Percheron Data Center

Geotechnical Engineering Report

May 2, 2023 | Terracon Project No. 82225118

Prepared for:

Rowan Percheron, LLC
1330 Post Oak Boulevard, Suite 1350
Houston, Texas 77056

Explore with us

Nationwide

Terracon.com

- Facilities
- Environmental
- Geotechnical
- Materials

700 NE 55th Avenue
Portland, OR 97203
P (503) 659-3281
Terracon.com

May 2, 2023

Rowan Percheron, LLC
1330 Post Oak Boulevard, Suite 1350
Houston, Texas 77056

Attn: Joel Zemanek
P: 231-463-6079
E: jzemanek@rowandigit.al

Re: Geotechnical Engineering Report
Percheron Data Center
Tower Road
Morrow County, Oregon
Terracon Project No. 82225118

Dear Mr. Zemanek:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P82225118 dated February 6, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

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

Sincerely,

Terracon

Ryan T. Houser, CEG
Project Geologist

Kristopher T. Hauck, P.E.
Senior Principal | Office Manager

Table of Contents

Diagrams

Tables

Figures

Attachments

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Report Summary

Topic [1]	Overview Statement [2]
Project Description	Site consists of a single 275-acre parcel. Project consists of construction of four, 225,000-square-foot data center buildings, a power substation, security guard house, generator yards, retention ponds, and associated pavements.
Geotechnical Characterization	▪ **Data Center Building Area**: The surface soils underlying the data center area consisted of a thin mantle of rooted topsoil underlain by loose silty sand and silt soils up to about 15 feet below the ground surface (bgs). These soils are interpreted to be wind-blown (loess) deposits and are susceptible to collapse. The loess was generally underlain by dense to very dense cemented silty sand soils and basalt bedrock. Basalt bedrock was encountered in the data center building area at depths as shallow as 2 feet bgs. Perched groundwater was observed in one boring in the data center building area at a depth of about 22½ feet bgs. ▪ **Substation and Guard House Area:** The substation and guard house area was generally underlain by the same materials as described above, with the exception of one boring that did not encounter bedrock. In this boring (SS-3), subsurface materials consisted of loess extending to about 15 feet bgs, underlain by flood deposits consisting of silty sand, sand, and elastic silt to the full depth explored (61½ feet bgs). Groundwater was encountered in this area ranging from 6½ to 9½ feet bgs.
Loess Soils Collapse Risk	The near surface loess soils exhibit moderate risk collapsible and the deeper soils exhibit negligible to slight risk collapsible soils. The collapse of the "honeycomb" structure is typically instigated by wetting and loading or overstressing from the loading without wetting. Therefore, we recommend mitigation of the collapse risk by removing and replacing the shallow loess soils or performing ground improvement of these soils within the proposed building areas. Ground improvement is also recommended where total settlements for duct banks and utilities outside of the data center building pads must not exceed 1 inch.

Topic [1]	Overview Statement [2]
Earthwork	We understand the data center pads will be developed by maintaining a building pad with 7 to 10 feet of excavatable material for installation of underground utilities (i.e. 7 to 10 foot separation from bedrock). Depending on finish grades, this likely will require removal of basalt bedrock, which was encountered as shallow as 2 feet bgs in our explorations. Amount of rock excavation is not known, since the grading plan is currently in development. Much of the site surficial soils consist of low-density material, we expect significant shrinkage that should be accounted for in the grading planning from excavation to placement and compaction of the loess materials. The moisture content of the in-situ material is significantly below optimum moisture content and will require moisture conditioning in order to be able to be compacted in accordance with the compaction requirements. It is possible that a significant water import to the site will be needed.
Shallow Foundations	Shallow foundations can be used to support the structures following mitigation of the loess soils and/or ground improvements.
Deep Foundations	Cast-in-place reinforced concrete drilled shafts may be used to support the planned dead-end support structures for the substation.
Pavements	With a minimum of 12 inches of scarified and compacted subgrades prepared as noted in Earthwork, typical pavement section can be expected for this development.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed data center buildings, a power substation, security guard house, generator yards, retention ponds, and associated pavements to be located at Tower Road in Morrow County, Oregon. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil (and rock) conditions
- Groundwater conditions
- Seismic site classification per ASCE 7-16
- Liquefaction and lateral spread potential
- Site preparation and earthwork
- Dewatering considerations
- Foundation design and construction
- Floor slab design and construction
- Lateral earth pressure
- Pavement design and construction
- Stormwater considerations
- Frost considerations

The geotechnical engineering Scope of Services for this project included the advancement of twenty-nine borings to depths of 6 to 61½ feet below existing ground surface (bgs), twelve test pits to depths of up to 10½ feet bgs, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Table 1: Project Description

Item	Description
Information Provided	Site Layout, prepared by Dotterweich Carlson Mehner Design, Inc., dated January 10, 2023.
Project Description	Site consists of a single 275-acre parcel. Project consists of construction of four, 225,000-square-foot data center buildings, a power substation, guardhouse, generator yards, retention ponds, and associated pavements.
Proposed Structure	The data center structures will consist of one-story buildings with steel superstructures and shallow foundations. We anticipate the buildings will incorporate loading docks. Back-up generators are planned to be supported on mat foundations. Water tanks are planned for service to the data centers and expected to be supported on mat foundations.
Finished Floor Elevation	Finished floor elevations were not provided.
Maximum Loads (Assumed)	▪ Columns: 1,200 kips ▪ Walls: 8 kips per linear foot (klf) ▪ Slabs: 500 pounds per square foot (psf)
Grading/Slopes	Significant cuts and fills are anticipated on this site based on topography.
Below-Grade Structures	No basement levels planned.
Free-Standing Retaining Walls	Retaining walls are not expected to be constructed as part of site development to achieve final grades.
Pavements	Paved driveway and parking will be constructed around the proposed building and will include 64 parking spaces. We assume both rigid (concrete) and flexible (asphalt) pavement sections should be considered. Please confirm this assumption. Anticipated traffic is as follows: ▪ Autos/light trucks: 100 vehicles per day ▪ Light delivery and trash collection vehicles: 10 vehicles per week ▪ Tractor-trailer trucks: <3 vehicle per week The pavement design period is 20 years.
Building Code	2022 Oregon Structural Specialty Code (OSSC)

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Table 2: Site Conditions

Item	Description
Parcel Information	The project is located at Tower Road in Morrow County, Oregon. The approximate center of the 275-acre site is located at the following coordinates: ■ Latitude: 45.7115° N ■ Longitude: 119.8232° W See **Site Location**
Existing Improvements	Vacant lot
Current Ground Cover	Grass and scrub brush.
Existing Topography	The site generally descends gradually to the northeast to a south-trending drainage. Total relief across the site is on the order of 40 feet. Site topography is shown on the attached **Topographic Plan**.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

Geotechnical Characterization

Geology

Based on our review of the geologic map[1] of the area and experience on the adjacent site, the site is underlain by eolian sand and ash (Qe - loess deposits) that extend to a depth of about 15 feet, although the depth is variable across the site. Loess soils within the site vicinity typically are comprised of eolian (wind deposited) silt and fine sand. The unit is present across the site up to about 15 feet in thickness and is material derived from the underlying Missoula Flood Deposits (described later) being re-worked and deposited once allowed to dry. Loess deposits are made up of a semi-stable soil structure commonly referred to as a "honeycomb" structure. This structure makes the soil susceptible to collapse under additional applied load and saturation. In addition to the collapse potential of this soils type, other characteristics of this soil unit are low relative density and high void ratios.

This loess unit can often be broken into two units consisting of younger loess, typically 3 to 7 feet in thickness, and older loess ranging from 3 to 21 feet in thickness[1]. The older loess is also described as consolidated with strong calcium carbonate contents (referred to as caliche cementation in this report). General consensus from the geologic community is that the calcium carbonate was leached from the upper loess layer by infiltrating surface water and precipitated out as the water evaporated[2, 3] and is generally found in the loess deposits where mean annual precipitation is less than 15 inches. This older unit is referred to as Cemented Loess in this report. In general, these geologic descriptions are relatively consistent with the findings in the geotechnical borings. The cemented loess is generally not susceptible to collapse.

The loess is generally underlain by Pleistocene catastrophic flood deposits originating from glacial outburst floods of Lake Missoula. Periodic failure of glacial ice dams that impounded

---

[1] Madin, I.P and Gietgey, R.P., 2007, Preliminary geologic map of the Umatilla Basin, Morrow and Umatilla Counties, Oregon, Oregon Department of Geology and Mineral Industries, Open-File Report O-07-15.

[2] Washington Department of Transportation Publication WA-RD 69.1, Development of Guidelines for Cuts in Loess Soils, by Higgins, Fragaszy, and Beard (1985)

[3] Engineering Geology in Washington (Volume II), Washington Division of Geology and Earth Resources – Bulletin 78, article titled "Engineering Geology of Loess in Southeastern Washington", by J. D. Higgins, R. J. Fragaszy, and L. D Beard (p. 887-898)

Lake Missoula in present day Montana between 18,000 to 15,000 years ago[4] produced catastrophic floods that flowed through northern Idaho, eastern Washington, and into northern Oregon and through the Columbia River Gorge. These soils were deposited repeatedly over the time period, each depositional layer represents a single flood event. The flood deposits in the region extend to depths of up to about 80 feet, and generally consist of layers of silt, sand, and clay.

The Missoula Flood deposits are underlain by underlain by Miocene Columbia River Basalt. Our explorations indicate the depth to basalt ranges from about 2 to over 60 feet at the site.

Seismic Hazards

Seismic hazards resulting from earthquake motions can include slope stability, liquefaction, and surface rupture due to faulting or lateral spreading. Liquefaction is the phenomenon wherein soil strength is dramatically reduced when subjected to vibration or shaking.

We reviewed the Statewide Geohazards Viewer (HazVu) published by the Oregon Department of Geology and Mineral Studies (DOGAMI) and available online[5]. The viewer categorizes the expected earthquake shaking from light, moderate, strong, very strong, severe and violent; and the landslide susceptibility from low, moderate, high, and very high.

- Earthquake Liquefaction Hazard: Moderate
- Expected Earthquake Shaking: Moderate to Strong
- Landslide Susceptibility (due to earthquake): Low to Moderate

Nearby Faults

The United States Geological Survey (USGS) maintains the Quaternary Fault and Fold Database containing descriptions and locations of recently active faults within the United States. The three closest faults to the project site include the Arlington-Shutler Butte fault (No.847), the Columbia Hills structures (No.568), and the Horse Heaven Hills structures

---

4 Allen, John Eliot, et al., 2009. Cataclysms on the Columbia, The Great Missoula Floods, Revised Second Edition: Ooligan Press, Portland State University.

5 Statewide Geohazards Viewer (HazVu) published by the Oregon Department of Geology and Mineral Studies (DOGAMI) https://gis.dogami.oregon.gov/hazvu/, accessed April 2023.

(No.567). Published information pertaining to each fault or fault zone is provided in the following table:

Table 3: Nearby Faults

Fault Name	Arlington-Shutler Butte fault	Columbia Hills structures	Horse Heaven Hills structures
USGS Fault Number	847	568	567
USGS Fault Class	A	A	A
Distance to Fault from Site	15 mi W	16 mi W	30 mi SW
Length of Fault	33 miles	100 miles	112 miles
Strike (degrees)	N42°W	N75°E	N90°W
Sense of Movement	Right lateral, Normal	Thrust	Thrust
Dip Direction	Vertical	2–80° S	24-42°S
Slip-rate Category	Less than 0.2 mm/yr	Less than 0.2 mm/yr	Less than 0.2 mm/yr
Most recent prehistoric deformation	Middle and late Quaternary (<750 ka)	Undifferentiated Quaternary (<1.6 Ma)	Undifferentiated Quaternary (<1.6 Ma)

Based on our review of the available fault information, the depth to bedrock, and the site's proximity to the nearest known faults, it is our opinion that the risk of surface rupture due to ground faulting is low.

Groundwater Conditions

We observed our explorations while drilling and after completion for the presence and level of groundwater. Groundwater was encountered in seven of our explorations as indicated on the exploration logs in **Exploration Results**, and as summarized in the table below.

Table 4: Groundwater Conditions

Exploration Number	Approximate Ground Surface Elevation (feet) [1]	Approximate Depth to Groundwater while Drilling (feet)
DC-14	598	22½
GS-1	593	6½
SS-1	591	9
SS-2	590	6½

Exploration Number	Approximate Ground Surface Elevation (feet) [1]	Approximate Depth to Groundwater while Drilling (feet)
SS-3	595	9½
TP-5	605	2

1. Based on elevations obtained from Google Earth and depth to the observed groundwater during explorations. Note the assumed ground surface elevation is presented on the boring logs.

Groundwater was not observed in the remaining explorations conducted for this investigation. Well logs available on the Oregon Water Resources Department (OWRD)[6] website indicate that groundwater levels in the area of the site generally range from about 50 to 200 feet below site grades, depending on topography.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GeoModel

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and Sections showing the GeoModel (Sections A-A′ through D-D') can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to Sections A-A′ through D-D′ in the **Figures** attachment of this report.

6 Oregon Water Resources Department, 2023. Well Log Records, accessed April 2023, from OWRD web site: http://apps.wrd.state.or.us/apps/gw/well_log/.

Table 5: GeoModel

Model Layer	Layer Name	General Description
1	Topsoil	**TOPSOIL (OL)**; fine grained sand, nonplastic, brown, moist, very loose, rootlets and some roots
2	Loess	**POORLY GRADED SAND (SP), POORLY GRADED SAND WITH SILT (SP-SM), SILTY SAND (SM), SILT (ML)**; fine grained sand, nonplastic where silt, light brown to brown, very loose/soft to medium dense/very stiff
3	Cemented Loess	**SILTY SAND (SM), POORLY GRADED SAND WITH SILT (SP-SM)**; fine to coarse grained, light brown to white, dense to very dense, moderate to strong cementation
4	Flood Deposits	**SILTY SAND (SM), POORLY GRADED SAND (SP)**; fine grained sand, brown to brownish gray, medium dense. **POORLY GRADED GRAVEL WITH CLAY (GP-GC);** coarse grained, brown, dense. **ELASTIC SILT (MH)**; trace sand, high plasticity, gray, moist.
5	Bedrock	**BASALT**; gray, fine-grained, variable fracturing, slightly weathered to unweathered, medium strong to strong, variable vesicle content.

Corrosivity

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Table 6: Corrosivity Test Results Summary

Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (%)	Soluble Chloride (%)	Electrical Resistivity (Ω-cm)	pH
DC-2	0.5-4.5	Silty Sand (SM)	<0.01	<0.01	2231	8.37
DC-13	0.5-4.5	Silty Sand (SM)	0.01	<0.01	2813	8.26

Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (%)	Soluble Chloride (%)	Electrical Resistivity (Ω-cm)	pH
DC-24	0.5-4.5	Silty Sand (SM)	<0.01	<0.01	2716	8.17

Results of soluble sulfate testing can be classified in accordance with ACI 318 – Building Code Requirements for Structural Concrete. Numerous sources are available to characterize corrosion potential to buried metals using the parameters above. ANSI/AWWA is commonly used for ductile iron, while threshold values for evaluating the effect on steel can be specific to the buried feature (e.g., piling, culverts, welded wire reinforcement, etc.) or agency for which the work is performed. Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with metals used for construction. Consultation with a NACE certified corrosion professional is recommended for buried metals on the site.

Thermal Resistivity Results

Thermal resistivity dryout curve testing was performed on soil samples collected from borings DC-10, DC-13, DC-24, and TP-1. The soil samples were remolded to a density of about 95% of their maximum dry density determined by ASTM D1557 near optimum water content to model the parameters for potential backfill soils.

The results of the thermal resistivity testing and the thermal resistivity dryout curves are summarized in the table below. Interpretation of the thermal resistivity test results should be performed by the design team in determination of underground cable sizes and/or rating. The results of the thermal resistivity dryout curves and laboratory compaction tests are presented in the **Exploration Results** section.

Table 7: Laboratory Thermal Resistivity Testing Summary

Location / Depth	Description	Remolding Modeled Condition [1]	Water Content (%)	Dry Unit Weight (lb/ft^3)	Thermal Resistivity (ºC-cm/Watt)	
					Wet[2]	Dry[3]
DC-10 / ½ ft	Silty Sand	95% MDD	12.6	118.9	82	243
DC-13 / ½ ft	Silty Sand	95% MDD	12.6	111.1	104	308
DC-24 / ½ ft	Silty Sand	95% MDD	12.6	119.5	89287	

Location / Depth	Description	Remolding Modeled Condition [1]	Water Content (%)	Dry Unit Weight (lb/ft^3)	Thermal Resistivity (°C-cm/Watt)	
					Wet[2]	Dry[3]
TP-1 / ½ ft	Silty Sand	95% MDD	12.6	110.6	92	326

1. Soil samples molded to near measured water content and dry unit weight measured in place (in-situ), and to dry unit weight of approximately 95% of maximum dry unit weight near the optimum water content determined by standard Proctor (ASTM D698) compaction criteria.
2. Thermal resistivity value measured at initial "wet" water content.
3. Thermal resistivity value measured at final "dry" at 0.3% to 1.4% water content.

Geotechnical Overview

The subsurface conditions at the site were evaluated to develop geotechnical related design and construction recommendations for site development. In our opinion, the site is feasible for the proposed development provided the recommendations in this report are followed. The opinions and recommendations presented in this report are based on the understanding that each data center pad will be underlain by 7 to 10 feet of new structural fill.

Collapsible (Loess) Soils

The primary geotechnical consideration for this site is that the upper 1 to 15 feet of loess (GeoModel Layer 2) soils are loose and structures founded directly on these soils could experience excessive total and differential settlements. These soils were deposited by wind and the soil particles are generally considered to be oriented in a "honeycomb" like structure, which can make them susceptible to high volumetric strains due to collapse of the soil structure. The collapse of the "honeycomb" structure is typically instigated by wetting and/or loading. Based on laboratory consolidation and collapse testing for this project and others in the similar widespread deposit, this soil is susceptible to collapse upon loading and wetting generally ranging from 0.5 to about 4 percent strain at full saturation. Laboratory testing from samples collected from the site indicates collapse potential of about 1.2 to 2.7 percent. We estimate that this hazard equates to about 1 to 5 inches of potential collapse related settlements across the site explorations if the loess were to remain in place and utilized for support.

Several methods have been implemented for reducing or mitigating the risk of collapse settlements including: overexcavation and replacement with structural fill, pre-wetting and surcharging the underlying soils, dynamic compaction, and/or deep foundations. The most appropriate option depends on the structure's tolerance for total and differential settlement, the owner's risk tolerance for the potential collapse settlements to limit the structure's use, the cost of remedial measures versus traditional construction methods, and other factors that affect the decision-making process.

Due to the critical nature of data center foundations, we recommend complete mitigation of the settlement hazard because settlement of the above magnitude would exceed the owner's risk tolerance. Based on our experience with data center construction, we understand floor slabs must be held to a similar standard.

For mitigation of the collapse settlement risk, we recommend the soils be remediated prior to construction of the proposed development. Remediation of loose soils may consist of one of the following options:

- **Removal and Recompaction**: The loose soils could be removed to expose cemented loess or basalt bedrock. The surface of the underlying soils should be scarified, wetted and compacted prior to placement of new structural fill. The loess, cemented loess, and flood deposits (GeoModel Layers 2, 3, and 4) encountered at the site are suitable for reuse as structural fill, provided they meet the recommendations presented in the **Earthwork** section.
- **Aggregate Piers**: Aggregate piers consist of compacted gravel columns typically placed in a grid pattern within a building pad to improve the bearing capacity of the soils and reduce the potential for differential settlements.
- **In-Place Densification**: The existing loose soils could be remediated using Dynamic Compaction (DC) or Rapid Impact Compaction (RIC) techniques. Both techniques are cost effective compared to aggregate piers and generally do not require the amount of grading as required with removal and recompaction. Dynamic Compaction could be completed using traditional Deep Dynamic Compaction techniques (dropping a weight from a specified height using a crane) or using Roller Dynamic Compaction.

The proposed structures may be founded on conventional shallow foundations following remediation of the loose soils. Additional discussions of these options are presented in the **Ground Improvement** section below. Since grading plans are not yet defined, it's important to note that all footings should bear on consistent subsurface conditions. In other words, if one portion of the structure is to be supported on structural fill or bedrock, the materials at the other end of the structure should be similar.

The near-surface loose sand/silt soils were taken into account for pavement design recommendations presented in the **Pavements** section below.

Shallow Bedrock

Hard basalt bedrock will likely be encountered during site grading under potions of the site. Excavation into the basalt bedrock (GeoModel Layer 5) may require heavy-duty construction equipment, such as a hoe ram, a heavy dozer equipped with a ripper, a rock saw or jack hammer or with rock trenching equipment, is likely suitable for grading, shallow excavations, and utility trench excavations. Blasting may also be considered if acceptable to the local jurisdiction.

While not bedrock, the cemented loess soils will also be difficult to excavate and may necessitate using rock excavation equipment like rippers and/or rock trenching equipment.

Reuse of Site Soils

The soils at the site are generally suitable for reuse as structural fill, with the following exceptions:

- The upper few inches of soils encountered at the site consists of topsoil with organic debris (roots, leaves, etc). The topsoil is not considered suitable for reuse as structural fill due to its high organic content.
- The elastic silt encountered in SS-3 has a high expansion potential, and is not recommended for reuse as structural fill. This material was first encountered at a depth of 42 feet below existing grades; therefore, we do not anticipate this soil will constitute much, if any, material produced from excavations during construction.

In addition to reuse of the soils, the basalt bedrock materials could also be available for reuse if planned to be excavated in any significance. It’s been our experience these basalt flows often can produce quality aggregate for use at the site using mobile crushing and processing equipment.

Liquefiable Soils

The loess soils (GeoModel Layer 2) are susceptible to liquefaction-induced settlement from a design-level seismic event when saturated. There is one location where these soils were observed to be wet (boring SS-3). Shallow groundwater was encountered in a portion of the proposed substation where loess soils extend to depths of up to 15 feet bgs (see boring SS-3). Mitigation of the collapse potential of the loess soils described above will also mitigate against the potential for liquefaction these soils. Note that this risk was identified in the boring location SS-3 and not in any other locations.

General

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and structural fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas.

Stripped materials consisting of vegetation and organic materials should be wasted from the site or used in non-structural areas and/or topsoil to re-vegetate landscaped areas or exposed slopes after completion of grading operations. If it is necessary to dispose of organic materials on-site, they should be placed in non-structural areas, and in fill sections not exceeding 5 feet in height.

Loess soils were encountered across the area of proposed development to depths ranging from 1 to 15 feet below the ground surface. The subsequent section (**Subgrade Preparation**) discusses the recommendations of subgrade preparations of the foundation elements. We recommend complete removal of the loess soils within foundation areas for all major structures (i.e. structure foundations, water tower, substation equipment pads, generators, transformers, etc.) and at least a partial removal and replacement for surface structure features (i.e. on-grade floor slabs not supporting walls, pavements, minor equipment storage pads, etc.).

Subgrade Preparation

While a grading plan was not provided prior to the issuance of this report, we anticipate loose loess soils to be exposed at the base of many of the excavations for new structural fill. These soils are not suitable for support of foundations or new structural fill, and should be improved by removal and recompaction or alternatively by other ground improvement methods.

After stripping, cutting to design subgrade improvement elevations, and prior to placement of new fill in areas below final grades, we recommend that the exposed subgrades be observed and evaluated for the presence of soft, loose or unsuitable materials. Due to the nature of loess soils, disconnected and distinct areas of additional removal of Loess soils will likely be necessary and the earthwork contractor should be prepared to complete additional overexcavation in discrete areas across the pads as necessary. We do not necessarily expect a smooth transitional surface across the pads.

We recommend testing of the exposed subgrades include visual observation, hand probing, density testing, and proof rolling (where feasible) to help locate weak or unstable areas at or just below the exposed subgrade level. Proof rolling should be performed using heavy rubber-tired equipment, such as a fully loaded dump truck, having a minimum gross weight of about 20 tons. Unsuitable areas observed at this time should be excavated and replaced with engineered fill. Those soils which are soft, yielding, or unable to be compacted to the specified criteria should be overexcavated and replaced with structural fill material later described in the **Fill Material Types** section of this report.

Exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 12 inches, conditioned to near optimum moisture content, and compacted.

Subsequent to the surface clearing, grubbing and fill placement efforts, the exposed subgrade soils should be prepared to an approximate depth of 12 inches. Subgrade preparation should generally include some form of scarification (or removal), moisture conditioning, and compaction. The moisture content and compaction of subgrade soils should be maintained until slab or pavement construction.

Bedrock Excavations

Excavation operations at this site will penetrate through the overburden soils and into the underlying bedrock. While the overburden soils should be relatively easy to excavate in comparison to the underlying bedrock, excavators should expect to encounter large block or fragments broken bedrock and boulders within these soils.

We anticipate that excavations for the proposed construction within the topsoil, loess, and flood deposits (GeoModel Layers 1, 2, and 4, respectively) can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

The cemented loess (GeoModel Layer 3) exhibited variable cementation and hardness. Strongly cemented areas of the cemented loess may require ripping using heavy-duty dozers and/or jack hammers.

Excavation into the basalt bedrock (GeoModel Layer 5) should be anticipated to involve blasting for fracturing and breaking bedrock into manageable size material to transport to on-site crushing operations or fill areas if breakdown to small particles is possible with large dozers or compaction equipment. Upper portions of the bedrock strata are anticipated to be excavatable with heavy-duty dozers equipped with ripping attachments if this is a more efficient method. Other isolated excavations into bedrock will require heavy-duty construction equipment, such as a hoe ram, a rock saw or jack hammer or with rock trenching equipment, is likely suitable for grading, shallow excavations, and utility trench excavations.

Our comments on excavation are based on our experience with the rock formation. Rock excavation depends on not only the rock hardness, weathering and fracture frequency, but also the contractor's equipment, capabilities, and experience.

Two P-Wave geophysical surveys were performed at the site, which consisted of placing geophones setup in linear configurations along the arrays as shown on the **Exploration Plan**. Seismic compression wave (p-wave) velocities obtained from our field tests ranged from about 1,000 ft/s to 17,000 ft/s, with trend of increasing with depth into the bedrock layers. The cross-sectional images of the wave velocities generated from the seismic testing are included in the **Exploration Results** section of this report.

In construction, the hardness of rock is often discussed in terms of Rippability. This means that a bulldozer of particular size equipped with ripping attachments should be able to rip or break the rock to a certain depth. For reference, we compared the findings to the "Caterpillar Performance Handbook" and the Caterpillar "Handbook of Ripping – 12th Edition". Per the Caterpillar publications and guidance related to igneous basalt bedrock, the following criteria is often used for prediction of excavatability:

Caterpillar Dozer Model	Seismic Wave Velocity for Basalt and Rippability (ft/sec)		
	Rippable	Marginal	Non-Rippable
D9R	<7,600	7,600 to 8,600	>8,600
D10R	<8,000	8,000 to 8,900	>8,900
D11R	<8,700	8,700 to 9,900	>9,900

For reference a D9R dozer was selected for comparison of the field test results. Per the Caterpillar performance handbook, bedrock with P-wave velocity to about 7,500 ft/s is rippable with a D9R dozer, and where P-wave velocity is over about 8,500 ft/s the bedrock is predicted to likely be unrippable and would require blasting. Based on these guidelines, we estimate that the bedrock at the project site is rippable with a D9R within depths presented in the following table with variability in depth as indicated on the geophysical survey exhibits:

Geophysics Line	Approximate Depth with P-Wave Velocities Less Than 7,600 ft/sec (range in depths bgs along arrays)
1	25 to 35 feet

Geophysics Line	Approximate Depth with P-Wave Velocities Less Than 7,600 ft/sec (range in depths bgs along arrays)
2	25 to 40 feet

One item to note in the above table and plot of wave velocity contours on the figures is the variability of the depth of rippable materials in a short (300-foot length) cross section. Depth to bedrock as encountered in our explorations varied greatly across the site from about 1 foot to over 60 feet bgs. Velocity measurements indicate the upper portion of the basalt flow is fractured and/or weathered. The rippability criteria presented in the Caterpillar performance handbook is regarding mass grading and is not necessarily indicative of rippability of the materials within trenches using an excavator and other rock excavation techniques such as hoe-rams may be needed.

While these figures indicated a significant thickness of rippability, practical production of ripping rock can often be slowed due to breakage in slabs and variability of weathering in boulders and/or crevasses of the flow surface.

Rippability interpreted from information presented in the Caterpillar performance handbook is a guideline and rippability can vary with rock structure, fracturing and weathering as well as the limits and confines of the excavation. The charts are intended to be interpreted as a mass, unlimited access grading operation and for trenching methods could grossly overstate the rippability of the bedrock. The use of D10R or D11R equipment, if it is an option for this project, may provide the needed power and ripping capabilities with a higher degree of confidence in areas of the rock formation, rock condition, or depths that the D9R may not be able to rip satisfactorily. While some of the bedrock may be marginally rippable with the equipment outlined above, blasting of bedrock should be anticipated during mass grading.

Blasting methods or approaches should be discussed during design phases and development of specifications. A trial ripping and blasting program should be conducted on the site in the planning process to select appropriate procedures. Pre-blasting can be considered ahead of a ripping and excavation procedure to possibly produce smaller rock sizes for the processing and rock fill procedures. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to blasting activities.

Blankets of site soils are often left in place over bedrock masses to be blasted to absorb energy of the blast and reduce scatter of material. This can result in portions of the excavated blasted rock to include the finer soils that produce a less suitable gradation or mixture upon crushing and processing for structural fill. Sorting of rock fragments for the crushing operations might be needed to develop better suited granular material for fill placement applications.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes.

Reuse of On-Site Soil: Excavated on-site loess (GeoModel Layer 2), cemented loess (GeoModel Layer 3), flood deposits (GeoModel Layer 4), and basalt bedrock (GeoModel Layer 5) may be reused as structural fill if processed to meet the criteria presented in **Fill Placement and Compaction Requirements** below. Topsoil (GeoModel Layer 1) contains a high percentage of organics and should not be reused as structural fill.

Fill Materials: Structural fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Table 8: Structural Fill Criteria

Fill Type [1]	Specifications	Acceptable Parameters (for Structural Fill)
Stone Embankment Material (processed site rock fill)	ODOT SSC Section 330.16, limited to fragments not larger than 6"	Mass grading of pads Not within 2 feet of bottom of floor slabs / pavements / foundations
Common Fill	Oregon Standard Specifications for Construction (OSSC) Section 00300.13 Selected General Backfill	All locations across the site. Dry weather only acceptable
Select Fill	OSSC Section 00330.14 Selected Granular Backfill [2]	All locations across the site. Wet and Dry weather acceptable.
Crushed Aggregate Base (CAB)	OSSC Section 02630.10 Dense Graded Aggregate (2"-0 to ¾"-0) [2]	All locations across the site. Wet and Dry weather acceptable.
Trench Backfill	OSSC Section 00405.14 for Trench Backfill with additional stipulations [4]	Acceptable materials include Common and Select Fill listed above.

