CITY OF SILVERTON, OREGON

GEOTECHNICAL REPORT

FOR

WWTP PRIMARY SLUDGE PUMP STATION

JUNE 2024

GEOTECHNICAL REPORT

FOR

WWTP PRIMARY SLUDGE PUMP STATION

JUNE 2024

SUBMITTED TO:
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GEOTECHNICAL ENGINEERING REPORT

City of Silverton WWTP Primary Sludge Pump Station

SILVERTON, OR

June 2024

Shannon & Wilson No: 112564

Submitted To: Hazen and Sawyer
4640 S. Macadam Avenue, Suite 50
Portland, OR 97239
Attn: Dan Garbely

Subject: GEOTECHNICAL ENGINEERING REPORT, CITY OF SILVERTON WWTP PRIMARY SLUDGE PUMP STATION, SILVERTON, OR

Shannon & Wilson, Inc. (Shannon & Wilson) prepared this report and participated in this project as a subconsultant to Hazen and Sawyer. Our scope of services was specified in our Subcontract Agreement for Professional Services dated January 23, 2024. This report presents a geotechnical engineering report and was prepared by the undersigned.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON

REGISTERED PROFESSIONAL ENGINEER
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1 INTRODUCTION

1.1 General

This report presents the results of our geotechnical site evaluations, engineering analysis, and recommendations to support design and construction of the Primary Sludge Pump Station at the City of Silverton Wastewater Treatment Plant (WWTP) in Silverton, Oregon. The WWTP is located at 400 Schemmel Lane in Silverton, Oregon. The Vicinity Map, Figure 1, shows the general location of the project site.

1.2 Project Understanding

We understand that a sludge pump station is proposed at the City of Silverton WWTP. The project will replace the existing pump with two pumps in a new structure. The proposed structure will be located between the control building and primary clarifier as shown on Figure 2, Site and Exploration Plan. We understand the structure will be a 20 by 15-foot Concrete Masonry Unit (CMU) or pre-fabricated fiberglass building with a finished floor elevation of approximately 213.5 feet.

1.3 Scope of Services

Our services were performed in accordance with the scope described in our Subcontract Agreement dated January 23, 2024. The scope items included in this report are summarized as follows:

- Review existing information, including available geologic maps and previous geotechnical reports;
- Complete hand augers to explore subsurface conditions;
- Observe test pits completed by the City of Silverton;
- Provide geotechnical recommendations for foundation support of the new sludge pump building including bearing capacity and anticipated settlement;
- Provide Site Class and associated site seismic ground motion parameters in accordance with IBC 2021 and ASCE 7-16;
- Provide construction considerations including subgrade preparation, reuse of on-site materials, and preparation and compaction of site fills and backfill; and
- Prepare this geotechnical engineering report.

2 GEOLOGY AND SEISMIC SETTING

The Silverton WWTP site is located along the eastern side of the Willamette Valley physiographic province. The site is bounded to the east by the Western Cascades, to the north and west by the Willamette Valley, and to the south by Silver Creek, a tributary to the Willamette River. The Willamette Valley is a forearc basin with a trough-like configuration brought about by uplift and tilting of the Coast Range and the Western Cascades. Bedrock underlying the Willamette Valley generally consists of Tertiary age volcanic rock, which has been overlain by sedimentary deposits, including Pleistocene Flood deposits.

During the Ice Age of the Pleistocene epoch, enormous lakes formed behind glacial ice in western Montana. Water in the deep glacial lakes repeatedly breached the ice dam, resulting in catastrophic floods known as the Missoula Floods, which scoured across eastern Washington, were constricted in the Columbia River Gorge, and then back-flooded into the Willamette Valley, creating another temporary lake. The floods conveyed large blocks of ice, many of which contained sediment and even large boulders. Numerous large ice-rafted boulders (“erratics”) were left scattered across the Willamette Valley, along with a thick layer of fine-grained sediment, after the flood waters drained away to the Pacific Ocean.

2.1 Site-Specific Geology

Geology onsite consists of older alluvial deposits (Pleistocene) and includes poorly to moderately indurated silt, sand, and conglomerate that comprise older alluvial terrace/fan deposits along major streams. Below 300 feet Elevation, the Willamette Valley includes late Pleistocene poorly indurated glaciofluvial clays and silts deposited by the Missoula Floods (Tolan and Beeson, 1999).

Groundwater is assumed to be generally at the water level in Silver Creek. Locally, groundwater is assumed to generally flow to the south toward Silver Creek, while regionally the overall movement of groundwater flow should be to the west – in the direction of the stream flow. Due to the close proximity to the creek, the water table at the site will likely be influenced by the water level in Silver Creek.

2.2 Regional Seismological Setting

Earthquakes in the Pacific Northwest occur largely as a result of the subduction of the Juan de Fuca plate beneath the North American plate along the Cascadia Subduction Zone (CSZ). The CSZ is located approximately parallel to the coastline from northern California to southern British Columbia. The compressional forces that exist between these two colliding plates cause the oceanic Juan de Fuca plate to descend, or subduct, beneath the continental plate at a rate of about 1.5-inches per year (DeMets and others, 2010). This process leads to volcanism in the North American plate and stresses and faulting in both plates throughout much of the western regions of southern British Columbia, Washington, Oregon, and northern California. Stress between the colliding plates is periodically relieved through great earthquakes at the CSZ plate interface.

Within the regional tectonic framework and historical seismicity, three broad earthquake sources are identified:

- Subduction Zone Interface Earthquakes originate along the CSZ, which is located 25 miles beneath the coastline. Paleoseismic evidence and historic tsunami records from Japan indicate that the most recent subduction zone interface event was in 1700 AD and was an approximately magnitude 9 earthquake that likely ruptured the full length of the CSZ.
- Deep-Focus, Intraplate Earthquakes originate from within the subducting Juan de Fuca oceanic plate as a result of the downward bending and tension in the subducted plate. These earthquakes typically occur 28 to 38 miles beneath the surface. Such events on the CSZ are estimated to be as large as magnitude 7.5. Historic earthquakes include the 1949 magnitude 7.1 Olympia earthquake, the 1965 magnitude 6.5 earthquake between Tacoma and Seattle, and the magnitude 6.8 2001 Nisqually earthquake. The highest rate of CSZ intraslab activity is beneath the Puget Sound area, with much lower rates observed beneath western Oregon.
- Shallow-Focus Crustal Earthquakes are typically located within the upper 12 miles of the earth’s surface. The relative plate movements along the CSZ cause not only east-west compressive strain but dextral shear, clockwise rotation, and north-south compression of the leading edge of the North American Plate (Wells and others, 1998), which is the cause of much of the shallow crustal seismicity of engineering significance in the region. The largest known crustal earthquake in the Pacific Northwest is the 1872 North Cascades earthquake with an estimated magnitude of about 7. Other examples include the 1993 magnitude 5.6 Scotts Mill earthquake and magnitudes 5.9 and 6.0 Klamath Falls earthquakes.

2.2.1 Local Crustal Faults

Shallow crustal faults and folds throughout Oregon have been located and characterized by the United States Geological Survey (USGS). The USGS provides approximate fault locations and a detailed summary of available fault information in the USGS Quaternary Fault and Fold Database. The database defines four categories of faults, Class A through D, based on evidence of tectonic movement known or presumed to be associated with large earthquakes during the Quaternary time (within the last 2.6 million years). For Class A faults, geologic evidence demonstrates that a tectonic fault exists and that it has likely been active within the Quaternary period. For Class B faults, there is equivocal geologic evidence of Quaternary tectonic deformation, or the fault may not extend deep enough to be considered a source of significant earthquakes. Class C and D faults lack convincing geologic evidence of Quaternary tectonic deformation or have been studied carefully enough to determine that they are not likely to generate significant earthquakes.

