SAND WITH SILT	POORLY GRADED SAND WITH SILT AND GRAVEL		
			<b>SP-SC</b> 	POORLY GRADED SAND WITH CLAY	POORLY GRADED SAND WITH CLAY AND GRAVEL		
		<b>SANDS WITH FINES<sup>3</sup></b> (> 12% FINES)	<b>SM</b> 	SILTY SAND	SILTY SAND WITH GRAVEL		
			<b>SC</b> 	CLAYEY SAND	CLAYEY SAND WITH GRAVEL		
		<b>FINE-GRAINED SOILS</b> (50% OR MORE PASSES NO. 200 SIEVE)	<b>SILTS AND CLAYS</b> (LL < 50)	INORGANIC	<b>ML</b> 	SILT	SILT WITH SAND OR GRAVEL; SANDY OR GRAVELLY SILT
				<b>CL</b> 	LEAN CLAY	LEAN CLAY WITH SAND OR GRAVEL; SANDY OR GRAVELLY LEAN CLAY	
ORGANIC	<b>OL</b> 			ORGANIC SOIL	ORGANIC SOIL WITH SAND OR GRAVEL; SANDY OR GRAVELLY ORGANIC SOIL		
<b>SILTS AND CLAYS</b> (LL ≥ 50)	INORGANIC		<b>MH</b> 	ELASTIC SILT	ELASTIC SILT WITH SAND OR GRAVEL; SANDY OR GRAVELLY ELASTIC SILT		
	<b>CH</b> 		FAT CLAY	FAT CLAY WITH SAND OR GRAVEL; SANDY OR GRAVELLY FAT CLAY			
	ORGANIC		<b>OH</b> 	ORGANIC SOIL	ORGANIC SOIL WITH SAND OR GRAVEL; SANDY OR GRAVELLY ORGANIC SOIL		
<b>SILT/CLAY<sup>2</sup></b>	INORGANIC		<b>CL-ML</b> 	SILTY CLAY	SILTY CLAY WITH SAND OR GRAVEL; SANDY OR GRAVELLY SILTY CLAY		
<b>HIGHLY ORGANIC SOILS</b>	ORGANIC	<b>PT</b> 	PEAT				

**NOTES:**

1. The USCS described here is based on ASTM standards D2487 & D2488.
2. Dual symbol materials (e.g., SP-SM) are used for soils between 5% and 12% fines or when liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart, (LL: 12 -25, PI: 4-7).
3. ASTM D2488 specifies the use of dual symbol coarse-grained soils between 5% and 15% fines.

BACKFILL, WELL, AND SAMPLE SYMBOLS					
	Bentonite Chips		Grout		2" OD Split Barrel Sampler
	Concrete		Observation Well - Solid		Shelby Tube Sample
	Sand		Observation Well - Screen		Grab Sample
	Asphalt		Vibrating Wire Piezometer		Rock Core Run
	Gravel		Measured Groundwater Level		

# Key to Rock Core Logs

## Rock Strength

Grade <sup>1</sup>	Description	Recognition	UCS <sup>2</sup> (psi)
R0	Extremely Weak	Indented by thumbnail	30 to 150
R1	Very Weak	Peeled by pocketknife	150 to 700
R2	Weak	Peeled with difficulty by pocketknife	700 to 3,600
R3	Medium Strong	Indented 5 mm with sharp end of pick	3,600 to 7,200
R4	Strong	One hammer blow to fracture	7,200 to 14,500
R5	Very Strong	Many hammer blows to fracture	14,500 to 36,000
R6	Extremely Strong	Only chipped by hammer blows	>36,000

1: Rock strength grades from Brown (1981)  
2: Uniaxial Compressive Strength (pounds per square inch)

## Rock Weathering/Alteration

Residual Soil	Entirely decomposed to secondary minerals; material can be easily broken by hand
Completely Weathered/Altered	Almost entirely decomposed to secondary minerals; material can be granulated by hand
Highly Weathered/Altered	More than half of the rock is decomposed
Moderately Weathered/Altered	Rock is discolored and noticeably weakened, but less than half is decomposed
Slightly Weathered/Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh/Unweathered	Rock shows no discoloration, loss of strength, or other effect of weathering or alteration

## Rock Fracture Spacing

IF	Intensely Fractured	Fractures spaced less than 2 inches apart
HF	Highly Fractured	Fractures spaced 2 inches to 1 foot apart
MF	Moderately Fractured	Fractures spaced 1 foot to 3 feet apart
SF	Slightly Fractured	Fractures spaced 3 feet to 10 feet apart
M	Massive	Fracture spacing greater than 10 feet

## Lithology Graphics

		
Basalt	Sandstone	Conglomerate

## Joint Infill

CL	Clay	Ctg	Coating/ Staining	Fe	Iron Oxide	U	Unknown
Fi	100% Filling	--	None/ Not observed	Si	Silt		

## Core Recovery Calculation (%)

$$\frac{\sum \text{Length of the recovered core pieces}}{\text{Total Length of core run}} \times 100$$

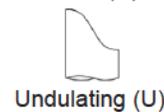
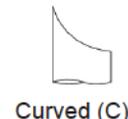
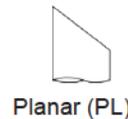
## RQD Calculation (%)

$$\frac{\sum \text{Length of intact core pieces } >4 \text{ in.}}{\text{Total Length of core run}} \times 100$$

## Discontinuity Type

J	Joint
MB	Mechanical Break
FJ	Joint along foliation
S	Shear
F	Fault
HJ	Healed joint
B	Joint along bedding

## Shape



## Aperture (Inches)

VW	Wide (<1.0)
W	Moderately Wide (0.2-1.0)
N	Narrow (0.05-0.2)
VN	Very Narrow (0-0.05)
T	Tight (0)

## Surface Roughness

SLK	Slickensided
S	Smooth
SR	Slightly Rough
R	Rough
VR	Very Rough

## Bedding Spacing

Very Thin	Laminated (<2 in.)
Thin	2 in to 1 ft
Medium	1 ft to 3 ft
Thick	3 ft to 10 ft
Very Thick	>10 ft

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**RWP-MI-BH01**

Date(s) Drilled	03/09/2021	Client	Jacobs Engineering Group	Final Depth	70.2 ft bgs
Coordinates	7745689.4 E, 659465.5 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	499.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 9+18	Logged by/Checked by	D. Roth / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
495		5		73	2-1-2 (N=3)	S-01	■	○		ML	Moist, brown, SILT with Sand (ML). <b>Topsoil</b>	S-01: 73.0% Fines.	
				80	4-6-10 (N=16)	S-02	■	○		ML	Soft, moist, orange-brown SILT with Sand (ML); trace subangular to angular fine gravel, medium to coarse sand, low plasticity fines. <b>Gresham Formation</b>	S-02: 32.6% Fines.	
490		10		3	27-22-10 (N=32)	S-03	○	■			Medium dense to dense, moist, gray and mottled gray, light brown, and black, Clayey SAND with Gravel (SC); fine to medium sand, highly to completely weathered fine to coarse angular gravel, high plasticity fines.	S-03, S-04, and S-05 composite sample: 22.0% Gravel, 47.1% Sand, 30.9% Fines.	
				0	4-4-8 (N=12)	S-04a MC-4 b	■	○					
485		15		83	8-9-32 (N=41)	S-05	○	■					
				60	3-12-21 (N=33)	S-06	■						
480		20		53	9-12-20 (N=32)	S-07	■			SC			
475		25		77	9-12-16 (N=28)	S-08a MC-8 b	○	■				MC-8b; 13.1% Gravel, 59.6% Sand, 27.3% Fines.	
470													



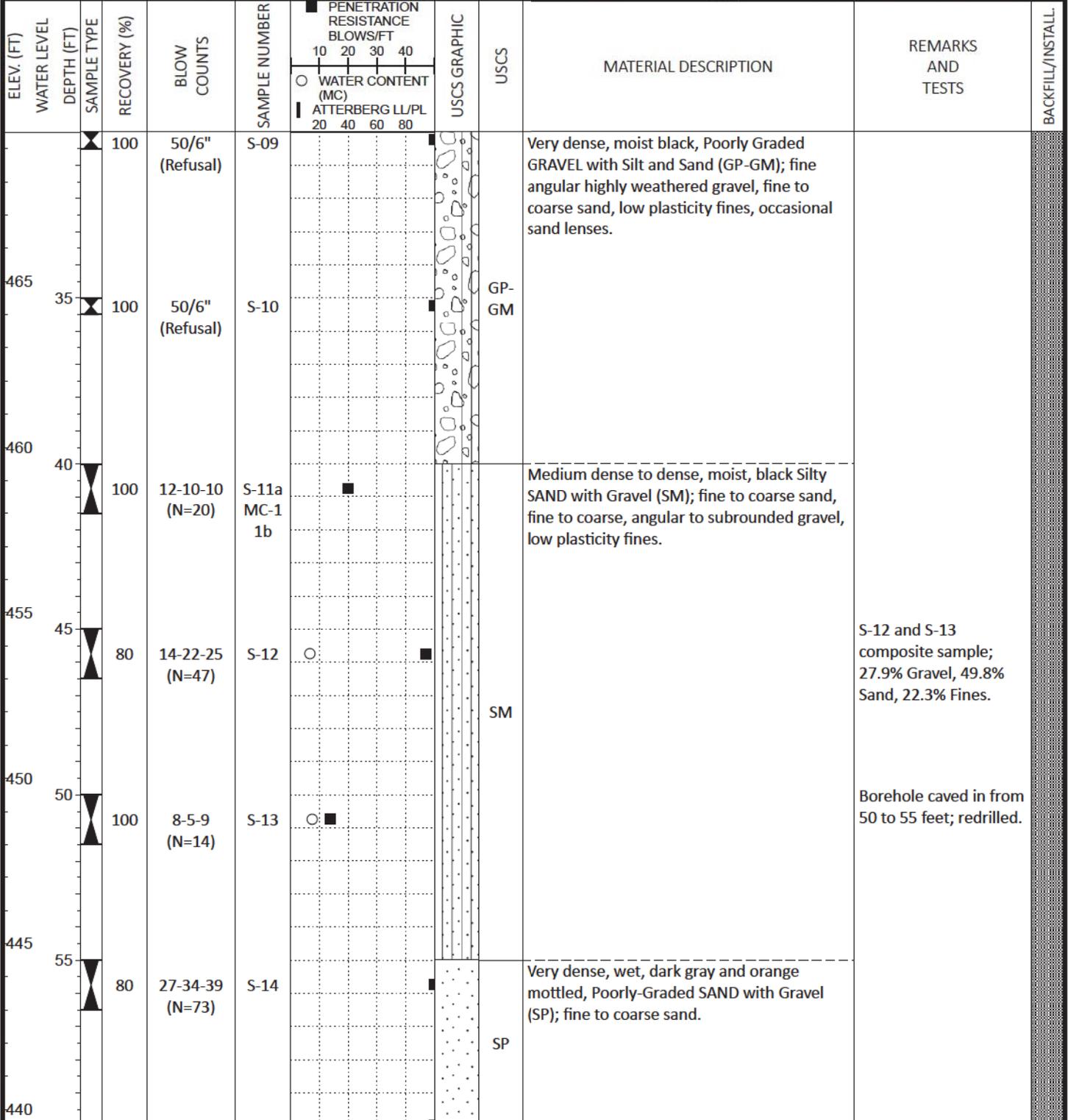
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring RWP-MI-BH01**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**RWP-MI-BH01**

Date(s) Drilled	03/09/2021	Client	Jacobs Engineering Group	Final Depth	70.2 ft bgs
Coordinates	7745689.4 E, 659465.5 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	499.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 9+18	Logged by/Checked by	D. Roth / K. Elliott	Hammer Type	140 lb / 30 in / Automatic



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
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**Boring RWP-MI-BH01**

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Log of Boring

**RWP-MI-BH01**

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Coordinates	7745689.4 E, 659465.5 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	499.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 9+18	Logged by/Checked by	D. Roth / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL		
							10	20						30	40
				0	50/0" (Refusal)	S-15					Very dense, wet, dark gray and orange mottled, Poorly-Graded SAND with Gravel (SP); fine to coarse sand.	Driller reported easier drilling from 61 to 64 feet.			
435		65		100	50/1" (Refusal)	S-16			SP					Poor recovery, broken black rock fragment in sampler at 70 feet.	
430		70		0	50/3" (Refusal)	S-17									
											Borehole completed at 70.25 feet below ground surface (bgs).				



