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DRAFT

GEOTECHNICAL REPORT

Washougal Grade Separation

WASHOUGAL, WASHINGTON

October 2021

Shannon & Wilson No: 101835-202

SHANNON & WILSON

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Submitted To: WSP USA Inc.
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Attn: Dan Shafar

Subject: DRAFT GEOTECHNICAL REPORT, WASHOUGAL GRADE SEPARATION, WASHOUGAL, WASHINGTON

Shannon & Wilson, Inc. (Shannon & Wilson) prepared this report and participated in this project as a subconsultant to WSP USA Inc. (WSP). Our scope of services was specified in Amendment No. 01 dated May 13, 2021, in association with WSP Project No. WA18.0270.00. This report presents geologic conditions and geotechnical analyses 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, INC.

Mike Harney, PE
Vice President, Geotechnical Engineer

RAW:AJB/mmb

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ACRONYMS

ACRONYMS

bgs	below ground surface
BNSF	Burlington Northern Santa Fe Railway
CFs	correction factors
ESUs	Engineering Stratigraphic Units
FS	factor of safety
GPS	global positioning system
LL	liquid limit
PGA	peak ground acceleration
PI	plasticity index
PIT	pilot infiltration test
PL	plastic limit
QA/QC	Quality Assurance/Quality Control
SOW	Statement of Work
SPTs	Standard Penetration Tests
SWAP	Source Water Assessment Program
SWMMWW	Stormwater Management Manual of Western Washington
S_1	spectral acceleration at 1-second period
S_s	short-period spectral acceleration
VWPs	Vibrating Wire Piezometer
WSDOT	Washington State Department of Transportation

1 INTRODUCTION

This document presents the geologic conditions, geotechnical analyses, infiltration analyses, and groundwater monitoring data (7/23/2021 - 9/29/2021) from the recently installed vibrating wire piezometers (VWPs) at the project site.

1.1 Site and Project Description

The project consists of a proposed grade separation of arterial traffic and Burlington Northern Santa Fe Railway (BNSF) tracks near Evergreen Way in Washougal, Washington. The proposed separation grade is an underpass at 32nd Street and installation of sunken traffic roundabouts. Based on drawings provided by WSP, the underpass at 32nd Street for the BNSF bridge is approximately 25 ft below the existing ground surface and the sunken roundabouts will incorporate retaining walls and permanent cut slopes around the proposed roadways. The site is located in the historic floodplain of the Columbia River, and existing subsurface information indicates that the groundwater table is approximately 30 feet below the ground surface (bgs). The underpass structure would consist of "watertight" walls and potentially a bottom seal to reduce groundwater seepage into the undercrossing. A pump station is planned to remove the accumulated groundwater leakage and collected stormwater. The project vicinity is presented in Figure 1.

1.2 Scope of Services

Our work was conducted under Statement of Work (SOW) WSP Amendment No. 01 dated May 13, 2021, in association with WSP Project No. WA18.0270.00. Work elements of the SOW and our scope of engineering services included the following tasks:

- Site Investigation - Consisting of four rotosonic geotechnical borings and two infiltration test pits. These borings were performed from the roadway surface. Two borings, SW-5P and SW-8P, were drilled to approximately 80 feet bgs and two borings, SW-6P and SW-10P, were drilled to approximately 60 feet bgs. The infiltration test pits, TP-1 and TP-2, were excavated in vegetated areas adjacent to the Client's streets within the existing right-of-way.
- Laboratory Testing - Performed on selected soil samples retrieved from the geotechnical borings and infiltration test pits to estimate properties and engineering characteristics of the soil.
- Groundwater Monitoring - Monitor the groundwater elevation in the installed piezometers for a total of 24 months after installation. This report is being submitted prior to the full 24 months and only includes groundwater readings from installation to 9/29/2021.

- Geotechnical analyses to support the development of preliminary designs.
- Preparation of this letter report.

2 FIELD EXPLORATIONS

The field exploration program for this project consisted of drilling six vertical borings, excavating and performing infiltration testing in two test pits, obtaining geologic samples, and performing laboratory testing. Exploration locations are shown in Figure 2, Site and Exploration Plan.

The subsurface exploration program consisted of six geotechnical borings designated SC-1P-18, SC-2P-18, SW-5P-21, SW-6P-21, SW-8P-21, and SW-10P-21, and two infiltration test pits designated TP-1 and TP-2. The geotechnical borings were advanced to a depth ranging from approximately 61.5 to 101.5 feet bgs using rotosonic drilling and standard penetration testing (SPT) sample collection. The infiltration test pits were excavated to a depth ranging from 10 to 18 feet bgs using a subcontractor-supplied excavator. The final boring and test pit depths, locations, and final sampled depths are summarized in Exhibit 2-1. Exploration locations were captured using a handheld global positioning system (GPS) unit and based on observation features on-site. GPS measurements are accurate to 30 feet; however, in our opinion, location accuracy was improved using observable features onsite and relative positions to identifiable infrastructure.

Exhibit 2-1: Geotechnical Exploration Summary

Boring Designation	Final Sampled Depth (feet bgs)	Easting[1]	Northing[1]	Approximate Ground Surface Elevation (feet)[2]
SC-1P-18	101.5	1170089.27	94731.881	45
SC-2P-18	96.4	1170054	94581.325	40
SW-5P-21	81.4	1169983.225	94611.06	38
SW-6P-21	61.5	1169851.779	94917.243	46
SW-8P-21	81.5	1170047.647	94990.375	45
SW-10P-21	61.3	1170234.033	94777.388	42
TP-1	10	1169471.667	95214.634	52
TP-2	18	1169453.692	94443.938	35

[1] Horizontal Datum is Washington State Plane South US Feet
[2] Vertical Datum is NAD83

The geotechnical borings were drilled in two phases. Borings SC-1P-18 and SC-2P-18 were drilled between October 1 and 12, 2018, by Holt Services, Inc., of Vancouver, Washington, under subcontract to Shannon & Wilson. Borings SW-5P-21, SW-6P-21, SW-8P-21, and SW-10P-21 were drilled between June 8 and 14, 2021, by Holt Services, Inc., of Vancouver, Washington, under subcontract to Shannon & Wilson. Traffic control was provided by D&H Flagging of Portland, Oregon under subcontract to Shannon & Wilson to facilitate safe access to the drilling locations. The infiltration test pits were performed between June 21 to 23, 2021, by Western States Soil Conservation, Inc., (Western States) of Hubbard, Oregon under subcontract to Shannon & Wilson.

A Shannon & Wilson geologist documented drilling and excavation activity. During drilling and sampling, the Shannon & Wilson geologist kept a detailed log including, but not limited to, drilling descriptions, date and time of activities, and geologic sample information. Sonic core, SPT samples, and test pit bag samples were collected for purposes of geologic evaluation and geotechnical testing, as described below. Boring logs and sonic core photographs are included in Appendix A. The following sections present the exploration program, methods, sample review, and classification.

2.1 Geotechnical Borings

The following sections present the details of the subsurface drilling program, including the method of drilling, sample collection and handling, and review and classification. Laboratory testing is presented in Section 3.

2.1.1 Sonic Core Drilling

Rotosonic drilling was utilized to advance each boring through the soil. The rotosonic (sonic) drilling method uses high-frequency vibratory motion applied to the top of the drill column along with down-pressure and rotation to obtain nearly continuous core samples in soil.

Four-inch diameter soil samples are obtained using a 6-inch outside diameter core barrel. As the drill column is advanced into the ground, soil enters the core barrel. After advancing the core barrel a specific distance (termed a core "run"), the drill column and core barrel are then removed from the borehole and the soil core is extracted from the core barrel. After retrieval of the soil core for a specified interval, a temporary casing is vibrated to the bottom of the sampled interval. The casing is then cleared of slough, and the next core sample is collected, starting at the bottom of the temporary casing.

2.1.2 Standard Penetration Test and Split-spoon Sampling

Split-spoon samples were taken to collect representative soil samples. Standard Penetration Tests (SPTs) were performed, consisting of a 140lb auto-hammer weight falling 30 inches and driving a split-spoon that collected samples in accordance with ASTM D1586. SPTs were performed generally every five feet.

2.2 Infiltration Test Pits

Western States excavated the test pits using a ZX 135 34k Excavator. For each test pit, the initial excavation depth was to the PIT test depth. The morning following the PIT, each test pit was excavated deeper, allowing us to check for the presence of perched water and to collect additional soil samples.

- TP-1 was initially excavated on June 22, 2021, to an infiltration test depth of 7 feet. On June 23, 2021, post-PIT excavation reached a final depth of 10 feet. Additional excavation was impractical due to site restraints.
- TP-2 was initially excavated on June 21, 2021, to an infiltration test depth of 6 feet. On June 22, 2021, post-PIT excavation reached a final depth of 18 feet.

2.3 Sample Review and Classification

2.3.1 Field Observations

Drilling and excavation were observed by Shannon & Wilson geologists, who collected and classified the soil samples and prepared detailed logs. In addition to examining and collecting sonic samples, SPT samples, and test pit samples, the field representatives noted drill action, problems during drilling or excavation (e.g., fluid loss, hole/sidewall collapse, etc.), and other issues that occurred.

2.3.2 Soil Classification System

Soils classification for this project was based on ASTM D2487, Standard Test Method for Classification of Soil for Engineering Purposes (ASTM, 2017a), and ASTM D2488, Standard Recommended Practice for Description of Soils (Visual-Manual Procedures) (ASTM, 2017b). The soil units encountered were described using the Shannon & Wilson standardized field classification system in accordance with the Unified Soil Classification System. The Shannon & Wilson classification system is summarized in Appendix A.

2.3.3 Boring and Test Pit Logs

Logs of the borings and test pits performed for this study are presented in Appendix A. A boring log is a written record of the subsurface conditions encountered in the boring. A test pit log is a written record of the subsurface conditions encountered along a given sidewall of the test pit during excavation. For the subsurface explorations in this study, they show the soil classification of subsurface materials encountered. Boring information includes a visual description of the soil encountered and also includes sample information, soil penetration resistance, instrument installation details, and observed groundwater conditions. Test pit information includes a visual description of the soil encountered and also includes sample information and infiltrating testing details.

The completion of the boring and test pit logs was performed following a Quality Assurance/Quality Control (QA/QC) process developed by Shannon & Wilson. This program included review of the soil samples by an experienced geologist after initial field observations were made and cross-checked with laboratory test results. This detailed procedure was followed to increase consistency of the data presentation and to provide adequate QA/QC for each exploration. This process is further described in the following sections.

Shannon & Wilson tracks the compilation of the exploration logs through a four-step revision numbering system, as follows:

- Revision 0. The field log is provided to the project geologist. The field logs are reviewed for completeness. Sample recovery and depths are checked for accuracy and agreement between the field logs and sample information. The data is entered into a geotechnical subsurface database to create a summary log. The preliminary logs created from the field interpretation are labeled as Revision 0 (Rev. 0).
- Revision 1. A senior geologist reviews and characterizes each sample and revises the Rev. 0 logs, as needed, based on their observations of the soil. Laboratory tests are assigned on selected samples, as needed, to assist in classification and provide information for design. These revised logs are reviewed by the project geologist and are labeled as Revision 1 (Rev. 1).
- Revision 2. Once laboratory testing is complete, a Shannon & Wilson engineer reviews and incorporates the laboratory testing results into the descriptions. Discrepancies between the laboratory testing results and the geologist's descriptions from Step 2 are reviewed. Additional index tests are performed if necessary. These reviewed logs are labeled as Revision 2 (Rev. 2).
- Revision 3. The senior geologist reviews the logs for consistency and evaluates the assigned geologic units relative to the geology encountered in the project area. Modifications to the logs and/or profiles are made as necessary. A final check of geology, syntax, and format is performed. These final logs are at the Revision 3 (Rev. 3) stage. The logs contained in this report are Revision 3 logs.

3 GEOTECHNICAL LABORATORY TESTING

Soil samples were transported from the field to the Shannon & Wilson laboratory in general accordance with ASTM D4220, Standard Practices for Preserving and Transporting Soil Samples (ASTM, 2014b). Laboratory testing methods include visual classification, particle size, Atterberg limits, and moisture content. Laboratory testing was performed by Shannon & Wilson. The following sections describe the laboratory testing procedures. All laboratory test results are included in Appendix B.

3.1 Sample Preparation and Handling

Sonic core, SPT samples, and test pit samples were stored in their original boxes and jars and logged into the Shannon & Wilson laboratory for tracking and testing. Shannon & Wilson geologists reviewed and classified the samples and assigned laboratory testing in accordance with our scope of services.

3.2 Soil Testing

To assist in development of design parameters and the characterization of subsurface conditions, a suite of laboratory testing was performed on the soil samples collected from the SPTs and infiltration test pit bulk samples. Particle size, Atterberg limit, and moisture content tests were performed on SPT samples and particle size tests were performed on infiltration test pit bulk samples.

3.2.1 Atterberg Limits

Soil plasticity was determined by performing Atterberg Limits tests on selected fine-grained samples, or samples with greater than 50% passing the No. 200 sieve. The tests were performed in general accordance with ASTM Designation D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. The Atterberg Limits include a liquid limit (LL), plastic limit (PL), and plasticity index (PI=LL-PL). During the current exploration phase, Atterberg Limits tests were performed by Shannon & Wilson.

The LL, PL, and PI values determined from the Atterberg Limits tests during the current exploration phase are summarized in the laboratory test summary and the plasticity charts included in Appendix B. The plasticity charts provide the USCS group symbol, the sample description, water content, and percent passing the No. 200 sieve (if a grain-size analysis was performed). The results of the Atterberg Limits determinations from the current exploration phase performed by Shannon & Wilson are also shown graphically in the exploration logs presented in Appendix A.

3.2.2 Moisture Content

Moisture content was determined on selected samples in general accordance with ASTM Designation D2216-10, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (ASTM, 2010a). Water contents are plotted as data points on each boring log in Appendix A and included in the Laboratory Test Summary table in Appendix B.

3.2.3 Particle Size

Grain-size distribution analyses separate soil particles through mechanical or sedimentation processes. Grain-size distributions are used to classify the granular component of soils and can correlate with soil properties, including frost susceptibility, permeability, shear strength, liquefaction potential, capillary action, and sensitivity to moisture. Grain-size distribution analysis results are plotted per boring in Appendix B. The plots provide tabular information about each specimen, including USCS group symbol and group name, water content, constituent (i.e., gravel, sand, and fines) percentages, coefficients of uniformity and curvature, if applicable, personnel initials, ASTM standard designation, and testing remarks. The ASTM standards used included ASTM C136-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates (ASTM, 2014a), and ASTM D422, Standard Test Method for Particle-Size Analysis of Soils (ASTM, 2007a). The constituent percentages and coefficients of uniformity and curvature are also included in the Laboratory Test Summary table in Appendix B. The fines contents are also plotted as data points in the boring logs in Appendix A.

4 GEOLOGIC AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Washougal and the Project site are located between the Portland Basin to the west and the Columbia River Gorge to the east.

The Columbia Gorge was formed by the Columbia River cutting through the Cascade Mountain Range while flowing east to west. The Portland Basin formed approximately 20 million years ago in association with the Cascade Mountain Range. Between 16 and 15 million years ago Columbia River Basalt flowed through the Columbia Gorge into the basin. The Columbia River then deposited sediments that formed a series of thinly bedded sedimentary rocks within the region.

Overlying the basalt and sedimentary rocks is a series of alluvial and flood deposits. The alluvial soils are associated with Columbia River sedimentation occurring before and after the flood deposits. The flood deposits were deposited between 16,000 and 12,000 years ago and are associated with the Missoula Floods, a series of glacial outburst floods during the last glaciation (Evarts 2013).

The U.S. National Resources Conservation Service (2021) identifies the predominant Soil Map Unit for the site as HsB: Hillsboro bouldery silt loam, 3 to 8% slopes, parent material alluvium; hydrologic soil group B; well-drained.

4.2 Seismic Setting and Criteria

The tectonics and seismicity of the region are the result of the relative northeastward subduction of the Juan de Fuca Plate beneath the North American Plate. The Portland Basin is part of the Puget-Willamette forearc trough. The forearc trough, a geologic depression, is associated with the subduction forming the Cascade Mountain Range. North-south compression is accommodated beneath the Portland Basin by a series of oblique-slip northwest-striking fault zones. The seismicity is distributed throughout the basin and in general the fault locations are obscured by sedimentation and vegetation (Evarts 2009).

4.3 Subsurface Conditions

Our understanding of the subsurface soil conditions along the alignment is based on our review of existing subsurface investigations, current Project subsurface investigations, and our general understanding of the geologic history and stratigraphy of the region. In general, the soils at the Project site are the result of deposition from the Columbia River and the Missoula Floods. No bedrock was encountered in the Project subsurface explorations.

The soil types interpreted from the existing geotechnical data and observed in the current project borings include:

- Fill: Fill deposits are placed by humans and can be both engineered and nonengineered. The deposits consist of various compositions of silt, sand, gravel and may contain other materials including debris, cobbles, and boulders. Typically, engineered fill is dense or stiff and non-engineered fill is very loose to medium dense or very soft to stiff.
- Flood Deposits: Gravel and sand deposits of the Missoula Floods. These soils are typically very loose to very dense, clean to silty gravel, clayey gravel, gravel with sand, and cobbles. Boulders may be present.
- Alluvium: Sand and gravel deposits of the Columbia River. These soils are typically very loose to very dense, clean to silty sand; sand with gravel; and gravel with sand and

cobbles. Hard silt and clay overbank deposits are present. Wood or logs, cobbles, and boulders may be present.

Groundwater elevations were measured in each of the borings using vibrating wire piezometers (VWPs) that were buried in the boreholes as they were backfilled. Hydrographs of approximate groundwater elevations and precipitation data from a nearby weather station are presented in Appendix C. Groundwater level data collection is ongoing, and higher groundwater levels than those shown on these hydrographs may be possible.

5 INFILTRATION TESTING

The 2016 City of Washougal Engineering Standards for Public Works Construction require that stormwater infiltration rates be determined using either a single-ring falling head test or a pilot infiltration test (PIT); grain size-based methods are not allowed by the City of Washougal for determining stormwater infiltration rates. As the actual depth and location of the final infiltration facilities are currently not known, the PITs were conducted in the general vicinity anticipated for the future infiltration systems. We understand from WSP. that infiltration ponds and/or buried infiltration facilities are currently under consideration, with likely infiltration depths of about 6 to 8 feet below current grade.

We performed a small-scale PIT in each test pit, using nearby fire hydrants as the water sources. Each PIT included excavating the test pit to the target infiltration test depth, followed by saturating the bottom of the test pit for approximately 7 hours, typically with at least 1 foot of being water ponded in the bottom of the test pit. We monitored PIT water levels via manual readings of temporarily installed staff gages and using pressure transducers. We monitored water inflow rates using a flow meter and by timing the filling of a graduated bucket. During the last approximately one hour of PIT saturation, we performed a constant head test, during which the water level and inflow rate were both held approximately constant. After completing the constant head test, we allowed the test pit to drain until empty (falling head test). The morning following each PIT, Western States continued excavation below the PIT level. Test pit logs and PIT test data are presented in Appendix A.

5.1 Infiltration Rates

For the design of drainage facilities, the City of Washougal has adopted the 2012 Stormwater Management Manual of Western Washington (SWMMWW), as amended in December 2014 (Washington State Department of Ecology [Ecology], 2014). In 2019, Ecology published the 2019 SWMMWW, which, among other revisions, provides updated guidance for stormwater infiltration facilities considered to be underground injection controls (UICs).

We understand from Ecology that the 2019 manual would be applicable to the project if UICs (e.g., dry wells) is selected as an infiltration option. Based on the Washington State Department of Health (DOH) Source Water Assessment Program (SWAP) mapping application (DOH, 2021), the proposed infiltration sites in the TP-1 and TP-2 vicinities are not currently identified by the SWAP application as being within a Group A or B drinking water supply source time of travel zone of contribution. (Use of UICs may be restricted within certain drinking water supply contribution zones.)

The PIT guidance presented in the 2014 and 2019 SWMMWWs describes the calculation of the infiltration rate (IR) as the constant head IR, but they also refer to the falling head rate as the IR. The constant head IR calculation is dependent, among other factors, on the accuracy of the measurement of the dimensions of the test pit as well as the accuracy of the measurement of the inflow rate. The falling head IR is simply the measured head drop over time. In our experience, the falling head IR tends to decrease with time as the driving head declines and, in some cases, as fines settle out on the base of the test pit floor. In our opinion, we consider the falling head IR measured relatively early in the falling head period (i.e., during the drop from 12 to 6 inches of head) to be a reasonable measured IR for these PITs. In particular, we do not recommend considering the TP-1 constant head IR as the measured native soil IR for that location, because utility trench backfill was present near the top of the ponded water level during the TP-1 PIT, and it may have resulted in more rapid drainage due to its relatively previous nature as compared to the surrounding soils.

Based on the two PITs, the observed IRs were as follows:

- Test pit TP-1:
  - Constant head IR = 18.7 inch/hour (possibly elevated due to potential drainage into utility trench bedding material)
  - Falling head IR = 7.0 inch/hour (based on the head drop from 12 to 6 inches)
  - Soils encountered below about 8.5 feet deep were less silty than those tested by the PIT, so higher infiltration rates might be realized by targeting the base of the infiltration facilities at or below this depth.
- Test pit TP-2:
  - Constant head IR = 7.4 inch/hour
  - Falling head IR = 3.8 inch/hour (based on the head drop from 12 to 6 inches)

5.2 Infiltration Rate Correction Factors

Assuming the infiltration facilities are not designed as permeable pavement or bioretention, we derived the recommended correction factors for estimating design infiltration rates as follows. The field-measured (short-term) infiltration rates are reduced using correction factors (CFs). The CFs are based on site variability, the number of tested locations, test method, and degree of anticipated future influent control. The field infiltration rate is then multiplied by each of the selected partial CFs. We recommend the following partial CFs for the two study areas:

- Partial CF for site variability and number of locations tested (CF_v): 1.0 (based on relatively consistent subsurface conditions, i.e., similar soils encountered at each exploration)
- Partial CF for test method (CF_t): 0.5 (for small-scale PIT)
- Partial CF for degree of influent control (CF_m): 0.9

Based on the above, and using the field-measured falling head infiltration rates (for the head drop from 12 to 6 inches), we recommend the following preliminary design infiltration rates for the two infiltration study areas:

- TP-1: 3.1 inch/hour (= 7.0 x 1.0 x 0.5 x 0.9)
- TP-2: 1.7 inch/hour (= 3.8 x 1.0 x 0.5 x 0.9)

5.3 Groundwater Mounding

Based on the groundwater elevations measured to date by VWPs installed in the six project borings, and assuming similar conditions beneath the proposed TP-1 and TP-2 infiltration sites, groundwater is typically more than 15 feet below the preliminary infiltration target depth of about 6 to 8 feet. (Groundwater elevations and grade elevations are approximate at this point, as the locations have not been surveyed.) It may be appropriate to later evaluate infiltration-related groundwater mounding beneath the proposed infiltration facilities. This would ideally be performed once more information is available regarding infiltration contribution areas, grade elevations, infiltration facility geometries, and longer-term groundwater elevation fluctuations.

6 GEOTECHNICAL ANALYSES

The following sections describe the engineering analyses and geotechnical engineering recommendations for the proposed Washougal Grade Separation and its associated facilities. Our recommendations are based on our interpretation of the subsurface conditions described previously.

6.1 Engineering Stratigraphic Units

Several soil and rock types are present at the project locations or will be imported and incorporated into the project. The soil types consist of native soils, in-place fills, and proposed engineered compacted fills. The soils have variable consistency, density, and strength. This section summarizes our classification of those soil and rock types into Engineering Stratigraphic Units (ESUs) and provides default design parameters to be used for geotechnical analysis and design of project elements. The purpose of providing these default parameters is to provide consistency for the project by simplifying selection for use in and review of geotechnical analyses.

Based on existing subsurface information and construction requirements, we have classified the most common native and fill (existing or import) soil expected at the project locations into the engineering units described below and presented in Exhibit 6-1.

- ESU 1 - Existing Fill (Hf): This ESU corresponds to near surface fill soils in the upper 5 to 7.5 ft bgs and consists of brown, moist, very loose to very dense, silty gravel with sand. Cobbles and boulders 2 to 3 feet in diameter were observed in boring SC-2P-18.
- ESU 2 – Flood Deposits (Qfg): This ESU was observed below the fill and ranged in thickness to approximately 41 to 50 ft bgs. The soil types in ESU 2 are stratified and vary with location. They are predominantly brown, moist to wet, medium dense to very dense, gravels with varying amounts of silt, clay, and sand. Boulders may be present.
- ESU 3 – Alluvium (Qa): This ESU was observed below the flood deposits and was observed to the bottom of the borings. The soil types in ESU 3 are stratified and vary with location. They are predominantly orange-brown to brown, moist to wet, dense to very dense, cohesionless sands, with some interbeds of elastic silt and elastic silt with sand.
- ESU 4 - Gravel Borrow for Structural Earth Walls: The imported fill to be installed within the MSE walls at Trafton Creek will meet the requirements for Gravel Borrow for Structural Earth Walls (WSDOT Standard Specification 9 03.14(4) [WSDOT, 2018b]).

The soil parameters provided in Exhibit 6-1 were estimated using published correlations and our experience. In cases where direct guidance is provided by the Geotechnical Design Manual (GDM) (WSDOT, 2019), the GDM was used as a primary source. In other cases, correlations from literature were used.

Exhibit 6-1: Engineering Stratigraphic Units

				Shear Strength Parameters	
ESU	Description	USCS	Total Unit Weight (pcf)	Effective Angle of Internal Friction (degrees)	Effective Cohesion (psf)
1	Existing Fill (Hf)	GM	130	40	0
2	Flood Deposits (Qfg)	GM, GP-GM, GW-GM, GC, SM	130	40	0
3	Alluvium (Qa)	SM, SP, SP-SM, GM, GP, MH, ML	135	36	0
4	Gravel Borrow for Structural Earth Wall	GW, GW-GM, SW, SW-SM	130	38	0

NOTES:
n/a = not applicable; pcf = pounds per cubic foot; psf = pounds per square foot; USCS = Unified Soil Classification System

6.2 Seismic Design Criteria

The seismic design of the BNSF bridge crossing structures should be in accordance with AREMA guidelines, which require the seismic design to meet performance criteria for three levels of ground motion, Levels I through III, which correspond to the seismic event return periods of 100, 475, and 2,475 years, respectively.

For other retaining structures away from the bridge abutment, such as retaining walls for the sunken roundabouts, we understand seismic design for the project will be in accordance with the Washington State Department of Transportation (WSDOT) Geotechnical Design Manual (GDM) (WSDOT, 2021) and the American Association of State and Highway Transportation Officials (AASHTO) LRFD Bridge Design Specifications (AASHTO, 2020). The hazard level specified in the GDM and AASHTO corresponds to a 7% probability of exceedance in a 75-year design life (1,000-year average return period).

Based on the subsurface conditions at the project sites, it is our opinion that the overall site conditions at both sites correspond to a Site Class C. Site Class C is defined as very dense soil and soft rock profile that has a depth-averaged SPT blow count in the top 100 feet of between greater than 50 blows per foot. Seismic inputs for design include the peak ground acceleration (PGA), short-period maximum spectra acceleration (S_S), and spectral acceleration at a period of one second (S_1). We obtained PGA, S_S, and S_1 corresponding to a Site Class B/C from the most recently published probabilistic ground motion study by the U.S. Geological Survey (USGS) 2014 National Seismic Hazard Mapping Project (USGS, 2021) for the different return periods of interest. To evaluate the response for Site Class C, the seismological parameters were multiplied by site soil response factors as provided in the

WSDOT GDM (WSDOT, 2021) and AREMA Manual (AREMA, 2021) for the respective return periods.

Exhibits 6-2 through 6-4 presents our recommendations for site class, site coefficients, and the spectral accelerations for each AREMA Level, and Exhibit 6-5 presents the WSDOT GDM design event.

Exhibit 6-2: 100-yr Seismic Design Parameters

Description	Recommended Value	
Site class based on soil conditions	Site Class =	C
Mean Magnitude	M =	6.78
Peak horizontal ground acceleration coefficient on Class B rock*	PGA =	0.05
0.2-second period spectral acceleration coefficient on Class B rock*	S_s =	0.11 g
1.0-second period spectral acceleration coefficient on Class B rock*	S_1 =	0.03 g
Site coefficient for the peak ground acceleration	F_{pga} =	1.2
Site coefficient for 0.2-second period spectral acceleration	F_a =	1.2
Site coefficient for 1.0-second period spectral acceleration	F_v =	1.7
Effective peak ground acceleration coefficient (g)	$A_S = F_{pga}(PGA)$ =	0.06 g
Design earthquake response spectral acceleration coefficient at 0.2-second period	$S_{DS} = F_a{*}S_S$ =	0.13 g
Design earthquake response spectral acceleration coefficient at 1.0-second period	$S_{D1} = F_v{*}S_1$ =	0.05 g

NOTE:
* Based on the USGS Uniform Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) using the U.S. Dynamic Conterminous edition for 2014 (v.4.2.0).

Exhibit 6-3: 475-yr Seismic Design Parameters

Description	Recommended Value	
Site class based on soil conditions	Site Class =	C
Mean Magnitude	M =	7.15
Peak horizontal ground acceleration coefficient on Class B rock*	PGA =	0.15
0.2-second period spectral acceleration coefficient on Class B rock*	S_S =	0.34 g
1.0-second period spectral acceleration coefficient on Class B rock*	S_1 =	0.11 g
Site coefficient for the peak ground acceleration	F_{pga} =	1.2
Site coefficient for 0.2-second period spectral acceleration	F_a =	1.2
Site coefficient for 1.0-second period spectral acceleration	F_v =	1.69
Effective peak ground acceleration coefficient (g)	$A_S = F_{pga}(PGA)$ =	0.18 g
Design earthquake response spectral acceleration coefficient at 0.2-second period	$S_{DS} = F_a{*}S_S$ =	0.40 g
Design earthquake response spectral acceleration coefficient at 1.0-second period	$S_{D1} = F_v{*}S_1$ =	0.18 g

NOTE:
* Based on the USGS Uniform Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) using the U.S. Dynamic Conterminous edition for 2014 (v.4.2.0).

Exhibit 6-4: 2,475-yr Seismic Design Parameters

Description	Recommended Value	
Site class based on soil conditions	Site Class =	C
Mean Magnitude	M =	7.3
Peak horizontal ground acceleration coefficient on Class B rock*	PGA =	0.35
0.2-second period spectral acceleration coefficient on Class B rock*	S_S =	0.78 g
1.0-second period spectral acceleration coefficient on Class B rock*	S_1 =	0.27 g
Site coefficient for the peak ground acceleration	F_{pga} =	1.05
Site coefficient for 0.2-second period spectral acceleration	F_a =	1.09
Site coefficient for 1.0-second period spectral acceleration	F_v =	1.53
Effective peak ground acceleration coefficient (g)	$A_S = F_{pga}(PGA)$ =	0.37 g
Design earthquake response spectral acceleration coefficient at 0.2-second period	$S_{DS} = F_a{*}S_S$ =	0.85 g
Design earthquake response spectral acceleration coefficient at 1.0-second period	$S_{D1} = F_v{*}S_1$ =	0.41 g

NOTE:
* Based on the USGS Uniform Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) using the U.S. Dynamic Conterminous edition for 2014 (v.4.2.0).

Exhibit 6-5: 1,000-yr Seismic Design Parameters

Description	Recommended Value	
Site class based on soil conditions	Site Class =	C
Mean Magnitude	M =	7.24
Peak horizontal ground acceleration coefficient on Class B rock*	PGA =	0.23
0.2-second period spectral acceleration coefficient on Class B rock*	S_S =	0.51 g
1.0-second period spectral acceleration coefficient on Class B rock*	S_1 =	0.17 g
Site coefficient for the peak ground acceleration	F_{pga} =	1.2
Site coefficient for 0.2-second period spectral acceleration	F_a =	1.3
Site coefficient for 1.0-second period spectral acceleration	F_v =	1.5
Effective peak ground acceleration coefficient (g)	$A_S = F_{pga}(PGA)$ =	0.28 g
Design earthquake response spectral acceleration coefficient at 0.2-second period	$S_{DS} = F_a*S_S$ =	0.66 g
Design earthquake response spectral acceleration coefficient at 1.0-second period	$S_{D1} = F_v*S_1$ =	0.26 g
Seismic design category based on S_{D1}	SDC =	B

NOTE:
* Based on the USGS Uniform Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) using the U.S. Dynamic Conterminous edition for 2014 (v.4.2.0).

6.3 Liquefaction

Soil liquefaction is a phenomenon in which porewater pressure in loose, saturated, granular soils increases during ground shaking to a level near the initial effective stress, thus resulting in a reduction of shear strength of the soil (a quicksand-like condition). Ground settlement, lateral spreading, and landslides may occur as a result of soil strength reduction. The following sections describe our liquefaction analyses at the site and include discussions on the liquefaction potential, seismic settlements, and lateral spreading.

6.3.1 Liquefaction Potential

We performed liquefaction analyses using three widely accepted empirical methods for evaluating liquefaction potential: Youd and Idriss (2001), Cetin and others (2004), and Boulanger and Idriss (2014). Each method uses laboratory testing, computer modeling, probabilistic techniques, and liquefaction data from historical earthquakes to create a relationship between soil density and liquefaction potential. We used these empirical methods to estimate a factor of safety (FS) against liquefaction for various samples in each boring based on the results of field and laboratory testing. The ability of soil to resist liquefaction is expressed as a cyclic resistance ratio (CRR). The demand placed on the soil deposit by seismic loading is expressed as the cyclic stress ratio (CSR). The FS against liquefaction is the ratio of the CRR to the CSR.

We performed liquefaction analyses for the project borings at the site. We evaluated the seismic demand for the 2,475-year event as it is more conservative than Section 7.4 of the WSDOT GDM. The WSDOT GDM requires that liquefaction hazard mitigation measures be developed if the FS against liquefaction is less than 1.2 for facilities that require seismic stability. Liquefaction is not likely to occur, and the results of our analyses are included in Figures 3 through 8.

6.3.2 Liquefaction-Related Settlement

Loose, granular soils that are susceptible to liquefaction are also susceptible to earthquake-induced densification and settlement. We estimated liquefaction-related settlement per the procedures of Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992), which use the FS against liquefaction and the soil's initial relative density to predict seismic settlements.

Liquefaction is not likely to occur based on our analyses and the drilled shaft foundations for the BNSF bridge crossings and other retaining walls for the sunken roundabouts will be founded on soils that are not susceptible to liquefication or significant earthquake-induced settlement.

6.3.3 Lateral Spreading

Liquefaction in gently sloping ground or adjacent to a free face can result in permanent lateral ground displacement in a phenomenon known as lateral spreading. Liquefaction-induced lateral spreading ground movement can occur toward a free face during or after seismic shaking in saturated, loose to medium dense granular soil. Based on the site topography and groundwater levels, the potential for lateral spreading at the site is relatively low.

6.4 Drilled Shaft Axial Capacity

We understand the BNSF bridge crossing will be supported by drilled shaft foundations that bear into the dense flood deposits (ESU 1). We understand these foundations will consist of 6-foot-diameter drilled shafts. We evaluated axial resistance in accordance with the AASHTO LRFD Bridge Design Specifications (AASHTO, 2020) and the WSDOT Geotechnical Design Manual (WSDOT, 2021). Axial capacity will be derived from both shaft friction and end bearing and axial resistance versus embedment depths for the drilled shafts are provided in Figure 9.

6.5 Drilled Shaft LPILE Parameters

The computer program LPILE (Ensoft, Inc., 2018) may be used to generate p-y curves (load-deflection curves) for the lateral resistance analysis of the drilled shafts and to calculate the magnitude of deflection, shear, and moment along the shaft. Our recommended soil parameters for input into LPILE are provided in Table 1.

6.6 Lateral Earth Pressure Parameters BNSF Abutment

For the BNSF bridge crossing, the bridge abutment drilled shaft retaining wall will be subjected to lateral earth pressures and surcharge loads, including Cooper E-80 train loading should be added to the recommended lateral earth pressures where appropriate. We assumed that the abutment wall will be free to deflect and recommend designing for active earth pressures conditions and a factor of 0.5xPGA was used in determining seismic loading. Therefore, they should be designed for active lateral earth pressures using the parameters provided in Exhibit 6-6.

Exhibit 6-6: BNSF Abutment Lateral Earth Pressures

Parameter	Recommended Design Value
Soil above 40 ft bgs:	
Retained Soil Moist Unit Weight, γm	130 pcf
Retained Soil Effective Internal Friction Angle, ϕ'	40°
Static Active Lateral Earth Pressure Coefficient, Ka	0.20
Seismic Active Lateral Earth Pressure Coefficient, Kae	0.31
Static Passive Lateral Earth Pressure Coefficient, Kp	13.37
Seismic Passive Lateral Earth Pressure Coefficient, Kpe	15.89
Soil below 40 ft bgs:	
Soil Moist Unit Weight, γm	135 pcf
Retained Soil Effective Internal Friction Angle, ϕ'	36°
Static Active Lateral Earth Pressure Coefficient, Ka	0.23
Seismic Active Lateral Earth Pressure Coefficient, Kae	0.36
Static Passive Lateral Earth Pressure Coefficient, Kp	9.56
Seismic Passive Lateral Earth Pressure Coefficient, Kpe	9.38

NOTE:
pcf = pounds per cubic foot

6.7 Hydrostatic Uplift

Due to the presence of groundwater near the bottom of the excavation cut for the sunken roadway below the BNSF bridge crossing, the new roadway surface for 32nd Street may need to account for drainage and a bottom seal to handle potential uplift pressure from higher groundwater levels. Hydrostatic uplift resistance should be accounted for when designing the bottom seal. The uplift pressure due to the buoyancy acting against the base of the bottom seal can be resisted by the dead weight of the seal, through the use of structural tiedowns, or by the combined weight of the seal and walls, if structural shear connections are designed and provided between them. Based on groundwater observations to date at the site, the groundwater near the bridge crossing is approximately 5 feet below the roadway cut. Further recommendations for the design of hydrostatic uplift resistance are provided in Figure 10. We recommend further groundwater monitoring measurements to assess the potential for higher groundwater which would influence the roadway design.

6.8 Global Stability

We evaluated the global stability of the BNSF bridge abutment under static and seismic conditions using the computer program SLOPE/W (Geo-Slope International, 2021). We used SLOPE/W to analyze many potential failure surfaces for the bridge abutment retaining walls to evaluate the potential required embedment of the drilled shafts below the roadway cut. The soil profile was modeled based on the nearby borings and the highest groundwater measurements. For each potential failure surface, we used the general limit equilibrium method (Fredlund and Krahn, 1977), which satisfies both force and moment equilibrium to calculate an FS against failure. The FS is the ratio of the forces available to resist movement to the forces of the driving soil mass. An FS of 1.0 means that the driving and resisting forces are equal. An FS of less than 1.0 means that the driving forces are greater than the resisting forces, indicating an unstable slope. The potential failure surface with the lowest FS is called the critical failure surface. WSDOT (2021) guidelines set a minimum critical failure surface FS of 1.5 for static stability and 1.1 for seismic stability. For seismic stability calculations, a horizontal pseudo-static coefficient, k_h, of 0.5xAs equal to 0.185g was used in the analysis as well as a Cooper E-80 train surcharge loading. We modeled the drilled shafts as reinforcement lines and assumed at least 5 ft of embedment below the roadway cut. The analyses estimate acceptable FSs for all analyzed cases and conditions. The results of our analyses are summarized in Exhibits 6-7 and outputs from our analyses are included in Figures 11 and 12.

Exhibit 6-7: I-5 Wingwalls Global Stability Results

Analysis Condition	Factor of Safety
Static	1.75
Seismic	1.47

6.9 Sunken Roundabout Retaining Wall Lateral Earth Pressures

The other retaining walls for the sunken roundabouts are assumed to potentially be MSE or cast-in-place concrete walls. The walls will be founded on dense flood deposits. The areas behind the wall will be backfilled with Gravel Backfill for Walls within the walls' influence zone. We assume the walls will be free to deflect and a factor of 0.5xPGA was used in determining seismic loading. Therefore, they should be designed for active lateral earth pressures using the parameters provided in Exhibit 6-8.

Exhibit 6-8: Sunken Roundabout Lateral Earth Pressure and Sliding Parameters

Parameter	Recommended Design Value
Backfill Moist Unit Weight, γm	130 pcf
Backfill Effective Internal Friction Angle, ϕ'	38°
Coefficient of sliding friction	0.58
Static Active Lateral Earth Pressure Coefficient, Ka	0.22
Seismic Active Lateral Earth Pressure Coefficient, Kae	0.30

NOTE:
pcf = pounds per cubic foot

7 CONSTRUCTION CONSIDERATIONS

The applicability of engineering recommendations is contingent upon good construction practice. Poor construction techniques and methods may alter the subsurface conditions from which our recommendations are based and may result in unsatisfactory performance of the proposed structures. We have identified considerations for construction for the project to assist you in developing geotechnical-related plans and specifications, but not to dictate methods or sequences used by contractors. Prospective contractors should undertake their own independent review and evaluation of all the available information to arrive at decisions concerning the planning of the work; the selection of equipment, means and methods, techniques, and sequences of construction; establishment of safety precautions; and evaluation of the influence of construction on adjacent sites.

Once the plans and specifications are developed, we recommend that we review those portions of the plans and specifications that pertain to the culverts, retaining walls, foundations, pavements, utilities, and earthwork to determine if they are consistent with our recommendations.

7.1 Earthwork

A large amount of earthwork will be performed for this project. The following sections describe recommendations for re-use of excavated material and considerations for temporary slopes and shoring. Our explorations performed for the project may not be sufficient for design of temporary slopes and shoring. It is the responsibility of the Contractor to conduct additional explorations if needed for the design of their temporary works.

7.1.1 Excavation Slopes

Temporary slopes are the responsibility of the Contractor. The Contractor shall determine the appropriate measures to ensure that all excavation work complies with local, state, and federal safety codes. Washington Administration Code (WAC) Section 296 155 contains maximum allowable temporary cut slope inclinations and applies to cuts of 20 feet or less in height. Slope heights greater than 20 feet must be designed by a registered professional engineer. GDM Section 15-7 contains additional requirements for the design of temporary cut slopes.

We anticipate that the excavation slopes will primarily encounter material from ESU 1 and ESU 2. Perched groundwater may be encountered during excavations. Where groundwater seepage is encountered, erosion could occur such that the stability of temporary excavation slopes is adversely affected. The Contractor should be prepared to control groundwater seepage and prevent erosion that could cause slope instability.

7.2 Drilled Shafts

Drilled shafts may be installed for the BNSF bridge crossing abutments. Requirements for drilled shaft installation are provided in WSDOT Standard Specification Section 6-19. The following sections provide construction considerations for the shafts planned for the project.

7.2.1 Shaft Excavation

Subsurface conditions at the sites will present several challenges for the constructability of drilled shafts. Granular soils at the sites will require the use of temporary excavation support during the drilling process. This could be accomplished by using temporary casing, drilling fluid, or a combination thereof. Loss of drilling fluid may occur in areas with significant cobbles and boulders. To overcome this issue, the Contractor could construct the shafts using an oscillator to simultaneously advance casing with the excavation. In this procedure, the shaft casing is equipped with cutting teeth or a cutting shoe and installed by either rotating or oscillating the casing. Such methods are advantageous in that they can advance through cobbles, boulders, obstructions, and rock.

We anticipate that groundwater will be encountered in shaft excavations. Below the groundwater table, drilling fluid would be required to prevent heave at the base of the shaft excavation.

7.2.2 Obstructions

Obstructions may be encountered during earthwork, shaft installation, or other activities that extend below grade. Obstructions for this project may include miscellaneous debris in fills and potentially cobbles and boulders in fill and flood deposits.

The degree to which these obstructions may affect construction depends on the Contractor's means and methods. The Contractor should plan their work to consider the above-listed obstructions and be prepared with mitigation measures to penetrate obstructions to achieve the project requirements.

8 CONSTRUCTION MONITORING

We recommend that we be retained to observe the geotechnical aspects of construction, particularly the temporary slope excavation, foundation subgrade preparation, structural fill placement, and deep foundation installation. This observation would allow us to verify the subsurface conditions as they are exposed during construction and to determine that the work is accomplished in accordance with our recommendations.

9 CONCLUSIONS AND RECOMMENDATIONS

Elevations for the explorations and groundwater elevations are approximate, as surveys have not been completed. We recommend the project explorations be surveyed.

Infiltration appears feasible at the two areas where the PITs were performed. If infiltration facilities are designed for different locations and/or elevations, we recommend performing additional infiltration testing at those locations and elevations.

10 LIMITATIONS

This report was prepared for the exclusive use of WSP and their representatives for the Washougal Grade Separation Project. The recommendations in this report supersede those provided in all previous versions of this report, and those provided via email or other correspondence before this report was published. This report should be provided to prospective contractors for their information, but our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions included in this report.

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist, and further assume that the explorations are representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. If subsurface conditions different from those encountered in the explorations are encountered or appear to be present during construction, we should be advised at once so that we can review these conditions and reconsider our recommendations, where necessary. If there is a substantial lapse of time between the submission of this report and the start of construction at the site, or if conditions have changed because of natural forces or construction operations at or adjacent to the site, we recommend that we review our report to determine the applicability of the conclusions and recommendations.

Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. These conclusions and recommendations were based on our understanding of the project as described in this report and the site conditions as observed at the time of our explorations.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

The scope of our present work did not include environmental assessments or evaluations regarding the presence or absence of wetlands, or hazardous or toxic substances in the soil, surface water, groundwater, or air on or below or around this site, or for the evaluation or disposal of contaminated soils or groundwater should any be encountered.

Shannon & Wilson, Inc. has prepared the enclosed "Important Information About Your Geotechnical/Environmental Proposal" to assist you and others in understanding the use and limitations of our proposals.

11 REFERENCES

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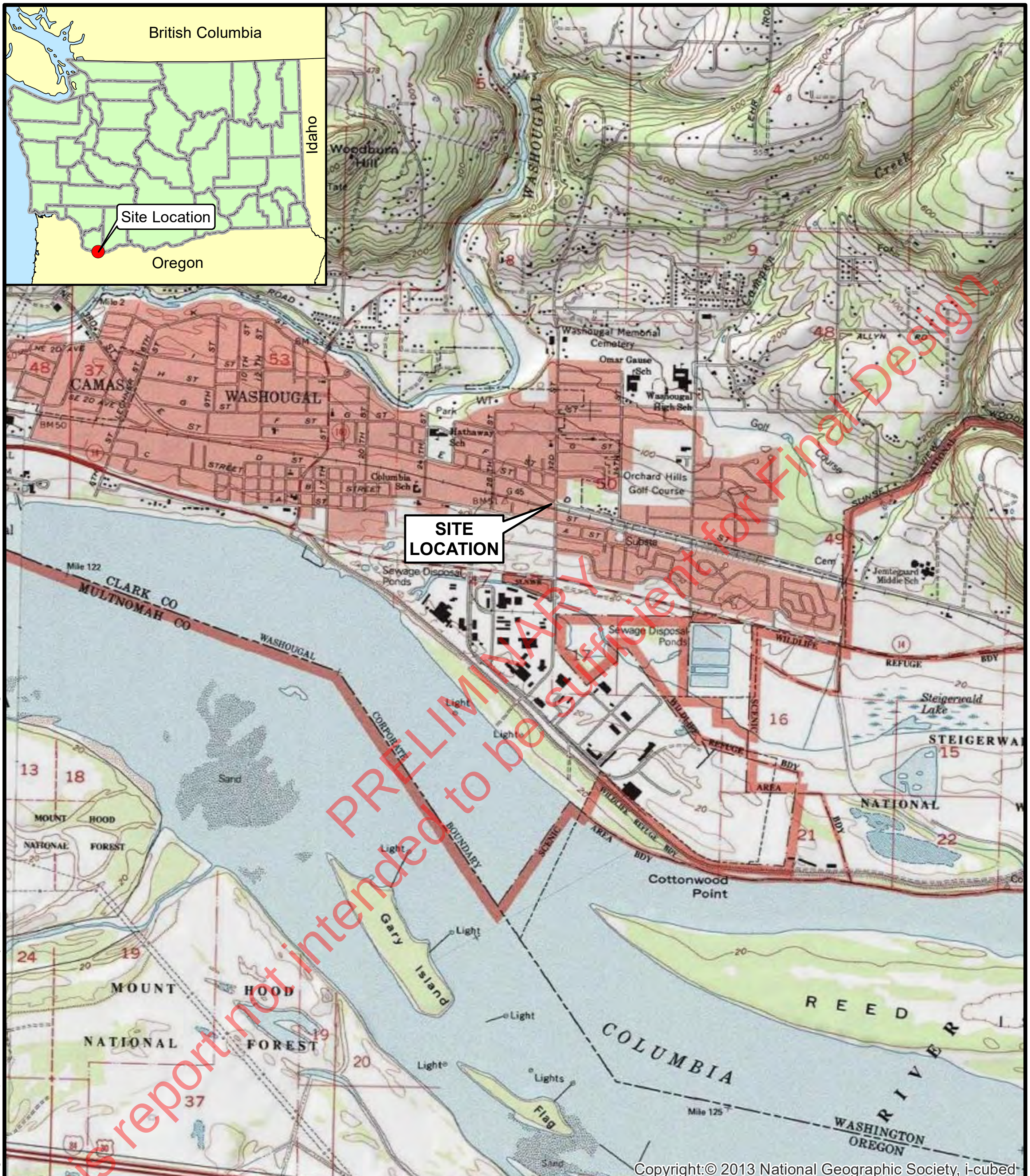
Table 1 - Soil Parameters for Lpile Lateral Analysis for 32nd Street Bridge

Deposit	Layer Depth below ground surface (feet)		Layer Description	LPILE Soil Model	Effective Unit Weight (pcf)	Friction Angle ϕ' (deg)	Modulus of Subgrade Reaction k (pci)
	Top	Bottom					
Flood Deposits	0	30	VD Silty Gravel above GWT	Sand (Reese/API)	130	40	225
Flood Deposits	30	40	VD Silty Gravel below GWT	Sand (Reese/API)	67.6	40	125
Alluvium	40	80	VD Silty Sand below GWT	Sand (Reese/API)	72.6	36	125

NOTES:
deg = degrees; pcf = pounds per cubic foot; pci = pounds per cubic inch;



0 0.25 0.5 1

Scale in Miles

N

Washougal Grade Separation
Washougal, Washington

VICINITY MAP

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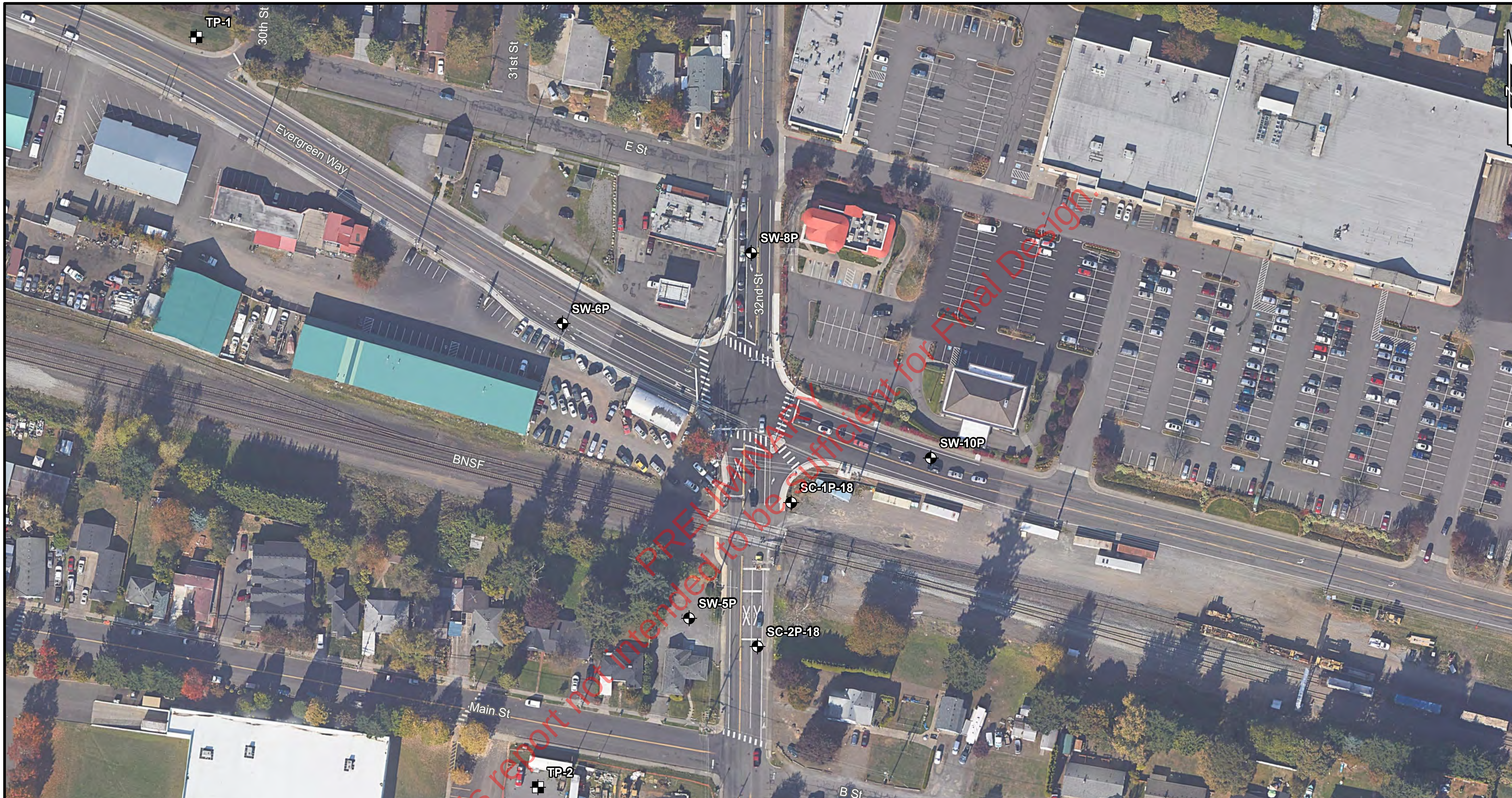
FIG. 1

Filename: T:\Projects\SEA101835_Washougal Grade Separation\Avmxd\VicinityMap_10.6.mxd Date: 10/21/2021 Login: AEH



LEGEND

SW-5P — Designation and Approximate Location of Boring

TP-1 — Designation and Approximate Location of Infiltration Test Pit

0 50 100 200

Scale in Feet

NOTES

1. Aerial imagery obtained through Google Maps Satellite.

Washougal Grade Separation
Washougal, Washington

SITE AND EXPLORATION PLAN

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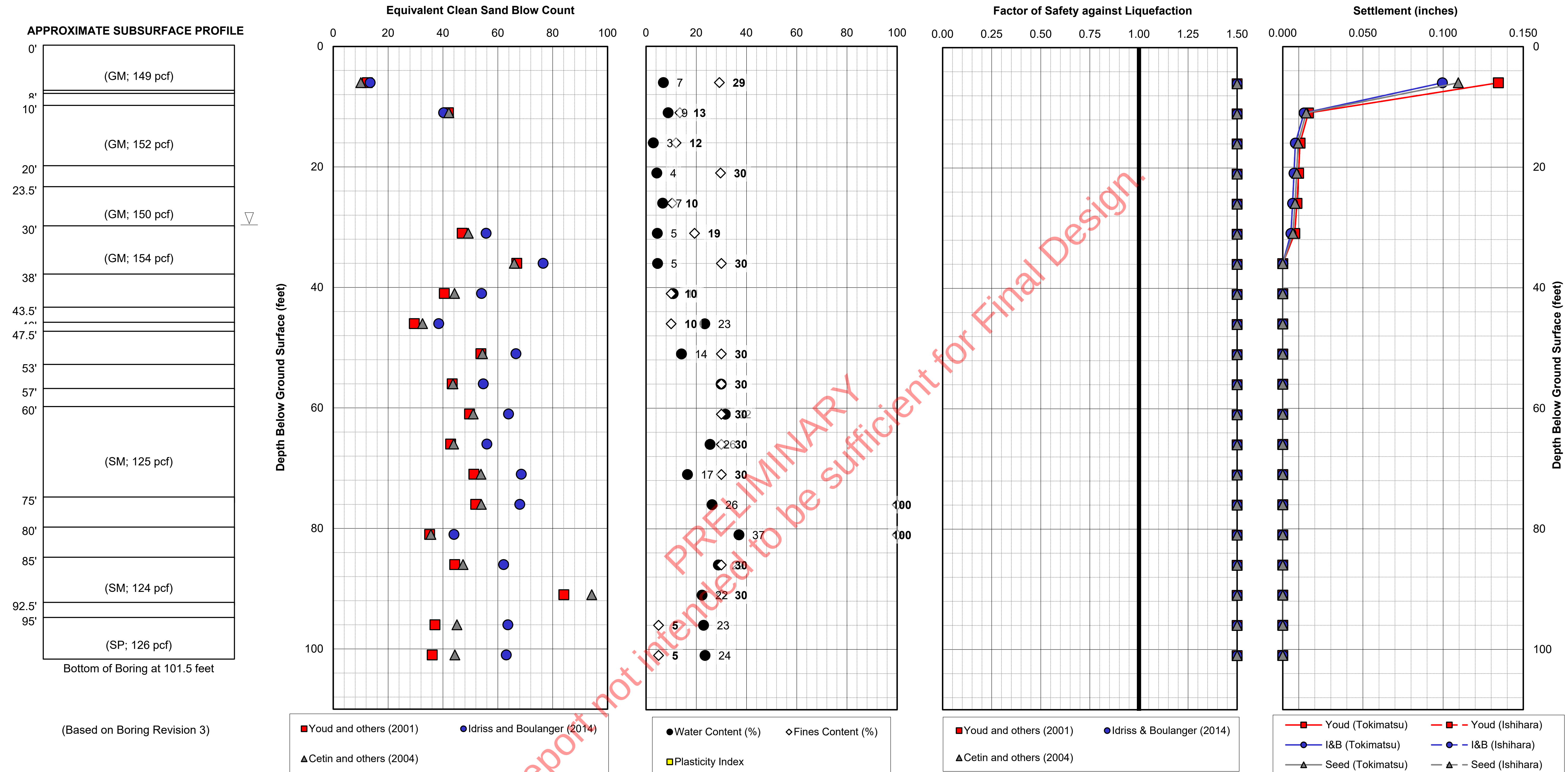
FIG. 2

Filename: T:\Projects\SEA\101835_Washougal Grade Separation\Avmxd\SitePlan_10.6.mxd Date: 10/21/2021 Login: AEH



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.
3. We estimated the seismic settlement below the water table using Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992). We estimated the settlement above the water table using Pradel (1998).
4. Average shear wave velocity in upper 30 feet = 822 fps
   Hammer energy ratio = 83%
   Groundwater table depth = 31.39 feet
5. pcf = pounds per cubic foot
   g = gravitational acceleration
   PGA = peak ground acceleration

Washougal Grade Separation
Washougal, Washington

LIQUEFACTION ANALYSIS SUMMARY
BORING SC-1P-18
M = 7.3, PGA = 0.19g

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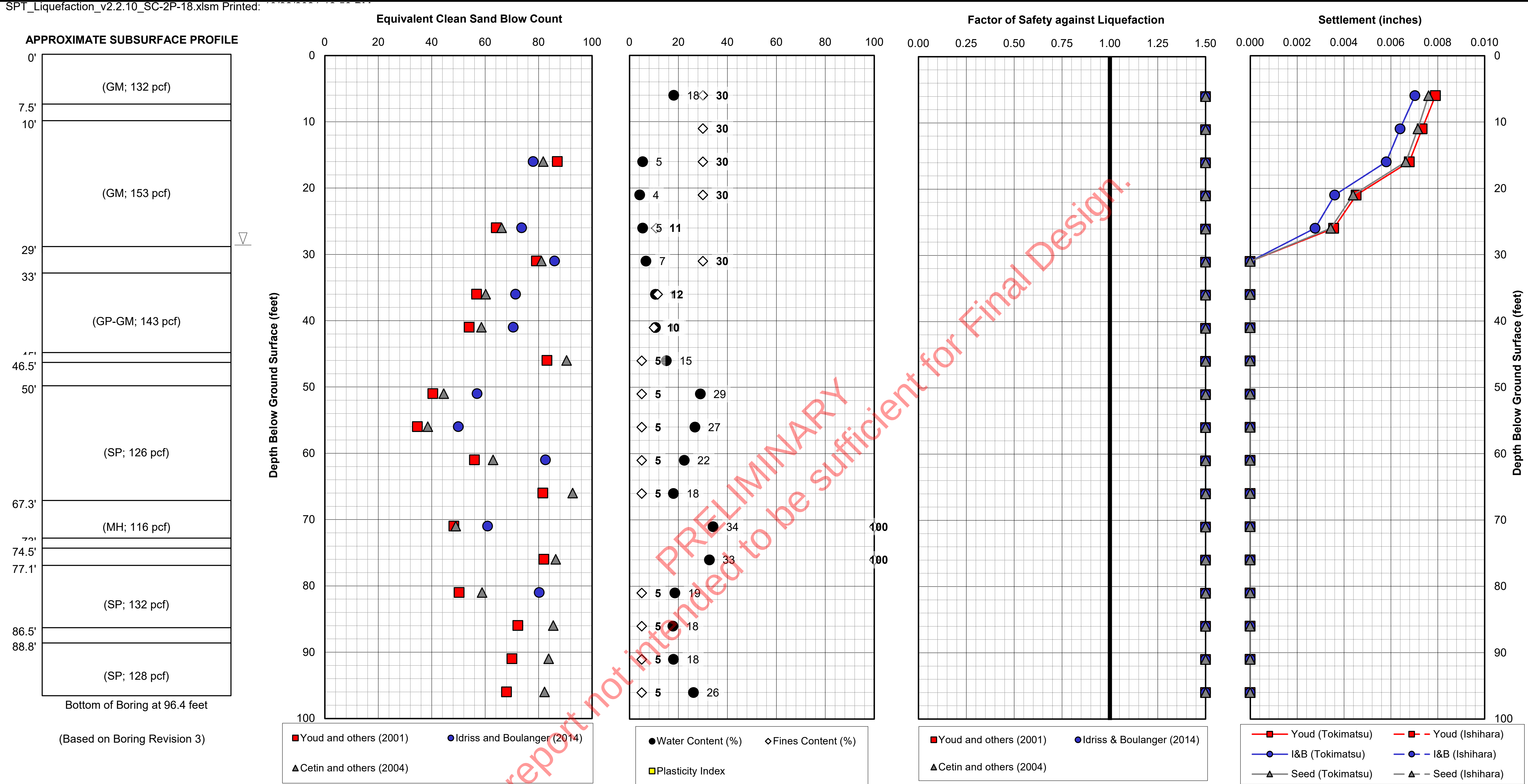
FIG. 3

SPT_Liquefaction_v2.2.10_SC-2P-18.xlsm Printed:



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.
3. We estimated the seismic settlement below the water table using Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992). We estimated the settlement above the water table using Pradel (1998).
4. Average shear wave velocity in upper 30 feet = 887 fps
   Hammer energy ratio = 83%
   Groundwater table depth = 30.19 feet
5. pcf = pounds per cubic foot
   g = gravitational acceleration
   PGA = peak ground acceleration