According to the USGS Quaternary Fault and Fold database (USGS, 2024), there are 4 Class A features within approximately 15 miles of the project site. Their names, general locations relative to the site, and the time since their most recent deformation are summarized in Exhibit 2-1. The CSZ itself is approximately 135 miles west of the project site, with an average slip rate of approximately 40 millimeters (1.5 inches) per year and the most recent deformation occurring about 300 years ago (USGS, 2024).

Exhibit 2-1: USGS Class A Faults Within an Approximate 15-mile Radius of the Project Site

Fault Name	USGS Fault Number	Approximate Length	Approximate Distance and Direction from Project Site^1	Slip Rate Category^2	Time Since Last Deformation3
Mount Angel fault	873	18.6 miles	3.1 mile NE	< 0.2 mm/yr	< 15 ka
Waldo Hills fault	872	7.5 miles	9.1 mile SW	< 0.2 mm/yr	< 1.6 ma
Canby-Molalla fault	716	31.1 miles	14.2 mile NE	< 0.2 mm/yr	< 130 ka
Mill Creek fault	871	11.2 miles	12.4 mile S	< 0.2 mm/yr	< 1.6 ma

NOTES:
1 Approximate distance between project site and nearest extent of fault mapped at the ground surface.
2 mm = millimeters; yr = year.
3 Ma = “Mega-annum” or million years ago; ka = “Kilo-annum” or one thousand years ago.

3 FIELD EXPLORATION AND LABORATORY TESTING

3.1 Subsurface Explorations

Shannon & Wilson explored subsurface conditions at the project site with one hand auger, designated HA-1 and two test pits, designated TP-1 and TP-2. Hand auger HA-1 was completed to a depth of 2.3 feet on February 21, 2024. Test pits TP-1 and TP-2 were completed to depths of 5.3 and 5.5 feet, respectively, on February 21, 2024.

Approximate locations of the explorations are shown on the Site and Exploration Plan, Figure 2. Details of the explorations, sampling procedures, and our log of the materials encountered are presented in Appendix A, Subsurface Explorations.

3.2 Historical Explorations

Our knowledge of the site is supplemented by historical explorations performed by Shannon & Wilson in 2011 as part of the Silverton WWTP Expansion Project, for the proposed new bigas and digester buildings, and anaerobic digester. The historical explorations include three geotechnical borings completed to depths between 15 and 30 feet below grade. The location of the historical exploration is shown on Figure 2, Site and Exploration Plan. Historical explorations are included in Appendix B, Historical Explorations.

4 SUBSURFACE CONDITIONS

4.1 Geotechnical Soil Units

We grouped the materials encountered in our current and historical field explorations into three geotechnical units, as described below. Our interpretation of the subsurface conditions is based on current and historical explorations, and regional geologic information from published sources. Typical characteristics of the geotechnical units are as follows:

- **Topsoil:** Topsoil ranging from 6- to 12-inches thick was encountered in test pits TP-1 and TP-2.
- **Fill**: Below the surficial topsoil, fill soil was encountered in all explorations up to a depth of about 10 feet below the existing grade. Fill soil generally consists of medium-dense to very dense gray and brown-orange sandy silty gravel.
- **Alluvium**: Alluvial deposits were encountered underlying the gravelly fill soil in historical borings B-1 to B-3. In general, this unit consists of very dense orange-brown silty sandy gravel to sandy gravel with fines existing in a weakly to moderately cemented conglomerate with a clast supported matrix.

These geotechnical units were grouped based on their engineering properties, geologic origins, and their distribution in the subsurface. Contacts between the units may be more gradational than shown on the boring logs in Appendix A, Subsurface Explorations and Appendix B, Historical Explorations. The sections below characterize the geotechnical units in greater detail.

4.2 Groundwater

Groundwater was not encountered during our current explorations. During historical explorations, groundwater was identified at 12.6 feet in boring B-1 (Shannon and Wilson, 2011) on November 2, 2010.

Groundwater levels should be expected to vary with changes in topography and precipitation. Generally, groundwater highs occur at the end of the wet season in late spring or early summer, and groundwater lows occur towards the end of the dry season in the early to mid-fall.

5 GEOLOGIC AND SEISMIC HAZARD EVALUATION

5.1 Seismic Design Ground Motions

The 2021 International Building Code refers to ASCE 7-16 Chapter 20 for determination of Site Class. In accordance with the site classification criteria in Chapter 20 of ASCE 7-16, we recommend using a Site Class C for the project site. Code-based seismic design parameters are presented in Exhibit 5-1.

Exhibit 5-1: Recommended ASCE 7-16 Seismic Design Parameters

Seismic Parameters	Symbol	Value
Site Class	-	C
Mapped MCE Peak Ground Acceleration	PGA	0.357g
PGA Site Coefficient	F_{PGA}	1.2
Peak Ground Acceleration Corrected for Site Effects	PGA_M	0.428g
Mapped Short Period Spectral Acceleration	S_S	0.778g
Mapped 1-Second Spectral Acceleration	S_1	0.377g
Short Period Site Coefficient	F_a	1.2
1-Second Period Site Coefficient	F_v	1.5
Adjusted MCER Spectral Response Acceleration for Short Periods	S_{MS}	0.934g
Adjusted Spectral Response Acceleration at 1-Second Period	S_{M1}	0.565g
Short Period Design Spectral Acceleration	S_{DS}	0.623g
1-Second Period Design Spectral Acceleration	S_{D1}	0.377

NOTES:
g = gravity acceleration
N/A = Not applicable

5.2 Liquefaction

Considering the very dense condition of the alluvial deposits below the groundwater table, the site is considered to have a low-risk potential for soil liquefaction.

5.3 Lateral Spreading

Due to low risk of liquefaction, the potential of liquefaction induced lateral spreading is considered low.

5.4 Fault Rupture

The nearest mapped Class A or Class B fault is approximately 3 miles from the site, and in our opinion the risk of fault rupture is low.

6 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

6.1 General

As described above, historical explorations identified apparent undocumented fill at depths up to 10 feet near the study area. The properties, performance, and behavior of undocumented fill can be highly variable and impossible to predict. Although the relative density of this fill soil (sandy silty gravel) has been classified as medium-dense to dense based on the SPT N-values ranging from 11 to 69 blows per foot (bpf), these high blow counts may be due to the split spoon sampler encountering gravel and even larger-size particles (such as cobbles). Additionally, there are no construction records available to us to verify the composition of the fill soil material or its proper placement and compaction.

Due to the presence of undocumented fill, we recommend that the Primary Sludge Pump Station be supported on conventional shallow footings founded on a geogrid reinforced crushed rock pad. The purpose of the crushed rock pad is to enhance the foundation performance by providing a uniform bearing stratum for the building foundation and slabs, and to reduce the differential settlement potential of the undocumented fill.

The following sections provide our geotechnical engineering recommendations for the foundation design of the proposed sludge pump station structure, site earthwork recommendations, as well as construction considerations.

6.2 Overexcavation and Reinforced Crush Rock Mat

The crushed rock mat should consist of a 4.5-foot-thick reinforced crushed rock section that extends at least 3-feet beyond the footprint of the proposed structure. The subgrade beneath the reinforced crushed rock pad should be prepared as described in Section 7.1 of this report. A typical reinforced crushed rock mat is presented in Figure 3.

After a prepared subgrade described in Section 7.1 has been approved by the Owner's Representative, we recommend placing a layer of non-woven geotextile conforming to the properties provided in Table 02320-4, Section 02320.20 of the Oregon Standard Specification for Construction (OSSC), such as Mirafi 180N. The non-woven geotextile layer should be immediately overlain by a geogrid such as Tensar InterAx NX750 or NX850 Geogrid or an approved alternative. An alternative to having separate geotextile layers (i.e., separate non-woven and geogrid materials) overlying the subgrade is to use a Tensar FilterGrid InterAx which has the non-woven fabric pre-bonded to the geogrid or to use a Mirafi RS580i or equivalent, which serves as both a separation geotextile and a reinforcing layer. All geotextile and geogrid layers should be placed over the entire surface of the subgrade and joints overlapped and/or tied (in the case of geogrid) in accordance with the manufacturer's recommendations. The geogrid described above should not be placed along uneven surfaces or along localized low areas created by additional over-excavations and should be placed as a horizontal layer.