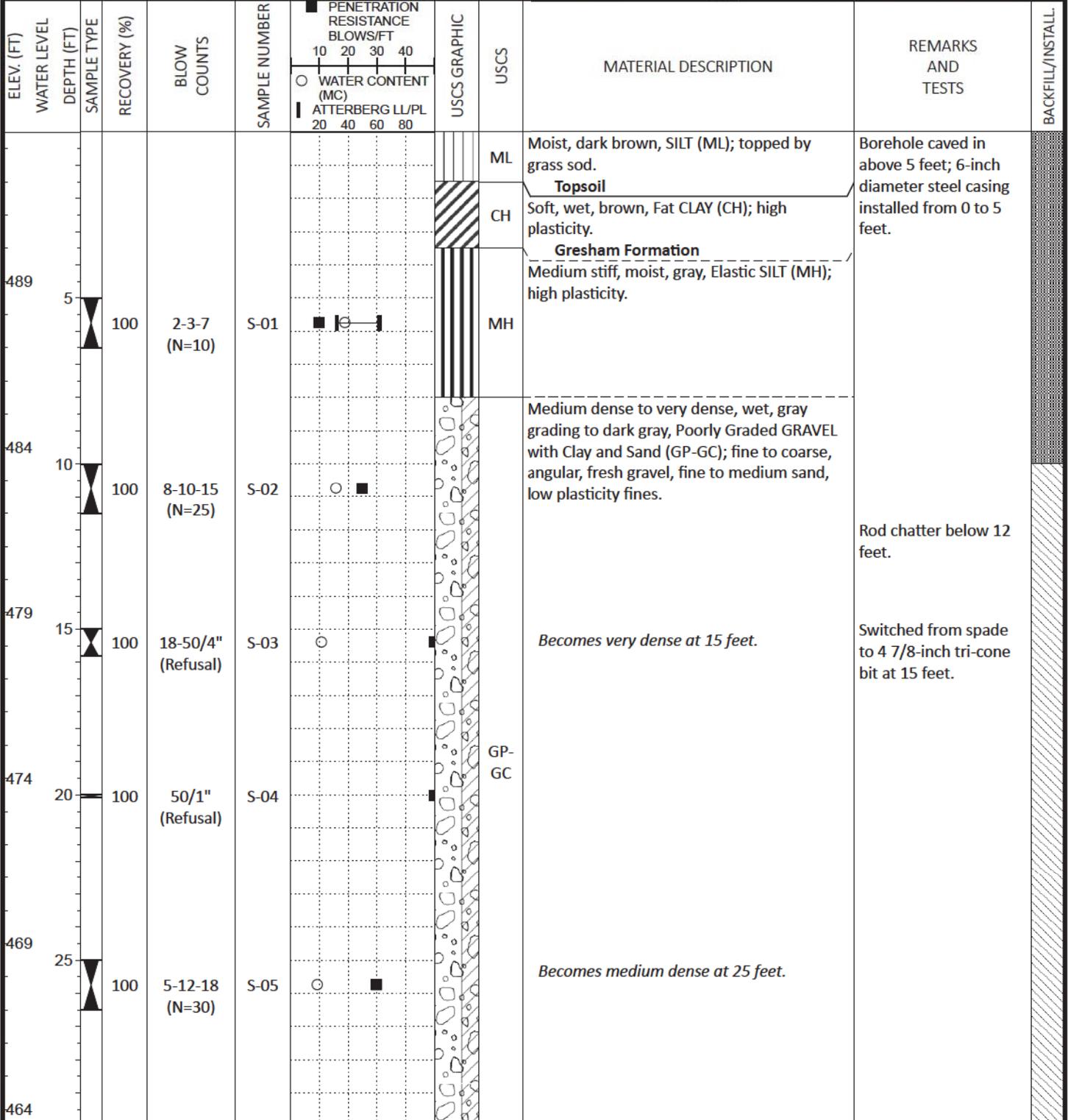
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**Boring RWP-MI-BH01**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH01**

Date(s) Drilled	03/23/2021	Client	Jacobs Engineering Group	Final Depth	70.5 ft bgs
Coordinates	7745150.0 E, 659473.2 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	493.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 14+90	Logged by/Checked by	K. Elliott / J. Fissel	Hammer Type	140 lb / 30 in / Automatic



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH01**

Date(s) Drilled	03/23/2021	Client	Jacobs Engineering Group	Final Depth	70.5 ft bgs
Coordinates	7745150.0 E, 659473.2 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	493.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 14+90	Logged by/Checked by	K. Elliott / J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
				100	28-50/5" (Refusal)	S-06					Medium dense to very dense, wet, gray grading to dark gray, Poorly Graded GRAVEL with Clay and Sand (GP-GC); fine to coarse, angular, fresh gravel, fine to medium sand, low plasticity fines. <i>Becomes very dense at 30 feet.</i>		
459		35		7	7-10-8 (N=18)	S-07					<i>Becomes medium dense at 35 feet.</i>	Periodic rod chatter from 35 to 40 feet.	
454		40		40	16-12-16 (N=28)	S-08					<i>Coarse gravel at 40 feet.</i>		
449		45		73	8-10-13 (N=23)	S-09				GP-GC	<i>Becomes dense at 48 feet.</i>	Rod chatter at 48 feet.	
444		50		100	8-13-27 (N=40)	S-10						Rod chatter at 53 feet.	
439		55		84	18-50/4" (Refusal)	S-11					<i>Becomes very dense at 55 feet.</i>		
434													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH01**

Date(s) Drilled	03/23/2021	Client	Jacobs Engineering Group	Final Depth	70.5 ft bgs
Coordinates	7745150.0 E, 659473.2 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	493.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 14+90	Logged by/Checked by	K. Elliott / J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
429		65		100	16-10-15 (N=25)	S-12				GP-GC	Medium dense to very dense, wet, gray grading to dark gray, Poorly Graded GRAVEL with Clay and Sand (GP-GC); fine to coarse, angular, fresh gravel, fine to medium sand, low plasticity fines. <i>Becomes medium dense at 60 feet.</i>		
424		70		100	9-18-17 (N=35)	S-13				GP-GC	<i>Becomes dense at 65 feet.</i>  <i>Becomes very dense at 68 feet.</i>		
419		75		40	50/6"	S-14					(Refusal)	Borehole completed at 70.5 feet below ground surface (bgs).	
414		80											
409		85											
404													



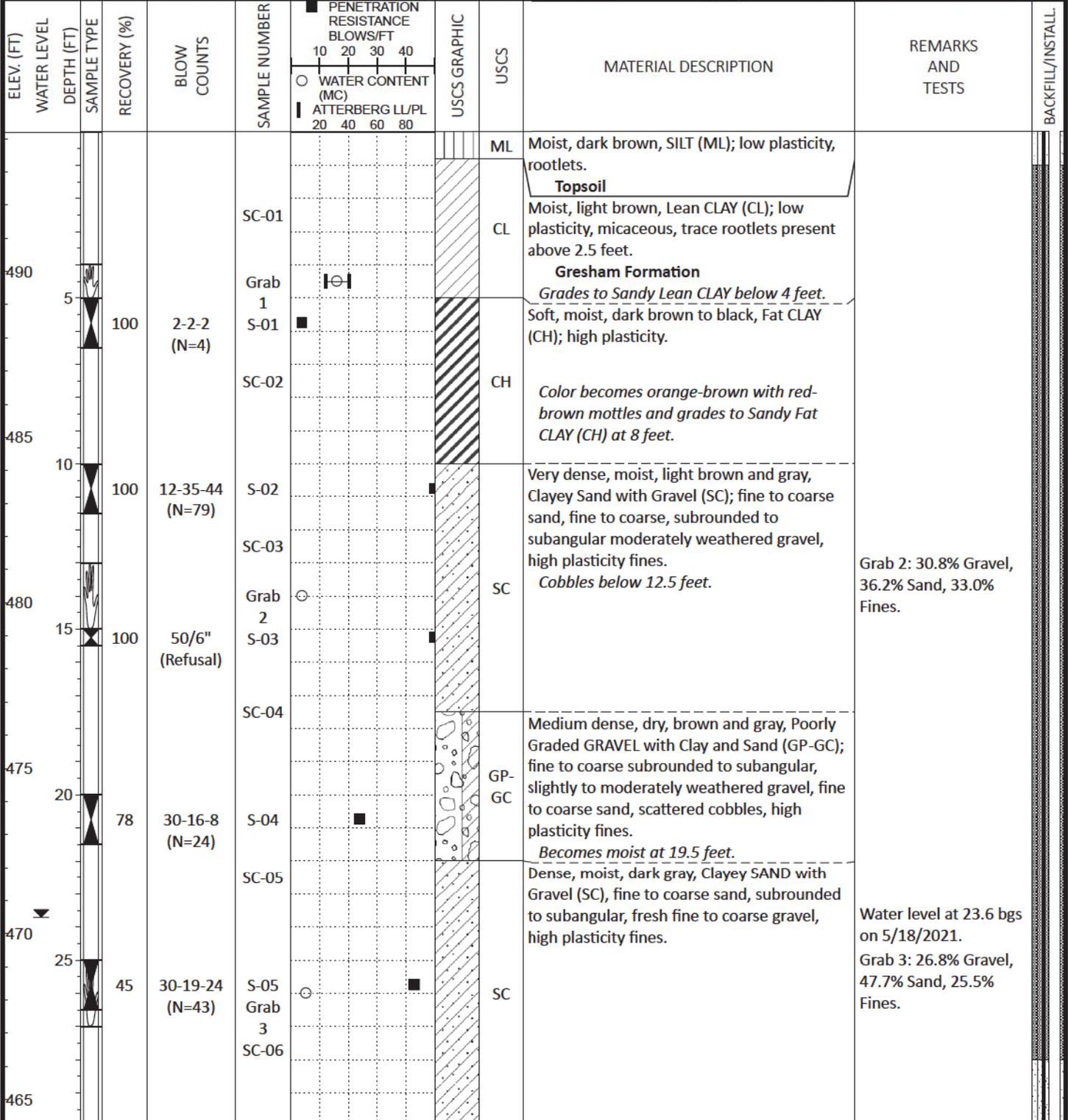
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH01**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH02**

Date(s) Drilled	03/25/2021 - 03/26/2021	Client	Jacobs Engineering Group	Final Depth	70.9 ft bgs
Coordinates	7745002.0 E, 659483.1 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	494.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 15+91	Logged by/Checked by	A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH02**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH02**

Date(s) Drilled	03/25/2021 - 03/26/2021	Client	Jacobs Engineering Group	Final Depth	70.9 ft bgs
Coordinates	7745002.0 E, 659483.1 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	494.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 15+91	Logged by/Checked by	A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		WATER CONTENT (MC)	ATTERBERG LL/PL	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20							
460		35		100	1-2-3 (N=5)	S-06	█	█				SC	Loose to dense, wet, dark gray, Clayey SAND with Gravel (SC); fine to coarse sand, fine to coarse fresh gravel and cobbles, high plasticity fines.	S-06: 24.0% Fines. Water level at 31.2 bgs on 10/24/2021.	
						SC-07									
				100	8-11-29 (N=40)	S-07						GC	Encountered red-brown volcanic cinder from 35 to 36 feet bgs. Dense, moist, gray, Clayey GRAVEL with Sand and Cobbles (GC); fine to coarse gravel, fine to medium sand, high plasticity fines.	Grab 4: 15.7% Cobbles, 35.6% Gravel, 28.5% Sand, 20.2% Fines.	
						Grab 4							Encountered fresh, hard basalt cobbles >4 inches or boulders from 37.5 to 39 feet bgs.		
						SC-08									
455		40		55	5-5-8 (N=13)	S-08	○	█				SC	Medium dense, wet, gray, Clayey SAND with Gravel (SC); fine to medium sand, fine to coarse, subrounded to subangular gravel, high plasticity fines.	S-08: 17.2% Fines.	
						SC-09									
450		45		100	7-9-11 (N=20)	S-09	○	█							
						Grab 5									
						SC-10									
445		50		100	11-13-11 (N=24)	S-10		█				SC	Coarse gravel layer from 52 to 53 feet.	Grab 5: 26.8% Gravel, 51.6% Sand, 21.6% Fines.	
						SC-11									
440		55		100	11-21-23 (N=44)	S-11		█							
						SC-12							Coarse gravel and cobble layer from 57.5 to 59 feet.		
435															



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH02**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH02**

Date(s) Drilled	03/25/2021 - 03/26/2021	Client	Jacobs Engineering Group	Final Depth	70.9 ft bgs
Coordinates	7745002.0 E, 659483.1 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	494.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 15+91	Logged by/Checked by	A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
430		65		100	6-23-29 (N=52)	S-12 Grab 6 SC-13	○			SC	Medium dense, wet, gray, Clayey SAND with Gravel (SC); fine to medium sand, fine to coarse, subrounded to subangular gravel, high plasticity fines.	Grab 6: 30.2% Gravel, 47.8% Sand, 22.0% Fines.	
425		70		83	12-18-19 (N=37)	S-13 SC-14		■		SC	Boulder or cobble > 4-inches at 66 feet.		
420		75		90	22-50/5" (Refusal)	S-14						Borehole completed at 70.92 feet below ground surface (bgs).	
415		80											
410		85											
405													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH02**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH03**

Date(s) Drilled	03/24/2021	Client	Jacobs Engineering Group	Final Depth	50.0 ft bgs
Coordinates	7744061.0 E, 659399.1 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	503.7 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 18+12	Logged by/Checked by	A. Havekost / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
499		5		100	2-2-3 (N=5)	S-01	■	○	[Hatched]	ML	Soft, wet, dark brown, SILT with Sand (ML); organics and grass. <b>Topsoil</b>	6-inch diameter steel casing installed from 0 to 5 feet.	[Hatched]
					2-2-4 (N=6)	S-02	■	○	[Hatched]	CL	Medium stiff grading to stiff, moist, brown, Lean CLAY with Sand (CL); fine sand, low plasticity, trace red-brown and gray mottles. <b>Gresham Formation</b>  <i>Color becomes gray with brown and red-brown mottling at 5 feet.</i>		
494		10		100	3-4-5 (N=9)	S-03	■	○	[Hatched]				
				100	3-4-7 (N=11)	S-04	■	○	[Hatched]				
489		15		100		SH-01	[Hatched]	[Hatched]	[Hatched]			SH-1: Dry Unit Weight = 84.4 pcf.	[Hatched]
				100	4-7-10 (N=17)	S-05	■	○	[Hatched]	CH	Stiff, moist, gray with red-brown mottles, Fat CLAY with Sand (CH); fine to medium sand, high plasticity.  <i>Below 12 feet, becomes very stiff with fine, subangular highly weathered gravel present in concentrated layers.</i>		
484		20		100	3-5-6 (N=11)	S-06	■	○	[Hatched]				
									[Hatched]				
479		25		100	50/5" (Refusal)	S-07a S-07b			[Hatched]	GP-GC	Very dense, wet, gray and brown with pink mottles, Poorly Graded GRAVEL with Clay and Sand (GP-GC); fine to coarse, angular, fresh gravel, fine to coarse sand.	Rod chatter followed by slow and hard drilling at 23 feet. Switched from spade to 4 7/8-inch tricone bit at 25 feet. Slow and hard drilling from 25 to 30 feet.	[Hatched]
474									[Hatched]				