Fill Type [1]	Specifications	Acceptable Parameters (for Structural Fill)
Subgrade Stabilization	OSSC Section 00330.14 for Selected Granular Backfill above groundwater seepage and OSSC Section 00330.16 for Stone Embankment Material with additional stipulations [4]	12-inch compacted lift in wet or soft subgrades encountered in subgrade and other utility excavations.
Bedding & Haunching	OSSC Section 00405.13, Pipe Zone Material	Thickness above and below pipe recommended by Electrical Engineer

1. Controlled, compacted fill should consist of approved materials that are free (free = less than 3% by weight) of organic matter and debris (i.e. wood sticks greater than ½ inch in diameter). A sample of each material type should be submitted to the geotechnical engineer for evaluation.
2. Material should have a maximum aggregate size of 2 inches, and a minimum laboratory CBR of 20% for granular soils, and no more than 12% passing the No. 200 sieve by weight determined by ASTM D6913. Fines should have a Plasticity Index (PI) of less than 20% per ASTM D4318. Reclaimed glass will not be accepted.
3. The contractor shall select the appropriate material for use based on the current and forecasted weather conditions at the time of construction.
4. Maximum aggregate size shall be limited to 2½ inches.

Fill Placement and Compaction Requirements

Structural should meet the following compaction requirements.

Table 9: Fill Compaction Requirements

Item	Structural Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1,2,3]	95% of max. above and below foundations and within 2 feet of finished pavement subgrade 92% of max. when more than 2 feet below finished pavement subgrade
Water Content Range [1]	Common Fill, Select Fill, & CAB: -2% to +2% of optimum

Item	Structural Fill
Non-Density Testable Materials (e.g. Stone Embankment Materials, etc.)	Materials not amenable to density testing should be placed and compacted to a stable condition under full-time observation by the Geotechnical Engineer or representative in general accordance with ODOT SSC Section 00300.43 (c).

1. Maximum density and optimum water content as determined by the modified Proctor test (ASTM D1557).
2. High plasticity cohesive fill should not be compacted to more than 100% of standard Proctor maximum dry density.
3. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D4253 and D4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Dewatering

Perched groundwater was encountered in the planned substation area at the north end of the site. The contractor should be prepared to control areas of localized groundwater seepage in the excavations. Construction activity should be monitored and should be curtailed if the construction activity is causing subgrade disturbance. A Terracon representative can help with monitoring and developing recommendations to aid in limiting subgrade disturbance

We anticipate that dewatering for site preparations as well as subgrade preparations will be necessary for utility trenches and/or perched water within the substation area (depending on the season) for the foundation excavations. We provide the following recommendations for incorporation into the project specifications with respect to dewatering:

- The contractor should be made responsible for designing, permitting, and constructing dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom or sides.
- The dewatering system should be of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow work to be installed in a dry condition (i.e. no standing water) that maintains stability of the subgrade soils.
- The contractor should be responsible for obtaining discharge permits and designing settling basins, as necessary by permit, for the pumped water and performing water quality testing that may be required by regulatory agencies including but not limited to Oregon Department of Environmental Quality. All data and other submittals required by regulatory agencies shall be submitted to the owner and Civil Engineer.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1H:1V projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of structural fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proof rolling and mitigation of unsuitable areas delineated by the proof roll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill and a minimum of one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer’s evaluation of subsurface conditions, including assessing variations and associated design changes.

Seismic Considerations

Seismic Site Class

The seismic design requirements for structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7-16.

Data Center Building Area Site Class

Two geophysical ReMi arrays were conducted at the site in the area of the proposed data center buildings to measure shear wave velocities within the upper 100 feet of the subsurface materials at the site. The average shear wave velocities were used to determine the corresponding Site Class according to section 20.3 of ASCE 7-16, as summarized in the following table:

Table 10: Data Center Building Area Site Class

Geophysical Array	Average Shear Wave Velocity V_{s100} (ft/sec)	Site Class (Table 20.3-1 of ASTM 7-16)
Line 1	2,493	C
Line 2	2,189	C

Based on our geophysical survey, we recommend using a **Seismic Site Classification of C** for preliminary planning of the data center buildings. We recommend Seismic Site Class be revisited during preparation of the final geotechnical report, once grading plans have been developed.

Substation Area Site Class

The substation area lies north of the geophysical lines completed for this project. Some of the soils encountered under the substation area are susceptible to liquefaction (see **Liquefaction** section below). According to ASCE 7-16, the **Seismic Site Classification is F**. Following mitigation of the liquefaction-susceptible materials within the substation, and to account for subsurface variability, we recommend a **Seismic Site Classification of D** be used for structures in the substation area. This classification is based on the SPT blow counts collected in SS-3 and an estimate of the SPT blow counts for the improved soils.

Seismic Design Parameters

The following seismic design parameters may be used for design of the proposed structures:

Table 11: Seismic Design Parameters

Description	Value	
Area of Site	**Data Center Building Area**	**Substation Area**
2022 Oregon Structural Specialty Code (2022 OSSC) Site Class	C	D[1,2]
Site Latitude	45.7115° N	
Site Longitude	119.8232° W	
S_s Mapped Spectral Acceleration for Short (0.2 second) Period[3]	0.411g	
S_1 Mapped Spectral Acceleration for 1 Second Period[3]	0.162g	
F_a Site Coefficient, 0.2 second	1.300	1.471
F_v Site Coefficient, 1.0 second	1.500	2.276
S_{DS}	0.356g	0.403g

Description	Value	
S_{D1}	0.162g	0.246g

1. Seismic site classification in general accordance with the 2022 OSSC, which refers to ASCE 7-16.
2. ASCE 7-16 requires a site soil profile extending to a depth of 100 feet be used for seismic site classification. See **Seismic Site Class** section for discussion.
3. These values were obtained using online seismic design maps and tools Available on the Applied Technology Council (ATC) website referenced in Section 1613.2.1 of the 2022 OSSC.

Liquefaction

Liquefaction is the phenomenon where saturated soils develop high pore-water pressures during seismic shaking and lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is shallow and loose granular soils or relatively low- to non-plastic fine-grained soils are present. Soft silts and loose sands were encountered in the substation area in boring SS-3 to depths of about 15 feet bgs. Groundwater was observed in this boring at a depth of about 9½ feet during our field exploration. Our fieldwork took place during the end of the rainy season when groundwater is near its seasonal high, so was estimated to be about 9 feet bgs for this liquefaction evaluation.

We performed a site-specific liquefaction analysis using the methods based on empirical methods developed by Boulanger and Idriss (2014). The peak ground acceleration and moment magnitude used in the analysis were based on the PGA as required by the 2022 OSSC and factored for the site class coefficient. The risk for liquefaction of the non-plastic to low plasticity site soils encountered between the top of the groundwater surface and about 15 feet bgs is high and we estimate liquefaction-induced total settlements of approximately 4 inches could be experienced at the site. We anticipate up to 2/3 of the total settlement (or 2⅔ inches) could be experienced as differential settlement. It has been our experience that this magnitude of settlement exceeds Umatilla Electric Company’s tolerances for turn-key substation pads. Therefore, we have included remediation strategies in this report.

Liquefaction Lateral Movement

Lateral spread can occur on sites underlain by liquefiable soils that are located on or near slopes, and/or adjacent to a free face, such as a stream bank or the shore of an open body of water. The potentially liquefiable materials identified in boring SS-3 are in an area where bedrock was encountered at shallower levels in the surrounding borings, so no free faces were identified for this discontinuous layer. Therefore, it is our opinion that the potential risk for lateral spread from liquefaction is low.

Ground Improvement

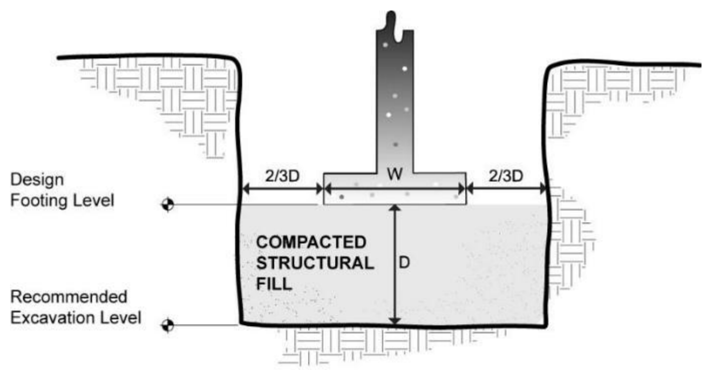
As described in the **Geotechnical Overview** section of this report, the site is underlain by up to 15 feet of loose sand soil that is prone to collapse. Structures founded directly on these soils could experience total and differential settlements exceeding structure design tolerances. Therefore, ground improvements are necessary in order to limit unpredictable settlements.

For this site, we recommend complete removal and recompaction of the loose loess soils (GeoModel Layer 2), installation of aggregate piers, or in-place recompaction using Dynamic Compaction (DC) or Rapid Impact Compaction (RIC) to improve site soils. These methods all allow for the proposed structures to be founded on conventional shallow foundations.

Removal and Recompaction

For this mitigation option, the existing loose soils should be removed to expose medium dense to better underlying native soils or bedrock (GeoModel 3, 4, or 5). The exposed subgrade should be proof rolled to identify areas of excessive yielding. After remediation of any identified areas, the surface should be scarified and recompacted prior to placement of additional fill. The excavation should be backfilled with fill placed and compacted in accordance with the recommendations presented in the **Earthwork** section above.

Over-excavation for engineered fill placement below footings should extend laterally beyond edges of the footings at least 8 inches per foot of over-excavation depth below footing base elevation. The over-excavation should then be backfilled up to the footing base elevation with engineered fill placed in lifts of 8 inches or less in loose thickness and should be moisture conditioned and compacted following the recommendations in this report. The limits of required over-excavation and engineered fill are shown in the following figure.



Overexcavation / Backfill

NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

Special care must be taken with site soils to maintain proper moisture conditions. Over wetting of soils being placed may result in underlying soils exceeding their optimum moisture condition resulting in "pumping" during earthwork activities. If such conditions occur, over excavation, moisture conditioning, and recompaction may be required.

Aggregate Piers

Aggregate pier construction is accomplished using a rammer attached to a mandrel with a tamper foot that typically penetrates the ground. Depending on the stiffness of the upper soils, sometimes the holes are pre-drilled to facilitate penetration by the mandrel. When the mandrel has achieved design depth, aggregate is placed in lifts with normal heavy-duty construction equipment. Each gravel lift is forced into the surrounding soil, by the tamper, forming an aggregate pier. Aggregate piers are designed and constructed by a qualified design-build contractor based upon type of aggregate pier, replacement area, densification, and settlement criteria. The design-build contractor also develops specifications for construction of the aggregate piers, the diameter and spacing, products to be used, as well as tolerance and acceptance criteria. The planned conventional foundations and floor slabs would then be constructed on top of the aggregate pier/soil matrix.

Based on our experience, we estimate that increased bearing pressures on the order of 4,000 to 6,000 psf could be achieved with an aggregate pier design.

Dynamic Compaction (DC)

Deep Dynamic Compaction is a ground improvement technique where a heavy weight dropped from a height to densify soils. Generally, a 5 to 20-ton tamper weight is repeatedly dropped from heights up to 100 feet above the ground surface in a grid pattern throughout the building pad. Grid spacing depends on the size and weight of the tamper used. This technique can improve soils up to 30 feet below the impact surface, depending on the weight of the tamper and the height from which it is dropped. This technique is well suited for densifying loose surficial soils that are prone to collapse.

Roller Dynamic Compaction is a method of dynamic compaction where a roller is pulled behind tractor type equipment. However, the roller (module) is non-circular having three, four, or five sides. As the module rotates, it imparts energy to the soil as it falls to impact the ground. The module is traversed across the site usually in multiple (greater than 10) full coverage passes.

Based on our experience, we estimate that increased bearing pressures on the order of 4,000 psf or higher could be achieved with a dynamic compaction design.

Rapid Impact Compaction (RIC)

Similar to DDC, Rapid Impact Compaction (RIC) is a ground improvement technique that densifies shallow, loose granular soils, using a hydraulic hammer which repeatedly strikes an impact plate. The energy impact is generally less than DC, but can be applied in shorter timeframes between impacts. The energy is transferred to the underlying loose granular soils and rearranges the particles into a denser configuration. The impact locations are typically located on a grid pattern, the spacing of which is determined by the subsurface conditions and foundation loading and geometry.

Based on our experience, we estimate that increased bearing pressures on the order of 3,500 to 4,500 psf could be achieved with an RIC densification design.

Design-Build Contractors

We recommend that design build proposals for ground improvement be based on soil conditions noted on the explorations, and the settlement tolerances established by the project structural engineer depending on the final building structural tolerances. We recommend that a qualified design-build contractor be contacted regarding ground improvement design and installation for this project to determine relative costs. The contractor will require the subsurface information presented in this report to formulate a scope and budget for the improvements.

We recommend that the design-build contractor's design be based on the following minimum criteria:

- Static Settlement within and below improved zone < 1 inch
- Achieve an allowable bearing capacity of 3,500 psf or more, depending on the structural requirements

We anticipate the ground improvement elements will extend to depths of about 10 feet across the site. The actual depth of the ground improvement elements will be a function of the settlement and lateral spread tolerances of the proposed structure while maintaining life-safety.

Geotechnical Review

Design of a ground improvement system requires a thorough understanding of site subsurface conditions. Furthermore, ground improvement design is somewhat approximate and often involves an evaluation of project risks and benefits relative to the extent of the improvement. We recommend that Terracon be retained to assist the design-build contractor in the preparation of suitable improvement plans and specifications for this project. Terracon should also be retained to review the plans, calculations, and specifications once they have been prepared.

Because ground improvement is considered a specialty type construction, it is our opinion that geotechnical special inspection during the construction should be performed by personnel experienced in the construction methods. Therefore, we recommend that a qualified geotechnical engineer provide construction observation and testing services during the ground improvement process.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in the **Earthwork** section, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Table 12: Shallow Foundation Design Parameters

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2]	■ Bearing Condition 1: 3,500 psf (foundations bearing within new structural fill) ■ Bearing Condition 2: 3,500 psf or greater, depending on selected design (foundations bearing on soils densified using aggregate piers, DC, or RIC)
Required Bearing Stratum [3]	■ Bearing Condition 1: Foundation subgrades overexcavated to medium dense or better GeoModel Layer 3 – cemented loess and backfilled with structural fill. ■ Bearing Condition 2: Soils improved per the **Ground Improvement** section of this report.
Minimum Foundation Dimensions	■ Columns: 30 inches ■ Continuous: 18 inches
Ultimate Passive Resistance[4] **(equivalent fluid pressures)**	400 pcf (improved soils)
Ultimate Sliding Resistance [5]	0.6 (improved soils)
Minimum Embedment below Finished Grade [6]	■ Exterior footings in unheated areas: 24 inches ■ Exterior footings in heated areas: 24 inches ■ Interior footings in heated areas: 18 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About 2/3 of total settlement between columns and 50 ft along continuous footings

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Values assume that exterior grades are no steeper than 20% within 10 feet of structure. These values can be increased by 1/3 for short-term wind and seismic loading condition cases.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in the **Earthwork** section.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces

Item	Description

or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure.

5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.

Footing Drains

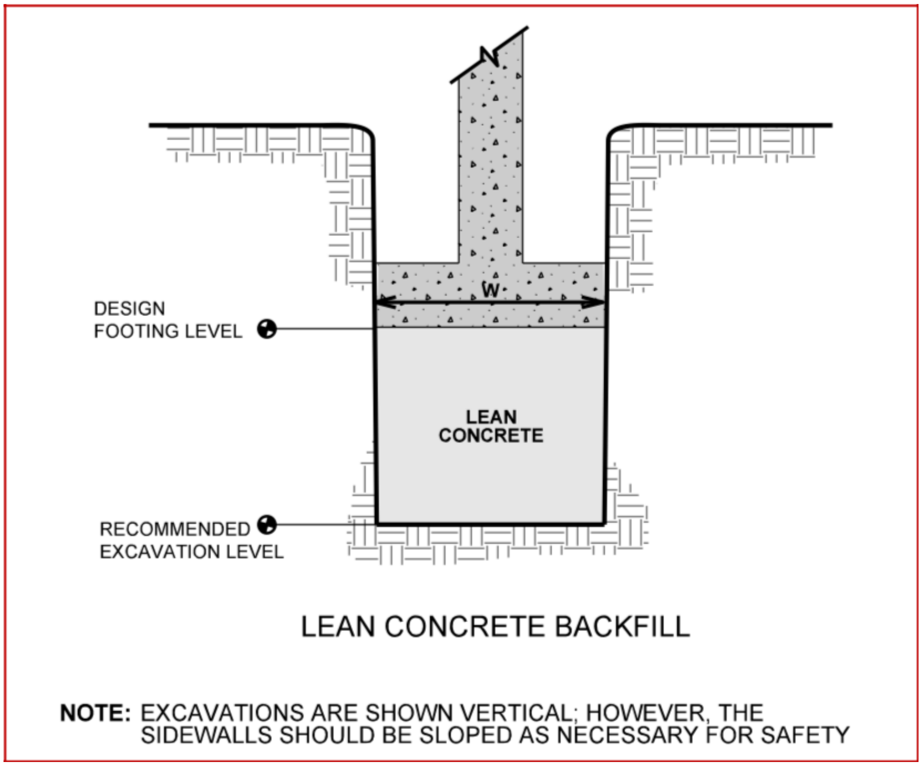
A perforated rigid plastic drain line installed at the base of footings along the perimeter of the structures. The invert of a drain line around a building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material meeting the specifications for Select Fill as defined in the **Fill Material Types** section. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted native material to reduce infiltration of surface water into the drain system.

Foundation Construction Considerations

As noted in the **Earthwork** section, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

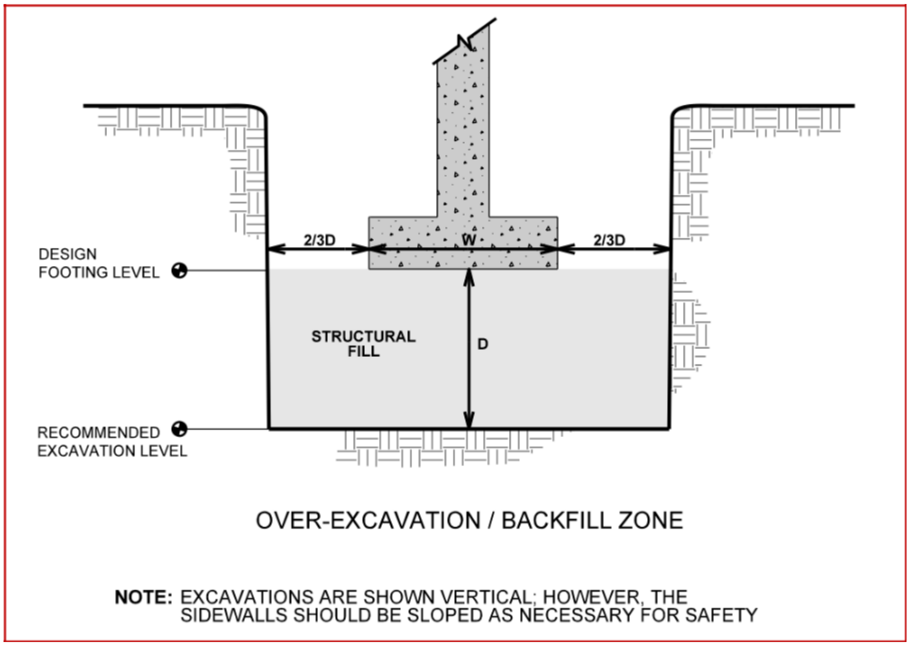
If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.

Diagram 1: Over Excavation Backfill with Lean Concrete



Over excavation for structural fill placement below footings should be conducted as shown below. The over excavation should be backfilled up to the footing base elevation, with Select Fill placed and compacted as recommended in the **Earthwork** section.

Diagram 2: Over Excavation Backfill with Structural Fill



Floor Slabs

Design parameters for floor slabs assume the requirements in the **Earthwork** and **Ground Improvement** sections have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Table 13: Floor Slab Design Parameters

Item	Description
Floor Slab Support[1]	A minimum of 6 inches of CAB compacted to at least 95% of the maximum dry density determined by ASTM D1557 Subgrade compacted to recommendations in the **Earthwork** and **Ground Improvement** sections.
Estimated Modulus of Subgrade Reaction [2]	175 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.

Item	Description

2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in the **Earthwork** section, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in the **Earthwork** section, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams, and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Mat Foundations - Tanks

Based on the existing topography, we anticipate the water tank will be constructed on up to about 15 feet of structural fill. Our explorations indicate the tank area is underlain by 2 to 3 feet of soft loess materials. These materials should be removed and replaced with engineered fill within the area of the proposed tank prior to placement of new structural fill. New structural fill should be placed and compacted in accordance with the recommendations in the **Earthwork** section of this report. A preliminary allowable bearing pressure of 3,500 psf is recommended for use in the design of the mat foundation. Final design bearing pressure and settlement calculations should be revisited once grading plans have been developed.

Deep Foundations – Substation Elements

Recommendations for support for substation elements using deep foundations will be developed once a grading plan is available for the site.

Lateral Earth Pressures

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).

Diagram 3: Retaining Wall Restraint Conditions

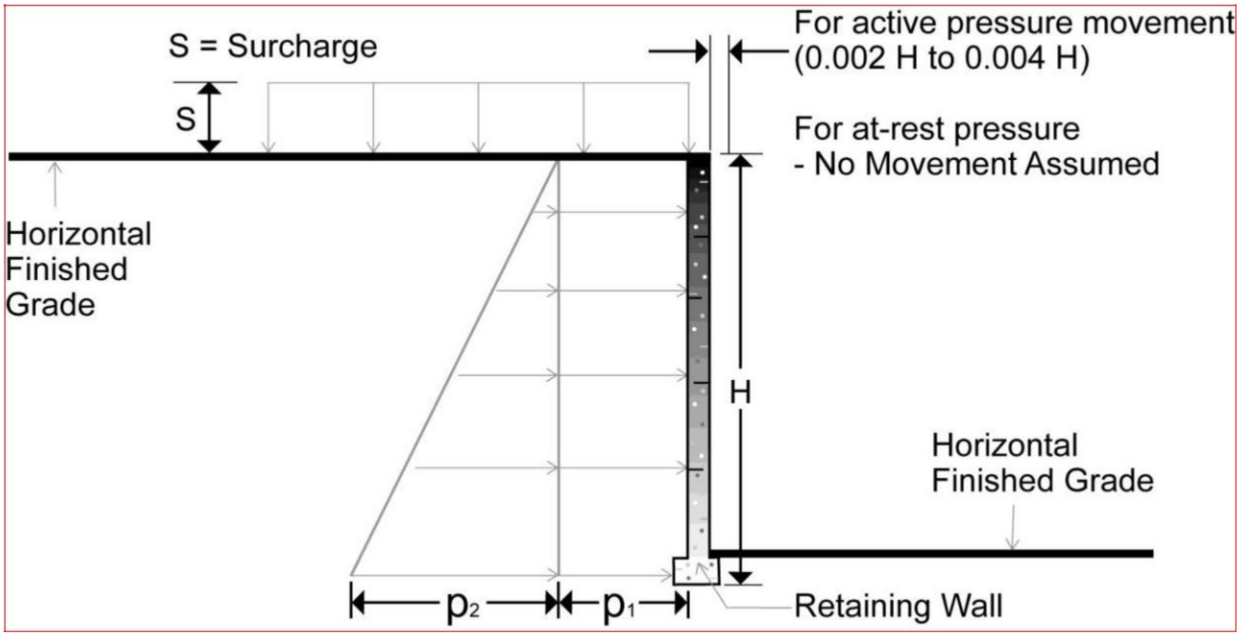


Table 14: Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4] Unsaturated [5]
Active (Ka)	Granular - 0.31	(0.31)S	(34)H
At-Rest (Ko)	Granular - 0.47	(0.47)S	(55)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance. Fat clay or other expansive soils should not be used as backfill behind the wall.
2. Uniform, horizontal backfill, with a maximum unit weight of 125 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. To achieve "Unsaturated" conditions, follow guidelines in the **Subsurface Drainage for Below-Grade Walls** section. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

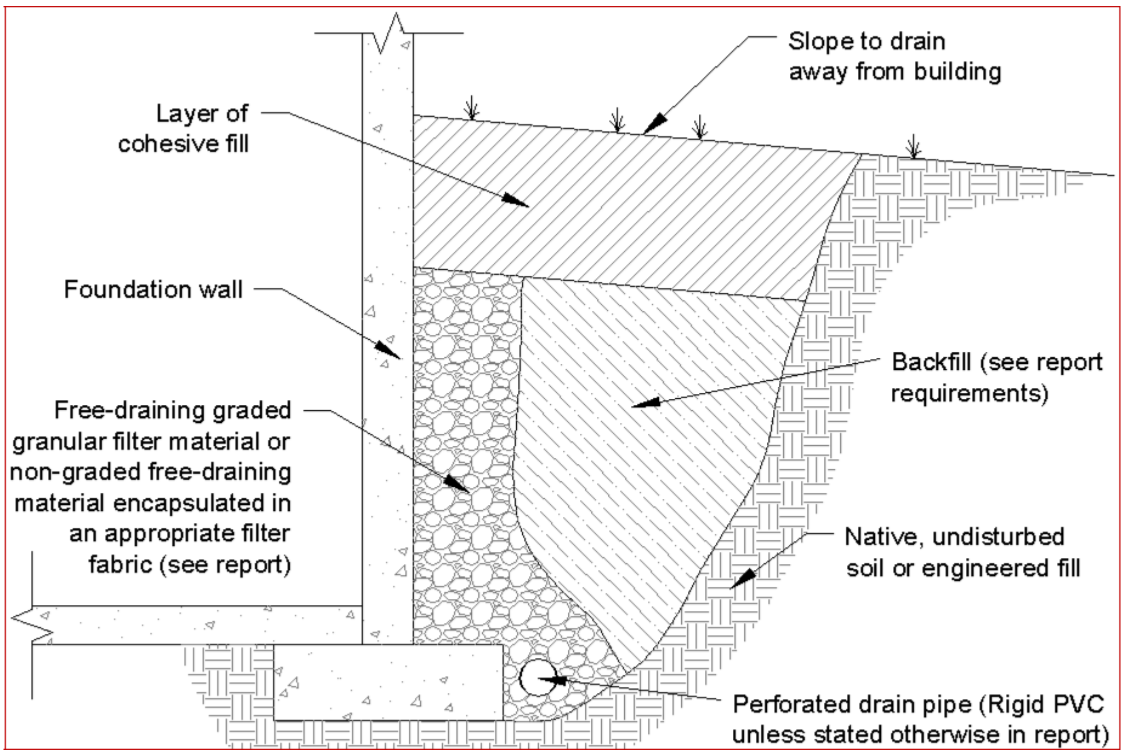
Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

Footings, floor slabs or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should be a minimum of 12 inches in thickness and extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.

Diagram 4: Retaining Wall Backfill and Drain Placement



As an alternative to free-draining granular fill, a prefabricated drainage structure may be used. A prefabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

Pavements

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Pavement Design Parameters

Design of Asphaltic Concrete (AC) pavements are based on the procedures outlined in the American Association of State Highway and Transportation Officials (AASHTO), 1993. Design of Portland Cement Concrete (PCC) pavements are based upon American Concrete Institute (ACI) 330; Guide for Design and Construction of Concrete Parking Lots.

Based on laboratory California Bearing Ratio (CBR) testing, a subgrade CBR of 10 was used for the AC pavement designs, and a modulus of subgrade reaction (k) of 200 pci was used for the PCC pavement designs. The values are based on achieving a 95 percent compaction of a Modified Proctor effort (ASTM D1557) as prescribed by the **Site Preparation** section. A modulus of rupture of 580 psi was used for pavement concrete.

Pavement Section Thicknesses

The following table provides our opinion of minimum thickness for AC sections:

Table 15: Asphaltic Concrete Design

Layer	Thickness (inches)
	Anticipated Traffic Loading [1]
AC[2,3]	3
Aggregate Base	6

1. See the **Project Description** section for more specifics regarding traffic assumptions.
2. All materials should meet the Oregon Department of Transportation (ODOT) Standard Specifications for Construction (2018).
   - Asphaltic Surface - ODOT Type A Asphaltic Cement Concrete: Section 00744
   - Asphaltic Base - ODOT Type B Asphaltic Cement Concrete, Class I: Section 00745
3. A minimum 1.5-inch surface course should be used on ACC pavements.
4. Minimum of 12-inches of subgrade should be scarified and compacted to 95% of a Modified Proctor effort (ASTM D1557).

The following table provides our estimated minimum thickness of PCC pavements.

Table 16: Portland Cement Concrete Design

Layer	Thickness (inches)
	Anticipated Traffic Loading [1]
PCC [2]	5
Aggregate Base	4

1. See the **Project Description** section for more specifics regarding traffic classifications.
2. All materials should meet the current State Department of Transportation ODOT) Standard Specifications for Highway and Construction (2018).
   - Concrete Pavement - ODOT Portland Cement Concrete Type C: Section 00756
3. In areas of anticipated heavy traffic, fire trucks, delivery trucks, or concentrated loads (e.g. dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles.
4. Subgrade should be scarified and compacted to 95% of a Modified Proctor effort (ASTM D1557).

We anticipate that typical fire departments require that the proposed pavement sections at the site will support a fire emergency truck once the store is constructed. Typically, we estimate total fire-truck load of 80,000 pounds for a three axle (single tire) truck. Based on these assumptions and the proposed loading conditions, we computed the ultimate bearing capacity of the pavement sections relative to a 20 percent increase of the factored load of the fire truck. From a bearing failure standpoint, the pavements are estimated to be adequate for support of the fire truck vehicle (with a factor of safety of 1½). Pavement areas may experience some localized cracking from these large fire truck vehicle loads but are not expected to experience bearing failure of the pavement section. Based on this analysis, it is our opinion that pavement will provide adequate support for the temporary use of an emergency fire truck at the site.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation is recommended to determine the type and extent of a cost -effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2% slope.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

Stormwater Management

The infiltration tests were performed in general accordance with the Falling Head Infiltration Test method as described in Chapter 3 of the 1980 EPA Onsite Wastewater Treatment and Disposal Systems Design Manual (1980 EPA).

The tests were conducted in 6-inch inner diameter PVC pipes placed into holes excavated using a backhoe by our excavation subcontractor, Dan Fischer Excavating. PVC pipes were pushed approximately 3 inches into the soils at the infiltration test depth to create a seal with the surrounding soils, and a thin layer of open-graded gravel was placed in the bottom of the pipe to prevent scouring.

The test pipes were filled with 12 inches of water, and the soils were allowed to soak for 4 hours in accordance with the test method. After the soaking period, we adjusted the water level so that there was approximately 6 inches of water in the pipe, and the drop in water level was recorded at 30-minute intervals. Measurements were taken with a water level meter and recorded to the nearest 1/8 of an inch. Water was added to maintain the 6-inch head after each measurement. Soil samples were collected at the infiltration test depths following completion of the testing for laboratory analysis.

INFILTRATION TEST RESULTS				
Test Location	**Test Depth (feet)**	**GeoModel Layer**	**Soil Classification**	**Infiltration Rate (in/hr)**
IT-1	3	2	Silty Sand (SM)	1.8

INFILTRATION TEST RESULTS				
Test Location	**Test Depth (feet)**	**GeoModel Layer**	**Soil Classification**	**Infiltration Rate (in/hr)**
IT-2	½	2	Silty Sand (SM)	5.9
IT-3	5	2	Silty Sand (SM)	9.4
IT-5	½	2	Silty Sand (SM)	6.1

Based on our field test results, we recommend using the lowest measured rates expressed above for the stormwater facility. The measured rates should be reduced with the code prescribed correction factors. The long-term infiltration rates will depend on many factors, and can be reduced if the following conditions are present:

- Variability of site soils,
- Fine layering of soils, or
- Maintenance and pre-treatment of the influent

Subsurface Variations

Variations in subsurface conditions and the presence of fine layering can affect the infiltration rate of the receptor soils. Variable fines contents were noted in the near surface sand soils. These mixtures can impede vertical infiltration of stormwater. Due to the low in situ infiltration rates of near surface soils, we recommend the design and construction of an infiltration facility large enough to facilitate the appropriate average design rainfall event.