The over-excavation zone should be backfilled using 1-1/2-inch-minus dense-graded aggregate fill (structural backfill) conforming to the grading requirements provided in Table 02630-1 (OSSC, 2021), with allowance for a leveling course. Within the crushed rock fill, we recommend placing a layer of geogrid at 12-inch intervals during backfill placement. Over the 1-1/2-inch-minus dense-graded aggregate fill, a leveling course should consist of ¾-inch-minus dense-graded aggregate conforming to the grading requirements provided in Table 02630-1, OSSC 2021. The leveling course under the edge of the foundation should be at least 3 inches, and under the remaining foundation, the leveling course may be thicker depending on the structural design of the concrete foundation.

The crushed rock material used for the geogrid reinforced crushed rock mat and leveling course should have less than 7 percent by weight passing the No. 200 wet sieve, and 90 percent fracture on at least two faces applying to the combined aggregate retained on the U.S. No. 4 sieve. The crushed rock layers should be a maximum of 1 foot thick and be compacted by self-propelled compaction equipment to at least 95 percent per AASHTO T99. Prior to placement of the crushed rock pad the subgrade should be recompacted as discussed in Section 7.1, Subgrade Preparation.

6.3 Foundation Recommendations

If the reinforced crushed rock pad placement recommendations in this Section 6.2 are incorporated into the design and construction, we recommend a maximum allowable bearing pressure of 3,000 pounds per square foot (psf). Settlement is estimated to be less than 1 inch for total settlement and a 1/2 inch or less over 100 feet for differential settlement. Based on the presence of undocumented fill beneath the foundation, there is a minor risk of settlement that exceeds the predicted settlement values. However, we understand the Biogas Building and Digester Control Building constructed using similar mat foundation design recommendations have performed well.

Exterior footings and foundations in unheated areas should be located at a depth of at least 18 inches below the final exterior grade to provide adequate frost protection. Interior foundations can be located at 12 inches below final grade.

6.4 Lateral Load Resistance

Foundation lateral loads should be resisted with partial passive lateral earth pressures and frictional resistance between the subgrade and the bottom of foundation. In our opinion, an allowable friction factor of 0.50 for mass concrete on crushed rock fill is appropriate. The partial passive equivalent fluid pressure is 250H, where H is the depth of the foundation embedment, not counting the top 12 inches of fill. Partial passive pressure is recommended because the large amounts of foundation movement that would be necessary to mobilize full passive resistance will probably be considered unacceptable by the structural engineer.

6.5 Slab-on-Grade Floors

Support for slab-on-grade floors can be obtained from the reinforced crushed rock pad. We recommend at least 4 inches of leveling course (as described in Section 6.2) be placed between the floor slab and the reinforced crushed rock pad to provide a smooth bearing surface. The geogrid reinforced crushed rock pad and the leveling course will provide a capillary break; however, if additional protection against moisture vapor is desired, a vapor-retarding membrane specific for this type of application may also be incorporated into the design. Typically, vapor barriers are specified by the project’s architect or structural engineer.

Provided the site is constructed as described above, a subgrade modulus value of 150 pounds per cubic inch (pci) can be used to design the floor slabs. Use of this subgrade modulus for design or other on-grade structural elements should include appropriate modification based on dimensions as necessary.

7 CONSTRUCTION CONSIDERATIONS

7.1 Subgrade Preparation

Following stripping and excavation down to the design elevation of the reinforced crushed rock section, but prior to placement of any geosynthetic or the reinforced crushed rock material, organics material, cobbles, boulders, and or concrete and asphalt debris encountered at the base of the over-excavation should be removed prior to subgrade acceptance.

The exposed subgrade should be inspected for the presence of any unsuitable subgrade material (i.e., deleterious material, organic material, or soft zones) should be removed. If deleterious, organic matter, or soft zones are observed, additional overexcavation may be recommended. However, we recommend that the actual amount of over-excavation and additional work related to the acceptance of the subgrade be determined in the field, observed, and approved by a qualified Owner's Representative.

Prior to placement of any geosynthetic or crushed rock, the exposed subgrade should be proof-rolled using a procedural method consisting of compaction equipment weighing at least 3 to 5 tons (dead weight) such as a smooth drum roller or "peanut" roller. The approved equipment should make several passes to obtain at least 3 to 5 complete coverages of the subgrade. Any areas that pump, weave, or appear soft should be removed by over-excavation and backfilled with structural fill. The proof-rolling should be observed full-time by a representative of the geotechnical engineer of record. We recommend that the specifications should include a unit cost bid item for any over-excavation and backfill with specified materials. The geotechnical representative should observe and approve subgrades prior to placing the geosynthetic or crushed rock.

7.2 Wet Weather Earthwork

In the project area, wet weather generally begins about mid-October and continues through about May, although rainy periods may occur at any time of the year.

Most of the soils at the site contain sufficient fines to produce an unstable mixture when wet. Such soils are highly susceptible to changes in water content, and may become muddy, and unstable, if their moisture content significantly exceeds the optimum. Performing earthwork during dry weather would reduce these problems and costs associated with rainwater, trafficability, and excavation of wet soil.

We recommend against leaving the subgrade exposed to rainfall. Instead, after proof-rolling it should be protected with geosynthetic and compacted crushed rock to avoid softening of the subgrade.

7.3 Groundwater Control and Drainage Considerations

In general, surface water or perched groundwater seepage should not be allowed to collect in the foundation excavations or on prepared subgrades. Positive site drainage should be maintained throughout construction activities. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected surface runoff rainwater or perched groundwater.

The site grading plan should be developed to provide rapid drainage of surface water away from the new facilities and to inhibit infiltration of surface water around the perimeter of the building and beneath the building foundation system. Roof runoff should be piped away from the new facilities to a storm sewer or approved disposal area.

8 LIMITATIONS

This Geotechnical Engineering Report has been prepared for Hazen and Sawyer for the exclusive use of the City of Silverton WWTP Primary Sludge Pump Station project to aid in the preliminary design of the proposed project.

The data contained herein are based upon site conditions as they existed during the time of our subsurface investigation. Additionally, the explorations are representative of the subsurface conditions at the exploration locations at the time of the explorations. It cannot be assumed that the subsurface conditions throughout the project area are similar to those disclosed by the explorations. Within the limitations of the scope, schedule, and budget, the data presented in this report were collected and presented in accordance with the generally accepted professional geotechnical practice in this area at the time this report was prepared. No other warranty, expressed or implied, is made.

This report provides the geotechnical data obtained at our exploration location and is not a warranty of subsurface conditions across the project area. Unanticipated soil conditions are commonly encountered and cannot fully be disclosed by information from the exploration and testing described in this report. Such unexpected conditions frequently require additional expenditures to better resolve during final design, as more is known about the final design elements and loads. Therefore, contingency funds are recommended to accommodate potential additional explorations and testing as final design proceeds.

The scope of our geotechnical services did not include environmental site assessments or evaluations regarding the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below the site, or for evaluation or disposal of contaminated soils or groundwater associated with construction, should any be encountered, except as noted in this report.

Shannon & Wilson has prepared "Important Information About Your Geotechnical/Environmental Report" to assist you and others in understanding the use and limitations of this document which is attached at the end of this report.