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH03**

Date(s) Drilled	03/24/2021	Client	Jacobs Engineering Group	Final Depth	50.0 ft bgs
Coordinates	7744061.0 E, 659399.1 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	503.7 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 18+12	Logged by/Checked by	A. Havekost / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
							WATER CONTENT (MC)	ATTERBERG LL/PL					
				24	50/5" (Refusal)	S-08					Very dense, wet, gray and brown with pink mottles, Poorly Graded GRAVEL with Clay and Sand (GP-GC); fine to coarse, angular, fresh gravel, fine to coarse sand.	Intermittent rod chatter from 30 to 35 feet.	
469		35		100	11-11-12 (N=23)	S-09				GP-GC	Becomes medium dense at 35 feet.	Driller notes "more gravelly" from 35 to 40 feet.	
464		40		100	10-10-41 (N=51)	S-10				GP-GC	Becomes very dense at 40 feet.		
459		45		78	14-26-24 (N=50)	S-11						Intermittent rod chatter from 45 to 50 feet.	
454		50		0	50/0" (Refusal)	S-12						Borehole completed at 50 feet below ground surface (bgs).	
449		55											
444													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

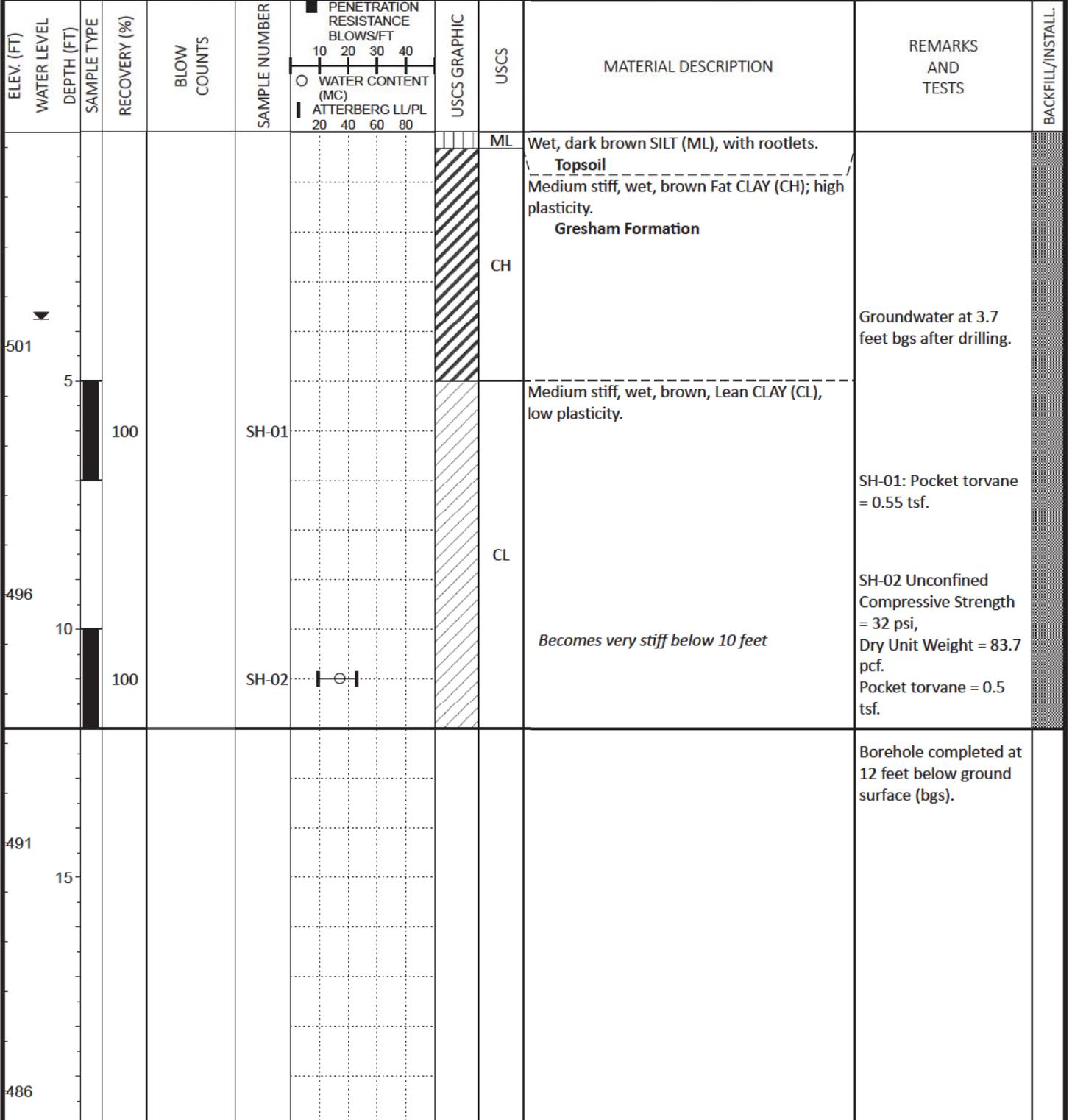
**Boring LRWP-BH03**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-P01**

Date(s) Drilled	11/16/2021	Client	Jacobs Engineering Group	Final Depth	12.0 ft bgs
Coordinates	7744030.8 E, 659399.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Geoprobe/Track-Mounted GeoProbe 6622 CPT
Surface Elevation	505.3 ft.	Drilling Contractor	Oregon Geotechnical Explorations, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 18+42	Logged by/Checked by	F. Sariosseiri / J. Fissel	Hammer Type	N/A



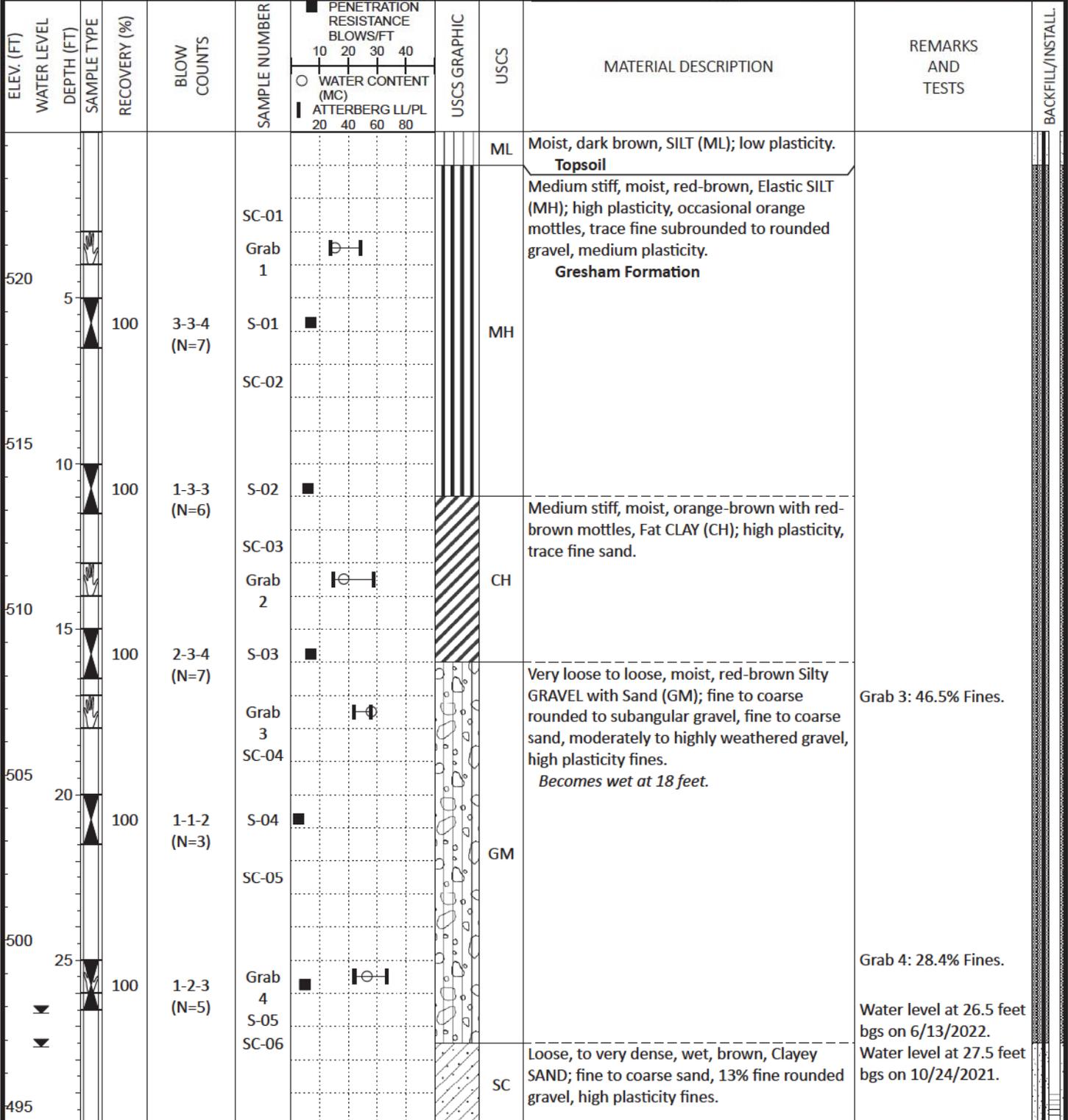
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-P01**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH04**

Date(s) Drilled	03/23/2021 - 03/24/2021	Client	Jacobs Engineering Group	Final Depth	70.0 ft bgs
Coordinates	7744469.2 E, 659550.4 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	524.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 21+92	Logged by/Checked by	A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH04**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH04**

Date(s) Drilled	03/23/2021 - 03/24/2021	Client	Jacobs Engineering Group	Final Depth	70.0 ft bgs
Coordinates	7744469.2 E, 659550.4 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	524.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 21+92	Logged by/Checked by	A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						10	20					
490	35		100	18-31-35 (N=66)	S-06 Grab 5 SC-07	○			SC	Loose, to very dense, wet, brown, Clayey SAND; fine to coarse sand, 13% fine rounded gravel, high plasticity fines.	Grab 5: 13.0% Gravel, 48.9% Sand, 38.1% Fines.	
485	40		32	50/0" (Refusal)	S-07 SC-08 Grab 6 S-08				GC	Very dense, moist, brown, gray and red, Clayey GRAVEL with Cobbles and Boulders (GC); fine to coarse, subrounded to subangular, moderately to highly weathered gravel, some fine to coarse sand, low plasticity fines. <i>Color becomes brown and gray at 35 feet.</i>	Driller noted material becomes much harder at 31 feet. Driller noted 1-2 foot diameter boulders below 33 feet. Grab 6: 46.8% Gravel, 30.7% Sand, 22.5% Fines.	
480	45		100	7-50/5" (Refusal)	S-09 Grab 7 SC-10	○				Very dense, moist, dark brown Clayey GRAVEL with Sand (GC); fine to coarse subangular to rounded gravel, occasional cobbles, high plasticity fines.	Driller noted cored rock/boulder at 40 feet. Grab 7: 54.2% Gravel, 31.3% Sand, 14.5% Fines.	
475	50		100	50/6" (Refusal)	S-10 SC-11				GC	<i>Encountered hard, fresh to moderately weathered cobbles from 51.5 to 54 feet.</i>		
470	55		84	50/6" (Refusal)	S-11 Grab 8 SC-12	○					Grab 8: 54.4% Gravel, 24.4% Sand, 21.2% Fines.	



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH04**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH04**

Date(s) Drilled	03/23/2021 - 03/24/2021	Client	Jacobs Engineering Group	Final Depth	70.0 ft bgs
Coordinates	7744469.2 E, 659550.4 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	524.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 21+92	Logged by/Checked by	A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						10	20					
460 65 455 70			75	14-50/6" (Refusal)	S-12					Very dense, moist, dark brown Clayey GRAVEL with Sand (GC); fine to coarse subangular to rounded gravel, occasional cobbles, high plasticity fines.		
					SC-13				GC			
				100	50/6" (Refusal)	S-13				Very dense, moist, dark brown with multicolored clasts, Clayey SAND with Gravel (SC); fine to coarse sand, fine to coarse subrounded gravel., low plasticity fines.		
						SC-14			SC			
			100	45-50/2" (Refusal)	S-14							Borehole completed at 70 feet below ground surface (bgs).