Construction Considerations

The infiltration rate of the receptor soils will be reduced in the event that fine sediment or organic materials are allowed to accumulate on the exposed soil surface. Use of an infiltration facility as a temporary construction phase sedimentation pond is not recommended. If site conditions are such that this cannot be avoided, it will likely be necessary to excavate the soils below the infiltration facility bottom that have been contaminated with sediment, organic materials, or other deleterious materials that may reduce the permeability of the receptor soils, prior to operation of the facility for infiltration purposes. Additional field infiltration testing may be necessary in order to verify that the restoration activity has been successful and that the infiltration rate of the receptor soils is consistent with that considered in the design.

Operation of heavy equipment may densify the receptor soils below the infiltration facility. The soils exposed in the bottom of the infiltration facility should not be compacted. It may be necessary to scarify the infiltration facility subgrade to facilitate infiltration.

Maintenance of Facilities

Satisfactory long-term performance of an infiltration facility will require some degree of maintenance. Accumulations of sediment, organic materials, or other material that serves to mask the receptor soils or reduce their permeability should be removed on a regular basis. As part of the maintenance program, the contractor should be required to dispose of the fines at an approved facility in accordance with applicable regulation.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly effect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

Site Location

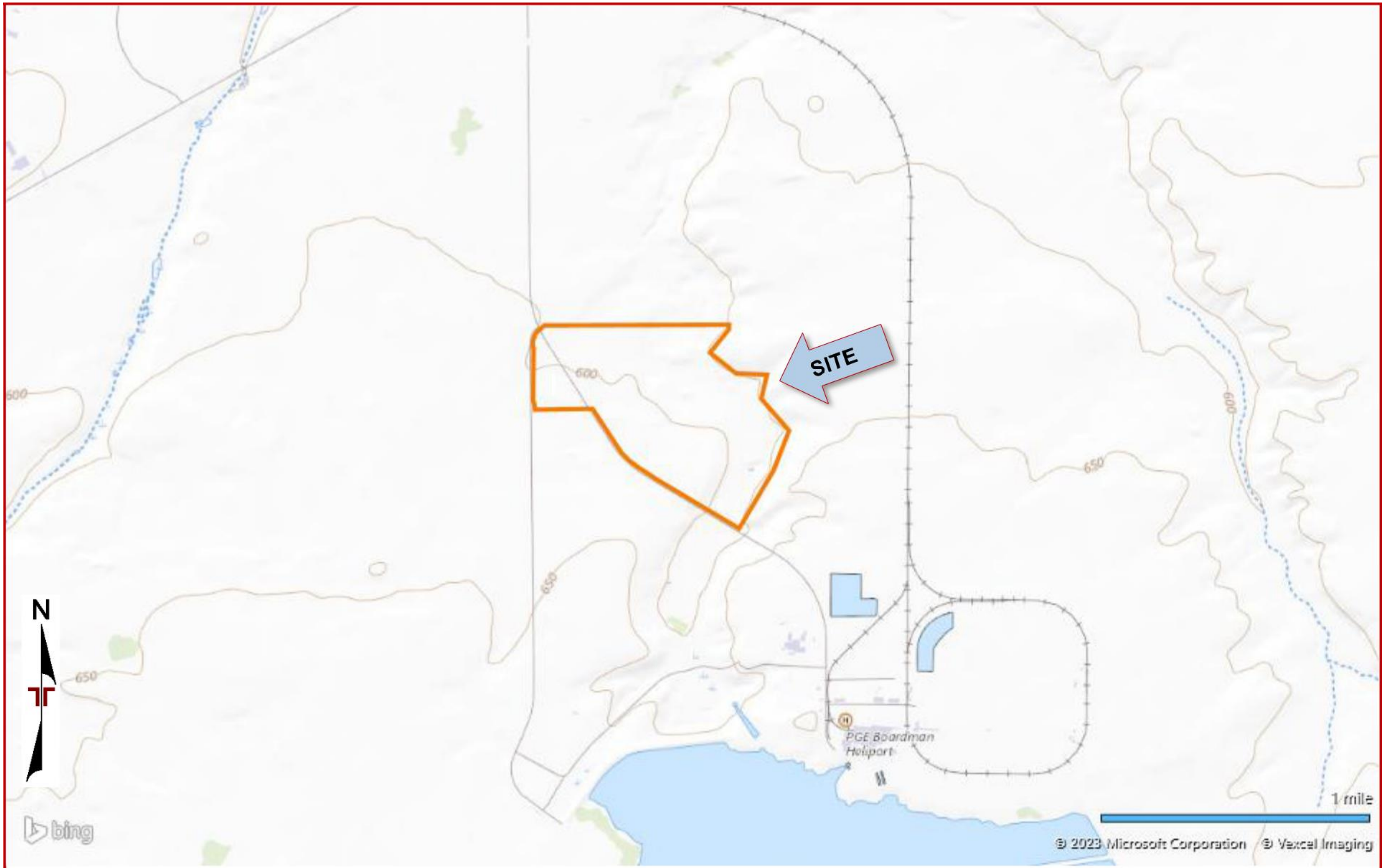


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

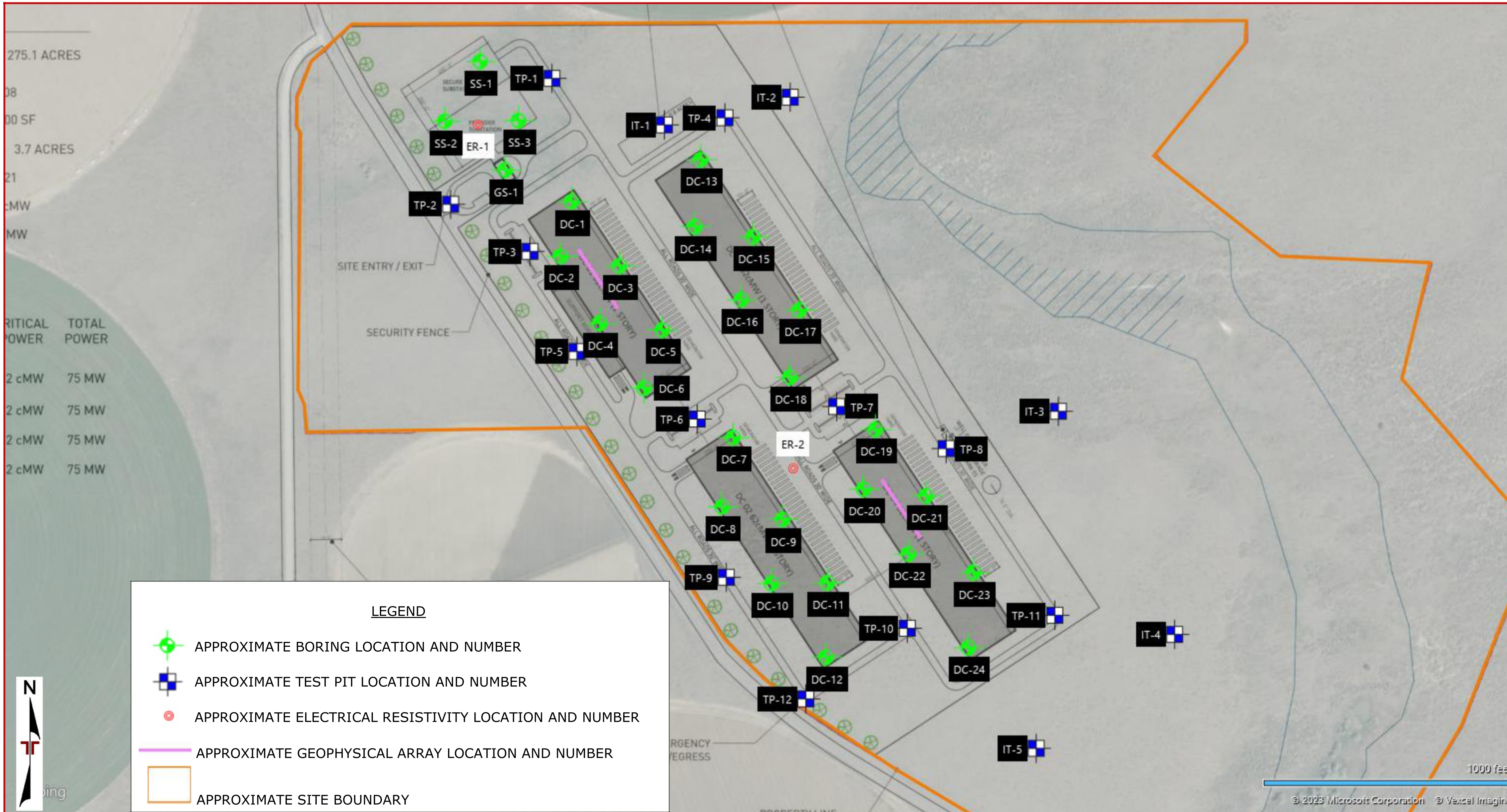


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Topographic Plan

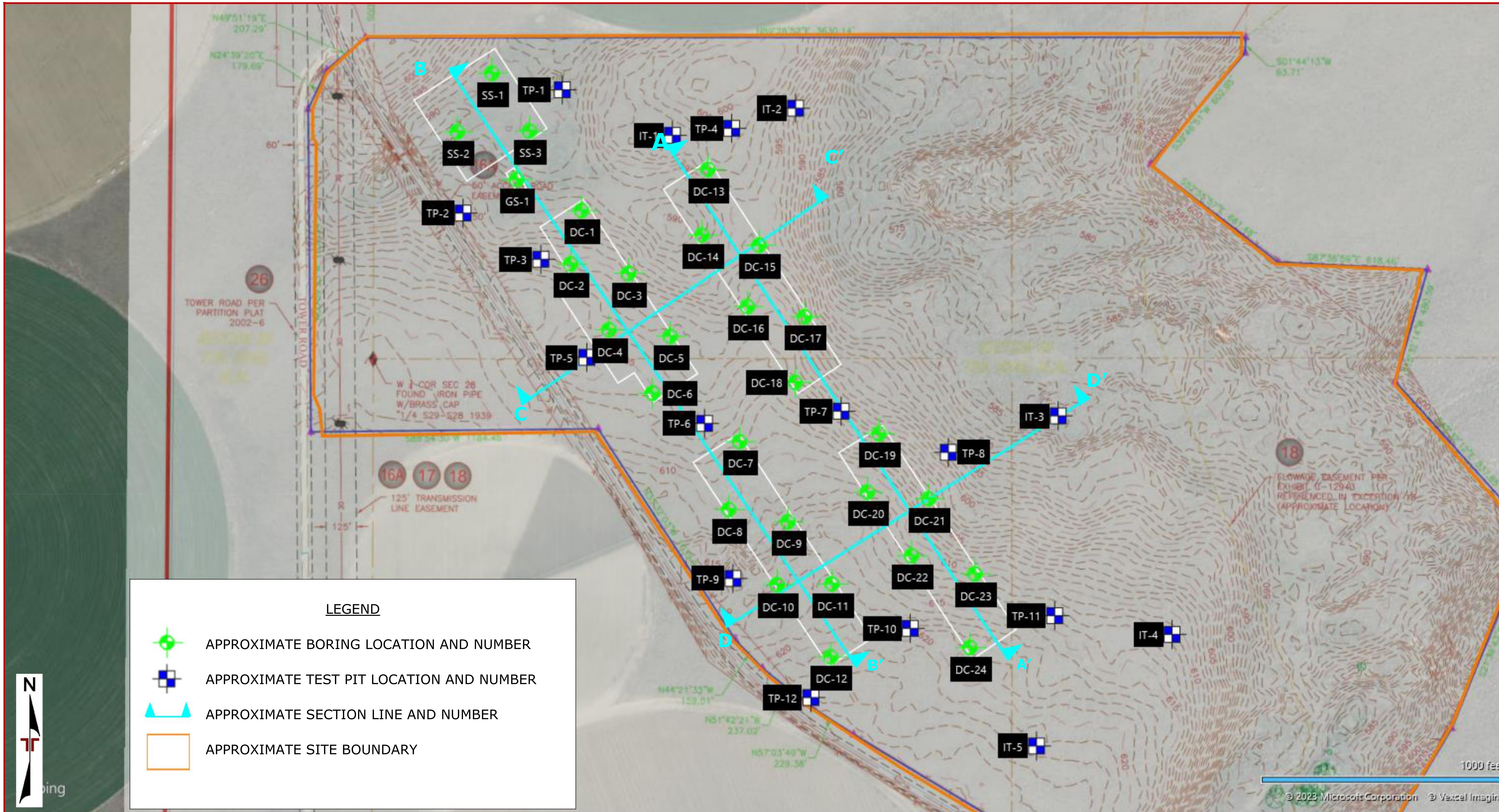


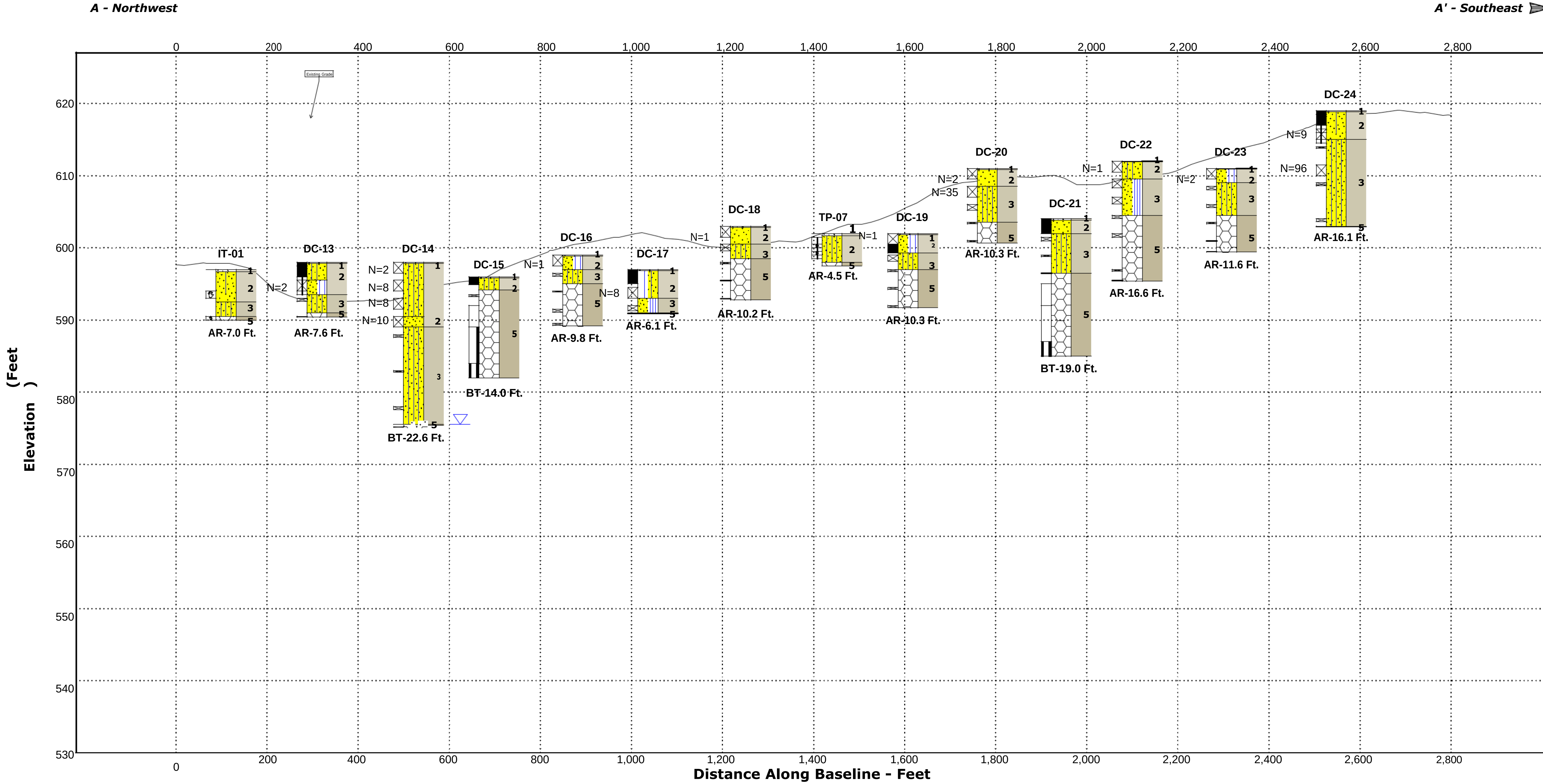
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

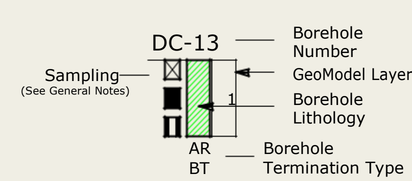
Subsurface Profile

SECTION A-A'

Terracon
700 NE 55th Ave
Portland, OR



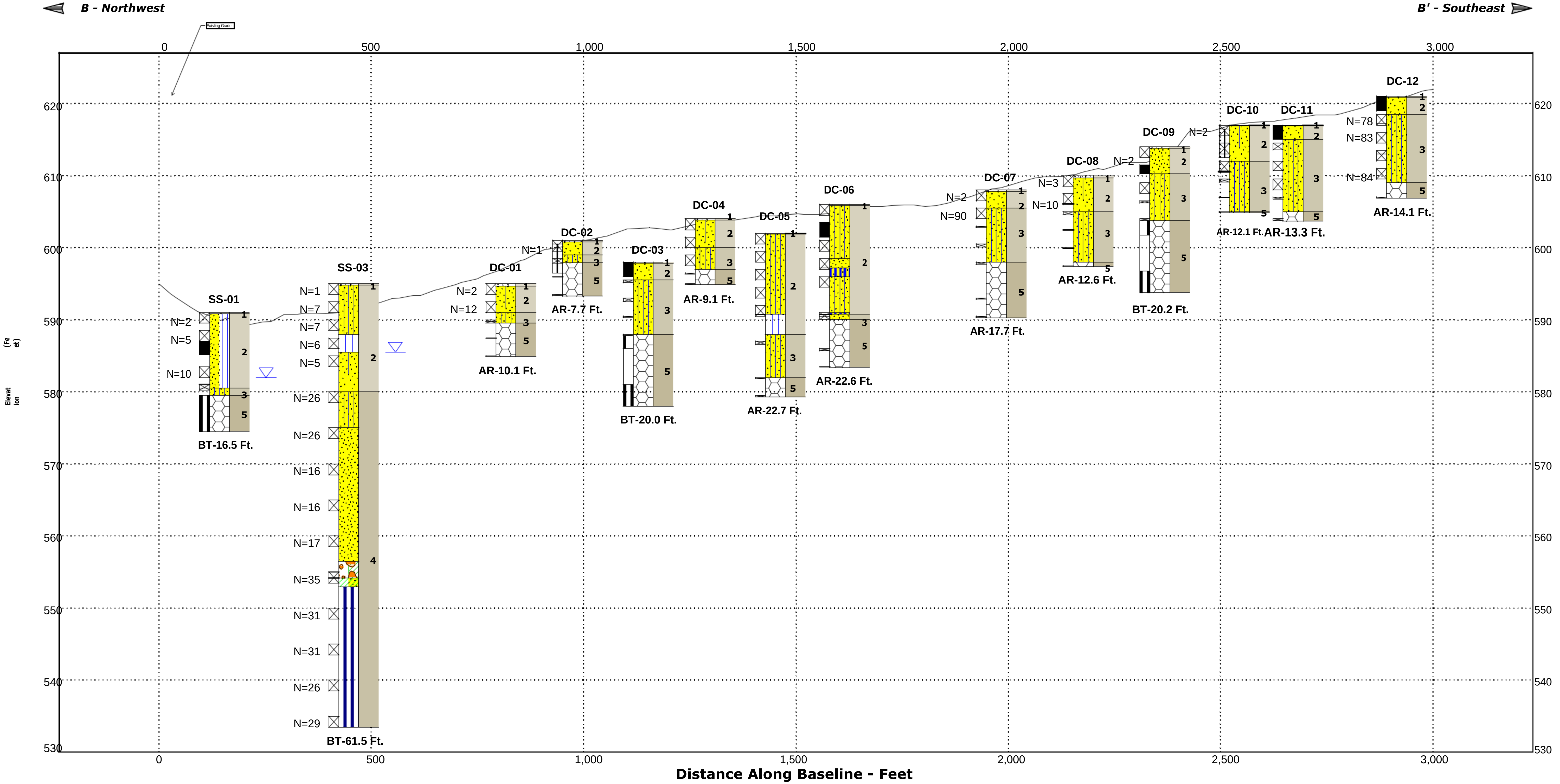
Notes	Water Level Observations	Explanation
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information and GeoModel for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	



Subsurface Profile

SECTION B-B'

Terracon
700 NE 55th Ave
Portland, OR

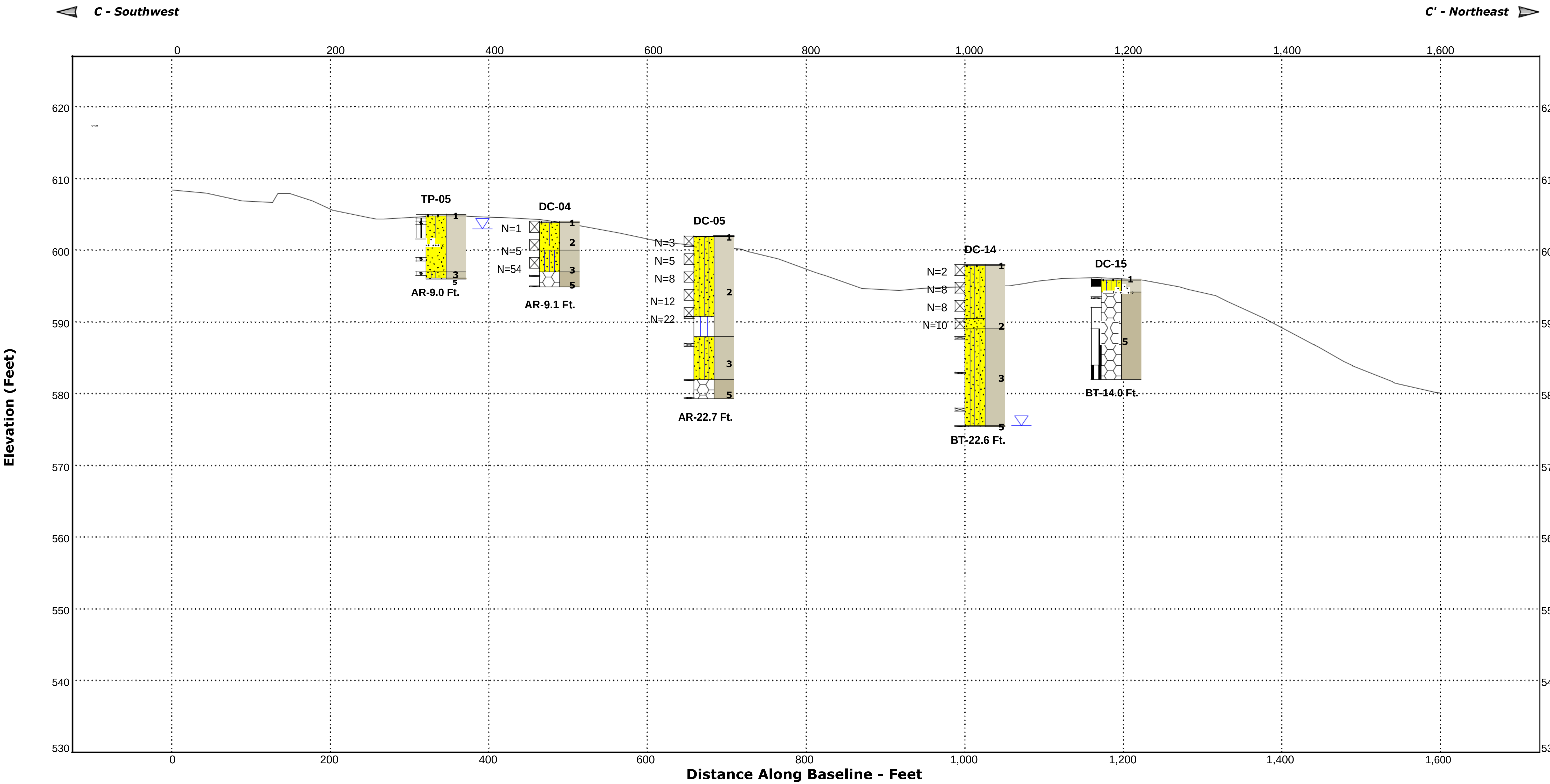


Notes	Water Level Observations	Explanation
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information and GeoModel for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	▽ Water Level Reading at time of drilling. Water Level Reading after drilling.	DC-01 — Borehole Number Sampling (See General Notes) GeoModel Layer Borehole Lithology AR / BT — Borehole Termination Type

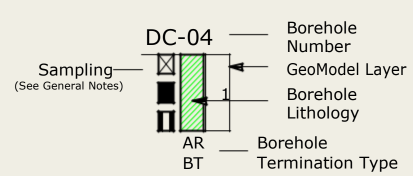
Subsurface Profile

SECTION C-C'

Terracon
700 NE 55th Ave
Portland, OR



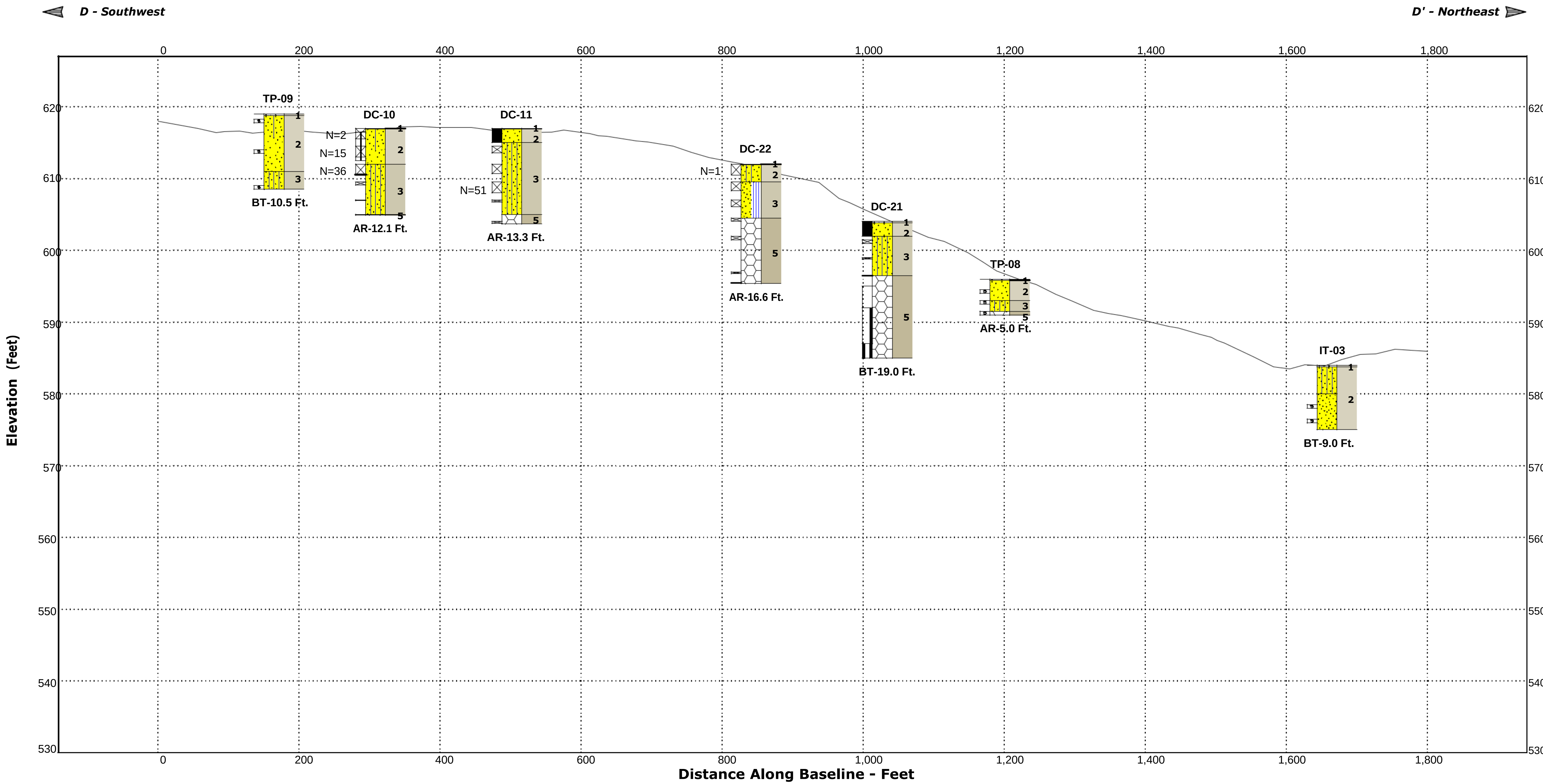
Notes	Water Level Observations	Explanation
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information and GeoModelfor symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	Water Level Reading at time of drilling. Water Level Reading after drilling.	



Subsurface Profile

SECTION D-D'

Terracon
700 NE 55th Ave
Portland, OR



Notes	Water Level Observations	Explanation
See Exploration Plan for orientation of soil profile. See General Notes in Supporting Information and GeoModel for symbols and soil classifications. Soils profile provided for illustration purposes only. Soils between borings may differ AR - Auger Refusal BT - Boring Termination	∇ Water Level Reading at time of drilling. Water Level Reading after drilling.	DC-10 — Borehole Number Sampling (See General Notes) GeoModel Layer Borehole Lithology AR / BT — Borehole Termination Type

Attachments

Exploration and Testing Procedures

Field Exploration

Exploration Number	Exploration Type	Approximate Exploration Depth (feet)	Location	
			Latitude	Longitude
DC-1	Drilled Boring	10.1	45.7137°N	119.8284°W
DC-2	Drilled Boring	7.7	45.7130°N	119.8286°W
DC-3	Drilled Boring	20	45.7130°N	119.8276°W
DC-4	Drilled Boring	9.1	45.7123°N	119.8280°W
DC-5	Drilled Boring	22.7	45.7128°N	119.8270°W
DC-6	Drilled Boring	22.6	45.7116°N	119.8273°W
DC-7	Drilled Boring	17.7	45.7111°N	119.8259°W
DC-8	Drilled Boring	12.6	45.3103°N	119.8261°W
DC-9	Drilled Boring	20.2	45.7102°N	119.8251°W
DC-10	Drilled Boring	12.1	45.7095°N	119.8253°W
DC-11	Drilled Boring	13.3	45.7095°N	119.8244°W
DC-12	Drilled Boring	14.1	45.7086°N	119.8244°W
DC-13	Drilled Boring	7.6	45.7142°N	119.8264°W
DC-14	Drilled Boring	22.6	45.7134°N	119.8264°W
DC-15	Drilled Boring	14	45.7133°N	119.8260°W
DC-16	Drilled Boring	9.8	45.7126°N	119.8257°W
DC-17	Drilled Boring	6.1	45.7125°N	119.8248°W
DC-18	Drilled Boring	10.2	45.7118°N	119.9250°W
DC-19	Drilled Boring	10.3	45.7112°N	119.8236°W
DC-20	Drilled Boring	10.3	45.7106°N	119.8238°W
DC-21	Drilled Boring	19	45.7104°N	119.8228°W
DC-22	Drilled Boring	16.6	45.7097°N	119.8231°W
DC-23	Drilled Boring	11.6	45.7096°N	119.8221°W
DC-24	Drilled Boring	16.1	45.7088°N	119.8220°W
GS-1	Drilled Boring	11.1	45.7140°N	119.8294°W
SS-1	Drilled Boring	16.5	45.7153°N	119.8291°W
SS-2	Drilled Boring	10.2	45.7146°N	119.8304°W

Exploration Number	Exploration Type	Approximate Exploration Depth (feet)	Location	
			Latitude	Longitude
SS-3	Drilled Boring	61.5	45.7146°N	119.8292°W
TP-1	Test Pit	10	45.7151°N	119.8290°W
TP-2	Test Pit	5.5	45.7137°N	119.8300°W
TP-3	Test Pit	6	45.7132°N	119.8290°W
TP-4	Test Pit	10	45.7146°N	119.8260°W
TP-5	Test Pit	9	45.7120°N	119.8280°W
TP-6	Test Pit	10	45.7113°N	119.8260°W
TP-7	Test Pit	4.5	45.7114°N	119.8240°W
TP-8	Test Pit	5	45.7110°N	119.8230°W
TP-9	Test Pit	10.5	45.7096°N	119.8260°W
TP-10	Test Pit	5.5	45.7090°N	119.8230°W
TP-11	Test Pit	6	45.7091°N	119.8210°W
TP-12	Test Pit	6	45.7082°N	119.8250°W
IT-1	Test Pit	7	45.7146°N	119.8270°W
IT-2	Test Pit	4.5	45.7149°N	119.8250°W
IT-3	Test Pit	9	45.7114°N	119.8210°W
IT-4	Test Pit	2.5	45.7089°N	119.8290°W
IT-5	Test Pit	5.5	45.7077°N	119.8210°W

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from the topographic survey. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths.