Washougal Grade Separation
Washougal, Washington

LIQUEFACTION ANALYSIS SUMMARY
BORING SC-2P-18
M = 7.3, PGA = 0.19g

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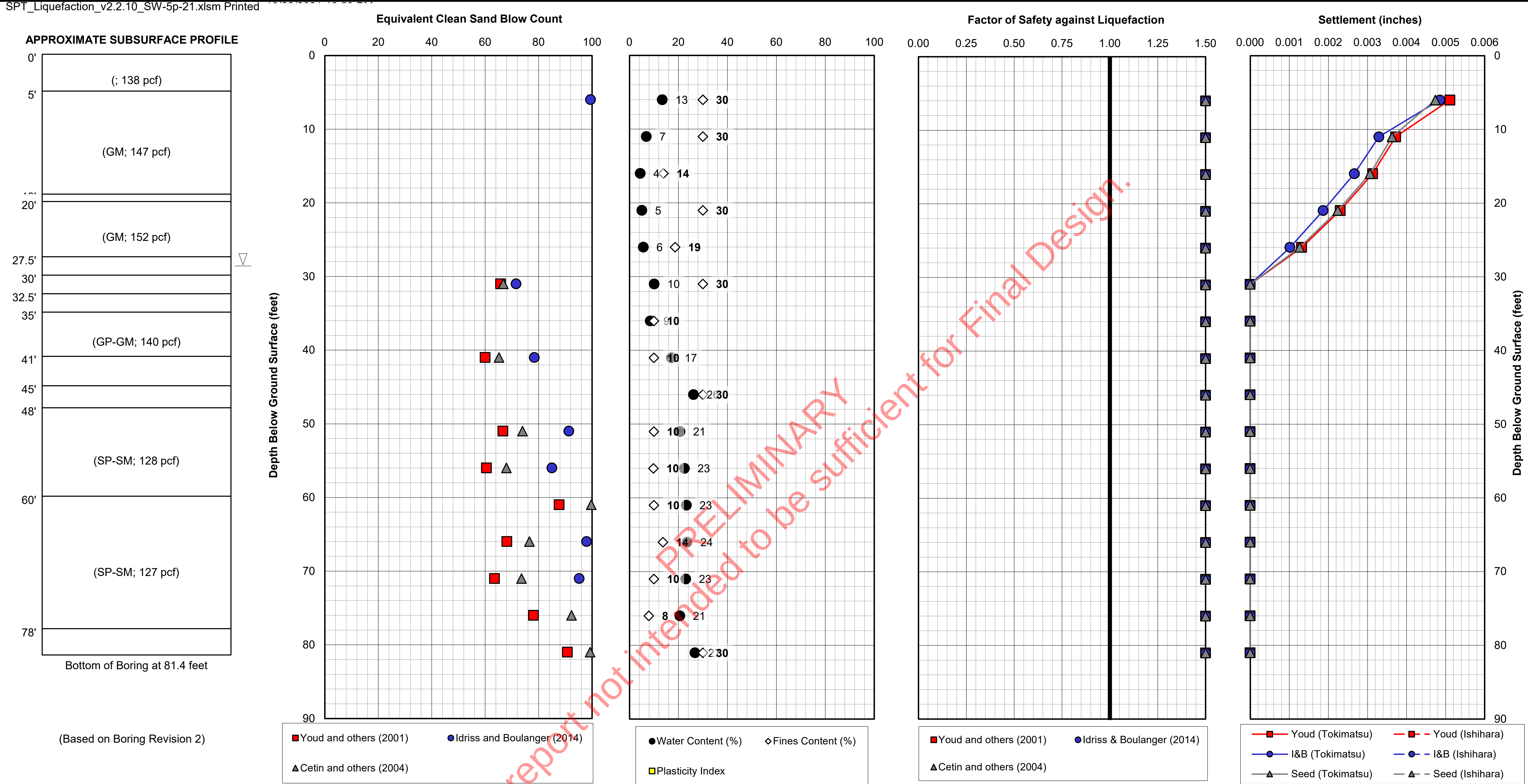
FIG. 4

SPT_Liquefaction_v2.2.10_SW-5p-21.xlsm Printed



This report not intended to be sufficient for Final Design. PRELIMINARY

NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.
3. We estimated the seismic settlement below the water table using Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992). We estimated the settlement above the water table using Pradel (1998).
4. Average shear wave velocity in upper 30 feet = 931 fps
   Hammer energy ratio = 83%
   Groundwater table depth = 30 feet
5. pcf = pounds per cubic foot
   g = gravitational acceleration
   PGA = peak ground acceleration

Washougal Grade Separation
Washougal, Washington

LIQUEFACTION ANALYSIS SUMMARY
BORING SW-5P-21
M = 7.3, PGA = 0.19g

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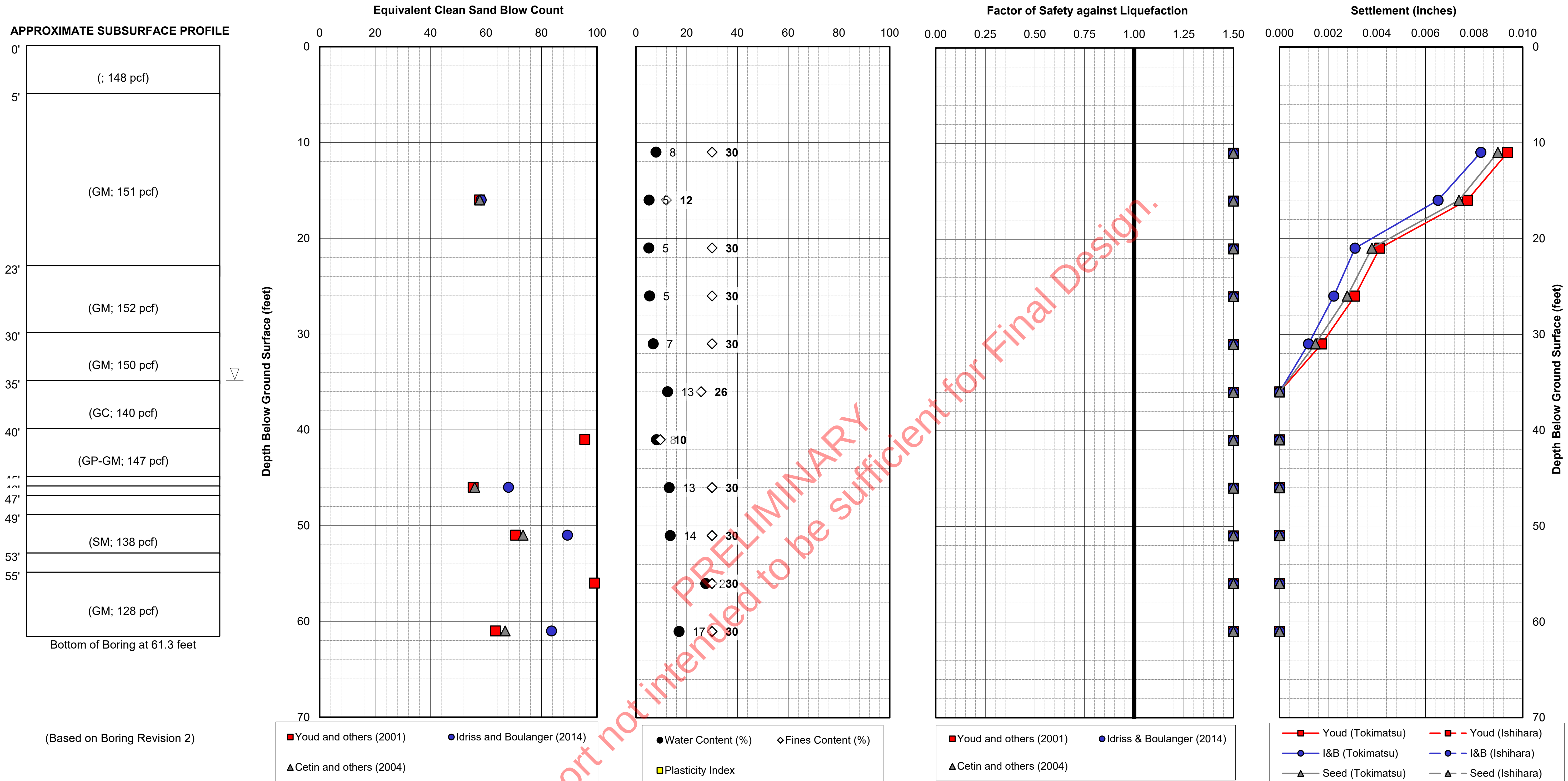
FIG. 5



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.
3. We estimated the seismic settlement below the water table using Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992). We estimated the settlement above the water table using Pradel (1998).
4. Average shear wave velocity in upper 30 feet = 990 fps
   Hammer energy ratio = 83%
   Groundwater table depth = 36 feet
5. pcf = pounds per cubic foot
   g = gravitational acceleration
   PGA = peak ground acceleration

Washougal Grade Separation
Washougal, Washington

LIQUEFACTION ANALYSIS SUMMARY
BORING SW-6P-21
M = 7.3, PGA = 0.19g

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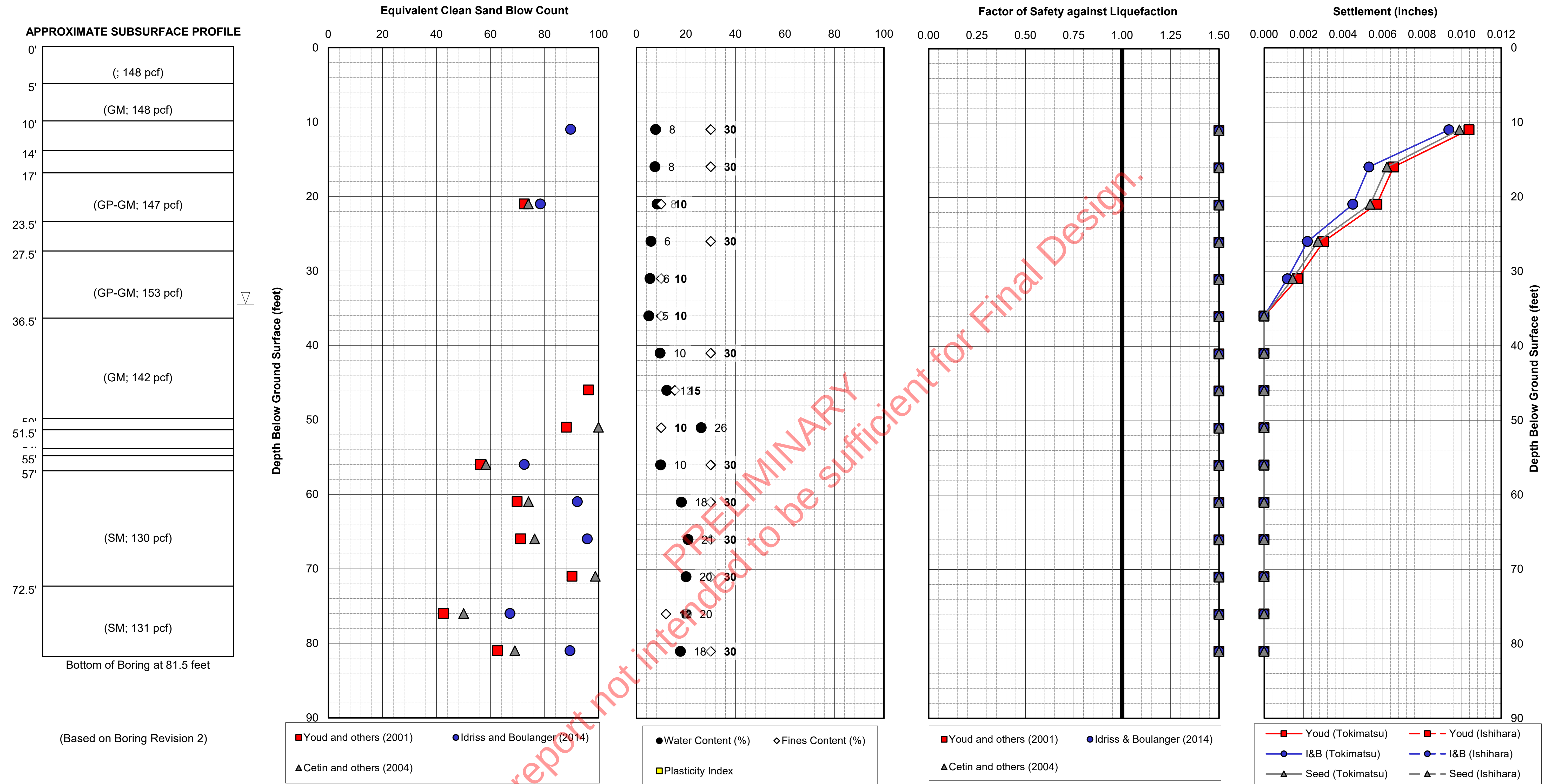
FIG. 6



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.
3. We estimated the seismic settlement below the water table using Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992). We estimated the settlement above the water table using Pradel (1998).
4. Average shear wave velocity in upper 30 feet = 981 fps
   Hammer energy ratio = 83%
   Groundwater table depth = 36 feet
5. pcf = pounds per cubic foot
   g = gravitational acceleration
   PGA = peak ground acceleration

Washougal Grade Separation
Washougal, Washington

LIQUEFACTION ANALYSIS SUMMARY
BORING SW-8P-21
M = 7.3, PGA = 0.19g

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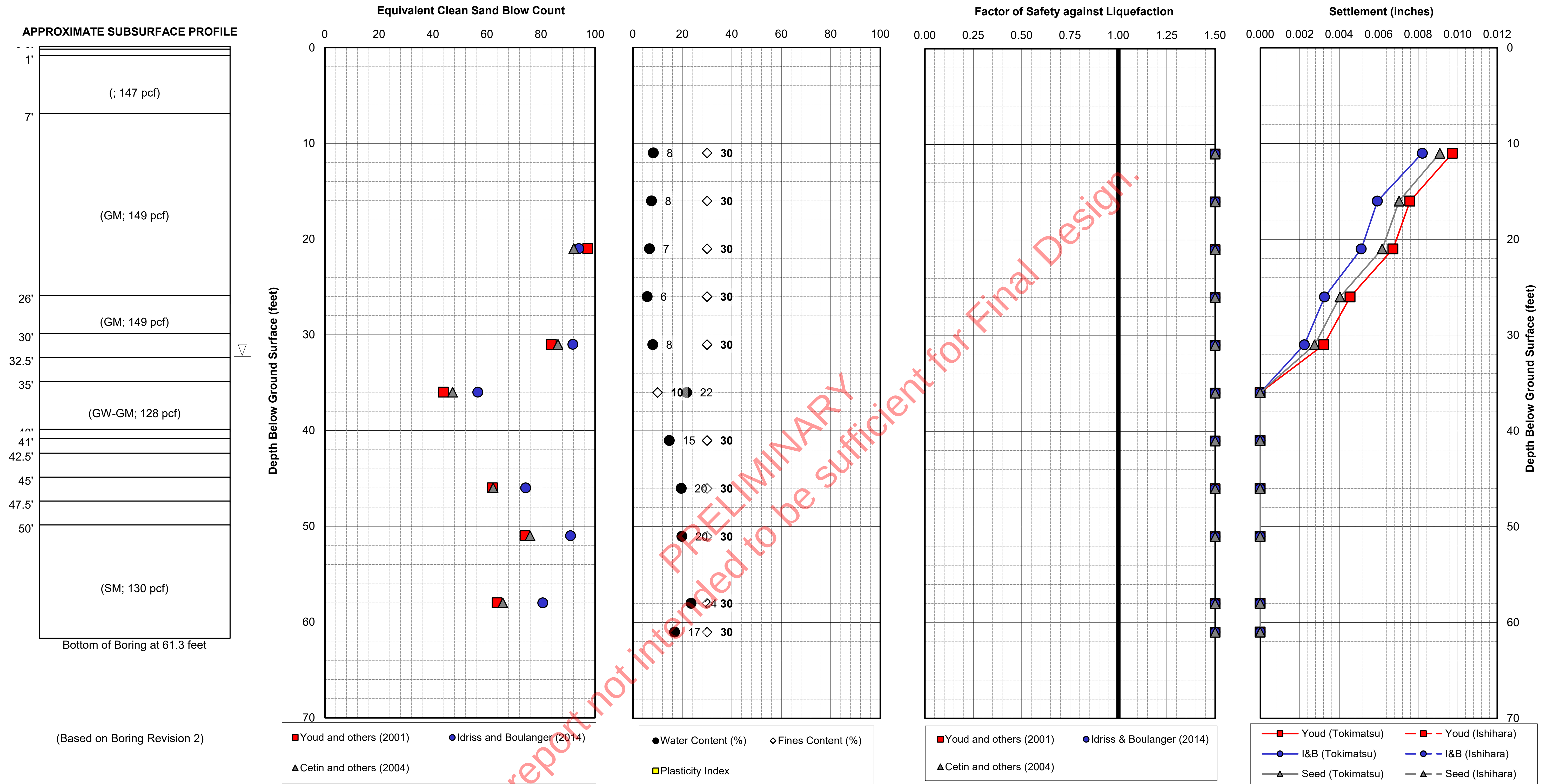
FIG. 7



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.
3. We estimated the seismic settlement below the water table using Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992). We estimated the settlement above the water table using Pradel (1998).
4. Average shear wave velocity in upper 30 feet = 948 fps
   Hammer energy ratio = 83%
   Groundwater table depth = 33.4 feet
5. pcf = pounds per cubic foot
   g = gravitational acceleration
   PGA = peak ground acceleration

Washougal Grade Separation
Washougal, Washington

LIQUEFACTION ANALYSIS SUMMARY
BORING SW-10P-21
M = 7.3, PGA = 0.19g

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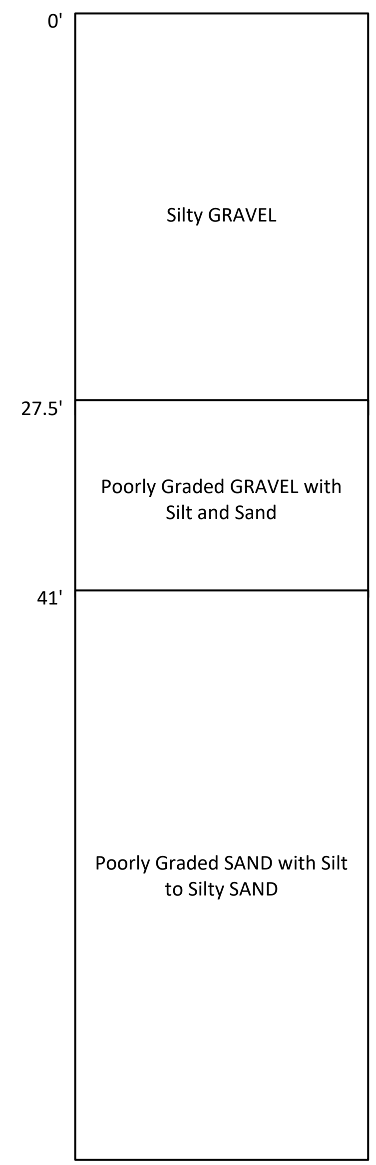
FIG. 8

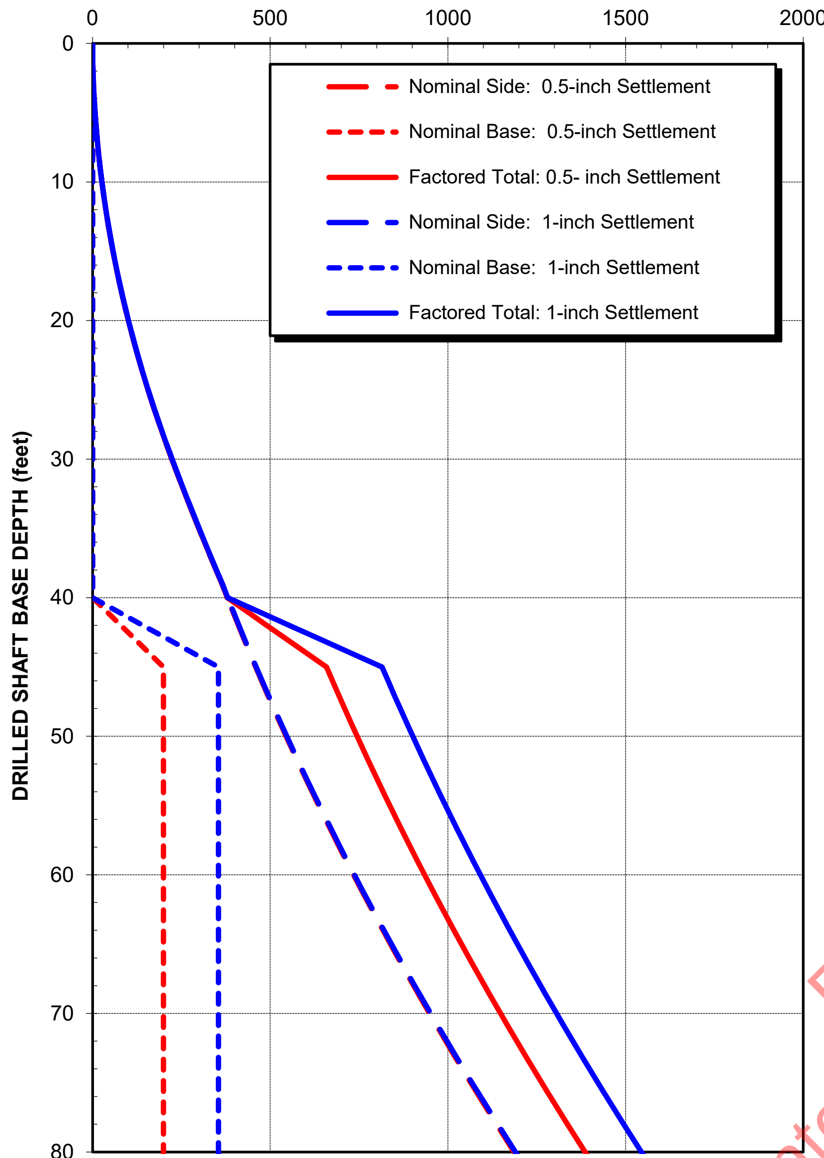
ASSUMED SUBSURFACE PROFILE

Based on Nearby Explorations:
SW-5p-21



SERVICE LIMIT

NOMINAL RESISTANCE (tons)

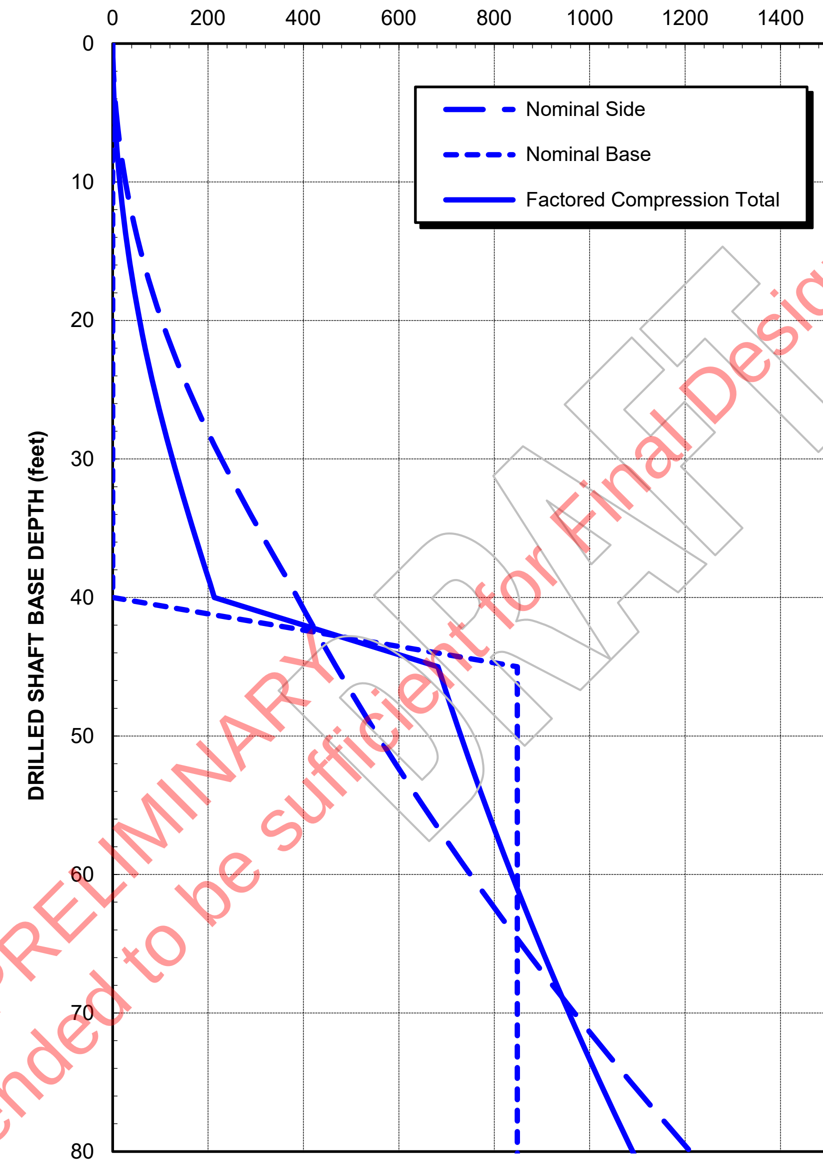


SERVICE LIMIT NOTES:

1. Recommended resistance factors per WSDOT GDM are 1.0 for both side and base resistance.
2. Settlement is based on a single shaft. No group action is considered.

STRENGTH LIMIT

NOMINAL RESISTANCE (tons)

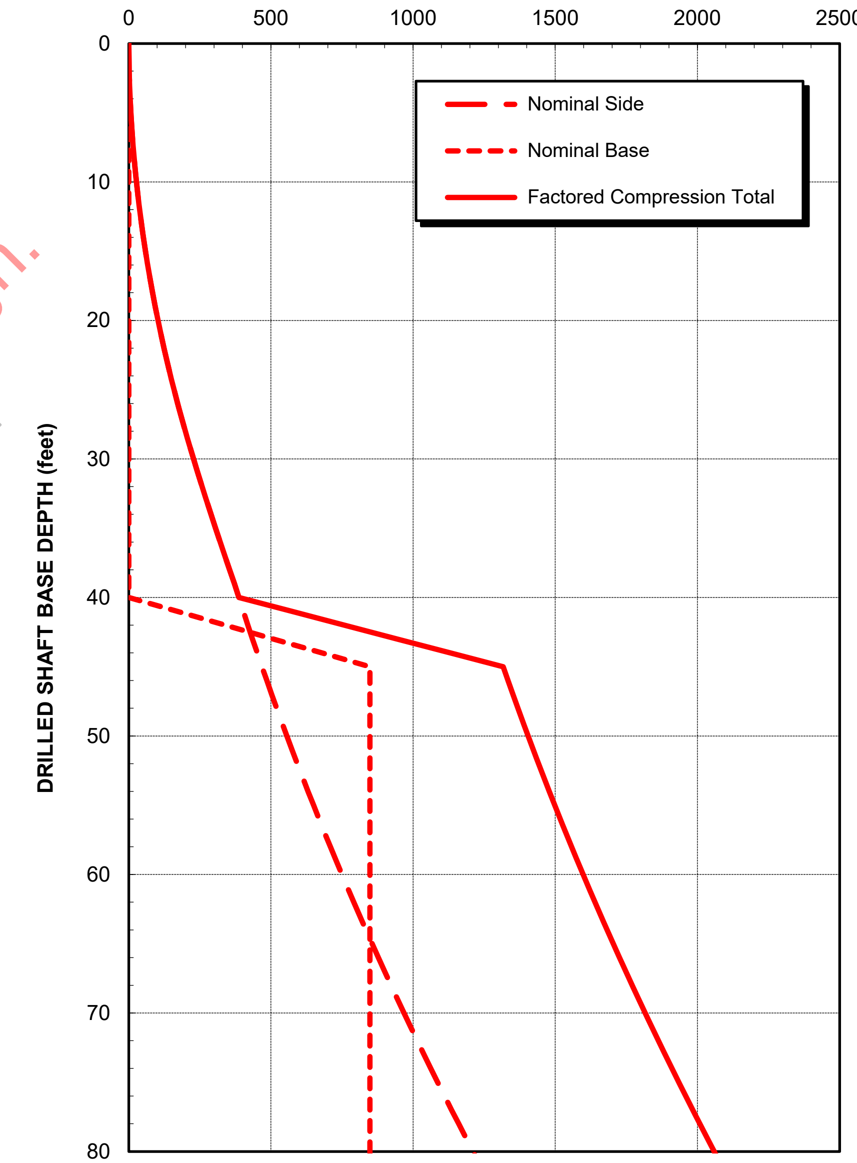


STRENGTH LIMIT NOTES:

1. Recommended compression resistance factors per WSDOT GDM are 0.55 and 0.5 for side and base resistance, respectively.
2. Shaft uplift resistance can be estimated by using the nominal side resistance shown above and a recommended resistance factor of 0.35 (per WSDOT GDM).

EXTREME EVENT LIMIT

NOMINAL RESISTANCE (tons)



EXTREME EVENT LIMIT NOTES:

1. Recommended resistance factors per WSDOT GDM for both side and base resistance are 1.0 for compression and 0.8 for uplift.
2. Unfactored downdrag force is estimated to be 0 tons. Per the WSDOT GDM, a load factor of 1.25 is recommended to determine factored downdrag force. Downdrag force is recommended to be applied with post-earthquake loading.

GENERAL NOTES

1. The analyses were performed based on guidelines included in the WSDOT Geotechnical Design Manual (GDM) and local experience. The analyses are based on a single shaft and do not consider group action of closely spaced shafts (closer than 4 diameters, center to center).
2. Factored total shaft resistance shown on plots is determined by adding its nominal side and base resistances multiplied by the appropriate resistance factors as noted above.
3. Estimated shaft resistance assumes that if casing is used, it will be removed after the shaft installation. If, however, the casing is left in place, grouting should be used to fill all potential voids around the casing and the estimated resistance given above should be re-evaluated.
4. Estimated shaft resistance assumes that the drilled shafts will be installed after construction of the approach embankments. Downdrag loads due to potential fill embankment settlement have not been included.
5. Per the WSDOT GDM, potential liquefaction below a depth of 80 feet was not considered in the calculations

Washougal Grade Separation
Washougal, Washington

32ND ST BRIDGE
ESTIMATED AXIAL SHAFT RESISTANCE
6-FOOT DIAMETER DRILLED SHAFT

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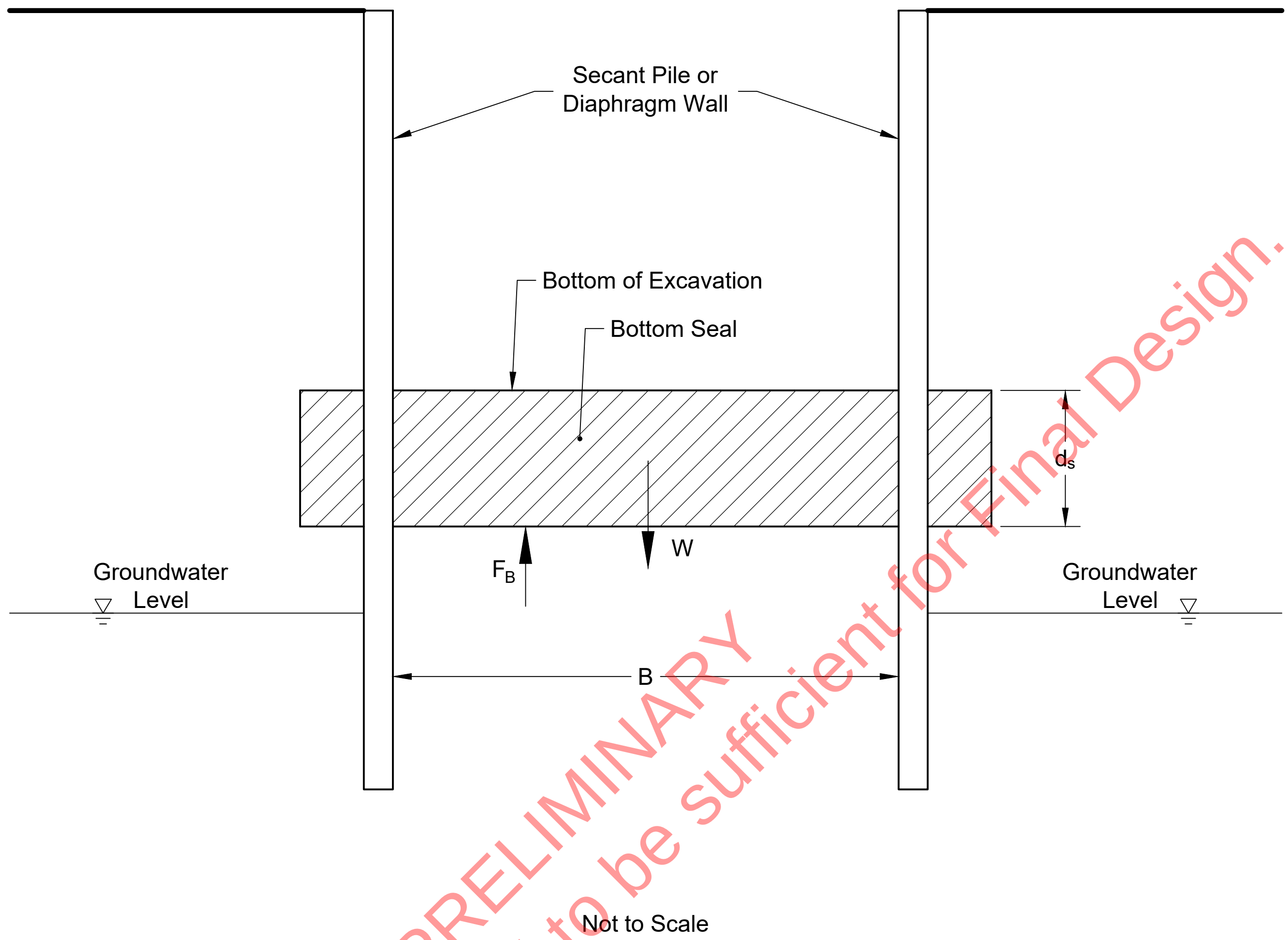
FIG. 9



$F_B \leq 0.9\ W$

W = Weight of Bottom Seal

F_B = Buoyant Force
$H_1 \times \gamma_w \times B$

d_s = Bottom Seal Thickness (Ft.)

γ_w = Unit Weight of Water, 62.4 pcf

B = Width of Bottom Seal (Ft.)

Washougal Grade Separation
Washougal, Washington

UPLIFT RESISTANCE

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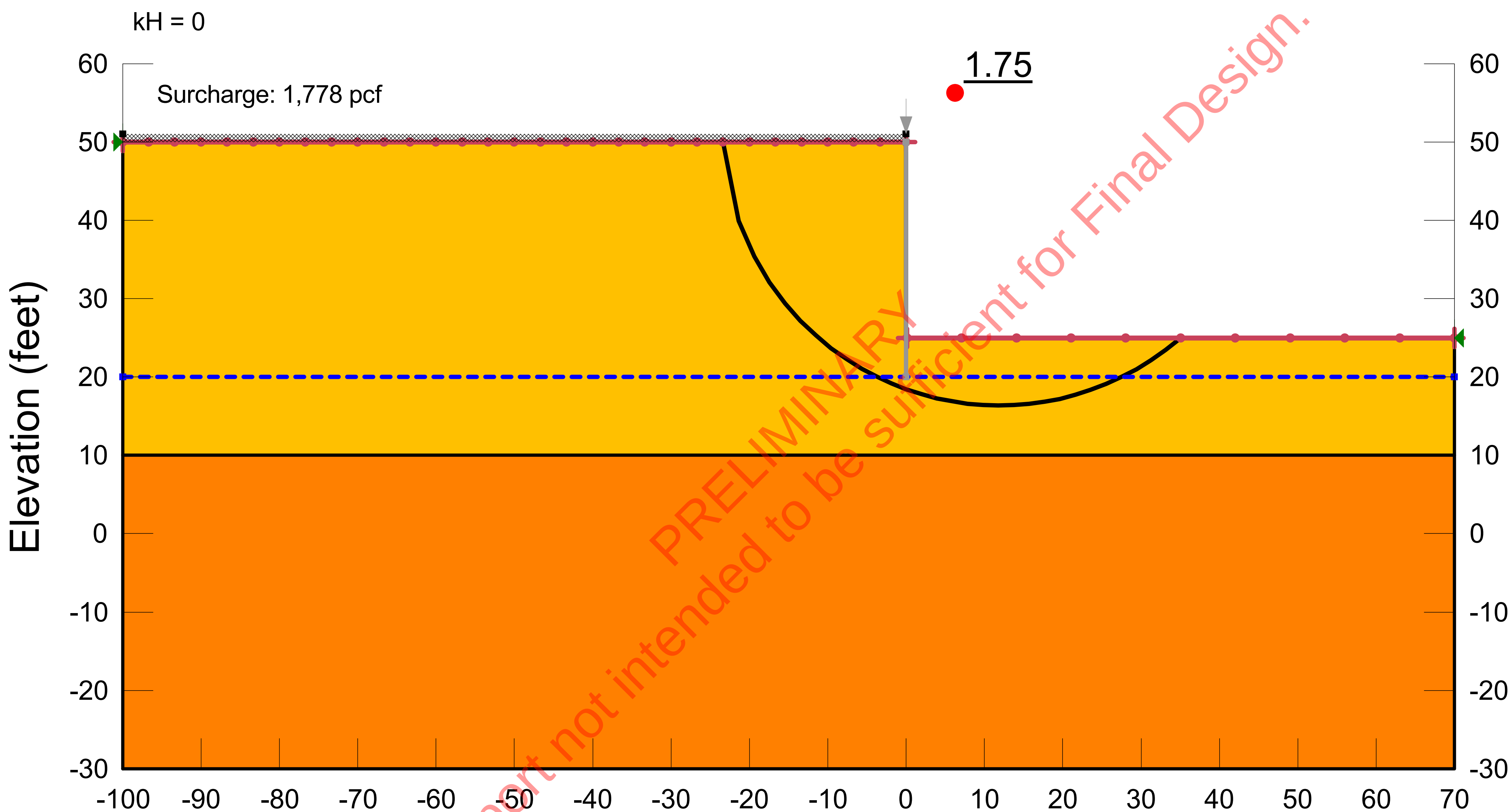
FIG. 10

WEST

EAST



Notes:
1. pcf = pounds per cubic foot, psf = pounds per square foot
2. Seismic acceleration coefficient = 0.
3. Geostudio File Name: BNSF bridge crossing.gsz; Analysis Name: STATIC

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
Orange	Advance Outwash (Silty Sand)	Mohr-Coulomb	135	0	36
Yellow	Outburst Flood (Silty Gravel)	Mohr-Coulomb	130	0	40

Washougal Grade Separation
Washougal, Washington

32ND ST BRIDGE
SLOPE STABILITY ANALYSIS
STATIC

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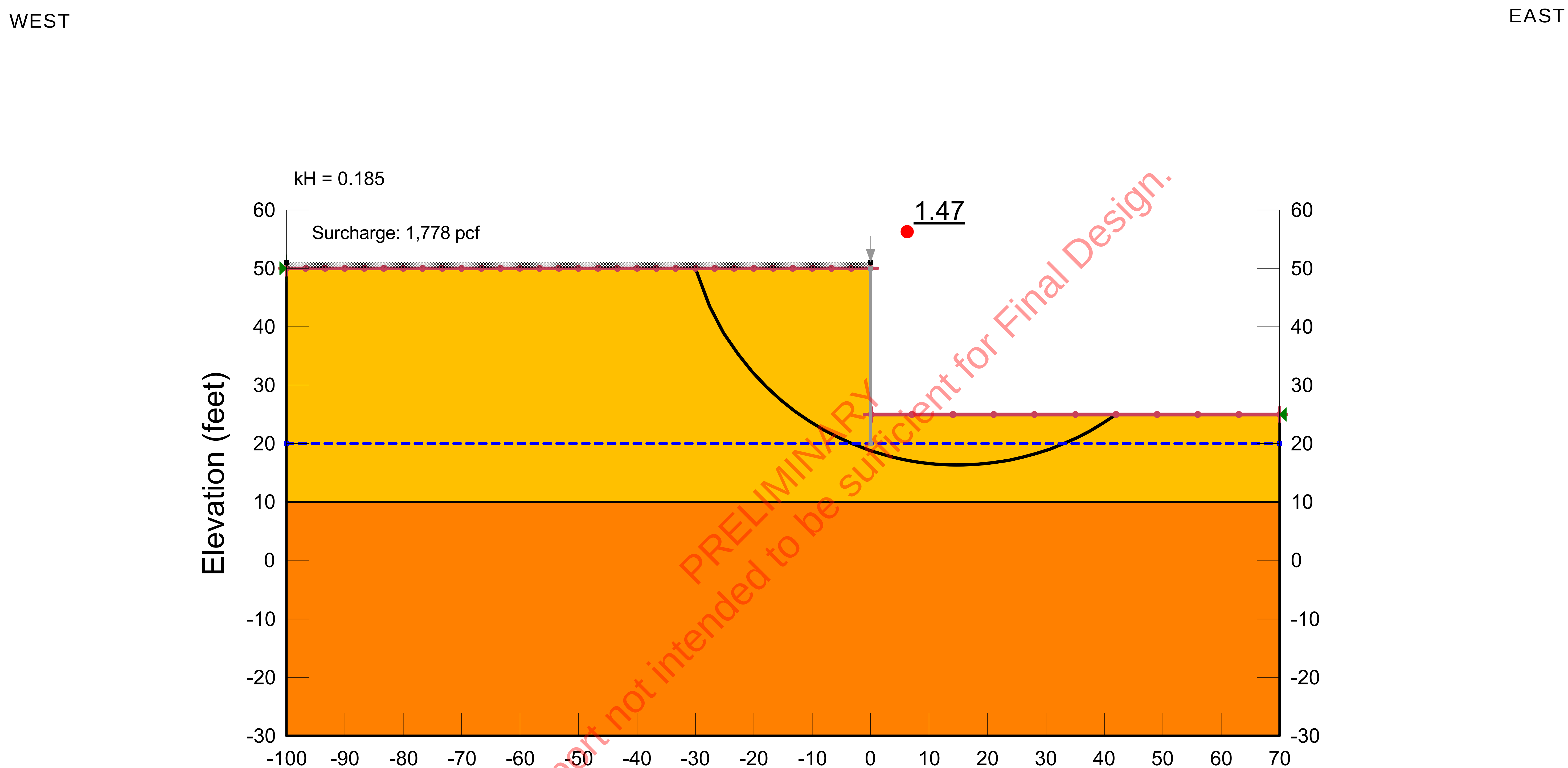
FIG. 11

Directory: \\SEA-FS1\Vol1\EF\SEA\101000s\101835 Washougal Grade Separation\Analysis and Engineering\02 Bridge Crossing Global Stability\



Notes:
1. pcf = pounds per cubic foot, psf = pounds per square foot
2. Seismic acceleration coefficient = 0.185.
3. Geostudio File Name: BNSF bridge crossing.gsz; Analysis Name: SEISMIC

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
(orange)	Advance Outwash (Silty Sand)	Mohr-Coulomb	135	0	36
(yellow)	Outburst Flood (Silty Gravel)	Mohr-Coulomb	130	0	40

Washougal Grade Separation
Washougal, Washington

32ND ST BRIDGE
SLOPE STABILITY ANALYSIS
SEISMIC

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FIG. 12

Directory: \\SEA-FS1\Vol1\EF\SEA\101000s\101835 Washougal Grade Separation\Analysis and Engineering\02 Bridge Crossing Global Stability\

APPENDIX A: GEOTECHNICAL EXPLORATIONS

Appendix A

Geotechnical Explorations

CONTENTS

- Soil Key
- Boring Logs
- Test Pit Logs and Pilot Infiltration Test Data
- Sonic Core Photographs

SOIL DESCRIPTION AND LOG KEY

Washougal Grade Separation
Washougal, Washington

Shannon & Wilson 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 page. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

Structure[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.

Angularity and Shape[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.

Standard Penetration Test (SPT)[3]

Hammer	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diameter cathead 2-1/4 rope turns, > 100 rpm. If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
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 or 10 blows for 0 inch.

Moisture Content

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

Gradation

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[1]

Weak	Crumbles/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]

Nonplastic	Cannot roll a 1/8-in. thread at any water content.	PI < 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 < PI < 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 < PI < 20
Hard	It takes 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.	PI > 21

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.

Notes:

[1]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.

[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.

[3]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.

Unified Soil Classification System (USCS)
Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488

Major Divisions			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)

Acronyms and Abbreviations

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

Well and Backfill Symbols

- Bentonite Cement Grout
- Bentonite Grout
- Bentonite Chips
- Silica Sand
- Perforated or Screened Casing
- Surface Cement Seal
- Asphalt or Cap
- Slough
- Inclinometer or Non-perforated Casing
- Instrumentation Riser or Electrical Lead
- Vibrating Wire Piezometer with Designation

Relative Density
Cohesionless Soils

N, SPT, Blows/ft	Relative Density
< 4	Very loose
4 - 10	Loose
10 - 30	Medium dense
30 - 50	Dense
> 50	Very dense

Relative Consistency
Cohesive Soils

N, SPT, Blows/ft	Relative Consistency
< 2	Very soft
2 - 4	Soft
4 - 8	Medium stiff
8 - 15	Stiff
15 - 30	Very stiff
> 30	Hard

Percentages[1, 2]

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

Notes:

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. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

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.

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

Total Depth:	101.5 ft.	Northing:	~ 94,732 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 45 ft.	Easting:	~ 1,170,089 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	Offset:	~	Other Comments:			

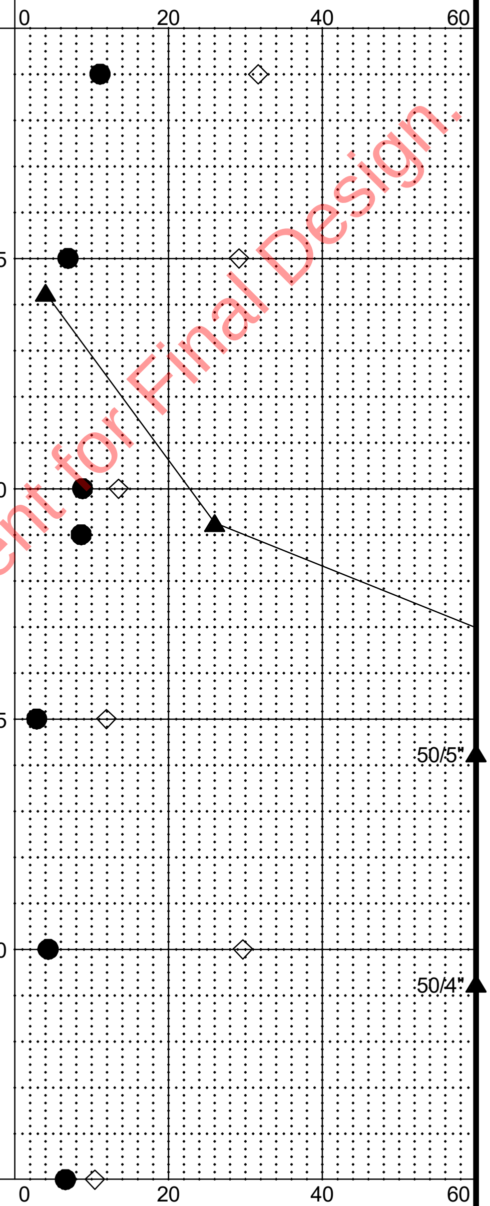
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Loose, red-brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic; few organics. (Hf)		R-1, 1
Medium dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; trace cobbles; fine to coarse, subangular gravel; fine to coarse sand; low plasticity; trace organics. (Qfg)	7.5 / 8.0	R-2
Medium dense, brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; moist; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic. (Qfg)	10.0	2, R-3
Very dense, gray-brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few, subrounded cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg) - Boulder at approximately 14 feet.		3, R-4
Very dense, gray-brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	20.0	4, R-5
Very dense, gray-brown, *Silty Gravel with Sand and Cobbles (GM)* to *Poorly Graded Gravel with*	23.5	

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-1P-18

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FIG. A-1
Sheet 1 of 5

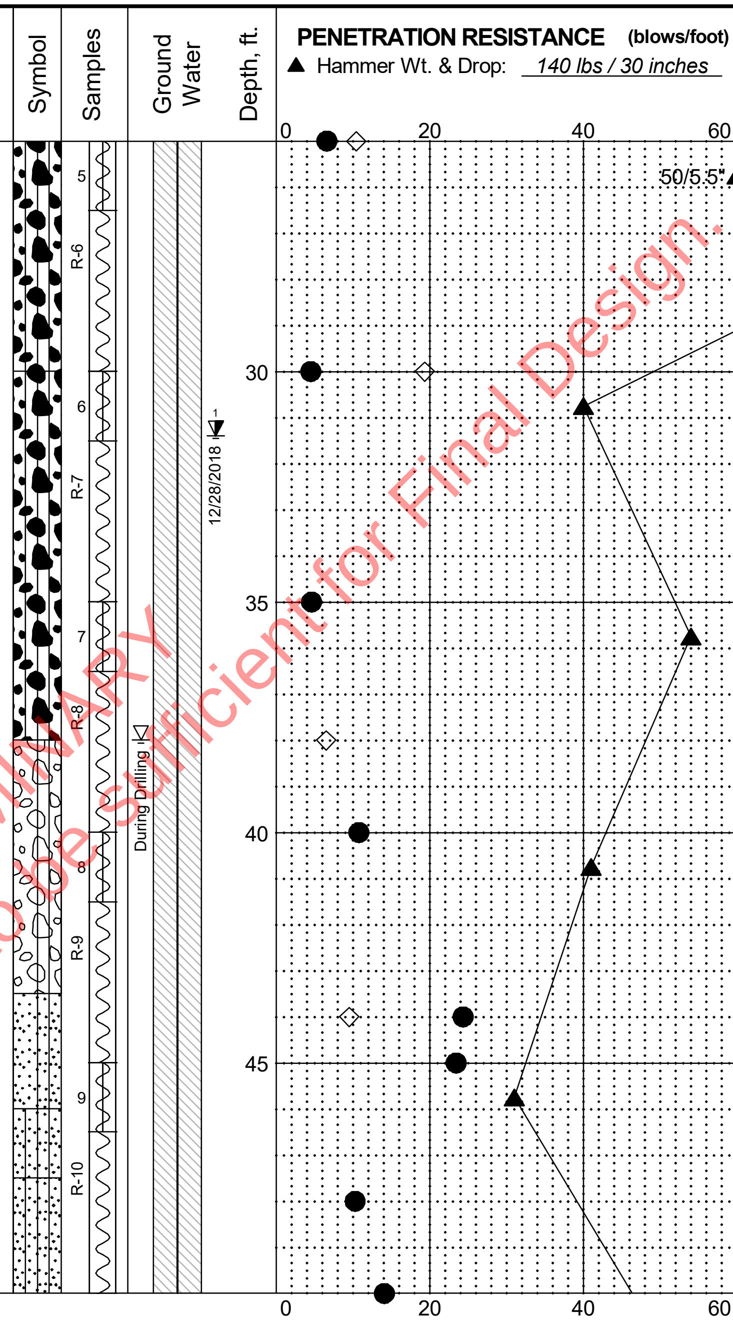
REV 3 - Approved for Submittal

Total Depth:	*101.5 ft.*	Northing:	*~ 94,732 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 45 ft.*	Easting:	*~ 1,170,089 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	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 material types, and the transition may be gradual.

Soil Description	Depth, ft.
Silt, Sand, and Cobbles (GP-GM); moist; little subrounded cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic. (Qfg)	30.0
Dense to very dense, gray-brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few subrounded cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	38.0
Dense, brown, *Poorly Graded Gravel with Silt, Sand, and Cobbles (GP-GM)* to *Silty Gravel with Sand and Cobbles (GM)*; wet; few subrounded cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	43.5
Dense, brown, *Poorly Graded Sand with Silt (SP-SM)*; wet; fine to medium sand; nonplastic; iron oxide staining in places. (Qa)	46.0
Dense, brown, *Silty Sand (SM)*; moist; trace fine to coarse gravel; fine to medium sand; nonplastic. (Qa)	47.5



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-1P-18

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FIG. A-1
Sheet 2 of 5

REV 3 - Approved for Submittal

MASTER_LOG_E 101835.GPJ SHAN_WIL.GDT 10/22/21 Log: JXS Rev: EAS Typ: LKN

Total Depth:	*101.5 ft.*	Northing:	*~ 94,732 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 45 ft.*	Easting:	*~ 1,170,089 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	Offset:	*~*	Other Comments:			

SOIL DESCRIPTION

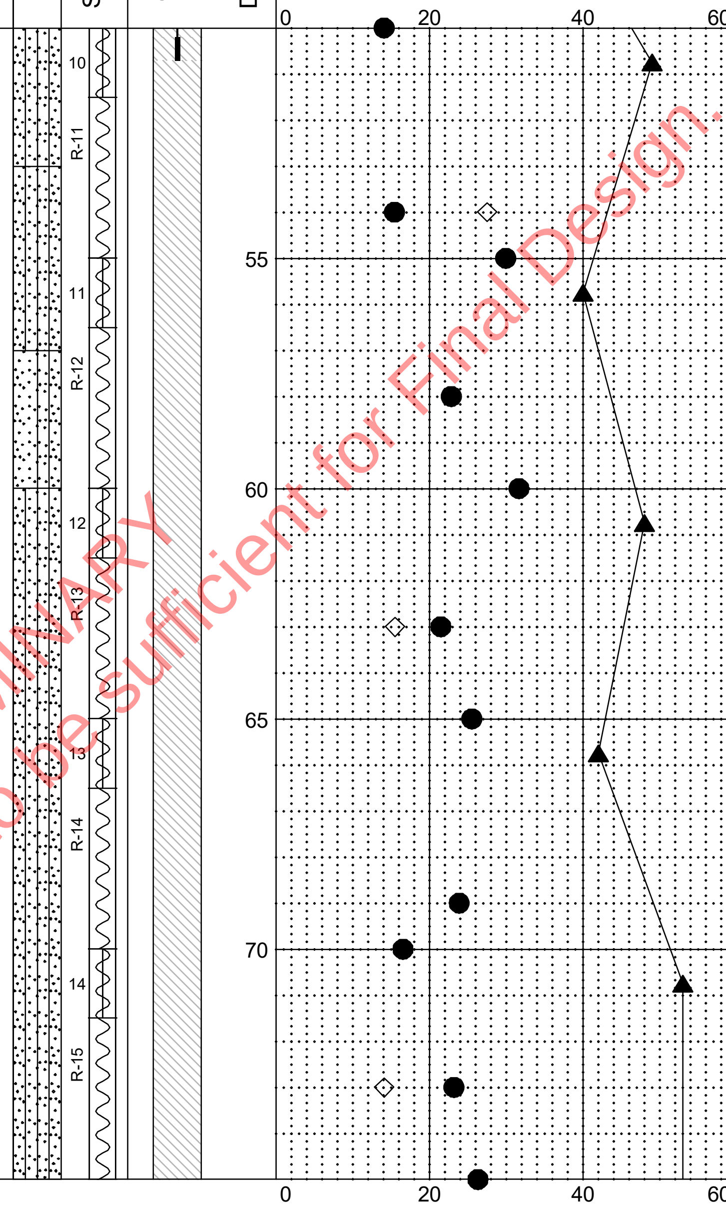
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

Soil Description	Depth, ft.
Dense, gray-brown, *Silty Sand with Gravel (SM)*; moist; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic; diamict; few seams with iron oxide staining. (Qa) - Layer of silty sand from 51.5 to 52 feet.	53.0
Dense, brown, *Silty Sand (SM)*; wet; trace fine, subrounded gravel; fine to medium sand; nonplastic. (Qa)	57.0
Dense, brown, *Poorly Graded Sand with Silt (SP-SM)*; wet; fine to medium sand; nonplastic; few seams with iron oxide staining. (Qa)	60.0
Dense, brown, *Silty Sand (SM)*; wet; trace fine gravel; fine to medium sand; nonplastic; few seams with iron oxide staining. (Qa)	



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-1P-18

October 2021 101835-202

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FIG. A-1

REV 3 - Approved for Submittal

Total Depth:	101.5 ft.	Northing:	~ 94,732 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 45 ft.	Easting:	~ 1,170,089 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	Offset:	~	Other Comments:			

SOIL DESCRIPTION

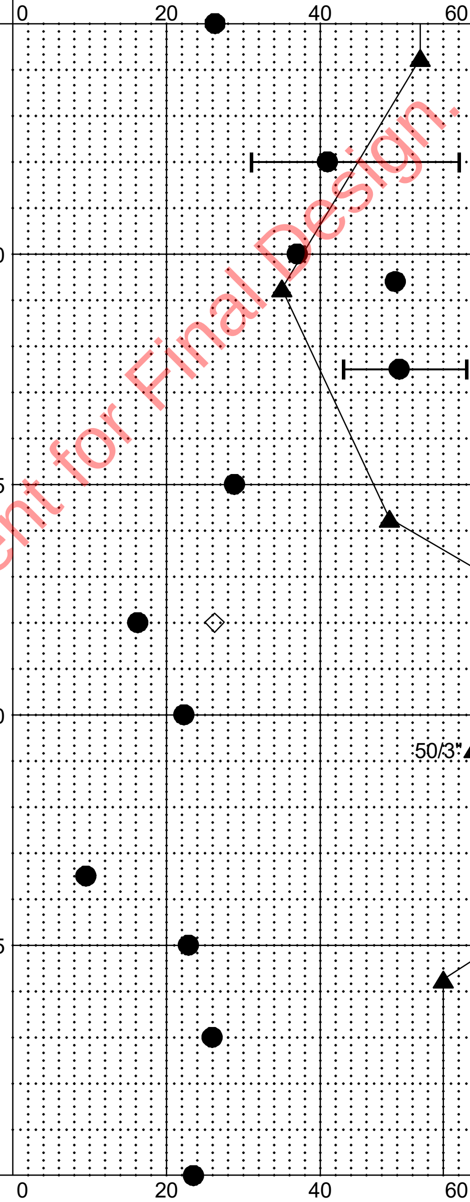
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Hard, gray *Elastic Silt (MH)*; moist; trace fine sand; low to medium plasticity; laminated. (Qa)	75.0	15, R-16
Hard, brown *Elastic Silt with Sand (MH)*; moist; fine sand; low to medium plasticity. (Qa)	80.0	16, R-17
Dense to very dense, brown, *Silty Sand (SM)*; few fine to coarse, subrounded gravel; fine to coarse sand; nonplastic; few seams with iron oxide staining. (Qa) - Seam of wet, poorly graded sand at 86 feet. - Layer of silty gravel with sand from 90.5 to 91 feet. - Layer of silty gravel with sand at 92 feet.	85.0	17, R-18, 18
Very dense, gray, *Silty Gravel (GM)*; moist; fine to coarse, subangular gravel; few fine to coarse sand; nonplastic to low plasticity. (Qa)	92.5	R-19
Very dense, gray, *Poorly Graded Sand (SP)*; wet; fine to medium sand; trace nonplastic; trace organics. (Qa) - Silty sand seam at 98 feet. - Trace gravel below 99 feet.	95.0	19, R-20

CONTINUED NEXT SHEET

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-1P-18

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 4 of 5

REV 3 - Approved for Submittal

Total Depth:	*101.5 ft.*	Northing:	*~ 94,732 ft.*	Drilling Method:	*Sonic Core*
Top Elevation:	*~ 45 ft.*	Easting:	*~ 1,170,089 ft.*	Drilling Company:	*Holt Services*
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*
Horiz. Datum:	*WA S US FT*	Offset:	*~*	Other Comments:	

Hole Diam.: *4 in.*
Rod Diam.:
Hammer Type: *Automatic*

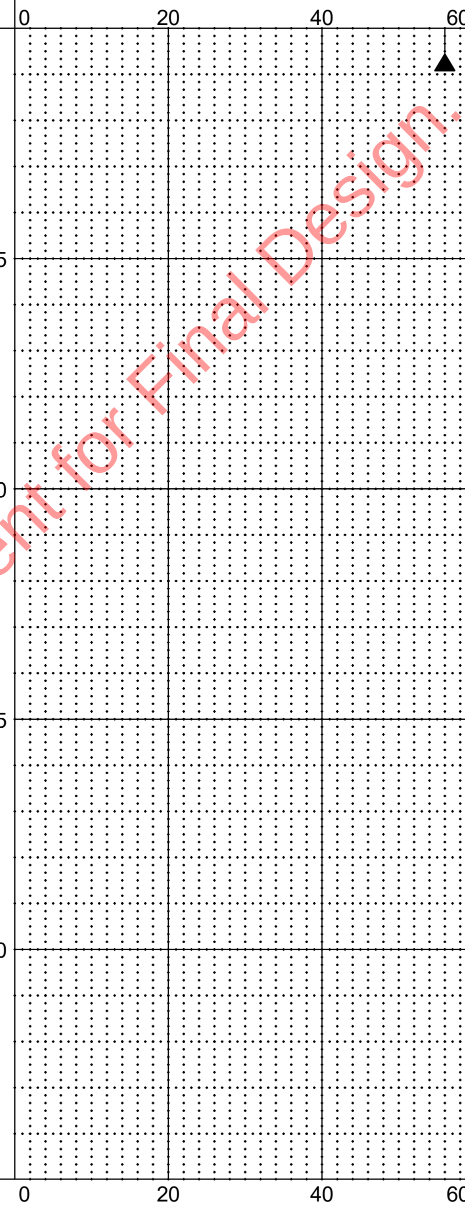
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
			20		
BOTTOM OF BORING COMPLETED 10/12/2018	101.5				

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ⊢●⊣ Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-1P-18

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 5 of 5

REV 3 - Approved for Submittal

Log: JXS Rev: EAS Typ: LKN

MASTER_LOG_E 101835.GPJ SHAN_WIL.GDT 10/22/21

Total Depth:	96.4 ft.	Northing:	~ 94,581 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 40 ft.	Easting:	~ 1,170,054 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	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 material types, and the transition may be gradual.

Brown, *Silty Gravel with Sand, Cobbles, and Boulders (GM)*; moist; boulders 2 to 3 feet in diameter from 3 to 5 feet below ground surface; few cobbles; fine to coarse, subrounded gravel; fine to coarse sand; low plasticity.
(Hf)

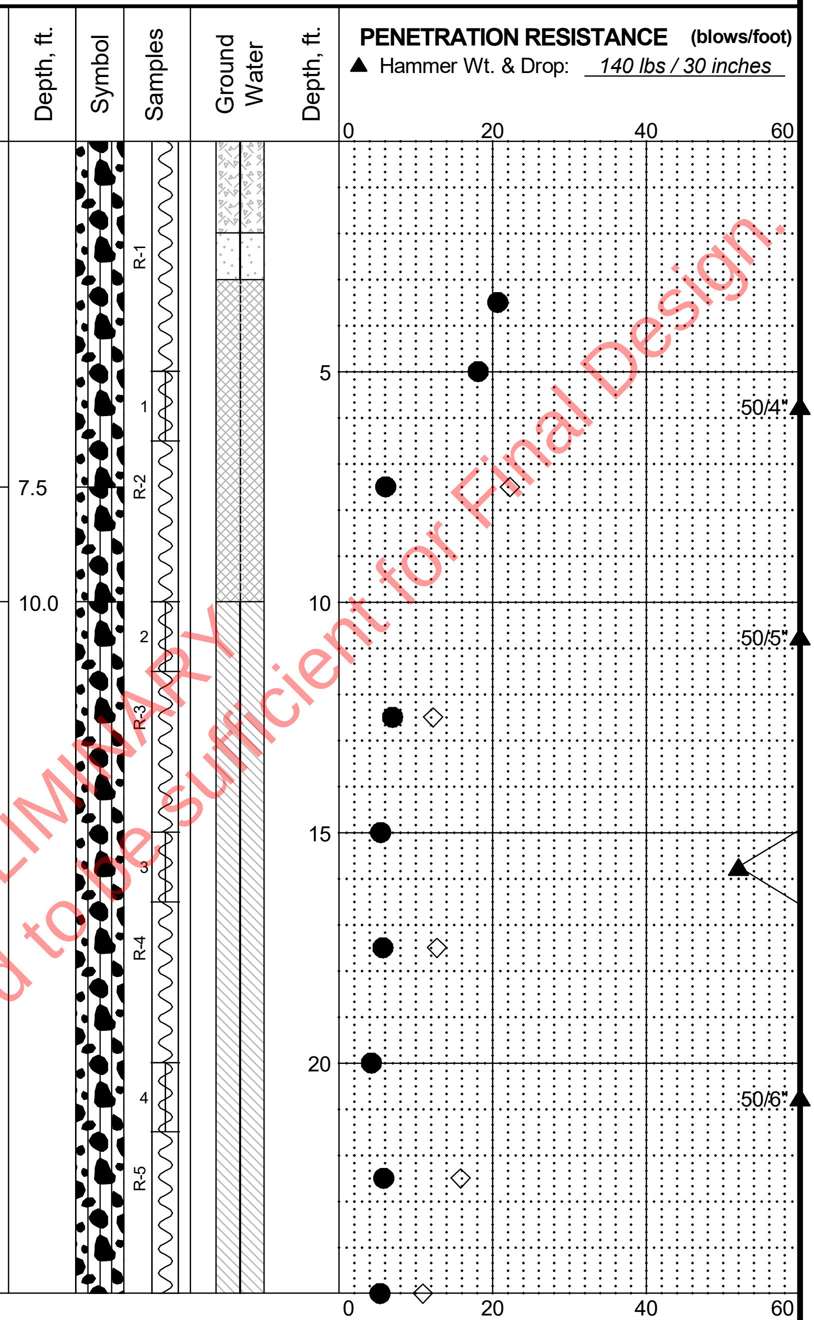
7.5

Very dense, red-brown to brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; little cobbles; fine to coarse, subangular gravel; fine to coarse sand; nonplastic.
(Qfg)

10.0

Very dense, gray-brown, *Silty Gravel with Sand (GM)* to *Poorly Graded Gravel with Silt (GP-GM)*; moist; fine to coarse, subangular gravel; fine to coarse sand; low plasticity.
(Qfg)

- Trace to few cobbles below 16 feet.