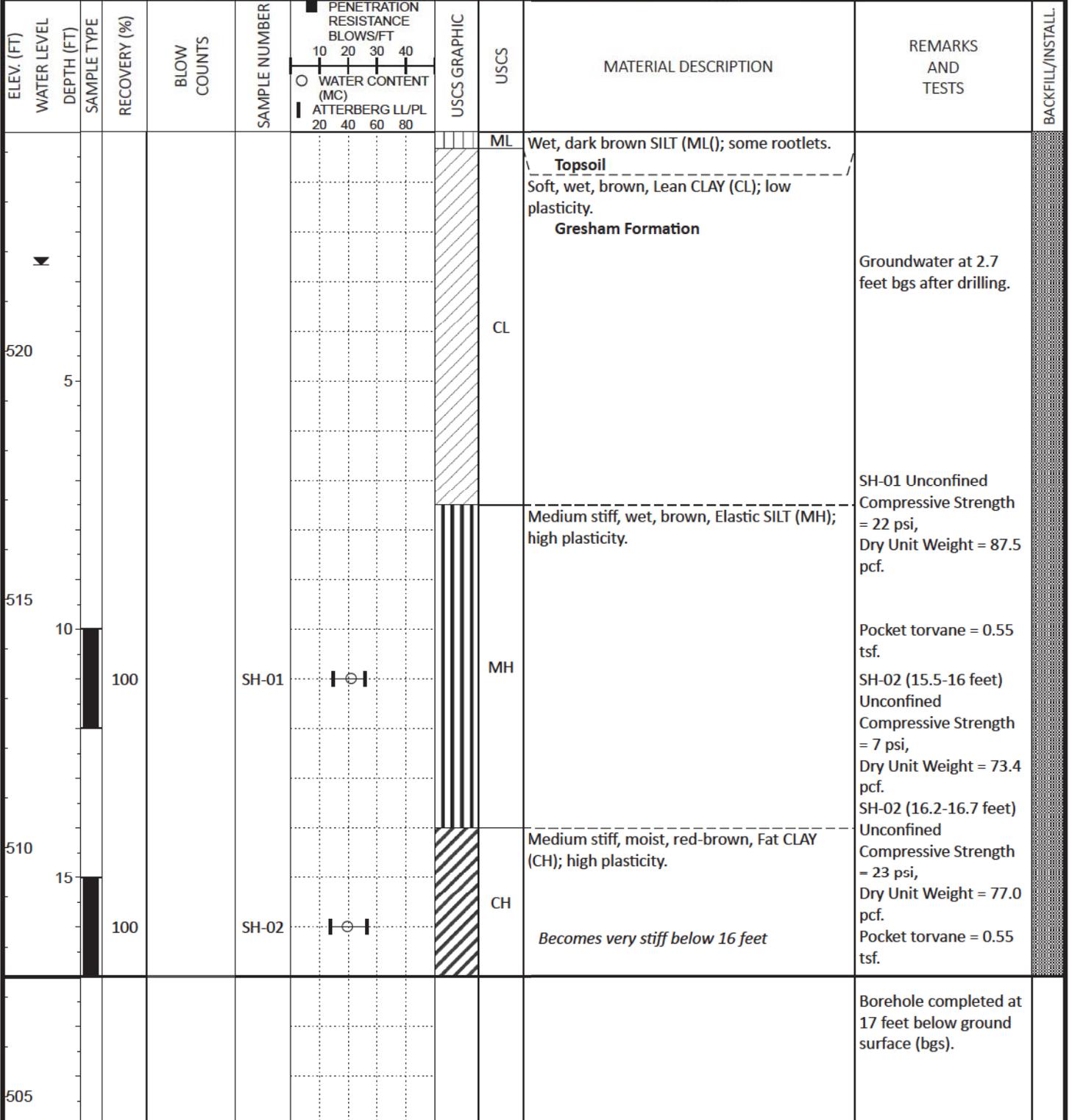
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-P02**

Date(s) Drilled	11/16/2021	Client	Jacobs Engineering Group	Final Depth	17.0 ft bgs
Coordinates	7743681.6 E, 659492.2 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Geoprobe/Track-Mounted GeoProbe 6622 CPT
Surface Elevation	524.4 ft.	Drilling Contractor	Oregon Geotechnical Explorations, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 22+93	Logged by/Checked by	F. Sariosseiri / J. Fissel	Hammer Type	N/A



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-P02**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH05**

Date(s) Drilled	04/13/2021 - 04/15/2021	Client	Jacobs Engineering Group	Final Depth	207.0 ft bgs
Coordinates	7743393.3 E, 659476.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	614.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 24+80	Logged by/Checked by	K. Elliott, J. Fissel / J. Quinn	Hammer Type	N/A

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
610		5				Grab 1				GP	<p>ASPHALT PAVEMENT - 6 inches thick</p> <p><b>Pavement Section</b></p> <p>Loose to medium dense, moist, brown, Poorly Graded GRAVEL with Sand (GP); subrounded and subangular fine to coarse gravel, fine to medium sand.</p> <p><b>Base Aggregate/Fill</b></p>		
605		10		75		SC-01				CL	<p>Wet, brown, Sandy Lean CLAY with Gravel (CL); low plasticity, fine to coarse subrounded gravel, fine to coarse sand.</p> <p><b>Residual Soil of the Springwater Formation</b></p>		
600		15				Grab 2				GP-GC	<p>Moist, brown, Poorly Graded GRAVEL with Sand, Clay, and Cobbles (GP-GC); fine to coarse rounded gravel, fine to coarse sand, low plasticity fines.</p> <p><b>Less Weathered Springwater Formation</b></p>	Grab 2: 9.5% Cobbles, 39.1% Gravel, 25.1% Sand, 26.3% Fines.	
595		20				Grab 3				GP-GC	<p>Moist, brown with slight orange mottling, Poorly Graded GRAVEL with Clay, Sand, and Cobbles (GP-GC); fine to coarse sand, fine to coarse subangular to rounded gravel and cobble, low plasticity fines.</p>		
590		25											
585													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH05**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH05**

Date(s) Drilled	04/13/2021 - 04/15/2021	Client	Jacobs Engineering Group	Final Depth	207.0 ft bgs
Coordinates	7743393.3 E, 659476.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	614.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 24+80	Logged by/Checked by	K. Elliott, J. Fissel / J. Quinn	Hammer Type	N/A

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
580		35		81		SC-02					Moist, brown with slight orange mottling, Poorly Graded GRAVEL with Clay, Sand, and Cobbles (GP-GC); fine to coarse sand, fine to coarse subangular to rounded gravel and cobble, low plasticity fines.		
575		40				Grab 4	○			GP-GC	Encountered three nested 8-inch cobbles at 40 feet.		
570		45		100		SC-03						Grab 5: 30% Fines.	
						Grab 5	○						
						Grab 6	○						
565		50									Moist, red-brown, Lean CLAY (CL); low plasticity, saprolitic. Residual Soil of Boring Lava		
										CL			
560		55		100		SC-04					Dark brown to slightly red-brown Lean CLAY (CL); low plasticity, scattered, moderately to highly weathered vesicular basalt cobbles.		
										CL			
											Light gray-brown, Clayey GRAVEL (GC); fine to coarse gravel, low plasticity fines.		
										GC			
555													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH05**

Date(s) Drilled	04/13/2021 - 04/15/2021	Client	Jacobs Engineering Group	Final Depth	207.0 ft bgs
Coordinates	7743393.3 E, 659476.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	614.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 24+80	Logged by/Checked by	K. Elliott, J. Fissel / J. Quinn	Hammer Type	N/A

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
550		65		100		SC-05				GC	Light gray-brown, Clayey GRAVEL (GC); fine to coarse gravel, low plasticity fines. <i>Encountered 9-inch cobble in brown clay with angular basaltic gravel at 60 feet.</i>		
545		70				Grab 7	○				<b>BASALT</b> ; moderately weathered, hard, moderately spaced clay-filled joints. <b>Boring Lava</b>	Unconfined Compressive Strength of sample from 70.1 to 70.8 feet = 13,542 psi.	
540		75		100		SC-06					<i>Basalt rock broken in fine to coarse gravel and cobble sizes, angular, vesicular, moderately weathered form 75 to 80 feet.</i>		
535		80									<i>Moderately to closely spaced clay-filled joints; bright orange oxidized zone at 83 feet.</i>		
530		85		100		SC-07					<i>Fragmented, clay-filled zone present between 85 and 86 feet followed by slightly to moderately weathered vesicular basalt.</i>		
525													



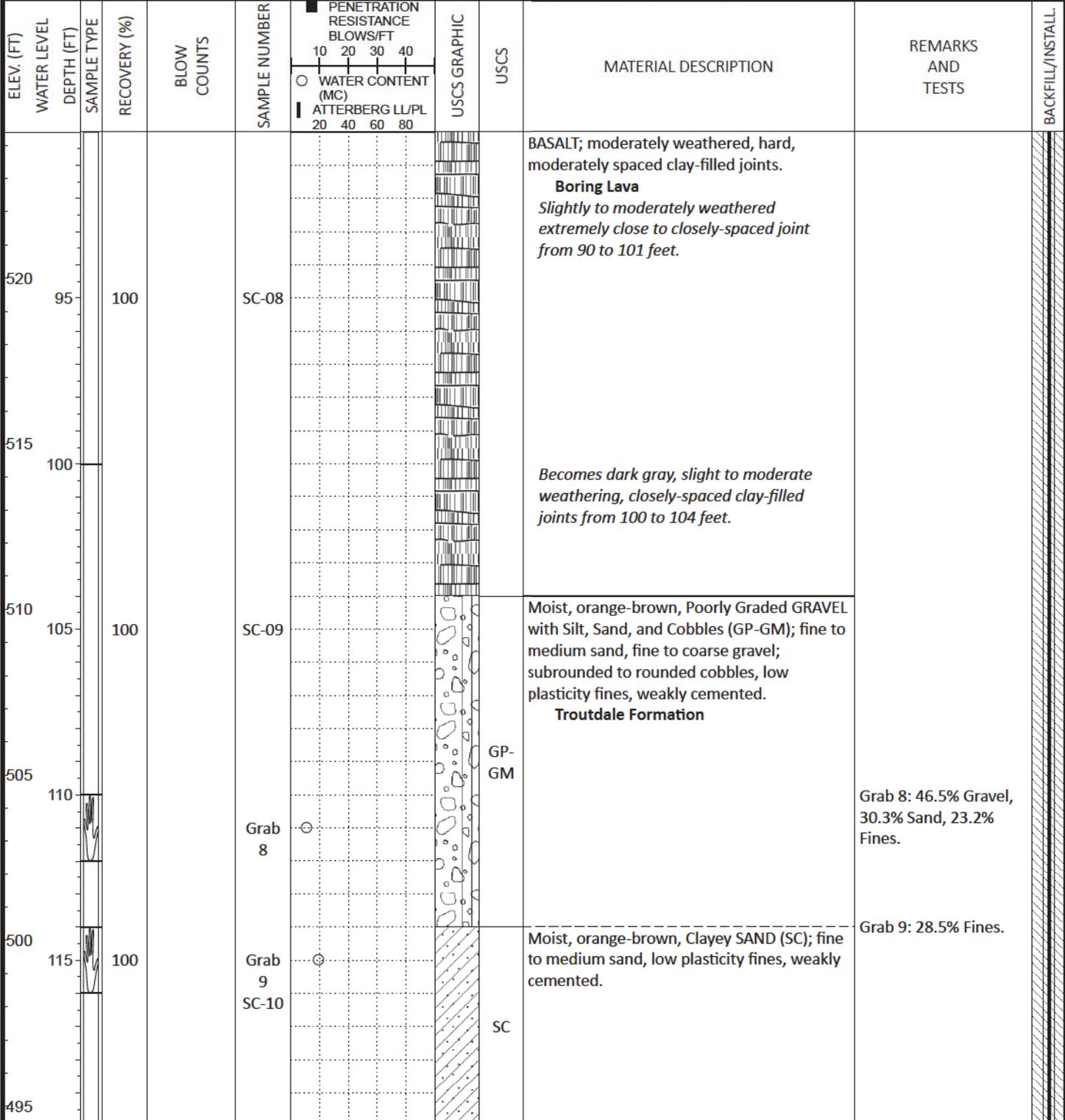
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH05**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH05**

Date(s) Drilled	04/13/2021 - 04/15/2021	Client	Jacobs Engineering Group	Final Depth	207.0 ft bgs
Coordinates	7743393.3 E, 659476.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	614.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 24+80	Logged by/Checked by	K. Elliott, J. Fissel / J. Quinn	Hammer Type	N/A



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH05**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH05**

Date(s) Drilled	04/13/2021 - 04/15/2021	Client	Jacobs Engineering Group	Final Depth	207.0 ft bgs
Coordinates	7743393.3 E, 659476.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	614.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 24+80	Logged by/Checked by	K. Elliott, J. Fissel / J. Quinn	Hammer Type	N/A

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
490		125		100		Grab 10			[Diagonal Hatching]	SC	Moist, orange-brown, Clayey SAND (SC); fine to medium sand, low plasticity fines, weakly cemented.		
						SC-11			[Diagonal Hatching]	GP-GC	Moist, brown-gray, Poorly Graded GRAVEL with Clay and Cobbles (GP-GC); fine subangular and subrounded gravel, trace fine to coarse sand, low plasticity fines.	Grab 11: 34.1% Fines.	
485		130				Grab 11			[Diagonal Hatching]		Moist, orange-brown grading to gray brown, then back to orange-brown, Clayey SAND (SC); fine to medium sand, low plasticity fines. <i>Encountered some fine rounded gravel and scattered cobbles up to 4-inch particle size below 128 feet.</i>		
						Grab 12			[Diagonal Hatching]			Grab 13: 30.8% Fines.	
						Grab 13			[Diagonal Hatching]	SC			
480		135		100		SC-12			[Diagonal Hatching]			Grab 14: 66.1% Sand, 33.9% Fines.	
						Grab 14			[Diagonal Hatching]				
475		140				Grab 15			[Dotted]	SP	Moist, gray-brown, Poorly Graded SAND (SP); fine to medium sand, low plasticity fines.	Core loss 140 to 145 feet.	
						SC-13			[Dotted]		<i>Becomes orange-brown and becomes weakly cemented with fine to coarse gravel below 147 feet.</i>		
470		145		75					[Dotted]				
465									[Dotted]				



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH05**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH05**

Date(s) Drilled	04/13/2021 - 04/15/2021	Client	Jacobs Engineering Group	Final Depth	207.0 ft bgs
Coordinates	7743393.3 E, 659476.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	614.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 24+80	Logged by/Checked by	K. Elliott, J. Fissel / J. Quinn	Hammer Type	N/A

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
460		155		100		Grab 16	○			SC	Wet, gray, Clayey SAND with Gravel (SC); fine to medium sand, fine subangular and subrounded gravel, low plasticity fines with scattered cobbles. <i>Encountered two 4-inch cobbles at 152 feet.</i> <i>Becomes orange-brown with trace fine to coarse, rounded, weakly cemented gravel. at 153.5 feet.</i>	Grab 16: 16.3% Cobbles/Boulders, 22.8% Gravel, 39.3% Sand, 21.6% Fines.	
455		160				Grab 17	⊙					Grab 17: 24.7% Fines.	
450		165		100		SC-15							
445		170				Grab 18	○			SC	<i>Becomes gray-brown and weakly cemented at 170 feet.</i>	Grab 19: 18.9% Fines.	
440		175		100		Grab 19	○						
435						SC-16							
						Grab 20	○						



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH05**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH05**

Date(s) Drilled	04/13/2021 - 04/15/2021	Client	Jacobs Engineering Group	Final Depth	207.0 ft bgs
Coordinates	7743393.3 E, 659476.3 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	614.4 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 24+80	Logged by/Checked by	K. Elliott, J. Fissel / J. Quinn	Hammer Type	N/A

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
430		185		100		SC-17			[Diagonal Hatching]	SC	Moist, red-brown and gray, Clayey SAND (SC); fine to medium sand,, scattered weakly cemented regions.		
425		190				Grab 21	○		[Diagonal Hatching]	SC	Moist, red-brown and gray, Clayey SAND with Gravel (SC); fine to coarse sand, fine to coarse subrounded gravel, weakly cemented.  <i>Encountered 8-inch basalt cobble at 189 feet bgs.</i>	Grab 21: 27.9% Fines.	
420		195				Grab 22	○		[Dotted Pattern]	SP	Moist, red-brown and gray, Poorly Graded SAND with Gravel (SP); medium to coarse sand, coarse subrounded gravel, moderately cemented regions.		
415		200		100		SC-18			[Dotted Pattern]				
410		205											
405												Borehole completed at 207 feet below ground surface (bgs).	