Test Pits Explorations: A geologist logged test pits and collected Thin-walled tube and grab soil samples. The test pits were excavated using a tracked excavator under subcontract to our firm. The test pits areas were backfilled with the excavated materials and tamped with the backhoe bucket as it was placed.

Infiltration Testing: Four infiltration tests were conducted within the stormwater management areas at the site. The tests were conducted in general accordance with the 1980 EPA Encased Falling Head test method. Details of the testing are presented in the **Stormwater Management** section of this report. Results of the infiltration testing are presented in the **Exploration Results**.

Exploration Logging: All explorations were supervised and logged by a field engineering technician who recorded field test data, classified soils, and collected the samples from the explorations. Our exploration team prepared field boring logs as part of standard drilling operations including sampling depths, penetration distances, and other relevant sampling information. Field logs include visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Final boring logs, prepared from field logs, represent the geotechnical engineer's interpretation, and include modifications based on observations and laboratory tests.

Property Disturbance: We backfilled borings according to local jurisdiction requirements after completion of each exploration. Pavements were patched with cold-mix asphalt and/or ready mixed concrete, as appropriate. Our services did not include repair of the site beyond backfilling our boreholes and cold patching existing pavements. Excess auger cuttings were dispersed in the general vicinity of each borehole. Since backfill material often settles below the surface after a period, we recommend boreholes be checked periodically and additional backfill added, if necessary.

Geophysical Exploration Methods

P-Wave: A seismic refraction system consisting of a Geometrics Geode seismograph in a linear array of 24 4.5Hz geophones was utilized to perform two seismic surveys using the P-wave Refraction method. To create the seismic signal (source), we struck a metal plate placed on the ground surface with an instrumented sledgehammer at multiple locations along each array. The first-arrival travel times of compression waves (p-waves), produced by the source, are recorded on a laptop using SeisModule Controller software, and the field results were analyzed in our office.

Using Geometrics Seisimager software package and Rayfract software, the first-arrival travel times are identified, and the survey geometry entered to perform forward modeling using Wavepath Eikonal Traveltime (WET) tomography. This algorithm helps determine the compressive wave velocity model for a corresponding depth and resolution from multiple signal paths produced by each first break. The resulting model provides a p-wave velocity depth profile of the possible depth-to-rock from the ground surface.

S-Wave: Geophysical testing was performed along two arrays (Line 1 and Line 2) representative of the subsurface conditions encountered at the project site. Terracon used a Geometrics Geode Exploration Seismograph and a linear array of 24 geophones to collect seismic refraction data. The profile was collected using the Multichannel Analysis of Surface Waves (MASW) method.

Passive MASW was performed by recording ambient seismic "noise." Active MASW was performed by recording surface waves generated by a vertical impact seismic source such as a sledgehammer striking a plate on the ground surface. The resulting seismic energy was recorded using the Geometrics SeisModule Controller software software. For each active MASW survey, the shot point was produced at the end of the line because the 1-Dimensional (1D) models are defined as being beneath the center of the geophone array. The recorded data was processed using the computer program SurfSeis, published by the Kansas Geological Survey. This program extracts the fundamental-mode surface waves from the shot gathers to form dispersion curve(s). These curves are inverted and modeled to yield a 1D shear-wave velocity versus depth (profile) for the line, as shown on the Shear Wave Velocity Results in the **Exploration Results**.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Dry Unit Weight
- Unconfined Compression
- Atterberg Limits
- Thermal Resistivity Testing
- California Bearing Ratio Testing
- Moisture-Density Relationship (Proctor) Testing
- Hydrometer Testing
- Collapse Testing

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Photography Log

Photo 1 - Western States drill crew on site

Photo 2 - Example of bentonite-backfilled borehole

Photo 3 - Sample from borehole

Photo 4 - Excavator used for digging test pits

Photo 5 - Test pit location

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-01

Location: See Exploration Plan

Latitude: 45.7137° Longitude: -119.8284°

LayerModel	Depth (Ft.)	Material Description	Elevation: 595 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	594.67								
2		**SILTY SAND (SM)**, fine grained, brown with white, moist, very loose, trace fine rootlets to ~1½ feet bgs					18	0-1-1 N=2	8.3		
	4.0	medium dense, weak cementation	591				4	3-4-8 N=12	7.7		26
3	5.4	**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, very dense, strong cementation	589.58	5			5	50/5"	10.6 / 6.7		25
5	10.1	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, strong rock	584.9				1	50/1"	5.6		
				10			2	50/1"	4.9		

Auger Refusal at 10.1 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-14-2023

Boring Completed
03-14-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

700 NE 55th Ave
Portland, OR

Boring Log No. DC-02

Location: See Exploration Plan

Latitude: 45.7131° Longitude: -119.8286°

Model Layer	Graphic Log	Depth (Ft.)	Material Description	Elevation.: 601 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)		Atterberg Limits LL-PL-PI	Fines Percent
1		0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	600.83				16	1-0-1 N=1	9.9			
2		2.0	**SILTY SAND (SM)**, fine grained, brown, moist, very loose, weak cementation, trace fine rootlets to ~1½ feet bgs	599									
3		3.1	**SILTY SAND (SM)**, fine to coarse grained, light brown, dry, very dense	597.92				8	47-50/2"	2.1			
5		7.7	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, strong rock	593.3	5			1	50/1"	4.9			
								1	50/2"	5.8			

Auger Refusal at 7.7 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-14-2023

Boring Completed
03-14-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

700 NE 55th Ave
Portland, OR

Boring Log No. DC-03

Location: See Exploration Plan

Latitude: 45.7130° Longitude: -119.8277°

LayerModel	Depth (Ft.)	Material Description	Elevation.: 598 (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, brown, moist, rootlets	597.83
2	2.5	**SILTY SAND (SM)**, fine grained, brown, moist	595.5
3	10.0	**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, very dense, with fractured basalt fragments.	588
5	20.0	**BASALT**, gray, dry, fine-grained, extremely fractured, slightly weathered, medium strong	578

Boring Terminated at 20 Feet

Depth (Ft.)	Water Level Observations	Sample Type					Atterberg Limits LL-PL-PI	
0–2			23		9.1			
2.5			4	50/4"	13.7			
5			6	50/6"	11.3			27
7.5			2	50/2"	5.7			
10			1	50/2"	7.1			
10–12			21	RQD = 0%				
12–17			21	RQD = 0%				
17–20			27	RQD = 0%				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger & HQ Core

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-14-2023

Boring Completed
03-14-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-04

Location: See Exploration Plan

Latitude: 45.7124° Longitude: -119.8280°

LayerModel	Depth (Ft.)	Description	Elevation.: 604 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	603.83								
2		**SILTY SAND (SM)**, trace gravel, fine grained, brown, moist, very loose, trace fine rootlets to ~1½ feet bgs				X	18	1-0-1 N=1	6.8		
		loose, trace subrounded gravel				X	18	2-2-3 N=5	8.9		
3	4.0	**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, very dense, subrounded to subangular gravel	600	5		X	18	16-21-33 N=54	11.7		
5	7.0	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	597			X	2	50/2"	4.2		
	9.1	*Auger Refusal at 9.1 Feet*	594.9			X	1	50/1"	5.2		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-10-2023

Boring Completed
03-10-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-05

Location: See Exploration Plan

Latitude: 45.7123° Longitude: -119.8270°

Depth (Ft.) Elevation.: 602 (Ft.)

Layer Model	Depth (Ft.)	Material Description	Elevation (Ft.)	Sample Depth (Ft.)	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.1	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	601.92						
2		**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets to ~1 foot bgs			11	1-1-2 N=3	8.9		
		loose			18	2-3-2 N=5	11.7		
		dry		5	18	3-4-4 N=8	3.4		26
		medium dense			18	3-5-7 N=12	4.6		
	11.3		590.75	10	18	7-11-11 N=22	3.2		
	14.0	**SILT (ML)**, trace sand, fine grained, low plasticity, light brown, moist, very stiff	588				17.8		
3	20.0	**SILTY SAND (SM)**, trace gravel, fine to coarse grained, subrounded, grayish brown and yellowish brown, very dense	582	15	5	50/5"	10.6		
5	22.7	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	579.3	20	2	50/2"	4.0		
					1	50/2"	5.0		

Auger Refusal at 22.7 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-16-2023

Boring Completed
03-16-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-06

Location: See Exploration Plan

Latitude: 45.7116° Longitude: -119.8273°

LayerModel	Depth (Ft.)	Description	Elevation.: 606 (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	605.83
2	7.5	**SILTY SAND (SM)**, fine grained, brown, moist, loose, trace fine rootlets to ~1¼ feet bgs; dry	598.5
2	8.8	**POORLY GRADED SAND (SP)**, fine grained, brown, dry, loose	597.25
2	10.0	**SANDY SILT (ML)**, low plasticity, brown, dry, stiff, fine grained sand	596
2	15.0	**SILTY SAND (SM)**, fine grained, brown, dry	591
2	15.3	**SANDY SILT (ML)**, low plasticity, brown, moist, medium stiff, fine grained sand	590.75
3	15.9	**POORLY GRADED SAND (SP)**, trace gravel, fine grained, black and reddish brown, dry, loose, moderate cementation, contains some fractured basalt fragments	590.08
5	22.6	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	583.4

Auger Refusal at 22.6 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0–1.5			14	1-1-1 N=2	6.2			18
2.5–4.5			23		10.0	94		
5–6.5			13	3-3-4 N=7	3.4			
7.5–9			18	3-4-5 N=9	2.4			
					4.4			
10–11.5			13	4-5-5 N=10	3.0			14
15–15.9			11	6-50/5"	29.9			
					4.5			
					4.3			
20			2	50/3"	2.7			
22.6			0	50/0"				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-16-2023

Boring Completed
03-16-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-07

Location: See Exploration Plan

Latitude: 45.7111° Longitude: -119.8259°

LayerModel	Depth (Ft.)	Material Description	Elevation.: 608 (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	607.83
2	2.5	**SILTY SAND (SM)**, trace gravel, fine grained, brown, moist, very loose	605.5
3	10.0	**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, very dense, strong cementation dry, very dense brown gray and white, moist, very dense, with fractured basalt fragments.	598
5	17.7	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	590.3

Auger Refusal at 17.7 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
0–1.5			14	0-1-1 N=2	7.2		
2.5–4			18	28-48-42 N=90	18.5		
5			5	50/2"	5.2		
7.5			5	50/5"	7.1		
10			2	50/4"	6.5		
15			2	50/2"	3.3		
17.5			2	50/2"	5.4		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-16-2023

Boring Completed
03-16-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-08

Location: See Exploration Plan

Latitude: 45.7103° Longitude: -119.8261°

Layer Model	Depth (Ft.)	Material Description	Elevation (Ft.) 610	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	609.67								
2		**SILTY SAND (SM)**, trace gravel, fine grained, brown, moist, very loose				X	18	1-1-2 N=3	6.9		
		loose				X	18	2-3-7 N=10	9.0		
	5.0		605						14.8		
3		**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, very dense, strong cementation		5		X	3	50/5"	10.2		
		gray, dry					1	50/1"	4.8		
		brown		10			1	50/1"	6.8		
	12.0		598								
5	12.6	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	597.4				1	50/1"	3.6		

Auger Refusal at 12.6 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-07-2023

Boring Completed
03-07-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-09

Location: See Exploration Plan

Latitude: 45.7102° Longitude: -119.8251°

Layer Model	Depth (Ft.)	Material Description	Elevation: 614 (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, dry, very loose, rootlets	613.83
2	3.8	**POORLY GRADED SAND (SP)**, fine grained, light brown, moist, loose	610.25
3	10.3	**SILTY SAND (SM)**, fine to coarse grained, light brown and white, moist, very dense, strong cementation	603.75
5	20.2	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, strong rock moderately fractured, unweathered, trace vesicules up to 1/8 inch in diameter extremely fractured moderately fractured	593.8

Boring Terminated at 20.2 Feet

Water Level Observations	Sample Type				Dry Unit Weight	Atterberg Limits LL-PL-PI	Percent Fines
		18	0-1-1 N=2	5.4			
		15		8.0	107		
		18	7-13-18 N=31	16.4			19
		4	50/4"	12.4			
		2	50/3"	4.8			14
		24	RQD = 25%				
		54	RQD = 33%				
		30	RQD = 17%				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger & HQ Core

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-08-2023

Boring Completed
03-08-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-10

Location: See Exploration Plan

Latitude: 45.7095° Longitude: -119.8253°

Layer Model	Depth (Ft.)	Material Description	Elevation.: 617 (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.1	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose	616.92						
2		**SILTY SAND (SM)**, fine grained, brown, moist, loose, trace fine rootlets to ~1½ feet bgs		X	18	2-1-1 N=2	6.4		
				X	18	7-8-7 N=15	13.1		
3	5.0	**SILTY SAND (SM)**, fine to coarse grained, angular, light brown, moist, medium dense, weak cementation	612	X	18	10-13-23 N=36	11.7 / 18.0	NP	
		light brown and gray, dense, strong cementation		X	5	50/5"	9.8		
		very dense			1	50/1"	8.6		
5	12.0 / 12.1	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, strong rock	605 / 604.92		1	50/1"	5.9		
		Auger Refusal at 12.1 Feet							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-07-2023

Boring Completed
03-07-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

700 NE 55th Ave
Portland, OR

Boring Log No. DC-11

Location: See Exploration Plan

Latitude: 45.7095° Longitude: -119.8244°

Model Layer	Depth (Ft.)	Material Description	Elevation.: 617 (Ft.)	Depth (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.1	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist	616.9							
2	2.0	**SILTY SAND (SM)**, fine grained, subrounded, brown, moist	615			23				
3	12.0	**SILTY SAND (SM)**, fine to coarse grained, subangular, light brown, moist, very dense, strong cementation	605			8	49-50/5"	11.3		14
				5		16	19-40-50/4"	6.3		
						18	18-28-23 N=51	7.7		10
				10		3	50/3"	8.4		
5	13.3	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	603.7			3	50/3"	4.7		

Auger Refusal at 13.3 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-07-2023

Boring Completed
03-07-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-12

Location: See Exploration Plan

Latitude: 45.7087° Longitude: -119.8244°

LayerModel	Graphic Log	Depth (Ft.)	Material Description	Elevation.: 621 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)			DryUnit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1		0.1	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist	620.9									
2			**SILTY SAND (SM)**, fine grained, subrounded, brown, moist					24		5.7	92		
		2.5		618.5									
3			**SILTY SAND (SM)**, fine grained, light brown, moist, very dense					18	3-28-50 N=78	6.7			
			coarse grained, angular, light brown							8.9			
			fine to coarse grained, angular		5			18	15-40-43 N=83	17.0			
			brown and light brown					18	25-35-50/5"	13.1			
										16.6			
			fine to coarse grained, subrounded to subangular, light brown		10			18	20-34-50 N=84	14.4			
		12.0		609									
5			**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong										
		14.1		606.9				1	50/1"	4.8			
			Auger Refusal at 14.1 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-08-2023

Boring Completed
03-08-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-13

Location: See Exploration Plan

Latitude: 45.7142° Longitude: -119.8264°

LayerModel	Depth (Ft.)	Description	Elevation.: 598 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	597.83									
2		**SILTY SAND (SM)**, fine grained, brown, moist, very loose, trace fine rootlets to ~1½ feet					24		5.2	84		13
	2.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, black, moist, very loose	595.5				18	2-1-1 N=2	30.0			7
3	4.5	**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, very dense, strong cementation	593.5	5			5	50/5"	13.3			
5	7.0	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	591									
	7.6	***Auger Refusal at 7.6 Feet***	590.4				1	50/1"	3.4			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-10-2023

Boring Completed
03-10-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-14

Location: See Exploration Plan

Latitude: 45.7134° Longitude: -119.8265°

Model Layer	Depth (Ft.)	Material Description	Elevation.: 598 (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose	597.83
1		**SILTY SAND (SM)**, fine grained, subrounded, brown, moist, loose, trace fine rootlets to ~1½ feet bgs; light brown, dry	
2	7.5	**POORLY GRADED SAND (SP)**, fine grained, light brown, dry, medium dense	590.5
3	9.0	**SILTY SAND (SM)**, fine to coarse grained, subangular, brown and brownish yellow, moist, very dense, moderate to strong cementation; dark gray and brownish yellow, very dense	589
5	22.5	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	575.5
	22.6	***Boring Terminated at 22.6 Feet***	575.42

Depth (Ft.)	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
0–1.5	18	1-1-1 N=2	8.8		
2.5–4	18	2-3-5 N=8	8.9		
5–6.5	18	3-4-4 N=8	4.9	NP	48
7.5–9	18	3-4-6 N=10	3.2		
10	5	50/5"	9.2		
15	3	50/3"	9.3		
20	5	50/5"	14.5		
22.5	1	50/1"	9.3		

Water level symbol at approximately 22.5 ft (while sampling).

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ While sampling

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-10-2023

Boring Completed
03-10-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-15

Location: See Exploration Plan

Latitude: 45.7133° Longitude: -119.8256°

Model Layer	Depth (Ft.)	Material Description (Elevation.: 596 (Ft.))	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	595.83				18		32.1	80		
2	1.8	**SILTY SAND (SM)**, fine grained, subrounded, brown, moist, loose, trace fine rootlets	594.2									
5		**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong					2	50/3"	6.0			
		moderately fractured		5			34	RQD = 25%				
		extremely fractured, unweathered										
		moderately fractured		10			60	RQD = 22%				
	14.0	slightly fractured	582				18	RQD = 21%				

Boring Terminated at 14 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger & HQ Core

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-09-2023

Boring Completed
03-10-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-16

Location: See Exploration Plan

Latitude: 45.7126° Longitude: -119.8258°

Model Layer	Depth (Ft.)	Material Description	Elevation.: 599 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	598.83				18	0-0-1 N=1	9.4			
2	2.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, brown, moist, very loose, trace fine rootlets	597									
3	4.0	**SILTY SAND (SM)**, fine to coarse grained, gray and brown, moist, very dense	595				5	50/5"	7.8			
5	9.8	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	589.2	5			1	50/1"	4.3			
							3	50/5"	2.7			
							1	50/3"	3.3			

Auger Refusal at 9.8 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-09-2023

Boring Completed
03-09-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-17

Location: See Exploration Plan

Latitude: 45.7125° Longitude: -119.8248°

Depth (Ft.) Elevation.: 597 (Ft.)

LayerModel	Depth (Ft.)	Material Description	Elevation (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose	596.83
2	4.0	**SILT WITH SAND (ML)**, fine grained, moist, very loose	593
3	6.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, light brown, moist, very dense	591
5	6.1	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	590.92

Auger Refusal at 6.1 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)			DryUnitWeight (pcf)	Atterberg Limits LL-PL-PI	PercentFines
			23		6.4	78		74
			18	4-4-4 N=8	9.2			
5			9	29-50/3"	5.7			11
			1	50/1"	2.0			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-09-2023

Boring Completed
03-09-2023

700 NE 55th Ave
Portland, OR

Boring Log No. DC-18

Location: See Exploration Plan

Latitude: 45.7118° Longitude: -119.8250°

Elevation.: 603 (Ft.)

LayerModel	Depth (Ft.)	Material Description	Elevation (Ft.)	Depth(Ft.)	WaterLevel Observations	SampleType	Recovery(In.)				Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	602.83									
2	2.5	**SILTY SAND (SM)**, fine grained, brown, moist, very loose	600.5			X	18	0-1-0 N=1	7.1			
3	4.5	**SILTY SAND (SM)**, fine to coarse grained, subrounded to subangular, light brown, moist, very dense	598.5			X	11	37-50/5"	6.4			
5	10.2	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	592.8	5		X	2	50/3"	4.5			
						X	1	50/1"	5.3			
				10		X	1	50/1"				

Auger Refusal at 10.2 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-09-2023

Boring Completed
03-09-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

700 NE 55th Ave
Portland, OR

Boring Log No. DC-19

Location: See Exploration Plan

Latitude: 45.7112° Longitude: -119.8236°

Depth (Ft.) Elevation.: 602 (Ft.)

Layer Model	Depth (Ft.)	Material Description	Elevation (Ft.)	Sample Depth (Ft.)	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	601.83		18	0-0-1 N=1	6.5		
2	2.8	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, light brown, moist, very loose, trace fine rootlets	599.25		15		9.8		
3	5.0	**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, very dense, strong cementation	597		10	14-50/4"	24.9		15
5	10.3	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	591.7	5	2	50/4"	6.7		
					1	50/3"	6.7		
				10	2	50/3"	4.7		

Auger Refusal at 10.3 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-09-2023

Boring Completed
03-09-2023

700 NE 55th Ave
Portland, OR

Boring Log No. DC-20

Location: See Exploration Plan

Latitude: 45.7105° Longitude: -119.8238°

LayerModel	Graphic Log	Depth (Ft.)	Description	Elevation.: 611 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)				Atterberg Limits LL-PL-PI	Fines Percent
1		0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	610.83									
2		2.5	**SILTY SAND (SM)**, fine grained, brown, moist, very loose, trace fine rootlets to ~1 foot bgs	608.5				8	0-1-1 N=2	8.9			
3			**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, dense					18	12-18-17 N=35	13.4			14
		7.5	very dense	603.5	5			10	25-50/4"	8.4			
5			**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong					1	50/2"	6.1			
		10.3		600.7	10			2	50/2"	5.5			

Auger Refusal at 10.3 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-09-2023

Boring Completed
03-09-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-21

Location: See Exploration Plan

Latitude: 45.7105° Longitude: -119.8228°

Elevation.: 604 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	603.83
2	2.0	**SILTY SAND (SM)**, fine grained, brown, moist, very loose	602
3	7.5	**SILTY SAND (SM)**, gravelly, fine to coarse grained, angular, brown and white, moist, very dense, strong cementation; very dense	596.5
5	19.0	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong; unweathered; sound, strong rock; extremely fractured; sound, very strong	585

Boring Terminated at 19 Feet

Approx. Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results		Atterberg Limits LL-PL-PI	Fines Percent
0–2			23		8.0		
2.5–3			7	33-50/1"	8.8		
5			1	50/3"	5.7		
7.5			1	50/1"	4.4		
9–12			26	RQD = 39%			
12–17			43	RQD = 13%			
17–19			24	RQD = 33%			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger & HQ Core

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-09-2023

Boring Completed
03-09-2023

700 NE 55th Ave
Portland, OR

Boring Log No. DC-22

Location: See Exploration Plan

Latitude: 45.7098° Longitude: -119.8231°

Layer Model	Depth (Ft.)	Material Description	Elevation: 612 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.1	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose	611.92								
2	2.5	**SILTY SAND (SM)**, fine grained, brown, moist, very loose	609.5			X	18	0-0-1 N=1	7.5		
3	7.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, subrounded to subangular, light brown, moist, very dense	604.5			X	14	14-58-50/2"	16.7		
				5		X	5	18-50/5"	5.5		9
5	16.6	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	595.4			X	4	50/5"	4.6		
		brown to gray, extremely fractured, highly weathered, very weak		10		X	7	45-50/1"	9.1		
		gray, moderately fractured, slightly weathered, medium strong		15		X	3	50/3"	6.8		
						X	0	50/1"			

Auger Refusal at 16.6 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-08-2023

Boring Completed
03-08-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-23

Location: See Exploration Plan

Latitude: 45.7096° Longitude: -119.8221°

Model Layer	Depth (Ft.)	Description	Elevation.: 611 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.1	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, trace fine rootlets	610.92								
2	2.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, brown, moist	609			X	11	0-1-1 N=2	10.1		
3		**SILTY SAND (SM)**, fine grained, light brown, moist, very dense, strong cementation				X	6	50/6"	14.7		
	6.5	fine to coarse grained	604.5	5		X	3	50/5"	9.8		
5		**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong				X	1	50/2"	5.6		
				10		X	1	50/1"	5.0		
	11.6		599.4			X	1	50/1"	4.7		

Auger Refusal at 11.6 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-08-2023

Boring Completed
03-08-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. DC-24

Location: See Exploration Plan

Latitude: 45.7088° Longitude: -119.8222°

LayerModel	Depth (Ft.)	Description	Elevation.: 619 (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose	618.83
2	4.0	**SILTY SAND (SM)**, fine grained, brown, moist, medium dense	615
3	16.0	**SILTY SAND (SM)**, fine to coarse grained, subrounded to subangular, light brown, moist, very dense, strong cementation	603
5	16.1	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	602.9

Auger Refusal at 16.1 Feet

Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)			Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
			19		5.3	78		19
			18	6-5-4 N=9	7.6 / 11.2			
5			3	50/3"	9.5			
			18	37-46-50 N=96	10.6			12
10			5	50/5"	20.2 / 3.6			
15			2	50/4"	5.4			
			0	50/1"				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-08-2023

Boring Completed
03-08-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. GS-01

Location: See Exploration Plan

Latitude: 45.7141° Longitude: -119.8295°

LayerModel	Graphic Log	Depth (Ft.)	Material Description	Elevation.: 593 (Ft.)
1		0.2	**TOPSOIL (OL)**, dark brown, moist, mulch	592.83
2			**SILTY SAND (SM)**, fine grained, brown, moist, very loose	
			very loose	
		6.5		586.5
			POORLY GRADED SAND WITH SILT (SP-SM), fine grained, light brown, wet, loose	
		9.5		583.5
5			**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	
		11.1		581.92
			Boring Terminated at 11.1 Feet	

Depth (Ft.)	Water Level Observations	Sample Type				Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
			18	0-1-1 N=2	6.6			
			22		7.4	80		14
5	▽		18	1-2-1 N=3	23.0			
			18	3-4-5 N=9	25.1			5
10			2	50/1"	6.2			
			1	50/1"	7.8			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ While drilling

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-14-2023

Boring Completed
03-14-2023

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

700 NE 55th Ave
Portland, OR

Boring Log No. SS-01

Location: See Exploration Plan

Latitude: 45.7153° Longitude: -119.8299°

LayerModel	Depth (Ft.)	Description	Elevation.: 591 (Ft.)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	590.83
2	10.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, brown, moist, loose, trace fine rootlets to ~1 foot	580.5
3	11.5	**SILTY SAND (SM)**, fine to coarse grained, subrounded to subangular, brown, moist, very dense	579.5
5	16.5	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	574.5
		Boring Terminated at 16.5 Feet	

Depth	Water Level Observations					Atterberg Limits LL-PL-PI	Percent Fines
0–1.5		13	0-1-1 N=2	7.5			
2.5–4		12	2-3-2 N=5	14.9			
4–5.8 (5)		15		12.3			11
7.5–9	▽ (about 8.5)	10	5-4-6 N=10	11.8			
10–10.75 (10)		9	10-50/3"	21.2 / 11.2			
11.5–16.5 (15)		44	RQD = 35%				

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ While drilling

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Advancement Method
Mud Rotary & HQ Core

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-15-2023

Boring Completed
03-16-2023

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. SS-02

Location: See Exploration Plan

Latitude: 45.7146° Longitude: -119.8305°

Model Layer	Depth (Ft.)	Material Description	Elevation.: 590 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.4	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, very loose, rootlets	589.58			X	18	0-1-1 N=2	7.6			
2		**SILTY SAND (SM)**, fine grained, brown, moist, very loose										
		loose				X	18	2-2-2 N=4	13.3 / 23.2 / 13.5			
				5	▽ ▽	Shelby tube	24		23.5			
3	7.5	**SILTY SAND (SM)**, fine to coarse grained, subrounded to subangular, brownish yellow and black, moist, very dense	582.5			X	18	18-28-22 N=50	18.7			
5	9.5	**BASALT**, gray, fine-grained, extremely fractured, slightly weathered, medium strong	580.5									
	10.2		579.8	10		X	1	50/2"	8.2			

Auger Refusal at 10.2 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ At completion of drilling
▽ After 1 hour

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Advancement Method
4¼ inch ID Hollow Stem Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite

Drill Rig CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-14-2023

Boring Completed
03-14-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. SS-03

Location: See Exploration Plan

Latitude: 45.7146° Longitude: -119.8292°

Model Layer	Depth (Ft.)	Material Description	Elevation.: 595 (Ft.)	Sample Depth (Ft.)	Water Level	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, trace fine rootlets	594.83			14	1-0-1 N=1	7.2		
		SILTY SAND (SM), fine grained, brown, moist, very loose, trace fine rootlets to ~1.0 foot				16	2-4-3 N=7	9.7		
		loose		5		16	2-3-4 N=7	11.2		24
	7.0	**SILT (ML)**, trace sand, nonplastic, light brown, moist, medium stiff, fine grained sand	588			18	3-3-3 N=6	31.5	NP	90
2	9.5	**SILTY SAND (SM)**, fine grained, brown, wet, loose	585.5	10	▽	18	2-3-2 N=5	27.0		
	15.0	**SILTY SAND (SM)**, fine grained, brownish gray, moist, medium dense, alternating layers of silty sand and sandy silt.	580	15		14	3-8-18 N=26	30.8		47
4	20.0	**POORLY GRADED SAND (SP)**, fine grained, brown, moist, medium dense	575	20		18	8-12-14 N=26	21.2		
				25						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
▽ While drilling

Drill Rig CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-15-2023

Boring Completed
03-15-2023

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Tooling lost down hole at 20 feet bgs. Hole backfilled and new hole advanced 5 feet east of original hole to continue sampling.

Advancement Method
Mud Rotary

Abandonment Method
Boring backfilled with bentonite grout, up to 8-feet, bentonite chips 2-8-feet, capped with 2-feet of cuttings.

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. SS-03

Location: See Exploration Plan

Latitude: 45.7146° Longitude: -119.8292°

Depth (Ft.) Elevation.: 595 (Ft.)

