Seismic Vulnerability Assessment

Owens Corning
Trumball Asphalt Plant

11910 NW St. Helens Road
Portland, OR 97231

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Norwest Engineering, Inc.
4110 NE 122nd Avenue, Suite 207
Portland, OR 97230
(503) 254-0110

TABLE OF CONTENTS

SECTION PAGE NO.

SECTION 6: Appendices

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Date: 05/31/2024

54567
MICHAEL J. SMITH
JULY 9, 2001

Expires: 06/23/2024

Printed Name: Michael J. Smith, PE

Discipline: Structural & Civil Engineering

Licensing Agency: State of Oregon

97882PE
DANIEL CORDER SIMPSON
JAN 11, 2022

Expires: 06/30/2024

Printed Name: Daniel Simpson, PE

Discipline: Geotechnical Engineering

Licensing Agency: State of Oregon

ERRATA SHEET FOR NORWEST ENGINEERING SEISMIC VULNERABILITY ASSESSMENT

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SEISMIC VULNERABILITY ASSESSMENT

SECTION 1: Seismic Vulnerability Assessment

1.1 Facility Overview

The Owens Corning Trumbull Plant in Linnton Oregon receives asphaltic petroleum fractions and processes them to produce modified asphalt binders. These asphalt binders have a variety of uses including asphalt pavement, the manufacture of fiberglass composite shingles, binders for built-up roofing, and binders for sealing pavement and other waterproofing applications.

Asphalt is delivered by rail and offloaded then stored in the tank farm. The facility does not refine asphalt; processing is limited to modifying asphalt to meet client specifications. Asphalt is loaded onto trucks for local distribution. The remainder of the site is used as storage and distribution of finished palleted shingle products.

1.2 Background

Per the State, a Cascadia Subduction Zone earthquake impacting the large capacity fuel handling facilities in Oregon could create widespread environmental damage, fires, endanger health and safety of surrounding communities and place impossible demands on the state's emergency response capabilities. The purpose of this act is to protect public health, life safety and environmental safety against fires and release of fuel products from large fuel storage facilities.

Oregon Laws 2022 Chapter 99 addresses the Oregon Resilience Plan written by the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) issued February 2013 and the Oregon Fuel Action Plan written by the Oregon Department of Energy (ODOE) issued October 2017. The two plans bring the recovery of basic infrastructure from a Cascadia earthquake event into sharp relief: The projected recovery for inland areas is expected to require up to 3 months. The projected recovery for coastal areas is expected to exceed 3 to 6 months.

Continued operation of existing fuel unloading and distribution terminals in Oregon will be essential in the recovery effort. Liquid fuels (gasoline, diesel, and jet fuel) will be a critical part of the recovery process ranging from fueling emergency and public safety vehicles to construction equipment required for restoration of transportation and utilities. Liquid fuels will need to be sourced from outside of the Cascadia impact areas. but there needs to be functioning local distribution terminals (with unloading and loading capabilities) to receive and distribute that fuel.

Based on the above, it is important to note that **this facility does not meet the intent of Oregon Resilience Plan nor the Oregon Fuel Action Plan and is not an essential facility for energy supporting emergency efforts.** An appeal for exemption from the Tank Seismic Stability Rules is discussed in Section 5.1.4 of this report.

1.3 Oregon Laws 2022 Chapter 99

The 2022 Oregon legislature adopted Senate Bill 1567 enacted as Chapter 99 of Oregon Laws 2022. The law authorizes the Oregon Department of Environmental Quality (ODEQ) to adopt requirements for Seismic Vulnerability Assessments (SVA) and the Risk Mitigation Implementation Plans (RMIP) for large capacity bulk fuels terminals in Columbia, Lane, and Multnomah counties.

Oregon Department of Environmental Quality (ODEQ) requires a Seismic Vulnerability Assessment (SVA) be submitted to the ODEQ by June 1, 2024. Within 180 days following ODEQ acceptance of the SVA, a facility-wide Seismic Risk Mitigation Implementation Plan must be submitted to the ODEQ.

The law applies to owners and operators of bulk fuel terminals or industrial facilities in Oregon with at least 2-million-gallon oil or liquid fuel products storage capacity. It is important to note that **asphalt is not a liquid fuel** and cannot be used as such.

1.4 The Oregon Resilience Plan

A Cascadia earthquake and tsunami will affect both Oregon and Washington. A particular vulnerability is Oregon’s liquid fuel supply. Oregon depends primarily on liquid fuels transported into the state by pipeline and barges from Washington state refineries. Both states share common challenges, among them the interstate bridges and the Columbia River navigation channel as well as the regional power grid and liquid fuel supply. Once here, fuels are stored temporarily at Oregon’s critical energy infrastructure hub, a six-mile stretch of the lower Willamette River where industrial facilities occupy liquefiable riverside soils. Disrupting the transportation, storage, and distribution of liquid fuels would rapidly disrupt most, if not all, sectors of the economy critical to emergency response and economic recovery.

1.5 Oregon Fuel Action Plan

As a result of a Cascadia earthquake Oregon can expect to lose most of the normal incoming supply of fuel. The Oregon Department of Geology and Mineral Industries (DOGAMI) 2013 Seismic Study found that the region’s refineries and petroleum distribution terminals are expected to sustain moderate to significant damage. Existing facilities will have tank farm failures, marine dock failures, pipeline system breaks, hazardous material spills, fires, and structural damages onsite. Restoring the region’s petroleum infrastructure will likely take months if not longer. In addition, the Olympic Pipeline that transports most of the gasoline, diesel, and jet fuel used in Oregon from refineries in Washington state is projected to be disabled for an extended period.

It is estimated that the existing petroleum terminals currently average a one-week fuel inventory at normal rates of consumption. So even if the terminals remain capable of distribution, they must also be capable of unloading product via barge and/or ship deliveries and/or tanker truck and/or rail car deliveries.

SECTION 2: Tank Seismic Stability Rules

2.1 Summary of the Rules

The owners and operators of bulk fuel terminals or industrial facilities with at least 2-million-gallon liquid fuel products storage capacity located in Columbia, Multnomah and Lane counties must provide a facility wide Seismic Vulnerability Assessment to ODEQ. The Oregon Department of Environmental Quality (ODEQ) Chapter 340 Division 300 Fuel Tank Seismic Stability provides the process criteria for the SVA. As noted in Section 1.3 above, **asphalt is not a fuel** and thus the inclusion for facilities subjected of the Rules should not apply to this facility.

2.2 Seismic Vulnerability Assessment (SVA)

The owners and operators of bulk fuel terminals or industrial facilities must:

(A) Prepare and submit to Oregon Department of Environmental Quality (DEQ) a facility-wide Seismic Vulnerability Assessment (SVA) by June 1, 2024.

(B) Be conducted and verified by an Assessment Team of qualified professionals.

(C) Evaluate the existing site structures and facilities potential to maintain safe operating conditions, or safe shutdown procedures, to protect public health, life safety and environmental safety against releases of oils or liquid fuel products, including information about operational procedures during disasters.

(D) Describe each facility component including fuel stored or handled, maximum and minimum storage volume, type of construction, age, inspection records, (if applicable), routine maintenance performed and when, and current normal operation.

(E) Summarize currently implemented spill prevention and mitigation measures and their ability to achieve the performance objective defined in 340-300-0002;

(F) Develop the Design Level Earthquake for the site in accordance with ASCE 7.

2.3 SVA Implementation

The SVA shall use the Codes and Standards as defined by OAR 340-300-0002(4) and the Design Level Earthquake determined using ASCE 7 to evaluate the potential for a spill greater than the Maximum Allowable Uncontained Spill during or after the Design Level Earthquake of all components including:

(A) Existing buildings, structures, and ancillary components.

(B) Tanks, pipes, and piping systems.

(C) Spill containment measures and structures.

(D) Transloading facilities, including wharves, berths, piers, moorings and retaining structures; railcar unloading racks, and pipeline connections.

(E) Truck Loading racks.

(F) Control equipment; and

(G) Any other structures related to or supporting facilities part of the bulk fuel terminal.

(H) Evaluate soil's vulnerability to liquefaction, lateral spreading, and seismic-induced settlement.

(I) Evaluate the safety of operating conditions, safe shutdown procedures, and potential spills.

(J) Evaluate the availability and integrity of automated fire suppression systems and sufficient supplies of firewater and firefighting foam and other emergency response equipment located in seismically resilient locations that will be accessible after an earthquake or secondary effects to mitigate the risk of fire and explosions following an earthquake.

(K) Evaluate the integrity of fire control measures such as firewalls surrounding the facility to limit fire spreading into surrounding communities; and

(L) Evaluate the availability of day and night onsite personnel trained in emergency response and able to respond in the event of an earthquake.

(M) Facility owner or operator must submit subsequent Seismic Vulnerability Assessment updates to DEQ.

2.4 Seismic Risk Mitigation Implementation Plan (SRMIP)

A seismic risk mitigation implementation plan must, at a minimum, identify actions, with timelines, to protect public health, life safety and environmental safety within the facility, in areas adjacent to the facility, and in other areas that may be affected because of damages to the facility. The Oregon Department of Environmental Quality (ODEQ) Chapter 340 Division 300 Fuel Tank Seismic Stability provides the process criteria for the SRMIP.

The SRMIP, as a risk-based assessment, must include consideration of the likelihood of a magnitude 9.0 Cascadia Subduction Zone earthquake or other seismic event that exceeds the impact of the Cascadia event, the potential consequences of that event and the resources needed to respond to that event.

Following acceptance of the SVA by the DEQ, the owners and operators of the regulated facilities shall prepare and submit to DEQ the facility-wide Seismic Risk Mitigation Implementation Plan (SRMIP) within 180 days which is designed to:

(A) Mitigate earthquake-induced damage to reduce the potential of fuel spills and fires.

(B) Address potential of facility to safely shut down during or immediately after a damaging earthquake, if needed, to minimize spills (as required by the performance objective defined in 340-300-0002). Performance criteria must conform with the building codes in effect on September 1, 2023 as defined by OAR and may be based on the probabilistic or deterministic analysis or on an alternative analysis proposed by facility owner for DEQ's approval.

(C) Provide risk mitigation measures implementation plans and timeline; and

(D) Provide periodic reports of the ongoing implementation of mitigation measures.

(E) Implement the risk minimization measures described in Risk Mitigation Implementation Plans when approved by DEQ within the approved timeline.

(F) Prepare and submit to DEQ post-implementation reports documenting completion of mitigation work and addressing residual risks.

(G) The Risk Mitigation Implementation Plan must outline interim mitigation actions that will be completed within 1, 3, & 5 years based on feasibility and order of importance.

(H) All mitigation measures approved by DEQ must be completed within 10 years after the DEQ approves the Risk Mitigation Implementation Plan.

(I) Annual Risk Mitigation Implementation Plan implementation status reports must be submitted by June 1st of each year, or on a schedule approved by DEQ in the Risk Mitigation Implementation Plan.

SECTION 3: Basis for Rules Development

The Environmental Quality Commission, in consultation with the State Department of Geology and Mineral Industries, shall adopt by rule a seismic risk mitigation implementation program for bulk oils or liquid fuels terminals that is based on risk. To the extent feasible and appropriate, the program adopted under this section shall be consistent and coordinated with the program established under ORS 468B.345 to 468B.415. Rules adopted under this section shall include, but not be limited to:

2 (a) Rules for the required content of seismic risk mitigation implementation plans and rules for approval by the Department of Environmental Quality of seismic risk mitigation implementation plans.

2 (b) Provisions for training, response exercises, external peer reviews, inspections, and tests to verify the ability of the facility to sustain safe conditions and respond to uncontrolled releases of hazardous materials from the bulk oils or liquid fuels terminal due to an earthquake.

2 (c) Requirements to minimize harmful impacts to local communities and natural resources due to uncontrolled releases of hazardous materials from the bulk oils or liquid fuels terminal due to an earthquake and its associated direct and indirect impacts, including fires and flooding.

2 (d) Requirements for the inspection of bulk storage tanks at bulk oils or liquid fuels terminals.

2 (e) Design and construction standards for new bulk storage tanks constructed at bulk oils or liquid fuels terminals.

2 (f) Design and construction standards for seismic mitigation of existing bulk storage tanks, piping and related structures constructed at bulk oils or liquid fuels terminals.

2 (g) Provisions requiring the proper installation of seismically certified generators to power critical operations, or at a minimum, the installation of electrical hookups for emergency generators.

2 (h) Provisions for the review of seismic vulnerability assessments required under section 2 of this 2022 Act and seismic risk mitigation implementation plans required under subsection (1) of this section by state agencies with expertise in earthquake hazards, risk mitigation or emergency preparedness or management.

2 (i) Provisions requiring the owner or operator of a bulk oils or liquid fuels terminal to submit seismic vulnerability mitigation implementation plan updates to the department:

(A) According to a schedule established by the commission.

(B) Upon the retrofit or reconstruction of all or a part of a bulk oils or liquid fuels terminal; and

(C) Based on new scientific or technical findings, but no more frequently than once every three years.

2 (j) Provisions establishing a fee calculated to cover the costs to the department of reviewing seismic risk mitigation implementation plans submitted under this section and seismic risk assessments submitted under section 2 of this 2022 Act, less any federal funds received by the department for those purposes. Fees received by the department under this paragraph shall be deposited in the Seismic Risk Mitigation Fund established under section 6 of this 2022 Act.

2 (k) Provisions establishing grants or other financial assistance to owners or operators of bulk oils or liquid fuels terminals for improvements to existing infrastructure, provided that federal funds are made available to the department for that purpose.

SECTION 4: Assessment Methods and Approach

4.1 Summary of Evaluation Methods

4.1.1 Geotechnical

Sage's geotechnical evaluation included:

- An assessment of site conditions, including the geotechnical properties of subsurface soil and groundwater.

- A seismic hazard evaluation. Strong ground motion hazards were defined in accordance with the response spectrum in the American Society of Civil Engineers' (ASCE) *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (2017). Soil liquefaction and potential liquefaction effects were evaluated in accordance with guidelines established by the National Academies of Sciences, Engineering, and Medicine (2021).
- A geotechnical evaluation in which the results of the site-condition assessment and seismic hazard evaluation were combined to estimate the effects that earthquakes could have on site soils and foundations.

Most of the infrastructure was constructed prior to the codification of contemporary seismic design standards; as such, even moderate lateral spreading could result in an exceedance of the performance threshold specified in Oregon Administrative Rule (OAR) 340-300. To account for this, Sage established an idealized site condition or geotechnical profile that could be used to assess seismic hazards (mainly, lateral spreading and liquefaction-induced settlement) and the horizontal extent of the site likely to be affected by significant lateral spreading.

4.1.2 Structural

Norwest conducted an on-site visual structural assessment of the facility to identify items which may be vulnerable in a design seismic event. The assessment was conducted by a team of licensed professional engineers. Efforts were focused on facility components including tanks, piping supports, loading facilities, containment structures, building structures, and other equipment identified as in-service and potentially impactful to the transportation of bulk oil or liquid fuels.

Our seismic performance expectations outlined below have been produced with consideration of sitewide liquefaction potential, as identified in the geotechnical evaluation. Some items identified as low risk in a design seismic event may be subject to additional lateral displacement, settlement, or residual stresses in a liquefaction or lateral spreading event. As indicated above, potentially liquefiable soil is present at the site, but risk to specific items should be evaluated on a case-by-case basis.

Additionally, a distinction should be made between facility components which transport or hold asphalt, and components which transport or hold oil and fuel. While some items which transport or hold asphalt may be at risk of spill in a design seismic event, the spill of asphalt material does not have the same environmental implications as a spill of oil or fuel. In a spill scenario, asphalt will harden and become viscous at ambient temperature. This process helps mitigate contamination of the environment or adjacent properties, aid in cleaning of a spill, and differentiates an asphalt spill from an oil or fuel spill.

4.1.3 Safety/Mechanical/Fire

The safety assessment was limited to review of available documentation, drawings, reports, and procedures provided by Owens Corning. Many of the documents have been developed in accordance with Federal regulations. The information was reviewed and analyzed by a licensed professional engineer. Judgements and conclusions were drawn relative to the facility's safety of operating conditions, fire suppression systems, emergency response, and spill containment.

4.2 Facility Areas Evaluated

4.2.1 Process Area

The process area serves the truck rack, where asphalt product is loaded and shipped off site. This area contains multiple vessels and tanks, pumps, boilers, piping and conduit, and steel supports throughout this area. A small building for operations is located in this area, as well as a CMU building housing an MCC and boiler.

4.2.2 Tank Farm

The tank farm contains two large tanks and associated piping. The tank secondary containment is provided by soil embankments; the tank farm was constructed such that the tanks sit lower in elevation than the surrounding grades. A hot oil thermal system is also located in the tank farm.

4.2.3 Rail Spur

A single spur curves around the northern property, terminating adjacent to the tank farm. Multiple railcar unloading spots are located along the spur, where the railcars are unloaded from the underside of the cars. Small pumps, steam lines, and miscellaneous infrastructure supports the rail operations.

4.2.4 Marine Facility

A short pier and pier head structure is located on the river adjacent to the tank farm. It is a steel and concrete structure with two mooring/breasting dolphins and access walkways in addition to the pier/pier head. It has been out of service for some time and the service piping to/from the pier is disconnected.

4.2.5 North Warehouse Area

Two warehouses are located north of the process area. They are unoccupied structures that house materials and tools and some electrical equipment for the plant.

4.2.6 South Warehouse Area

The two-story administrative building located south of the main process area houses additional operations and administrative staff.

Two warehouses are located south of the administration building and are associated with the plant's asphalt shingle storage and distribution business. They are not associated with asphalt storage and distribution.

SECTION 5: Vulnerability Assessments

5.1 Summary of Evaluation Methods

5.1.1 Geotechnical Assessment (Site Wide)

5.1.1.1 Site Conditions Assessment

5.1.1.1.1 Site surface conditions, topography, shoreline topography.

Regional topography is depicted on Figure -1. Site topography and near-shore bathymetry are shown on Figure G-2. Readily available light detection and ranging data (DNR, accessed February 19, 2024), bathymetric surveys of the Willamette River (City of Portland, accessed February 19, 2024), and site-specific survey data were used to evaluate the topography and bathymetry of the site and the surrounding area.

The site is bordered by the Portland Hills to the west and by the Willamette River to the east. As shown on Figure G-2, the site is mostly level with 10 to 30 percent slopes near the riverbanks. The site is located approximately 20 to 30 feet (ft) above the average surface water elevation of the Willamette River. Local topographic relief includes secondary containment berms and railway embankments.

The site is surfaced with sod, soil, asphalt, and concrete. Tanks, mechanical equipment, buildings, and parking/drive aisles are present throughout the site.

5.1.1.1.2 Description of regional and site geology including soil stress history, deposition environment, and bedrock and soil units.

Geologic information for the site and the surrounding area was obtained from the Preliminary Geologic Map of the Linnton 7.5’ Quadrangle, Multnomah and Washington Counties, Oregon (Madin et al. 2008). Near-surface deposits at the site are mapped as artificial fill (af), a man-made mixture of clay, silt, sand, gravel, debris, and rubble. Alluvium (Qal) is also mapped at the site and consists of clay, silt, and sand deposited by the Willamette River during the Holocene Epoch. The alluvium is underlain by a 130-ft-thick layer of Grande Ronde Basalt (Tsgb), an extrusive, igneous rock formed by the rapid cooling of dark gray or black lava. The condition of the artificial fill and alluvium likely ranges from normally consolidated to slightly overconsolidated.

Previous site operations—plywood manufacturing facility, sawmill, and log yard/log float—likely influence the constituents of the fill soils.

5.1.1.1.3 Description of field explorations and laboratory testing.

While at Landau Associates, Inc. (Landau), Sage Principal Engineer Daniel Simpson oversaw the site subsurface investigation, which included four cone penetration test soundings (CPT-1 through CPT-4) and two mud rotary borings (B-1 and B-2). The approximate locations of the explorations are shown on Figure G-2b. Sage reviewed the site subsurface data reported by Landau (2022) when preparing this seismic vulnerability assessment (SVA). A complete copy of Landau's geotechnical engineering report is provided in Appendix G-1; exploration methods are described in Section 2.3 of the report.

Representative soil samples collected from the explorations were analyzed for grain size, plasticity, moisture content, and consolidation properties. Laboratory test methods and results are described in Appendix C of Landau's geotechnical engineering report (Appendix G-1).

5.1.1.1.4 Description of site subsurface conditions, including soil and rock units encountered, extents and properties of those units, and groundwater conditions.

Site subsurface conditions were characterized by generalizing soil with similar geotechnical behavior according to the following engineering stratigraphic units (ESUs):

ESU 1 Fill. ESU 1 consists of fill used to raise site grades. The fill observed in Landau's explorations primarily consisted of coarse-grained soils with variable wood debris and interbedded layers of wood waste.

ESU 2a Recent Alluvium. ESU 2a consists of very soft to soft, low-plasticity silt with interbeds of elastic silt.

ESU 2b Old Alluvium (loose). ESU 2b consists of loose to medium dense, silty sand to sandy silt with interbeds of low-plasticity and elastic silt.

ESU 2c Old Alluvium (dense). ESU 2c consists of medium dense to very dense, silty sand to sand with silt that may be remnants of the Troutdale Formation.

ESU 3 Basalt. ESU 3 consists of basalt. A CME-75 truck-mounted drill rig with a tricone bit was advanced approximately 1 to 3 ft into the basalt before encountering refusal.

On August 27, 2020, the groundwater elevation at the site was estimated to be approximately 10 ft below ground surface (bgs). This estimate was based on the results of pore pressure dissipation tests completed in cone penetration test soundings CPT-1 and CPT-3. Moisture content observations from borings B-1 and B-2, advanced in June 2021, indicate a site groundwater elevation of approximately 8.5 ft bgs.

A geotechnical cross section of the site is shown on Figure G-3.

5.1.1.1.5 Description of methods, analyses, assumptions, and judgments.

Analyses for the geotechnical portion of the SVA were completed in general accordance with current standards of practice and with methods described in peer-reviewed literature. The individual methods, analyses, assumptions, and judgments are described in the following sections.

5.1.1.2 Seismic Hazard Evaluation

The following were used to support the seismic hazard evaluation (see Appendix G-2):

- Site class determination (G-2-1).
- Building code seismic design parameters for the site (G-2-2).
- The U.S. Geological Survey (USGS) seismic hazard disaggregation for the site (G-2-3).
- Liquefaction and residual strength calculations (G-2-4).
- Empirical lateral spreading calculations (G-2-5).
- Seismic bearing capacity calculations (G-2-6).

5.1.1.2.1 Description of seismic hazards at the site, including seismic evaluation criteria (expected ground shaking), liquefaction, settlement, surface effects, loss of strength, lateral spread, and slope stability as appropriate.

Sage used the USGS 2014 National Seismic Hazard Model (v4.2.0) to review the peak ground acceleration (PGA) seismic hazard disaggregation for the site with a seismic site class of D. Based on this review, approximately 55 percent of the seismic hazard at the site stems from an interface rupture along the Cascadia subduction zone. The nearby Portland Hills fault constitutes approximately 9 percent of the seismic hazard at the stie. The remaining hazard stems from other finite fault sources, random crustal events, and random deep intra-slab events. The mean moment magnitude from the PGA disaggregation, reproduced in Table G-1, was selected for liquefaction and lateral spreading analyses.

Table G-1. Seismic Parameters for Liquefaction and Lateral Spreading Analyses

Parameter	Value
Moment magnitude (M_W)	7.91
Peak ground acceleration (PGA_M)	0.486 g

g = force of gravity

Seismic evaluation criteria (expected ground shaking) were determined in accordance with *ASCE 7,* per OAR 340-300-0002(4)(a):

- The seismic site classification was determined using the shear wave velocity (Vs) measurements collected from cone penetration test sounding CPT-1 and the estimated shear wave velocities for soil and rock layers between CPT refusal (81 ft bgs) and 100 ft bgs. The Vs for the soil layers between CPT refusal and the bottom of ESU 2c was correlated with the standard penetration test N-value from the adjacent mud rotary boring (Wair et al. 2012). The Vs for the basalt layer between the bottom of ESU 2c and 100 ft bgs was determined by reviewing the Vs for similar materials in Sowers and Boyd (2019). The Vs,30 calculation is presented in Appendix G-2.

- Based on Vs,30 the site classifies as a seismic Site Class D; however, the presence of liquefiable soils results in modification to a seismic Site Class F. Per ASCE 7-16 and the 2022 Oregon Structural Specialty Code (hereafter, 2022 OSSC): For structures with a fundamental period of vibration of 0.5 seconds or less, a design response spectrum corresponding to the non-liquefied site class may be used where the presence of liquefiable soils would otherwise result in a Site Class F. For structures with a longer fundamental period of vibration, a site response analysis is required to determine the design response spectrum. The minimum response spectrum allowed at this site, following a seismic site response analysis, is 80 percent of the Site Class D response spectrum. Because this is a screening-level study, potentially vulnerable structures should be assessed using the Site Class D response spectrum, even if they have a fundamental period of vibration longer than 0.5 seconds. Additional analysis (e.g., a site response analysis) may be required if potentially vulnerable structures do not exceed the performance criteria for the Site Class D response spectrum and if the structures have a fundamental period of vibration longer than 0.5 seconds.
- The parameters in Table G-2 can be used to determine the Site Class D response spectrum. Structural analyses completed with this response spectrum are subject to the requirements in the notes following Table 11.4-2 in ASCE 7-16, Supplement 3 and to the corresponding limitations on the use of the site coefficient FV.

Table G-2. Seismic Response Spectrum Parameters

S_s	F_a	S_1	F_v
0.898	1.141	0.413	1.887

F_a, F_v = acceleration (0.2-second period) and velocity (1.0-second period) site coefficients, respectively
S_s, S_1 = 0.2-second and 1.0-second period spectral accelerations, respectively

Soil liquefaction hazards, including liquefaction-induced settlement, soil strength loss, and lateral spreading/flow failure, are also present at the site.

5.1.1.2.2 Liquefaction/lateral spreading

Sage used the following methods to complete liquefaction and lateral spreading analyses:

- **Liquefaction susceptibility** (i.e., whether soil will behave like sand or clay during dynamic loading) was determined in accordance with Boulanger and Idriss (2006) where Atterberg limits were available and with Robertson and Wride (1998) where CPT data were available. A soil behavior index of I_c = 3.0 was used as the cutoff for non-liquefiable soil (i.e., I_c >= 3.0 is not susceptible to liquefaction).

- **Liquefaction triggering potential** (i.e., whether the earthquake cyclic stress ratio would exceed the cyclic resistance ratio of soil) was calculated in accordance with the procedure established by Boulanger and Idriss (2014). The calculations (Appendix G-2) were completed using 1) cone penetration test data and CLiq software, version 3.5.2.22 (Geologismiki 2024), and 2) standard penetration test data and a Microsoft Excel spreadsheet. A groundwater elevation of 8 ft bgs was selected for the liquefaction triggering analysis, and soil layers above groundwater were assumed to be non-liquefiable.
- **Liquefaction/seismic strength loss:** Liquefied soil residual shear strength was computed using the procedure established by Boulanger and Idriss (2008), with void redistribution assumed to be significant. The seismic shear strength of non-liquefiable soils with triggering potential was taken as the static strength reduced by 15 percent (WSDOT 2022). Residual strength calculations are provided in Appendix G-2.
- **Liquefaction-induced settlement** was estimated in accordance with the procedure established by Boulanger and Idriss (2008). Settlement calculations are provided in Appendix G-2. Liquefaction-induced settlement of dry sand was omitted from the calculations, as the site is underlain by little, if any, dry sand.
- **Lateral spreading** was calculated in accordance with the procedure established by Zhang et al. (2004). Lateral spreading calculations are provided in Appendix G-2.

Based on the results of the liquefaction calculations, the cyclic stress ratio for the design-level earthquake exceeds the cyclic resistance ratio for almost all soil layers.

Sage estimates that 10 to 30 inches of liquefaction-induced total settlement could occur following a seismic event; up to 30 inches of liquefaction-induced differential settlement could occur over 50-ft spans. Estimated lateral spreading contours are shown on Figure G-2a.

5.1.1.2.3 Seismic settlement

Seismic settlement typically is caused by the reconsolidation or ejection of liquefied soils (liquefaction-induced settlement), consolidation of dry sands, or reduced seismic bearing capacity. Liquefaction-induced settlement was calculated in accordance with the procedure established by Boulanger and Idriss (2008); calculations are provided in Appendix G-2. Settlement caused by dry sand consolidation was omitted from the calculations, as the site is underlain by little, if any, dry sand.

Liquefaction-induced settlement and seismic bearing capacities are discussed in Section 5.1.1.3.

5.1.1.2.4 Slope stability

With the exception of the riverbank, the site is flat, and slope instability is not considered a seismic hazard. As noted, the riverbank and near-shore area are susceptible to flow failure.

5.1.1.2.5 Miscellany, Such as Surface Effects

The presence of seismic hazards, other than those discussed herein, is anticipated to be insignificant. No active faults are present at the site (USGS, accessed February 19, 2024).

5.1.1.3 Geotechnical Evaluation

Section 5.1.1.2 describes the methodology Sage used to evaluate seismic hazards at the site. Based on the results of its evaluation, Sage has identified the following potential hazards:

- During, or immediately after, a seismic event, a non-liquefied crust of variable thickness will be present at the site. The crust will be underlain by a laterally and vertically variable mixture of liquefied, sand-like soils and cyclically degraded, non-liquefied, clay-like soils (ESUs 2a and 2b). The sand- and clay-like soils will be underlain by a medium dense to dense, coarse-grained material that is generally not susceptible to liquefaction (ESU 2c) and a competent basalt layer (ESU 3).
- Following the onset of liquefaction, flow failure may occur within approximately 300 ft of the shoreline toe at the Willamette River. The seismic hazard transitions from flow failure to lateral spreading with distance from the shoreline; estimated lateral displacement decreases with distance from the shoreline.
- A significant percentage of the seismic hazard stems from large-magnitude sources, and seismic analysis should combine internal loading and liquefied soil conditions (WSDOT 2024), except where noted below (e.g., liquefaction downdrag loading).
- Sage made the following simplifying assumptions when completing its seismic hazard/geotechnical evaluation that lead to conservatism in estimating seismic demand:
    - When completing its lateral spreading analysis, Sage assumed that soils would strain to the maximum theoretical limit and that all soil layers strain in the same direction (Zhang et al. 2004).
    - When calculating the seismic bearing capacity, Sage assumed that all soils below the water table would reach a residual strength to vertical effective stress ratio of 0.1.

5.1.1.3.1 Seismic design parameters

Seismic design parameters are provided in Section 5.1.1.2.

5.1.1.3.2 Estimated vertical settlement

Sage estimates that 10 to 30 inches of liquefaction-induced total settlement could occur following a seismic event; up to 30 inches of liquefaction-induced differential settlement could occur over 50-ft spans. The effects of lateral spreading may increase these settlement estimates.

5.1.1.3.3 Lateral ground deformations

Flow failure is estimated to occur within approximately 300 ft of the toe of the Willamette riverbank. The flow failure zone shown on Figure G-2a was delineated by selecting areas with lateral displacements of more than 15 ft (Zhang et al. 2004).

The severity of lateral spreading is estimated to decrease with distance from the riverbank. The lateral spreading contours shown on Figure G-2a were developed in accordance with the procedure described in Section 5.1.1.2.2.

5.1.1.3.4 Foundation design parameters

5.1.1.3.4.1 Shallow Foundations

Liquefaction may affect the bearing capacity of shallow foundations wider than 4 ft or of foundations embedded more than 4 ft below grade. If seismic bearing pressures exceed those listed in Table G-3, foundations may experience a degree of settlement greater than that noted in Section 5.1.1.3.2. The values in Table G-3 include a safety factor of approximately 1.5.

Table G-3. **Seismic (liquefied soil) Shallow Foundation Allowable Bearing Capacity**

Foundation Width	4 ft	8 ft	16 ft	32 ft	64 ft	128 ft
Allowable Seismic Bearing Capacity	1.6 ksf	1.2 ksf	1.2 ksf	1.1 ksf	1.0 ksf	1.0 ksf

ft = feet
ksf = kips per square foot

5.1.1.3.4.2 Lateral Resistance of Shallow Foundations

If ground displacement occurs, shallow foundations will move laterally in accordance with the lateral spreading contours shown on Figure G-2. Lateral resistance can be provided by passive pressure and basal friction.

Basal friction can be computed with a friction coefficient of 0.4 using dead loads. Passive pressure can be estimated with an allowable equivalent fluid density of 250 pounds per cubic foot. This includes a safety factor of at least 1.5. When computing passive resistance, the 2 feet of soil should be neglected. When combining passive resistance and basal friction, the passive component should not exceed one-third of the total resistance.

References

ASCE. 2017. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures (7-16).* American Society of Civil Engineers.

Boulanger, R.W., and I.M. Idriss. 2014. “CPT and SPT Based Liquefaction Triggering Procedures.” Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California Davis. Report No. UCD/CGM-14/01. April.

City of Portland. “PortlandMaps – Open Data: Willamette River Bathymetry (2005).” Accessed February 19, 2024. Available online at: https://gis-pdx.opendata.arcgis.com/datasets/PDX::willamette-river-bathymetry-2005/about.

DNR. “Washington LIDAR Portal.” Washington Department of Natural Resources. Accessed February 19, 2024. Available online at: https://lidarportal.dnr.wa.gov/.

ICC. 2022. *2022 Oregon Structural Specialty Code.* International Code Council. October.

Landau. 2022. Geotechnical Engineering Report: Owens Corning Linnton Asphalt Terminal Final Design, 11910 Northwest St. Helens Road, Portland, Oregon. Landau Associates, Inc. January 13.

Madin, I.P., L. Ma, and C.A. Niewendorp. 2008. *Preliminary Geologic Map of the Linnton 7.5' Quadrangle, Multnomah and Washington Counties, Oregon.* State of Oregon, Department of Geology and Mineral Industries.

National Academies of Sciences, Engineering, and Medicine. 2021. State of the Art and Practice in the Assessment of Earthquake-Induced Soil Liquefaction and Its Consequences. Washington DC: The National Academies Press.

Oregon Secretary of State. Oregon Administrative Rules. Chapter 340 – Department of Environmental Quality. Division 300 – Fuel Tank Seismic Stability.

Robertson, P.K., and C.E. Wride. 1998. “Evaluating Cyclic Liquefaction Potential Using the Cone Penetration Test.” *Canadian Geotechnical Journal.* 35.3:442–459.

Sowers, T., and O.S Boyd. 2019. “Petrologic and Mineral Physics Database for Use with the U.S. Geological Survey National Crustal Model.” Open-File Report 2019-1035. U.S. Geological Survey.

USGS. 2018. “Additional Period and Site Class Maps for the 2014 National Seismic Hazard Model for the Conterminous United States.” Open-File Report 2018-1111. U.S. Geological Survey, U.S. Department of the Interior.

USGS. "Quaternary Fault and Fold Database of the United States." U.S. Geological Survey. Accessed February 19, 2024. Available online at: https://www.usgs.gov/programs/earthquake-hazards/faults.

Wair, B.R., J.T. DeJong, and T. Shantz. 2012. Guidelines for Estimation of Shear Wave Velocity Profiles. Pacific Earthquake Engineering Research Center. PEER Report 2012/08. December.

WSDOT. 2022. *M46-03: Geotechnical Design Manual.* Washington State Department of Transportation. February 10.

Zhang, G., P.K. Robertson, and R.W.I. Brachman. 2004. "Estimating Liquefaction-Induced Lateral Displacements Using the Standard Penetration Test or Cone Penetration Test." *Journal of Geotechnical and Geoenvironmental Engineering.* 130.8:861–871.

5.1.2 Structural Assessment

5.1.2.1 Seismic Performance Expectations

5.1.2.1.1 Process Area

5.1.2.1.1a Tanks

Several tanks are provided at the Process Area near the center of the facility, including tanks labeled T-3 through T-18, T-51, T-60, C-1 through C-4, K-1, and K-2. Tanks are typically used for storage of asphalt, cooling water, and other mixing products as indicated by a placard at each tank.

Tall slender tanks have mechanical anchorage, and a foundation is provided. Other larger diameter tanks appear to be self-anchored. We believe storage tanks at the Process Area are of low risk in a design seismic event.

5.1.2.1.1b Truck Loading Rack

Several truck loading racks are provided around the Process Area. The racks are comprised of steel braced frames with a platform level and cantilevered awning. The truck racks appear to be well conceived, have a low seismic mass and are of low risk in a design seismic event.

5.1.2.1.1c Pipe Supports/Racks

Several pipe rack structures are provided at the Process Area supporting multiple pipes which run between tanks and process buildings. The pipe bridges typically consist of braced frames in the longitudinal direction and transverse moment frames. Piping is supported at approximately 20-feet above grade. At most locations, the pipe racks appear to be engineered and of low risk in a design seismic event. At a few isolated locations, deficiencies were observed including removed bracing and missing anchor rods. However, due to the infrequency of observed deficiencies, we believe the pipe racks are of low seismic risk.

A few pipe bridges are provided at the Process Area to cross over driving lanes. The pipe bridges are typically well braced and appear to be well conceived. We believe the pipe bridges are of low seismic risk.

Numerous individual pipe supports are provided around the Process Area in addition to the pipe racks and bridges. Pipe supports typically appear to be engineered and well-conceived, with a few exceptions.

One row of pipe supports between tanks T-3 and T-6 consists of a tall slender steel pipe with several added steel members to support piping. Based on the height and construction we believe this support type is at risk in a design level seismic event.

At one location adjacent to the MCC building, a long-span cantilever is provided at the end of a pipe rack. The cantilever is approximately 10 feet and supports large diameter piping close to the cantilever tip. We believe this support type is at risk in a design level seismic event.

5.1.2.1.1d Ancillary Equipment

Various ancillary tanks and equipment are provided in the Process Area, including smaller tanks, pumps, and electrical panel equipment. With a few exceptions, the in-service ancillary equipment appeared to be properly anchored and located on a foundation. We believe the anchored and founded equipment is of low risk in a design level seismic event.

The columns (equipment) are on concrete foundations and are connected to the columns with mechanical anchorage. We believe the columns are of low risk in a design level seismic event. The piping connected to the columns appear to be well engineered and supported. We believe the piping is of low risk in a design level seismic event.

At one location a horizontally oriented Patterson-Kelley pressure vessel is provided on saddle bases. The saddles are located on concrete piers and appear to be placed on shims without anchorage. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

A horizontally oriented tank indicated as pre-heater #2 is provided toward the south end of the Process Area. The pre-heater is located on a steel skid which was not observed to be anchored. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

A small diameter vertically oriented tank indicated as the Loading Rack #1 Fiber Filter was observed without anchorage at the base. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

An RTO is located on a skid at the Process Area along with electrical equipment. No anchorage was observed at the base of the skid. We believe this piece of equipment may be subject to sliding or overturning in a design level seismic event.

A boiler is also in the area. It sits on a concrete foundation and is anchored. We believe the boiler is of low risk in a design level seismic event. The pipe supports around the boiler appear to be in good condition and robust. The piping connections to the boiler and the surrounding piping is also of low risk in a design seismic event.

5.1.2.1.1e Canopies and Building Structures

Several buildings are located in the Process Area, including an administrative office building, operations center, boiler/MCC building, and numerous smaller canopy structures.

The boiler/MCC building is used for housing process equipment. The original building is two stories and constructed of cast-in-place concrete. Additions have been completed over time with masonry construction. Based on provided documents, the masonry additions appear to be reinforced and of low seismic risk. No information is available on the two-story concrete building. We believe the original two-story concrete building may be at risk in a design seismic event.

Several smaller canopy type structures are provided around the Process Area to cover mechanical and electrical equipment. The canopies are light framed and appear to be well conceived. Due to their low seismic mass the canopy buildings are of low risk in a design seismic event.

5.1.2.1.2 Tank Farm

5.1.2.1.2a Tanks

Two large diameter tanks are located in the tank farm area. The tanks are denoted T-1 and T-2. Both can be used for storing raw (flux) material and finished asphalt. It is understood that the tanks are supported with piles. No anchorage bolting was observed at either tank. Based on the height and diameter, the tanks appear to be self-anchored. Self-anchored tanks perform well during seismic events and lateral spread is not expected to create significant differential settlement in the area. This minimizes the likelihood of the tank becoming unstable. The tanks generally appear to be well conceived and engineered. Based on our analysis we believe there is a low risk of tank overturning during the design seismic event but there is a concern with tank rupturing due to non-compliance with API 650 Appendix E.

5.1.2.1.2b Pipe Supports/Racks

Pipe supports at the tank farm area typically consist of steel tube and wide flange T-supports on a concrete pier foundation. The supports carry a few large diameter process pipes which are elevated approximately 12-feet above grade. The supports typically appear to be engineered and well-conceived and are likely at minimal risk in a design seismic event.

5.1.2.1.2c Ancillary Equipment

A few ancillary tanks and equipment are provided in the tank farm area, including smaller tanks, pumps, and electrical panel equipment. With a few exceptions, the in-service ancillary equipment appeared to be properly anchored and located on a foundation. We believe the anchored and founded equipment is of low risk in a design level seismic event.

At one location two CECO fume filters are provided on light framed bases. Due to the height and weight of the filters, and the slenderness of the bases, we believe these may be at risk in a design seismic event.

A hot oil expansion tank is located at the top level of a platform next to the hot oil heater building. The tank is located directly on beams framing the top level of the platform and no diaphragm bracing was observed. We believe this tank may be subject to lateral movement and may potentially compromise the platform framing in a design level seismic event, leading to failure of the tank.

5.1.2.1.2d Canopies and Building Structures

Structures provided at the Tank Farm area include the hot oil heater building and hot oil surge tank platform.

The hot oil heater building is a light-gage metal storage building which houses a hot oil storage drum and process equipment. The building has a low seismic mass and is of low risk in a design seismic event.

The hot oil surge tank platform is a two-story steel structure consisting of chevron braced frames. The platform houses an elevated tank at the top level, and various equipment and piping. The platform appears to be engineered and is of low risk in a design seismic event.

5.1.2.1.3 Rail Spur

5.1.2.1.3a Pipe Supports

Several active piping runs are supported on steel pipe supports at the Rail Spur. Piping at the Rail Spur is typically located 3-feet above grade or less with anchorage and a foundation provided. The pipe supports are well conceived, and of low seismic risk given the height of the supports.

5.1.2.1.3b Ancillary Equipment

Isolated pumps and other equipment are provided near the rail unloading area at the Rail Spur. The equipment is typically anchored and well-conceived, and of low seismic risk.

5.1.2.1.3c Containment Structure

Cast-in-place concrete containment walls are provided at the Rail Spur. The containment walls typically appear to be of adequate height and construction to resist hydrostatic loading in a spill event.

5.1.2.1.4 Marine Facility

5.1.2.1.4a Dock Structure

The dock structure consists of steel and concrete construction. The dock was permitted through the US Army Corps of Engineers and all repairs, modernizations and improvements have been permitted through federal and state agencies. The dock structure is currently in compliance with all requirements set forth by the US Coast Guard and the US Army Corps of Engineers.

The dock and berthing dolphins consist of precast concrete battered piles, and the dock consists of approximately 220-feet of berthing. Limited information is available on the dock structure beyond what is visually available.

Battered piles are typically not recommended in new dock construction in seismic zones, due to their rigidity which may restrict seismic force dissipation. Based on the weight supported by the dock and the presence of a battered pile lateral resisting system, we believe the dock structure is at risk in a design level seismic event.

5.1.2.1.4b Pipe Supports

Numerous pipe supports are present within the Marine Facility area. Piping at the Marine Facility is typically located 3-feet above grade or less and anchored to the concrete dock structure. The pipe supports are well conceived, and of low seismic risk given the height of the supports provided the dock structure itself is adequate.

5.1.2.1.4c Canopies and Building Structures

An operations shack is located on the pier head. The shack is of light frame construction, appears to have a low seismic mass and poses minimal risk of impacting spill prevention.

5.1.2.1.5 North Warehouse Area

Several building structures are provided at the North warehouse area, including the pour building and materials storage buildings. The buildings are typically light framed buildings which are used for storage of solid materials and manufactured products. The buildings appear to be well conceived and pose minimal risk of impacting spill prevention.

5.1.2.1.6 South Warehouse Area

Several building structures are provided at the South warehouse area, including Building “C”, the shipping and receiving office, and warehouse buildings. The buildings are typically light framed buildings which are used for storage of solid materials and manufactured products. The buildings appear to be well conceived and pose minimal risk of impacting spill prevention.

The administrative office building is a two-story light framed structure used for plant operations. The building appears to be well conceived and poses minimal risk of impacting spill prevention.

The operations center and Obeya room is a single-story light framed structure for plant check-in and meetings. The building appears to be well conceived and poses minimal risk of impacting spill prevention.

5.1.3 Safety Assessment

5.1.3.1 Description of fire control system

5.1.3.1.1 General system description

The Owens Corning Trumball Plant is served by a single 6-inch lateral originating from an 8-inch tap of the municipal water main in Old St. Helens Road (Hwy 30). Water is provided by the City of Portland. The size of the municipal main is unknown, as this information is typically classified for public safety reasons. The facility has five private fire hydrants, spaced throughout the site. The asphalt tanks are all equipped with steam snuffing systems which are considered an industry standard suppression technique for heavy oil.

The facility contains a fire access road stemming from Hwy 30 that encircles the processing equipment and storage facilities. The access road width and minimum turning radius for the access road are both compliant with Portland Fire Code.

Prior evaluations and industry best practice have concluded that steam snuffing is the preferred method of asphalt fire suppression. The tanks are fully insulated, making it difficult to apply cooling water to the shell and tank roof from fire suppression equipment. Thus, internal tank suppression is determined to be the most effective. It should be noted that asphalt, despite being a petrochemical, is not flammable without a large, sustained ignition source.

5.1.3.1.2 City water supply, vulnerability of the feed and the onsite U/G lines to liq/lat spreading damage.

During a seismic event, underground pipes are at risk of being damaged including the fire protection water lines that serve the facility. This applies to both the water main in Hwy 30, which could be affected anywhere along its length upstream of this property, and the onsite lines connecting the fire hydrants. Liquefaction-induced lateral spreading may create stress on the underground pipes, potentially causing damage. If a pipe in the system breaks, the network would lose pressure and no longer be effective. Therefore, the water feed is vulnerable in a design seismic event.

Additionally, the City water main in Hwy 30 has limited capacity in terms of flow and pressure. Many terminals along Hwy 30 have determined that any limitations in their fire suppression abilities are a result of the City water main flow and pressure and not the terminal infrastructure. It is reasonable to assume that the existing water supply is sufficient for the full range of suppression quantities recommended in the Bitumen Safety Code. This assumes that other terminals and properties upstream of this site are also not operating at maximum fire suppression capacity, simultaneously.

5.1.3.2 Description of spill containment systems equipment, procedures

Owens Corning maintains a Spill Prevention, Control, and Countermeasure (SPCC) Plan for the Trumball Plant, in accordance with 40 CFR 112. It describes transfer operations, drainage, spill response and reporting, discharge prevention, security, inspections, and training. Aside from the two large tanks, other ancillary equipment tanks are of very low storage volume.

The two largest tanks containing asphalt are located inside the Tank Farm secondary containment structure. Earthen and concrete walls were used in the construction of the secondary containment perimeter, while the floor of the secondary containment is earth. The possibility of a leak through the containment walls or floor in the event product is released from the tanks is extremely low, provided differential settlement does not greatly affect the geometry of the system. The site-wide secondary containment system will provide additional backup in this case.

A catastrophic tank failure beyond design level would result in material flowing out of the main tank farm secondary containment into the plant wide secondary containment system. Within the plant wide containment system, there are smaller containment areas for the hot oil system, knockout tanks, and cutter stock storage tank. The material of construction of both the tank farm and the plant wide secondary containment systems are appropriate for the asphalt flux stored in the area.

The facility uses dikes, catch pans, sumps, sorbent materials and/or catch basins to provide secondary containment for petroleum products stored on-site. Secondary containment systems in these areas, including walls and floors, are capable of containing oil and have been constructed so that any discharge from a primary containment system, such as a tank, will not escape the containment system before cleanup occurs.

The secondary containment structures are sized to hold the contents of the largest container located in that structure and sufficient freeboard to contain precipitation. For containment areas not large enough to hold the tank contents and a rain event during a spill, the site-wide containment is large enough to hold the materials. Diked areas are sufficiently impervious to contain discharged oil.

A hot oil system is used to heat asphalt in stored tanks and in lines to keep it fluid. The hot oil system is self-contained and pumps hot oil through coils and lines. A leak in the system will result in a loss of pressure in the system, decreased hot oil flow and/or the expansion tank empties. If any of those conditions are detected, the system will automatically shut down. The hot oil heater and expansion tank are located in secondary containment.

5.1.3.2.1 Risks in the event of a catastrophic failure

The facility's spill prevention and secondary containment measures described above are adequate if an earthquake were to rupture the single largest tank in each containment area. In an extreme event where multiple tanks are ruptured simultaneously, the spill volume would exceed the containment capacity. However, it is not standard practice to design for this event and would require excessive infrastructure and space.

However, in such an event, the **risk to soil** is extremely low and the resulting cleanup has very low environmental risks. The **risk to groundwater** is equally low, given that asphalt does not emulsify easily, is highly viscous and cannot permeate soil. These risks are described further in Sections 5.1.3.2.2 and 5.1.4.1 below. The **risk of reaching the river** is possible. However, this risk is very difficult to assess analytically given the changing rates of asphalt viscosity as it cools, the unknown rate of release from either tank, and the presumptive ground effects (including potential ground deformation from the seismic event) on the asphalt pool as it moves over open areas of the plant. We judge the risk of reaching the river as low given the number of compounding failures that must occur for this event to materialize.

5.1.3.2.2 Prior 3rd party acknowledgment of low risk

The Owens Corning Trumball Plant is prepared in the event a spill occurs. The facility has a strict procedure in place to properly contain, clean up, and dispose of spilled products while ensuring personnel and external safety.

Furthermore, the City of Portland, Oregon has granted Owens Corning a code exemption request to Section 1613.1 of the OSSC where it applies to ancillary structures. The appeal states that failures to the asphalt tanks pose minor risk to Life Safety and product release to nearby waters. As mentioned in previous sections, the spill of asphalt material does not have the same environmental implications as a spill of oil or fuel. Asphalt quickly solidifies and there is negligible outward running of the product and soil penetration. In a spill scenario, asphalt will harden and become viscous at ambient temperature. When solidified, it is easily rolled up on the ground. This process helps mitigate contamination of the environment or adjacent properties and aids in cleaning of a spill.

In a catastrophic event in which primary and secondary containment structures fail, the spilled asphalt product still does not pose a risk to Life Safety and product release to groundwater or the nearby river.

5.1.3.3 Mechanical-specific items

The material and construction of all bulk storage containers are compatible with the materials stored and conditions of storage such as pressure and temperature.

While the materials of construction of the secondary containment system are compatible with the asphalt stored in most of the tanks, there are several pieces of process equipment and tanks that contain materials that would soak into the soil. These tanks and pieces of process equipment are located inside their own secondary containment systems. These containment systems have concrete walls and floors, which are compatible with the materials stored in them.

The process oil and asphalt tanks are designed with automatic level gauges to monitor individual tank levels during filling. The gauges provide data to computers in the Control Room. An operator is present to monitor the gauges during filling to prevent overfilling of a tank. The system has a visual and audible alarm that will turn on if a tank is filled within 90% of capacity. The operator will also monitor the overall filling of bulk storage containers.

Asphalt piping within the Tank Farm area is aboveground and constructed of minimum of Schedule 40 carbon steel, certified welded, and rated to operating pressures of 150 psig. Piping is wrapped with insulation and inspected on a monthly or transfer event basis with particular attention to connecting joints, valves, pumps, and pipe supports.

The mechanical-specific measures described above play a significant role to improve site safety and mitigate risk of damage during a seismic event.

5.1.3.4 Description of onsite emergency equipment, ops safety measures, personnel policies, and procedures

Lateral soil displacement and subsequent collapse would not be instantaneous during the maximum seismic event. This allows safe egress from the open tank farm area in the unlikely event of worker presence. This is based on standard safety training specifying immediate egress to safe muster points at the onset of ground shaking.

Plant personnel will promptly correct visible discharges that result in a loss of oil from a container, including but not limited to seams, gaskets, pumps and valves. Oil accumulated in a containment area will be promptly and properly removed. Two spill kit stations are located at the facility. The kits include shovels, pads, brooms, absorbent, drums, etc. and are located south of the Materials Storage Shed and south of the PPA tank.

Pursuant to 40 CFR Part 112, the Plant conducts required inspections of all tanks, pipelines, secondary containment, and associated equipment. A documented inspection of storage containers, pumps and piping systems containing petroleum products are performed monthly. As part of this inspection, the facility will inspect the outside of a container for signs of deterioration, discharges or accumulation of oil inside diked areas. As part of the plant daily operations, informal observations are made by personnel working in areas around the plant, such as the truck unloading rack area. Personnel are trained to notify supervisors if any problems are observed.

The Trumball Plant maintains a Facility Response Plan that describes the facility’s response to an onshore asphalt spill incident. It is consistent with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300) and is consistent with the Area Contingency Plan. It has been updated in accordance with the State of Oregon Department of Environmental Quality requirements in accordance with Administrative Code (OAR) 340-47- 150 and 340-47-160.

Owens Corning orients, informs, and educates its employees so that they have the skills and knowledge to perform their work safely, productively, and efficiently. In order to accomplish this the training program includes orientation and general safety and health training, operational job training, specialized training, and refresher training. Oil-handling personnel will receive additional training on the following:

- Operation and maintenance equipment to prevent discharges
- Discharge procedure protocols
- Applicable pollution control laws, rules and regulations
- General facility operations
- Contents of the SPCC Plan

Owens Corning designates qualified individuals and alternates pursuant to 33 CFR Part 154.1026 Key attributes of the qualified individual are they are located in the U.S., available on a 24-hour basis, familiar with the facility response plan, trained in their responsibilities under the plan, speak English, and have full authority to implement the response plan.

The facility maintains spill response agreements with external contractors to facilitate a swift response to a release, when external support is required. Spill response contractor(s) and contact information is provided in the SPCC Plan.

With many procedures and policies in place, the Trumball Plant is adequately prepared to respond to any emergency, including an earthquake.

5.1.4 Case for Tank Seismic Stability Rules Exemption

The purpose of the Rules as summarized in Section 1 of this report is to limit the environmental impact and immediate risk to the public, while supporting the regional energy needs immediately after a design seismic event. This facility qualifies under the Rules based only on total volume of hazardous material storage, while not meeting the intent of the Rules on the other grounds previously stated. Asphalt spills would not impact public health or the environment relative to the intent of the Rules and Oregon Law Ch 99. City of Portland exemptions, along with experience with asphalt spills at the site and elsewhere, demonstrate the validity of this argument.

5.1.4.1 Asphalt behavior in the event of a spill

Asphalt does not behave like water OR fuel when exposed on the ground surface. The following distinguish asphalt from other stored petrochemical liquids:

a. Asphalt is quite viscous, increasing with decreased temperature until it solidifies at 200°F.

b. Asphalt presents a low risk of soil permeability given its viscosity characteristics. In fact, tank leaks are typically self-sealing, as the cooling asphalt solidifies and creates a seal.

c. Asphalt does not emulsify easily. It is not flammable or combustible without a large, sustained ignition source. It does not evaporate or create air hazards once it reaches 200°F. The product with the largest volume by far onsite is less of a fire hazard than many other industrial chemicals found in other facilities throughout the State of Oregon.

Asphalt is found commonly within the local environment where runoff is collected in City stormwater systems: Paved roads and parking lots, in roofing shingles, for roof coverings, as pond liners, and other uses where all-weather surfaces and durable waterproofing are required. For this and other reasons, solidified asphalt is generally not considered hazardous to the environment. For instance, asphalt tank heels (remainder in the tank below the pump suction nozzle) removed for cleaning and maintenance are typically landfilled as non-hazardous solid waste.

Asphalt spilled on the ground will immediately begin to cool. It will bind with the surface soil and, as it cools, will form a surface seal. Asphalt will cool and harden in the catch basin or pipe, or on the ground before progressing any further in the event of a spill. The typical cleanup effort would require excavating the hardened asphalt and bound soil as necessary.

5.1.4.2 Asphalt storage vs. fuel storage in other states

There is relevant precedence in Federal EPA and other State environmental agencies that are useful examples here. They are based on the properties and characteristics of the product and the associated risk to the environment:

A. The US Environmental Protection Agency (EPA) has published guidance documents for SPCC Regional Inspectors that specifically address containment for asphalt products. Below is an excerpt from the attached guidance document.

   i. "The earthen floor of a secondary containment system may be considered *"capable of containing oil"* until cleanup occurs, or *"sufficiently impervious"* if there is no subsurface conduit to navigable waters allowing the oil to reach navigable waters before it is cleaned up. Should oil reach navigable waters or adjoining shorelines, it is a reportable discharge under 40 CFR part 110. The suitability of earthen material for secondary containment systems may depend on the properties of both the product stored and the soil. For example, compacted local soil may be suitable to contain a viscous product, such as liquid asphalt cement, but may not be suitable to contain gasoline."

   ii. Based on the above, asphalt on the ground is not considered a hazard so long as it does not reach navigable waters or shoreline before it has hardened.

B. On the West Coast, California has its own Above-Ground Storage Tank (AST) program under the Aboveground Petroleum Storage Tank Act (APSA). Asphalt products that are not liquid (solidify) at 60°F and at absolute atmospheric pressure (psia) are exempt from this rule. Contrast with “petroleum”, which is crude oil or its fractions that are liquid at 60°F and 14.7 psia.

C. Many States with AST programs also recognize the unique characteristics of asphalt and have certain exemptions for asphalt storage vs. petroleum storage. Some examples of these exemptions for asphalt storage tanks include the following:

  i. Corrosion protection and corrosion protection monitoring
  ii. Containment for substance transfer areas
  iii. Overfill protection
  iv. Leak detection
  v. Internal inspections
  vi. Soil or groundwater sampling during removal for possible contamination

5.1.4.3 Conclusions

Asphalt does not behave like fuel. It is much easier to remove in the event of a spill, does not contaminate groundwater, and is not combustible nor flammable like a fuel. A spill does poses neither a direct nor indirect risk to the public. Asphalt or asphalt products will not play a role in emergency fuel or energy plans at any level; thus Oregon Laws 2022 Chapter 99, the Oregon Resilience Plan, and the Oregon Fuel Action Plan are not relevant to this site. The Tank Seismic Stability Rules are intended for *fuel* storage facilities over 2 million gallons in stored volume, which disqualifies this facility. Therefore, **it is our opinion that this facility should be exempt from any further action relative to the requirements of the Rules.** This report addresses all required elements for assessment listed in Section 2.2 subpart A through F and Section 2.3 subpart A through M listed above and should conclude Owens Corning’s requirements relative to the Rules.

SECTION 6: APPENDICIES

6.1 Appendix A: Geotechnical Exhibits

Appendix G-1 Geotechnical Engineering Report

Appendix G-2 Calculations

Figure G-1 Vicinity Map Site Class Determination

Figure G-2a Site and Exploration Plan

Figure G-2b Site and Exploration Plan (Section)

Figure G-3 Geotechnical Cross Section

Geotechnical Engineering Report
Owens Corning Linnton Asphalt Terminal Final Design
11910 Northwest St. Helens Road
Portland, Oregon

January 13, 2022

Prepared for

Norwest Engineering
4110 NE 122nd Avenue, Suite 207
Portland, Oregon 97230

Landau Associates

500 Columbia St NW, Ste 110
Olympia, WA
360.791.3178

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This document was prepared by, or under the direct supervision of, the undersigned, whose seal is affixed below.

Name: Calvin McCaughan, PE
Oregon/No. 85813PE

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REGISTERED PROFESSIONAL ENGINEER
85813PE
OREGON
NOVEMBER 08, 2011
CALVIN ALAN MCCAUGHAN

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Document prepared by: Daniel Simpson, PE
Project Manager

Document reviewed by: Whitney Ciani, PE
Quality Reviewer

Document reviewed by: Calvin McCaughan, PE
Quality Reviewer

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Project Coordinator:	**MCS**

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

AGI	Advanced Geosolutions, Inc.
ASCE	American Society of Civil Engineers
BC	British Columbia
bgs	below ground surface
City	City of Portland
CPT	cone penetration test
CSZ	Cascadia Subduction Zone
deg	degree(s)
ESU	engineering stratigraphic unit
ft	foot/feet
ft/ft	feet per foot
g	force of gravity
GMHA	ground motion hazard analysis
GMPE	ground motion prediction equation
H:V	horizontal to vertical
km	kilometer(s)
ksf	kips per square foot
LAI	Landau Associates, Inc.
M	moment magnitude
NAVD 88	North American Vertical Datum of 1988
NGA	Next Generation Attenuation
Norwest	Norwest Engineering
OSSC	Oregon Structural Specialty Code
PGA	peak ground acceleration
PPDT	pore water pressure dissipation test
PSHA	probabilistic seismic hazard analysis
R	hypocentral distance
SEI	Structural Engineering Institute
SPT	standard penetration test
USGS	US Geological Survey
V_s	shear wave velocity
Z_{TDR}	depth to top of rupture

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1.0 INTRODUCTION

This report summarizes the results of geotechnical engineering services provided by Landau Associates, Inc. (LAI) in support of the Linnton Asphalt Terminal expansion project, located at 11910 Northwest St Helens Road in Portland, Oregon (site; Figure 1).

This report has been prepared with information provided by Owens Corning (project owner) and Norwest Engineering (Norwest; prime engineer) and with data collected during LAI's geotechnical field exploration and laboratory testing programs.

1.1 Project Understanding

Owens Corning plans to improve the site by adding a new asphalt tank (Tank 11), associated piping, and ancillary equipment. The new tank will measure 70 feet (ft) in diameter and 42 ft tall. Based on the results of LAI's preliminary geotechnical services (2020), the project team has elected to use ground improvement to support the tank and mitigate the effects of seismically induced liquefaction.

1.2 Scope of Work

LAI provided the following geotechnical services to support design of the proposed improvements:

- Provided project management services and attended meetings, including a pre-application meeting with the City of Portland (City, authority having jurisdiction).
- Advanced two mud rotary borings at the site and collected representative soil samples.
- Completed geotechnical laboratory testing on select soil samples obtained from the borings. LAI's laboratory program included soil index testing and consolidation testing.
- Prepared this geotechnical engineering report, which includes:
  - A summary of the subsurface soil and groundwater conditions observed in LAI's explorations.
  - A summary of regional geologic conditions and recommended seismic design parameters.
  - Performance objectives for reinforcement-type ground improvement in accordance with the 2019 *Oregon Structural Specialty Code* (*2019 OSSC;* ICC) and the American Society of Civil Engineers' *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (*ASCE/SEI 7-16*).
  - Geotechnical design recommendations for pipe rack and appurtenant foundations.
- Provided bid support by:
  - Reviewing the bid package for compliance with the performance objectives in this report) and preparing two schematic drawings.
  - Reviewing and responding to bidders' questions.
  - Assisting Norwest and Owens Corning with review of the bidders' proposals.

2.0 SITE CONDITIONS

The following sections describe the geologic setting of the site and the surrounding area and the surface and subsurface conditions observed in LAI's explorations. Interpretations of site conditions are based on LAI's review of available geologic information and on the results of the subsurface explorations and laboratory testing.

2.1 Geologic Setting

Geologic information for the site was obtained from the *Preliminary Geologic Map of the Linnton 7.5' Quadrangle, Multnomah and Washington Counties, Oregon* (Madin et al. 2008). Near-surface deposits at the site are mapped as artificial fill (af), a mixture of clay, silt, sand, gravel, debris, and rubble deposited by man. Alluvium (Qal) is also mapped at the site and consists of a mixture of clay, silt, and sand. This unit was deposited by the Willamette River during the Holocene Epoch. The alluvium is underlain by the Sentinel Bluffs Member of the Grande Ronde Basalt (Tsgb), an extrusive, igneous rock formed by the rapid cooling of dark gray or black lava. The layer of Grande Ronde Basalt measures up to 130 ft thick (Madin et al. 2008).

The subsurface conditions observed in LAI's explorations were consistent with the mapped geology for the site.

2.2 Surface Conditions

With the exception of secondary containment berms, the ground surface surrounding the proposed tank location is relatively flat. It is surfaced with grass and low scrub vegetation and located near paved access roads.

The Willamette River, flowing southeast to northwest, is located approximately 250 ft northeast of the site. The approximate surface elevation at the proposed tank location is 30 ft (North American Vertical Datum of 1988 [NAVD 88]). The riverbank slopes at approximately 3 horizontal to 1 vertical (3H:1V). Using bathymetric data provided by the City (accessed August 4, 2021), LAI estimated an approximate bottom-of-river-channel elevation of -25 ft NAVD 88.

2.3 Subsurface Explorations

Site subsurface conditions were explored on August 27, 2020 by advancing four cone penetration test (CPT) soundings (CPT-1 through CPT-4), and on June 24 through 29, 2021 by advancing and sampling two mud rotary borings (B-1 and B-2). The approximate locations of the explorations are shown on Figure 2.

Sounding CPT-1 included shear wave velocity measurements, and soundings CPT-1 and CPT-3 included pore pressure dissipation tests (PPDTs). Soil samples were collected from borings B-1 and B-2 using the standard penetration test (SPT) procedure and Shelby tube samplers. A description of LAI's field investigation program, boring logs, and CPT data are provided in Appendix A; and photographs of SPT samples are provided in Appendix B.

Samples were transported to LAI's soils laboratory for further examination and testing. A summary of test methods and results are provided in Appendix C.

2.4 Subsurface Conditions

The site is generally underlain by fill over alluvium over basalt. Site subsurface conditions are characterized by the following engineering stratigraphic units (ESUs):

> **ESU 1 Fill.** ESU 1 consists of fill used to raise site grades. The fill observed in LAI's explorations primarily consisted of coarse-grained soils (SP, SP-SM, and SM) with variable wood debris and interbedded layers of wood waste. LAI understands that, prior to 1990, the site was used as a plywood manufacturing facility, sawmill, and log yard.
>
> **ESU 2a Recent Alluvium.** ESU 2a consists of very soft to soft, low-plasticity silt with interbeds of elastic silt.
>
> **ESU 2b Old Alluvium (loose).** ESU 2b consists of loose to medium dense, silty sand to sandy silt with interbeds of low-plasticity and elastic silt.
>
> **ESU 2c Old Alluvium (dense).** ESU 2c consists of medium dense to very dense, silty sand to sand with silt.
>
> **ESU 3 Basalt.** ESU 3 consists of basalt. A CME-75 truck-mounted drill rig was advanced approximately 1 to 3 ft into the basalt before encountering refusal.

On August 27, 2020, the site groundwater elevation was estimated at approximately 10 ft below ground surface (bgs), based on the results of PPDTs completed in soundings CPT-1 and CPT-3. The moisture content observed in samples collected from borings B-1 and B-2 indicates a groundwater elevation of approximately 8.5 ft bgs. Site groundwater elevations are expected to fluctuate as a function of precipitation, river stage, and upgradient seepage.

Figure 3 shows a conceptual geologic cross section through the tank location.

3.0 SEISMIC DESIGN CONSIDERATIONS

The site is located in the seismically active Pacific Northwest and could be subject to ground shaking during a major seismic event. The following sections describe the seismic hazards present at the site. LAI prepared this section with the understanding that the proposed tank would have a fundamental period of vibration of less than 0.5 second and a sloshing period of more than 2 seconds.

3.1 Seismic Setting

The site is located on the North American tectonic plate near the convergent continental boundary known as the Cascadia Subduction Zone (CSZ). The CSZ is formed by the subduction of the oceanic Juan de Fuca Plate and Gorda Plate beneath the North American Plate, extending approximately from Vancouver Island, Canada to the Mendocino Escarpment off Northern California, United States (Goldfinger et al. 2012). This tectonic setting creates three potential seismic sources for the site: a subduction zone interface rupture, a deep intraslab rupture, and shallow crustal fault rupture. The CSZ lies approximately 80 miles west of the site.

The nearest shallow crustal fault is the Portland Hills fault, mapped approximately 1,000 ft southwest of the site (USGS 2021). The Portland Hills fault is a steeply dipping (approximately 70-degree) reverse fault. The fault dips to the southwest, and the site is situated on the footwall. Based on the US Geological Survey's (USGS) disaggregation for the site, the maximum considered event from the fault corresponds to a moment magnitude 7 event.

3.2 Ground Motion Hazard Analysis and Seismic Design Parameters

The seismic site class was determined in accordance with Section 20 of *ASCE/SEI 7-16.* The average shear wave velocity (V_s) in the top 30 meters (100 ft, denoted $V_{s,30}$) of the soil profile was computed using site-specific V_s measurements collected in sounding CPT-1 to a depth of 78.74 ft bgs, SPT N-V_s correlations (Wair et al. 2012) between 78.74 ft bgs and refusal at 90 ft bgs, and presumptive basalt V_s from 90 ft bgs to 100 ft bgs (Sowers and Boyd 2019). The computed $V_{s,30}$ is 685 feet per second, resulting in a **seismic site class D.**

The USGS has completed a countrywide probabilistic seismic hazard analysis (PSHA) that provides estimated strong motion at a given location, for a given probability of exceedance. The PSHA can be used to determine geotechnical and structural seismic design parameters for a given seismic site class. The *2019 OSSC* requires completion of a ground motion hazard analysis (GMHA) for a seismic site class of D and a USGS-mapped, 1-second spectral ordinate (S_1) greater than 0.2g. Because the mapped S_1 for the subject site is 0.4g, LAI completed a GMHA.

The GMHA was completed in general accordance with the procedure outlined in Section 21.2, Method 1 of *ASCE 7-16.* The deterministic sources in Table 1 were used to complete the GMHA. To develop the

GMHA probabilistic spectrum, the uniform hazard spectrum in the USGS's PSHA was risk- and direction-adjusted in accordance with Federal Emergency Management Agency report P-1051.

Table 1. Ground Motion Hazard Analysis Deterministic Source Summary

ID	Source Type and Characteristics	GMPE
Source 1	Shallow Crustal/Portland Hills Fault M = 7.0, R = 1.4 km, Z_{TOR} = 0 km	NGA-West 2 weighted average
Source 2	Subduction intraslab M = 6.0, R = 12 km, Z_{TOR} = 30 km	Updated BC Hydro (Abrahamson et al. 2018)
Source 3	Subduction interface/Cascadia Subduction Zone M= 9.3, R = 70 km	Updated BC Hydro (Abrahamson et al. 2018)

BC = British Columbia
GMPE = ground motion prediction equation
ID = identifier
km = kilometer(s)
M = moment magnitude
NGA = Next Generation Attenuation
R = hypocentral distance
Z_{TOR} = depth to top of rupture

The results of the GMHA are presented on Figure 4 as a recommended site-specific design response spectrum. Based on the results of the GMHA and the USGS seismic hazard disaggregation for the site, LAI recommends the seismic design parameters provided in Table 2.

Table 2. Seismic Design Parameters, 2 percent in 50-year probability of exceedance

Site Class	Mean M	PGA_M	S_{DS}	S_{D1}
D	8.2	0.488g	0.776g	0.693g

g = force of gravity
M = moment magnitude
PGA = peak ground acceleration
S_{D1} = design short-period spectral ordinate
S_{DS} = design 1-second period spectral ordinate

3.3 Liquefaction and Lateral Spreading

Liquefaction is a phenomenon that occurs when strong ground motions cause saturated sand, gravel, and low-plasticity silt to lose shear strength. In LAI's opinion, seismically induced soil liquefaction is likely to occur at the subject site and could result in:

- ground surface settlement,
- lateral spreading (incremental, lateral movement of the ground surface toward the Willamette River during ground shaking), and
- flow failure (slope instabilities near the riverbank caused by loss of soil strength).

LAI used the methods noted to evaluate the:

- Potential for soils to be susceptible to liquefaction (Bray and Sancio 2006).
- Potential for susceptible soils to liquefy at design-level earthquake intensity (Boulanger and Idriss 2014).
- Shear strength loss (i.e., the residual shear strength of liquefied soils) and liquefaction-induced free-field vertical ground settlements (Idriss and Boulanger 2008).
- Estimated lateral spreading and flow failure, developed using a limit-equilibrium analysis and Bray et al.'s (2019) empirical Newmark's sliding block analysis.

Based on the results of the liquefaction analysis, LAI estimates that the site could be subject to 8 to 16 inches of liquefaction-induced settlement, more than 10 ft of lateral spreading displacement, and flow failure near the proposed tank.

4.0 CONCLUSIONS AND RECOMMENDATIONS

A design-level seismic event is estimated to cause liquefaction and significant vertical and lateral ground deformation. Based on the results of LAI's geotechnical explorations and engineering analyses, shallow and deep foundations would not be able to withstand the estimated ground deformation. As a result, the design team has selected ground improvement to mitigate liquefaction- induced settlement and lateral spreading to within tolerable limits for shallow foundation support.

Advanced Geosolutions, Inc. (AGI) will complete ground improvement design and construction.