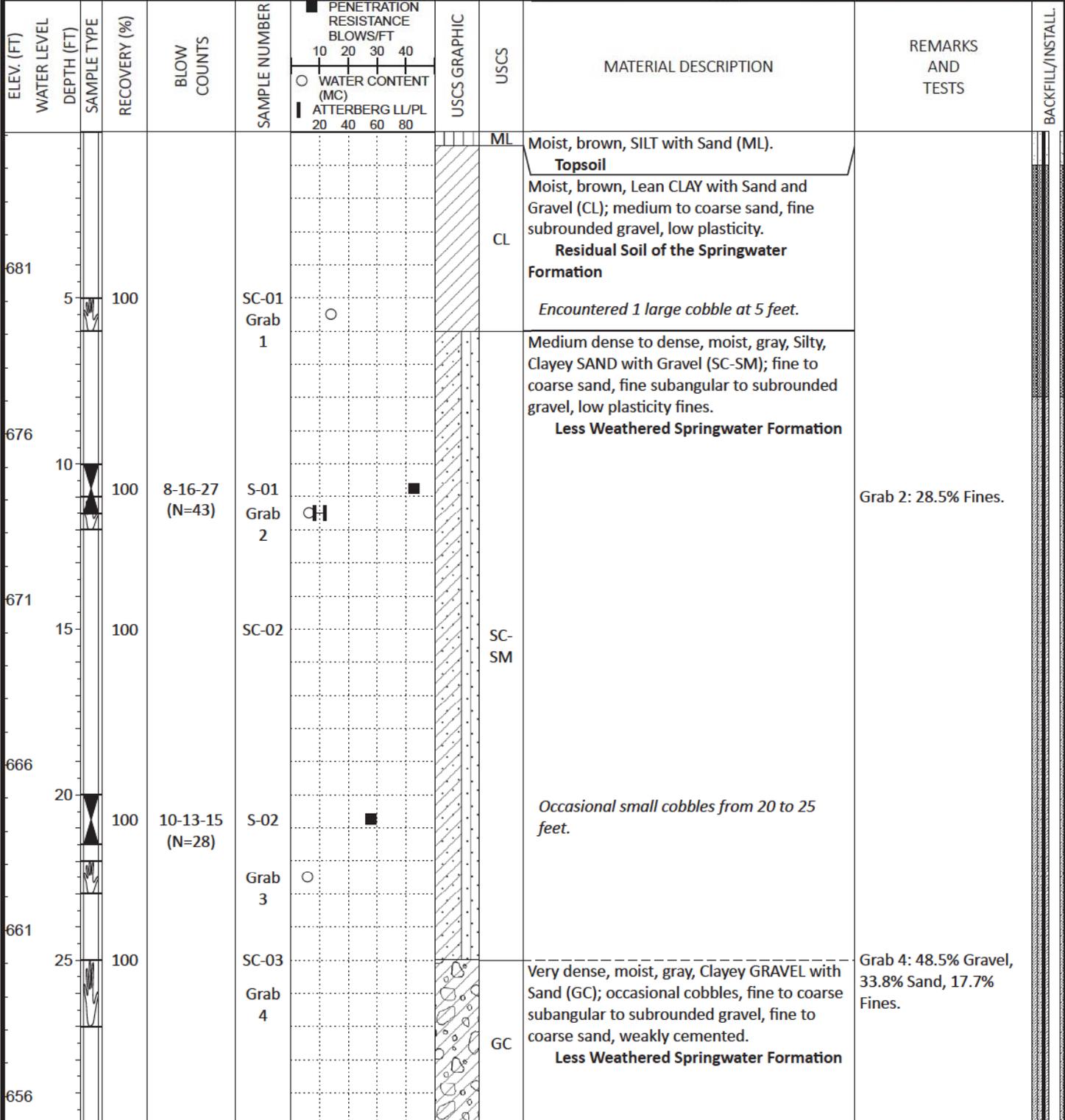
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH05**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
651		35		100		S-03					Very dense, moist, gray, Clayey GRAVEL with Sand (GC); occasional cobbles, fine to coarse subangular to subrounded gravel, fine to coarse sand, weakly cemented. <b>Less Weathered Springwater Formation</b>  Occasional cobbles up to 4-inches from 40 to 50 feet.  GC  5-inch cobble at 55 feet.  GC  Very dense, moist, gray and brown, Clayey GRAVEL with Sand (GC); fine to coarse angular to rounded gravel, medium sand, low plasticity fines. <b>Less Weathered Springwater Formation</b>	Grab 7: 43.6% Gravel, 40.8% Sand, 15.6% Fines.	
					31-50/3" (Refusal)	Grab 5							
						SC-04							
						SC-05							
						Grab 6							
					20-50/3" (Refusal)	SC-06							
						S-04							
						Grab 7							
						SC-07							
636		50											
631		55		100									
626													



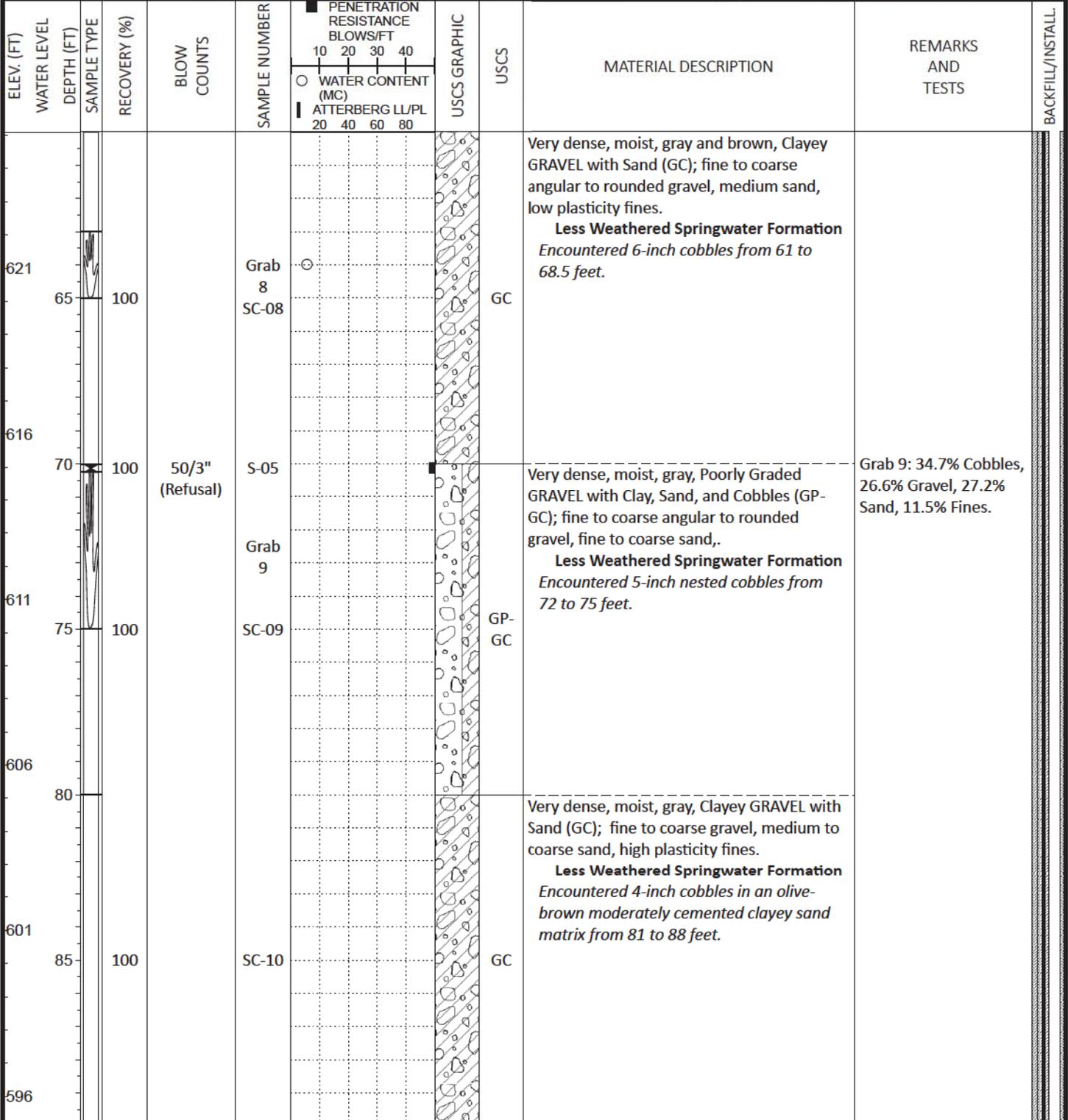
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
591				100	50/5" (Refusal)	S-06					<p>Very dense, moist, brown and gray, Clayey GRAVEL with Sand and Cobbles (GC); fine to coarse subrounded gravel, fine to coarse sand, high plasticity fines, cobbles up to 5-inch particle size.</p> <p><b>Less Weathered Springwater Formation</b></p> <p>Grab 11: 40.5% Gravel, 27.7% Sand, 31.8% Fines.</p> <p>Becomes weakly cemented from 110 to 135 feet.</p> <p>Occasional cobbles up to 5-inch particle size below 114 feet.</p>		
						Grab 10							
95				100		SC-11							
586						Grab 11							
100													
581						SC-12				GC			
105				85									
576						S-07							
110				100	50/4" (Refusal)								
571						SC-13							
100													
115													
566													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						10	20					
561			90		SC-14					Very dense, moist, brown and gray, Clayey GRAVEL with Sand and Cobbles (GC); fine to coarse subrounded gravel, fine to coarse sand, high plasticity fines, cobbles up to 5-inch particle size. <b>Less Weathered Springwater Formation</b> <i>Large nested cobbles from 122 to 128 feet.</i>	Grab 12: 17.7% Cobbles, 23.8% Gravel, 32.7% Sand, 25.8% Fines.	
556	130		100	50/4" (Refusal)	Grab 12 S-08			GC				
551			100		SC-15							
546			140						GM	Very dense, moist, orange-brown grading to brown, Silty GRAVEL (GM); fine to coarse gravel, completely weathered angular vesicular lava. <b>Residual Soil of Boring Lava</b>		
541			145		SC-16					BASALT: gray, highly weathered, vesicular, closely-spaced joints. <b>Boring Lava</b>		
536												



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
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**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
				100	50/1" (Refusal)	S-09					BASALT: gray, highly weathered, vesicular, closely-spaced joints. <b>Boring Lava</b>		
531		155		100		SC-17						Unconfined Compressive Strength on sample from 154 to 155 feet = 7,579 psi.	
526		160											
521		165		100		SC-18							
516		170							GC	Very dense, moist, gray and brown, Clayey GRAVEL with Sand (GC); fine to coarse gravel, high plasticity fines, gravel consists of highly weathered vesicular basalt. <b>Weathered Boring Lava</b>			
511		175		100		Grab 13 SC-19			GM	Very dense, moist, gray, brown and yellow-brown, Silty GRAVEL with Sand (GM); coarse subrounded gravel, medium to coarse sand, low plasticity fines, gray vesicular basalt cobbles up to 5-inches in particle size. <b>Troutdale Formation</b>	Grab 13: 14.1% Cobbles, 37.9% Gravel, 23.1% Sand, 24.9% Fines.		
506													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
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**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
501				100	50/1" (Refusal)	S-10				GM	Very dense, moist, gray, Silty GRAVEL (GM); some medium sand, high plasticity fines, cobbles of vesicular lava up to 4-inches.	Grab 14: 28.6% Fines. Liquid Limit = 113.	
185				100		Grab 14					<b>Troutdale Formation</b>		
496				100	50/6" (Refusal)	SC-20				SM	Very dense, moist, light brown and gray, Silty SAND (SM); fine to medium sand, weakly cemented, high plasticity fines, trace subangular gravel.	Grab 15: 19.2% Fines.	
190				100		Grab 15					<b>Troutdale Formation</b>		
491				90		S-11				SM	Very dense, moist, gray, Silty SAND with Gravel (SM); fine to coarse sand, fine to coarse subrounded gravel, high plasticity fines, weakly cemented regions.	Grab 16: 33.4% Gravel, 36.8% Sand, 30.1% Fines.	
195				90		Grab 16					<b>Troutdale Formation</b>		
486				100	16-30-50/6" (Refusal)	SC-21				SM	Very dense, moist, red-brown and gray, Silty SAND (SM); trace fine and coarse subrounded gravel, fine to medium sand, high plasticity fines, weakly cemented.	Grab 17: 32.5% Fines.	
200				100		Grab 17					<b>Troutdale Formation</b>		
481				95		S-12				SM	Encountered a 4 inch cobble at 202 feet.		
205				95		SC-22					Large cobble at 207 feet.		
476													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH06**