Model Layer	Material Description	Depth (Ft.)	Elevation (Ft.)	Recovery	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI
4	**POORLY GRADED SAND (SP)**, fine grained, brown, moist, medium dense *(continued)*			8	4-8-8 N=16	26.1	
		30		14	6-8-8 N=16	34.9	
		35		17	7-10-7 N=17	29.2	
		38.5	556.5				
	POORLY GRADED GRAVEL WITH CLAY (GC), coarse grained, brown, wet, dense						
		40		18	40-19-16 N=35	11.3 / 26.5	
		40.8	554.2				
	LEAN CLAY WITH SAND (CL), fine grained, low plasticity, brown and yellowish brown, moist						
		42.0	553				
	ELASTIC SILT (MH), trace sand, fine grained, high plasticity, gray, moist						
	dark gray to white, with brownish-yellow veins	45		13	11-16-15 N=31	30.8	57-34-23
		50					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
While drilling

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-15-2023

Boring Completed
03-15-2023

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Tooling lost down hole at 20 feet bgs. Hole backfilled and new hole advanced 5 feet east of original hole to continue sampling.

Advancement Method
Mud Rotary

Abandonment Method
Boring backfilled with bentonite grout, up to 8-feet, bentonite chips 2-8-feet, capped with 2-feet of cuttings.

Terracon
700 NE 55th Ave
Portland, OR

Boring Log No. SS-03

Location: See Exploration Plan

Latitude: 45.7146° Longitude: -119.8292°

Model Layer	Graphic Log	Depth (Ft.) / Material Description	Elevation.: 595 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)		Atterberg Limits LL-PL-PI	
4		**ELASTIC SILT (MH)**, trace sand, fine grained, high plasticity, gray, moist *(continued)* grayish brown				X	18	12-13-18 N=31	33.9			
				55		X	18	11-13-13 N=26	30.6			
		brownish gray, with white, yellow and brown veins		60		X	18	11-14-15 N=29	45.7			
		61.5	533.5									

Boring Terminated at 61.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
While drilling

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.
Tooling lost down hole at 20 feet bgs. Hole backfilled and new hole advanced 5 feet east of original hole to continue sampling.

Advancement Method
Mud Rotary

Abandonment Method
Boring backfilled with bentonite grout, up to 8-feet, bentonite chips 2-8-feet, capped with 2-feet of cuttings.

Drill Rig
CME 55-Track

Hammer Type
Automatic

Driller
Western States

Logged by
D. Dunn

Boring Started
03-15-2023

Boring Completed
03-15-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-01

Location: See Exploration Plan

Latitude: 45.7151° Longitude: -119.8288°

	Depth (Ft.) / Elevation.: 595 (Ft.)						Atterberg Limits LL-PL-PI	
1	0.2 **TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	594.83						
2	**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets to ~4 feet bgs, very loose based on digging effort				12	5.8		
					6	7.1		12
			5					
					12	5.5		
	10.0	585	10					

Test Pit Terminated at 10 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Minor caving of test pit sidewalls observed

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-02

Location: See Exploration Plan

Latitude: 45.7137° Longitude: -119.8304°

LayerModel	Depth (Ft.)	Description	Elevation.: 598 (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field TestResults	WaterContent(%)	Dry UnitWeight(pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	597.67								
2		**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets to ~3 feet bgs, very loose based on digging effort				6		8.2			
	4.5		593.5								
3	5.0	**SILTY SAND (SM)**, fine to coarse grained, light brown, moist, strong cementation	593			6					
5	5.5	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	592.5			3		4.5			

Test Pit Refusal at 5.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-03

Location: See Exploration Plan

Latitude: 45.7132° Longitude: -119.8291°

Layer Model	Depth (Ft.)	Material Description	Elevation: 602 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	601.83									
2	2.0	**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets, very loose based on digging effort	600			Grab	6		7.7			
3	5.0	**SILTY SAND (SM)**, fine to coarse grained, white, strong cementation, dense based on digging effort	597			Grab	6		15.9			
5	6.0	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	596	5		Grab	3		6.3			

Test Pit Refusal at 6 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-04

Location: See Exploration Plan

Latitude: 45.7146° Longitude: -119.8260°

LayerModel	Depth (Ft.)	Material Description	Elevation.: 596 (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	595.83							
2	4.0	**SILTY SAND (SM)**, trace gravel, fine grained, subrounded, brown, moist, trace fine rootlets to ~2 feet bgs, very loose based on digging effort	592	Grab	6		8.1			
3	9.0	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	587	Grab	6					
5	10.0	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	586	Grab	6		6.1			

Test Pit Refusal at 10 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-05

Location: See Exploration Plan

Latitude: 45.7120° Longitude: -119.8284°

Model Layer	Depth (Ft.)	Material Description	Elevation.: 605 (Ft.)
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	604.75
2	8.0	**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets to ~2 feet bgs, very loose based on digging effort	597
3	8.9	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	596.1
5	9.0	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	596

Test Pit Refusal at 9 Feet

Sample depth (approx., Ft.)	Sample			Atterberg Limits LL-PL-PI	
1	Grab sample	6	8.7		
6	Grab sample	6	5.9		15
8	Grab sample	6	12.2		

Minor caving observed at approx. 2 ft.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
While drilling

Minor caving of test pit sidewalls observed

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-06

Location: See Exploration Plan

Latitude: 45.7113° Longitude: -119.8265°

LayerModel	Depth (Ft.)	Material Description	Elevation.: 605 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results			Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	604.83									
2		**SILTY SAND (SM)**, fine grained, brown, moist, abundant rootlets to ~1 foot, trace fine rootlets to ~2½ feet bgs, very loose based on digging effort				Grab	6		7.6			
	5.0	light brown	600			Grab	6					
3	9.5	**SILT (ML)**, trace sand, light brown, moist, moderate cementation, fine grained sand, hard based on digging effort	595.5	5		Grab	6		4.1			87
5	10.0	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	595	10		Grab	6		5.5			

Test Pit Refusal at 10 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-07

Location: See Exploration Plan

Latitude: 45.7114° Longitude: -119.8243°

Model Layer	Depth (Ft.)	Description	Elevation.: 602 (Ft.)	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	601.67				
2		**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets, very loose based on digging effort		Grab	6	6.2	
				Grab	6	4.3	
	4.0		598				
5	4.5	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	597.5				

Test Pit Refusal at 4.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-08

Location: See Exploration Plan

Latitude: 45.7110° Longitude: -119.8225°

LayerModel	Depth (Ft.)	Description	Elevation.: 596 (Ft.)	Sample Type	Recovery (In.)	Field TestResults	WaterContent (%)	Dry UnitWeight(pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	595.83							
2	3.0	**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets, very loose based on digging effort	593	Hand	6		6.2			
3	4.5	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	591.5	Hand	6		4.1			
5	5.0	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	591	Hand	6		1.4			

Test Pit Refusal at 5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-09

Location: See Exploration Plan

Latitude: 45.7096° Longitude: -119.8260°

Model Layer	Graphic Log	Depth (Ft.)	Description	Elevation.: 619 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	618.75									
2			**SILTY SAND (SM)**, fine grained, brown, moist, abundant rootlets to ~ 1 foot bgs, very loose based on digging effort				Hand	6		8.3			
			medium dense based on digging effort		5		Hand	6					
		8.0		611									
3			**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort										
		10.5		608.5	10		Hand	6		34.6			

Test Pit Terminated at 10.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

minor caving of test pit sidewalls

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-10

Location: See Exploration Plan

Latitude: 45.7090° Longitude: -119.8231°

Elevation.: 619 (Ft.)

LayerModel	Graphic Log	Depth (Ft.)	Material Description	Elevation (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1		0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	618.67									
2			**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets to ~2 feet bgs, very loose based on digging effort				Hand	6		5.7			
		4.0		615									
3			**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort				Hand	6					
					5		Hand	6		10.6			
		5.5		613.5									

Test Pit Refusal at 5.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-11

Location: See Exploration Plan

Latitude: 45.7091° Longitude: -119.8208°

LayerModel	Depth (Ft.)	Description	Elevation.: 614 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.1	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	613.92									
2	3.5	**SILTY SAND (SM)**, trace gravel, fine grained, subrounded, brown, moist, trace fine rootlets to ~3 feet bgs, trace subrounded rounded gravel up to 1/2 inch diameter, very loose based on digging effort	610.5			Grab	6		7.1			
3	6.0	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	608			Grab	6		16.3			
				5		Grab	6					

Test Pit Refusal at 6 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. TP-12

Location: See Exploration Plan

Latitude: 45.7082° Longitude: -119.8248°

Layer Model	Depth (Ft.)	Material Description	Elevation: 623 (Ft.)	Sample Type	Recovery (In.)	Water Content (%)
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	622.83			
2	4.0	**SILTY SAND (SM)**, fine grained, brown, moist, weak cementation, trace fine rootlets to ~1.5 feet bgs, very loose based on digging effort	619	Grab	6	6.6
2	5.0	**SILT (ML)**, nonplastic, light brown, moist, weak cementation	618	Grab	6	
3	6.0	**SILTY SAND (SM)**, fine to coarse grained, white, strong cementation, dense based on digging effort	617	Grab	6	12.3

Test Pit Refusal at 6 Feet

Columns without entries: Water Level Observations, Field Test Results, Dry Unit Weight (pcf), Atterberg Limits LL-PL-PI, Fines Percent.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-22-2023

Test Pit Completed
03-22-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. IT-01

Location: See Exploration Plan

Latitude: 45.7146° Longitude: -119.8270°

LayerModel	Depth (Ft.)	Material Description	Elevation.: 597 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	596.67									
2	4.5	**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets to ~2 feet bgs, very loose based on digging effort	592.5			Hand	12		23.8			24
3	6.5	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	590.5	5								
5	7.0	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	590			Hand	6		5.2			

Test Pit Refusal at 7 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.
Infiltration test performed at 3 feet bgs

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. IT-02

Location: See Exploration Plan

Latitude: 45.7149° Longitude: -119.8250°

LayerModel	Graphic Log	Depth (Ft.)	Description	Elevation.: 593 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	WaterContent(%)	Dry UnitWeight(pcf)	Atterberg Limits LL-PL-PI	PercentFines
1		0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, [redacted] rootlets, very loose based on digging effort	592.75									
2		3.5	**SILTY SAND (SM)** , fine grained, brown, moist, trace fine rootlets, very loose based on digging effort	589.5			Grab	6		25.5			33
3		4.0	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	589			Grab	3		4.2			
5		4.5	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	588.5									

Test Pit Refusal at 4.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.
Infiltration test performed at ½ foot bgs

Advancement Method
2-foot toothed bucket

Logged by
D. Dunn

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

700 NE 55th Ave
Portland, OR

Test Pit Log No. IT-03

Location: See Exploration Plan

Latitude: 45.7114° Longitude: -119.8208°

Depth (Ft.) Elevation.: 584 (Ft.)

Model Layer	Depth (Ft.)	Material Description	Elevation (Ft.)
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	583.75
2	4.0	**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets to ~2 feet bgs, very loose based on digging effort	580
2	9.0	**POORLY GRADED SAND (SP)**, trace silt, fine grained, brown, test pit caving in during excavation ~1.5 feet bgs. Terminated ~9.0 feet bgs.	575

Test Pit Terminated at 9 Feet

Depth (Ft.)	Sample Type	Recovery (In.)	Field Test Results			Atterberg Limits LL-PL-PI	
~1.5	minor caving of test pit sidewalls						
~5.5	Grab (hand)	6		28.0			5
~7.5	Grab (hand)	6		4.9			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevations were interpolated from a topographic site plan.

Infiltration test performed at 5 feet bgs

Water Level Observations
Groundwater not encountered

minor caving of test pit sidewalls

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

700 NE 55th Ave
Portland, OR

Test Pit Log No. IT-04

Location: See Exploration Plan

Latitude: 45.7089° Longitude: -119.8189°

LayerModel	Depth (Ft.)	Material Description	Elevation.: 611 (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Fines Percent
1	0.2	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	610.83								
2	1.5	**SILTY SAND (SM)**, fine grained, brown, moist, trace fine rootlets, very loose based on digging effort	609.5		Grab	6		9.3			
3	2.5	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	608.5		Grab	6		11.7			

Test Pit Refusal at 2.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

Terracon
700 NE 55th Ave
Portland, OR

Test Pit Log No. IT-05

Location: See Exploration Plan

Latitude: 45.7077° Longitude: -119.8211°

Layer Model	Depth (Ft.)	Material Description	Elevation: 622 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.3	**TOPSOIL (OL)**, fine grained, nonplastic, brown, moist, rootlets, very loose based on digging effort	621.67									
2		**SILTY SAND (SM)**, trace gravel, fine grained, subrounded, brown, moist, very loose based on digging effort				Hand	6		24.5			20
						Hand	6					
						Hand	6					
3	4.0	**SILTY SAND (SM)**, fine to coarse grained, white, dense based on digging effort	618									
						Hand	6					
5	5.0	**BASALT**, gray, fine-grained, moderately fractured, slightly weathered, medium strong	617	5		Hand	3					
	5.5	***Test Pit Refusal at 5.5 Feet***	616.5									

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevations were interpolated from a topographic site plan.
Infiltration test performed at ½ foot bgs

Water Level Observations
Groundwater not encountered

Advancement Method
2-foot toothed bucket

Abandonment Method
Test pit backfilled with bucket-tamped cuttings

Excavator
CASE 580N

Operator
Dan Fischer Excavating

Logged by
D. Dunn

Test Pit Started
03-21-2023

Test Pit Completed
03-21-2023

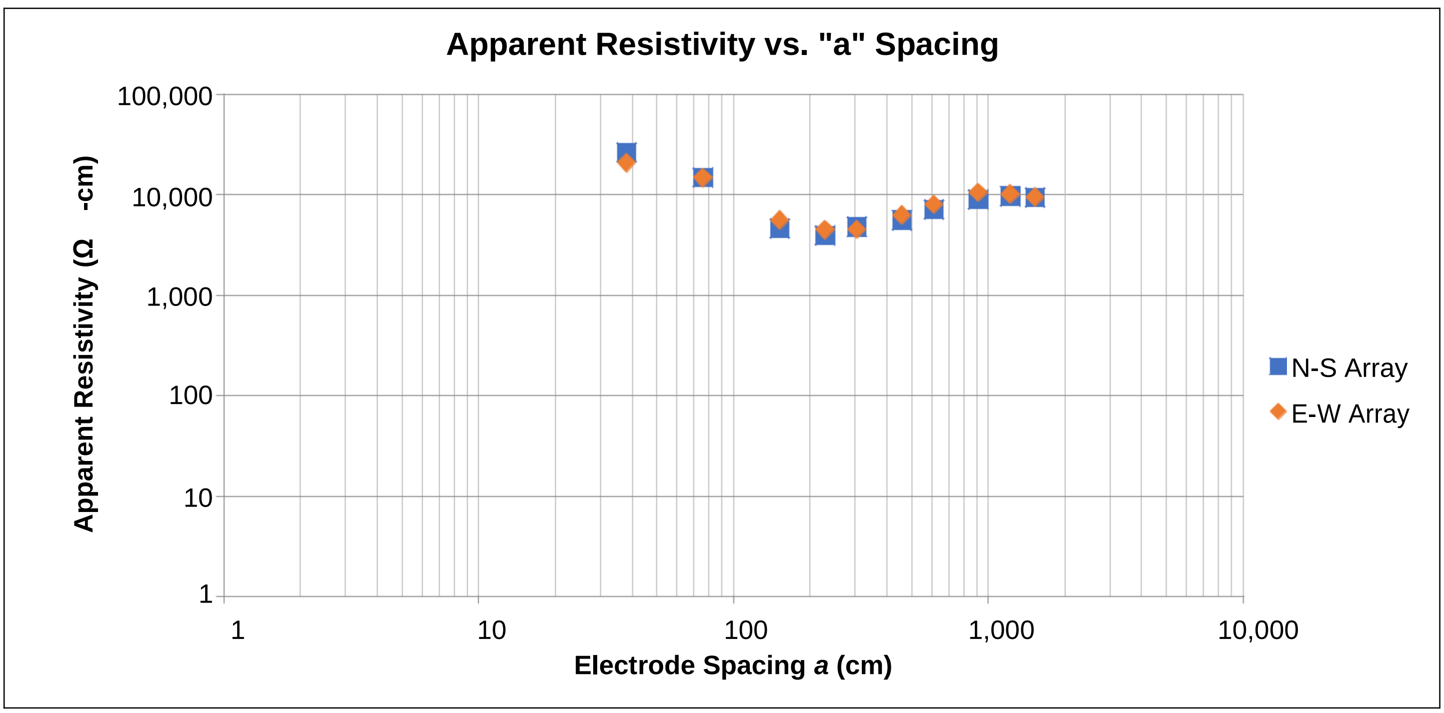
FIELD ELECTRICAL RESISTIVITY TEST DATA
Percheron Data Center | Morrow County, Oregon
Field Date: March 123, 2023 | Terracon Project No. 82225118

Terracon

Array Loc.	ER-1 (45.7146, -119.8299)		
Instrument	Mini-res	**Weather**	35 F, Cloudy
Serial #	347	**Ground Cond.**	Grassy Topsoil - Silty Sand (SM)
Cal. Check	December 2, 2022	**Tested By**	JDPP
Test Date	March 23, 2023	**Method**	Wenner 4-pin (ASTM G57-06 (2020); IEEE 81-2012)
Notes & Conflicts	Area is mostly covered with scrub brush,1 to 3 feet high		

Apparent resistivity ρ is calculated as : $= 1 + \sqrt{\ 2\ 4} - \sqrt{\ }$

Electrode Spacing *a*		**Electrode Depth *b***		**N-S**			
(feet)	(centimeters)	(inches)	(centimeters)	Measured Resistance *R* Ω	Apparent Resistivity *ρ* (Ω-cm)	Measured Resistance *R* Ω	Apparent Resistivity *ρ* (Ω-cm)
1.25	38	24	61	59.70	26,740	46.90	21,010
2.5	76	24	61	19.95	14,910	19.78	14,790
5	152	24	61	3.97	4,650	4.81	5,630
7.5	229	24	61	2.47	3,950	2.82	4,510
10	305	24	61	2.36	4,820	2.23	4,550
15	457	24	61	1.90	5,630	2.14	6,330
20	610	24	61	1.85	7,220	2.06	8,040
30	914	24	61	1.57	9,100	1.83	10,600
40	1219	24	61	1.27	9,790	1.33	10,220
50	1,524	24	61	0.98	9,450	1.00	9,570

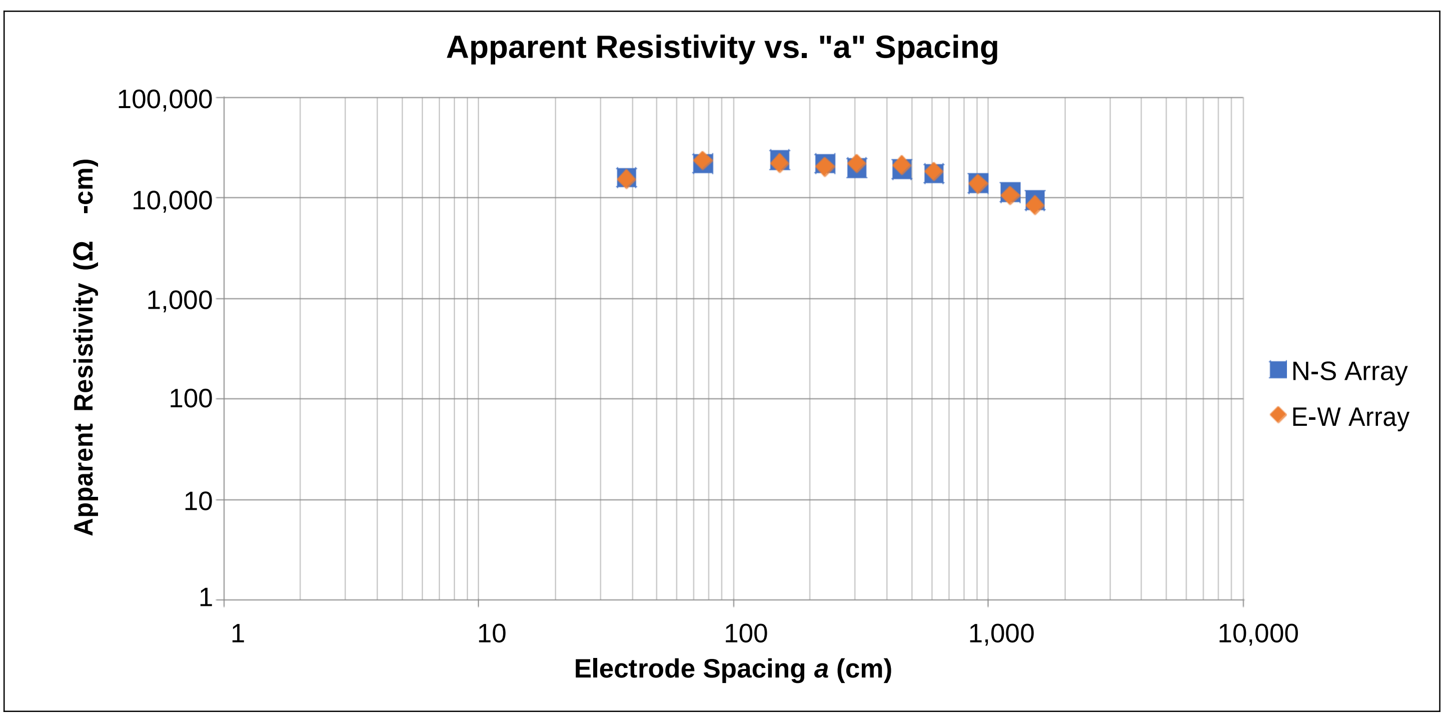


FIELD ELECTRICAL RESISTIVITY TEST DATA
Percheron Data Center | Morrow County, Oregon
Field Date: March 23, 2023 | Terracon Project No. 82225118

Array Loc.	ER-2 (45.7108, -119.8250)		
Instrument	Mini-res	**Weather**	35 F, Cloudy
Serial #	347	**Ground Cond.**	Grassy Topsoil - Silty Sand (SM)
Cal. Check	December 2, 2022	**Tested By**	JDPP
Test Date	March 23, 2023	**Method**	Wenner 4-pin (ASTM G57-06 (2020); IEEE 81-2012)
Notes & Conflicts	Patches of scrub brush about 1 foot high in this area		

Apparent resistivity ρ is calculated as : $= 1 + \sqrt{\quad 2 \ 4} - \sqrt{\quad}$

Electrode Spacing *a*		**Electrode Depth *b***		**N-S**			
(feet)	(centimeters)	(inches)	(centimeters)	Measured Resistance *R* Ω	Apparent Resistivity *ρ* (Ω-cm)	Measured Resistance *R* Ω	Apparent Resistivity *ρ* (Ω-cm)
1.25	38	24	61	35.80	16,040	34.60	15,500
2.5	76	24	61	29.50	22,050	31.80	23,770
5	152	24	61	20.50	24,000	19.06	22,310
7.5	229	24	61	13.81	22,090	12.83	20,520
10	305	24	61	9.79	19,990	10.85	22,160
15	457	24	61	6.56	19,410	7.17	21,210
20	610	24	61	4.49	17,510	4.75	18,500
30	914	24	61	2.43	14,080	2.40	13,910
40	1219	24	61	1.49	11,470	1.38	10,640
50	1,524	24	61	0.99	9,530	0.88	8,480

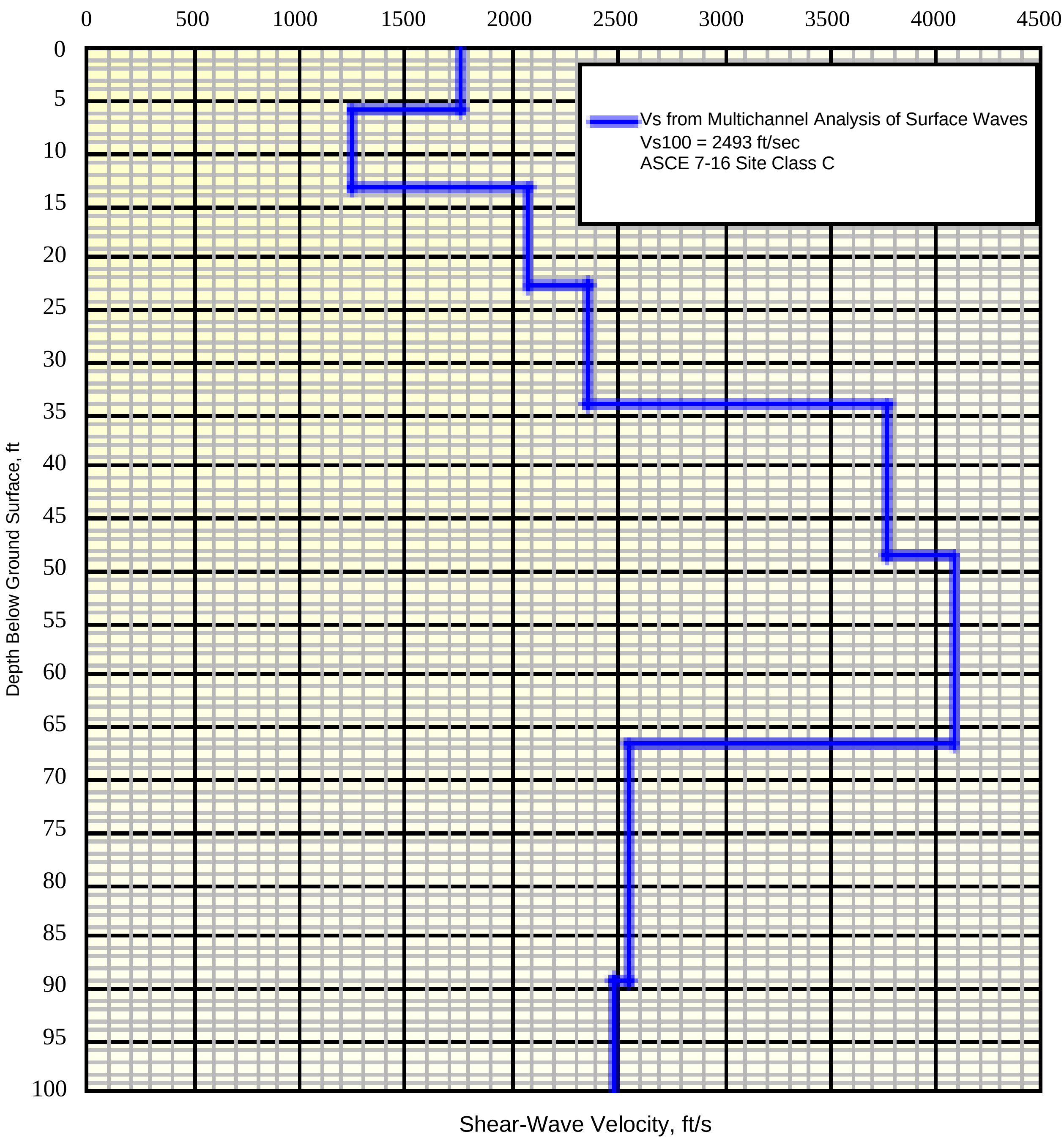


Shear Wave Velocity - Line 1

Percheron Data Center | Morrow County, OR

Field Data Collection: March 8, 2023 |Terracon Project No. 82225118

Shear-Wave Velocity Profile from SurfSeis6 MASW Software Analysis

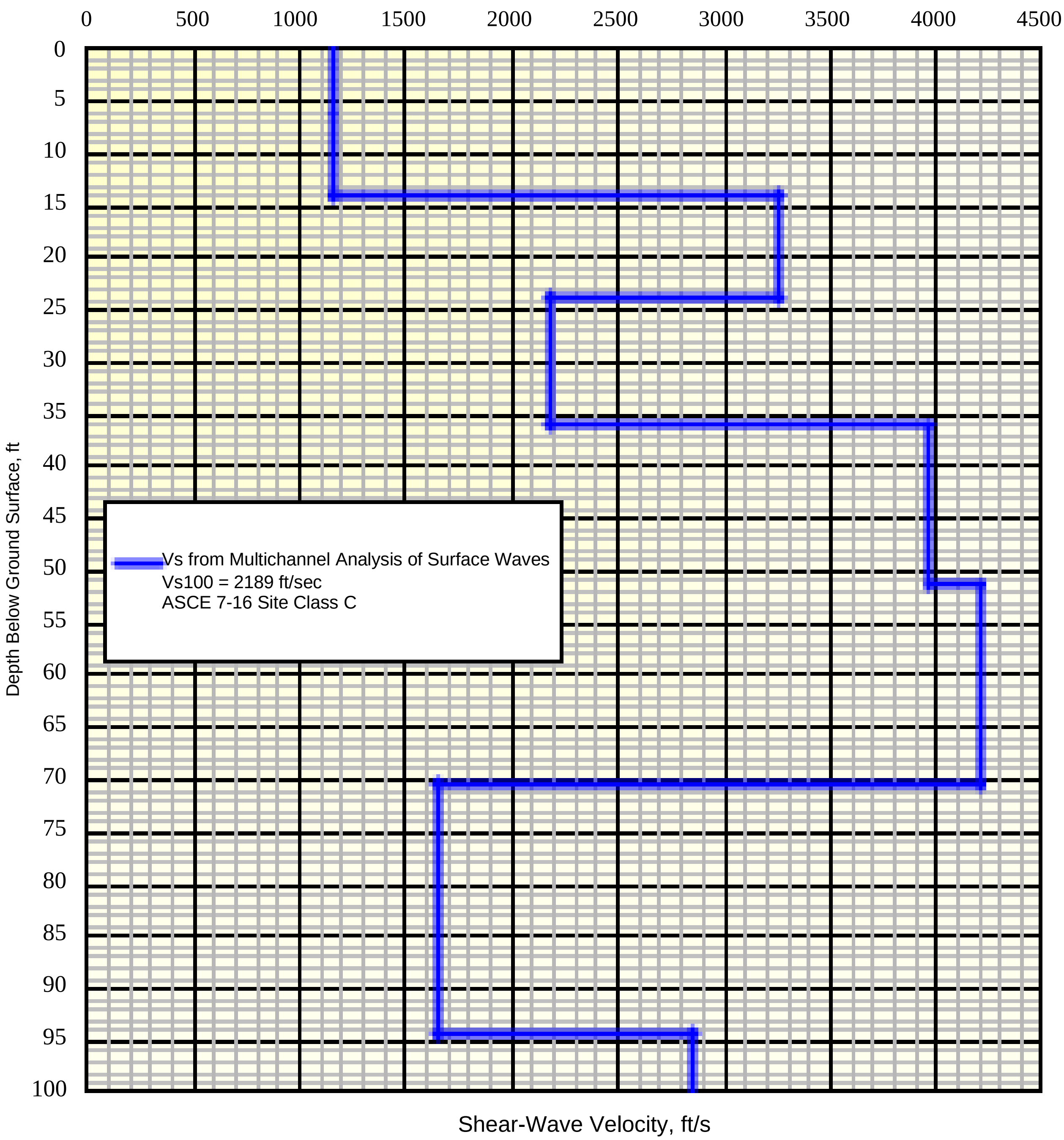


Shear Wave Velocity - Line 2

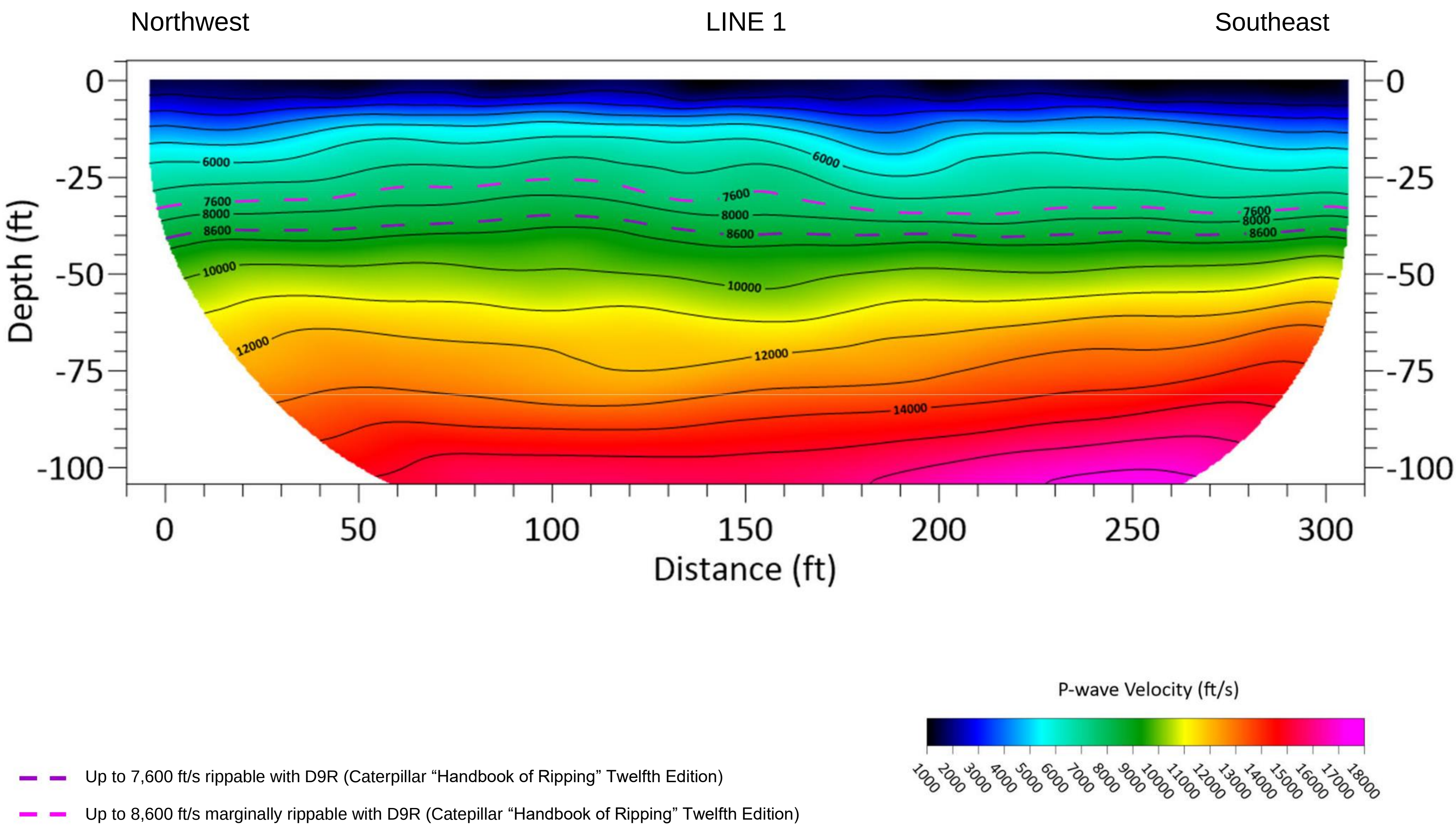
Percheron Data Center | Morrow County, OR