9 REFERENCES

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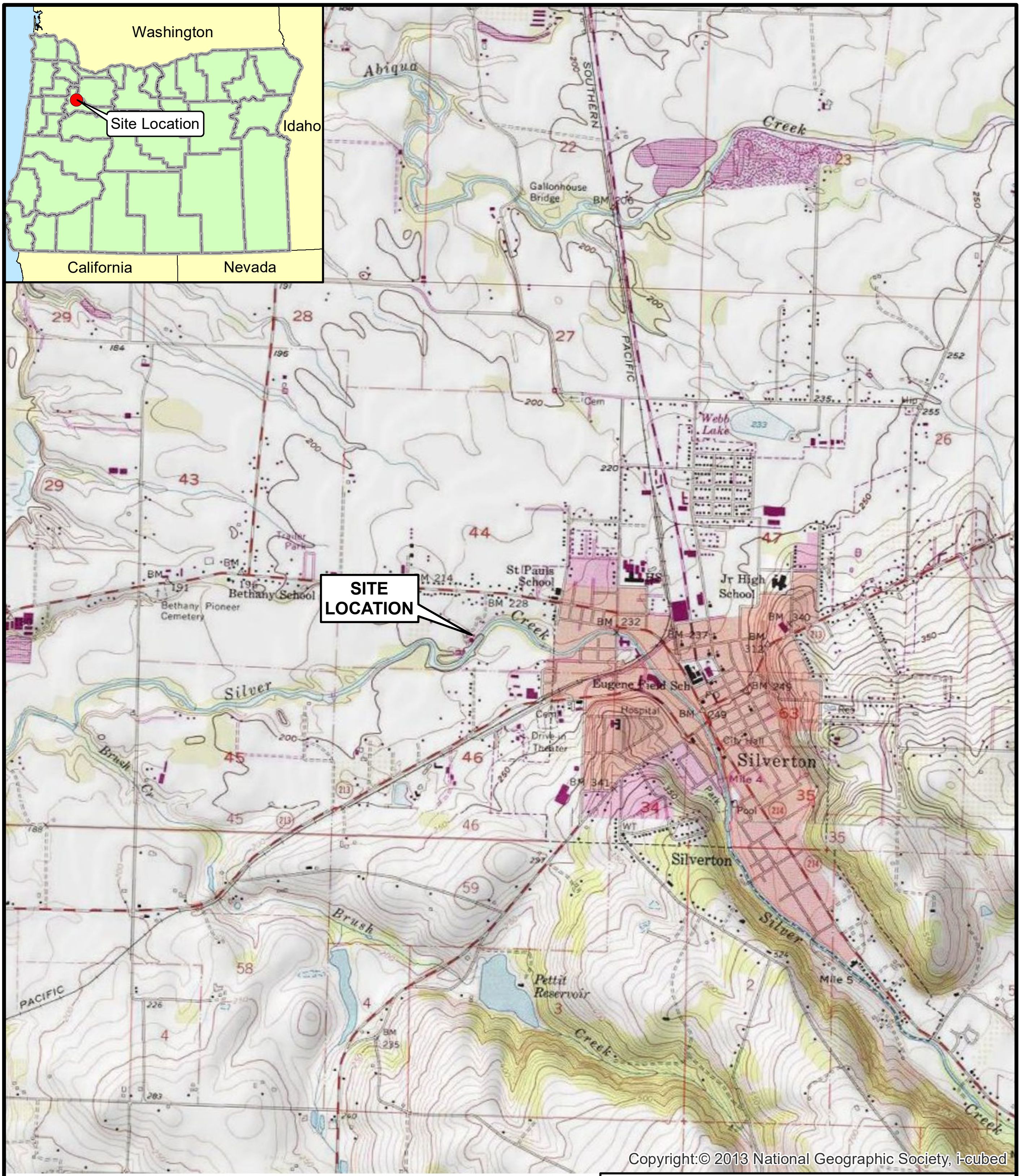

WWTP Primary Sludge Pump Station
Silverton, Oregon

VICINITY MAP

June 2024
112564

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FIG. 1

LEGEND

HA-1 ○ Designation and Approximate Location of Hand Auger
TP-1 ◩ Designation and Approximate Location of Test Pit
B-1 ⊕ Designation and Approximate Location of Boring (2010)
🟪 Approximate Location of Proposed Building

0 30 60 120
Scale in Feet

NOTES

1. Aerial imagery obtained through Google Maps Satellite.
2. Existing base map adapted from file SILVERTON WWTP Proposed Building Location W_TOPO.dwg, provided by Hazen and Sawyer on March 11, 2024. Vertical datum is NGVD1929.
3. Proposed building location adapted from file SILVERTON WWTP Proposed Building Location W_TOPO.dwg, provided by Hazen and Sawyer on March 11, 2024.

WWTP Primary Sludge Pump Station
Silverton, Oregon

SITE AND EXPLORATION PLAN

June 2024
112564

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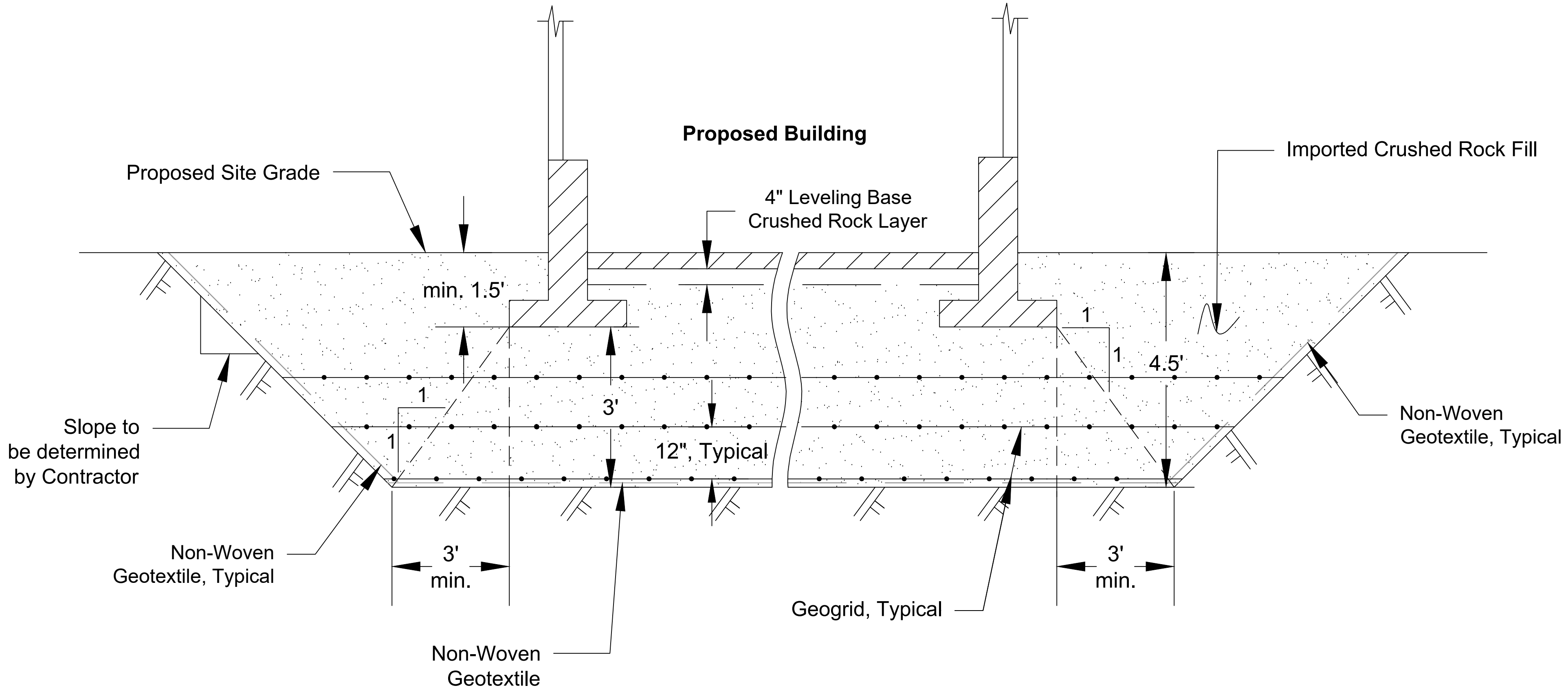
FIG. 2

Filename: P:\GIS\PDX\112000s\112564_Silverton WWTP\Avmxd\SitePlan.mxd Date: 3/11/2024 Login: AEH



Not to Scale

WWTP Primary Sludge Pump Station
Silverton, Oregon

TYPICAL SECTION EXCAVATION AND REINFORCED CRUSHED ROCK PAD

June 2024 112564

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 3

FIG. 3

Appendix A

Subsurface Explorations

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Figure A1: Soil Description and Log Key
Figure A2: Log of Hand Auger HA-1
Figure A3: Log of Test Pit TP-1
Figure A4: Log of Test Pit TP-2

APPENDIX A: SUBSURFACE EXPLORATIONS

A.1 GENERAL

The geotechnical field exploration program included one geotechnical hand auger, designated HA-1, and two test pits, designated TP-1 and TP-2. Completed exploration locations were measured in the field and are shown on the Site and Exploration Plan, Figure 2. Shannon & Wilson geology and engineering staff were present during the completion of the hand augers and test pits, to locate the exploration locations, log the materials encountered, and collect soil samples.