Date(s) Drilled <b>03/31/2021 - 04/12/2021</b>	Client <b>Jacobs Engineering Group</b>	Final Depth <b>250.4 ft bgs</b>
Coordinates <b>7743845.7 E, 659520.6 N</b>	Geotechnical Consultant <b>McMillen Jacobs Associates</b>	Method/Rig Type <b>Sonic Drilling/Track Mounted Geoprobe 8150 LS</b>
Surface Elevation <b>685.1 ft.</b>	Drilling Contractor <b>Western States Soil Conservation, Inc.</b>	Hole Diameter <b>5.00 in</b>
Location <b>LRWP North Station 27+59</b>	Logged by/Checked by <b>J. Fissel / K. Elliott</b>	Hammer Type <b>140 lb / 30 in / Automatic</b>

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
471				100	50/5" (Refusal)	S-13					Very dense, moist, red-brown and gray, Silty SAND (SM); trace fine and coarse subrounded gravel, fine to medium sand, high plasticity fines, weakly cemented. <b>Troutdale Formation</b>		
215													
466				65		SC-23					Large cobble or boulder at 220 feet.		
461										SM			
456						Grab 18						Grab 18: 1% Gravel, 70.2% Sand, 28.7% Fines.	
230				100	15-29-50/5" (Refusal)	S-14							
451													
235													
446				75		SC-24							



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH06**

Date(s) Drilled	03/31/2021 - 04/12/2021	Client	Jacobs Engineering Group	Final Depth	250.4 ft bgs
Coordinates	7743845.7 E, 659520.6 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Sonic Drilling/Track Mounted Geoprobe 8150 LS
Surface Elevation	685.1 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 27+59	Logged by/Checked by	J. Fissel / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
441		245				SC-25				SM	Very dense, moist, red-brown and gray, Silty SAND (SM); trace fine and coarse subrounded gravel, fine to medium sand, high plasticity fines, weakly cemented. <b>Troutdale Formation</b> <i>Encountered &gt;7-inch cobbles from 240 to 245 feet.</i>		
436		250		100	50/5"	S-15							
431		255			(Refusal)							Borehole completed at 250.42 feet below ground surface (bgs).	
426		260											
421		265											
416													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH06**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
703		5								CL	Moist, dark brown, Lean CLAY with Sand (CL). <b>Topsoil</b>	Material description from 0.5 to 90.0 feet is inferred from drilling action.	
										CL	Moist CLAY (CL); low plasticity. <b>Residual Soil of the Springwater Formation</b>		
698		10									Medium dense to very dense, moist, poorly graded GRAVEL with Clay and Sand (GP-GC); low plasticity fines, fine to coarse sand, fine to coarse gravel with occasional cobbles and scattered boulders. <b>Less Weathered Springwater Formation</b>	Drill rod chatter from 7 to 7.5 feet.	
693		15										Drill rod chatter from 10 to 10.5 feet.	
688		20								GP-GC			
683		25											
678													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH07**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
673		35									Medium dense to very dense, moist, poorly graded GRAVEL with Clay and Sand (GP-GC); low plasticity fines, fine to coarse sand, fine to coarse gravel with occasional cobbles and scattered boulders. <b>Less Weathered Springwater Formation</b>	Strong drill rod chatter at 34 feet.	
668		40											
663		45								GP-GC		Strong drill rod chatter at 45 feet.	
658		50											
653		55										Strong drill rod chatter from 52 to 63 feet.	
648													



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
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**Boring LRWP-BH07**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
643		65									Medium dense to very dense, moist, poorly graded GRAVEL with Clay and Sand (GP-GC); low plasticity fines, fine to coarse sand, fine to coarse gravel with occasional cobbles and scattered boulders. <b>Less Weathered Springwater Formation</b>		
638		70											
633		75								GP-GC			
628		80										Very strong drill rod chatter from 80 to 85 feet.	
623		85											
618													



NOTES:  
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**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.
						10	20					
613			100	50/2" (Refusal)	S-01					Very dense, moist, dark gray, poorly graded GRAVEL with Clay and Sand (GP-GC); low plasticity fines, fine to coarse sand, fine to coarse angular to subrounded gravel with occasional cobbles and boulders; weakly bound by low plasticity fines.  <b>Less Weathered Springwater Formation</b>	Moderate drill rod chatter from 90 to 95 feet.	
608			100	50/3" (Refusal)	S-02							
603			100	50/3" (Refusal)	S-03							
598			132	50/3" (Refusal)					GP-GC			
593												
588												



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**Boring LRWP-BH07**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL.	
							10	20						
583		125		26	50/15" (Refusal)	S-04					Very dense, moist, dark gray, poorly graded GRAVEL with Clay and Sand (GP-GC); low plasticity fines, fine to coarse sand, fine to coarse angular to subrounded gravel with occasional cobbles and boulders; weakly bound by low plasticity fines. <b>Less Weathered Springwater Formation</b>			
578		130		147	50/2" (Refusal)	S-05				GP-GC		Becomes gray and orange at 130 feet.		
573		135												
568		140		32	50/3" (Refusal)	S-06					Becomes yellow-brown.			
563		145												
558														



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**Boring LRWP-BH07**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH07**

Date(s) Drilled <b>11/16/2021 - 11/30/2021</b>	Client <b>Jacobs Engineering Group</b>	Final Depth <b>232.0 ft bgs</b>
Coordinates <b>7742874.8 E, 659436.9 N</b>	Geotechnical Consultant <b>McMillen Jacobs Associates</b>	Method/Rig Type <b>Mud Rotary and HQ Wireline/CME 850 Track Mounted</b>
Surface Elevation <b>707.5 ft.</b>	Drilling Contractor <b>Western States Soil Conservation, Inc.</b>	Hole Diameter <b>4.00 in</b>
Location <b>LRWP North Station 29+98</b>	Logged by/Checked by <b>K. Elliott, A. Judy / K. Elliott</b>	Hammer Type <b>140 lb / 30 in / Automatic</b>

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT	WATER CONTENT (MC)	ATTERBERG LL/PL	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
553 155				68	50/3" (Refusal)	S-07	<div style="display: flex; justify-content: space-between;"> <span>10</span><span>20</span><span>30</span><span>40</span> </div> <div style="display: flex; justify-content: space-between;"> <span>20</span><span>40</span><span>60</span><span>80</span> </div>	○			GP-GC	<p>Very dense, moist, dark gray, poorly graded GRAVEL with Clay and Sand (GP-GC); low plasticity fines, fine to coarse sand, fine to coarse angular to subrounded gravel with occasional cobbles and boulders; weakly bound by low plasticity fines.</p> <p style="border: 1px dashed black; padding: 2px; text-align: center;"><b>Less Weathered Springwater Formation</b></p> <p style="text-align: center;"><i>Log continued on next page.</i></p>	151.6 ft.: switched to HQ coring – 2-3/8" ID bit.	



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Log of Boring

**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES								GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination					
150																	
			46	32	R-1	J	R	PL	N	Fe	Ctg	0		BASALT; moderately strong to strong, slightly weathered to fresh, highly fractured, dark gray. Joint surfaces are planar to undulating, rough, and iron oxide stained. Common joint sets occur between 0 and 15 degrees and at +/- 60 degrees with apertures between 2 and 3mm. Except as noted below, basalt is 5% to 20% vesicular throughout. [Boring Lava]	Lost approx. 1,800 gal. of drilling fluid between 151.6 and 180 feet.  Grab 1: Unconfined Compressive Strength = 2,045 psi; Dry Density= 150.8 pcf. Core Loss: 153.8 to 157.5 feet.		
					J	R	U	M	Fe/Si	Ctg	60						
					MB												
					Grab 1	MB	R	C	N	Fe	Ctg	30					
553																	
155																	
			80	58	R-2									156.6 ft.: Becomes residual soil from 156.6 to 157.2 feet.			
					J	R	PL	N	Fe	Ctg	60						
					MB												
					Grab 2	MB											
548																	
160																	



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**Boring LRWP-BH07**

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Log of Boring

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Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
160						J	R	PL	VN	U	Ctg	20	<p>BASALT; moderately strong to strong, slightly weathered to fresh, highly fractured, dark gray. Joint surfaces are planar to undulating, rough, and iron oxide stained. Common joint sets occur between 0 and 15 degrees and +/- 60 degrees with apertures between 2 and 3mm.</p> <p>Except as noted below, basalt is 5% to 20% vesicular throughout.</p> <p>[Boring Lava]</p>			
					J	R	PL	N	Fe	Ctg	40					
					J	R	PL	N	Fe	Ctg	0					
			98	58	R-3	J	R	PL	N	Fe	Ctg	0				
					J	R	C	N			15					
					J	VR	IR	N	Fe	Ctg	0					
					J	R	U	W	Fe	Ctg	10					
					J	VR	IR	W	F	Ctg	0					
					J	VR	IR	W	CL	Fi						
					MB											
543					Grab 4	MB						<p>Grab 4: Unconfined Compressive Strength = 4,924 psi; Dry Density= 139.7 pcf.</p>				
						J	R	C	N	Fe	Ctg				60	
						J	VR	ST	VN	Fe	Ctg				10	
						J	VR	ST	N	Fe	Ctg				0	
			84	76	R-4	J	VR	IR	N	F	Ctg				0	
					J	VR	ST		Fe	Ctg	0					
					MB											
					J	R	U	N	Fe	Ctg	60					
					J	R	U	M	W	Fe	Ctg				20	
					Grab 5	MB										
						J	VR	PL	VN	U	Ctg	55				
						J	R	PL	M	W	Fe	Ctg	40			
538						MB										
170																



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Log of Boring

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Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
170					Grab 6	MB								BASALT; moderately strong to strong, slightly weathered to fresh, highly fractured, dark gray. Joint surfaces are planar to undulating, rough, and iron oxide stained. Common joint sets occur between 0 and 15 degrees and at +/- 60 degrees with apertures between 2 and 3mm.		
			100	48	R-5	MB	J	ST	N	N	Fe	Ctg	0			
					Grab 7	MB								Grab 7: Unconfined Compressive Strength = 6,182 psi; Dry Density = 158.6 pcf.		
					Grab 8	J	R	C	VN	Fe	Ctg	10				
						MB	J	R	PL	VN	Fe	Ctg	10			
						J	R	C	VN	U	Ctg	10				
						J	R	IR	N	Fe	Ctg	35				
						J	VR	ST	VN	U	Ctg	15				
						J	VR	PL	VN	Fe	Ctg	15				
						J	R	PL	VN	Fe	Ctg	15				
						J	R	PL	VN	Fe	Ctg	10				
			100	70	R-6	MB	VR	PL	HF	Fe	Fi	80				
						J	VR	IR		Fe	Ctg	10				
						J	VR	IR		Fe	Ctg	10				
					Grab 9	J	VR	IR		Fe	Ctg	10				
						J	VR	PL	W	Fe	Ctg	35				
						J	VR	PL	W	Fe	Ctg	10	178.5 - 181.0 ft.: Slightly vesicular, moderately weathered.			
						J	VR	U	N	Fe	Ctg	90	179.8 ft.: Irregular vertical joint, heavily iron stained, vesicular, aperture 1-2 mm, trace clay.			



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Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	RQD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
180						J	VR	PL	VN	Fe	Ctg	60	<p>BASALT; moderately strong to strong, slightly weathered to fresh, highly fractured, dark gray. Joint surfaces are planar to undulating, rough, and iron oxide stained. Common joint sets occur between 0 and 15 degrees and at +/- 60 degrees with apertures between 2 and 3mm.</p> <p>Except as noted below, basalt is 5% to 20% vesicular throughout.</p> <p>[Boring Lava]</p> <p>180.0 ft.: Common joint sets occur between 5 and 35 degrees and between 60 and 70 degrees below 180 feet.</p> <p>182.0 - 190.0 ft.: Fresh.</p> <p>183.5 - 189.0 ft.: No vesicles.</p>	<p>Lost approx. 1,500 gal. of drilling fluid at 180 feet.</p> <p>Run R-7: HQ coring bit blocked off in clay.</p> <p>Run R-8: HQ coring bit blocked off in clay and sand.</p> <p>Run R-10: Drilling fluid partially returns.</p> <p>Grab 12: Unconfined Compressive Strength = 11,570 psi; Dry Density= 163.9 pcf.</p> <p>Drilling fluid fully returns below 187.0 feet.</p>		
			100	100	R-7	MB						45				
			100	50	R-8	MB										
						J	VR	C	W	Fe	Ctg	0				
						J	R	C	T			5				
			100	0	Grab 10	MB										
						MB										
			94	91	Grab 11 R-10	MB										
						J	R	PL	VN	Fe	Ctg	20				
523					Grab 12	MB										
185						J	R	PL		Fe	Ctg	40				
			100	70	R-11	MB										
						MB										
						J	R	PL	W	Fe	Ctg	70				
						J	R	PL	N	Fe	Ctg	20				
518						J	VR	IR	VN	Fe	Ctg	15				
190																



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**Boring LRWP-BH07**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
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Log of Boring

**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES								GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination					
190					Grab 13	MB									<p>BASALT; moderately strong to strong, slightly weathered to fresh, highly fractured, dark gray. Joint surfaces are planar to undulating, rough, and iron oxide stained. Common joint sets occur between 0 and 15 degrees and at +/- 60 degrees with apertures between 2 and 3mm.</p> <p>Except as noted below, basalt is 5% to 20% vesicular throughout.</p> <p>[Boring Lava]</p> <p>190.0 ft.: Vesicular, moderately weathered.</p> <p>192.5 - 195.0 ft.: No vesicles.</p> <p>195.5 - 197.2 ft.: Open 25 mm wide horizontal joint with heavy iron stain.</p>	<p>Grab 13: Unconfined Compressive Strength = 3,018 psi; Dry Density = 120.4 pcf.</p> <p>Grab 15: Unconfined Compressive Strength = 2,446 psi; Dry Density = 123.5 pcf.</p>	
			100	78	R-12	MB											
					Grab 14	J	VR	IR	N	Fe	Ctg	30					
						J	R	PL	VN	Fe	Ctg	15					
						J	SR	PL		Fe	Ctg	25					
						J	SR	PL		Fe	Ctg	15					
					Grab 15	MB											
						J	R	PL				25					
						J	VR	C	W	Fe	Ctg	25					
						MB											
			100	42	R-13	MB											
						MB											
					Grab 16	J	R	PL	N	Fe	Ctg	0					
						J	R	PL	N	Fe	Ctg	80					
						J	R	PL	N	Fe	Ctg	0					
						J	R	PL	N	Fe	Ctg	0					
					Grab 17	J	R	PL	N	Fe	Ctg	5					
						J	R	PL	N	Fe	Ctg	0					
						J	R	PL	N	Fe	Ctg	0					
						J	R	PL	N	Fe	Ctg	0					
200						J	R	PL	N	Fe	Ctg	0					



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**Boring LRWP-BH07**



**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
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Log of Boring

**LRWP-BH07**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
210					Grab 23									CONGLOMERATE; weak, moderately to highly weathered, massive; fresh, hard gravel and cobbles in an orange-brown silty sand matrix; largest clasts tend to be vesicular, subangular, and occur near the basalt contact and grade finer and rounder with depth. [Troutdale Formation]		
			76		R-16											
493																
215																
			100		Grab 24 R-17								SANDSTONE; weak, moderately to highly weathered, massive, orange-brown, with occasional fine to coarse gravel, few cobbles; gravel clasts are fresh, hard, fine to coarse, subrounded to rounded of basaltic composition. [Troutdale Formation]	Grab 24: Unconfined Compressive Strength = 731 psi; Dry Density = 89.0 pcf.		
488																
220																



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Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
220					Grab 25									SANDSTONE; weak, moderately to highly weathered, massive, orange-brown, with occasional fine to coarse gravel, few cobbles; gravel clasts are fresh, hard, fine to coarse, subrounded to rounded of basaltic composition. [Troutdale Formation]	Grab 25: Unconfined Compressive Strength = 253 psi; Dry Density = 101.4 pcf.	
			74		R-18											
225					Grab 26										Grab 26: 0.4% Gravel, 94.6% Sand, 5.0% Fines.	
			100		R-19											
230					Grab										Grab 27: 0.1% Gravel, 99.4% Sand, 0.5% Fines.	