Field Data Collection: March 8, 2023 |Terracon Project No. 82225118

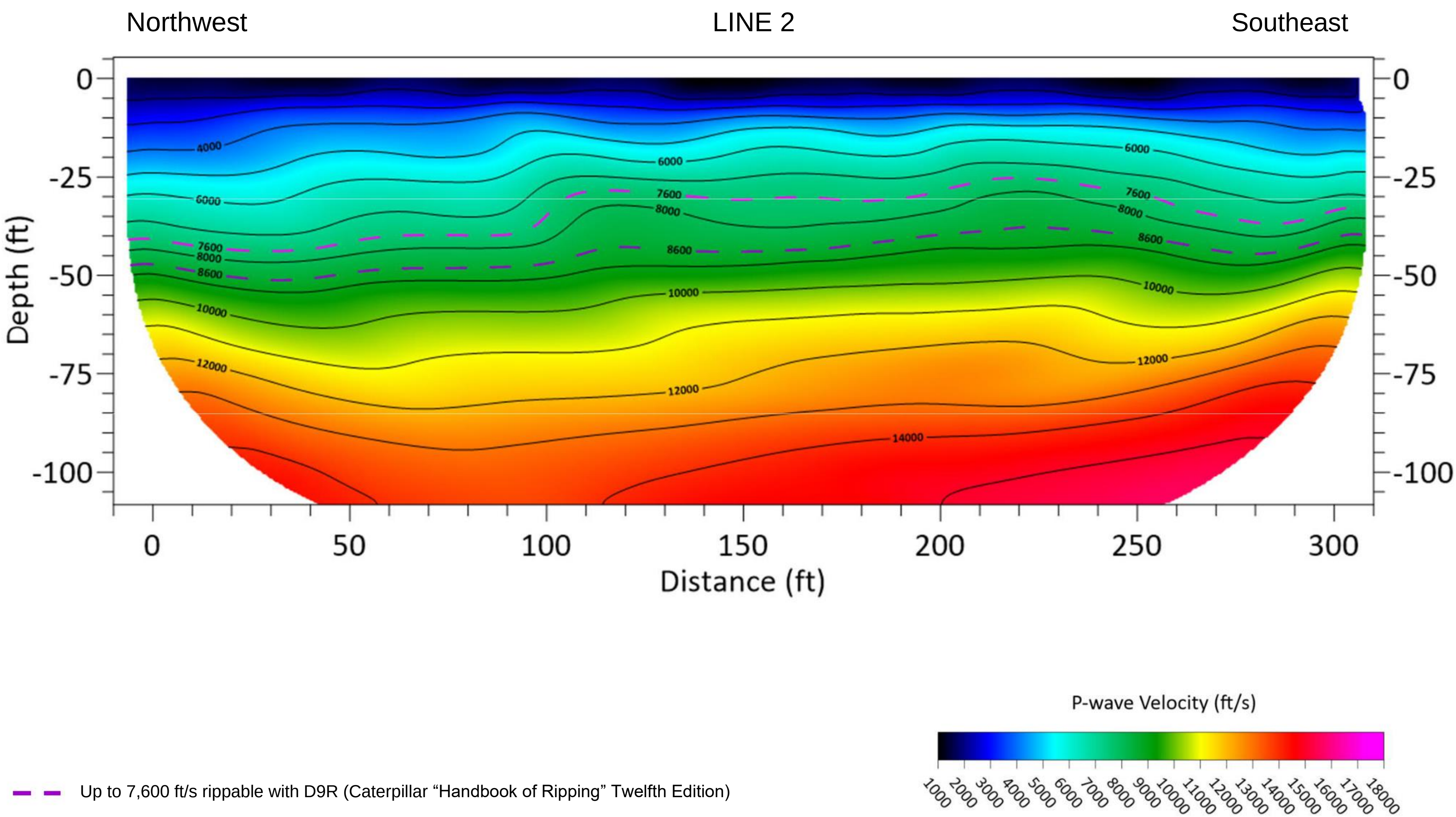
Shear-Wave Velocity Profile from SurfSeis6 MASW Software Analysis



Line 1 Seismic Profile



Line 2 Seismic Profile



Up to 7,600 ft/s rippable with D9R (Caterpillar "Handbook of Ripping" Twelfth Edition)

Up to 8,600 ft/s marginally rippable with D9R (Catepillar "Handbook of Ripping" Twelfth Edition)

Infiltration Testing Results

Percheron Data Center ■ Morrow County, Oregon

Test Date: March 21, 2023 ■ Terracon Project No. 82225118

Project	Percheron Data Center	Date	3/21/2023	Exploration Number	IT-1
Test Method	Encased Falling Head	Inner Diameter of Pipe	6 inches	Infiltration Test Depth	3 feet
Soil at infiltration test depth	Silty Sand (SM)		Approximate Test Elevation[1]		594 ft
Presaturation Start Time	9:04 AM	Presaturation Notes	Water added periodically to maintain 12 inch head		
Presaturation End Time	1:15 PM				
Head During Presaturation	12 inches				

Time	Time Interval (Minutes)	Measurement[2] (inches)	Drop in Water level (inches)	Infiltration Rate[3] (inches per hour)	Remarks
1:15 PM	0	35 1/4	---		Water adjusted to provide 6 inch head
1:45 PM	30	36 1/2	1 1/4	**2.5**	
2:18 PM	33	34 5/8	5/8	**1.1**	Water adjusted to provide 6 inch head
2:50 PM	32	34 1/4	1	**1.9**	Water adjusted to provide 6 inch head
3:21 PM	31	34	1 1/4	**2.4**	Water adjusted to provide 6 inch head
3:53 PM	32	34	1 1/2	**2.8**	Water adjusted to provide 6 inch head

1 Elevation interpolated from Site Topographic Survey

2 Measured to nearest 1/16 inch from top of pipe

3 Values calculated are raw (unfactored) rates.

Infiltration Testing Results

Percheron Data Center ■ Morrow County, Oregon

Test Date: March 21, 2023 ■ Terracon Project No. 82225118

Project	Percheron Data Center	Date	3/21/2023	Exploration Number	IT-2
Test Method	Encased Falling Head	Inner Diameter of Pipe	6 inches	Infiltration Test Depth	½ foot
Soil at infiltration test depth	Silty Sand (SM)		Approximate Test Elevation[1]		592½ ft
Presaturation Start Time	9:40 AM	Presaturation Notes	Water added periodically to maintain 12 inch head		
Presaturation End Time	1:41 PM				
Head During Presaturation	12 inches				

Time	Time Interval (Minutes)	Measurement[2] (inches)	Drop in Water level (inches)	Infiltration Rate[3] (inches per hour)	Remarks
1:41 PM	0	34 3/4	---		Water adjusted to provide 6 inch head
2:11 PM	30	37 3/4	3	**6.0**	Water adjusted to provide 6 inch head
2:43 PM	32	37 7/8	3 1/8	**5.9**	Water adjusted to provide 6 inch head
3:15 PM	32	38 1/4	3 1/2	**6.6**	Water adjusted to provide 6 inch head
3:48 PM	33	38	3 1/4	**5.9**	Water adjusted to provide 6 inch head

1 Elevation interpolated from Site Topographic Survey

2 Measured to nearest 1/16 inch from top of pipe

3 Values calculated are raw (unfactored) rates.

Infiltration Testing Results

Percheron Data Center ■ Morrow County, Oregon

Test Date: March 21, 2023 ■ Terracon Project No. 82225118

Project	Percheron Data Center	Date	3/21/2023	Exploration Number	IT-3
Test Method	Encased Falling Head	Inner Diameter of Pipe	6 inches	Infiltration Test Depth	5 feet
Soil at infiltration test depth	Silty Sand (SM)		Approximate Test Elevation[1]		583½ ft
Presaturation Start Time	9:15 AM	Presaturation Notes	Water added periodically to maintain 12 inch head		
Presaturation End Time	1:15 PM				
Head During Presaturation	12 inches				

Time	Time Interval (Minutes)	Measurement[2] (inches)	Drop in Water level (inches)	Infiltration Rate[3] (inches per hour)	Remarks
1:15 PM	0	65 3/4	---		Water adjusted to provide 6 inch head
1:45 PM	30	71	5 1/4	**10.5**	Water adjusted to provide 6 inch head
2:17 PM	32	70 1/2	5	**9.4**	Water adjusted to provide 6 inch head
2:48 PM	31	70 3/4	5 3/4	**11.1**	Water adjusted to provide 6 inch head
3:21 PM	33	71 1/4	5 1/2	**10.0**	Water adjusted to provide 6 inch head
3:54 PM	33	71 1/8	5 3/8	**9.8**	Water adjusted to provide 6 inch head
4:27 PM	33	71	5 1/4	**9.5**	Water adjusted to provide 6 inch head

1 Elevation interpolated from Site Topographic Survey

2 Measured to nearest 1/16 inch from top of pipe

3 Values calculated are raw (unfactored) rates.

Infiltration Testing Results

Percheron Data Center ■ Morrow County, Oregon
Test Date: March 21, 2023 ■ Terracon Project No. 82225118

Project	Percheron Data Center	**Date**	3/21/2023	**Exploration Number**	**IT-3**
Test Method	Encased Falling Head	**Inner Diameter of Pipe**	6 inches	**Infiltration Test Depth**	**½ foot**
Soil at infiltration test depth	Silty Sand (SM)			**Approximate Test Elevation**[1]	**621½ ft**
Presaturation Start Time	9:55 AM	**Presaturation Notes**	Water added periodically to maintain 12 inch head		
Presaturation End Time	1:55 PM				
Head During Presaturation	12 inches				
Time	**Time Interval (Minutes)**	**Measurement**[2] **(inches)**	**Drop in Water level (inches)**	**Infiltration Rate**[3] **(inches per hour)**	**Remarks**
1:55 PM	0	27	---		Water adjusted to provide 6 inch head
2:25 PM	30	30 1/8	3 1/8	**6.3**	Water adjusted to provide 6 inch head
2:57 PM	32	30 1/4	3 1/4	**6.1**	Water adjusted to provide 6 inch head
3:28 PM	31	30 3/8	3 3/8	**6.5**	Water adjusted to provide 6 inch head
4:00 PM	32	30 1/4	3 1/4	**6.1**	Water adjusted to provide 6 inch head

1 Elevation interpolated from Site Topographic Survey

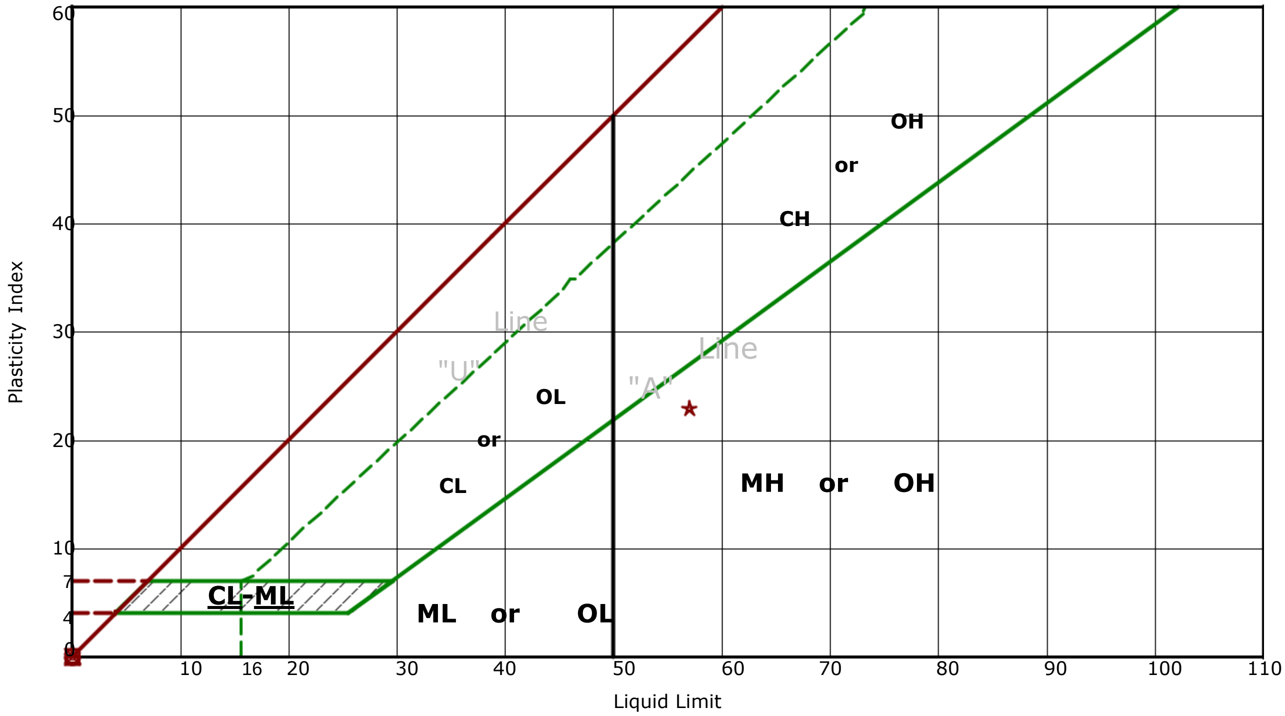
2 Measured to nearest 1/16 inch from top of pipe

3 Values calculated are raw (unfactored) rates.

700 NE 55th Ave
Portland, OR

Atterberg Limit Results

ASTM D4318



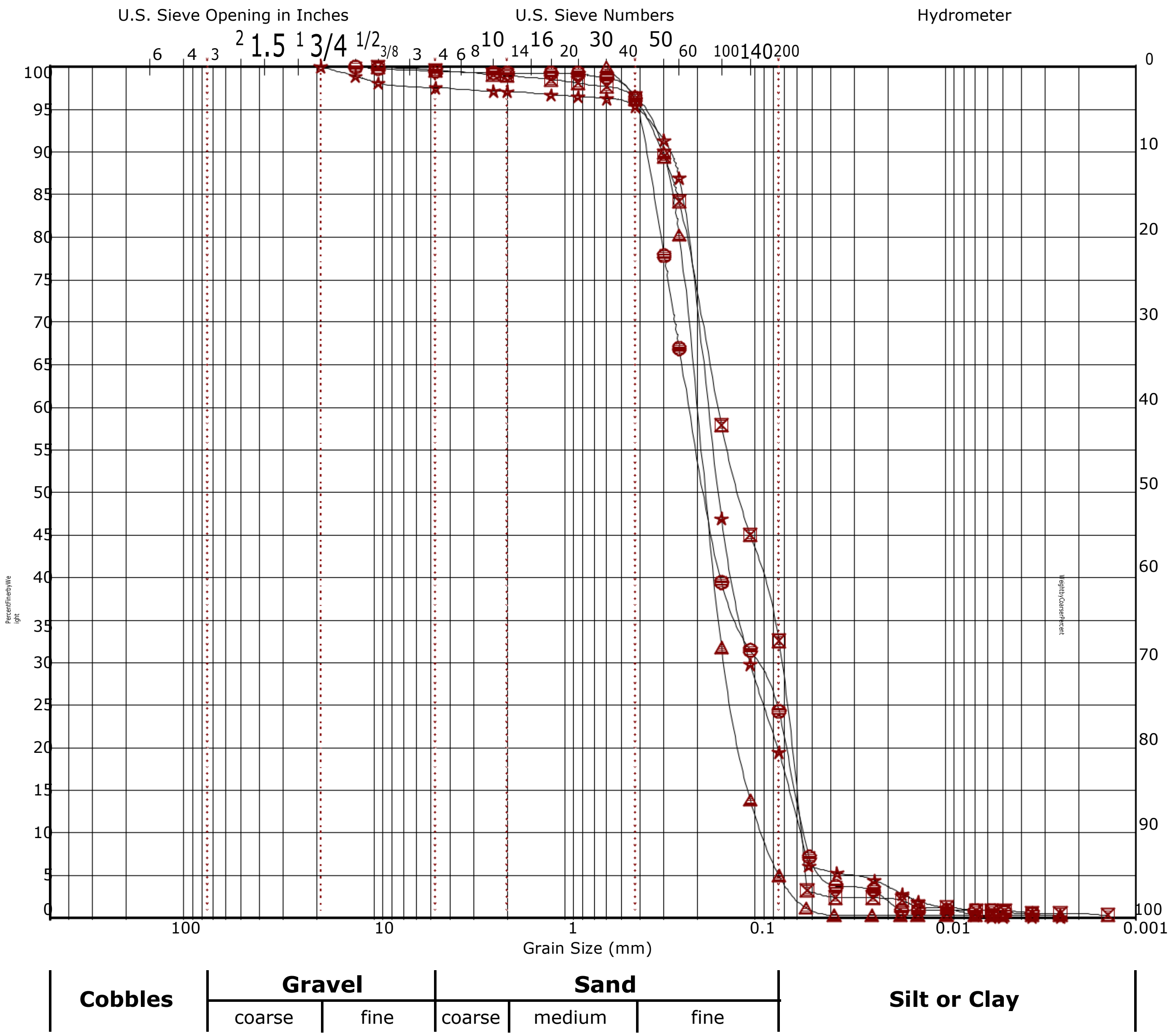
	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
	DC-10	5 - 6.4	NP	NP	NP		SM	SILTY SAND
⊠	DC-14	5 - 6.5	NP	NP	NP	47.8	SM	SILTY SAND
	SS-03	7.5-9	NP	NP	NP	89.7	ML	SILT
★	SS-03A	45 - 46.5	57	34	23		MH	ELASTIC SILT

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

Terracon
700 NE 55th Ave
Portland, OR

Grain Size Distribution

ASTM D422 / ASTM C136



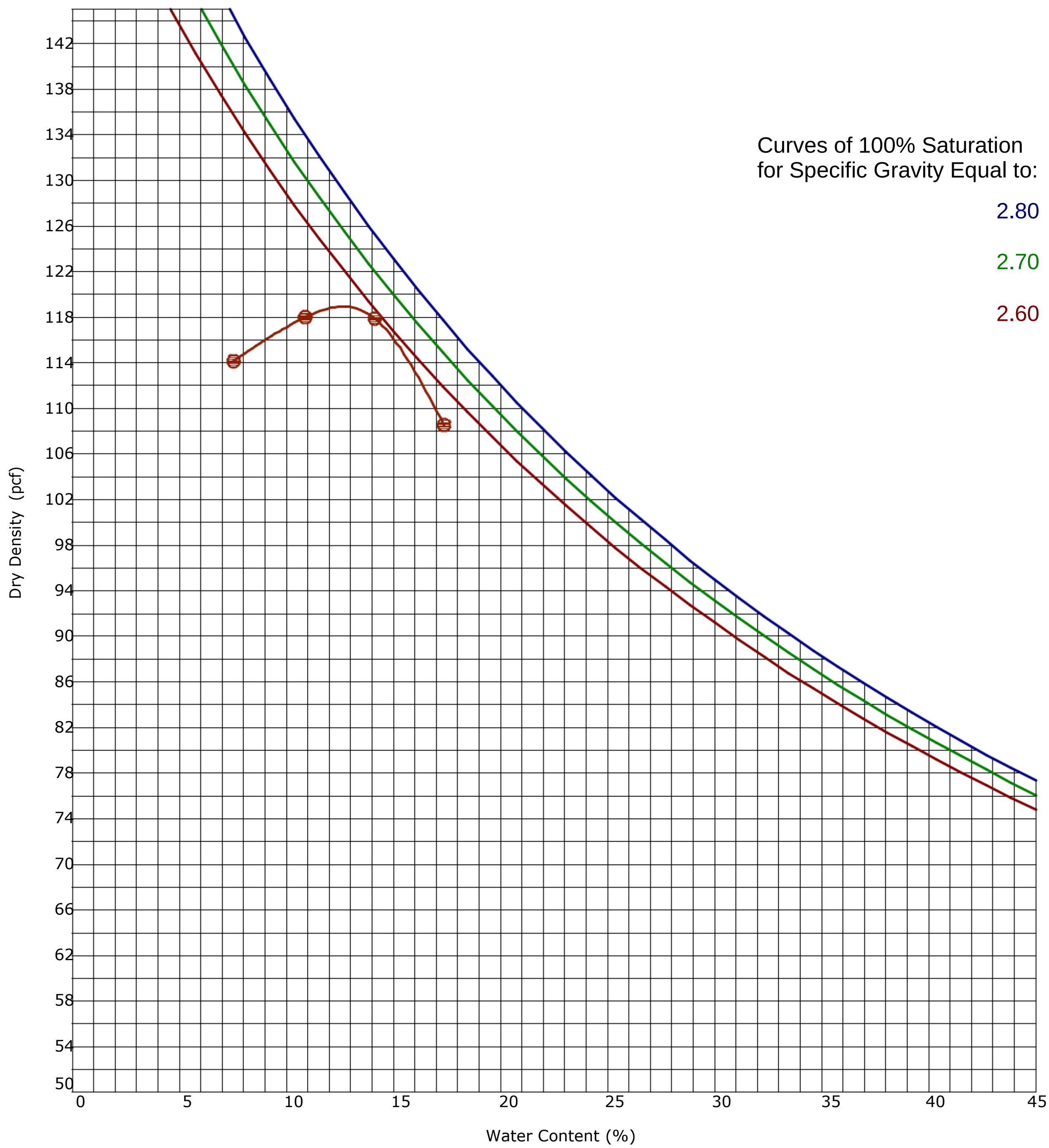
	Boring ID	Depth (Ft)	Description		LL	PL	PI	Cc	Cu
⊖	IT-01	3 - 4	SILTY SAND					0.80	3.98
⊠	IT-02	0.5-1	SILTY SAND					0.59	2.71
△	IT-03	5.5-6	POORLY GRADED SAND					1.14	2.22
★	IT-05	0.5-1	SILTY SAND					1.10	3.06

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
⊖	IT-01	3 - 4	12.5	0.22	0.099	0.055	0.0	0.5	75.2		23.6	0.7
⊠	IT-02	0.5-1	9.5	0.156	0.073	0.058	0.0	0.4	67.0		31.7	0.9
△	IT-03	5.5-6	0.6	0.202	0.145	0.091	0.0	0.0	95.0		4.6	0.3
★	IT-05	0.5-1	19	0.177	0.106	0.058	0.0	2.4	78.1		19.4	0.2

Terracon
700 NE 55th Ave
Portland, OR

Moisture-Density Relationship

ASTM D1557-Method A



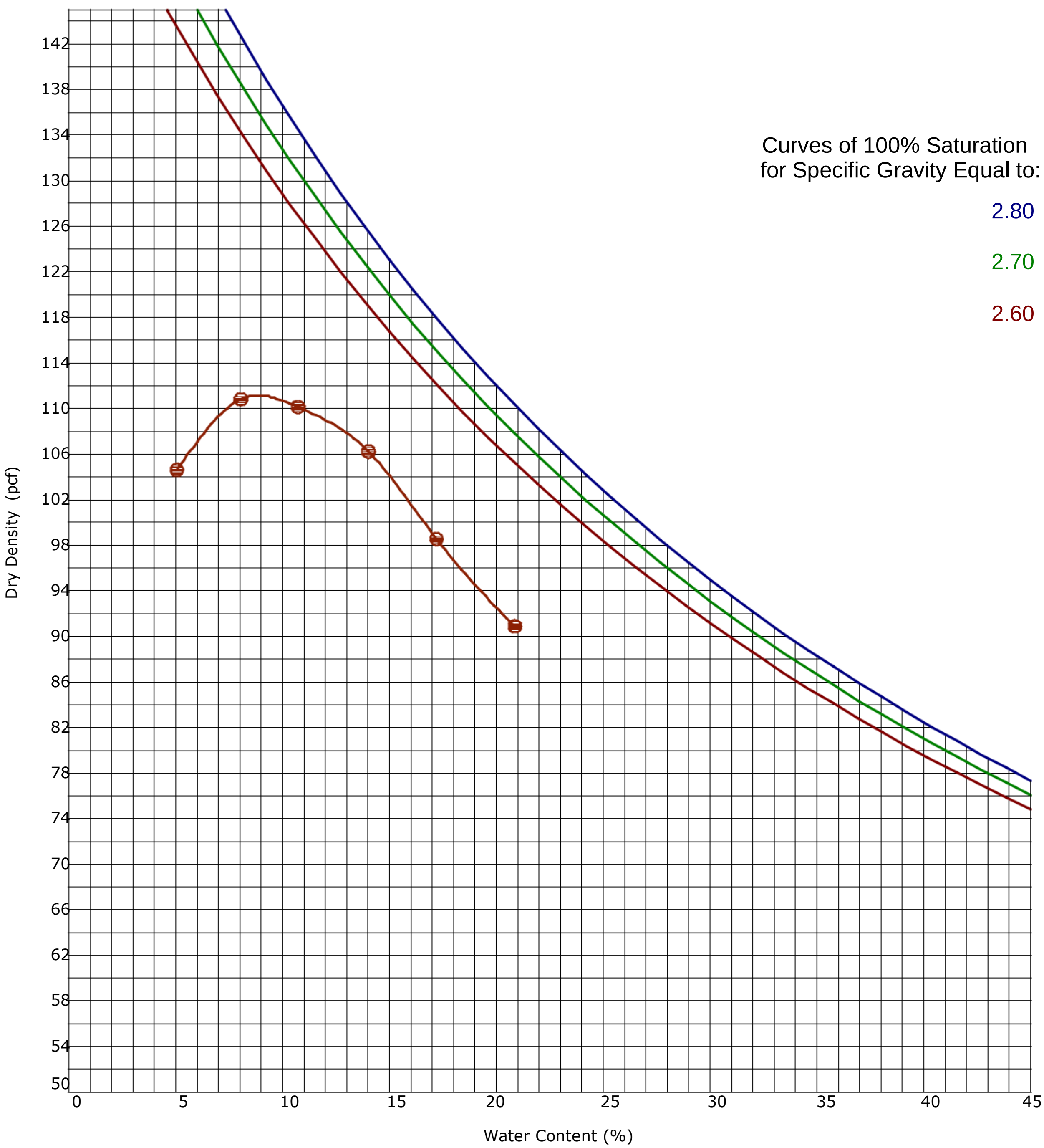
Boring ID	Depth (Ft)	Description of Materials
DC-10	0.5 - 4.5	SILTY SAND

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
	0.0				ASTM D1557-Method A	118.9	12.6

Terracon
700 NE 55th Ave
Portland, OR

Moisture-Density Relationship

ASTM D1557-Method A



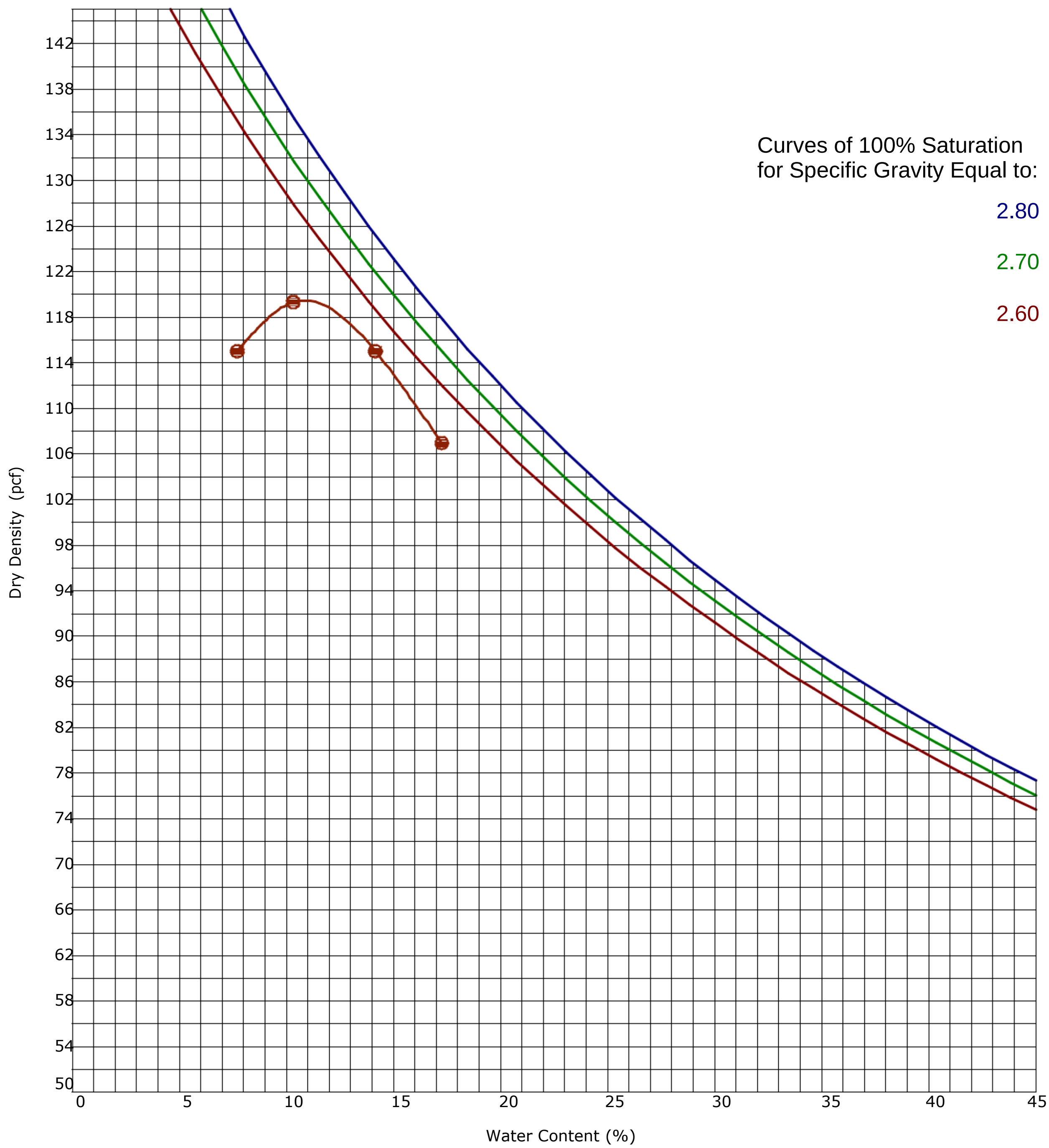
Boring ID	Depth (Ft)	Description of Materials
DC-13	0.5 - 4.5	SILTY SAND to POORLY GRADED SAND WITH SILT