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-2P-18

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 1 of 4

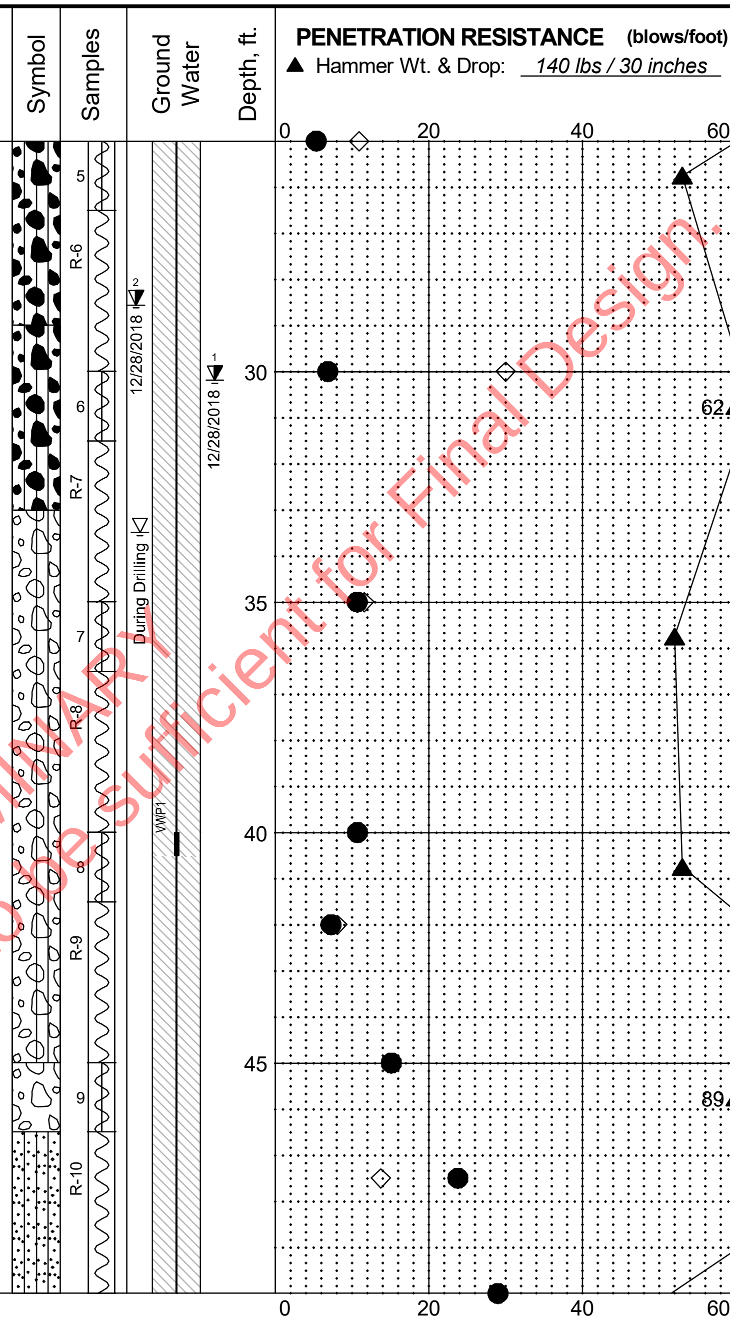
REV 3 - Approved for Submittal

Total Depth:	*96.4 ft.*	Northing:	*~ 94,581 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 40 ft.*	Easting:	*~ 1,170,054 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	~	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	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 material types, and the transition may be gradual.

Soil Description	Depth, ft.
Very dense, brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	29.0
Very dense, brown, *Poorly Graded Gravel with Silt, Sand, and Cobbles (GP-GM)* to *Silty Gravel with Sand and Cobbles (GM)*; wet; trace subrounded cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic. (Qfg)	33.0
Dense, brown, *Poorly Graded Gravel (GP)*; wet; fine, subrounded gravel; fine to medium sand; trace silt; nonplastic. (Qfg)	45.0
Brown, *Silty Sand with Gravel (SM)*; wet; few, fine to coarse gravel; fine to coarse sand; nonplastic.	46.5



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-2P-18

October 2021 — 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 2 of 4

REV 3 - Approved for Submittal

Total Depth:	96.4 ft.	Northing:	~ 94,581 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 40 ft.	Easting:	~ 1,170,054 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	Offset:	~	Other Comments:			

SOIL DESCRIPTION

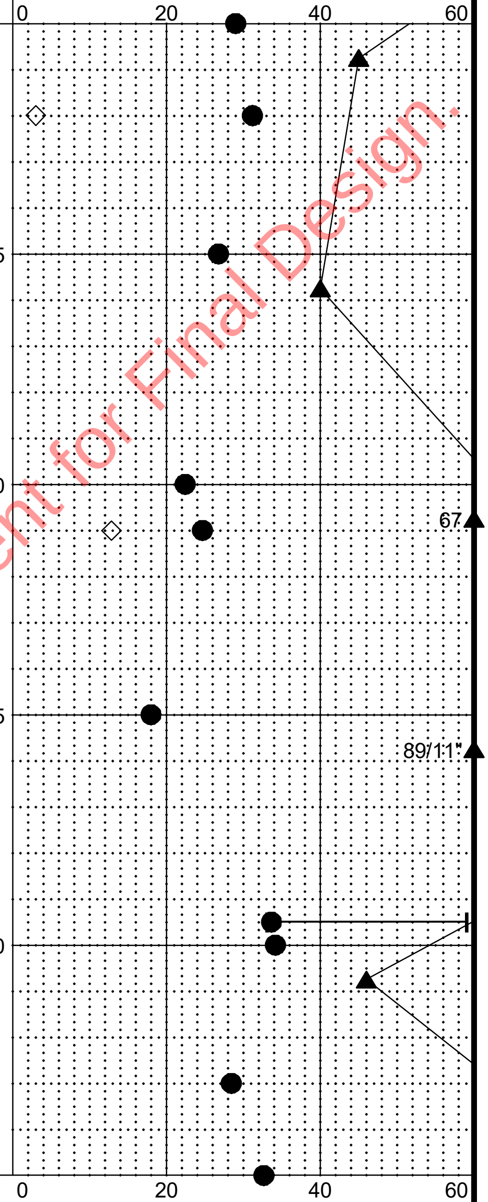
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
(Qfg)	50.0	10
Dense to very dense, brown, *Poorly Graded Sand (SP)*; wet; fine to medium sand; trace nonplastic fines; few silty sand seams; trace laminations with oxidation staining. (Qa)		R-11
- Trace subangular gravel at 56.5 feet.		11, R-12
- Few silt seams below 60 feet.		12, R-13
- Layer of poorly graded gravel with sand with iron oxide staining from 66.5 to 67.3 feet.		13
Hard, gray *Elastic Silt (MH)*; moist; trace fine sand; low to medium plasticity; laminated. (Qa)	67.3	R-14
- Iron oxide staining from 67.5 to 68 feet.		14
- Few silty, fine sand seams below 72 feet.		R-15
Gray, *Poorly Graded Sand (SP)*; moist; fine to medium sand; trace nonplastic fines. (Qa)	73.0	
	74.5	

Ground Water: VWP2

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-2P-18

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 3 of 4

MASTER_LOG_E 101835.GPJ SHAN WIL.GDT 10/22/21 Log: JXS Rev: EAS Typ: LKN

REV 3 - Approved for Submittal

Total Depth:	96.4 ft.	Northing:	~ 94,581 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 40 ft.	Easting:	~ 1,170,054 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	Offset:	~	Other Comments:			

SOIL DESCRIPTION

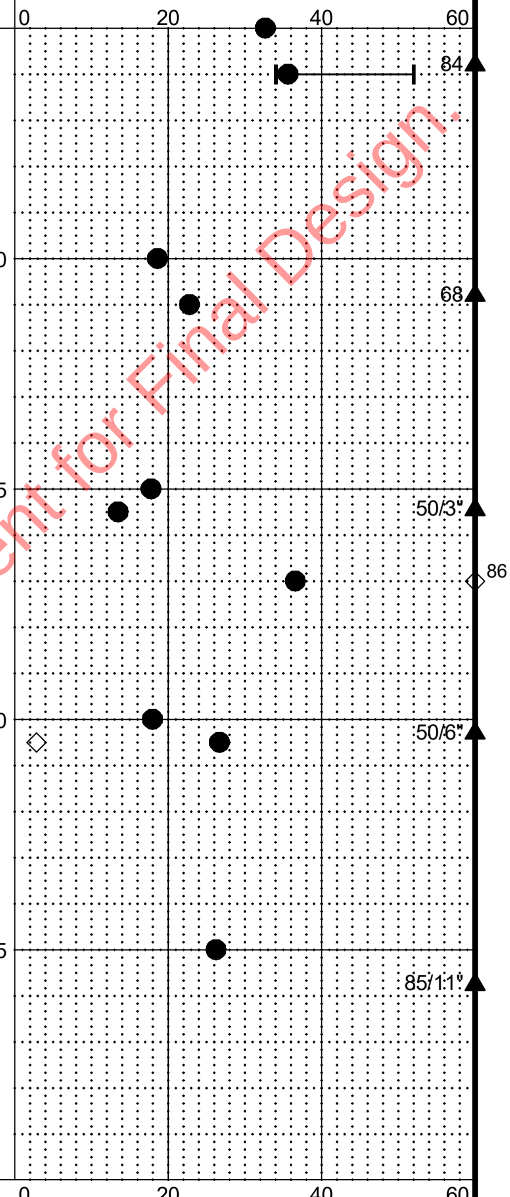
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Gray *Elastic Silt (MH)* to *Elastic Silt with Sand (MH)*; moist; fine sand; low to medium plasticity. (Qa)	77.1	15, R-16
Very dense, brown, *Poorly Graded Sand (SP)* to *Poorly Graded Sand with Silt (SP-SM)*; wet; fine to medium sand; nonplastic. (Qa) - Few fine to coarse gravel below 86 feet. - Iron oxide staining at 86.4 feet.	86.5	17, R-17, 18
Gray *Silt (ML)*; moist; trace fine sand; nonplastic to low plasticity. (Qa)	88.8	R-18
Brown, *Poorly Graded Sand (SP)*; moist to wet; trace fine gravel; fine to medium sand; nonplastic; few silty sand seams; few seams with iron oxide staining. (Qa)	96.4	19, R-19, 20
BOTTOM OF BORING COMPLETED 10/4/2018		

Symbol | Samples | Ground Water | Depth, ft.: 80, 85, 90, 95

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit |—●—| Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SC-2P-18

October 2021 — 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 4 of 4

REV 3 - Approved for Submittal

Total Depth:	*81.4 ft.*	Northing:	*~ 94,611 ft.*	Drilling Method:	*Sonic Core*
Top Elevation:	*~ 38 ft.*	Easting:	*~ 1,169,983 ft.*	Drilling Company:	*Holt Services*
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*
Horiz. Datum:	*WA S US FT*	Offset:	*~*	Other Comments:	

Hole Diam.:	*4 in.*
Rod Diam.:	
Hammer Type:	*Automatic*

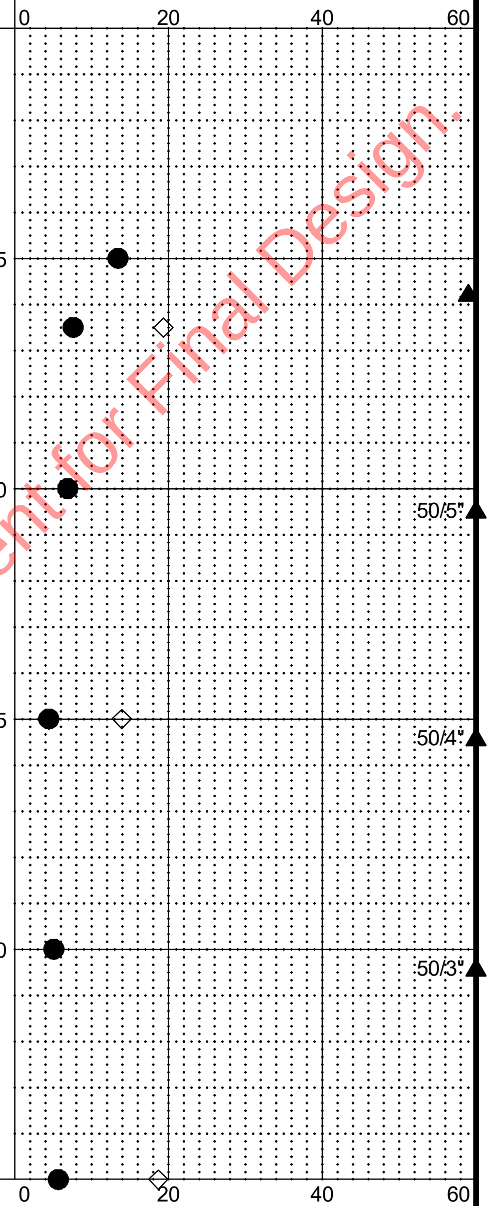
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Potholed to 3 feet, no samples were collected to 5 feet.		
Very dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few cobbles; fine to coarse, subangular to angular gravel; fine to coarse sand; nonplastic; trace organics. (Qfg) -Some cobbles from 10 to 14 feet.	5.0	1, R-1, 2, R-2, 3, R-3
Very dense, brown to orange-brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded to subangular gravel; fine to coarse sand; low to medium plasticity; oxidized (Qfg)	19.0	
Very dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; little cobbles; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity; .	20.0	4, R-4

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Soil Core (as in Sonic Core Borings)
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-5p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 1 of 4

REV 3 - Approved for Submittal

Total Depth:	81.4 ft.	Northing:	~ 94,611 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 38 ft.	Easting:	~ 1,169,983 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	Offset:	~	Other Comments:			

SOIL DESCRIPTION

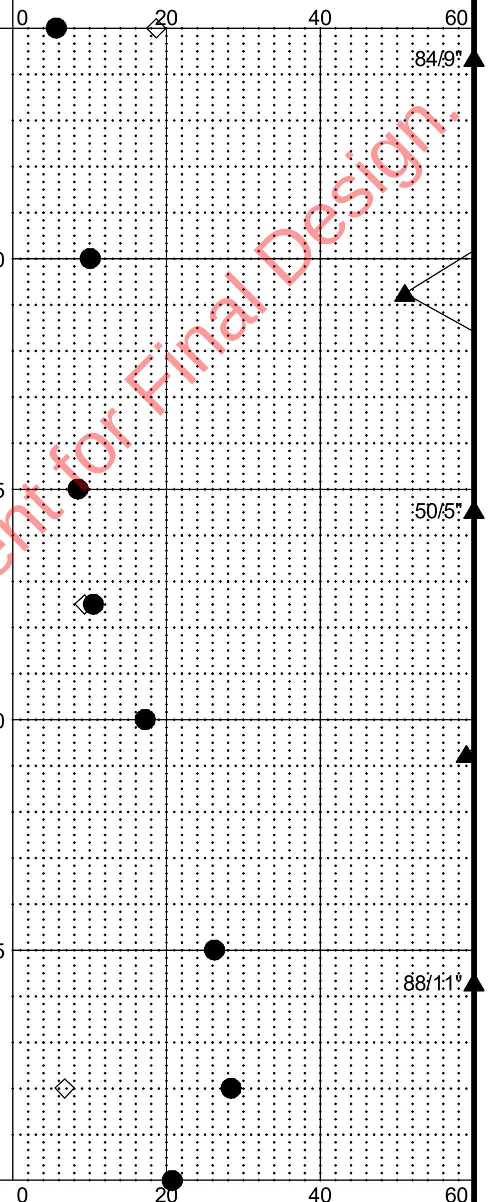
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
(Qfg)		5, R-5
Very dense, brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet; fine to coarse, subangular to angular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	27.5	
Very dense, brown, *Silty Sand with Gravel (SM)* to *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded to angular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	30.0	6, R-6
Very dense, brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	32.5	
Very dense, brown, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)*; wet; few cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic. (Qfg)	35.0	7, R-7
Very dense, brown to orange-brown, *Poorly Graded Sand with Silt (SP-SM)*; wet; trace fine, subrounded gravel; fine to medium sand; nonplastic; few oxidized pockets. (Qa) -Layer of silty gravel with sand from 41.5 to 42.5 feet.	41.0	8, R-8
Very dense, brown, *Silty Gravel with Sand (GM)*; wet; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic to low plasticity; few oxidized pockets. (Qfg)	45.0	9, R-9
	48.0	

Ground Water: 9/29/2021 (at 30 ft.); During Drilling (at 35 ft.)

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Soil Core (as in Sonic Core Borings)
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-5p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 2 of 4

REV 3 - Approved for Submittal

Total Depth:	*81.4 ft.*	Northing:	*~ 94,611 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 38 ft.*	Easting:	*~ 1,169,983 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	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 material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

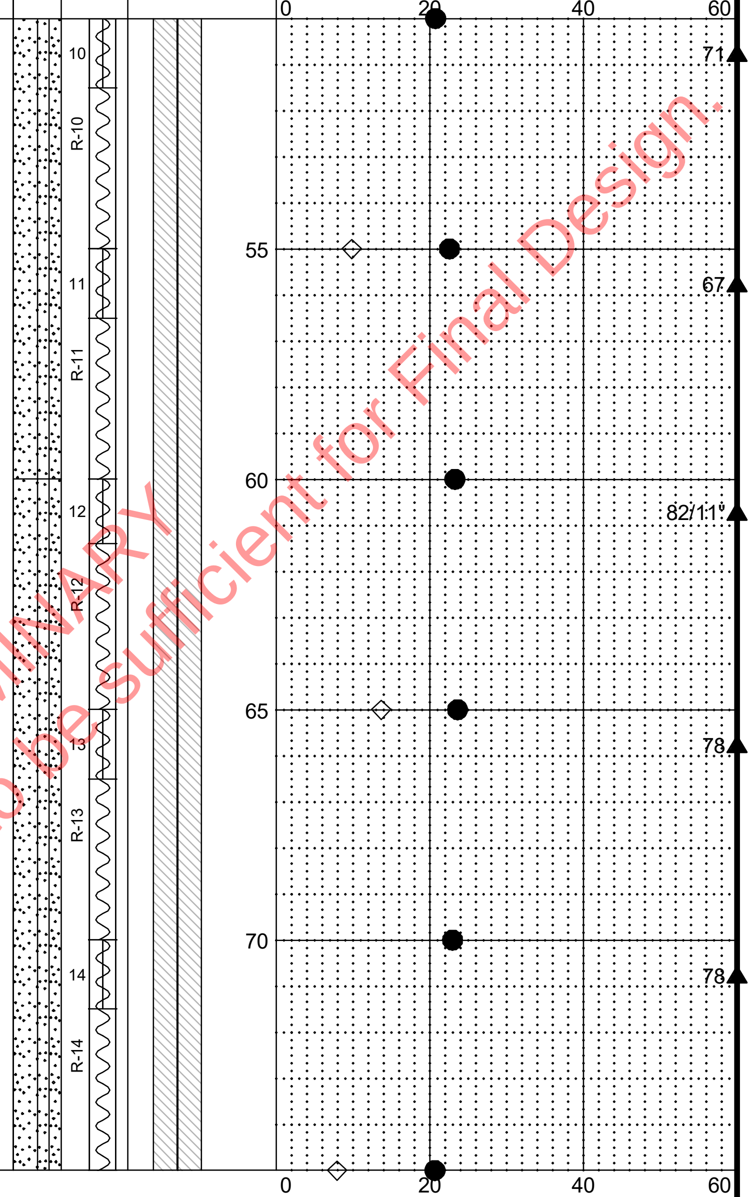
PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

Very dense, brown, *Poorly Graded Sand with Silt (SP-SM)*; wet; trace fine, subrounded gravel; fine to medium sand; nonplastic; trace iron-oxide staining.
(Qa)

60.0

Very dense, brown, *Poorly Graded Sand with Silt (SP-SM)* to *Silty Sand (SM)*; wet; trace fine, subrounded gravel; fine to medium sand; nonplastic.
(Qa)



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Soil Core (as in Sonic Core Borings)
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-5p-21

October 2021 — 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 3 of 4

REV 3 - Approved for Submittal

MASTER_LOG_E 101835.GPJ SHAN_WIL.GDT 10/22/21 Log: RAW Rev: EAS Typ: EAS

Total Depth:	81.4 ft.	Northing:	~ 94,611 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 38 ft.	Easting:	~ 1,169,983 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	Offset:	~	Other Comments:			

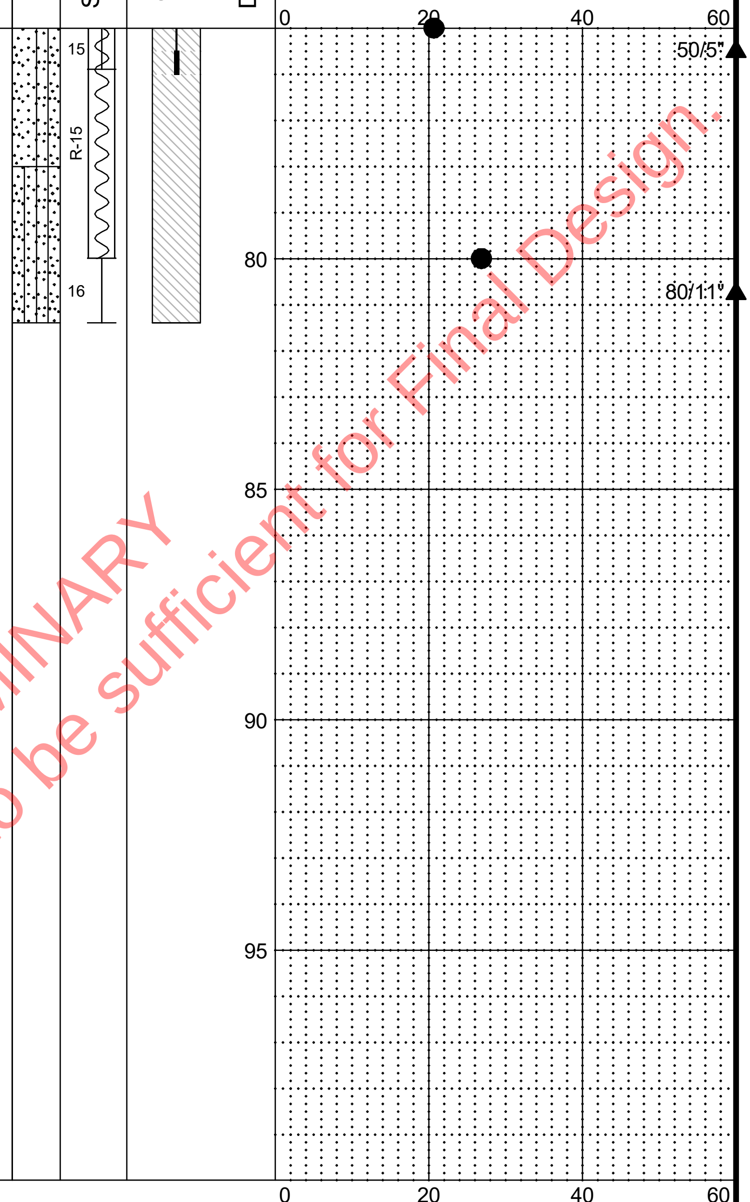
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
		15
Very dense, brown and orange-brown, *Silty Sand (SM)*; moist; trace fine, subrounded to subangular gravel; fine to medium sand; nonplastic; iron-oxided staining. (Qa)	78.0	R-15
BOTTOM OF BORING COMPLETED 6/14/2021	81.4	16

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Soil Core (as in Sonic Core Borings)
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-5p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 4 of 4

REV 3 - Approved for Submittal

Log: RAW Rev: EAS Typ: EAS

MASTER_LOG_E 101835.GPJ SHAN_WIL.GDT 10/22/21

Total Depth:	*61.5 ft.*	Northing:	*~ 94,917 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 46 ft.*	Easting:	*~ 1,169,852 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	Offset:	*~*	Other Comments:			

SOIL DESCRIPTION

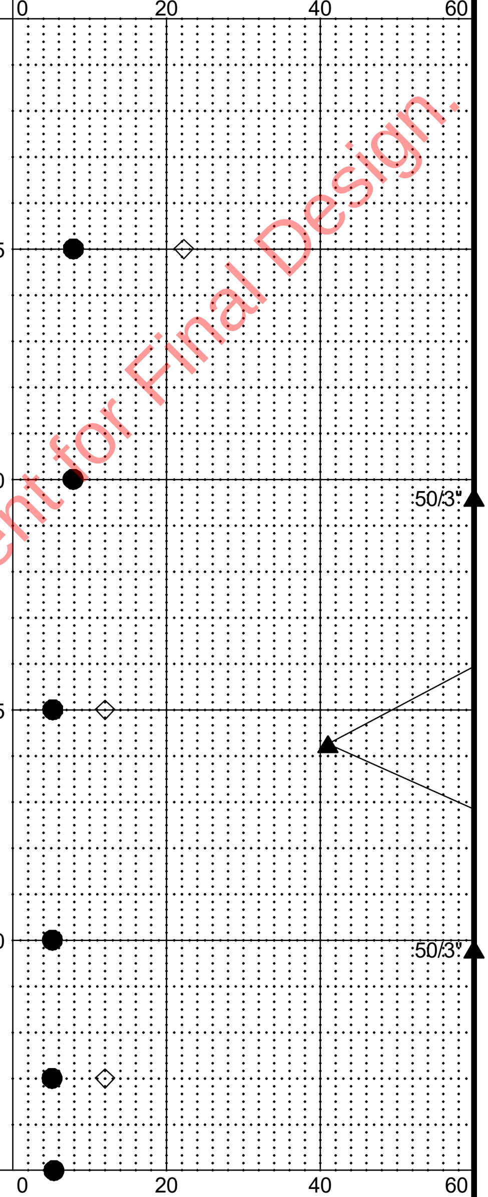
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Potholed to 5 feet, no samples were collected.		
Very dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few cobbles; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	5.0	R-1, 1, R-2, 2, R-3, 3, R-4
Very dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few cobbles; fine to coarse, subrounded to angular gravel; fine to	23.0	

CONTINUED NEXT SHEET

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-6p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-4
Sheet 1 of 3

REV 3 - Approved for Submittal

Total Depth:	*61.5 ft.*	Northing:	*~ 94,917 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 46 ft.*	Easting:	*~ 1,169,852 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	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 material types, and the transition may be gradual.

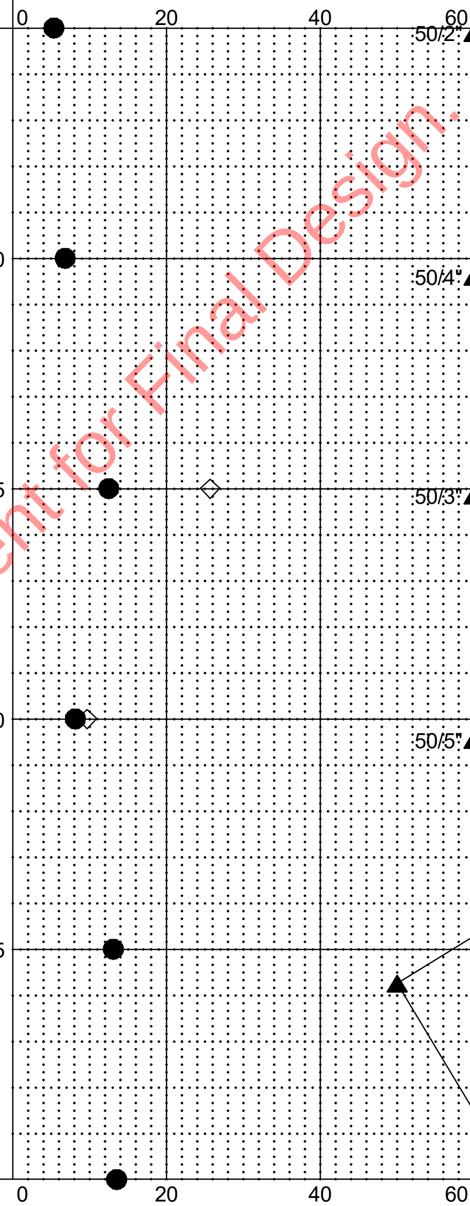
Soil Description	Depth, ft.
coarse sand; nonplastic to low plasticity. (Qfg)	
Very dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few cobbles; fine to coarse, subrounded to angular gravel; fine to coarse sand; nonplast6ic to low plasticity. (Qfg)	30.0
Very dense, gray-brown, *Clayey Gravel with Sand (GC)*; wet; fine to coarse, subrounded to angular gravel; fine to coarse sand; low to medium plasticity. (Qfg)	35.0
Very dense, gray-brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet; fine to coarse, subrounded to angular gravel; fine to coarse sand; nonplastic. (Qfg)	40.0
Very dense, gray-brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic. (Qfg)	45.0 / 46.0 / 47.0
Very dense, gray-brown, *Poorly Graded Sand with Silt (SP-SM)* to *Silty Sand (SM)*; wet; fine to	49.0

Samples: 4, R-5, 5, R-6, 6, R-7, 7, R-8, 8, R-9

Ground Water: During Drilling; 9/29/2021

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-6p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-4
Sheet 2 of 3

REV 3 - Approved for Submittal

Total Depth:	*61.5 ft.*	Northing:	*~ 94,917 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 46 ft.*	Easting:	*~ 1,169,852 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	Offset:	*~*	Other Comments:			

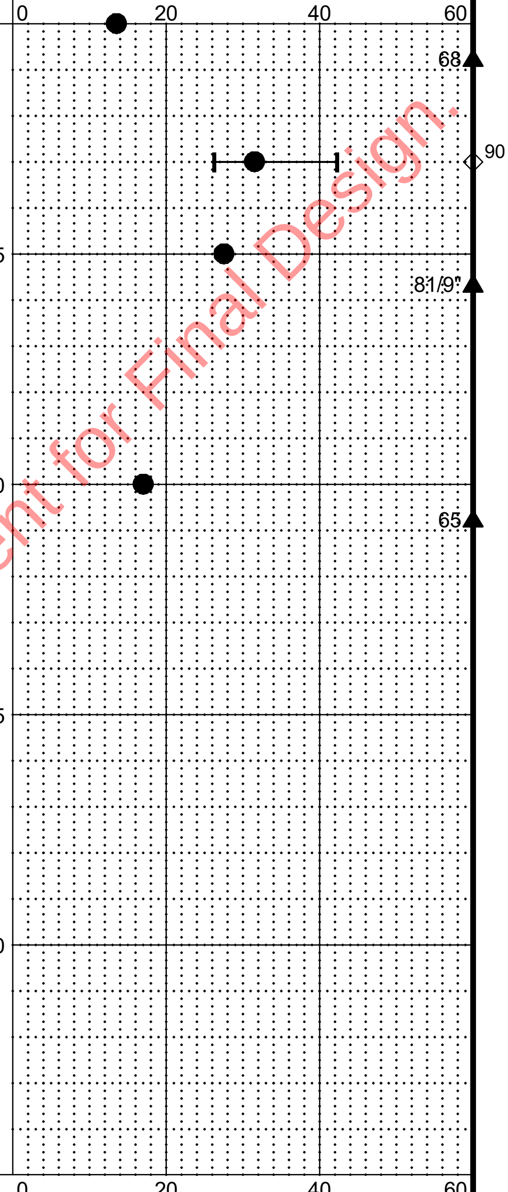
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

Soil Description	Depth, ft.	Samples
medium sand; nonplastic. (Qa)		9
Very dense, brown, *Silty Gravel with Sand (GM)*; wet; finet o coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	53.0	R-10
Very dense, brown, *Silty Sand (SM)*; wet; trace fine, subrounded gravel; fine to medium sand; nonplastic. (Qa)	55.0	10, R-11
Very dense, brown, *Silt (ML)*; moist; few fine sand; nonplastic to low plasticity; trace iron-oxide staining. (Qa)		11
Very dense, brown to orange-brown, *Silty Gravel with Sand (GM)* to *Silty Sand with Gravel (SM)*; moist to wet; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity; trace iron-oxide staining. (Qa)	61.3	



BOTTOM OF BORING
COMPLETED 6/10/2021

NOTE: While backfilling the driller pumped 13 batches of bentonite cement grout (94 lbs of cement, 1/4 bag of bentonite gel, and 35 gallons of water) into the boring. The grout did not rise above approximately 37 feet bgs. In order to complete the boring the driller subsequently backfilled the boring from approximately 37 feet to 1 foot bgs with bentonite chips.

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-6p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-4
Sheet 3 of 3

REV 3 - Approved for Submittal

Total Depth:	81.5 ft.	Northing:	~ 94,990 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 45 ft.	Easting:	~ 1,170,048 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	Offset:	~	Other Comments:			

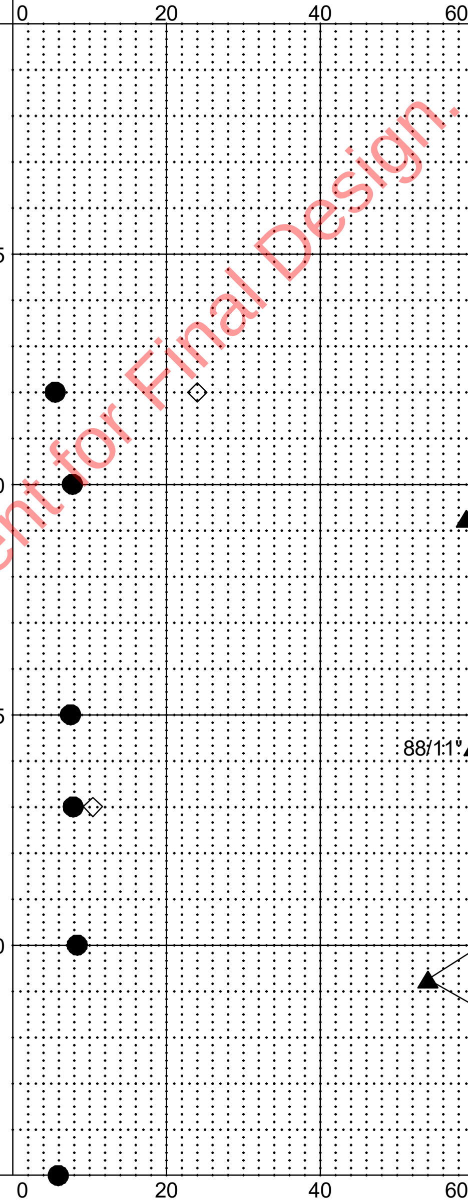
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Potholed to 5 feet, no samples were collected.		
Very dense, brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	5.0	R-1
Very dense, brown, *Silty Gravel with Sand (GM)* to *Clayey Gravel with Sand (GC)*; moist; fine to coarse, subangular to angular gravel; fine to coarse sand; low to medium plasticity; trace iron-oxide staining. (Qfg)	10.0	1, R-2
Very dense, brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	14.0	2
Very dense, brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; moist; fine to coarse, subangular to angular gravel; medium to coarse sand; low plasticity. (Qfg) -Layer of dry, oxidized silty gravel with sand from 20 to 21 feet.	17.0	R-3, 3, R-4
Very dense, brown to red-brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse,	23.5	

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



◇ % Fines (<0.075mm)
● % Water Content

CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-8p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-5
Sheet 1 of 4

REV 3 - Approved for Submittal

MASTER_LOG_E 101835.GPJ SHAN WIL.GDT 10/22/21 Log: RAW Rev: EAS Typ: EAS

Total Depth:	*81.5 ft.*	Northing:	*~ 94,990 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 45 ft.*	Easting:	*~ 1,170,048 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	~	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	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 material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

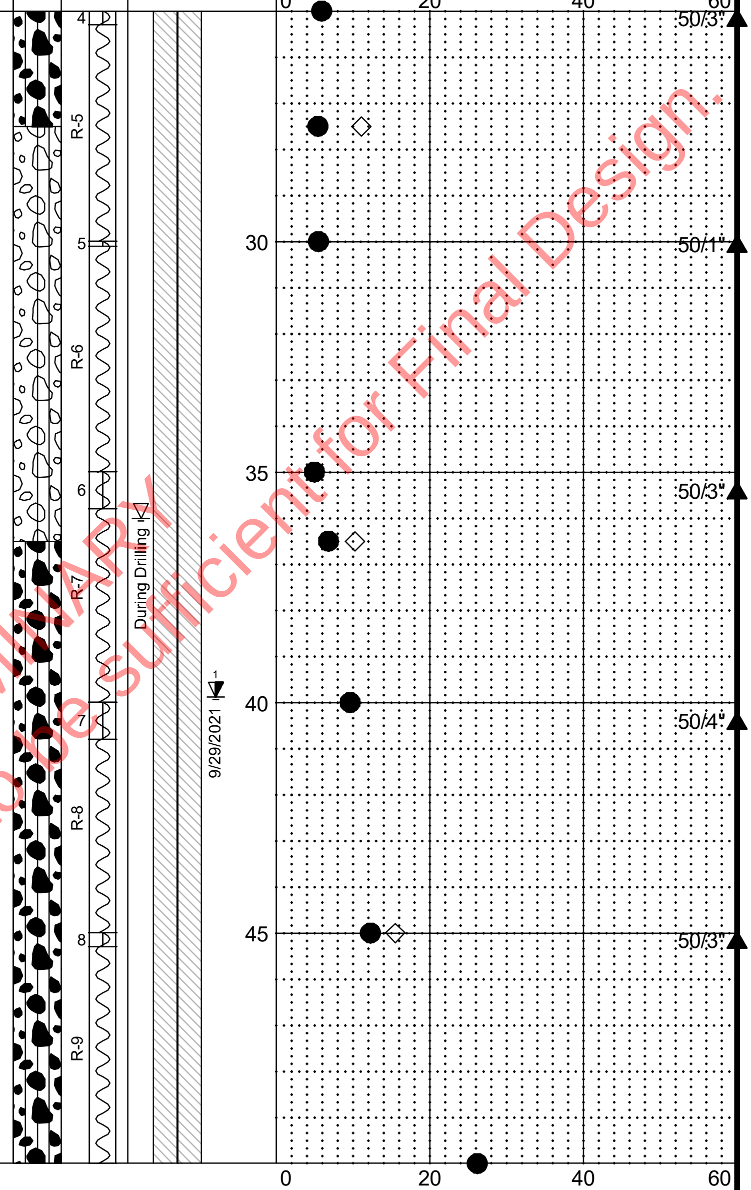
subangular to angular gravel; fine to coarse sand; nonplastic; oxidized.
(Qfg)

27.5

Very dense, brown, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)*; moist; few cobbles; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity.
(Qfg)

36.5

Very dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; wet; few to little cobbles; fine to coarse, subrounded to subangular gravel; fine to coarse sand; low to medium plasticity.
(Qfg)



◇ % Fines (<0.075mm)
● % Water Content

CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-8p-21

October 2021 | 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-5

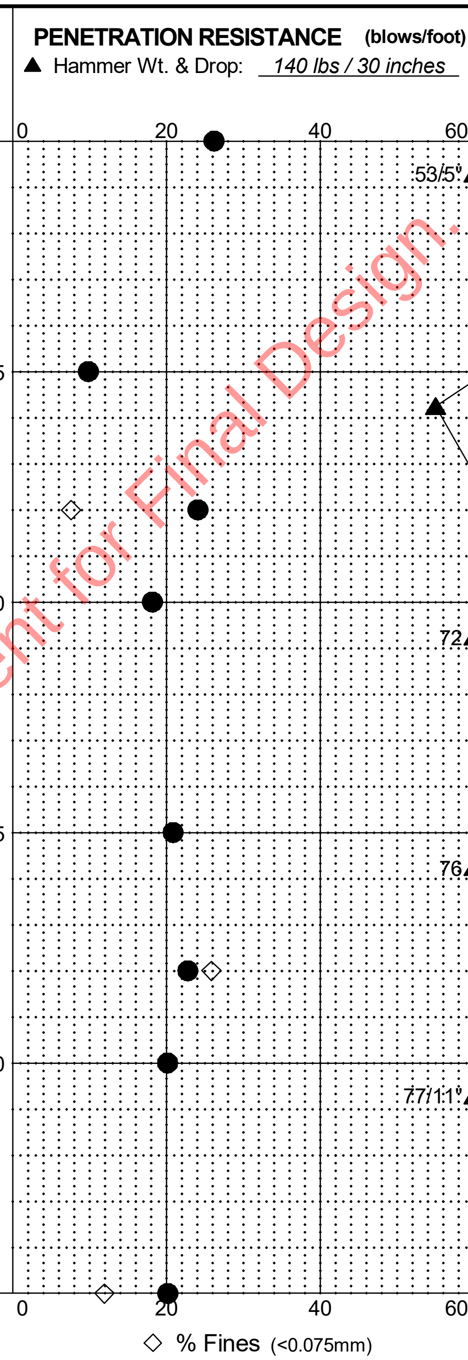
REV 3 - Approved for Submittal

Total Depth:	81.5 ft.	Northing:	~ 94,990 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 45 ft.	Easting:	~ 1,170,048 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Very dense, brown, *Poorly Graded Sand with Silt (SP-SM)* to *Poorly Graded Sand (SP)*; wet; trace fine to coarse, subangular gravel; fine to coarse sand; nonplastic. (Qa)	50.0	9
	51.5	R-10
Very dense, gray-brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrangular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)	54.0	
	55.0	10
Very dense, brown to yellow-brown, *Silty Sand with Gravel (SM)*; moist to wet; fine to coarse, subangular gravel; fine to coarse sand; nonplastic to low plasticity; oxidized. (Qfg)	57.0	R-11
Very dense, brown to orange-brown, *Silty Sand with Gravel (SM)*; moist to wet; fine to coarse, subangular gravel; fine to medium sand; nonplastic; iron-oxide staining. (Qa)		11, R-12
Very dense, orange-brown, *Silty Sand (SM)* to *Poorly Graded Sand with Silt (SP-SM)*; wet; trace fine to coarse, subangular gravel; fine to medium sand; nonplastic; iron-oxide staining. (Qa) -Changes from orange-brown to brown at 65 feet.		12, R-13, 13
Very dense, orange-brown and brown, *Silty Sand (SM)* to *Poorly Graded Sand with Silt (SP-SM)*; wet; fine to medium sand; nonplastic;	72.5	R-14



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-8p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-5
Sheet 3 of 4

REV 3 - Approved for Submittal

Total Depth:	*81.5 ft.*	Northing:	*~ 94,990 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*4 in.*
Top Elevation:	*~ 45 ft.*	Easting:	*~ 1,170,048 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*	Hammer Type:	*Automatic*
Horiz. Datum:	*WA S US FT*	Offset:	*~*	Other Comments:			

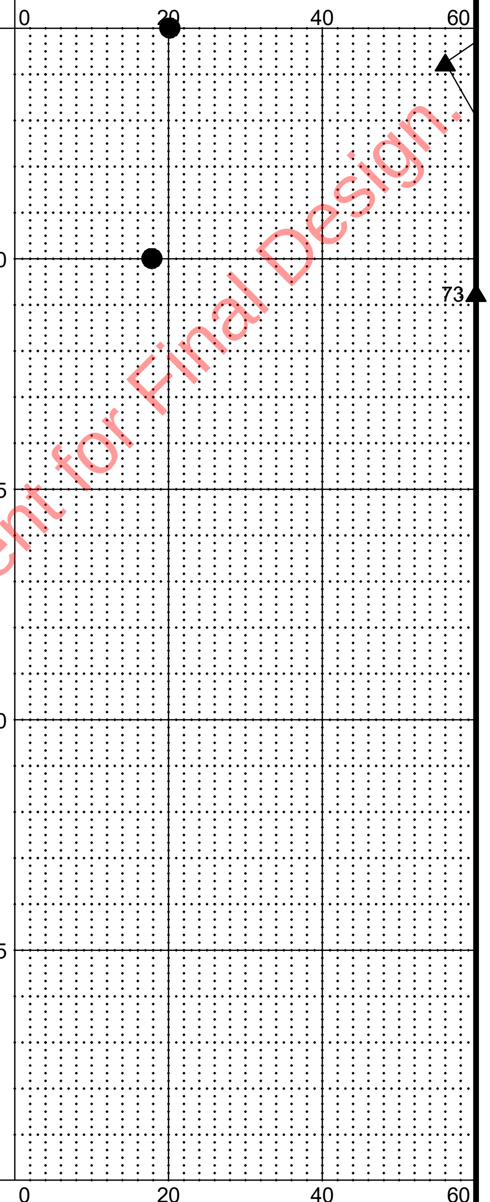
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
iron-oxide staining. (Qa)		14, R-15, 15
BOTTOM OF BORING COMPLETED 6/9/2021	81.5	

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)
● % Water Content

LEGEND

* Sample Not Recovered
Soil Core (as in Sonic Core Borings)
2.0" O.D. Split Spoon Sample
Well Screen and Sand Filter
Bentonite-Cement Grout
Bentonite Chips/Pellets
Bentonite Grout
Ground Water Level ATD
Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-8p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-5
Sheet 4 of 4

REV 3 - Approved for Submittal

Total Depth:	*61.3 ft.*	Northing:	*~ 94,777 ft.*	Drilling Method:	*Sonic Core*
Top Elevation:	*~ 42 ft.*	Easting:	*~ 1,170,234 ft.*	Drilling Company:	*Holt Services*
Vert. Datum:	*NAD83*	Station:	*~*	Drill Rig Equipment:	*Terra Sonic*
Horiz. Datum:	*WA S US FT*	Offset:	*~*	Other Comments:	

Hole Diam.:	*4 in.*
Rod Diam.:	
Hammer Type:	*Automatic*

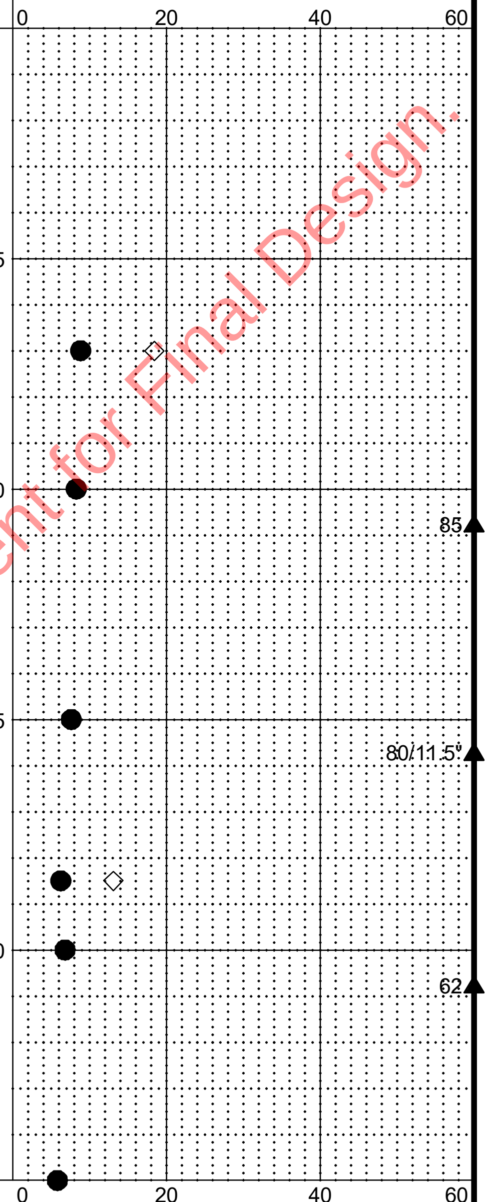
SOIL DESCRIPTION

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 material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Asphalt.	0.3	
Concrete.	1.0	
Potholed to 7 feet, no samples were collected.		
Very dense, brown to orange-brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few to little cobbles; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticitiy; few pockets with iron-oxide staining; trace organics. (Qfg)	7.0	R-1, 1, R-2, 2, R-3, 3, R-4

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)
● % Water Content

CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered
Soil Core (as in Sonic Core Borings)
2.0" O.D. Split Spoon Sample
Well Screen and Sand Filter
Bentonite-Cement Grout
Bentonite Chips/Pellets
Bentonite Grout
Ground Water Level ATD
Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-10p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-6
Sheet 1 of 3

REV 3 - Approved for Submittal

Total Depth:	61.3 ft.	Northing:	~ 94,777 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 42 ft.	Easting:	~ 1,170,234 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	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 material types, and the transition may be gradual.

Very dense, brown, *Silty Gravel with Sand and Cobbles (GM)*; moist to wet; few cobbles; fine to coarse, subrounded to angular gravel; fine to coarse sand; low to medium plasticity. (Qfg)

Very dense, brown, *Silty Gravel with Sand (GM)*; to *Silty Sand with Gravel (SM)*; moist; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic. (Qfg)

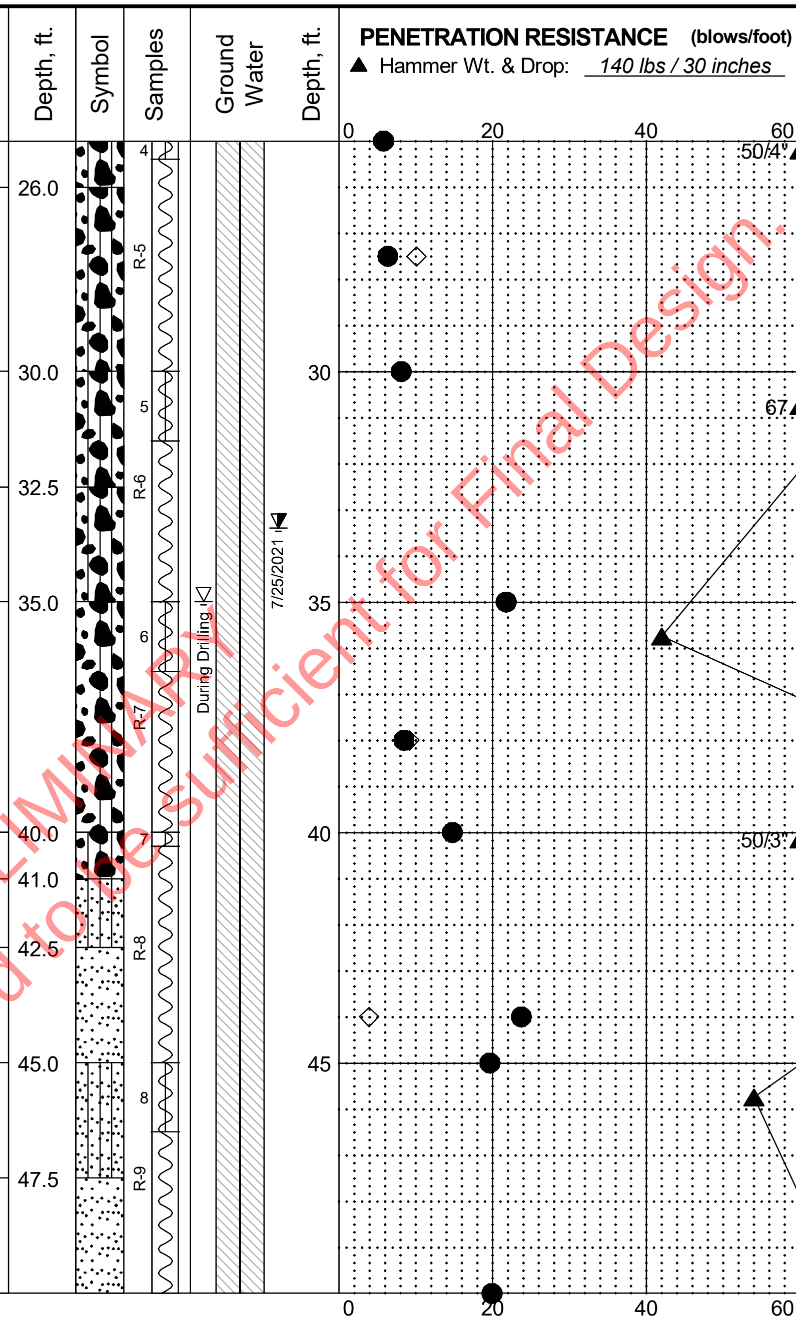
Very dense, brown, *Silty Gravel with Sand (GM)*; moist to wet; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic to low plasticity. (Qfg)

Very dense, brown, *Well Graded Gravel with Silt and Sand (GW-GM)*; wet; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic. (Qfg)

Very dense, brown, *Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded to angular gravel; fine to coarse sand; low to medium plasticity. (Qfg)

Very dense, orange-brown, *Silty Sand (SM)*; wet; few fine, subrounded gravel; fine to coarse sand; low plasticity; iron-oxide staining. (Qa)

Very dense, brown, *Poorly Graded Sand (SP)*; wet; trace fine, subrounded gravel; fine to medium sand; nonplastic. (Qa)



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-10p-21

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-6
Sheet 2 of 3

REV 3 - Approved for Submittal

Log: RAW Rev: EAS Typ: EAS

MASTER_LOG_E 101835.GPJ SHAN WIL.GDT 10/22/21

Total Depth:	61.3 ft.	Northing:	~ 94,777 ft.	Drilling Method:	Sonic Core	Hole Diam.:	4 in.
Top Elevation:	~ 42 ft.	Easting:	~ 1,170,234 ft.	Drilling Company:	Holt Services	Rod Diam.:	
Vert. Datum:	NAD83	Station:	~	Drill Rig Equipment:	Terra Sonic	Hammer Type:	Automatic
Horiz. Datum:	WA S US FT	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 material types, and the transition may be gradual.

Depth, ft. 50.0

Very dense, brown to orange-brown, *Silty Sand (SM)* to *Poorly Graded Sand with Silt (SP-SM)*; wet; few fine, subrounded to subangular gravel; fine to medium sand; nonplastic.
(Qa)

Very dense, brown, *Poorly Graded Sand (SP)* to *Poorly Graded Sand with Silt (SP-SM)*; wet; trace fine, subrounded gravel; fine to medium sand; nonplastic.
(Qa)

Very dense, brown to orange-brown, *Silty Sand (SM)*; moist to wet; trace fine, subrounded gravel; fine to medium sand; nonplastic; few seams with iron-oxide staining.
(Qa)
-3 feet of heave was observed after Run 10. While clearing heave the driller adavanced the casing to 57 feet. No samples were collected from 55 to 57 feet. SPT sample S-10 was attempted at 57 feet after the heave was cleared.

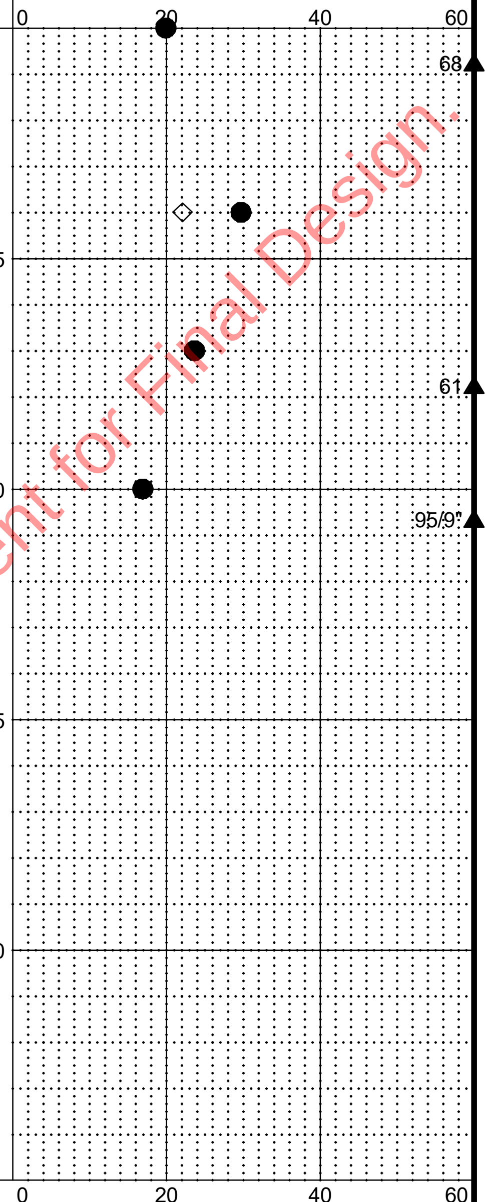
Depth, ft. 61.3

BOTTOM OF BORING
COMPLETED 6/8/2021

Samples: 9, R-10, R-11, 10, R-12, 11

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level ATD
- Ground Water Level in VWP

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 was measured from existing site features and should be considered approximate.

Washougal Grade Separation
Washougal, Washington

LOG OF BORING SW-10p-21

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FIG. A-6
Sheet 3 of 3

REV 3 - Approved for Submittal

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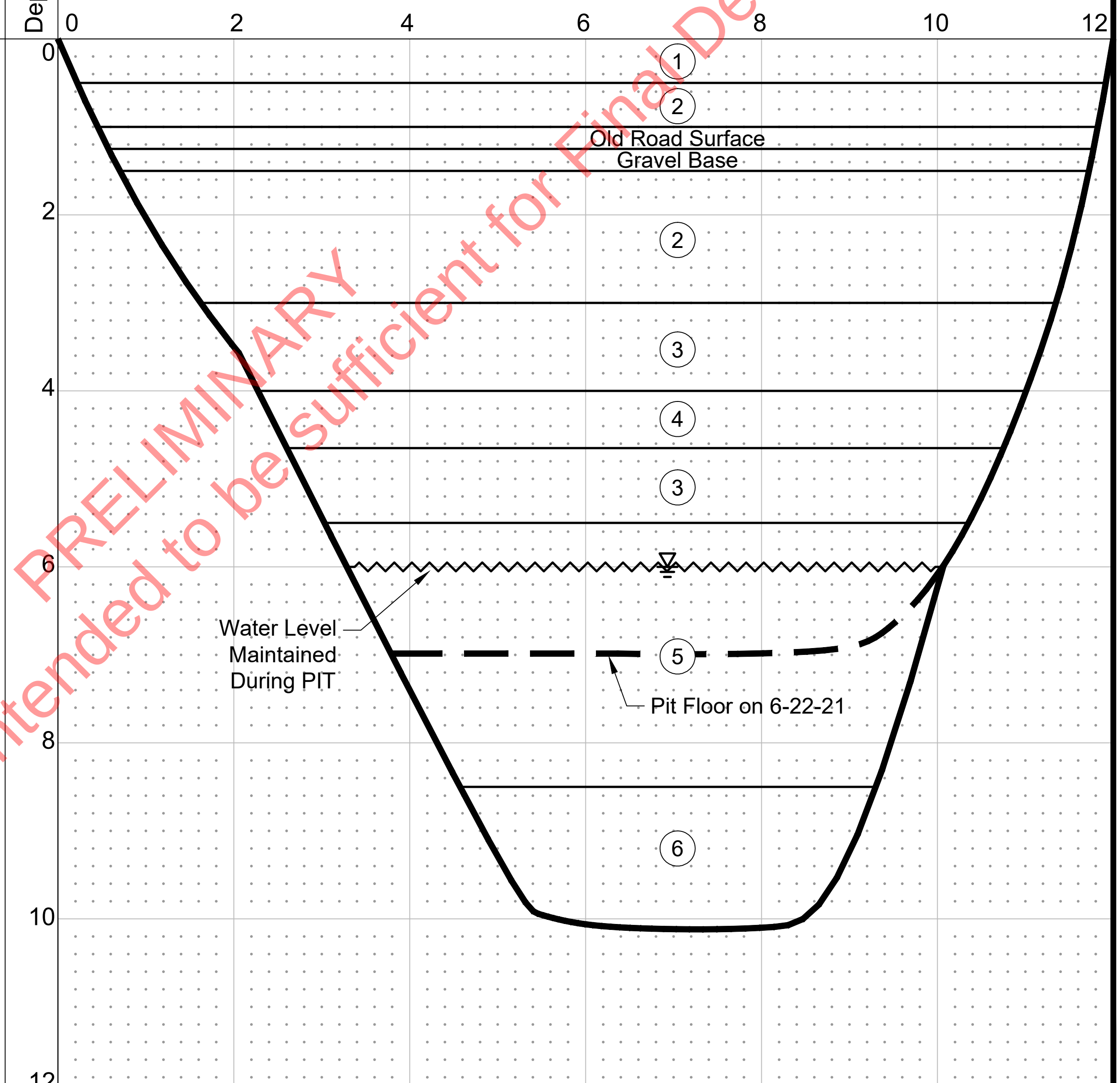
LOG OF TEST PIT TP-1

JOB NO: 101835-204   DATE: 6-22-2021 / 6-23-2021

PROJECT: Washougal Grade Separation   LOCATION: Washougal, Washington

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Topsoil	None Observed		
(2) Yellow-brown, *Gravelly Silt with Sand and Cobbles and Boulders (ML)*; few subrounded boulders; little subrounded cobbles; fine to coarse, subrounded to rounded gravel; fine to coarse sand; nonplastic.			
(3) Backfill, 1" minus.			
(4) Abandoned 8-inch water pipe.			
(5) Yellow-brown, *Silty Gravel with Sand and Cobbles and Boulders (GM)*; moist; few subrounded boulders, little subrounded cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic; trace organics.		9.6	S-1
(6) Brown, *Well Graded Gravel with Silt and Sand and Cobbles and Boulders (GW-GM)*; moist; few to little subrounded boulders; little subrounded cobbles; fine to coarse, subrounded gravel; fine to coarse sand; nonplastic.		15.9(4)	S-2
		8.3	S-3

Sketch of North Pit Side   Surface Elevation: Approx. 52 Ft.



NOTES

1. Pilot infiltration test (PIT) performed at 7 feet on 6-22-21.
2. Test pit excavated from 7 to 10 feet on 6-23-21. Excavation below 10 feet impractical due to site constraints.
3. Backfilled with bucket-compacted spoils.
4. Water content elevated due to effects of PIT.

File: C:\Users\jrs\CAD Group Dropbox\JDrive_SEA\101835\204\101835-204 Test Pit Logs.dwg Date: 10-08-2021 Author: JRS

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LOG OF TEST PIT TP-2

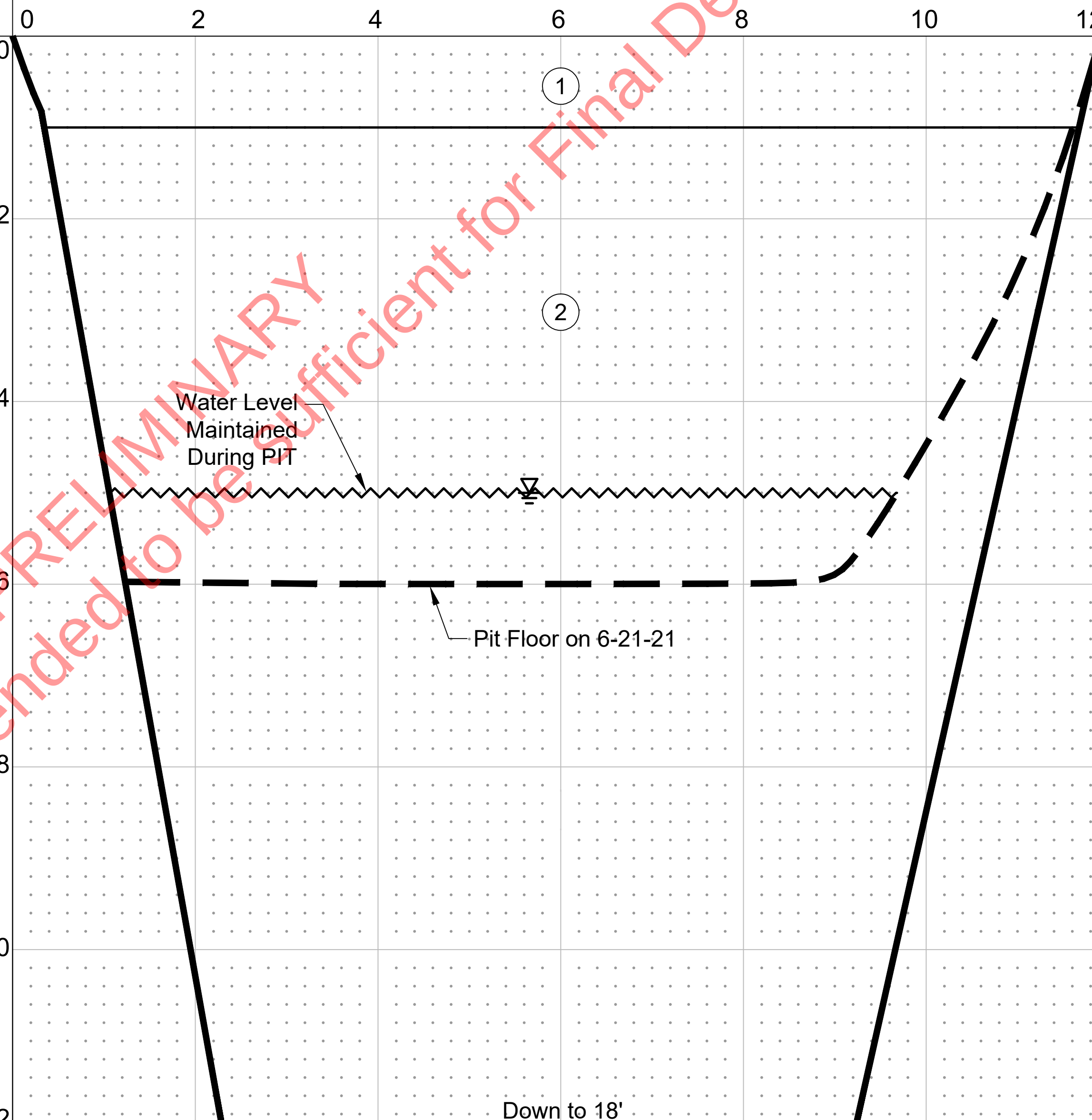
JOB NO: 101835-204 DATE: 6-21-2021 / 6-22-2021

PROJECT: Washougal Grade Separation LOCATION: Washougal, Washington

Surface Elevation: Approx. 35 Ft.