This appendix describes the techniques used to advance and sample the explorations and presents logs of the materials encountered.

A.2 GEOTECHNICAL TEST PITS

The geotechnical test pits were excavated on February 21, 2024, using a Kubota U35 mini excavator equipped with an 18-inch toothed bucket provided and operated by the City of Silverton, OR. The test pits were excavated to depths between 5.3 and 5.5 feet below the ground surface (bgs). The test pits were backfilled with the excavated material and lightly compacted with the excavator bucket. A Shannon & Wilson representative was present during the explorations to locate the test pits, observe the excavation, collect soil samples, and log the materials encountered.

A.2.1 Soil Sampling

Disturbed jar samples were collected of cuttings from the excavator bucket or the spoils pile at select intervals determined in the field by the Shannon & Wilson representative on site. The material was examined, classified, and described in the field, sealed to retain moisture, and returned to our in-house laboratory for additional examination and testing.

A.3 MATERIAL DESCRIPTIONS

Soil samples were described and identified visually in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the samples were noted. Once transported to Shannon & Wilson, the hand grab samples from the test pits were re-examined, and the field descriptions, and identifications were modified where necessary. The specific terminology used is defined in the Soil Description and Log Key, Figure A1.

A.4 DRILL LOGS

The summary logs of the hand augers and test pits are presented in the Logs of Borings, Figures A2 to A4. Material descriptions and interfaces on the logs are interpretive, and actual changes may be gradual. The left-hand portions of the logs show individual sample intervals, percent recovery, SPT data, and natural moisture content measurements. Material descriptions and geotechnical unit designations are shown in the center of the boring logs, and the right-hand portions provide a graphic log, miscellaneous comments, and a graphic depicting hole installation and backfill details.

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1] All percentages are by weight of total specimen passing a 3-inch sieve.
[2] The order of terms is: *Modifying Major with Minor.*
[3] Determined based on behavior.
[4] Determined based on which constituent comprises a larger percentage.
[5] Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

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

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

▧	Bentonite Cement Grout	▦	Surface Cement Seal
▨	Bentonite Grout	■	Asphalt or Cap
▩	Bentonite Chips	▤	Slough
⬚	Silica Sand	▥	Inclinometer or Non-perforated Casing
●	Gravel	▮	Vibrating Wire Piezometer
▤	Perforated or Screened Casing		

PERCENTAGES TERMS [1, 2]

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

[1] Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2] Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

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SOIL DESCRIPTION AND LOG KEY

June 2024
112564

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FIG. A1
Sheet 1 of 3

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW		Well-Graded Gravel; Well-Graded Gravel with Sand
			GP		Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM		Silty Gravel; Silty Gravel with Sand
			GC		Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW		Well-Graded Sand; Well-Graded Sand with Gravel
			SP		Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM		Silty Sand; Silty Sand with Gravel
			SC		Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML		Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL		Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH		Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH		Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH		Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT		Peat or other highly organic soils (see ASTM D4427)

FILL	Placed by humans, both engineered and nonengineered. May include various soil materials and debris.	▩	The Fill graphic symbol is combined with the soil graphic that best represents the observed material

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the *CL-ML* area of the plasticity chart.
2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.
3. The soil graphics above represent the various USCS identifications (i.e., *GP*, *SM*, etc.) and may be augmented with additional symbology to represent differences within USCS designations. *Sandy Silt (ML)*, for example, may be accompanied by the *ML* soil graphic with sand grains added. Non-USCS materials may be represented by other graphic symbols; see log for descriptions.

Silverton WWTP
Silverton, Oregon

SOIL DESCRIPTION AND LOG KEY

June 2024

112564

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FIG. A1
Sheet 2 of 3

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASITICTY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4%
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10%
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20%
High	It take considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20%

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
approx.	Approximate/Approximately
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Silverton WWTP
Silverton, Oregon

SOIL DESCRIPTION AND LOG KEY

June 2024
112564

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FIG. A1
Sheet 3 of 3

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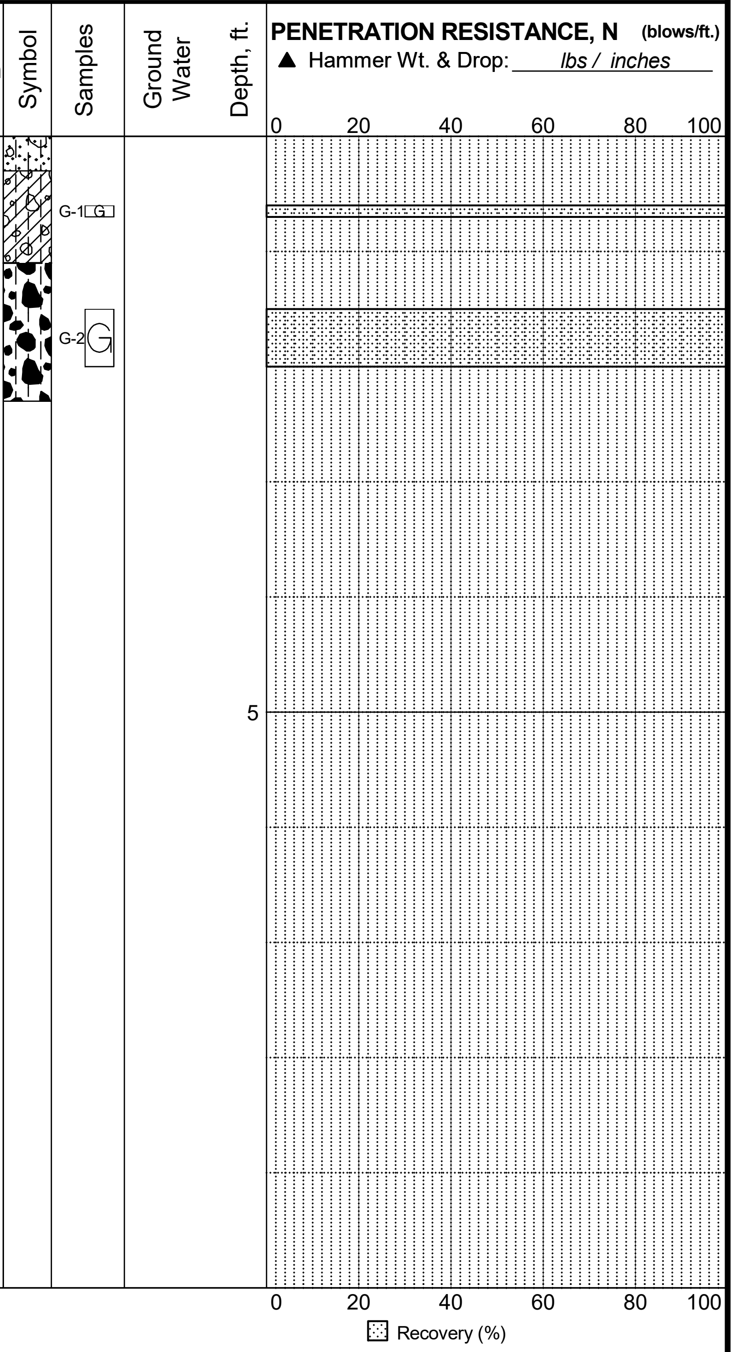
[2] Adapted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