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
	0.0				ASTM D1557-Method A	111.1	8.9

700 NE 55th Ave
Portland, OR

Moisture-Density Relationship

ASTM D1557-Method A



Boring ID	Depth (Ft)	Description of Materials
DC-24	0.5 - 4.5	SILTY SAND

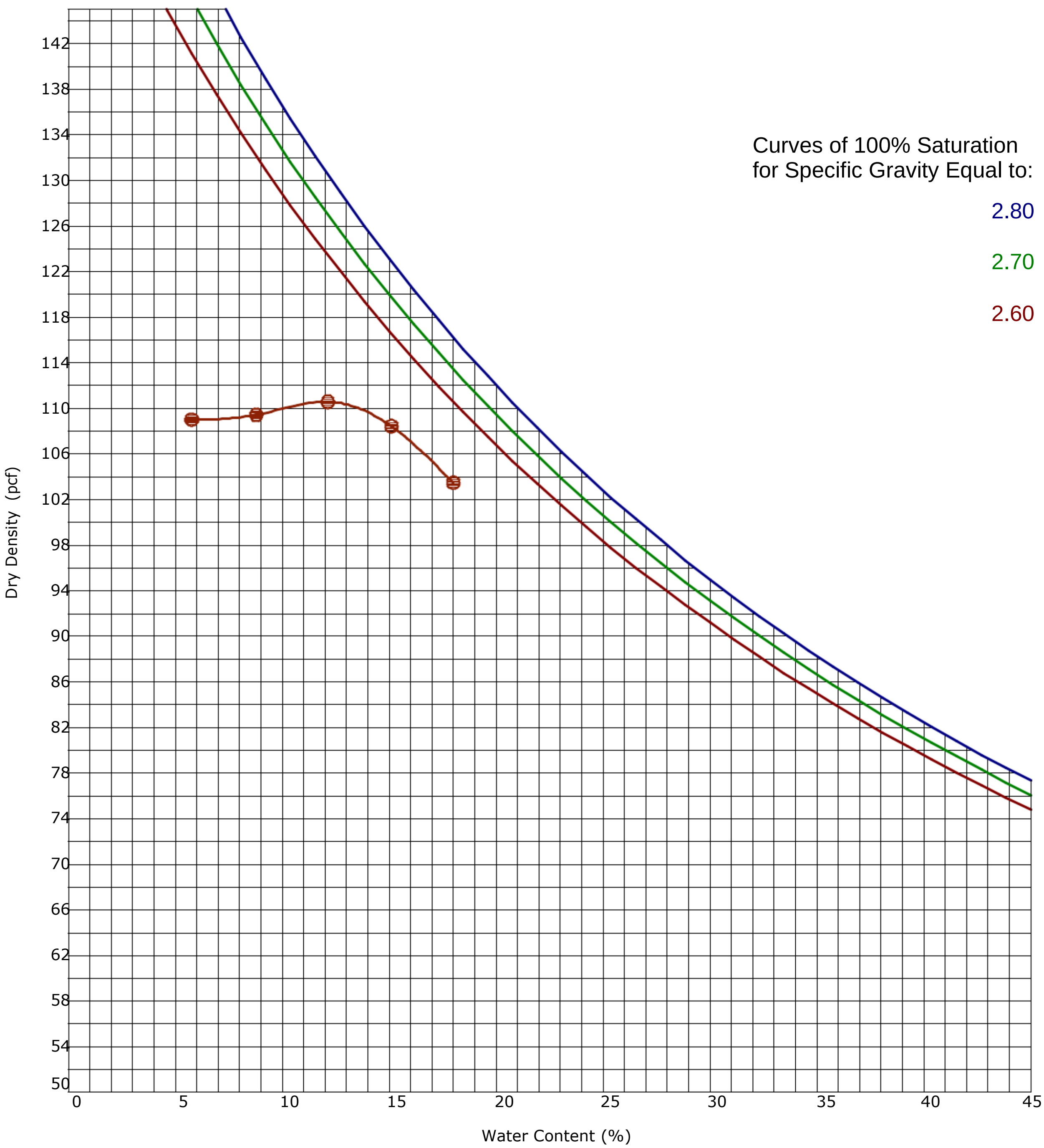
Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
	0.0				ASTM D1557-Method A	119.5	10.9

Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

700 NE 55th Ave
Portland, OR

Moisture-Density Relationship

ASTM D1557-Method A



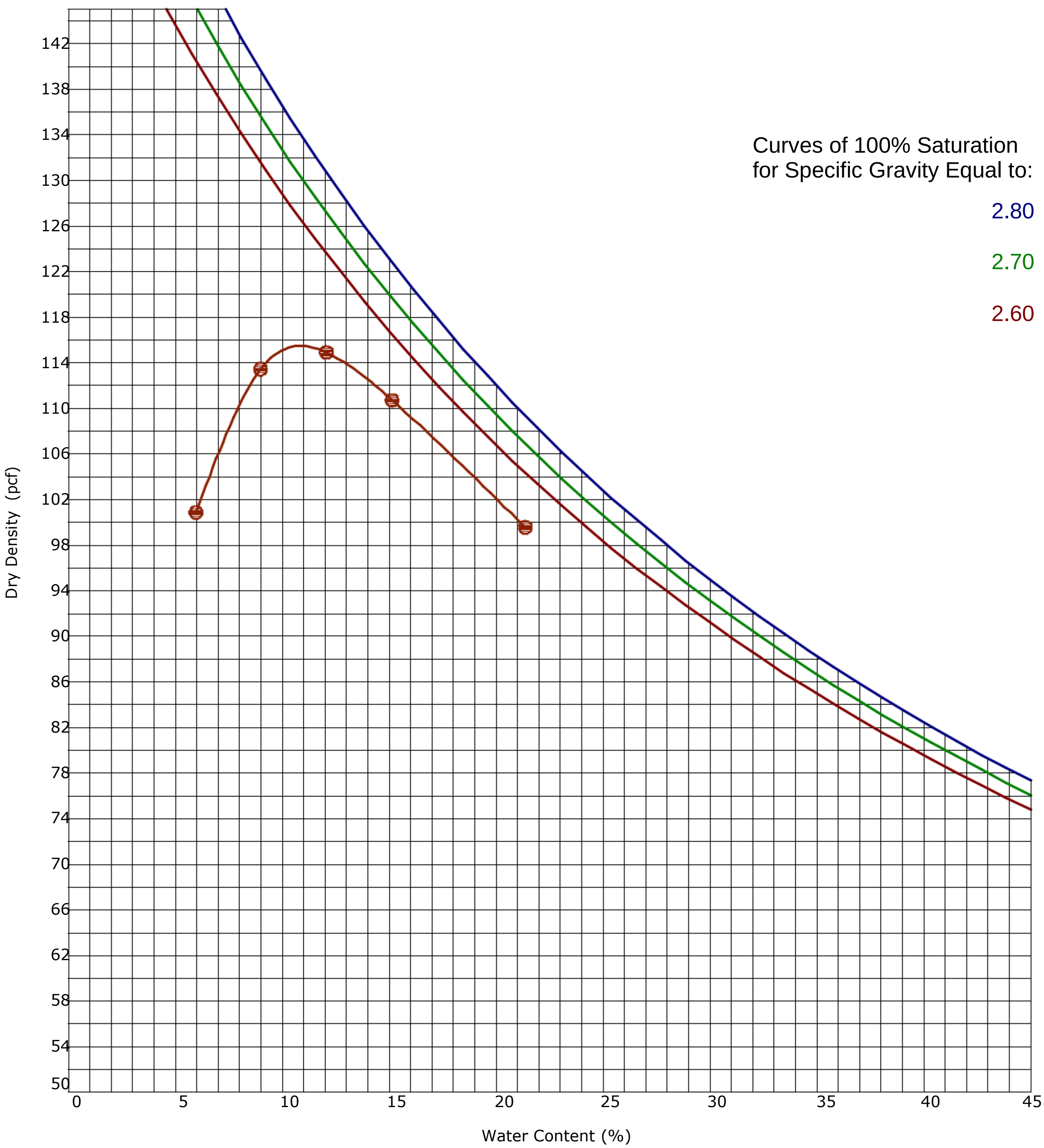
Boring ID	Depth (Ft)	Description of Materials
TP-01	0.5 - 3.5	SILTY SAND

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
	0.0				ASTM D1557-Method A	110.6	11.9

Terracon
700 NE 55th Ave
Portland, OR

Moisture-Density Relationship

ASTM D1557-Method A



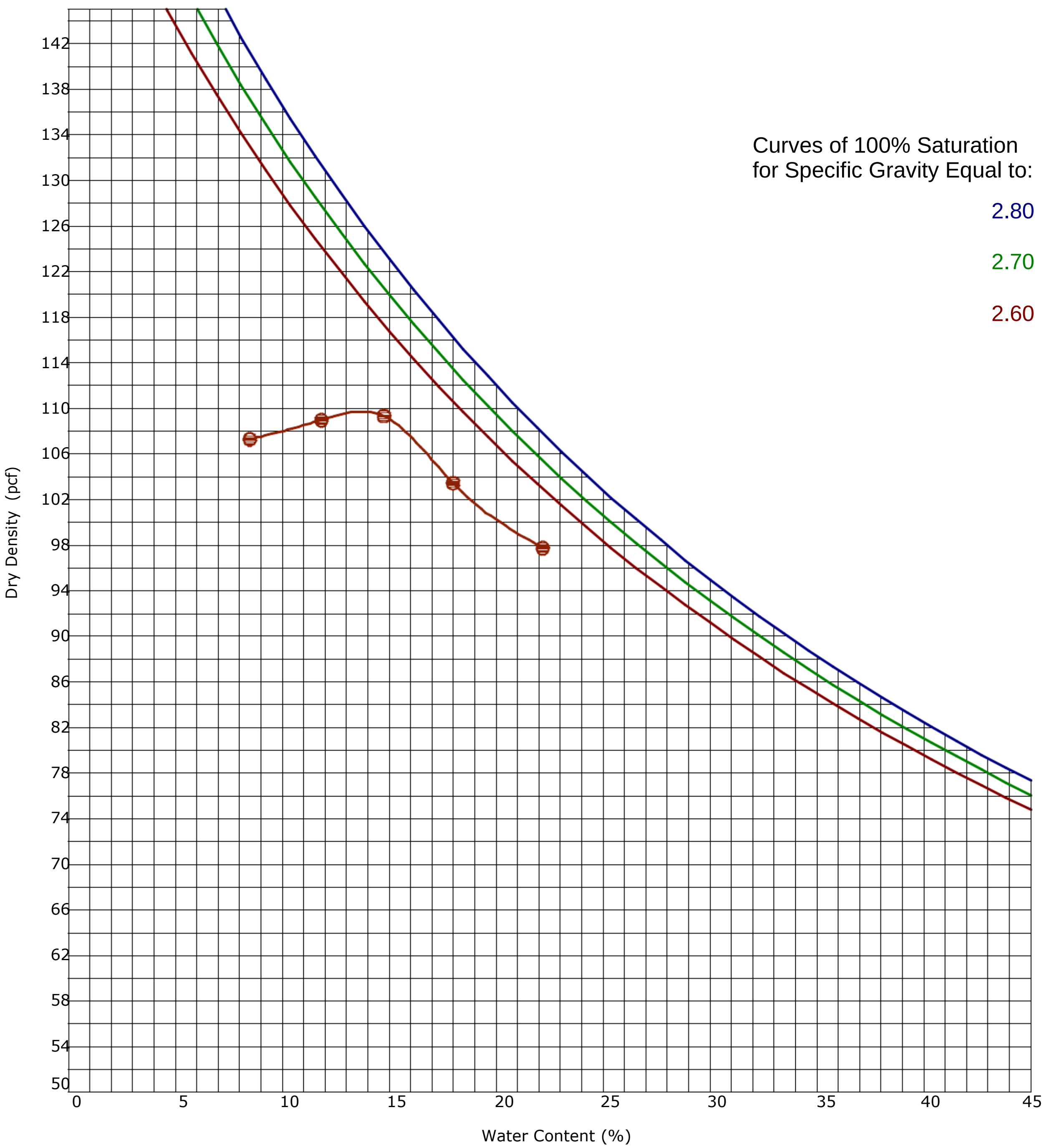
Boring ID	Depth (Ft)	Description of Materials
TP-05	0.5 - 3.5	SILTY SAND

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
	0.0				ASTM D1557-Method A	115.5	10.8

700 NE 55th Ave
Portland, OR

Moisture-Density Relationship

ASTM D1557-Method A



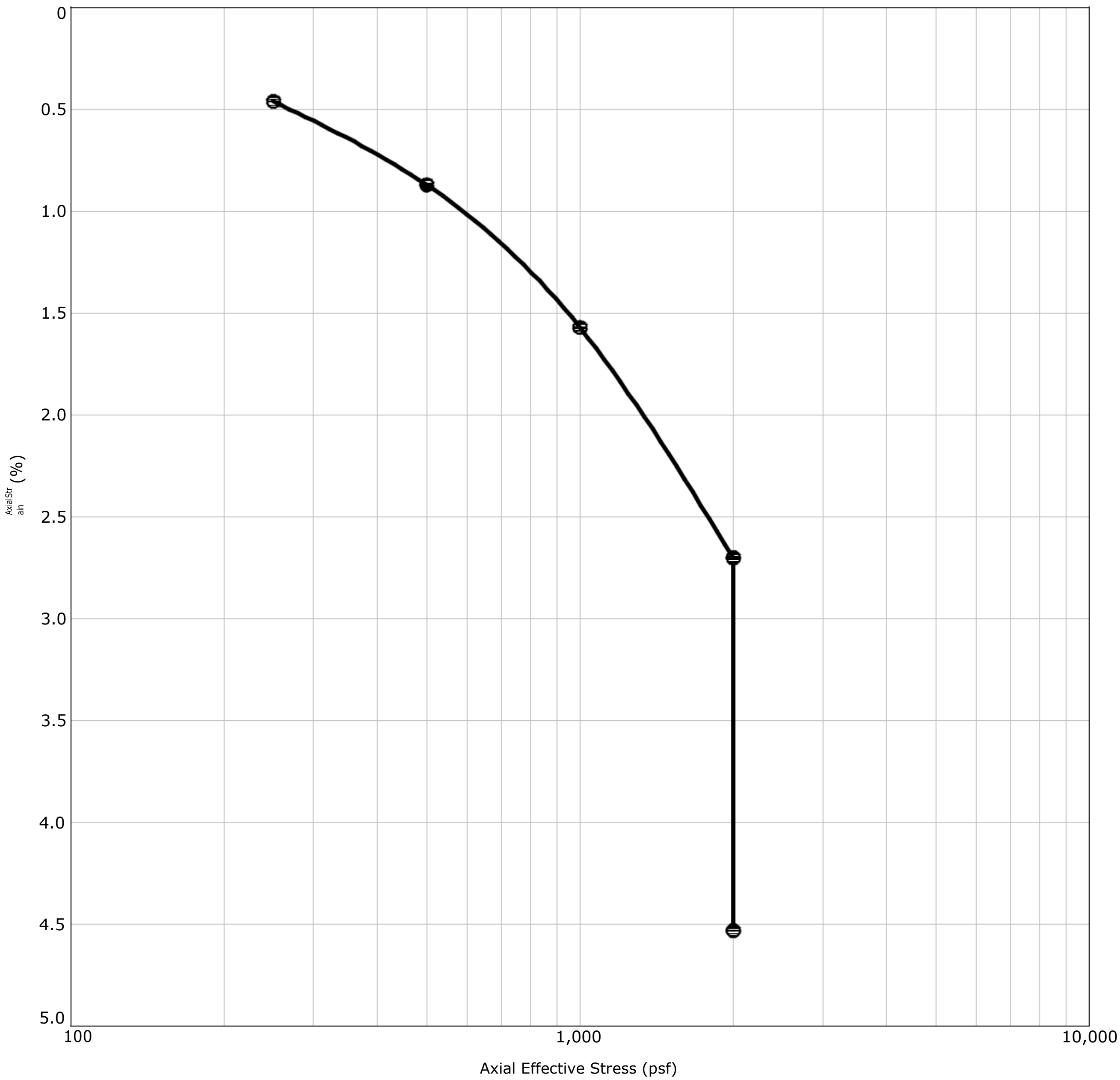
Boring ID	Depth (Ft)	Description of Materials
TP-10	1 - 4	SILTY SAND

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
	0.0				ASTM D1557-Method A	109.7	13.7

700 NE 55th Ave
Portland, OR

One-Dimensional Collapse Test

D4546



Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
DC-09	0-1.5	S-1	POORLY GRADED SAND w/SILT	SP	

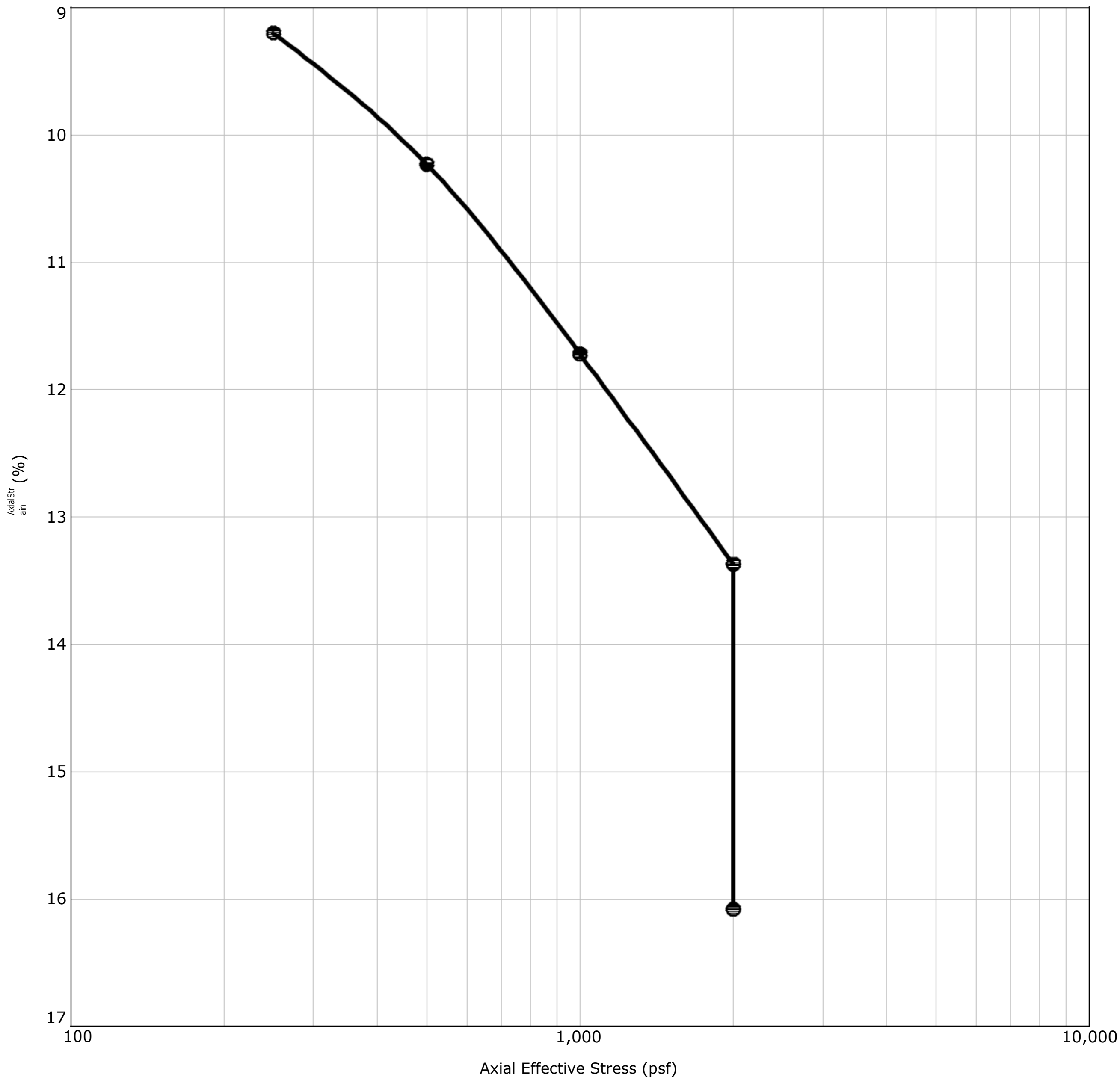
Natural Saturation (%)	Natural Moisture (%)	Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (% / log stress)	C_r (% / log stress)	Initial Void Ratio
	8.5	93.7			2.65					

Notes:

700 NE 55th Ave
Portland, OR

One-Dimensional Collapse Test

D4546



Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
DC-13	0 - 2	S-1	SILTY SAND	SM	

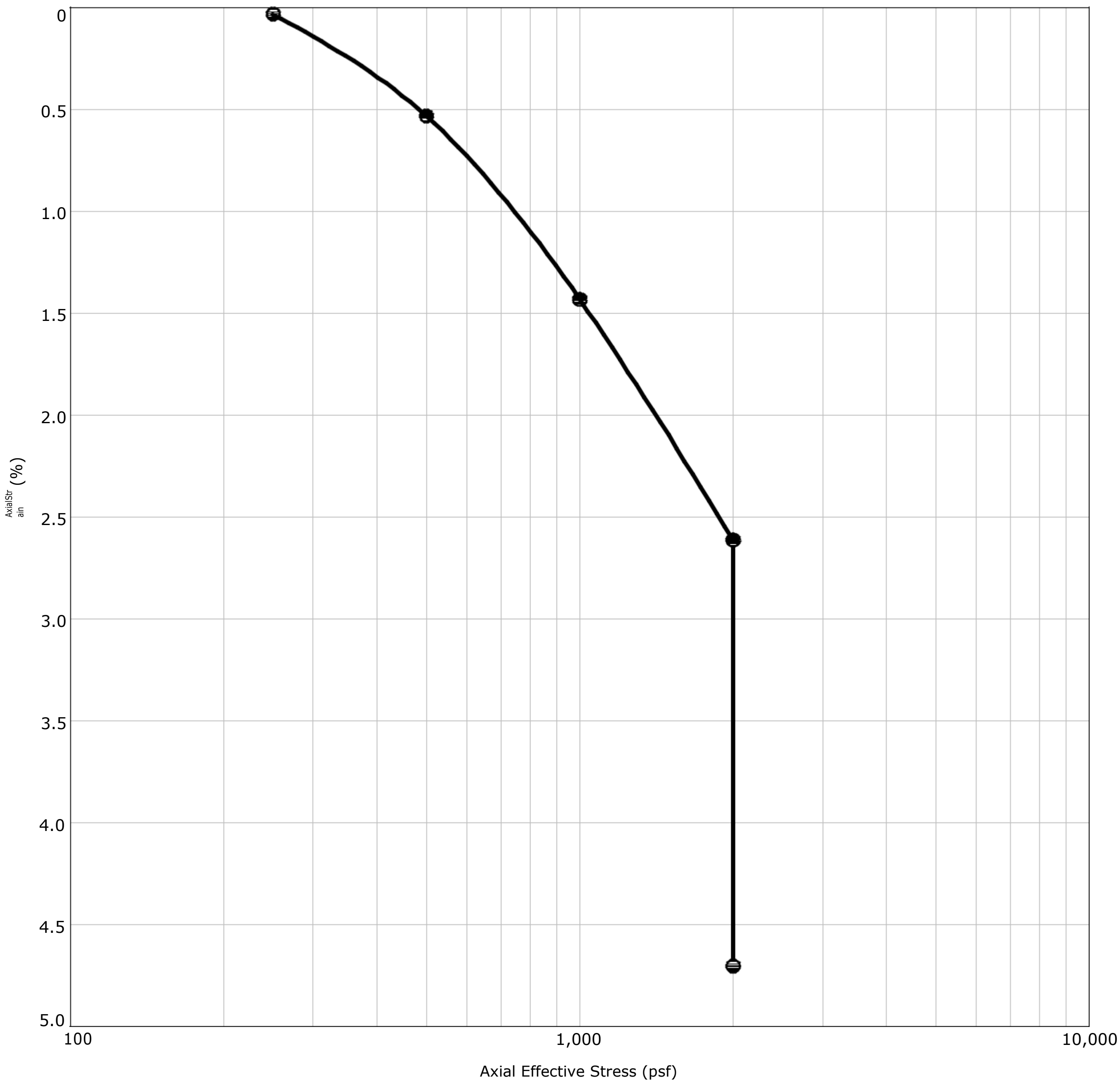
Natural Saturation (%)	Natural Moisture (%)	Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (% / log stress)	C_r (% / log stress)	Initial Void Ratio
5.8	1.5	98.7			2.65					0.675

Notes:

Terracon
700 NE 55th Ave
Portland, OR

One-Dimensional Collapse Test

D4546



Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
GS-01	0-1.5	S-1	SILTY SAND	SM	

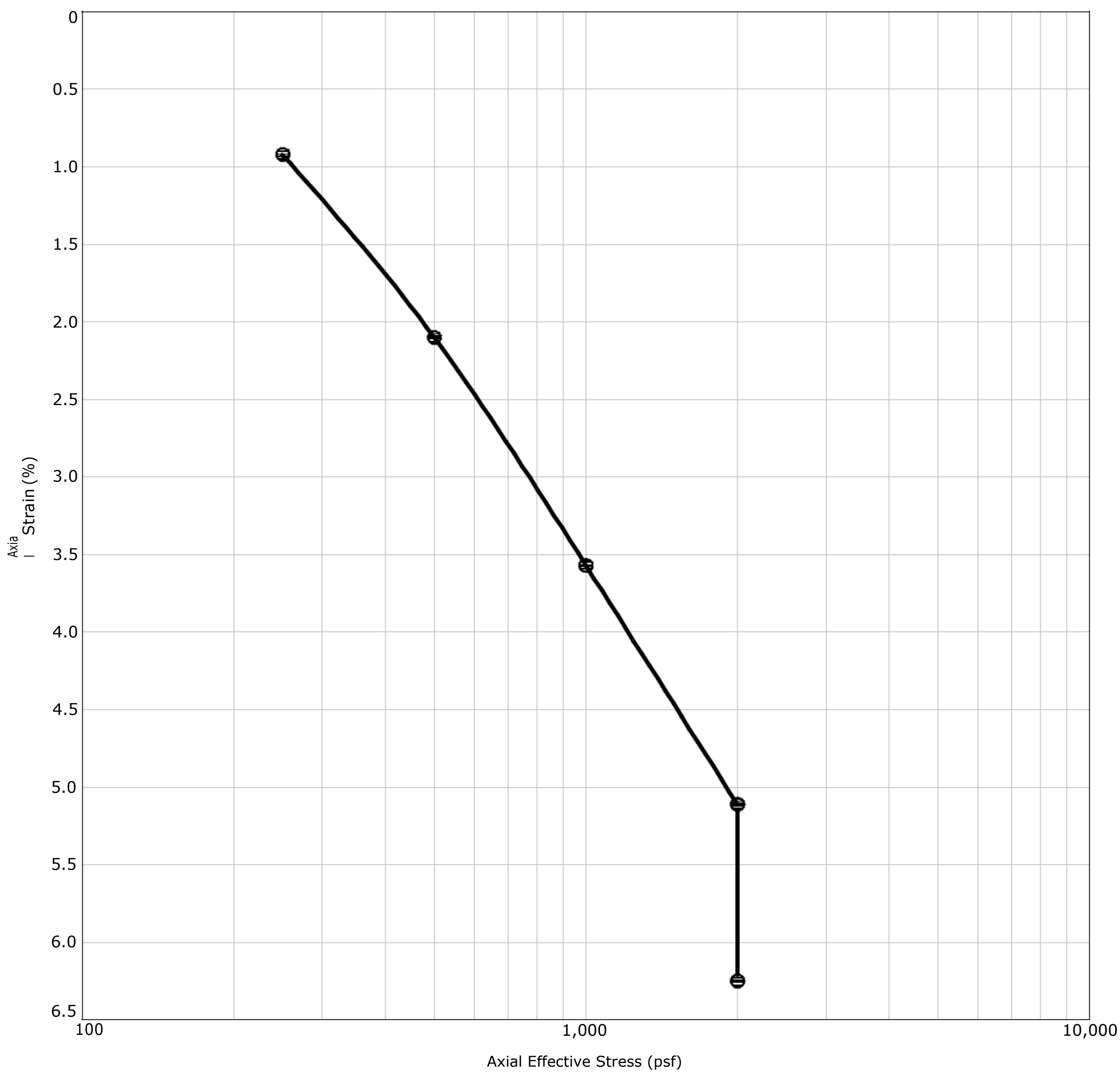
Natural Saturation (%)	Natural Moisture (%)	Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (% / log stress)	C_r (% / log stress)	Initial Void Ratio
	22.3	78.7			2.65					

Notes:

700 NE 55th Ave
Portland, OR

One-Dimensional Collapse Test

D4546



Boring ID	Depth (Ft)	Specimen #	Material Description	USCS	AASHTO
SS-01	0-1.5	S-1	POORLY GRADED SAND w/SILT	SP-SM	

Natural Saturation (%)	Natural Moisture (%)	Initial Dry Density (pcf)	LL	PI	Specific Gravity	Overburden (psf)	P_c (psf)	C_c (% / log stress)	C_r (% / log stress)	Initial Void Ratio
	5.1	82.5			2.65					

Notes:

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Client
Rowan Percheron LLC

Project
Percheron Data Center

Sample Submitted By: Terracon (82) **Date Received:** 4/6/2023 **Lab No.: 23-0218**

Results of Corrosion Analysis

Sample Number	--	--	--
Sample Location	DC-02	DC-13	DC-24
Sample Depth (ft.)	0.5-4.5	0.5-4.5	0.5-4.5
pH Analysis, ASTM G51	8.37	8.26	8.17
Water Soluble Sulfate (SO4), ASTM C 1580 (Percent %)	<0.01	0.01	<0.01
Sulfides, AWWA 4500-S D, (mg/Kg)	Nil	Nil	Nil
Chlorides, ASTM D512, (Percent %)	<0.01	<0.01	<0.01
Red-Ox, ASTM G200, (mV)	+723	+725	+728
Total Salts, AWWA 2540, (mg/Kg)	912	741	674
Saturated Minimum Resistivity, ASTM G-57, (ohm-cm)	2231	2813	2716