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Gravel, 1" minus.				0
(2) Brown, *Poorly Graded Gravel with Silt and Sand and Cobbles and Boulders (GP-GM)* to *Silty Gravel with Sand and Cobbles and Boulders (GM)*; moist; few subrounded boulders; little subrounded cobbles; fine to coarse, subrounded to subangular gravel; fine to coarse sand; nonplastic; trace organics.				2
				4
		10.1	S-1	6
- Moist to wet below ~15 feet (likely residual from PIT) but without obvious seepage.				
				8
		11.4	S-2	
				10
				12

Sketch of West Pit Side

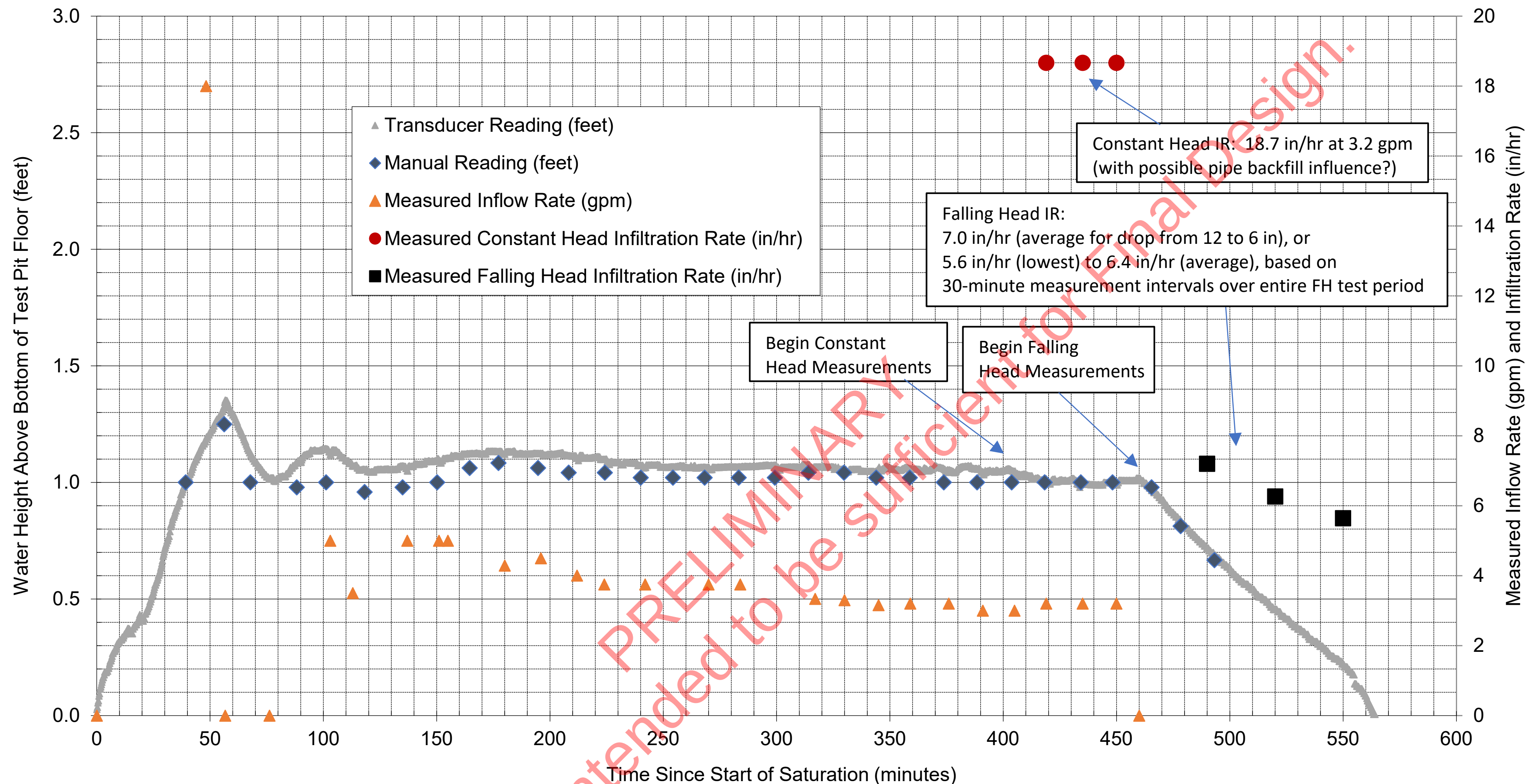


NOTES

1. Pilot infiltration test (PIT) performed at 6 feet on 6-21-21.
2. Test pit excavated from 6 to 18 feet on 6-22-21. Sample S-3 collected at 17 to 18 feet, water content 7.9%.
3. Backfilled with bucket-compacted spoils.

FIG. A-8

File: TP-1 PIT Calcs.xlsx Date: 10/28/2021 Author: PVH



NOTES

1. This small-scale pilot infiltration test (PIT) was performed on 6/22/21. Grade elevation was about 52 feet, estimated from Google Earth. Test pit floor was 7 feet deep during the PIT. The inflow rate during the constant head portion of the test was approximately 3.2 gpm, which maintained the water level approximately 12 inches above the test pit floor. Test pit dimensions during the PIT were approximately 3.0 feet by 5.5 feet, or 16.5 square feet. The test pit was over-excavated on 6/23/21 to 10 feet deep, with no seepage observed.

2. gpm = gallons per minute, in/hr = inches per hour, IR = measured infiltration rate

Washougal Grade Separation
Washougal, Washington

TEST PIT TP-1
PILOT INFILTRATION TEST DATA

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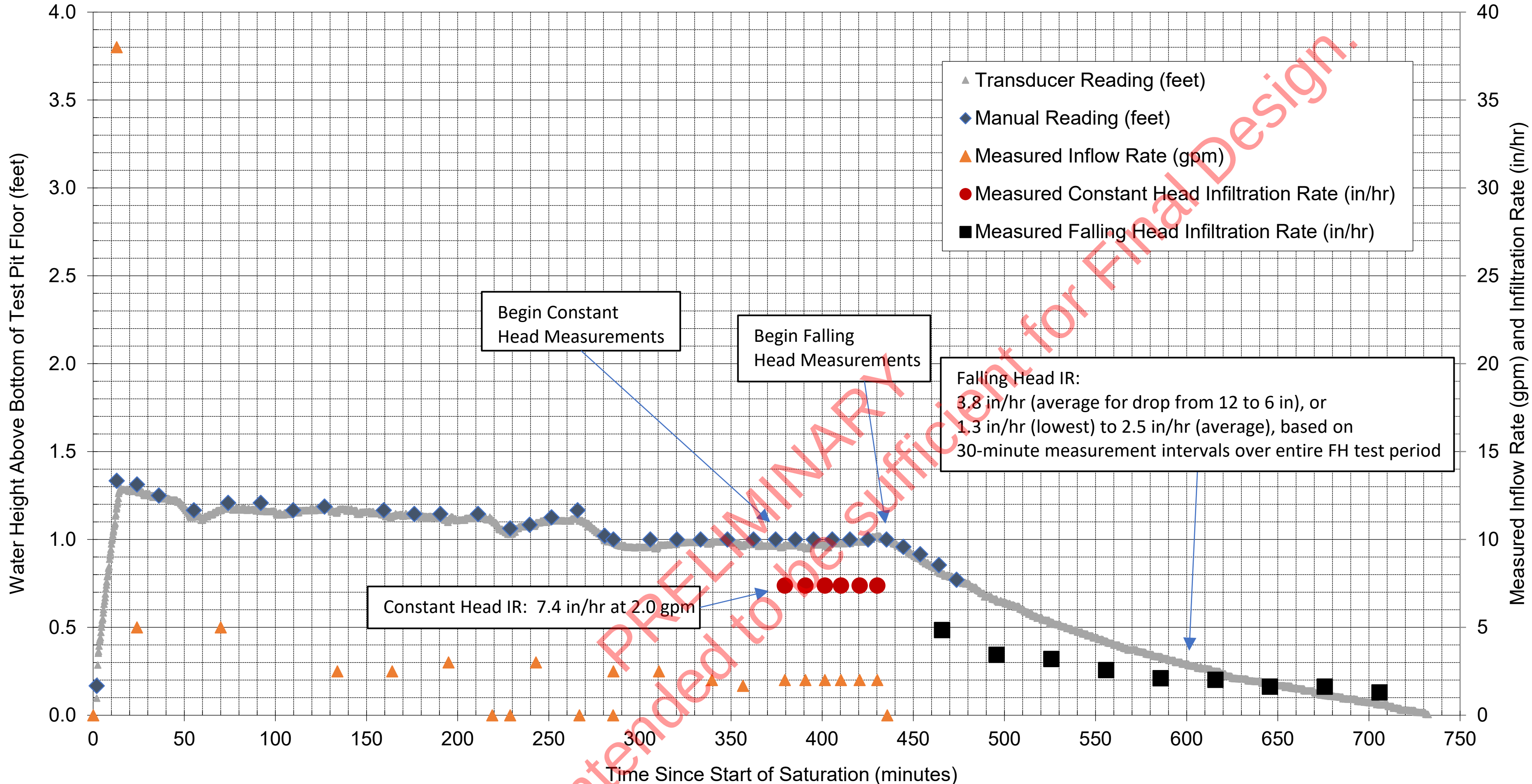
FIG. A-9



NOTES

1. This small-scale pilot infiltration test (PIT) was performed on 6/21/21. Grade elevation was about 35 feet, estimated from Google Earth. Test pit floor was 6 feet deep during the PIT. The inflow rate during the constant head portion of the test was approximately 2.0 gpm, which maintained the water level approximately 12 inches above the test pit floor. Test pit dimensions during the PIT were approximately 3.3 feet by 7.8 feet, or 26.1 square feet. The test pit was over-excavated on 6/22/21 to 18 feet deep, with no seepage observed.

2. gpm = gallons per minute, in/hr = inches per hour, IR = measured infiltration rate

Washougal Grade Separation
Washougal, Washington

TEST PIT TP-2
PILOT INFILTRATION TEST DATA

October 2021 101835-204

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FIG. A-10

Washougal Grade Separation
Washougal, Washington

SC-1P-18_000.0-001.0

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FIG. A-11

FIG. A-11

Washougal Grade Separation
Washougal, Washington

SC-1P-18_001.0-005.0

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FIG. A-12

FIG. A-12

Washougal Grade Separation
Washougal, Washington

SC-1P-18_005.0-008.0

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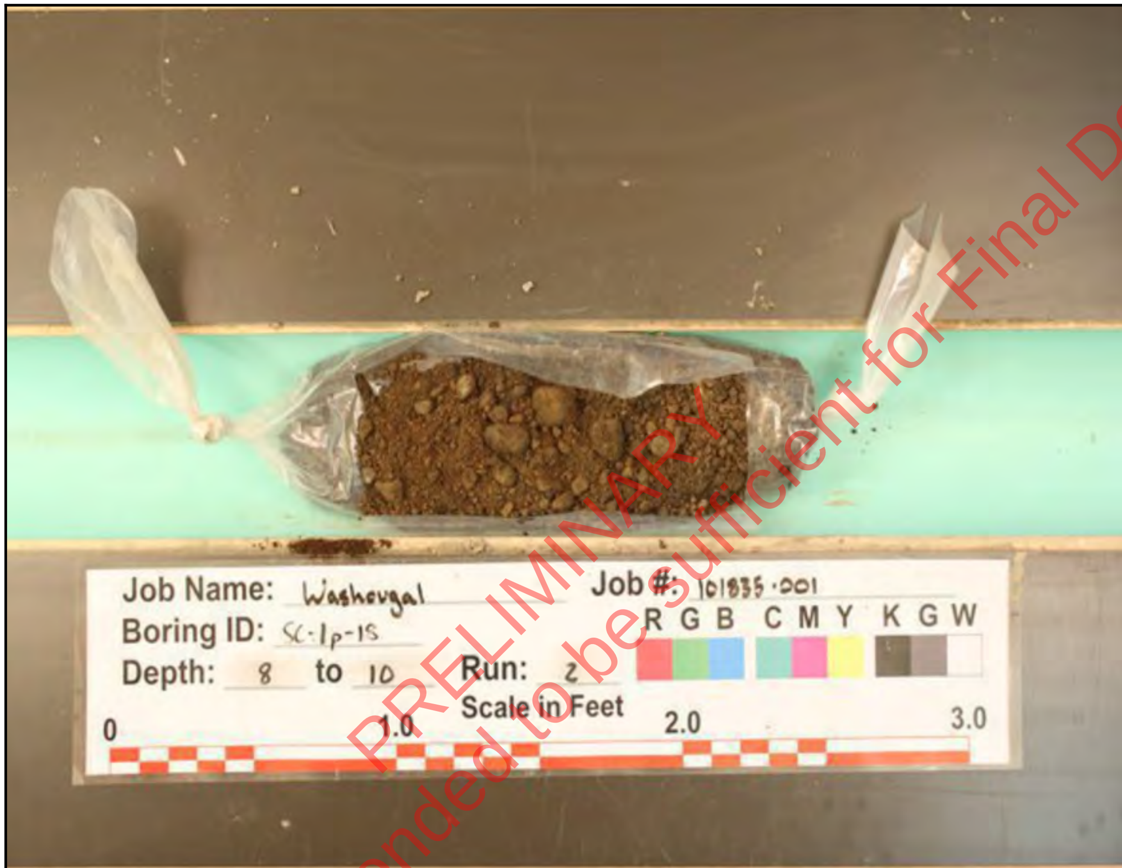
FIG. A-13

FIG. A-13



Washougal Grade Separation
Washougal, Washington

SC-1P-18_008.0-010.0

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FIG. A-14

FIG. A-14

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Washougal Grade Separation
Washougal, Washington

SC-1P-18_010.0-012.5

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FIG. A-15

FIG. A-15

Washougal Grade Separation
Washougal, Washington

SC-1P-18_012.5-014.5

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FIG. A-16

FIG. A-16

Washougal Grade Separation
Washougal, Washington

SC-1P-18_014.5-015.0

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FIG. A-17

FIG. A-17

Washougal Grade Separation
Washougal, Washington

SC-1P-18_015.0-017.5

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FIG. A-18

FIG. A-18

Washougal Grade Separation
Washougal, Washington

SC-1P-18_017.5-020.0

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FIG. A-19

FIG. A-19

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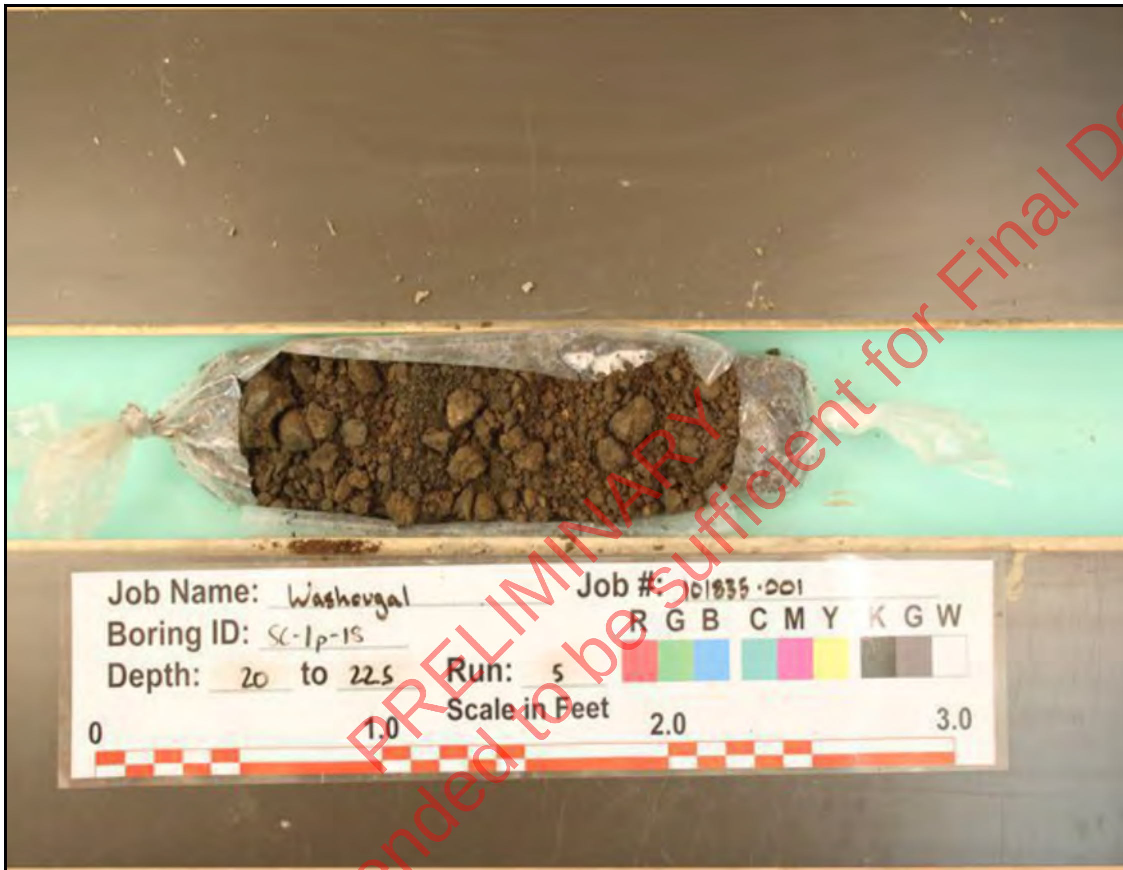

Washougal Grade Separation
Washougal, Washington

SC-1P-18_020.0-022.5

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FIG. A-20

Washougal Grade Separation
Washougal, Washington

SC-1P-18_022.5-025.0

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FIG. A-21

FIG. A-21

Washougal Grade Separation
Washougal, Washington

SC-1P-18_025.0-030.0

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FIG. A-22

FIG. A-22

Washougal Grade Separation
Washougal, Washington

SC-1P-18_030.0-032.5

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FIG. A-23

FIG. A-23

Washougal Grade Separation
Washougal, Washington

SC-1P-18_032.5-035.0

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FIG. A-24

FIG. A-24

Washougal Grade Separation
Washougal, Washington

SC-1P-18_035.0-040.0

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FIG. A-25

FIG. A-25

Washougal Grade Separation
Washougal, Washington

SC-1P-18_040.0-042.5

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FIG. A-26

FIG. A-26

Washougal Grade Separation
Washougal, Washington

SC-1P-18_042.5-045.0

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FIG. A-27

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FIG. A-27

Washougal Grade Separation
Washougal, Washington

SC-1P-18_045.0-048.0

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FIG. A-28

FIG. A-28

Washougal Grade Separation
Washougal, Washington

SC-1P-18_048.0-050.0

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FIG. A-29

FIG. A-29

Washougal Grade Separation
Washougal, Washington

SC-1P-18_050.0-052.5

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FIG. A-30

Washougal Grade Separation
Washougal, Washington

SC-1P-18_052.5-055.0

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FIG. A-31

FIG. A-31

Washougal Grade Separation
Washougal, Washington

SC-1P-18_055.0-057.0

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FIG. A-32

FIG. A-32

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Washougal Grade Separation
Washougal, Washington

SC-1P-18_057.0-060.0

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FIG. A-33

FIG. A-33

Washougal Grade Separation
Washougal, Washington

SC-1P-18_060.0-062.5

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FIG. A-34

FIG. A-34

Washougal Grade Separation
Washougal, Washington

SC-1P-18_062.5-065.0

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FIG. A-35

FIG. A-35

Washougal Grade Separation
Washougal, Washington

SC-1P-18_065.0-068.0

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FIG. A-36

FIG. A-36

Washougal Grade Separation
Washougal, Washington

SC-1P-18_068.0-070.0

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FIG. A-37

FIG. A-37

Washougal Grade Separation
Washougal, Washington

SC-1P-18_070.0-072.5

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FIG. A-38

FIG. A-38

Washougal Grade Separation
Washougal, Washington

SC-1P-18_072.5-075.0

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FIG. A-39

FIG. A-39

Washougal Grade Separation
Washougal, Washington

SC-1P-18_075.0-077.5

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FIG. A-40

FIG. A-40

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Washougal Grade Separation
Washougal, Washington

SC-1P-18_077.5-080.0

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FIG. A-41

FIG. A-41

Washougal Grade Separation
Washougal, Washington

SC-1P-18_080.0-082.5

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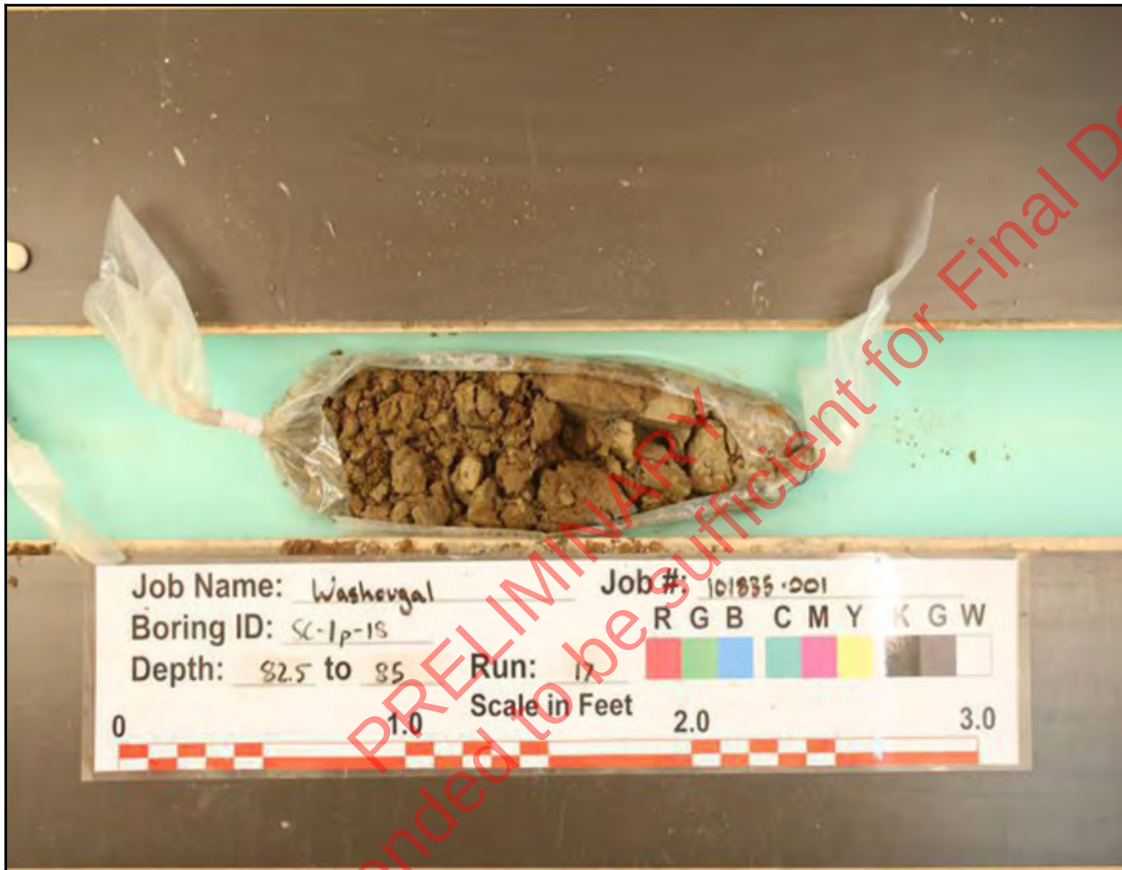
FIG. A-42

FIG. A-42



Washougal Grade Separation
Washougal, Washington

SC-1P-18_082.5-085.0

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FIG. A-43

FIG. A-43

Washougal Grade Separation
Washougal, Washington

SC-1P-18_085.0-088.0

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FIG. A-44

FIG. A-44

Washougal Grade Separation
Washougal, Washington

SC-1P-18_088.0-090.0

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FIG. A-45

Washougal Grade Separation
Washougal, Washington

SC-1P-18_090.0-092.5

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FIG. A-46

FIG. A-46

Washougal Grade Separation
Washougal, Washington

SC-1P-18_092.5-095.0

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FIG. A-47

FIG. A-47

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Washougal Grade Separation
Washougal, Washington

SC-1P-18_095.0-097.5

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FIG. A-48

FIG. A-48

Washougal Grade Separation
Washougal, Washington

SC-1P-18_097.5-100.0

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FIG. A-49

FIG. A-49

Washougal Grade Separation
Washougal, Washington

SC-2P-18_000.0-005.0

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FIG. A-50

FIG. A-50

Washougal Grade Separation
Washougal, Washington

SC-2P-18_005.0-007.5

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FIG. A-51

FIG. A-51

Washougal Grade Separation
Washougal, Washington

SC-2P-18_007.5-010.0

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FIG. A-52

Washougal Grade Separation
Washougal, Washington

SC-2P-18_010.0-012.5

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FIG. A-53

FIG. A-53

Washougal Grade Separation
Washougal, Washington

SC-2P-18_012.4-015.0

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FIG. A-54

FIG. A-54

Washougal Grade Separation
Washougal, Washington

SC-2P-18_015.0-017.5

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FIG. A-55

FIG. A-55

Washougal Grade Separation
Washougal, Washington

SC-2P-18_017.5-020.0

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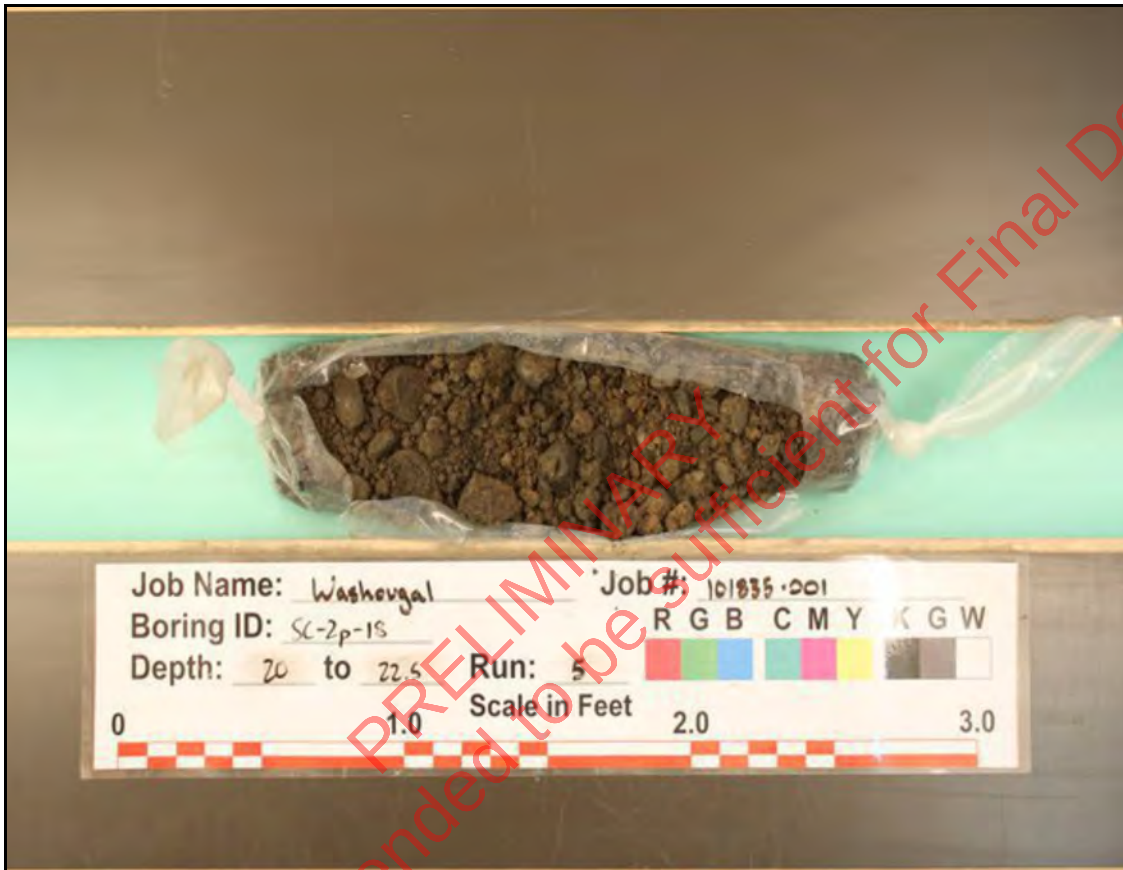
FIG. A-56

FIG. A-56



Washougal Grade Separation
Washougal, Washington

SC-2P-18_020.0-022.5

October 2021 101835-202

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FIG. A-57

FIG. A-57

Washougal Grade Separation
Washougal, Washington

SC-2P-18_022.5-025.0

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FIG. A-58

FIG. A-58

Washougal Grade Separation
Washougal, Washington

SC-2P-18_025.0-028.0

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FIG. A-59

FIG. A-59

Washougal Grade Separation
Washougal, Washington

SC-2P-18_028.0-030.0

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FIG. A-60

FIG. A-60

Washougal Grade Separation
Washougal, Washington

SC-2P-18_030.0-032.5

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FIG. A-61

FIG. A-61

Washougal Grade Separation
Washougal, Washington

SC-2P-18_032.5-035.0

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FIG. A-62

FIG. A-62

Washougal Grade Separation
Washougal, Washington

SC-2P-18_035.0-037.5

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FIG. A-63

FIG. A-63

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Washougal Grade Separation
Washougal, Washington

SC-2P-18_037.5-040.0

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FIG. A-64

FIG. A-64

Washougal Grade Separation
Washougal, Washington

SC-2P-18_040.0-042.0

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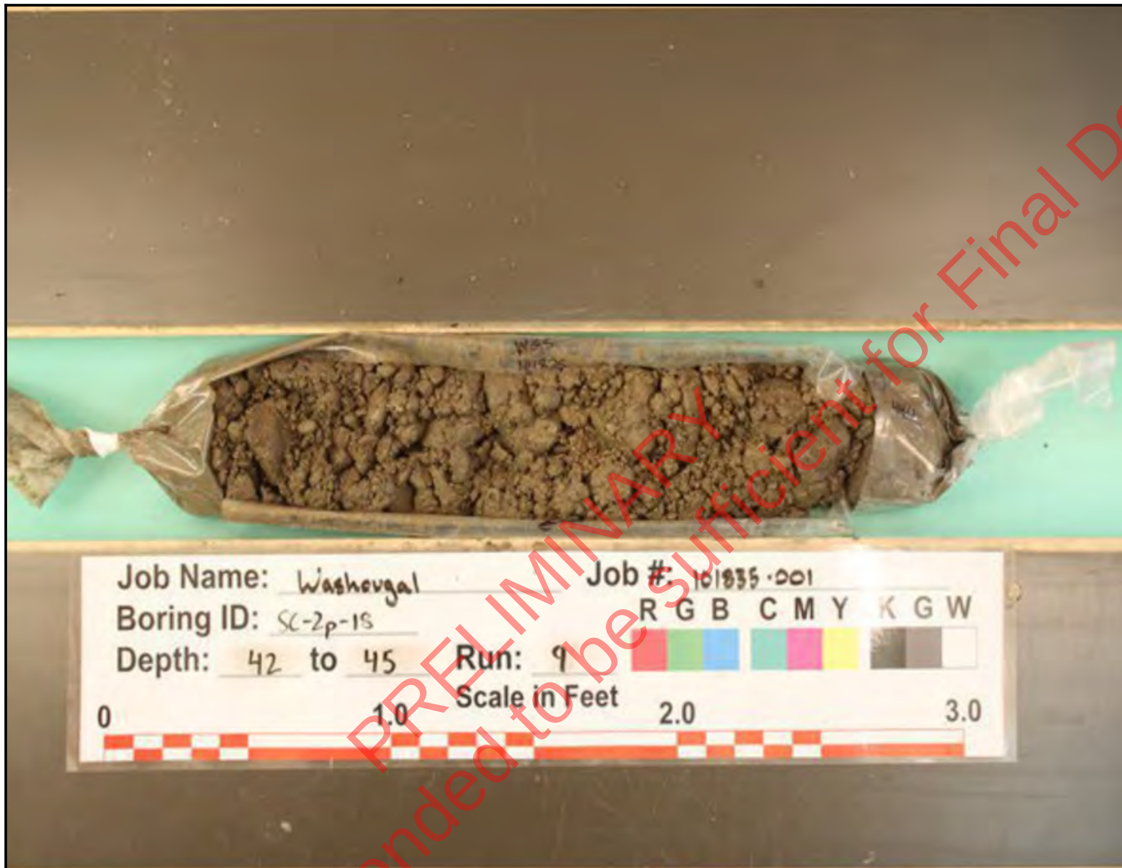
FIG. A-65

FIG. A-65



Washougal Grade Separation
Washougal, Washington

SC-2P-18_042.0-045.0

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FIG. A-66

FIG. A-66

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Washougal Grade Separation
Washougal, Washington

SC-2P-18_045.0-047.5

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FIG. A-67

Washougal Grade Separation
Washougal, Washington

SC-2P-18_047.5-050.0

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FIG. A-68

FIG. A-68

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Washougal Grade Separation
Washougal, Washington

SC-2P-18_050.0-052.0

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FIG. A-69

FIG. A-69

Washougal Grade Separation
Washougal, Washington

SC-2P-18_052.0-055.0

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FIG. A-70

FIG. A-70

Washougal Grade Separation
Washougal, Washington

SC-2P-18_055.0-057.5

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FIG. A-71

FIG. A-71

Washougal Grade Separation
Washougal, Washington

SC-2P-18_057.5-060.0

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FIG. A-72

Washougal Grade Separation
Washougal, Washington

SC-2P-18_060.0-062.5

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FIG. A-73

FIG. A-73

Washougal Grade Separation
Washougal, Washington

SC-2P-18_062.5-065.0

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FIG. A-74

FIG. A-74

Washougal Grade Separation
Washougal, Washington

SC-2P-18_065.0-067.5

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FIG. A-75

FIG. A-75

Washougal Grade Separation
Washougal, Washington

SC-2P-18_067.5-070.0

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FIG. A-76

FIG. A-76

Washougal Grade Separation
Washougal, Washington

SC-2P-18_070.0-073.0

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FIG. A-77

FIG. A-77

Washougal Grade Separation
Washougal, Washington

SC-2P-18_073.0-075.0

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FIG. A-78

FIG. A-78

Washougal Grade Separation
Washougal, Washington

SC-2P-18_075.0-078.0

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FIG. A-79

FIG. A-79

Washougal Grade Separation
Washougal, Washington

SC-2P-18_078.0-080.0

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FIG. A-80

Washougal Grade Separation
Washougal, Washington

SC-2P-18_080.0-082.5

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FIG. A-81

FIG. A-81

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Washougal Grade Separation
Washougal, Washington

SC-2P-18_082.5-085

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FIG. A-82

FIG. A-82

Washougal Grade Separation
Washougal, Washington

SC-2P-18_085.0-087.5

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FIG. A-83

FIG. A-83

Washougal Grade Separation
Washougal, Washington

SC-2P-18_087.5-090.0

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FIG. A-84

FIG. A-84

FIG. A-85

Washougal Grade Separation
Washougal, Washington

SC-2P-18_090.0-092.5

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FIG. A-85

Washougal Grade Separation
Washougal, Washington

SC-2P-18_092.5-095.0

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FIG. A-86

FIG. A-86

Washougal Grade Separation
Washougal, Washington

SW-5P-21_05.0-08.0

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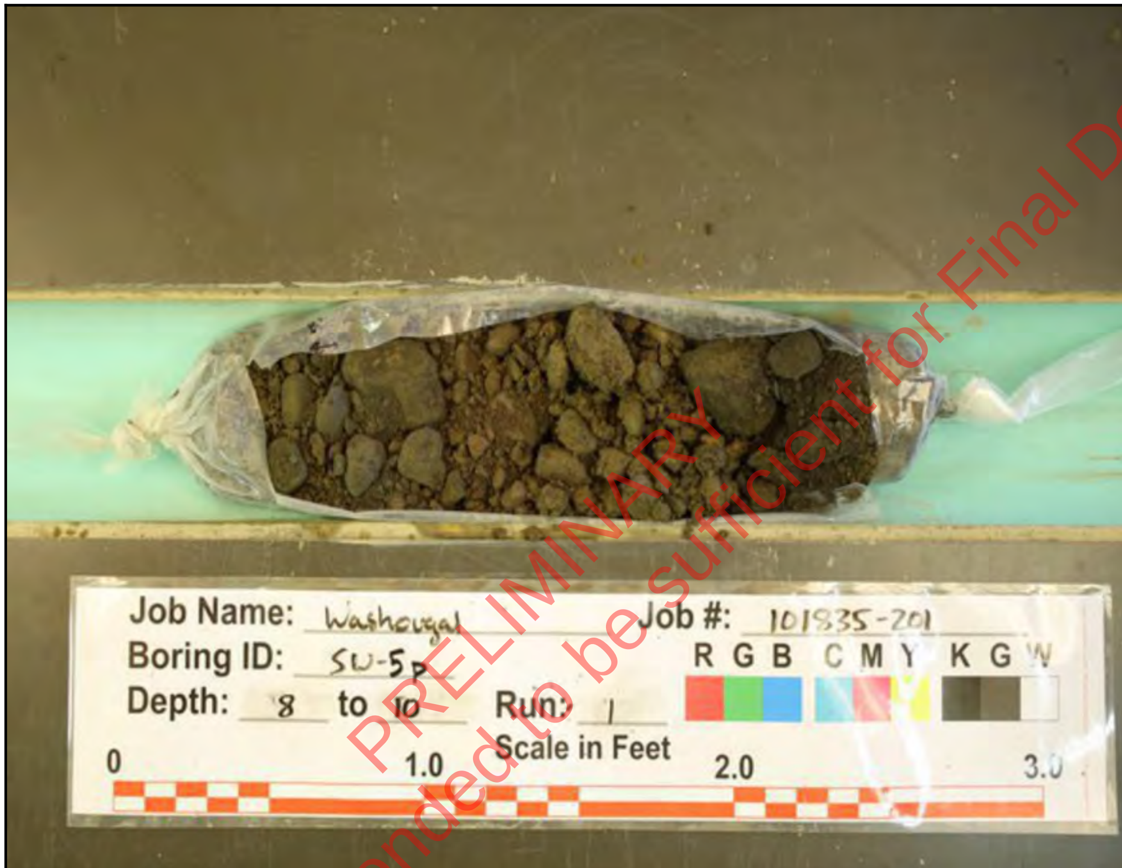
FIG. A-87

FIG. A-87



Washougal Grade Separation
Washougal, Washington

SW-5P-21_08.0-10.0

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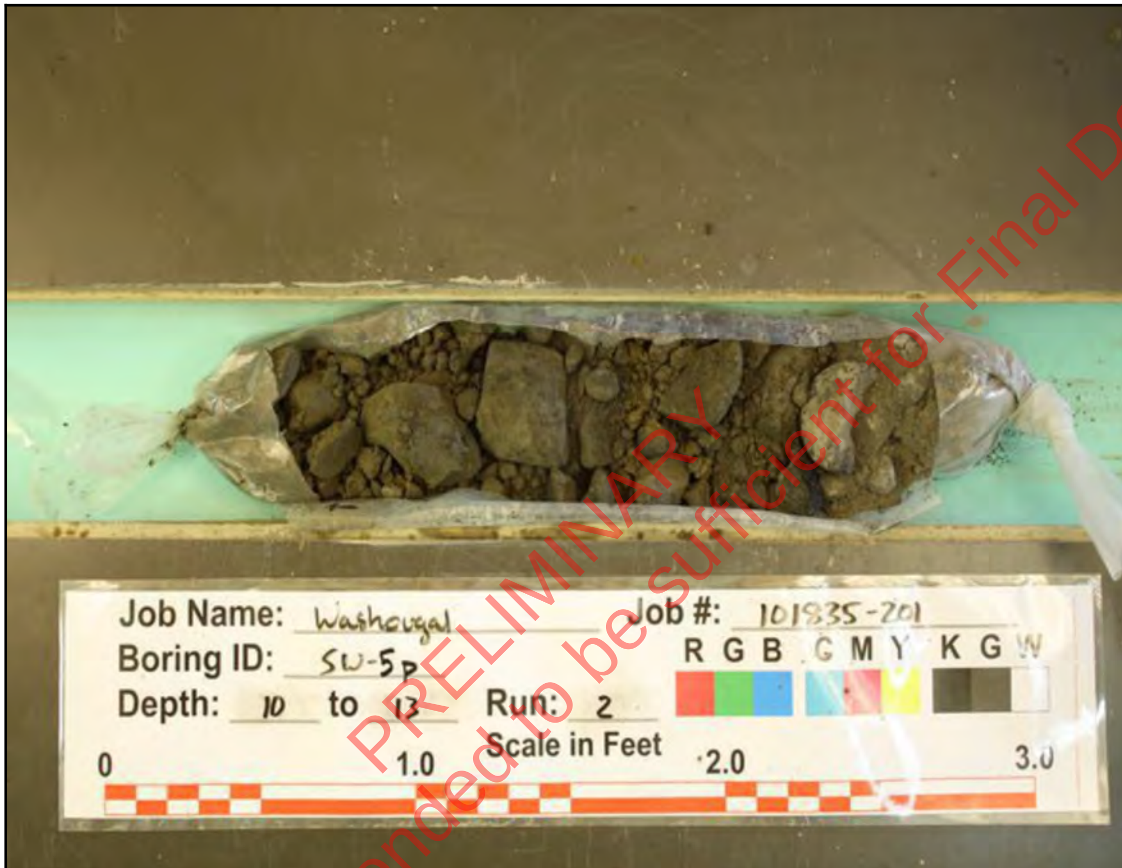
FIG. A-88

FIG. A-88



Washougal Grade Separation
Washougal, Washington

SW-5P-21_10.0-13.0

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FIG. A-89

FIG. A-89

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Washougal Grade Separation
Washougal, Washington

SW-5P-21_13.0-15.0

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FIG. A-90

FIG. A-90

Washougal Grade Separation
Washougal, Washington

SW-5P-21_15.0-17.5

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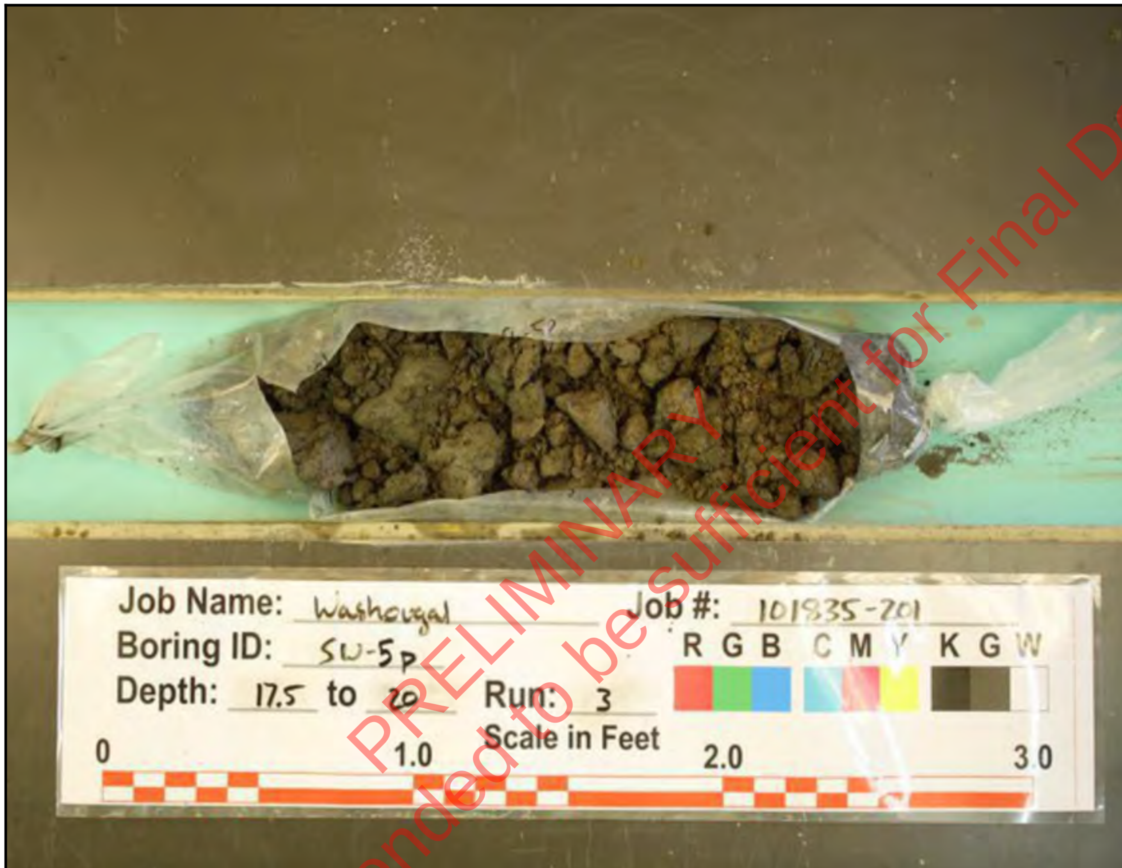
FIG. A-91

FIG. A-91



Washougal Grade Separation
Washougal, Washington

SW-5P-21_17.5-20.0

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FIG. A-92

FIG. A-92

Washougal Grade Separation
Washougal, Washington

SW-5P-21_20.0-21.5

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SHANNON & WILSON, INC.
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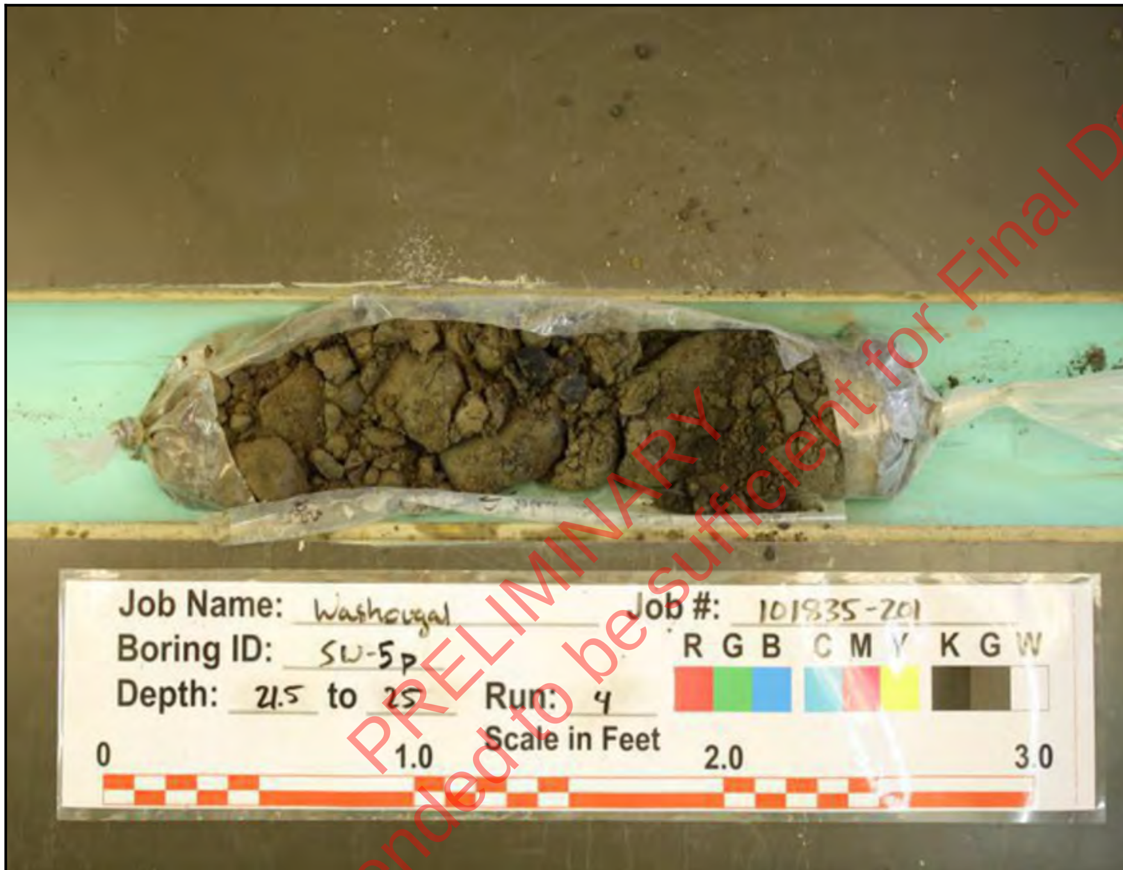
FIG. A-93

FIG. A-93



Washougal Grade Separation
Washougal, Washington

SW-5P-21_21.5-25.0

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FIG. A-94

FIG. A-94

Washougal Grade Separation
Washougal, Washington

SW-5P-21_25.0-27.0

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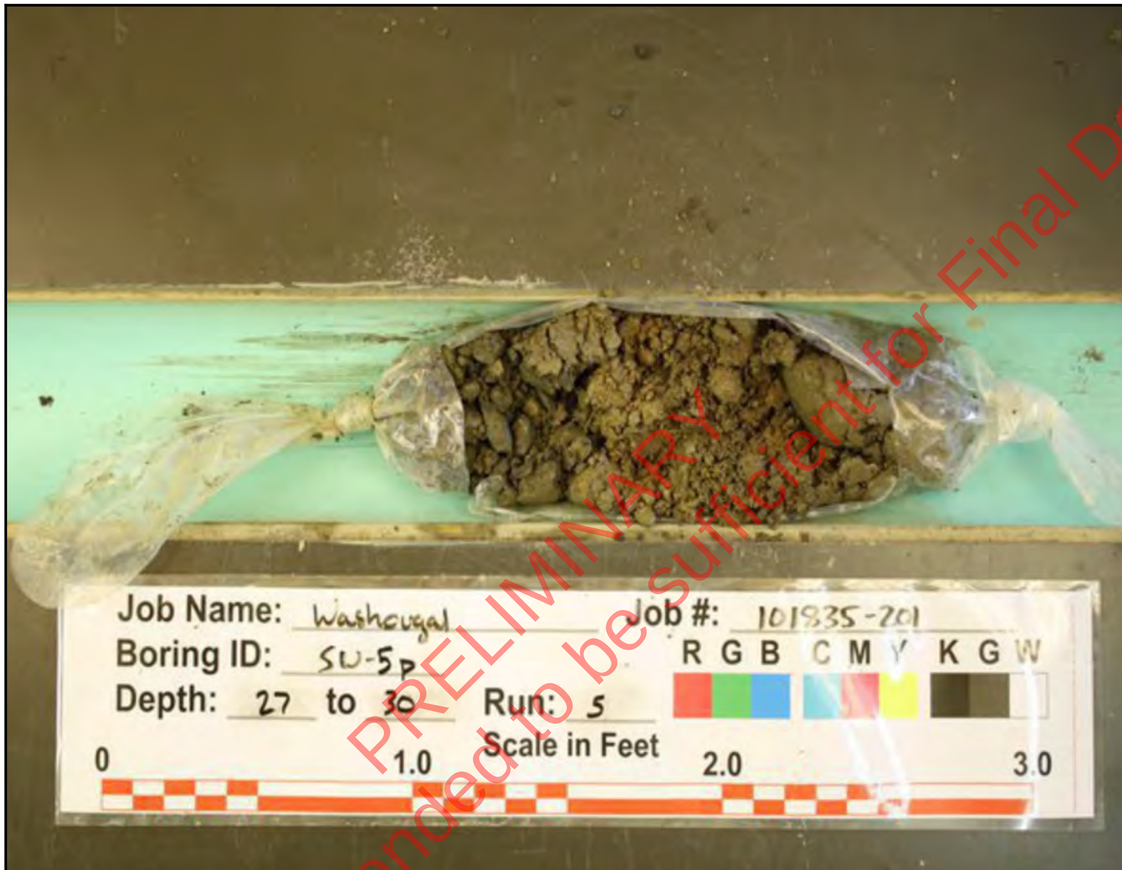
FIG. A-95



Washougal Grade Separation
Washougal, Washington

SW-5P-21_27.0-30.0

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FIG. A-96

FIG. A-96

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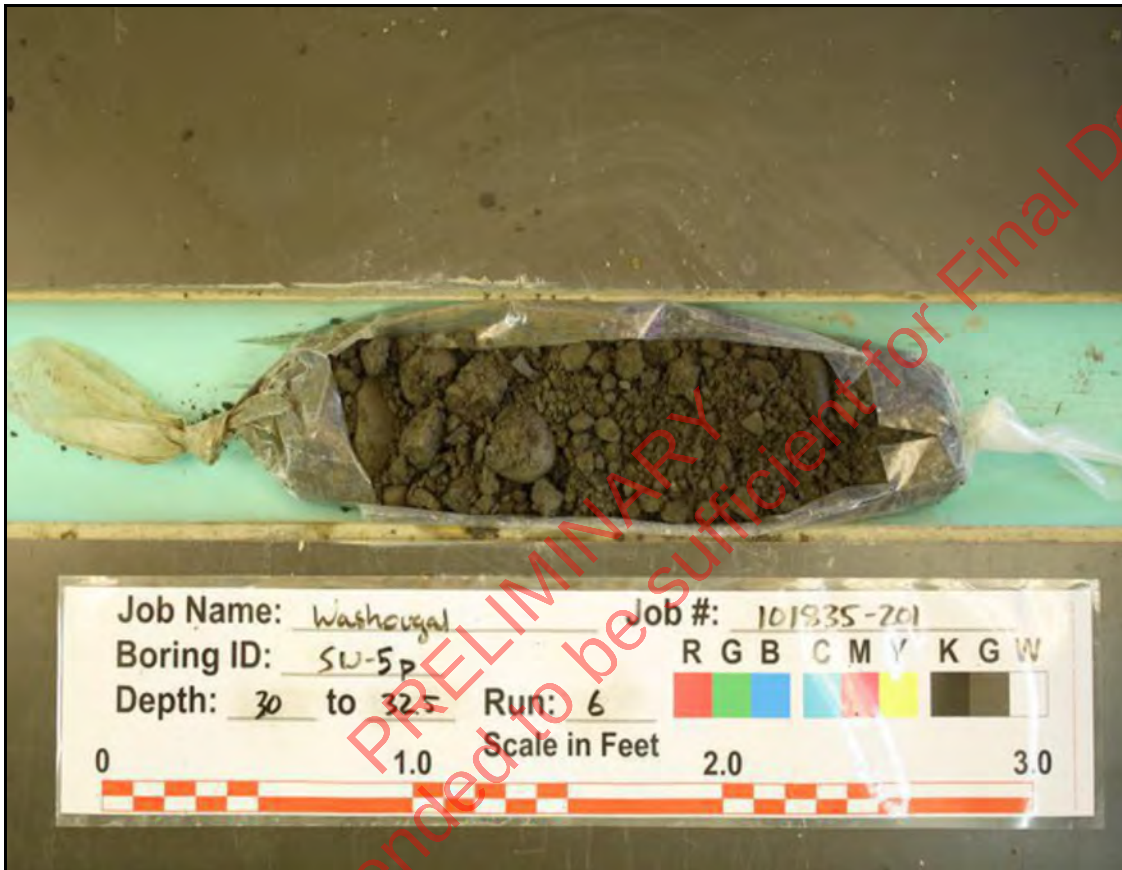

Washougal Grade Separation
Washougal, Washington

SW-5P-21_30.0-32.5

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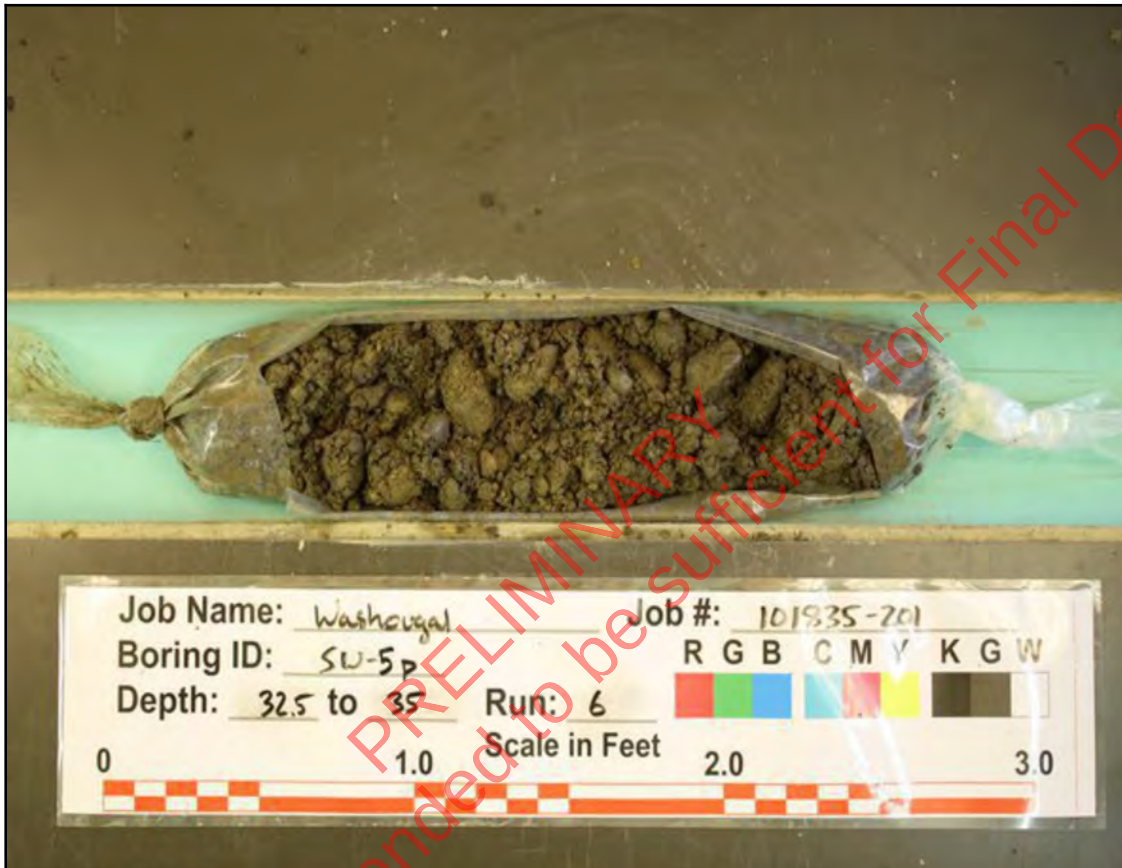
FIG. A-97



Washougal Grade Separation
Washougal, Washington

SW-5P-21_32.5-35.0

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FIG. A-98

FIG. A-98

Washougal Grade Separation
Washougal, Washington

SW-5P-21_35.0-37.5

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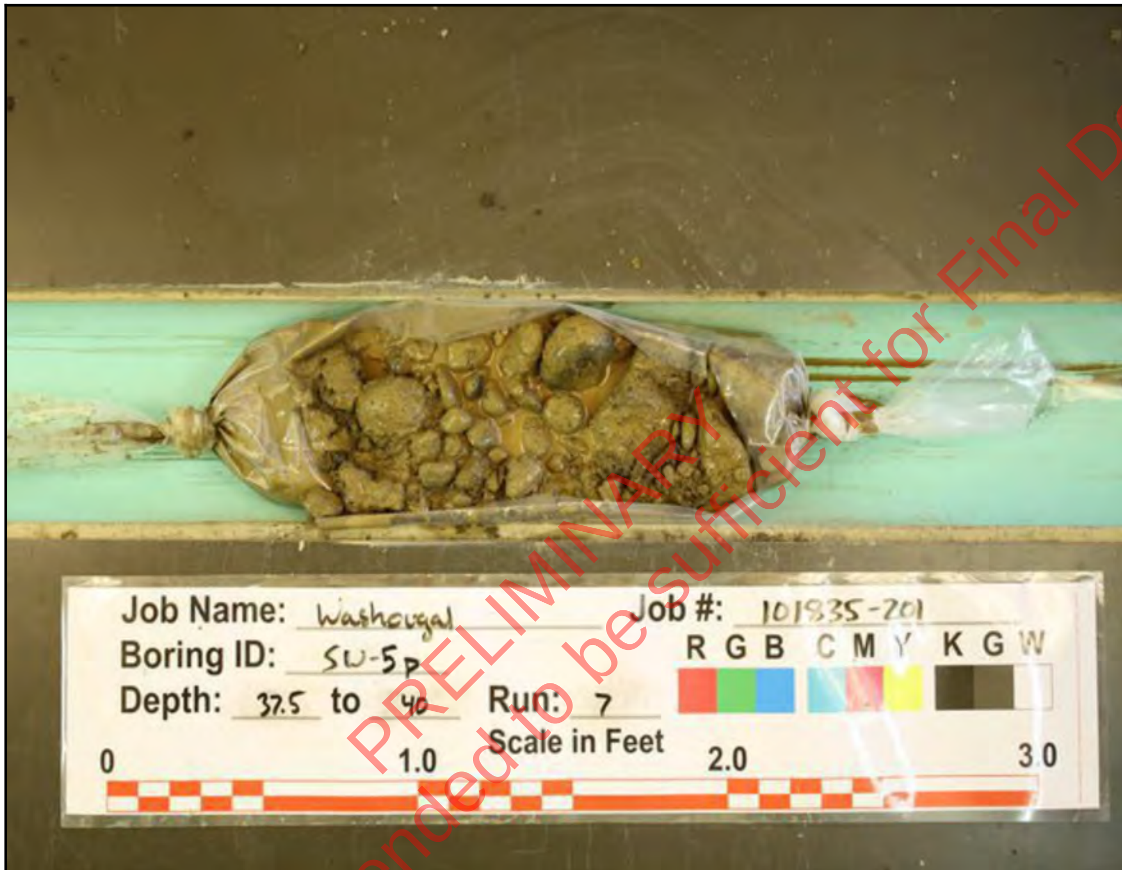
FIG. A-99

FIG. A-99



Washougal Grade Separation
Washougal, Washington

SW-5P-21_37.5-40.0

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FIG. A-100

FIG. A-100

Washougal Grade Separation
Washougal, Washington

SW-5P-21_40.0-42.5

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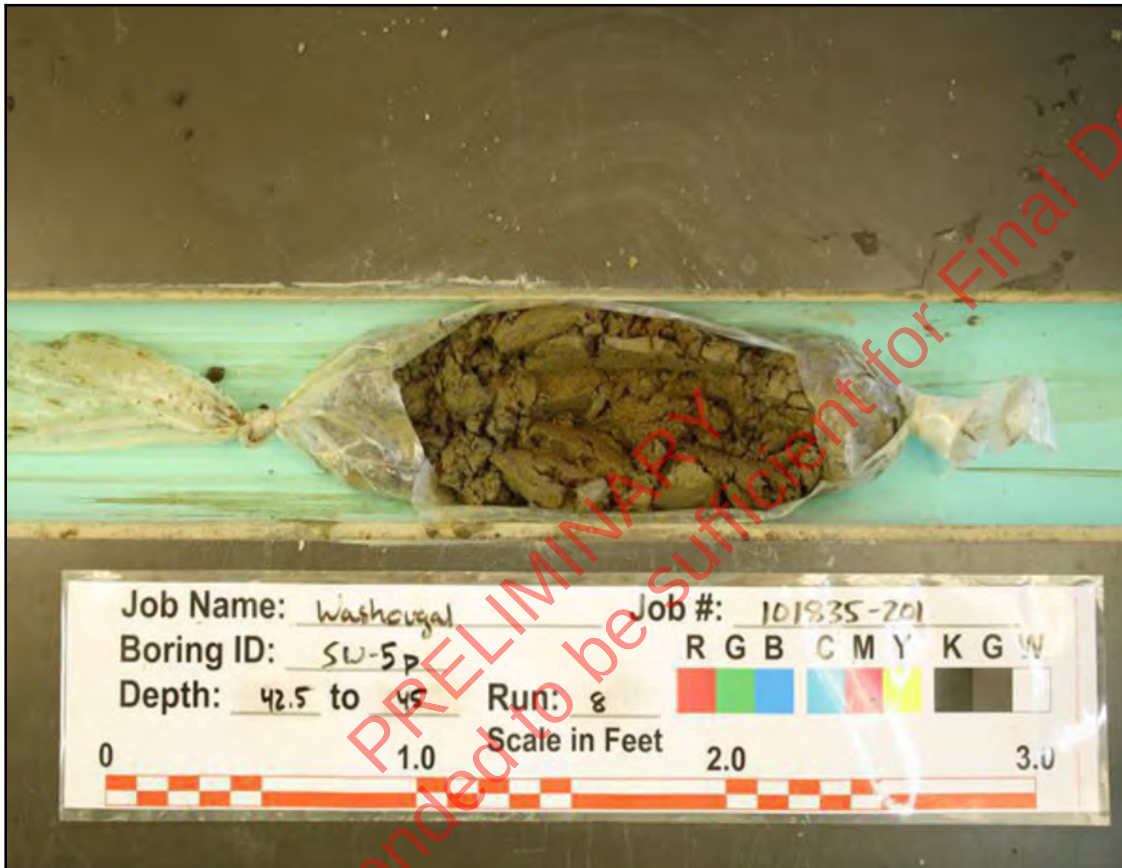
FIG. A-101