Total Depth: 2.3 ft.
Top Elevation: ~ 214 ft.
Vert. Datum: NAVD88
Horiz. Datum: OR83-NIF
Northing: ~ 497,901 ft.
Easting: ~ 7,607,233 ft.
Station: ~
Offset: ~
Drilling Method: Hand Boring
Drilling Company: Shannon & Wilson, Inc.
Drill Rig Equipment: Hand Auger
Other Comments:
Hole Diam.: ~
Rod Type: ~
Hammer Type: ~

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	*Elev.* Depth (ft.)
Brown, *Silty Sand with Gravel (SM)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse sand; low plasticity fines; trace organics and rootlets. **TOPSOIL**	*213.2* 0.3
Brown, *Gravelly Lean Clay with Sand with Cobbles (CL)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse sand; low plasticity; trace organics and rootlets.	*212.4* 1.1
Brown, *Clayey Gravel with Sand with Cobbles (GC)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse sand; medium plasticity fines; trace organics; micaceous; slight iron oxidation and staining. **FILL**	*211.2* 2.3

Completed: February 21, 2024



LEGEND

G Grab Sample

● % Water Content

Plastic Limit ├──┤ Liquid Limit

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations, and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

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Silverton, Oregon

LOG OF BORING HA-1

June 2024
112564

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FIG. A2

MASTER_LOG_E 112564.GPJ SW2013LIBRARYPDX.GLB SHANWIL_PDX.GDT 3/7/24 Log: NMB Rev: DSJ Typ: NMB

REV 2

Coordinates: N: ~ 497,939 ft. E: ~ 7,607,213 ft.
Elevation: ~ 215 ft.

SOIL PROFILE DESCRIPTION	Depth (ft)	Symbol	Samples	Type	Ground Water	NOTES
Brown, *Silty Sand with Gravel (SM)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse sand; nonplastic to low plasticity fines; trace organics and rootlets. **TOPSOIL**	0.3					
Brown, *Clayey Gravel with Sand with Cobbles (GC)*; moist; little to mostly cobbles; fine to coarse, rounded to angular gravel; fine to coarse sand; medium to high plasticity fines; trace organics; micaceous; mottled texture; slight iron oxidation and staining; concrete fragments. **FILL**			G-1	G		
			G-2	G		
	5.3					
Completed: February 21, 2024						

TEST PIT PHOTOS

NOTES

1. The description in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
2. Refer to Soil Classification and Log Key for explanation of "Symbols" and Definitions.
3. Group symbol is based on visual-manual identification.
4. Where possible, a 1/2-inch-diameter, steel T-bar probe was used to estimate the density of soil.

LEGEND

≈ Seepage
G Grab Sample

Silverton WWTP
Silverton, Oregon

LOG OF TEST PIT TP-1

June 2024 112564

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FIG. A3

FIG. A3

REV 2

Coordinates: N: ~ 497,901 ft. E: ~ 7,607,233 ft.
Elevation: ~ 214 ft.

SOIL PROFILE DESCRIPTION	Depth (ft)	Symbol	Samples	Type	Ground Water	NOTES
Brown, *Silty Sand with Gravel (SM)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse sand; low plasticity fines; trace organics and rootlets. **TOPSOIL**	0.3					
Brown, *Clayey Gravel with Sand with Cobbles (GC)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse sand; medium to high plasticity fines; micaceous; slight iron oxidation and staining; concrete and brick fragments. **FILL**			G-1	G		
	5.5		G-2	G		
Completed: February 21, 2024						

TEST PIT PHOTOS

NOTES

1. The description in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
2. Refer to Soil Classification and Log Key for explanation of "Symbols" and Definitions.
3. Group symbol is based on visual-manual identification.
4. Where possible, a 1/2-inch-diameter, steel T-bar probe was used to estimate the density of soil.

LEGEND

≈	Seepage
G	Grab Sample

FIG. A4

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LOG OF TEST PIT TP-2

June 2024 112564

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FIG. A4

REV 2

Appendix B

Historical Explorations

Borings and Lab from 2011 Silverton WTFF Expansion Project

CONTENTS

- Historic Figure A2-A4, Boring B-1 through B-3
- Historic Figure B-1, Grain Size Distribution

Total Depth:	*30.7 ft.*	Northing:	~	Drilling Method:	*Mud Rotary*	Hole Diam.:	*4 in.*
Top Elevation:	*210*	Easting:	~	Drilling Company:	*Hardcore Drilling*	Rod Type:	*NWJ*
Vert. Datum:		Station:	~	Drill Rig Equipment:	*CME 75*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Medium dense brown sandy SILT with clay, trace gravel; moist; low plasticity; scattered roots; topsoil. (ML)

Medium dense to dense brown sandy silty GRAVEL to GRAVEL with silt and sand; moist; low plasticity fines; coarse rounded to subangular gravel; occasional cobbles. (GP-GM)

FILL

Very dense brown-orange GRAVEL with sand, trace fines; moist to wet; low plasticity fines; coarse subangular to subrounded gravel; occasional cobbles. (GP)

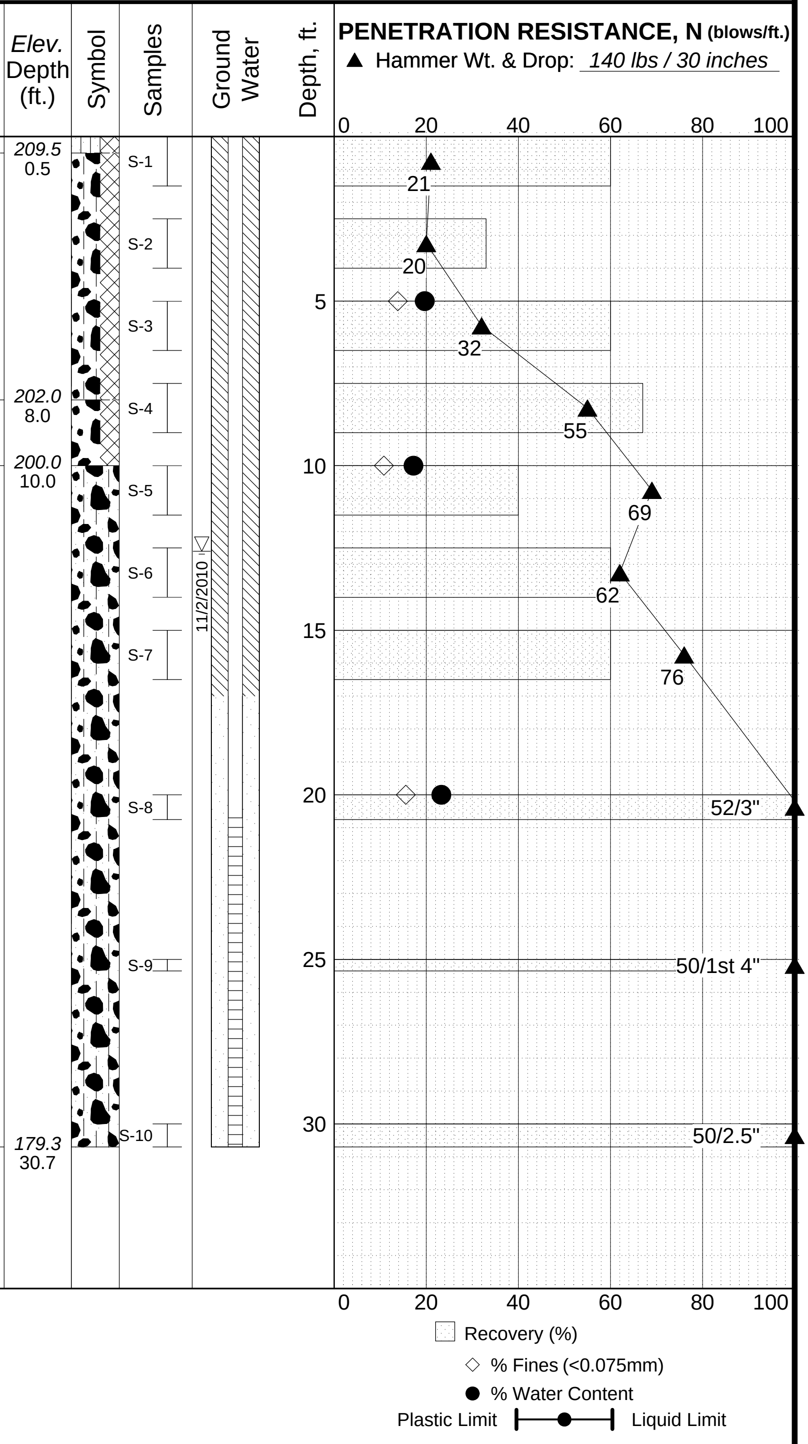
Very dense orange-brown sandy GRAVEL with silt to sandy silty GRAVEL; most to wet; fine to coarse rounded to subrounded gravel. (GM-GP)