Analyzed By N. Campo
Nathan Campo
Engineering Technician II

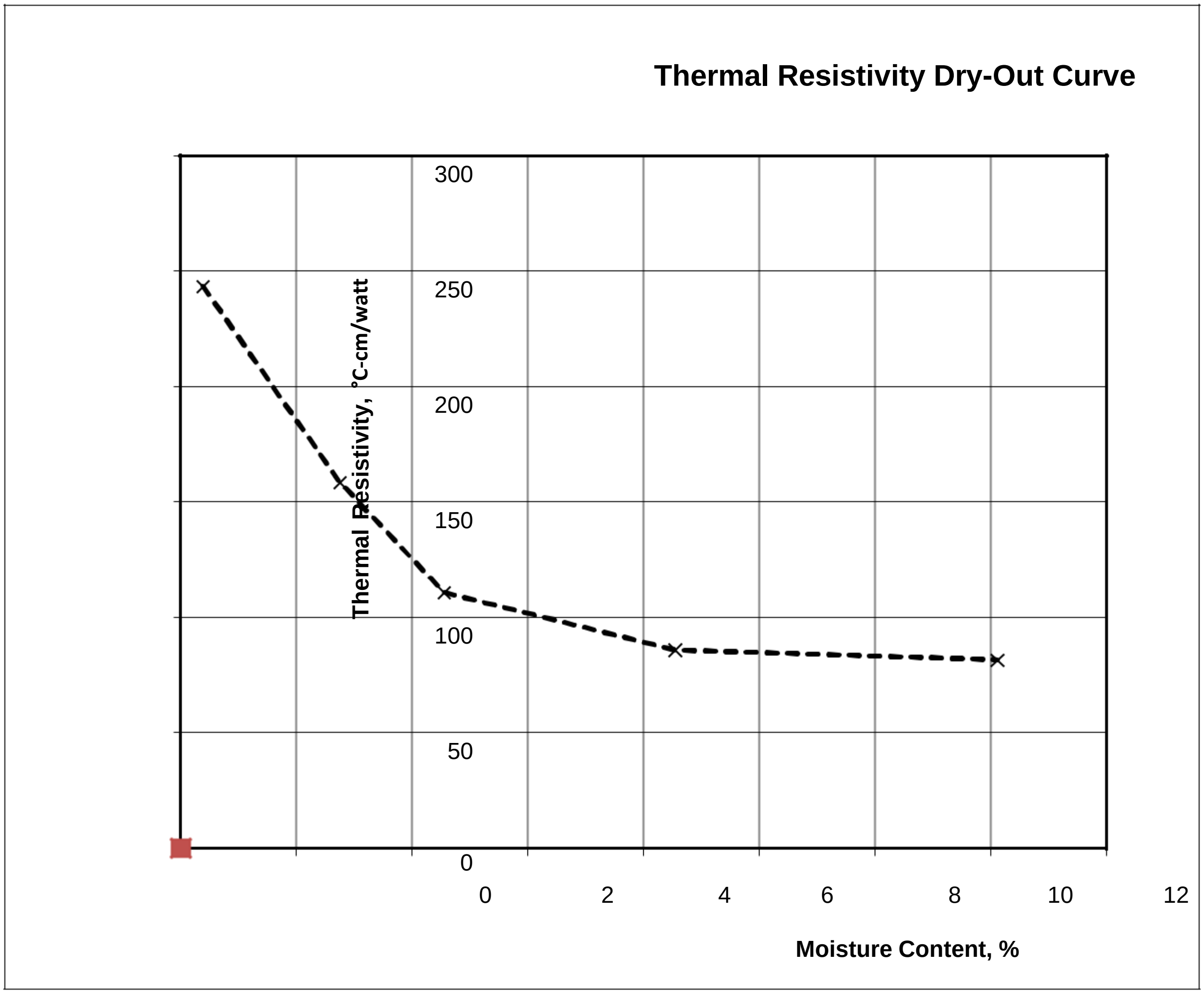
Thermal Resistivity Test Results
Percheron | Morrow County, Oregon
Test Completed: April 16, 2023 |Terracon Project No.82225118

Sample ID: DC-10, 0.5'

Soil Type: Silty Sand
Standard/Modified Proctor: ASTM D 1557-A
Max Dry Density, pcf: 118.9
Optimum Moisture Content, %: 12.6
Target % Compaction: 90
Sample Dry Density, pcf: 107
Sample % Compaction: 90
As-received Moisture Content, %:

Thermal Resistivity Test Resu

Moisture Content (%)	Thermal Resistivity (°C-cm/watt)	Tempe (°C
0.4	243	24
2.8	159	24
4.6	111	18
8.5	86	18
14.1	82	22



Thermal Resistivity Test Results

Percheron | Morrow County, Oregon

Test Completed: April 14, 2023 |Terracon Project No.82225118

Sample ID: DC-13, 0.5'

Soil Type: Silty Sand

Standard/Modified Proctor: ASTM D 1557-A

Max Dry Density, pcf: 111.1

Optimum Moisture Content, %: 12.6

Target % Compaction: 90

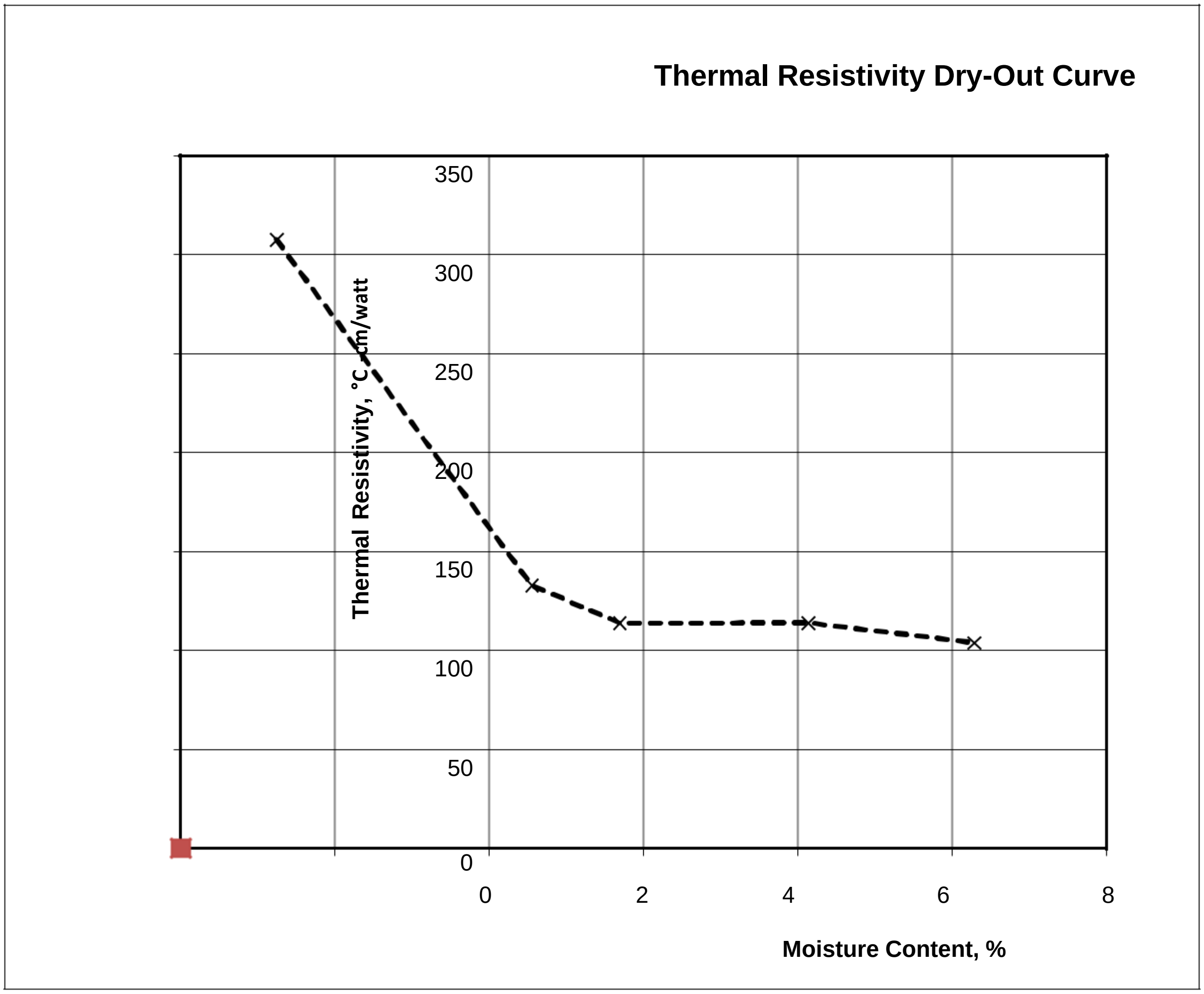
Sample Dry Density, pcf: 99

Sample % Compaction: 89

As-received Moisture Content, %:

Thermal Resistivity Test Results

Moisture Content (%)	Thermal Resistivity (°C-cm/watt)	Temper (°C
1.2	308	20
4.6	133	18
5.7	114	18
8.1	114	19
10.3	104	18



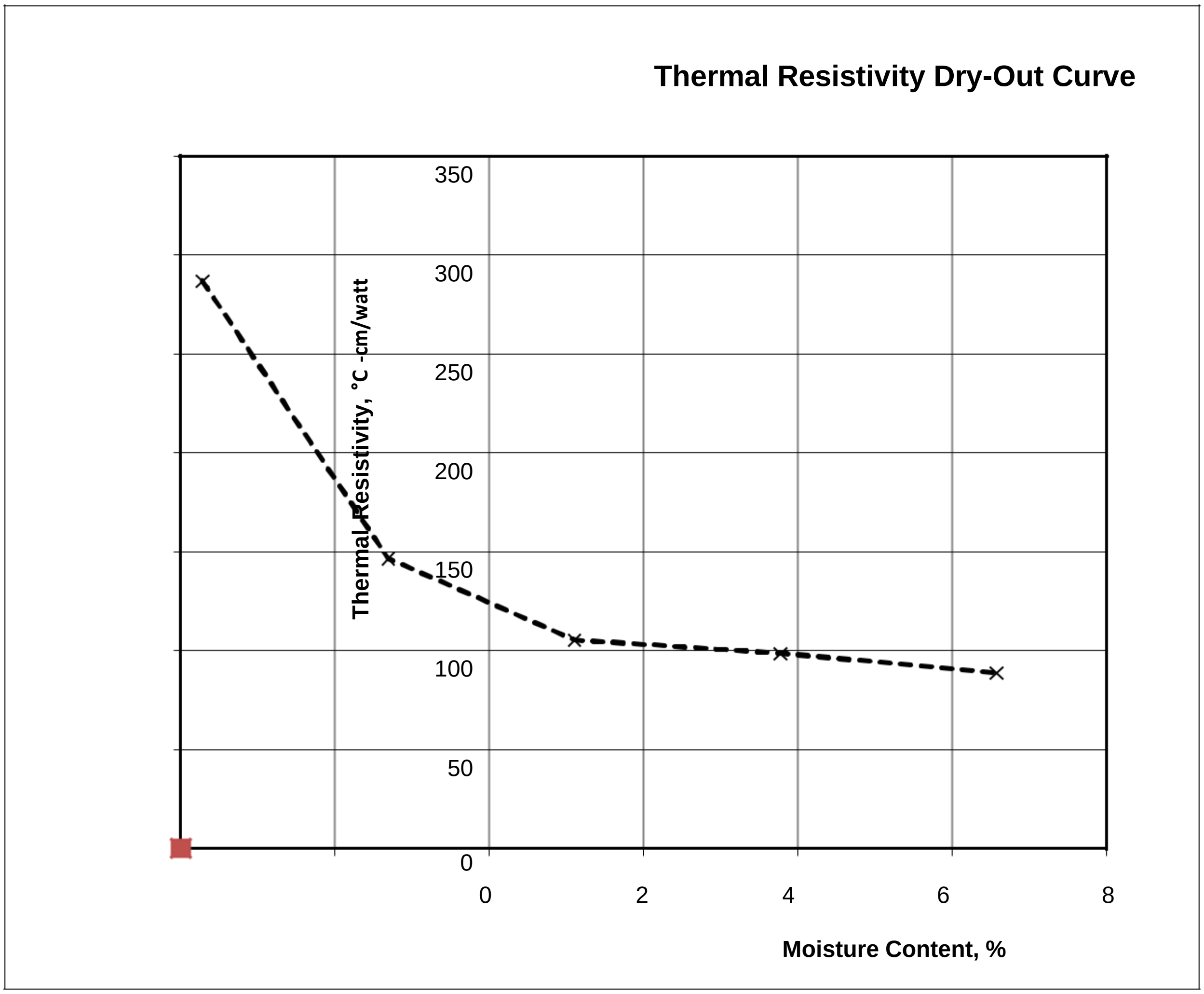
Thermal Resistivity Test Results
Percheron | Morrow County, Oregon
Test Completed: April 16, 2023 |Terracon Project No.82225118

Sample ID: DC-24, 0.5'

Soil Type: Silty Sand
Standard/Modified Proctor: ASTM D 1557-A
Max Dry Density, pcf: 119.5
Optimum Moisture Content, %: 12.6
Target % Compaction: 90
Sample Dry Density, pcf: 108
Sample % Compaction: 90
As-received Moisture Content, %:

Thermal Resistivity Test Results

Moisture Content (%)	Thermal Resistivity (°C-cm/watt)	Tempe (°C
0.3	287	23
2.7	147	18
5.1	105	18
7.8	98	18
10.6	89	23



Thermal Resistivity Test Results

Percheron | Morrow County, Oregon

Test Completed: April 16, 2023 |Terracon Project No.82225118

Sample ID: TP-1, 0.5'

Soil Type: Silty Sand

Standard/Modified Proctor: ASTM D 1557-A

Max Dry Density, pcf: 110.6

Optimum Moisture Content, %: 12.6

Target % Compaction: 90

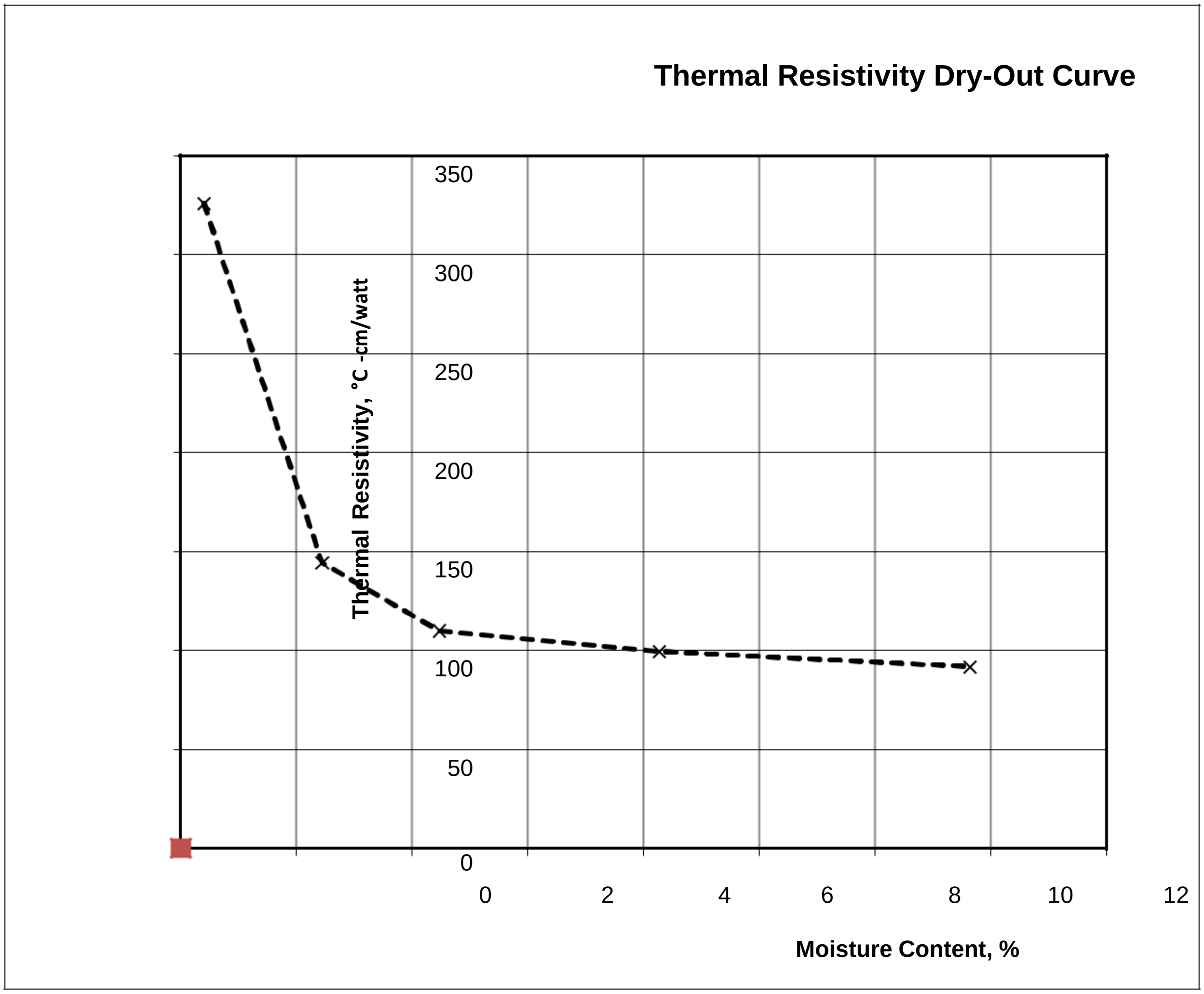
Sample Dry Density, pcf: 100

Sample % Compaction: 90

As-received Moisture Content, %:

Thermal Resistivity Test Resu

Moisture Content (%)	Thermal Resistivity (°C-cm/watt)	Temper (°C
0.4	326	24
2.4	144	18
4.5	110	19
8.3	99	18
13.6	92	23

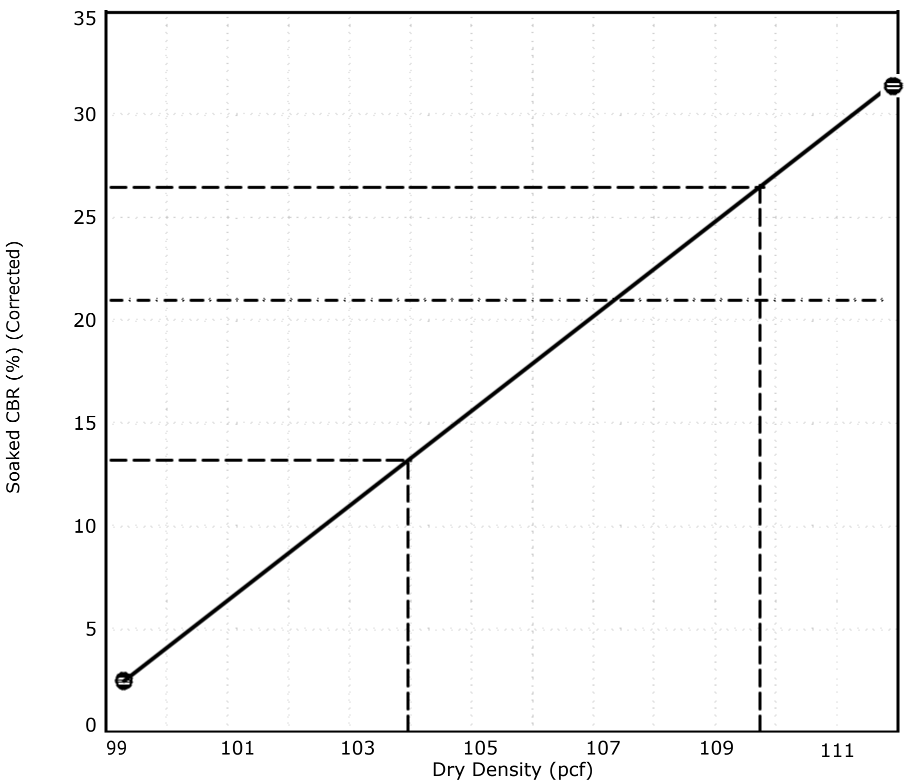


Percheron Data Center
Tower Road | Morrow, OR
Terracon Project No. 82225118

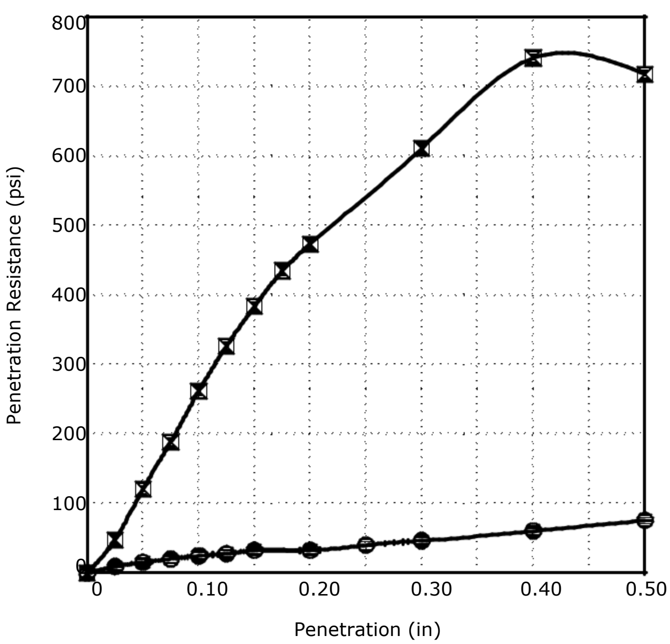
700 NE 55th Ave
Portland, OR

California Bearing Ratio

ASTM D1883-07[2]



Source of Material	TP-05 0.5		
Description of Material	SILTY SAND		
Percent Fines			
Atterberg Limits	LL	PL	PI
Remarks:			



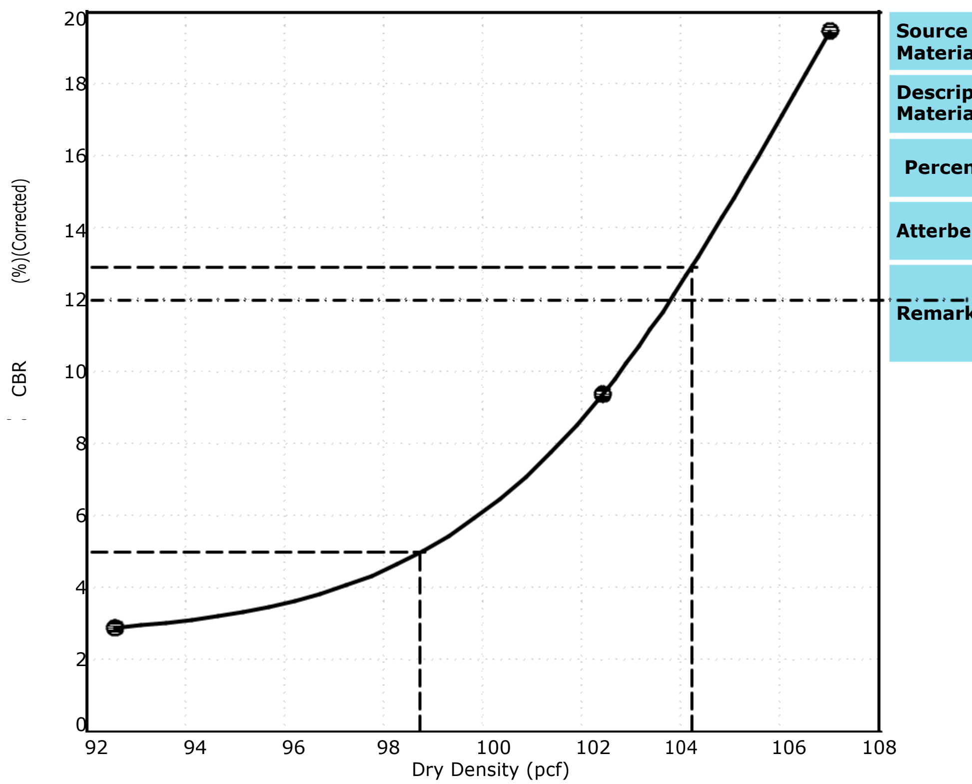
Sample No.	**1**	**3**
Sample Condition	Soaked	
Compaction Method	ASTM D1557A	
Maximum Dry Density, (pcf)	115.5	115.5
Optimum Moisture Content, (%)	10.8	10.8
Dry Density before Soaking, (pcf)	99.28	111.95
Moisture Content, (%)		
After Compaction	11.5	11.7
Top 1" After Soaking	18.5	14.3
Surcharge, (lbs)	10.00	10.00
Swell, (%)	-1.35	-3.39
Bearing Ratio, (%)	2.2	31.5

Dry Density @ 90%	104.0	pcf	CBR @ 90% Density	13.2
Dry Density @ 95%	109.7	pcf	CBR @ 95% Density	26.5
Dry Density @ 100%	115.5	pcf	CBR @ 100% Density	

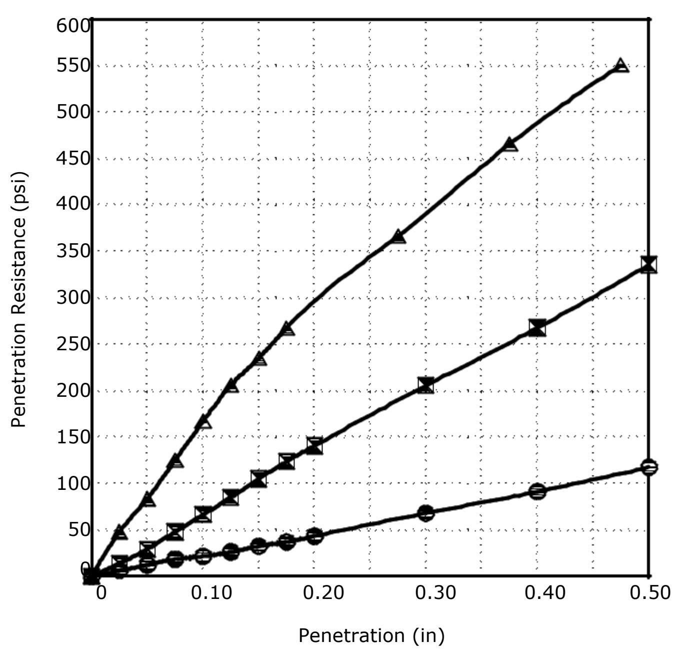
700 NE 55th Ave
Portland, OR

California Bearing Ratio

ASTM D1883-07[2]



Source of Material	TP-10 0.5
Description of Material	SILTY SAND
Percent Fines	
Atterberg Limits	LL PL PI
Remarks:	



Sample No.	1	2	3
Sample Condition		Soaked	
Compaction Method		ASTM D1557A	
Maximum Dry Density, (pcf)	109.7	109.7	109.7
Optimum Moisture Content, (%)	13.7	13.7	13.7
Dry Density before Soaking, (pcf)	92.56	102.41	107.01
Moisture Content, (%)			
After Compaction	14	14.1	13.5
Top 1" After Soaking	19.8	17.2	15.5
Surcharge, (lbs)	10.00	10.00	10.00
Swell, (%)	-0.61	-1.13	-1.44
Bearing Ratio, (%)	2.9	9.4	19.5

Dry Density @ 90%	98.7	pcf	CBR @ 90% Density	5.0
Dry Density @ 95%	104.2	pcf	CBR @ 95% Density	12.9
Dry Density @ 100%	109.7	pcf	CBR @ 100% Density	

ASTM D7012-14e - Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
Project 82225118
Portland, OR (Office 82)

Boring	Depth	Diameter (in)	Length, Pre-Trim (in)	Length, Post-Trim (in)	Mass, Post-Trim (g)	Length/Dia. Ratio	Area (in^2)	Volume (ft^3)	Density (pcf)	Max Load (lbs)	UCS* (psi)	UCS (Mpa)	Time to Failure (mm:ss)
DC-9	12.3-17.3	2.4	5.4	4.17	797	1.77	4.37	0.0106	166.3	53,475	**12,225**	84	4:13
DC-21	9.0-12.0	2.4	13.6	4.69	937	1.99	4.37	0.0119	174.0	98,135	**22,435**	155	5:18

Prepped by: Derek Powlison
Tested by: Derek Powlison
Received on:
Prepped on: 4/11/2023
Tested on: 4/13/2023

Lithographic Description: Basalt
Formation Name: Columbia River Basalt
Load Direction: Vertically As Cored
Moisture Condition at Test: Surface Dry

Compression Machine ID: C-56450
Fracture Type: Columnar (All)
Sub-Method: C - Uniaxial Comp. Strength

*UCS = Unconfined Compressive Strength

Terracon

Supporting Information

Contents:

Note: All attachments are one page unless noted above.

Terracon
700 NE 55th Ave
Portland, OR

General Notes

Sampling

- Auger Cuttings
- Rock Core
- Grab Sample
- Shelby Tube
- Standard Penetration Test

Water Level

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time
- Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8-15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

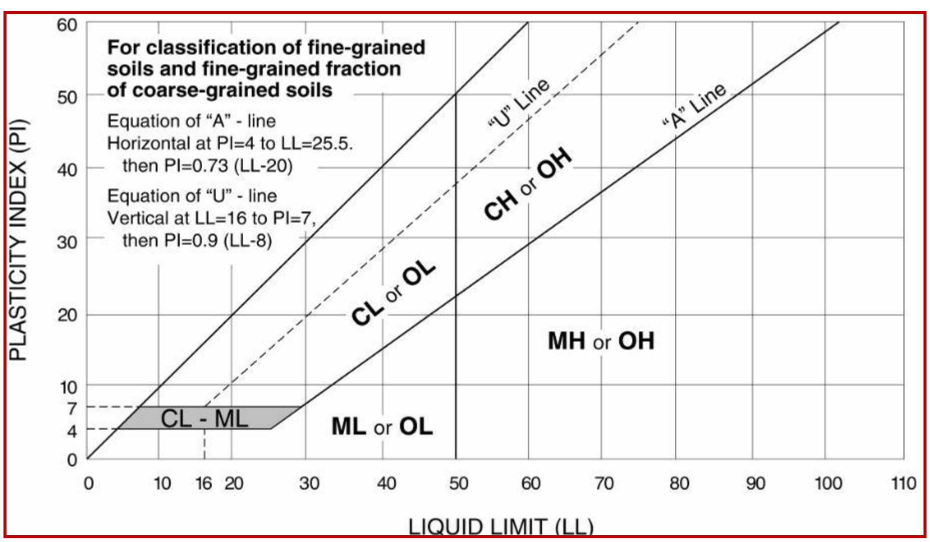
Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	**Group Name** [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	———	OL	Organic clay [K, L, M, N] Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	———	OH	Organic clay [K, L, M, P] Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name .
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



Rock Classification Notes

WEATHERING	
Term	**Description**
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi**
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Intensely fractured	< 2.5 inches	**Laminated**	< ½-inch
Highly fractured	2.5 – 8 inches	**Very thin**	½ – 2 inches
Moderately fractured	8 inches to 2 feet	**Thin**	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	**Medium**	1 – 3 feet
Very slightly fractured	> 6.5 feet	**Thick**	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0-25
Poor	25–50
Fair	50–75
Good	75–90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.