FIG. A-101



Washougal Grade Separation
Washougal, Washington

SW-5P-21_42.5-45.0

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FIG. A-102

FIG. A-102

Washougal Grade Separation
Washougal, Washington

SW-5P-21_45.0-47.5

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FIG. A-103

FIG. A-103

Washougal Grade Separation
Washougal, Washington

SW-5P-21_47.5-50.0

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FIG. A-104

FIG. A-104

Washougal Grade Separation
Washougal, Washington

SW-5P-21_50.0-52.5

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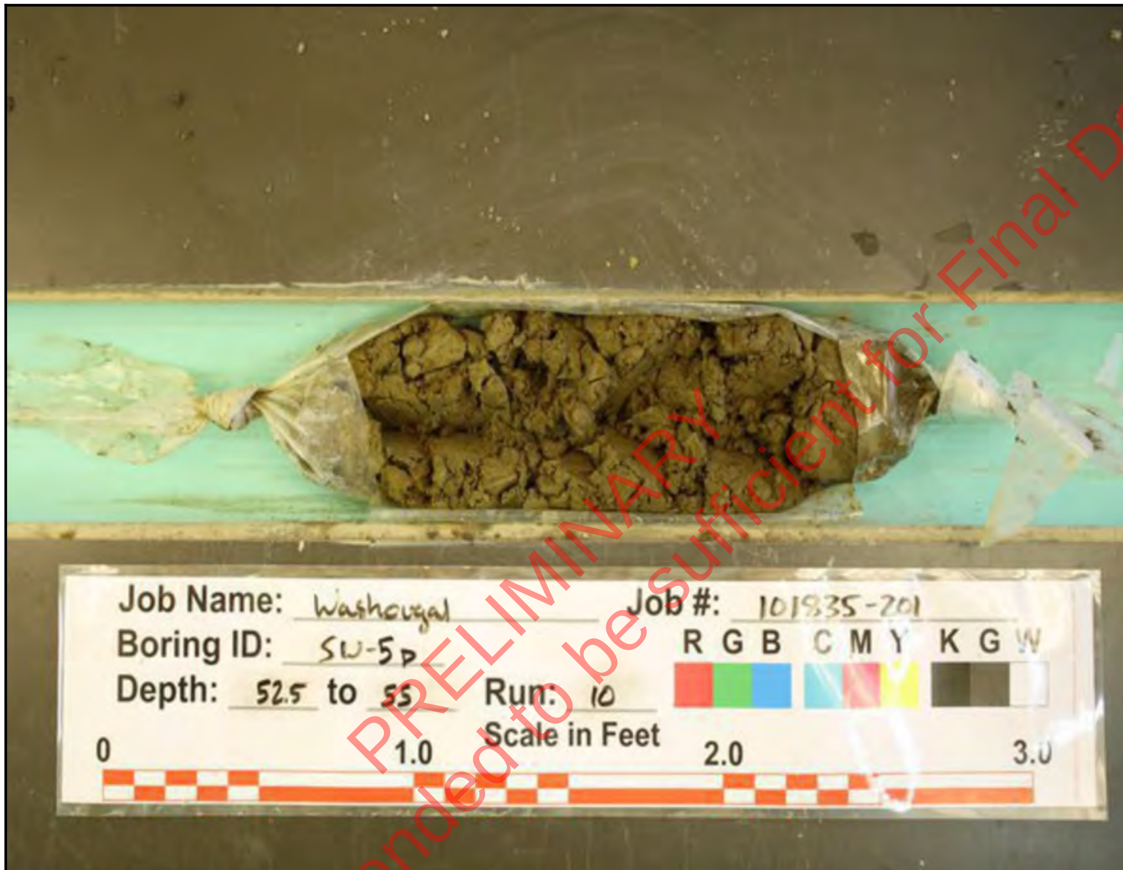
FIG. A-105

FIG. A-105



Washougal Grade Separation
Washougal, Washington

SW-5P-21_52.5-55.0

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FIG. A-106

FIG. A-106

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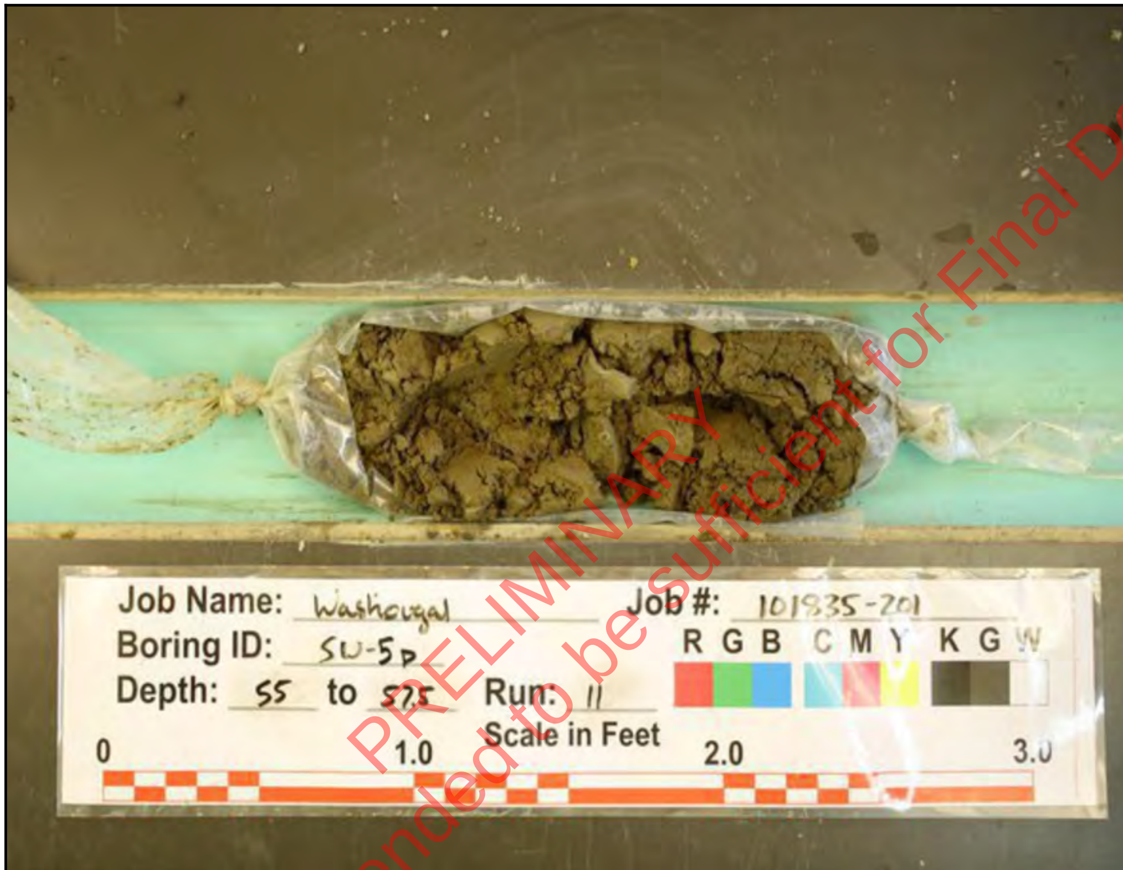

Washougal Grade Separation
Washougal, Washington

SW-5P-21_55.0-57.5

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FIG. A-107

FIG. A-107

FIG. A-108

Washougal Grade Separation
Washougal, Washington

SW-5P-21_57.5-60.0

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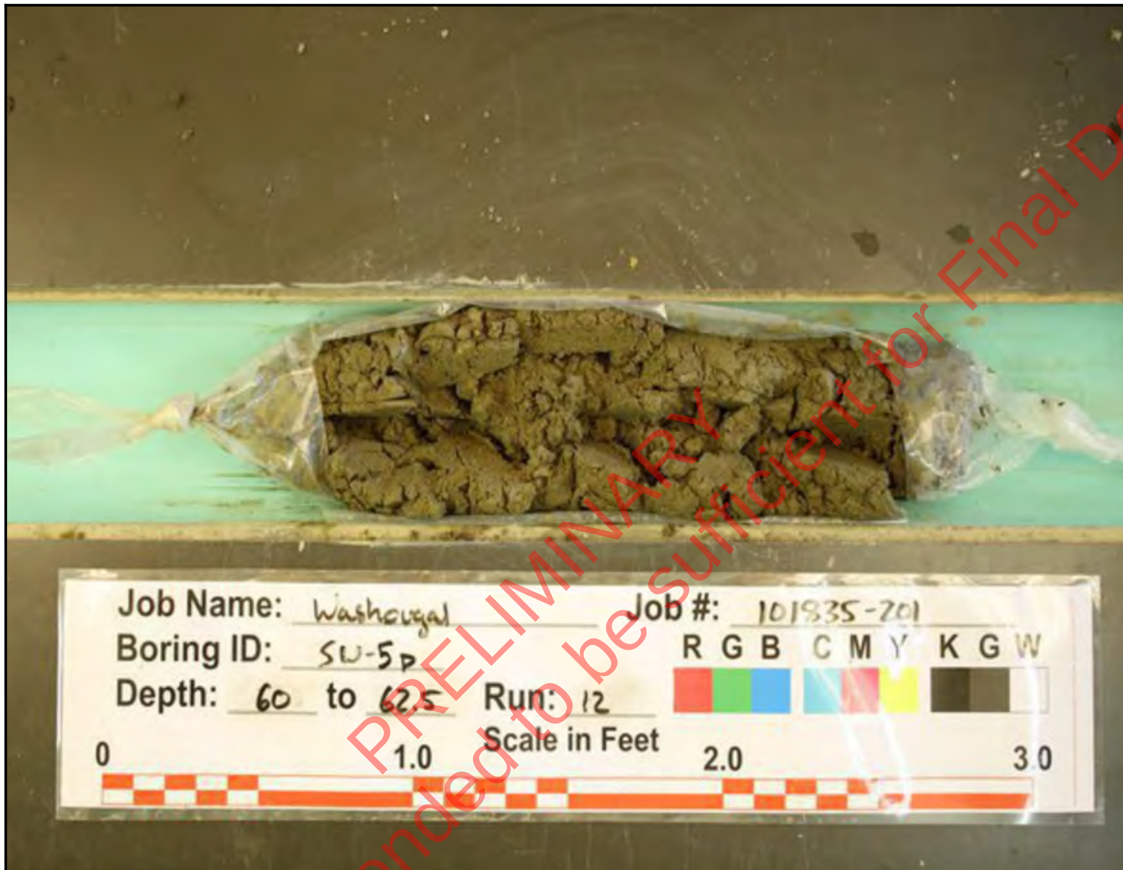
FIG. A-108



Washougal Grade Separation
Washougal, Washington

SW-5P-21_60.0-62.5

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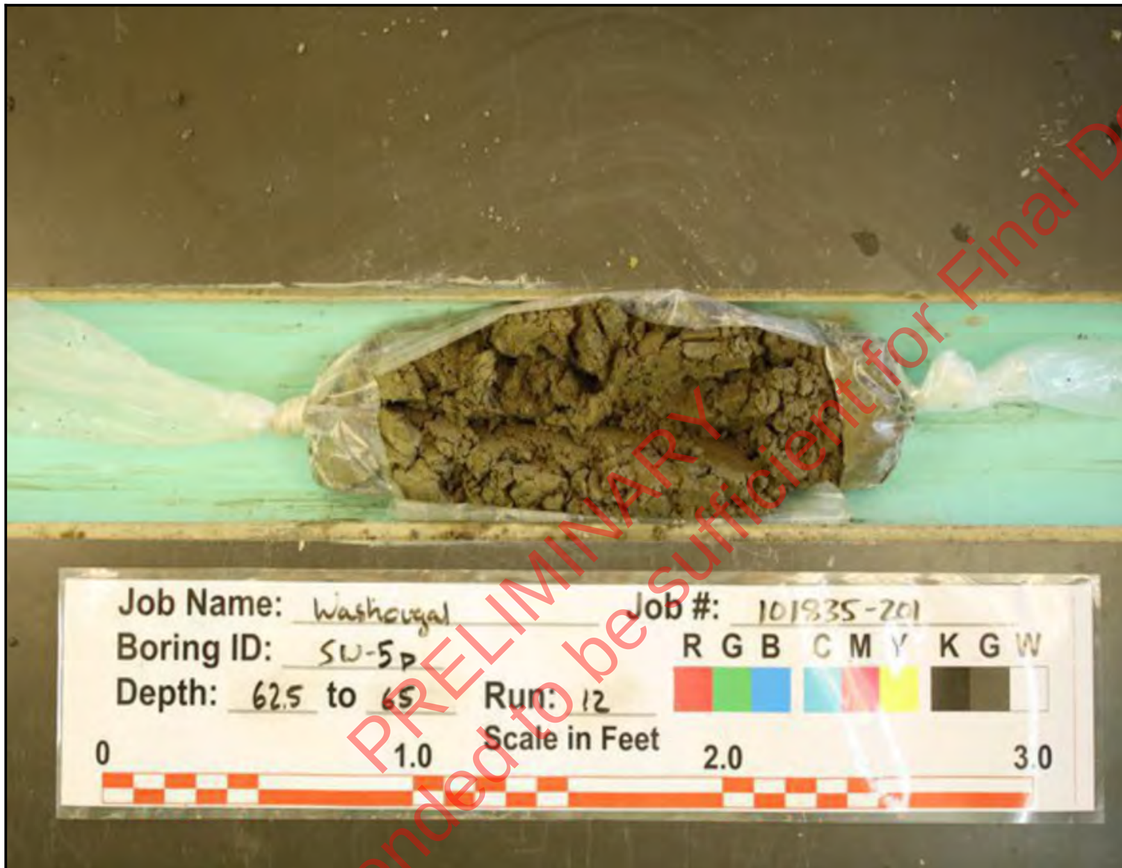
FIG. A-109

FIG. A-109



Washougal Grade Separation
Washougal, Washington

SW-5P-21_62.5-65.0

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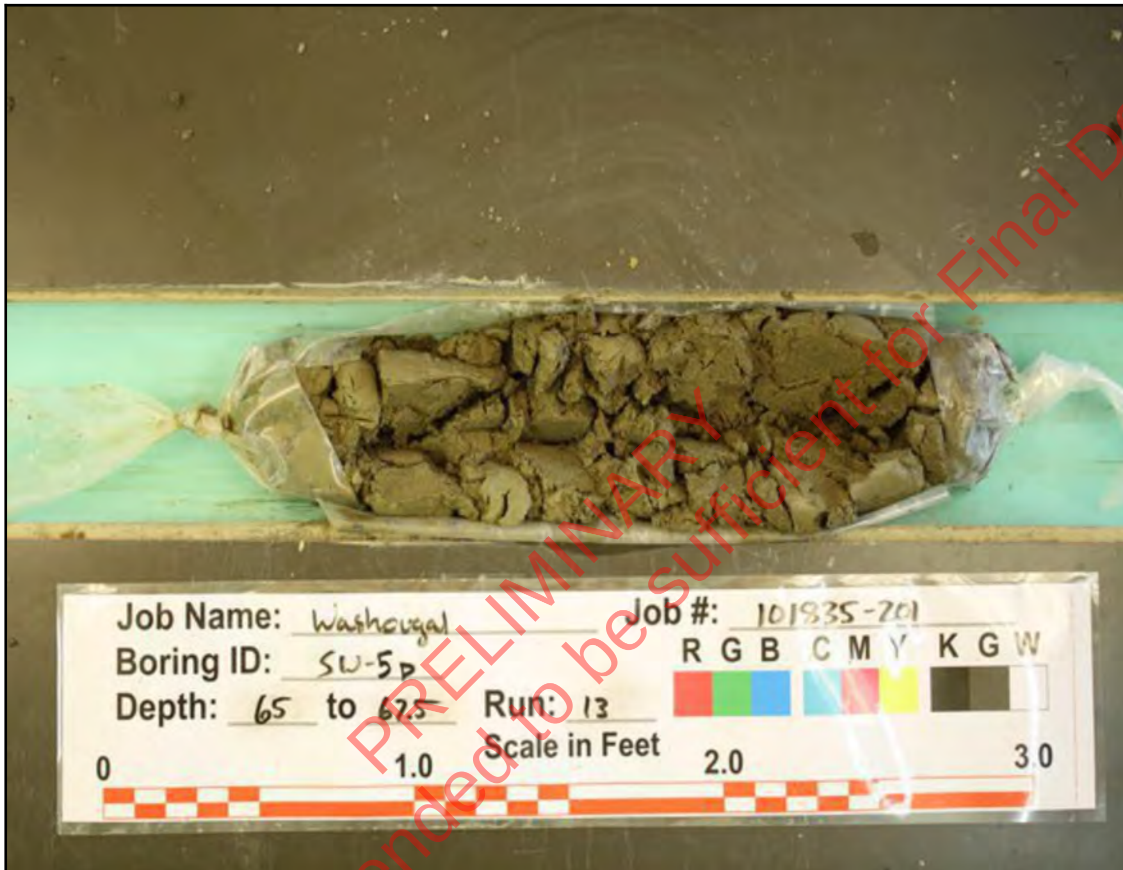
FIG. A-110



Washougal Grade Separation
Washougal, Washington

SW-5P-21_65.0-67.5

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FIG. A-111

FIG. A-111

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Washougal Grade Separation
Washougal, Washington

SW-5P-21_67.5-70.0

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FIG. A-112

FIG. A-112

Washougal Grade Separation
Washougal, Washington

SW-5P-21_70.0-71.0

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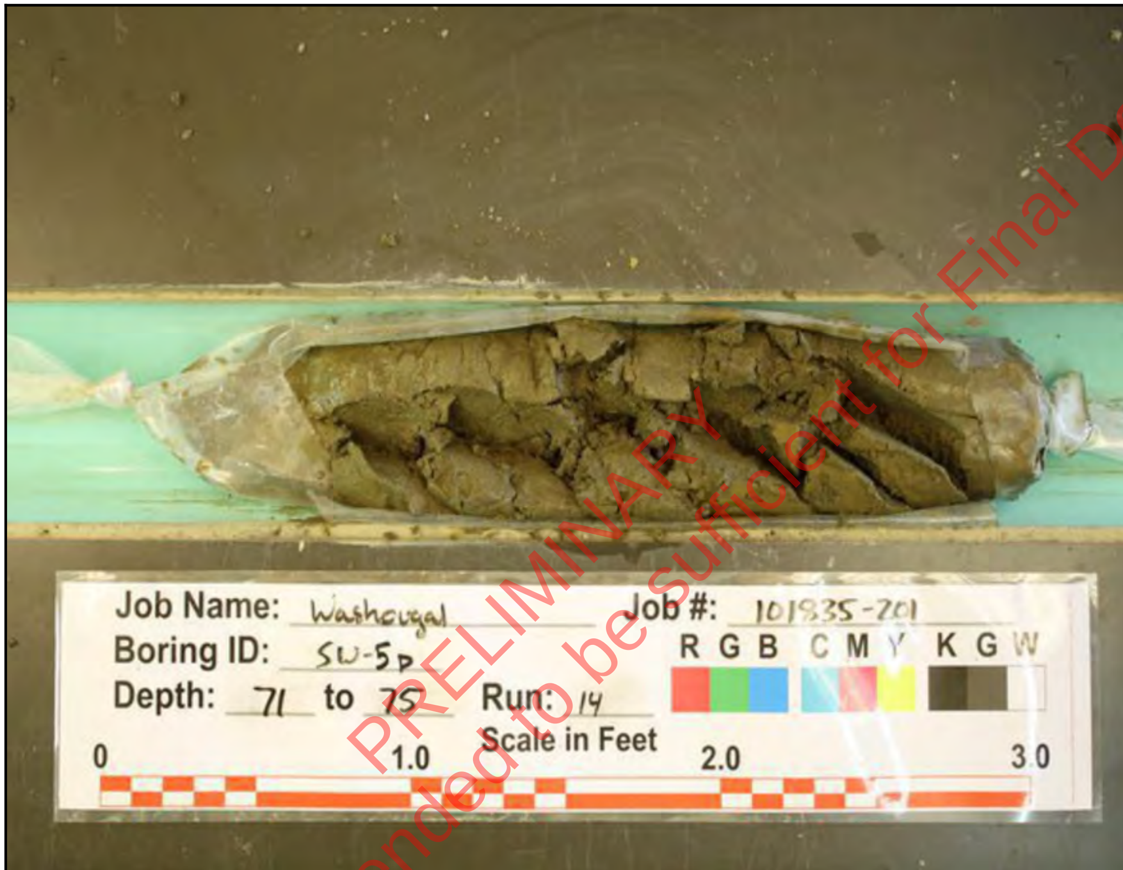
FIG. A-113

FIG. A-113



Washougal Grade Separation
Washougal, Washington

SW-5P-21_71.0-75.0

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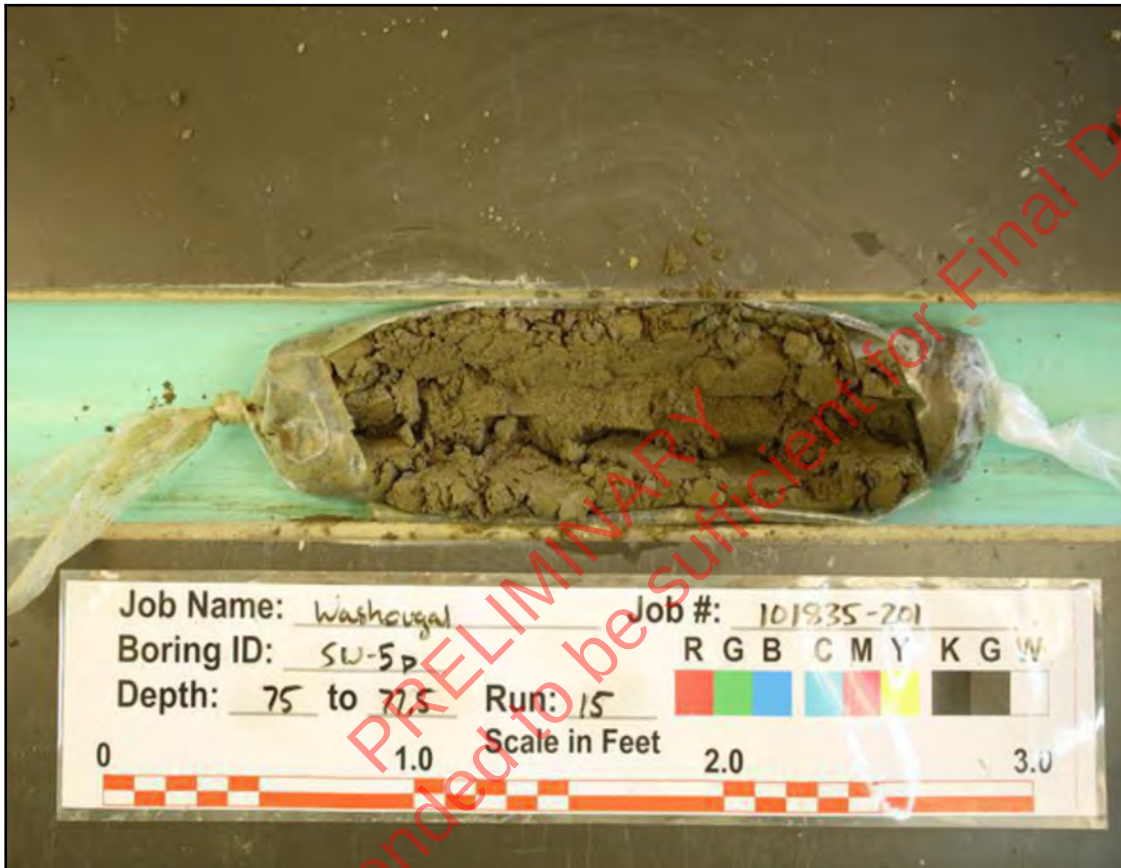
FIG. A-114

FIG. A-114



Washougal Grade Separation
Washougal, Washington

SW-5P-21_75.0-77.5

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FIG. A-115

Washougal Grade Separation
Washougal, Washington

SW-5P-21_77.5-80.0

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FIG. A-116

FIG. A-116

Washougal Grade Separation
Washougal, Washington

SW-6P-21_05.0-06.5

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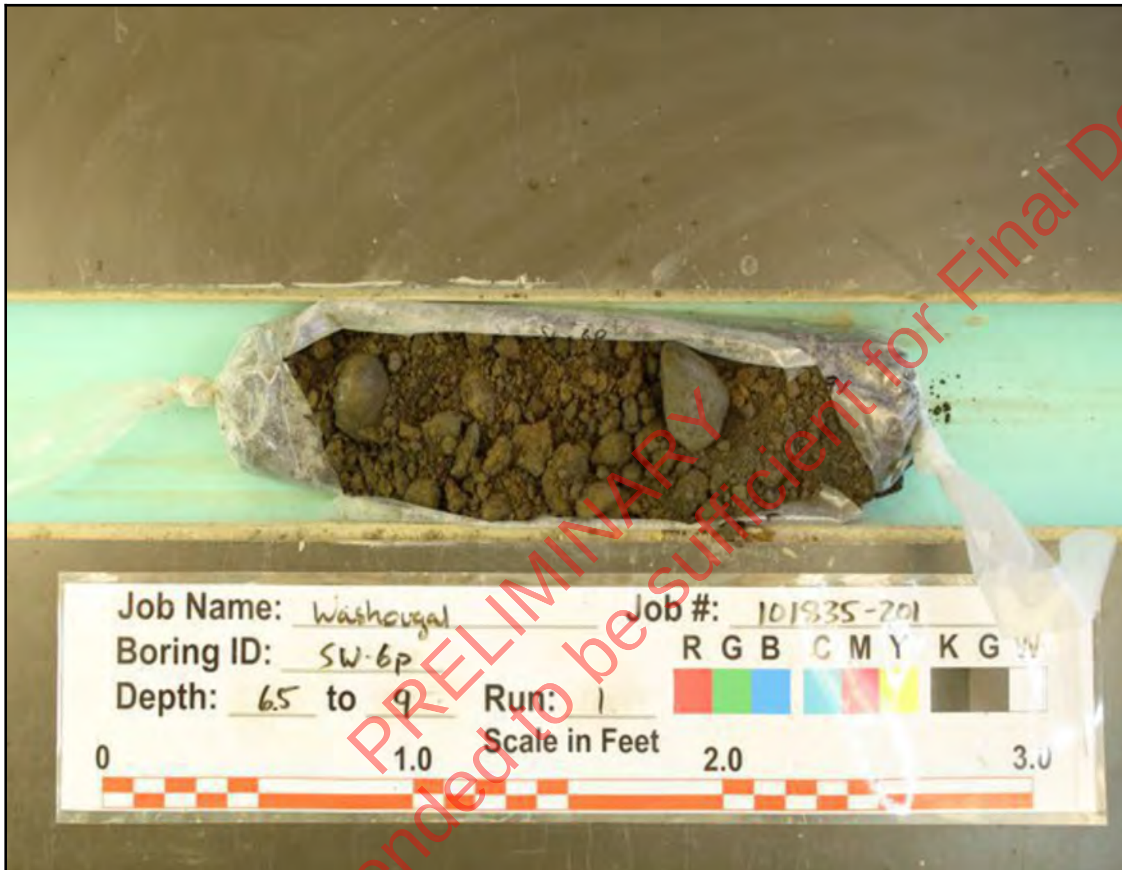
FIG. A-117

FIG. A-117



Washougal Grade Separation
Washougal, Washington

SW-6P-21_06.5-09.0

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FIG. A-118

FIG. A-118

Washougal Grade Separation
Washougal, Washington

SW-6P-21_09.0-10.0

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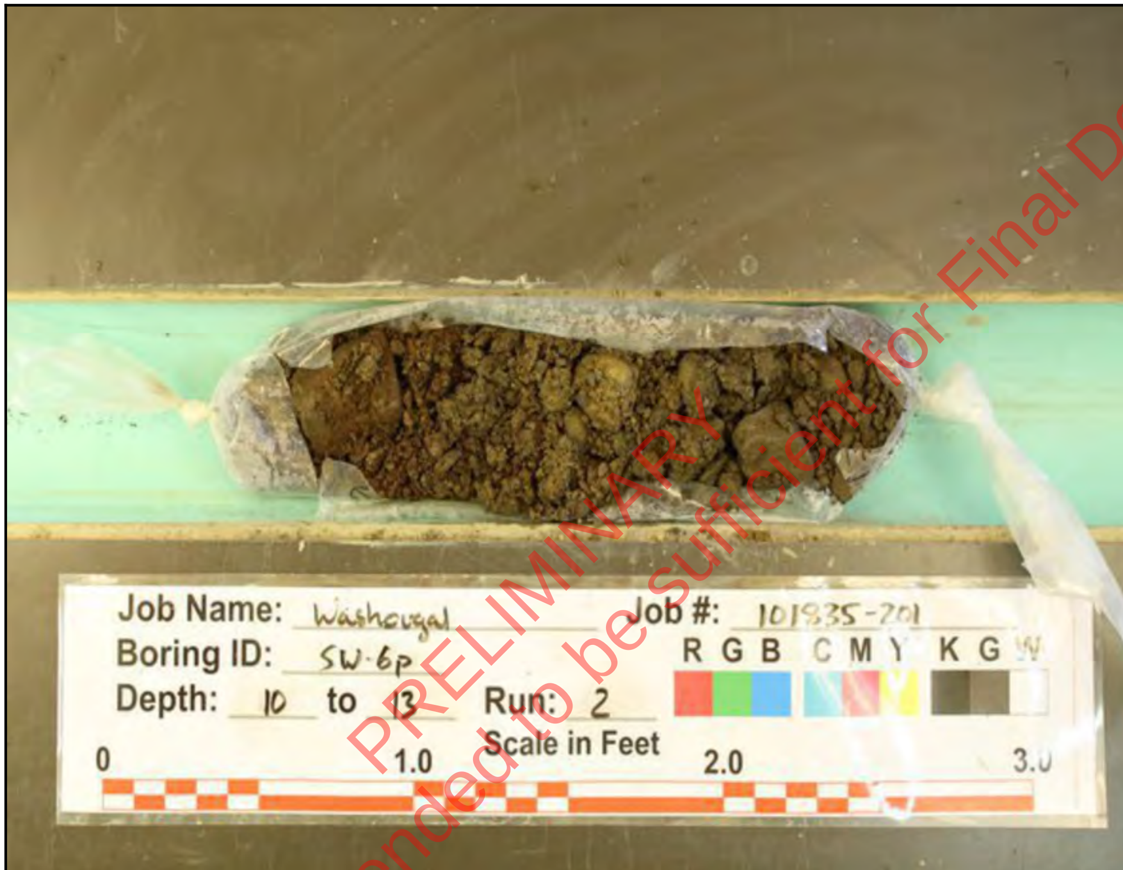
FIG. A-119

FIG. A-119



Washougal Grade Separation
Washougal, Washington

SW-6P-21_10.0-13.0

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FIG. A-120

Washougal Grade Separation
Washougal, Washington

SW-6P-21_13.0-15.0

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FIG. A-121

FIG. A-121

Washougal Grade Separation
Washougal, Washington

SW-6P-21_15.0-17.5

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FIG. A-122

FIG. A-122

Washougal Grade Separation
Washougal, Washington

SW-6P-21_17.5-20.0

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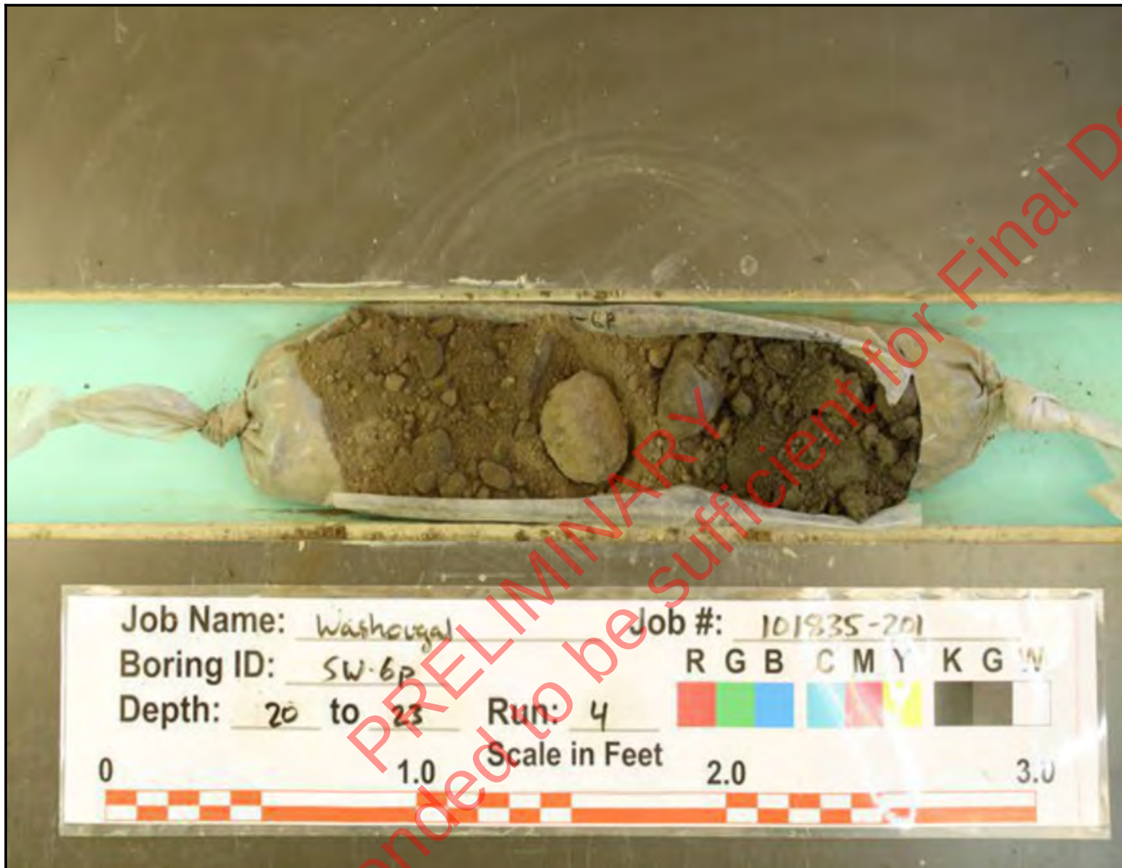
FIG. A-123

FIG. A-123



Washougal Grade Separation
Washougal, Washington

SW-6P-21_20.0-23.0

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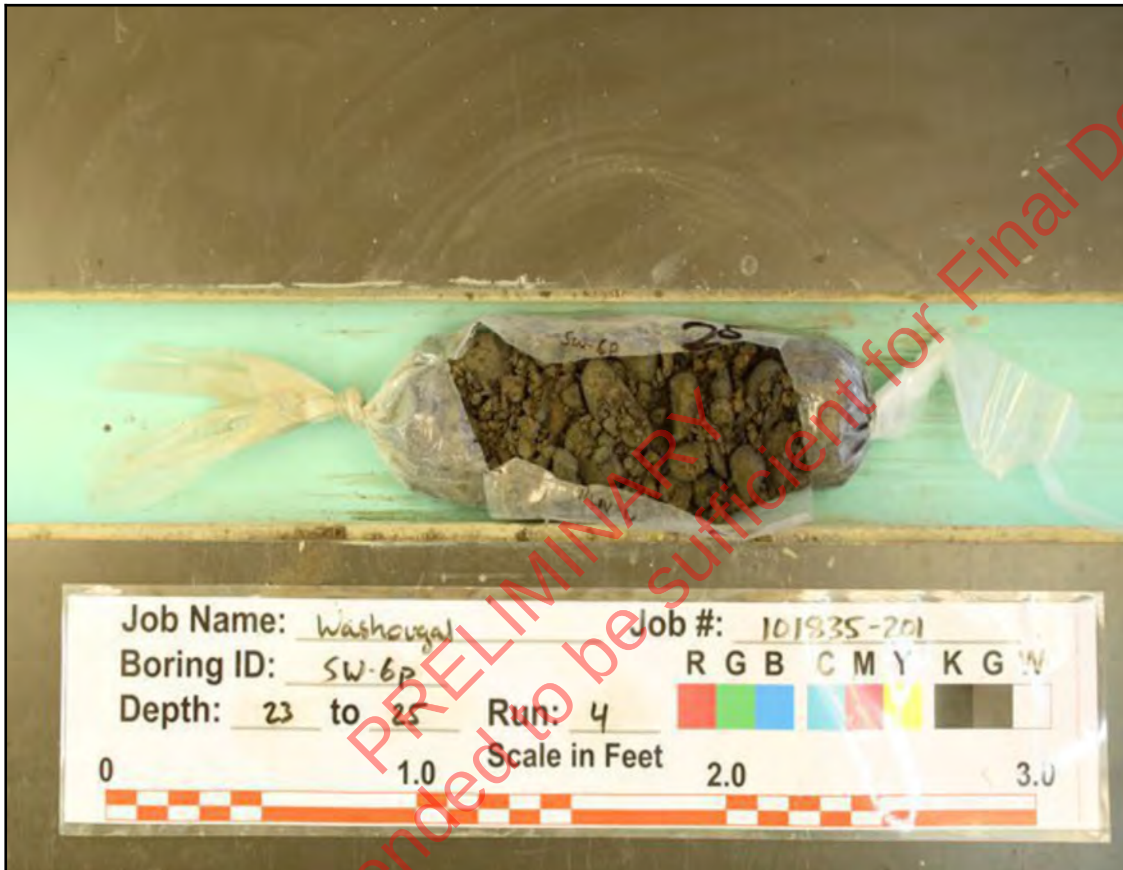
Geotechnical and Environmental Consultants

FIG. A-124

FIG. A-124



Washougal Grade Separation
Washougal, Washington

SW-6P-21_23.0-25.0

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FIG. A-125

Washougal Grade Separation
Washougal, Washington

SW-6P-21_25.0-28.0

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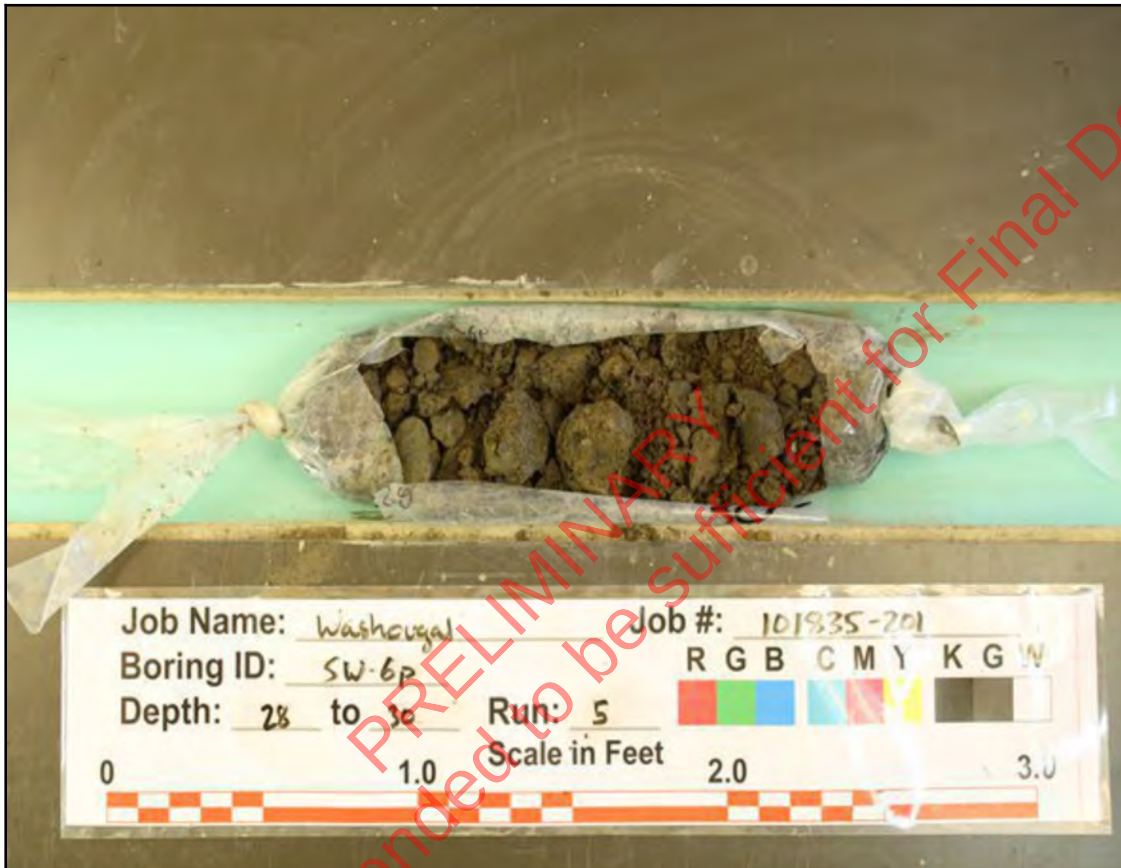
FIG. A-126



Washougal Grade Separation
Washougal, Washington

SW-6P-21_28.0-30.0

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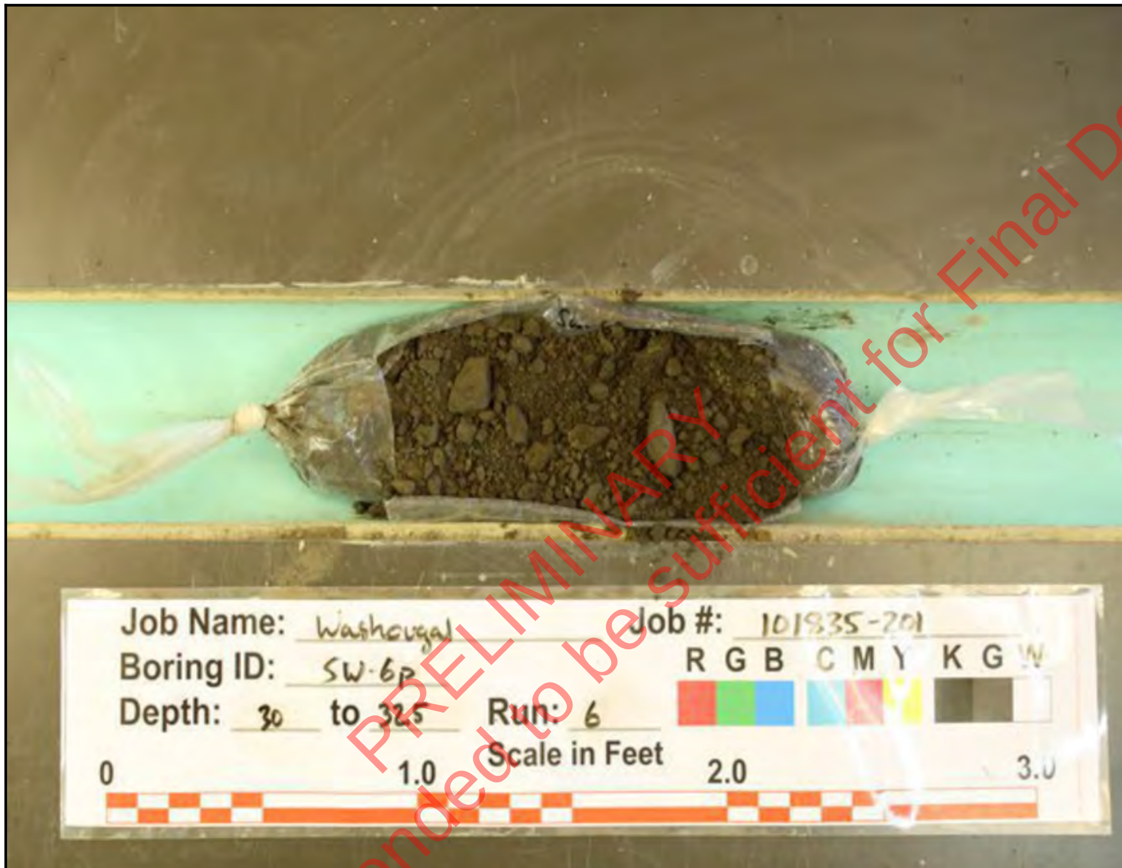
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-127

FIG. A-127



Washougal Grade Separation
Washougal, Washington

SW-6P-21_30.0-32.5

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Geotechnical and Environmental Consultants

FIG. A-128

FIG. A-128

Washougal Grade Separation
Washougal, Washington

SW-6P-21_32.5-35.0

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FIG. A-129

FIG. A-129

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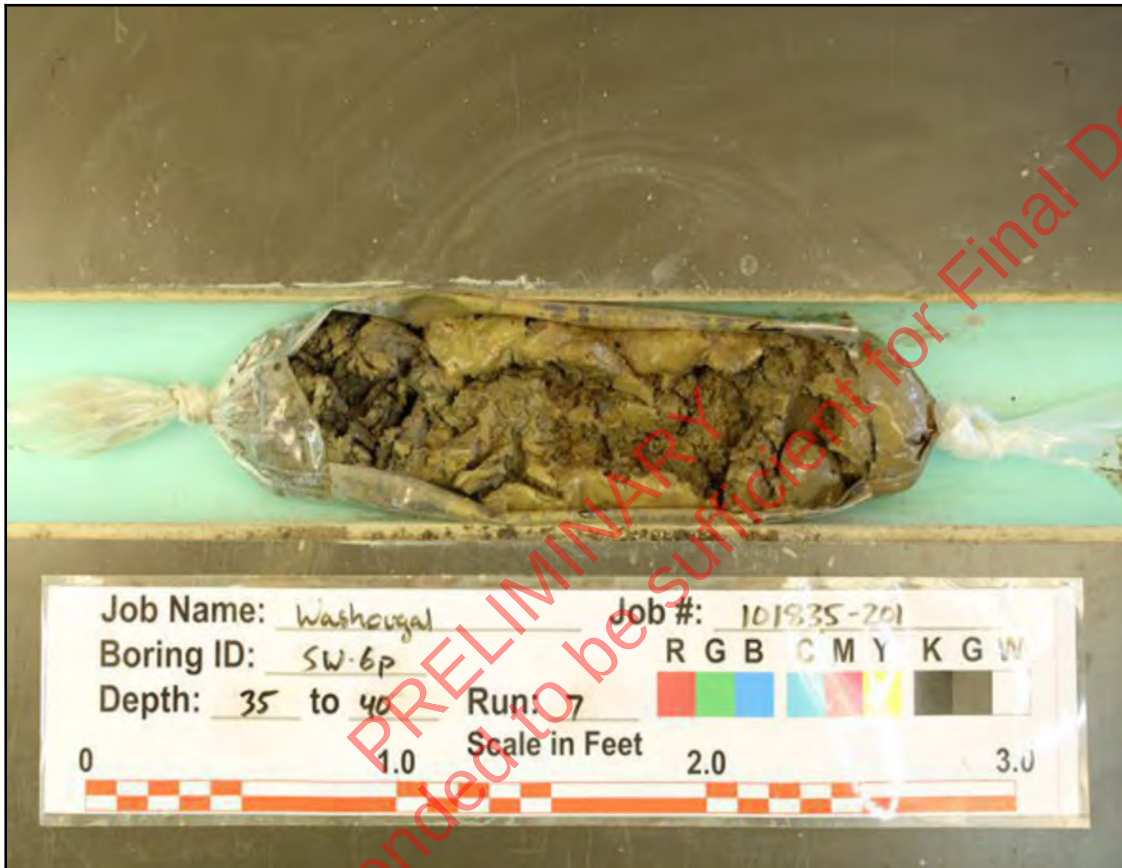

Washougal Grade Separation
Washougal, Washington

SW-6P-21_35.0-40.0

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SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-130

FIG. A-130

Washougal Grade Separation
Washougal, Washington

SW-6P-21_40.0-45.0

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FIG. A-131

FIG. A-131

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ver:0.13.0, by:AJB

Washougal Grade Separation
Washougal, Washington

SW-6P-21_45.0-47.0

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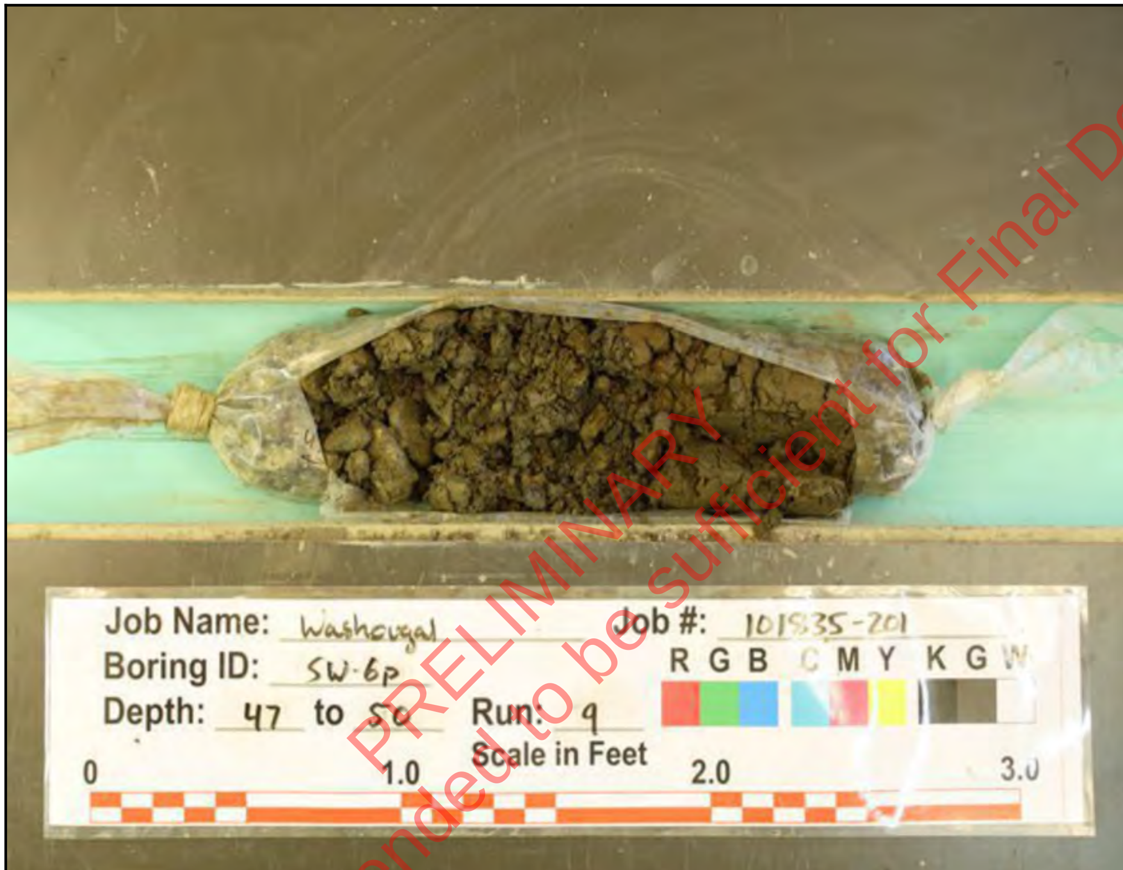
Geotechnical and Environmental Consultants

FIG. A-132

FIG. A-132



Washougal Grade Separation
Washougal, Washington

SW-6P-21_47.0-50.0

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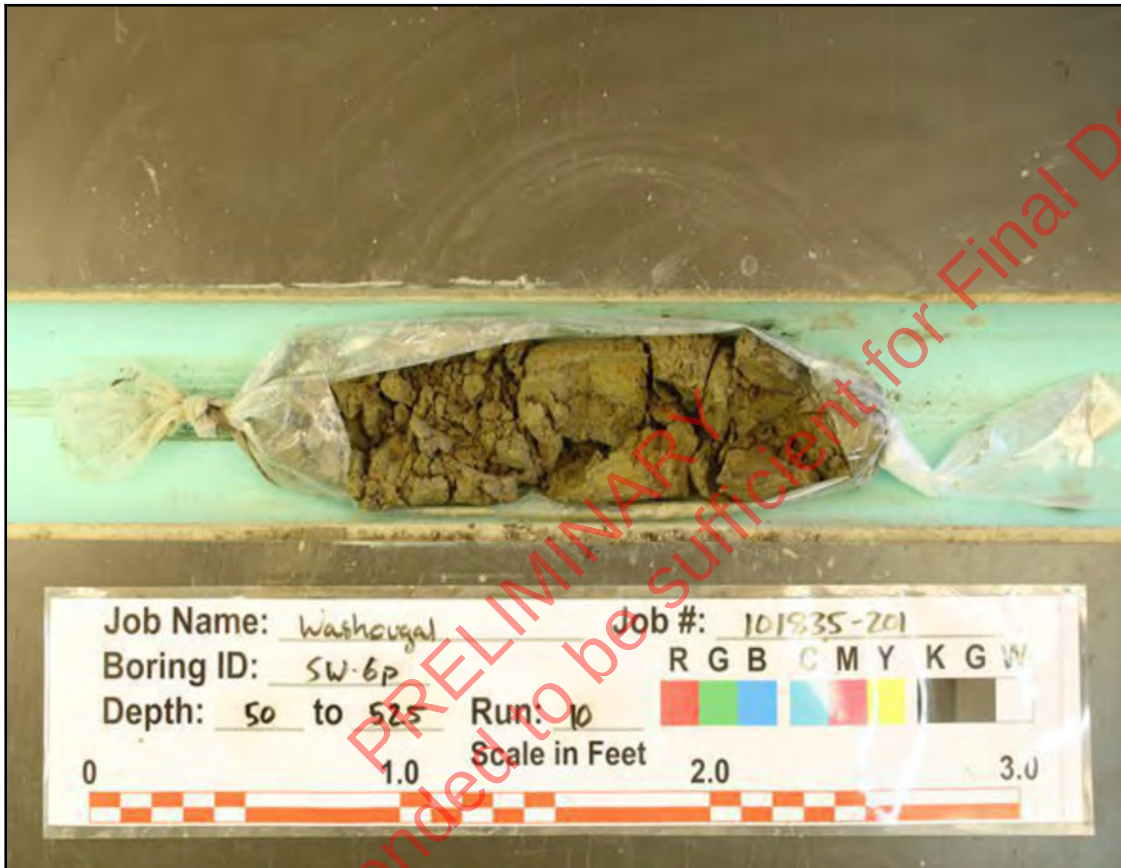
Geotechnical and Environmental Consultants

FIG. A-133

FIG. A-133



Washougal Grade Separation
Washougal, Washington

SW-6P-21_50.0-52.5

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SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-134

FIG. A-134

Washougal Grade Separation
Washougal, Washington

SW-6P-21_52.5-55.0

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FIG. A-135

FIG. A-135

Washougal Grade Separation
Washougal, Washington

SW-6P-21_55.0-57.5

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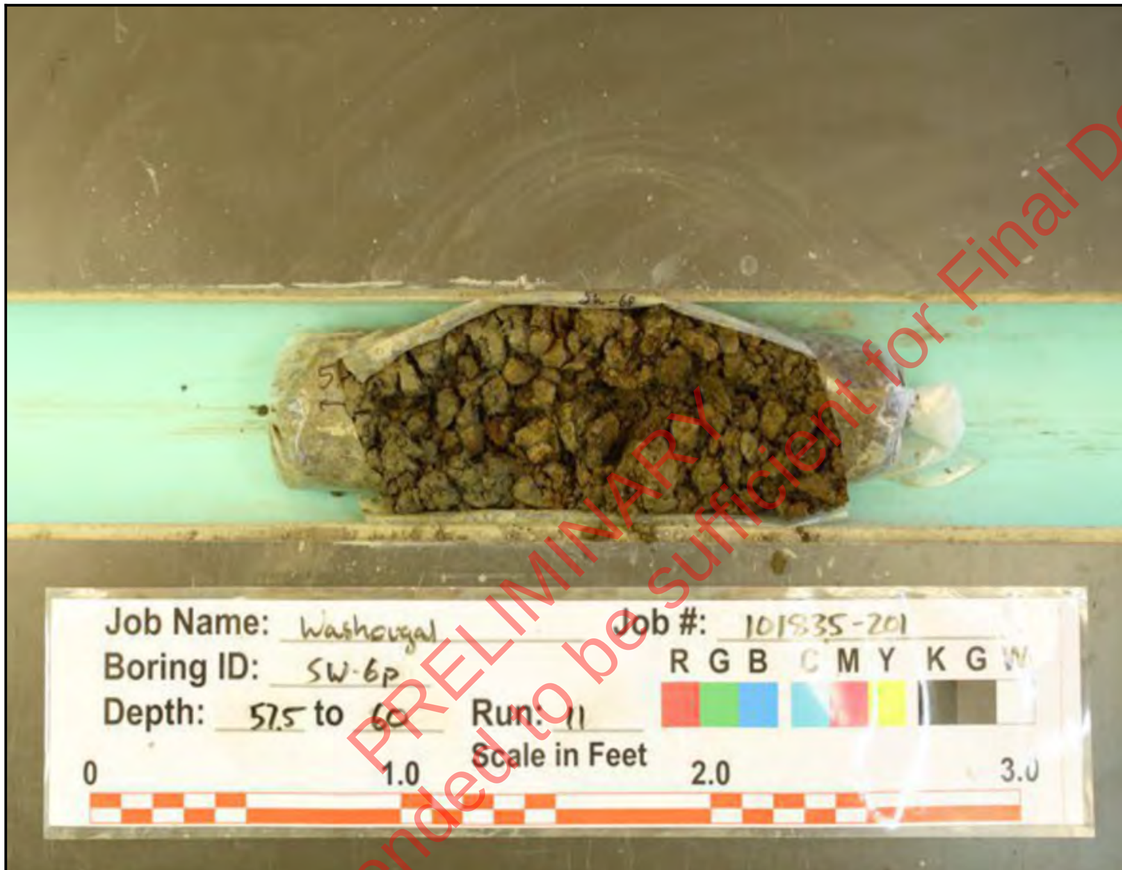
FIG. A-136

FIG. A-136



Washougal Grade Separation
Washougal, Washington

SW-6P-21_57.5-60.0

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FIG. A-137

FIG. A-137

Washougal Grade Separation
Washougal, Washington

SW-8P-21_05.0-08.0

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SHANNON & WILSON, INC.
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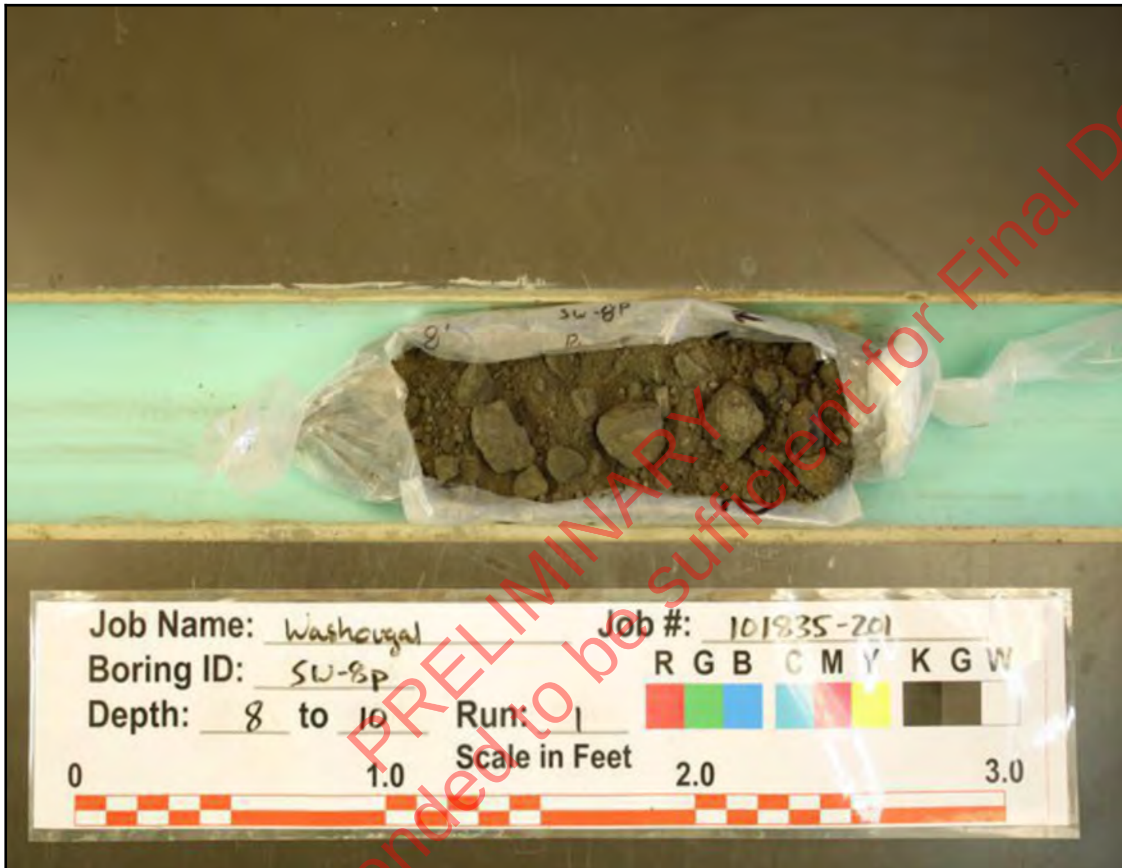
FIG. A-138



Washougal Grade Separation
Washougal, Washington

SW-8P-21_08.0-10.0

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FIG. A-139

FIG. A-139

Washougal Grade Separation
Washougal, Washington

SW-8P-21_10.0-12.5

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SHANNON & WILSON, INC.
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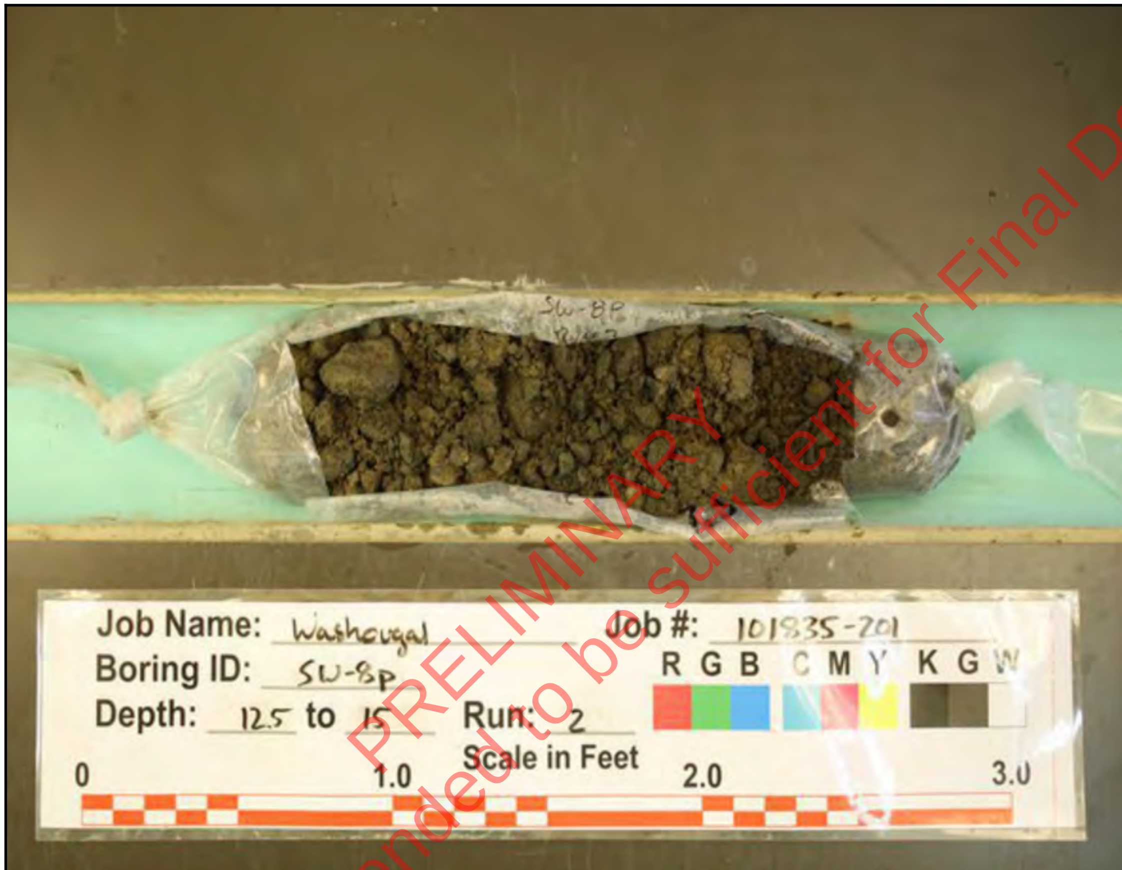
FIG. A-140