Lost mud at 11.0 feet.

Grades to weakly cemented clast supported conglomerate at 14.0 feet.

ALLUVIAL DEPOSITS

Completed - October 29, 2010



LEGEND

* Sample Not Recovered

⌶ Standard Penetration Test

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Silverton WWTF Expansion Project
Silverton, Oregon

LOG OF BORING B-1

June 2011 24-1-03618-001

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FIG. A2

REV 2

Typ: RAP/MAS/RRB *Rev:* *Log: RAP*

MASTER_LOG_E 24-1-3618.GPJ SHAN_WIL.GDT 7/5/11

Total Depth:	15.7 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	210	Easting:	~	Drilling Company:	Hardcore Drilling	Rod Type:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 75	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Medium stiff brown SILT with sand and clay, trace gravel; moist; low plasticity; topsoil. (ML)

Medium dense gray silty GRAVEL with sand, trace clay; moist; fine rounded to subrounded gravel; occasional cobbles. (GM)

FILL

Dense to medium dense brown-orange GRAVEL with sand and fines; wet; low to medium plasticity fines; coarse subrounded to subangular gravel; occasional cobbles. (GP)

Lost mud at 6.5 feet.

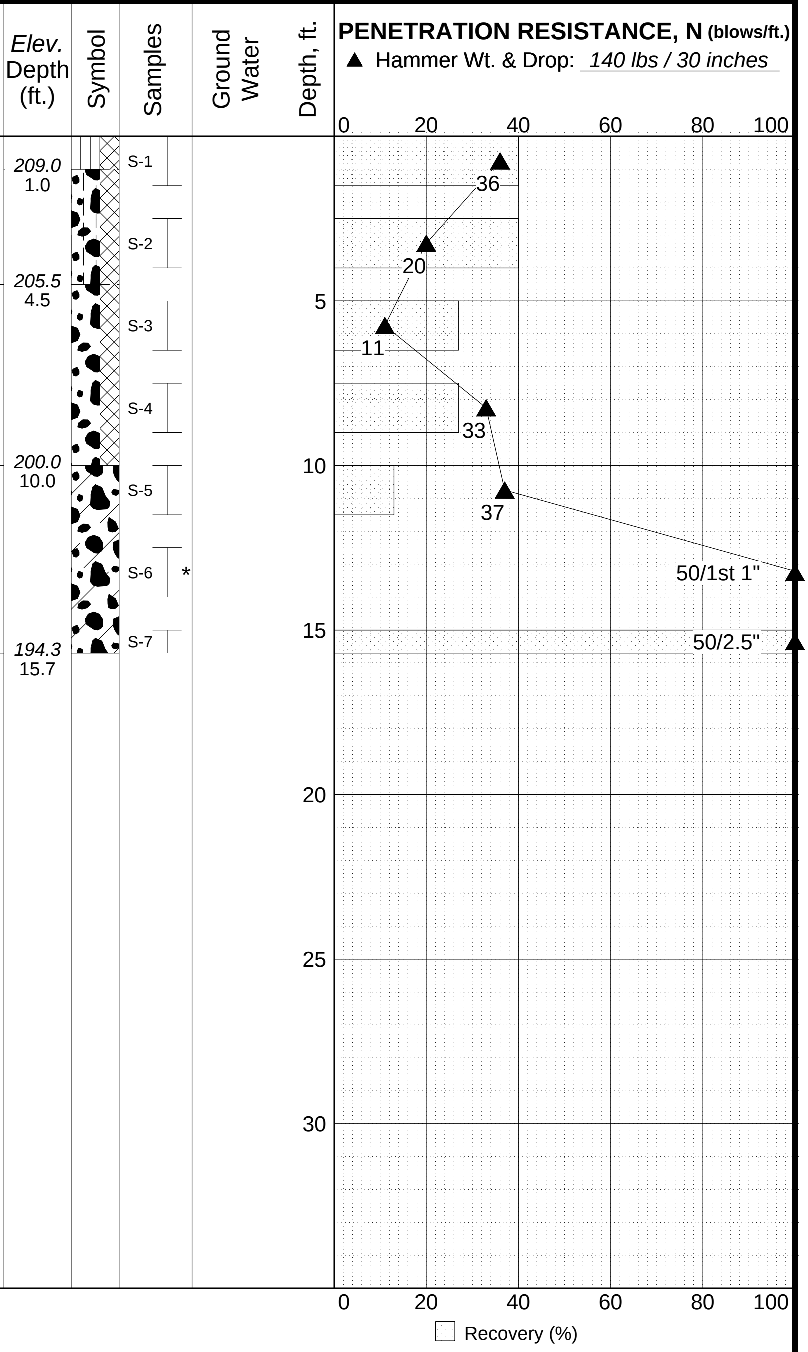
Dense to very dense orange-brown clayey GRAVEL with sand and silt; moist to wet; fine rounded gravel; clast supported in fine-grained matrix; very weakly cemented. (GC/GP)

Lost mud at 10.0 feet.

Lost mud at 11.5 feet.

ALLUVIAL DEPOSITS

Completed - October 29, 2010



LEGEND

* Sample Not Recovered

⌶ Standard Penetration Test

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Silverton WWTF Expansion Project
Silverton, Oregon

LOG OF BORING B-2

June 2011 24-1-03618-001

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FIG. A3

REV 2

Typ: RAP/MAS/RRB

Rev:

Log: RAP

MASTER_LOG_E 24-1-3618.GPJ SHAN_WIL.GDT 7/5/11

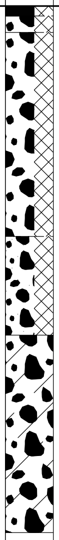
Total Depth: 16 ft.
Top Elevation: 210
Vert. Datum:
Horiz. Datum:
Northing: ~
Easting: ~
Station: ~
Offset: ~
Drilling Method: Mud Rotary
Drilling Company: Hardcore Drilling
Drill Rig Equipment: CME 75
Other Comments:
Hole Diam.: 4 in.
Rod Type: NWJ
Hammer Type: Automatic

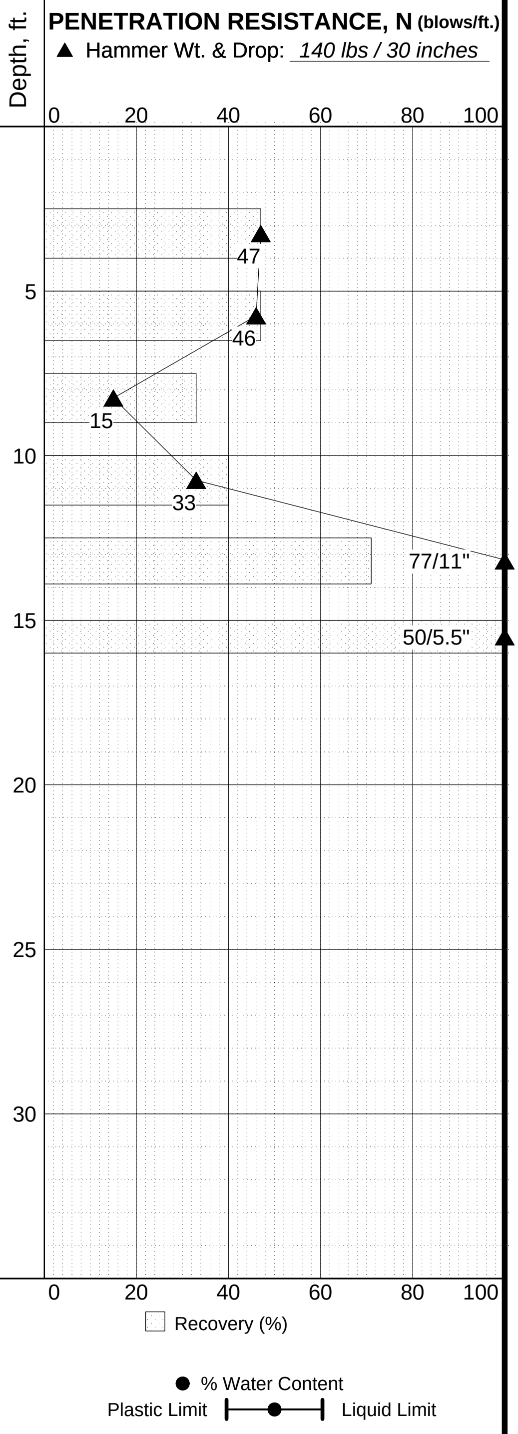
SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

SOIL DESCRIPTION	Elev. Depth (ft.)	Samples
ASPHALT CONCRETE	209.7 0.3	
BASE AGGREGATE	209.2 0.8	
Dense gray GRAVEL with sand and silt; moist to wet; low plasticity fines; angular to subangular gravel; occasional wood debris; occasional cobbles. (GP) **FILL**	203.0 7.0	S-1 S-2
Medium dense orange-brown sandy GRAVEL with silt; wet; subrounded to subangular gravel; iron oxidation; occasional cobbles. (GP)	200.0 10.0	S-3
Dense to very dense blue-gray-orange sandy clayey GRAVEL to sandy GRAVEL with fines; moist to wet; medium plasticity fines; rounded to subrounded gravel; weakly to moderately cemented. (GP-GC) *Lost mud at 12.0 feet.* **ALLUVIAL DEPOSITS**	194.0 16.0	S-4 S-5 S-6

Completed - October 29, 2010





LEGEND
* Sample Not Recovered
⌶ Standard Penetration Test

NOTES
1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Silverton WWTF Expansion Project
Silverton, Oregon

LOG OF BORING B-3

June 2011
24-1-03618-001

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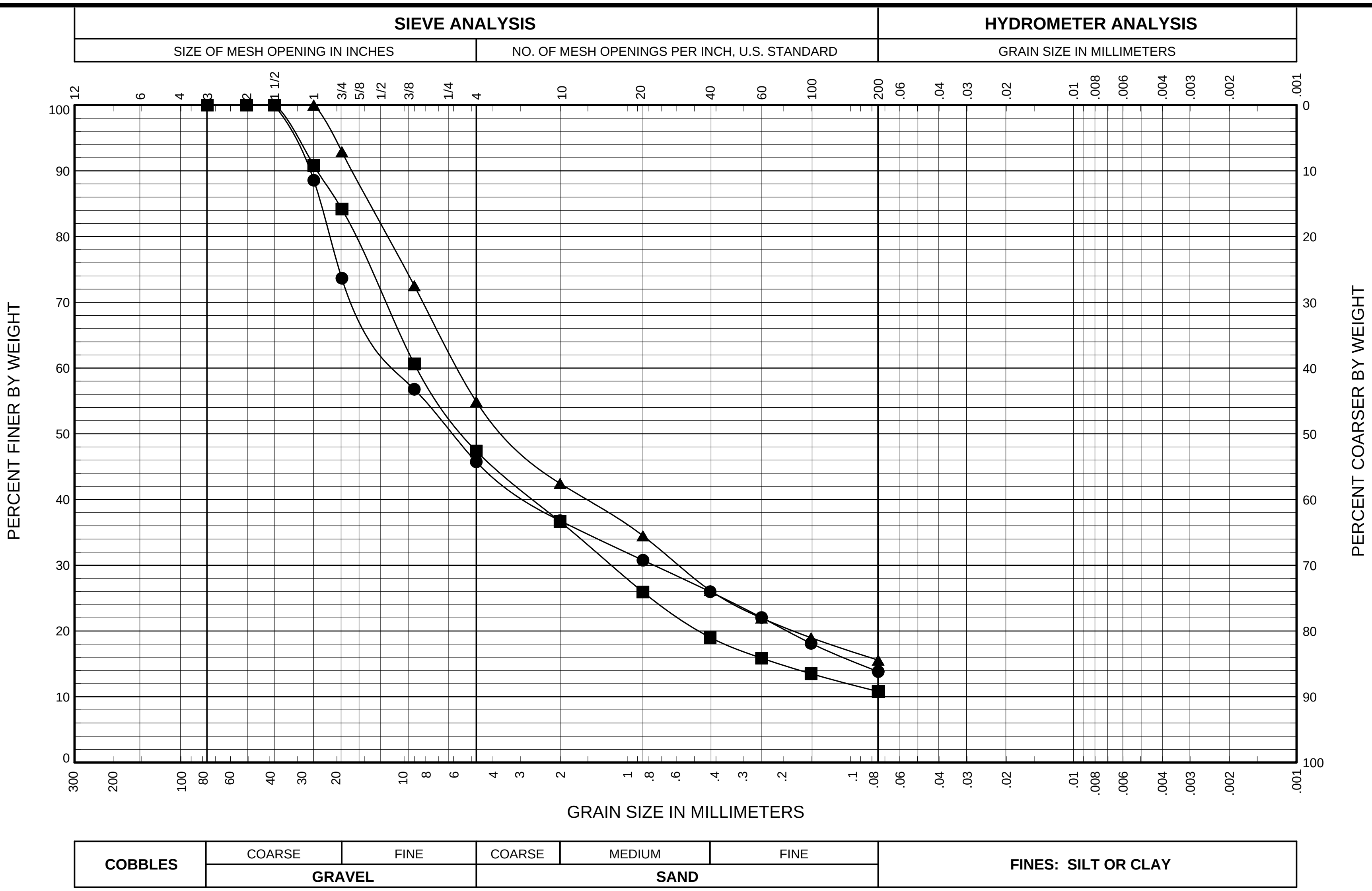
FIG. A4

REV 2

Typ: RAP/MAS/RRB
Rev:
Log: RAP
MASTER_LOG_E 24-1-3618.GPJ SHAN_WIL.GDT 7/5/11



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● B-1, S-3	5.0	GM	Brown sandy silty GRAVEL	54	32	14	20	
■ B-1, S-5	10.0	GM-GP	Brown sandy GRAVEL with silt	53	37	11	17	
▲ B-1, S-8	20.0	GM	Brown sandy silty GRAVEL	45	39	16	23	

Silverton WWTF Expansion Project
Silverton, Oregon

GRAIN SIZE DISTRIBUTION

June 2011
24-1-03618-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. B1

FIG. B1

GSA MAIN 24-1-3618.GPJ SHAN WIL.GDT 7/5/11

Important Information

About Your Geotechnical Engineering Report

IMPORTANT INFORMATION

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the Geoprofessional Business Association (https://www.geoprofessional.org)