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH07**

**Project: Filtration Pipelines Project – Raw Water Pipeline**

Log of Boring

**Project Location: Multnomah County, OR**

**LRWP-BH07**

**Project Number: 6218.0**

Date(s) Drilled	11/16/2021 - 11/30/2021	Client	Jacobs Engineering Group	Final Depth	232.0 ft bgs
Coordinates	7742874.8 E, 659436.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary and HQ Wireline/CME 850 Track Mounted
Surface Elevation	707.5 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	4.00 in
Location	LRWP North Station 29+98	Logged by/Checked by	K. Elliott, A. Judy / K. Elliott	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES								GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination					
230					27									SANDSTONE; weak, moderately to highly weathered, massive, orange-brown, with occasional fine to coarse gravel, few cobbles; gravel clasts are fresh, hard, fine to coarse, subrounded to rounded of basaltic composition. [Troutdale Formation]			
473															Borehole completed at 232 feet below ground surface (bgs).		
235																	
468																	
240																	



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH07**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		WATER CONTENT (MC)	ATTERBERG LL/PL	USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20							
711		5		87	2-4-4 (N=8)	S-01	■	○				ML	Medium stiff to stiff, moist, red-brown, SILT (ML); low plasticity, trace fine sand, trace black mottles. Residual Soil of the Springwater Formation		
706		10		100	3-5-6 (N=11)	S-02	■	○	—	—					
701		15		100	2-3-2 (N=5)	S-03	■	○				MH	Medium stiff, moist, orange with red, brown, and black mottles, Sandy Elastic SILT (MH); high plasticity, fine to medium sand. Sensitive Saprolite of the Springwater Formation <i>Becomes wet at 16.0 feet.</i>	S-03: 58.5% Fines.	
696		20		100	2-1-2 (N=3)	S-04a /b	■	○	—	—				<i>Becomes soft at 18.5 feet.</i>	SH-01: 300 psi from 16.5-17.5 ft, 450 psi from 17.5-18.5 feet.
691		25		100	1-2-3 (N=5)	S-05	■	○						<i>Becomes medium stiff at 25.0 feet.</i>	
686															



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring  
**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
							10	20					
681		100			2-3-2 (N=5)	S-06	■	10		MH	Medium stiff, moist, orange with red, brown, and black mottles, Sandy Elastic SILT (MH); high plasticity, fine to medium sand. <b>Sensitive Saprolite of the Springwater Formation</b>	A portion of Sample S-06 is light gray with a speckled texture; appears to be volcanic ash.	
		213				SH-02					Very dense, wet, light brown and green-gray, poorly graded GRAVEL with Clay and Sand (GP-GC); fine to coarse, subangular to angular gravel, fine to coarse sand, medium plasticity fines. <b>Less Weathered Springwater Formation</b> <i>Fines may be sensitive in sample S-07 at 35.0 feet.</i>	SH-02: 450 psi from 31.5 to 32.25 feet, unable to push beyond 32.25 feet.	
		35			46-37-26 (N=63)	S-07							
676		40								GP-GC			
671		45			50/4" (Refusal)	S-08							
666		50											
661		55			39-50/4" (Refusal)	S-09				GP-GM	Very dense, wet, light brown and gray, poorly graded GRAVEL with Silt and Sand (GP-GM); fine to coarse subrounded gravel, fine to coarse sand, non-plastic fines. <b>Less Weathered Springwater Formation</b>		
656													



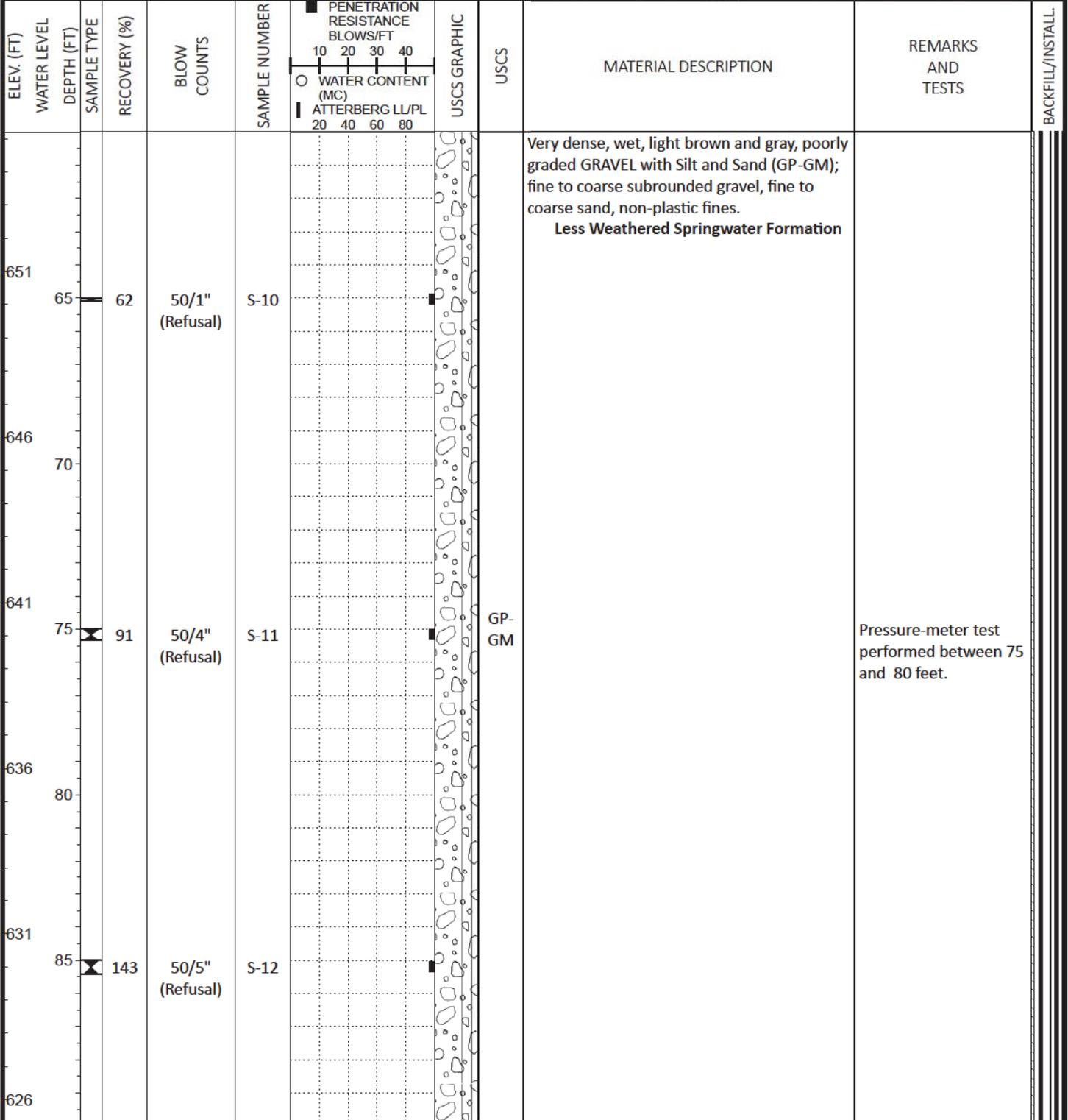
NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