Washougal Grade Separation
Washougal, Washington

SW-8P-21_12.5-15.0

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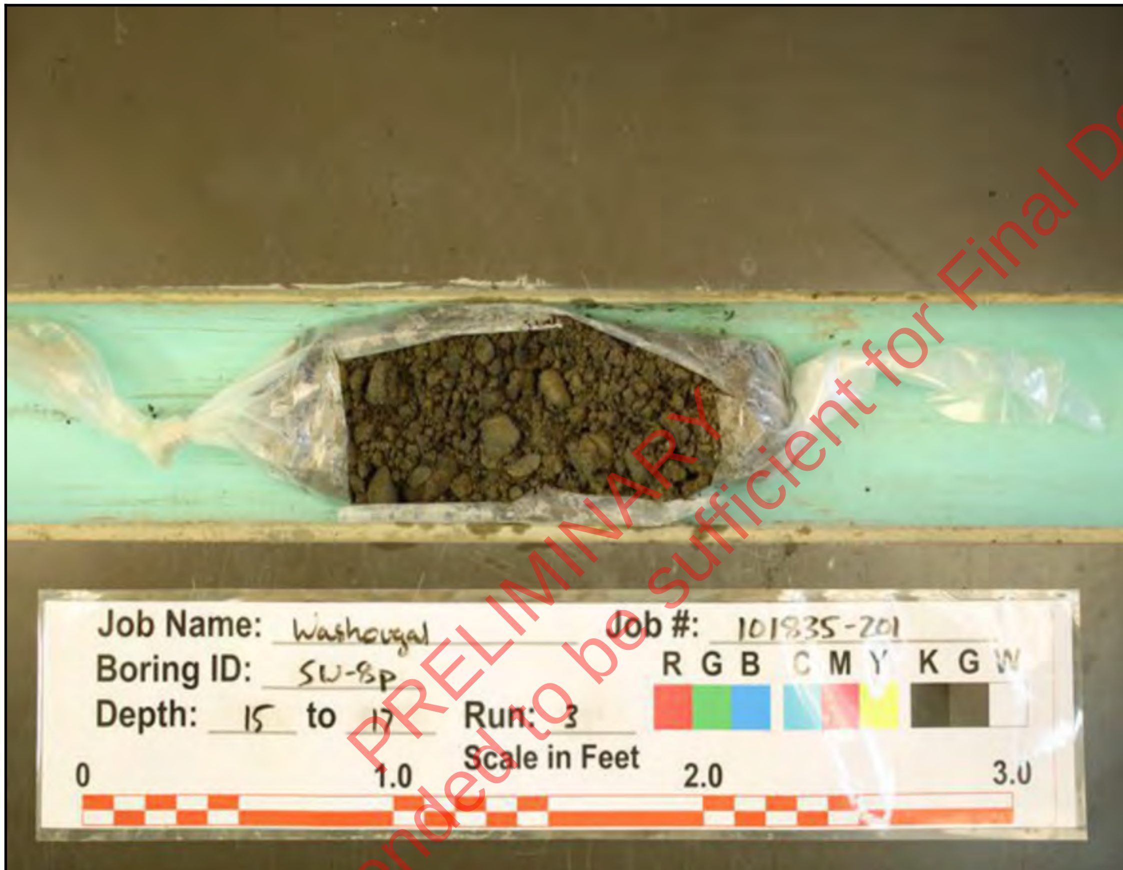
FIG. A-141

FIG. A-141



Washougal Grade Separation
Washougal, Washington

SW-8P-21_15.0-17.0

October 2021 101835-202

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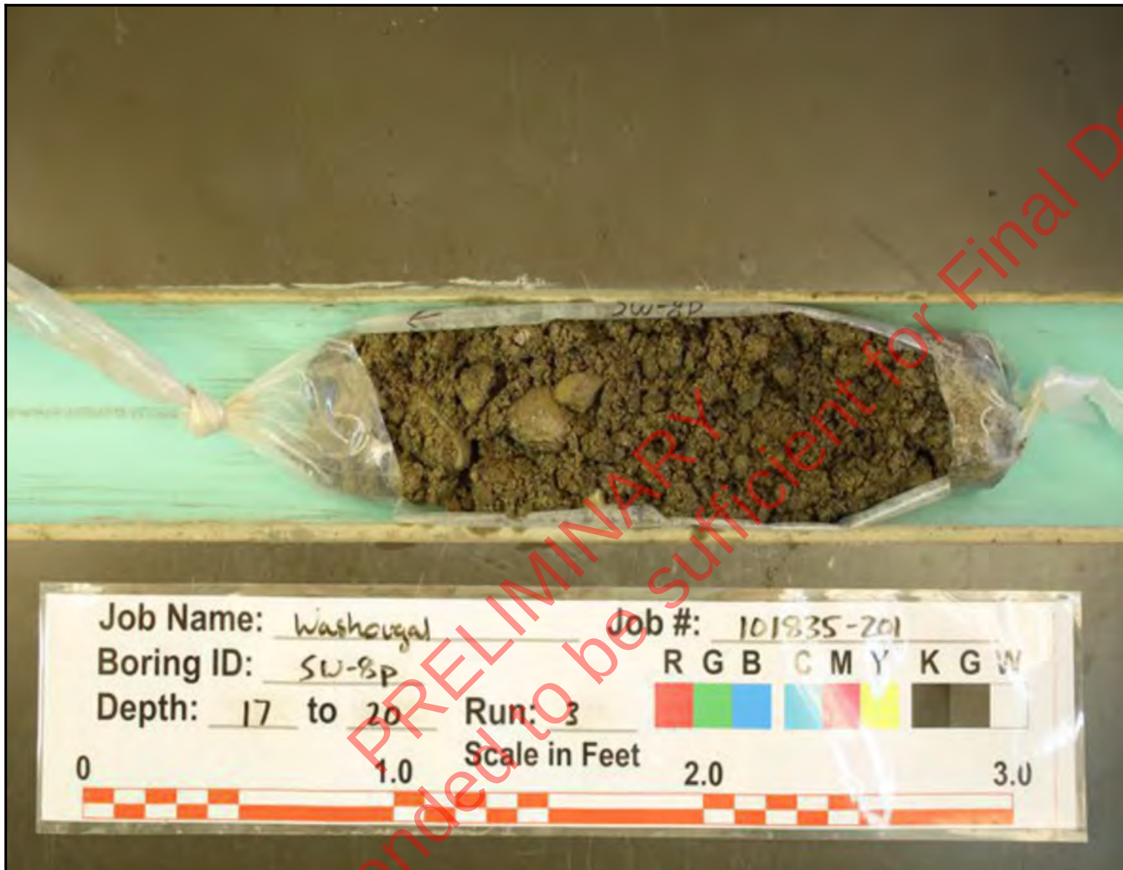
FIG. A-142



Washougal Grade Separation
Washougal, Washington

SW-8P-21_17.0-20.0

October 2021 101835-202

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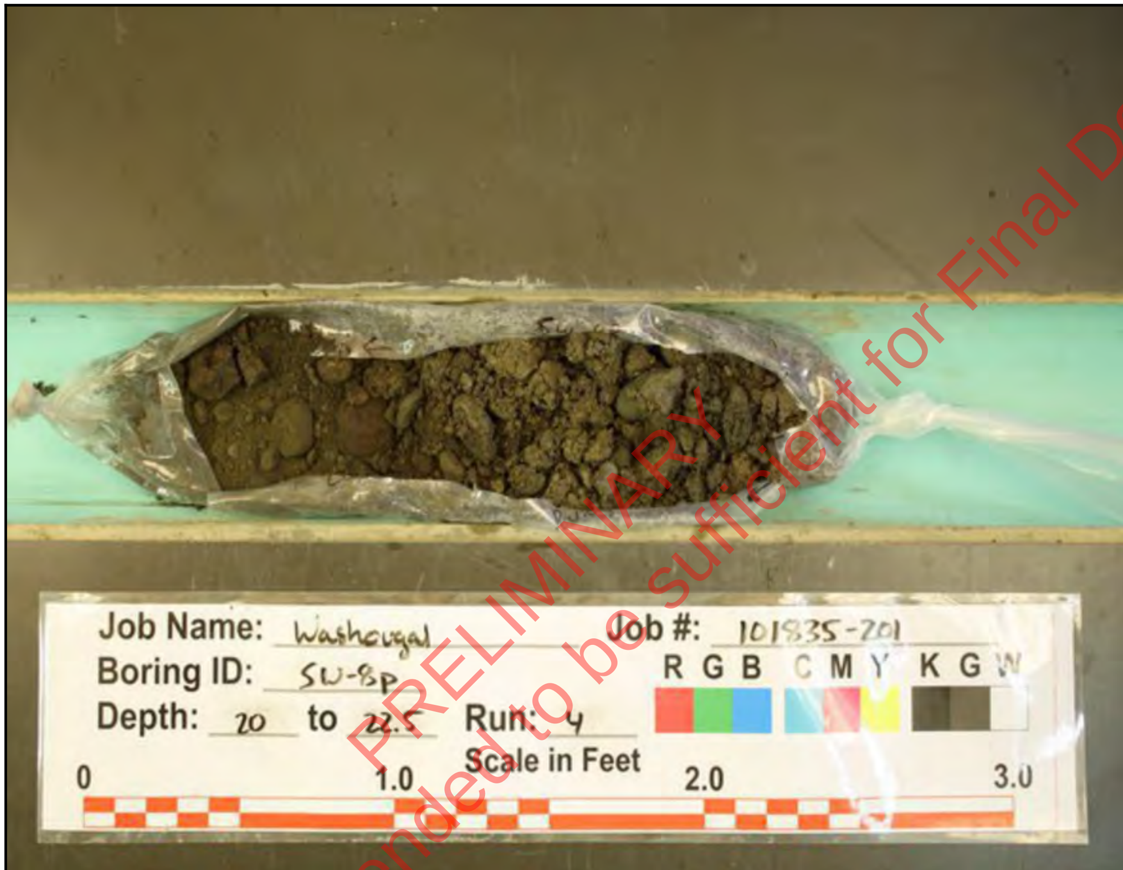
FIG. A-143



Washougal Grade Separation
Washougal, Washington

SW-8P-21_20.0-22.5

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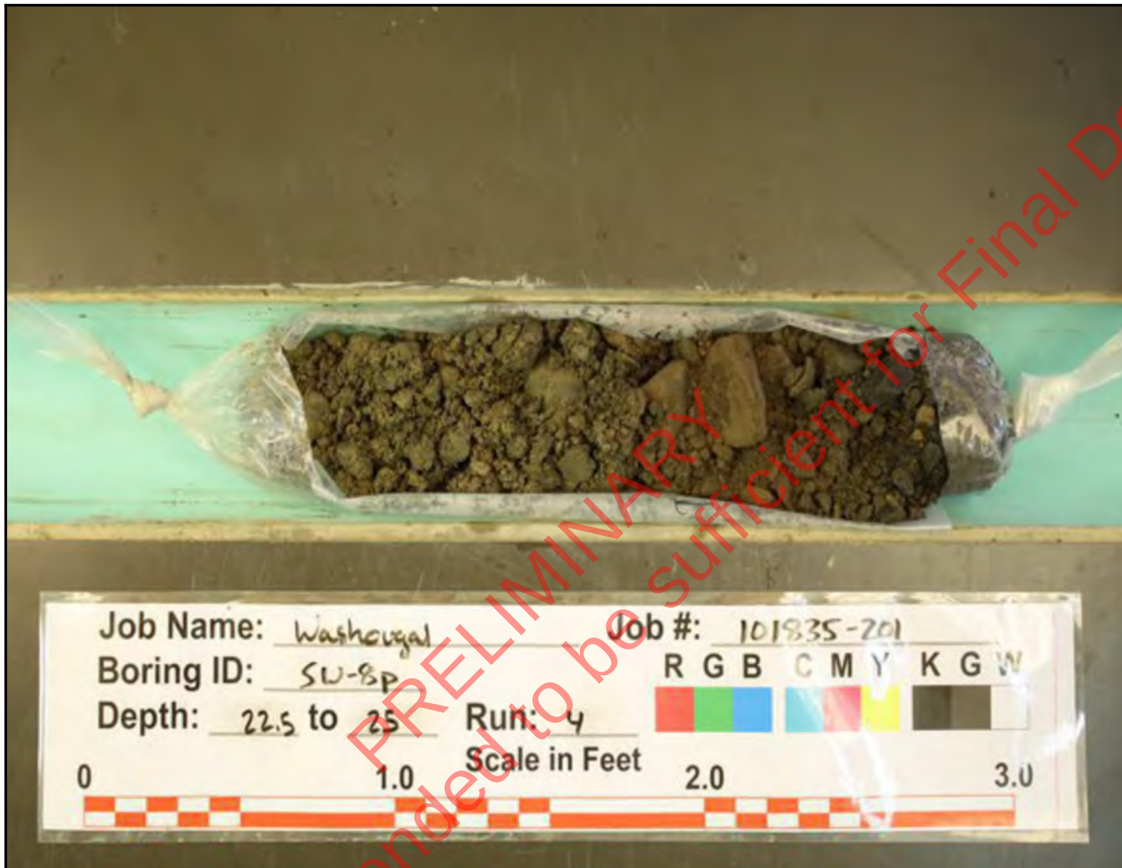
FIG. A-144

FIG. A-144



Washougal Grade Separation
Washougal, Washington

SW-8P-21_22.5-25.0

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FIG. A-145

FIG. A-145

Washougal Grade Separation
Washougal, Washington

SW-8P-21_25.0-26.5

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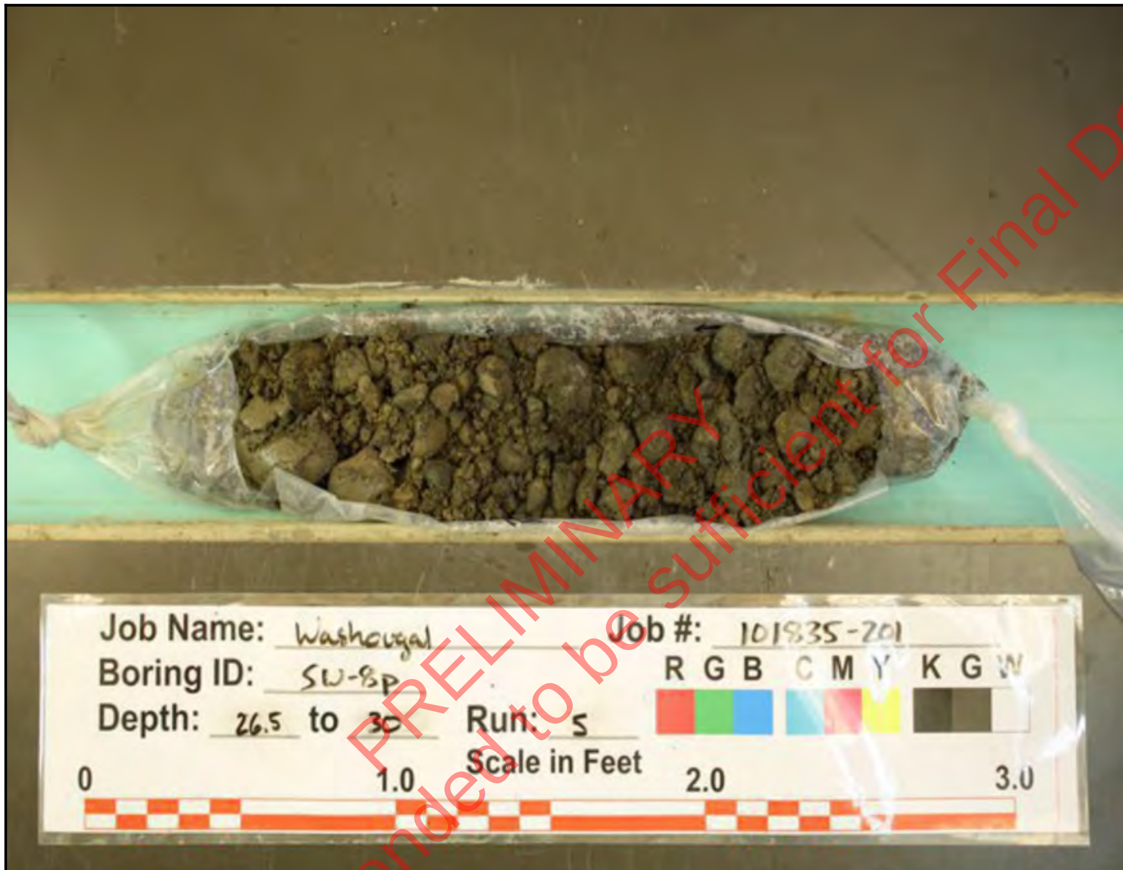
FIG. A-146

FIG. A-146



Washougal Grade Separation
Washougal, Washington

SW-8P-21_26.5-30.0

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FIG. A-147

FIG. A-147

Washougal Grade Separation
Washougal, Washington

SW-8P-21_30.0-32.5

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FIG. A-148

FIG. A-148

Washougal Grade Separation
Washougal, Washington

SW-8P-21_32.5-35.0

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FIG. A-149

FIG. A-149

Washougal Grade Separation
Washougal, Washington

SW-8P-21_35.0-36.5

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FIG. A-150

FIG. A-150

Washougal Grade Separation
Washougal, Washington

SW-8P-21_36.5-40.0

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FIG. A-151

FIG. A-151

Washougal Grade Separation
Washougal, Washington

SW-8P-21_40.0-45.0

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FIG. A-152

FIG. A-152

Washougal Grade Separation
Washougal, Washington

SW-8P-21_45.0-50.0

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FIG. A-153

FIG. A-153

Washougal Grade Separation
Washougal, Washington

SW-8P-21_50.0-53.0

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FIG. A-154

FIG. A-154

Washougal Grade Separation
Washougal, Washington

SW-8P-21_53.0-55.0

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FIG. A-155

FIG. A-155

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Washougal Grade Separation
Washougal, Washington

SW-8P-21_55.0-57.0

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FIG. A-156

FIG. A-156

Washougal Grade Separation
Washougal, Washington

SW-8P-21_57.0-60.0

October 2021 101835-202

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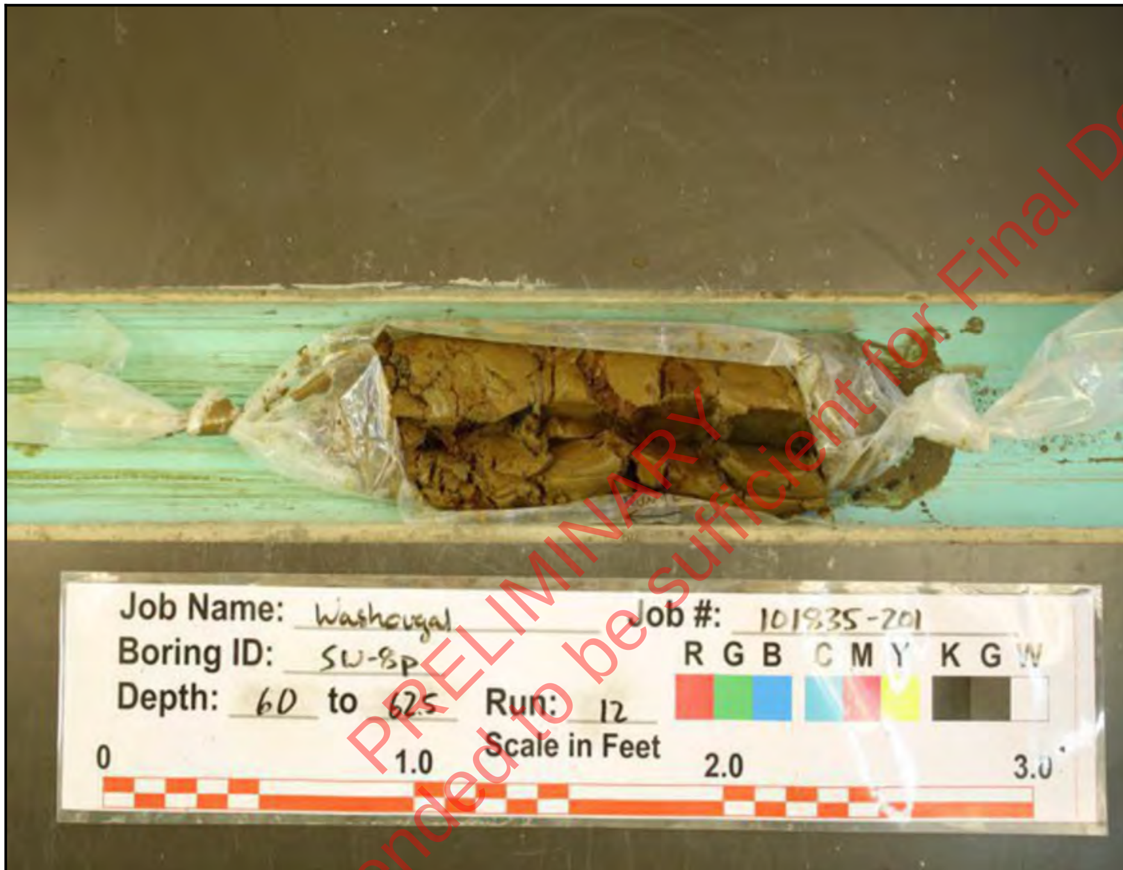
FIG. A-157



Washougal Grade Separation
Washougal, Washington

SW-8P-21_60.0-62.5

October 2021 101835-202

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FIG. A-158

FIG. A-158

Washougal Grade Separation
Washougal, Washington

SW-8P-21_62.5-65.0

October 2021 101835-202

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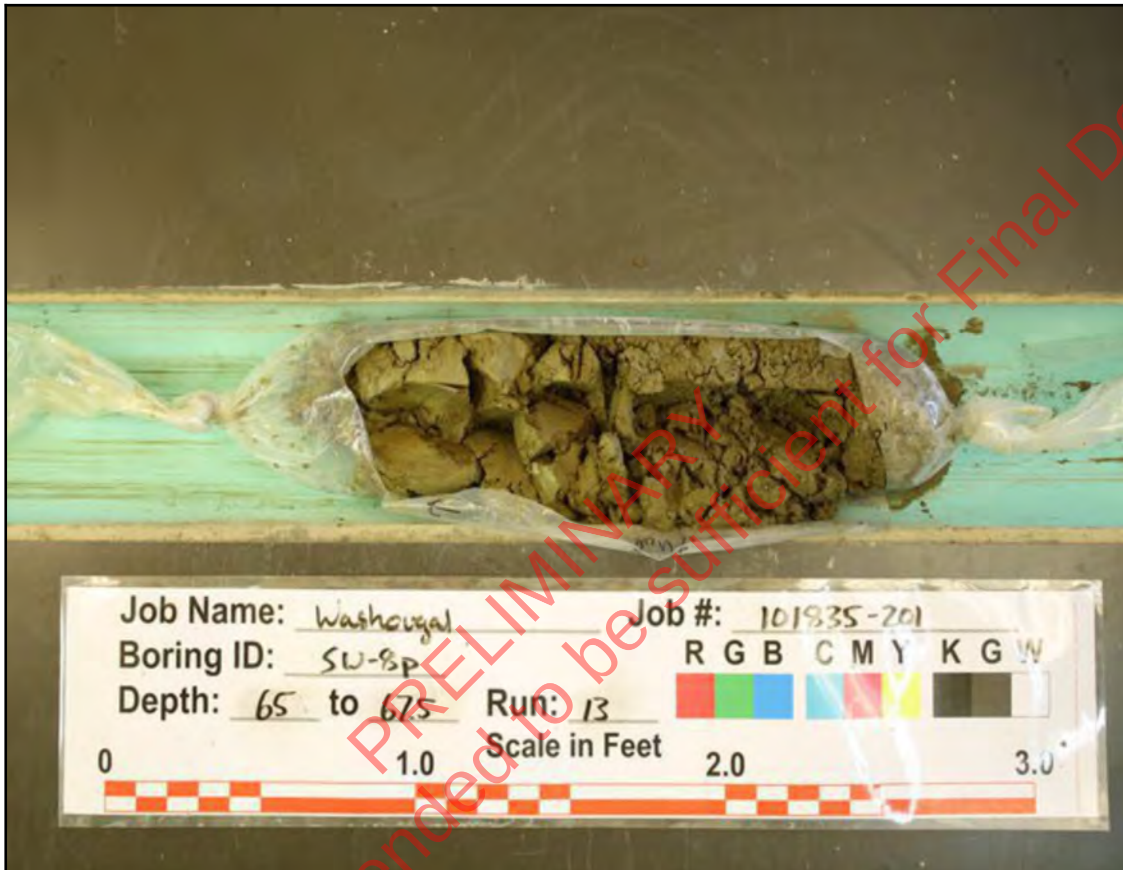
FIG. A-159

FIG. A-159



Washougal Grade Separation
Washougal, Washington

SW-8P-21_65.0-67.5

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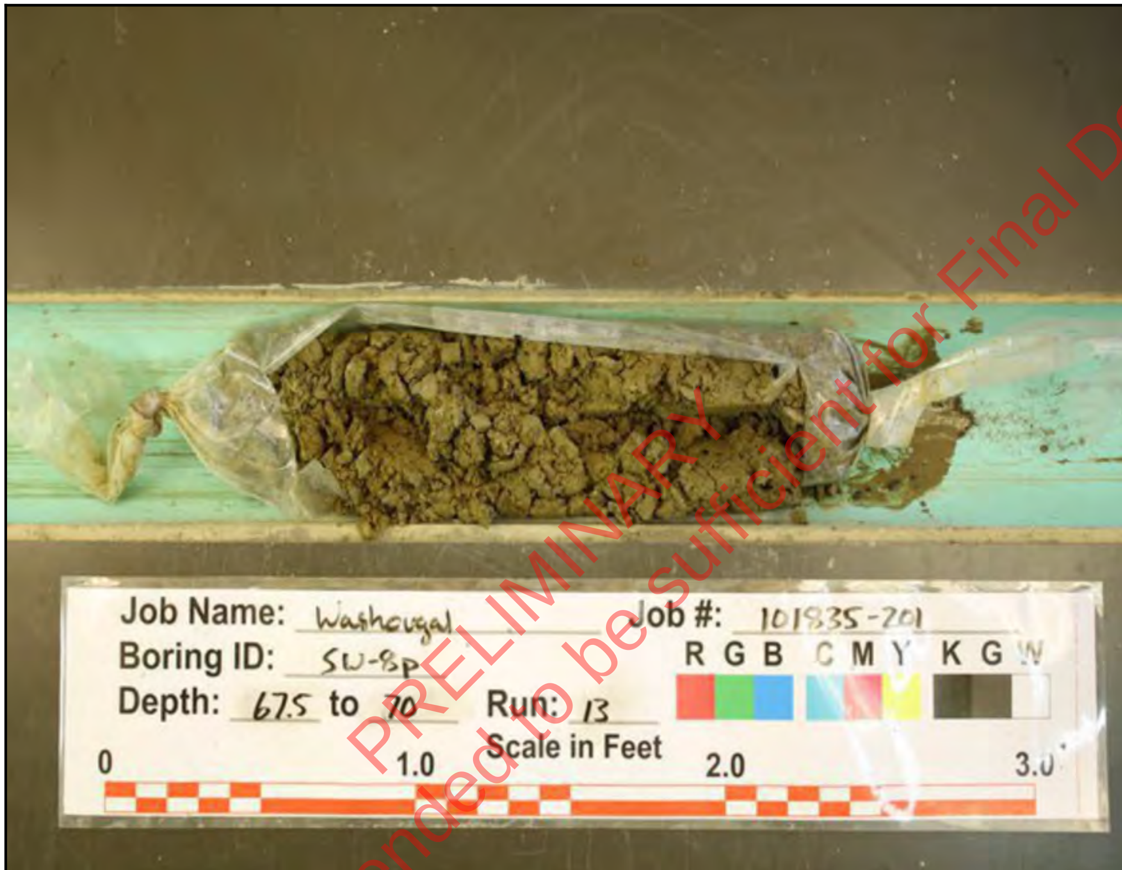
FIG. A-160

FIG. A-160



Washougal Grade Separation
Washougal, Washington

SW-8P-21_67.5-70.0

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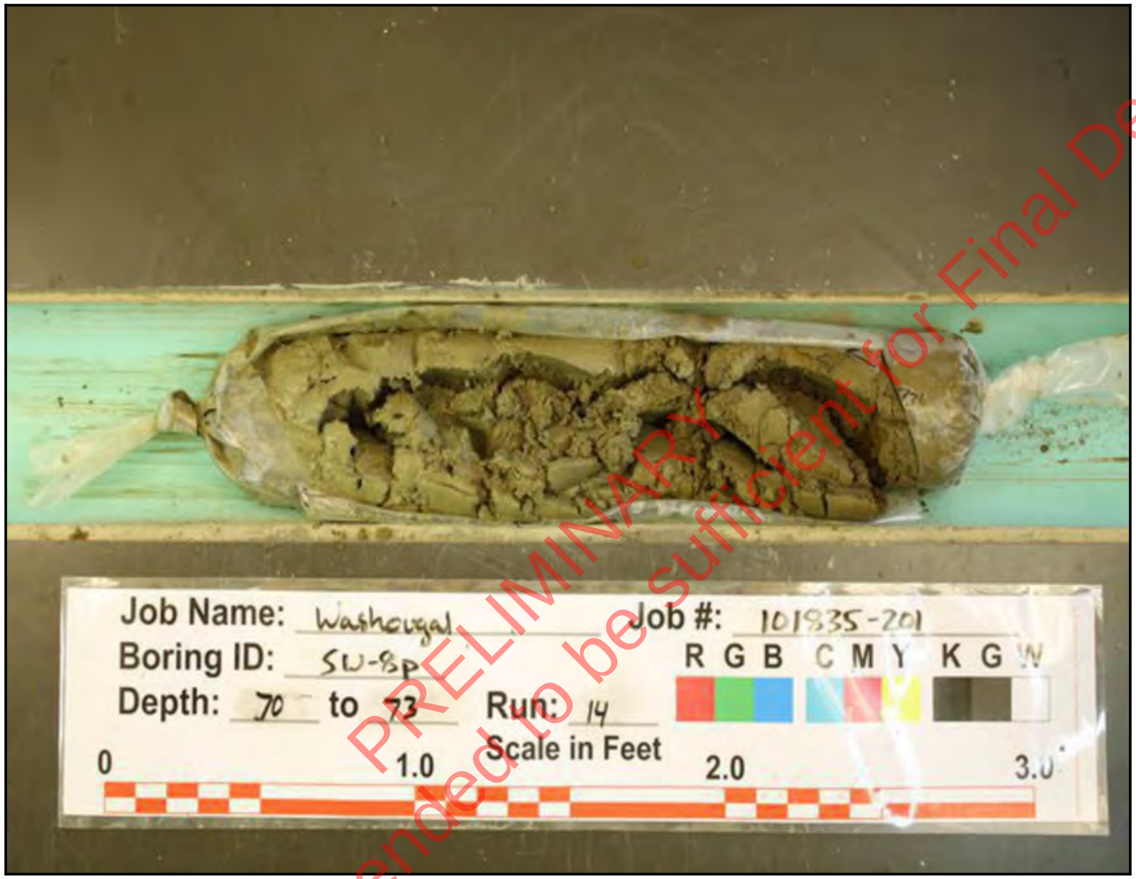
FIG. A-161

FIG. A-161



Washougal Grade Separation
Washougal, Washington

SW-8P-21_70.0-73.0

October 2021 101835-202

SHANNON & WILSON, INC.
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FIG. A-162

FIG. A-162

Washougal Grade Separation
Washougal, Washington

SW-8P-21_73.0-75.0

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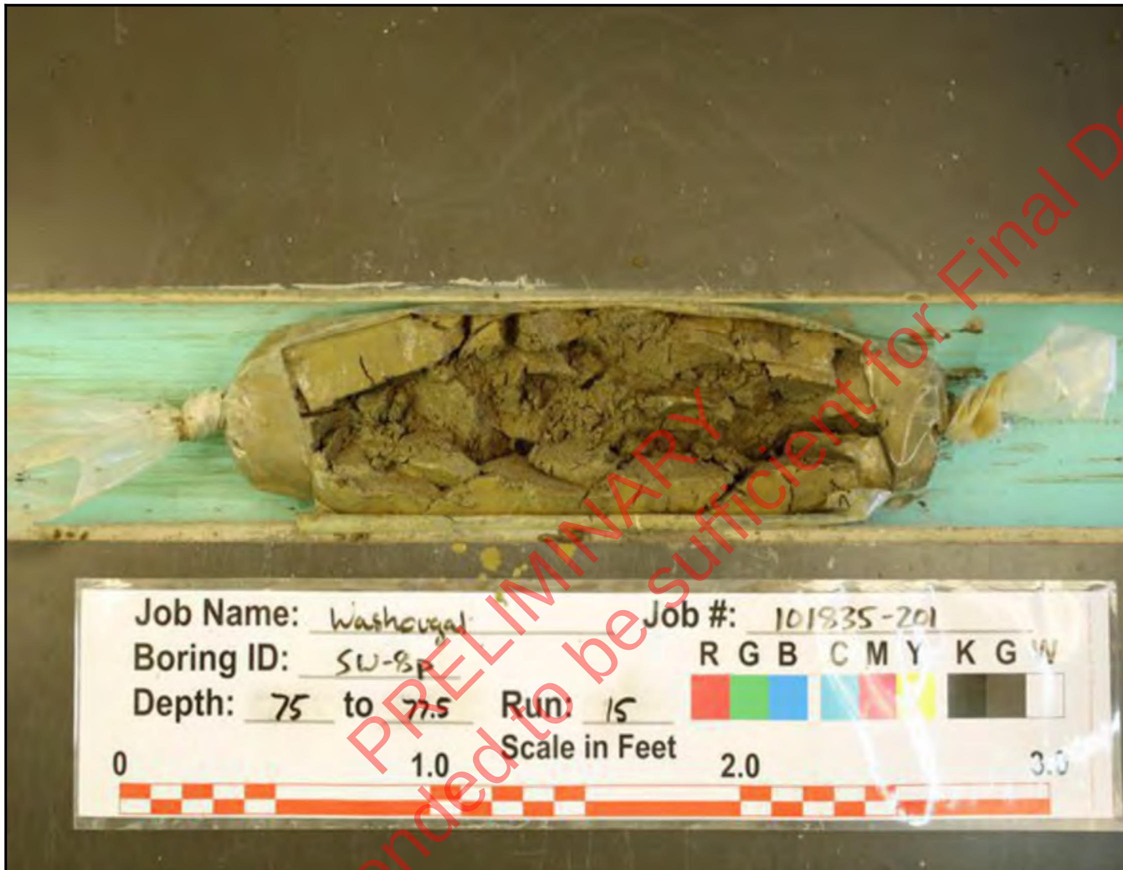
FIG. A-163

FIG. A-163



Washougal Grade Separation
Washougal, Washington

SW-8P-21_75.0-77.5

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FIG. A-164

FIG. A-164

Washougal Grade Separation
Washougal, Washington

SW-8P-21_77.5-80.0

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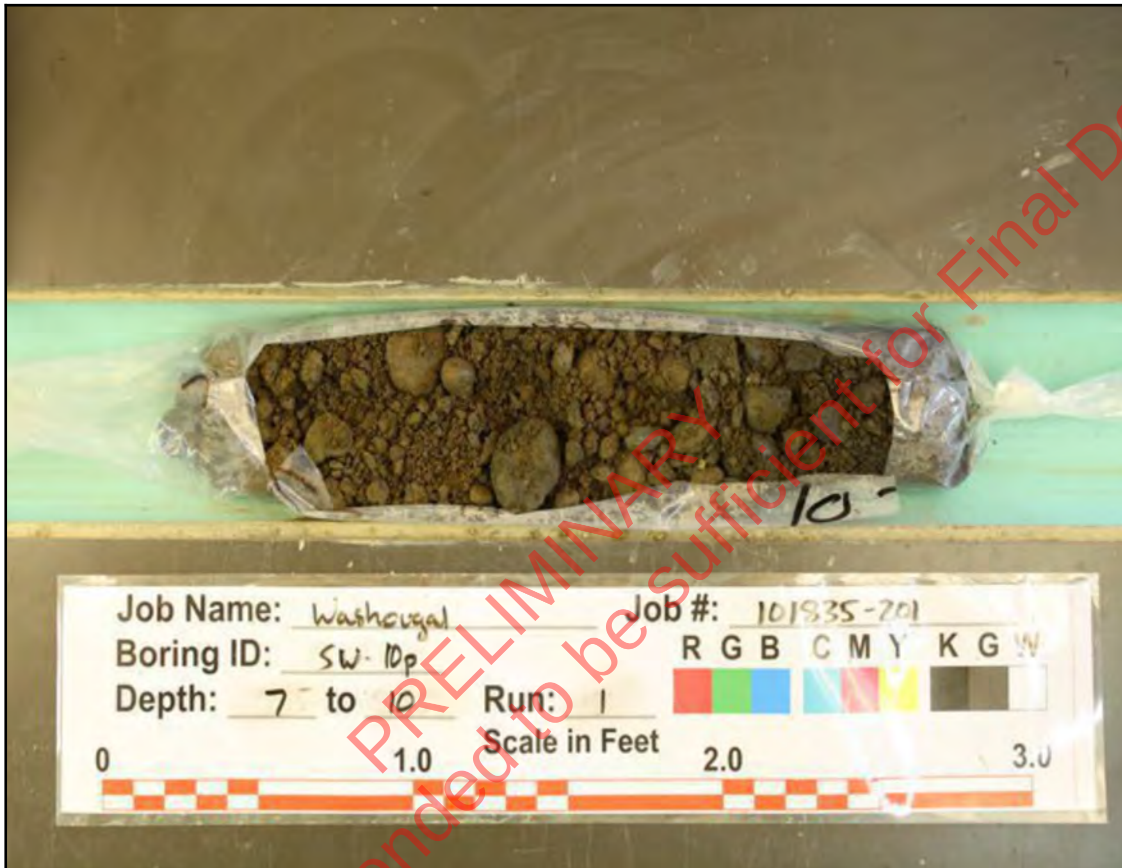
FIG. A-165

FIG. A-165



Washougal Grade Separation
Washougal, Washington

SW-10P-21_07.0-10.0

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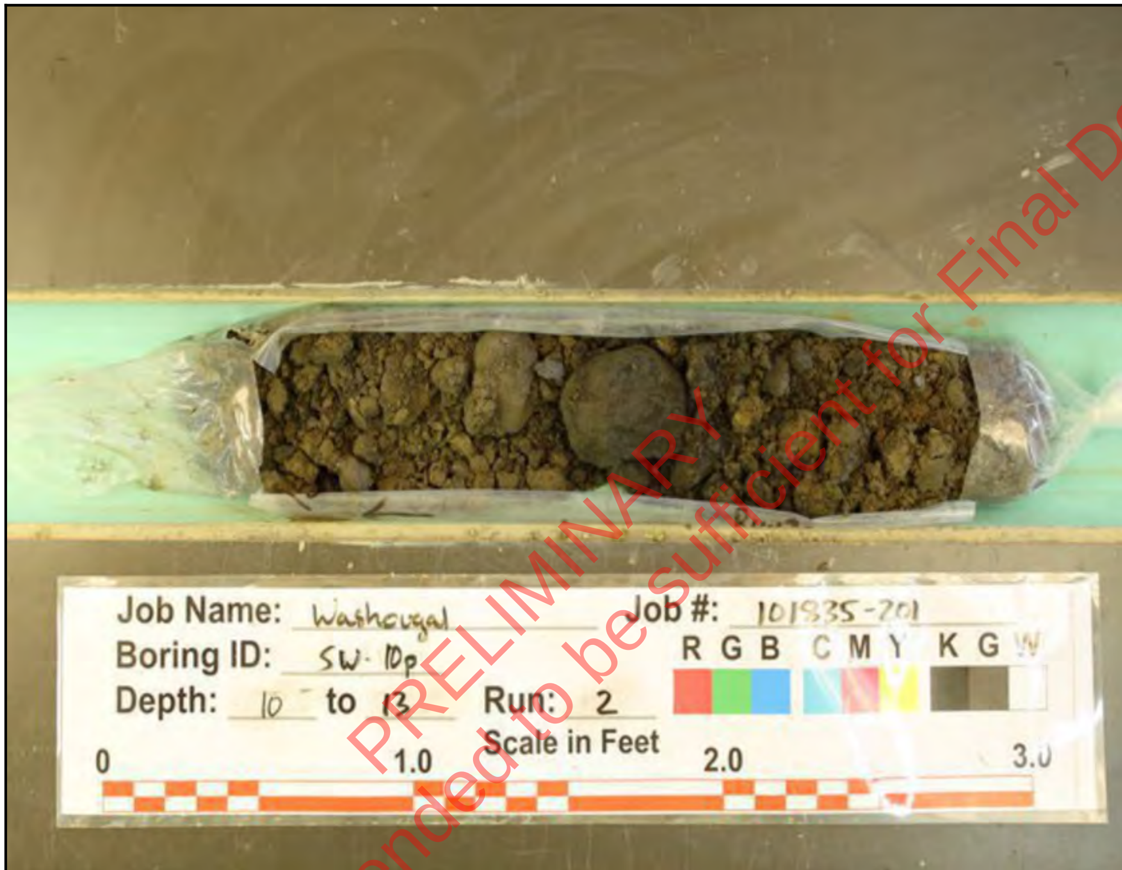
FIG. A-166



Washougal Grade Separation
Washougal, Washington

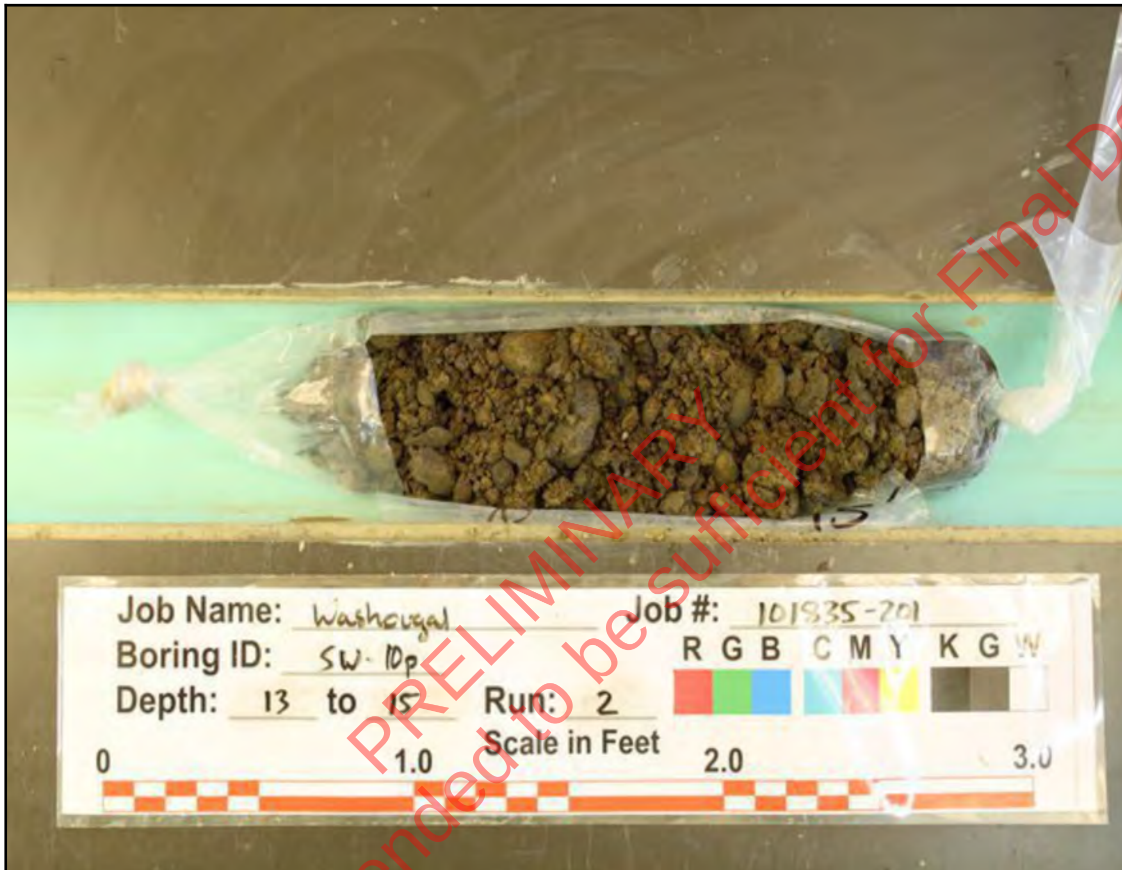
SW-10P-21_10.0-13.0

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-167

FIG. A-167



Washougal Grade Separation
Washougal, Washington

SW-10P-21_13.0-15.0

October 2021 101835-202

SHANNON & WILSON, INC.
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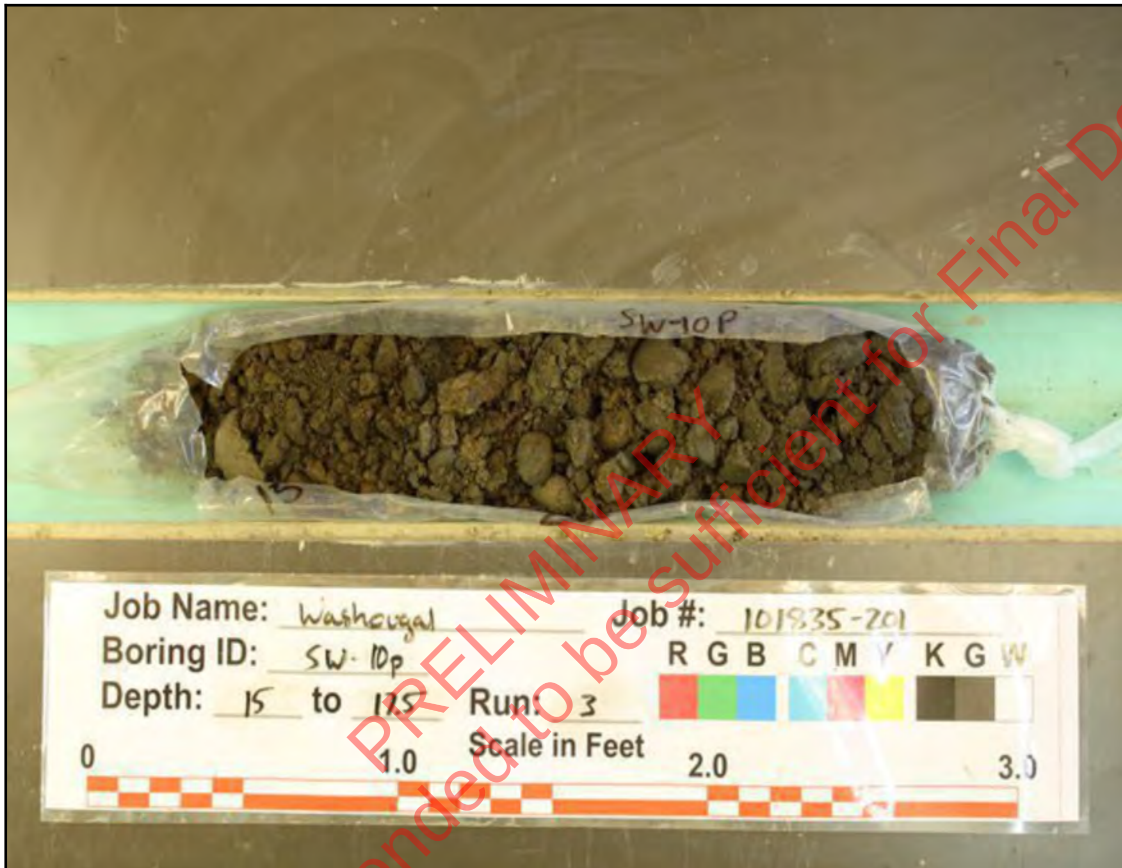
FIG. A-168

FIG. A-168



Washougal Grade Separation
Washougal, Washington

SW-10P-21_15.0-17.5

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Geotechnical and Environmental Consultants

FIG. A-169

FIG. A-169

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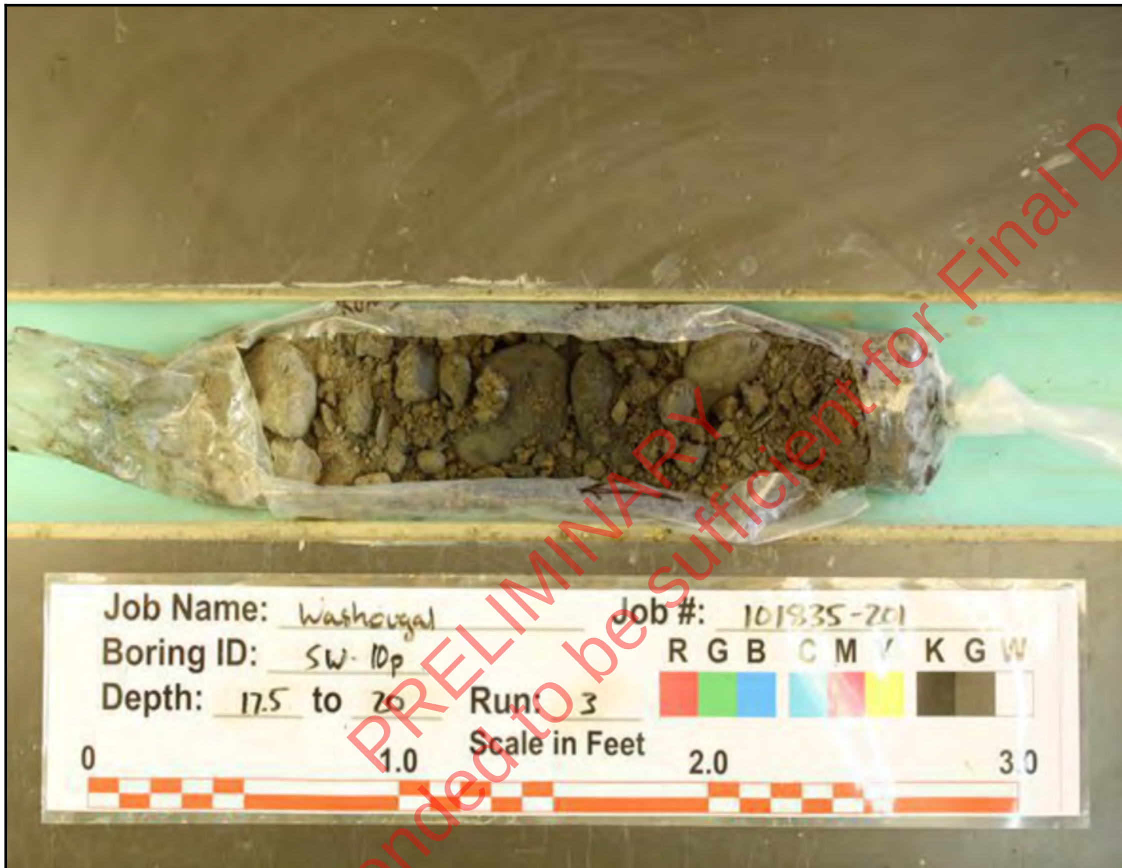


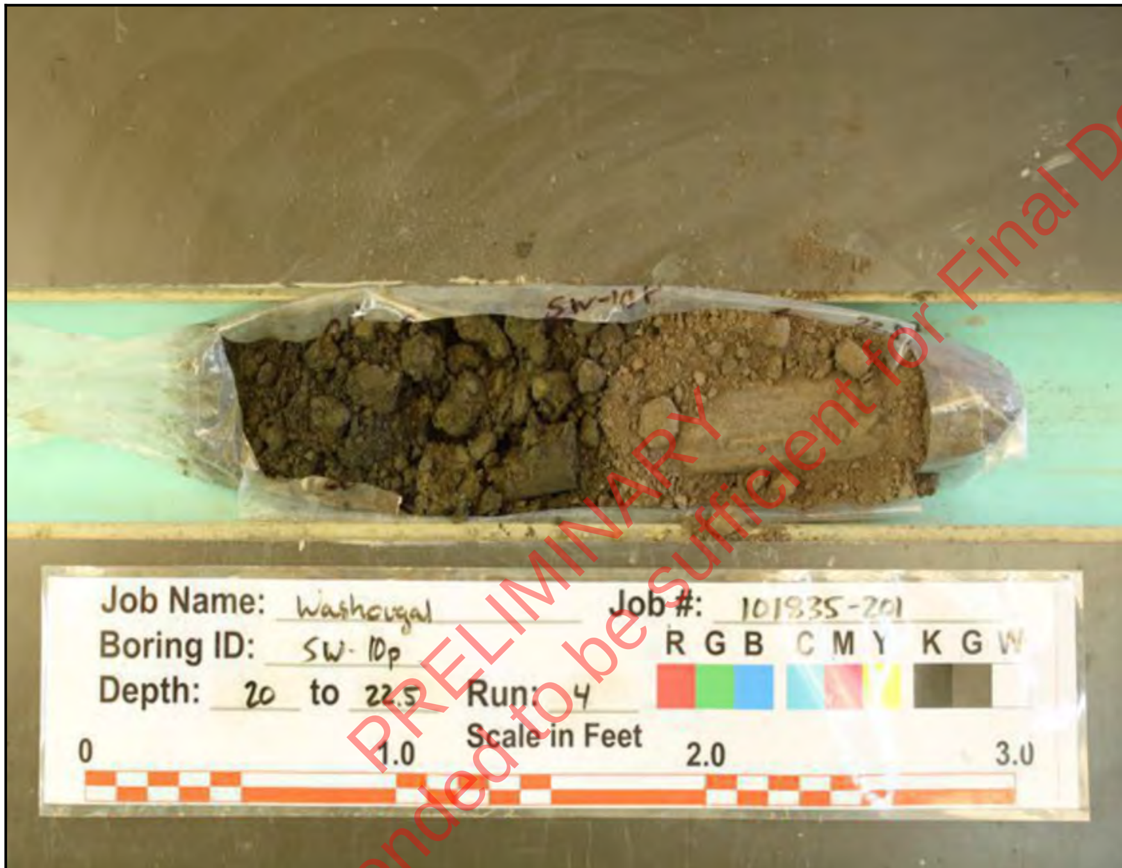
Washougal Grade Separation
Washougal, Washington

SW-10P-21_17.5-20.0

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-170



Washougal Grade Separation
Washougal, Washington

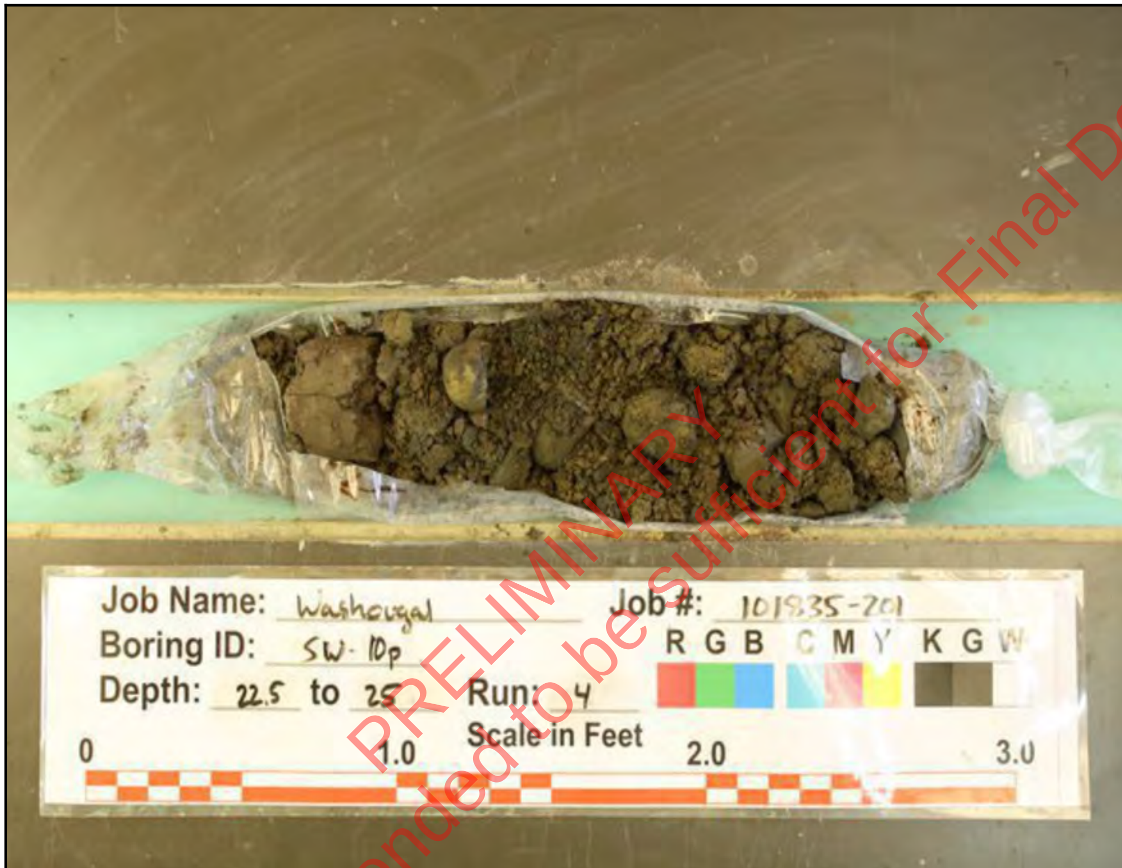
SW-10P-21_20.0-22.5

October 2021 101835-202

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-171

FIG. A-171



Washougal Grade Separation
Washougal, Washington

SW-10P-21_22.5-25.0

October 2021 101835-202

SHANNON & WILSON, INC.
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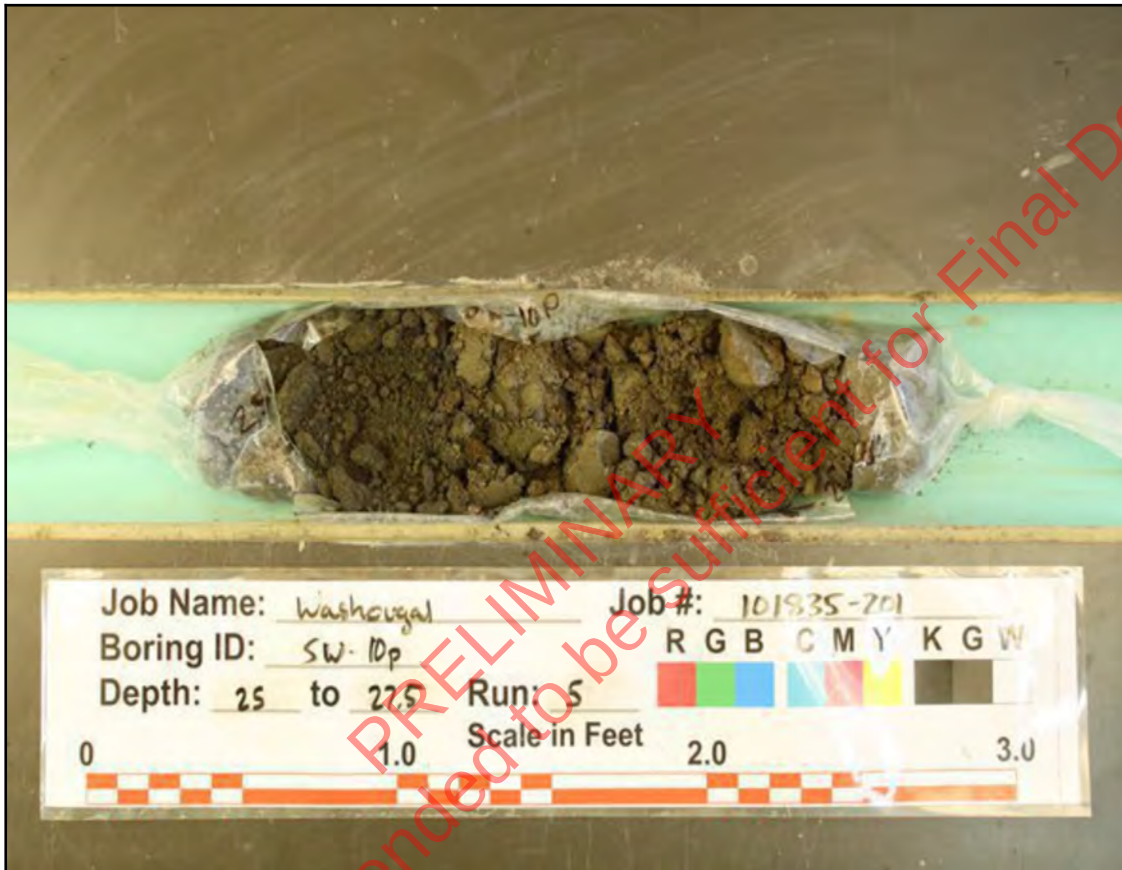
FIG. A-172

FIG. A-172



Washougal Grade Separation
Washougal, Washington

SW-10P-21_25.0-27.5

October 2021 101835-202

SHANNON & WILSON, INC.
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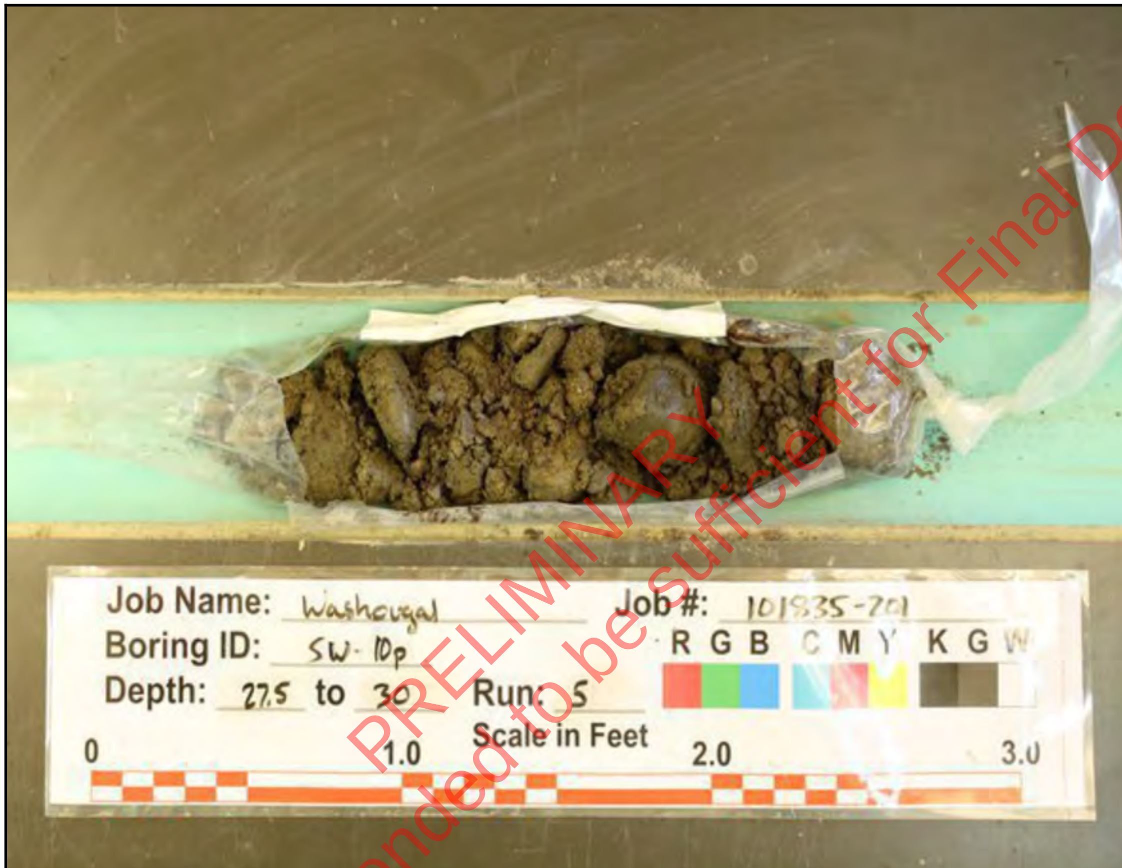
FIG. A-173

FIG. A-173



Washougal Grade Separation
Washougal, Washington

SW-10P-21_27.5-30.0

October 2021 101835-202

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FIG. A-174

FIG. A-174

Washougal Grade Separation
Washougal, Washington

SW-10P-21_30.0-32.5

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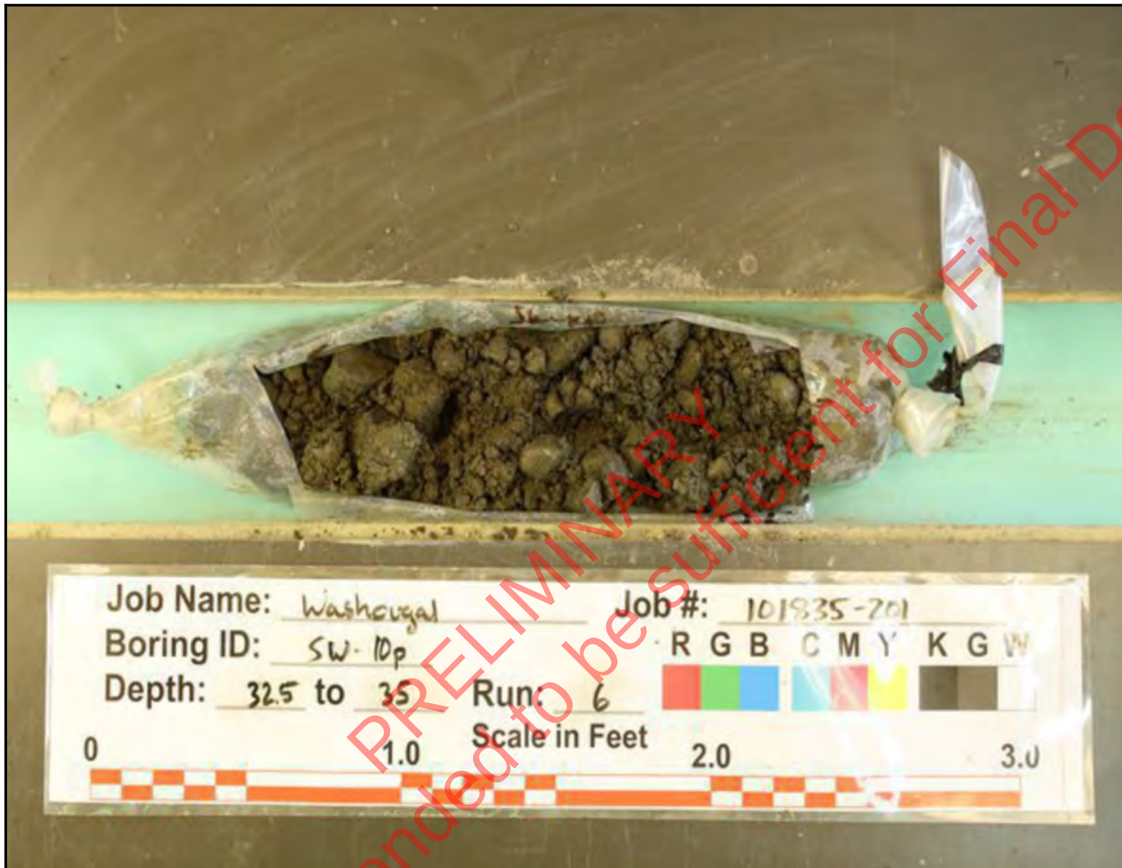
FIG. A-175