4.1 Tank Foundation Recommendations

LAI understands that the desired tank foundation consists of a gravel pad and concrete ring wall system. LAI, Norwest, and Owens Corning developed the performance specification that AGI will use to design ground improvement. Key performance criteria are provided below:

- Provide static and seismic allowable bearing capacity of 6 kips per square foot (ksf) beneath the ring wall.
- Provide static and seismic allowable bearing capacity of 2.6 ksf in the area beneath the tank.
- Limit static total settlement to 4 inches and static differential settlement to 0.003 feet per foot (ft/ft) in any horizontal direction.
- Limit seismic differential settlement to 0.006 ft/ft in any horizontal direction.
- Limit seismic lateral foundation deformation to 12 inches.
- Provide a load transfer platform or equivalent to achieve uniform bearing capacities.

Ground improvement design should account for the following soil engineering properties. ESU designations correspond to the ESUs delineated on Figure 3 and described in Section 2.4.

Table 3. Engineering Stratigraphic Unit Soil Properties

Material Name	Description	Unit Weight	Static Strength(a)	Seismic (Liquefied/Cyclically Softened) Strength(a)
ESU 1	Fill	120 pcf	ϕ = 35 deg c = 0	$S_{u,r}/\sigma'_v = 0.1$ $S_{u,r,min}$ = 100 psf
ESU 2a	Recent Alluvium	115 pcf	ϕ = 0 deg c = 800 psf	$S_{u,r}/\sigma'_v = 0.07$ $S_{u,r,min}$ = 100 psf
ESU 2b	Old Alluvium (loose)	120 pcf	ϕ = 0 deg c = 1,000 psf	$S_{u,r}/\sigma'_v = 0.14$ $S_{u,r,min}$ = 300 psf
ESU 2c	Old Alluvium (dense)	120 pcf	ϕ = 38 deg c = 0	N/A

(a) = Strength parameters should be used with a linear Mohr-Coulomb failure envelope.
ϕ = internal angle of friction; c = cohesion intercept; deg = degree(s); ESU = engineering stratigraphic unit; N/A = not applicable; pcf = pounds per cubic foot; psf = pounds per square foot

The volume beneath the tank within the concrete ring wall should be backfilled with well-compacted, 2-inch minus, dense-graded aggregate conforming to the requirements for structural fill in Section 02630 of the Oregon Department of Transportation's 2021 *Oregon Standard Specifications for Construction* (*2021 ODOT Standard Specifications*). A horizontal earth pressure coefficient of 0.3 may be used to compute hoop stress.

4.2 Ancillary Structure Foundation Recommendations

LAI understands that ancillary structure foundation design will not consider the effects of liquefaction. Ancillary structures include:

- Monopole pipe supports founded on piers cast in drilled holes or in excavations with a cylindrical form for a new 10-inch asphalt transfer line.
- Rectangular pipe rack foundations on the order of 4 ft to 8 ft wide and 10 ft to 12 ft long, with static bearing pressures less than 0.5 ksf and seismic earth pressures less than 1.5 ksf.
- Slab-on-grade for mechanical equipment with applied bearing pressures less than 0.25 ksf.

4.2.1 Monopole Column Supports

Monopole column supports will be used for the 10-inch transfer line running from the rail offload pipe rack to proposed Tank 11. Depending on the contractor's preference, pipe supports may be cast in a drilled hole or in an excavated hole with a cylindrical concrete form.

The contractor should complete the excavation with a smooth bladed bucket or a cleanout auger to limit bottom disturbance and leave a clean excavation. Owens Corning's representative should observe the bottom of excavations prior to placement of formwork or reinforcement to check that the contractor has sufficiently removed slough and loose soil from the bottom of the excavation.

Excavations below 4 ft bgs to 5 ft bgs may be unstable, depending on the excavation side slope and the presence of loose sand or groundwater. The contractor should be responsible for excavation stability and the maintenance of safe working conditions.

Excavations should be backfilled with controlled low-strength material in accordance with Section 00442 of the *2021 ODOT Standard Specifications*.

Because the site contains a potentially compressible soil layer from approximately 7 ft bgs to 10 ft bgs, LAI recommends two types of monopole foundations:

- **Type 1**: Embedded 3 ft or less, designed with an allowable bearing capacity of 3 ksf. The maximum diameter of Type 1 foundations should be 24 inches.
- **Type 2**: Embedded 10 ft bgs, designed with an allowable lateral bearing capacity of 7 ksf. The maximum diameter of Type 2 foundations should be 30 inches.

Lateral resistance of monopile column foundations can be computed with an allowable passive equivalent fluid density of 250 pounds per cubic foot. The top 2 ft of soil should be neglected when computing lateral resistance. Allowable bearing pressured and passive resistance may be increased by one-third for seismic loading.

4.2.2 Pipe Rack Shallow Foundations and Equipment Slabs-On-Grade

LAI recommends that shallow foundations and equipment slabs-on-grade bear on compacted structural fill, as detailed in the following sections. For the purposes of this section, subgrade is defined as the native soil at the elevation where structural fill is placed and compacted below foundation elements.

Subgrade soils can be recompacted to a firm, unyielding condition. If soft or loose soil encountered at subgrade elevation cannot be adequately recompacted, the unsuitable soil should be overexcavated and replaced with structural fill or controlled low-strength material. Overexcavations need not extend more than 3 ft below subgrade elevation.

If unsuitable materials are encountered following a 3-ft overexcavation, a separation geotextile and structural fill should be placed. The geotextile should conform to the criteria in Table 02320-4 of the *2021 ODOT Standard Specifications.*

The subgrade should be inspected by an Owens Corning representative prior to placement of formwork.

4.2.2.1 Shallow Foundations

Cast-in-place shallow foundations should bear at least 2 ft below adjacent finished grade. Foundations should bear on a minimum of 1 ft of well-compacted, 2-inch minus, dense-graded aggregate conforming to the requirements for structural fill in Section 02630 of the *2021 ODOT Standard Specifications*. The structural fill should extend 1 ft beyond the edge of the foundation.

The parameters in Table 4 can be used to design shallow foundations.

Table 4. Shallow Foundation Design Parameters

Footing Width	Allowable Bearing Capacity	Estimated Settlement
4 ft	1 ksf	Immediate = 0.5 inch Consolidation = < 0.5 inch
4 ft	3 ksf	Immediate = 1.5 inch Consolidation = 0.5 inch
8 ft	0.5 ksf	Immediate = 0.5 inch Consolidation = 0.5 inch

Footing Width	Allowable Bearing Capacity	Estimated Settlement
8 ft	1.5 ksf	Immediate = 1.5 inch Consolidation = 1 inch

Notes:

1. Values for intermediate-sized footings can be interpolated.
2. Values can be increased by one-third for seismic loading.
3. Lateral resistance can be computed assuming an allowable coefficient of friction of 0.5.
4. Footing length is assumed to be one to two times the width.
5. Immediate settlement should occur relatively quickly, as loads are applied.
6. Consolidation settlement is estimated to occur over 3 to 6 weeks.
7. Consolidation settlement need not be considered for short-term live loading.
8. Total settlement is the sum of immediate and consolidation settlement.
9. Differential settlement is estimated to be less than one-half of the values between similarly sized and loaded footings.

ft = foot
ksf = kips per square foot

4.2.2.2 Equipment Slabs-on-Grade

Equipment slabs-on-grade should bear on at least 1 ft of structural fill, and subgrade should be prepared as described above. A subgrade modulus of 100 pounds per cubic inch can be used to design slabs-on-grade. This value is for a 1-ft by 1-ft loaded area and should be adjusted for the actual size of the slab.

4.3 Long-Term Settlement Potential

Subsurface explorations revealed deposits of wood waste and organic matter, which may decompose, causing long-term settlement of overlying structures. Much of the existing site infrastructure is likely underlain by wood waste and organic matter. Over a 50-year period, structures not supported by ground improvement may settle 1 to 2 inches. Long-term settlement of new, shallow foundation-supported structures is anticipated to be similar to that of existing, shallow foundation-supported structures.

5.0 USE OF THIS REPORT

Landau Associates has prepared this report for the exclusive use of Norwest Engineering and Owens Corning for the proposed Owens Corning Linnton Asphalt Terminal project in Portland, Oregon. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Reuse of the information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that, within the limitations of scope, schedule, and budget, its services have been provided in a manner consistent with that level of skill and care ordinarily exercised by members of the profession currently practicing in the same locality, under similar conditions as this project. Landau Associates makes no other warranty, either express or implied.

6.0 REFERENCES

Abrahamson, N., N. Kuehn, Z. Gulerce, et al. 2018. *Update of the BC Hydro Subduction Ground-Motion Model using the NGA-Subduction Dataset.* PEER Report No. 2018/02. Pacific Earthquake Engineering Center. June.

ASCE. 2017. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SEI 7-16.* American Society of Civil Engineers, Structural Engineering Institute.

Boulanger, R.W., and Idriss, I.M. 2014. "CPT and SPT Based Liquefaction Triggering Procedures." Report No. UCD/CGM-14/01. Center for Geotechnical Modeling, Department of Civil & Environmental Engineering, University of California, Davis. April.

Bray, J.D., J. Macedo, and T. Travasarou. 2018. "Simplified Procedure for Estimating Seismic Slope Displacements for Subduction Zone Earthquakes." *Journal of Geotechnical and Geoenvironmental Engineering.* 144(3).

Bray, J.D., and R.B. Sancio. 2006. "Assessment of the Liquefaction Susceptibility of Fine-Grained Soils." *Journal of Geotechnical and Geoenvironmental Learning.* 132(9).

Germaine, J.T., and A.V. Germaine. 2009. *Geotechnical Laboratory Measurements for Engineers.* John Wiley and Sons.

Goldfinger, C., C.H. Nelson, A.E. Morey, et al. 2012. "Turbidite Event History—Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone" U.S. Geological Survey Professional Paper 1661–F.

ICC. 2019. *2019 Oregon Structural Specialty Code.* International Code Council. August 23.

Idriss, I.M., and R.W. Boulanger. 2008. *Soil Liquefaction during Earthquake.* EERI Publication, Monograph MNO-121. Earthquake Engineering Research Institute, Oakland.

LAI. 2020. Technical Memorandum: Preliminary Geotechnical Engineering Recommendations, Owens Corning Linnton Asphalt Terminal, Portland, Oregon. Landau Associates, Inc. November 13.

Madin, P., L. Ma, and C.A. Niewendorp. 2008. *Preliminary Geologic Map of the Linnton 7.5' Quadrangle, Multnomah and Washington Counties, Oregon.* Open File Report O-08-06. State of Oregon, Department of Geology and Mineral Industries.

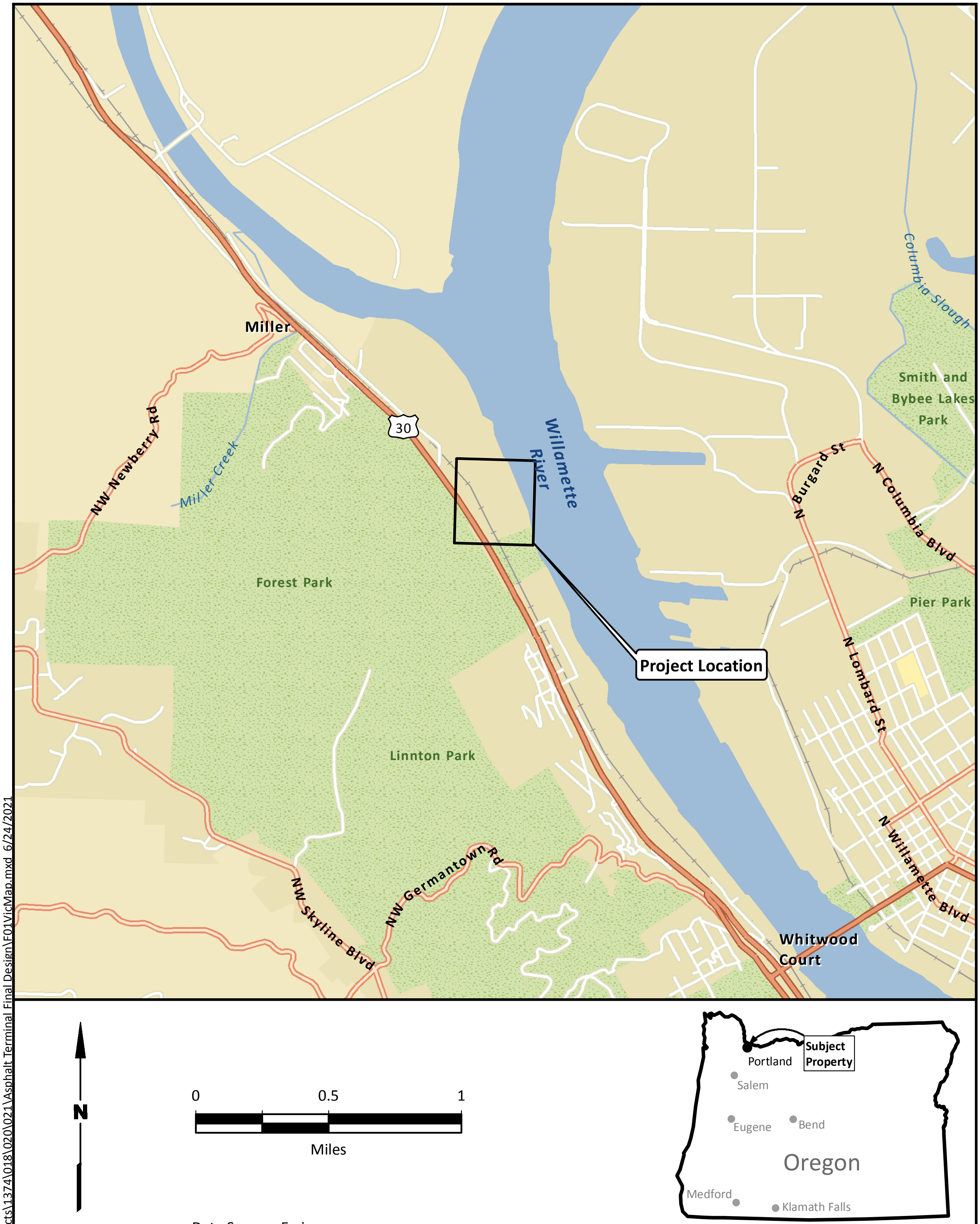
ODOT. 2020. *Oregon Standard Specifications for Construction.* 2021 Edition. Oregon Department of Transportation.

Portland, City of. PortlandMap – Open Data: Willamette River Bathymetry (2005). Accessed August 4, 2021. Available online at: https://gis-pdx.opendata.arcgis.com/datasets/PDX::willamette-river-bathymetry-2005/explore?location=45.604230%2C-122.788136%2C14.31.

Sowers, T., and O.S. Boyd. 2019. *Petrologic and Mineral Physics Database for Use with the U.S. Geological Survey National Crustal Model.* Open-File Report 2019-1035. U.S. Geological Survey.

USGS. Quarternary Fault and Fold Database for the United States. Accessed August 11, 2021. Available online at: https://www.usgs.gov/natural-hazards/earthquake-hazards/faults.

Wair, B.R., and J.T. DeJong. 2012. *Guidelines for Estimation of Shear Wave Velocity Profiles.* PEER Report No. 2012/08. Pacific Earthquake Engineering Research Center.



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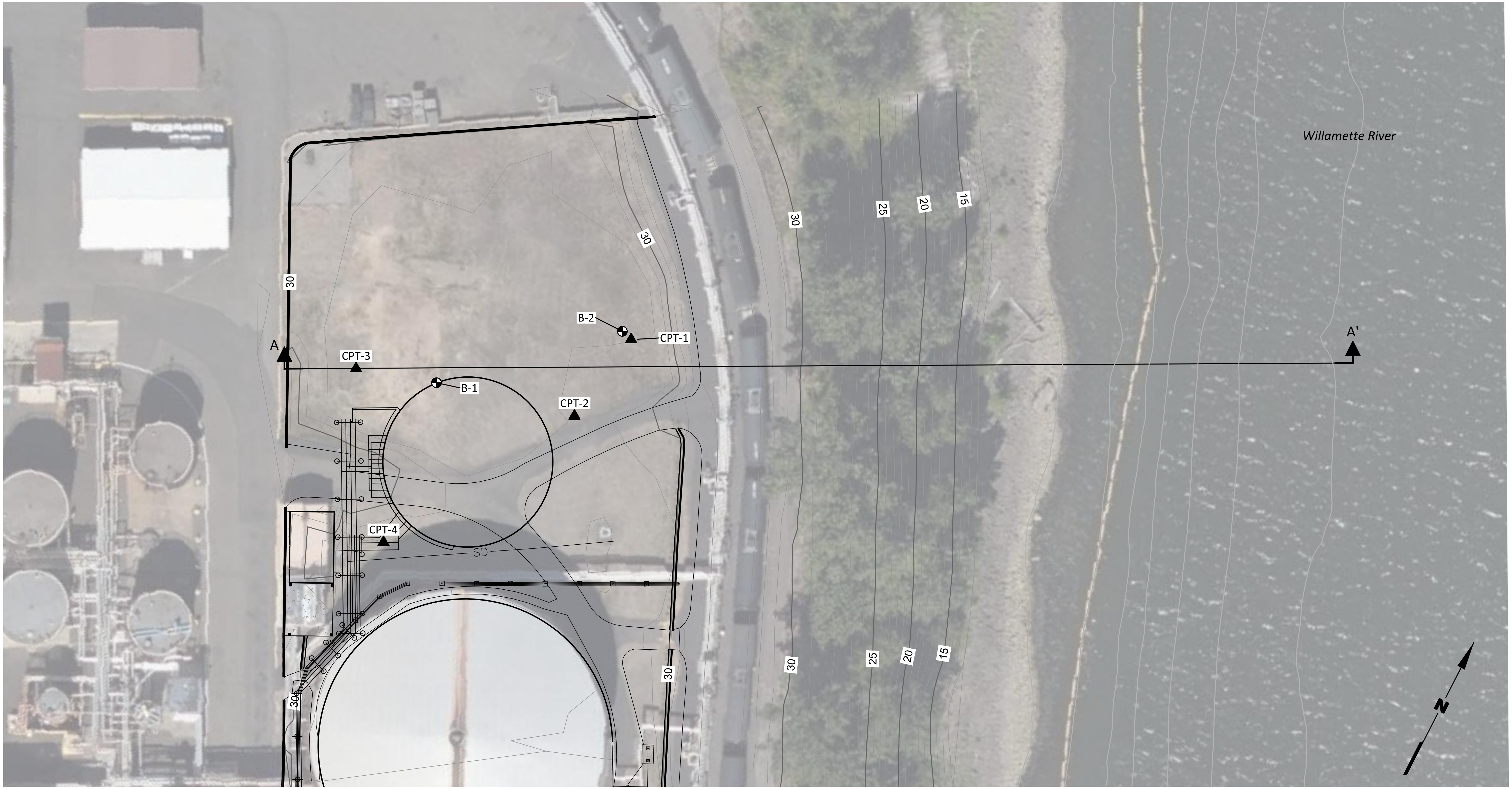
Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Vicinity Map

Figure
1



Notes

1. Ground surface survey by Norwest Engineering, Inc. dated 7/26/2021. Vertical Datum: City of Portland

2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

B-1 ◐	Approximate Boring Location and Designation
CPT-1 ▲	Approximate Cone Penetration Test Location and Designation
—20—	Elevation Contour
A A'	Cross-Section View Location and Designation

0 40 80
Scale in Feet

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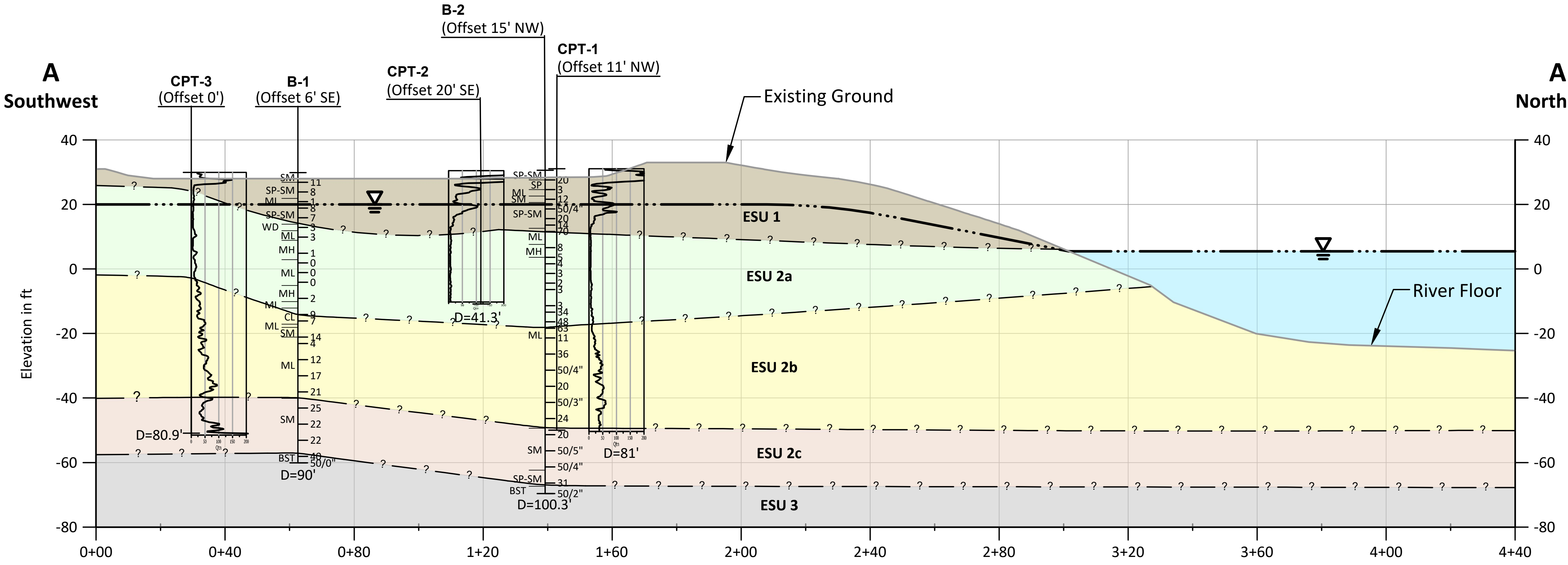
Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Site and Exploration Location Plan

Figure
2

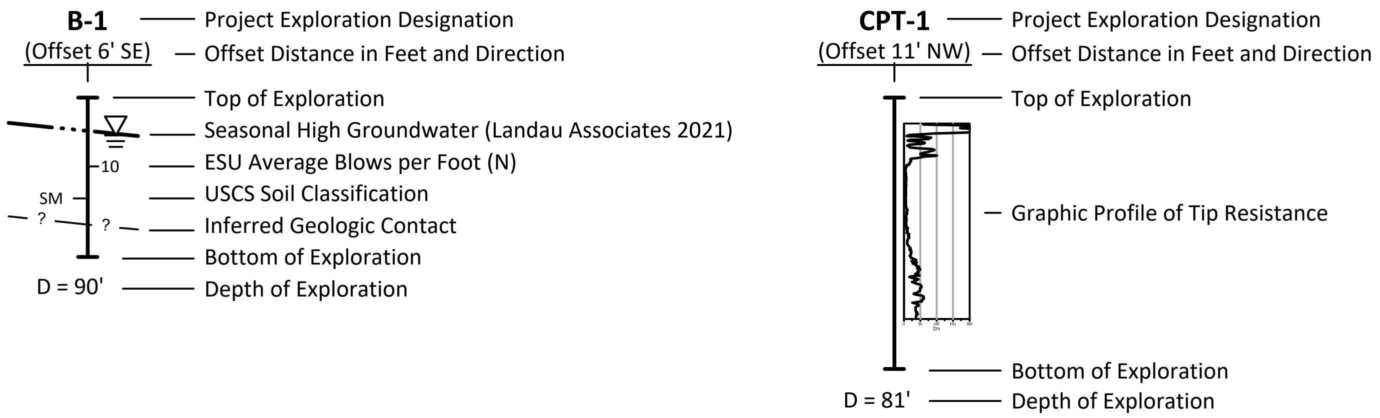


Geologic Profile Alignment A-A'

Horizontal Scale in Feet: 1"=40'
Vertical Scale in Feet: 1"=40'

0 40 80
Scale in Feet

Legend



Notes:

1. Vertical Datum: City of Portland
2. ESU = Engineering Stratigraphic Unit
3. For cross-section location, see Figure 2.
4. See main text and boring logs for description of soil conditions encountered in the field explorations.
5. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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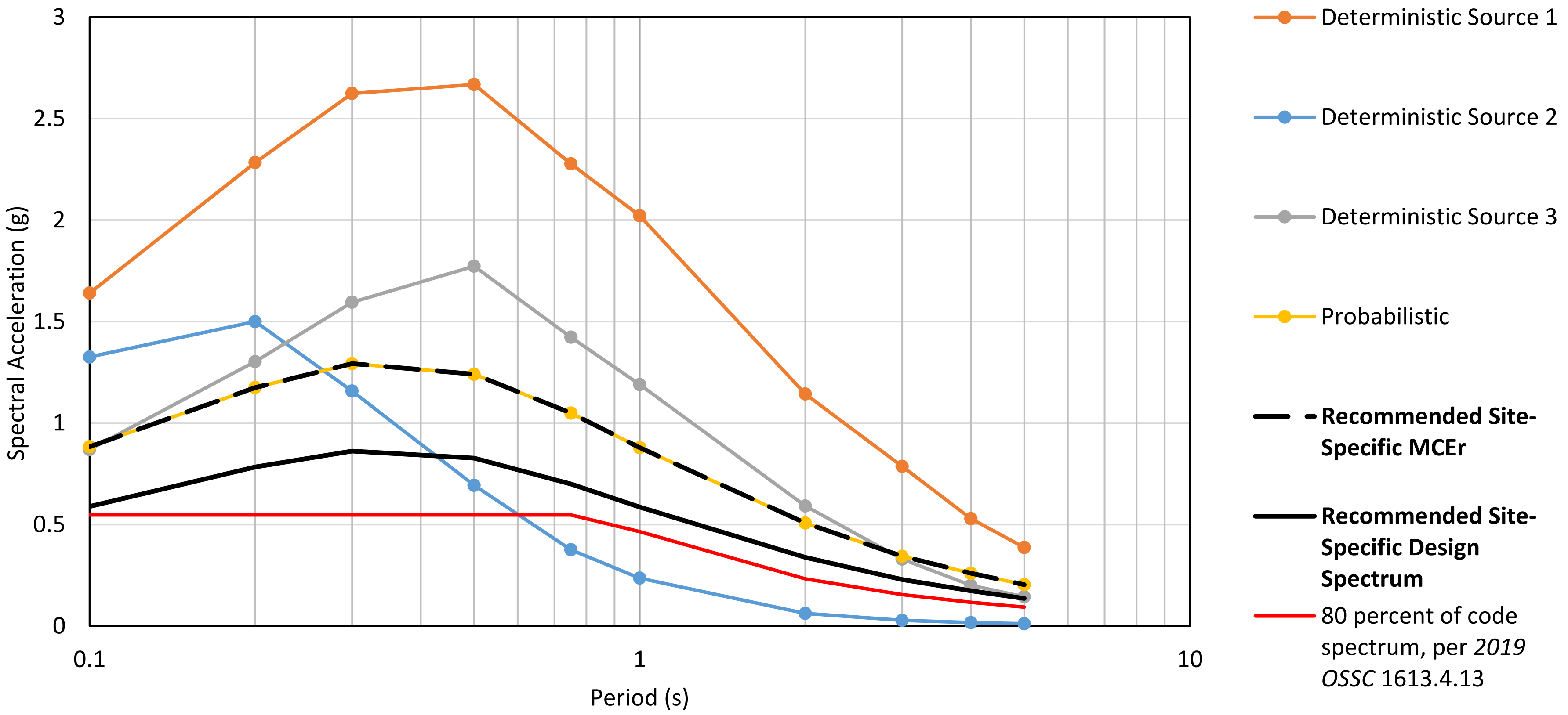
Geologic Profile A-A'

Figure
3



Notes:

1. Refer to main text for explanation of the ground motion hazard analysis and description of source parameters.
2. Black and white reproduction of this multicolor figure may lead to incorrect interpretation.
3. The 80 percent code spectrum is determined using a 65 percent contribution to total hazard by the Cascadia Subduction Zone, based on the 2014 US Geological Survey disaggregation for the site at the 1-second spectral ordinate, resulting in F_v = 2.1 (see Section 1613.4.13 of the *2019 OSSC*).

Parameter	Calculation	Value (g)
S_{DS}	90% of S_{aD} [T>=0.2s]	0.776
S_{D1}	max{T x S_{aD} [1s <= T <= 5s]}	0.693
S_{MS}	1.5 x S_{DS}	1.163
S_{M1}	1.5 x S_{D1}	1.039

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Portland, Oregon

Ground Motion Hazard Analysis

Figure
4

APPENDIX A

Field Explorations

APPENDIX A

FIELD EXPLORATIONS

Between June 24 and 29, 2021, Western States Soil Conservation, Inc., subcontracted by Landau Associates, Inc. (LAI), advanced two mud rotary borings (B-1 and B-2) at the approximate locations shown on Figure 2. Boring B-1 was advanced 90.5 feet (ft) below ground surface (bgs), and boring B-2 100.3 ft bgs. Hollow-stem auger drilling was used to advance the first 10 ft of borings B-1 and B-2.

LAI personnel monitored the field explorations, obtained representative soil samples, maintained a detailed record of the subsurface soil and groundwater conditions observed, and described the soil by visual and textural examination. Each representative soil type was described using the soil classification system shown on Figure A-1, in general accordance with ASTM International (ASTM) standard test method D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).* Summary logs of the explorations are presented on Figures A-2 and A-3. The stratigraphic contacts shown on the logs represent the approximate boundaries between soil types; actual transitions may be more gradual.

Disturbed soil samples were obtained at regular intervals using a 1.5-inch-inside-diameter, standard penetration test split-spoon sampler. A 140-pound automatic hammer, falling approximately 30 inches, was used to drive the sampler 18 inches (or a portion thereof) into the undisturbed soil. The number of blows required to drive the sampler for the final 12 inches of soil penetration (or a portion thereof) is noted on the boring logs, adjacent to the appropriate sample notation.

During advancement of boring B-2, the drill rig broke down at approximately 10 ft bgs and was replaced with a different rig. The automatic trip hammer on the new rig sporadically malfunctioned, delivering below-average energy that resulted in artificially inflated blow counts. Samples with blow counts presumed to be inflated are noted on the summary boring log.

Upon completion of fieldwork, the boreholes were decommissioned in general accordance with local requirements. Samples were sealed in plastic bags and transported to LAI's soils laboratory for further examination and testing.

Cone Penetration Tests

On August 27, 2020, Oregon Geotechnical Explorations, Inc., subcontracted by LAI, advanced four cone penetration test (CPT) soundings (CPT-1 through CPT-4) at the approximate locations shown on Figure 2. CPT soundings were advanced in general accordance with ASTM standard test method D5778, *Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils*. Cone tip pressure, sleeve friction, and pore water pressure measurements were collected at approximately 2-inch intervals. Seismic shear wave velocity measurements were collected at 1-meter (3.28 ft) intervals. CPT data are included at the end of this appendix.

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL(1)	TYPICAL DESCRIPTIONS (2)(3)
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)	▨	**GW**	Well-graded gravel; gravel/sand mixture(s); little or no fines
			▨	**GP**	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)	▨	**GM**	Silty gravel; gravel/sand/silt mixture(s)
			▨	**GC**	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)	▨	**SW**	Well-graded sand; gravelly sand; little or no fines
			▨	**SP**	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)	▨	**SM**	Silty sand; sand/silt mixture(s)
			▨	**SC**	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)		▨	**ML**	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
			▨	**CL**	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
			▨	**OL**	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)		▨	**MH**	Inorganic silt; micaceous or diatomaceous fine sand
			▨	**CH**	Inorganic clay of high plasticity; fat clay
			▨	**OH**	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL		▨	**PT**	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT	■ ▨	**AC** or **PC**	Asphalt concrete pavement or Portland cement pavement
ROCK	▨	**RK**	Rock (See Rock Classification)
WOOD	▨	**WD**	Wood, lumber, wood chips
DEBRIS	▨	**DB**	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50%	- "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50%	- "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30%	- "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15%	- "with gravel," "with sand," "with silt," etc.
	≤ 5%	- "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

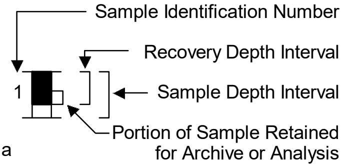
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽	Approximate water level at time of drilling (ATD)
▼	Approximate water level at time after drilling/excavation/well

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Portland, Oregon

Soil Classification System and Key

Figure
A-1

B-1

LAI Project No: 1374018.020

SAMPLE DATA / SOIL PROFILE

Drilling Method: Mud Rotary

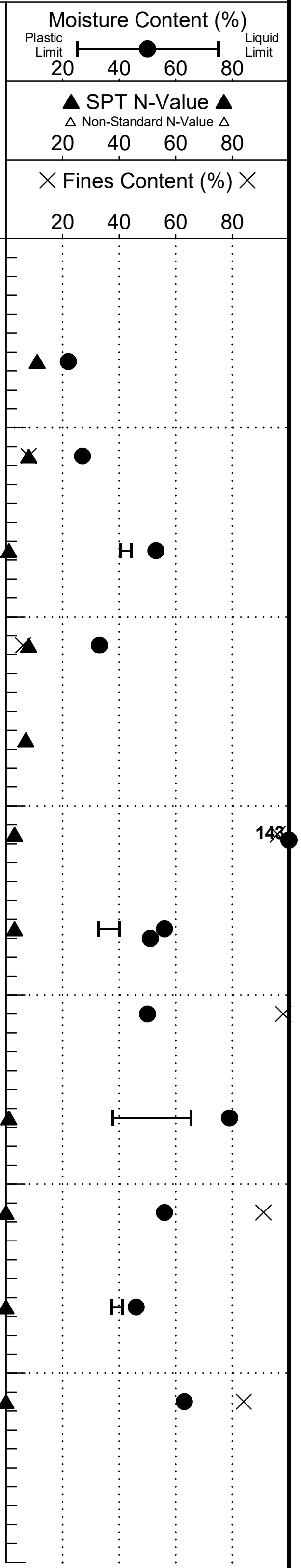
Ground Elevation (ft): Not Measured

Drilled By: Western States Soil Conservation

Logged By: CAL   Date: 06/24/21

Groundwater: Groundwater Not Determined

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Description
0						SM	Brown, silty, fine to coarse SAND with trace organics (loose, damp) **(FILL)**
		S-1	b2	11	W = 22	SP-SM	Dark gray, fine to coarse SAND with silt (medium dense, moist)
5		S-2	b2	8	W = 27 -200 = 8		-Grades to loose and wet at 5.0 ft bgs
		S-3	b2	1	W = 53 GS AL	ML	Gray SILT (very soft, wet) -Seam of organics at 8.1 ft bgs
10		S-4	b2	8	W = 33 -200 = 6	SP-SM	Dark gray, fine to coarse SAND with silt (loose, wet)
		S-5	b2	7			
15							-Grades to very loose
		S-6A S-6B	b2	3	GS W = 143	WD	-Lens of silt with wood debris observed Orange-brown, fine WOOD DEBRIS (very loose, wet)
		S-7A S-7B	b2	3	W = 56 AL W = 51	ML	Gray SILT with wood debris (soft, wet) -Grades to moist to wet, with trace organics, and without wood debris
20		S-8	c3		CO W = 50 GS	MH	Gray, elastic SILT with trace organics (very soft, moist to wet) **(ALLUVIUM)**
		S-9	b2	1	W = 79 AL		-Grades to gray-brown
25		S-10	b2	0	W = 56 GS		
		S-11	b2	0	W = 46 GS AL	ML	Dark gray SILT (very soft, moist to wet)
30		S-12	b2	0	W = 63 GS		-Grades to gray and with fine sand
		S-13	c3				
35							



Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Asphalt Terminal Final Design
Portland, Oregon

Log of Boring B-1

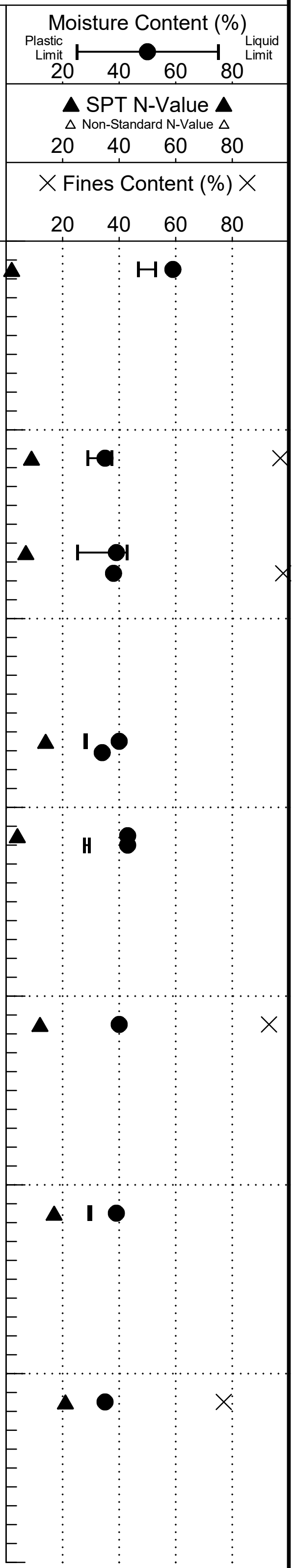
Figure
A-2
(1 of 3)

B-1

LAI Project No: 1374018.020

Drilling Method: Mud Rotary
Ground Elevation (ft): Not Measured
Drilled By: Western States Soil Conservation
Logged By: CAL Date: 06/24/21

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Groundwater
35		S-14	b2	2	W = 59 AL	MH	Gray, elastic SILT (very soft, moist)	Groundwater Not Determined
		S-15	b2					
40		S-16	b2	9	W = 35 GS AL	ML	Blue-gray to gray SILT (stiff, moist)	
		S-17A S-17B	b2	7	W = 39 GS AL W = 38 -200 = 98	CL	Gray-brown CLAY (medium stiff, moist) -Observed minor iron staining	
45		S-18	c3				-Grades to gray	
						ML	Gray-brown SILT (stiff, wet)	
		S-19A S-19B	b2	14	W = 40 AL W = 34	SM	Gray-brown, silty, fine to coarse SAND (medium dense, wet)	
50		S-20A S-20B	b2	4	W = 43 W = 43 GS AL	ML	Gray-brown to brown SILT (soft, wet)	
55		S-21	b2	12	W = 40 GS		-Grades to stiff and with fine sand	
60		S-22	b2	17	W = 39 GS AL		-Grades to very stiff, moist to wet, and without sand -Observed vertical laminations between 60.0 and 60.5 ft	
65		S-23	b2	21	W = 35 GS			
70								



Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Asphalt Terminal Final Design
Portland, Oregon

Log of Boring B-1

Figure
A-2
(2 of 3)

B-1

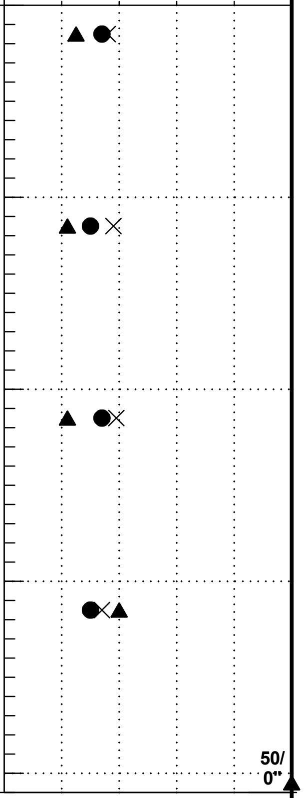
LAI Project No: 1374018.020

SAMPLE DATA / SOIL PROFILE

Drilling Method: Mud Rotary
Ground Elevation (ft): Not Measured
Drilled By: Western States Soil Conservation
Logged By: CAL Date: 06/24/21

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Description	Groundwater
70		S-24	b2	25	W = 34 -200 = 36	SM	Gray-brown, very silty, fine to medium SAND (medium dense, wet)	Groundwater Not Determined
75		S-25	b2	22	W = 30 -200 = 38		-Grades to gray	
80		S-26	b2	22	W = 34 -200 = 39		-Grades to brown	
85		S-27	b2	40	W = 30 -200 = 34		-Grades to iron stained and dense	
						BST	Basalt (very dense, damp) **(BASALT)** -Drill rig chatter between 87.5 and 90.0 ft bgs	
90		S-28	b2	50/ 0"				
95								
100								
105								

Moisture Content (%) — Plastic Limit, Liquid Limit — 20 40 60 80
▲ SPT N-Value ▲ — △ Non-Standard N-Value △ — 20 40 60 80
× Fines Content (%) × — 20 40 60 80



Boring Completed 06/24/21
Total Depth of Boring = 90.5 ft.

ft = feet
bgs = below ground surface

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Log of Boring B-1

Figure
A-2
(3 of 3)

B-2

LAI Project No: 1374018.020

SAMPLE DATA

Sample Number & Interval	Sampler Type	Blows/Foot	Test Data
S-1	b2	20	W = 9
S-2	b2	3	W = 34
S-3	b2	12	W = 39
S-4	b2	50/ 4"	
S-5	b2	20	W = 23 -200 = 7
S-6	b2	14	W = 34 -200 = 10
S-7	b2	70	W = 44 AL
S-8	c3		CO W = 42 GS AL
S-9	b2	8	W = 57 GS AL
S-10	b2	5	W = 52 GS
S-11	b2	4	W = 49 GS
S-12	b2	3	W = 50 GS AL
S-13	b2	2	W = 59

SOIL PROFILE

Drilling Method: Mud Rotary

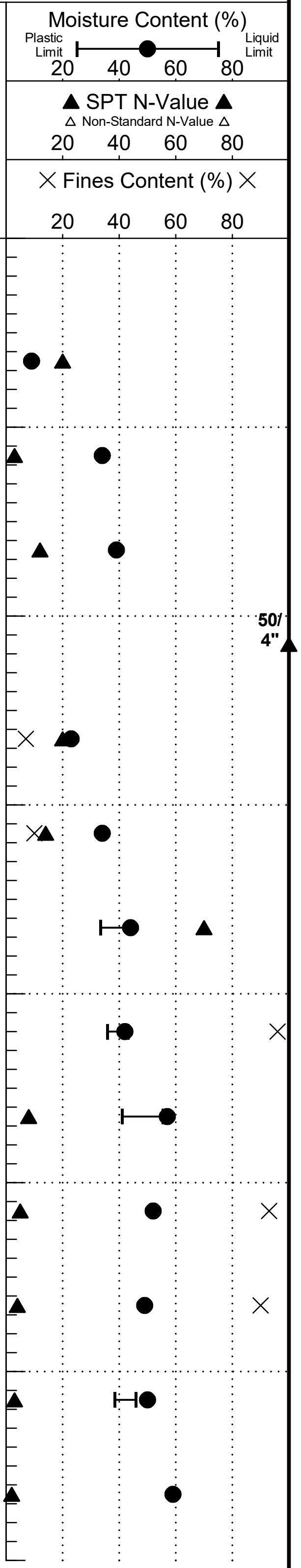
Ground Elevation (ft): Not Measured

Drilled By: Western States Soil Conservation

Logged By: CAL Date: 06/25/21

USCS Symbol	Description
SP-SM	Brown, fine to coarse SAND with silt and trace organics (loose, damp to moist) **(FILL)**
SP	Brown, fine to coarse SAND (medium dense, moist) -Grades to very loose and wet
ML	Dark gray to gray SILT (soft, wet)
SM	Light brown, silty, fine to coarse SAND with organics (medium dense, wet) -Grades to black -Grades to gray
SP-SM	Dark gray to gray, fine to coarse SAND with gravel and silt (very dense, wet) -Blow counts in error due to hammer malfunction -Grades to medium dense -Grades to with wood debris
ML	Gray SILT with trace organics (hard, wet) -Seam of silty sand at 8.1 ft bgs -Blow counts in error due to hammer malfunction
MH	Light gray to gray, elastic SILT with organics (medium stiff, wet) **(ALLUVIUM)** -Minor iron staining -Grades to gray and without organics
ML	Dark gray SILT (soft, moist to wet) -Grades to with trace organics -Wood debris between 33.5 and 33.7 ft bgs

Groundwater: ATD



Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Log of Boring B-2

B-2

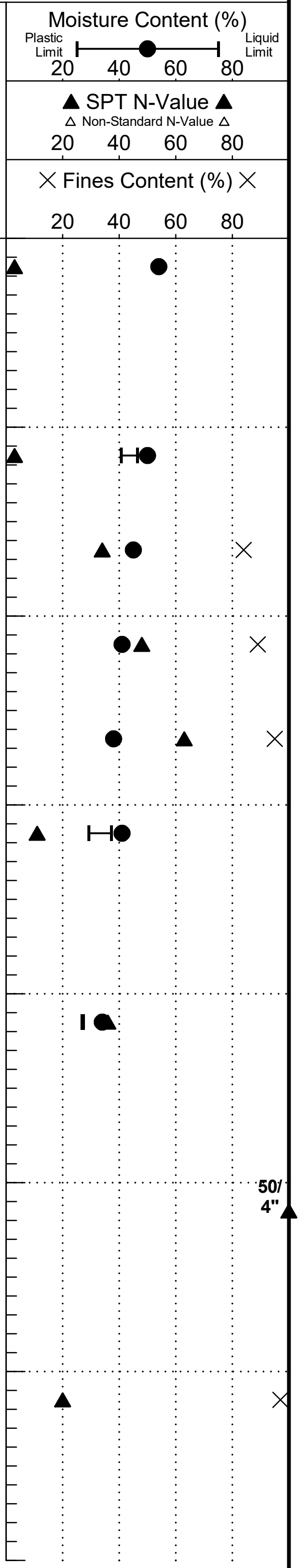
LAI Project No: 1374018.020

SAMPLE DATA

SOIL PROFILE

Drilling Method: Mud Rotary
Ground Elevation (ft): Not Measured
Drilled By: Western States Soil Conservation
Logged By: CAL Date: 06/25/21

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Description
35		S-14	b2	3	W = 54 GS	ML	Dark gray SILT with trace organics (soft, moist to wet)
		S-15	c3				
40		S-16	b2	3	W = 50 GS AL		
		S-17	b2	34	W = 45 GS		-Grades to hard -Wood debris between 42.5 and 44.0 ft bgs
45		S-18	b2	48	W = 41 GS	ML	Light gray to blue-gray SILT (hard, moist to wet) -Slickensides between 45.7 and 45.8 ft bgs
		S-19	b2	63	W = 38 GS		-Grades to wet
50		S-20	b2	11	W = 41 GS AL		-Grades to moist to wet -Grades to gray-brown, stiff, and with organics
55		S-21	b2	36	W = 34 GS AL		-Grades to brown, hard and wet
60		S-22	b2	50/ 4"	GS		-Blow counts in error due to hammer malfunction
65		S-23	b2	20	GS		-Grades to very stiff
70							



Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

1374018.02 1/13/22 C:\USERS\MSKINNER\DESKTOP\1374018.020.GPJ SOIL BORING LOG WITH GRAPH

LANDAU ASSOCIATES

Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Log of Boring B-2

Figure
A-3
(2 of 3)

B-2

LAI Project No: 1374018.020

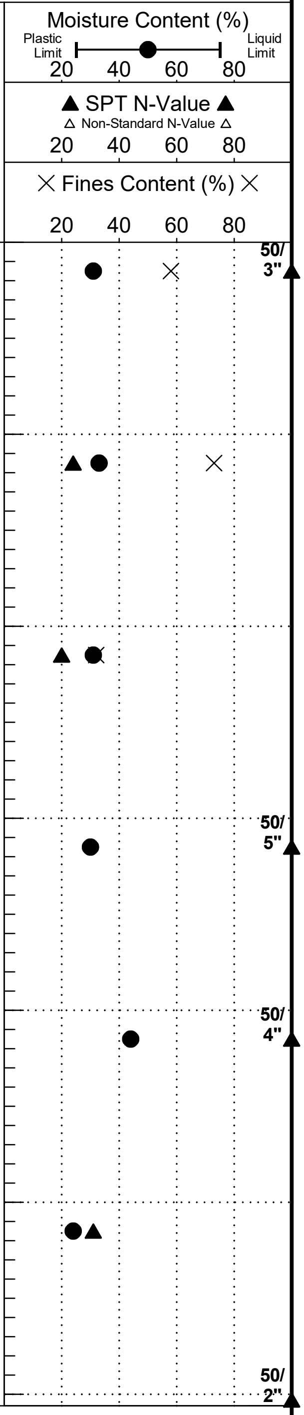
Drilling Method: Mud Rotary

Ground Elevation (ft): Not Measured

Drilled By: Western States Soil Conservation

Logged By: CAL Date: 06/25/21

Depth (ft)	Elevation (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Soil Profile	Groundwater
70		S-24	b2	50/ 3"	W = 31 -200 = 58	ML	Gray, very sandy SILT with organics (hard, wet) -Blow counts in error due to hammer malfunction	
75		S-25	b2	24	W = 33 -200 = 73		-Grades to gray-brown, sandy, and very stiff	
80		S-26	b2	20	W = 31 -200 = 32	SM	Gray-brown, very silty, fine SAND (medium dense, wet)	
85		S-27	b2	50/ 5"	W = 30		-Grades to very dense	
90		S-28	b2	50/ 4"	W = 44		-Grades to moist to wet	
						SP- SM	Gray-brown, fine SAND with silt (dense, wet)	
95		S-29	b2	31	W = 24		-Iron staining between 95.6 and 96.2 ft bgs	
						BST	Basalt (very dense, damp) **(BASALT)**	
100		S-30	b2	50/ 2"				
105								



Boring Completed 06/25/21
Total Depth of Boring = 100.3 ft.

ft = feet
bgs = below ground surface

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

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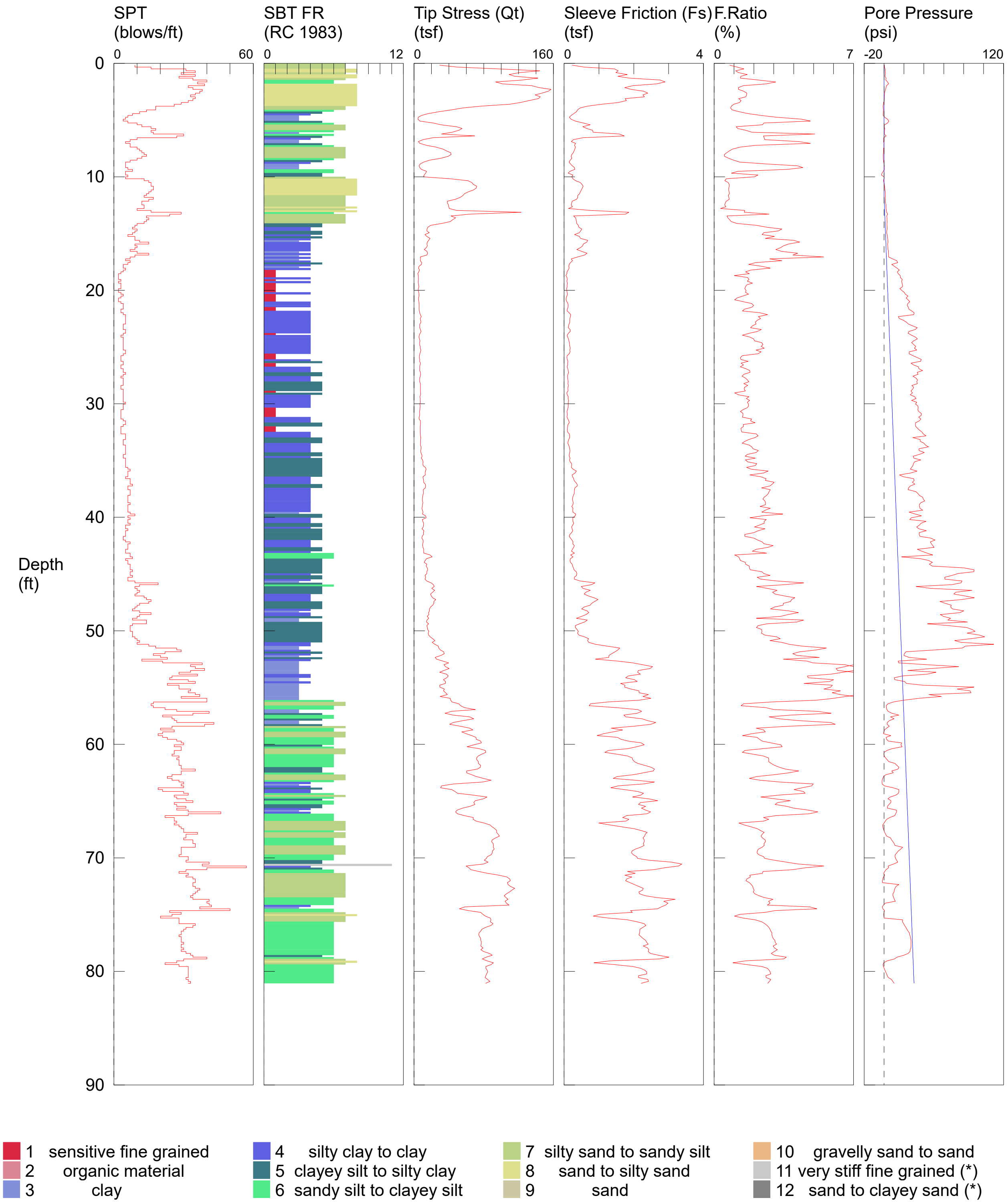
Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Log of Boring B-2

Figure
A-3
(3 of 3)

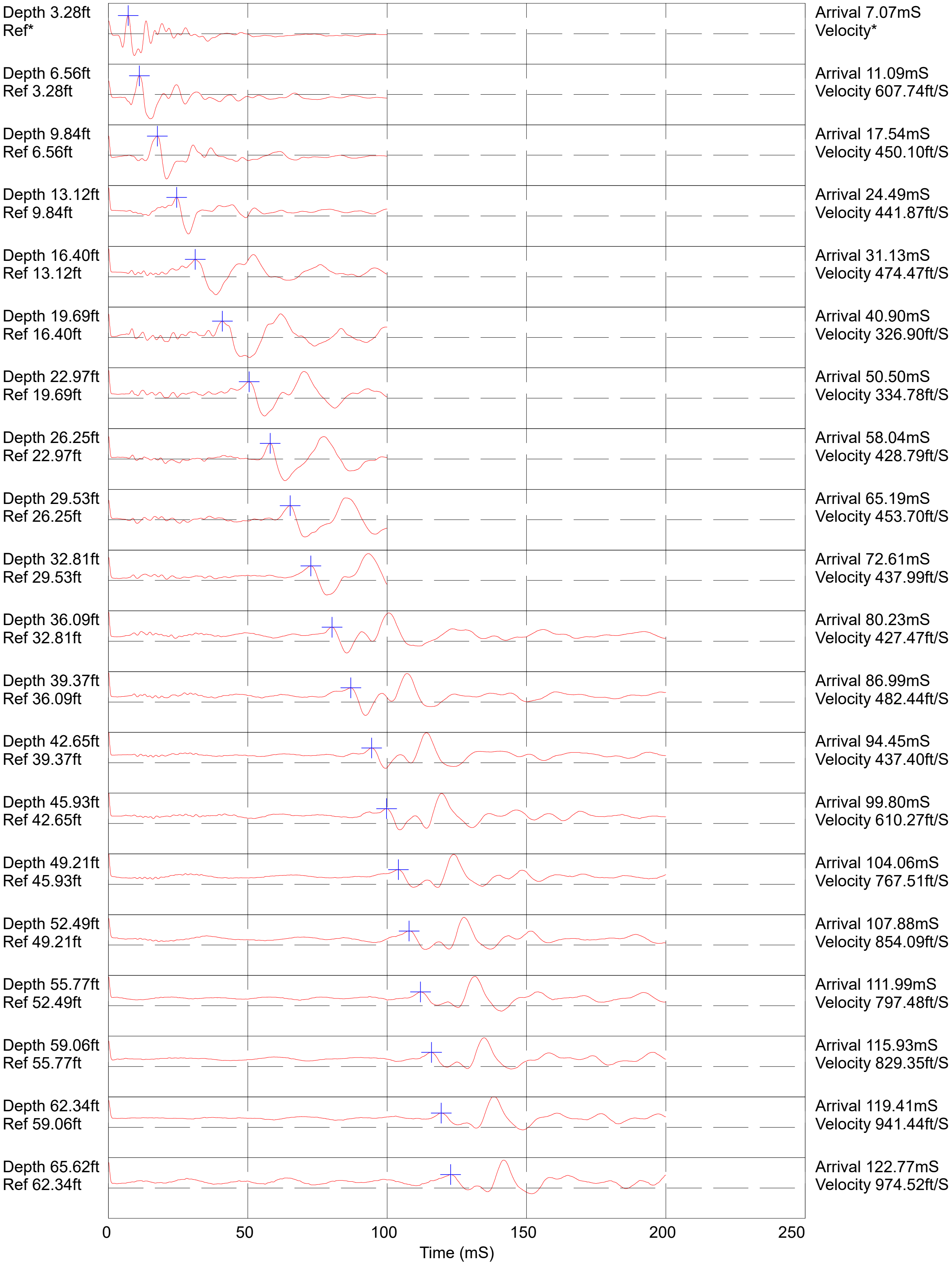
Landau Associates / CPT-1 / 11910 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-1
TEST DATE: 8/27/2020 9:56:01 AM
TOTAL DEPTH: 81.037 ft



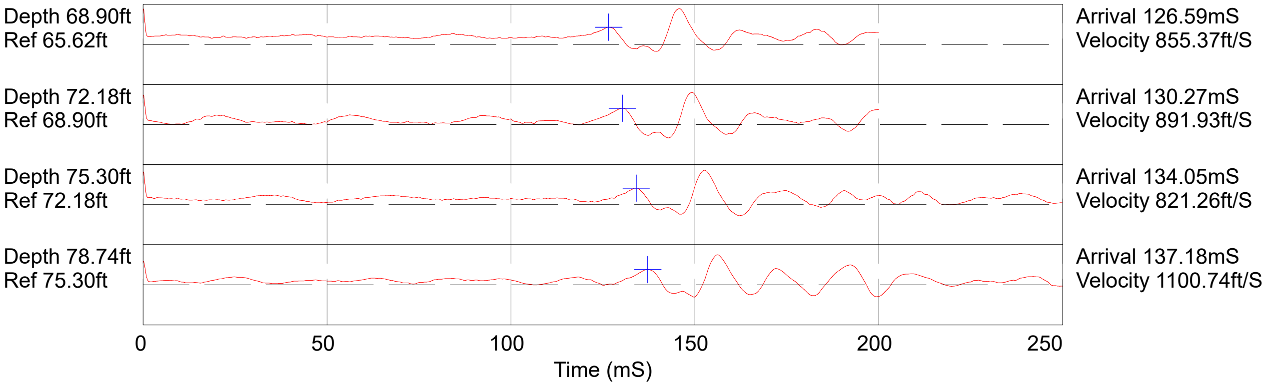
*SBT/SPT CORRELATION: UBC-1983

COMMENT: Landau Associates / CPT-1 / 1191 NW St. Helens Road Portland



Hammer to Rod String Distance (ft): 4.27
* = Not Determined

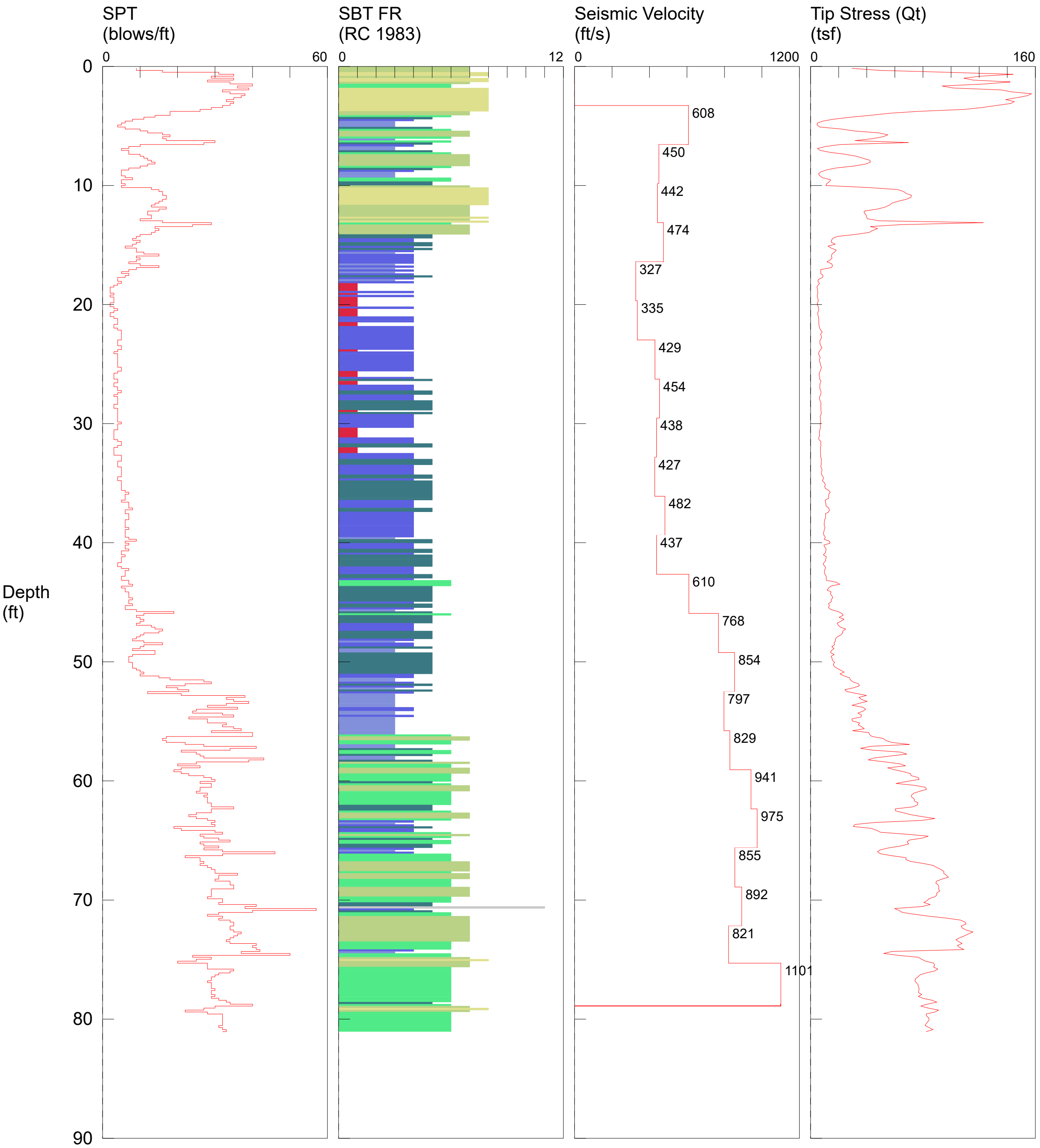
COMMENT: Landau Associates / CPT-1 / 1191 NW St. Helens Road Portland



Hammer to Rod String Distance (ft): 4.27
* = Not Determined

Landau Associates / CPT-1 / 11910 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-1
TEST DATE: 8/27/2020 9:56:01 AM
TOTAL DEPTH: 81.037 ft



🟥 1 sensitive fine grained
🟥 2 organic material
🟦 3 clay
*SBT/SPT CORRELATION: UBC-1983

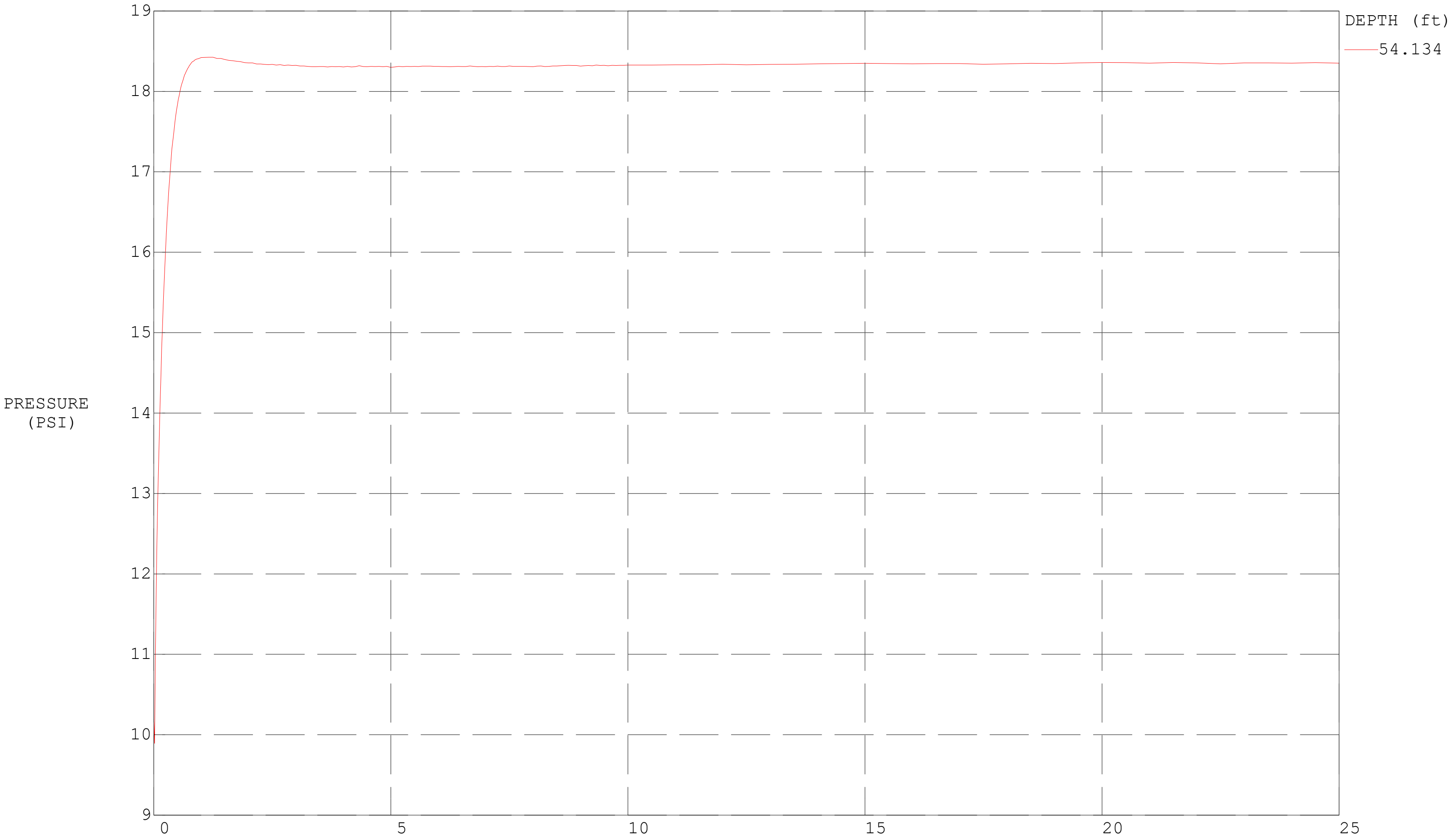
🟦 4 silty clay to clay
🟩 5 clayey silt to silty clay
🟩 6 sandy silt to clayey silt

🟩 7 silty sand to sandy silt
🟨 8 sand to silty sand
🟫 9 sand

🟧 10 gravelly sand to sand
⬜ 11 very stiff fine grained (*)
⬛ 12 sand to clayey sand (*)

COMMENT: Landau Associates / CPT-1 / 1191 NW St. Helens Road Portland

TEST DATE: 8/27/2020 9:56:01 AM



MAXIMUM PRESSURE = 18.426 (PSI)

HYDROSTATIC PRESSURE = 18.392 (PSI), WATER TABLE: 11.70 ft

Landau Associates / CPT-1 / 11910 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-1
TEST DATE: 8/27/2020 9:56:01 AM
TOTAL DEPTH: 81.037 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
0.164	29.40	0.2305	0.784	0.287	9	7	silty sand to sandy silt
0.328	49.44	0.5667	1.146	0.444	16	7	silty sand to sandy silt
0.492	96.86	1.4463	1.493	0.908	31	7	silty sand to sandy silt
0.656	144.23	1.5526	1.076	1.038	35	8	sand to silty sand
0.820	121.07	1.4835	1.225	1.413	29	8	sand to silty sand
0.984	109.19	1.8084	1.656	1.091	35	7	silty sand to sandy silt
1.148	115.61	1.5459	1.337	0.820	28	8	sand to silty sand
1.312	141.95	1.8756	1.321	2.028	34	8	sand to silty sand
1.476	124.30	2.7545	2.216	1.557	40	7	silty sand to sandy silt
1.640	93.58	2.9001	3.099	3.545	36	6	sandy silt to clayey silt
1.804	101.54	2.6527	2.613	4.519	39	6	sandy silt to clayey silt
1.969	135.24	1.9738	1.460	2.350	32	8	sand to silty sand
2.133	143.52	1.7385	1.211	1.855	34	8	sand to silty sand
2.297	157.23	1.9252	1.224	1.488	38	8	sand to silty sand
2.461	154.22	2.2813	1.479	0.820	37	8	sand to silty sand
2.625	146.79	2.4006	1.635	0.570	35	8	sand to silty sand
2.789	138.97	2.2608	1.627	0.264	33	8	sand to silty sand
2.953	144.93	2.3063	1.591	0.189	35	8	sand to silty sand
3.117	142.64	1.7506	1.227	0.168	34	8	sand to silty sand
3.281	132.09	1.7885	1.354	0.104	32	8	sand to silty sand
3.445	122.28	1.5605	1.276	-0.596	29	8	sand to silty sand
3.609	109.60	1.0748	0.981	-0.663	26	8	sand to silty sand
3.773	75.94	0.6585	0.867	-1.075	18	8	sand to silty sand
3.937	55.89	0.4589	0.821	-0.937	18	7	silty sand to sandy silt
4.101	42.48	0.3860	0.909	-0.820	14	7	silty sand to sandy silt
4.265	28.57	0.3565	1.248	-0.860	11	6	sandy silt to clayey silt
4.429	16.23	0.2779	1.712	-0.921	8	5	clayey silt to silty clay
4.593	8.81	0.2067	2.346	-0.985	6	4	silty clay to clay
4.757	4.83	0.1508	3.124	0.546	5	3	clay
4.921	4.51	0.1978	4.388	3.306	4	3	clay
5.085	6.58	0.3179	4.834	4.655	6	3	clay
5.249	21.88	0.5459	2.495	3.553	10	5	clayey silt to silty clay
5.413	30.80	0.7473	2.426	0.399	12	6	sandy silt to clayey silt
5.577	48.73	0.5381	1.104	0.149	16	7	silty sand to sandy silt
5.741	55.07	0.6504	1.181	0.703	18	7	silty sand to sandy silt
5.906	51.57	0.8198	1.590	0.450	16	7	silty sand to sandy silt
6.070	43.86	0.8306	1.894	0.271	17	6	sandy silt to clayey silt
6.234	31.50	1.5902	5.049	0.133	30	3	clay
6.398	69.62	1.7234	2.475	2.041	27	6	sandy silt to clayey silt
6.562	21.48	0.5393	2.511	-0.474	10	5	clayey silt to silty clay
6.726	10.37	0.2632	2.539	-0.410	7	4	silty clay to clay
6.890	4.95	0.2100	4.245	-0.586	5	3	clay
7.054	6.79	0.3278	4.826	-0.274	7	3	clay
7.218	14.18	0.2989	2.107	-0.309	7	5	clayey silt to silty clay

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7.382	24.87	0.3252	1.308	-0.248	10	6	sandy silt to clayey silt
7.546	32.90	0.3068	0.933	-0.657	11	7	silty sand to sandy silt
7.710	37.07	0.2857	0.771	-0.516	12	7	silty sand to sandy silt
7.874	42.11	0.2648	0.629	-0.806	13	7	silty sand to sandy silt
8.038	42.49	0.2188	0.515	-0.889	14	7	silty sand to sandy silt
8.202	39.16	0.2029	0.518	-0.905	12	7	silty sand to sandy silt
8.366	30.87	0.2234	0.724	-0.916	10	7	silty sand to sandy silt
8.530	17.89	0.1745	0.975	-0.759	7	6	sandy silt to clayey silt
8.694	10.91	0.1401	1.284	-0.476	5	5	clayey silt to silty clay
8.858	7.17	0.1843	2.572	-0.210	5	4	silty clay to clay
9.022	5.59	0.2345	4.195	0.136	5	3	clay
9.186	6.65	0.2961	4.455	0.077	6	3	clay
9.350	8.42	0.3082	3.661	0.226	8	3	clay
9.514	14.33	0.1702	1.188	-0.878	5	6	sandy silt to clayey silt
9.678	13.43	0.1173	0.873	-2.209	5	6	sandy silt to clayey silt
9.843	11.52	0.2528	2.195	-2.555	6	5	clayey silt to silty clay
10.007	10.83	0.2189	2.022	-0.197	5	5	clayey silt to silty clay
10.171	41.37	0.2530	0.612	-0.293	13	7	silty sand to sandy silt
10.335	61.87	0.3298	0.533	-0.676	15	8	sand to silty sand
10.499	66.15	0.4625	0.699	-0.237	16	8	sand to silty sand
10.663	68.04	0.5153	0.757	0.189	16	8	sand to silty sand
10.827	71.87	0.5445	0.758	0.594	17	8	sand to silty sand
10.991	71.40	0.5217	0.731	0.761	17	8	sand to silty sand
11.155	68.23	0.4948	0.725	0.865	16	8	sand to silty sand
11.319	62.28	0.4666	0.749	1.019	15	8	sand to silty sand
11.483	57.91	0.4435	0.766	1.110	14	8	sand to silty sand
11.647	56.23	0.3940	0.701	1.206	13	8	sand to silty sand
11.811	53.18	0.3917	0.737	1.307	17	7	silty sand to sandy silt
11.975	47.52	0.3601	0.758	1.387	15	7	silty sand to sandy silt
12.139	38.12	0.2323	0.609	1.403	12	7	silty sand to sandy silt
12.303	38.15	0.2135	0.560	1.464	12	7	silty sand to sandy silt
12.467	39.46	0.2067	0.524	1.834	13	7	silty sand to sandy silt
12.631	39.82	0.2348	0.590	1.932	13	7	silty sand to sandy silt
12.795	40.39	0.1296	0.321	2.031	10	8	sand to silty sand
12.959	48.83	0.7499	1.536	2.177	16	7	silty sand to sandy silt
13.123	122.95	1.8547	1.508	2.515	29	8	sand to silty sand
13.287	63.89	1.7605	2.756	3.495	24	6	sandy silt to clayey silt
13.451	42.47	0.2733	0.644	2.659	14	7	silty sand to sandy silt
13.615	47.66	0.3275	0.687	2.824	15	7	silty sand to sandy silt
13.780	44.00	0.3451	0.784	2.885	14	7	silty sand to sandy silt
13.944	41.64	0.3551	0.853	2.936	13	7	silty sand to sandy silt
14.108	31.58	0.3635	1.151	2.920	10	7	silty sand to sandy silt
14.272	19.24	0.4072	2.116	2.901	9	5	clayey silt to silty clay
14.436	15.83	0.4192	2.648	2.981	8	5	clayey silt to silty clay
14.600	14.89	0.5058	3.398	2.946	10	4	silty clay to clay
14.764	14.70	0.4724	3.215	2.638	9	4	silty clay to clay
14.928	17.44	0.4343	2.491	2.454	8	5	clayey silt to silty clay
15.092	12.48	0.3000	2.405	2.986	6	5	clayey silt to silty clay
15.256	14.57	0.4407	3.024	3.348	9	4	silty clay to clay
15.420	18.25	0.4700	2.576	3.521	9	5	clayey silt to silty clay
15.584	16.97	0.6757	3.981	3.843	11	4	silty clay to clay
15.748	15.23	0.6540	4.294	3.915	15	3	clay
15.912	14.82	0.5528	3.730	3.532	9	4	silty clay to clay

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16.076	15.23	0.5308	3.485	3.641	10	4	silty clay to clay
16.240	14.07	0.4702	3.341	3.851	9	4	silty clay to clay
16.404	11.66	0.3613	3.098	3.979	7	4	silty clay to clay
16.568	14.91	0.5031	3.375	4.285	10	4	silty clay to clay
16.732	15.63	0.6553	4.194	4.272	15	3	clay
16.896	14.77	0.5847	3.960	4.413	9	4	silty clay to clay
17.060	7.10	0.3903	5.498	4.490	7	3	clay
17.224	7.31	0.2042	2.793	8.568	5	4	silty clay to clay
17.388	7.14	0.2424	3.396	12.632	7	3	clay
17.552	8.83	0.1836	2.080	13.660	6	4	silty clay to clay
17.717	8.46	0.1471	1.739	7.623	4	5	clayey silt to silty clay
17.881	5.59	0.1341	2.399	10.295	4	4	silty clay to clay
18.045	5.11	0.1435	2.810	12.965	5	3	clay
18.209	6.29	0.1162	1.847	15.249	4	4	silty clay to clay
18.373	5.35	0.0841	1.571	13.330	3	1	sensitive fine grained
18.537	4.47	0.0788	1.760	14.133	2	1	sensitive fine grained
18.701	4.94	0.0499	1.009	16.140	2	1	sensitive fine grained
18.865	4.95	0.0832	1.681	16.297	2	1	sensitive fine grained
19.029	5.18	0.0906	1.749	18.176	3	4	silty clay to clay
19.193	4.79	0.0796	1.662	17.609	2	1	sensitive fine grained
19.357	4.88	0.0939	1.924	18.001	3	4	silty clay to clay
19.521	5.30	0.0862	1.625	18.459	3	1	sensitive fine grained
19.685	5.49	0.0865	1.575	18.395	3	1	sensitive fine grained
19.849	4.89	0.0750	1.533	15.733	2	1	sensitive fine grained
20.013	4.75	0.0760	1.600	17.636	2	1	sensitive fine grained
20.177	5.42	0.0855	1.578	20.181	3	1	sensitive fine grained
20.341	5.69	0.0982	1.725	21.301	4	4	silty clay to clay
20.505	5.64	0.0810	1.436	24.067	3	1	sensitive fine grained
20.669	5.08	0.0582	1.145	22.081	2	1	sensitive fine grained
20.833	5.08	0.0525	1.033	24.067	2	1	sensitive fine grained
20.997	5.52	0.0810	1.468	25.861	3	1	sensitive fine grained
21.161	5.75	0.1079	1.877	23.808	4	4	silty clay to clay
21.325	5.85	0.1159	1.980	23.258	4	4	silty clay to clay
21.490	5.92	0.1120	1.891	24.186	4	4	silty clay to clay
21.654	5.90	0.0901	1.526	24.833	3	1	sensitive fine grained
21.818	6.05	0.0862	1.424	27.508	3	1	sensitive fine grained
21.982	6.48	0.1486	2.293	30.220	4	4	silty clay to clay
22.146	7.14	0.1915	2.683	29.675	5	4	silty clay to clay
22.310	8.32	0.1844	2.216	14.216	5	4	silty clay to clay
22.474	7.05	0.1643	2.330	15.206	5	4	silty clay to clay
22.638	7.66	0.1658	2.164	19.398	5	4	silty clay to clay
22.802	7.81	0.1615	2.067	22.528	5	4	silty clay to clay
22.966	6.74	0.1416	2.102	24.474	4	4	silty clay to clay
23.130	6.58	0.1264	1.920	28.573	4	4	silty clay to clay
23.294	6.60	0.1204	1.826	33.252	4	4	silty clay to clay
23.458	7.24	0.1714	2.367	31.216	5	4	silty clay to clay
23.622	8.08	0.1751	2.168	24.918	5	4	silty clay to clay
23.786	7.03	0.1242	1.767	24.037	4	4	silty clay to clay
23.950	6.02	0.0854	1.417	27.482	3	1	sensitive fine grained
24.114	5.60	0.1003	1.791	31.580	4	4	silty clay to clay
24.278	6.20	0.1228	1.982	33.332	4	4	silty clay to clay
24.442	6.86	0.1388	2.025	29.747	4	4	silty clay to clay
24.606	6.33	0.1512	2.390	27.673	4	4	silty clay to clay

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24.770	6.38	0.1565	2.453	29.725	4	4	silty clay to clay
24.934	6.94	0.1641	2.365	31.730	4	4	silty clay to clay
25.098	6.98	0.1754	2.512	30.444	4	4	silty clay to clay
25.262	7.84	0.1652	2.106	32.752	5	4	silty clay to clay
25.427	7.31	0.1726	2.362	25.211	5	4	silty clay to clay
25.591	6.75	0.1487	2.203	25.145	4	4	silty clay to clay
25.755	6.11	0.0863	1.412	29.073	3	1	sensitive fine grained
25.919	6.03	0.0796	1.320	33.361	3	1	sensitive fine grained
26.083	6.58	0.0879	1.337	37.364	3	1	sensitive fine grained
26.247	6.38	0.1085	1.701	36.728	4	4	silty clay to clay
26.411	7.39	0.1002	1.355	26.928	4	5	clayey silt to silty clay
26.575	6.85	0.1009	1.472	29.608	3	1	sensitive fine grained
26.739	6.51	0.0854	1.311	34.428	3	1	sensitive fine grained
26.903	6.57	0.1043	1.587	34.814	4	4	silty clay to clay
27.067	6.52	0.1166	1.788	38.501	4	4	silty clay to clay
27.231	7.25	0.1302	1.797	33.188	5	4	silty clay to clay
27.395	7.45	0.1113	1.494	33.952	4	5	clayey silt to silty clay
27.559	7.11	0.0996	1.401	28.852	3	5	clayey silt to silty clay
27.723	6.46	0.1008	1.560	31.817	4	4	silty clay to clay
27.887	6.42	0.1074	1.673	33.614	4	4	silty clay to clay
28.051	6.65	0.1159	1.743	32.685	4	4	silty clay to clay
28.215	7.33	0.1091	1.488	33.478	4	5	clayey silt to silty clay
28.379	7.30	0.1232	1.687	27.910	3	5	clayey silt to silty clay
28.543	7.25	0.1107	1.527	29.747	3	5	clayey silt to silty clay
28.707	7.41	0.1116	1.506	28.685	4	5	clayey silt to silty clay
28.871	7.33	0.1148	1.566	27.026	4	5	clayey silt to silty clay
29.035	7.47	0.0769	1.030	28.429	4	1	sensitive fine grained
29.199	7.52	0.0922	1.226	26.180	4	5	clayey silt to silty clay
29.364	6.75	0.1184	1.753	30.686	4	4	silty clay to clay
29.528	6.94	0.1120	1.614	31.956	4	4	silty clay to clay
29.692	6.97	0.1243	1.784	27.702	4	4	silty clay to clay
29.856	7.13	0.1187	1.664	32.682	5	4	silty clay to clay
30.020	6.78	0.1168	1.723	31.549	4	4	silty clay to clay
30.184	6.98	0.1207	1.730	33.893	4	4	silty clay to clay
30.348	6.93	0.1148	1.657	34.237	4	4	silty clay to clay
30.512	6.72	0.0972	1.446	33.758	3	1	sensitive fine grained
30.676	6.26	0.0828	1.323	34.644	3	1	sensitive fine grained
30.840	6.38	0.0925	1.450	37.290	3	1	sensitive fine grained
31.004	6.34	0.0918	1.447	37.287	3	1	sensitive fine grained
31.168	5.85	0.0830	1.419	34.620	3	1	sensitive fine grained
31.332	5.92	0.1113	1.879	36.898	4	4	silty clay to clay
31.496	7.31	0.1335	1.827	35.440	5	4	silty clay to clay
31.660	7.26	0.1489	2.050	31.676	5	4	silty clay to clay
31.824	7.41	0.1082	1.460	31.346	4	5	clayey silt to silty clay
31.988	6.94	0.1022	1.471	31.801	3	5	clayey silt to silty clay
32.152	7.03	0.0942	1.341	33.569	3	1	sensitive fine grained
32.316	6.94	0.0942	1.356	35.392	3	1	sensitive fine grained
32.480	6.99	0.0972	1.390	38.000	3	1	sensitive fine grained
32.644	7.10	0.1500	2.113	39.318	5	4	silty clay to clay
32.808	7.19	0.1586	2.205	42.073	5	4	silty clay to clay
32.972	7.77	0.1588	2.045	28.783	5	4	silty clay to clay
33.136	7.66	0.1329	1.734	36.230	4	5	clayey silt to silty clay
33.301	7.50	0.1159	1.545	36.244	4	5	clayey silt to silty clay

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33.465	7.46	0.1048	1.405	39.949	4	5	clayey silt to silty clay
33.629	7.23	0.1272	1.758	41.567	5	4	silty clay to clay
33.793	8.01	0.1510	1.884	44.479	5	4	silty clay to clay
33.957	8.14	0.1589	1.953	34.926	5	4	silty clay to clay
34.121	7.66	0.1697	2.217	35.091	5	4	silty clay to clay
34.285	7.79	0.1643	2.110	40.359	5	4	silty clay to clay
34.449	8.85	0.1473	1.664	35.424	4	5	clayey silt to silty clay
34.613	9.19	0.1430	1.556	29.180	4	5	clayey silt to silty clay
34.777	8.33	0.1725	2.070	29.821	5	4	silty clay to clay
34.941	9.77	0.1531	1.567	36.638	5	5	clayey silt to silty clay
35.105	10.44	0.1759	1.684	30.550	5	5	clayey silt to silty clay
35.269	10.04	0.2151	2.143	29.337	5	5	clayey silt to silty clay
35.433	10.43	0.2152	2.063	28.866	5	5	clayey silt to silty clay
35.597	12.86	0.2093	1.628	27.577	6	5	clayey silt to silty clay
35.761	13.96	0.2581	1.850	26.313	7	5	clayey silt to silty clay
35.925	12.99	0.3519	2.708	33.055	6	5	clayey silt to silty clay
36.089	12.75	0.3167	2.485	26.715	6	5	clayey silt to silty clay
36.253	12.91	0.2309	1.789	15.411	6	5	clayey silt to silty clay
36.417	10.33	0.2414	2.337	19.140	5	5	clayey silt to silty clay
36.581	10.60	0.2765	2.609	29.574	7	4	silty clay to clay
36.745	11.03	0.2839	2.573	30.258	7	4	silty clay to clay
36.909	11.00	0.3310	3.010	28.432	7	4	silty clay to clay
37.073	12.88	0.3757	2.917	30.771	8	4	silty clay to clay
37.238	13.42	0.3762	2.804	26.425	6	5	clayey silt to silty clay
37.402	12.90	0.3077	2.386	24.559	6	5	clayey silt to silty clay
37.566	10.58	0.2984	2.821	24.032	7	4	silty clay to clay
37.730	10.71	0.2956	2.760	31.908	7	4	silty clay to clay
37.894	10.65	0.2892	2.716	33.856	7	4	silty clay to clay
38.058	10.06	0.2660	2.643	35.272	6	4	silty clay to clay
38.222	9.85	0.2477	2.514	38.692	6	4	silty clay to clay
38.386	9.63	0.2349	2.440	39.374	6	4	silty clay to clay
38.550	9.74	0.2482	2.548	40.806	6	4	silty clay to clay
38.714	10.27	0.2652	2.581	36.768	7	4	silty clay to clay
38.878	9.71	0.2502	2.576	35.325	6	4	silty clay to clay
39.042	9.59	0.2215	2.309	35.493	6	4	silty clay to clay
39.206	9.05	0.2551	2.819	35.988	6	4	silty clay to clay
39.370	9.54	0.2447	2.564	38.695	6	4	silty clay to clay
39.534	10.49	0.2513	2.397	24.998	7	4	silty clay to clay
39.698	9.72	0.3345	3.440	31.250	9	3	clay
39.862	13.31	0.3200	2.404	37.503	6	5	clayey silt to silty clay
40.026	13.87	0.2487	1.793	27.346	7	5	clayey silt to silty clay
40.190	9.45	0.2473	2.617	25.621	6	4	silty clay to clay
40.354	10.06	0.2523	2.508	42.131	6	4	silty clay to clay
40.518	11.10	0.2792	2.516	37.010	7	4	silty clay to clay
40.682	10.80	0.2451	2.270	35.554	5	5	clayey silt to silty clay
40.846	10.55	0.2139	2.028	32.557	5	5	clayey silt to silty clay
41.011	9.04	0.2306	2.549	34.900	6	4	silty clay to clay
41.175	11.24	0.2487	2.212	42.472	5	5	clayey silt to silty clay
41.339	10.72	0.2143	1.998	35.144	5	5	clayey silt to silty clay
41.503	10.80	0.1657	1.534	35.208	5	5	clayey silt to silty clay
41.667	9.37	0.1448	1.545	36.039	4	5	clayey silt to silty clay
41.831	9.00	0.1797	1.997	47.007	4	5	clayey silt to silty clay
41.995	10.42	0.2282	2.190	51.114	5	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
42.159	10.55	0.2539	2.407	46.419	7	4	silty clay to clay
42.323	9.92	0.2483	2.504	47.455	6	4	silty clay to clay
42.487	9.83	0.2906	2.957	48.897	6	4	silty clay to clay
42.651	10.17	0.2748	2.702	50.180	6	4	silty clay to clay
42.815	11.13	0.2352	2.113	33.388	5	5	clayey silt to silty clay
42.979	11.05	0.2119	1.917	37.944	5	5	clayey silt to silty clay
43.143	11.27	0.2975	2.640	43.188	7	4	silty clay to clay
43.307	18.25	0.1885	1.033	48.753	7	6	sandy silt to clayey silt
43.471	20.75	0.2548	1.228	17.623	8	6	sandy silt to clayey silt
43.635	14.31	0.1825	1.275	36.395	5	6	sandy silt to clayey silt
43.799	12.81	0.1679	1.311	44.660	6	5	clayey silt to silty clay
43.963	11.78	0.1845	1.566	48.493	6	5	clayey silt to silty clay
44.127	14.56	0.2292	1.574	45.376	7	5	clayey silt to silty clay
44.291	14.00	0.2462	1.758	48.405	7	5	clayey silt to silty clay
44.455	15.13	0.2674	1.767	80.512	7	5	clayey silt to silty clay
44.619	15.73	0.2851	1.812	90.366	8	5	clayey silt to silty clay
44.783	14.61	0.3506	2.400	90.110	7	5	clayey silt to silty clay
44.948	14.64	0.3651	2.493	74.228	7	5	clayey silt to silty clay
45.112	12.65	0.3552	2.809	68.000	8	4	silty clay to clay
45.276	13.43	0.2906	2.165	60.893	6	5	clayey silt to silty clay
45.440	12.67	0.2960	2.336	61.202	6	5	clayey silt to silty clay
45.604	14.45	0.4535	3.138	78.239	9	4	silty clay to clay
45.768	19.57	0.8799	4.496	77.265	19	3	clay
45.932	22.17	0.7811	3.523	67.750	11	5	clayey silt to silty clay
46.096	23.21	0.4947	2.132	32.094	9	6	sandy silt to clayey silt
46.260	20.27	0.5409	2.669	46.901	10	5	clayey silt to silty clay
46.424	23.73	0.7505	3.163	88.236	11	5	clayey silt to silty clay
46.588	21.27	0.6242	2.935	71.782	10	5	clayey silt to silty clay
46.752	18.88	0.5782	3.062	69.916	9	5	clayey silt to silty clay
46.916	19.70	0.6963	3.535	81.242	13	4	silty clay to clay
47.080	21.23	0.8596	4.050	90.440	14	4	silty clay to clay
47.244	25.00	0.9714	3.885	77.816	16	4	silty clay to clay
47.408	22.79	0.8745	3.837	55.924	15	4	silty clay to clay
47.572	22.82	0.7938	3.478	61.338	11	5	clayey silt to silty clay
47.736	21.52	0.7452	3.464	67.422	10	5	clayey silt to silty clay
47.900	18.95	0.5753	3.036	66.767	9	5	clayey silt to silty clay
48.064	17.75	0.5027	2.833	68.532	8	5	clayey silt to silty clay
48.228	17.66	0.6600	3.738	79.967	11	4	silty clay to clay
48.392	16.72	0.7073	4.230	76.211	16	3	clay
48.556	17.05	0.6321	3.707	56.464	11	4	silty clay to clay
48.720	15.08	0.5035	3.340	59.557	10	4	silty clay to clay
48.885	16.76	0.3555	2.122	66.634	8	5	clayey silt to silty clay
49.049	14.82	0.6661	4.493	63.997	14	3	clay
49.213	14.21	0.5900	4.152	83.701	14	3	clay
49.377	16.70	0.4445	2.662	43.555	8	5	clayey silt to silty clay
49.541	14.59	0.3220	2.207	64.518	7	5	clayey silt to silty clay
49.705	15.20	0.3220	2.119	82.748	7	5	clayey silt to silty clay
49.869	15.54	0.3700	2.380	88.324	7	5	clayey silt to silty clay
50.033	17.04	0.4087	2.398	91.284	8	5	clayey silt to silty clay
50.197	16.14	0.3832	2.374	83.347	8	5	clayey silt to silty clay
50.361	16.68	0.4234	2.539	95.742	8	5	clayey silt to silty clay
50.525	18.70	0.5879	3.145	100.994	9	5	clayey silt to silty clay
50.689	21.22	0.7030	3.314	87.079	10	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
50.853	23.97	0.6711	2.800	70.930	11	5	clayey silt to silty clay
51.017	20.87	0.7093	3.398	77.342	10	5	clayey silt to silty clay
51.181	23.93	0.9003	3.762	109.987	15	4	silty clay to clay
51.345	27.78	1.2266	4.415	81.769	18	4	silty clay to clay
51.509	28.30	1.5963	5.642	78.495	27	3	clay
51.673	30.10	1.5440	5.129	51.027	29	3	clay
51.837	34.02	1.4643	4.304	22.065	22	4	silty clay to clay
52.001	34.68	1.3680	3.945	20.287	17	5	clayey silt to silty clay
52.165	30.93	1.2872	4.161	19.941	20	4	silty clay to clay
52.329	24.30	1.2835	5.283	24.900	23	3	clay
52.493	25.87	0.9021	3.486	42.560	12	5	clayey silt to silty clay
52.657	33.13	1.5460	4.666	14.125	21	4	silty clay to clay
52.822	39.79	1.9713	4.955	14.525	38	3	clay
52.986	34.35	2.2507	6.553	42.757	33	3	clay
53.150	36.12	2.5394	7.031	74.800	35	3	clay
53.314	40.25	2.4653	6.125	47.023	39	3	clay
53.478	34.42	2.1341	6.201	23.798	33	3	clay
53.642	29.48	2.1065	7.145	52.059	28	3	clay
53.806	37.27	2.1876	5.869	43.284	36	3	clay
53.970	39.24	1.8397	4.688	18.230	25	4	silty clay to clay
54.134	37.47	1.7680	4.718	10.122	24	4	silty clay to clay
54.298	33.65	2.0196	6.002	10.604	32	3	clay
54.462	36.17	2.0992	5.803	20.527	35	3	clay
54.626	35.93	1.6222	4.515	22.273	23	4	silty clay to clay
54.790	29.41	1.7452	5.934	38.881	28	3	clay
54.954	29.66	1.7361	5.853	90.100	28	3	clay
55.118	34.83	1.9211	5.515	73.331	33	3	clay
55.282	33.88	2.1470	6.338	86.261	32	3	clay
55.446	36.28	2.1515	5.930	87.291	35	3	clay
55.610	38.26	2.4209	6.327	45.112	37	3	clay
55.774	29.81	2.2602	7.583	57.409	29	3	clay
55.938	41.43	2.4915	6.014	35.387	40	3	clay
56.102	42.04	2.1576	5.132	19.523	40	3	clay
56.266	43.70	1.2406	2.839	9.151	17	6	sandy silt to clayey silt
56.430	51.51	0.7587	1.473	3.870	16	7	silty sand to sandy silt
56.594	53.54	0.7216	1.348	2.148	17	7	silty sand to sandy silt
56.759	57.74	1.4970	2.593	2.183	22	6	sandy silt to clayey silt
56.923	70.30	2.1152	3.009	2.763	27	6	sandy silt to clayey silt
57.087	42.87	2.2269	5.194	4.080	41	3	clay
57.251	35.60	2.0908	5.874	7.756	34	3	clay
57.415	44.63	1.7132	3.839	14.775	21	5	clayey silt to silty clay
57.579	64.11	1.7690	2.759	6.441	25	6	sandy silt to clayey silt
57.743	68.34	2.2394	3.277	9.973	26	6	sandy silt to clayey silt
57.907	56.73	2.3918	4.216	5.374	27	5	clayey silt to silty clay
58.071	44.92	2.6286	5.852	3.175	43	3	clay
58.235	40.90	2.4905	6.089	2.933	39	3	clay
58.399	53.13	2.0053	3.774	5.262	25	5	clayey silt to silty clay
58.563	63.99	1.3512	2.112	2.401	20	7	silty sand to sandy silt
58.727	67.53	1.6791	2.486	0.253	26	6	sandy silt to clayey silt
58.891	54.78	1.4065	2.567	-0.303	21	6	sandy silt to clayey silt
59.055	59.79	1.1362	1.900	-0.697	19	7	silty sand to sandy silt
59.219	66.27	0.9471	1.429	6.598	21	7	silty sand to sandy silt
59.383	71.03	1.5322	2.157	2.031	23	7	silty sand to sandy silt

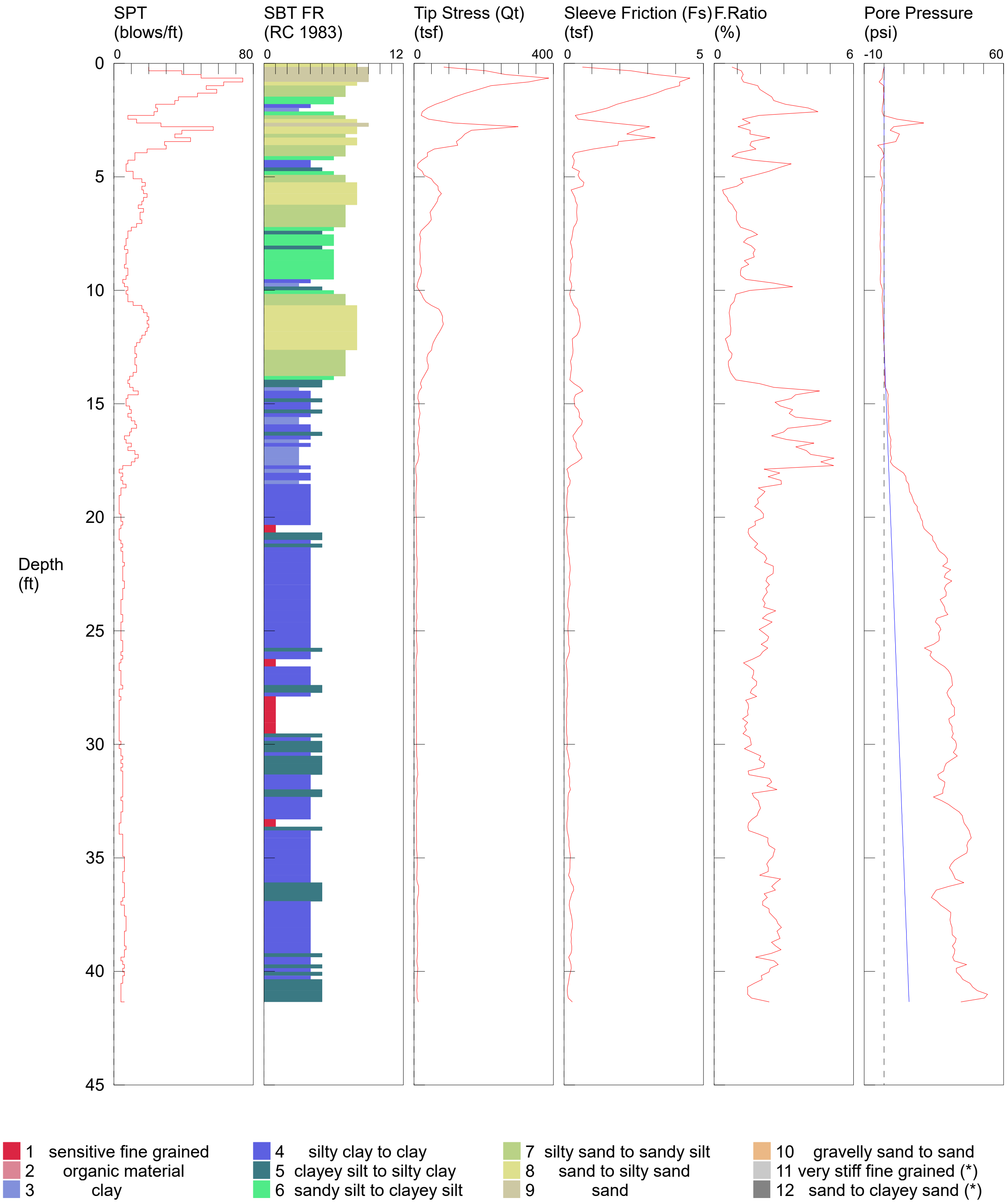
Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
59.547	71.58	1.6309	2.278	2.568	27	6	sandy silt to clayey silt
59.711	76.51	1.8447	2.411	4.251	29	6	sandy silt to clayey silt
59.875	77.27	2.2135	2.865	17.681	30	6	sandy silt to clayey silt
60.039	68.63	2.2967	3.347	16.806	26	6	sandy silt to clayey silt
60.203	60.84	2.0818	3.422	18.136	29	5	clayey silt to silty clay
60.367	74.74	1.8305	2.449	7.934	29	6	sandy silt to clayey silt
60.532	81.85	1.2673	1.548	2.816	26	7	silty sand to sandy silt
60.696	82.51	1.1686	1.416	0.008	26	7	silty sand to sandy silt
60.860	77.72	1.5167	1.951	-0.386	25	7	silty sand to sandy silt
61.024	73.73	1.8174	2.465	0.224	28	6	sandy silt to clayey silt
61.188	71.74	1.9572	2.728	1.480	27	6	sandy silt to clayey silt
61.352	71.91	1.9708	2.741	2.994	28	6	sandy silt to clayey silt
61.516	73.83	2.0155	2.730	4.645	28	6	sandy silt to clayey silt
61.680	73.89	2.1133	2.860	10.796	28	6	sandy silt to clayey silt
61.844	76.41	2.3105	3.024	12.848	29	6	sandy silt to clayey silt
62.008	76.10	2.4957	3.280	14.889	29	6	sandy silt to clayey silt
62.172	72.74	2.5910	3.562	13.928	35	5	clayey silt to silty clay
62.336	60.19	2.5593	4.252	7.679	29	5	clayey silt to silty clay
62.500	60.36	2.2752	3.769	9.236	29	5	clayey silt to silty clay
62.664	65.99	1.9979	3.027	1.876	25	6	sandy silt to clayey silt
62.828	71.23	1.5266	2.143	-0.570	23	7	silty sand to sandy silt
62.992	79.60	1.4082	1.769	-1.373	25	7	silty sand to sandy silt
63.156	88.45	2.0363	2.302	-2.121	28	7	silty sand to sandy silt
63.320	78.93	2.5878	3.279	-2.201	30	6	sandy silt to clayey silt
63.484	45.94	2.2856	4.975	-1.954	29	4	silty clay to clay
63.648	31.64	1.5506	4.900	0.314	30	3	clay
63.812	30.40	1.3440	4.420	9.044	19	4	silty clay to clay
63.976	43.15	1.7296	4.009	14.639	21	5	clayey silt to silty clay
64.140	47.12	2.1115	4.481	14.852	30	4	silty clay to clay
64.304	49.79	2.2769	4.573	14.320	32	4	silty clay to clay
64.469	67.64	2.2028	3.257	11.868	26	6	sandy silt to clayey silt
64.633	83.69	1.9665	2.350	6.037	27	7	silty sand to sandy silt
64.797	79.72	2.4262	3.043	3.764	31	6	sandy silt to clayey silt
64.961	70.22	2.6888	3.829	6.875	34	5	clayey silt to silty clay
65.125	68.64	2.1951	3.198	6.681	26	6	sandy silt to clayey silt
65.289	69.89	2.1339	3.053	4.818	27	6	sandy silt to clayey silt
65.453	64.13	2.3407	3.650	3.340	31	5	clayey silt to silty clay
65.617	55.56	2.2223	4.000	3.394	27	5	clayey silt to silty clay
65.781	49.54	2.3386	4.721	12.353	32	4	silty clay to clay
65.945	47.65	2.4809	5.207	12.499	46	3	clay
66.109	49.76	2.3770	4.777	11.589	32	4	silty clay to clay
66.273	57.70	1.7949	3.111	10.750	22	6	sandy silt to clayey silt
66.437	67.94	1.6815	2.475	5.656	26	6	sandy silt to clayey silt
66.601	67.90	1.8584	2.737	2.632	26	6	sandy silt to clayey silt
66.765	71.31	1.7766	2.492	1.171	27	6	sandy silt to clayey silt
66.929	80.33	0.9956	1.239	-0.165	26	7	silty sand to sandy silt
67.093	87.30	1.3147	1.506	-1.368	28	7	silty sand to sandy silt
67.257	89.82	1.6667	1.856	-1.437	29	7	silty sand to sandy silt
67.421	92.64	2.0017	2.161	-0.886	30	7	silty sand to sandy silt
67.585	94.91	2.2171	2.336	-0.101	30	7	silty sand to sandy silt
67.749	94.72	2.3819	2.515	0.559	36	6	sandy silt to clayey silt
67.913	96.54	2.3283	2.412	1.445	31	7	silty sand to sandy silt
68.077	98.01	2.3084	2.355	2.393	31	7	silty sand to sandy silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
68.241	93.59	2.2643	2.419	6.558	30	7	silty sand to sandy silt
68.406	89.71	2.2966	2.560	7.418	34	6	sandy silt to clayey silt
68.570	89.11	2.3006	2.582	8.799	34	6	sandy silt to clayey silt
68.734	90.84	2.2738	2.503	10.080	35	6	sandy silt to clayey silt
68.898	91.26	2.2938	2.513	10.942	35	6	sandy silt to clayey silt
69.062	91.09	2.1928	2.407	18.514	29	7	silty sand to sandy silt
69.226	91.95	2.0429	2.222	16.532	29	7	silty sand to sandy silt
69.390	89.92	1.9444	2.162	14.242	29	7	silty sand to sandy silt
69.554	89.79	1.9370	2.157	12.850	29	7	silty sand to sandy silt
69.718	88.62	1.9817	2.236	11.139	28	7	silty sand to sandy silt
69.882	84.18	2.0818	2.473	10.785	32	6	sandy silt to clayey silt
70.046	82.93	2.1064	2.540	11.496	32	6	sandy silt to clayey silt
70.210	80.57	2.4323	3.019	12.478	31	6	sandy silt to clayey silt
70.374	85.00	3.0819	3.626	13.745	41	5	clayey silt to silty clay
70.538	79.63	3.3784	4.243	9.398	38	5	clayey silt to silty clay
70.702	59.72	3.2852	5.501	4.094	57	11	very stiff fine grained (*)
70.866	62.90	2.8847	4.586	4.362	40	4	silty clay to clay
71.030	65.30	2.5662	3.930	1.938	31	5	clayey silt to silty clay
71.194	74.28	1.8206	2.451	0.530	28	6	sandy silt to clayey silt
71.358	84.26	2.0444	2.426	-0.421	32	6	sandy silt to clayey silt
71.522	97.52	1.7426	1.787	0.575	31	7	silty sand to sandy silt
71.686	106.75	1.9420	1.819	-0.719	34	7	silty sand to sandy silt
71.850	109.88	1.7973	1.636	-1.320	35	7	silty sand to sandy silt
72.014	110.61	1.7660	1.597	-1.741	35	7	silty sand to sandy silt
72.178	107.14	1.8905	1.765	-1.746	34	7	silty sand to sandy silt
72.343	108.03	2.0194	1.869	14.668	34	7	silty sand to sandy silt
72.507	110.51	2.1396	1.936	12.020	35	7	silty sand to sandy silt
72.671	115.57	2.2708	1.965	10.923	37	7	silty sand to sandy silt
72.835	112.36	2.2560	2.008	10.205	36	7	silty sand to sandy silt
72.999	109.41	2.1442	1.960	9.981	35	7	silty sand to sandy silt
73.163	106.18	2.1646	2.039	8.797	34	7	silty sand to sandy silt
73.327	103.48	2.3279	2.250	8.786	33	7	silty sand to sandy silt
73.491	105.47	2.6454	2.508	9.547	34	7	silty sand to sandy silt
73.655	107.85	3.1863	2.954	10.125	41	6	sandy silt to clayey silt
73.819	104.51	2.8586	2.735	11.259	40	6	sandy silt to clayey silt
73.983	106.14	2.9804	2.808	1.288	41	6	sandy silt to clayey silt
74.147	109.13	2.9138	2.670	-0.793	42	6	sandy silt to clayey silt
74.311	58.02	2.7879	4.805	-1.900	37	4	silty clay to clay
74.475	51.98	2.6825	5.160	-1.248	50	3	clay
74.639	62.50	1.9091	3.054	0.354	24	6	sandy silt to clayey silt
74.803	76.60	1.9572	2.555	-0.298	29	6	sandy silt to clayey silt
74.967	79.03	1.0278	1.301	-0.476	25	7	silty sand to sandy silt
75.131	81.79	0.8333	1.019	-0.394	20	8	sand to silty sand
75.295	87.49	1.2678	1.449	-0.093	28	7	silty sand to sandy silt
75.459	88.28	1.8218	2.064	18.653	28	7	silty sand to sandy silt
75.623	87.51	2.0923	2.391	18.291	28	7	silty sand to sandy silt
75.787	90.62	2.3014	2.540	19.571	35	6	sandy silt to clayey silt
75.951	88.37	2.3464	2.655	20.487	34	6	sandy silt to clayey silt
76.115	82.09	2.2578	2.751	21.791	31	6	sandy silt to clayey silt
76.280	77.97	2.1790	2.795	22.858	30	6	sandy silt to clayey silt
76.444	76.39	2.1728	2.844	23.995	29	6	sandy silt to clayey silt
76.608	74.62	2.1660	2.903	25.318	29	6	sandy silt to clayey silt
76.772	74.25	2.1475	2.892	25.650	28	6	sandy silt to clayey silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
76.936	75.24	2.2049	2.930	26.310	29	6	sandy silt to clayey silt
77.100	76.38	2.2608	2.960	26.640	29	6	sandy silt to clayey silt
77.264	76.71	2.3401	3.050	26.925	29	6	sandy silt to clayey silt
77.428	77.30	2.3695	3.065	26.947	30	6	sandy silt to clayey silt
77.592	76.94	2.4126	3.136	26.883	29	6	sandy silt to clayey silt
77.756	76.74	2.2719	2.961	26.923	29	6	sandy silt to clayey silt
77.920	79.14	2.3944	3.026	26.787	30	6	sandy silt to clayey silt
78.084	76.73	2.4332	3.171	26.140	29	6	sandy silt to clayey silt
78.248	79.76	2.4127	3.025	25.996	31	6	sandy silt to clayey silt
78.412	86.53	2.4756	2.861	24.176	33	6	sandy silt to clayey silt
78.576	89.72	2.7065	3.017	19.797	34	6	sandy silt to clayey silt
78.740	82.96	3.0069	3.624	12.952	40	5	clayey silt to silty clay
78.904	78.43	2.7422	3.496	10.404	30	6	sandy silt to clayey silt
79.068	83.68	1.3138	1.570	3.013	27	7	silty sand to sandy silt
79.232	91.05	0.8580	0.942	-0.487	22	8	sand to silty sand
79.396	88.47	1.4458	1.634	-1.137	28	7	silty sand to sandy silt
79.560	82.33	1.9729	2.396	-0.772	32	6	sandy silt to clayey silt
79.724	82.44	2.1997	2.668	0.040	32	6	sandy silt to clayey silt
79.888	84.06	2.3184	2.758	0.791	32	6	sandy silt to clayey silt
80.052	84.38	2.3725	2.811	1.528	32	6	sandy silt to clayey silt
80.217	83.33	2.3728	2.847	2.406	32	6	sandy silt to clayey silt
80.381	82.29	2.1345	2.594	3.165	32	6	sandy silt to clayey silt
80.545	81.50	2.1316	2.615	4.197	31	6	sandy silt to clayey silt
80.709	84.40	2.4033	2.848	7.399	32	6	sandy silt to clayey silt
80.873	87.15	2.4207	2.777	8.616	33	6	sandy silt to clayey silt
81.037	82.25	2.2105	2.688	10.114	32	6	sandy silt to clayey silt

Landau Associates / CPT-2 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-2
TEST DATE: 8/27/2020 12:13:29 PM
TOTAL DEPTH: 41.339 ft



*SBT/SPT CORRELATION: UBC-1983

Landau Associates / CPT-2 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-2
TEST DATE: 8/27/2020 12:13:29 PM
TOTAL DEPTH: 41.339 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
0.164	85.53	0.6577	0.769	0.027	20	8	sand to silty sand
0.328	206.04	2.4057	1.168	-0.487	39	9	sand
0.492	262.72	3.2885	1.252	-0.796	50	9	sand
0.656	386.48	4.5128	1.168	-0.908	74	9	sand
0.820	328.62	4.1439	1.261	-2.539	63	9	sand
0.984	220.93	4.1505	1.879	-0.186	53	8	sand to silty sand
1.148	185.30	3.6440	1.967	-0.322	59	7	silty sand to sandy silt
1.312	148.96	3.3045	2.218	-0.202	48	7	silty sand to sandy silt
1.476	116.73	2.8921	2.478	-0.279	37	7	silty sand to sandy silt
1.640	92.35	2.3721	2.569	-0.418	35	6	sandy silt to clayey silt
1.804	61.65	1.8924	3.070	-0.668	24	6	sandy silt to clayey silt
1.969	38.49	1.5584	4.049	-0.913	25	4	silty clay to clay
2.133	23.71	1.0597	4.470	-0.972	23	3	clay
2.297	20.47	0.3973	1.941	-0.389	8	6	sandy silt to clayey silt
2.461	41.47	0.5043	1.216	6.439	13	7	silty sand to sandy silt
2.625	112.95	1.7514	1.551	19.821	27	8	sand to silty sand
2.789	298.71	3.0629	1.025	4.780	57	9	sand
2.953	164.63	2.5615	1.556	3.064	39	8	sand to silty sand
3.117	146.06	2.2461	1.538	7.724	35	8	sand to silty sand
3.281	136.33	3.2618	2.393	6.801	44	7	silty sand to sandy silt
3.445	121.43	1.9491	1.605	5.906	29	8	sand to silty sand
3.609	125.45	1.9269	1.536	-3.269	30	8	sand to silty sand
3.773	58.05	1.0445	1.799	-1.344	19	7	silty sand to sandy silt
3.937	37.92	0.3899	1.028	-0.484	12	7	silty sand to sandy silt
4.101	38.51	0.2948	0.766	-0.048	12	7	silty sand to sandy silt
4.265	21.80	0.3609	1.655	-1.562	8	6	sandy silt to clayey silt
4.429	10.46	0.3470	3.317	-1.860	7	4	silty clay to clay
4.593	10.24	0.2863	2.797	-1.746	7	4	silty clay to clay
4.757	23.22	0.5465	2.354	-1.943	11	5	clayey silt to silty clay
4.921	28.26	0.4984	1.763	-1.959	11	6	sandy silt to clayey silt
5.085	49.71	0.5630	1.133	-1.126	16	7	silty sand to sandy silt
5.249	56.95	0.7136	1.253	-0.854	18	7	silty sand to sandy silt
5.413	68.81	0.6753	0.981	-1.014	16	8	sand to silty sand
5.577	69.19	0.2511	0.363	-1.733	17	8	sand to silty sand
5.741	78.39	0.3195	0.408	-1.131	19	8	sand to silty sand
5.906	69.43	0.3880	0.559	-1.123	17	8	sand to silty sand
6.070	66.87	0.4131	0.618	-1.142	16	8	sand to silty sand
6.234	60.13	0.4732	0.787	-1.586	14	8	sand to silty sand
6.398	53.37	0.4612	0.864	-1.727	17	7	silty sand to sandy silt
6.562	46.11	0.4474	0.970	-1.706	15	7	silty sand to sandy silt
6.726	48.29	0.4601	0.953	-1.658	15	7	silty sand to sandy silt
6.890	49.36	0.4728	0.958	-1.674	16	7	silty sand to sandy silt
7.054	41.28	0.4282	1.037	-1.706	13	7	silty sand to sandy silt
7.218	30.22	0.3455	1.143	-1.802	10	7	silty sand to sandy silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
7.382	19.67	0.3163	1.608	-1.908	8	6	sandy silt to clayey silt
7.546	15.98	0.2981	1.866	-2.004	8	5	clayey silt to silty clay
7.710	19.29	0.2741	1.421	-1.829	7	6	sandy silt to clayey silt
7.874	17.59	0.2218	1.261	-2.018	7	6	sandy silt to clayey silt
8.038	16.49	0.2624	1.591	-2.041	6	6	sandy silt to clayey silt
8.202	16.30	0.2878	1.765	-1.956	8	5	clayey silt to silty clay
8.366	17.52	0.2932	1.674	-1.706	7	6	sandy silt to clayey silt
8.530	17.81	0.3076	1.727	-1.703	7	6	sandy silt to clayey silt
8.694	17.13	0.2230	1.302	-1.754	7	6	sandy silt to clayey silt
8.858	16.84	0.2502	1.485	-1.711	6	6	sandy silt to clayey silt
9.022	20.65	0.2414	1.169	-1.666	8	6	sandy silt to clayey silt
9.186	21.16	0.2387	1.128	-1.722	8	6	sandy silt to clayey silt
9.350	18.80	0.2144	1.140	-1.906	7	6	sandy silt to clayey silt
9.514	13.94	0.1902	1.365	-1.930	5	6	sandy silt to clayey silt
9.678	9.97	0.2554	2.561	-1.855	6	4	silty clay to clay
9.843	8.15	0.2755	3.380	-1.203	8	3	clay
10.007	14.78	0.2270	1.536	-0.639	7	5	clayey silt to silty clay
10.171	21.53	0.2010	0.934	-0.860	8	6	sandy silt to clayey silt
10.335	26.38	0.2356	0.893	-1.057	8	7	silty sand to sandy silt
10.499	33.81	0.2894	0.856	-0.958	11	7	silty sand to sandy silt
10.663	49.98	0.3511	0.703	-0.775	16	7	silty sand to sandy silt
10.827	71.11	0.4818	0.677	-0.756	17	8	sand to silty sand
10.991	77.66	0.5010	0.645	-0.732	19	8	sand to silty sand
11.155	81.87	0.5511	0.673	-0.602	20	8	sand to silty sand
11.319	81.44	0.5607	0.688	-0.511	19	8	sand to silty sand
11.483	83.92	0.5811	0.692	-0.466	20	8	sand to silty sand
11.647	79.38	0.5658	0.713	-0.399	19	8	sand to silty sand
11.811	73.38	0.5279	0.719	-0.351	18	8	sand to silty sand
11.975	66.65	0.4601	0.690	-0.314	16	8	sand to silty sand
12.139	60.67	0.2901	0.478	-0.271	15	8	sand to silty sand
12.303	55.27	0.3035	0.549	-0.194	13	8	sand to silty sand
12.467	51.87	0.3080	0.594	0.061	12	8	sand to silty sand
12.631	50.20	0.3178	0.633	0.101	12	8	sand to silty sand
12.795	40.23	0.3107	0.772	0.184	13	7	silty sand to sandy silt
12.959	37.10	0.2757	0.743	0.224	12	7	silty sand to sandy silt
13.123	37.56	0.2299	0.612	0.269	12	7	silty sand to sandy silt
13.287	40.66	0.2488	0.612	0.319	13	7	silty sand to sandy silt
13.451	40.59	0.2637	0.650	0.373	13	7	silty sand to sandy silt
13.615	34.29	0.2399	0.700	0.378	11	7	silty sand to sandy silt
13.780	28.18	0.2276	0.808	0.354	9	7	silty sand to sandy silt
13.944	22.10	0.2071	0.937	0.370	8	6	sandy silt to clayey silt
14.108	18.26	0.3580	1.961	0.373	9	5	clayey silt to silty clay
14.272	21.99	0.5637	2.564	0.633	11	5	clayey silt to silty clay
14.436	14.89	0.6757	4.537	1.432	14	3	clay
14.600	11.78	0.4126	3.502	2.103	8	4	silty clay to clay
14.764	10.81	0.3585	3.315	1.863	7	4	silty clay to clay
14.928	13.97	0.3658	2.618	1.943	7	5	clayey silt to silty clay
15.092	13.40	0.3817	2.849	2.049	9	4	silty clay to clay
15.256	14.94	0.5044	3.377	2.041	10	4	silty clay to clay
15.420	17.12	0.5535	3.232	2.119	8	5	clayey silt to silty clay
15.584	15.43	0.5393	3.495	2.419	10	4	silty clay to clay
15.748	13.03	0.6564	5.039	2.196	12	3	clay
15.912	13.72	0.6276	4.575	2.316	13	3	clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
16.076	15.92	0.5046	3.169	2.350	10	4	silty clay to clay
16.240	14.01	0.4190	2.991	2.278	9	4	silty clay to clay
16.404	12.71	0.3142	2.471	2.821	6	5	clayey silt to silty clay
16.568	11.10	0.3472	3.129	3.436	7	4	silty clay to clay
16.732	10.15	0.4360	4.294	3.210	10	3	clay
16.896	12.24	0.4303	3.515	3.402	8	4	silty clay to clay
17.060	12.46	0.4943	3.967	3.069	12	3	clay
17.224	14.47	0.6013	4.155	3.189	14	3	clay
17.388	12.49	0.6441	5.157	3.721	12	3	clay
17.552	10.44	0.4793	4.590	3.090	10	3	clay
17.717	4.94	0.2537	5.140	4.416	5	3	clay
17.881	4.69	0.1008	2.151	6.915	3	4	silty clay to clay
18.045	5.18	0.1463	2.826	9.774	5	3	clay
18.209	7.01	0.1628	2.324	10.915	4	4	silty clay to clay
18.373	7.65	0.2202	2.880	11.022	5	4	silty clay to clay
18.537	7.13	0.2063	2.894	12.331	7	3	clay
18.701	6.55	0.1245	1.900	12.523	4	4	silty clay to clay
18.865	5.90	0.1294	2.191	12.755	4	4	silty clay to clay
19.029	5.32	0.1084	2.037	13.785	3	4	silty clay to clay
19.193	5.31	0.0989	1.862	14.402	3	4	silty clay to clay
19.357	4.95	0.0945	1.908	15.118	3	4	silty clay to clay
19.521	5.30	0.0924	1.745	16.606	3	4	silty clay to clay
19.685	5.26	0.1044	1.983	16.619	3	4	silty clay to clay
19.849	5.88	0.1250	2.125	17.868	4	4	silty clay to clay
20.013	6.53	0.1380	2.115	18.272	4	4	silty clay to clay
20.177	7.06	0.1239	1.755	19.276	5	4	silty clay to clay
20.341	6.48	0.1154	1.780	19.364	4	4	silty clay to clay
20.505	6.50	0.0964	1.484	20.103	3	1	sensitive fine grained
20.669	6.51	0.0950	1.459	22.203	3	1	sensitive fine grained
20.833	7.24	0.1114	1.539	24.288	3	5	clayey silt to silty clay
20.997	7.38	0.1253	1.699	24.463	4	5	clayey silt to silty clay
21.161	7.60	0.1421	1.871	25.882	5	4	silty clay to clay
21.325	7.48	0.1297	1.733	26.513	4	5	clayey silt to silty clay
21.490	7.26	0.1418	1.953	27.804	5	4	silty clay to clay
21.654	7.51	0.1642	2.185	30.292	5	4	silty clay to clay
21.818	8.53	0.1936	2.270	31.756	5	4	silty clay to clay
21.982	9.03	0.1954	2.164	31.714	6	4	silty clay to clay
22.146	8.49	0.2158	2.544	29.422	5	4	silty clay to clay
22.310	8.61	0.2194	2.547	33.449	5	4	silty clay to clay
22.474	7.90	0.2007	2.540	30.979	5	4	silty clay to clay
22.638	7.84	0.1792	2.286	30.157	5	4	silty clay to clay
22.802	9.08	0.2023	2.227	33.981	6	4	silty clay to clay
22.966	8.95	0.2130	2.380	31.181	6	4	silty clay to clay
23.130	8.11	0.1802	2.222	30.199	5	4	silty clay to clay
23.294	7.38	0.1693	2.293	31.203	5	4	silty clay to clay
23.458	7.17	0.1553	2.166	31.059	5	4	silty clay to clay
23.622	6.77	0.1413	2.086	28.115	4	4	silty clay to clay
23.786	6.03	0.1322	2.193	29.244	4	4	silty clay to clay
23.950	6.07	0.1291	2.129	30.356	4	4	silty clay to clay
24.114	6.41	0.1698	2.649	30.612	4	4	silty clay to clay
24.278	8.28	0.1883	2.274	32.036	5	4	silty clay to clay
24.442	8.23	0.1712	2.081	26.537	5	4	silty clay to clay
24.606	6.48	0.1616	2.492	25.698	4	4	silty clay to clay

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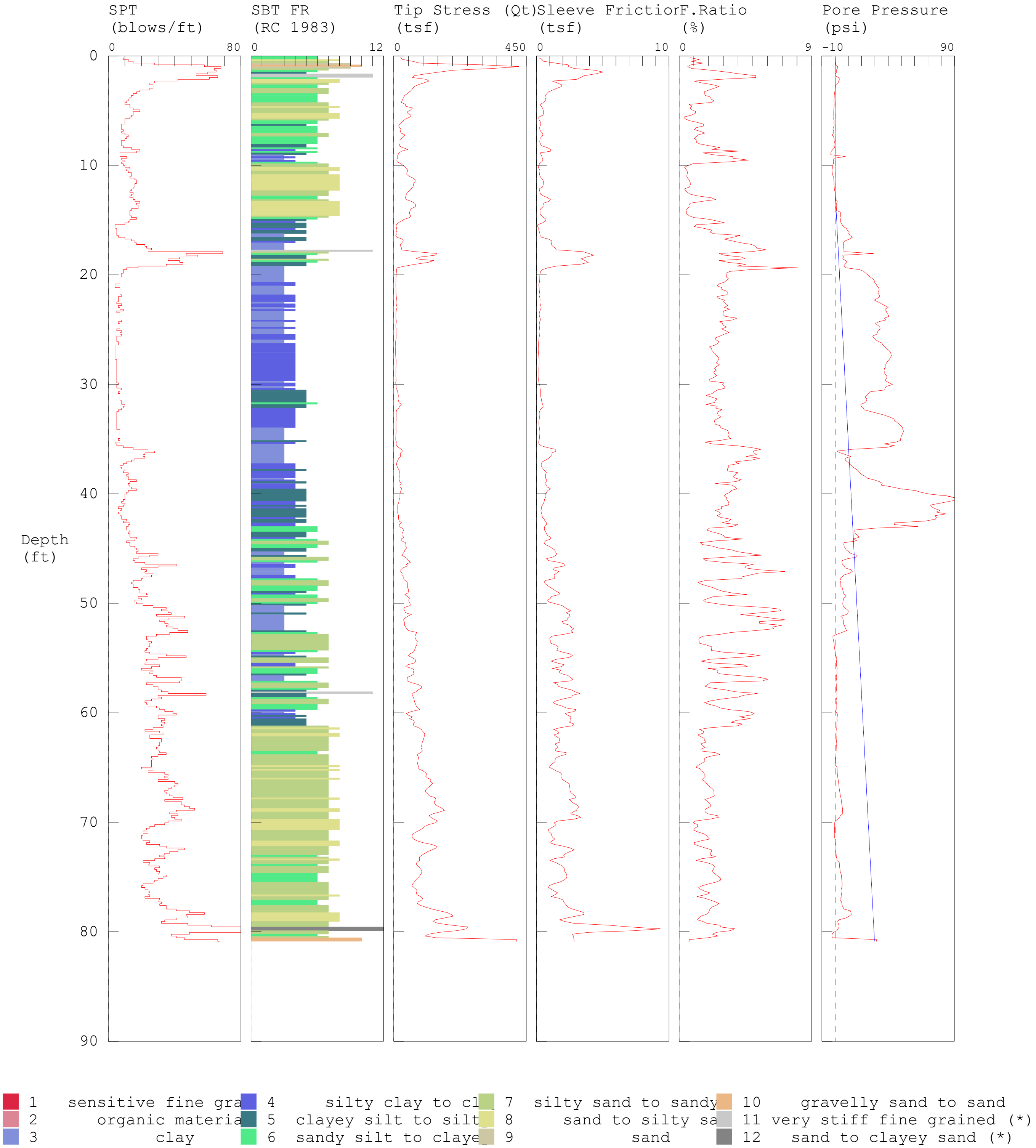
24.770	6.28	0.1408	2.243	27.577	4	4	silty clay to clay
24.934	7.00	0.1357	1.937	28.501	4	4	silty clay to clay
25.098	6.84	0.1473	2.153	27.234	4	4	silty clay to clay
25.262	6.89	0.1621	2.353	27.761	4	4	silty clay to clay
25.427	7.28	0.1661	2.281	27.596	5	4	silty clay to clay
25.591	8.13	0.1646	2.023	24.849	5	4	silty clay to clay
25.755	8.46	0.1950	2.304	20.266	5	4	silty clay to clay
25.919	9.09	0.1908	2.099	23.814	4	5	clayey silt to silty clay
26.083	7.58	0.1495	1.972	23.007	5	4	silty clay to clay
26.247	6.03	0.0998	1.654	24.783	4	4	silty clay to clay
26.411	5.62	0.0708	1.261	27.348	3	1	sensitive fine grained
26.575	5.66	0.0855	1.510	30.324	3	1	sensitive fine grained
26.739	6.14	0.1047	1.704	32.257	4	4	silty clay to clay
26.903	6.38	0.1081	1.694	33.342	4	4	silty clay to clay
27.067	6.74	0.1096	1.627	33.904	4	4	silty clay to clay
27.231	6.62	0.1213	1.833	34.112	4	4	silty clay to clay
27.395	7.25	0.1322	1.823	34.330	5	4	silty clay to clay
27.559	7.11	0.1157	1.627	32.438	3	5	clayey silt to silty clay
27.723	7.09	0.1102	1.555	31.533	3	5	clayey silt to silty clay
27.887	6.32	0.1158	1.834	32.259	4	4	silty clay to clay
28.051	6.62	0.0897	1.356	33.606	3	1	sensitive fine grained
28.215	6.80	0.0996	1.464	33.766	3	1	sensitive fine grained
28.379	6.28	0.0930	1.482	35.288	3	1	sensitive fine grained
28.543	6.48	0.0930	1.434	35.238	3	1	sensitive fine grained
28.707	6.43	0.0939	1.460	35.429	3	1	sensitive fine grained
28.871	6.86	0.0840	1.225	32.493	3	1	sensitive fine grained
29.035	6.48	0.0935	1.443	32.792	3	1	sensitive fine grained
29.199	6.46	0.0844	1.307	34.120	3	1	sensitive fine grained
29.364	6.67	0.0926	1.390	34.005	3	1	sensitive fine grained
29.528	7.01	0.0871	1.243	34.764	3	1	sensitive fine grained
29.692	6.93	0.1062	1.532	33.928	3	5	clayey silt to silty clay
29.856	6.84	0.1078	1.576	35.868	4	4	silty clay to clay
30.020	7.28	0.1161	1.595	36.305	3	5	clayey silt to silty clay
30.184	7.32	0.0953	1.303	36.055	4	5	clayey silt to silty clay
30.348	7.69	0.1282	1.667	34.692	4	5	clayey silt to silty clay
30.512	7.72	0.1549	2.007	36.741	5	4	silty clay to clay
30.676	9.20	0.1773	1.927	33.870	4	5	clayey silt to silty clay
30.840	9.45	0.2055	2.174	31.131	5	5	clayey silt to silty clay
31.004	9.23	0.1960	2.123	30.306	4	5	clayey silt to silty clay
31.168	10.02	0.1467	1.465	29.917	5	5	clayey silt to silty clay
31.332	11.11	0.1660	1.494	26.896	5	5	clayey silt to silty clay
31.496	8.21	0.1957	2.384	27.577	5	4	silty clay to clay
31.660	8.00	0.1978	2.474	30.481	5	4	silty clay to clay
31.824	8.50	0.1927	2.268	30.324	5	4	silty clay to clay
31.988	8.31	0.2250	2.707	29.494	5	4	silty clay to clay
32.152	9.70	0.1587	1.636	29.470	5	5	clayey silt to silty clay
32.316	8.22	0.1406	1.711	24.724	4	5	clayey silt to silty clay
32.480	7.22	0.1375	1.904	28.911	5	4	silty clay to clay
32.644	7.19	0.1393	1.938	32.379	5	4	silty clay to clay
32.808	7.07	0.1411	1.996	34.852	5	4	silty clay to clay
32.972	6.87	0.1310	1.906	37.636	4	4	silty clay to clay
33.136	6.97	0.1289	1.849	39.227	4	4	silty clay to clay
33.301	6.94	0.1129	1.627	39.675	4	4	silty clay to clay

Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

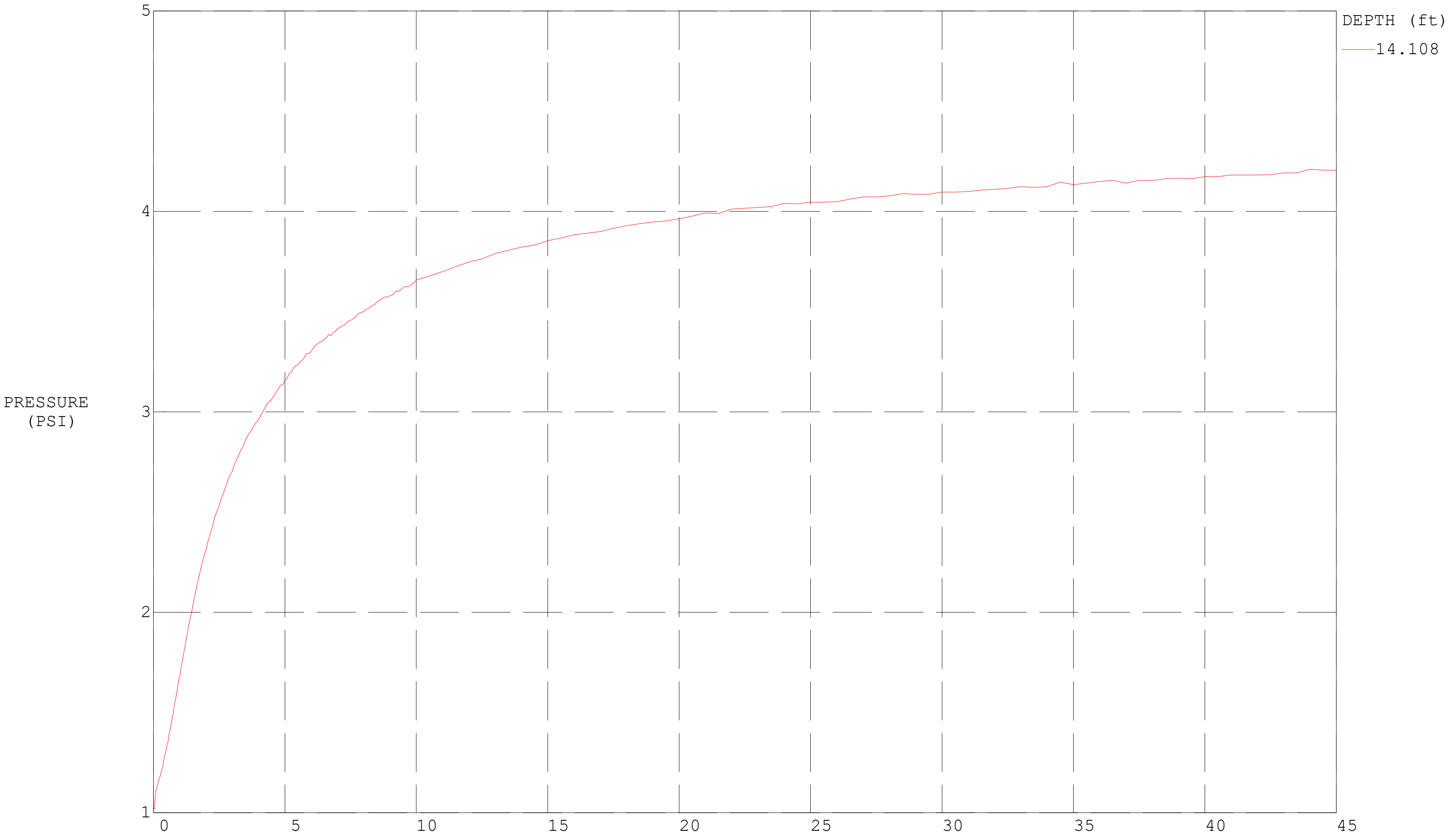
OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-3
TEST DATE: 8/27/2020 12:54:59 PM
TOTAL DEPTH: 80.873 ft



*SBT/SPT CORRELATION: UBC-1983

COMMENT: Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

TEST DATE: 8/27/2020 12:54:59 PM

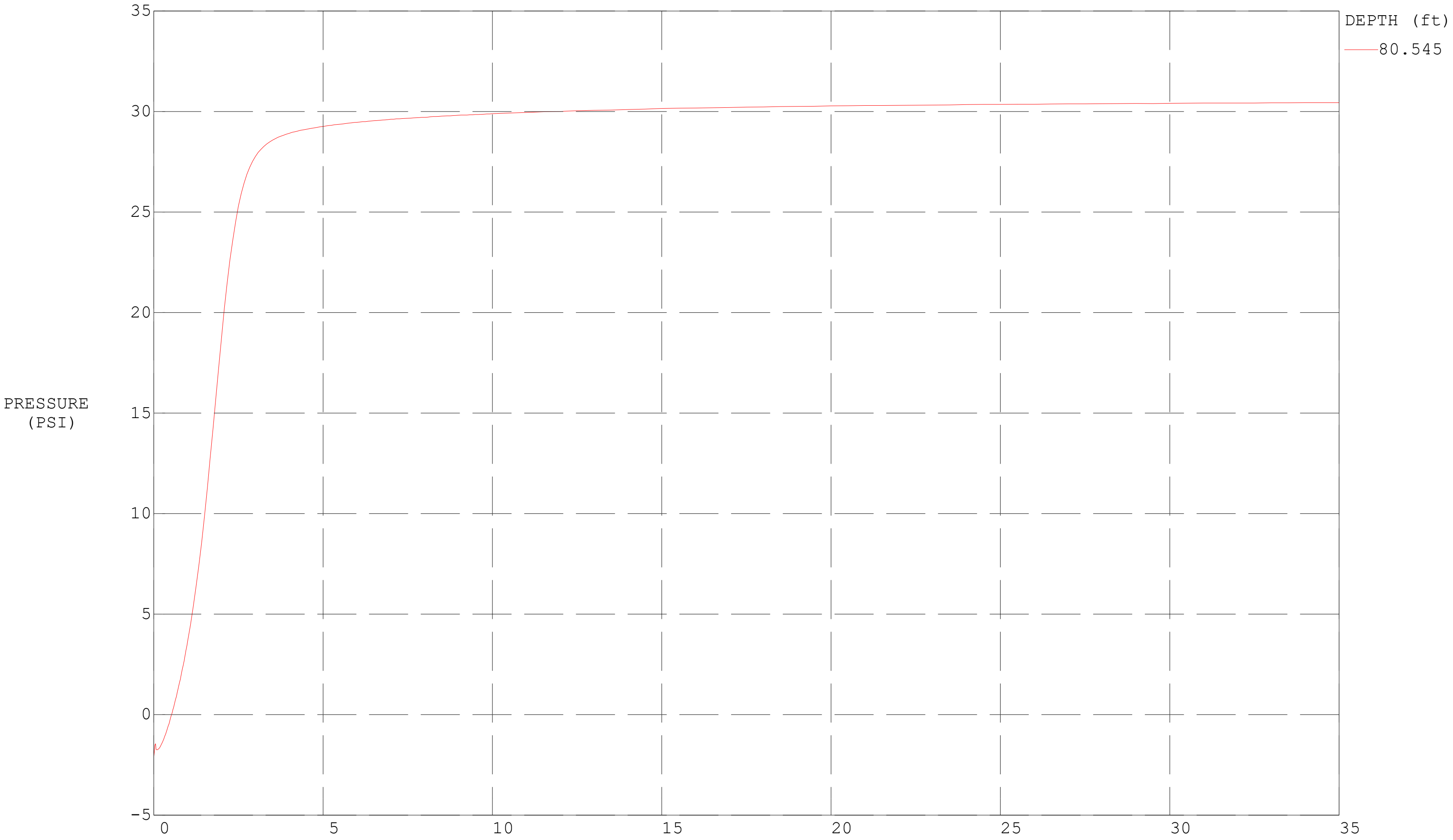


MAXIMUM PRESSURE = 4.211 (PSI)

HYDROSTATIC PRESSURE = 4.215 (PSI), WATER TABLE: 4.38 ft

COMMENT: Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

TEST DATE: 8/27/2020 12:54:59 PM



MAXIMUM PRESSURE = 30.438 (PSI)

TIME: (MINUTES)

HYDROSTATIC PRESSURE = 30.472 (PSI), WATER TABLE: 10.23 ft

Landau Associates / CPT-3 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-3
TEST DATE: 8/27/2020 12:54:59 PM
TOTAL DEPTH: 80.873 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
0.164	22.94	0.1712	0.746	0.077	9	6	sandy silt to clayey silt
0.328	30.08	0.4101	1.363	0.037	12	6	sandy silt to clayey silt
0.492	63.36	0.5299	0.836	0.064	15	8	sand to silty sand
0.656	88.66	1.4152	1.596	0.325	28	7	silty sand to sandy silt
0.820	300.94	2.3976	0.797	0.245	58	9	sand
0.984	424.08	2.4262	0.572	1.919	68	10	gravelly sand to sand
1.148	333.55	2.8494	0.854	1.632	64	9	sand
1.312	203.75	4.3624	2.141	0.841	65	7	silty sand to sandy silt
1.476	155.62	4.9968	3.211	1.208	60	6	sandy silt to clayey silt
1.640	109.71	4.4637	4.069	-0.027	53	5	clayey silt to silty clay
1.804	69.10	3.5979	5.207	-0.011	66	11	very stiff fine grained (*)
1.969	63.56	3.3044	5.199	2.321	61	11	very stiff fine grained (*)
2.133	109.19	3.0462	2.790	3.599	42	6	sandy silt to clayey silt
2.297	118.91	1.1960	1.006	2.654	28	8	sand to silty sand
2.461	102.37	1.5570	1.521	2.164	25	8	sand to silty sand
2.625	83.22	1.8980	2.281	0.500	27	7	silty sand to sandy silt
2.789	71.01	1.9278	2.715	0.250	27	6	sandy silt to clayey silt
2.953	64.51	1.5328	2.376	0.112	25	6	sandy silt to clayey silt
3.117	60.32	1.2164	2.017	-0.088	19	7	silty sand to sandy silt
3.281	53.74	0.9201	1.712	-0.298	17	7	silty sand to sandy silt
3.445	45.97	0.7868	1.712	-0.522	15	7	silty sand to sandy silt
3.609	37.20	0.6645	1.786	-0.681	14	6	sandy silt to clayey silt
3.773	34.12	0.7301	2.140	-0.676	13	6	sandy silt to clayey silt
3.937	31.21	0.6747	2.162	-0.759	12	6	sandy silt to clayey silt
4.101	27.99	0.6581	2.351	-0.841	11	6	sandy silt to clayey silt
4.265	25.69	0.5634	2.193	-0.910	10	6	sandy silt to clayey silt
4.429	40.04	0.2647	0.661	-0.657	13	7	silty sand to sandy silt
4.593	39.72	0.3423	0.862	-0.825	13	7	silty sand to sandy silt
4.757	63.51	0.4635	0.730	-0.828	15	8	sand to silty sand
4.921	58.04	0.5019	0.865	-1.011	19	7	silty sand to sandy silt
5.085	46.84	0.5267	1.124	-1.121	15	7	silty sand to sandy silt
5.249	47.80	0.5223	1.093	-1.142	15	7	silty sand to sandy silt
5.413	59.10	0.4886	0.827	-1.083	14	8	sand to silty sand
5.577	55.37	0.1719	0.310	-1.062	13	8	sand to silty sand
5.741	41.84	0.1664	0.398	-1.168	10	8	sand to silty sand
5.906	32.76	0.2193	0.669	-0.703	10	7	silty sand to sandy silt
6.070	26.19	0.3225	1.231	-0.769	10	6	sandy silt to clayey silt
6.234	20.03	0.3277	1.636	-0.804	8	6	sandy silt to clayey silt
6.398	16.16	0.2693	1.666	-0.740	8	5	clayey silt to silty clay
6.562	20.99	0.2387	1.137	-1.480	8	6	sandy silt to clayey silt
6.726	24.65	0.2549	1.034	-1.538	9	6	sandy silt to clayey silt
6.890	21.99	0.3119	1.419	-1.046	8	6	sandy silt to clayey silt
7.054	25.18	0.4397	1.746	-1.248	10	6	sandy silt to clayey silt
7.218	38.58	0.4884	1.266	-2.281	12	7	silty sand to sandy silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
7.382	33.53	0.3917	1.168	-1.294	11	7	silty sand to sandy silt
7.546	26.38	0.2701	1.024	-0.713	10	6	sandy silt to clayey silt
7.710	21.05	0.2543	1.208	-0.708	8	6	sandy silt to clayey silt
7.874	21.31	0.2444	1.147	-0.492	8	6	sandy silt to clayey silt
8.038	21.19	0.2961	1.398	-0.783	8	6	sandy silt to clayey silt
8.202	18.45	0.3836	2.079	-0.769	9	5	clayey silt to silty clay
8.366	28.99	0.7954	2.744	-0.258	14	5	clayey silt to silty clay
8.530	48.48	1.0714	2.210	-1.666	19	6	sandy silt to clayey silt
8.694	26.70	1.0721	4.015	-2.861	17	4	silty clay to clay
8.858	17.24	0.2781	1.613	-3.242	7	6	sandy silt to clayey silt
9.022	14.97	0.3419	2.284	-3.237	7	5	clayey silt to silty clay
9.186	11.34	0.4125	3.638	7.751	11	3	clay
9.350	12.02	0.4387	3.648	-0.809	8	4	silty clay to clay
9.514	10.43	0.4904	4.703	-1.341	10	3	clay
9.678	11.81	0.3929	3.328	-1.200	8	4	silty clay to clay
9.843	23.56	0.2297	0.975	-1.299	9	6	sandy silt to clayey silt
10.007	32.05	0.1900	0.593	-1.978	10	7	silty sand to sandy silt
10.171	39.30	0.1405	0.358	-1.797	13	7	silty sand to sandy silt
10.335	45.35	0.2035	0.449	-2.294	11	8	sand to silty sand
10.499	48.06	0.2597	0.540	-2.374	12	8	sand to silty sand
10.663	44.00	0.2486	0.565	-2.175	14	7	silty sand to sandy silt
10.827	44.17	0.2336	0.529	-1.991	14	7	silty sand to sandy silt
10.991	52.28	0.2656	0.508	-1.467	13	8	sand to silty sand
11.155	66.09	0.3781	0.572	-1.062	16	8	sand to silty sand
11.319	72.45	0.4851	0.670	-0.990	17	8	sand to silty sand
11.483	72.95	0.5228	0.717	-0.876	17	8	sand to silty sand
11.647	65.20	0.5110	0.784	-0.841	16	8	sand to silty sand
11.811	67.49	0.5005	0.742	-0.764	16	8	sand to silty sand
11.975	64.42	0.4530	0.703	-0.663	15	8	sand to silty sand
12.139	59.10	0.2108	0.357	-0.546	14	8	sand to silty sand
12.303	53.40	0.2364	0.443	-0.434	13	8	sand to silty sand
12.467	45.94	0.2573	0.560	-0.061	15	7	silty sand to sandy silt
12.631	42.68	0.3227	0.756	-0.008	14	7	silty sand to sandy silt
12.795	41.22	0.5284	1.282	0.061	13	7	silty sand to sandy silt
12.959	38.94	0.8499	2.182	0.226	15	6	sandy silt to clayey silt
13.123	42.48	1.0564	2.487	0.708	16	6	sandy silt to clayey silt
13.287	59.17	0.9407	1.590	1.648	19	7	silty sand to sandy silt
13.451	71.18	0.5472	0.769	1.110	17	8	sand to silty sand
13.615	74.53	0.4906	0.658	1.105	18	8	sand to silty sand
13.780	73.67	0.4970	0.675	1.107	18	8	sand to silty sand
13.944	59.19	0.3324	0.562	1.019	14	8	sand to silty sand
14.108	55.68	0.2574	0.462	1.022	13	8	sand to silty sand
14.272	53.84	0.2681	0.498	4.059	13	8	sand to silty sand
14.436	53.92	0.2692	0.499	4.062	13	8	sand to silty sand
14.600	57.99	0.3997	0.689	4.173	14	8	sand to silty sand
14.764	54.26	0.5343	0.985	3.607	17	7	silty sand to sandy silt
14.928	34.72	0.7183	2.069	4.016	13	6	sandy silt to clayey silt
15.092	25.13	0.6581	2.619	4.059	12	5	clayey silt to silty clay
15.256	14.92	0.4629	3.103	4.394	10	4	silty clay to clay
15.420	8.69	0.1002	1.152	5.270	4	5	clayey silt to silty clay
15.584	8.04	0.0813	1.011	6.202	4	5	clayey silt to silty clay
15.748	9.63	0.1581	1.642	8.320	5	5	clayey silt to silty clay
15.912	7.55	0.1674	2.216	9.124	5	4	silty clay to clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
16.076	10.74	0.2229	2.076	10.695	5	5	clayey silt to silty clay
16.240	10.87	0.2517	2.316	10.146	5	5	clayey silt to silty clay
16.404	6.71	0.2782	4.143	11.078	6	3	clay
16.568	10.53	0.3853	3.660	13.013	10	3	clay
16.732	29.72	0.9087	3.057	10.729	14	5	clayey silt to silty clay
16.896	32.58	1.1765	3.611	7.261	16	5	clayey silt to silty clay
17.060	27.11	1.1378	4.197	5.983	17	4	silty clay to clay
17.224	22.68	1.1141	4.912	6.444	22	3	clay
17.388	23.60	1.2251	5.190	6.090	23	3	clay
17.552	26.73	1.4089	5.271	6.462	26	3	clay
17.717	25.14	1.4882	5.919	6.659	24	3	clay
17.881	72.12	3.5080	4.864	6.662	69	11	very stiff fine grained (*)
18.045	146.66	3.9634	2.702	28.847	47	7	silty sand to sandy silt
18.209	140.80	4.3069	3.059	5.704	54	6	sandy silt to clayey silt
18.373	89.21	3.7614	4.216	6.239	43	5	clayey silt to silty clay
18.537	75.37	3.3705	4.472	5.717	36	5	clayey silt to silty clay
18.701	135.57	3.6659	2.704	7.996	43	7	silty sand to sandy silt
18.865	116.70	3.9089	3.350	8.810	45	6	sandy silt to clayey silt
19.029	73.37	3.3306	4.539	7.482	35	5	clayey silt to silty clay
19.193	38.45	1.5096	3.926	6.590	18	5	clayey silt to silty clay
19.357	11.02	0.8857	8.037	7.873	11	3	clay
19.521	9.22	0.4457	4.836	18.347	9	3	clay
19.685	9.29	0.3202	3.445	21.597	9	3	clay
19.849	8.62	0.2738	3.178	23.021	8	3	clay
20.013	7.97	0.2551	3.199	24.953	8	3	clay
20.177	7.62	0.2439	3.203	26.305	7	3	clay
20.341	7.29	0.2437	3.343	28.213	7	3	clay
20.505	7.36	0.2367	3.218	29.512	7	3	clay
20.669	7.25	0.2205	3.042	29.691	7	3	clay
20.833	6.95	0.1861	2.675	30.872	4	4	silty clay to clay
20.997	7.04	0.1815	2.580	31.477	4	4	silty clay to clay
21.161	7.12	0.2065	2.901	32.808	7	3	clay
21.325	7.19	0.2074	2.885	33.276	7	3	clay
21.490	7.16	0.2310	3.225	32.839	7	3	clay
21.654	7.16	0.2382	3.325	32.203	7	3	clay
21.818	8.18	0.2650	3.242	33.169	8	3	clay
21.982	8.78	0.2252	2.564	33.627	6	4	silty clay to clay
22.146	9.74	0.2623	2.694	31.833	6	4	silty clay to clay
22.310	8.76	0.2695	3.076	29.526	6	4	silty clay to clay
22.474	8.35	0.2515	3.010	32.403	5	4	silty clay to clay
22.638	8.42	0.2675	3.176	34.865	8	3	clay
22.802	9.71	0.3198	3.294	37.561	6	4	silty clay to clay
22.966	11.54	0.3533	3.063	39.997	7	4	silty clay to clay
23.130	9.32	0.3200	3.435	37.559	9	3	clay
23.294	8.28	0.2507	3.029	38.567	5	4	silty clay to clay
23.458	7.21	0.2142	2.972	38.948	7	3	clay
23.622	6.87	0.2051	2.985	39.941	7	3	clay
23.786	7.07	0.2205	3.116	40.540	7	3	clay
23.950	7.03	0.2750	3.914	37.127	7	3	clay
24.114	8.24	0.2973	3.607	38.171	8	3	clay
24.278	9.00	0.2474	2.749	33.002	6	4	silty clay to clay
24.442	7.45	0.2185	2.933	30.409	7	3	clay
24.606	6.94	0.2070	2.984	32.211	7	3	clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
24.770	7.00	0.2251	3.217	33.603	7	3	clay
24.934	8.01	0.2307	2.880	33.939	5	4	silty clay to clay
25.098	8.14	0.2574	3.162	32.416	8	3	clay
25.262	7.50	0.2531	3.375	31.929	7	3	clay
25.427	8.01	0.2439	3.044	31.285	8	3	clay
25.591	7.97	0.2213	2.775	28.293	5	4	silty clay to clay
25.755	7.82	0.1916	2.450	29.156	5	4	silty clay to clay
25.919	7.16	0.1781	2.489	30.524	5	4	silty clay to clay
26.083	6.08	0.1629	2.678	32.847	6	3	clay
26.247	5.93	0.1558	2.627	35.296	6	3	clay
26.411	6.30	0.1527	2.423	36.015	4	4	silty clay to clay
26.575	6.47	0.1322	2.044	37.625	4	4	silty clay to clay
26.739	6.34	0.1396	2.200	38.610	4	4	silty clay to clay
26.903	6.38	0.1416	2.220	40.651	4	4	silty clay to clay
27.067	6.23	0.1456	2.336	41.681	4	4	silty clay to clay
27.231	6.32	0.1553	2.456	42.142	4	4	silty clay to clay
27.395	6.59	0.1674	2.541	42.429	4	4	silty clay to clay
27.559	6.85	0.1848	2.697	41.588	4	4	silty clay to clay
27.723	7.54	0.2031	2.692	40.864	5	4	silty clay to clay
27.887	7.80	0.2025	2.595	39.600	5	4	silty clay to clay
28.051	7.88	0.1987	2.522	38.605	5	4	silty clay to clay
28.215	7.38	0.2017	2.733	38.184	5	4	silty clay to clay
28.379	7.62	0.1919	2.518	38.248	5	4	silty clay to clay
28.543	7.07	0.1693	2.395	37.186	5	4	silty clay to clay
28.707	7.22	0.1819	2.519	37.551	5	4	silty clay to clay
28.871	7.28	0.1701	2.336	37.407	5	4	silty clay to clay
29.035	7.10	0.1726	2.431	37.436	5	4	silty clay to clay
29.199	7.07	0.1806	2.554	38.818	5	4	silty clay to clay
29.364	7.29	0.1713	2.351	39.108	5	4	silty clay to clay
29.528	7.55	0.1568	2.076	38.141	5	4	silty clay to clay
29.692	7.79	0.1575	2.022	38.099	5	4	silty clay to clay
29.856	6.28	0.1899	3.023	40.580	6	3	clay
30.020	7.72	0.2277	2.948	43.201	5	4	silty clay to clay
30.184	8.44	0.2576	3.051	38.602	5	4	silty clay to clay
30.348	8.41	0.2628	3.124	37.596	8	3	clay
30.512	11.55	0.2995	2.593	37.415	7	4	silty clay to clay
30.676	13.25	0.3192	2.409	26.790	6	5	clayey silt to silty clay
30.840	14.19	0.3186	2.245	25.243	7	5	clayey silt to silty clay
31.004	15.37	0.2806	1.826	23.659	7	5	clayey silt to silty clay
31.168	15.28	0.3343	2.188	22.605	7	5	clayey silt to silty clay
31.332	14.31	0.3690	2.578	23.944	7	5	clayey silt to silty clay
31.496	15.74	0.3846	2.443	23.641	8	5	clayey silt to silty clay
31.660	17.51	0.4211	2.405	22.560	8	5	clayey silt to silty clay
31.824	25.86	0.4675	1.808	19.324	10	6	sandy silt to clayey silt
31.988	19.78	0.5105	2.580	19.638	9	5	clayey silt to silty clay
32.152	17.24	0.4243	2.462	21.354	8	5	clayey silt to silty clay
32.316	10.13	0.2951	2.913	21.831	6	4	silty clay to clay
32.480	8.59	0.2265	2.635	26.915	5	4	silty clay to clay
32.644	7.87	0.2055	2.611	32.262	5	4	silty clay to clay
32.808	7.92	0.2095	2.644	37.151	5	4	silty clay to clay
32.972	7.93	0.2251	2.837	40.936	5	4	silty clay to clay
33.136	8.21	0.2118	2.579	44.247	5	4	silty clay to clay
33.301	8.07	0.1916	2.375	44.857	5	4	silty clay to clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
33.465	7.41	0.1792	2.418	46.507	5	4	silty clay to clay
33.629	7.55	0.1853	2.454	48.200	5	4	silty clay to clay
33.793	7.15	0.1998	2.794	49.632	5	4	silty clay to clay
33.957	7.61	0.2122	2.790	50.941	5	4	silty clay to clay
34.121	7.50	0.2362	3.149	50.928	7	3	clay
34.285	7.49	0.2534	3.384	51.647	7	3	clay
34.449	7.57	0.2534	3.345	51.040	7	3	clay
34.613	7.28	0.2471	3.394	50.414	7	3	clay
34.777	6.86	0.2285	3.331	49.853	7	3	clay
34.941	6.56	0.2290	3.491	49.448	6	3	clay
35.105	6.83	0.1913	2.802	49.267	7	3	clay
35.269	9.08	0.1583	1.744	46.020	4	5	clayey silt to silty clay
35.433	8.06	0.1803	2.235	36.856	5	4	silty clay to clay
35.597	9.13	0.3561	3.898	44.822	9	3	clay
35.761	15.95	0.7720	4.841	38.565	15	3	clay
35.925	25.37	1.4068	5.545	13.234	24	3	clay
36.089	29.53	1.4863	5.033	1.227	28	3	clay
36.253	23.37	1.1865	5.077	3.870	22	3	clay
36.417	22.06	1.1557	5.238	7.961	21	3	clay
36.581	22.89	1.0432	4.556	11.757	22	3	clay
36.745	17.12	0.9344	5.457	7.812	16	3	clay
36.909	14.24	0.7039	4.944	7.442	14	3	clay
37.073	11.47	0.4336	3.782	9.207	11	3	clay
37.238	9.09	0.3674	4.043	10.665	9	3	clay
37.402	10.51	0.3494	3.324	12.108	7	4	silty clay to clay
37.566	12.14	0.4069	3.352	13.503	8	4	silty clay to clay
37.730	15.73	0.5140	3.266	15.792	10	4	silty clay to clay
37.894	19.09	0.6271	3.285	17.421	9	5	clayey silt to silty clay
38.058	18.83	0.7527	3.997	18.357	12	4	silty clay to clay
38.222	17.92	0.6868	3.833	19.891	11	4	silty clay to clay
38.386	18.82	0.6927	3.681	22.456	12	4	silty clay to clay
38.550	18.08	0.6869	3.798	23.777	12	4	silty clay to clay
38.714	17.83	0.7535	4.225	29.145	17	3	clay
38.878	20.36	0.7853	3.857	33.295	13	4	silty clay to clay
39.042	25.42	0.6258	2.462	35.459	12	5	clayey silt to silty clay
39.206	21.06	0.7509	3.566	34.809	13	4	silty clay to clay
39.370	21.46	0.8118	3.783	42.823	14	4	silty clay to clay
39.534	26.92	1.0571	3.926	49.182	17	4	silty clay to clay
39.698	24.29	0.8577	3.531	60.310	12	5	clayey silt to silty clay
39.862	22.06	0.7623	3.456	64.801	11	5	clayey silt to silty clay
40.026	21.05	0.6650	3.159	71.407	10	5	clayey silt to silty clay
40.190	20.95	0.6424	3.067	84.121	10	5	clayey silt to silty clay
40.354	20.88	0.6741	3.228	97.049	10	5	clayey silt to silty clay
40.518	18.73	0.6059	3.234	99.104	9	5	clayey silt to silty clay
40.682	17.45	0.5798	3.324	98.529	8	5	clayey silt to silty clay
40.846	15.75	0.5312	3.373	79.336	10	4	silty clay to clay
41.011	13.57	0.4553	3.356	71.952	9	4	silty clay to clay
41.175	13.57	0.3845	2.833	72.618	6	5	clayey silt to silty clay
41.339	13.09	0.3804	2.907	75.189	8	4	silty clay to clay
41.503	13.81	0.3392	2.456	78.950	7	5	clayey silt to silty clay
41.667	13.00	0.3511	2.700	76.371	6	5	clayey silt to silty clay
41.831	13.89	0.3914	2.818	83.493	7	5	clayey silt to silty clay
41.995	16.62	0.4294	2.583	75.210	8	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
42.159	15.75	0.4457	2.830	76.522	8	5	clayey silt to silty clay
42.323	16.65	0.5845	3.511	75.490	11	4	silty clay to clay
42.487	19.05	0.6395	3.357	67.755	9	5	clayey silt to silty clay
42.651	26.18	0.7565	2.890	44.966	13	5	clayey silt to silty clay
42.815	19.05	0.7595	3.988	44.769	12	4	silty clay to clay
42.979	17.21	0.6206	3.607	62.442	11	4	silty clay to clay
43.143	29.16	0.5980	2.050	29.741	11	6	sandy silt to clayey silt
43.307	32.73	0.6074	1.855	14.746	13	6	sandy silt to clayey silt
43.471	31.54	0.7001	2.220	14.756	12	6	sandy silt to clayey silt
43.635	28.12	0.7618	2.710	15.198	13	5	clayey silt to silty clay
43.799	27.52	0.8292	3.013	17.122	13	5	clayey silt to silty clay
43.963	34.97	1.0805	3.089	18.113	17	5	clayey silt to silty clay
44.127	24.45	1.0572	4.323	13.375	16	4	silty clay to clay
44.291	27.50	0.6792	2.469	16.316	11	6	sandy silt to clayey silt
44.455	39.53	0.5660	1.432	6.715	13	7	silty sand to sandy silt
44.619	41.50	0.6564	1.582	6.460	13	7	silty sand to sandy silt
44.783	40.81	0.9326	2.285	6.705	16	6	sandy silt to clayey silt
44.948	43.33	1.1659	2.691	7.466	17	6	sandy silt to clayey silt
45.112	38.09	1.3655	3.585	8.339	18	5	clayey silt to silty clay
45.276	36.09	1.4137	3.917	10.058	17	5	clayey silt to silty clay
45.440	31.81	1.5092	4.745	11.815	30	3	clay
45.604	26.58	1.4819	5.575	15.824	25	3	clay
45.768	37.83	1.2505	3.306	16.606	18	5	clayey silt to silty clay
45.932	45.92	0.7446	1.622	9.116	15	7	silty sand to sandy silt
46.096	49.72	0.9088	1.828	5.249	16	7	silty sand to sandy silt
46.260	56.56	1.6836	2.977	5.110	22	6	sandy silt to clayey silt
46.424	42.45	2.1512	5.068	5.390	41	3	clay
46.588	46.22	2.0967	4.536	6.982	30	4	silty clay to clay
46.752	30.65	1.3642	4.451	7.501	20	4	silty clay to clay
46.916	23.64	1.2509	5.291	11.701	23	3	clay
47.080	23.31	1.6733	7.177	12.949	22	3	clay
47.244	28.13	1.5044	5.347	10.942	27	3	clay
47.408	27.29	1.3144	4.816	6.620	26	3	clay
47.572	32.60	1.3908	4.266	5.281	21	4	silty clay to clay
47.736	31.81	1.3532	4.254	3.662	20	4	silty clay to clay
47.900	37.92	0.7075	1.866	4.488	15	6	sandy silt to clayey silt
48.064	45.30	0.5679	1.254	3.992	14	7	silty sand to sandy silt
48.228	46.37	0.6761	1.458	3.873	15	7	silty sand to sandy silt
48.392	46.55	0.8609	1.849	3.819	15	7	silty sand to sandy silt
48.556	46.59	1.0624	2.280	5.326	18	6	sandy silt to clayey silt
48.720	49.39	1.2542	2.540	5.637	19	6	sandy silt to clayey silt
48.885	50.34	1.4649	2.910	5.954	19	6	sandy silt to clayey silt
49.049	48.21	1.7259	3.580	6.271	23	5	clayey silt to silty clay
49.213	37.21	1.7123	4.602	7.093	24	4	silty clay to clay
49.377	46.98	1.1073	2.357	8.243	18	6	sandy silt to clayey silt
49.541	53.22	1.0569	1.986	6.399	20	6	sandy silt to clayey silt
49.705	50.86	0.8369	1.645	6.037	16	7	silty sand to sandy silt
49.869	52.15	0.9388	1.800	5.837	17	7	silty sand to sandy silt
50.033	55.43	1.4340	2.587	5.707	21	6	sandy silt to clayey silt
50.197	55.69	1.9231	3.453	5.927	27	5	clayey silt to silty clay
50.361	36.95	2.1294	5.762	6.686	35	3	clay
50.525	33.91	2.3226	6.850	8.746	32	3	clay
50.689	37.74	2.5972	6.882	9.968	36	3	clay

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50.853	39.75	2.2130	5.567	9.635	38	3	clay
51.017	60.07	2.5048	4.170	8.501	29	5	clayey silt to silty clay
51.181	47.53	2.4857	5.230	4.293	46	3	clay
51.345	37.83	2.3573	6.232	5.717	36	3	clay
51.509	32.76	2.3641	7.217	6.007	31	3	clay
51.673	35.66	1.9420	5.446	6.188	34	3	clay
51.837	37.40	2.0434	5.464	6.202	36	3	clay
52.001	36.21	2.5265	6.977	6.899	35	3	clay
52.165	40.51	2.5695	6.343	7.304	39	3	clay
52.329	44.01	2.8211	6.410	7.926	42	3	clay
52.493	50.45	2.6020	5.157	8.672	48	3	clay
52.657	78.05	2.7607	3.537	5.089	37	5	clayey silt to silty clay
52.822	75.00	2.0888	2.785	1.198	29	6	sandy silt to clayey silt
52.986	71.63	1.1783	1.645	-1.616	23	7	silty sand to sandy silt
53.150	72.46	0.9937	1.371	-1.677	23	7	silty sand to sandy silt
53.314	75.61	1.0053	1.330	-1.443	24	7	silty sand to sandy silt
53.478	80.04	1.0836	1.354	-1.081	26	7	silty sand to sandy silt
53.642	78.52	1.0708	1.364	-0.838	25	7	silty sand to sandy silt
53.806	78.08	1.4439	1.849	-0.705	25	7	silty sand to sandy silt
53.970	74.08	1.6422	2.217	-0.591	24	7	silty sand to sandy silt
54.134	72.01	1.5878	2.205	-0.402	23	7	silty sand to sandy silt
54.298	70.32	1.5346	2.182	-0.205	22	7	silty sand to sandy silt
54.462	66.35	1.9965	3.009	-0.096	25	6	sandy silt to clayey silt
54.626	54.35	2.5409	4.675	0.075	35	4	silty clay to clay
54.790	49.50	2.7221	5.500	0.490	47	3	clay
54.954	62.19	2.4161	3.885	1.142	30	5	clayey silt to silty clay
55.118	72.38	1.5017	2.075	1.230	23	7	silty sand to sandy silt
55.282	74.22	1.1029	1.486	1.041	24	7	silty sand to sandy silt
55.446	70.25	1.5579	2.218	0.924	22	7	silty sand to sandy silt
55.610	47.94	2.0931	4.366	0.921	31	4	silty clay to clay
55.774	40.85	1.8896	4.625	1.200	26	4	silty clay to clay
55.938	61.40	1.2041	1.961	1.565	20	7	silty sand to sandy silt
56.102	69.44	1.8308	2.637	1.294	27	6	sandy silt to clayey silt
56.266	66.32	1.6957	2.557	1.379	25	6	sandy silt to clayey silt
56.430	69.26	1.9042	2.749	1.315	27	6	sandy silt to clayey silt
56.594	60.32	2.3778	3.942	0.934	29	5	clayey silt to silty clay
56.759	46.33	2.5328	5.467	0.788	44	3	clay
56.923	45.52	2.7375	6.014	1.057	44	3	clay
57.087	45.12	2.5637	5.683	1.310	43	3	clay
57.251	60.45	1.2858	2.127	1.315	23	6	sandy silt to clayey silt
57.415	83.44	1.6067	1.926	1.105	27	7	silty sand to sandy silt
57.579	93.87	1.6370	1.744	1.113	30	7	silty sand to sandy silt
57.743	94.08	2.0802	2.211	1.086	30	7	silty sand to sandy silt
57.907	82.59	2.6113	3.162	1.057	32	6	sandy silt to clayey silt
58.071	75.95	2.8811	3.794	1.270	36	5	clayey silt to silty clay
58.235	61.70	3.2756	5.309	1.251	59	11	very stiff fine grained (*)
58.399	62.68	2.7411	4.373	1.251	30	5	clayey silt to silty clay
58.563	66.13	2.6479	4.004	1.387	32	5	clayey silt to silty clay
58.727	68.77	2.0232	2.942	0.876	26	6	sandy silt to clayey silt
58.891	69.73	1.4950	2.144	0.761	22	7	silty sand to sandy silt
59.055	71.60	1.2331	1.722	0.908	23	7	silty sand to sandy silt
59.219	74.41	1.4976	2.013	0.801	24	7	silty sand to sandy silt
59.383	76.26	1.9235	2.522	0.780	29	6	sandy silt to clayey silt

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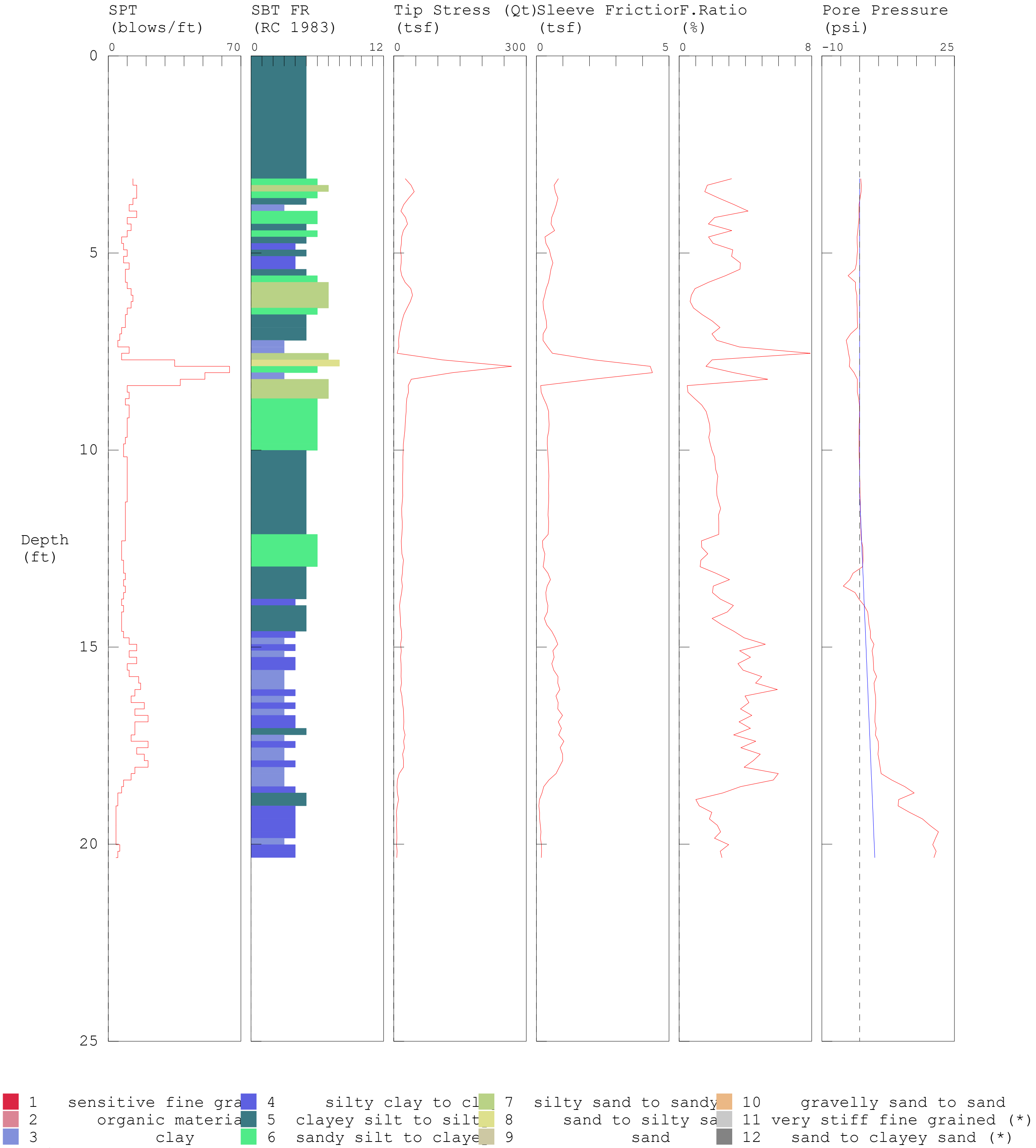
59.547	81.04	2.2565	2.784	0.777	31	6	sandy silt to clayey silt
59.711	87.68	2.9997	3.421	0.828	34	6	sandy silt to clayey silt
59.875	60.50	2.8418	4.697	0.450	39	4	silty clay to clay
60.039	42.68	2.1782	5.103	1.440	41	3	clay
60.203	47.64	2.3278	4.886	2.145	30	4	silty clay to clay
60.367	63.57	2.5980	4.087	1.517	30	5	clayey silt to silty clay
60.532	53.15	2.5630	4.822	1.299	34	4	silty clay to clay
60.696	67.38	2.6247	3.895	1.549	32	5	clayey silt to silty clay
60.860	70.48	2.4841	3.524	1.291	34	5	clayey silt to silty clay
61.024	66.22	2.8410	4.290	1.275	32	5	clayey silt to silty clay
61.188	68.34	2.7059	3.960	1.270	33	5	clayey silt to silty clay
61.352	83.67	1.8202	2.176	1.211	27	7	silty sand to sandy silt
61.516	93.85	1.2924	1.377	1.089	22	8	sand to silty sand
61.680	97.89	1.6108	1.645	1.347	31	7	silty sand to sandy silt
61.844	104.04	1.7041	1.638	1.267	33	7	silty sand to sandy silt
62.008	104.80	1.3281	1.267	1.235	25	8	sand to silty sand
62.172	103.14	1.5075	1.462	1.216	25	8	sand to silty sand
62.336	101.80	1.7213	1.691	1.171	32	7	silty sand to sandy silt
62.500	100.20	1.7233	1.720	1.102	32	7	silty sand to sandy silt
62.664	97.13	1.7910	1.844	0.876	31	7	silty sand to sandy silt
62.828	96.04	1.4046	1.462	0.806	31	7	silty sand to sandy silt
62.992	94.47	1.4868	1.574	0.897	30	7	silty sand to sandy silt
63.156	92.30	1.6318	1.768	0.785	29	7	silty sand to sandy silt
63.320	95.38	1.4116	1.480	0.798	30	7	silty sand to sandy silt
63.484	97.41	1.4603	1.499	0.737	31	7	silty sand to sandy silt
63.648	91.22	2.2490	2.465	0.719	35	6	sandy silt to clayey silt
63.812	78.98	2.1760	2.755	0.498	30	6	sandy silt to clayey silt
63.976	82.59	1.7114	2.072	0.538	26	7	silty sand to sandy silt
64.140	84.05	1.4661	1.744	0.439	27	7	silty sand to sandy silt
64.304	81.96	1.3993	1.707	0.303	26	7	silty sand to sandy silt
64.469	81.74	1.4010	1.714	0.290	26	7	silty sand to sandy silt
64.633	80.78	1.2070	1.494	0.330	26	7	silty sand to sandy silt
64.797	82.52	1.0619	1.287	0.373	26	7	silty sand to sandy silt
64.961	85.17	0.9711	1.140	1.509	20	8	sand to silty sand
65.125	84.50	1.2242	1.449	1.461	27	7	silty sand to sandy silt
65.289	98.42	1.4594	1.483	1.584	24	8	sand to silty sand
65.453	107.21	1.8053	1.684	1.618	34	7	silty sand to sandy silt
65.617	112.55	1.9130	1.700	1.765	36	7	silty sand to sandy silt
65.781	107.97	1.9250	1.783	1.922	34	7	silty sand to sandy silt
65.945	114.17	1.9025	1.666	2.044	36	7	silty sand to sandy silt
66.109	126.34	1.9635	1.554	2.286	30	8	sand to silty sand
66.273	125.04	2.1927	1.754	2.433	40	7	silty sand to sandy silt
66.437	131.67	2.4267	1.843	2.638	42	7	silty sand to sandy silt
66.601	126.53	2.4902	1.968	2.813	40	7	silty sand to sandy silt
66.765	119.49	2.4977	2.090	2.962	38	7	silty sand to sandy silt
66.929	112.17	2.5223	2.249	3.125	36	7	silty sand to sandy silt
67.093	107.41	2.5227	2.349	3.290	34	7	silty sand to sandy silt
67.257	108.56	2.5681	2.366	3.511	35	7	silty sand to sandy silt
67.421	115.63	2.7307	2.362	3.809	37	7	silty sand to sandy silt
67.585	121.01	2.8925	2.390	3.966	39	7	silty sand to sandy silt
67.749	140.82	2.9696	2.109	4.365	45	7	silty sand to sandy silt
67.913	143.30	2.4790	1.730	4.583	34	8	sand to silty sand
68.077	137.91	2.6311	1.908	4.645	44	7	silty sand to sandy silt

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
68.241	137.54	2.7738	2.017	4.850	44	7	silty sand to sandy silt
68.406	143.18	3.0528	2.132	5.129	46	7	silty sand to sandy silt
68.570	152.18	3.2134	2.112	5.374	49	7	silty sand to sandy silt
68.734	164.06	3.0642	1.868	5.587	52	7	silty sand to sandy silt
68.898	172.71	3.0213	1.749	5.675	41	8	sand to silty sand
69.062	155.64	2.7529	1.769	5.589	37	8	sand to silty sand
69.226	132.23	2.5767	1.949	5.731	42	7	silty sand to sandy silt
69.390	119.60	3.0989	2.591	3.998	38	7	silty sand to sandy silt
69.554	125.80	3.3567	2.668	3.191	40	7	silty sand to sandy silt
69.718	136.48	2.8242	2.069	2.145	44	7	silty sand to sandy silt
69.882	148.29	1.6009	1.080	0.056	36	8	sand to silty sand
70.046	141.56	1.3355	0.943	-0.423	34	8	sand to silty sand
70.210	118.78	1.4769	1.243	-0.407	28	8	sand to silty sand
70.374	105.92	1.3309	1.257	-0.442	25	8	sand to silty sand
70.538	97.92	1.0484	1.071	-0.452	23	8	sand to silty sand
70.702	89.21	0.8709	0.976	-0.458	21	8	sand to silty sand
70.866	76.65	0.9578	1.250	-0.514	24	7	silty sand to sandy silt
71.030	66.68	1.1095	1.664	-0.551	21	7	silty sand to sandy silt
71.194	61.71	1.1416	1.850	-0.551	20	7	silty sand to sandy silt
71.358	62.44	1.2145	1.945	-0.516	20	7	silty sand to sandy silt
71.522	66.99	1.3767	2.055	-0.048	21	7	silty sand to sandy silt
71.686	78.66	1.1834	1.504	-0.021	25	7	silty sand to sandy silt
71.850	97.84	1.0029	1.025	0.189	23	8	sand to silty sand
72.014	128.67	1.3389	1.040	0.325	31	8	sand to silty sand
72.178	145.25	2.0012	1.378	0.556	35	8	sand to silty sand
72.343	143.84	2.5406	1.766	0.548	46	7	silty sand to sandy silt
72.507	130.84	2.8566	2.183	0.487	42	7	silty sand to sandy silt
72.671	115.80	2.5363	2.190	0.516	37	7	silty sand to sandy silt
72.835	105.67	2.2323	2.112	0.735	34	7	silty sand to sandy silt
72.999	96.01	2.0403	2.125	0.836	31	7	silty sand to sandy silt
73.163	87.51	2.1728	2.483	0.902	34	6	sandy silt to clayey silt
73.327	86.75	1.3237	1.526	1.254	28	7	silty sand to sandy silt
73.491	87.73	1.0137	1.155	1.312	21	8	sand to silty sand
73.655	78.61	1.4172	1.803	3.122	25	7	silty sand to sandy silt
73.819	76.67	1.6959	2.212	3.165	24	7	silty sand to sandy silt
73.983	81.77	1.9532	2.389	3.231	31	6	sandy silt to clayey silt
74.147	87.49	2.0790	2.376	3.415	28	7	silty sand to sandy silt
74.311	92.34	2.1264	2.303	3.628	29	7	silty sand to sandy silt
74.475	95.63	2.1329	2.230	3.788	31	7	silty sand to sandy silt
74.639	93.97	2.2244	2.367	4.221	30	7	silty sand to sandy silt
74.803	90.11	2.2754	2.525	4.700	35	6	sandy silt to clayey silt
74.967	85.54	2.2944	2.682	4.786	33	6	sandy silt to clayey silt
75.131	79.30	2.2425	2.828	4.889	30	6	sandy silt to clayey silt
75.295	73.57	2.0563	2.795	5.049	28	6	sandy silt to clayey silt
75.459	69.72	1.7459	2.504	5.297	27	6	sandy silt to clayey silt
75.623	64.37	1.2980	2.016	5.289	21	7	silty sand to sandy silt
75.787	61.51	0.9654	1.570	5.363	20	7	silty sand to sandy silt
75.951	68.67	0.9087	1.323	4.961	22	7	silty sand to sandy silt
76.115	75.44	1.0954	1.452	4.551	24	7	silty sand to sandy silt
76.280	79.26	1.3397	1.690	4.437	25	7	silty sand to sandy silt
76.444	76.62	1.5972	2.084	4.581	24	7	silty sand to sandy silt
76.608	78.65	1.4122	1.796	4.826	25	7	silty sand to sandy silt
76.772	91.19	1.0990	1.205	5.153	22	8	sand to silty sand

Landau Associates / CPT-4 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-4
TEST DATE: 8/27/2020 3:54:20 PM
TOTAL DEPTH: 20.341 ft



*SBT/SPT CORRELATION: UBC-1983

Landau Associates / CPT-4 / 1191 NW St. Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1532
HOLE NUMBER: CPT-4
TEST DATE: 8/27/2020 3:54:20 PM
TOTAL DEPTH: 20.341 ft

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
3.117	26.11	0.8257	3.163	0.256	13	5	clayey silt to silty clay
3.281	39.01	0.6640	1.702	0.399	15	6	sandy silt to clayey silt
3.445	46.30	0.7132	1.540	0.367	15	7	silty sand to sandy silt
3.609	33.64	0.8101	2.408	0.053	13	6	sandy silt to clayey silt
3.773	22.61	0.7469	3.304	-0.181	11	5	clayey silt to silty clay
3.937	16.16	0.6728	4.163	-0.240	15	3	clay
4.101	26.63	0.5698	2.140	-0.197	10	6	sandy silt to clayey silt
4.265	31.17	0.5485	1.760	-0.357	12	6	sandy silt to clayey silt
4.429	21.56	0.6837	3.170	-0.506	10	5	clayey silt to silty clay
4.593	17.86	0.3164	1.772	-0.713	7	6	sandy silt to clayey silt
4.757	17.34	0.3548	2.046	-0.681	8	5	clayey silt to silty clay
4.921	15.01	0.4855	3.235	-0.588	10	4	silty clay to clay
5.085	17.06	0.5390	3.160	-0.753	8	5	clayey silt to silty clay
5.249	16.72	0.6173	3.692	-0.809	11	4	silty clay to clay
5.413	14.88	0.5461	3.670	-1.216	9	4	silty clay to clay
5.577	18.18	0.5079	2.794	-3.109	9	5	clayey silt to silty clay
5.741	25.64	0.4543	1.772	-1.115	10	6	sandy silt to clayey silt
5.906	38.62	0.3668	0.950	-1.110	12	7	silty sand to sandy silt
6.070	42.23	0.3107	0.736	-0.761	13	7	silty sand to sandy silt
6.234	37.41	0.2461	0.658	-0.775	12	7	silty sand to sandy silt
6.398	30.02	0.2595	0.865	-0.673	10	7	silty sand to sandy silt
6.562	22.79	0.3167	1.389	-0.676	9	6	sandy silt to clayey silt
6.726	18.58	0.3708	1.996	-0.631	9	5	clayey silt to silty clay
6.890	15.54	0.3822	2.460	-0.570	7	5	clayey silt to silty clay
7.054	12.63	0.2497	1.977	-2.401	6	5	clayey silt to silty clay
7.218	10.85	0.2463	2.271	-3.567	5	5	clayey silt to silty clay
7.382	11.52	0.4185	3.635	-3.207	11	3	clay
7.546	7.61	0.6025	7.915	-2.968	7	3	clay
7.710	109.52	2.1682	1.980	-2.630	35	7	silty sand to sandy silt
7.874	266.07	4.2915	1.613	-2.781	64	8	sand to silty sand
8.038	133.14	4.3744	3.285	-1.522	51	6	sandy silt to clayey silt
8.202	39.65	2.1144	5.333	-0.644	38	3	clay
8.366	32.69	0.1577	0.483	-0.628	10	7	silty sand to sandy silt
8.530	33.43	0.1767	0.528	-0.644	11	7	silty sand to sandy silt
8.694	29.38	0.2758	0.939	-0.279	9	7	silty sand to sandy silt
8.858	28.26	0.3851	1.363	-0.090	11	6	sandy silt to clayey silt
9.022	28.08	0.4585	1.633	-0.059	11	6	sandy silt to clayey silt
9.186	26.77	0.4649	1.737	-0.104	10	6	sandy silt to clayey silt
9.350	25.71	0.4737	1.842	-0.144	10	6	sandy silt to clayey silt
9.514	24.99	0.4657	1.863	-0.168	10	6	sandy silt to clayey silt
9.678	23.22	0.4151	1.788	-0.176	9	6	sandy silt to clayey silt
9.843	21.67	0.4074	1.880	-0.173	8	6	sandy silt to clayey silt
10.007	21.40	0.4227	1.975	-0.176	8	6	sandy silt to clayey silt
10.171	20.59	0.4377	2.126	-0.146	10	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.335	20.69	0.4485	2.168	-0.090	10	5	clayey silt to silty clay
10.499	20.75	0.4573	2.204	-0.053	10	5	clayey silt to silty clay
10.663	20.04	0.4672	2.331	-0.016	10	5	clayey silt to silty clay
10.827	19.94	0.4560	2.287	0.035	10	5	clayey silt to silty clay
10.991	20.11	0.4538	2.257	0.045	10	5	clayey silt to silty clay
11.155	20.28	0.4622	2.279	0.069	10	5	clayey silt to silty clay
11.319	19.35	0.4609	2.382	0.109	9	5	clayey silt to silty clay
11.483	17.89	0.4467	2.496	0.154	9	5	clayey silt to silty clay
11.647	18.25	0.4330	2.373	0.200	9	5	clayey silt to silty clay
11.811	19.15	0.4576	2.389	0.237	9	5	clayey silt to silty clay
11.975	18.99	0.4529	2.385	0.269	9	5	clayey silt to silty clay
12.139	18.43	0.4401	2.388	0.327	9	5	clayey silt to silty clay
12.303	17.10	0.2301	1.345	0.431	7	6	sandy silt to clayey silt
12.467	17.48	0.2379	1.361	0.804	7	6	sandy silt to clayey silt
12.631	18.35	0.3162	1.723	0.854	7	6	sandy silt to clayey silt
12.795	22.05	0.2882	1.307	0.884	8	6	sandy silt to clayey silt
12.959	20.18	0.2544	1.261	0.727	8	6	sandy silt to clayey silt
13.123	19.45	0.4282	2.201	-1.762	9	5	clayey silt to silty clay
13.287	17.46	0.5301	3.036	-2.632	8	5	clayey silt to silty clay
13.451	19.59	0.4032	2.058	-4.341	9	5	clayey silt to silty clay
13.615	17.64	0.3535	2.004	-1.259	8	5	clayey silt to silty clay
13.780	15.08	0.3738	2.478	-0.229	7	5	clayey silt to silty clay
13.944	13.09	0.4290	3.278	1.171	8	4	silty clay to clay
14.108	14.09	0.4100	2.910	2.097	7	5	clayey silt to silty clay
14.272	14.85	0.2939	1.979	2.284	7	5	clayey silt to silty clay
14.436	15.06	0.3894	2.586	2.446	7	5	clayey silt to silty clay
14.600	17.50	0.5789	3.309	2.811	8	5	clayey silt to silty clay
14.764	17.94	0.7037	3.922	2.811	11	4	silty clay to clay
14.928	15.38	0.7995	5.199	3.737	15	3	clay
15.092	17.04	0.6219	3.650	3.261	11	4	silty clay to clay
15.256	15.53	0.6688	4.307	3.511	15	3	clay
15.420	16.28	0.5772	3.545	3.604	10	4	silty clay to clay
15.584	16.86	0.6500	3.854	3.681	11	4	silty clay to clay
15.748	16.34	0.8138	4.980	4.432	16	3	clay
15.912	17.48	0.8066	4.616	3.766	17	3	clay
16.076	14.92	0.8830	5.919	3.910	14	3	clay
16.240	18.47	0.7337	3.972	4.144	12	4	silty clay to clay
16.404	19.44	0.8186	4.211	4.227	19	3	clay
16.568	21.68	0.8025	3.702	4.181	14	4	silty clay to clay
16.732	22.35	0.9808	4.388	4.043	21	3	clay
16.896	22.66	0.8194	3.616	4.019	14	4	silty clay to clay
17.060	21.91	0.9403	4.291	4.309	14	4	silty clay to clay
17.224	25.46	0.8371	3.288	4.110	12	5	clayey silt to silty clay
17.388	22.34	1.0316	4.618	4.873	21	3	clay
17.552	24.08	0.8972	3.726	4.964	15	4	silty clay to clay
17.717	20.09	0.9826	4.892	4.823	19	3	clay
17.881	22.04	0.9855	4.471	5.102	21	3	clay
18.045	21.94	0.8600	3.919	5.369	14	4	silty clay to clay
18.209	12.40	0.7416	5.981	5.651	12	3	clay
18.373	8.27	0.4697	5.682	8.440	8	3	clay
18.537	7.32	0.2712	3.704	11.892	7	3	clay
18.701	7.99	0.2104	2.633	14.360	5	4	silty clay to clay
18.865	10.94	0.1102	1.007	10.258	5	5	clayey silt to silty clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
19.029	7.73	0.0937	1.212	10.120	4	5	clayey silt to silty clay
19.193	6.07	0.1196	1.971	13.143	4	4	silty clay to clay
19.357	6.57	0.1199	1.825	16.582	4	4	silty clay to clay
19.521	6.27	0.1445	2.303	18.477	4	4	silty clay to clay
19.685	6.77	0.1689	2.494	20.780	4	4	silty clay to clay
19.849	7.02	0.1500	2.137	20.013	4	4	silty clay to clay
20.013	6.28	0.1875	2.985	19.262	6	3	clay
20.177	7.67	0.1900	2.478	20.175	5	4	silty clay to clay
20.341	6.97	0.1800	2.583	19.576	4	4	silty clay to clay

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
76.936	98.23	1.7202	1.751	3.750	31	7	silty sand to sandy silt
77.100	94.96	2.0107	2.117	3.649	30	7	silty sand to sandy silt
77.264	83.18	2.0435	2.457	4.815	32	6	sandy silt to clayey silt
77.428	80.43	2.1693	2.697	4.996	31	6	sandy silt to clayey silt
77.592	90.60	2.2606	2.495	5.326	35	6	sandy silt to clayey silt
77.756	108.94	2.3802	2.185	5.975	35	7	silty sand to sandy silt
77.920	129.95	2.7109	2.086	6.468	41	7	silty sand to sandy silt
78.084	154.25	3.1550	2.045	11.509	49	7	silty sand to sandy silt
78.248	181.36	3.5837	1.976	11.953	58	7	silty sand to sandy silt
78.412	195.00	3.5803	1.836	12.145	47	8	sand to silty sand
78.576	201.81	2.9669	1.470	10.737	48	8	sand to silty sand
78.740	171.55	2.2901	1.335	8.086	41	8	sand to silty sand
78.904	140.78	1.7482	1.242	2.907	34	8	sand to silty sand
79.068	132.73	2.1319	1.606	1.988	32	8	sand to silty sand
79.232	150.55	2.8277	1.878	2.249	48	7	silty sand to sandy silt
79.396	195.22	5.4304	2.782	2.776	62	7	silty sand to sandy silt
79.560	252.23	7.0811	2.807	3.000	81	7	silty sand to sandy silt
79.724	247.15	9.3378	3.778	2.143	118	12	sand to clayey sand (*)
79.888	214.40	7.4188	3.460	1.373	103	12	sand to clayey sand (*)
80.052	154.04	3.9026	2.533	-1.222	49	7	silty sand to sandy silt
80.217	118.27	2.6790	2.265	-2.361	38	7	silty sand to sandy silt
80.381	106.29	2.7989	2.633	-2.478	41	6	sandy silt to clayey silt
80.545	143.13	2.7974	1.954	-2.097	46	7	silty sand to sandy silt
80.709	416.64	2.8308	0.679	31.168	66	10	gravelly sand to sand
80.873	417.14	2.8407	0.681	31.139	67	10	gravelly sand to sand

Depth ft	Tip Stress (Qt) (tsf)	Sleeve Friction (Fs) (tsf)	F.Ratio (%)	Pore Pressure (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
33.465	6.82	0.1008	1.479	40.162	3	1	sensitive fine grained
33.629	6.84	0.0993	1.452	41.471	3	1	sensitive fine grained
33.793	7.19	0.1069	1.487	42.664	3	5	clayey silt to silty clay
33.957	7.15	0.1374	1.923	43.185	5	4	silty clay to clay
34.121	7.17	0.1659	2.314	43.739	5	4	silty clay to clay
34.285	7.61	0.1752	2.303	42.099	5	4	silty clay to clay
34.449	7.30	0.1723	2.360	41.476	5	4	silty clay to clay
34.613	7.31	0.1918	2.624	41.974	5	4	silty clay to clay
34.777	8.21	0.2108	2.566	41.556	5	4	silty clay to clay
34.941	9.03	0.2280	2.525	38.200	6	4	silty clay to clay
35.105	9.12	0.2158	2.366	35.365	6	4	silty clay to clay
35.269	9.36	0.2120	2.265	33.710	6	4	silty clay to clay
35.433	8.98	0.2096	2.334	32.728	6	4	silty clay to clay
35.597	8.40	0.1956	2.330	34.005	5	4	silty clay to clay
35.761	8.17	0.1601	1.960	34.910	5	4	silty clay to clay
35.925	7.73	0.2207	2.857	35.711	5	4	silty clay to clay
36.089	9.41	0.2499	2.655	40.031	6	4	silty clay to clay
36.253	13.31	0.3297	2.477	32.491	6	5	clayey silt to silty clay
36.417	13.15	0.3467	2.638	26.169	6	5	clayey silt to silty clay
36.581	12.83	0.2757	2.150	24.878	6	5	clayey silt to silty clay
36.745	10.46	0.2391	2.286	23.715	5	5	clayey silt to silty clay
36.909	9.36	0.1955	2.089	26.521	4	5	clayey silt to silty clay
37.073	8.68	0.1810	2.086	28.389	6	4	silty clay to clay
37.238	8.67	0.2049	2.362	31.056	6	4	silty clay to clay
37.402	9.62	0.2280	2.369	33.478	6	4	silty clay to clay
37.566	10.53	0.2653	2.519	33.377	7	4	silty clay to clay
37.730	10.53	0.2818	2.677	33.060	7	4	silty clay to clay
37.894	11.05	0.3036	2.747	33.444	7	4	silty clay to clay
38.058	10.25	0.2971	2.899	34.117	7	4	silty clay to clay
38.222	9.77	0.2646	2.707	34.056	6	4	silty clay to clay
38.386	8.90	0.2468	2.773	34.218	6	4	silty clay to clay
38.550	9.20	0.2607	2.833	36.182	6	4	silty clay to clay
38.714	10.08	0.2485	2.465	35.749	6	4	silty clay to clay
38.878	10.24	0.2712	2.648	34.269	7	4	silty clay to clay
39.042	9.59	0.2760	2.880	35.525	6	4	silty clay to clay
39.206	10.05	0.2469	2.456	35.240	6	4	silty clay to clay
39.370	9.27	0.1656	1.785	34.410	4	5	clayey silt to silty clay
39.534	8.10	0.2093	2.583	35.192	5	4	silty clay to clay
39.698	8.97	0.2472	2.755	41.421	6	4	silty clay to clay
39.862	10.70	0.2582	2.413	36.201	5	5	clayey silt to silty clay
40.026	9.80	0.2315	2.362	36.270	6	4	silty clay to clay
40.190	9.40	0.1902	2.023	38.184	5	5	clayey silt to silty clay
40.354	8.44	0.1743	2.065	39.496	5	4	silty clay to clay
40.518	8.64	0.1492	1.728	43.113	4	5	clayey silt to silty clay
40.682	8.53	0.1223	1.433	44.468	4	5	clayey silt to silty clay
40.846	8.05	0.1165	1.446	46.781	4	5	clayey silt to silty clay
41.011	8.48	0.1220	1.439	51.971	4	5	clayey silt to silty clay
41.175	9.34	0.1500	1.607	50.401	4	5	clayey silt to silty clay
41.339	12.26	0.2901	2.365	38.562	6	5	clayey silt to silty clay

APPENDIX B

Sample Photograph Log

1. Boring B-1 at 2.5 feet: Dark gray, fine to coarse SAND with silt.

2. Boring B-1 at 5 feet: Dark gray, fine to coarse SAND with silt.

LANDAU ASSOCIATES	Owens Corning Linnton Asphalt Terminal Final Design Portland, Oregon	**Sample Photograph Log**	Figure B-1

3. Boring B-1 at 7.5 feet: Gray SILT.

4. Boring B-1 at 10 feet: Dark gray, fine to coarse SAND with silt.

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Portland, Oregon

Sample Photograph Log

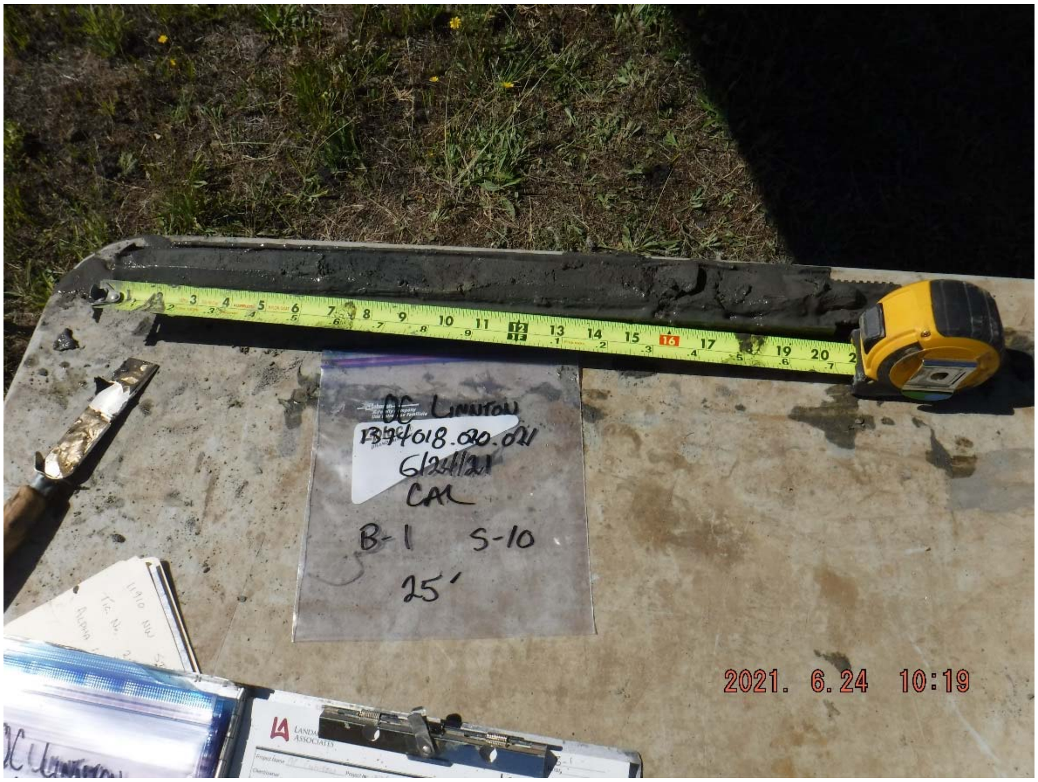
Figure
B-2

5. Boring B-1 at 15 feet: Dark gray, fine to coarse SAND with silt.

6. Boring B-1 at 17.5 feet: Gray SILT with wood debris.

Landau Associates	Owens Corning Linnton Asphalt Terminal Final Design Portland, Oregon	**Sample Photograph Log**	Figure B-3

7. Boring B-1 at 22.5 feet: Gray, elastic SILT with trace organics.



8. Boring B-1 at 25 feet: Gray, elastic SILT with trace organics.

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Asphalt Terminal Final Design
Portland, Oregon

Sample Photograph Log

Figure
B-4

9. Boring B-1 at 27.5 feet: Dark gray SILT.

10. Boring B-1 at 30 feet: Gray SILT with fine sand.

11. Boring B-1 at 35 feet: Gray, elastic SILT.

12. Boring B-1 at 40 feet: Blue-gray to gray SILT.

Landau Associates

Owens Corning Linnton Asphalt Terminal Final Design Portland, Oregon	**Sample Photograph Log**	Figure B-6

13. Boring B-1 at 42.5 feet: Gray-brown to gray CLAY.

14. Boring B-1 at 47.5 feet: Gray-brown SILT and gray-brown, silty, fine to coarse SAND.

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Sample Photograph Log

Figure
B-7

15. Boring B-1 at 50 feet: Gray-brown to brown SILT.

16. Boring B-1 at 55 feet: Gray-brown to brown SILT with fine sand.

Landau Associates

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Portland, Oregon

Sample Photograph Log

Figure
B-8

17. Boring B-1 at 60 feet: Gray-brown to brown SILT.

18. Boring B-1 at 65 feet: Gray-brown to brown SILT.

19. Boring B-1 at 70 feet: Gray-brown, very silty, fine to medium SAND.

20. Boring B-1 at 75 feet: Gray, very silty, fine to medium SAND.

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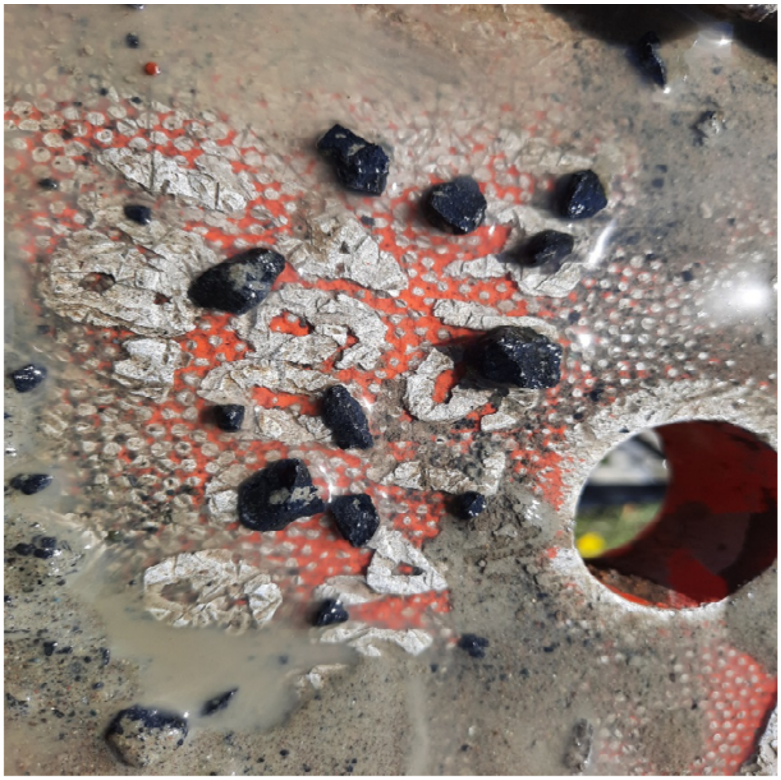
Portland, Oregon

Sample Photograph Log

Figure
B-10

21. Boring B-1 at 80 feet: Brown, very silty, fine to medium SAND.

22. Boring B-1 at 85 feet: Brown, very silty, fine to medium SAND.



23. Boring B-1 at 90 feet: Basalt pieces from drill cuttings.

24. Boring B-2 at 2.5 feet: Brown, fine to coarse SAND.

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Sample Photograph Log

Figure
B-12

25. Boring B-2 at 5 feet: Brown, fine to coarse SAND.

26. Boring B-2 at 7.5 feet: Light brown, silty, fine to coarse SAND with organics.

27. Boring B-2 at 10 feet: Dark gray to gray, fine to coarse SAND with gravel and silt.

28. Boring B-2 at 12.5 feet: Dark gray to gray, fine to coarse SAND with gravel and silt.

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Sample Photograph Log

Figure
B-14

29. Boring B-2 at 15 feet: Dark gray to gray, fine to coarse SAND with gravel and silt.

30. Boring B-2 at 17.5 feet: Gray SILT with trace organics.

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Sample Photograph Log

Figure
B-15

31. Boring B-2 at 22.5 feet: Light gray to gray, elastic SILT with organics.

32. Boring B-2 at 25 feet: Gray, elastic SILT.

Landau Associates	Owens Corning Linnton Asphalt Terminal Final Design Portland, Oregon	**Sample Photograph Log**	Figure B-16

33. Boring B-2 at 27.5 feet: Dark gray SILT.

34. Boring B-2 at 30 feet: Dark gray SILT with trace organics.

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Portland, Oregon

Sample Photograph Log

Figure
B-17

35. Boring B-2 at 32.5 feet: Dark gray SILT with trace organics.

36. Boring B-2 at 35 feet: Dark gray SILT with trace organics.

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Sample Photograph Log

Figure
B-18

37. Boring B-2 at 40 feet: Dark gray SILT with trace organics.

38. Boring B-2 at 42.5 feet: Dark gray SILT with trace organics.

39. Boring B-2 at 45 feet: Light gray to blue-gray SILT with slickensides.

40. Boring B-2 at 47.5 feet: Light gray to blue-gray SILT.

LANDAU ASSOCIATES	Owens Corning Linnton Asphalt Terminal Final Design Portland, Oregon	**Sample Photograph Log**	Figure B-20

41. Boring B-2 at 50 feet: Gray to gray-brown SILT.

42. Boring B-2 at 55 feet: Gray-brown to brown SILT.

LANDAU ASSOCIATES

Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Sample Photograph Log

Figure
B-21

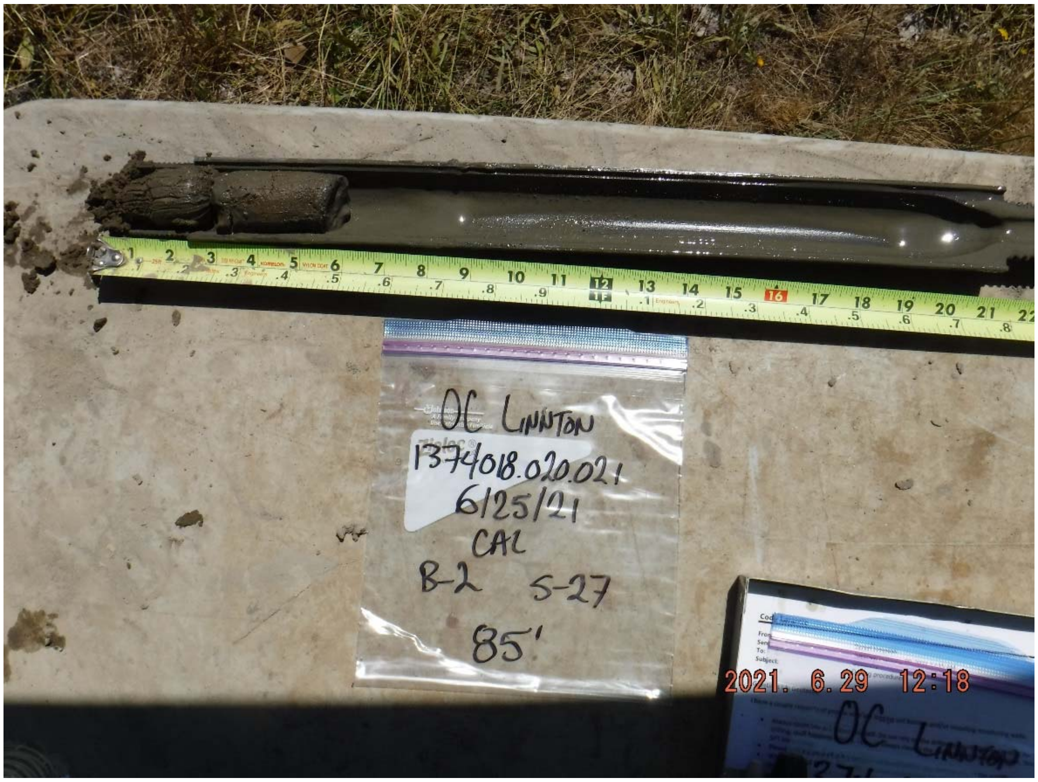
43. Boring B-2 at 60 feet: Gray-brown to brown SILT.

44. Boring B-2 at 65 feet: Gray-brown to brown SILT.

45. Boring B-2 at 70 feet: Gray, very sandy SILT with organics.

46. Boring B-2 at 75 feet: Gray-brown, sandy SILT with organics.

47. Boring B-2 at 80 feet: Gray-brown, very silty, fine SAND.



48. Boring B-2 at 85 feet: Gray-brown, very silty, fine SAND.

LANDAU ASSOCIATES

Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

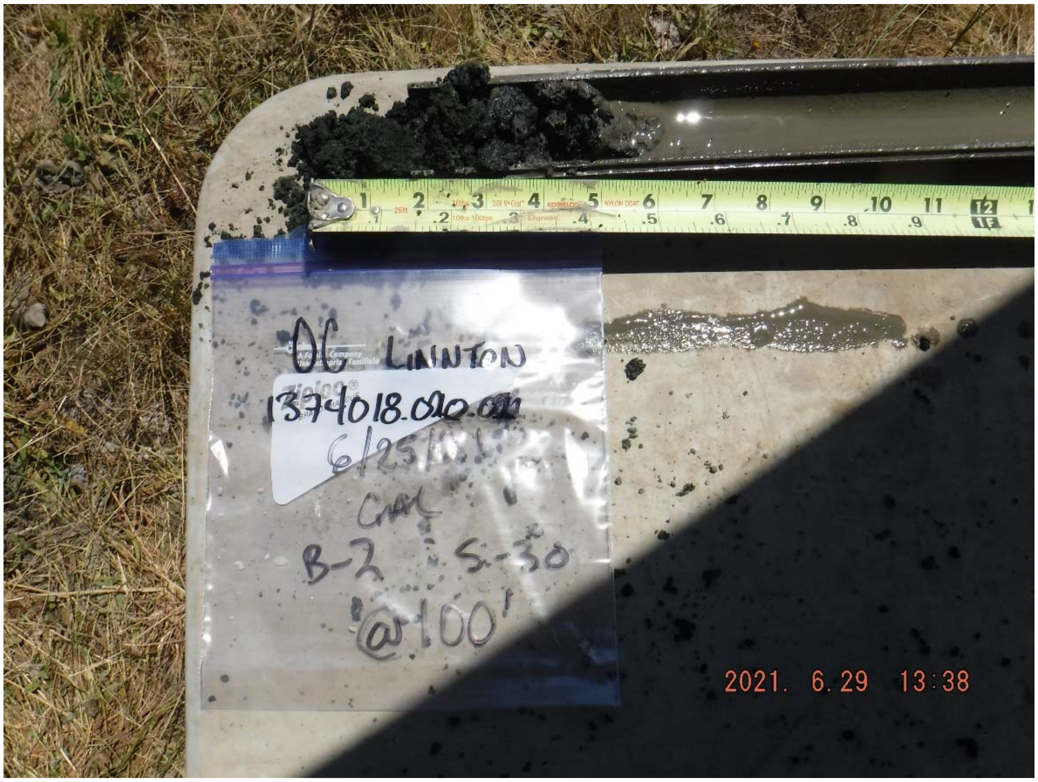
Sample Photograph Log

Figure
B-24

49. Boring B-2 at 90 feet: Gray-brown, very silty, fine SAND.

50. Boring B-2 at 95 feet: Gray-brown, fine SAND with silt.

LANDAU ASSOCIATES	Owens Corning Linnton Asphalt Terminal Final Design Portland, Oregon	**Sample Photograph Log**	Figure B-25



51. Boring B-2 at 100 feet: Basalt.

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Portland, Oregon

Sample Photograph Log

Figure
B-26

APPENDIX C

Laboratory Soil Testing

APPENDIX C
LABORATORY SOIL TESTING

Samples obtained from the explorations were transported to Landau Associates, Inc.'s (LAI) soils laboratory for further examination and testing. Testing was performed in general accordance with the ASTM International (ASTM) standard test methods described below. Field log descriptions were checked against the samples and updated, where appropriate, in general accordance with ASTM standard D2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).*

Soiltest Farm Consultants, subcontracted by LAI, completed cation exchange capacity (CEC) and soil pH measurements on two samples. Results are included at the end of Appendix C.

Natural Moisture Content

Natural moisture content determinations were performed on select soil samples in general accordance with ASTM standard test method D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.* The natural moisture content is shown as "W = xx" (i.e., percent of dry weight) in the "Test Data" column on the summary boring logs in Appendix A.

Grain Size Analyses

Grain size analyses were performed on select soil samples in general accordance with ASTM standard test method D7928, *Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.* Samples selected for grain size analyses are designated with a "GS" in the "Test Data" column on the summary boring logs in Appendix A. The results of the grain size analyses are presented on Figures C-1 through C-6 in this appendix. Some hydrometer tests did not include a US No. 200 sieve wash.

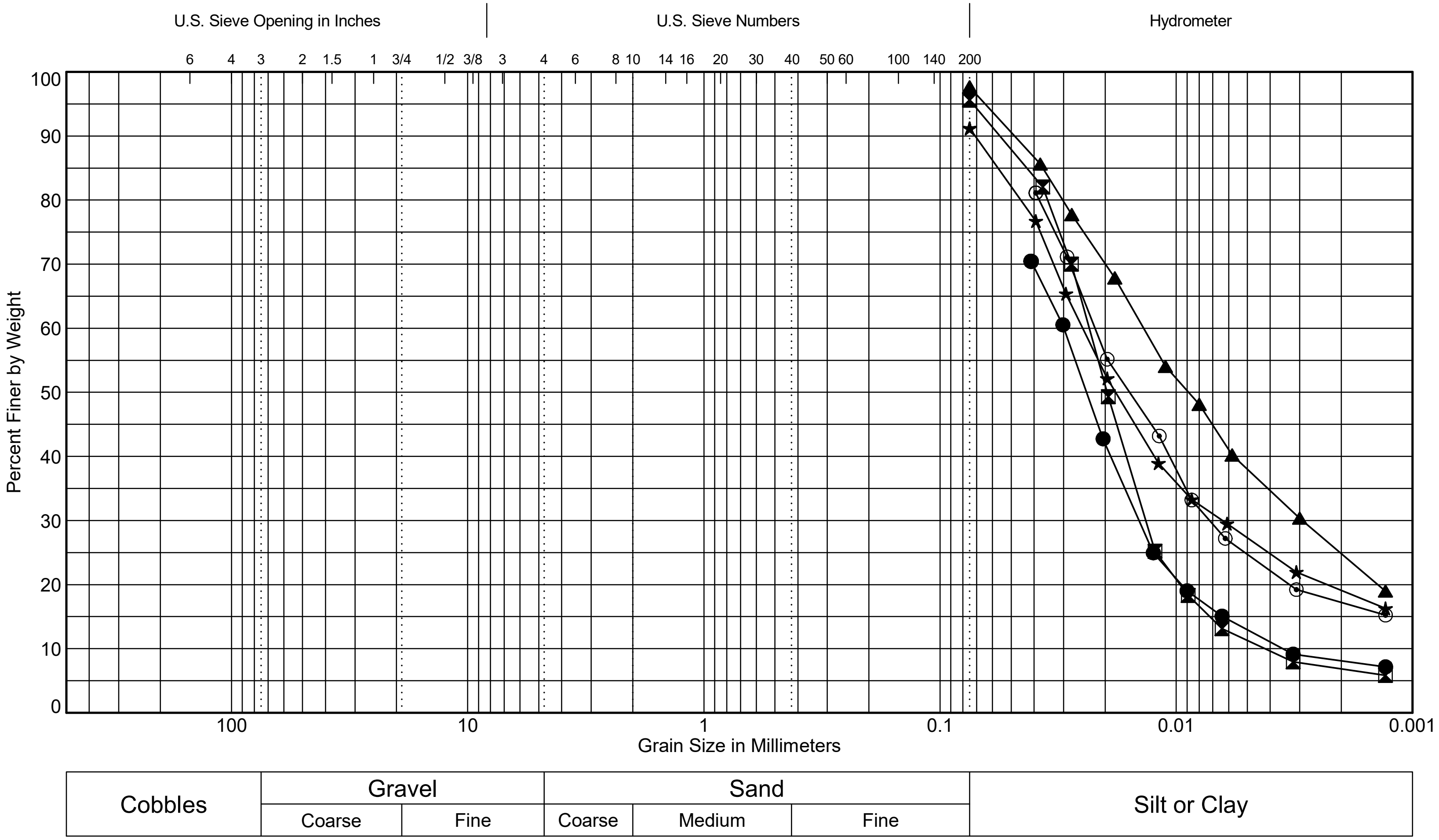
Atterberg Limits Determinations

Atterberg limits determinations were performed on select soil samples in general accordance with ASTM standard test method D4318, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.* Samples selected for Atterberg limits determinations are designated with an "AL" in the "Test Data" column on the summary boring logs in Appendix A. The results of the Atterberg limit tests are presented on Figures C-7 and C-8 in this appendix.

One-Dimensional Incremental Loading Consolidation Tests

Consolidation properties of subsurface site soils were evaluated with one-dimensional incremental loading consolidation tests. Tests were performed in general accordance with ASTM standard test method D2435, *Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading.* A load increment ratio of 2 was used with a 24-hour load duration.

The purpose of the test was to measure the coefficient of consolidation, the compression index, and the recompression index. Testing was performed on relatively undisturbed soil samples obtained with a Shelby tube sampler. Shelby tube samples were cut, extruded, and trimmed in general accordance with the Massachusetts Institute of Technology procedure (Germaine and Germaine 2009). The results of the consolidation tests are presented on Figures C-9 through C-12 in this appendix.



Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-3	7.5	53	SILT	ML
☒	B-1	S-6A	15.0		SILT	ML
▲	B-1	S-8	19.0	50	SILT	ML
★	B-1	S-10	25.0	56	SILT with sand	ML
⊙	B-1	S-11	27.5	46	SILT	ML

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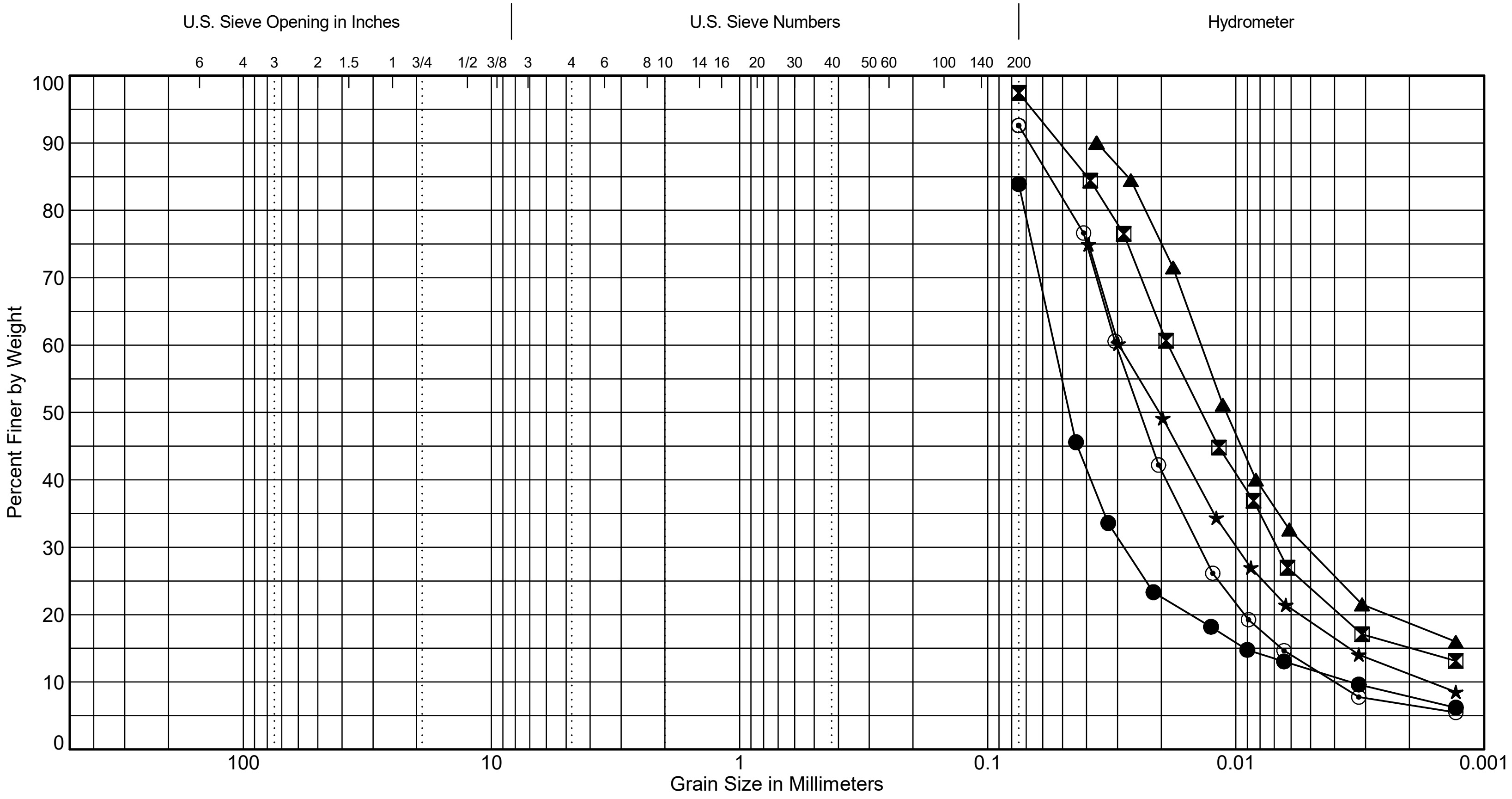
Grain Size Distribution

Figure
C-1



<table>
<tr><td rowspan="2">Cobbles</td><td colspan="2">Gravel</td><td colspan="3">Sand</td><td rowspan="2">Silt or Clay</td></tr>
<tr><td>Coarse</td><td>Fine</td><td>Coarse</td><td>Medium</td><td>Fine</td></tr>
</table>

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-12	30.0	63	SILT with sand	ML
☒	B-1	S-16	40.0	35	SILT	ML
▲	B-1	S-17A	42.5	39	CLAY	CL
★	B-1	S-20B	50.5	43	SILT	ML
⊙	B-1	S-21	55.0	40	SILT	ML

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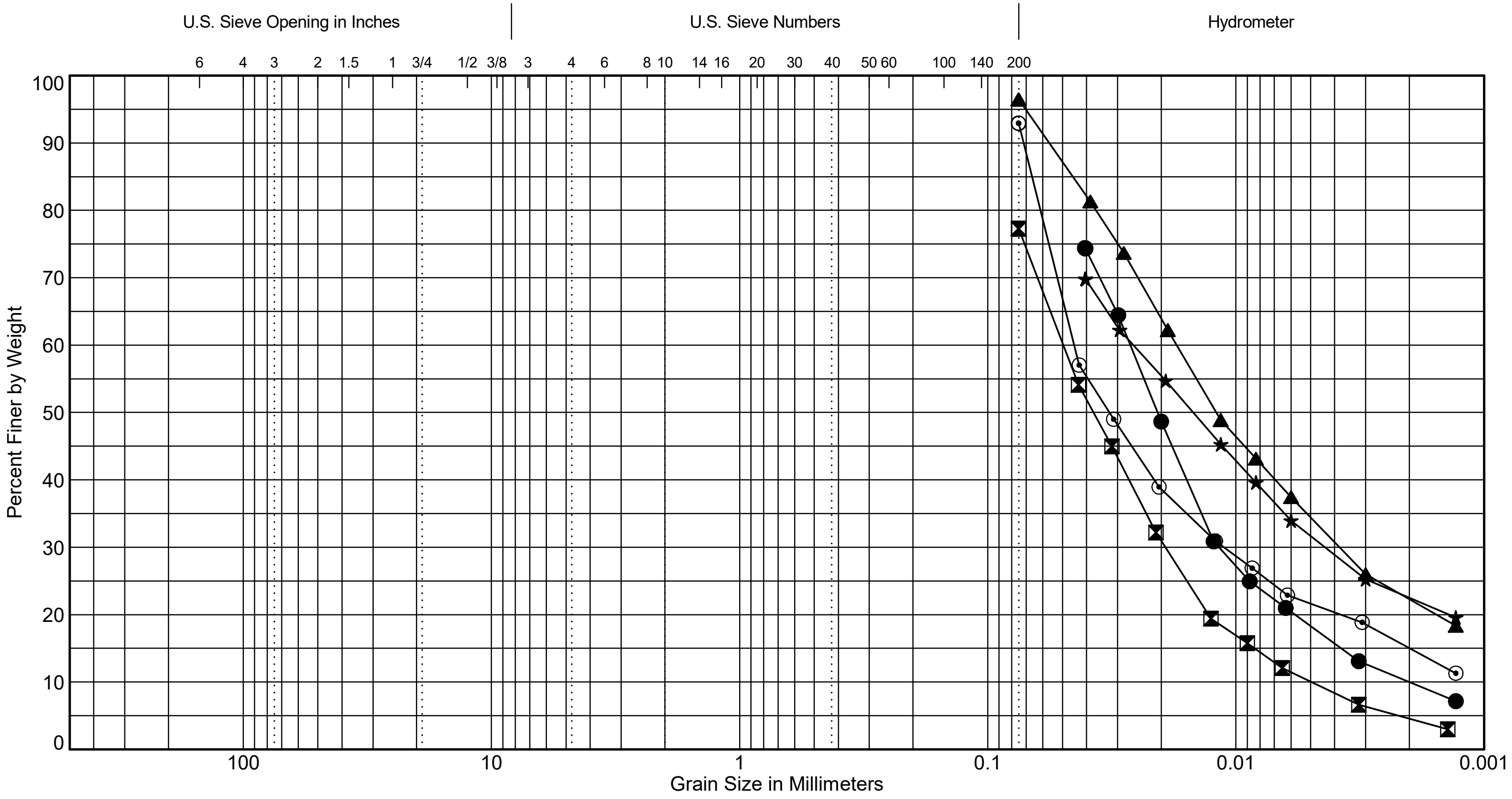
Grain Size Distribution

Figure
C-2



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-22	60.0	39	SILT	ML
⧗	B-1	S-23	65.0	35	SILT with sand	ML
▲	B-2	S-8	21.0	42	SILT	ML
★	B-2	S-9	22.5	57	Elastic SILT	MH
⊙	B-2	S-10	25.0	52	SILT	ML

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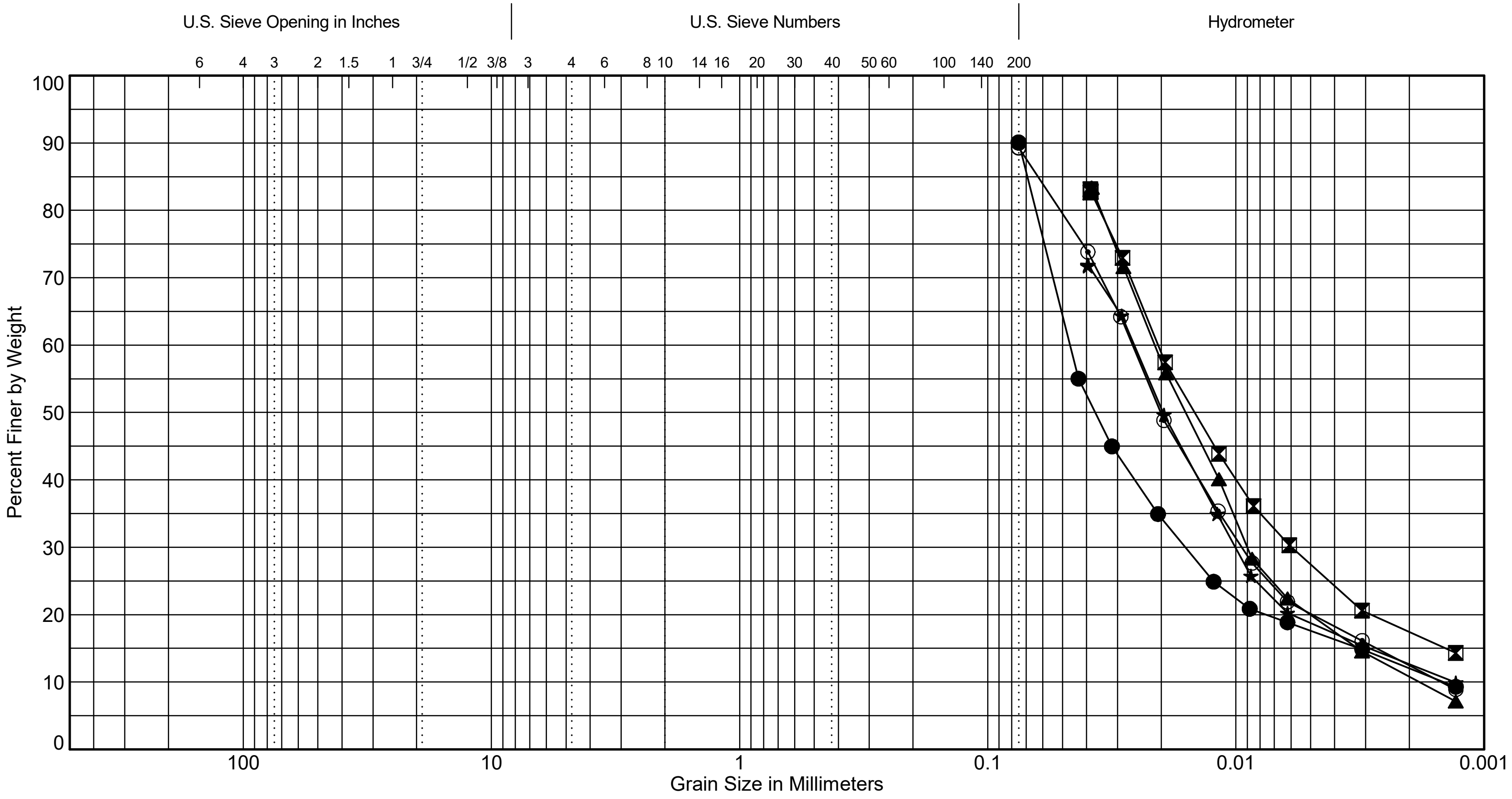
Grain Size Distribution

Figure
C-3



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	S-11	27.5	49	SILT	ML
⧗	B-2	S-12	30.0	50		
▲	B-2	S-14	35.0	54	SILT	ML
★	B-2	S-16	40.0	50		
⦿	B-2	S-18	42.3	41	SILT with sand	ML

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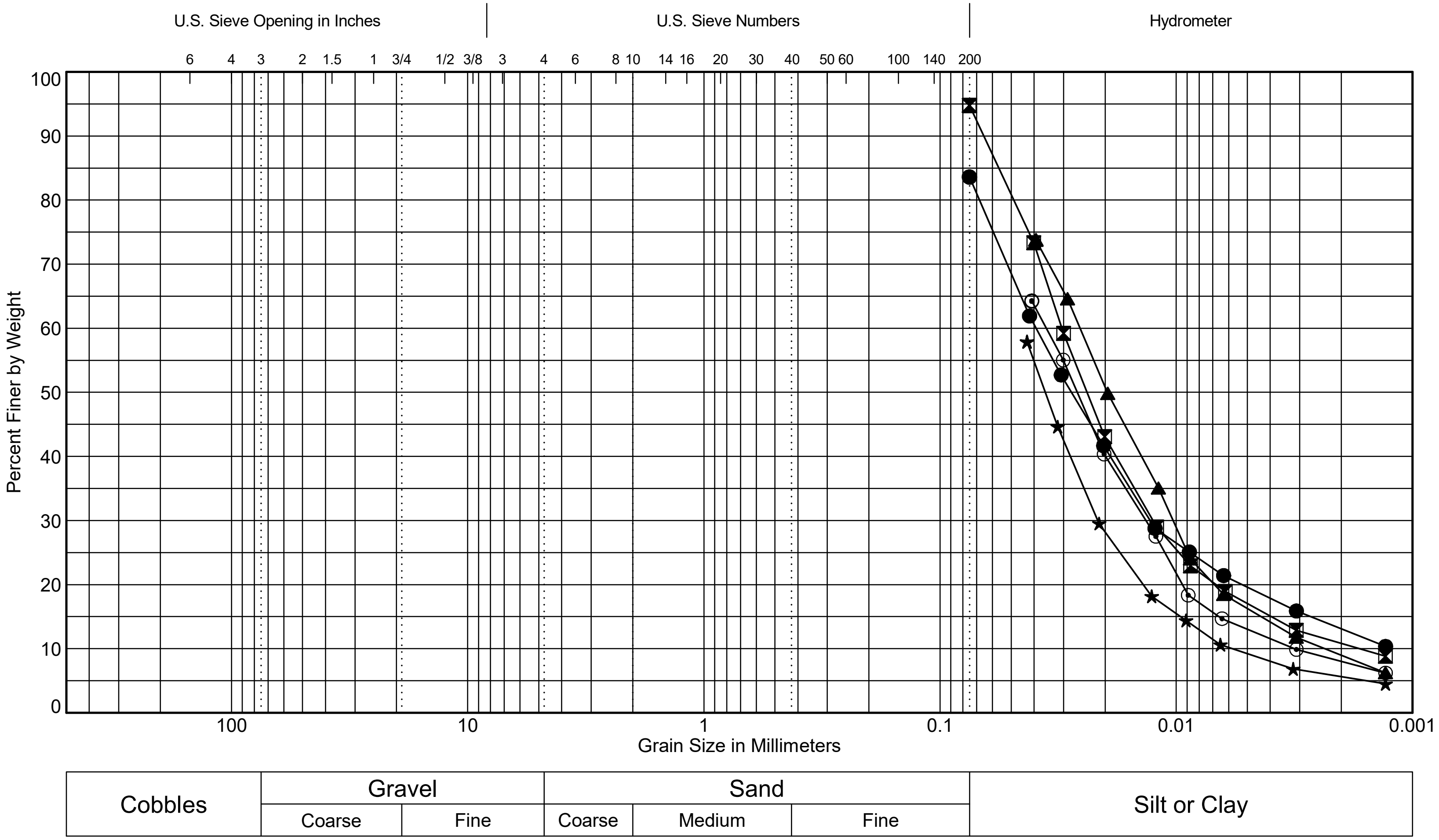
Grain Size Distribution

Figure
C-4

1374018.02 1/13/22 C:\USERS\MSKINNER\DESKTOP\1374018.020.GPJ GRAIN SIZE FIGURE_STRAIGHT LINE



Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	S-17	42.5	45	SILT with sand	ML
⧗	B-2	S-19	47.5	38	SILT	ML
▲	B-2	S-20	50.0	41		
★	B-2	S-21	55.0	34		
⊙	B-2	S-22	60.0			

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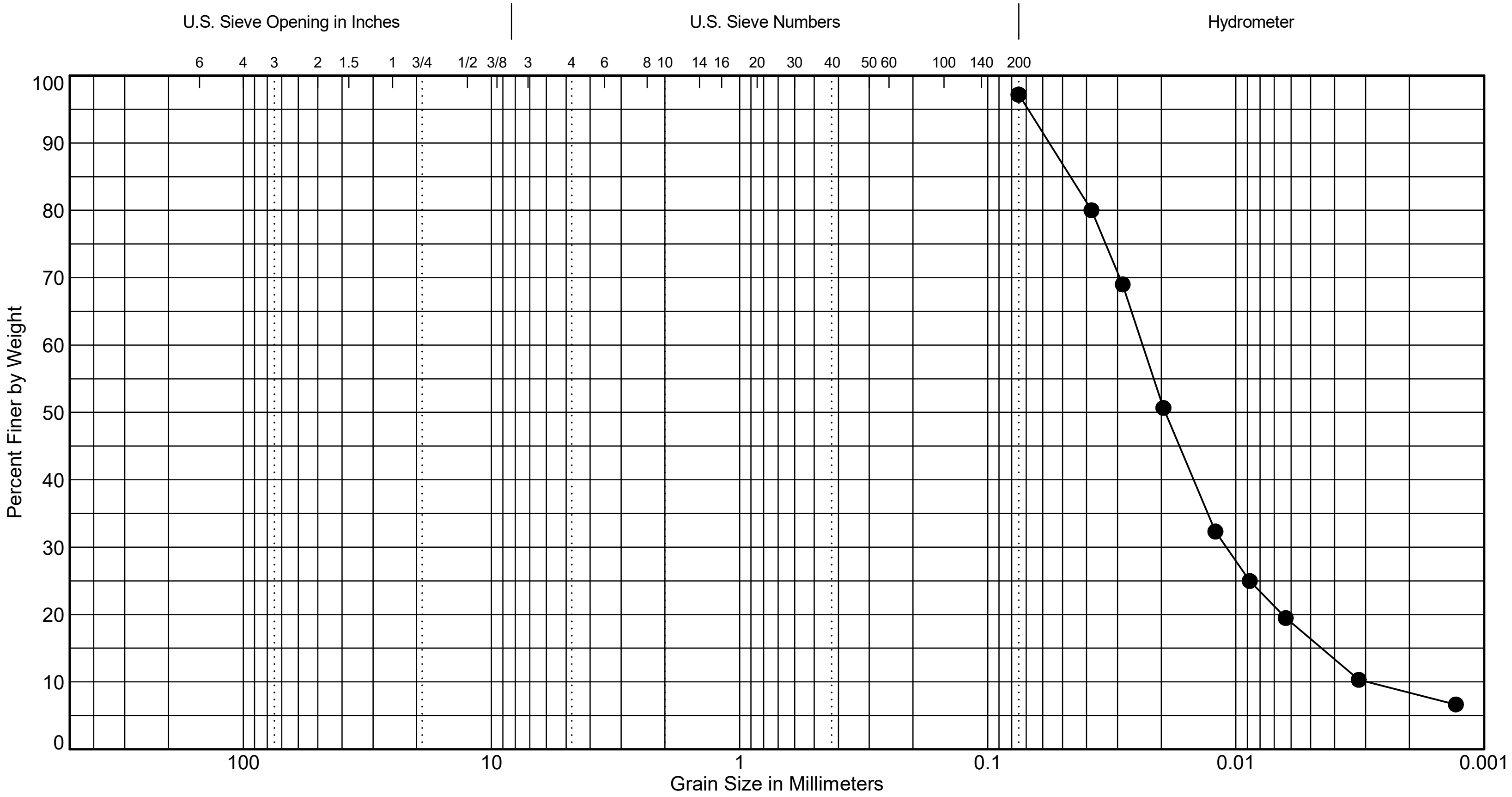
Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Grain Size Distribution

Figure
C-5



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	S-23	65.0		SILT	ML

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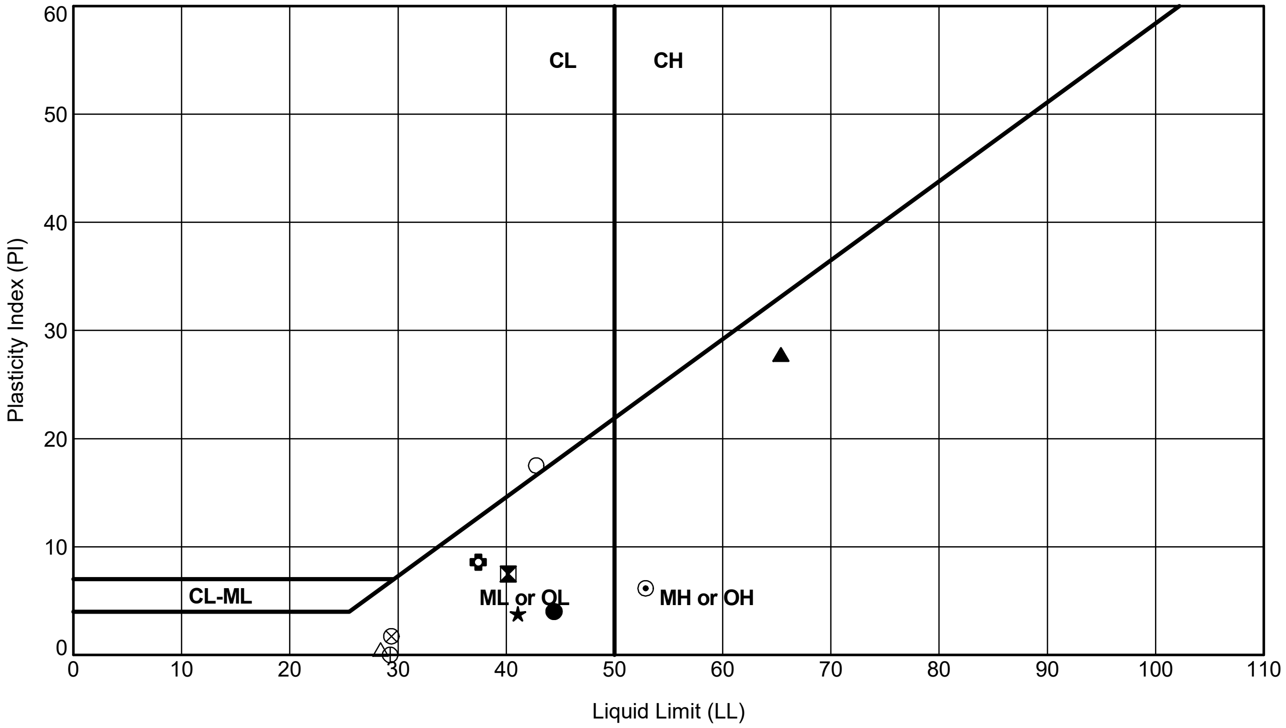
Grain Size Distribution

Figure
C-6



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-1	S-3	7.5	44	40	4	53	SILT	ML
⧗	B-1	S-7A	17.5	40	33	7	56	SILT	ML
	B-1	S-9	22.5	65	38	27	79	Elastic SILT	MH
★	B-1	S-11	27.5	41	37	4	46	SILT	ML
⊙	B-1	S-14	35.0	53	47	6	59	Elastic SILT	MH
✤	B-1	S-16	40.0	37	29	8	35	SILT	ML
○	B-1	S-17A	42.5	43	25	18	39	CLAY	CL
△	B-1	S-19A	47.5	28	28	0	40	SILT	ML
⊗	B-1	S-20B	50.5	29	28	1	43	SILT	ML
⊕	B-1	S-22	60.0	29	30	-1	39	SILT	ML

ASTM D 4318 Test Method

1374018.02 1/13/22 C:\USERS\MSKINNER\DESKTOP\1374018.020.GPJ ATTERBERG LIMITS FIGURE_PRINTS NP

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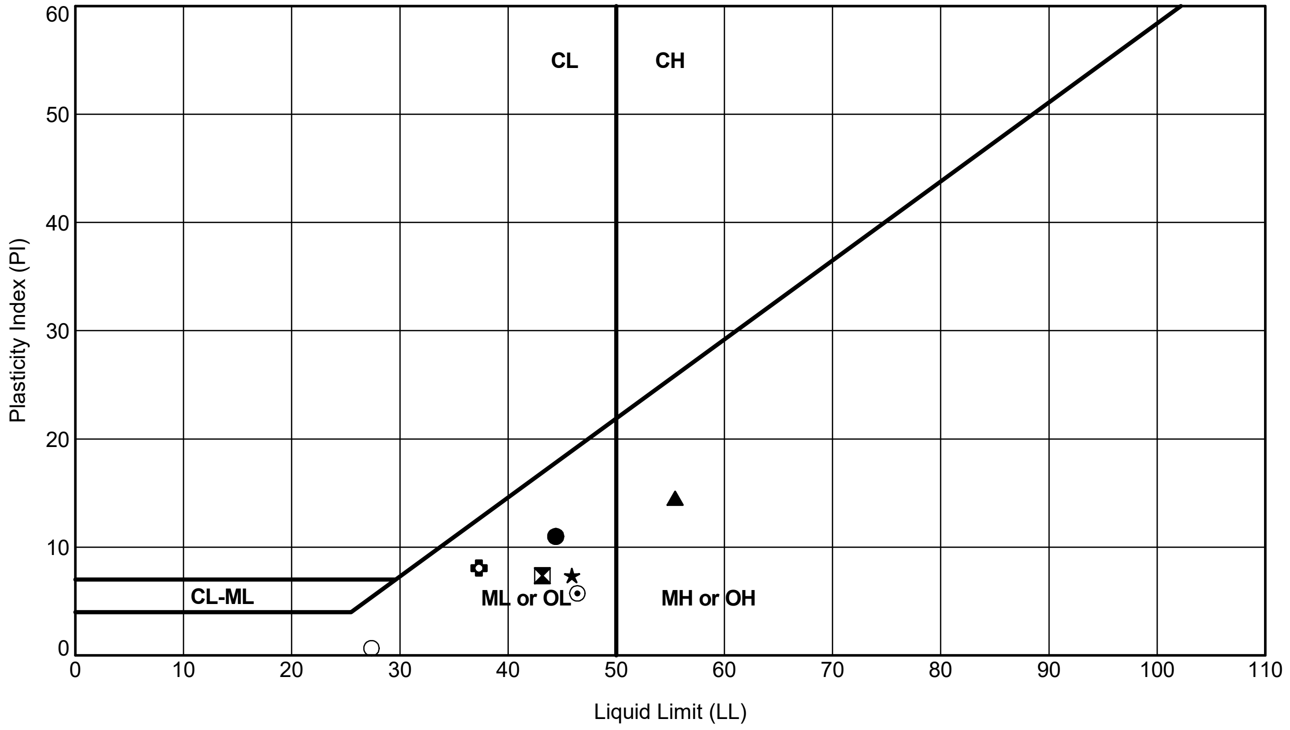
Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Plasticity Chart

Figure
C-7



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	S-7	17.5	44	33	11	44	SILT	ML
⧗	B-2	S-8	21.0	43	36	7	42	SILT	ML
▲	B-2	S-9	22.5	55	41	14	57	Elastic SILT	MH
★	B-2	S-12	30.0	46	39	7	50		
⊙	B-2	S-16	40.0	46	41	5	50		
✿	B-2	S-20	50.0	37	29	8	41		
○	B-2	S-21	55.0	27	27	0	34		

ASTM D 4318 Test Method

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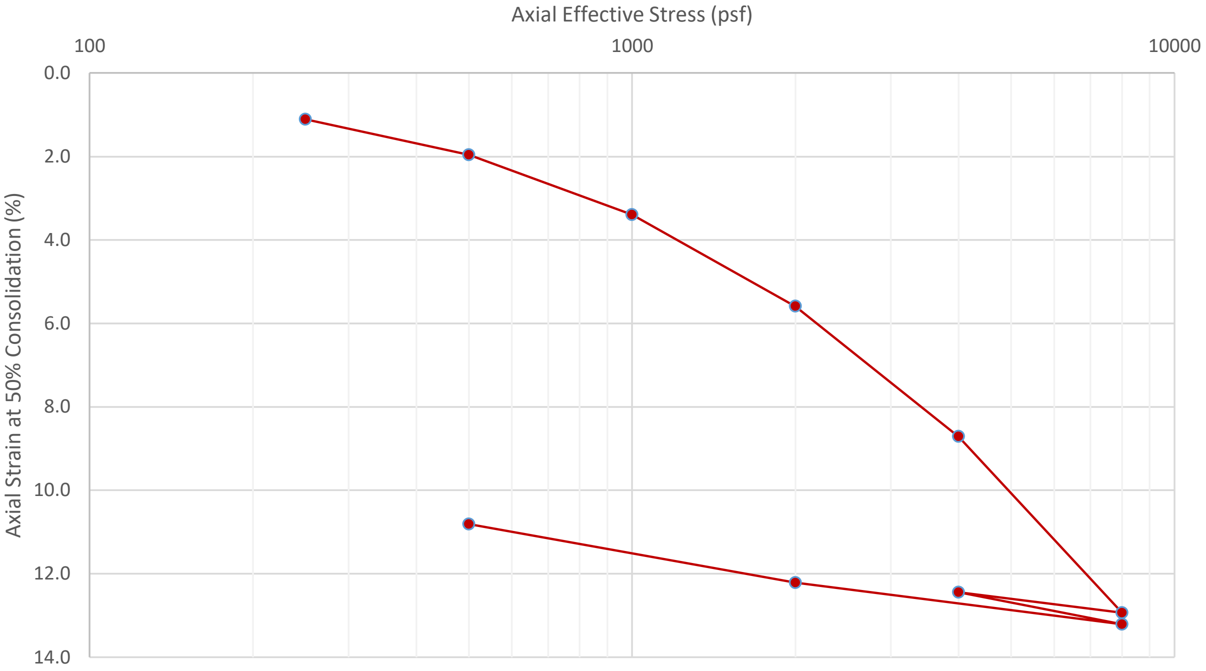
LANDAU ASSOCIATES

Owens Corning Linnton
Asphalt Terminal Final Design
Portland, Oregon

Plasticity Chart

Figure
C-8



B-1, S-8 at 19.8 Feet Below Ground Surface

Sample Description: Gray SILT with trace organics

Specific Gravity: 2.65

	Initial	Final	
Moisture (%):	45	43	Comments:
Dry Density (pcf):	71.1	77.0	
Saturation (%):	100	100	
Void Ratio:	1.32	1.14	

Landau Associates

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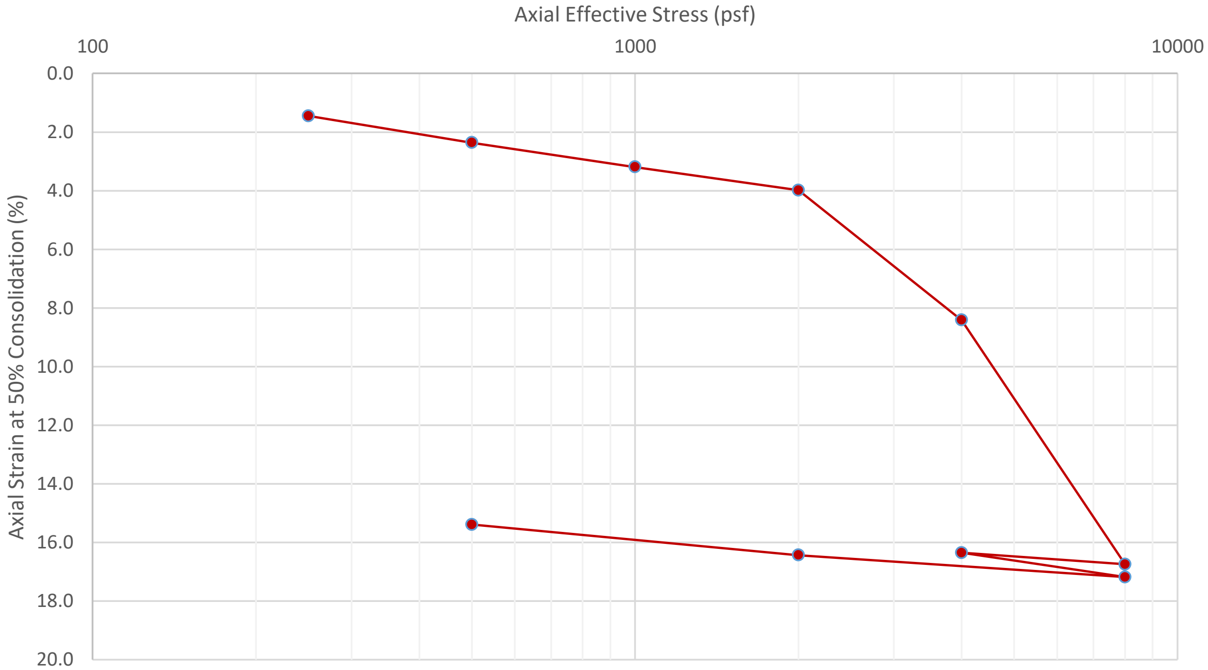
Portland, Oregon

One-Dimensional Consolidation Test Summary

Figure
C-9



B-1, S-13 at 34 Feet Below Ground Surface

Sample Description: Gray SILT

Specific Gravity: 2.65

	Initial	Final	
Moisture (%):	64	53	Comments:
Dry Density (pcf):	60.5	68.3	
Saturation (%):	109	99	
Void Ratio:	1.72	1.42	

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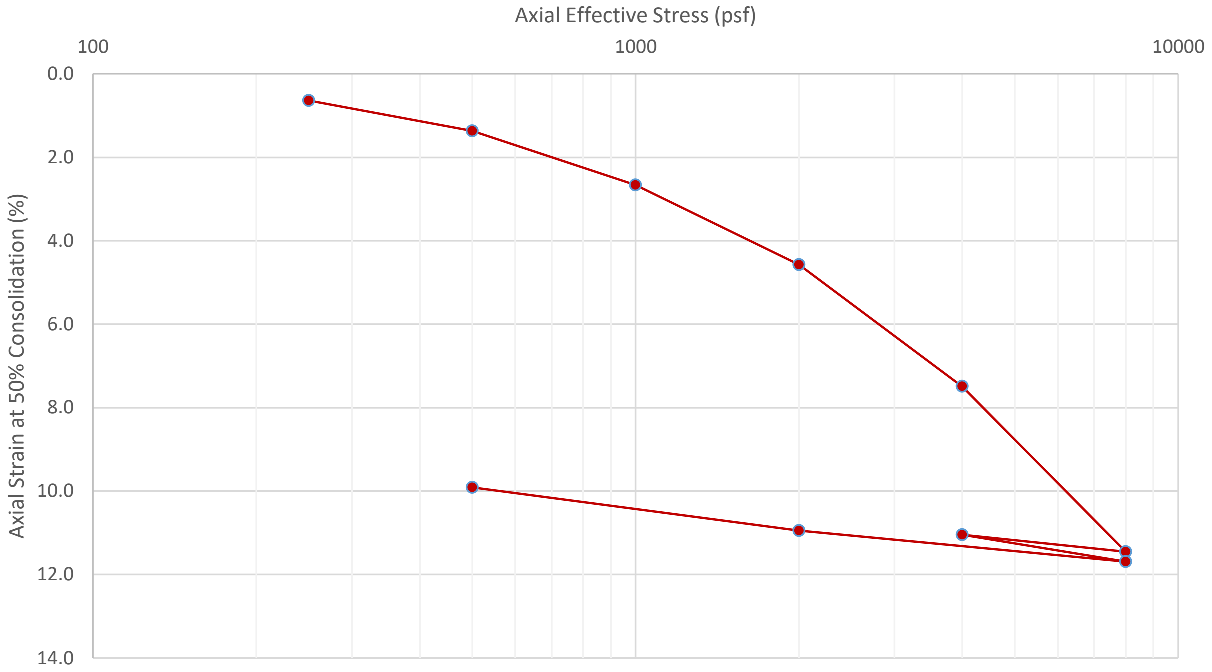
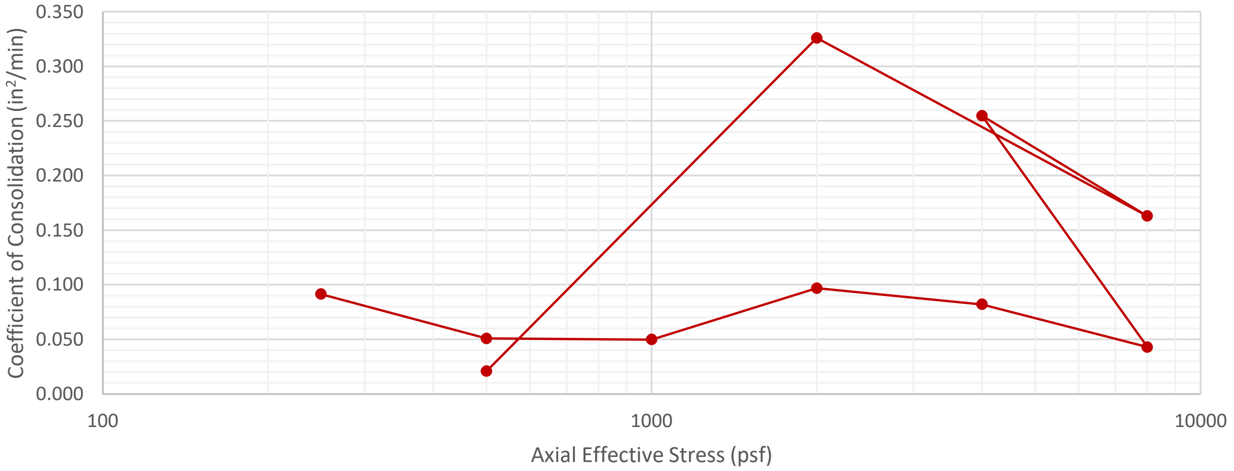
Portland, Oregon

One-Dimensional Consolidation Test Summary

Figure
C-10





B-2, S-8 at 20.7 Feet Below Ground Surface

Sample Description: Gray SILT with trace organics

Specific Gravity: 2.65

	Initial	Final	
Moisture (%):	43	39	Comments:
Dry Density (pcf):	76.6	83.1	
Saturation (%):	109	105	
Void Ratio:	1.15	0.99	

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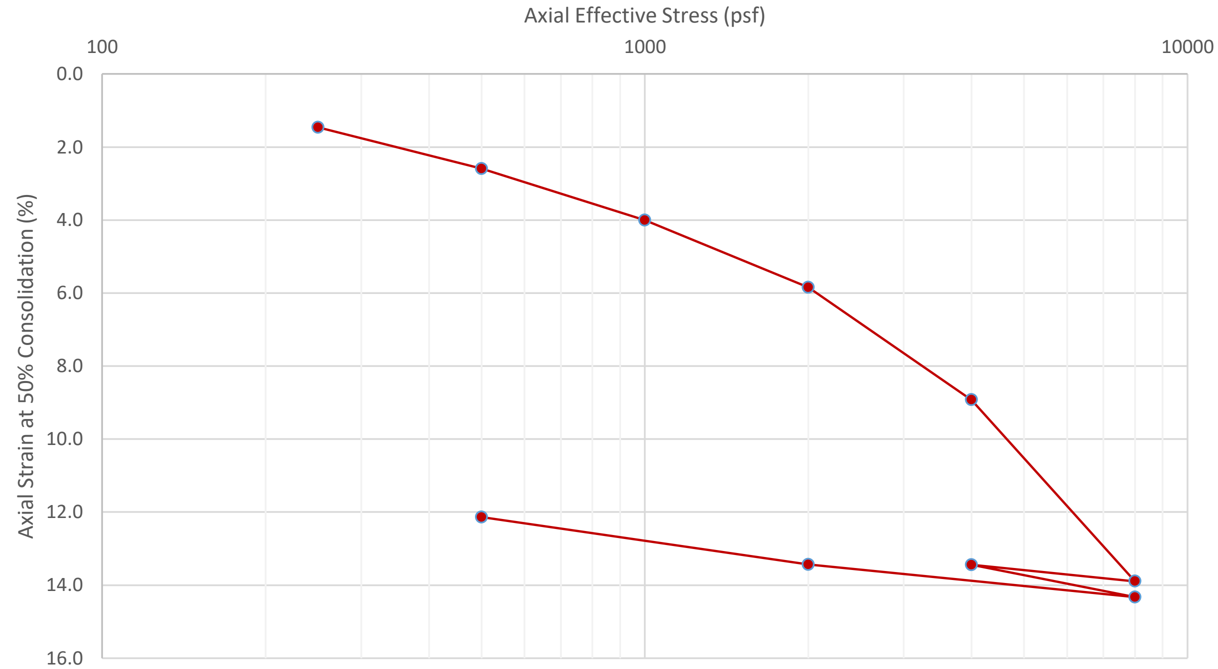
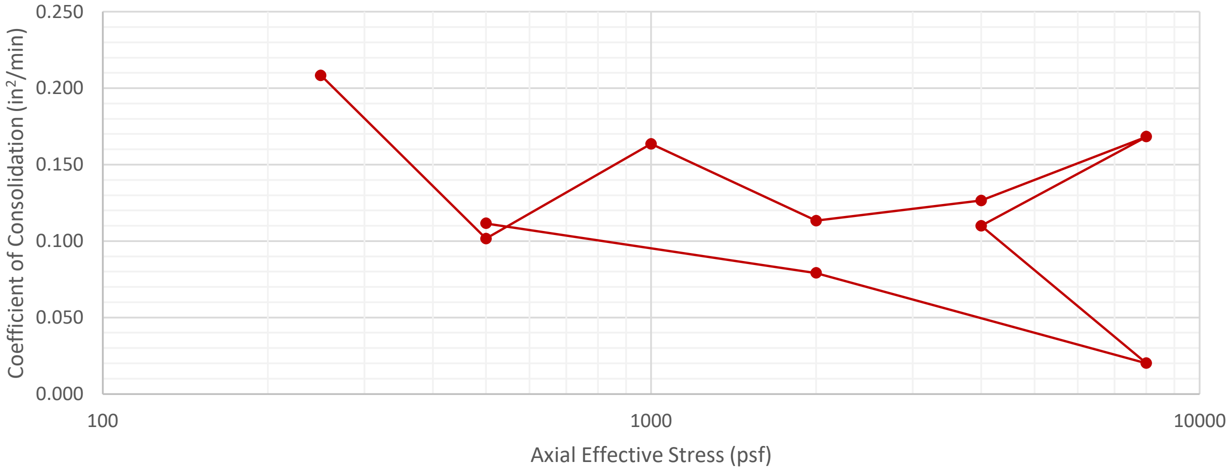
Owens Corning Linnton Asphalt Terminal
Final Design
Portland, Oregon

One-Dimensional Consolidation Test Summary

Figure
C-11





B-2, S-15 at 37.5 Feet Below Ground Surface

Sample Description: Dark gray SILT

Specific Gravity: 2.65

	Initial	Final	Comments:
Moisture (%):	58	53	
Dry Density (pcf):	62.4	69.4	
Saturation (%):	98	102	
Void Ratio:	1.65	1.38	

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Portland, Oregon

One-Dimensional Consolidation Test Summary

Figure
C-12

LANDAU ASSOC - TUMWATER
955 MALIN LANE SW STE B

TUMWATER , WA 98501

Laboratory #: S21-15919

Date Received: 8/16/2021
Grower: OC LINNTON
Field: B-2 S-6
Sampled By:
Customer Account #:
Customer Sample ID:

Soil Test Results

Cation Exchange	CEC	meq/100g	7.2

pH 1:1 5.9
E.C. 1:1 m.mhos/cm
Est Sat Paste E.C. m.mhos/cm
Effervescence

Ammonium - N mg/kg
Organic Matter W.B. %

Other Tests:

We make every effort to provide an accurate analysis of your sample. For reasonable cause we will repeat tests, but because of factors beyond our control in sampling procedures and the inherent variability of soil, our liability is limited to the price of the tests. Recommendations are to be used as general guides and should be modified for specific field conditions and situations. Note: "u" indicates that the element was analyzed for but not detected

This is your Invoice #: S21-15919 Account #: 227500 Reviewed by: K. Bair, PhD, C List Cost: $26.00

PAP-Accredited
NAPT
2021

soiltest
farm consultants, inc.
2925 Driggs Dr., Moses Lake, Wa 98837 · www.soiltestlab.com
Office: (509)765-1622 · Fax:(509)765-0314 · (800)764-1622

Soil & Plant Program
2021
NAPT
Participating Laboratory

LANDAU ASSOC - TUMWATER
955 MALIN LANE SW STE B

TUMWATER , WA 98501

Laboratory #: S21-15920

Date Received: 8/16/2021
Grower: OC LINNTON
Field: B-2 S-14
Sampled By:
Customer Account #:
Customer Sample ID:

Soil Test Results

Cation Exchange	CEC	meq/100g	18.8

pH 1:1 6.1
E.C. 1:1 m.mhos/cm
Est Sat Paste E.C. m.mhos/cm
Effervescence

Ammonium - N mg/kg
Organic Matter W.B. %

Other Tests:

We make every effort to provide an accurate analysis of your sample. For reasonable cause we will repeat tests, but because of factors beyond our control in sampling procedures and the inherent variability of soil, our liability is limited to the price of the tests. Recommendations are to be used as general guides and should be modified for specific field conditions and situations. Note: "u" indicates that the element was analyzed for but not detected

This is your Invoice #: S21-15920 Account #: 227500 Reviewed by: K. Bair, PhD, C List Cost: $26.00

G-2-1
Site Class Calculation

Owens Corning Linnton Asphalt Terminal SVA
Site Class Calculation

	A	B	C	D	E
1	**CPT-1**	**Shear Wave Vel. for Layer i**	**Layer Thickness**		
2	**CPT Measurement Depth (ft)**	**Vs,i (ft/s)**	**di (ft)**	**di/vsi**	**Notes**
3	6.56	607.74	6.56	0.010794	Measured
4	9.84	450.1	3.28	0.007287	Measured
5	13.12	441.87	3.28	0.007423	Measured
6	16.4	474.47	3.28	0.006913	Measured
7	19.69	326.9	3.29	0.010064	Measured
8	22.97	334.78	3.28	0.009797	Measured
9	26.25	428.79	3.28	0.007649	Measured
10	29.53	453.7	3.28	0.007229	Measured
11	32.81	437.99	3.28	0.007489	Measured
12	36.09	427.47	3.28	0.007673	Measured
13	39.37	482.44	3.28	0.006799	Measured
14	42.65	437.4	3.28	0.007499	Measured
15	45.93	610.27	3.28	0.005375	Measured
16	49.21	767.51	3.28	0.004274	Measured
17	52.49	854.09	3.28	0.00384	Measured
18	55.77	797.48	3.28	0.004113	Measured
19	59.06	829.35	3.29	0.003967	Measured
20	62.34	941.44	3.28	0.003484	Measured
21	65.62	974.52	3.28	0.003366	Measured
22	68.9	855.37	3.28	0.003835	Measured
23	72.18	891.93	3.28	0.003677	Measured
24	75.3	821.26	3.12	0.003799	Measured
25	78.74	1100.74	3.44	0.003125	Measured
26	80	999.1	1.26	0.001261	SPT N to Vs Correlation (Wair et al 2012)
27	85	2234.0	5	0.002238	SPT N to Vs Correlation (Wair et al 2012)
28	90	2234.0	5	0.002238	SPT N to Vs Correlation (Wair et al 2012)
29	95	12000.0	5	0.000417	Sowers and Boyd (2019)
30	100	12000.0	5	0.000417	Sowers and Boyd (2019)
31					
32			=SUM(D3:D30)	0.146043	**Sum**
33				**Vs,30**	
34			=100/D32	684.7314	**(ft/s)**
35				208.7596	(m/s)

G-2-2

Building Code Seismic Design Parameters

⚠ This is a beta release of the new ATC Hazards by Location website. Please contact us with feedback.

ℹ The ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

ATC Hazards by Location

Search Information

Coordinates:	45.609, -122.791
Elevation:	32 ft
Timestamp:	2024-02-19T16:59:30.531Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	III
Site Class:	D

Basic Parameters

Name	Value	Description
S_S	0.898	MCE$_R$ ground motion (period=0.2s)
S_1	0.413	MCE$_R$ ground motion (period=1.0s)
S_{MS}	1.024	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	0.683	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

▾Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1.141	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.89	Coefficient of risk (0.2s)
CR_1	0.87	Coefficient of risk (1.0s)
PGA	0.408	MCE$_G$ peak ground acceleration
F_{PGA}	1.192	Site amplification factor at PGA
PGA_M	0.486	Site modified peak ground acceleration
T_L	16	Long-period transition period (s)
SsRT	0.898	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.009	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.413	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.475	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.611	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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G-2-3
PGA Disaggregation

```
*** Deaggregation of Seismic Hazard at One Period of Spectral Acceleration ***
*** Data from Dynamic: Conterminous U.S. 2014 (update) (4.2.0) ****
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: Total
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 100 %
  Residual: 0 %
  Trace: 0.51 %
Mean (over all sources):
  m: 7.78
  r: 55.05 km
  ε□: 0.94 σ
Mode (largest m-r bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.59 σ
  Contribution: 12.47 %
Mode (largest m-r-ε□ bin):
  m: 9.01
  r: 70.14 km
  ε□: 0.68 σ
  Contribution: 8.04 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)
ε=[2,2.5)   ε=[2.5,∞)
270 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
250 7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
250 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
250 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
250 8.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
230 7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
230 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
     0.000   0.000   0.000
62   230 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
63   230 8.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
64   230 8.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
65   230 8.5 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.006
66   230 8.7 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.007
67   210 7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
68   210 7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.001
69   210 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
70   210 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
71   210 8.1 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.001
72   210 8.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.001
73   210 8.5 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.002
74   190 7.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
75   190 7.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.001
76   190 7.5 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.001   0.002
77   190 7.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.001   0.000
78   190 7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.001   0.001
79   190 8.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.002
80   190 8.3 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.001
81   190 8.5 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.005   0.003
82   170 7.1 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.007
83   170 7.3 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.001   0.006
84   170 7.5 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.006   0.003
85   170 7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.002   0.000
86   170 7.9 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.001   0.003   0.002
87   170 8.1 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.003   0.002
88   170 8.3 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.003   0.001
89   170 8.5 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.017   0.003
90   170 8.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.001   0.000
91   150 6.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.002
92   150 7.1 0.045   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.003   0.043
93   150 7.3 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.012   0.003
94   150 7.5 0.017   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.003   0.013   0.001
95   150 7.7 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.002   0.002   0.000
```

```
150 7.9 0.014   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.005   0.008   0.001
150 8.1 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.016   0.003
150 8.3 0.196   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.187   0.010
150 8.5 0.115   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.013   0.101   0.000
150 8.7 0.173   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.107   0.066   0.000
130 6.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
130 6.9 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.002   0.019
130 7.1 0.103   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.078   0.025
130 7.3 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.007   0.017   0.002
130 7.5 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.019   0.005   0.001
130 7.7 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.006   0.001   0.000
130 7.9 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005
0.005   0.018   0.002
130 8.1 0.051   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.012   0.037   0.002
130 8.3 0.053   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.024   0.029   0.000
130 8.5 0.354   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.292   0.062   0.000
130 8.7 1.528   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
1.528   0.000   0.000
130 9.1 1.129   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
1.126   0.000   0.003
110 6.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
110 6.7 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.014
110 6.9 0.062   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.044   0.017
110 7.1 0.182   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.049   0.118   0.015
110 7.3 0.038   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.027   0.009   0.001
110 7.5 0.032   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.012
0.017   0.003   0.000
110 7.7 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007
0.002   0.000   0.000
110 7.9 0.047   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005   0.009
0.024   0.009   0.000
110 8.1 0.085   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.060   0.025   0.000
110 8.3 0.056   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.038   0.018   0.000
110 8.5 0.778   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.274
0.499   0.000   0.005
110 8.7 3.438   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.320
3.103   0.000   0.016
110 8.9 3.836   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   2.211
1.573   0.020   0.032
110 9.1 5.187   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   5.012
0.000   0.175   0.000
90  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  6.5 0.024   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.010   0.014
90  6.7 0.099   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
     0.003   0.076   0.020
131  90  6.9 0.255   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.097   0.144   0.013
132  90  7.1 0.478   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.052
     0.338   0.085   0.002
133  90  7.3 0.080   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.049
     0.028   0.002   0.000
134  90  7.5 0.052   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.040
     0.006   0.000   0.000
135  90  7.7 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007   0.004
     0.000   0.000   0.000
136  90  7.9 0.030   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.007   0.005
     0.012   0.000   0.000
137  90  8.1 0.038   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.015
     0.022   0.000   0.000
138  90  8.3 0.022   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.015
     0.006   0.000   0.000
139  90  8.5 0.246   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.237
     0.002   0.003   0.004
140  90  8.7 0.223   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.216
     0.001   0.002   0.004
141  90  8.9 0.251   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.239
     0.000   0.012   0.000
142  70  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
143  70  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
144  70  6.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
145  70  6.5 0.163   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.068   0.090   0.006
146  70  6.7 0.576   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.028
     0.412   0.130   0.006
147  70  6.9 1.019   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.501
     0.474   0.044   0.000
148  70  7.1 1.637   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.277   1.153
     0.207   0.000   0.000
149  70  7.3 0.220   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.142   0.072
     0.003   0.000   0.000
150  70  7.5 0.138   0.000   0.000   0.000   0.000   0.000   0.000   0.025   0.098   0.014
     0.000   0.000   0.001
151  70  7.7 0.027   0.000   0.000   0.000   0.000   0.000   0.003   0.014   0.009   0.000
     0.000   0.000   0.001
152  70  7.9 0.163   0.000   0.000   0.000   0.000   0.002   0.011   0.010   0.004   0.118
     0.007   0.011   0.000
153  70  8.1 0.308   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.281
     0.013   0.014   0.000
154  70  8.3 0.183   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.167
     0.015   0.002   0.000
155  70  8.5 0.828   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.380   0.360
     0.086   0.002   0.000
156  70  8.7 1.265   0.000   0.000   0.000   0.000   0.000   0.000   0.000   1.079   0.078
     0.107   0.000   0.000
157  70  8.9 7.975   0.000   0.000   0.000   0.000   0.000   0.000   0.000   6.780   1.195
     0.000   0.000   0.000
158  70  9.1 9.800   0.000   0.000   0.000   0.000   0.000   0.000   0.000   8.039   1.761
     0.000   0.000   0.000
159  70  9.3 12.468  0.000   0.000   0.000   0.000   0.000   0.000   5.575   6.893   0.000
     0.000   0.000   0.000
160  50  5.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
161  50  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
162  50  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
163  50  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
     0.000   0.000   0.000
164  50  6.5 0.344   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.073
     0.265   0.005   0.001
```

```
50  6.7 1.010   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.760
0.247   0.000   0.003
50  6.9 1.595   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.572   1.003
0.012   0.000   0.008
50  7.1 2.395   0.000   0.000   0.000   0.000   0.000   0.000   0.088   2.105   0.186
0.000   0.003   0.014
50  7.3 0.326   0.000   0.000   0.000   0.000   0.000   0.000   0.187   0.108   0.000
0.000   0.018   0.013
50  7.5 0.202   0.000   0.000   0.000   0.000   0.000   0.024   0.151   0.004   0.000
0.000   0.019   0.005
50  7.7 0.035   0.000   0.000   0.000   0.000   0.003   0.014   0.013   0.000   0.000
0.001   0.003   0.000
50  7.9 0.027   0.000   0.000   0.000   0.000   0.013   0.003   0.009   0.000   0.000
0.001   0.001   0.000
30  5.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
30  5.3 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.007
30  5.5 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.002   0.028
30  5.7 0.059   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.015   0.044
30  5.9 0.113   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.062   0.051
30  6.1 0.266   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.202   0.063
30  6.3 0.335   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.022   0.243   0.070
30  6.5 0.263   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.062   0.161   0.041
30  6.7 0.214   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004
0.062   0.119   0.029
30  6.9 0.164   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.012
0.058   0.078   0.015
30  7.1 0.189   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.021
0.101   0.063   0.004
30  7.3 0.220   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.048
0.118   0.050   0.003
30  7.5 0.142   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.047
0.071   0.019   0.001
30  7.7 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.012
0.010   0.001   0.000
30  7.9 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.003
0.002   0.000   0.000
10  5.1 1.779   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.934
0.410   0.351   0.082
10  5.3 1.978   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.429   0.630
0.524   0.334   0.062
10  5.5 2.180   0.000   0.000   0.000   0.000   0.000   0.000   0.477   0.363   0.502
0.515   0.289   0.035
10  5.7 1.912   0.000   0.000   0.000   0.000   0.000   0.000   0.364   0.511   0.379
0.445   0.195   0.019
10  5.9 1.643   0.000   0.000   0.000   0.000   0.000   0.000   0.269   0.410   0.398
0.424   0.133   0.009
10  6.1 2.650   0.000   0.000   0.000   0.000   0.000   0.000   0.600   0.666   0.864
0.359   0.146   0.014
10  6.3 2.871   0.000   0.000   0.000   0.000   0.000   0.000   0.734   0.903   0.843
0.349   0.040   0.002
10  6.5 4.278   0.000   0.000   0.000   0.000   0.000   0.392   1.900   1.241   0.519
0.200   0.025   0.000
10  6.7 5.631   0.000   0.000   0.000   0.000   0.000   0.947   3.311   0.978   0.269
0.118   0.008   0.000
10  6.9 5.619   0.000   0.000   0.000   0.000   0.470   1.917   2.567   0.388   0.221
0.057   0.001   0.000
10  7.1 3.797   0.000   0.000   0.000   0.000   1.072   0.806   1.492   0.239   0.166
0.022   0.000   0.000
10  7.3 0.992   0.000   0.000   0.000   0.000   0.166   0.158   0.344   0.189   0.120
0.015   0.000   0.000
10  7.5 0.277   0.000   0.000   0.000   0.000   0.013   0.032   0.089   0.094   0.046
```

```
0.004   0.000   0.000
10  7.7 0.041   0.000   0.000   0.000   0.000   0.001   0.006   0.013   0.015   0.005
0.000   0.000   0.000
10  7.9 0.009   0.000   0.000   0.000   0.000   0.000   0.001   0.003   0.003   0.001
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
sub0_ch_bot.in:
  Percent Contributed: 29.7
  Distance (km): 70.179382
  Magnitude: 9.1055834
  Epsilon (mean values): 0.72309455
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 29.7
  Distance (km): 70.179382
  Magnitude: 9.1055834
  Epsilon (mean values): 0.72309455
  Azimuth: 260.19218
  Latitude: 45.50147
  Longitude: -123.59924
sub0_ch_mid.in:
  Percent Contributed: 11.34
  Distance (km): 118.71992
  Magnitude: 8.9254869
  Epsilon (mean values): 1.453965
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 11.34
  Distance (km): 118.71992
  Magnitude: 8.9254869
  Epsilon (mean values): 1.453965
  Azimuth: 264.55326
  Latitude: 45.48932
  Longitude: -124.32961
Geologic Model Partial Rupture:
  Percent Contributed: 8.12
  Distance (km): 2.6307074
  Magnitude: 6.7417979
  Epsilon (mean values): 0.084527773
Portland Hills:
  Percent Contributed: 8.06
  Distance (km): 2.463229
  Magnitude: 6.7427124
  Epsilon (mean values): 0.06892305
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
coastalOR_deep.in:
  Percent Contributed: 6.48
  Distance (km): 58.997177
  Magnitude: 6.9341436
  Epsilon (mean values): 1.1568256
Geologic Model Full Rupture:
  Percent Contributed: 3.8
  Distance (km): 1.0705765
  Magnitude: 6.9956517
  Epsilon (mean values): -0.10232568
Portland Hills:
  Percent Contributed: 3.76
  Distance (km): 0.76905363
  Magnitude: 6.9988433
  Epsilon (mean values): -0.13052881
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
WUSmap_2014_fixSm.ch.in (opt):
  Percent Contributed: 3.72
  Distance (km): 10.593647
  Magnitude: 6.0309203
  Epsilon (mean values): 1.2076221
PointSourceFinite: -122.786, 45.616:
```

```
    Percent Contributed: 1.01
    Distance (km): 5.4362135
    Magnitude: 5.5854201
    Epsilon (mean values): 0.76675699
    Azimuth: 0
    Latitude: 45.616417
    Longitude: -122.78573
  noPuget_2014_fixSm.ch.in (opt):
    Percent Contributed: 3.72
    Distance (km): 10.592672
    Magnitude: 6.0308705
    Epsilon (mean values): 1.2075827
  PointSourceFinite: -122.786, 45.616:
    Percent Contributed: 1.01
    Distance (km): 5.4362135
    Magnitude: 5.5854201
    Epsilon (mean values): 0.76675699
    Azimuth: 0
    Latitude: 45.616417
    Longitude: -122.78573
  WUSmap_2014_fixSm.gr.in (opt):
    Percent Contributed: 3.52
    Distance (km): 10.507784
    Magnitude: 5.9931315
    Epsilon (mean values): 1.2138064
  PointSourceFinite: -122.786, 45.616:
    Percent Contributed: 1.01
    Distance (km): 5.4362135
    Magnitude: 5.5854201
    Epsilon (mean values): 0.76675699
    Azimuth: 0
    Latitude: 45.616417
    Longitude: -122.78573
  noPuget_2014_fixSm.gr.in (opt):
    Percent Contributed: 3.52
    Distance (km): 10.506752
    Magnitude: 5.9930769
    Epsilon (mean values): 1.2137653
  PointSourceFinite: -122.786, 45.616:
    Percent Contributed: 1.01
    Distance (km): 5.4362135
    Magnitude: 5.5854201
    Epsilon (mean values): 0.76675699
    Azimuth: 0
    Latitude: 45.616417
    Longitude: -122.78573
  coastalOR_deep.in:
    Percent Contributed: 2.5
    Distance (km): 68.719381
    Magnitude: 6.9730829
    Epsilon (mean values): 1.5306657
  sub0_ch_top.in:
    Percent Contributed: 2.39
    Distance (km): 136.64542
    Magnitude: 8.83072
    Epsilon (mean values): 1.7334477
  Cascadia Megathrust - whole CSZ Characteristic:
    Percent Contributed: 2.39
    Distance (km): 136.64542
    Magnitude: 8.83072
    Epsilon (mean values): 1.7334477
    Azimuth: 265.16041
    Latitude: 45.48466
    Longitude: -124.54931
  Geologic Model Small Mag:
    Percent Contributed: 1.71
    Distance (km): 12.879756
    Magnitude: 6.3293065
    Epsilon (mean values): 1.0909879
```

```
Helvetia:
  Percent Contributed: 1.19
  Distance (km): 9.9278244
  Magnitude: 6.3726484
  Epsilon (mean values): 0.62045469
  Azimuth: 223.99764
  Latitude: 45.52135
  Longitude: -122.89808
Zeng Model Partial Rupture:
  Percent Contributed: 1.49
  Distance (km): 2.6254197
  Magnitude: 6.7417933
  Epsilon (mean values): 0.084136407
Portland Hills:
  Percent Contributed: 1.48
  Distance (km): 2.463229
  Magnitude: 6.7427124
  Epsilon (mean values): 0.06892305
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
sub1_ch_bot.in:
  Percent Contributed: 1.32
  Distance (km): 69.53628
  Magnitude: 8.860661
  Epsilon (mean values): 0.85495506
Cascadia Megathrust - Goldfinger Case B Characteristic:
  Percent Contributed: 1.32
  Distance (km): 69.53628
  Magnitude: 8.860661
  Epsilon (mean values): 0.85495506
  Azimuth: 260.19218
  Latitude: 45.50147
  Longitude: -123.59924
WUSmap_2014_fixSm_M8.in (opt):
  Percent Contributed: 1.09
  Distance (km): 11.276305
  Magnitude: 6.2920663
  Epsilon (mean values): 1.1161568
noPuget_2014_fixSm_M8.in (opt):
  Percent Contributed: 1.09
  Distance (km): 11.273728
  Magnitude: 6.2919703
  Epsilon (mean values): 1.1160721
sub2_ch_bot.in:
  Percent Contributed: 1.03
  Distance (km): 102.21559
  Magnitude: 8.7415072
  Epsilon (mean values): 1.3724691
Cascadia Megathrust - Goldfinger Case C Characteristic:
  Percent Contributed: 1.03
  Distance (km): 102.21559
  Magnitude: 8.7415072
  Epsilon (mean values): 1.3724691
  Azimuth: 227.24299
  Latitude: 45
  Longitude: -123.70227
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: Abrahamson, Silva & Kamai (2014)
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
```

```
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 9.71 %
  Residual: 0 %
  Trace: 0.09 %
Mean (over all sources):
  m: 6.3
  r: 7.92 km
  ε□: 0.9 σ
Mode (largest m-r bin):
  m: 6.69
  r: 4.4 km
  ε□: 0.34 σ
  Contribution: 1.35 %
Mode (largest m-r-ε□ bin):
  m: 6.87
  r: 1.35 km
  ε□: 0.05 σ
  Contribution: 1.16 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)
ε=[2,2.5)   ε=[2.5,∞)
110 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
70  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
50  7.1 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.005
50  7.3 0.010   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.006   0.005
50  7.5 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
0.000   0.006   0.002
50  7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
50  7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
30  5.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
30  5.3 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.006
30  5.5 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.011
30  5.7 0.019   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.003   0.017
30  5.9 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.010   0.021
30  6.1 0.072   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.044   0.028
30  6.3 0.104   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.007   0.078   0.019
30  6.5 0.083   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.009   0.062   0.012
30  6.7 0.063   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.014   0.040   0.008
30  6.9 0.045   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.016   0.025   0.004
30  7.1 0.050   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.029   0.019   0.000
30  7.3 0.057   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004
0.038   0.015   0.000
30  7.5 0.037   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.008
0.023   0.006   0.000
30  7.7 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003
0.003   0.000   0.000
30  7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.001   0.000   0.000
10  5.1 0.796   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.362
0.228   0.191   0.015
10  5.3 0.668   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.326
0.185   0.142   0.014
10  5.5 0.561   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.223   0.075
0.158   0.095   0.010
10  5.7 0.477   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.181   0.090
0.132   0.071   0.002
10  5.9 0.410   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.147   0.101
0.126   0.035   0.000
10  6.1 0.630   0.000   0.000   0.000   0.000   0.000   0.000   0.046   0.206   0.231
0.097   0.049   0.000
10  6.3 0.679   0.000   0.000   0.000   0.000   0.000   0.000   0.101   0.178   0.274
0.125   0.000   0.000
10  6.5 0.988   0.000   0.000   0.000   0.000   0.000   0.000   0.470   0.302   0.152
0.062   0.000   0.000
10  6.7 1.354   0.000   0.000   0.000   0.000   0.000   0.003   1.045   0.194   0.076
0.036   0.000   0.000
10  6.9 1.336   0.000   0.000   0.000   0.000   0.000   0.005   1.156   0.098   0.061
0.015   0.000   0.000
10  7.1 0.882   0.000   0.000   0.000   0.000   0.000   0.004   0.765   0.060   0.051
0.002   0.000   0.000
10  7.3 0.231   0.000   0.000   0.000   0.000   0.000   0.004   0.141   0.046   0.038
0.002   0.000   0.000
10  7.5 0.065   0.000   0.000   0.000   0.000   0.000   0.004   0.019   0.023   0.018
0.000   0.000   0.000
10  7.7 0.010   0.000   0.000   0.000   0.000   0.000   0.001   0.003   0.004   0.002
0.000   0.000   0.000
10  7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.001   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
Geologic Model Partial Rupture:
  Percent Contributed: 1.95
  Distance (km): 2.7478731
```

```
  Magnitude: 6.7407248
  Epsilon (mean values): 0.18185032
Portland Hills:
  Percent Contributed: 1.93
  Distance (km): 2.5131818
  Magnitude: 6.7419801
  Epsilon (mean values): 0.16144947
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
WUSmap_2014_fixSm.ch.in (opt):
  Percent Contributed: 1.04
  Distance (km): 10.868336
  Magnitude: 5.9418069
  Epsilon (mean values): 1.3413844
noPuget_2014_fixSm.ch.in (opt):
  Percent Contributed: 1.04
  Distance (km): 10.867227
  Magnitude: 5.9417499
  Epsilon (mean values): 1.3413442
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: Boore, Stewart, Seyhan & Atkinson (2014)
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 12.38 %
  Residual: 0 %
  Trace: 0.11 %
Mean (over all sources):
  m: 6.28
  r: 8.48 km
  ε□: 0.73 σ
Mode (largest m-r bin):
  m: 6.69
  r: 4.8 km
  ε□: 0.29 σ
  Contribution: 1.48 %
Mode (largest m-r-ε□ bin):
  m: 6.69
  r: 3.19 km
  ε□: 0.12 σ
  Contribution: 1.17 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
```

```
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
90  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
90  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
70  7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
70  7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
70  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
70  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  6.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  6.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
50  6.9 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005
50  7.1 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.006
50  7.3 0.013   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.008   0.004
50  7.5 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007   0.002
50  7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.000
50  7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
30  5.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
30  5.5 0.018   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.016
30  5.7 0.036   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.012   0.023
30  5.9 0.071   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.051   0.020
30  6.1 0.155   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.144   0.011
30  6.3 0.167   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.015   0.137   0.015
30  6.5 0.119   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.048   0.061   0.009
30  6.7 0.096   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.037   0.050   0.005
30  6.9 0.068   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.009   0.028   0.029   0.002
30  7.1 0.069   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.010   0.040   0.019   0.000
30  7.3 0.074   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.020   0.043   0.012   0.000
30  7.5 0.046   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.018   0.024   0.004   0.000
30  7.7 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.004   0.003   0.000   0.000
30  7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.000   0.000   0.000
10  5.1 0.499   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.336   0.082   0.054   0.026
10  5.3 0.761   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.428   0.075   0.144   0.093   0.020
10  5.5 1.038   0.000   0.000   0.000   0.000   0.000   0.000   0.477   0.035   0.254   0.186   0.080   0.006
10  5.7 0.875   0.000   0.000   0.000   0.000   0.000   0.000   0.364   0.158   0.125   0.201   0.027   0.000
```

```
10  5.9 0.696   0.000   0.000   0.000   0.000   0.000   0.000   0.269   0.120   0.123
0.157   0.027   0.000
10  6.1 1.044   0.000   0.000   0.000   0.000   0.000   0.000   0.512   0.141   0.277
0.069   0.045   0.000
10  6.3 1.038   0.000   0.000   0.000   0.000   0.000   0.000   0.547   0.197   0.193
0.102   0.000   0.000
10  6.5 1.272   0.000   0.000   0.000   0.000   0.000   0.002   0.879   0.211   0.127
0.054   0.000   0.000
10  6.7 1.480   0.000   0.000   0.000   0.000   0.000   0.004   1.169   0.217   0.062
0.028   0.000   0.000
10  6.9 1.412   0.000   0.000   0.000   0.000   0.000   0.805   0.411   0.128   0.058
0.008   0.000   0.000
10  7.1 0.953   0.000   0.000   0.000   0.000   0.000   0.783   0.047   0.078   0.044
0.001   0.000   0.000
10  7.3 0.260   0.000   0.000   0.000   0.000   0.000   0.122   0.044   0.058   0.035
0.000   0.000   0.000
10  7.5 0.074   0.000   0.000   0.000   0.000   0.000   0.010   0.025   0.029   0.010
0.000   0.000   0.000
10  7.7 0.011   0.000   0.000   0.000   0.000   0.000   0.001   0.004   0.005   0.001
0.000   0.000   0.000
10  7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.001   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
Geologic Model Partial Rupture:
  Percent Contributed: 2.04
  Distance (km): 2.8096351
  Magnitude: 6.7381876
  Epsilon (mean values): 0.13958118
Portland Hills:
  Percent Contributed: 2.02
  Distance (km): 2.5223492
  Magnitude: 6.7396868
  Epsilon (mean values): 0.11479336
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
WUSmap_2014_fixSm.ch.in (opt):
  Percent Contributed: 1.38
  Distance (km): 10.699143
  Magnitude: 5.9811048
  Epsilon (mean values): 1.0434387
noPuget_2014_fixSm.ch.in (opt):
  Percent Contributed: 1.38
  Distance (km): 10.698072
  Magnitude: 5.9810523
  Epsilon (mean values): 1.0433888
WUSmap_2014_fixSm.gr.in (opt):
  Percent Contributed: 1.32
  Distance (km): 10.586956
  Magnitude: 5.9471806
  Epsilon (mean values): 1.0429062
noPuget_2014_fixSm.gr.in (opt):
  Percent Contributed: 1.31
  Distance (km): 10.58583
  Magnitude: 5.9471237
  Epsilon (mean values): 1.042854
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: Campbell & Bozorgnia (2014)
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
```

```
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 5.42 %
  Residual: 0 %
  Trace: 0.1 %
Mean (over all sources):
  m: 6.59
  r: 5.81 km
  ε□: 0.82 σ
Mode (largest m-r bin):
  m: 6.69
  r: 4.23 km
  ε□: 0.52 σ
  Contribution: 1.09 %
Mode (largest m-r-ε□ bin):
  m: 6.87
  r: 1.33 km
  ε□: 0.28 σ
  Contribution: 0.93 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
70  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  7.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
50  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
30  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
30  6.1 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.008
30  6.3 0.026   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.019
30  6.5 0.030   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.022   0.008
30  6.7 0.024   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.014   0.008
30  6.9 0.016   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.009   0.005
30  7.1 0.017   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.011   0.003
30  7.3 0.019   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.010   0.003
```

```
30  7.5 0.012   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.004   0.006   0.001
30  7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.001   0.001   0.000
30  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
10  5.1 0.061   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.010   0.041   0.010
10  5.3 0.089   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.059   0.021   0.008
10  5.5 0.128   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.027
0.059   0.030   0.012
10  5.7 0.143   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.076
0.028   0.028   0.011
10  5.9 0.156   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.073
0.045   0.031   0.007
10  6.1 0.338   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.066   0.154
0.085   0.026   0.008
10  6.3 0.457   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.171   0.192
0.067   0.024   0.002
10  6.5 0.842   0.000   0.000   0.000   0.000   0.000   0.000   0.279   0.377   0.127
0.043   0.015   0.000
10  6.7 1.091   0.000   0.000   0.000   0.000   0.000   0.000   0.606   0.375   0.077
0.028   0.006   0.000
10  6.9 1.057   0.000   0.000   0.000   0.000   0.000   0.000   0.932   0.049   0.052
0.024   0.001   0.000
10  7.1 0.692   0.000   0.000   0.000   0.000   0.000   0.000   0.611   0.030   0.033
0.018   0.000   0.000
10  7.3 0.165   0.000   0.000   0.000   0.000   0.000   0.000   0.101   0.027   0.027
0.010   0.000   0.000
10  7.5 0.042   0.000   0.000   0.000   0.000   0.000   0.000   0.011   0.015   0.011
0.004   0.000   0.000
10  7.7 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.002   0.002
0.000   0.000   0.000
10  7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
Geologic Model Partial Rupture:
  Percent Contributed: 1.58
  Distance (km): 2.5834073
  Magnitude: 6.7376899
  Epsilon (mean values): 0.3802706
Portland Hills:
  Percent Contributed: 1.58
  Distance (km): 2.4779336
  Magnitude: 6.7383079
  Epsilon (mean values): 0.37044835
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: Chiou & Youngs (2014)
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 10.27 %
  Residual: 0 %
```

```
  Trace: 0.08 %
Mean (over all sources):
  m: 6.47
  r: 6.53 km
  ε□: 0.47 σ
Mode (largest m-r bin):
  m: 6.87
  r: 2.57 km
  ε□: -0.28 σ
  Contribution: 1.81 %
Mode (largest m-r-ε□ bin):
  m: 6.84
  r: 1.5 km
  ε□: -0.4 σ
  Contribution: 1.11 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)
ε=[2,2.5)   ε=[2.5,∞)
110 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  7.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
50  7.3 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.004   0.004
50  7.5 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.005   0.002
50  7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.001   0.001   0.000
50  7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
30  5.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
30  5.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
30  5.7 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.004
30  5.9 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.002   0.009
```

```
30  6.1 0.030   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.014   0.016
30  6.3 0.039   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.001   0.021   0.016
30  6.5 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.005   0.015   0.011
30  6.7 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.009   0.015   0.007
30  6.9 0.035   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004
0.012   0.014   0.005
30  7.1 0.053   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.010
0.028   0.013   0.002
30  7.3 0.070   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.025
0.031   0.012   0.000
30  7.5 0.048   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.021
0.019   0.004   0.000
30  7.7 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.005
0.002   0.000   0.000
30  7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.001
0.000   0.000   0.000
10  5.1 0.423   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.236
0.090   0.066   0.031
10  5.3 0.461   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.229
0.135   0.077   0.019
10  5.5 0.452   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.105   0.145
0.111   0.084   0.006
10  5.7 0.418   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.172   0.088
0.084   0.068   0.006
10  5.9 0.381   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.143   0.101
0.095   0.039   0.002
10  6.1 0.638   0.000   0.000   0.000   0.000   0.000   0.000   0.042   0.253   0.203
0.108   0.026   0.006
10  6.3 0.698   0.000   0.000   0.000   0.000   0.000   0.000   0.086   0.357   0.183
0.055   0.016   0.000
10  6.5 1.177   0.000   0.000   0.000   0.000   0.000   0.390   0.272   0.352   0.113
0.040   0.010   0.000
10  6.7 1.706   0.000   0.000   0.000   0.000   0.000   0.940   0.491   0.192   0.053
0.026   0.003   0.000
10  6.9 1.814   0.000   0.000   0.000   0.000   0.470   1.106   0.067   0.112   0.050
0.009   0.000   0.000
10  7.1 1.270   0.000   0.000   0.000   0.000   1.072   0.019   0.070   0.072   0.037
0.001   0.000   0.000
10  7.3 0.336   0.000   0.000   0.000   0.000   0.166   0.031   0.059   0.059   0.020
0.002   0.000   0.000
10  7.5 0.096   0.000   0.000   0.000   0.000   0.013   0.017   0.033   0.027   0.006
0.000   0.000   0.000
10  7.7 0.014   0.000   0.000   0.000   0.000   0.001   0.003   0.005   0.004   0.000
0.000   0.000   0.000
10  7.9 0.003   0.000   0.000   0.000   0.000   0.000   0.001   0.001   0.001   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
Geologic Model Partial Rupture:
  Percent Contributed: 2.54
  Distance (km): 2.4265787
  Magnitude: 6.7480805
  Epsilon (mean values): -0.2185292
Portland Hills:
  Percent Contributed: 2.54
  Distance (km): 2.369036
  Magnitude: 6.748415
  Epsilon (mean values): -0.22539354
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
Geologic Model Full Rupture:
  Percent Contributed: 1.26
  Distance (km): 0.87072767
  Magnitude: 6.9999197
  Epsilon (mean values): -0.52211048
```

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Portland Hills:
  Percent Contributed: 1.26
  Distance (km): 0.76905363
  Magnitude: 7.0008807
  Epsilon (mean values): -0.53453986
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: Atkinson & Macias (2009) : Interface
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 6.73 %
  Residual: 0 %
  Trace: 0.03 %
Mean (over all sources):
  m: 9.12
  r: 72.01 km
  ε□: 1.15 σ
Mode (largest m-r bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.82 σ
  Contribution: 3.19 %
Mode (largest m-r-ε□ bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.82 σ
  Contribution: 3.19 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2) ε=[2,2.5)   ε=[2.5,∞)
130 8.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
130 9.1 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003
110 8.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
110 8.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
0.000   0.000   0.000
110 8.5 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.005
110 8.7 0.016   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.016
110 8.9 0.052   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.020   0.032
110 9.1 0.175   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.175   0.000
90  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  8.1 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  8.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  8.5 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.003   0.004
90  8.7 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.001   0.002   0.004
90  8.9 0.012   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.012   0.000
70  7.9 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.011   0.000
70  8.1 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.011   0.014   0.000
70  8.3 0.016   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.015   0.002   0.000
70  8.5 0.088   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.086   0.002   0.000
70  8.7 0.165   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.058
0.107   0.000   0.000
70  8.9 1.195   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   1.195
0.000   0.000   0.000
70  9.1 1.761   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   1.761
0.000   0.000   0.000
70  9.3 3.193   0.000   0.000   0.000   0.000   0.000   0.000   0.000   3.193   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
sub0_ch_bot.in:
  Percent Contributed: 6.04
  Distance (km): 70.179382
  Magnitude: 9.1527281
  Epsilon (mean values): 1.05749
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 6.04
  Distance (km): 70.179382
  Magnitude: 9.1527281
  Epsilon (mean values): 1.05749
  Azimuth: 260.19218
  Latitude: 45.50147
  Longitude: -123.59924
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: BC Hydro (2012) : Interface
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 19.58 %
```

```
  Residual: 0 %
  Trace: 0.07 %
Mean (over all sources):
  m: 8.93
  r: 92.56 km
  ε□: 1.16 σ
Mode (largest m-r bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.72 σ
  Contribution: 3.7 %
Mode (largest m-r-ε□ bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.72 σ
  Contribution: 3.7 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
250 8.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
230 8.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
230 8.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
230 8.5 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006
230 8.7 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007
210 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
210 8.1 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
210 8.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
210 8.5 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
190 7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
190 8.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
190 8.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
190 8.5 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005   0.001
170 7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
170 8.1 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.002
170 8.3 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.000
170 8.5 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
0.000   0.015   0.000
170 8.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
150 7.9 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.007   0.000
150 8.1 0.016   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.016   0.000
150 8.3 0.141   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.141   0.000
150 8.5 0.074   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.013   0.061   0.000
150 8.7 0.102   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.102   0.000   0.000
130 7.9 0.016   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.016   0.000
130 8.1 0.037   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.012   0.025   0.000
130 8.3 0.034   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.024   0.010   0.000
130 8.5 0.208   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.207   0.001   0.000
130 8.7 0.823   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.823   0.000   0.000
130 9.1 0.519   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.519   0.000   0.000
110 7.9 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.024   0.001   0.000
110 8.1 0.057   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.057   0.000   0.000
110 8.3 0.034   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.034   0.000   0.000
110 8.5 0.411   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.139
0.272   0.000   0.000
110 8.7 1.693   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.152
1.541   0.000   0.000
110 8.9 1.759   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.186
1.573   0.000   0.000
110 9.1 2.111   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   2.111
0.000   0.000   0.000
90  7.9 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004
0.006   0.000   0.000
90  8.1 0.022   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.014
0.008   0.000   0.000
90  8.3 0.012   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.010
0.002   0.000   0.000
90  8.5 0.119   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.119
0.000   0.000   0.000
90  8.7 0.102   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.102
0.000   0.000   0.000
90  8.9 0.103   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.103
0.000   0.000   0.000
70  7.9 0.075   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.075
0.000   0.000   0.000
70  8.1 0.156   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.156
0.000   0.000   0.000
70  8.3 0.086   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.086
0.000   0.000   0.000
70  8.5 0.350   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.115   0.235
0.000   0.000   0.000
70  8.7 0.488   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.467   0.020
0.000   0.000   0.000
70  8.9 2.900   0.000   0.000   0.000   0.000   0.000   0.000   0.000   2.900   0.000
0.000   0.000   0.000
70  9.1 3.331   0.000   0.000   0.000   0.000   0.000   0.000   0.000   3.331   0.000
0.000   0.000   0.000
70  9.3 3.700   0.000   0.000   0.000   0.000   0.000   0.000   0.000   3.700   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
sub0_ch_bot.in:
```

```
  Percent Contributed: 9.75
  Distance (km): 70.179382
  Magnitude: 9.0876546
  Epsilon (mean values): 0.80695799
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 9.75
  Distance (km): 70.179382
  Magnitude: 9.0876546
  Epsilon (mean values): 0.80695799
  Azimuth: 260.19218
  Latitude: 45.50147
  Longitude: -123.59924
sub0_ch_mid.in:
  Percent Contributed: 5.06
  Distance (km): 118.71992
  Magnitude: 8.9099098
  Epsilon (mean values): 1.497474
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 5.06
  Distance (km): 118.71992
  Magnitude: 8.9099098
  Epsilon (mean values): 1.497474
  Azimuth: 264.55326
  Latitude: 45.48932
  Longitude: -124.32961
sub0_ch_top.in:
  Percent Contributed: 1.2
  Distance (km): 136.64542
  Magnitude: 8.8158252
  Epsilon (mean values): 1.74205
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 1.2
  Distance (km): 136.64542
  Magnitude: 8.8158252
  Epsilon (mean values): 1.74205
  Azimuth: 265.16041
  Latitude: 45.48466
  Longitude: -124.54931
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: BC Hydro (2012) : Slab
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 6.67 %
  Residual: 0 %
  Trace: 0.12 %
Mean (over all sources):
  m: 7
  r: 68.97 km
  ε□: 1.3 σ
Mode (largest m-r bin):
  m: 7.1
  r: 54.05 km
  ε□: 0.76 σ
  Contribution: 1.19 %
Mode (largest m-r-ε□ bin):
  m: 7.11
```

```
    r: 53.82 km
    ε□: 0.75 σ
    Contribution: 1.13 %
  Discretization:
    r: min = 0.0, max = 1000.0, Δ = 20.0 km
    m: min = 4.4, max = 9.4, Δ = 0.2
    ε: min = -3.0, max = 3.0, Δ = 0.5 σ
  Epsilon keys:
    ε0: [-∞ .. -2.5)
    ε1: [-2.5 .. -2.0)
    ε2: [-2.0 .. -1.5)
    ε3: [-1.5 .. -1.0)
    ε4: [-1.0 .. -0.5)
    ε5: [-0.5 .. 0.0)
    ε6: [0.0 .. 0.5)
    ε7: [0.5 .. 1.0)
    ε8: [1.0 .. 1.5)
    ε9: [1.5 .. 2.0)
    ε10: [2.0 .. 2.5)
    ε11: [2.5 .. +∞]
  Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
  270 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  250 7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  250 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  250 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  230 7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  230 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  230 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  210 7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  210 7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
  210 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  210 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  190 7.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  190 7.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
  190 7.5 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.002
  190 7.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.000
  190 7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.000
  170 7.1 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007
  170 7.3 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.006
  170 7.5 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.003
  170 7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.000
  170 7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.002   0.000
  150 6.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
  150 7.1 0.045   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.043
```

```
150 7.3 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.012   0.003
150 7.5 0.016   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.013   0.000
150 7.7 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.002   0.001   0.000
150 7.9 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.000   0.000
130 6.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
130 6.9 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.002   0.019
130 7.1 0.101   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.078   0.023
130 7.3 0.023   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.007   0.016   0.000
130 7.5 0.021   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.019   0.002   0.000
130 7.7 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.004   0.000   0.000
130 7.9 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
0.003   0.000   0.000
110 6.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
110 6.7 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.014
110 6.9 0.059   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.044   0.015
110 7.1 0.155   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.049   0.105   0.000
110 7.3 0.030   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.026   0.002   0.000
110 7.5 0.023   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.011
0.012   0.000   0.000
110 7.7 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004
0.001   0.000   0.000
110 7.9 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005
0.000   0.000   0.000
90  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  6.5 0.022   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.010   0.013
90  6.7 0.086   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.073   0.010
90  6.9 0.198   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.095   0.103   0.000
90  7.1 0.340   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.052
0.277   0.011   0.000
90  7.3 0.052   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.042
0.009   0.000   0.000
90  7.5 0.032   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.026
0.000   0.000   0.000
90  7.7 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.002
0.000   0.000   0.000
90  7.9 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.001
0.000   0.000   0.000
70  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  6.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  6.5 0.114   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.065   0.049   0.000
70  6.7 0.383   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.028
0.307   0.049   0.000
70  6.9 0.635   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.379
```

```
0.255   0.000   0.000
70  7.1 0.951   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.173   0.730
0.048   0.000   0.000
70  7.3 0.118   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.085   0.034
0.000   0.000   0.000
70  7.5 0.070   0.000   0.000   0.000   0.000   0.000   0.000   0.009   0.059   0.002
0.000   0.000   0.000
70  7.7 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.005   0.006   0.000
0.000   0.000   0.000
70  7.9 0.010   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.004   0.000
0.000   0.000   0.000
50  5.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.5 0.201   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.073
0.128   0.000   0.000
50  6.7 0.566   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.477
0.089   0.000   0.000
50  6.9 0.843   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.334   0.509
0.000   0.000   0.000
50  7.1 1.192   0.000   0.000   0.000   0.000   0.000   0.000   0.000   1.135   0.057
0.000   0.000   0.000
50  7.3 0.140   0.000   0.000   0.000   0.000   0.000   0.000   0.078   0.062   0.000
0.000   0.000   0.000
50  7.5 0.081   0.000   0.000   0.000   0.000   0.000   0.000   0.078   0.004   0.000
0.000   0.000   0.000
50  7.7 0.012   0.000   0.000   0.000   0.000   0.000   0.000   0.012   0.000   0.000
0.000   0.000   0.000
50  7.9 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.009   0.000   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
coastalOR_deep.in:
  Percent Contributed: 3.6
  Distance (km): 60.262693
  Magnitude: 6.9251684
  Epsilon (mean values): 1.1662481
coastalOR_deep.in:
  Percent Contributed: 1.6
  Distance (km): 70.678731
  Magnitude: 6.963448
  Epsilon (mean values): 1.5215149
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: Zhao et al. (2006) : Interface
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 24.57 %
  Residual: 0 %
  Trace: 0.07 %
Mean (over all sources):
  m: 8.98
  r: 88.79 km
```

```
  ε□: 0.9 σ
Mode (largest m-r bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.37 σ
  Contribution: 5.58 %
Mode (largest m-r-ε□ bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.37 σ
  Contribution: 5.58 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
210 8.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
190 8.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
190 8.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
170 8.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
170 8.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
170 8.5 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.003
170 8.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
150 7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
150 8.1 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003
150 8.3 0.055   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.045   0.010
150 8.5 0.040   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.040   0.000
150 8.7 0.071   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005   0.065   0.000
130 7.9 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.002
130 8.1 0.014   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.012   0.002
130 8.3 0.018   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.018   0.000
130 8.5 0.146   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.085   0.061   0.000
130 8.7 0.706   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.706   0.000   0.000
130 9.1 0.607   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.607   0.000   0.000
110 7.9 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.009   0.000
```

```
110 8.1 0.028   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.025   0.000
110 8.3 0.022   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.004   0.018   0.000
110 8.5 0.362   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.136
0.227   0.000   0.000
110 8.7 1.729   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.167
1.562   0.000   0.000
110 8.9 2.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   2.025
0.000   0.000   0.000
110 9.1 2.901   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   2.901
0.000   0.000   0.000
90  7.9 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.006   0.000   0.000
90  8.1 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
0.013   0.000   0.000
90  8.3 0.010   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006
0.004   0.000   0.000
90  8.5 0.120   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.118
0.002   0.000   0.000
90  8.7 0.114   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.113
0.000   0.000   0.000
90  8.9 0.136   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.136
0.000   0.000   0.000
70  7.9 0.051   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.044
0.007   0.000   0.000
70  8.1 0.127   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.125
0.002   0.000   0.000
70  8.3 0.081   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.081
0.000   0.000   0.000
70  8.5 0.390   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.265   0.125
0.000   0.000   0.000
70  8.7 0.612   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.612   0.000
0.000   0.000   0.000
70  8.9 3.880   0.000   0.000   0.000   0.000   0.000   0.000   0.000   3.880   0.000
0.000   0.000   0.000
70  9.1 4.708   0.000   0.000   0.000   0.000   0.000   0.000   0.000   4.708   0.000
0.000   0.000   0.000
70  9.3 5.575   0.000   0.000   0.000   0.000   0.000   0.000   5.575   0.000   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
sub0_ch_bot.in:
  Percent Contributed: 13.9
  Distance (km): 70.179382
  Magnitude: 9.097665
  Epsilon (mean values): 0.51895748
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 13.9
  Distance (km): 70.179382
  Magnitude: 9.097665
  Epsilon (mean values): 0.51895748
  Azimuth: 260.19218
  Latitude: 45.50147
  Longitude: -123.59924
sub0_ch_mid.in:
  Percent Contributed: 6.07
  Distance (km): 118.71992
  Magnitude: 8.9336796
  Epsilon (mean values): 1.3814773
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 6.07
  Distance (km): 118.71992
  Magnitude: 8.9336796
  Epsilon (mean values): 1.3814773
  Azimuth: 264.55326
  Latitude: 45.48932
  Longitude: -124.32961
sub0_ch_top.in:
  Percent Contributed: 1.18
```

```
  Distance (km): 136.64542
  Magnitude: 8.845435
  Epsilon (mean values): 1.7217898
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 1.18
  Distance (km): 136.64542
  Magnitude: 8.845435
  Epsilon (mean values): 1.7217898
  Azimuth: 265.16041
  Latitude: 45.48466
  Longitude: -124.54931
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: GMM: Zhao et al. (2006) : Slab
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 4.66 %
  Residual: 0 %
  Trace: 0.08 %
Mean (over all sources):
  m: 7.02
  r: 61.35 km
  ε□: 1.18 σ
Mode (largest m-r bin):
  m: 7.1
  r: 53.87 km
  ε□: 0.75 σ
  Contribution: 1.19 %
Mode (largest m-r-ε□ bin):
  m: 7.1
  r: 53.59 km
  ε□: 0.73 σ
  Contribution: 0.97 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
230 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
210 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
190 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
190 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
170 7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
170 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
170 7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
150 7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
150 7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
150 7.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
150 7.9 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.002   0.001   0.000
130 7.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
130 7.3 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
130 7.5 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.003   0.001
130 7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.002   0.001   0.000
130 7.9 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003
0.002   0.000   0.000
110 6.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
110 6.9 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
110 7.1 0.027   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.012   0.015
110 7.3 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.001   0.007   0.001
110 7.5 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.005   0.003   0.000
110 7.7 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
0.002   0.000   0.000
110 7.9 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.004
0.000   0.000   0.000
90  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  6.5 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
90  6.7 0.014   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.003   0.010
90  6.9 0.057   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.041   0.013
90  7.1 0.137   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.060   0.074   0.002
90  7.3 0.028   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007
0.019   0.002   0.000
90  7.5 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.013
0.006   0.000   0.000
90  7.7 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.002
0.000   0.000   0.000
90  7.9 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.003   0.000
0.000   0.000   0.000
70  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  6.5 0.049   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.041   0.006
70  6.7 0.192   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
0.105   0.081   0.006
70  6.9 0.384   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.122
0.218   0.044   0.000
70  7.1 0.686   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.104   0.423
0.159   0.000   0.000
70  7.3 0.101   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.058   0.039
0.003   0.000   0.000
70  7.5 0.067   0.000   0.000   0.000   0.000   0.000   0.000   0.016   0.039   0.012
0.000   0.000   0.000
70  7.7 0.015   0.000   0.000   0.000   0.000   0.000   0.003   0.009   0.003   0.000
0.000   0.000   0.000
70  7.9 0.017   0.000   0.000   0.000   0.000   0.002   0.011   0.004   0.000   0.000
0.000   0.000   0.000
50  5.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
50  6.5 0.142   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.137   0.005   0.000
50  6.7 0.441   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.284
0.157   0.000   0.000
50  6.9 0.745   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.238   0.494
0.012   0.000   0.000
50  7.1 1.186   0.000   0.000   0.000   0.000   0.000   0.000   0.088   0.970   0.129
0.000   0.000   0.000
50  7.3 0.155   0.000   0.000   0.000   0.000   0.000   0.000   0.109   0.046   0.000
0.000   0.000   0.000
50  7.5 0.097   0.000   0.000   0.000   0.000   0.000   0.024   0.073   0.000   0.000
0.000   0.000   0.000
50  7.7 0.018   0.000   0.000   0.000   0.000   0.003   0.014   0.001   0.000   0.000
0.000   0.000   0.000
50  7.9 0.016   0.000   0.000   0.000   0.000   0.013   0.002   0.000   0.000   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
coastalOR_deep.in:
  Percent Contributed: 2.88
  Distance (km): 57.412881
  Magnitude: 6.9453795
  Epsilon (mean values): 1.1450295
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: Source Type: Grid
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 20.07 %
  Residual: 0 %
  Trace: 0.14 %
Mean (over all sources):
  m: 6.06
  r: 10.77 km
  ε□: 1.2 σ
Mode (largest m-r bin):
  m: 6.1
```

```
    r: 9.57 km
    ε□: 1.04 σ
    Contribution: 2.25 %
  Mode (largest m-r-ε□ bin):
    m: 5.1
    r: 5.15 km
    ε□: 1.18 σ
    Contribution: 0.93 %
  Discretization:
    r: min = 0.0, max = 1000.0, Δ = 20.0 km
    m: min = 4.4, max = 9.4, Δ = 0.2
    ε: min = -3.0, max = 3.0, Δ = 0.5 σ
  Epsilon keys:
    ε0: [-∞ .. -2.5)
    ε1: [-2.5 .. -2.0)
    ε2: [-2.0 .. -1.5)
    ε3: [-1.5 .. -1.0)
    ε4: [-1.0 .. -0.5)
    ε5: [-0.5 .. 0.0)
    ε6: [0.0 .. 0.5)
    ε7: [0.5 .. 1.0)
    ε8: [1.0 .. 1.5)
    ε9: [1.5 .. 2.0)
    ε10: [2.0 .. 2.5)
    ε11: [2.5 .. +∞]
  Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
  110 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  90  7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  90  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  70  7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  70  7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
  70  7.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
  70  7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  50  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
  50  6.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
  50  6.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
  50  6.9 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006
  50  7.1 0.016   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.013
  50  7.3 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.018   0.013
  50  7.5 0.024   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.019   0.005
  50  7.7 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.003   0.000
  50  7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.001   0.000
  30  5.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
  30  5.3 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007
  30  5.5 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.028
  30  5.7 0.058   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.014   0.044
  30  5.9 0.082   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
0.000   0.038   0.044
30  6.1 0.142   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.105   0.037
30  6.3 0.169   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.022   0.107   0.040
30  6.5 0.150   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.037   0.087   0.025
30  6.7 0.128   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004
0.042   0.062   0.020
30  6.9 0.138   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.012
0.054   0.060   0.012
30  7.1 0.185   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.021
0.099   0.060   0.004
30  7.3 0.220   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.048
0.118   0.049   0.003
30  7.5 0.142   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.047
0.071   0.019   0.001
30  7.7 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.012
0.010   0.001   0.000
30  7.9 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.003
0.002   0.000   0.000
10  5.1 1.779   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.934
0.410   0.351   0.082
10  5.3 1.978   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.429   0.630
0.524   0.334   0.062
10  5.5 2.180   0.000   0.000   0.000   0.000   0.000   0.000   0.477   0.363   0.502
0.515   0.289   0.035
10  5.7 1.911   0.000   0.000   0.000   0.000   0.000   0.000   0.364   0.511   0.379
0.445   0.194   0.019
10  5.9 1.617   0.000   0.000   0.000   0.000   0.000   0.000   0.263   0.410   0.395
0.423   0.118   0.008
10  6.1 2.253   0.000   0.000   0.000   0.000   0.000   0.000   0.430   0.641   0.730
0.359   0.090   0.004
10  6.3 2.118   0.000   0.000   0.000   0.000   0.000   0.000   0.437   0.704   0.676
0.277   0.025   0.000
10  6.5 1.309   0.000   0.000   0.000   0.000   0.000   0.006   0.198   0.489   0.426
0.172   0.018   0.000
10  6.7 1.040   0.000   0.000   0.000   0.000   0.000   0.016   0.192   0.463   0.245
0.116   0.008   0.000
10  6.9 0.876   0.000   0.000   0.000   0.000   0.002   0.038   0.173   0.386   0.221
0.057   0.001   0.000
10  7.1 0.624   0.000   0.000   0.000   0.000   0.003   0.028   0.166   0.239   0.166
0.022   0.000   0.000
10  7.3 0.512   0.000   0.000   0.000   0.000   0.002   0.039   0.146   0.189   0.120
0.015   0.000   0.000
10  7.5 0.246   0.000   0.000   0.000   0.000   0.002   0.022   0.079   0.094   0.046
0.004   0.000   0.000
10  7.7 0.041   0.000   0.000   0.000   0.000   0.001   0.006   0.013   0.015   0.005
0.000   0.000   0.000
10  7.9 0.009   0.000   0.000   0.000   0.000   0.000   0.001   0.003   0.003   0.001
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
WUSmap_2014_fixSm.ch.in (opt):
  Percent Contributed: 3.72
  Distance (km): 10.593647
  Magnitude: 6.0309203
  Epsilon (mean values): 1.2076221
PointSourceFinite: -122.786, 45.616:
  Percent Contributed: 1.01
  Distance (km): 5.4362135
  Magnitude: 5.5854201
  Epsilon (mean values): 0.76675699
  Azimuth: 0
  Latitude: 45.616417
  Longitude: -122.78573
noPuget_2014_fixSm.ch.in (opt):
  Percent Contributed: 3.72
  Distance (km): 10.592672
  Magnitude: 6.0308705
```

```
  Epsilon (mean values): 1.2075827
PointSourceFinite: -122.786, 45.616:
  Percent Contributed: 1.01
  Distance (km): 5.4362135
  Magnitude: 5.5854201
  Epsilon (mean values): 0.76675699
  Azimuth: 0
  Latitude: 45.616417
  Longitude: -122.78573
WUSmap_2014_fixSm.gr.in (opt):
  Percent Contributed: 3.52
  Distance (km): 10.507784
  Magnitude: 5.9931315
  Epsilon (mean values): 1.2138064
PointSourceFinite: -122.786, 45.616:
  Percent Contributed: 1.01
  Distance (km): 5.4362135
  Magnitude: 5.5854201
  Epsilon (mean values): 0.76675699
  Azimuth: 0
  Latitude: 45.616417
  Longitude: -122.78573
noPuget_2014_fixSm.gr.in (opt):
  Percent Contributed: 3.52
  Distance (km): 10.506752
  Magnitude: 5.9930769
  Epsilon (mean values): 1.2137653
PointSourceFinite: -122.786, 45.616:
  Percent Contributed: 1.01
  Distance (km): 5.4362135
  Magnitude: 5.5854201
  Epsilon (mean values): 0.76675699
  Azimuth: 0
  Latitude: 45.616417
  Longitude: -122.78573
WUSmap_2014_fixSm_M8.in (opt):
  Percent Contributed: 1.09
  Distance (km): 11.276305
  Magnitude: 6.2920663
  Epsilon (mean values): 1.1161568
noPuget_2014_fixSm_M8.in (opt):
  Percent Contributed: 1.09
  Distance (km): 11.273728
  Magnitude: 6.2919703
  Epsilon (mean values): 1.1160721
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: Source Type: Slab
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 11.33 %
  Residual: 0 %
  Trace: 0.13 %
Mean (over all sources):
  m: 7.01
  r: 65.84 km
  ε□: 1.25 σ
```

```
Mode (largest m-r bin):
  m: 7.1
  r: 53.96 km
  ε□: 0.76 σ
  Contribution: 2.38 %
Mode (largest m-r-ε□ bin):
  m: 7.11
  r: 53.71 km
  ε□: 0.74 σ
  Contribution: 2.1 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)
ε=[2,2.5)   ε=[2.5,∞)
270 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
250 7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
250 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
250 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
230 7.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
230 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
230 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
210 7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
210 7.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
210 7.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
210 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
190 7.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
190 7.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
190 7.5 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.002
190 7.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
190 7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
170 7.1 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.007
170 7.3 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.006
170 7.5 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.006   0.003
170 7.7 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
0.000   0.002   0.000
170 7.9 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.001   0.002   0.000
150 6.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
150 7.1 0.045   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.003   0.043
150 7.3 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.012   0.003
150 7.5 0.017   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.013   0.001
150 7.7 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.002   0.002   0.000
150 7.9 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.005   0.001   0.000
130 6.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
130 6.9 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.002   0.019
130 7.1 0.103   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.078   0.025
130 7.3 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.007   0.017   0.002
130 7.5 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.019   0.005   0.001
130 7.7 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.006   0.001   0.000
130 7.9 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005
0.005   0.000   0.000
110 6.5 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
110 6.7 0.015   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.014
110 6.9 0.062   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.044   0.017
110 7.1 0.182   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.049   0.118   0.015
110 7.3 0.038   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
0.027   0.009   0.001
110 7.5 0.032   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.012
0.017   0.003   0.000
110 7.7 0.009   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007
0.002   0.000   0.000
110 7.9 0.014   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005   0.009
0.000   0.000   0.000
90  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
90  6.5 0.024   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.010   0.014
90  6.7 0.099   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.003   0.076   0.020
90  6.9 0.255   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.097   0.144   0.013
90  7.1 0.478   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.052
0.338   0.085   0.002
90  7.3 0.080   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.049
0.028   0.002   0.000
90  7.5 0.052   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.040
0.006   0.000   0.000
90  7.7 0.011   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007   0.004
0.000   0.000   0.000
90  7.9 0.012   0.000   0.000   0.000   0.000   0.000   0.000   0.004   0.007   0.001
0.000   0.000   0.000
70  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
70  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
```

```
70  6.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
70  6.5 0.163   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.068   0.090   0.006
70  6.7 0.576   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.028   0.412   0.130   0.006
70  6.9 1.019   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.501   0.474   0.044   0.000
70  7.1 1.637   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.277   1.153   0.207   0.000   0.000
70  7.3 0.219   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.142   0.072   0.003   0.000   0.000
70  7.5 0.137   0.000   0.000   0.000   0.000   0.000   0.000   0.025   0.098   0.014   0.000   0.000   0.000
70  7.7 0.026   0.000   0.000   0.000   0.000   0.000   0.003   0.014   0.009   0.000   0.000   0.000   0.000
70  7.9 0.027   0.000   0.000   0.000   0.000   0.002   0.011   0.010   0.004   0.000   0.000   0.000   0.000
50  5.7 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  5.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  6.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  6.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
50  6.5 0.343   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.073   0.265   0.005   0.000
50  6.7 1.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.760   0.247   0.000   0.000
50  6.9 1.587   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.572   1.003   0.012   0.000   0.000
50  7.1 2.378   0.000   0.000   0.000   0.000   0.000   0.000   0.088   2.105   0.186   0.000   0.000   0.000
50  7.3 0.296   0.000   0.000   0.000   0.000   0.000   0.000   0.187   0.108   0.000   0.000   0.000   0.000
50  7.5 0.178   0.000   0.000   0.000   0.000   0.000   0.024   0.151   0.004   0.000   0.000   0.000   0.000
50  7.7 0.030   0.000   0.000   0.000   0.000   0.003   0.014   0.013   0.000   0.000   0.000   0.000   0.000
50  7.9 0.025   0.000   0.000   0.000   0.000   0.013   0.003   0.009   0.000   0.000   0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
coastalOR_deep.in:
  Percent Contributed: 6.48
  Distance (km): 58.997177
  Magnitude: 6.9341436
  Epsilon (mean values): 1.1568256
coastalOR_deep.in:
  Percent Contributed: 2.5
  Distance (km): 68.719381
  Magnitude: 6.9730829
  Epsilon (mean values): 1.5306657
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: Source Type: Interface
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
```

```
Totals:
  Binned: 50.88 %
  Residual: 0 %
  Trace: 0.14 %
Mean (over all sources):
  m: 8.98
  r: 88.02 km
  ε□: 1.03 σ
Mode (largest m-r bin):
  m: 9.34
  r: 70.18 km
  ε□: 0.59 σ
  Contribution: 12.47 %
Mode (largest m-r-ε□ bin):
  m: 9.01
  r: 70.14 km
  ε□: 0.68 σ
  Contribution: 8.04 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5) ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)   ε=[2,2.5)   ε=[2.5,∞)
250 8.5 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
230 8.1 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
230 8.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
230 8.5 0.006   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006
230 8.7 0.007   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.007
210 7.9 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
210 8.1 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
210 8.3 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
210 8.5 0.003   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
190 7.9 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
190 8.1 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
190 8.3 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001
190 8.5 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.005   0.003
170 7.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002
170 8.1 0.005   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.002
170 8.3 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

```
0.000   0.003   0.001
170 8.5 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.017   0.003
170 8.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
150 7.9 0.008   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.007   0.001
150 8.1 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.016   0.003
150 8.3 0.196   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.187   0.010
150 8.5 0.115   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.013   0.101   0.000
150 8.7 0.173   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.107   0.066   0.000
130 7.9 0.020   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.018   0.002
130 8.1 0.051   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.012   0.037   0.002
130 8.3 0.053   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.024   0.029   0.000
130 8.5 0.354   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.292   0.062   0.000
130 8.7 1.528   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
1.528   0.000   0.000
130 9.1 1.129   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
1.126   0.000   0.003
110 7.9 0.034   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.024   0.009   0.000
110 8.1 0.085   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.060   0.025   0.000
110 8.3 0.056   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.038   0.018   0.000
110 8.5 0.778   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.274
0.499   0.000   0.005
110 8.7 3.438   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.320
3.103   0.000   0.016
110 8.9 3.836   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   2.211
1.573   0.020   0.032
110 9.1 5.187   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   5.012
0.000   0.175   0.000
90  7.9 0.017   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.004
0.012   0.000   0.000
90  8.1 0.038   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.015
0.022   0.000   0.000
90  8.3 0.022   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.015
0.006   0.000   0.000
90  8.5 0.246   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.237
0.002   0.003   0.004
90  8.7 0.223   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.216
0.001   0.002   0.004
90  8.9 0.251   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.239
0.000   0.012   0.000
70  7.9 0.136   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.118
0.007   0.011   0.000
70  8.1 0.308   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.281
0.013   0.014   0.000
70  8.3 0.183   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.167
0.015   0.002   0.000
70  8.5 0.828   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.380   0.360
0.086   0.002   0.000
70  8.7 1.265   0.000   0.000   0.000   0.000   0.000   0.000   0.000   1.079   0.078
0.107   0.000   0.000
70  8.9 7.975   0.000   0.000   0.000   0.000   0.000   0.000   0.000   6.780   1.195
0.000   0.000   0.000
70  9.1 9.800   0.000   0.000   0.000   0.000   0.000   0.000   0.000   8.039   1.761
0.000   0.000   0.000
70  9.3 12.468  0.000   0.000   0.000   0.000   0.000   0.000   5.575   6.893   0.000
0.000   0.000   0.000
```

```
Principal Sources (faults, subduction, random seismicity having > 3% contribution
sub0_ch_bot.in:
  Percent Contributed: 29.7
  Distance (km): 70.179382
  Magnitude: 9.1055834
  Epsilon (mean values): 0.72309455
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 29.7
  Distance (km): 70.179382
  Magnitude: 9.1055834
  Epsilon (mean values): 0.72309455
  Azimuth: 260.19218
  Latitude: 45.50147
  Longitude: -123.59924
sub0_ch_mid.in:
  Percent Contributed: 11.34
  Distance (km): 118.71992
  Magnitude: 8.9254869
  Epsilon (mean values): 1.453965
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 11.34
  Distance (km): 118.71992
  Magnitude: 8.9254869
  Epsilon (mean values): 1.453965
  Azimuth: 264.55326
  Latitude: 45.48932
  Longitude: -124.32961
sub0_ch_top.in:
  Percent Contributed: 2.39
  Distance (km): 136.64542
  Magnitude: 8.83072
  Epsilon (mean values): 1.7334477
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 2.39
  Distance (km): 136.64542
  Magnitude: 8.83072
  Epsilon (mean values): 1.7334477
  Azimuth: 265.16041
  Latitude: 45.48466
  Longitude: -124.54931
sub1_ch_bot.in:
  Percent Contributed: 1.32
  Distance (km): 69.53628
  Magnitude: 8.860661
  Epsilon (mean values): 0.85495506
Cascadia Megathrust - Goldfinger Case B Characteristic:
  Percent Contributed: 1.32
  Distance (km): 69.53628
  Magnitude: 8.860661
  Epsilon (mean values): 0.85495506
  Azimuth: 260.19218
  Latitude: 45.50147
  Longitude: -123.59924
sub2_ch_bot.in:
  Percent Contributed: 1.03
  Distance (km): 102.21559
  Magnitude: 8.7415072
  Epsilon (mean values): 1.3724691
Cascadia Megathrust - Goldfinger Case C Characteristic:
  Percent Contributed: 1.03
  Distance (km): 102.21559
  Magnitude: 8.7415072
  Epsilon (mean values): 1.3724691
  Azimuth: 227.24299
  Latitude: 45
  Longitude: -123.70227
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.786°W
```

```
latitude: 45.603°E
imt: Peak Ground Acceleration
vs30 = 360 m/s (C/D boundary)
return period: 2475 yrs.
#This deaggregation corresponds to: Source Type: Fault
Summary statistics for PSHA PGA deaggregation, r=distance, ε=epsilon:
Deaggregation targets:
  Return period: 2475 yrs
  Exceedance rate: 0.0004040404 yr⁻¹
  PGA ground motion: 0.5326147 g
Recovered targets:
  Return period: 2476.0286 yrs
  Exceedance rate: 0.00040387255 yr⁻¹
Totals:
  Binned: 17.72 %
  Residual: 0 %
  Trace: 0.05 %
Mean (over all sources):
  m: 6.75
  r: 3.63 km
  ε□: 0.17 σ
Mode (largest m-r bin):
  m: 6.87
  r: 1.26 km
  ε□: -0.08 σ
  Contribution: 4.74 %
Mode (largest m-r-ε□ bin):
  m: 6.69
  r: 2.92 km
  ε□: 0.17 σ
  Contribution: 3.12 %
Discretization:
  r: min = 0.0, max = 1000.0, Δ = 20.0 km
  m: min = 4.4, max = 9.4, Δ = 0.2
  ε: min = -3.0, max = 3.0, Δ = 0.5 σ
Epsilon keys:
  ε0: [-∞ .. -2.5)
  ε1: [-2.5 .. -2.0)
  ε2: [-2.0 .. -1.5)
  ε3: [-1.5 .. -1.0)
  ε4: [-1.0 .. -0.5)
  ε5: [-0.5 .. 0.0)
  ε6: [0.0 .. 0.5)
  ε7: [0.5 .. 1.0)
  ε8: [1.0 .. 1.5)
  ε9: [1.5 .. 2.0)
  ε10: [2.0 .. 2.5)
  ε11: [2.5 .. +∞]
Closest Distance, rRup (km) Magnitude (Mw)  ALL_ε   ε=(-∞,-2.5) ε=[-2.5,-2) ε=[-2,-1.5)
ε=[-1.5,-1) ε=[-1,-0.5) ε=[-0.5,0)  ε=[0,0.5)   ε=[0.5,1)   ε=[1,1.5)   ε=[1.5,2)
ε=[2,2.5)   ε=[2.5,∞)
50  6.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
50  6.9 0.002   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.002
50  7.1 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.001
50  7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
30  5.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.001   0.000
30  5.9 0.031   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.024   0.007
30  6.1 0.124   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.097   0.026
30  6.3 0.166   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.136   0.030
30  6.5 0.114   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.024   0.073   0.016
```

```
30  6.7 0.086   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.020   0.057   0.010
30  6.9 0.025   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.004   0.018   0.003
30  7.1 0.004   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.002   0.002   0.000
30  7.3 0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
10  5.7 0.001   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
0.000   0.000   0.000
10  5.9 0.026   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.000   0.003
0.001   0.014   0.002
10  6.1 0.397   0.000   0.000   0.000   0.000   0.000   0.000   0.170   0.025   0.134
0.000   0.056   0.010
10  6.3 0.753   0.000   0.000   0.000   0.000   0.000   0.000   0.297   0.199   0.167
0.072   0.015   0.002
10  6.5 2.969   0.000   0.000   0.000   0.000   0.000   0.386   1.703   0.752   0.094
0.028   0.007   0.000
10  6.7 4.591   0.000   0.000   0.000   0.000   0.000   0.931   3.119   0.515   0.024
0.002   0.001   0.000
10  6.9 4.743   0.000   0.000   0.000   0.000   0.468   1.879   2.393   0.002   0.000
0.000   0.000   0.000
10  7.1 3.173   0.000   0.000   0.000   0.000   1.069   0.778   1.326   0.000   0.000
0.000   0.000   0.000
10  7.3 0.480   0.000   0.000   0.000   0.000   0.164   0.119   0.198   0.000   0.000
0.000   0.000   0.000
10  7.5 0.031   0.000   0.000   0.000   0.000   0.011   0.010   0.010   0.000   0.000
0.000   0.000   0.000
Principal Sources (faults, subduction, random seismicity having > 3% contribution
Geologic Model Partial Rupture:
  Percent Contributed: 8.12
  Distance (km): 2.6307074
  Magnitude: 6.7417979
  Epsilon (mean values): 0.084527773
Portland Hills:
  Percent Contributed: 8.06
  Distance (km): 2.463229
  Magnitude: 6.7427124
  Epsilon (mean values): 0.06892305
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
Geologic Model Full Rupture:
  Percent Contributed: 3.8
  Distance (km): 1.0705765
  Magnitude: 6.9956517
  Epsilon (mean values): -0.10232568
Portland Hills:
  Percent Contributed: 3.76
  Distance (km): 0.76905363
  Magnitude: 6.9988433
  Epsilon (mean values): -0.13052881
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
Geologic Model Small Mag:
  Percent Contributed: 1.71
  Distance (km): 12.879756
  Magnitude: 6.3293065
  Epsilon (mean values): 1.0909879
Helvetia:
  Percent Contributed: 1.19
  Distance (km): 9.9278244
  Magnitude: 6.3726484
  Epsilon (mean values): 0.62045469
  Azimuth: 223.99764
  Latitude: 45.52135
  Longitude: -122.89808
Zeng Model Partial Rupture:
```

```
  Percent Contributed: 1.49
  Distance (km): 2.6254197
  Magnitude: 6.7417933
  Epsilon (mean values): 0.084136407
Portland Hills:
  Percent Contributed: 1.48
  Distance (km): 2.463229
  Magnitude: 6.7427124
  Epsilon (mean values): 0.06892305
  Azimuth: 153.40008
  Latitude: 45.58227
  Longitude: -122.77095
```

G-2-4

Liquefaction and Residual Strength Calculations

TABLE OF CONTENTS

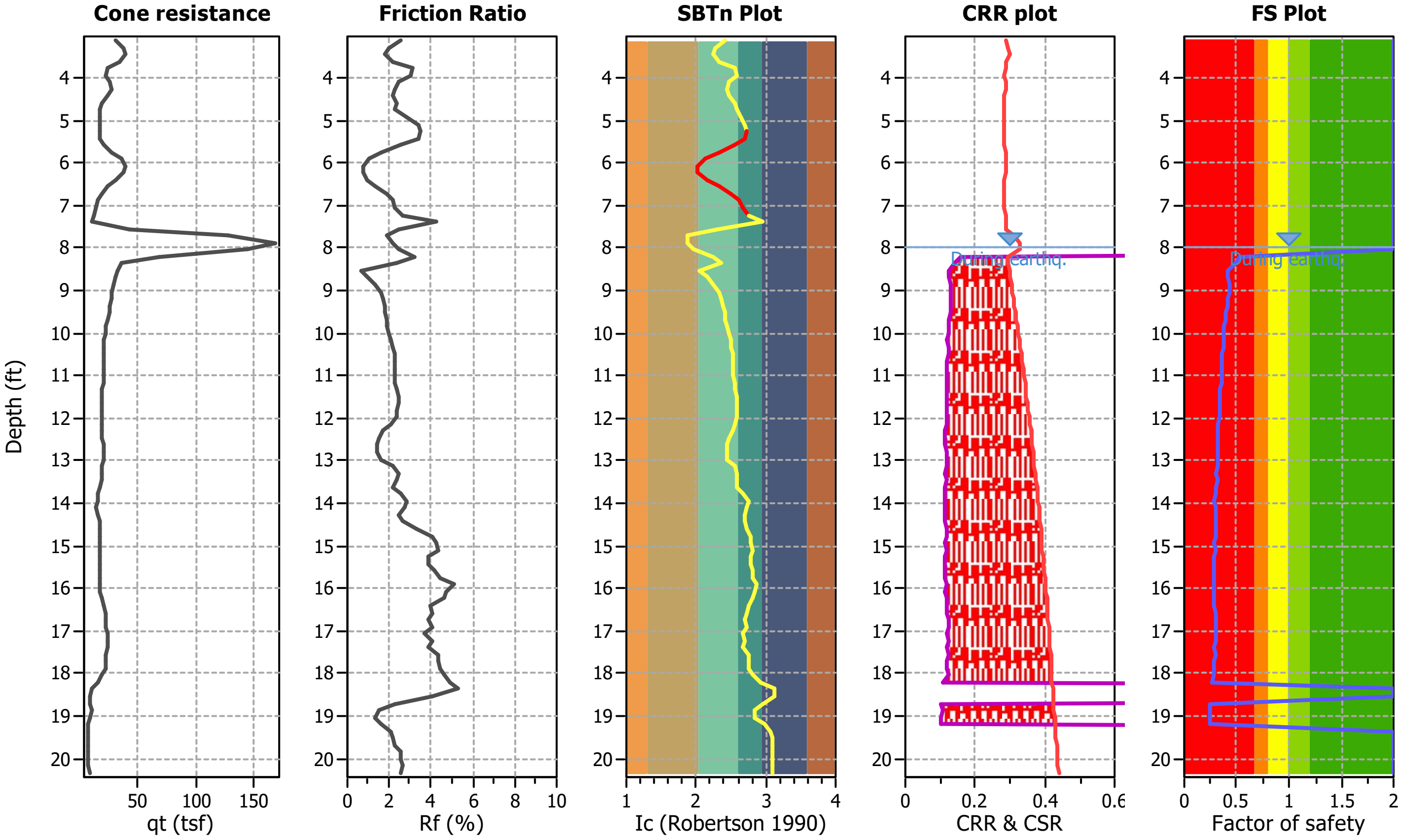
LIQUEFACTION ANALYSIS REPORT

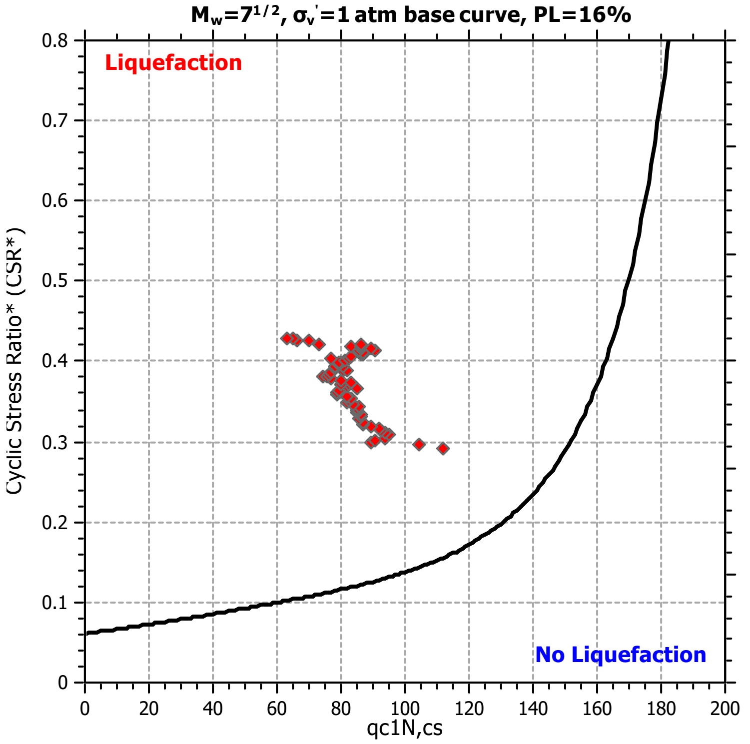
Project title : Owens Corning Linnton **Location : Portland**

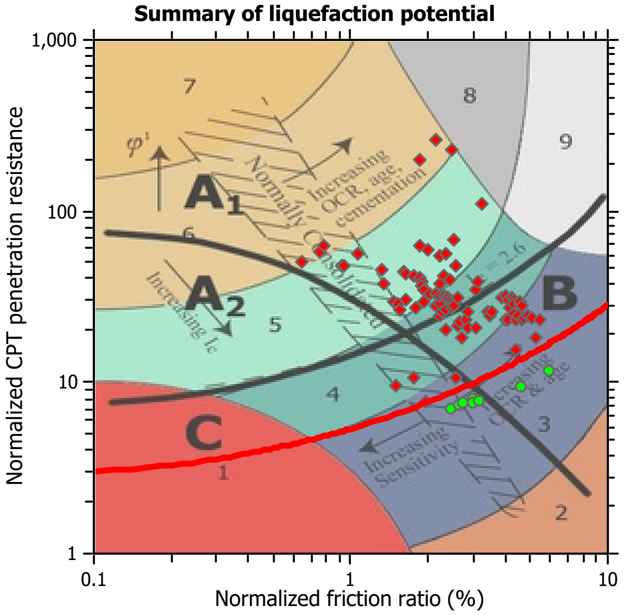
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

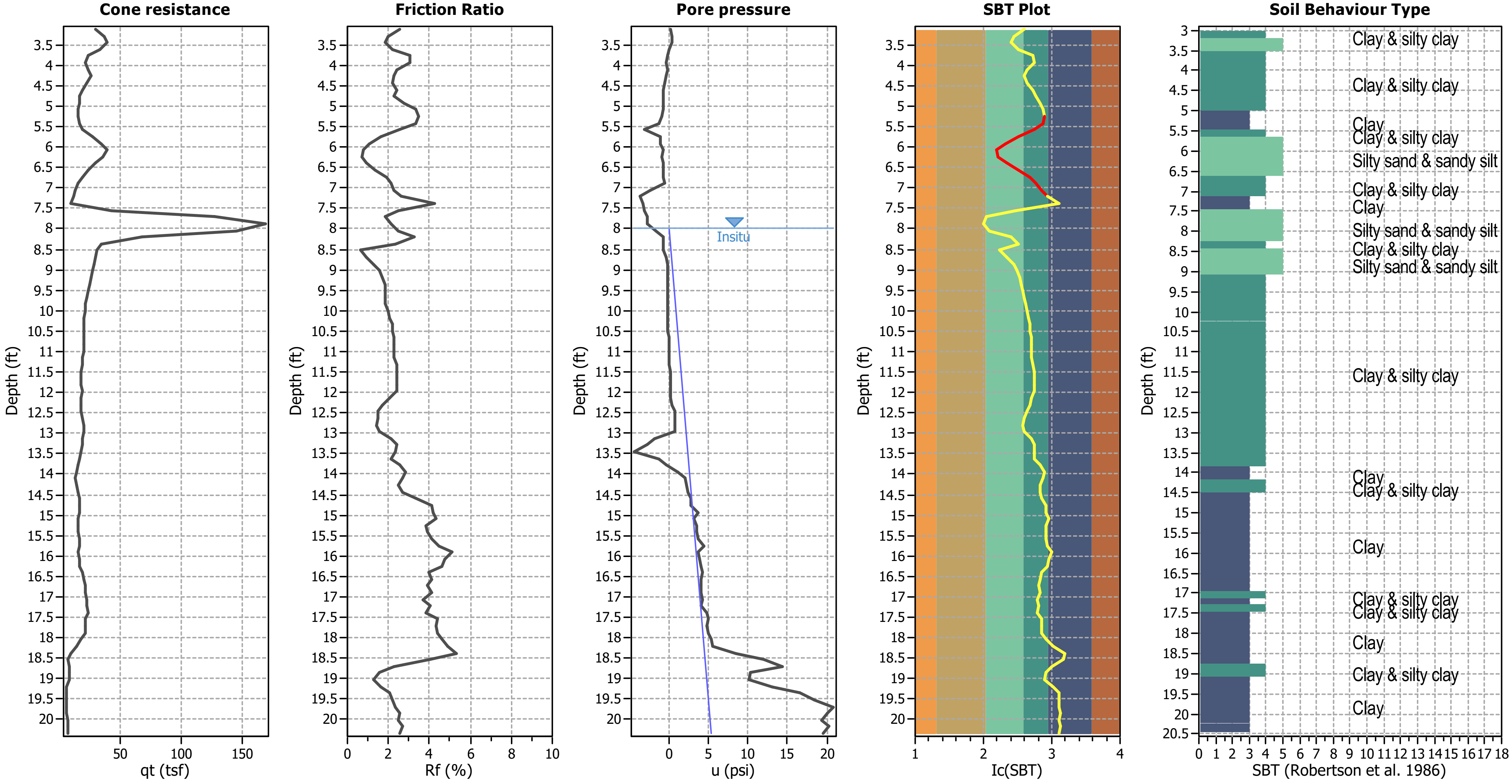






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



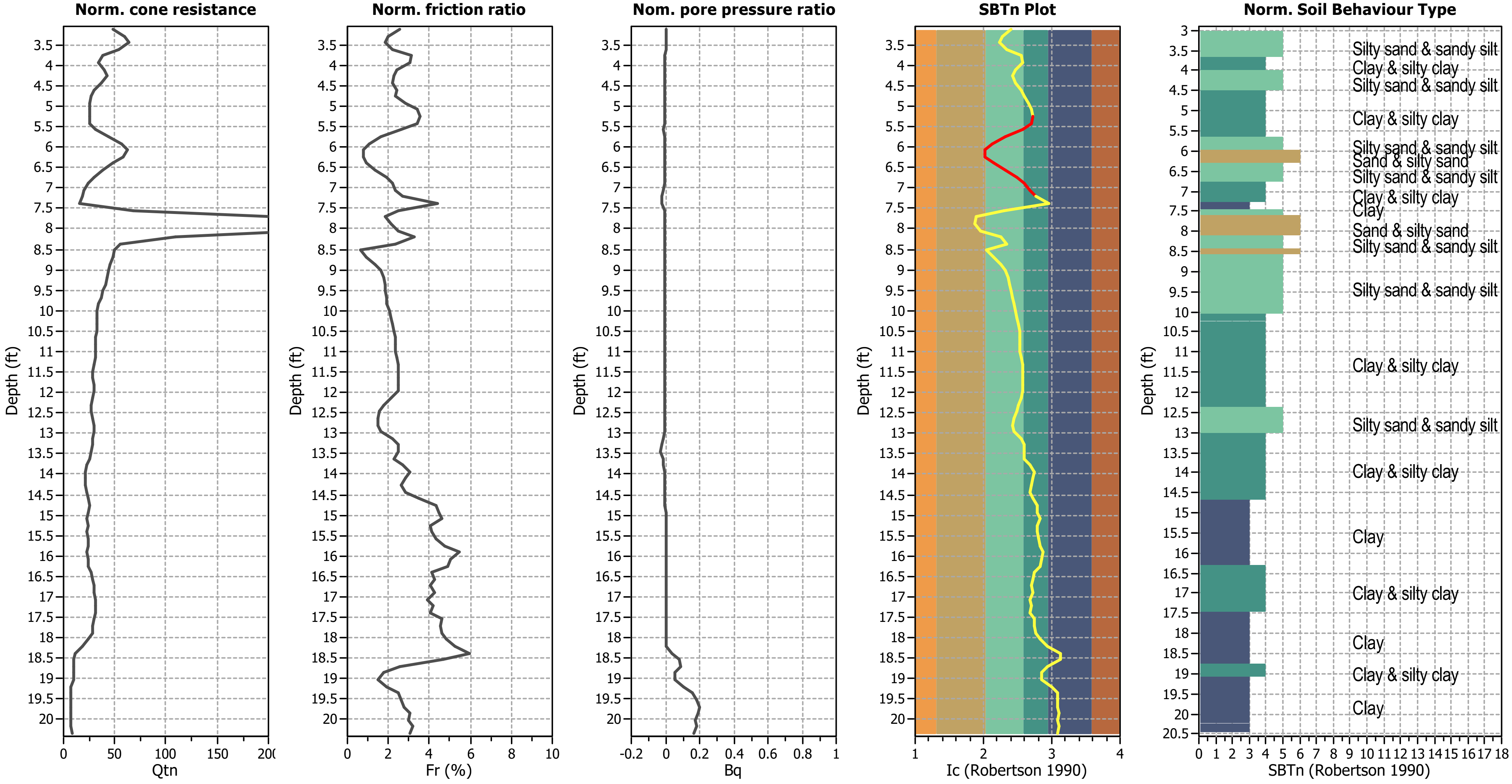
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟫 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬜ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



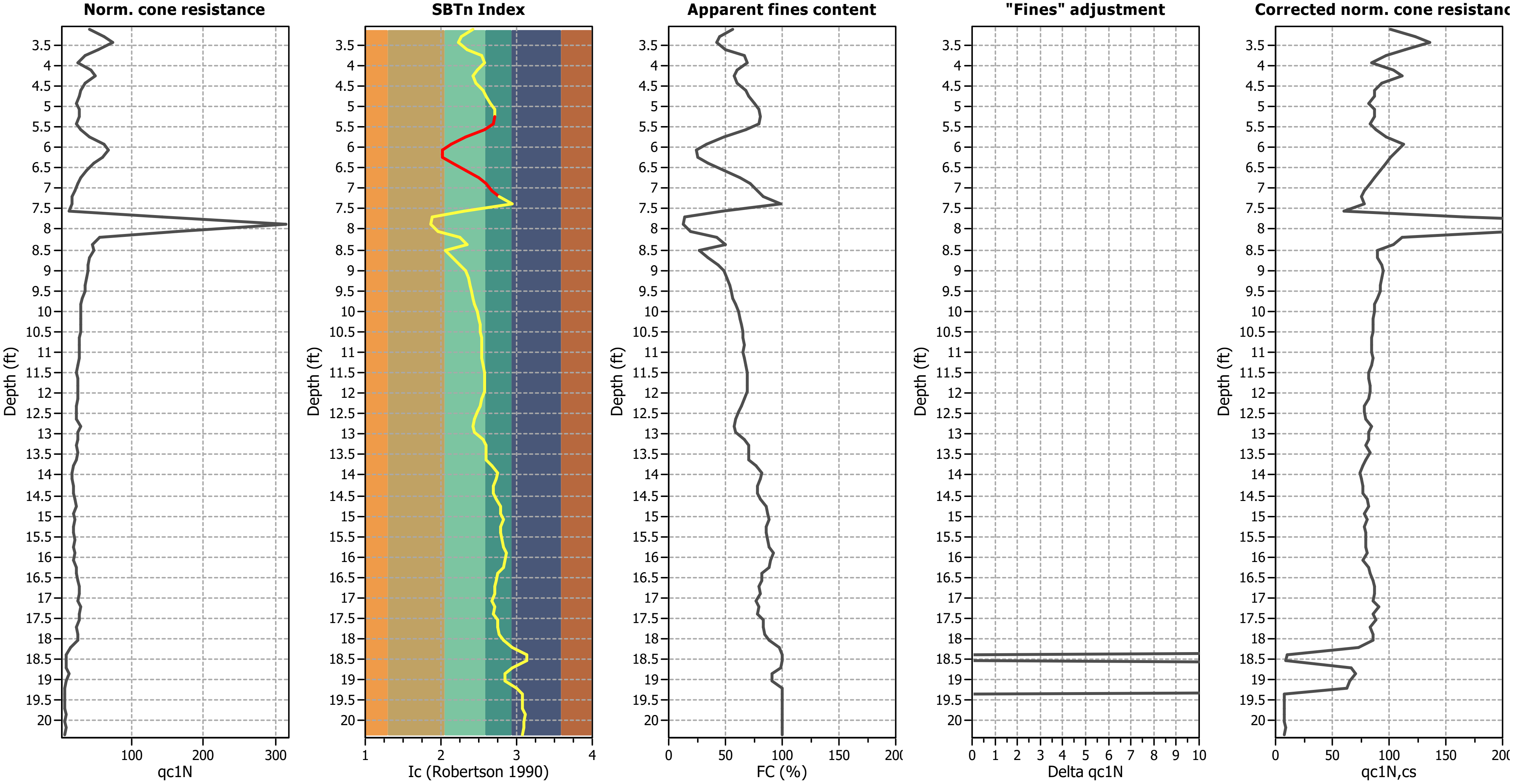
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

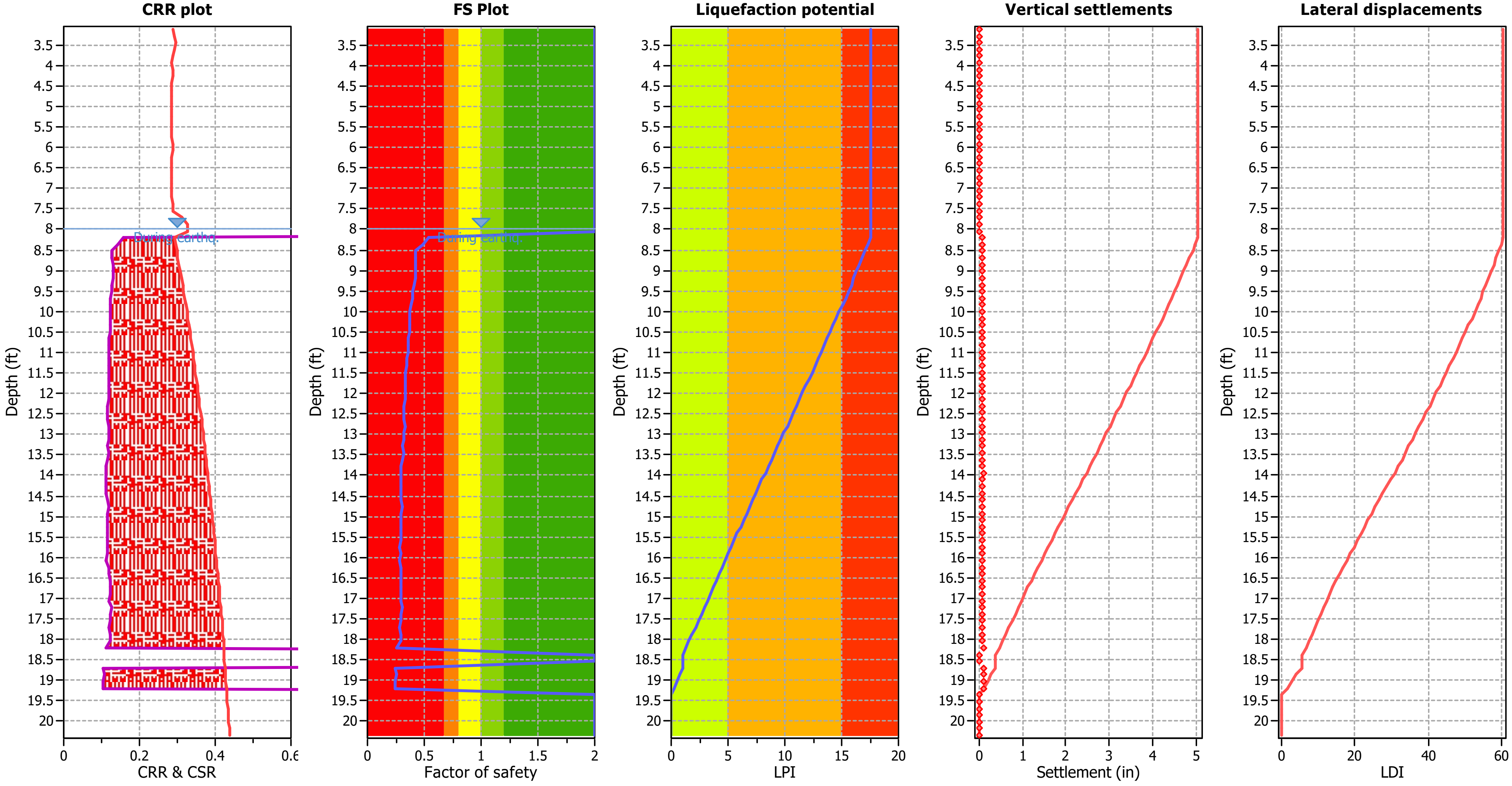
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.91
Peak ground acceleration: 0.47
Depth to water table (insitu): 8.00 ft

Depth to GWT (erthq.): 8.00 ft
Average results interval: 3
Ic cut-off value: 3.00
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

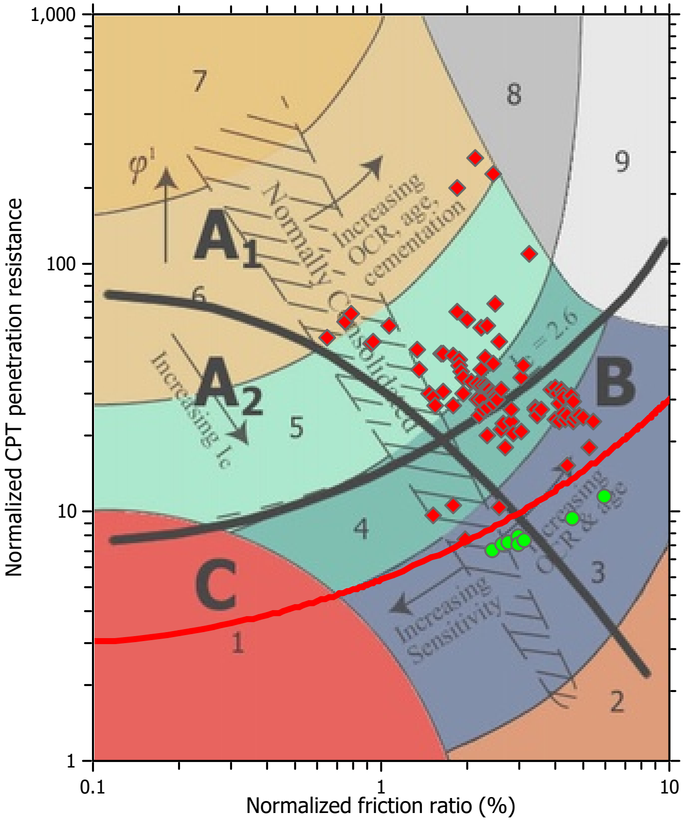
F.S. color scheme

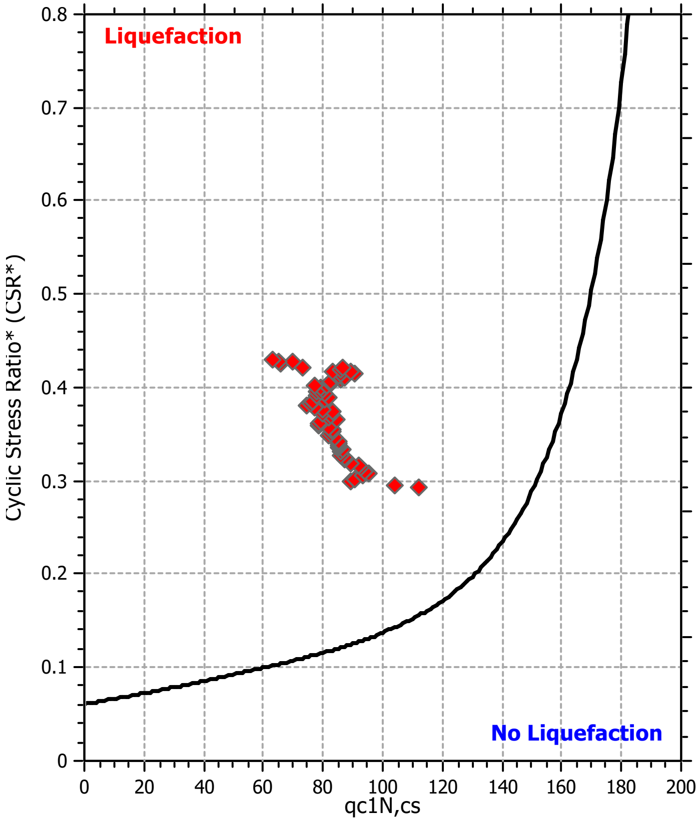
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

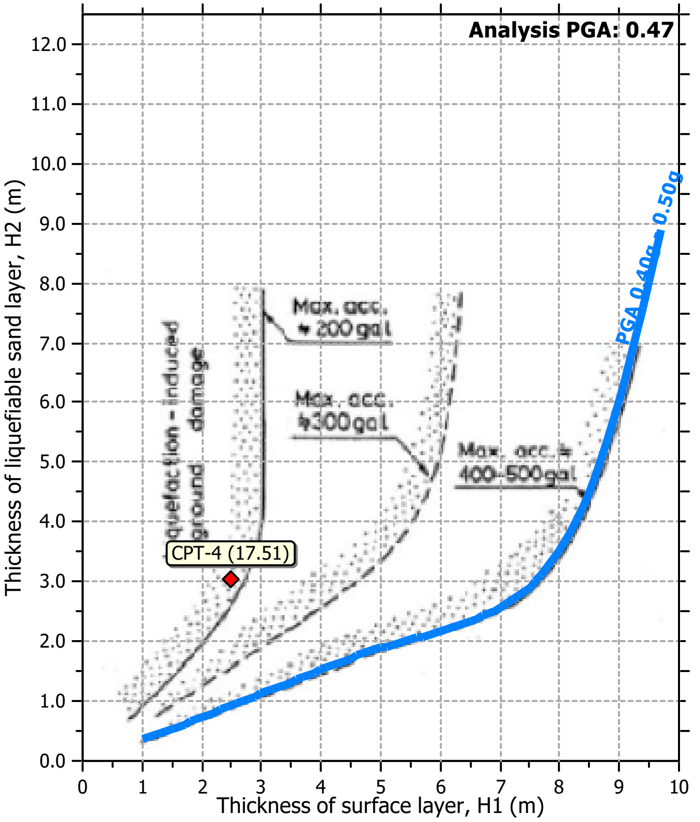
LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟨 Low risk

Liquefaction analysis summary plots



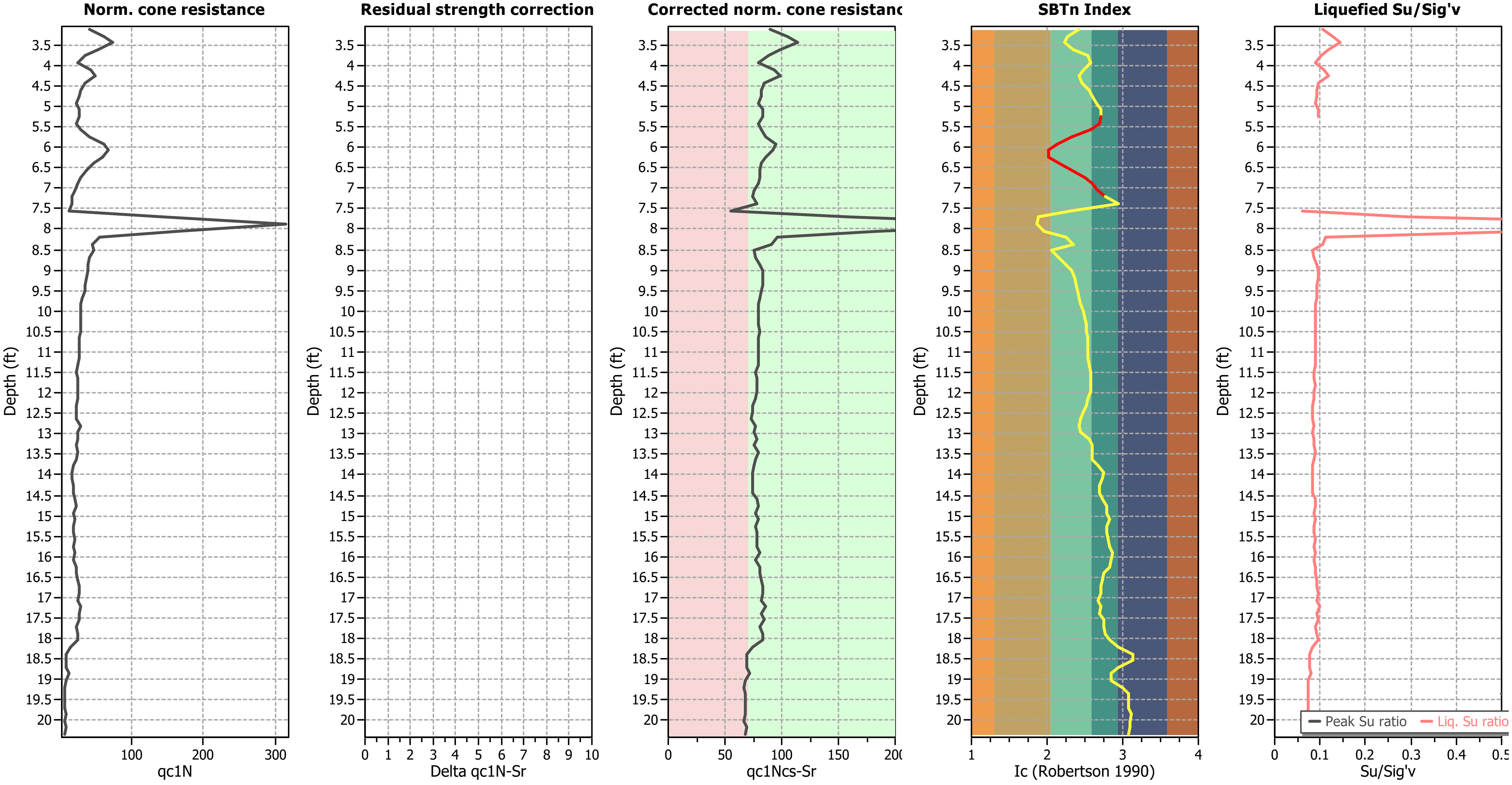




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

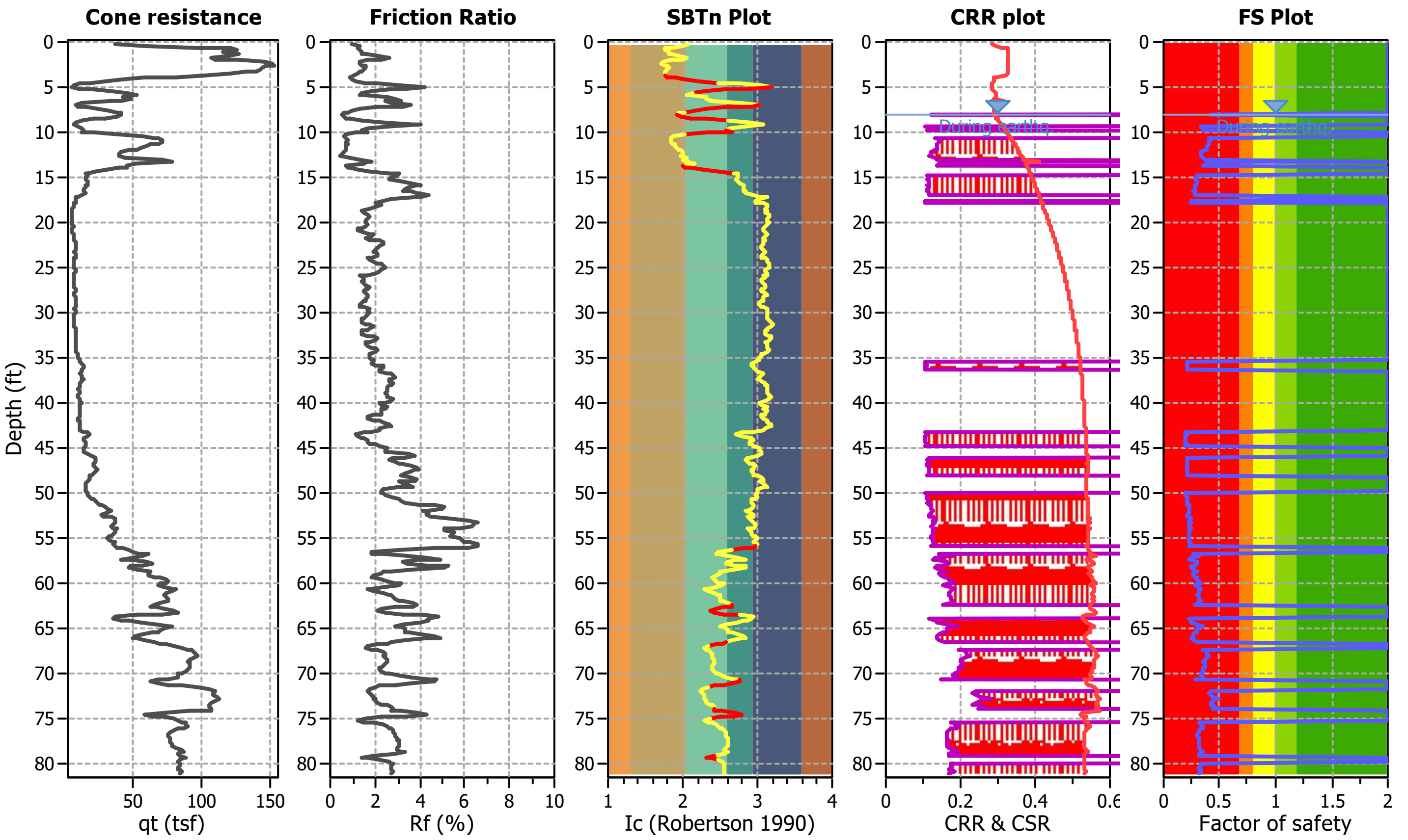
LIQUEFACTION ANALYSIS REPORT

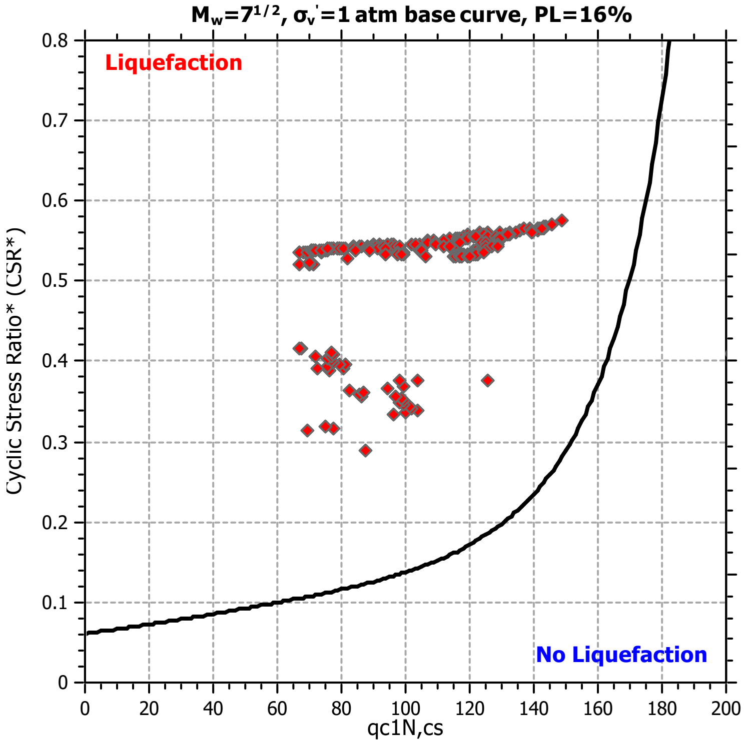
Project title : Owens Corning Linnton **Location : Portland**

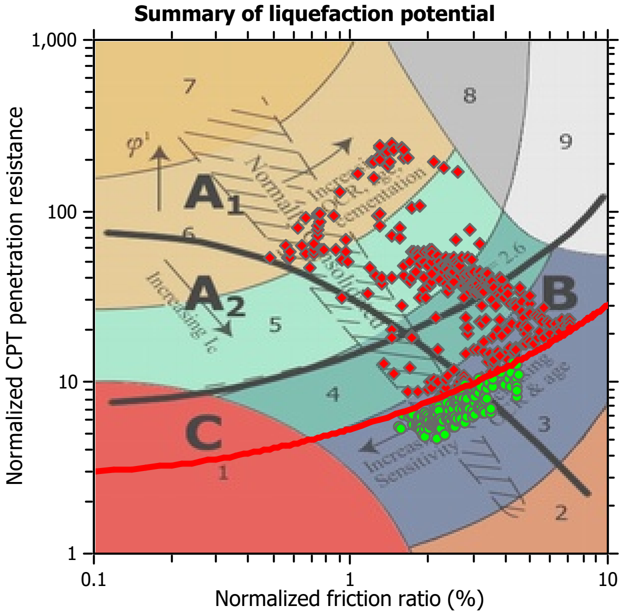
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

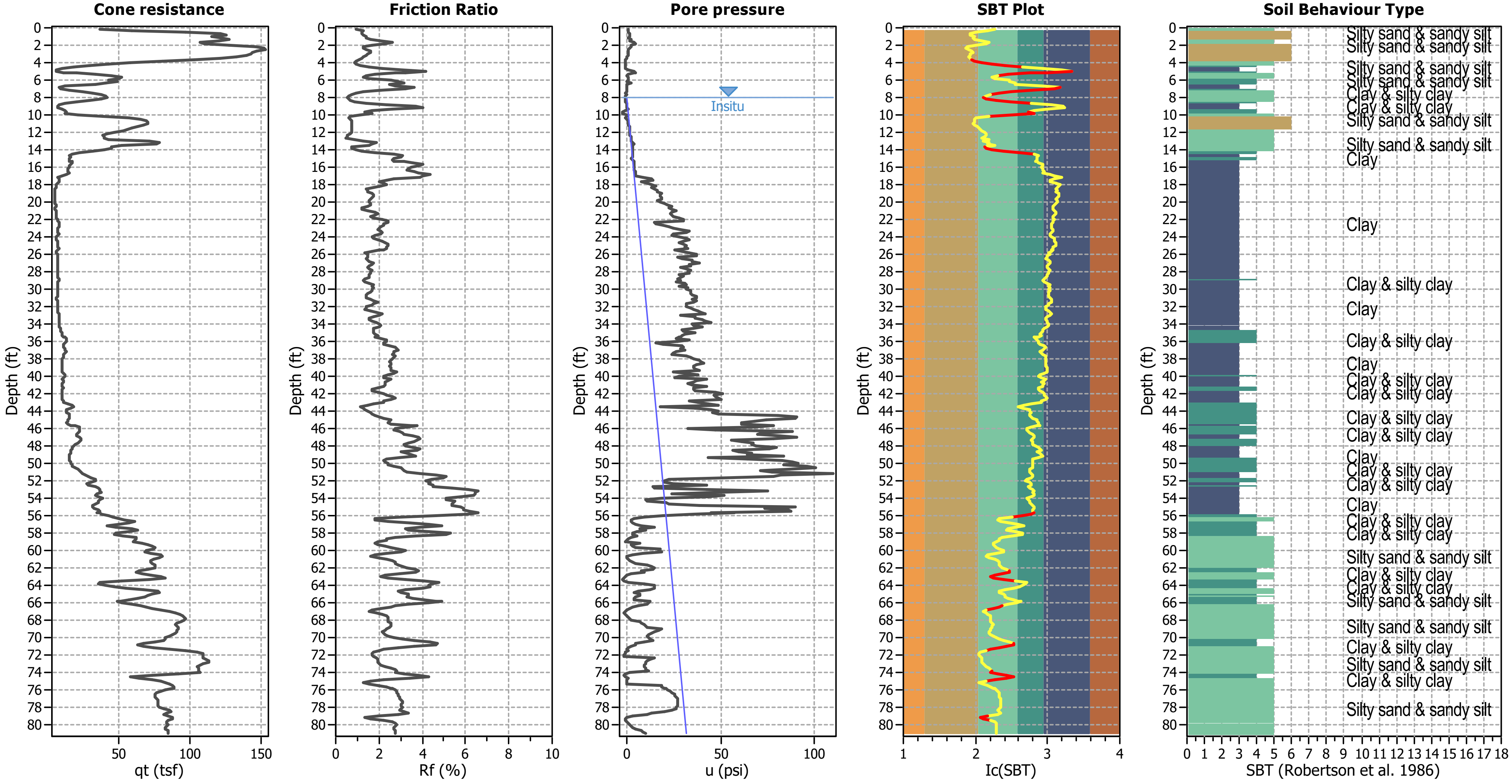






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



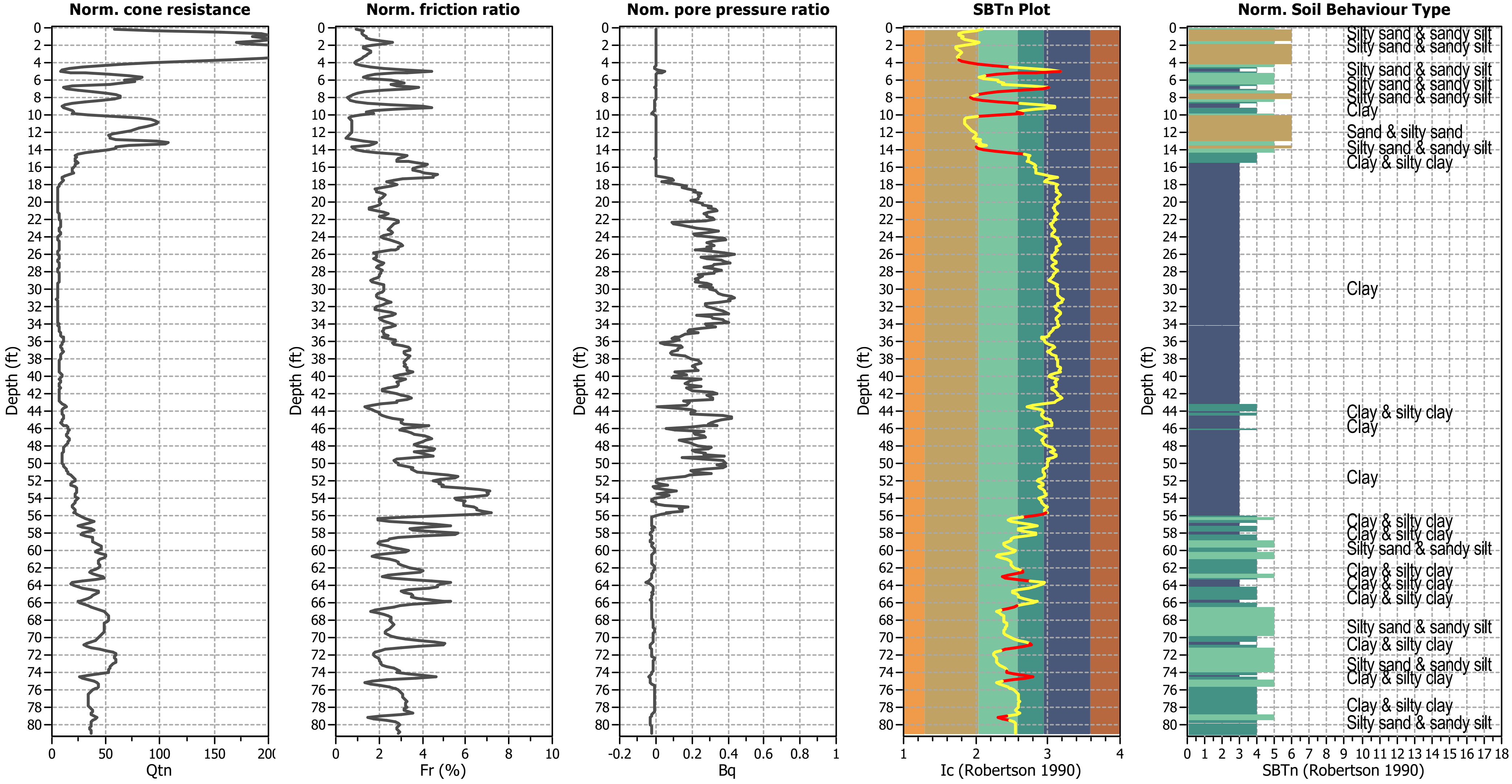
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

🟥	1. Sensitive fine grained	🟩	4. Clayey silt to silty	🟧	7. Gravely sand to sand
🟫	2. Organic material	🟩	5. Silty sand to sandy silt	⬛	8. Very stiff sand to
🟦	3. Clay to silty clay	🟫	6. Clean sand to silty sand	⬜	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



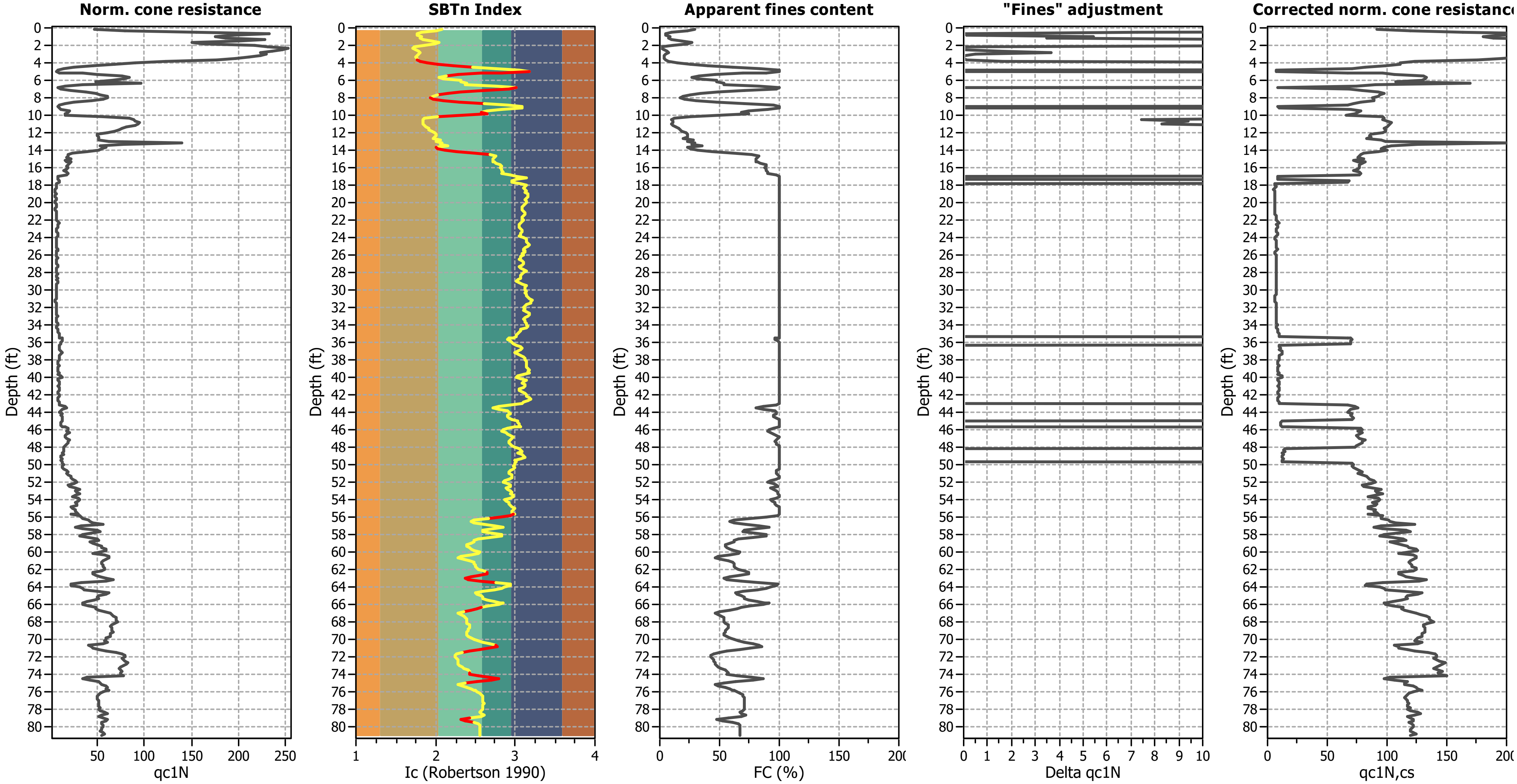
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

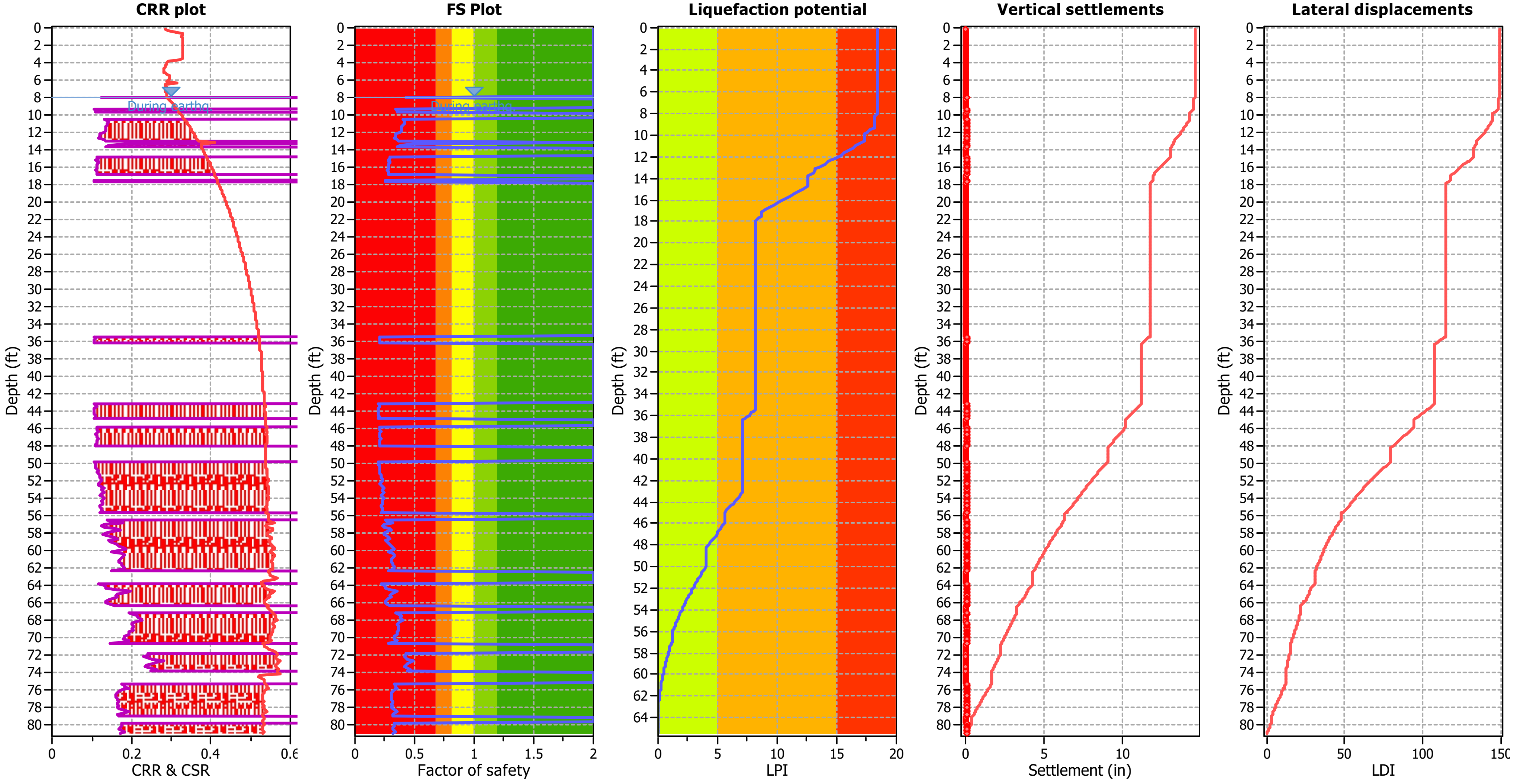
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

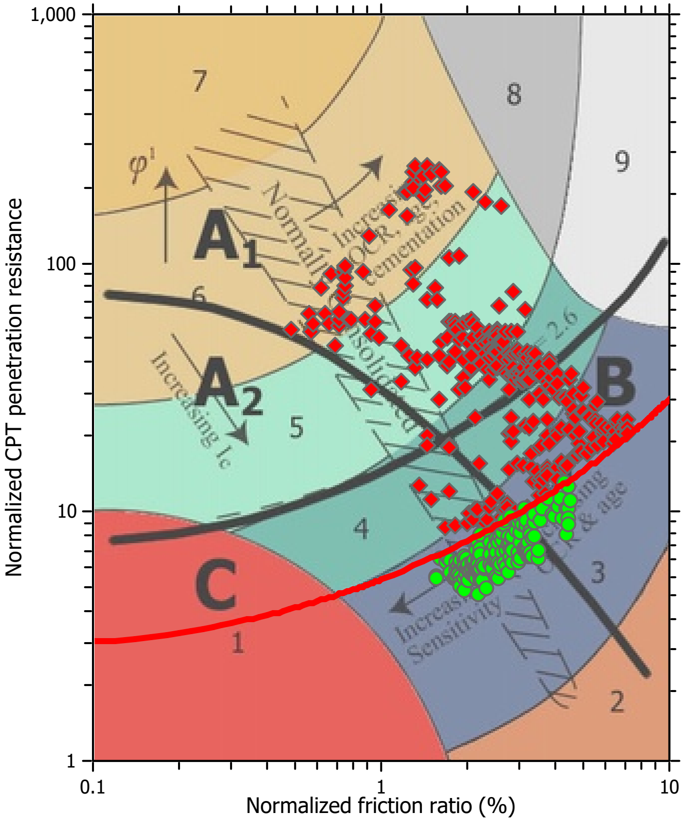
F.S. color scheme

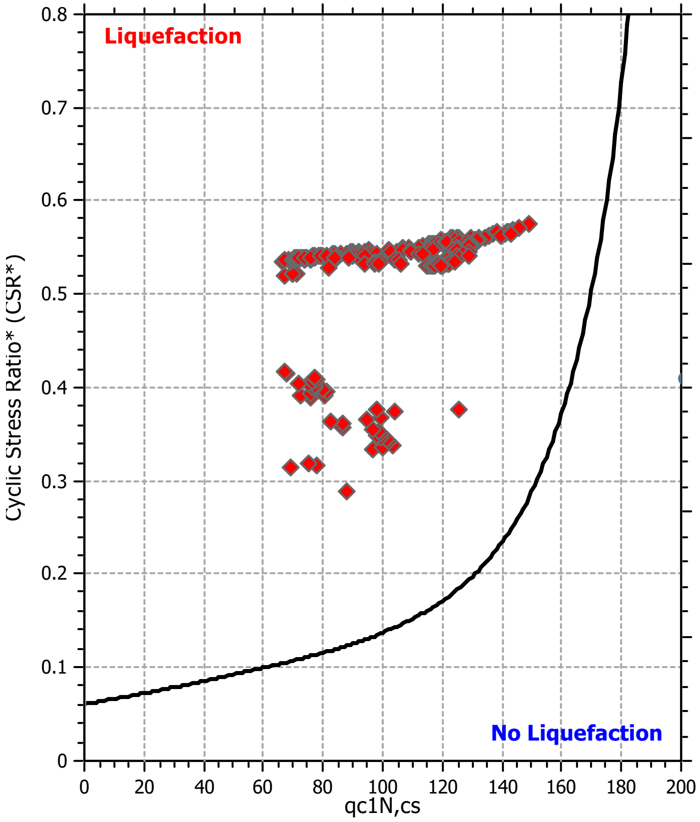
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

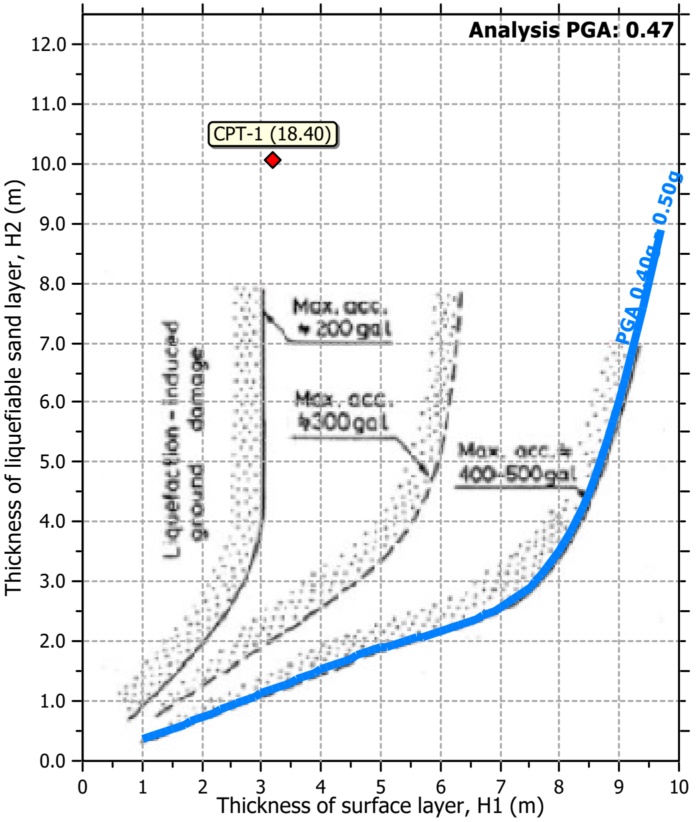
LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟨 Low risk

Liquefaction analysis summary plots



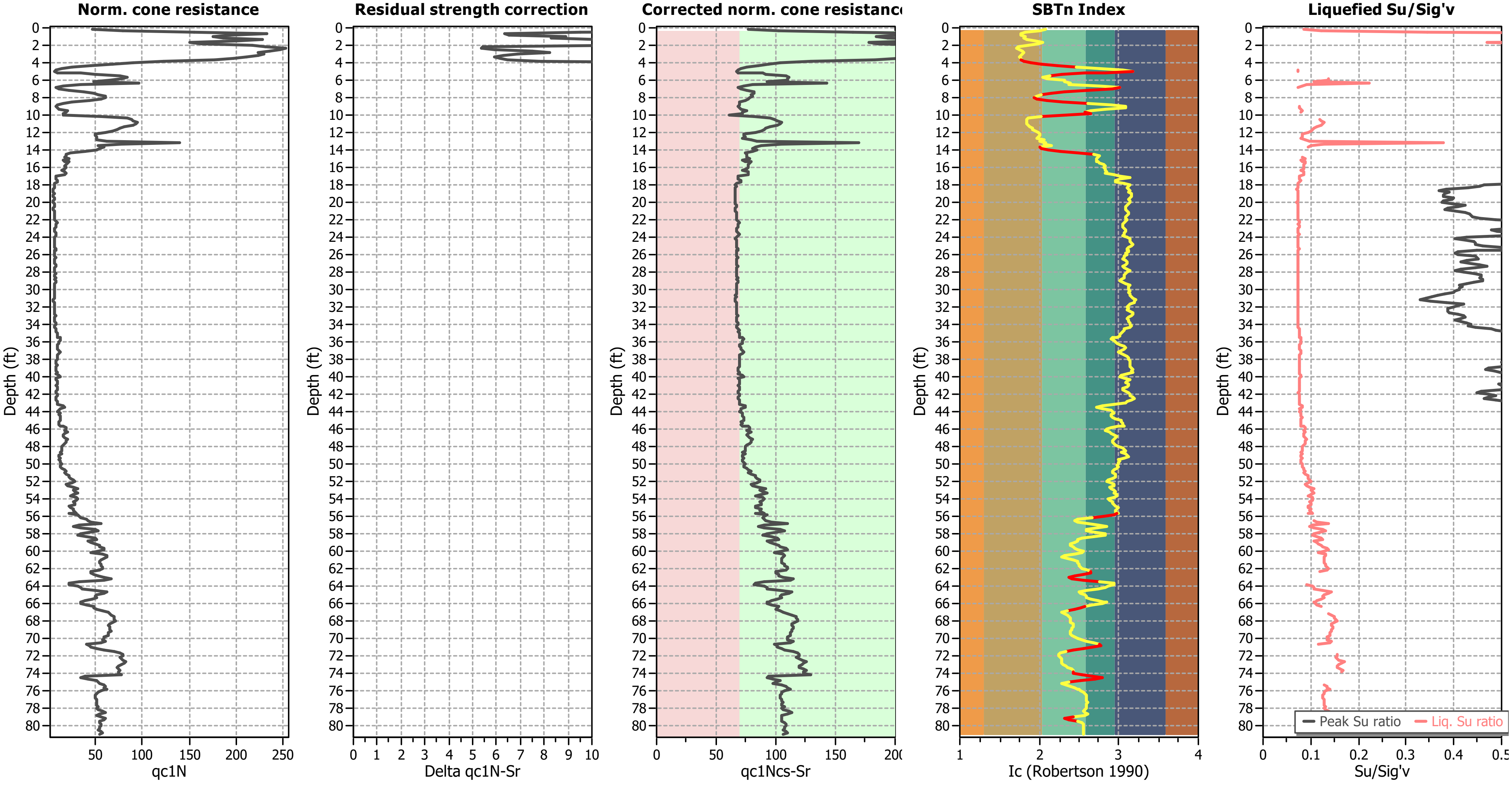




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.91
Peak ground acceleration: 0.47
Depth to water table (insitu): 8.00 ft

Depth to GWT (erthq.): 8.00 ft
Average results interval: 3
Ic cut-off value: 3.00
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

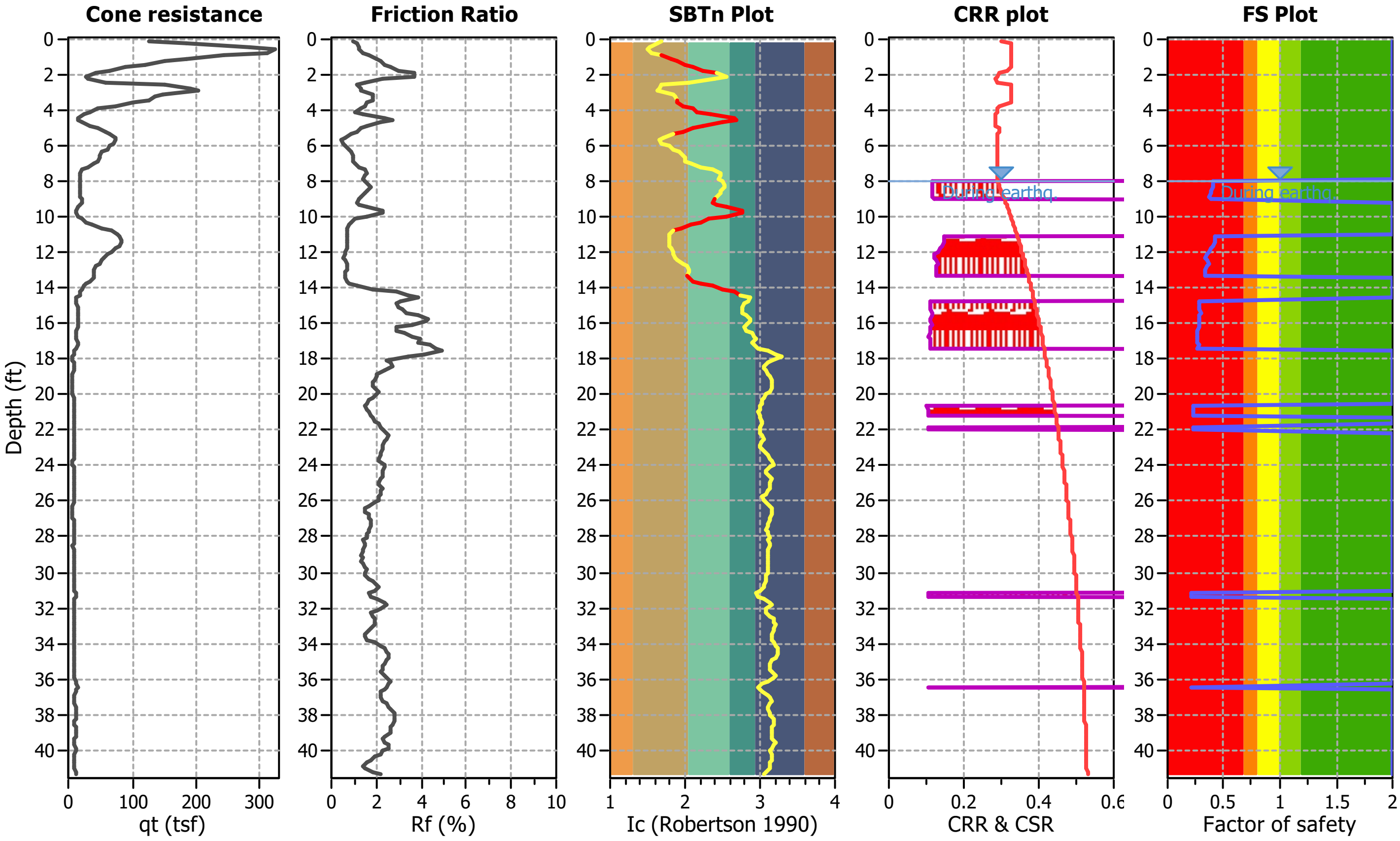
LIQUEFACTION ANALYSIS REPORT

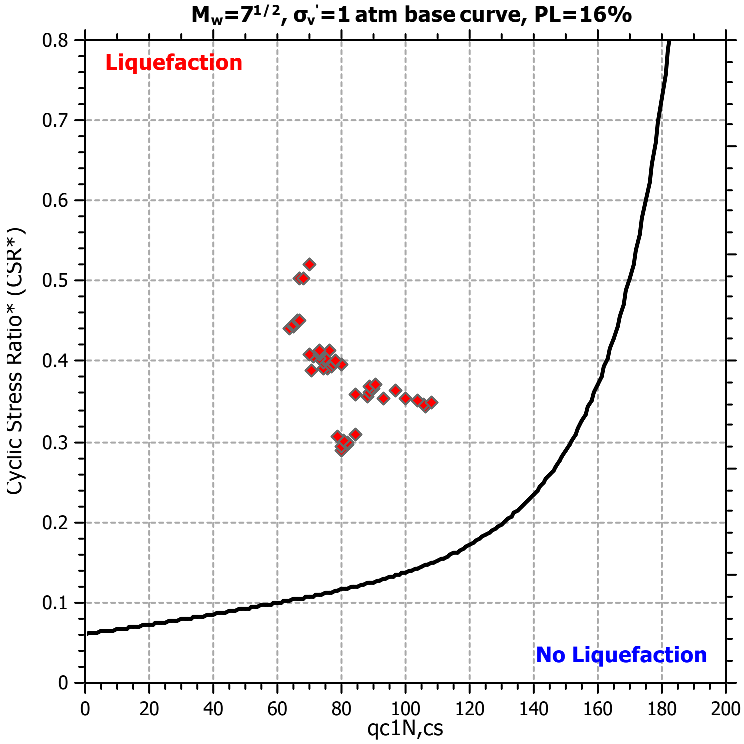
Project title : Owens Corning Linnton **Location : Portland**

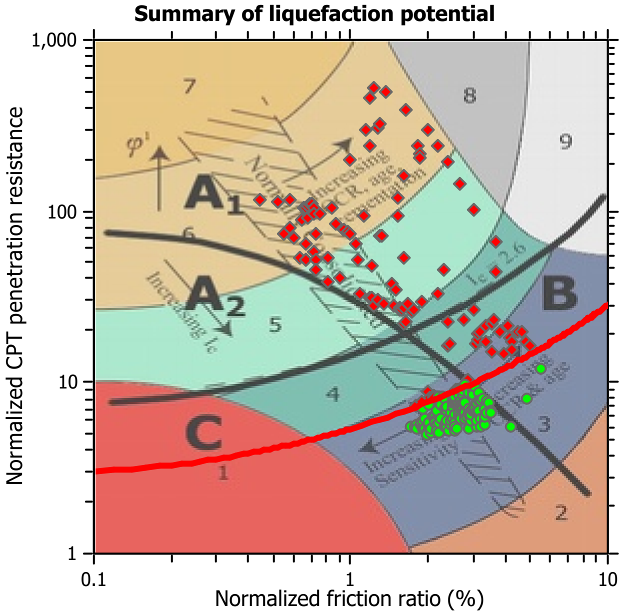
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

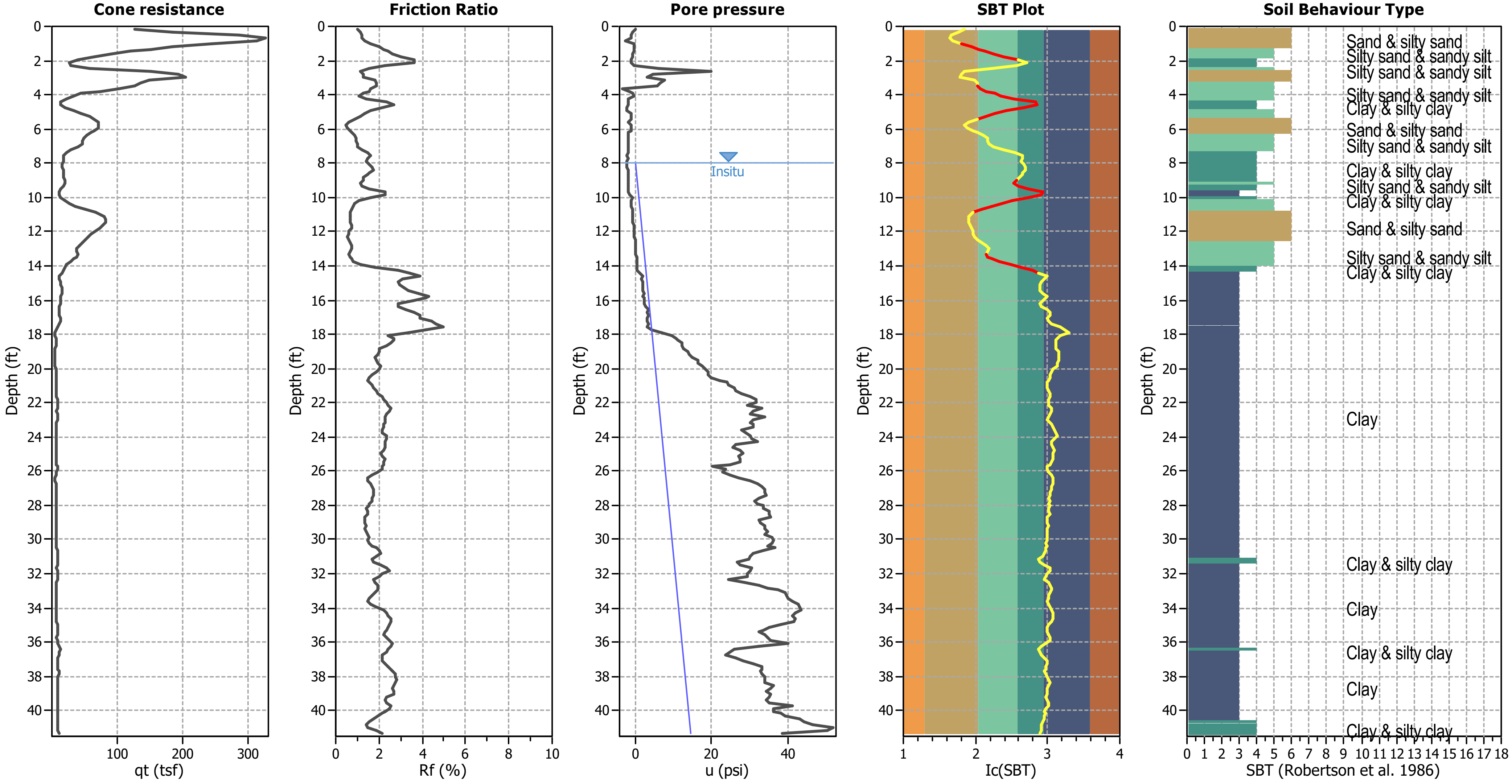






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



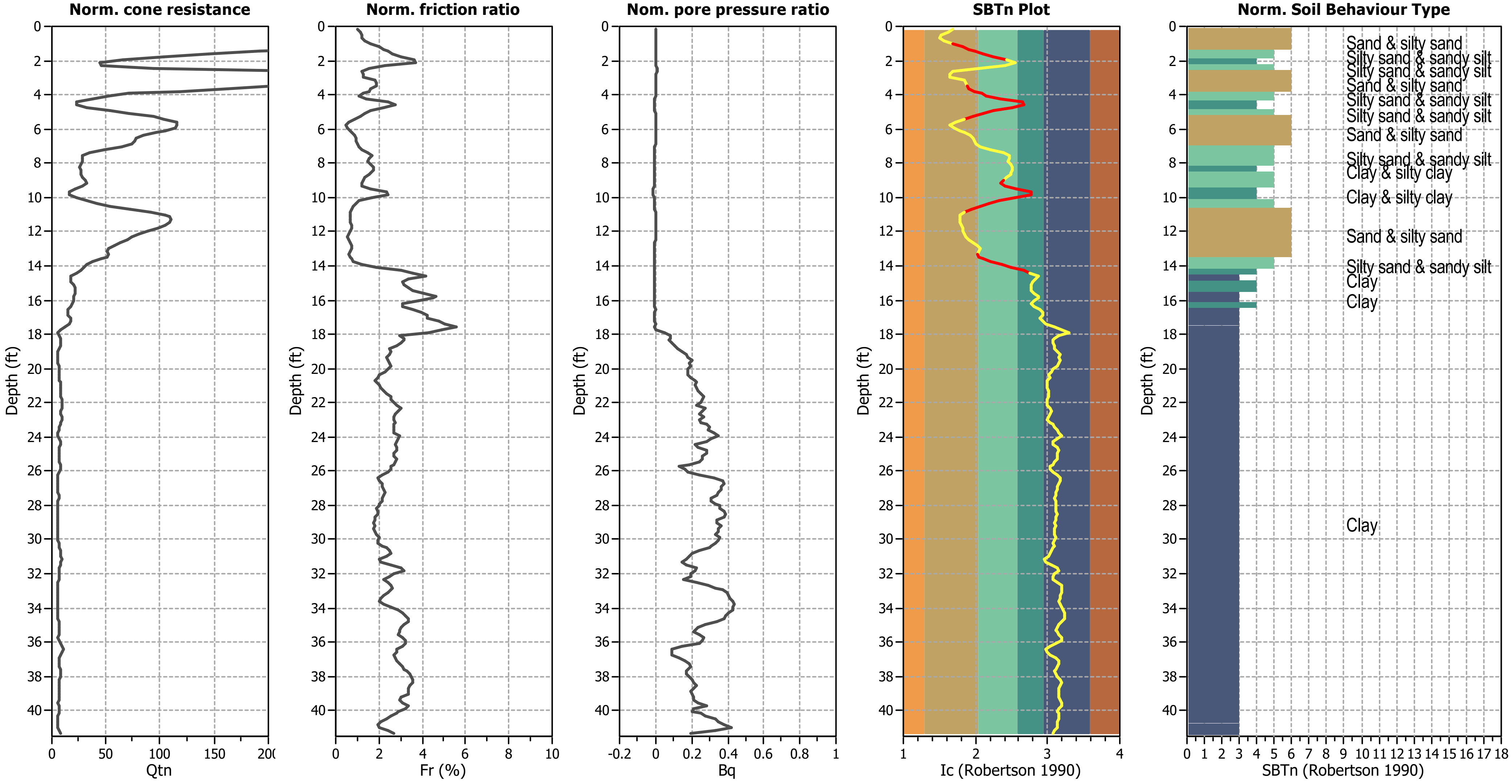
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

🟥	1. Sensitive fine grained	🟩	4. Clayey silt to silty	🟧	7. Gravely sand to sand
🟫	2. Organic material	🟩	5. Silty sand to sandy silt	⬛	8. Very stiff sand to
🟦	3. Clay to silty clay	🟫	6. Clean sand to silty sand	⬜	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



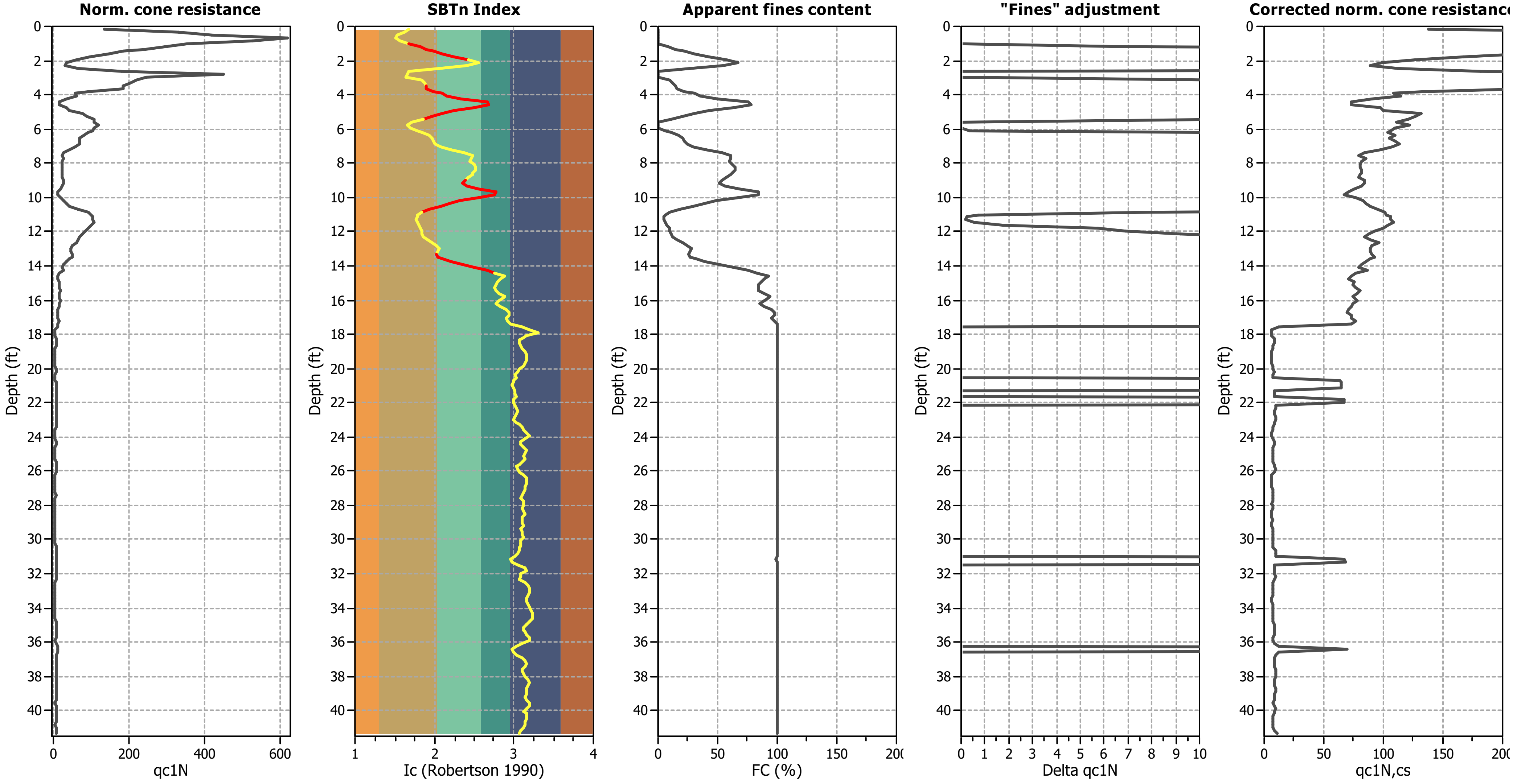
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

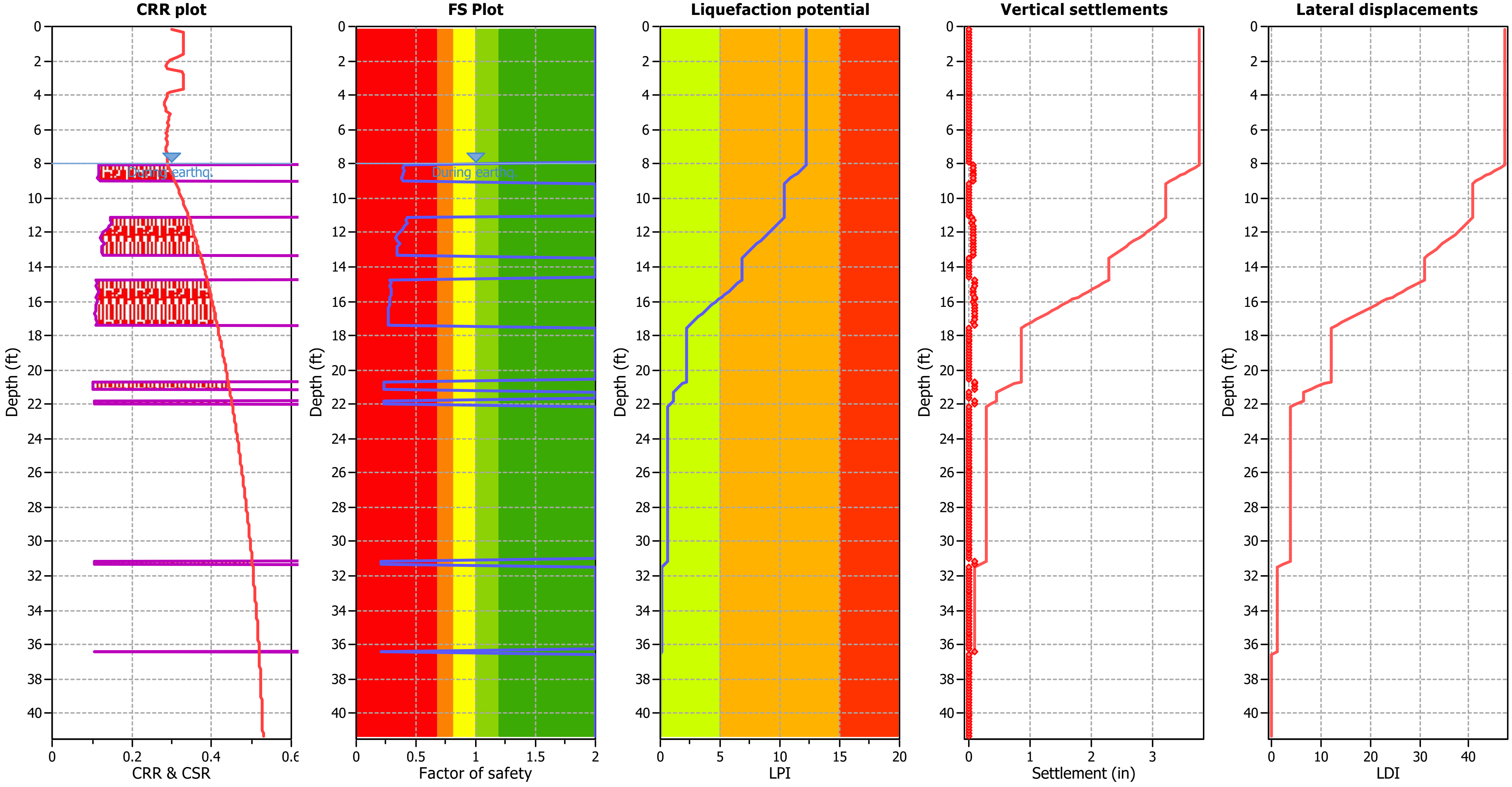
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
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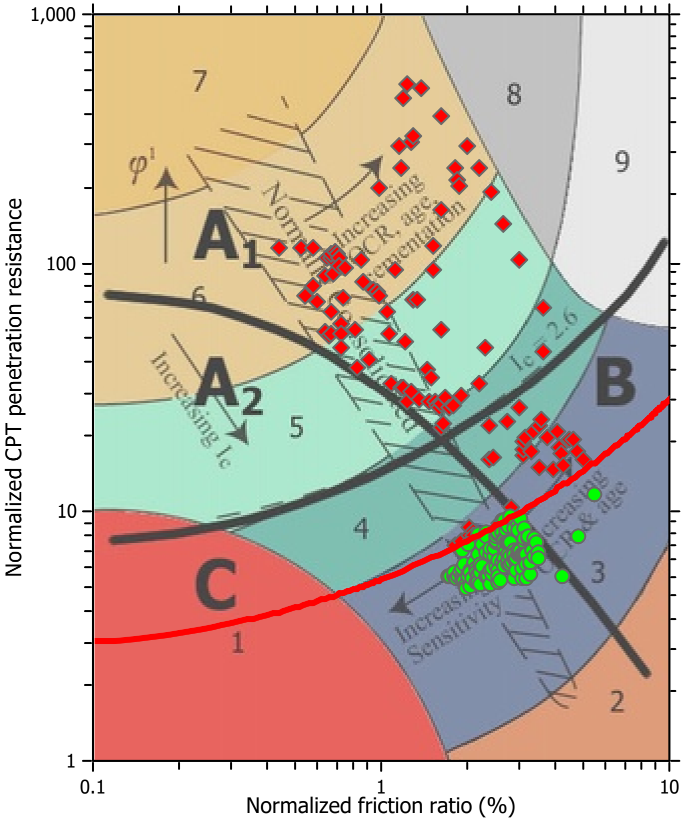
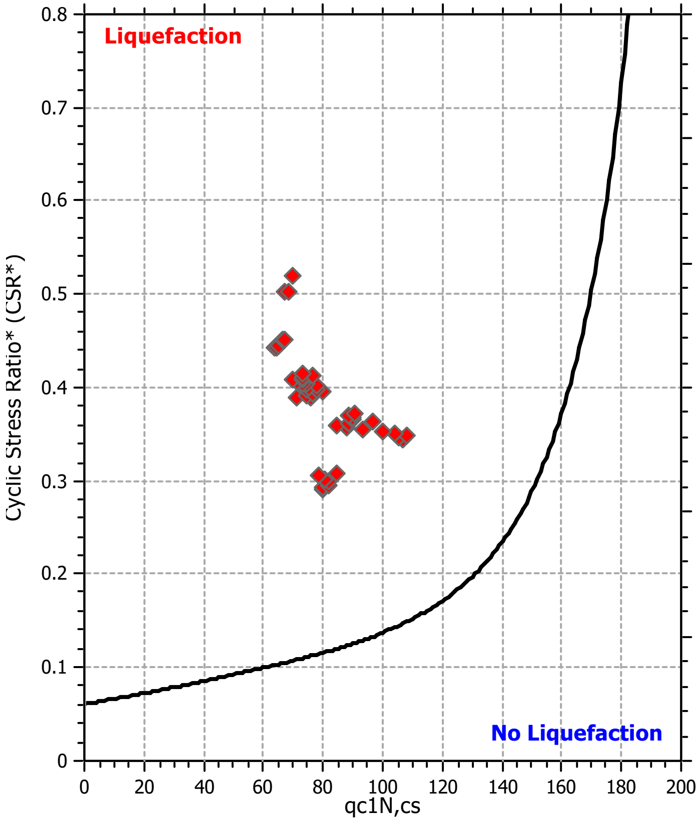
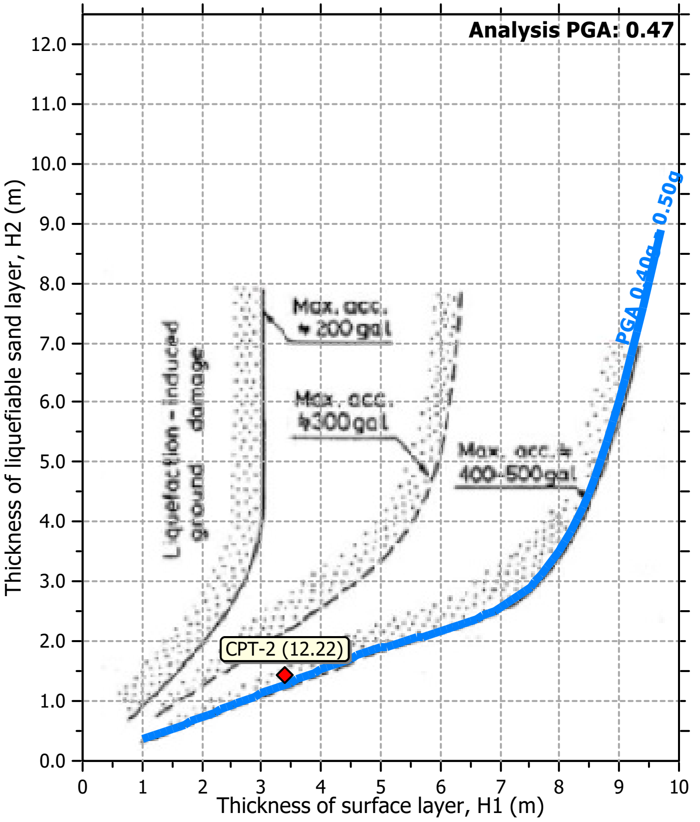
LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟨 Low risk

Liquefaction analysis summary plots



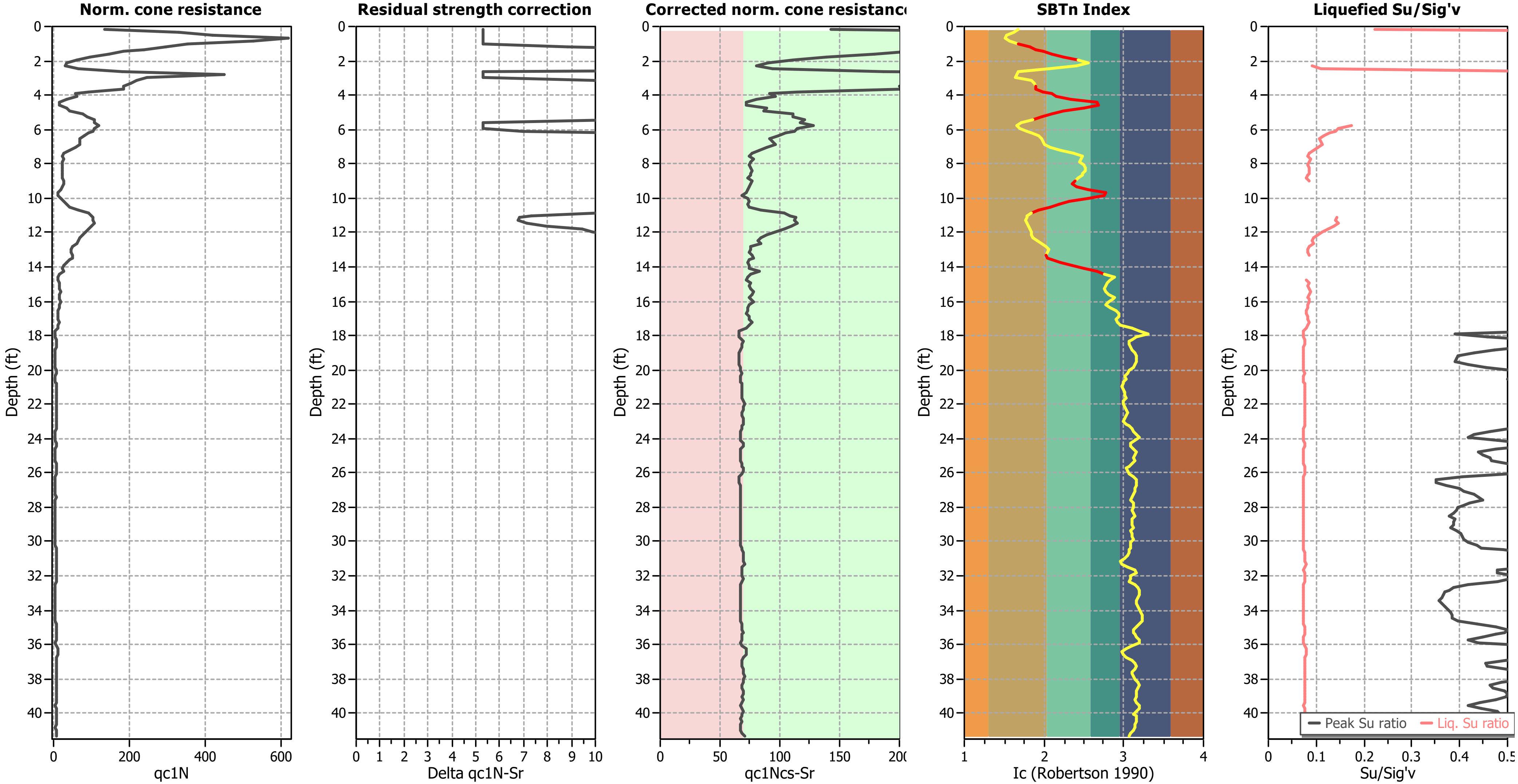




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

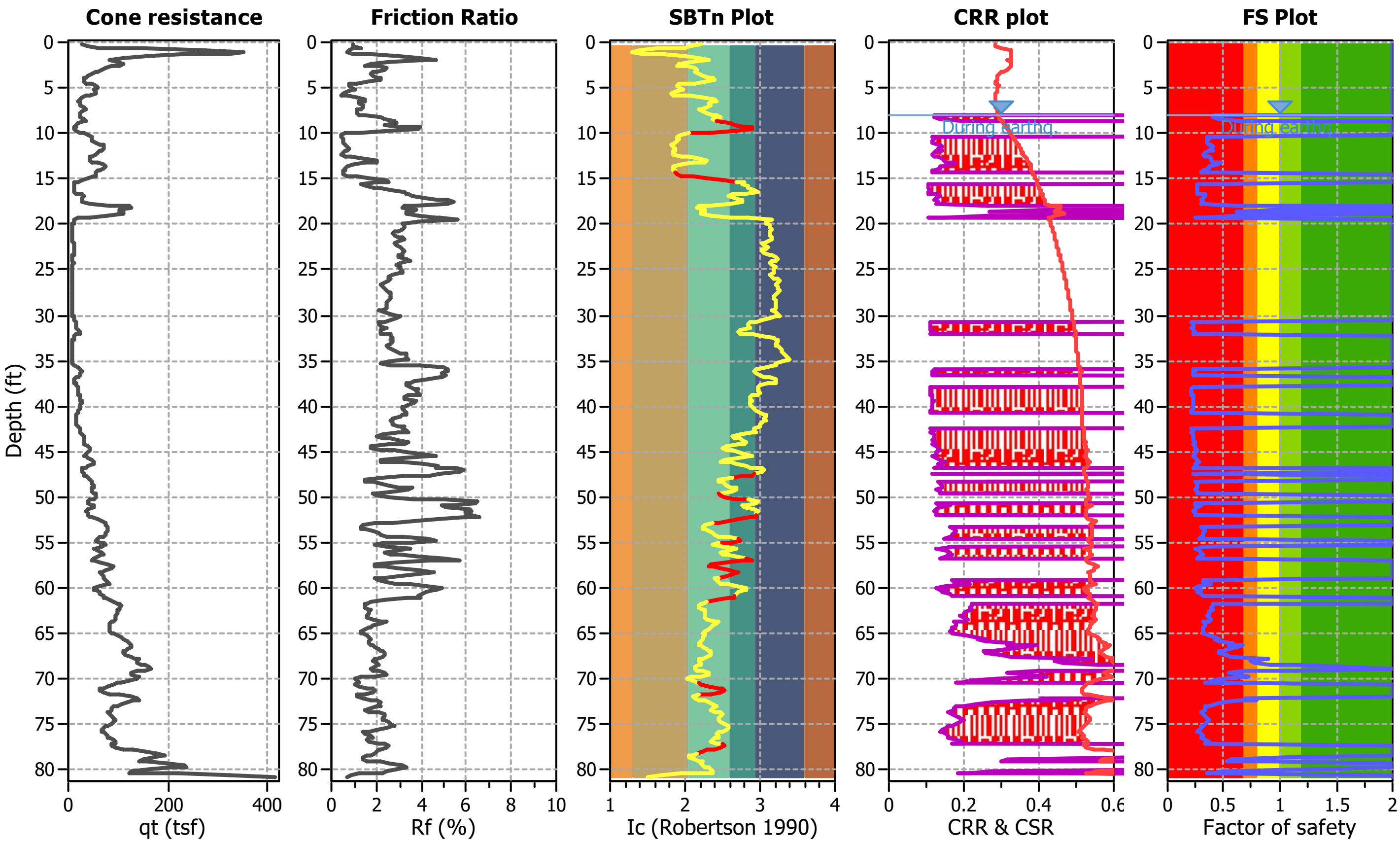
LIQUEFACTION ANALYSIS REPORT

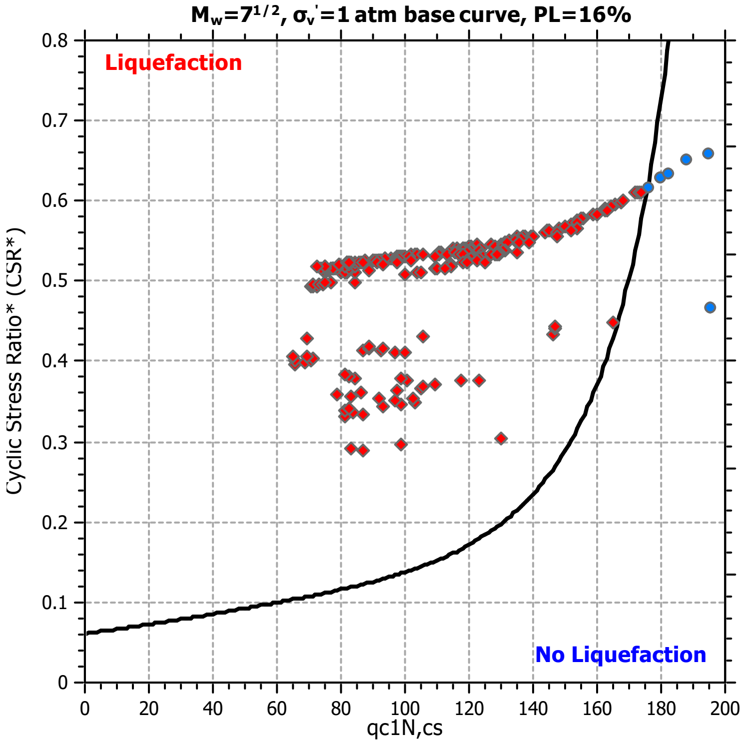
Project title : Owens Corning Linnton **Location : Portland**

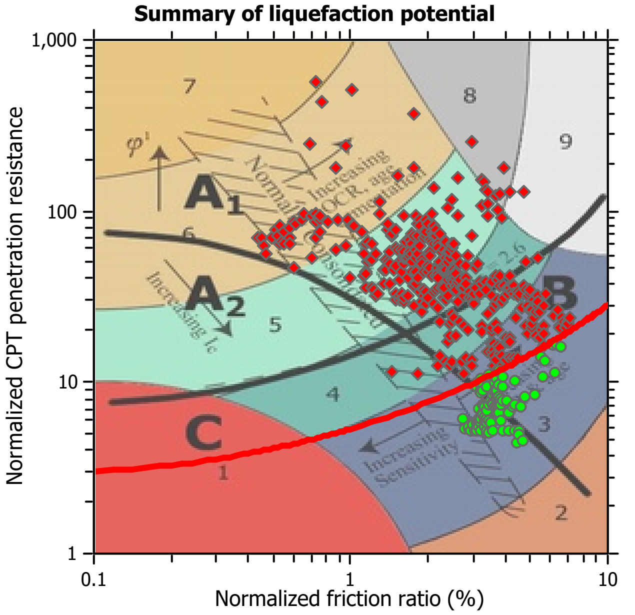
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	7.91	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

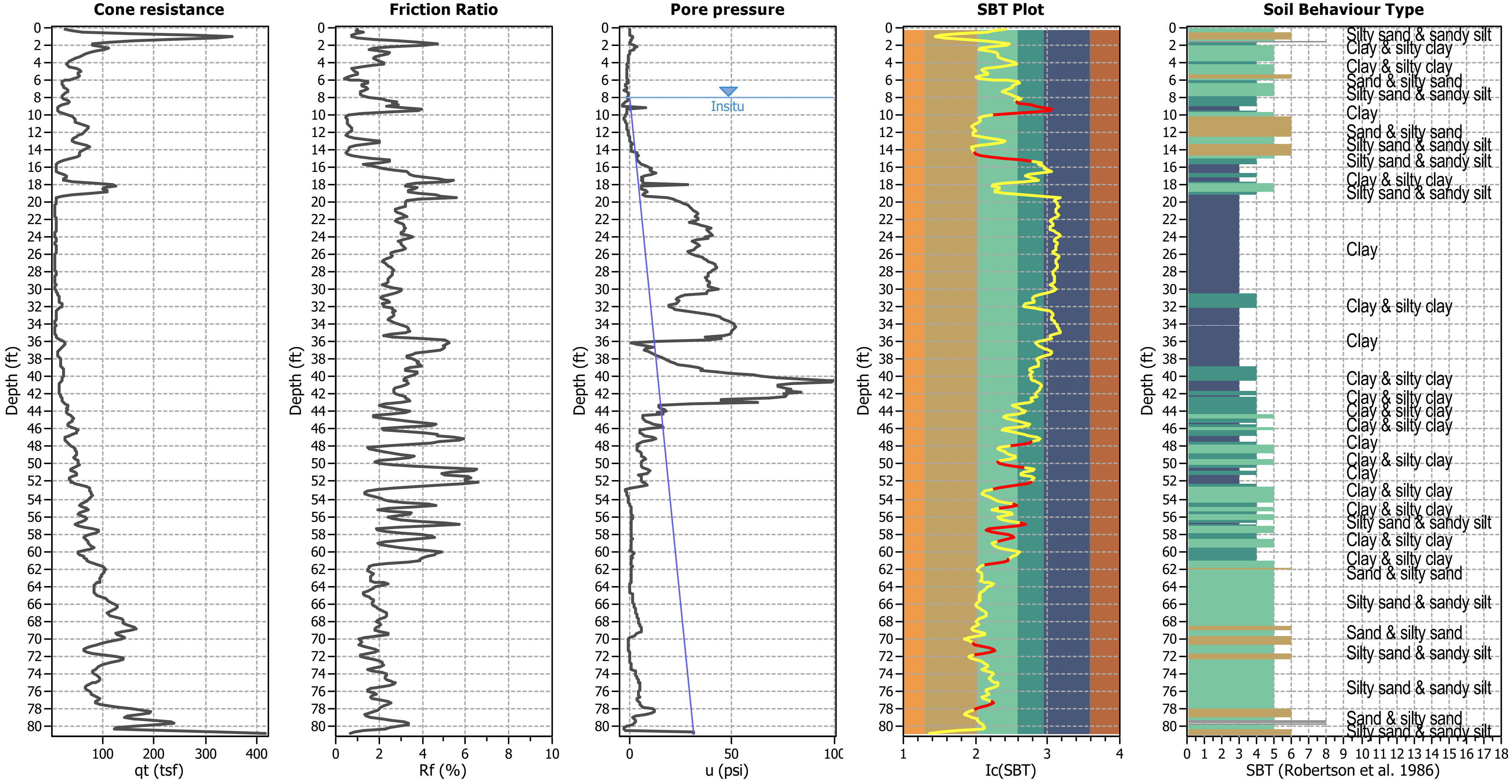






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



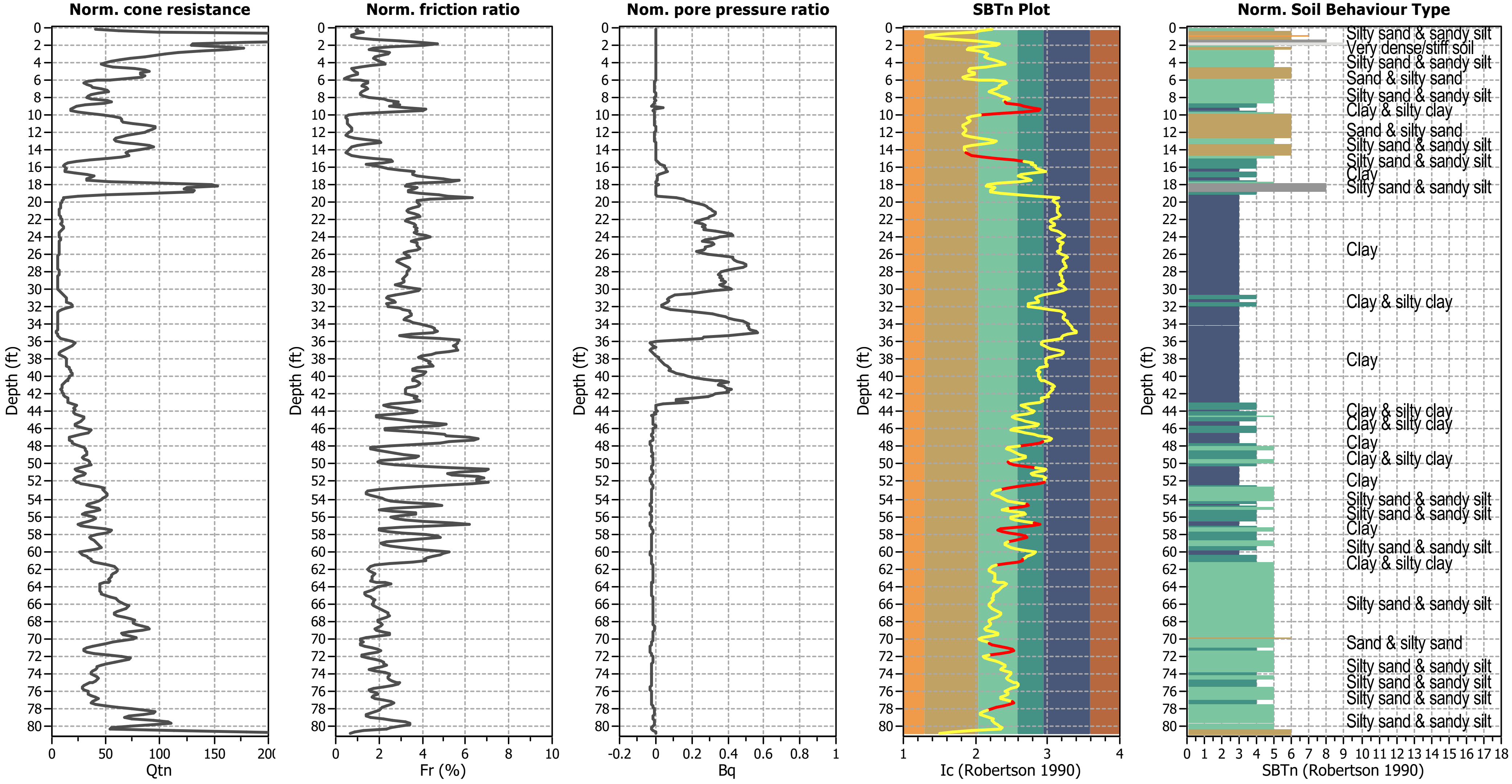
Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	7.91
Peak ground acceleration:	0.47
Depth to water table (insitu):	8.00 ft
Depth to GWT (erthq.):	8.00 ft
Average results interval:	3
Ic cut-off value:	3.00
Unit weight calculation:	Based on SBT
Use fill:	No
Fill height:	N/A
Fill weight:	N/A
Transition detect. applied:	Yes
K_σ applied:	Yes
Clay like behavior applied:	Sands only
Limit depth applied:	No
Limit depth:	N/A

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟫 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.91
Peak ground acceleration: 0.47
Depth to water table (insitu): 8.00 ft

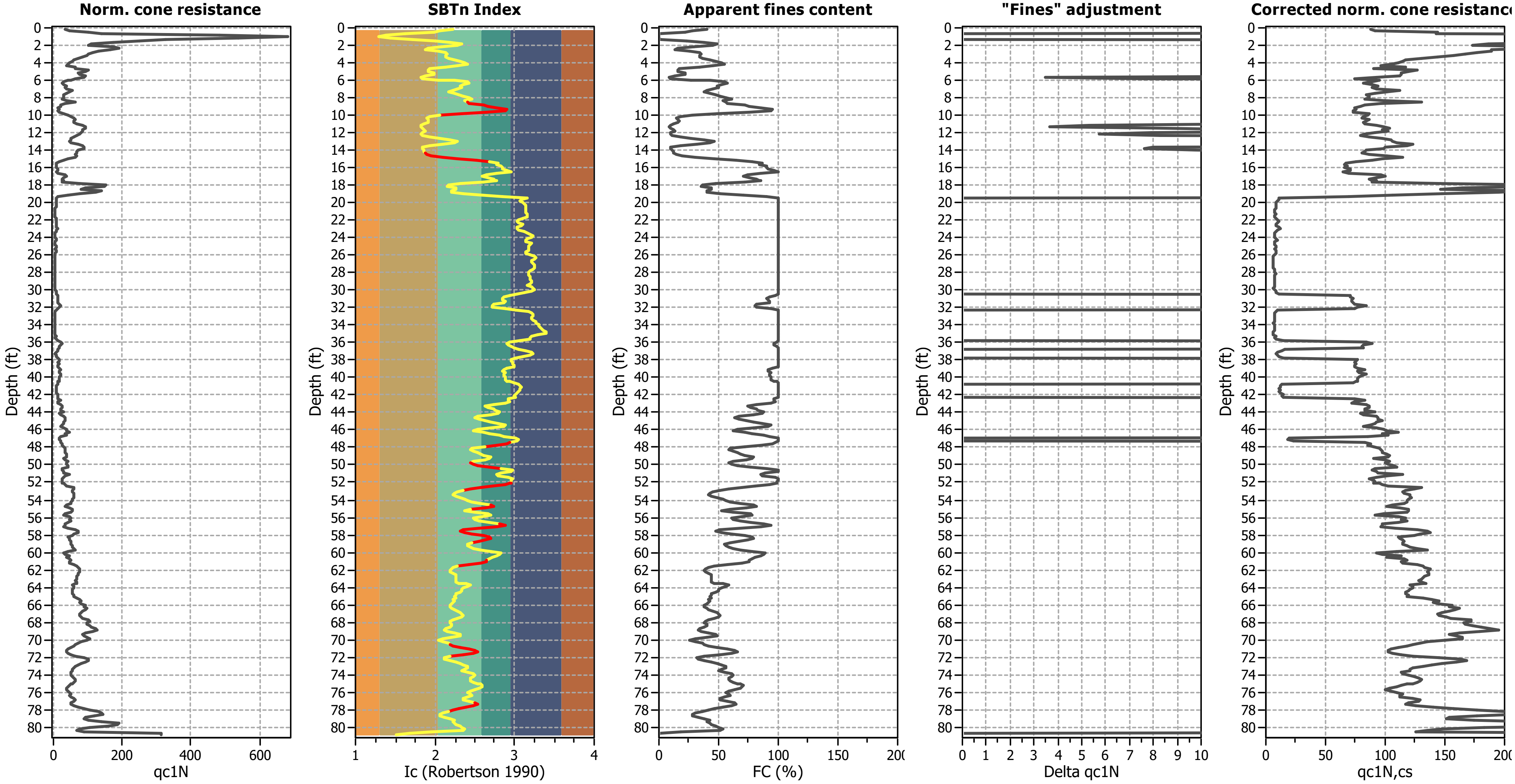
Depth to GWT (erthq.): 8.00 ft
Average results interval: 3
Ic cut-off value: 3.00
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

SBTn legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟫 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



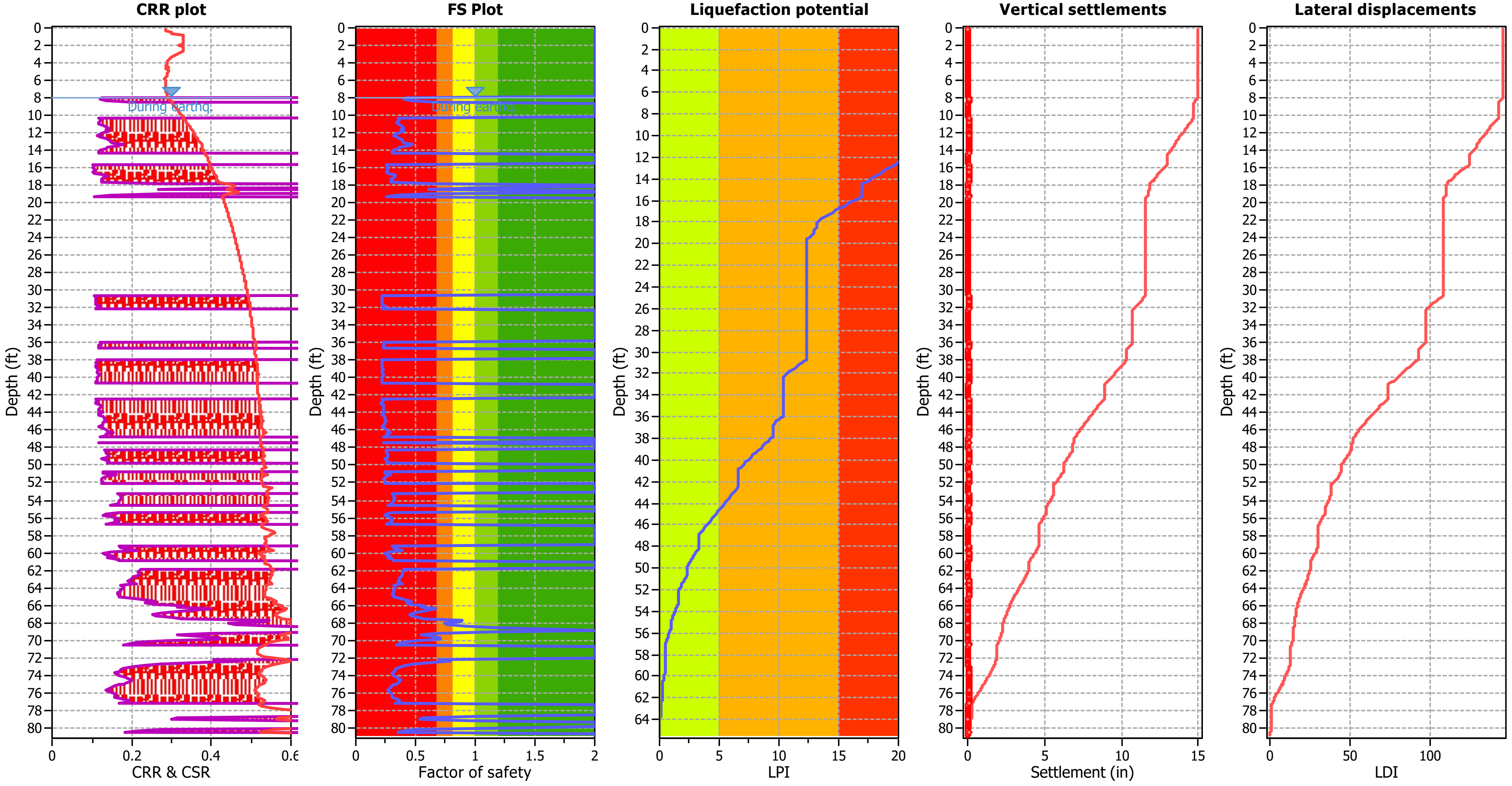
Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.91
Peak ground acceleration: 0.47
Depth to water table (insitu): 8.00 ft

Depth to GWT (erthq.): 8.00 ft
Average results interval: 3
Ic cut-off value: 3.00
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
Limit depth: N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

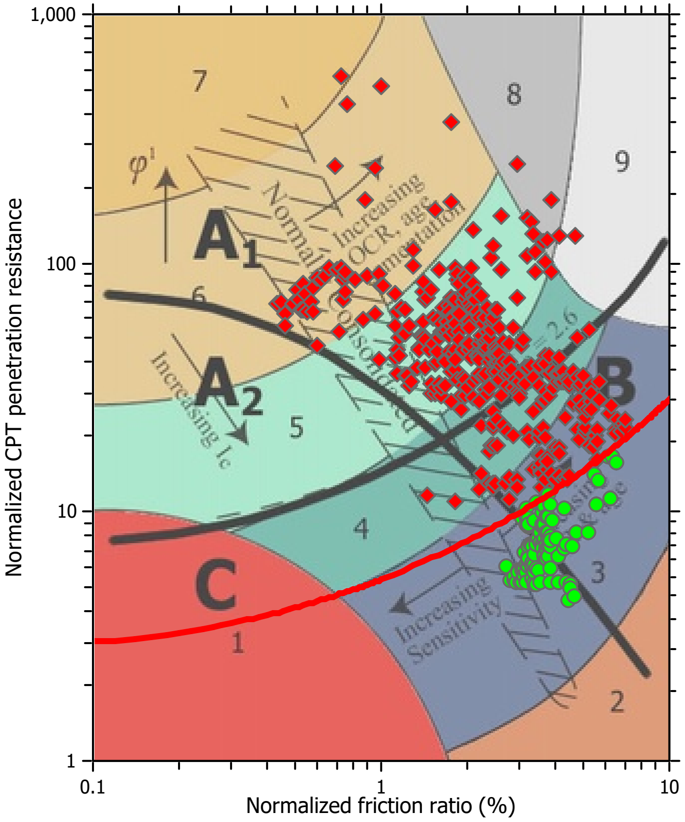
F.S. color scheme

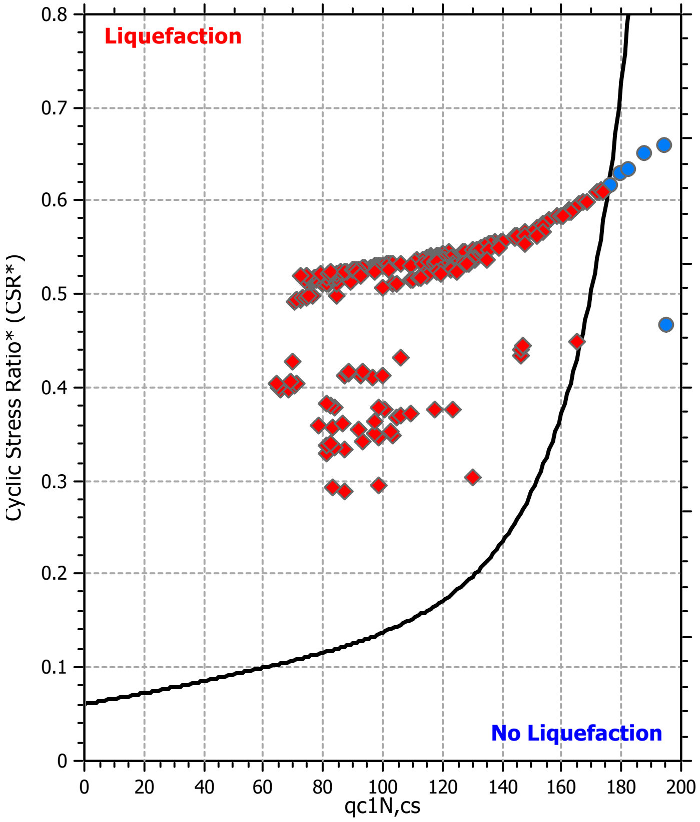
🟥	Almost certain it will liquefy
🟧	Very likely to liquefy
🟨	Liquefaction and no liq. are equally likely
🟩	Unlike to liquefy
🟩	Almost certain it will not liquefy

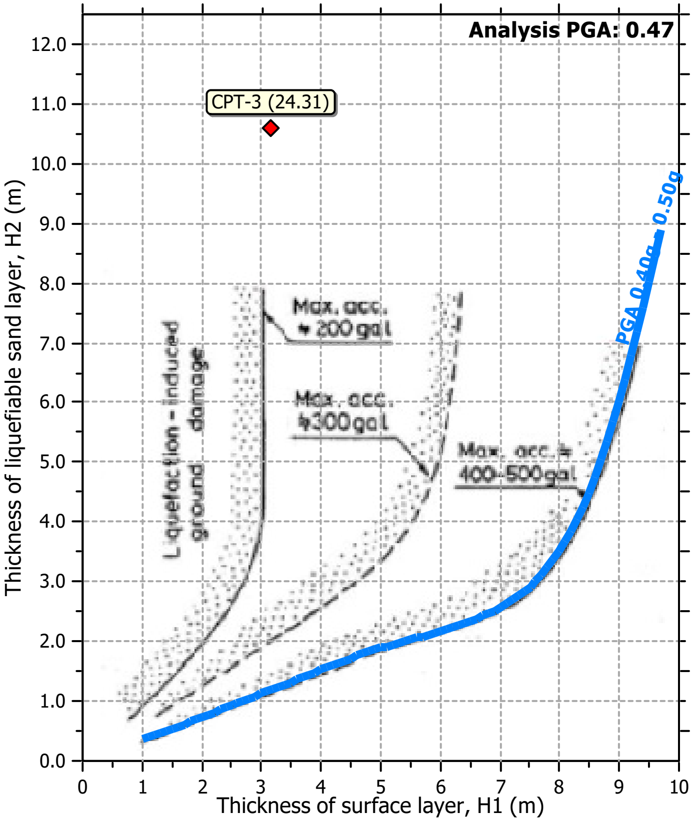
LPI color scheme

🟥	Very high risk
🟧	High risk
🟨	Low risk

Liquefaction analysis summary plots



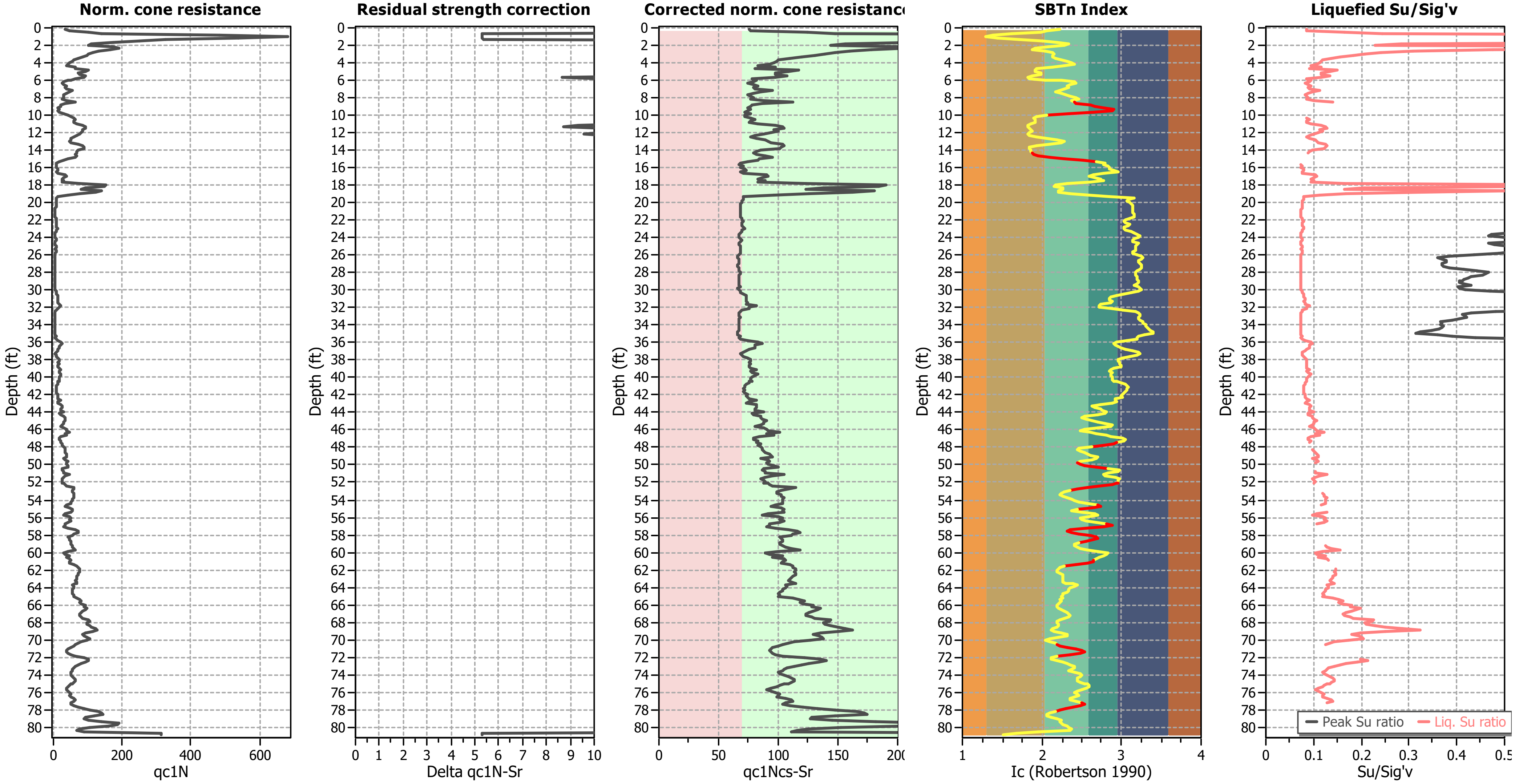




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.91	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

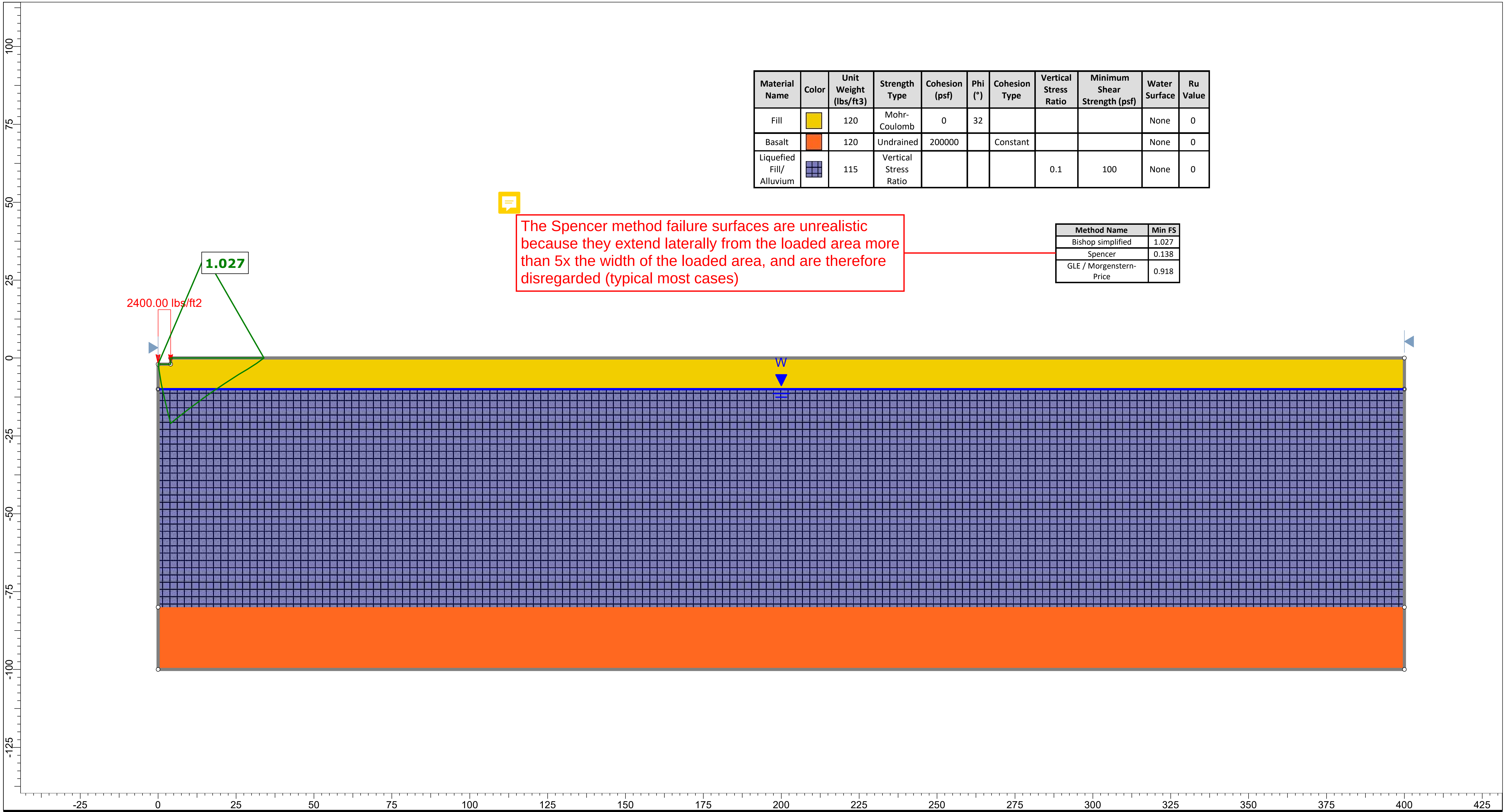
G-2-5
Lateral Spreading Calculations

Owens Corning Linnton Asphalt Terminal SVA

Zhang et al. (2004) Lateral Spreading

	A	B	C	D	E
1					
2	H=	50	ft		
3		CPT-1	CPT-3		
4	LDI	148	140	(from Cliq output)	
5	Lateral spreading (in.)				Lat. Spread (ft)
6	L (ft)	CPT-1	CPT-3	avg	
7	100	510.0221	482.4533	496.2377	41.35314078
8	200	292.9308	277.0967	285.0137	23.75114239
9	400	168.2445	159.1502	163.6974	13.6414491
10	600	121.6376	115.0626	118.3501	9.862510977
11					
12		exampl calculation, formual in cell B7:			
13		=6*(A7/50)^-0.8*B4			

G-2-6
Seismic Bearing Capacity Calculations



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill	🟨	120	Mohr-Coulomb	0	32				None	0
Basalt	🟧	120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium	▦	115	Vertical Stress Ratio				0.1	100	None	0

The Spencer method failure surfaces are unrealistic because they extend laterally from the loaded area more than 5x the width of the loaded area, and are therefore disregarded (typical most cases)

Method Name	Min FS
Bishop simplified	1.027
Spencer	0.138
GLE / Morgenstern-Price	0.918

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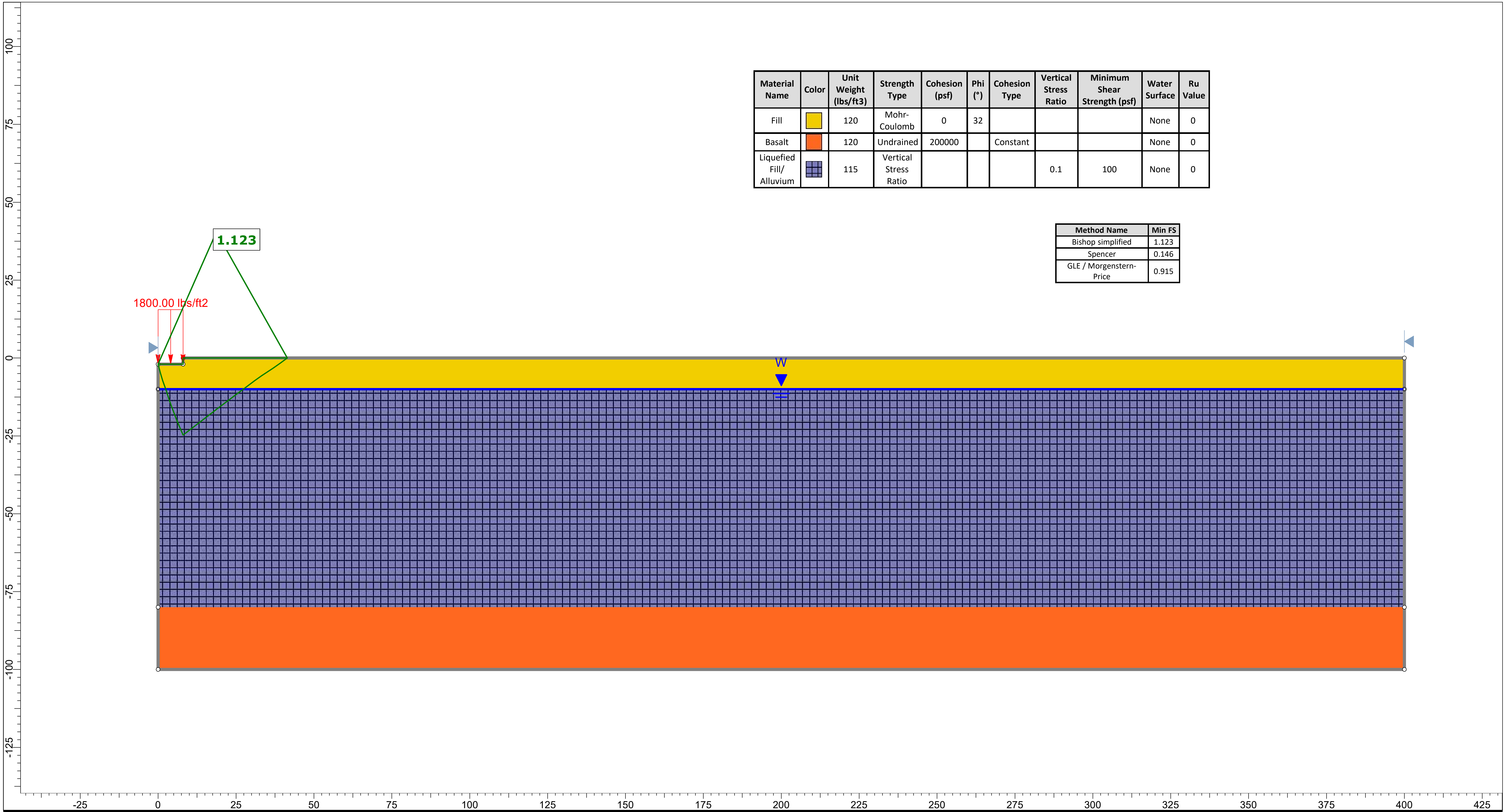
SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	4ft wide	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/25/2024, 10:09:55 AM	*File Name*	OC Linnton Bearing Cap.slmd



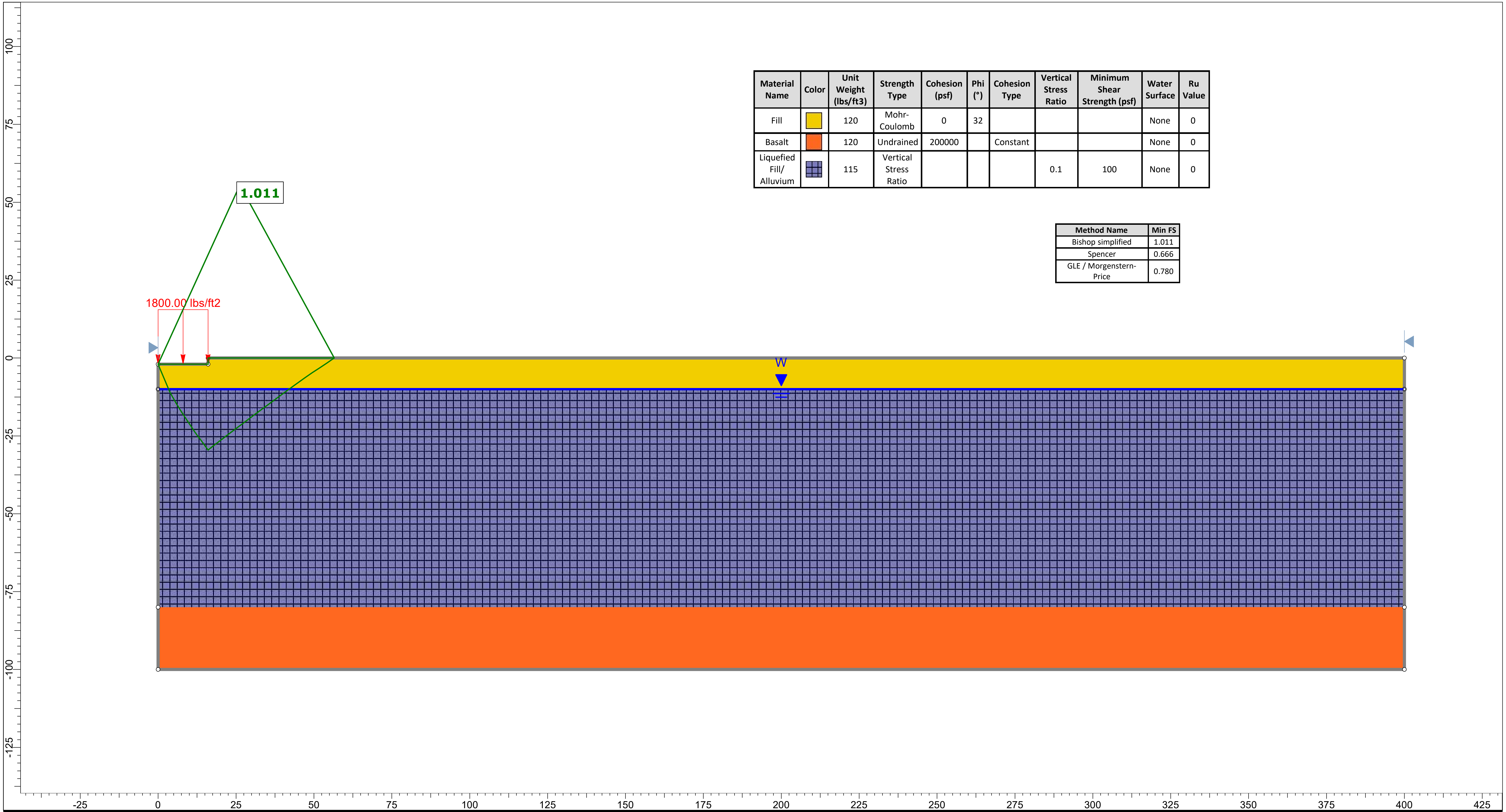
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill	🟨	120	Mohr-Coulomb	0	32				None	0
Basalt	🟧	120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium	▦	115	Vertical Stress Ratio				0.1	100	None	0

Method Name	Min FS
Bishop simplified	1.123
Spencer	0.146
GLE / Morgenstern-Price	0.915

SAGE
GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program
Group	8ft wide
Scenario	Master Scenario
Drawn By	
Checked By	
Date	3/25/2024, 10:09:55 AM
File Name	OC Linnton Bearing Cap.slmd



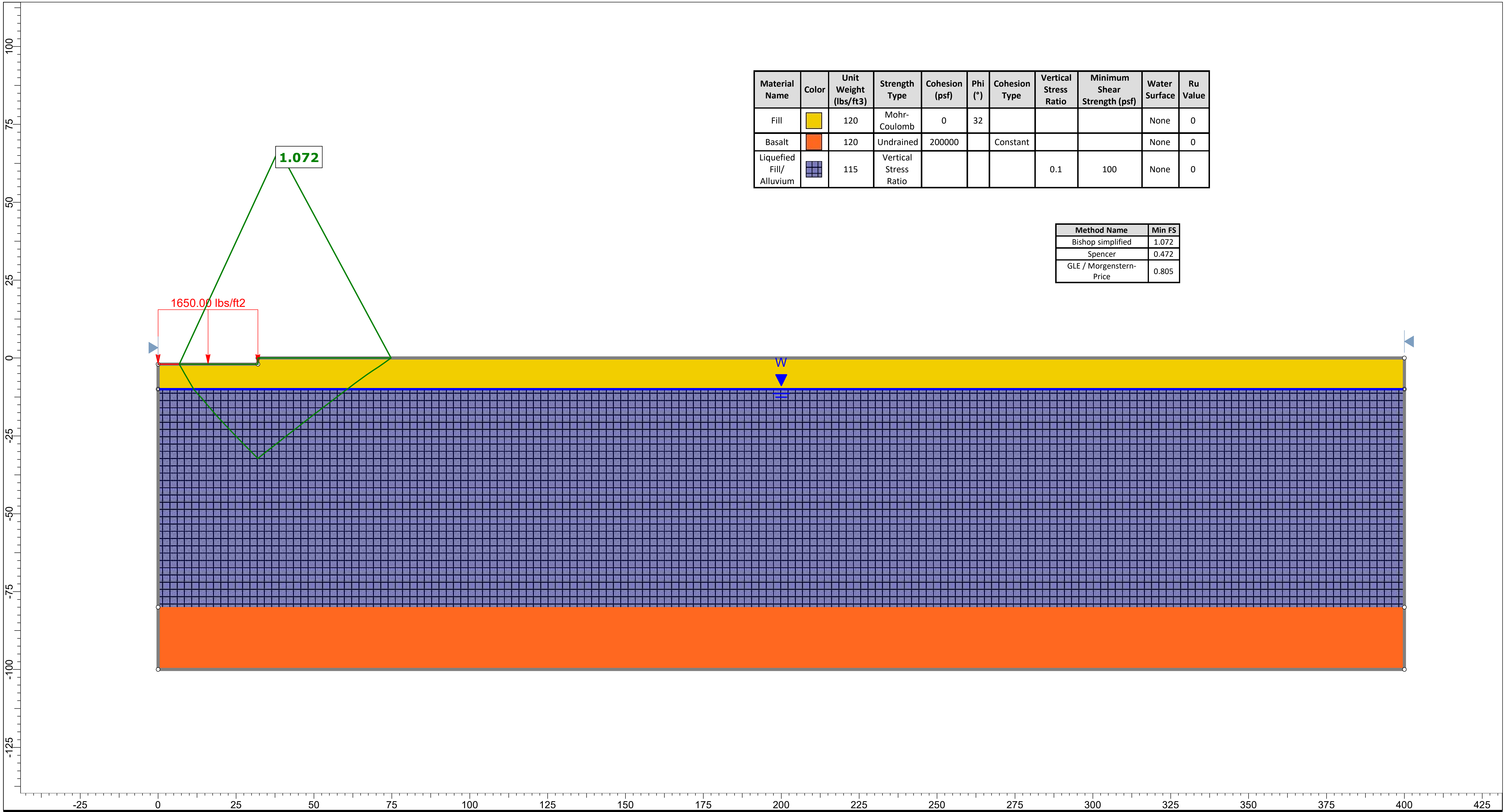
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill	🟨	120	Mohr-Coulomb	0	32				None	0
Basalt	🟧	120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium	▦	115	Vertical Stress Ratio				0.1	100	None	0

Method Name	Min FS
Bishop simplified	1.011
Spencer	0.666
GLE / Morgenstern-Price	0.780

SAGE
GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	16ft wide	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/25/2024, 10:09:55 AM	*File Name*	OC Linnton Bearing Cap.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill	🟨	120	Mohr-Coulomb	0	32				None	0
Basalt	🟧	120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium	▦	115	Vertical Stress Ratio				0.1	100	None	0

Method Name	Min FS
Bishop simplified	1.072
Spencer	0.472
GLE / Morgenstern-Price	0.805

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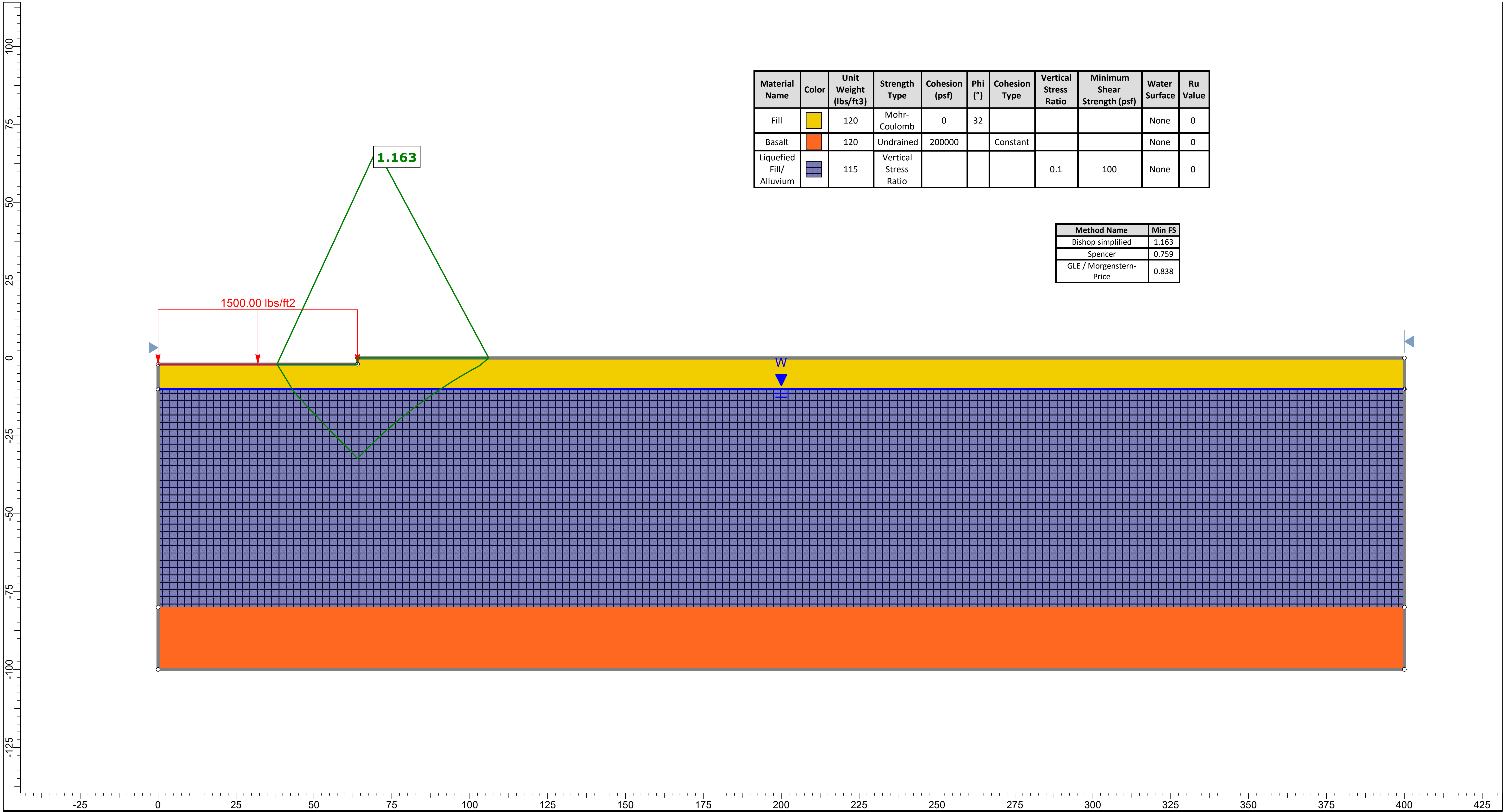
SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	32ft wide	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/25/2024, 10:09:55 AM	*File Name*	OC Linnton Bearing Cap.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Ru Value
Fill	🟨	120	Mohr-Coulomb	0	32				None	0
Basalt	🟧	120	Undrained	200000		Constant			None	0
Liquefied Fill/ Alluvium	▦	115	Vertical Stress Ratio				0.1	100	None	0

Method Name	Min FS
Bishop simplified	1.163
Spencer	0.759
GLE / Morgenstern-Price	0.838

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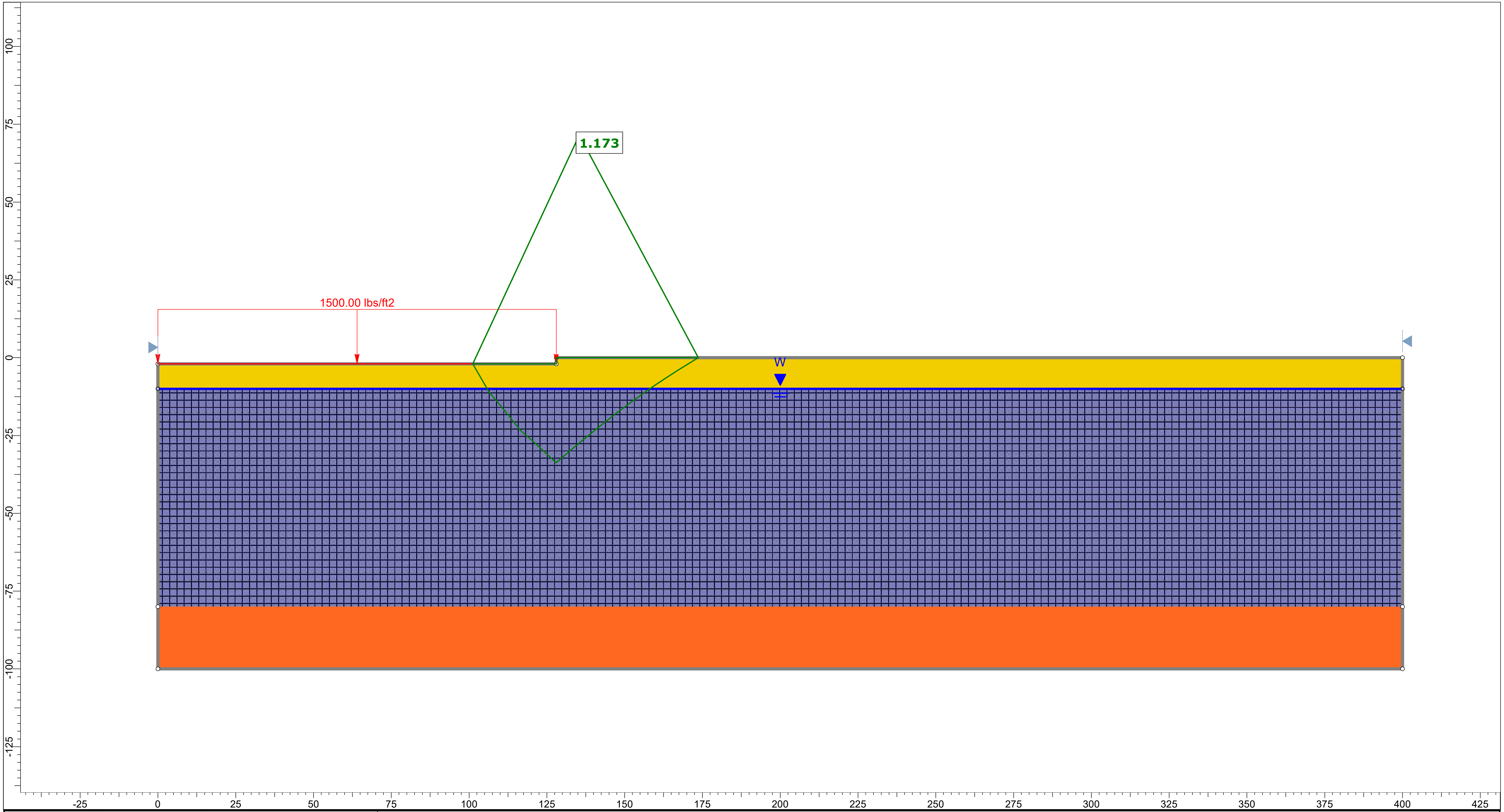
SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	64ft wide	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/25/2024, 10:09:55 AM	*File Name*	OC Linnton Bearing Cap.slmd



SAGE
GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	128ft wide	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/25/2024, 10:09:55 AM	*File Name*	OC Linnton Bearing Cap.slmd

Vicinity Map

Owens Corning Linnton Asphalt Terminal SVA

Portland, Oregon

Figure G-1

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Legend

—	Contours from LIDAR
—	Willamette_River_Bathymetry_(2005)
☐	Taxlot_Parcels
	Bing Maps Satellite Imagery
▨	Flow Failure Zone
┅	Lateral Spreading Contour

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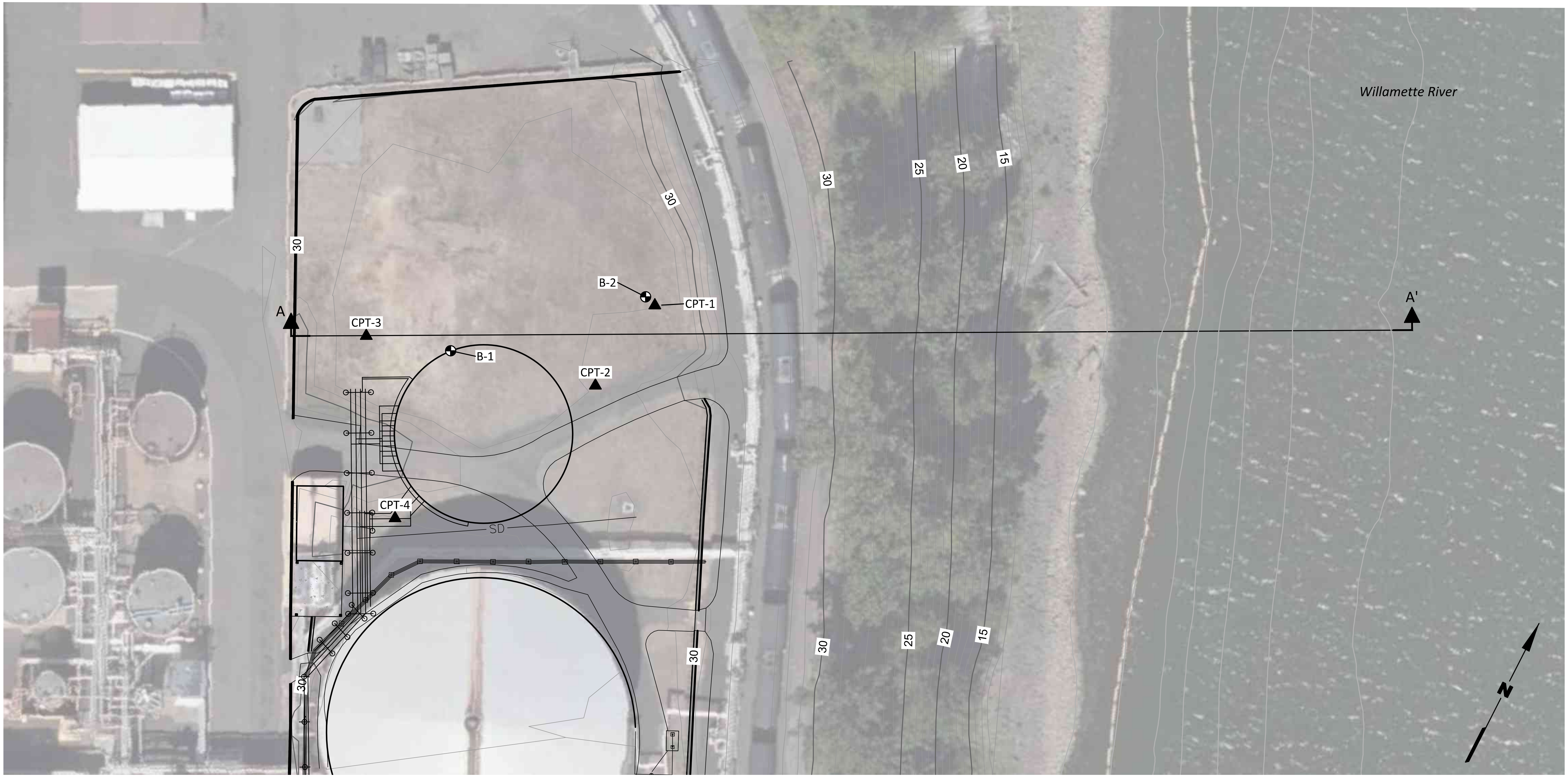
GEOTECHNICAL

Site and Exploration Plan

Owens Corning Linnton Asphalt Terminal SVA

Portland, Oregon

Figure G-2a



Notes
1. Ground surface survey by Norwest Engineering, Inc. dated 7/26/2021. Vertical Datum: City of Portland
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

B-1 ◐	Approximate Boring Location and Designation
CPT-1 ▲	Approximate Cone Penetration Test Location and Designation
—20—	Elevation Contour
A ▲ A' ▲	Cross-Section View Location and Designation

0 40 80
Scale in Feet

Source: Landau Associates (2022)

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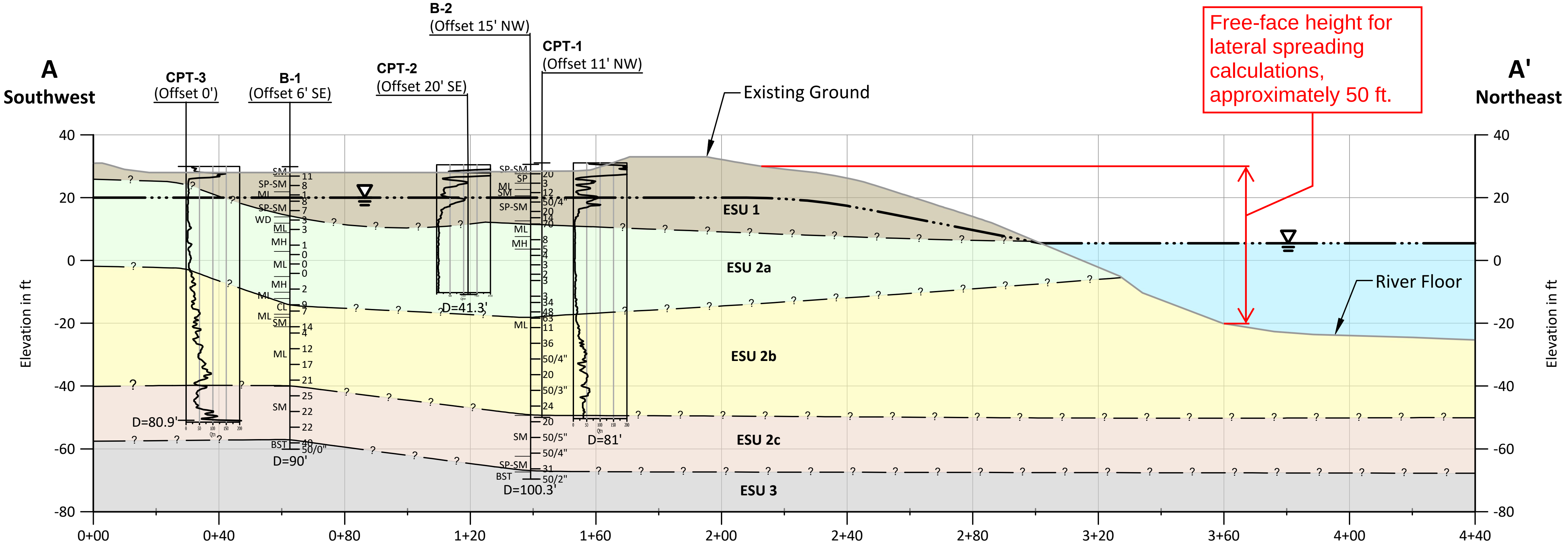
Site and Exploration Plan

Owens Corning Linnton Asphalt Terminal SVA

Portland, Oregon

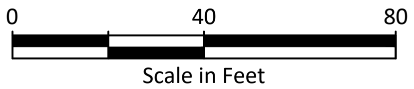
Figure G-2b



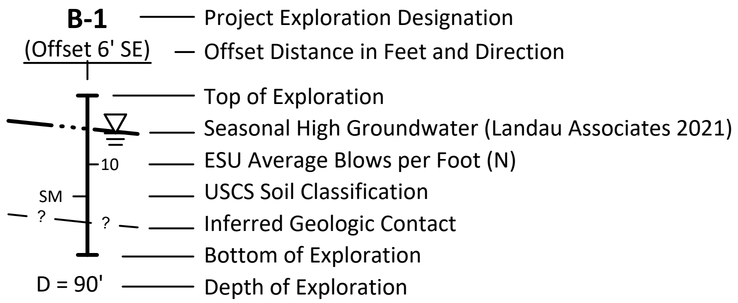
Free-face height for lateral spreading calculations, approximately 50 ft.

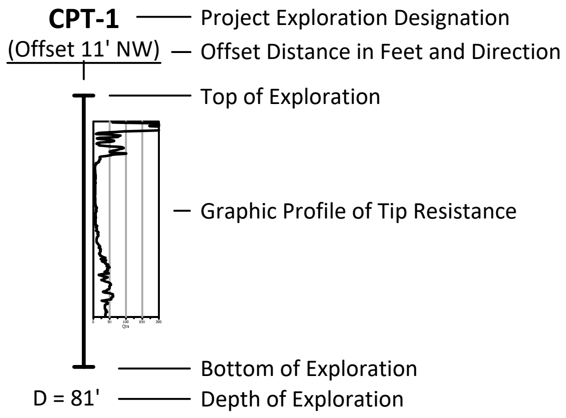
Geologic Profile Alignment A-A'

Horizontal Scale in Feet: 1"=40'
Vertical Scale in Feet: 1"=40'



Legend





Notes:

1. Vertical Datum: City of Portland
2. ESU = Engineering Stratigraphic Unit
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Source: Landau (2022)

Geotechnical Cross Section	
Owens Corning Linnton Asphalt Terminal SVA	
Portland, Oregon	Figure G-3

6.2 Appendix B: Site Plans

Figure B-1 Site Map

Figure B-2 Evacuation Plan

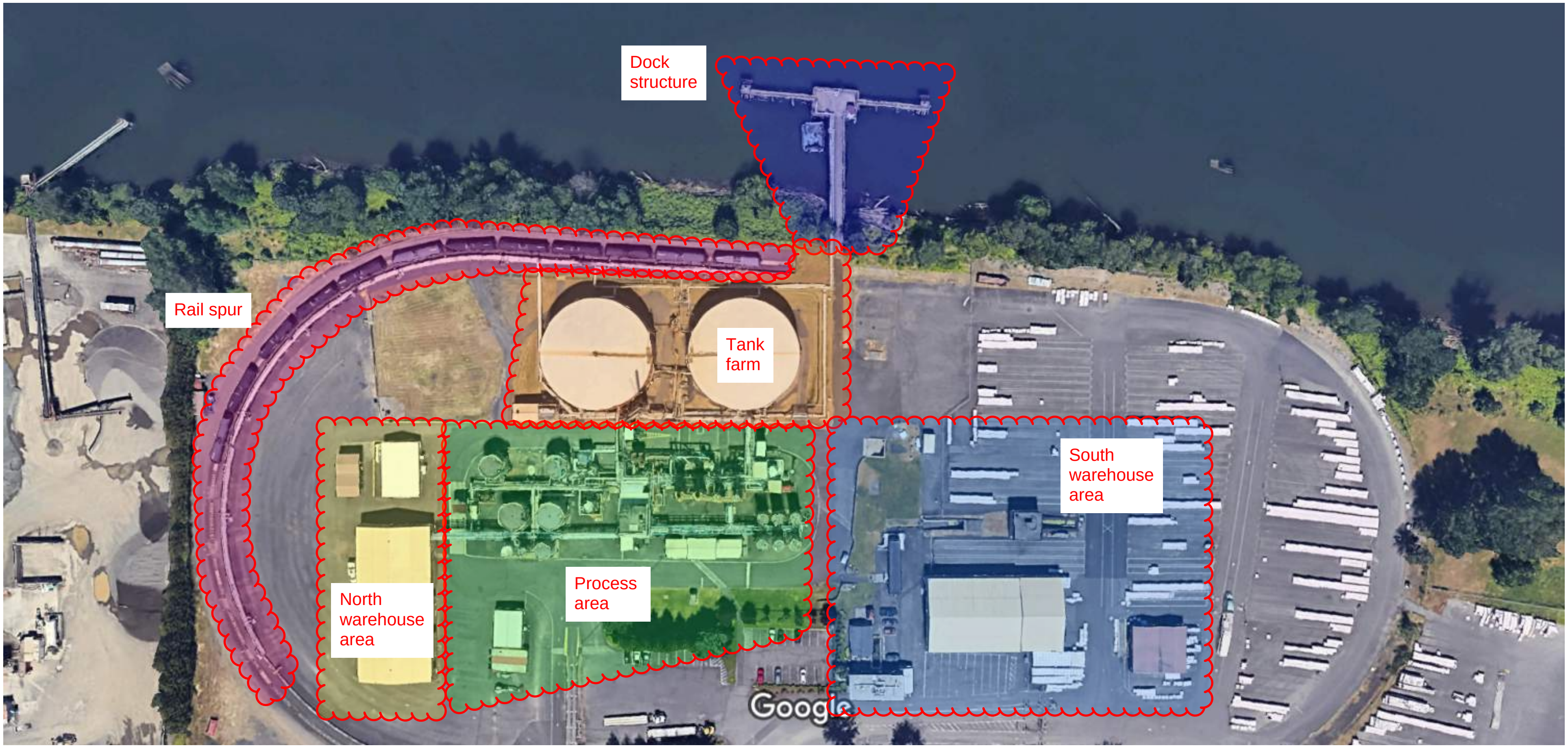


FIGURE B-1: SITE MAP

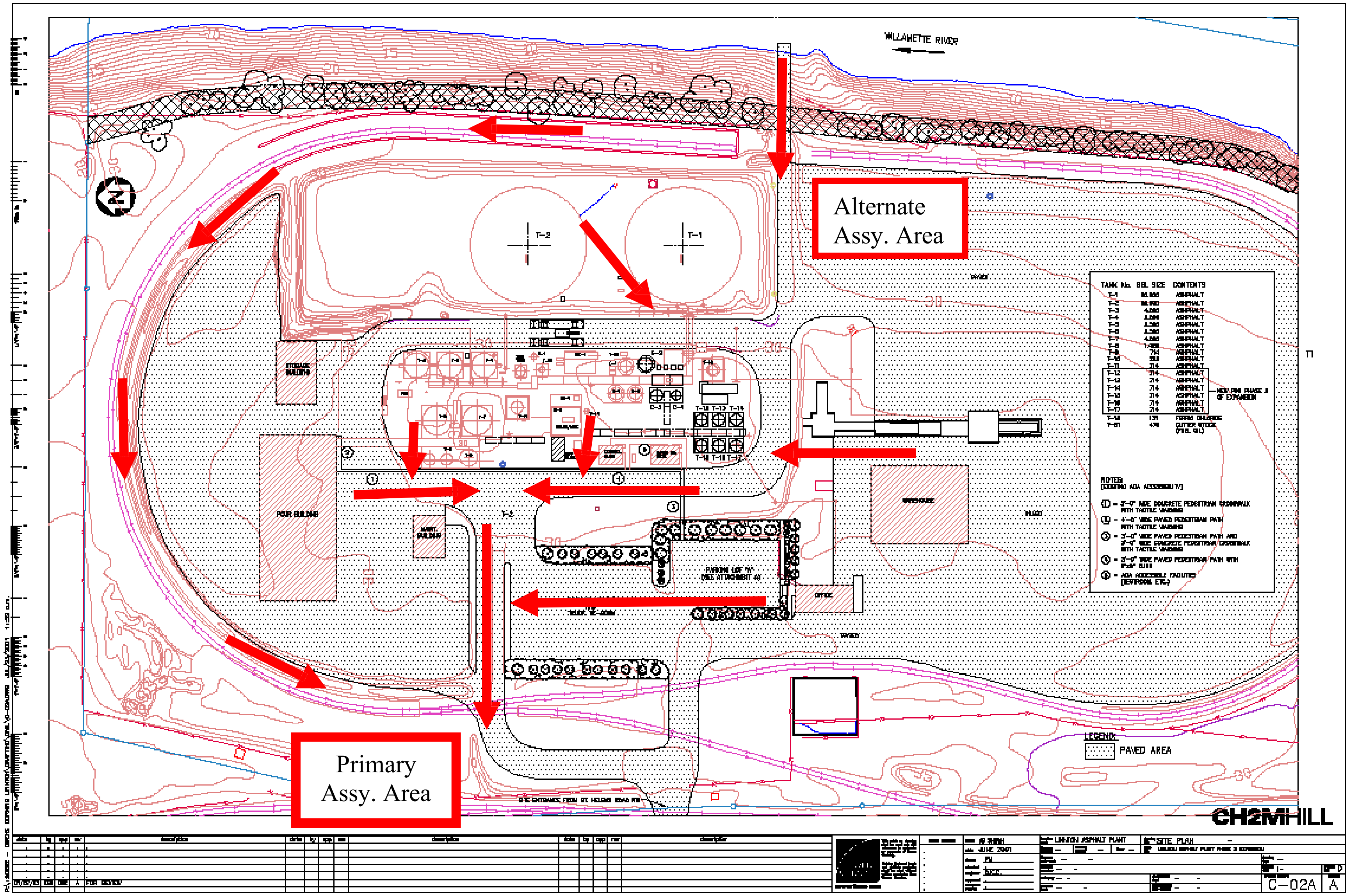


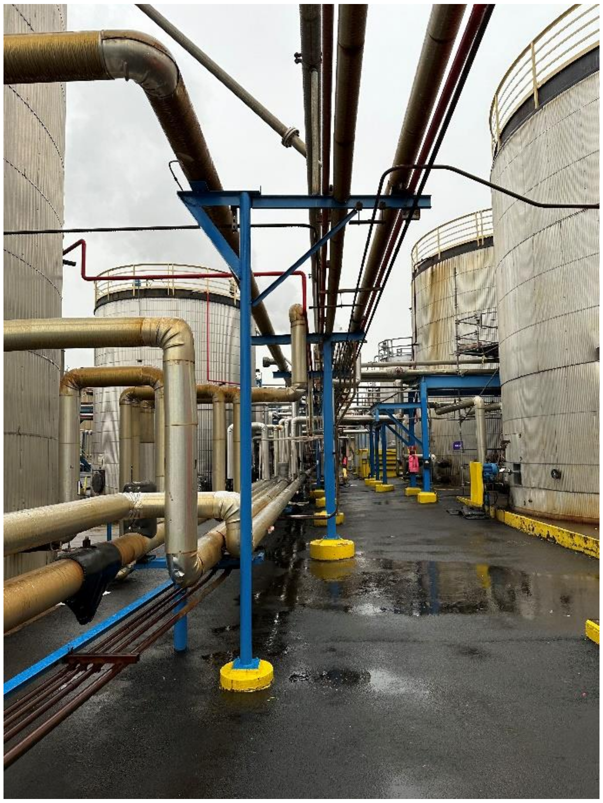
FIGURE B-2: EVACUATION PLAN

<u>6.3 Appendix C:</u> Photographs

Picture 1. Typical view of Process area.

Picture 2. View of tanks at Process Area.

Picture 3. Typical view of truck loading rack.



Picture 4. Typical view of slender pipe support at Process Area.

Picture 5. View of unanchored pressure vessel at Process Area.

Picture 6. View of anchorage provided at smaller tank.

Picture 7. Typical view of light-framed storage building.

Picture 8. Anchorage not observed at pipe base of Process Area pipe rack.

Picture 9. View of large tank at tank farm area.

Picture 10. View of hot oil heater building and platform.

Picture 11. Typical view of Rail Spur.

Picture 12. View of dock structure.

Picture 13. View of piping at dock structure.