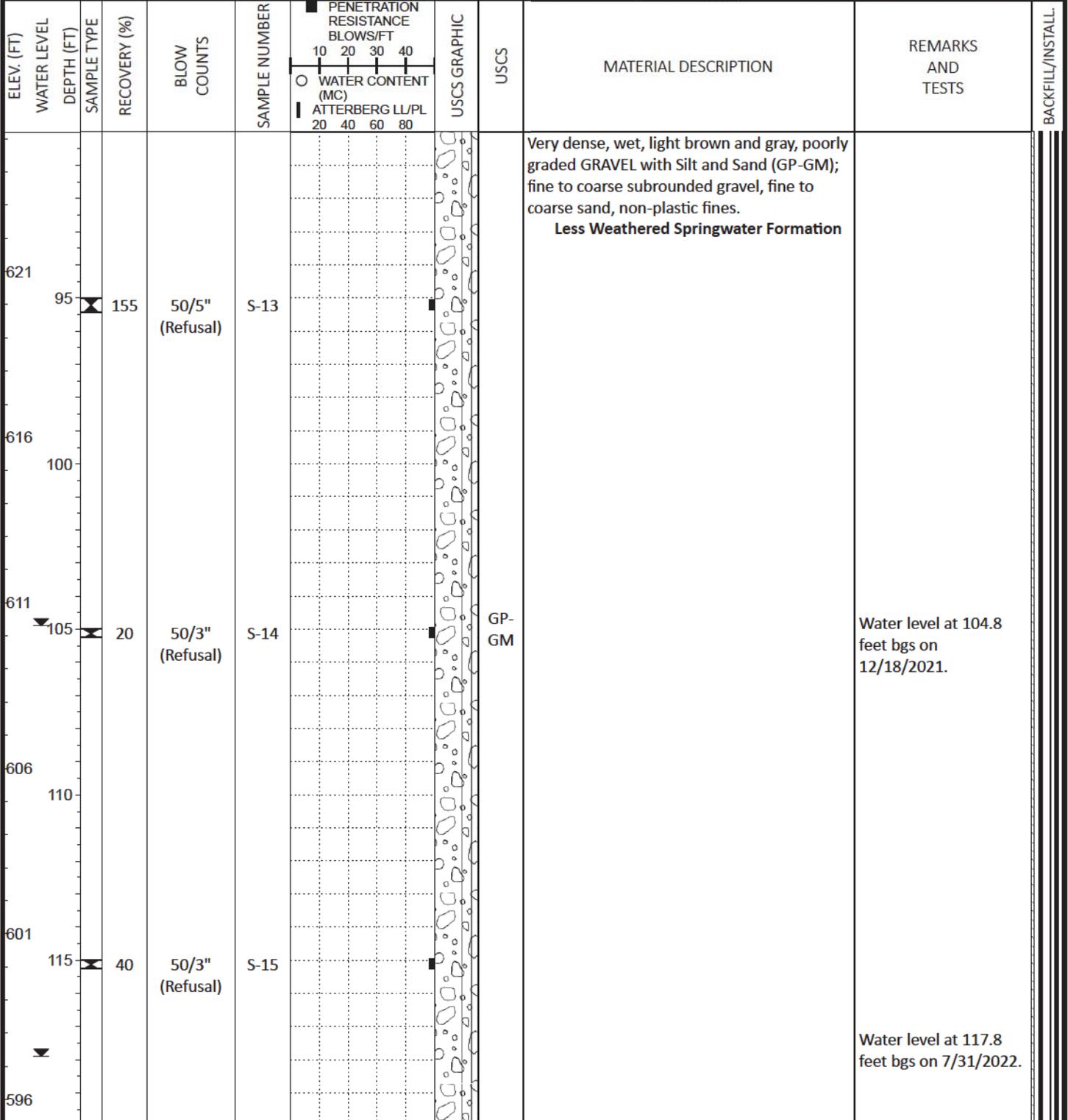


NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

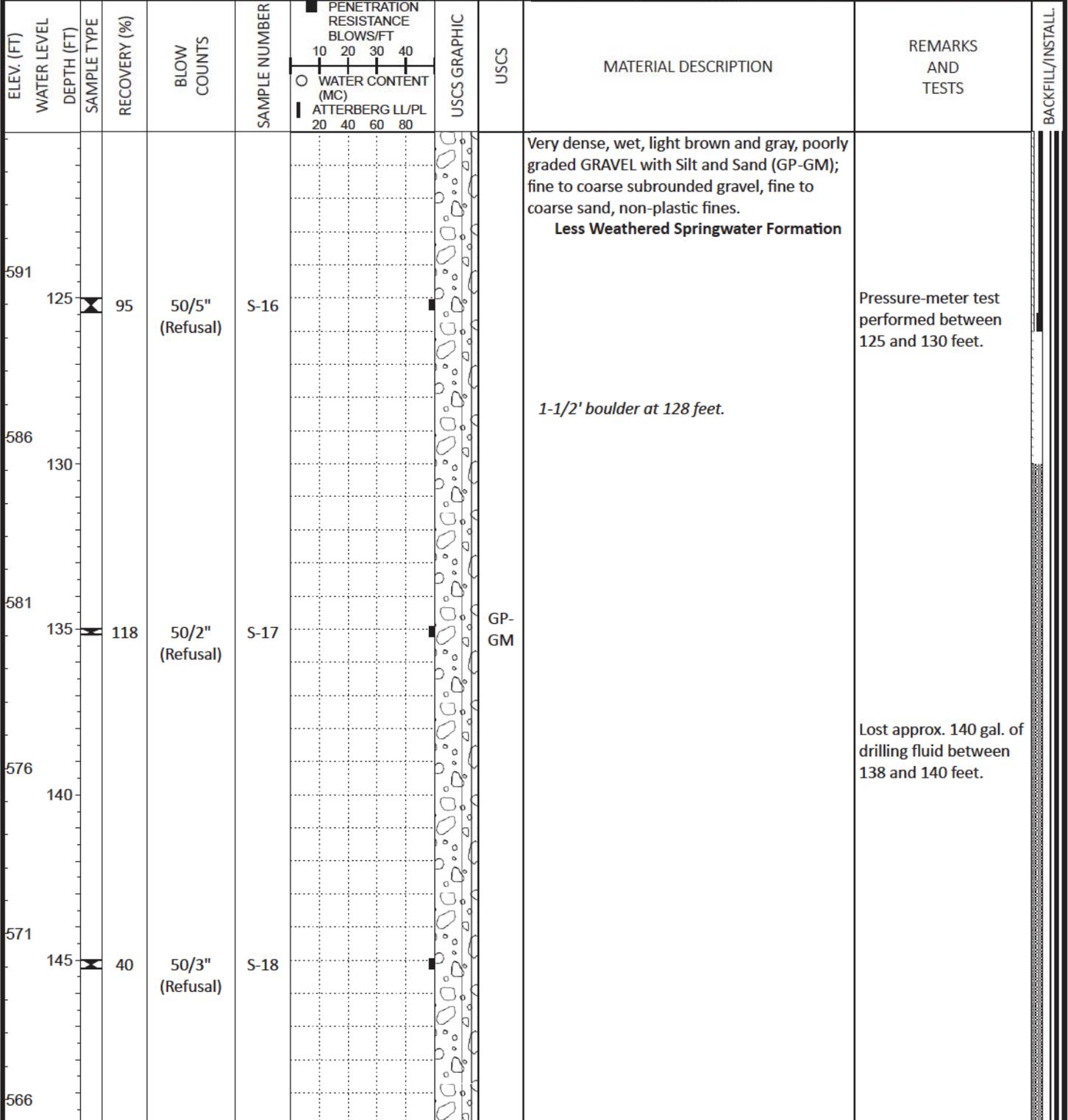


NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

*Log of Boring*  
**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Rig Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	BLOW COUNTS	SAMPLE NUMBER	PENETRATION RESISTANCE BLOWS/FT		USCS GRAPHIC	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						10	20					
561	155		40	50/3" (Refusal)	S-19				GP-GM	Very dense, wet, light brown and gray, poorly graded GRAVEL with Silt and Sand (GP-GM); fine to coarse subrounded gravel, fine to coarse sand, non-plastic fines. <b>Less Weathered Springwater Formation</b>		
556	160		40	50/3" (Refusal)	S-20							
<i>Log continued on next page.</i>										163.0 ft.: switched to PQ coring – 3-3/16" ID bit.		



NOTES:  
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**Project: Filtration Pipelines Project – Raw Water Pipeline**

*Log of Boring*

**Project Location: Multnomah County, OR**

**LRWP-BH08**

**Project Number: 6218.0**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	RQD (%)	SAMPLE ID	DISCONTINUITIES								GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination					
160																	
			18	0	R-1									Log continued from previous page.			
551																	
165																	
			20	0	R-2												
546																	
170																	



NOTES:  
 Location and Elevation Source: 90% Drawings  
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**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	RQD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
170			0	0	R-3									Poor Recovery : weakly cemented, light gray, CLAY (CL); unknown origin. <i>170.0 - 173.0 ft.:Drilling soft material; drilling fluid return is milky white; clay is inferred.</i>		
			0	0	R-4									No Recovery; Drilling soft material; drilling fluid is brown; Residual Soil is inferred.		
541																
175																
			0	0	R-5									Poor Recovery; Residual Soil grading to Basalt rock is inferred based on drilling action.	Coring Run #5 recovered several "half-round" pieces of the basalt plug (see the Appendix B Core Photos).	
536																
180																



NOTES:  
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**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES										GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination							
180																Poor Recovery; Residual Soil grading to Basalt rock is inferred based on drilling action.			
			83	83	R-6	MB													
					Grab 1	J	VR	IR		Fe	Ctg	0				BASALT; strong, moderately weathered to fresh, moderately to highly fractured, dark gray. Joint surfaces are curved to irregular and rough. Common joint sets occur between 0 and 25 degrees. Less common joint orientations are noted below. Except as noted below, basalt is 5% to 25% vesicular throughout. [Boring Lava]	Grab 1: Unconfined Compressive Strength = 4,590 psi; Dry Density= 131.9 pcf.		
					Grab 2	J	VR	ST		Fe	Ctg	0							
					Grab 2	J	R	PL		Fe	Ctg	0							
			86	52	Grab 3 R-7	MB										186.2 - 187.1 ft.: No vesicles.	Pressure-meter test from 186 to 191 feet.		
					Grab 4	J	R	PL	T	Fe	Ctg	15							
					Grab 5	J	R	PL	W	Fe	Fi	30							
					Grab 5	J	R	PL	W	Fe	Ctg	25					Lost approx. 70 gal. of drilling fluid at 188 feet. Grab 5: Unconfined Compressive Strength = 3,023 psi; Dry Density= 124.5 pcf.		
					Grab 5	J	R	PL	W	Fe	Fi	20							
					Grab 5	J	R	PL	T			80							
					Grab 5	J	R	PL	W	Fe	Ctg	0							
190																			



NOTES:  
 Location and Elevation Source: 90% Drawings  
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**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
190						J	R	C	W	Fe	Fi	0		BASALT; strong, moderately weathered to fresh, moderately to highly fractured, dark gray. Joint surfaces are curved to irregular and rough. Common joint sets occur between 0 and 25 degrees. Less common joint orientations are noted below. Except as noted below, basalt is 5% to 25% vesicular throughout. [Boring Lava]	Pressure-meter test performed between 191.6 and 196.6 feet.	
			100	100	R-8	MB										
			92	79	R-9	MB										
						MB										
						J	R	PL	T	Fe	Ctg	30				
						J	R	PL	VN	Fe	Ctg	40				
					Grab 6											
						J	R	PL	N	U	Ctg	40				
					Grab 7	J	R	PL	T	-	-	15				
						J	R	PL	VN	-	-	0				
						MB										
					Grab 8	J	SR	C	W	Fe	Ctg	20				
					Grab 9											
			92	72	R-10	MB										
						MB										
						J		C		U	Ctg	55				
						MB										
						J	R	PL	T	U	Ctg	40				
						J						80				

194.0 - 199.0 ft.: No vesicles.

Grab 6: Unconfined Compressive Strength = 4,601 psi; Dry Density = 157.4 pcf.

Grab 9: Unconfined Compressive Strength = 5,916 psi; Dry Density = 161.9 pcf.



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES								GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination					
200						J	R	IR	W	Fe	Ctg	40		<p>BASALT; strong, moderately weathered to fresh, moderately to highly fractured, dark gray. Joint surfaces are curved to irregular and rough. Common joint sets occur between 0 and 25 degrees. Less common joint orientations are noted below. Except as noted below, basalt is 5% to 25% vesicular throughout.</p> <p>[Boring Lava]</p> <p>200.0 ft.: Vertical latent plane of weakness.</p> <p>201.9 - 202.3 ft.: Three horizontal open joints in vesicular zone; rough, irregular, and heavily iron-stained, 2.5 mm apertures.</p> <p>203.7 ft.: 60 degree open joint, rough, curved surface, iron-stained, 3-5 mm aperture.</p> <p>206.5 - 208.5 ft.: No vesicles.</p>			
					J	R	ST	T	Fe	Ctg	0						
					J	VR	IR		Fe	Ctg	35						
			100	82	R-11	MB											
					J	VR	IR	VW	Fe	Ctg	0						
					J	VR	ST	W	Fe	Ctg	20						
					J	VR	IR	VW	Fe	Ctg	0						
					J	VR	IR	VW	Fe	Ctg	0						
					J	VR	ST	W	Fe	Ctg	30						
					J	SR	IR	W	Fe		15						
					J	R	C	W	Fe	Ctg	60						
					J	SR	IR	W	Fe	Fi	20						
511																	
					J	R	PL	N	Fe	Ctg	10						
205					Grab 10												
					J	VR	PL	N	Fe	Ctg	15						
					J	R	ST	W	Fe	Ctg	10						
			100	100	R-12												
					J	R	C	W	Fe	Ctg	15						
					MB												
					MB												
					J	VR	PL	N	U	Ctg	0						
506																	
210																	



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	RQD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
210					Grab 11	MB								<p>BASALT; strong, moderately weathered to fresh, moderately to highly fractured, dark gray. Joint surfaces are curved to irregular and rough. Common joint sets occur between 0 and 25 degrees. Less common joint orientations are noted below. Except as noted below, basalt is 5% to 25% vesicular throughout.                      [Boring Lava]</p> <p>213.1 - 216.4 ft.: No vesicles.</p>	<p>Grab 11: Unconfined Compressive Strength = 6,092 psi;                      Dry Density= 139.7 pcf.</p>	
					Grab 12	J	R	PL	W	Fe	Ctg	5				
						J	R	PL	W	Fe	Ctg	5				
			96	85	R-13	J	VR	PL	W	Fe	Ctg					
						J	VR	ST	W	Fe	Ctg	0				
						J	VR	PL	W	Fe	Ctg	20				
						J	VR	PL	W	Fe	Ctg	20				
						J	VR	PL	W	Fe	Ctg	25				
						J	R	PL	N	U	Ctg	15				
						MB										
501						J	SR	PL	N	Fe	Ctg	15				
						J	SR	PL	N	U	Ctg	15				
215						MB										
						MB										
			58	20	R-14	J	VR	PL	W	Fe	Fi	10				
						J	VR	C	W	Fe	Ctg	20				
													<p>CONGLOMERATE; weak, moderately to highly weathered, massive; orange-brown, fresh and hard gravel and cobbles in an orange-brown silty sand matrix; dominantly vesicular basalt cobbles near the upper contact grade with depth to rounded gravel.                      [Troutdale Formation]</p>	<p>No rock jointing was noted in the Troutdale Formation; numerous mechanical breaks resulted from handling the weakly cemented cores.                      RQD calculations were omitted for this intermediate geotechnical material (IGM).</p>		
496																
220																



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH08**



**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
**Project Number: 6218.0**

Log of Boring

**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
230					Grab 14									SANDSTONE; weak, moderately to highly weathered, massive, orange-brown, occasional gravel, rare cobbles; gravel clasts are fresh, hard, fine to coarse, rounded to well rounded and of basaltic composition. [Troutdale Formation]	Grab 14: Unconfined Compressive Strength = 373 psi; Dry Density = 85.0 pcf.	
			100		R-17											
-481					Grab 15								Grab 15: Unconfined Compressive Strength = 375 psi; Dry Density = 84.9 pcf. Pressure meter test performed between 236.5 and 241.5 feet.			
235					R-18											
			100		Grab 16											
					Grab 17											
					Grab 18											
					Grab 19											
-476																
240																



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
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**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**  
**Project Location: Multnomah County, OR**  
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Log of Boring

**LRWP-BH08**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES							GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination				
240													SANDSTONE; weak, moderately to highly weathered, massive, orange-brown, occasional gravel, rare cobbles; gravel clasts are fresh, hard, fine to coarse, rounded to well rounded and of basaltic composition. [Troutdale Formation]			
			84		R-19											
					Grab 20											
-471														Grab 17: Unconfined Compressive Strength = 213 psi; Dry Density = 98.5 pcf.		
245			100		R-20											
					Grab 21											
-466																
250																



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH08**

**Project: Filtration Pipelines Project – Raw Water Pipeline**

Log of Boring

**Project Location: Multnomah County, OR**

**LRWP-BH08**

**Project Number: 6218.0**

Date(s) Drilled	12/02/2021 - 12/16/2021	Client	Jacobs Engineering Group	Final Depth	251.6 ft bgs
Coordinates	7742647.7 E, 659429.9 N	Geotechnical Consultant	McMillen Jacobs Associates	Method/Riq Type	Mud Rotary/CME 850 Track Mounted
Surface Elevation	715.2 ft.	Drilling Contractor	Western States Soil Conservation, Inc.	Hole Diameter	5.00 in
Location	LRWP North Station 32+26	Logged by/Checked by	A. Judy, K. Elliott / K. Elliott, J. Fissel	Hammer Type	140 lb / 30 in / Automatic

ELEV. (FT)	WATER LVL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	ROD (%)	SAMPLE ID	DISCONTINUITIES								GRAPHIC	MATERIAL DESCRIPTION	REMARKS AND TESTS	BACKFILL/INSTALL
						Type	Roughness	Shape	Aperture	Infill	Infill Amount	Inclination					
250														SANDSTONE; weak, moderately to highly weathered, massive, orange-brown, occasional gravel, rare cobbles; gravel clasts are fresh, hard, fine to coarse, rounded to well rounded and of basaltic composition. [Troutdale Formation]			
-461															Borehole completed at 251.6 feet below ground surface (bgs).		
255																	
-456																	



NOTES:  
 Location and Elevation Source: 90% Drawings  
 Vertical Datum: Portland Vertical Datum Feet (NAVD88 - 2.1)  
 Coordinate System: Water Bureau Filtration Project Custom Coordinate System

**Boring LRWP-BH08**