FIG. A-175



Washougal Grade Separation
Washougal, Washington

SW-10P-21_32.5-35.0

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FIG. A-176

FIG. A-176

Washougal Grade Separation
Washougal, Washington

SW-10P-21_35.0-37.0

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FIG. A-177

FIG. A-177

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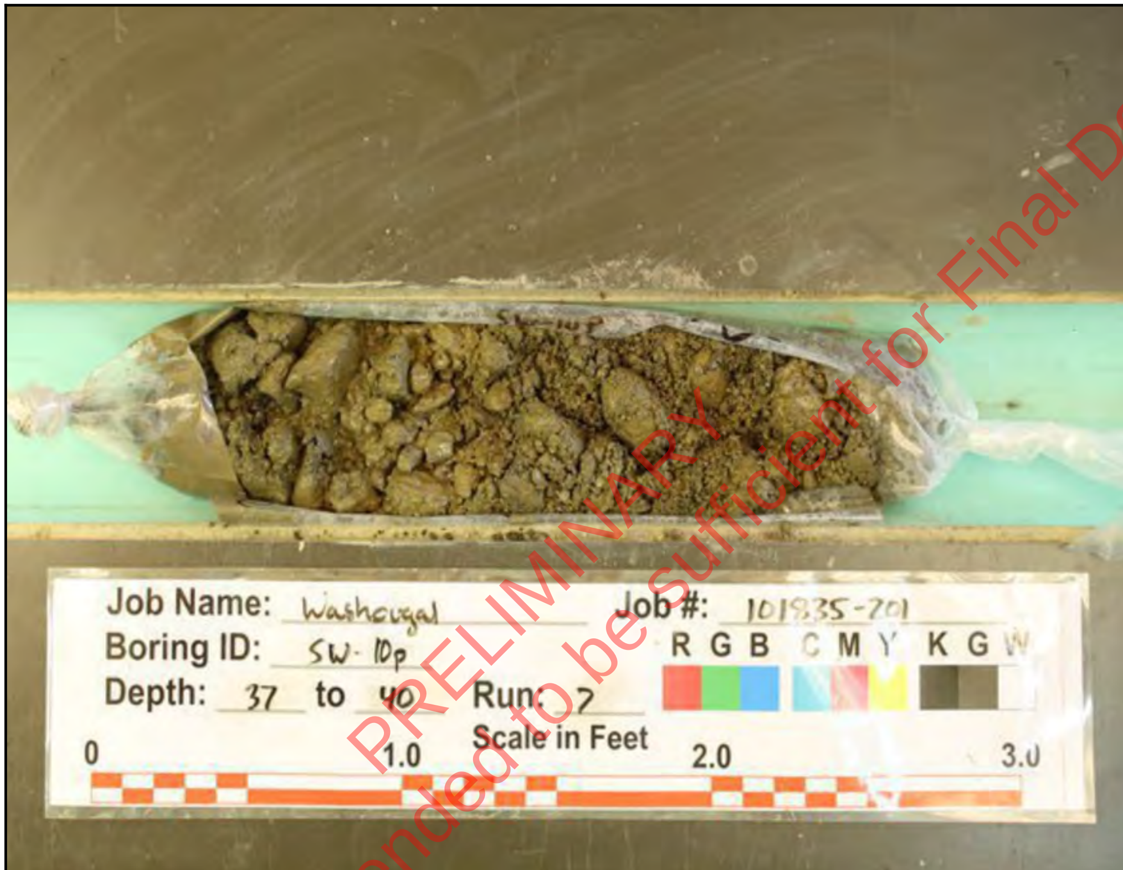

Washougal Grade Separation
Washougal, Washington

SW-10P-21_37.0-40.0

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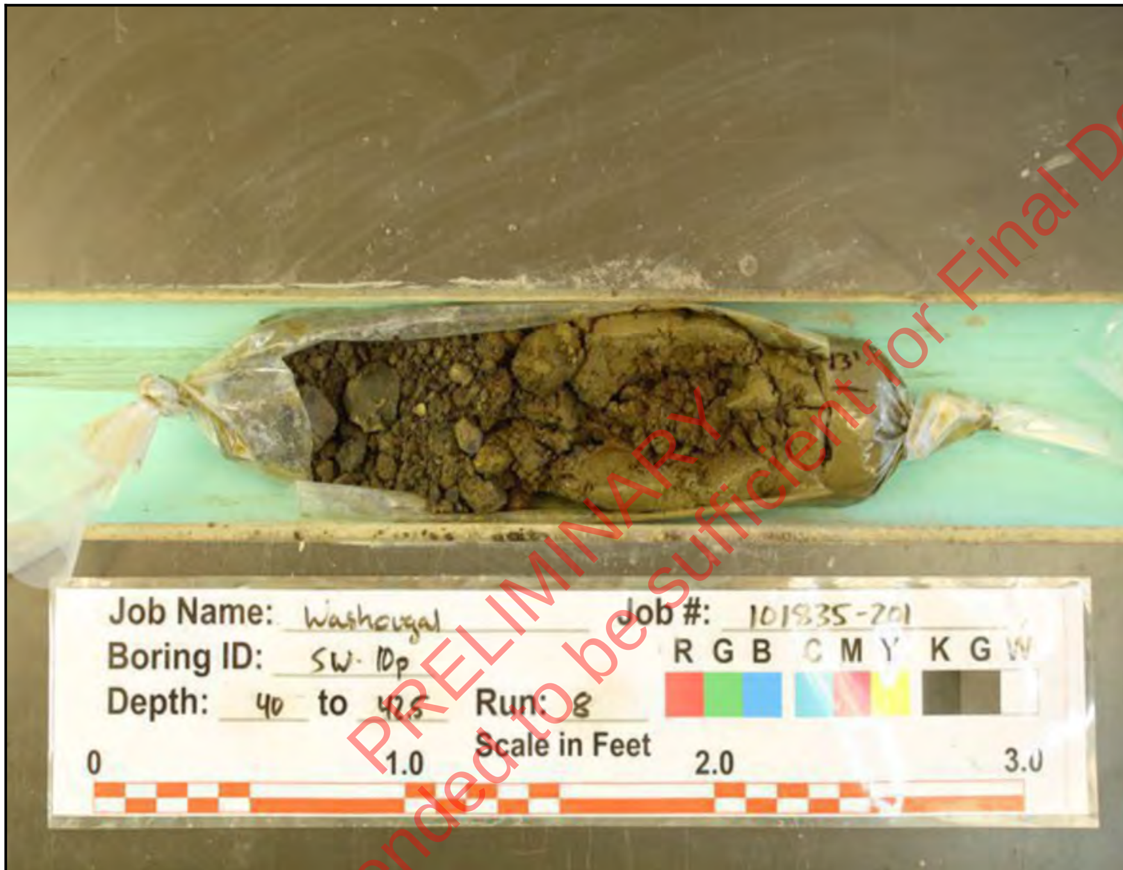
FIG. A-178

FIG. A-178



Washougal Grade Separation
Washougal, Washington

SW-10P-21_40.0-42.5

October 2021 101835-202

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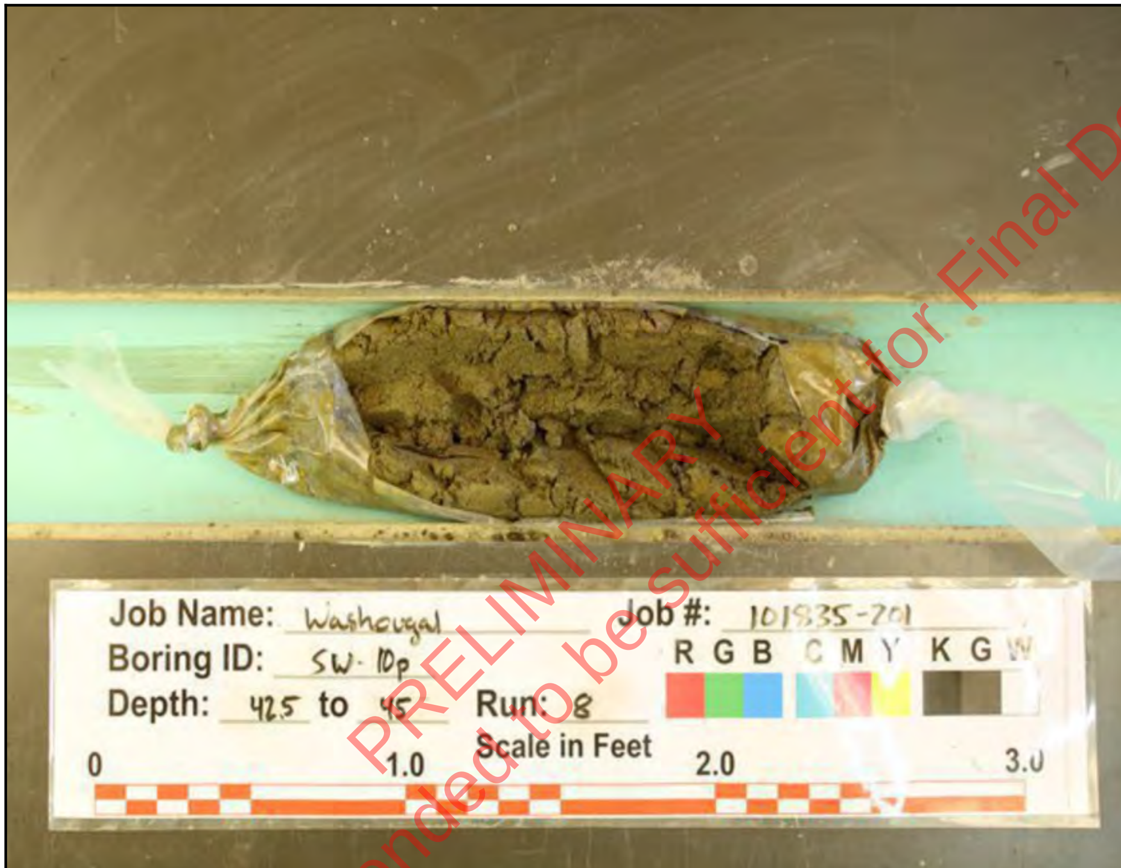
FIG. A-179



Washougal Grade Separation
Washougal, Washington

SW-10P-21_42.5-45.0

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FIG. A-180

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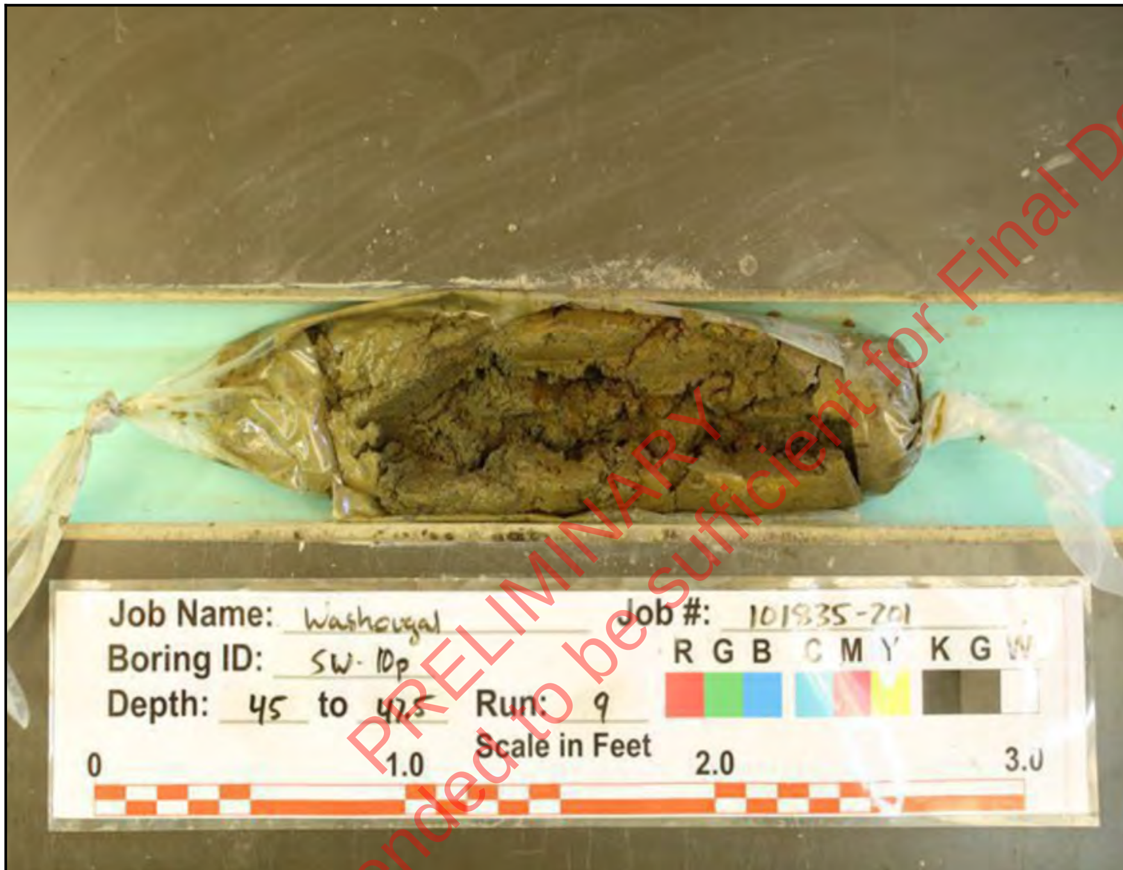

Washougal Grade Separation
Washougal, Washington

SW-10P-21_45.0-47.5

October 2021 101835-202

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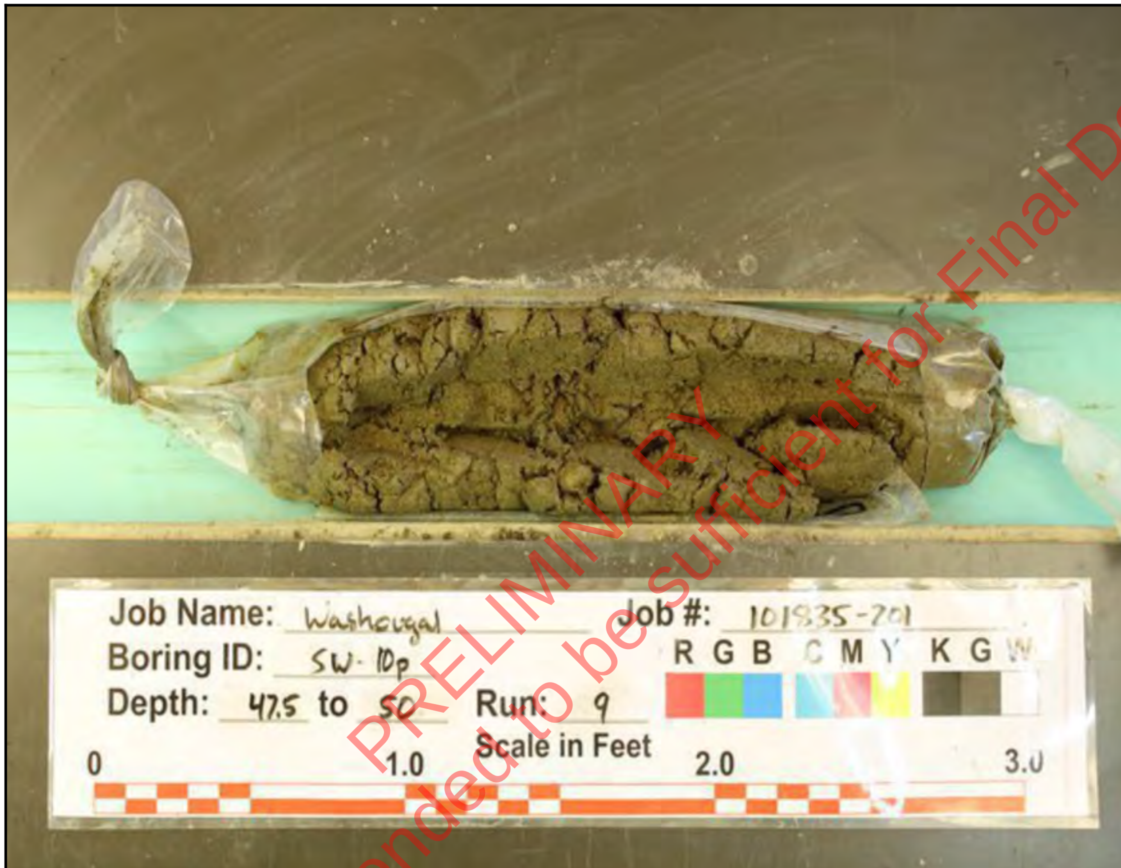
FIG. A-181

FIG. A-181



Washougal Grade Separation
Washougal, Washington

SW-10P-21_47.5-50.0

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FIG. A-182

FIG. A-182

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Washougal Grade Separation
Washougal, Washington

SW-10P-21_50.0-53.0

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FIG. A-183

Washougal Grade Separation
Washougal, Washington

SW-10P-21_53.0-55.0

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FIG. A-184

FIG. A-184

Washougal Grade Separation
Washougal, Washington

SW-10P-21_55.0-57.0

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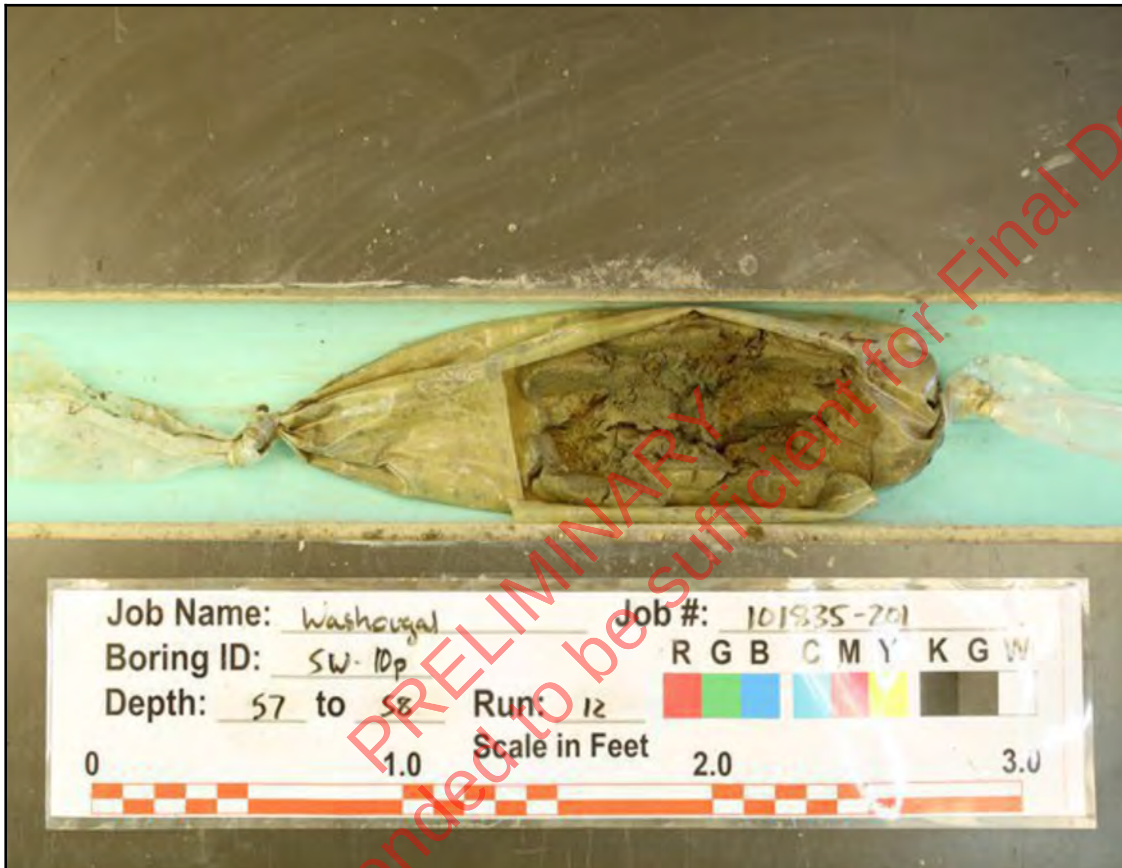
FIG. A-185



Washougal Grade Separation
Washougal, Washington

SW-10P-21_57.0-58.0

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FIG. A-186

FIG. A-186

Washougal Grade Separation
Washougal, Washington

SW-10P-21_58.0-60.0

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FIG. A-187

FIG. A-187

APPENDIX B: GEOTECHNICAL LABORATORY TESTING

Appendix B

Geotechnical Laboratory Testing

TABLE

- Laboratory Test Summary

TESTS

- Grain Size Distribution Plots
- Atterberg Plots

LABORATORY TERMS

Abbreviations, Symbols, and Terms	Descriptions
%	Percent
*	Sample specimen weight did not meet required minimum mass for the test method
"	Inch
#	Test not performed by Shannon & Wilson, Inc. laboratory
ASTM Std.	ASTM International Standard
C_c	Coefficient of curvature
Clay-size	Soil particles finer than 0.002 mm
cm	Centimeter
cm^2	Square centimeter
Coarse-grained	Soil particles coarser than 0.075 mm (cobble-, gravel- and sand-sized particles)
Cobbles	Soil particles finer than 305 mm and coarser than 76.2 mm
C_u	Coefficient of uniformity
CU	Consolidated-Undrained
ε	Axial strain
Fine-grained	Soil particles finer than 0.075 mm (silt- and clay-sized particles)
ft	Feet
γm	Wet unit weight
Gravel	Soil particles finer than 76.2 mm and coarser than 4.75 mm
G_s	Specific gravity of soil solids
H_o	Initial height
ΔH	Change in height
ΔH_{load}	End of load increment deformation
in	Inch
in^3	Cubic inch
LL	Liquid Limit
min	Minute
mm	Millimeter
μ_m	Micrometer
MC	Moisture content
MPa	Mega-Pascal
NP	Non-plastic
OC	Organic content
p	Total stress
p'	Effective stress
Pa	Pascal
pcf	Pounds per cubic foot
PI	Plasticity Index
PL	Plastic Limit
psf	Pounds per square foot
psi	Pounds per square inch
q	Deviatoric stress
Sand	Soil particles finer than 4.75 mm and coarser than 0.075 mm
sec	Second
Silt	Soil particles finer than 0.075 mm and coarser than 0.002 mm
t_n	Time to n% primary consolidation
t_{load}	Duration of load increment
tsf	Short tons per square foot
USCS	Unified Soil Classification System
UU	Unconsolidated-Undrained
WC	Water content

LABORATORY TERMS

Abbreviations, Symbols, and Terms	Descriptions
a	Average value of composite-specimen, component-sample values

SAMPLE TYPES

Abbreviations, Symbols, and Terms	Descriptions
2SS	2.5-inch Outside Diameter Split-Spoon Sample
2ST	2-inch Outside Diameter Thin-Walled Tube
3HSA	3-inch CME Hollow-stem Auger Sampler
3SS	3-inch Outside Diameter Split-Spoon Sample
4SS	4-inch Inside Diameter Split-Spoon Sample
6SS	6-inch Inside Diameter Split-Spoon Sample
CA_MC	Modified California Sampler
CA_SPT	Standard Penetration Test (SPT)
CORE	Rock Core
DM	+3.25 inch Outside Diameter Split-Spoon Sample
DMR	3.25-inch Sampler with Internal Rings
GRAB	Grab Sample
GUS	3-inch Outside Diameter Gregory Undisturbed Sampler (GUS) Sample
OSTER	3-inch Outside Diameter Osterberg Sample
PITCHER	3-inch Outside Diameter Pitcher Sample
PMT	Pressuremeter Test (f=failed)
PO	Porter Penetration Test Sample
PT	2.5-inch Outside Diameter Thin-Walled Tube
ROCK	Rock Core Sample
SCORE	Soil Core (as in Sonic Core Borings)
SH1	1-inch Plastic Sheath
SH2	2-inch Plastic Sheath with Soil Recovery
SH3	2-inch Plastic Sheath with no Soil Recovery
SPT	2-inch Outside Diameter Split-Spoon Sample
SS	Split-Spoon
ST	3-inch Outside Diameter Thin-Walled Tube
STW	3-inch Outside Diameter Thin-Walled Tube
TEST	Sample Test Interval
TW	Thin Wall Sample
UNDIST	Undisturbed Sample
VANE	Vane Shear
WATER	Water Sample for Probe Logs
XCORE	Core Sample

LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SW-5p-21	5	S-1	SPT	59		13.4									
SW-5p-21	5	R-1	SCORE			13.4									
SW-5p-21	6.5	R-1	SCORE		GM	7.6	10*	55*	23*	22*					Silty Gravel with Sand and Cobbles
SW-5p-21	10	S-2	SPT	50/5"		6.9									
SW-5p-21	10	R-2	SCORE			6.9									
SW-5p-21	15	R-3	SPT	50/4"	GM	4.4	14*	62*	22*	16*					Silty Gravel with Sand and Cobbles
SW-5p-21	15	R-3	SCORE		GM	4.4									Silty Gravel with Sand and Cobbles
SW-5p-21	20	S-4	SPT	50/3"		5.1									
SW-5p-21	20	R-4	SCORE			5.1									
SW-5p-21	25	R-5	SPT	84/9"	GM	5.7	9*	49*	30*	21*					Silty Gravel with Sand and Cobbles
SW-5p-21	25	R-5	SCORE		GM	5.7									Silty Gravel with Sand and Cobbles
SW-5p-21	30	S-6	SPT	51		10.1									
SW-5p-21	30	R-6	SCORE			10.1									
SW-5p-21	35	S-7	SPT	50/5"		8.5									
SW-5p-21	35	R-7	SCORE			8.5									
SW-5p-21	37.5	R-7	SCORE		GP-GM	10.5	14*	58*	31*	11*	557.6	5.1			Poorly Graded Gravel with Silt and Sand and Cobbles
SW-5p-21	40	S-8	SPT	59		17.2									
SW-5p-21	40	R-8	SCORE			17.2									
SW-5p-21	45	S-9	SPT	88/11"		26.2									
SW-5p-21	45	R-9	SCORE			26.2									
SW-5p-21	48	R-9	SCORE		SP-SM	28.4			93	6.8	2.6	1.5			Poorly Graded Sand with Silt
SW-5p-21	50	S-10	SPT	71		20.7									
SW-5p-21	50	R-10	SCORE			20.7									
SW-5p-21	55	S-11	SPT	67	SP-SM	22.5			90	9.8	3.6	1.5			Poorly Graded Sand with Silt
SW-5p-21	55	S-11	SCORE		SP-SM	22.5									Poorly Graded Sand with Silt
SW-5p-21	60	S-12	SPT	82/11"		23.3									
SW-5p-21	60	R-12	SCORE			23.3									
SW-5p-21	65	S-13	SPT	78	SM	23.6		1*	86*	14*					Silty Sand
SW-5p-21	65	S-13	SCORE		SM	23.6									Silty Sand
SW-5p-21	70	S-14	SPT	78		23.0									
SW-5p-21	70	R-14	SCORE			23.0									

LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SW-5p-21	75	S-15	SPT	50/5"	SP-SM	20.6		3*	90*	7.9*	3.6	1.7			Poorly Graded Sand with Silt
SW-5p-21	75	S-15	SCORE		SP-SM	20.6									Poorly Graded Sand with Silt
SW-5p-21	80	S-16	SPT	80/11"		26.8									
SW-6p-21	5	R-1	SCORE		GM	7.9		57*	21*	22*					Silty Gravel with Sand
SW-6p-21	10	S-1	SPT	50/3"		7.9									
SW-6p-21	10	R-2	SCORE			7.9									
SW-6p-21	15	R-3	SPT	41	GM	5.2		60*	28*	12*					Silty Gravel with Sand
SW-6p-21	15	R-3	SCORE		GM	5.2									Silty Gravel with Sand
SW-6p-21	20	S-3	SPT	50/3"		5.1									
SW-6p-21	20	R-4	SCORE			5.1									
SW-6p-21	23	R-4	SCORE		GM	5.1	9*	62*	25*	13*					Silty Gravel with Sand and Cobbles
SW-6p-21	25	S-4	SPT	50/2"		5.4									
SW-6p-21	25	R-5	SCORE			5.4									
SW-6p-21	30	S-5	SPT	50/4"		6.8									
SW-6p-21	30	R-6	SCORE			6.8									
SW-6p-21	35	R-7	SPT	50/3"	GC	12.5		52*	22*	26*					Clayey Gravel with Sand
SW-6p-21	35	R-7	SCORE		GC	12.5									Clayey Gravel with Sand
SW-6p-21	40	R-8	SPT	50/5"	GP-GM	8.1		55*	35*	9.6*	128.6	4.0			Poorly Graded Gravel with Silt and Sand
SW-6p-21	40	R-8	SCORE		GP-GM	8.1									Poorly Graded Gravel with Silt and Sand
SW-6p-21	45	S-8	SPT	50		13.1									
SW-6p-21	45	R-9	SCORE			13.1									
SW-6p-21	50	S-9	SPT	68		13.5									
SW-6p-21	50	R-10	SCORE			13.5									
SW-6p-21	53	R-10	SCORE		ML	31.5			10	90			42.2	26.2	Silt
SW-6p-21	55	S-10	SPT	81/9"		27.5									
SW-6p-21	55	R-11	SCORE			27.5									
SW-6p-21	60	S-11	SPT	65		17.0									
SW-8p-21	8	R-1	SCORE		GM	5.5		50*	26*	24*					Silty Gravel with Sand
SW-8p-21	10	S-1	SPT	59		7.8									
SW-8p-21	10	R-2	SCORE			7.8									

LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SW-8p-21	15	S-2	SPT	88/11"		7.5									
SW-8p-21	15	R-3	SCORE			7.5									
SW-8p-21	17	R-3	SCORE		GP-GM	7.9		49*	40*	10*	192.4	3.4			Poorly Graded Gravel with Silt and Sand
SW-8p-21	20	S-3	SPT	54		8.4									
SW-8p-21	20	R-4	SCORE			8.4									
SW-8p-21	25	S-4	SPT	50/3"		5.9									
SW-8p-21	25	R-5	SCORE			5.9									
SW-8p-21	27.5	R-5	SCORE		GP-GM	5.4		67*	22*	11*	544.3	12.0			Poorly Graded Gravel with Silt and Sand
SW-8p-21	30	S-5	SPT	50/1"		5.5									
SW-8p-21	30	R-6	SCORE			5.5									
SW-8p-21	35	S-6	SPT	50/3"		5.0									
SW-8p-21	35	R-7	SCORE			5.0									
SW-8p-21	36.5	R-7	SCORE		GM	6.8	19*	59*	29*	13*					Silty Gravel with Sand and Cobbles
SW-8p-21	40	S-7	SPT	50/4"		9.6									
SW-8p-21	40	R-8	SCORE			9.6									
SW-8p-21	45	R-9	SPT	50/3"	GM	12.3		47*	38*	15*					Silty Gravel with Sand
SW-8p-21	45	R-9	SCORE		GM	12.3									Silty Gravel with Sand
SW-8p-21	50	S-9	SPT	53/5"		26.2									
SW-8p-21	50	R-10	SCORE			26.2									
SW-8p-21	55	S-10	SPT	55		9.8									
SW-8p-21	55	R-11	SCORE			9.8									
SW-8p-21	58	R-11	SCORE		SP-SM	24.1			92	7.5	2.9	1.7			Poorly Graded Sand with Silt
SW-8p-21	60	S-11	SPT	72		18.2									
SW-8p-21	60	R-12	SCORE			18.2									
SW-8p-21	65	S-12	SPT	76		20.9									
SW-8p-21	65	R-13	SCORE			20.9									
SW-8p-21	68	R-13	SCORE		SM	22.8			74	26					Silty Sand
SW-8p-21	70	S-13	SPT	77/11"		20.1									
SW-8p-21	70	R-14	SCORE			20.1									
SW-8p-21	75	R-14	SPT	56	SM	20.2		0	88	12					Silty Sand

LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SW-8p-21	75	R-14	SCORE		SM	20.2									Silty Sand
SW-8p-21	80	S-15	SPT	73		17.8									
SW-10p-21	7	R-1	SCORE		GM	8.8	5*	59*	22*	19*					Silty Gravel with Sand and Cobbles
SW-10p-21	10	S-1	SPT	85		8.3									
SW-10p-21	10	R-2	SCORE			8.3									
SW-10p-21	15	S-2	SPT	80/11.5"		7.6									
SW-10p-21	15	R-3	SCORE			7.6									
SW-10p-21	18.5	R-3	SCORE		GM	6.2	14*	51*	34*	15*					Silty Gravel with Sand and Cobbles
SW-10p-21	20	S-3	SPT	62		6.8									
SW-10p-21	20	R-4	SCORE			6.8									
SW-10p-21	25	S-4	SPT	50/4"		5.8									
SW-10p-21	25	R-5	SCORE			5.8									
SW-10p-21	27.5	R-5	SCORE		GM	6.4	17*	62*	26*	12*					Silty Gravel with Sand and Cobbles
SW-10p-21	30	S-5	SPT	67		8.1									
SW-10p-21	30	R-6	SCORE			8.1									
SW-10p-21	35	S-6	SPT	42		21.8									
SW-10p-21	35	R-7	SCORE			21.8									
SW-10p-21	38	R-7	SCORE		GW-GM	8.5		61*	29*	9.2*	99.0	2.1			Well-Graded Gravel with Silt and Sand
SW-10p-21	40	S-7	SPT	50/3"		14.8									
SW-10p-21	40	R-8	SCORE			14.8									
SW-10p-21	44	R-8	SCORE		SP	23.7		1	95	3.9	3.1	1.0			Poorly Graded Sand
SW-10p-21	45	S-8	SPT	54		19.6									
SW-10p-21	45	R-9	SCORE			19.6									
SW-10p-21	50	S-9	SPT	68		19.9									
SW-10p-21	50	R-10	SCORE			19.9									
SW-10p-21	54	R-10	SCORE		SM	29.7			78	22					Silty Sand
SW-10p-21	57	S-10	SPT	61		23.6									
SW-10p-21	57	R-12	SCORE			23.6									
SW-10p-21	60	S-11	SPT	95/9"		16.9									
SC-1P-18	1	R-1	SCORE		GM	11.1		39*	29*	32*					Silty Gravel with Sand
SC-1P-18	5	R-2	SPT	4	GM	6.9		49*	22*	29*					Silty Gravel with Sand
SC-1P-18	5	R-2	SCORE		GM	6.9									Silty Gravel with Sand

LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SC-1P-18	10	R-3	SPT	26	GM	8.8	8*	63*	22*	15*					Silty Gravel with Sand and Cobbles
SC-1P-18	10	R-3	SCORE		GM	8.8									Silty Gravel with Sand and Cobbles
SC-1P-18	11	S-2	SPT	26		8.6									
SC-1P-18	11	R-3	SCORE			8.6									
SC-1P-18	15	R-4	SPT	50/5"	GM	2.9	5*	59*	28*	13*					Silty Gravel with Sand and Cobbles
SC-1P-18	15	R-4	SCORE		GM	2.9									Silty Gravel with Sand and Cobbles
SC-1P-18	20	R-5	SPT	50/4"	GM	4.3		41*	29*	30*					Silty Gravel with Sand
SC-1P-18	20	R-5	SCORE		GM	4.3									Silty Gravel with Sand
SC-1P-18	25	R-6	SPT	50/5.5"	GM	6.6	18*	68*	19*	13*					Silty Gravel with Sand and Cobbles
SC-1P-18	25	R-6	SCORE		GM	6.6									Silty Gravel with Sand and Cobbles
SC-1P-18	30	R-7	SPT	40	GM	4.5	9*	49*	29*	21*					Silty Gravel with Sand and Cobbles
SC-1P-18	30	R-7	SCORE		GM	4.5									Silty Gravel with Sand and Cobbles
SC-1P-18	35	S-7	SPT	54		4.6									
SC-1P-18	35	R-8	SCORE			4.6									
SC-1P-18	38	R-8	SCORE		GW-GM		10*	63*	30*	7.2*	116.3	1.8			Well-Graded Gravel with Silt and Sand and Cobbles
SC-1P-18	40	S-8	SPT	41		10.8									
SC-1P-18	40	R-9	SCORE			10.8									
SC-1P-18	44	R-9	SCORE		SP-SM	24.3			91	9.5	3.8	1.7			Poorly Graded Sand with Silt
SC-1P-18	45	S-9	SPT	31		23.4									
SC-1P-18	45	R-10	SCORE			23.4									
SC-1P-18	48	R-10	SCORE			10.3									
SC-1P-18	50	S-10	SPT	49		14.1									
SC-1P-18	50	R-11	SCORE			14.1									
SC-1P-18	54	R-11	SCORE		SM	15.4		0*	72*	28*					Silty Sand
SC-1P-18	55	S-11	SPT	40		29.9									
SC-1P-18	55	R-12	SCORE			29.9									
SC-1P-18	58	R-12	SCORE			22.8									
SC-1P-18	60	S-12	SPT	48		31.6									
SC-1P-18	60	R-13	SCORE			31.6									
SC-1P-18	63	R-13	SCORE		SM	21.5			85*	15*					Silty Sand
SC-1P-18	65	S-13	SPT	42		25.5									

LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SC-1P-18	65	R-14	SCORE			25.5									
SC-1P-18	69	R-14	SCORE			23.9									
SC-1P-18	70	S-14	SPT	53		16.5									
SC-1P-18	70	R-15	SCORE			16.5									
SC-1P-18	73	R-15	SCORE		SM	23.2			86	14					Silty Sand
SC-1P-18	75	S-15	SPT	53		26.3									
SC-1P-18	75	R-16	SCORE			26.3									
SC-1P-18	78	R-16	SCORE		MH	40.9							58	31	Elastic Silt
SC-1P-18	80	S-16	SPT	35		37.0									
SC-1P-18	80	R-17	SCORE			37.0									
SC-1P-18	80.6	S-16	SPT	35		49.7									
SC-1P-18	80.6	R-17	SCORE			49.7									
SC-1P-18	82.5	R-17	SCORE		MH	50.3							59	43	Sandy Elastic Silt
SC-1P-18	85	S-17	SPT	49		28.8									
SC-1P-18	85	R-18	SCORE			28.8									
SC-1P-18	88	R-18	SCORE		SM	16.2			74*	26*					Silty Sand
SC-1P-18	90	S-18	SPT	50/3"		22.3									
SC-1P-18	90	R-19	SCORE			22.3									
SC-1P-18	93.5	R-19	SCORE			9.5									
SC-1P-18	95	S-19	SPT	56		22.9									
SC-1P-18	95	R-20	SCORE			22.9									
SC-1P-18	97	R-20	SCORE			25.9									
SC-1P-18	100	S-20	SPT	56		23.5									
SC-2P-18	3.5	R-1	SCORE			20.6									
SC-2P-18	5	S-1	SPT	50/4"		18.1									
SC-2P-18	5	R-2	SCORE			18.1									
SC-2P-18	7.5	R-2	SCORE		GM	6.1	27*	40*	30*	30*					Silty Gravel with Sand and Cobbles
SC-2P-18	12.5	R-3	SCORE		GM	7.0		75*	12*	12*					Silty Gravel
SC-2P-18	15	S-3	SPT	52		5.4									
SC-2P-18	15	R-4	SCORE			5.4									
SC-2P-18	17.5	R-4	SCORE		GM	5.7	19*	61*	23*	16*					Silty Gravel with Sand and Cobbles
SC-2P-18	20	S-4	SPT	50/6"		4.2									

LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SC-2P-18	20	R-5	SCORE			4.2									
SC-2P-18	22.5	R-5	SCORE		GM	5.8		58*	26*	16*					Silty Gravel with Sand
SC-2P-18	25	R-6	SPT	53	GP-GM	5.4		60*	29*	11*	293.3	11.8			Poorly Graded Gravel with Silt and Sand
SC-2P-18	25	R-6	SCORE		GP-GM	5.4									Poorly Graded Gravel with Silt and Sand
SC-2P-18	30	R-7	SPT	62	GM	6.8		39*	31*	30*					Silty Gravel with Sand
SC-2P-18	30	R-7	SCORE		GM	6.8									Silty Gravel with Sand
SC-2P-18	35	R-8	SPT	52	GM	10.7		54*	35*	12*					Silty Gravel with Sand
SC-2P-18	35	R-8	SCORE		GM	10.7									Silty Gravel with Sand
SC-2P-18	40	S-8	SPT	53		10.7									
SC-2P-18	40	R-9	SCORE			10.7									
SC-2P-18	42	R-9	SCORE		GP-GM	7.3	4*	73*	19*	8.4*	91.7	6.0			Poorly Graded Gravel with Silt and Sand and Cobbles
SC-2P-18	45	S-9	SPT	89		15.1									
SC-2P-18	45	R-10	SCORE			15.1									
SC-2P-18	47.5	R-10	SCORE		SM	23.8		15*	71*	14*					Silty Sand with Gravel
SC-2P-18	50	S-10	SPT	45		29.0									
SC-2P-18	50	R-11	SCORE			29.0									
SC-2P-18	52	R-11	SCORE		SP	31.2			97	3.0	2.0	0.9			Poorly Graded Sand
SC-2P-18	55	S-11	SPT	40		26.8									
SC-2P-18	55	R-12	SCORE			26.8									
SC-2P-18	60	S-12	SPT	67		22.4									
SC-2P-18	60	R-13	SCORE			22.4									
SC-2P-18	61	R-13	SPT	67	SM	24.7			87*	13*					Silty Sand
SC-2P-18	61	R-13	SCORE		SM	24.7									Silty Sand
SC-2P-18	65	S-13	SPT	89/11"		18.0									
SC-2P-18	65	R-14	SCORE			18.0									
SC-2P-18	69.5	R-14	SCORE		MH	33.6							59	33	Elastic Silt
SC-2P-18	70	S-14	SPT	46		34.2									
SC-2P-18	70	R-15	SCORE			34.2									
SC-2P-18	73	R-15	SCORE			28.4									

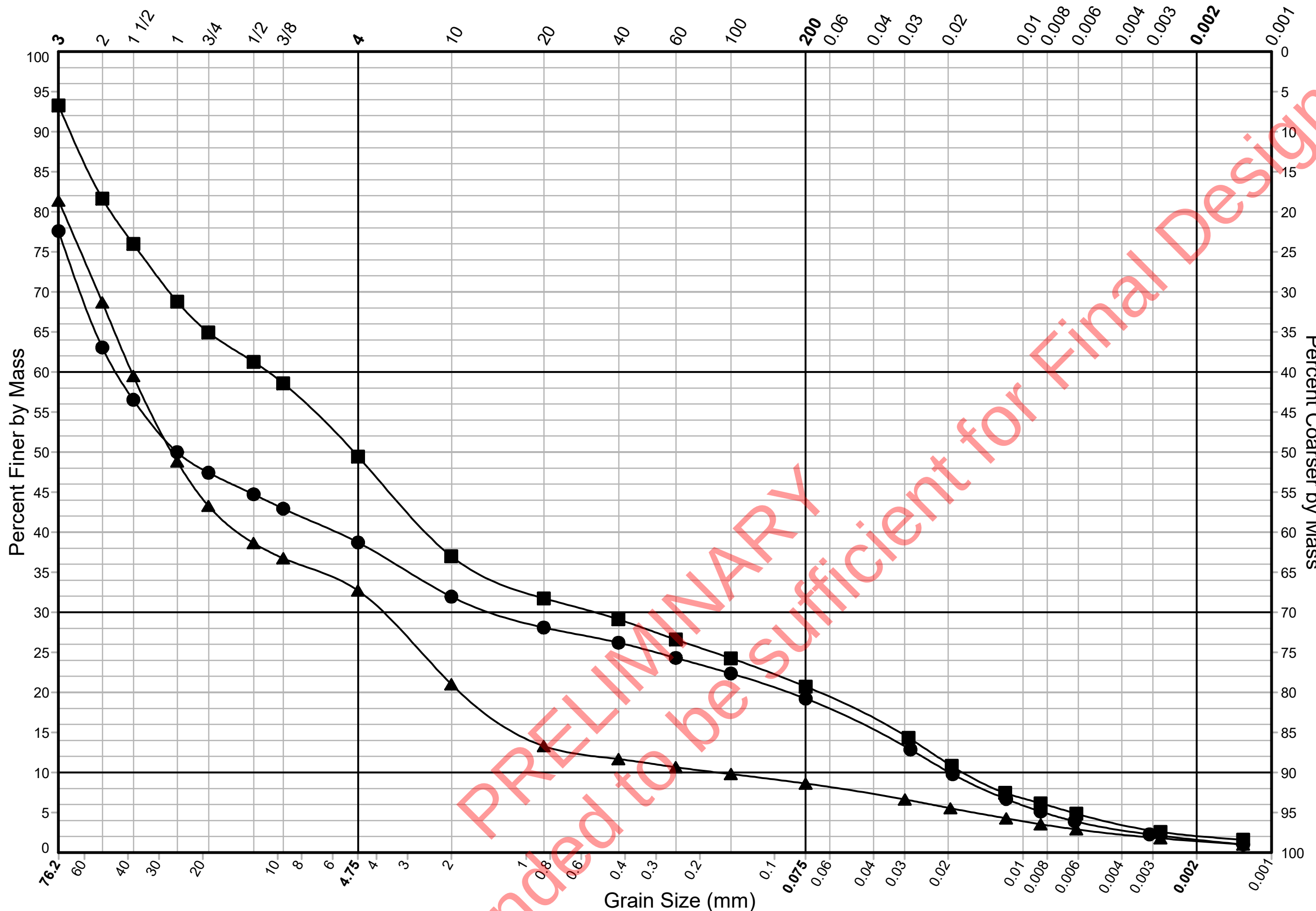
LABORATORY TEST SUMMARY

Boring	Top Depth (ft)	Sample Number	Sample Type	Blow Count	USCS	WC (%)	% Cobbles Removed	% Gravel	% Sand	% Fines	C_u	C_c	LL	PL	Soil Description
SC-2P-18	75	S-15	SPT	84		32.7									
SC-2P-18	75	R-16	SCORE			32.7									
SC-2P-18	76	R-16	SPT	84	MH	35.6							52	34	Elastic Silt
SC-2P-18	76	R-16	SCORE		MH	35.6							52	34	Elastic Silt
SC-2P-18	80	S-17	SPT	68		18.6									
SC-2P-18	80	R-17	SCORE			18.6									
SC-2P-18	81	S-17	SPT	68		22.8									
SC-2P-18	81	R-17	SCORE			22.8									
SC-2P-18	85	S-18	SPT	50/3"		17.8									
SC-2P-18	85	R-18	SCORE			17.8									
SC-2P-18	85.5	S-18	SPT	50/3"		13.5									
SC-2P-18	85.5	R-18	SCORE			13.5									
SC-2P-18	87	R-18	SCORE		ML	36.6			14*	86*					Silt
SC-2P-18	90	S-19	SPT	50/6"		18.0									
SC-2P-18	90	R-19	SCORE			18.0									
SC-2P-18	90.5	R-19	SCORE		SP	26.7			97	2.9	2.1	1.2			Poorly Graded Sand
SC-2P-18	95	S-20	SPT	85/11"		26.2									

GRAIN SIZE DISTRIBUTION PLOT

Washougal Grade Separation
Washougal, Washington

TEST PIT TP-1



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● TP-1, S-1	6.0	GM	Silty Gravel with Sand and Cobbles	22	39	19	19	10	2	9.6	SJD	MXM	D422
■ TP-1, S-2	7.0	GM	Silty Gravel with Sand and Cobbles	7	44	29	21	11	2	15.9	SJD	MXM	D422
▲ TP-1, S-3	9.0	GW-GM	Well-Graded Gravel with Silt and Sand and Cobbles	19	49	24	8.6	6	1	8.3	SJD	MXM	D422

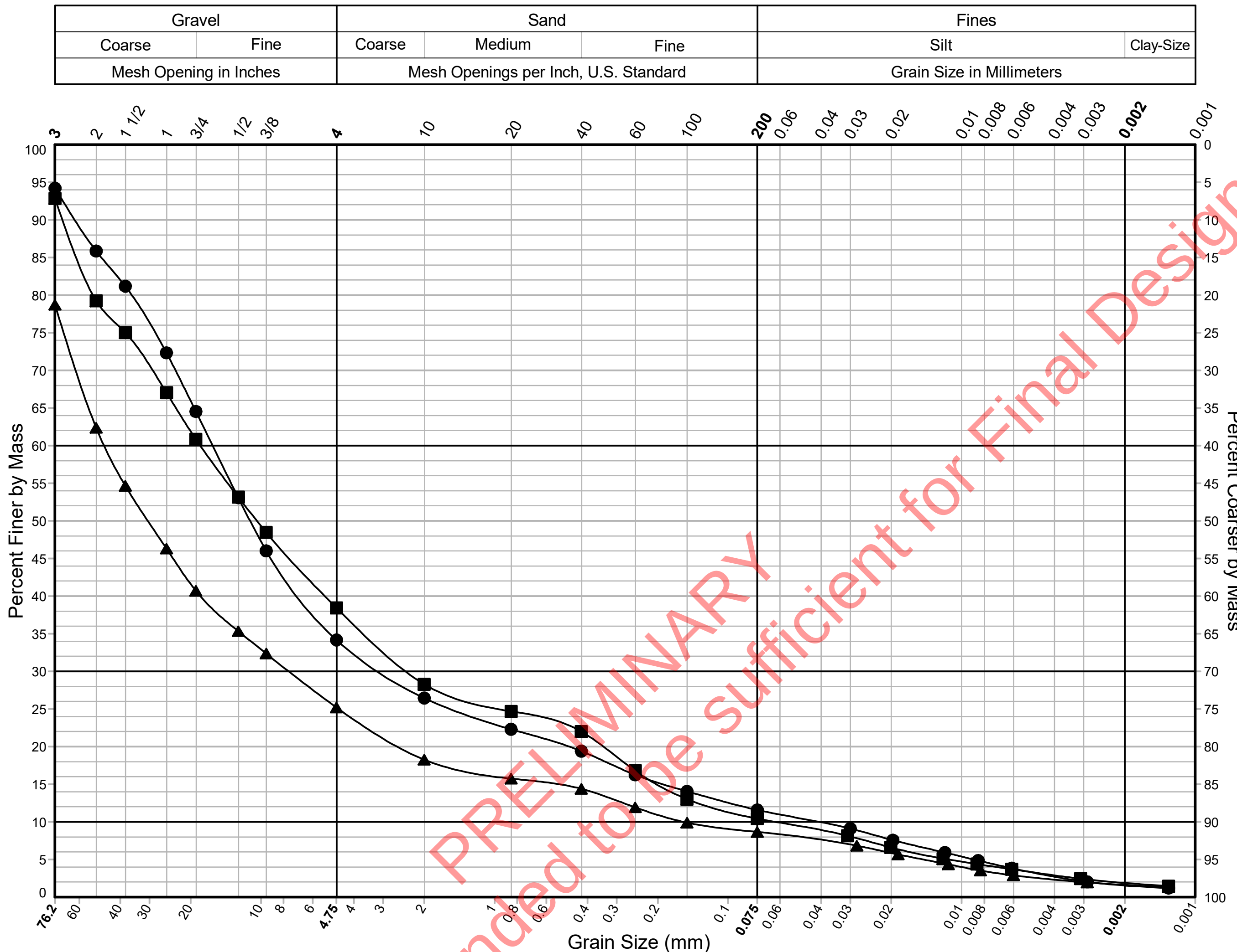
[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.

SHANNON & WILSON, INC.

GRAIN SIZE DISTRIBUTION PLOT

Washougal Grade Separation
Washougal, Washington

TEST PIT TP-2



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● TP-2, S-1	5.0	GP-GM	Poorly Graded Gravel with Silt and Sand and Cobbles	6	60	23	12	8	2	10.1	SJD	MXM	D422
■ TP-2, S-2	8.0	GP-GM	Poorly Graded Gravel with Silt and Sand and Cobbles	7	54	28	10	7	2	11.4	SJD	MXM	D422
▲ TP-2, S-3	17.0	GP-GM	Poorly Graded Gravel with Silt and Sand and Cobbles	21	54	17	8.7	6	2	7.9	SJD	MXM	D422

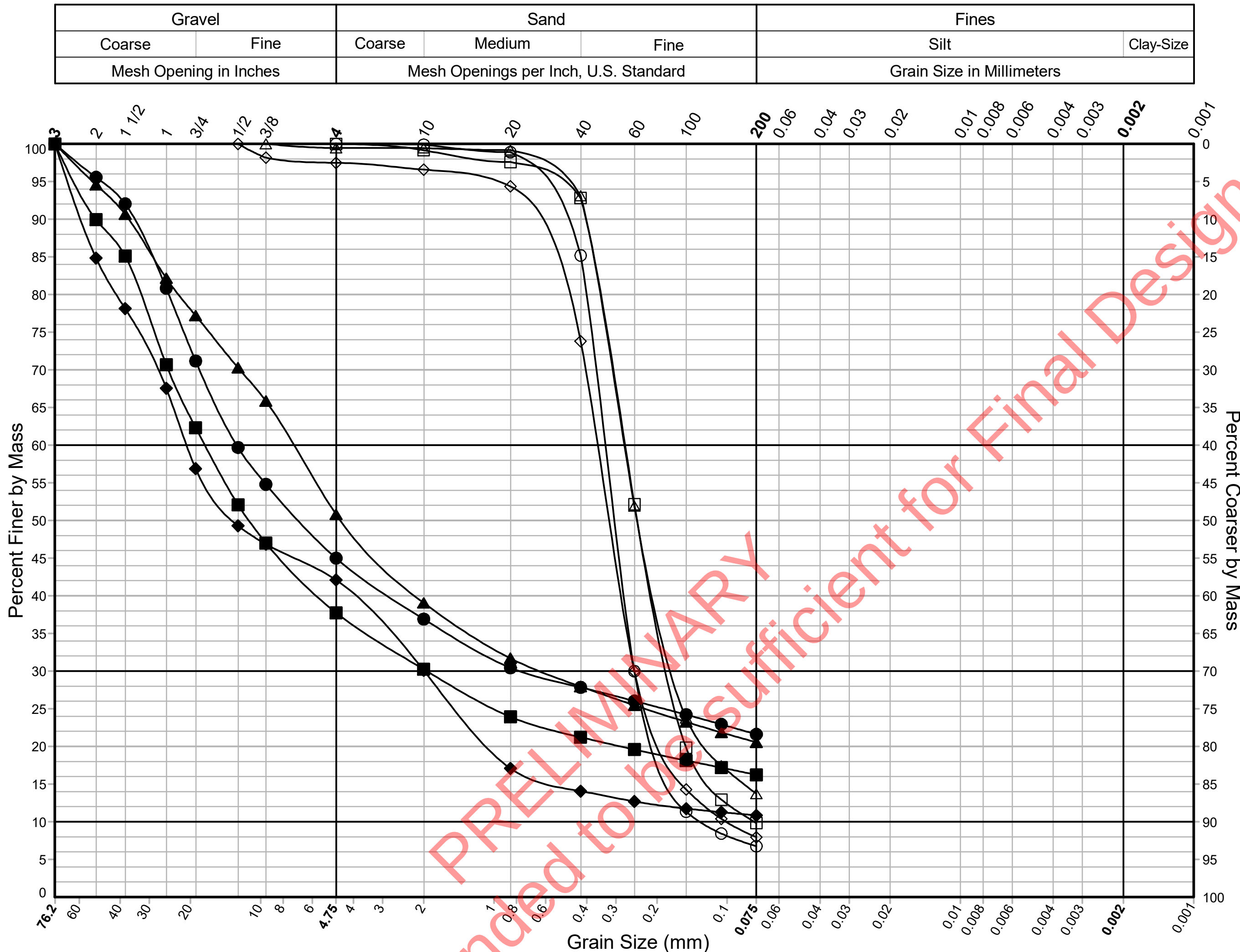
[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.

SHANNON & WILSON, INC.

GRAIN SIZE DISTRIBUTION PLOT

Washougal Grade Separation
Washougal, Washington

BORING SW-5p-21



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SW-5p-21, R-1[*]	6.5	GM	Silty Gravel with Sand and Cobbles	10	55	23	22			7.6	BXK		D6913
■ SW-5p-21, R-3[*]	15.0	GM	Silty Gravel with Sand and Cobbles	14	62	22	16			4.4	BXK		D6913
▲ SW-5p-21, R-5[*]	25.0	GM	Silty Gravel with Sand and Cobbles	9	50	30	21			5.7	BXK		D6913
◆ SW-5p-21, R-7[*]	37.5	GP-GM	Poorly Graded Gravel with Silt and Sand and Cobbles	14	58	31	11			10.5	BXK		D6913
○ SW-5p-21, R-9	48.0	SP-SM	Poorly Graded Sand with Silt			93	6.8			28.4	BXK		D6913
□ SW-5p-21, S-11	55.0	SP-SM	Poorly Graded Sand with Silt			90	9.8			22.5	BXK		D6913
△ SW-5p-21, S-13[*]	65.0	SM	Silty Sand		1	86	14			23.6	BXK		D6913
◇ SW-5p-21, S-15[*]	75.0	SP-SM	Poorly Graded Sand with Silt		3	90	7.9			20.6	BXK		D6913

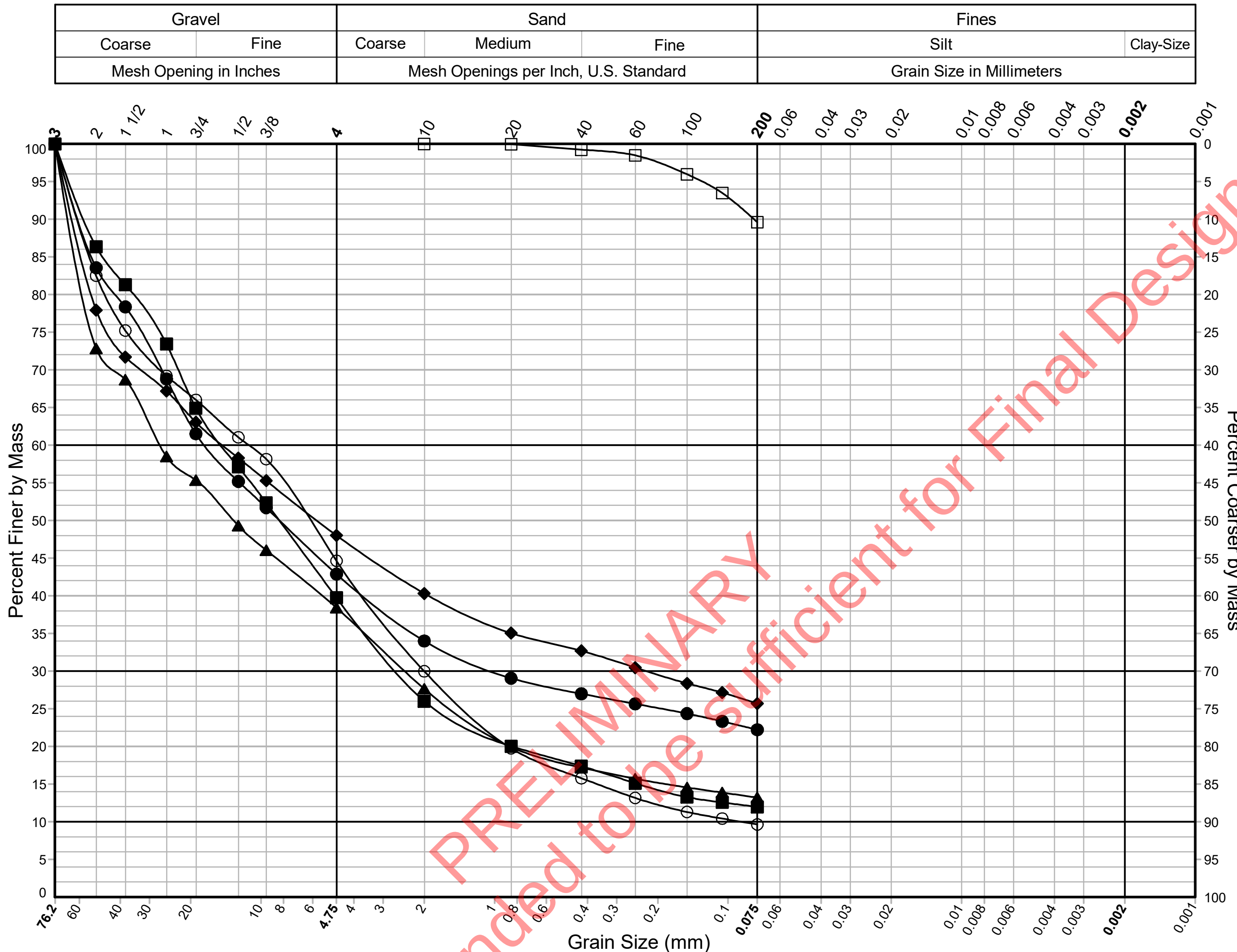
[*] Test specimen did not meet minimum mass recommendations.
[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.

SHANNON & WILSON, INC.

GRAIN SIZE DISTRIBUTION PLOT

Washougal Grade Separation
Washougal, Washington

BORING SW-6p-21



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SW-6p-21, R-1*	5.0	GM	Silty Gravel with Sand		57	21	22			7.9	BXK		D6913
■ SW-6p-21, R-3*	15.0	GM	Silty Gravel with Sand		60	28	12			5.2	BXK		D6913
▲ SW-6p-21, R-4*	23.0	GM	Silty Gravel with Sand and Cobbles	9	62	25	13			5.1	BXK		D6913
◆ SW-6p-21, R-7*	35.0	GC	Clayey Gravel with Sand		52	22	26			12.5	BXK		D6913
○ SW-6p-21, R-8*	40.0	GP-GM	Poorly Graded Gravel with Silt and Sand		55	35	9.6			8.1	BXK		D6913
□ SW-6p-21, R-10	53.0	ML	Silt			10	90			31.5	BXK		D6913

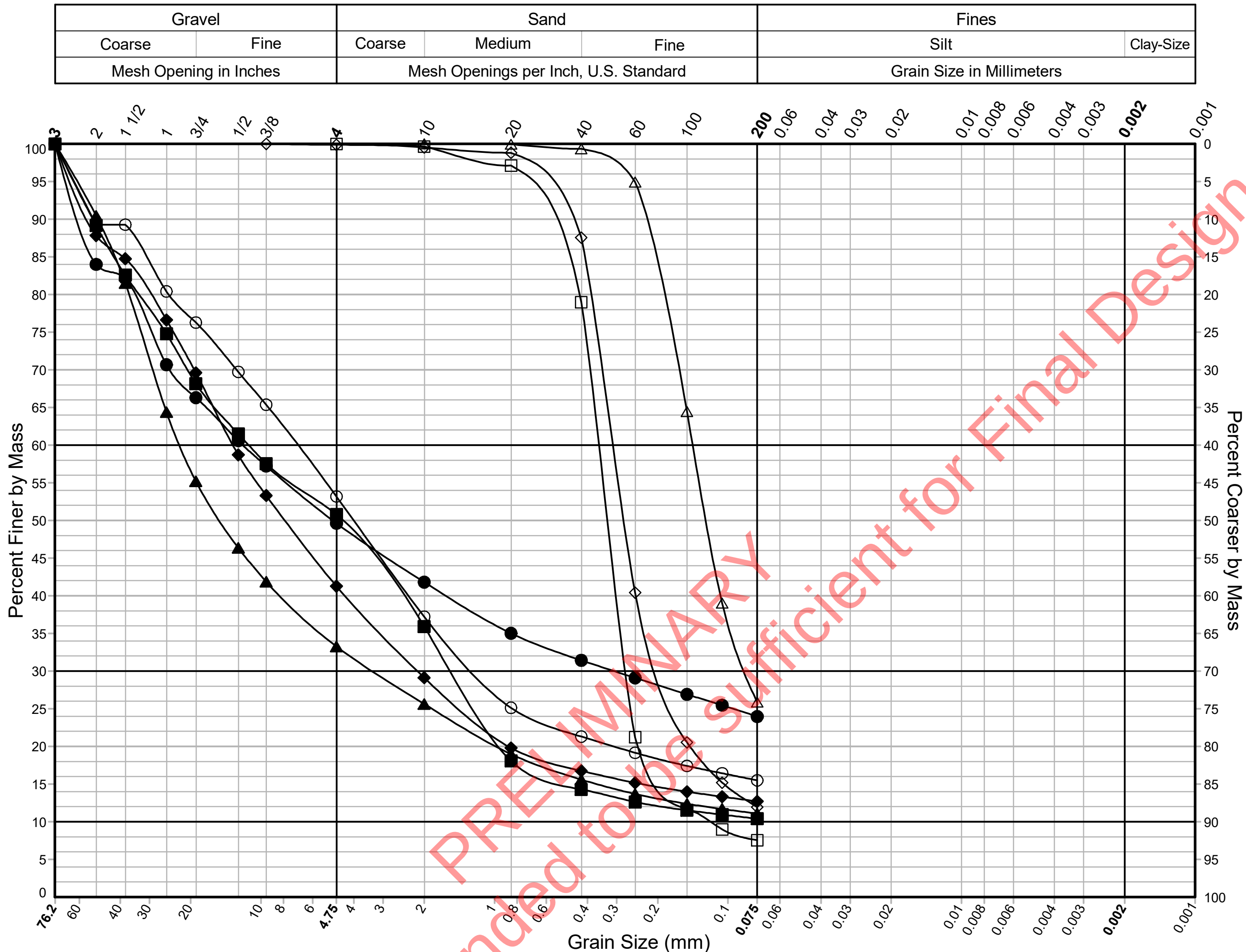
* *Test specimen did not meet minimum mass recommendations.*
[2] *Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.*

SHANNON & WILSON, INC.

GRAIN SIZE DISTRIBUTION PLOT

Washougal Grade Separation
Washougal, Washington

BORING SW-8p-21

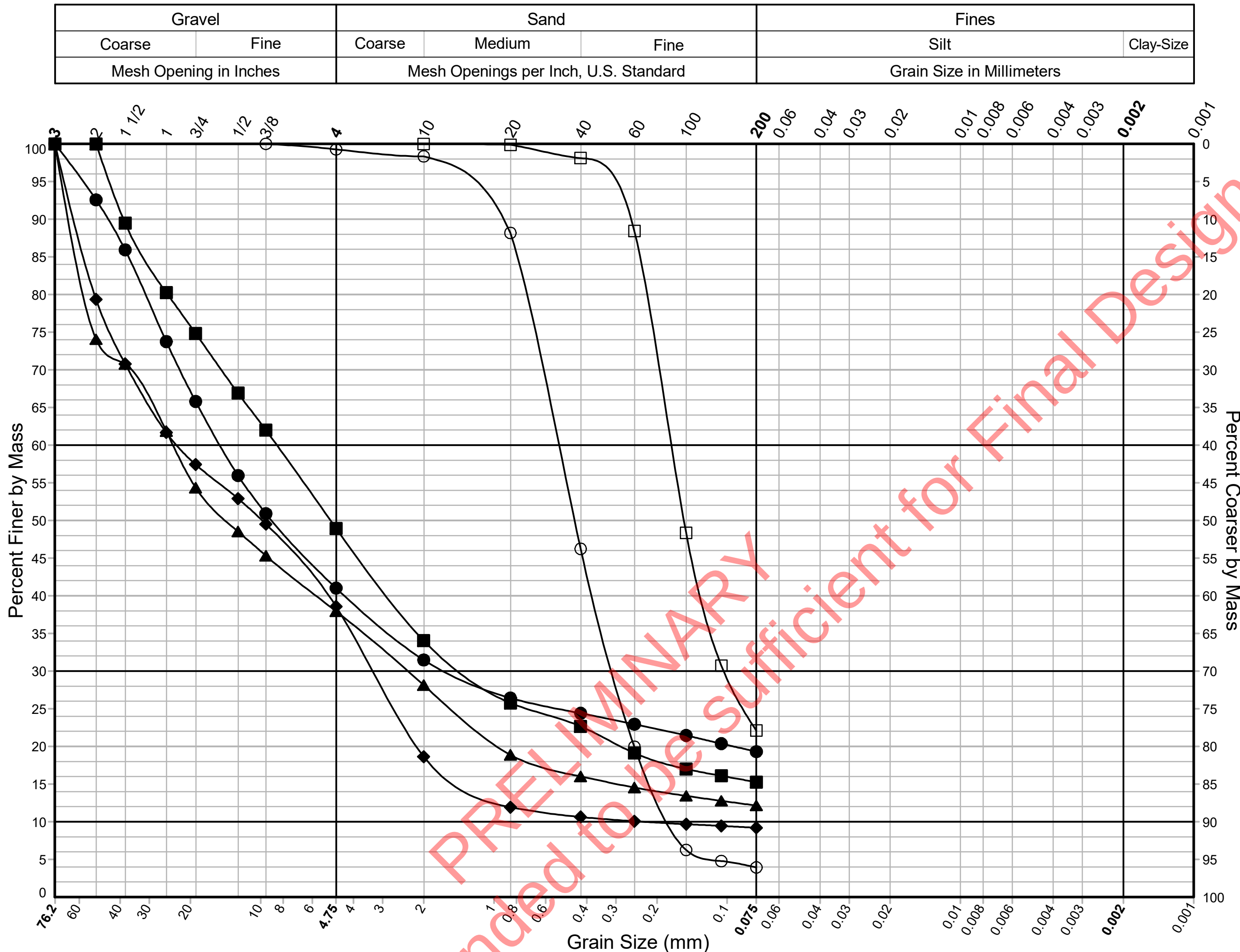


Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SW-8p-21, R-1*	8.0	GM	Silty Gravel with Sand		50	26	24			5.5	BXK		D6913
■ SW-8p-21, R-3*	17.0	GP-GM	Poorly Graded Gravel with Silt and Sand		49	40	10			7.9	BXK		D6913
▲ SW-8p-21, R-5*	27.5	GP-GM	Poorly Graded Gravel with Silt and Sand		67	22	11			5.4	BXK		D6913
◆ SW-8p-21, R-7*	36.5	GM	Silty Gravel with Sand and Cobbles	19	59	29	13			6.8	BXK		D6913
○ SW-8p-21, R-9*	45.0	GM	Silty Gravel with Sand		47	38	15			12.3	BXK		D6913
□ SW-8p-21, R-11	58.0	SP-SM	Poorly Graded Sand with Silt			92	7.5			24.1	BXK		D6913
△ SW-8p-21, R-13	68.0	SM	Silty Sand			74	26			22.8	BXK		D6913
◇ SW-8p-21, R-14	75.0	SM	Silty Sand		0	88	12			20.2	BXK		D6913

** Test specimen did not meet minimum mass recommendations.*
[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.

Washougal Grade Separation
Washougal, Washington

BORING SW-10p-21

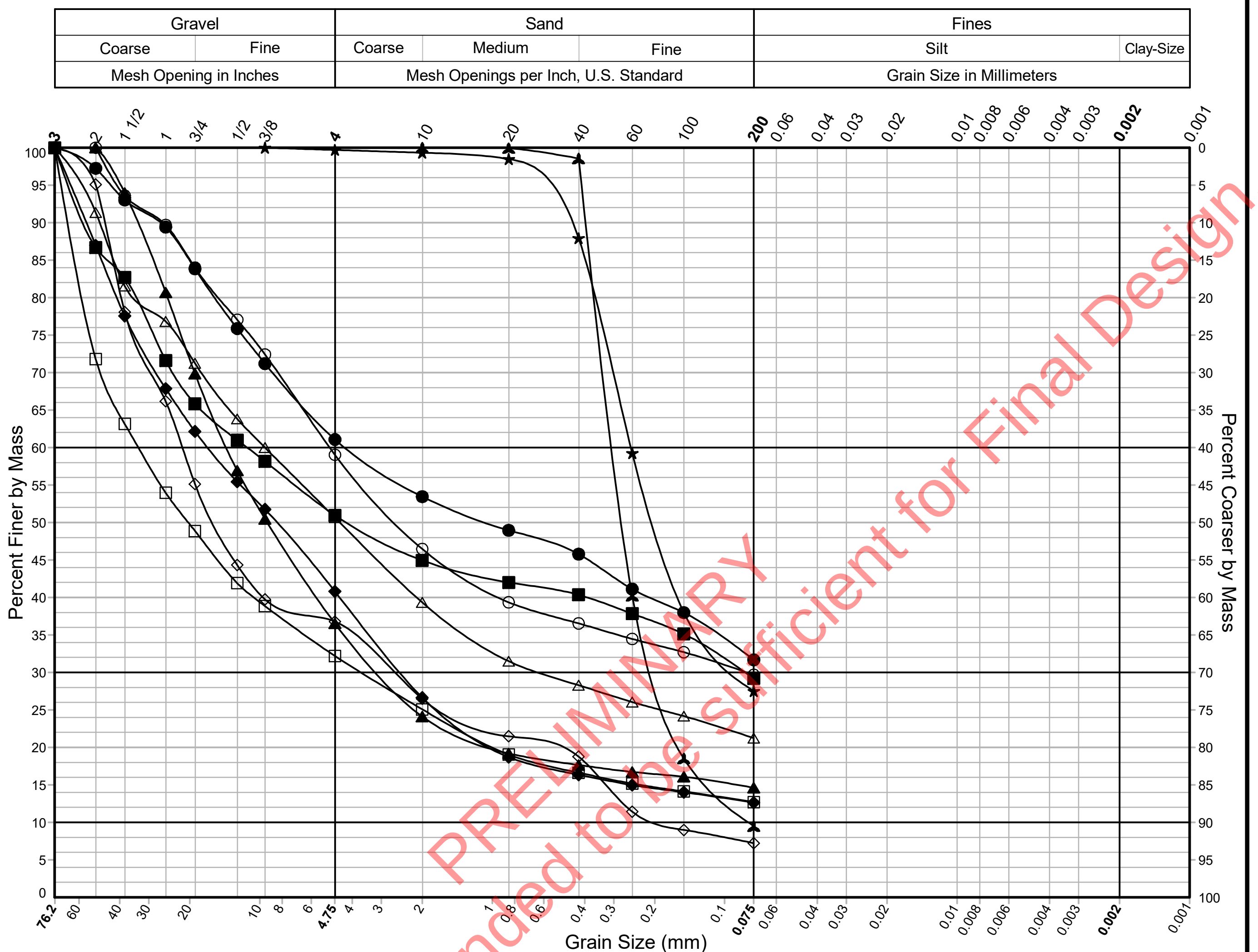


Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SW-10p-21, R-1*	7.0	GM	Silty Gravel with Sand and Cobbles	5	59	22	19			8.8	BXK		D6913
■ SW-10p-21, R-3*	18.5	GM	Silty Gravel with Sand and Cobbles	14	51	34	15			6.2	BXK		D6913
▲ SW-10p-21, R-5*	27.5	GM	Silty Gravel with Sand and Cobbles	17	62	26	12			6.4	BXK		D6913
◆ SW-10p-21, R-7*	38.0	GW-GM	Well-Graded Gravel with Silt and Sand		61	29	9.2			8.5	BXK		D6913
○ SW-10p-21, R-8	44.0	SP	Poorly Graded Sand		1	95	3.9			23.7	BXK		D6913
□ SW-10p-21, R-10	54.0	SM	Silty Sand			78	22			29.7	BXK		D6913

Test specimen did not meet minimum mass recommendations.
[2] *Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.*

Washougal Grade Separation
Washougal, Washington

BORING SC-1P-18



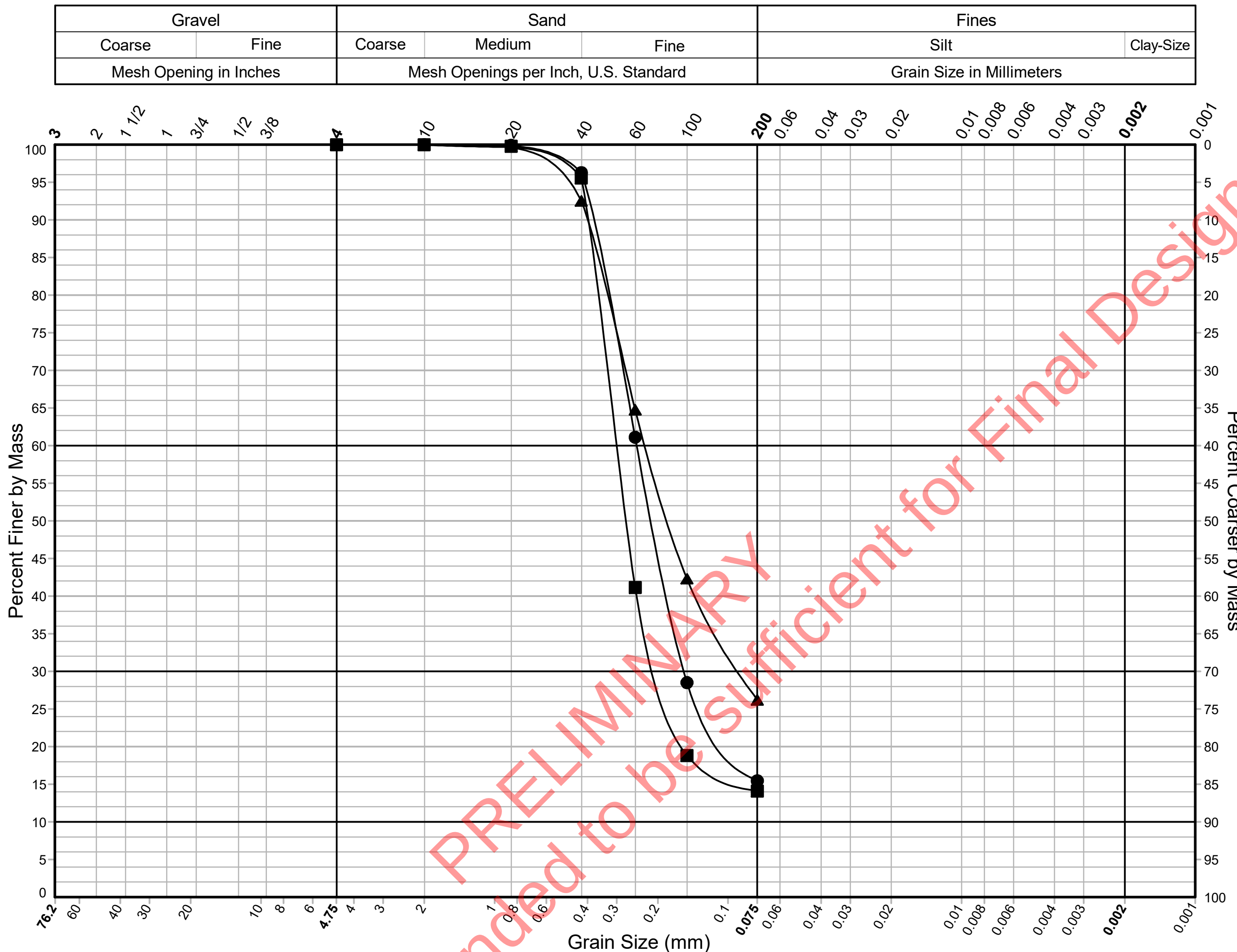
Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SC-1P-18, R-1*	1.0	GM	Silty Gravel with Sand		39	29	32			11.1	AKV	AKV	C136
■ SC-1P-18, R-2*	5.0	GM	Silty Gravel with Sand		49	22	29			6.9	AKV	AKV	C136
▲ SC-1P-18, R-3*	10.0	GM	Silty Gravel with Sand and Cobbles	8	64	22	15			8.8	AKV	AKV	C136
◆ SC-1P-18, R-4*	15.0	GM	Silty Gravel with Sand and Cobbles	5	59	28	13			2.9	AKV	AKV	C136
○ SC-1P-18, R-5*	20.0	GM	Silty Gravel with Sand		41	29	30			4.3	AKV	AKV	C136
□ SC-1P-18, R-6*	25.0	GM	Silty Gravel with Sand and Cobbles	18	67	19	13			6.6	AKV	AKV	C136
△ SC-1P-18, R-7*	30.0	GM	Silty Gravel with Sand and Cobbles	9	50	29	21			4.5	AKV	AKV	C136
◇ SC-1P-18, R-8*	38.0	GW-GM	Well-Graded Gravel with Silt and Sand and Cobbles	10	64	30	7.2				AKV	AKV	C136
⅄ SC-1P-18, R-9	44.0	SP-SM	Poorly Graded Sand with Silt			91	9.5			24.3	AKV	AKV	C136
★ SC-1P-18, R-11*	54.0	SM	Silty Sand		0	72	28			15.4	AKV	AKV	C136

Test specimen did not meet minimum mass recommendations.
[2] *Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.*

Washougal Grade Separation
Washougal, Washington

BORING SC-1P-18

Sheet 2 of 2



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SC-1P-18, R-13*	63.0	SM	Silty Sand			85	15			21.5	AKV	AKV	C136
■ SC-1P-18, R-15	73.0	SM	Silty Sand			86	14			23.2	AKV	AKV	C136
▲ SC-1P-18, R-18*	88.0	SM	Silty Sand			74	26			16.2	AKV	AKV	C136

** Test specimen did not meet minimum mass recommendations.*
[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.

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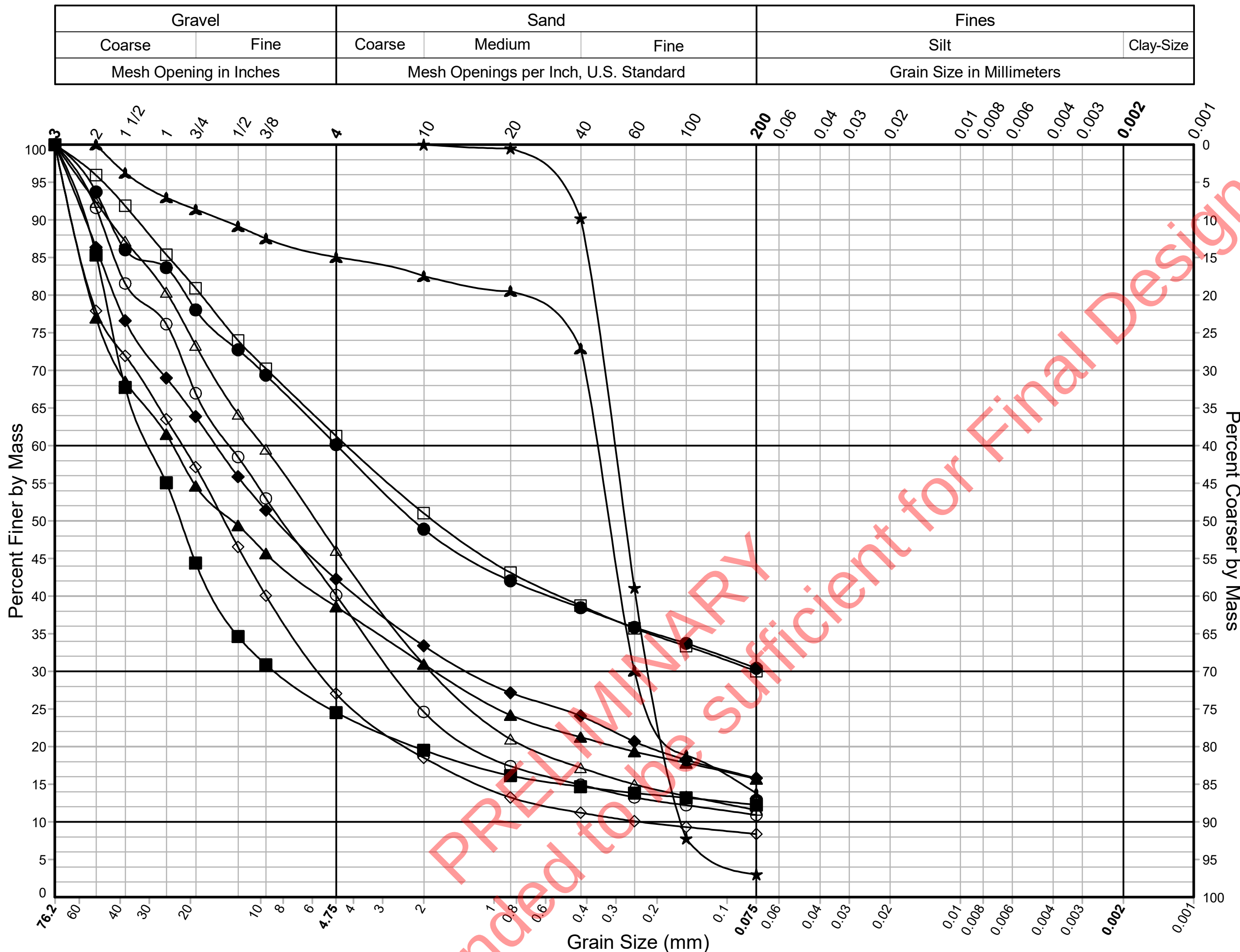
GRAIN SIZE DISTRIBUTION PLOT

Washougal Grade Separation
Washougal, Washington

BORING SC-2P-18

Sheet 1 of 2



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SC-2P-18, R-2*	7.5	GM	Silty Gravel with Sand and Cobbles	27	40	30	30			6.1	AKV	AKV	C136
■ SC-2P-18, R-3*	12.5	GM	Silty Gravel		75	12	12			7.0	AKV	AKV	C136
▲ SC-2P-18, R-4*	17.5	GM	Silty Gravel with Sand and Cobbles	19	62	23	16			5.7	AKV	AKV	C136
◆ SC-2P-18, R-5*	22.5	GM	Silty Gravel with Sand		58	26	16			5.8	AKV	AKV	C136
○ SC-2P-18, R-6*	25.0	GP-GM	Poorly Graded Gravel with Silt and Sand		60	29	11			5.4	AKV	AKV	C136
□ SC-2P-18, R-7*	30.0	GM	Silty Gravel with Sand		39	31	30			6.8	AKV	AKV	C136
△ SC-2P-18, R-8*	35.0	GM	Silty Gravel with Sand		54	35	12			10.7	AKV	AKV	C136
◇ SC-2P-18, R-9*	42.0	GP-GM	Poorly Graded Gravel with Silt and Sand and Cobbles	4	73	19	8.4			7.3	AKV	AKV	C136
⅄ SC-2P-18, R-10*	47.5	SM	Silty Sand with Gravel		15	71	14			23.8	AKV	AKV	C136
★ SC-2P-18, R-11	52.0	SP	Poorly Graded Sand			97	3.0			31.2	AKV	AKV	C136

** Test specimen did not meet minimum mass recommendations.*
[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.

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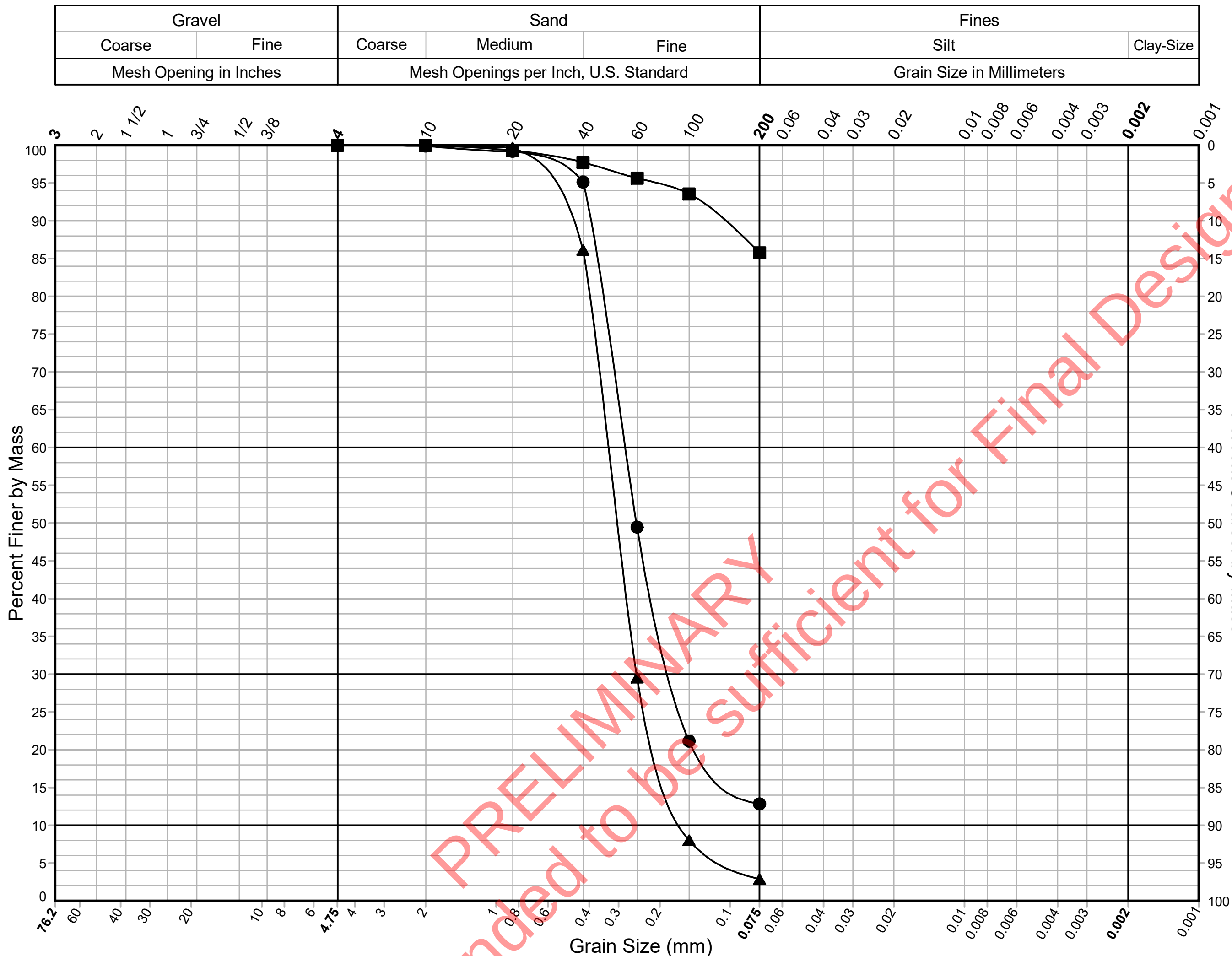
GRAIN SIZE DISTRIBUTION PLOT

Washougal Grade Separation
Washougal, Washington

BORING SC-2P-18
Sheet 2 of 2

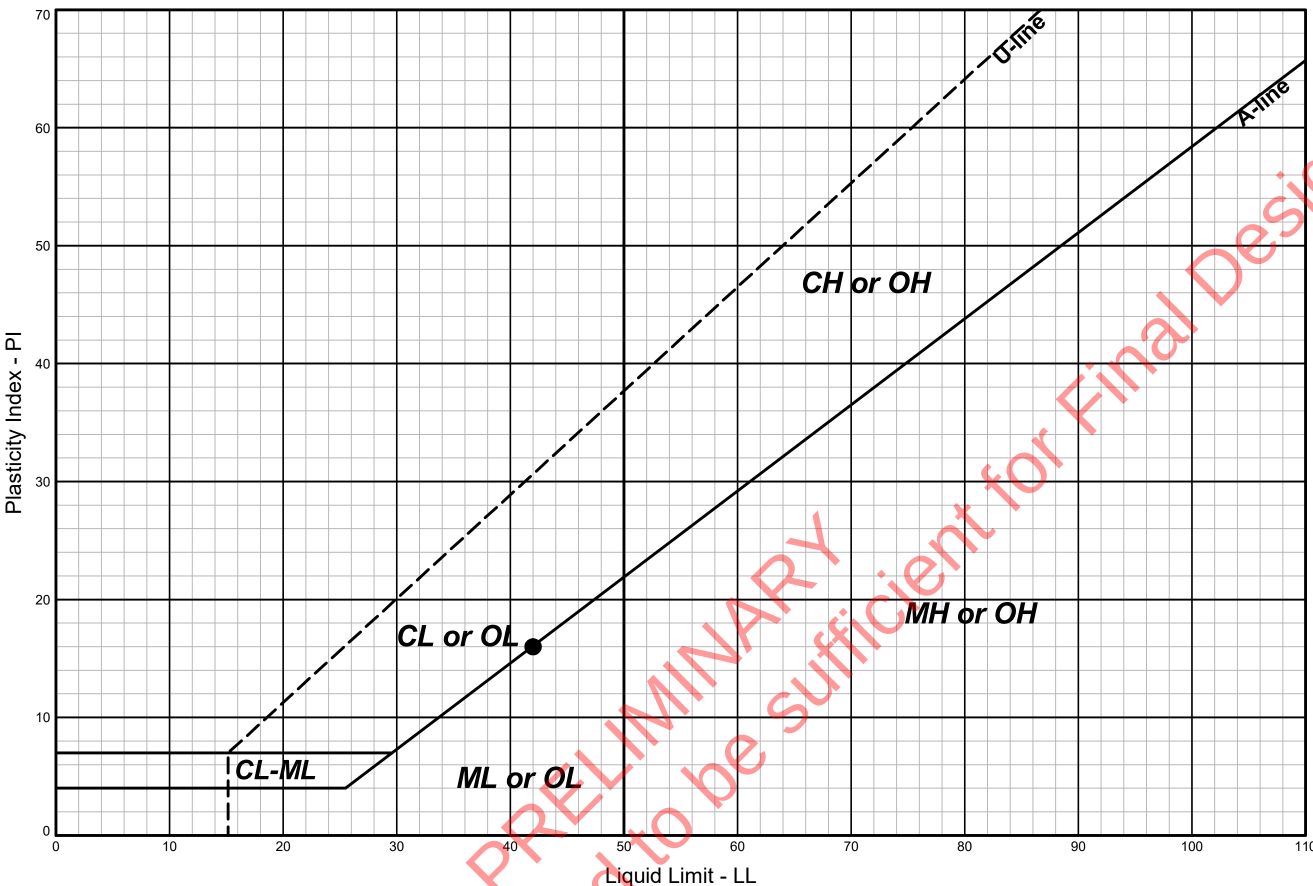


Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	Cobbles %[2]	Gravel %	Sand %	Fines %	< 20µm %	< 2µm %	WC %	Tested By	Review By	ASTM Std.
● SC-2P-18, R-13*	61.0	SM	Silty Sand			87	13			24.7	AKV	AKV	C136
■ SC-2P-18, R-18*	87.0	ML	Silt			14	86			36.6	AKV	AKV	C136
▲ SC-2P-18, R-19	90.5	SP	Poorly Graded Sand			97	2.9			26.7	AKV	AKV	C136

** Test specimen did not meet minimum mass recommendations.*
[2] Cobble percentages are calculated using the pre-removal, oven-dried mass of the total specimen. USCS Group Symbol, Soil Classification Group Name, Gravel %, Sand %, Fines %, <0.02mm %, <2um%, Cu, and Cc values are calculated from particles smaller than 76.2mm (3 inches) only, per ASTM D2487.

Washougal Grade Separation
Washougal, Washington

BORING SW-6p-21



Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	LL	PL	PI	WC %	Gravel %	Sand %	Fines %	< 2µm %	Tested By	Review By	ASTM Std.
● SW-6p-21, R-10	53.0	ML	Silt	42	26	16	31.5		10	90		BXK/AKV		D4318

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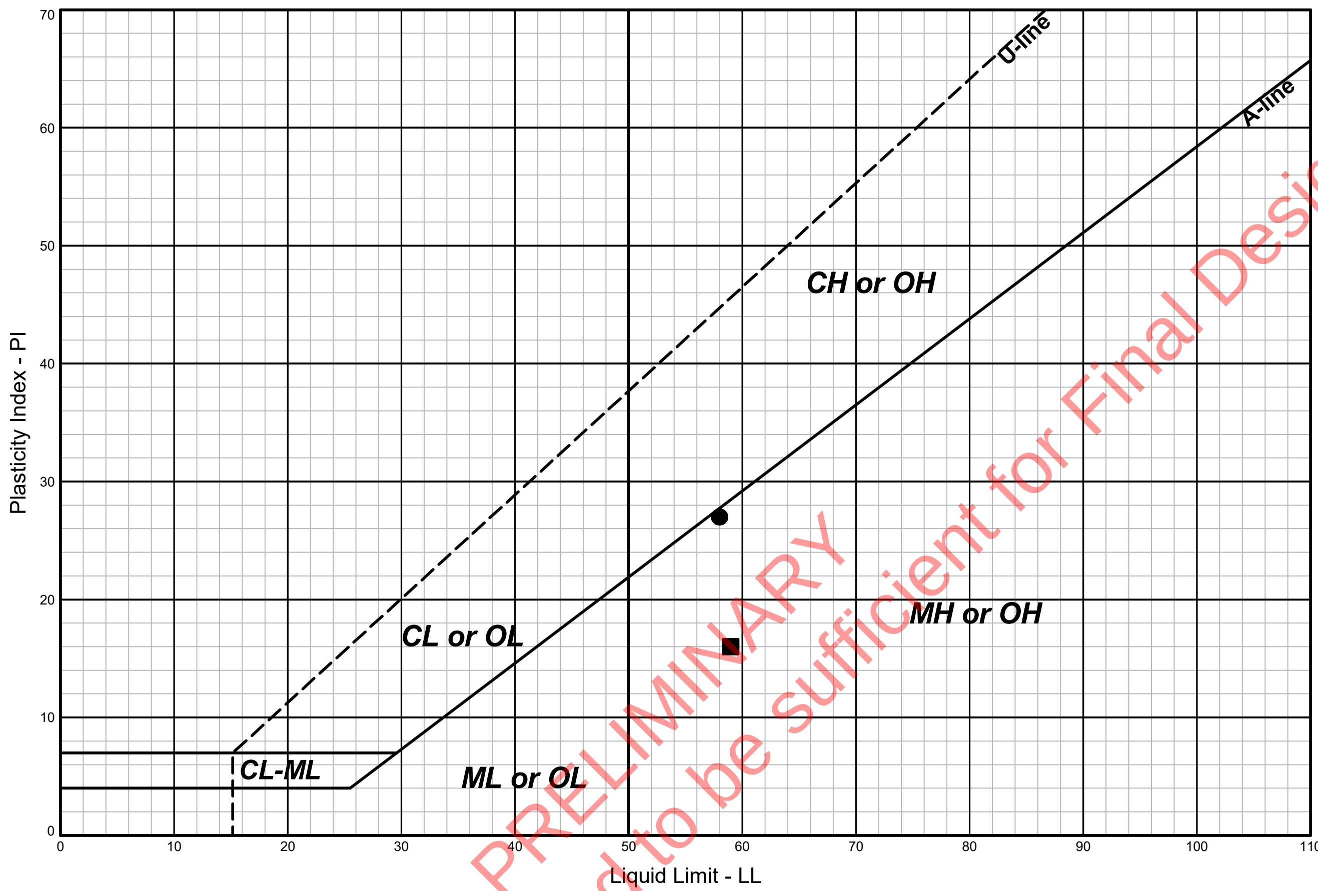
PLASTICITY CHART

Washougal Grade Separation
Washougal, Washington

BORING SC-1P-18

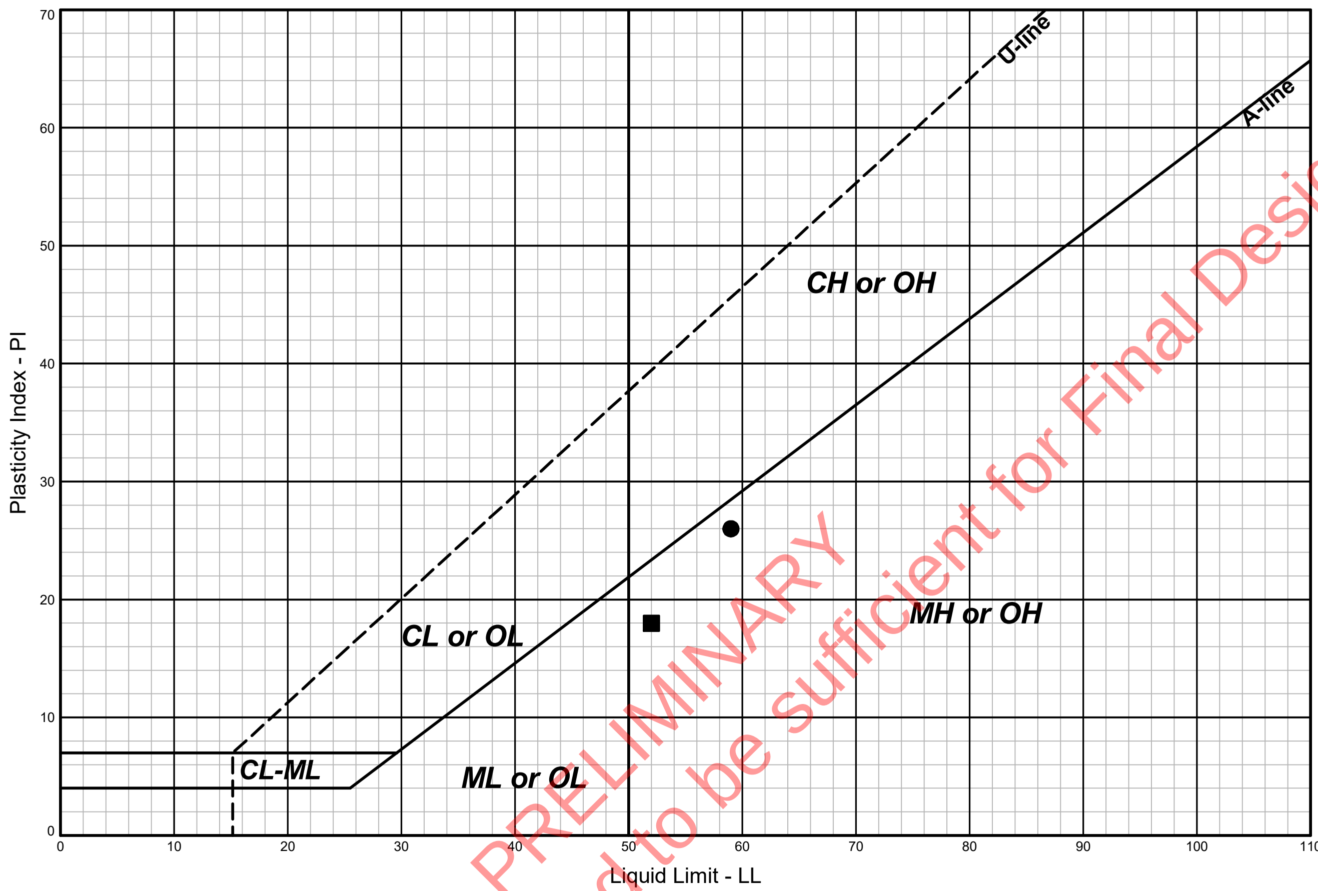


Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	LL	PL	PI	WC %	Gravel %	Sand %	Fines %	< 2µm %	Tested By	Review By	ASTM Std.
● SC-1P-18, R-16	78.0	MH	Elastic Silt	58	31	27	40.9					AKV	AKV	D4318
■ SC-1P-18, R-17	82.5	MH	Sandy Elastic Silt	59	43	16	50.3					MXC	AKV	D4318

PLASTICITY CHART

Washougal Grade Separation
Washougal, Washington

BORING SC-2P-18



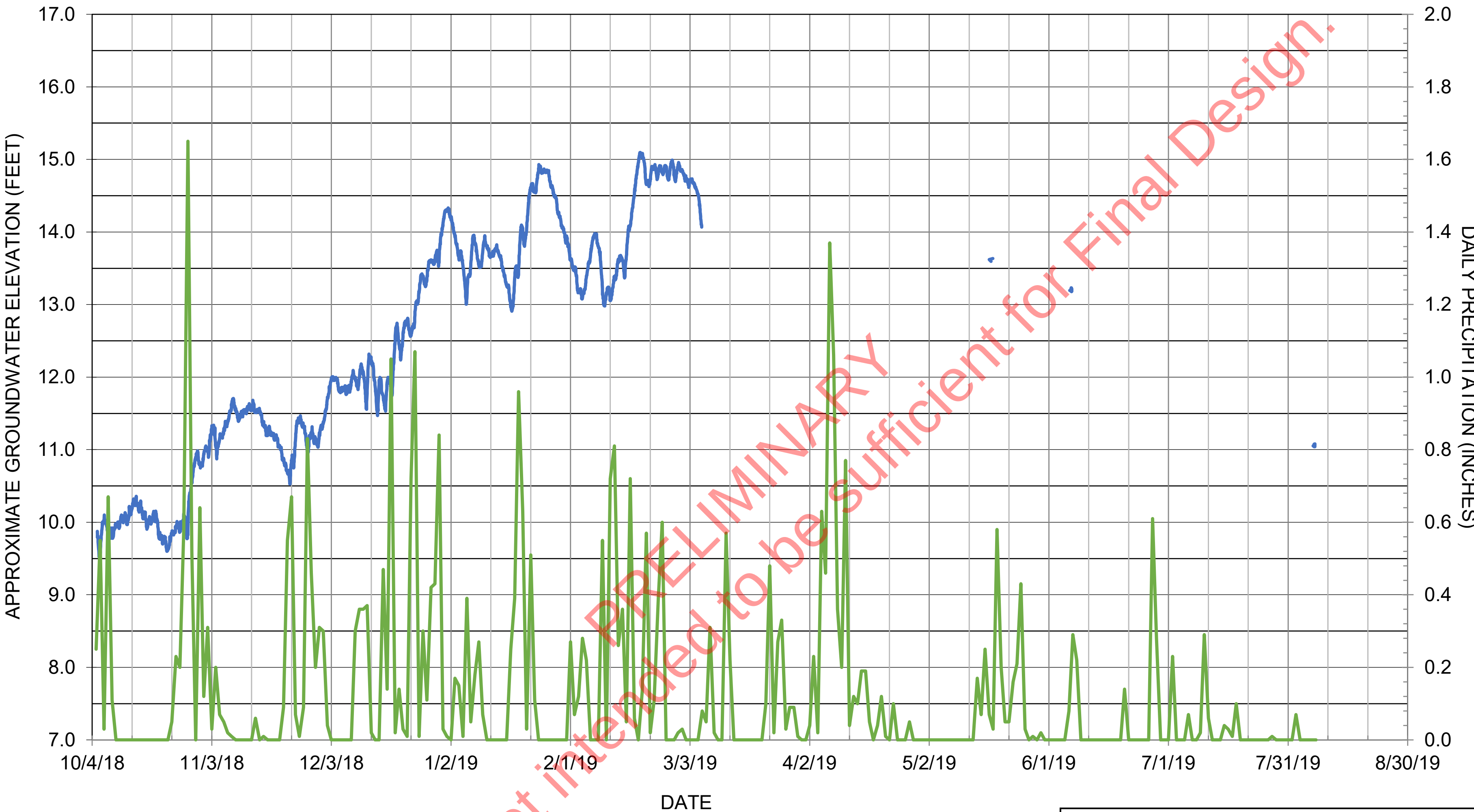
Sample Identification	Depth (ft)	USCS Group Symbol	USCS Group Name	LL	PL	PI	WC %	Gravel %	Sand %	Fines %	< 2µm %	Tested By	Review By	ASTM Std.
● SC-2P-18, R-14	69.5	MH	Elastic Silt	59	33	26	33.6					AKV	AKV	D4318
■ SC-2P-18, R-16	76.0	MH	Elastic Silt	52	34	18	35.6					AKV	AKV	D4318

APPENDIX C: VWP HYDROGRAPHS

Appendix C

VWP Hydrographs

CONTENTS



LEGEND

SC-1p-18, VWP at 50.2 feet deep

Daily Precipitation

NOTES

1. Boring SC-1p-18 ground surface elevation is approximately 45 feet.
2. Precipitation data were downloaded for the station at Camas, WA (US1WACK0029).
3. VWP = vibrating wire piezometer
4. Data logger experienced data gaps due to innundation with water that entered the flush monument.

Washougal Grade Separation Project
Washougal, Washington

SC-1P-18
HYDROGRAPH WITH PRECIPITATION

October 2021 | 101835-202

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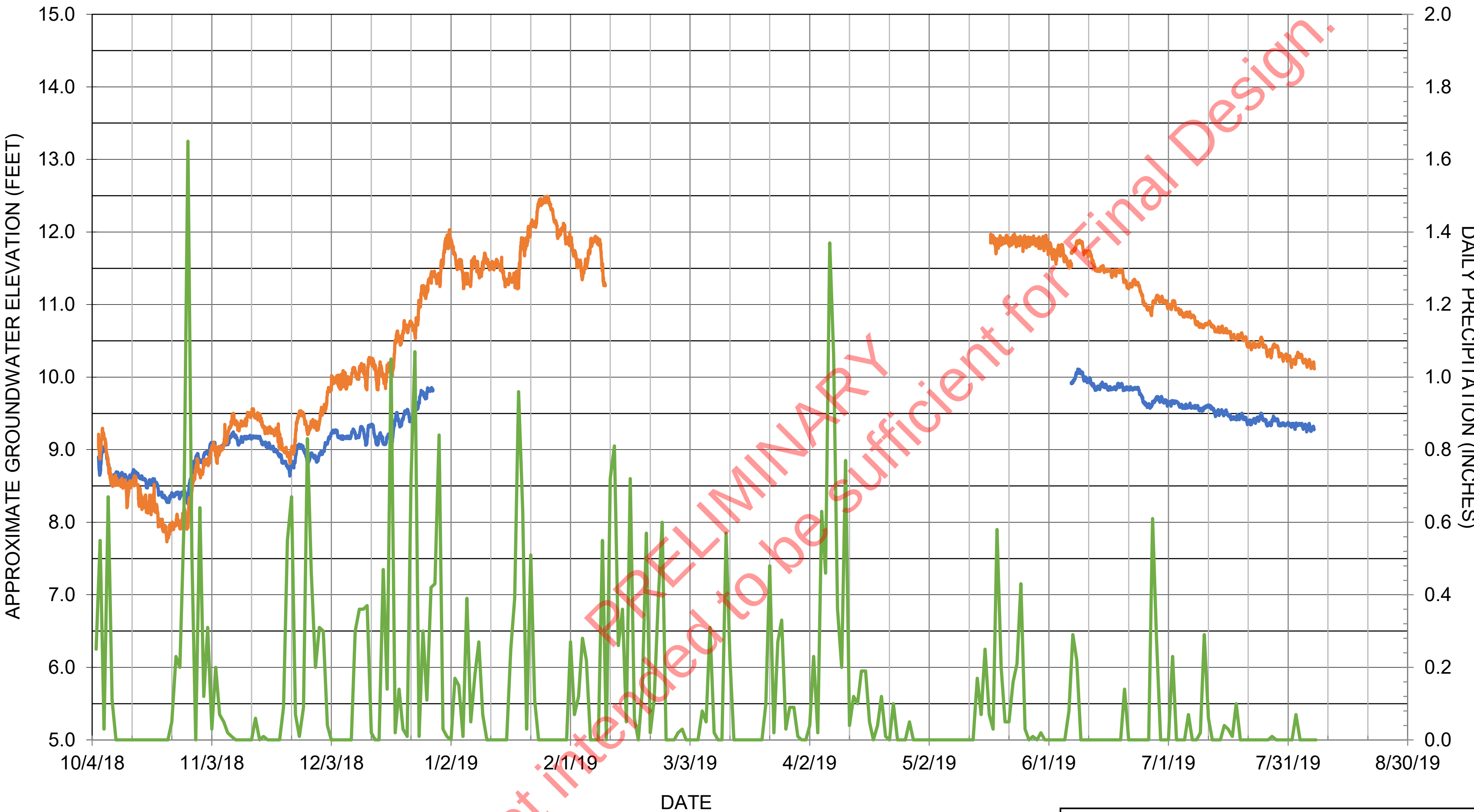
FIG. C-1

FIG. C-1

SC-1p-18 Hydrograph.xlsx-SC-1p-18_Plot-10/14/2021-pvh



LEGEND

- SC-2p-18, VWP at 40 feet deep
- SC-2p-18, VWP at 65 feet deep
- Daily Precipitation

NOTES

1. Boring SC-2p-18 ground surface elevation is approximately 45 feet.
2. Precipitation data were downloaded for the station at Camas, WA (US1WACK0029).
3. VWP = vibrating wire piezometer
4. Data loggers experienced data gaps due to innundation with water that entered the flush monuments.

Washougal Grade Separation Project
Washougal, Washington

SC-2P-18
HYDROGRAPH WITH PRECIPITATION

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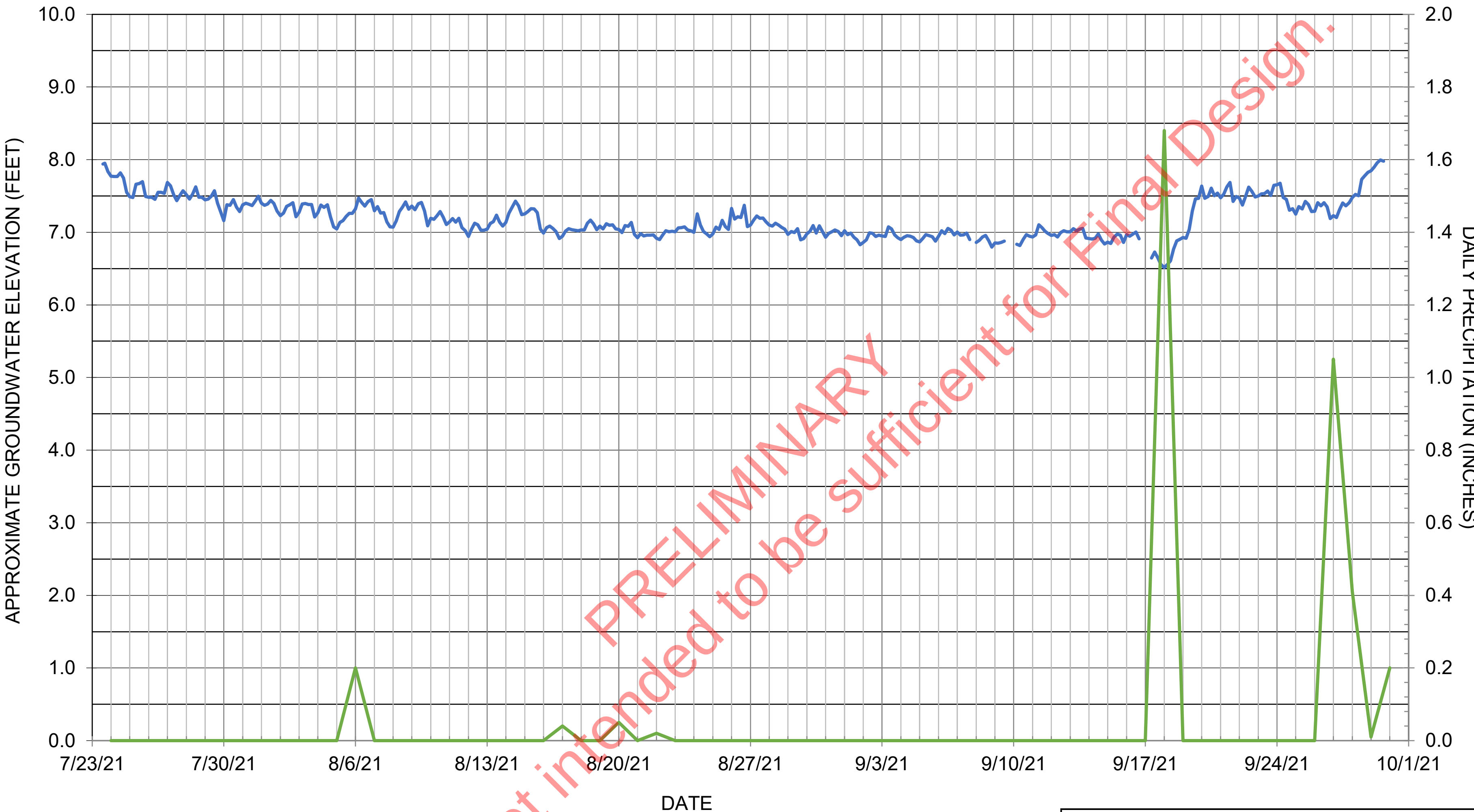
FIG. C-2

FIG. C-2

SC-2p-18 Hydrograph.xlsx-SC-2p-18_Plot-10/14/2021-pvh



LEGEND

NOTES

1. Boring SW-5p-21 ground surface elevation is approximately 38 feet.
2. Precipitation data were downloaded for the station at Camas, WA (US1WACK0029).
3. VWP = vibrating wire piezometer

Washougal Grade Separation Project
Washougal, Washington

SW-5P-21
HYDROGRAPH WITH PRECIPITATION

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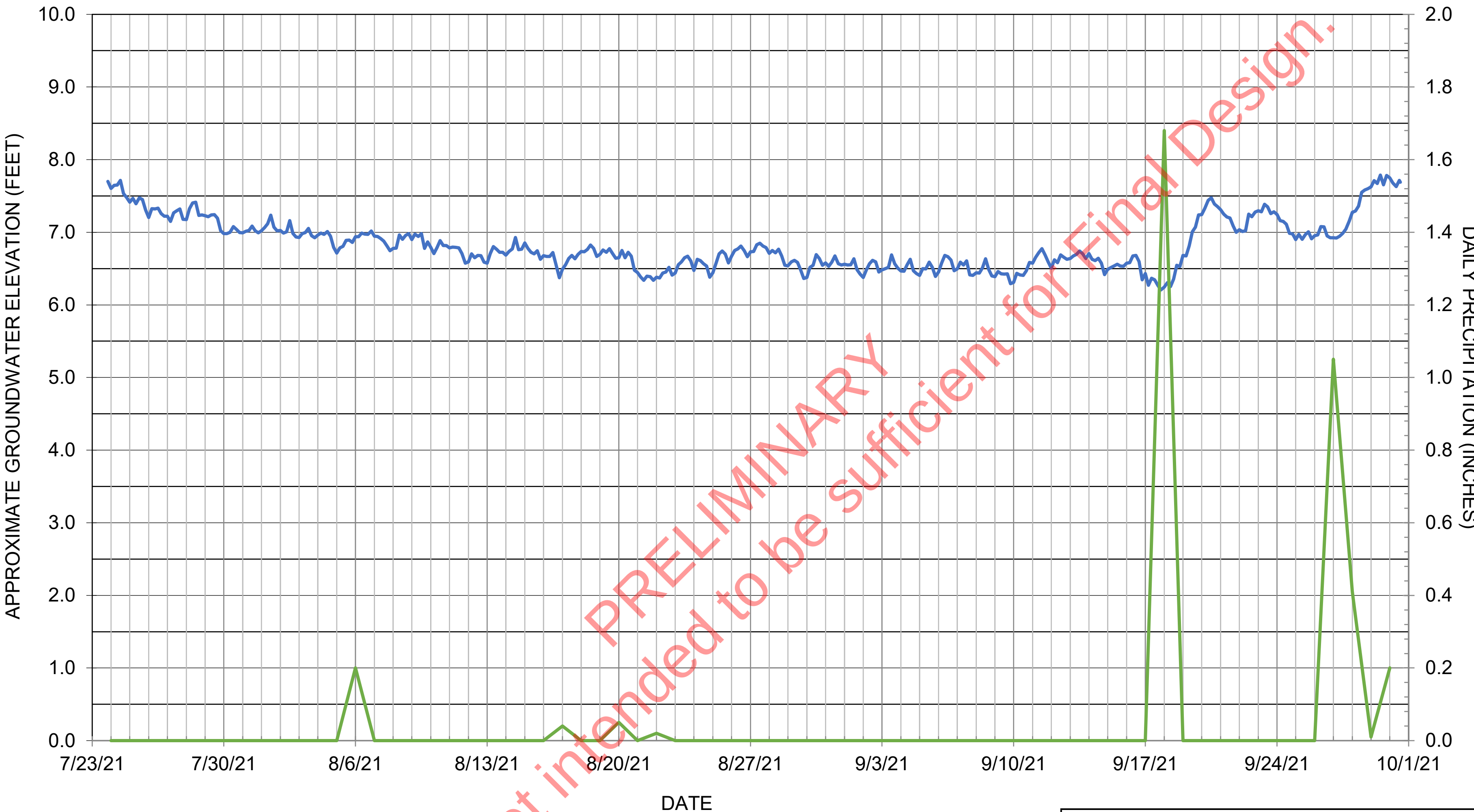
FIG. C-3

FIG. C-3



LEGEND

SW-6p-21, VWP at 55 feet deep

Daily Precipitation

NOTES

1. Boring SW-6p-21 ground surface elevation is approximately 46 feet.
2. Precipitation data were downloaded for the station at Camas, WA (US1WACK0029).
3. VWP = vibrating wire piezometer

Washougal Grade Separation Project
Washougal, Washington

SW-6P-21
HYDROGRAPH WITH PRECIPITATION

October 2021 | 101835-202

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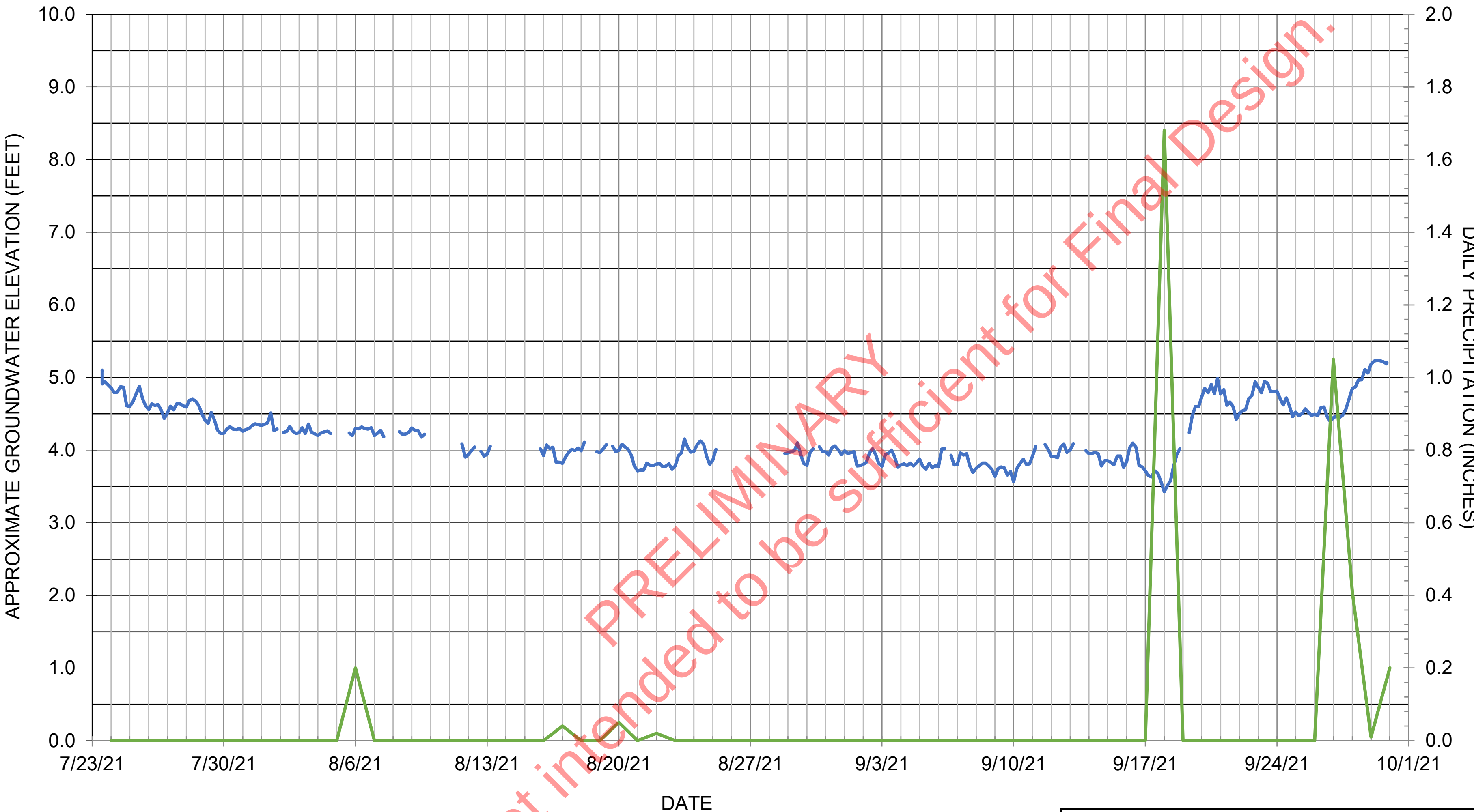
Geotechnical and Environmental Consultants

FIG. C-4

FIG. C-4



LEGEND

SW-8p-21, VWP at 75 feet deep

Daily Precipitation

NOTES

1. Boring SW-8p-21 ground surface elevation is approximately 45 feet.
2. Precipitation data were downloaded for the station at Camas, WA (US1WACK0029).
3. VWP = vibrating wire piezometer

Washougal Grade Separation Project
Washougal, Washington

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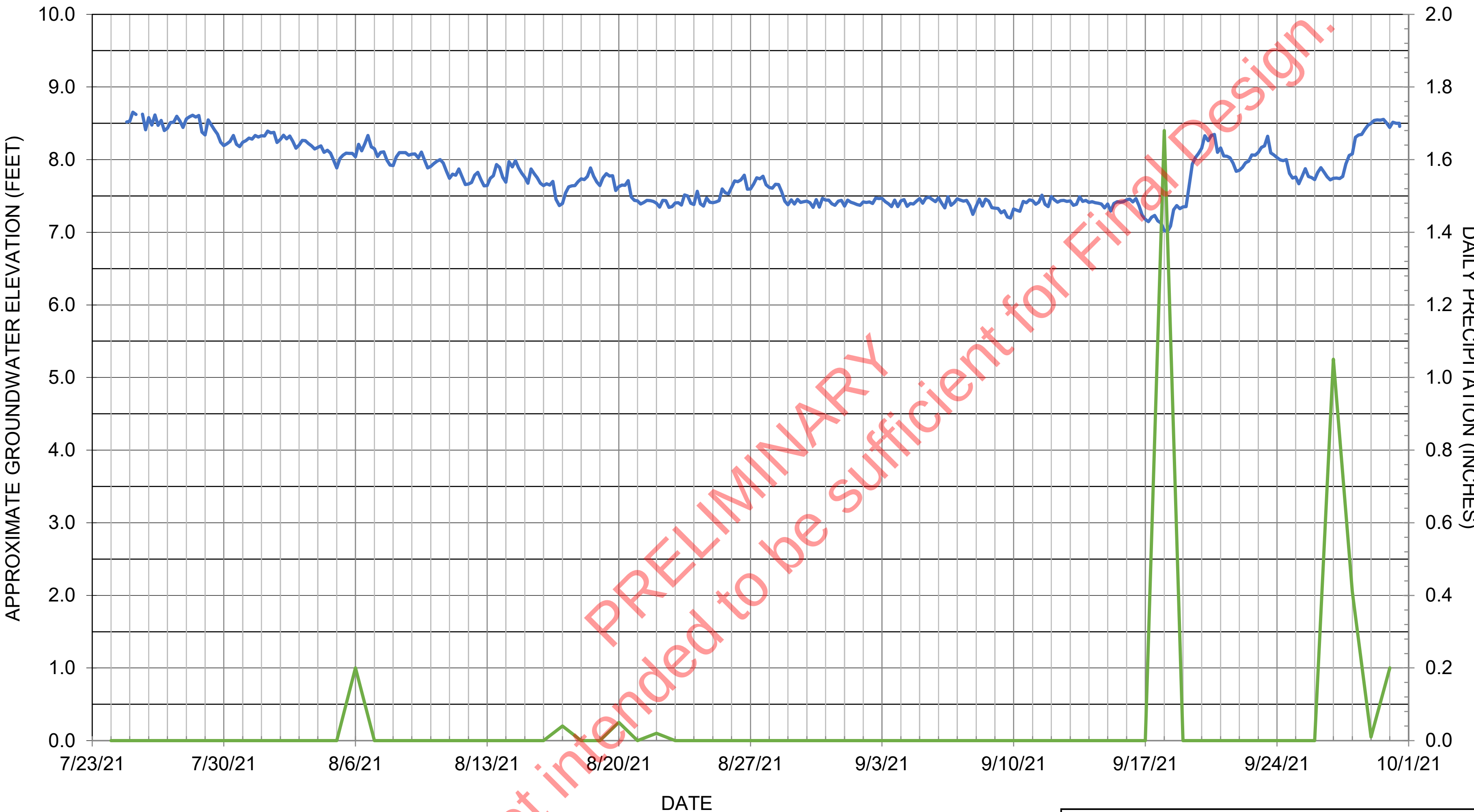
FIG. C-5



LEGEND

- SW-10p-21, VWP at 55 feet deep
- Daily Precipitation

NOTES

1. Boring SW-10p-21 ground surface elevation is approximately 42 feet.
2. Precipitation data were downloaded for the station at Camas, WA (US1WACK0029).
3. VWP = vibrating wire piezometer

Washougal Grade Separation Project
Washougal, Washington

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FIG. C-6

FIG. C-6

IMPORTANT INFORMATION

Important Information

About Your Geotechnical/Environmental Report

IMPORTANT INFORMATION

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

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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

IMPORTANT INFORMATION

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 ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland