Seismic Vulnerability Assessment

Kinder Morgan

Willbridge Terminal

5880 NW St. Helens Road

Portland, OR 97210

1568_REP101_SVA WILLBRIDGE

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TABLE OF CONTENTS

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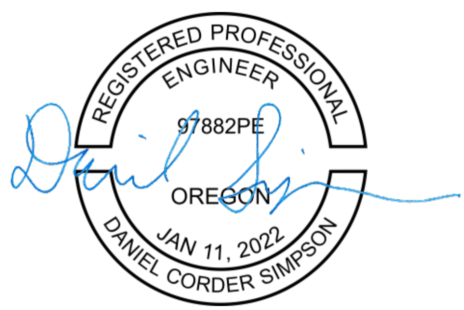

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ERRATA SHEET FOR NORWEST ENGINEERING SEISMIC VULNERABILITY ASSESSMENT

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SEISMIC VULNERABILITY ASSESSMENT

SECTION 1: Facility Overview and Report Purpose

1.1 Facility Overview

The Willbridge Terminal receives and distributes products including gasoline, turbine (jet) fuel, diesel, biodiesel and ethanol. Products are received via the Olympic pipeline, tankers and barges, railcars, and trucks. Products are distributed via tankers and barges, trucks, the SFPP pipeline to Eugene and the Conchin Portland Airport pipeline.

The terminal includes the capability to perform midgrade blending, ethanol rack blending, detergent additive blending, diesel red dye injection services, biodiesel blending (B5,B10,B15 and B20 grades), and diesel lubricity addition.

The terminal occupies 44 acres along the Willamette River. This terminal has Marine loading and unloading facilities include one vessel berth and one river barge berth.

The Willbridge Terminal Tank Farm has 40 tanks ranging from 3,000 to 120,000 barrels with a combined total storage capacity of 1,551,000 barrels. In addition, the facility has 53,500 square feet of warehouse space.

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.

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.

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.

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 Pipeline Regulations & Marine Facilities

Where in conflict with Oregon law Chapter 99, the federal Pipeline Safety Improvement Act of 2002, 49 U.S.C. 60101 et seq. prevails.

Interstate petroleum and natural gas pipelines are not subject to Oregon regulations as they are subject to regulation by the United States Federal Energy Regulatory Commission (FERC).

Intrastate pipelines are regulated by the U.S. Department of Transportation (US DOT). The US DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) may delegate some authority to state agencies, usually the Public Utilities Commission (PUC).

The United States Army Corps of Engineers (USACE) and the United States Coast Guard (USCG) are responsible for in-water and shoreline infrastructure, operations, and safety. This includes spill prevention and control. It is not known at this time what the impact of new State regulations will be on the current jurisdictional practice.

2.5 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.

Much of the site 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 and visual-only walkdown. The walkdown is the critical first step in evaluation methodology. In the walkdown, a team of licensed professional engineers systematically reviewed the facility with focus on the terminal systems including tanks, piping support, loading racks, containment structures, building structures, and other equipment identified as in-service and potentially impactful to the transportation of bulk oil or liquid fuels.

4.1.3 Safety/Mechanical/Fire

The safety assessment was limited to review of available documentation, drawings, reports, and procedures provided by Kinder Morgan. 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 to be Evaluated

See Appendix B for the terminal site plan, referencing the areas below.

4.2.1 Area 1 (North Yard)

Area 1 includes multiple above-ground storage tanks of various sizes, the fuel loading rack, and the office/lab building. The tanks are served by pipes and pumping systems, and other appurtenances and equipment. The pipes are supported by steel structures. Tank secondary containment is provided by free-standing concrete walls.

4.2.2 Area 2 (South Yard)

Area 2 is very similar to Area 1 above, with multiple above-ground storage tanks of various sizes. There are many small tanks in this area and the adjacent Area 5, which are all out of service. The tanks are served by pipes and pumping systems, and other appurtenances and equipment. The pipes are supported by steel structures. Tank secondary containment is provided by free-standing concrete walls.

4.2.3 Area 3 (Kinder Morgan Dock)

The dock is a primarily timber structure. The dock is in a manmade harbor along the west riverbank, aligned perpendicular to the bank along with two other neighboring piers operated by competing fuel terminals. The dock consists of a pier, eight dolphins, and an adjacent boathouse and boom storage vessel. There are two berths, one on each side. The upstream berth serves vessels up to ocean-going and coastal vessels, while the downstream berth serves only river barges. The pier supports product piping on the deck, multiple jib cranes, and an operations shack.

4.2.4 Area 4 (Rail and Additives Truck Transfer Area)

The rail area consists of two active rail spurs where railcars can be unloaded and product transferred to the tanks, and a third rail spur for parking railcars. A small truck transfer structure is located on the west end of Area 4, where fuel additives are transferred to onsite storage.

4.2.5 Area 5 (Warehouse and Storage Area)

This area is comprised of several small buildings and one warehouse, small ancillary equipment, and multiple tall slender tanks that are out of service.

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 Description of surface conditions, topography, shoreline topography.

Regional topography is depicted on Figure G-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) and bathymetric surveys of the Willamette River (City of Portland, accessed February 19, 2024) 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 southwest and by the Willamette River to the northeast. 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 *Geologic Map of the Portland Quadrangle, Multnomah and Washington Counties, Oregon, and Clark County, Washington* (Beeson et al. 1991). Near-surface deposits at the site are mapped as alluvium, a mixture of silt, sand, and organic-rich clay deposited by the Willamette River during the Holocene Epoch. The alluvium is likely normally consolidated to slightly overconsolidated. It is underlain by the Troutdale formation and undifferentiated Columbia River Basalts. Artificial fill is mapped adjacent to the site and consists of a man-made mixture of clay, silt, sand, gravel, debris, and rubble.

5.1.1.1.3 Description of field explorations and laboratory testing.

On March 5, 2024, Sage oversaw the completion of four cone penetration test (CPT) soundings (CPT-1 through CPT-4). Sage reviewed the resultant data as well as historical CPT, boring, and laboratory data collected by others (GeoEngineers 2011). The approximate locations of the recent and historical explorations are shown on Figure G-2.

The March 2024 CPT soundings were performed in general accordance with ASTM International standard test method D5778, *Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils.* Data from the recent CPT soundings are included in Appendix G-1; historical data collected by others are included in Appendix G-2.

Soundings CPT-1 through CPT-4 were advanced through 10-ft-deep, vacuum-excavated boreholes in accordance with Kinder Morgan's safety requirements. The vacuum excavations were backfilled with bentonite chips; the chips were placed around a 2-inch polyvinyl chloride (PVC) pipe to sleeve the CPT probe. This approach proved successful for soundings CPT-1, CPT-3, and CPT-4, which were advanced to refusal on suspected basalt. Sounding CPT-2 did not have enough lateral support and was refused at approximately 19 ft bgs due to CPT probe inclination.

Laboratory tests performed as part of Geoengineers' study included soil grain size analyses, Atterberg limits tests, moisture content and unit weight determinations, and one-dimensional consolidation tests. Laboratory test methods and results are reported in Appendix G-2.

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 into the following engineering stratigraphic units (ESUs):

ESU 1: Fill. ESU 1 consists of fill used to raise site grades. Coarse-grained fill (SP, SP-SM, and SM) was observed in Sage's 2024 vacuum excavations and GeoEngineers' soil borings.

ESU 2: Alluvium. ESU 2 consists of alluvium, a very soft to stiff or very loose to medium dense mixture of sand, silt, clay, and organic matter of varying proportions.

ESU 3: Basalt. ESU 3 consists of basalt.

Pore water pressure dissipation tests were completed during Sage's March 2024 field investigation. The measured equilibrium pore pressure indicated that groundwater was present at approximately 8 to 17 ft below ground surface (bgs). During its April 2009 site investigation, GeoEngineers encountered groundwater between 2 and 5 ft bgs. The seismic design groundwater elevation shown on Figure G-3 slopes from approximately 7 ft bgs at the western edge of the site to approximately 17 ft bgs at the eastern edge of the site, roughly coinciding with the typical high-water elevations of the Willamette River.

Figure G-3 shows a conceptual geotechnical cross section of the site as well as the engineering soil parameters selected for seismic geotechnical analyses.

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

Analyses for the geotechnical portion of the seismic vulnerability assessment (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-3):

- Site class determination (G-3-1).
- Building code seismic design parameters for the site (G-3-2).
- The U.S. Geological Survey (USGS) seismic hazard disaggregation for the site (G-3-3).
- Liquefaction and residual strength calculations (G-3-4).
- Yield acceleration calculations (G-3-5).
- Newmark sliding block results (G-3-6).
- Seismic bearing capacity calculations (G-3-7).

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(Petersen et al. 2014). Based on this review, more than 50 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 11 percent of the seismic hazard at the site. The remaining seismic hazard stems from other finite fault sources, random crustal events, or 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)	7.84
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 sounding CPT-3 and the estimated shear wave velocities for rock layers between CPT refusal and 100 ft bgs. The Vs for the basalt layer between the bottom of ESU 2 and 100 ft bgs was determined by reviewing similar materials in Sowers and Boyd (2019).

- Based on the Vs, 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 components per OAR 340-300-003 (1) (f) do not exceed the performance objective per OAR 340-300-0002 (18) 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 site coefficient F_V.

Table G-2. **Seismic Response Spectrum Parameters**

S_s	F_a	S_1	F_v
0.894	1.142	0.407	1.893

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

CPT data were used to complete liquefaction calculations, as CPT results are more easily reproduced (less uncertain) than standard penetration test results (i.e., the other type of data available for this study). Data collected from historical soil borings were used to confirm Sage's interpretation of the CPT data.

- **Liquefaction susceptibility** (i.e., whether the soil will behave like sand or clay during dynamic loading) was determined in accordance with Robertson and Wride (1998). A soil behavior index of Ic = 3.0 was used as the cutoff for non-liquefiable soil (i.e., Ic > 3.0 is not susceptible to liquefaction). Additionally, soils must be saturated to be susceptible to liquefaction. A groundwater depth of 10 ft bgs was selected for liquefaction calculations. This depth is intended to account for variations in seasonal groundwater levels.

- **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). Liquefaction triggering computations were performed using CLiq software, version 3.5.2.22 (Geologismiki 2024).
- **Liquefaction/seismic strength loss:** liquefied soil residual shear strength was computed using the procedure established by Idriss and Boulanger (2008), with void redistribution assumed to be significant. Calculations are provided in Appendix G-3. The CPT data indicate that approximately 65 to 75 percent of the measured soil layers are susceptible to strength loss. The CPT data suggest that zones of liquefied soil are discontinuous vertically and laterally (heterogeneous soil mixture) and interrupted by soils not susceptible to liquefaction. Geotechnical analyses captured the effect of this by averaging residual strengths as described below.
    - For lateral spreading analysis and analysis of shallow foundations 32 ft wide and wider, where potential failure surfaces would engage large quantities of soil, likely passing through both liquefied and non-liquefied soil: Residual strengths were averaged with non-liquefied soils (with a cap of $S_{u,r}/\sigma'_v$ = 0.6 for non-liquefied soils) to characterize the subsurface condition. This resulted in an average $S_{u,r}/\sigma'_v$ = 0.24. This ratio was applied to all soil in ESUs 1 and 2 below the design groundwater elevation.
    - For analysis of foundations less than 32 ft wide, where soil failure surfaces could be largely confined to a localized, liquefied, sand-like soil layer: The ratio $S_{u,r}/\sigma'_v$ = 0.1 was used for calculations, approximately corresponding to the lower end of calculated residual shear strengths for all layers. This ratio is applied to all soil in ESUs 1 and 2 below the design groundwater elevation.
    - A minimum shear strength of 100 psf was applied to all soil layers modeled with the vertical stress ratio described above.
- **Lateral spreading potential** was determined using Newmark sliding block analyses. First, the limit equilibrium method, implemented with Rocscience Slide2, was used to estimate the distribution of seismic yield acceleration at the site. Figure G-3 shows how the spatial distribution of seismic yield acceleration was calculated. Then, USGS' **S**eismic **LA**ndslide **M**ovement **M**odeled using **E**arthquake **R**ecords (SLAMMER) program was used to complete sliding block analyses. The results of the sliding block and seismic yield acceleration analyses were combined to estimate the magnitude and distribution of lateral spreading at the site, as represented by the lateral spreading contours and zone of potential flow failure shown on Figure G-2.

- **Ground motion selection for Newmark analyses** was based on the following screening criteria:
    - First, the Next-Generation Attenuation for Subduction Zone Regions project (NGA-SUB) and the Next Generation Attenuation-West 2 (NGA-West2) ground motion databases were used to generate a pool of ground motions representative of a subduction zone or shallow crustal event.
    - Next, the pool was reduced to only ground motions from recording sites with a shear wave velocity of the top 30 meters between 180 meters per second (m/s) and 360m/s (i.e., site class D conditions).
    - The pool was further reduced to only those ground motions that could be scaled to the design PGA by a factor of 0.25 to 4, or in the case of shallow crustal motions, by records with a PGA between 0.46g and 0.52g.
    - According to Jibson (1993), the Arias intensity (Ia) correlates well with the distribution of earthquake-induced landslides, especially compared with other intensity measures (namely, PGA). Therefore, Sage used Ia as a screening parameter to select representative ground motions for the Newmark analysis.
    - Ia ground motion prediction equations were used to predict Ia at the site resulting from a mean design-level earthquake originating from a suduction zone interface/intraslab event (Macedo et al. 2019) and for a shallow crustal event (Bahrampouri et al. 2021). The computed Ia were approximately 5 to 7 m/s for a subduction event and 0.8 m/s for a shallow crustal event.
    - The estimated Ia were used to select the ground motions listed in Table G-3. The selected ground motions were imported to SLAM MER for the Newmark calculation.

Table G-3. Ground Motions Selected for Newmark Calculation

Event	Station/Record	Scale Factor	Scaled PGA (g)	Arias Intensity, after scale factor applied (m/s)	Event Type
Imperial Valley 1979	E04 140	1	0.49	1.34	Crustal
Imperial Valley 1979	E05 140	1	0.52	1.66	Crustal
Imperial Valley 1979	E07 230	1	0.46	1.70	Crustal
N. Palm Springs 1986	WWT 180	1	0.49	1.77	Crustal
Northridge 1994	LOS 270	1	0.48	1.98	Crustal
Northridge 1994	STN 020	1	0.47	1.12	Crustal
Parkfield 1966	C02 065	1	0.48	1.78	Crustal
Westmoreland 1981	WSM 180	1	0.50	1.91	Crustal
Tohoku 2011	IBRH20 S2	2.18	0.49	6.41	Subduction
Tohoku 2011	CHB004 EW	1.57	0.49	6.03	Subduction
Tohoku 2011	CHB004 NS	1.70	0.49	6.74	Subduction
Tohoku 2011	CHBH13 NS2	3.10	0.49	5.54	Subduction
Tohoku 2011	IBR018 NS	1.37	0.49	6.53	Subduction
Tokachi-Oki 2003	NMRH05 EW2	1.47	0.49	6.75	Subduction
Tokachi-Oki 2003	HKD068 EW	1.58	0.49	7.00	Subduction
Ibaraki 2011 (Tohoku 2011 aftershock)	CHB004 NS	3.26	0.49	8.04	Subduction
Tokachi-Oki 2003	51563 NS	0.94	0.49	5.07	Subduction
Kaikōura 2016	SEDS N00E	0.67	0.49	3.50	Subduction

g = force of gravity
m/s = meters per second
PGA = peak ground acceleration

5.1.1.2.3 Seismic settlement

Seismic settlement is the result of liquefied soil reconsolidation or ejection to the ground surface (liquefaction-induced settlement), dry sand consolidation, or reductions in seismic bearing capacity. Liquefaction-induced settlement was calculated in accordance with Boulanger and Idriss (2008); calculations are provided in Appendix G-3. Settlement caused by dry sand consolidation was not included in the calculations, because there is very little, if any, dry sand at the site.

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

No seismic hazards, other than those discussed herein, are anticipated to be significantly present at the site. According to the USGS National Seismic Hazard Model Fault database, no active faults are present at the site.

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 crustal layer 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 non-liquefied clay-like soils (ESU 2 alluvium) over a competent basalt layer (ESU 3).
- Following the onset of liquefaction, flow failure may occur within approximately 200 ft of the shoreline toe at the Willamette River. The seismic hazard transitions to lateral spreading with distance from the shoreline, and lateral displacement will likely decrease with distance from the shoreline.
- Approximately 65 to75 percent of saturated site soils are susceptible to liquefaction. Based on a review of subsurface information, these soils appear to be laterally and vertically discontinuous/heterogeneous. Sage has incorporated this heterogeneity as described in section 5.1.1.2.2.
- 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).
- Sage made the following simplifying assumptions when completing its seismic hazard/geotechnical evaluation that lead to conservatism in estimating seismic demand:
    - The lateral spreading analysis is based on the assumption that soils will be fully liquefied at the onset of ground shaking.
    - Newmark analyses are based on the assumption of a sliding rigid block, neglecting the seismic damping caused by the impedance contrast between the material above and below the potential failure surface.
    - The lateral spreading failure surfaces are between 300 and 1,200 ft long. Sage's evaluation did not account for the spatial incoherence of seismic waves acting on the sliding mass.

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 20 inches of liquefaction-induced total settlement could occur following a seismic event; as much as 20 inches of liquefaction-induced differential settlement could 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 200 ft of the toe of the Willamette riverbank. The flow failure zone shown on Figure G-2 was delineated by selecting areas with a yield acceleration of less than 0.02g. (Yield accelerations were determined as part of the Newmark analysis described above.) Flow failure is estimated to result in ground deformations of more than 10 ft.

The severity of lateral spreading will likely decrease with distance from the riverbank. The lateral spreading displacement contours shown on Figure G-2 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

In addition to the settlement described in Section 5.1.1.3.2, liquefaction may affect the bearing capacity of shallow foundations wider than 4 ft. Table G-3 summarizes seismic bearing capacity with liquefaction. The values in Table G-4 include a safety factor of 1.5. When calculating the allowable bearing capacities, Sage assumed that the foundation would be embedded approximately 2 to 4 ft below surrounding site grades.

Table G-4. **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	2.0 ksf	1.7 ksf	1.3 ksf	2 ksf	1.8 ksf	1.6 ksf

ft = feet
ksf = kips per square foot

Where seismic bearing pressures are less than those listed in Table G-4, foundations will likely experience a degree of settlement equal to or less than the settlement noted in Section 5.1.1.3.2. Where seismic bearing pressures are greater than those listed in Table G-4, foundations will likely experience bearing capacity loss and settlement beyond that noted in Section 5.1.1.3.2.

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.

Bahrampouri, M., A. Rodriguez-Marek, and R.A. Green. 2021. Ground Motion Prediction Equations for Arias Intensity Using the Kiki-net Database. *Earthquake Spectra.* 371(1):248–448.

Beeson, T., L. Tolan, and I.P. Madin. 1991. *Geologic Map of the Portland Quadrangle, Multnomah and Washington Counties, Oregon, and Clark County, Washington.* State of Oregon Department of Geology and Mineral Industries.

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/.

GeoEngineers. 2011. Geotechnical Engineering Services: Willbridge Terminal Tank Replacement, Portland, Oregon. File No. 9552-014-02. July 25.

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

Idriss, I. M., and R.W. Boulanger. 2008. Soil Liquefaction during Earthquakes. Earthquake Engineering Research Institute Monograph. Geotechnical Report No. UCB/GT – 2010/01. April.

Jibson, R.W. 1993. "Predicting Earthquake-Induced Landslide Displacements Using Newmark's Sliding Block Analysis." In: Transportation Research Record 1411. Soil, Geology, and Foundations. Earthquake-Induced Ground Failure Hazards.

Macedo, J., N. Abrahamson, and J.D. Bray. 2019. “Aria Intensity Models for Subduction Zone Earthquake.” In: *Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions.*

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.

Petersen, M.D., M.P. Moschetti, P.M. Powers, et al. 2014. Documentation for the 2014 Update of the United States National Seismic Hazard Maps. USGS Numbered Series 2014-1091.

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

Rollins, K.M., T.M. Gerber, J.D. Lane, and S.A. Ashford. 2005. “Lateral Resistance of a Full-Scale Pile Group in Liquefied Sand.” *Journal of Geotechnical and Environmental Engineering.* 131(1):115–125.

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.

5.1.2 Structural Assessment

As Identified in Section 5.1.1, this site is subject to liquefaction and liquefaction induced lateral spreading. The nature of this hazard, the analytical methods used to estimate it, and the conventional design historically used in the facility present us with a situation that is hopelessly complicated and beyond the analytical tools at our disposal. The seismic performance expectation under lateral spreading is low. But tanks and piping are flexible structures and seismic performance under liquefaction settlement and seismic settlement are much better, well-conceived and maintained tanks and piping have performed well in past earthquakes. The seismic performance expectations outlined below have been formed based on the perceived structural response to the ground shaking hazard on Site Class D soils. [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.]

5.1.2.1 *Seismic Performance Expectations*

5.1.2.1.1 Area 01 (North Yard)

5.1.2.1.1a Tank Farm

Sixteen operational storage tanks are provided at the North Yard of the facility with various construction dates. The storage tanks are typically 100 to 120-feet in diameter and 40-feet in height. The operational tanks appear to be well engineered (per API 650), conceived and maintained. The foundations of the tanks vary with more modern installation utilizing ground improvements or piles and some older tanks on mat gravel foundations. The tanks are also self- anchored. Self-Anchored Tanks are very common and perform well during seismic events. At many of the tanks, placards were provided which give a repair or alteration date in accordance with API 653. API 653, Tank Inspection, Repair, Alteration, and Reconstruction is a standard developed and published by the American Petroleum Institute (API) and covers the inspection, repair, alteration, and reconstruction of steel aboveground storage tanks used in the petroleum and chemical industries. All active tanks are required to undergo an API 653 inspection based on certain parameters. This inspection ensures the tank floors and shells have not deteriorated as well as ensuring the tank has not experienced differential settlement. Given the nature of the inspection requirements we can be sure the tanks are plumb and have not been corroded. All the tanks are regulated by the Department of Transportation and Kinder Morgan is in compliance with all inspection requirements. 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.

5.1.2.1.1b Pipe Bridges and Supports

Several active piping runs are supported on steel pipe supports at the North Yard of the facility. Piping at the north yard is typically located 3-feet above grade or less with anchorage and a foundation provided. The majority of pipe supports are well conceived, and of low seismic risk given the height of the supports. A few exceptions are highlighted below:

At one piping run adjacent to tank WB-117, a slender pipe support was observed at approximately 15-feet in height. The lateral resisting system appears to be a cantilevered column. Based on the height and slenderness, we believe this support type is at risk in a design level seismic event.

At one location adjacent to the Kinder Morgan office and lab, a pipe run containing numerous primary supply lines and conduit is supported by C-channel steel framing. Small C-channel sections comprise the columns of the pipe rack system. Based on the weight supported and lateral resisting system, we believe this support type is at risk in a design level seismic event.

At one location at a pipe outlet for tank WB-123, the pipe was observed placed directly on stacked wood and concrete blocks. We believe this support is at risk in a design level seismic event.

A pipe bridge is provided adjacent to the truck loading rack, supporting multiple pipes running between the tank farm and truck loading rack. The pipe bridge appears to consist of moment frames in the transverse direction. No struts are provided between bent sections, indicating the columns of the pipe bridge are cantilevered column lateral resisting system in the longitudinal direction. Based on the height and tributary weight of the columns, we believe this support type is at risk in a design level seismic event.

5.1.2.1.1c Truck Loading Rack

A truck loading rack is provided at the south end of the North Yard. The loading rack is constructed of structural steel frames and C-channel roof purlins. The structure supports a canopy roof, multiple supply lines, and various mechanical and electrical equipment. The lateral resisting system of the truck loading rack appears to be knee braced frames parallel with the frames, and X-braced frames parallel with the purlins. The knee brace shapes visually appeared to be slender in comparison to the column and beam sizes. In addition, several knee braces were observed to have been removed over time. Based on the weight supported and apparent lateral resisting system, we believe the truck loading rack is at risk in a design level seismic event.

5.1.2.1.1d Containment Structure and Storm Flume

Containment walls are provided at the perimeter of the North Yard and consist of cast-in-place concrete. The walls generally appear to be in fair condition, with several previous spall repairs observed. Vertical construction joints are provided between pour sections, and a previous repair was observed consisting of a pre-formed flashing material installed over the construction joints. No information has been provided regarding the foundation of the containment walls. Based on our observations, the containment walls appear to be of adequate height and construction to resist static surcharge loading in the event of a tank spill. However, based on the age of construction we believe it is unlikely the containment wall was designed for lateral movement in a seismic scenario. Further analysis or retrofitting may be warranted to ensure their efficacy under seismic stress, thereby fortifying the overall resilience of the tank farm infrastructure.

The Saltzman Creek storm flume is provided at the North Yard, between the North Yard and the Rail Transfer Area. The storm flume consists of cast-in-place concrete retaining walls which support surcharge loading due to equipment and truck traffic. The walls appeared to be in generally good condition and an apparent reinforcement was observed along the majority of the length of the storm flume. Based on the observed construction we believe the storm flume is of low seismic risk.

5.1.2.1.1e Ancillary Equipment

Various ancillary tanks and equipment are provided in the North Yard, including smaller tanks, pumps, and electrical panel equipment. Much of the ancillary equipment at the North Yard was labeled out-of-service. 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.

Several horizontally oriented cylindrical additive tanks, including tanks labeled 190, 192, 193, 194, and 195 were placed on a skid which was not observed to be anchored. Additionally, tank 195 skid appeared to be placed directly on grade with no foundation observed. We believe these tanks may be subject to sliding or overturning in a design level seismic event.

At the north end of the North Yard, a gas foam building is provided to house a horizontally oriented cylindrical foam tank for fire suppression. The tank saddle was placed directly on concrete pedestals with no anchorage observed. We believe this tank may be subject to sliding or overturning in a design level seismic event.

A vertically oriented cylindrical tank and pump skid are provided inside the carbon treatment building at the west end of the North Yard. Both items were placed directly on the concrete slab with no anchorage observed. We believe these items may be subject to sliding or overturning in a design level seismic event.

Two vertically oriented cylindrical vapor recovery unit tanks are provided at the west end of the North Yard. The tanks are placed on a skirt which is located on a concrete slab. Anchors were observed at the base of the skirt; however, the anchors were placed in oversize holes and no epoxy was observed in the holes. We believe these tanks may be subject to sliding or overturning in a design level seismic event.

Several smaller tank structures are provided at the south end of the North Yard. Many of the tanks appear to be out of service. However, the tanks are tall and slender, and no anchorage was observed at several tanks. Many of the out of service tanks are in close proximity to active equipment and may be at risk of overturning in a design level seismic event.

5.1.2.1.1f Canopies and Building Structures

Contained in the North Yard are several buildings including the Kinder Morgan office and lab, riser room, gas foam building, carbon treatment building, and Building 7. In addition to the buildings, several smaller canopy-type buildings are also provided to cover mechanical and electrical equipment. Limited information is available on the buildings beyond what is visually available.

The Kinder Morgan office and lab is of masonry construction with an unknown construction date. The building appears to be well maintained and conceived and is of minimal risk regarding spill prevention.

The riser room, fixed firefighting foam building, and carbon treatment buildings are of light framed construction and appear to be modern construction. The buildings appear to have a low seismic mass, appear to be well conceived and are of minimal risk regarding spill prevention.

Building 7 is of masonry construction with an unknown construction date. The roof consists of dimensional lumber framing and wood plank sheathing. The building appears to be used for storage of non-petroleum materials and is of minimal risk regarding spill prevention.

The canopy-type buildings are light framed and appear to be of varied age and condition. The canopies appear to have a low seismic mass and are of minimal risk regarding spill prevention.

5.1.2.1.2 Area 02 (South Yard)

5.1.2.1.2a Tank Farm

Ten operational storage tanks are located at the South Yard of the facility with various construction dates. The storage tanks are typically 80 to 120-feet in diameter and 40 to 60-feet in height. The operational tanks appear to be well engineered (per API 650), conceived and maintained. The foundations of the tanks vary with more modern installation utilizing ground improvements or piles and some older tanks on mat gravel foundations. The tanks are also self- anchored. Self-Anchored Tanks are very common and perform well during seismic events. At many of the tanks, placards were provided which give a repair or alteration date in accordance with API 653. API 653, Tank Inspection, Repair, Alteration, and Reconstruction is a standard developed and published by the American Petroleum Institute (API) and covers the inspection, repair, alteration, and reconstruction of steel aboveground storage tanks used in the petroleum and chemical industries. All active tanks are required to undergo an API 653 inspection based on certain parameters. This inspection ensures the tank floors and shells have not deteriorated as well as ensuring the tank has not experienced differential settlement. Given the nature of the inspection requirements we can be sure the tanks are plumb and have not been corroded. All the tanks are regulated by the Department of Transportation and Kinder Morgan is in compliance with all inspection requirements. 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

Piping at the South Yard of the facility is typically elevated at varying heights above grade and supported by steel pipe supports. The pipe supports are located on concrete pedestals with a foundation, and support multiple pipe runs up to 12-inches in diameter. Simple shear connections frame the pipe support bents transverse to the piping, and no struts are provided between bent sections. This indicates the elevated pipe supports at the South Yard consist of a cantilevered column lateral system.

Given the widespread nature of this support type at the South Yard, a limited structural analysis of the cantilevered column system was performed. Our analysis estimated the seismic dead and lateral loading at a typical cantilevered column. Based on the results of our analysis, we believe this typical support type is at risk in a design level seismic event.

5.1.2.1.2c Containment Structure

Containment walls are provided at the perimeter of the South Yard and consist of cast-in-place concrete. The walls generally appear to be in fair condition, with several previous spall repairs observed. Unrepaired spalling and exposed reinforcement were observed at a few locations. No information has been provided regarding the foundation of the containment walls. Based on our observations, the containment walls appear to be of adequate height and construction to resist static surcharge loading in the event of a tank spill. However, based on the age of construction we believe it is unlikely the containment wall was designed for lateral movement in a seismic scenario. Further analysis or retrofitting may be warranted to ensure their efficacy under seismic stress, thereby fortifying the overall resilience of the tank farm infrastructure.

5.1.2.1.2d Ancillary Equipment

A few items of ancillary equipment are provided in the South Yard, primarily consisting of pumps and mechanical equipment. Ancillary equipment typically appeared to be properly anchored and located on a foundation.

Several smaller tank structures are provided at the south end of the South Yard. Many of the tanks appear to be out of service. However, the tanks are tall and slender, and no anchorage was observed at several tanks. Many of the out of service tanks are in close proximity to active equipment, and may be at risk of overturning in a design level seismic event.

5.1.2.1.2e Canopies and Building Structures

Several canopy structures are provided at the South Yard to cover mechanical and electrical equipment. The canopy-type buildings are light framed and generally appear to be of modern construction. The canopies appear to have a low seismic mass and are likely of minimal risk regarding spill prevention.

5.1.2.1.3 Area 03 (Kinder Morgan Dock)

5.1.2.1.3a Dock Structure

The Kinder Morgan dock structure consists of a steel and wooden pier, with concrete dolphins which are supported by battered steel pipe piles. The dock contains approximately 1,200-feet of berthing. The dock was permitted through the US Army Corps of Engineers and all repairs, modernizations and improvements have been permitted. The dock structure is currently in compliance with all requirements set forth by the US Coast Guard and the US Army Corps of Engineers. Based on provided documentation, the battered piles are embedded into the mudline, which is approximately 60-feet below the dock walking surface. The dock structure houses various piping and offloading equipment.

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.

5.1.2.1.3b Pipe Supports

Active piping is currently supported on shore leading to the pier structure. The pipe supports typically consist of sleepers or low elevation supports. The pipe supports generally appear to be well conceived, and of low seismic risk given the height of the piping.

5.1.2.1.3c Ancillary Equipment

Equipment such as pumps on the dock and piping running along the dock are at risk in a design level event owing to the dock structural risk covered above in 5.1.2.1.3a.

5.1.2.1.3d Warehouse Structures

A small warehouse is located on shore near the dock access gate. It does not store hazardous materials. The building is unoccupied, appears to be well maintained and conceived, and is of minimal risk with regard to spill prevention.

5.1.2.1.4 Area 04 (Rail and Truck Transfer Area)

5.1.2.1.4a Additives Truck Loading Rack

A truck loading rack for fuel additives is provided near the entrance of the facility at the south end of the Transfer Area. The loading rack is constructed of structural steel frames and cantilevered rolled steel roof purlins. The structure supports a canopy roof, and various piping, mechanical, and electrical equipment. The lateral resisting system of the truck loading rack appears to be moment frames and braced frames. Columns which comprise the moment frame are spaced closely together, and the construction appears unconventional given the cantilevered roof framing members above the moment frames. Based on the roof weight supported and apparent lateral resisting system, we believe the truck loading rack is at risk in a design level seismic event.

5.1.2.1.4b Rail Transfer Platform

The rail transfer platform runs parallel to the train tracks enter the Rail Transfer Area. The platform is constructed of steel braced frames, and supports a catwalk and isolated transfer piping. The platform generally appears to be well conceived, with pedestal foundations and anchorage provided. Several previous additions have been performed for the addition of articulating equipment for the material transfer process. Corrosion was observed at multiple original construction areas, which has likely compromised the lateral resistance at sections of the platform. However, struts are provided between bays of the platform, and the original construction has provided bracing at each bay of the platform which likely provides more capacity than is required. Based on the number of braced frames provided and low seismic mass, we believe the rail transfer platform is of low seismic risk.

5.1.2.1.4c Pipe Bridges and Supports

A total of three steel pipe bridges are provided which cross the Rail and Truck Transfer Area. For the purpose of this report, the pipe bridges are designated as Pipe Bridges 1, 2, and 3. The pipe bridges are numbered from south to north; i.e. Pipe Bridge 1 is the southernmost pipe bridge nearest the entrance of the facility, Pipe Bridge 2 is located near the center of the Rail Transfer Area, and Pipe Bridge 3 is the northernmost pipe bridge adjacent to N.W. Front Avenue.

Pipe Bridge 1 consists of braced frames in the transverse direction, and apparent truss-moment frames in the longitudinal direction. No struts are provided between truss-moment frames. The columns consist of two built-up rolled C-channel sections intermittently welded. The pipe bridge supports numerous primary supply pipes and conduit, and transports material between the North and South Yards. The piping is suspended approximately 25-feet to allow for rail and truck passage beneath. Based on the height, supported load, and lack of struts between frame sections, we believe Pipe Bridge 1 is at risk in a design level seismic event.

Pipe Bridge 2 consists of braced frames in the transverse and longitudinal direction. No struts are provided between frames in the longitudinal direction. The columns consist of round pipe sections. The pipe bridge supports several large diameter supply pipes, and transports material between the North and South Yards. The piping is suspended approximately 25-feet to allow for rail and truck passage beneath. Based on the height, supported load, and lack of struts between frame sections, we believe Pipe Bridge 2 is at risk in a design level seismic event.

Pipe Bridge 3 consists of moment frames in the transverse direction, and truss-moment frames in the longitudinal direction. The columns consist of round pipe sections. The pipe bridge supports three pipes and several conduit, and transports material between the North and South Yards. Moderate corrosion was observed throughout the steel framing but did not appear to fully penetrate the framing. The piping is suspended approximately 25-feet to allow for rail and truck passage beneath. Based on the relatively low supported load and number of lateral frames and struts provided, we believe Pipe Bridge 3 is of low risk in a design seismic event.

Additional isolated pipe runs are provided beneath the Rail Transfer Platform. The pipes are typically suspended from, or otherwise supported by, the Rail Transfer Platform framing. The supports typically consist of steel angle framing welded to the existing platform framing. At some locations, visible deflection is evident in the pipe support framing indicating the supports are not an engineered solution. We believe the pipe supports attached to the Rail Transfer Platform are at risk in a design level seismic event.

At some other locations beneath the Rail Transfer Platform, larger diameter pipes are supported by isolated steel supports which are embedded in a below-grade pier. These pipe supports generally appear to be well conceived, and of low seismic risk given the height of the supports.

5.1.2.1.4d Ancillary Equipment

Various pumps and other mechanical equipment are provided beneath the Rail Transfer Platform. The equipment is typically located at-grade, properly anchored and located on a foundation. We believe the anchored and founded equipment is of low risk in a design level seismic event.

5.1.2.1.5 Area 05 (Warehouse and Storage Area)

5.1.2.1.5a Ancillary Equipment

A few items of ancillary equipment are provided in the Warehouse and Storage Area, primarily consisting of pumps, mechanical equipment, and small tank structures.

Several pumps are provided beneath Pipe Bridge 1, located near Building 4 at the Warehouse and Storage Area. The pumps are located on a skid which bears directly on the pipe bridge column pedestals. At some locations, the skid was welded to the pipe bridge column bases however no anchorage was observed at the skid. We believe the pump skid may be subject to sliding or overturning in a design level seismic event.

At one location near the entrance to the facility, a vertically oriented tank indicated as the boiler room oil-water separator was placed on a foundation but no anchorage was observed. We believe this tank may be subject to sliding or overturning in a design level seismic event.

Several smaller tank structures are provided at the north end of the Warehouse and Storage Area. Many of the tanks appear to be out of service. However, the tanks are tall and slender, and no anchorage was observed at several tanks. Many of the out of service tanks are in close proximity to active equipment, and may be at risk of overturning in a design level seismic event.

5.1.2.1.5b Building Structures

Several building structures are provided at the Warehouse and Storage Area, including a boiler house, Buildings 2, 3, and 4, and a worksite trailer. Limited information is available on the buildings beyond what is visually available.

The boiler house and worksite trailer are light framed structures with an unknown construction date. The buildings appear to be well conceived and are of minimal risk regarding spill prevention.

Building 2 consists of multiple structures of steel construction. The buildings are typically either engineered steel trusses or pre-engineered metal buildings with steel purlins and appear to vary in age. The buildings appear to be used for storage of non-petroleum equipment and tools, appear to be well conceived and are of minimal risk regarding spill prevention.

Buildings 3 and 4 are of steel construction with an unknown construction date. The buildings house process equipment. The buildings appear to have a low seismic mass, appear to be well conceived and are of minimal risk regarding 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 Kinder Morgan Willbridge terminal has two fire pumps and foam pump that start by electricity. Once foam is injected into the system, the appropriate tank is then selected. The foam monitors will also discharge foam once the injection valve is opened. The foam pump is for the Ethanol system.

The Gasoline Tank Fire Pump is an electric pump. It starts by first opening three valves followed by the green button on the panel board. Once the unit starts it will pressure the entire system and pump to the tank that is open. The unit is shut down by pushing the red stop button. The Ethanol Fire Pump is set up to supply water to the foam building that is approximately 100 yards east of the pump itself. In the foam building there is a small electric pump system that is set to provide the foam to the correct tank when it is opened.

There are two water monitors on the dock located on both sides of the manifold system. At the shore end of the dock there is a Fire Department Connection (FDC) to introduce foam into the system from the fire department. The fire department also has a fire boat (Engine Company 6) with foam just 5 minutes away, up river from the dock.

All water comes from the city water system at normal water pressure. The fire protection system is fed by two separate water mains, one in Front Ave and the other in Balboa Ave. The Front Ave lateral enters the facility at the east corner of Front Ave and the flume. Once on-site the lateral runs to the Gasoline Tank foam building. The water to the ethanol foam system comes off the Balboa Ave lateral, which enters the property at the south side of Building #6. Once on-site, the lateral runs to the fire pump inside the yard next to the lab at Building #6.

The facility has (16) public fire hydrants located throughout the terminal, all painted red. Hydrants are spaced at safe distances from storage tanks to maintain operability during a potential fire. All hydrants have normal city water pressure, and it is possible to obtain water from any hydrant.

The facility's fire control system as described above is capable of mitigating risk of fire and explosions following an earthquake, as long as the system remains undamaged. With multiple laterals from the city water mains and an FDC, the water supply is also sufficient.

5.1.3.1.2 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 lines that serve the facility. This applies to the two water mains, which could be affected anywhere along its length upstream of the property, the onsite fire water lines, and the foam lines. 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.

5.1.3.2 Description of spill containment systems equipment, procedures

Kinder Morgan maintains a Spill Prevention, Control, and Countermeasure (SPCC) Plan for the Willbridge facility, in accordance with 40 CFR 112. It describes personnel, training and spill prevention procedures; inspections and records; facility drainage; bulk storage containers and operational equipment; transfer operations, pumping and in-plant processes; tank car and tank truck loading/unloading; and security.

The facility has a secondary containment system for the bulk oil and oil product storage containers to prevent oil from reaching navigable waters. All bulk storage tank installations are constructed so that a secondary means of containment is provided for the entire contents of the largest single container plus sufficient freeboard to allow for precipitation. The South and North Tank Yard containment areas are constructed of concrete walls with earthen floor, while the Lube Oil Tank Area is constructed of concrete curbs with concrete floor. The red-dye tanks are located at the loading rack and are therefore contained by the loading rack containment system.

At the loading rack, drainage flows into a catchment basin designed to handle discharges. The containment system is designed to hold the maximum capacity of any single compartment of a single tank truck loaded or unloaded at the Facility.

Based on the soil data available for this Facility, containment areas are sufficiently impervious to contain a discharge from an aboveground facility with line-of-sight inspection capability (tanks, containers, piping, etc.) until clean up occurs.

In addition to the containment system, the facility has a strong tank integrity program which significantly increases the chances of detecting corrosion or anomalies in the tank shell before it becomes compromised.

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.

5.1.3.2.1 Mechanical-specific items

Containers are constructed of a material that is compatible with the oil and oil products stored and the conditions of storage (including pressure and temperature). Vertical bulk storage containers are equipped with high and/or high-high liquid level alarms with an audible or visual signal at a constantly manned operation or surveillance station. Tank bottoms and associated buried appurtenances are cathodically protected.

The outside of all bulk storage containers and their associated supports and foundations are inspected during formal facility monthly inspections for signs of discharges or accumulation of oil inside secondary containment areas. Field-erected aboveground bulk containers are integrity tested on a regular schedule and when material repairs are made using API Standard 653 (Tanks 30,000 gallons and larger). Small shop-built containers, and those less than 30,000 gallons, may alternatively follow STI-SP001 testing standards set forth in STI-SP001.

All aboveground valves and pipes/pipelines are regularly examined during operating personnel rounds and formally monthly. During these examinations, operating personnel assess the general condition and necessity for corrective actions of items such as flange joints, valve glands and bodies, pipe supports, metal surfaces, expansion joints, catch pans, valve locks and other appurtenances. Periodic pressure testing may be warranted for piping in areas where facility drainage is such that a failure might lead to a spill event. Liquid level sensing devices on tanks are tested monthly to ensure proper operation.

The facility's buried piping installations are provided with corrosion protection. Buried piping installations are wrapped and coated to reduce corrosion. When a section of buried line is exposed for any reason, it is examined for deterioration. If corrosion damage is found, additional examination and corrective action will be taken as indicated by the magnitude of damage.

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

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

Kinder Morgan has placed five 20-lb dry chemical fire extinguishers on the dock. One located at the shore entrance to the dock. One located in the dock personnel shelter and three located near the dock transfer area. Fire extinguishers are located throughout the terminal and near the truck loading racks. Instructions for their use are printed on a label attached to the fire extinguisher. All are checked monthly and inspected annually.

The facility maintains notification and response procedures to be implemented immediately after discovering a discharge incident and securing the source. Oil-handling personnel must undergo minimum initial training including operation and maintenance of equipment, discharge procedure protocols, applicable oil spill prevention laws, rules, and regulation, general facility operations and the contents of the SPCC. Facility personnel maintain a high level of training and awareness on the Facility’s Integrated Contingency Plan and are capable of implementing this contingency plan in the event of an emergency.

Kinder Morgan maintains a Fire Prevention and Protection Plan for the Willbridge Terminal. The purpose of the plan is to provide employees with a minimum standard for fire protection and prevention and incorporates Kinder Morgan’s policy on fire prevention, training and maintenance. The plan complies with the OSHA Fire Prevention Standard, Title 29 CFR 1910.39 and Cal-OSHA Title 8 Sec. 3221

The facility also maintains an evacuation plan in the event of an emergency. The diagram includes a primary incident command center, staging areas, secondary command center, main exits, gates, stairs/ladders, and emergency panic bar exit gates.

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

SECTION 6: APPENDICIES

6.1 Appendix A: Geotechnical Exhibits

Appendix A-1 Geotechnical Engineering Report

Appendix A-2 CPT Data

Appendix A-3 Site Class Determination

Figure A-1 Vicinity Map

Figure A-2 Site Map

Figure A-3 Geotechnical Cross Section

Geotechnical Engineering Services

Willbridge Terminal Tank Replacement
Portland, Oregon

for

Kinder Morgan

July 25, 2011

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Services

Willbridge Terminal Tank Replacement
Portland, Oregon

for
Kinder Morgan

July 25, 2011

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30 YEARS 2010

Geotechnical Engineering Services

Willbridge Terminal Tank Replacement
Portland, Oregon

File No. 9552-014-02

July 25, 2011

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GeoEngineers

Table of Contents

Table of Contents (continued)

LIST OF FIGURES

APPENDICES

INTRODUCTION

This report presents the results of geotechnical engineering services for the Willbridge Terminal Tank Replacement project in Portland, Oregon. We previously provided preliminary geotechnical engineering services for the project, the results of which are presented in our report dated May 13, 2009. This report supersedes our geotechnical report dated May 13, 2009. This report incorporates the latest development plan by Kinder Morgan and includes the results of the additional geotechnical explorations completed.

The project site is located at 5880 NW Saint Helens Road, at Kinder Morgan's existing Willbridge Terminal. Figure 1 shows the site location in relation to surrounding features.

We understand that Kinder Morgan is planning to construct three new tanks at the Willbridge Terminal. One new tank will be located at the northern part of the terminal (i.e. the North Yard) and two new tanks will be located at the southern part of the terminal (i.e. the South Yard). The new tanks will be constructed within the footprint of the old tanks that were demolished. We understand that the new tanks will be approximately 60-foot-high, 120-foot-diameter, steel tanks. Figures 2 and 3 show the location of the new tanks at the north and south yard, respectively.

FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

The subsurface soil and groundwater conditions at the site were evaluated by drilling two borings (B-1 and B-2) in April 2009 and advancing four cone penetration tests (CPTs P-1 through P-4) in April 2011. The approximate locations of the explorations completed for this project are presented on the Site Plans, Figures 2 and 3. Details of the field exploration program and logs of the explorations are presented in Appendix A.

Laboratory Testing

Soil samples were obtained during the drilling program and taken to GeoEngineers' laboratory for further evaluation. Selected samples were tested for the determination of moisture content, percent fines, gradation analyses, and Atterberg limits (plasticity characteristics). The tests were performed in general accordance with test methods of the American Society for Testing and Materials (ASTM). A description of the laboratory testing and the test results are presented in Appendix B.

SITE CONDITIONS

Site Geology

The Willbridge Terminal site is located within the Portland Basin, which is part of the Willamette Valley physiographic province. The Willamette Valley is an elongate alluvial plain that was formed by uplift of the Coast Range to the west and the Western Cascades to the east and was subsequently filled with Pleistocene and Holocene alluvial sediment (Orr and Orr, 1999).

The Portland Basin is a roughly elliptical shaped, subsided lowland that was formed when faulting and subsequent uplifting of the adjacent Portland Hills lowered the basin relative to the Portland Hills and associated Portland Hills fault. The local geology at the Willbridge Terminal site is mapped as Holocene-aged alluvial deposits, which are described as sand, gravel, silt and clay forming flood plains and filling channels of present streams. The underlying bedrock is mapped as Columbia River Basalt (Walker and MacLeod, 1991).

Regional Seismicity

Earthquake Source Zones

The Portland area is located near the convergent continental boundary known as the Cascadia Subduction Zone (CSZ), an approximately 650-mile-long thrust fault that extends along the Pacific Coast from mid-Vancouver Island to Northern California. The CSZ is the zone where the westward advancing North American Plate is overriding the subducting Juan de Fuca Plate. The interaction of these two plates results in two potential seismic source zones: (1) the Benioff source zone, and (2) the CSZ interplate source zone. A third seismic source zone, referred to as the shallow crustal source zone, is associated with several northwest trending faults in the area. A discussion of these potential sources is provided below.

Crustal Earthquake Sources

Several northwest trending faults are mapped within a few miles of the site, the most notable being faults associated with the Portland Hills fault zone, which is located at about 0.25 mile southwest of the site. Recent investigations of this fault zone have concluded that the Portland Hills fault zone (including the Portland Hills Fault, the East Bank Fault and the Oatfield Fault), is potentially active based on contemporary seismicity in the vicinity of the fault (Wong and others, 2000). Seismic activity has been previously recorded beneath Kelly Point Park, located at a few miles northwest of the site. While this activity cannot be attributed to a mapped fault in the area, it indicates the potentially active nature of faults within the Portland Hills fault zone, or closely related unknown structures.

Cascadia Subduction Zone

The CSZ is a 680-mile long zone of active tectonic convergence where oceanic crust of the Juan de Fuca Plate is subducting beneath the North American continent at a rate of 4 cm/year (DeMets and others, 1990). Although very little seismicity has occurred on the plate interface in recorded history, a growing body of evidence strongly suggests that prehistoric subduction zone earthquakes have occurred. This evidence includes: (1) buried tidal marshes recording episodic, sudden subsidence along the coast of northern California, Oregon and Washington; (2) burial of subsided tidal marshes by tsunami wave deposits; (3) paleoliquefaction features; and (4) geodetic uplift patterns of the Oregon coast. Radiocarbon dates on the buried tidal marshes indicate a recurrence interval for major CSZ earthquakes of 250 to 650 years with the last event occurring about 300 years ago. (Geomatrix, 1995). The inferred seismogenic portion of the plate interface is roughly coincident with the Oregon coastline and lies approximately 60 miles west of the site.

Intraslab Earthquake Sources

In the CSZ, the subducting Juan de Fuca Plate moves eastward beneath the North American continental plate, dipping at an angle of 10 to 20 degrees. Earthquakes derived from intraslab sources occur within the subducting Juan de Fuca Plate at depths ranging from 20 to 40 miles. As the plate moves farther away from the CSZ, the curvature of the plate increases and causes normal faulting within the oceanic slab in response to the extensional forces of the down dipping plate. The region of maximum curvature of the slab is where large intraslab earthquakes are expected to occur, and is located roughly 30 miles below the Oregon Coast Range. This area is located roughly 30 to 40 miles west of the site. Historically, the rate of earthquake occurrence within the Juan de Fuca Plate beneath Oregon is low (Geomatrix, 1995).

Seismic Design Events and IBC Design Parameters

Based on our evaluation of the seismicity at the project site, we recommend that two design earthquake events be considered for this project. The first is the design earthquake event per Oregon Structural Specialty Code and the 2009 International Building Code (IBC). The second is the scenario earthquake that is associated to the nearby Portland Hills Fault. Table 1 below presents the seismic design parameters for the two design earthquake events considered for this project.

TABLE 1. SEISMIC DESIGN PARAMETERS

Design Earthquake	Magnitude	Peak Ground Acceleration (PGA) (g)
Building Code Event	9.0	0.24
Portland Hills Fault	7.0	0.53

Notes:

1. Magnitude is taken as the modal event per 2008 USGS seismic deaggregation results.
2. Design Pga Is Taken As S_{ds}/2.5 Per Oregon Structural Specialty Code.

We recommend the 2009 IBC parameters for site class, short period spectral response acceleration (S_S), 1-second period spectral response acceleration (S_1), and seismic coefficients F_A and F_V presented in the following table. These values are based on the 2002 United States Geological Survey (USGS) Seismic Hazard Maps.

TABLE 2. 2009 IBC SEISMIC DESIGN PARAMETERS

2009 IBC Parameter	Recommended Value
Site Class	E
Short Period Spectral Response Acceleration, S_S	0.99g
1-Second Period Spectral Response Acceleration, S_1	0.35g
Seismic Coefficient, F_A	0.92
Seismic Coefficient, F_V	2.60

SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

Subsurface Soils

In general, the soils observed in the explorations completed at the project site consisted of fill, alluvial deposits and bedrock. This section describes the units in the order of deposition, starting with the most recent.

Fill consisting of loose to medium dense sand with variable gravel and silt content, and medium stiff to stiff clay was observed in borings B-1 and B-2 and in CPTs P-1 through P-4. The fill was encountered in the explorations at depths ranging up to 10 to 12 feet below the ground surface.

Alluvial deposits were encountered below the fill in each of the borings and CPTs completed at the site. The alluvial deposits encountered in the explorations consist of interbedded layers of soft to medium stiff silt and clay with sand.

Rock was encountered below the alluvial deposits in each of the borings and CPTs completed at the site. Rock encountered in the explorations generally consist of basalt at depths ranging from approximately 34 to 48 feet below existing ground surface.

Groundwater

Grounwater was encountered in the borings at depths of about 2 to 5 feet during drilling. We anticipate that groundwater levels will fluctuate due to a variety of factors including seasonal variations in precipitation, changes in site utilization and site drainage, and water level fluctuations in the nearby Willamette River.

CONCLUSIONS AND RECOMMENDATIONS

Summary

A summary of the primary geotechnical considerations is provided below. The summary is presented for introductory purposes only and should be used in conjunction with the complete recommendations presented in this report.

- The near surface soils at the site may not provide adequate support for the planned concrete ringwall footing; therefore the ringwall should be founded on at least 2 feet of compacted structural fill.
- The elastic soil settlement within the tank footprint immediately after the construction is estimated to be about ½ to 1 inch at the center of the tank and about ¼ to ½ inch at the perimeter of the tank.
- The soils underlying the planned tanks are moderately compressible and post-construction deformation on the order of 1½ to 2½ inches should be expected at the center of the tank, and approximately ½ inch to 1½ inches of settlement at the perimeter.
- The calculated post-earthquake settlement induced by soil liquefaction within the tank footprint is estimated to range from 5 to 9 inches. The differential settlement between the

center and the perimeter of the tank after a design earthquake event is estimated to be 3 to 5 inches.

- The post-earthquake liquefaction induced lateral spreading is estimated to be less than about 8 inches within the tank footprint.

Our specific geotechnical recommendations are presented in the following sections of this report.

Seismic Hazards

Ground Rupture

Because of the anticipated infrequent recurrence of earthquake events and the project site's location with respect to the nearest known fault (Portland Hills Fault), it is our opinion that the risk of ground rupture at the site resulting from surface faulting is low.

Liquefaction Potential

Soil liquefaction refers to the condition by which vibration or shaking of the ground, usually from earthquake forces, results in the development of excess pore pressures in saturated soils with subsequent loss of strength. In general, soils that are susceptible to liquefaction at this site include very loose to medium dense, clean to silty sands and non-plastic silts that are below the water table.

The evaluation of liquefaction potential is complex and dependent on numerous parameters, including soil type, grain-size distribution, soil density, depth to groundwater, in-situ static ground stresses, earthquake-induced ground stresses and excess pore water pressure generated during seismic shaking.

We evaluated liquefaction potential of the site soils for the code design earthquake and the Portland Hills Fault event using subsurface data and information obtained from the CPTs and borings. We evaluated liquefaction potential using the simplified method proposed by Youd, et al (2001). For the design earthquake event per Oregon Structural Specialty Code and the 2009 IBC, the PGA used in the analysis was equal to $S_{DS}/2.5$, where S_{DS} is determined in accordance with Section 21.2.1 of the American Society of Civil Engineers (ASCE) 7. For the earthquake event associated to the Portland Hills Fault, the PGA was determined by performing a Deterministic Analysis based on the weighted average of the Abrahamson & Silva, Boore & Atkinson, Campbell & Borzognia, Chiou & Youngs and Idriss 2008 NGA models. These resulting PGA values along with the earthquake magnitude assumed are presented in Table 1 above.

Based on our analyses, we estimated that 5 to 9 inches of liquefaction-induced settlement may occur during a design-level earthquake. The differential settlement that may be anticipated across the tank footprint is on the order of 3 to 5 inches.

Lateral Spreading

Lateral spreading involves lateral displacements of large volumes of liquefied soil. Lateral spreading can occur on near-level ground as blocks of surface soils are displaced relative to adjacent blocks. Lateral spreading also occurs as blocks of surface soils are displaced toward a nearby slope or free-face by movement of the underlying liquefied soil. The Willamette River northeast of the site represents a free-face condition. The North Yard is located approximately 700 feet from the top of the free face. And the South Yard is located approximately 550 feet from the free face.

The evaluation of lateral spreading at the site was initially completed using Youd's MLR simplified method, as a screening analysis. The results of the simplified method indicated that the site is susceptible to lateral spreading movement. Based on the results, we completed a more sophisticated analysis to refine the amount of lateral spreading deformation that may occur during the seismic design events considered for this project.

Slope Stability and Newmark Analyses

Slope stability and Newmark analyses were completed to refine the lateral spreading deformation ancitipated at the site under the design earthquake events. We completed our slope stability analyses using the computer program SLOPE/W (GEO-SLOPE International, Ltd., 2005). SLOPE/W evaluates the stability of the critical failure surfaces identified using vertical slice limit-equilibrium methods. This method compares the ratio of forces driving slope movement with forces resisting slope movement for each trial failure surface, and presents the result as the FS.

Also computed is the yield acceleration, which is defined as the ground acceleration that will cause a failure surface to start yielding or moving (i.e., FS = 1.0). The yield acceleration values calculated for the critical failure surfaces are used to estimate permanent lateral soil movement under the design earthquake time histories using the Newmark analysis method.

We completed our Newmark analyses using the computer program developed by Jibson and Jibson of USGS (Open File Report 03-005) using the rigorous rigid block method. The earthquake time histories used in the analysis were selected from those available in the database built in the computer program.

Soil Profiles and Design Parameters

Based on the CPT data we collected in the vicinity of the tanks sites, we interpret general subsurface conditions at the North and South Yard tank sites as summarized in Tables 3 and 4 below. These interpreted soil profiles were used in our slope stability analyses completed for this project.

TABLE 3. INTERPRETED SUBSURFACE SOIL CONDITIONS - NORTH YARD SITE

Depth Interval (feet)	Soil Type	Consistency
0 - 16	Fill	Medium Dense to Dense
16 - 34	Sandy Silt to Clayey Silt	Medium Stiff to Stiff
34 - 41	Sand to Silty Sand	Medium Dense to Dense
41.0 +	Basalt Bedrock	Very Dense

TABLE 4. INTERPRETED SUBSURFACE SOIL CONDITIONS – SOUTH YARD SITE

Depth Interval (feet)	Soil Type	Consistency
0 - 7	Fill	Medium Dense to Dense
7 - 18	Clayey Silt to Silty Clay	Medium Stiff to Stiff
18 - 22	Sandy Silt to Clayey Silt	Medium Stiff
22 - 35	Sandy Silt to Silty Clay	Medium Stiff to Stiff
35 - 49	Sand to Silty Sand	Medium Dense to Dense
49.0 +	Basalt Bedrock	Very Dense

Based on the subsurface conditions encountered in our explorations, and the results of our soil liquefaction analysis, we developed the representative engineering properties of the soil units under the seismic conditions. Tables 5 and 6 provide the soil properties used in the slope stability analyses under the seismic loading conditions.

TABLE 5. SOIL PARAMETERS FOR SEISMIC CONDITIONS - NORTH YARD SITE

Depth Interval (feet)	Existing Conditions		
	$N_{1\text{-}60\_cs}$	Unit Weight (pcf)	Shear Strength
0 – 4		120	ϕ=36°, c=0 psf
4 - 16	64 to 79	120	ϕ=5°, c=0 psf
16 - 34	n/a	115	ϕ=0°, c=1500 psf[a]
34 - 41		125	ϕ=36°, c=0 psf
41.0 +	Firm Rock		

Notes:

1. The undrained shear strength of the clay is determined using the correlation: $(q_t - \sigma_{vo}) / N_{kt}$, where q_t = cone tip penetration resistance, σ_{vo} = vertical stress and N_{kt} = 15.

TABLE 6. SOIL PARAMETERS FOR SEISMIC CONDITIONS - SOUTH YARD SITE

Depth Interval (feet)	Existing Conditions		
	$N_{1\text{-}60\_cs}$	Unit Weight (pcf)	Shear Strength
0 – 4		120	ϕ=34°, c=0 psf
4 - 7	64 to 84	120	ϕ=5°, c=0 psf
7 - 18	n/a	115	ϕ=0°, c=1500 psf[a]
18 - 22	n/a	120	ϕ=0°, c=1000 psf[a]
22 - 35	n/a	120	ϕ=0°, c=1200 psf[a]
35 - 49		125	ϕ=36°, c=0 psf
49.0 +	Firm Rock		

Notes:

1. The undrained shear strength of the clay is determined using the correlation: $(q_t - \sigma_{vo}) / N_{kt}$, where q_t = cone tip penetration resistance, σ_{vo} = vertical stress and N_{kt} = 15.

Tank Surcharge

Based on the information provided by the project structural engineer, the weight of a tank plus the product weight will apply a surcharge pressure of about 3,494 psf. This surcharge is modeled in our slope stability analysis.

Analysis Results

The most critical failure surface that can potentially impact the stability of the tanks for both the North Yard and the South Yard after a design earthquake event are presented in Figures 4 and 5, respectively. The yield accelerations of the North and South Yard sites are determined to be 0.35g and 0.27g, respectively. The yield acceleration values for both sites are greater than the design PGA (0.24g) for the code design earthquake, therefore no lateral soil movement is expected under this event.

Newmark analysis was performed using the yield acceleration and the design PGA values for the Portland Hills Fault event. A total of 50 earthquake time histories recorded at soft soil sites with a magnitude between 6.0 and 7.4 were selected for use in the Newmark analyses. All of the selected earthquake records were scaled to 0.53g to match the design PGA value of the Portland Hills Fault Earthquake event.

Figures 6 and 7 present the results of the Newmark analyses completed for the Portland Hills Fault for both the North Yard and South Yard sites, respectively. As shown in Figure 6, the mean soil displacement for the North Yard site is estimated to be less than 0.8 inches (2.0 cm). The mean displacement of the critical slip surface is estimated to be about less than 3 inches (6.9 cm) for the South Yard site, as shown in Figure 7. The maximum calculated displacement at the North and South Yard are about 2¼ inches and 8 inches, respectively.

Shallow Foundations

We recommend that the planned new tanks be supported on compacted structural fill. The zone of structural fill should extend laterally beyond the footing edges for a horizontal distance at least equal to the thickness of the fill. Organic soils, where present below planned foundation and tank subgrade elevation, should be removed and replaced with properly compacted structural fill.

Allowable Bearing Pressure

We recommend that the ringwall foundations be design using an allowable soil bearing pressure of 3,500 pounds per square foot (psf). This bearing pressure applies to the total of dead and long-term live loads and may be increased by one-third when considering earthquake or wind loads. All footings should be designed by the structural engineer with reinforcing steel placed top and bottom to provide structural continuity and to permit spanning over local irregularities.

The concrete ringwall footing should be founded on at least 2 feet or properly compacted structural fill. The footing should be founded at least 18 inches below surrounding grades and should have a minimum width of at least 24 inches.

We expect that foundation excavations less than 4 feet deep will not encounter significant amounts of groundwater. Water that collects in the foundation excavations should be removed before placing concrete.

We recommend that the tank pad be proportioned using an allowable soil bearing pressure of 3,500 psf.

Elastic Settlement Immediately After Construction

Provided all loose and soft soil is removed and the subgrade is prepared as recommended under "Construction Considerations" below, we estimate the total immediate settlement of shallow foundations will be about ½ to 1 inch at the center of the tank and about ¼ to ½ inch at the perimeter of the tank. The settlements will occur rapidly, essentially as loads are applied. Differential settlements between footings could be half of the total settlement. Note that smaller settlements will result from lower applied loads.

Long Term Post-Construction Consolidation Settlement

The underlying soft to medium stiff clayey and silty soils are prone to consolidation settlement. Based on our consolidation settlement analyses, we anticipate that the long term post-construction consolidation settlement under the design pressure of 3,500 psf will be on the order of ½ to 1 inch at the perimeter of the tank and 1½ to 2 inches at the center of the tank at the North Yard. For the South Yard, the calculated long term consolidation settlement is approximately 1 to 1½ inches at the perimeter of the tank and 2 to 2½ inches at the center of the tank.

Lateral Resistance

Lateral foundation loads may be resisted by passive resistance on the sides of footings and by friction on the base of the shallow foundations. For shallow foundations supported on compacted structural fill, the allowable frictional resistance may be computed using a coefficient of friction of 0.4 applied to vertical dead-load forces.

The allowable passive resistance may be computed using an equivalent fluid density of 350 pounds per cubic foot (pcf) (triangular distribution). These values are appropriate for foundation elements that are surrounded by properly compacted structural fill.

The above coefficient of friction and passive equivalent fluid density values incorporate a factor of safety of about 1.5.

Construction Considerations

If soft areas or existing fill is present below the foundation subgrade elevation, the soft areas/existing fill should be removed and replaced with structural fill. In such instances, the zone of structural fill should extend laterally beyond the footing edges for a horizontal distance at least equal to the thickness of the fill.

The site soils are susceptible to softening from water or construction traffic. We recommend that GeoEngineers observe the condition of all subgrade areas to evaluate whether the work is completed in accordance with our recommendations and whether the subsurface conditions are as anticipated.

Earthwork Recommendations

Site Preparation

The suitability of the exposed subgrade should be evaluated by a qualified geotechnical engineer or their representative after site preparation by observing proof rolling of the subgrade with a fully-loaded dump truck or similar heavy rubber-tire construction equipment. Areas of excessive yielding may indicate underlying soft, loose or unsuitable soil. Proof rolling should be performed during dry weather.

Probing should be used to evaluate the subgrade during periods of wet weather and in areas not accessible by heavy equipment. Any soft areas identified during proof rolling or probing should be over excavated as recommended by the project geotechnical engineer or their representative during construction observation. Over excavations should be backfilled with structural fill as recommended in the structural fill section of this report.

Silt fences, hay bales, buffer zones of natural growth, sedimentation ponds, and granular haul roads should be used as required to reduce sediment transport during construction to acceptable levels. Measures to reduce erosion should be implemented in accordance with the State of Oregon, City of Portland and Multnomah County regulations regarding erosion control.

Wet Weather Construction

The fine-grained soils at the site can be expected to become disturbed during periods of wet weather or when the moisture content of the material is considerably above optimum. In these cases, the on site fine-grained soils generally will provide inadequate support for construction equipment. If site grading and fill placement must occur during wet weather conditions, it may be necessary to use track-mounted equipment, loading the excavated material into trucks supported on granular haul roads, or other methods to limit subgrade disturbance.

Haul roads subjected to continuous heavy construction traffic will require a minimum of 18 inches of imported granular material. Twelve inches of imported granular material should be sufficient for light staging areas. The imported granular material should consist of crushed rock that is well-graded between coarse and fine particle sizes, contains no unsuitable materials or particles larger than four inches, and has less than five percent by weight passing the U.S. Standard No. 200 sieve. The imported granular material should be placed in lifts over the prepared, undisturbed subgrade and be compacted using a smooth-drum, nonvibratory roller.

We recommend that a geotextile be placed between the subgrade and imported fill in areas of heavy construction traffic. The geotextile should have a minimum Mullen burst strength of 250 pounds per square inch (psi) for puncture resistance and an apparent opening size (AOS) between the U.S. No. 70 and 100 sieves.

Structural Fill

Structural areas include areas beneath foundations, and any other areas intended to support structures or within the influence zone of structures. The suitability of soil for use as structural fill will depend on its gradation, moisture content and the weather conditions during construction. All material used for structural fill should be free of debris, organic contaminants, other deleterious material and rock fragments or cobbles larger than 6 inches.

Recommendations for suitable fill material are provided in the following sections. See the Fill Placement and Compaction section of this report for placement and compaction requirements.

ON-SITE SOILS

The on site soils can be used as structural fill if the material is free of particles larger than 3 inches in diameter, organic matter, and other deleterious materials. Use of on-site silty and clayey soils as structural fill is not recommended, because the silt and clay are sensitive to small changes in moisture content and is difficult, if not impossible, to achieve the required compaction when the material is above optimum moisture. If the soil is too wet to achieve satisfactory compaction and moisture conditioning cannot be achieved, we recommend using imported granular material as structural fill. The on-site soils should be placed in lifts no greater than 8 inches loose thickness and compacted in accordance with the compaction criteria provided in the “Fill Placement and Compaction” section below.

SELECT IMPORTED GRANULAR FILL

Select imported granular material may be used as structural fill to supplement the on site soils. The imported material should consist of pit or quarry run rock, crushed rock, crushed gravel and sand or sand that is fairly well graded between coarse and fine sizes. It should be completely free of clay balls, roots, organic matter or other deleterious materials, and have a maximum particle size of 4 inches, with less than 12 percent passing the U.S. No. 200 Sieve. The material should be placed in lifts no greater than 8 inches loose thickness and compacted in accordance with the compaction criteria provided in the “Fill Placement and Compaction” section below.

IMPORTED AGGREGATE BASE ROCK/CRUSHED ROCK

Aggregate base rock should consist of imported clean, durable, crushed angular rock. Such rock should be well-graded, contain no roots, organic matter and other deleterious materials, have a maximum particle size of 1¼-inch, and less than 5 percent passing the U.S. No. 200 Sieve. The material should be placed in lifts no greater than 8 inches loose thickness and compacted in accordance with the compaction criteria provided in the “Fill Placement and Compaction” section below.

Fill Placement and Compaction

Structural fill should be mechanically compacted to a firm, non-yielding condition. Structural fill should be placed in uniform, horizontal loose lifts not exceeding 8 to 10 inches in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. The maximum lift thickness will vary depending on the material and compaction equipment used.

Structural fill should be compacted to a minimum relative compaction of 90 percent at soil moisture contents at or above optimum. The top 12 inches of structural fill, if required beneath tank footprint, should be compacted to a minimum relative compaction of 95 percent of the maximum dry density (MDD) estimated in accordance with ASTM D-1557.

LIMITATIONS

We have prepared this report for Kinder Morgan, AECOM and Commonwealth Engineering and Construction, their authorized agents and regulatory agencies for the Willbridge Terminal Tank Replacement project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for geotechnical engineering in this area at the time this report was prepared.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix A titled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

REFERENCES

DeMets, C., and others, 1990. Current Plate Motions, *Geophysical Journal International*, v. 101, pp. 425-478.

GeoEngineers, Inc. June 3, 2010. “Geotechnical Engineering Services, Willbridge Terminal Tank Replacement, Portland, Oregon,” for Kinder Morgan.

Geomatrix Consultants, 1995. Seismic Design Mapping – State of Oregon. Final report issued by Geomatrix Consultants in 1995 to the Oregon Department of Transportation under Personal Services Contract 11688.

GEO-SLOPE International, Ltd. (2005). “Slope/W” Version 6.17.

Idriss, I.M., and Boulanger R.W. (2008). “Soil Liquefaction During Earthquakes,” Earthquake Engineering Research Institute EERI Monograph MNO-12, Oakland, California.

International Building Code (2009): International Code Council, Sec. 1613, 2006.

Jibson, R.W. and Jibson, M.W. 2005. “Slope Performance During an Earthquake,” Java Programs for using Newmark’s method and simplified decoupled analysis to model slope performance during earthquakes, U.S. Geological Survey Open-File Report 03-005.

Mayne, P. (2007). “Cone Penetration Testing, A Synthesis of Highway Practice,” National Cooperative Highway Research Program, NCHRP Synthesis 368, Washington D.C.

Oregon Structural Specialty Code (2010): International Code Council.

Robertson, P.K. and R.G. Campanella (1983). "Guidelines for Use and Interpretation of the Electric Cone Penetration Test", 1st and 2nd Edition, Soil Mechanics Series No. 69, 176p.

USGS, 2008 Interactive Deaggregations, U.S. Geological Survey Earthquake Hazards Program, http://eqint.cr.usgs.gov/deaggint/2008/index.php, 2008.

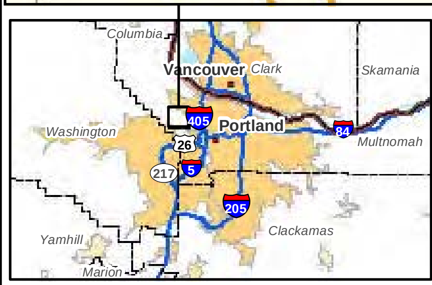
Walker, G. and MacLeod, N. (1991). Geologic Map of Oregon, U.S. Geological Survey, scale 1:500,000.

Wong, I., and others, 2000. Earthquake Scenario and Probabilistic Ground Shaking Maps for the Portland, Oregon Metropolitan Area. DOGAMI Interpretive Map Series IMS-16.

Youd, T.L., Hansen, C.M., and Bartlett, S.F., 1999, “Revised MLR Equations for Prediction Lateral Spread Displacement”, Proceedings, 7th U.S.-Japan Workshop on Earthquake Resistant Design of Lifeline Facilities and Countermeasures Against Liquefaction, Seattle, Washington, Multidisciplinary Center for Earthquake Engineering Research Technical Report MCEER-99-0019, p99-114.

Youd, T.L., Idriss, I.M., Andrus R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D.L., Harder, L.F. Jr., Hynes, M.E., Ishihara, K., Koester, J.P., Liao, S.S.C., Marcuson, W.F. III., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R.B., and Stokoe, K.H. II. 1997. “Summary Paper, Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils.” NCEER-97-0022.

FIGURES



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Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: ESRI Data & Maps, Street Maps 2005

Transverse Mercator, Zone 10 N North, North American Datum 1983
North arrow oriented to grid north

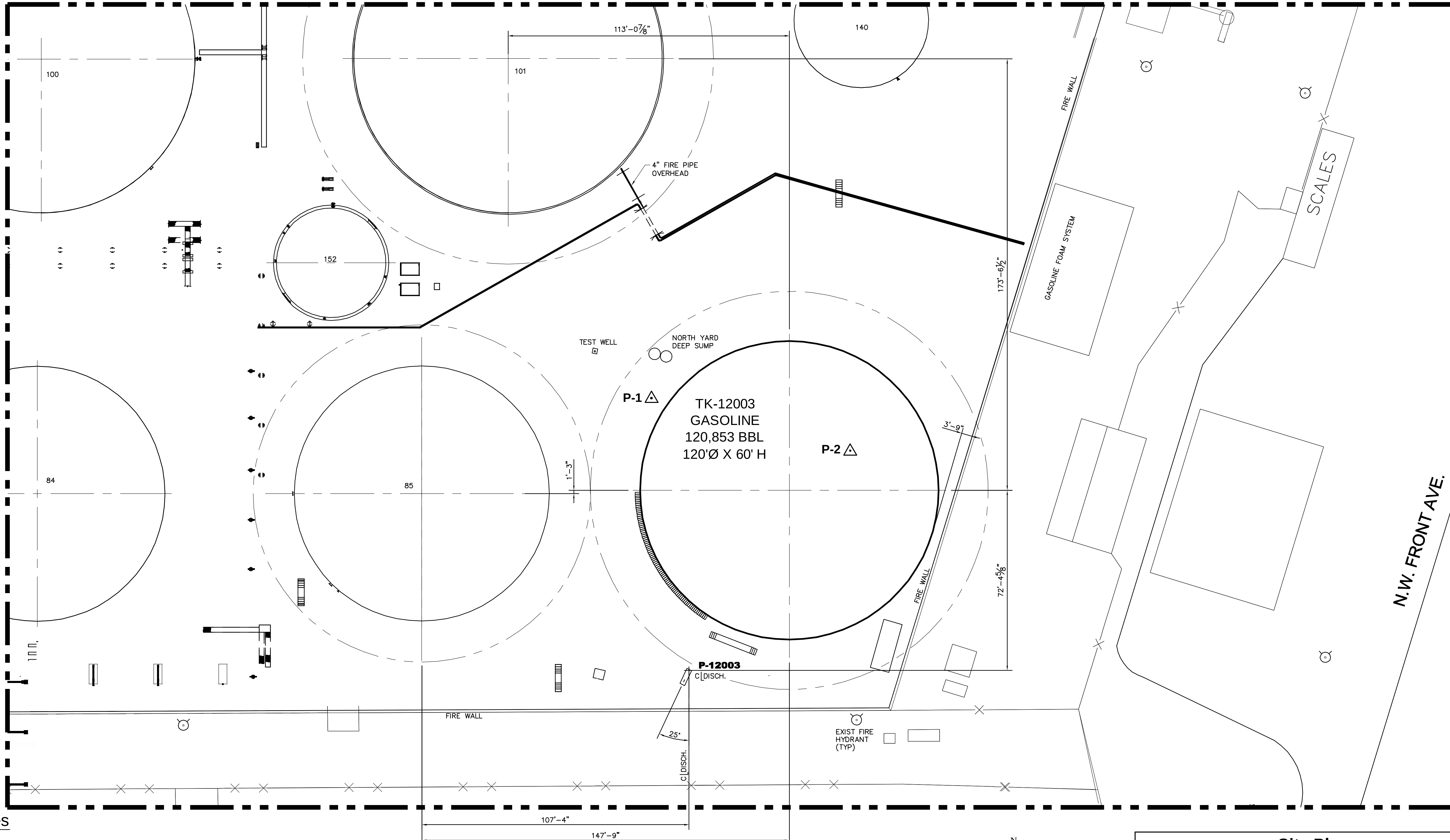
Vicinity Map

Willbridge Terminal Tank Replacement
Portland, Oregon

GEOENGINEERS

Figure 1

Office: Redmond Path: W:\Redmond\Projects\9\9552014\GIS\955201402_F1_VicinityMap.mxd Map Revised: June 29, 2011 EL



W:\Redmond\Projects\9\9552014\02\CAD\955201402_Site Plans.dwg\TAB:North Yard modified by tmichaud on Jul 06, 2011 - 14:40

Notes

1. The locations of all features shown are approximate.
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Reference: Base drawing CAD file "Site Plan - NORTH TANK FARM.dwg" provided by AECOM on 7/05/11.

Legend

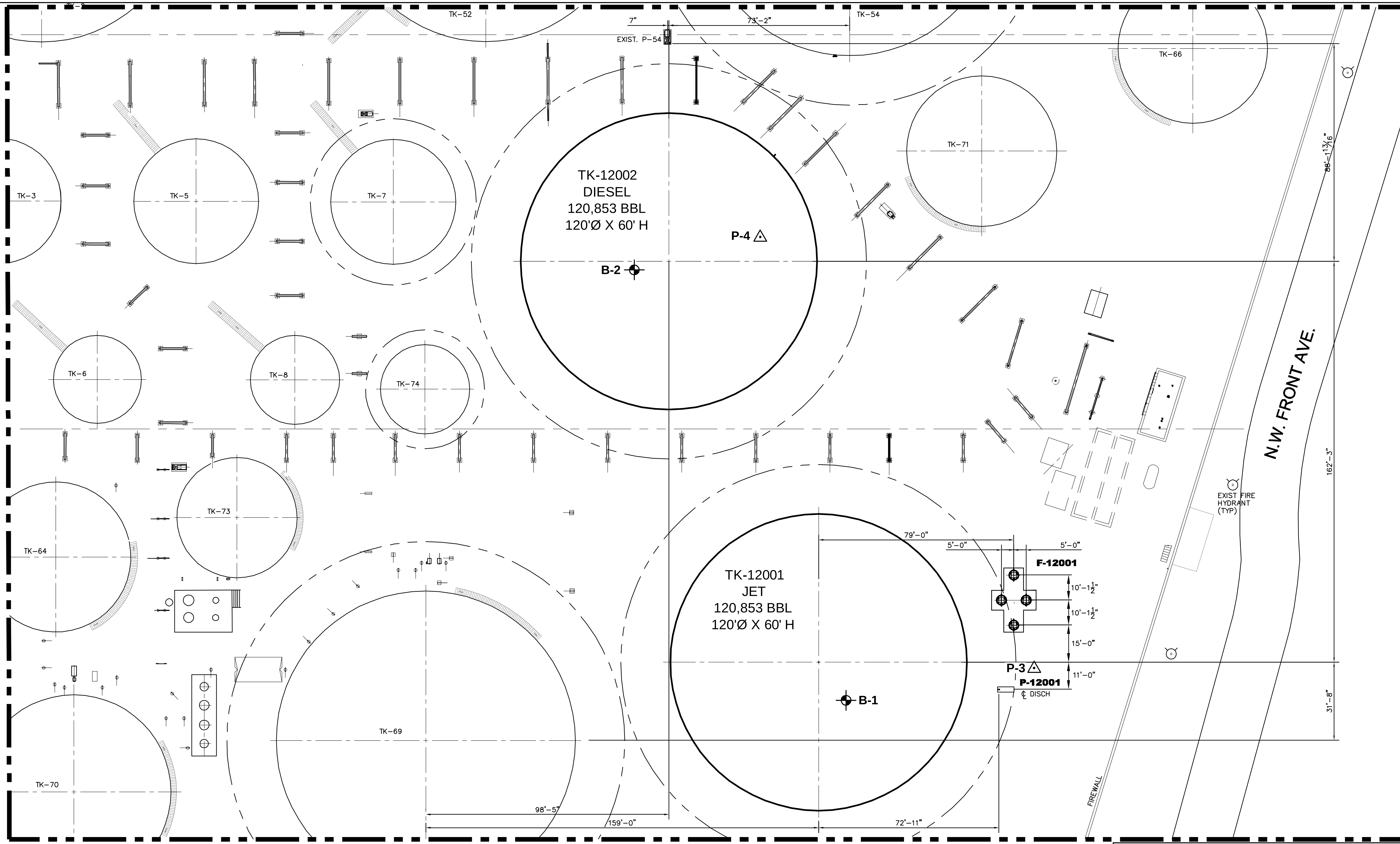
P-1 △ Approximate Location of Cone Penetrometer Test (CPT) Sounding

Site Plan
Proposed Tank Layout - North Yard

Willbridge Terminal Tank Replacement
Portland Oregon

GeoEngineers

Figure 2



Notes

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base drawing CAD file "Site Plan - SOUTH TANK FARM.dwg" provided by AECOM on 7/05/11.

Legend

P-3 △ Approximate Location of Cone Penetrometer Test (CPT) Sounding

B-1 ⊕ Approximate Boring Location (GeoEngineers, Inc., April, 2009)

Site Plan
Proposed Tank Layout - South Yard

Willbridge Terminal Tank Replacement
Portland Oregon

GEOENGINEERS

Figure 3

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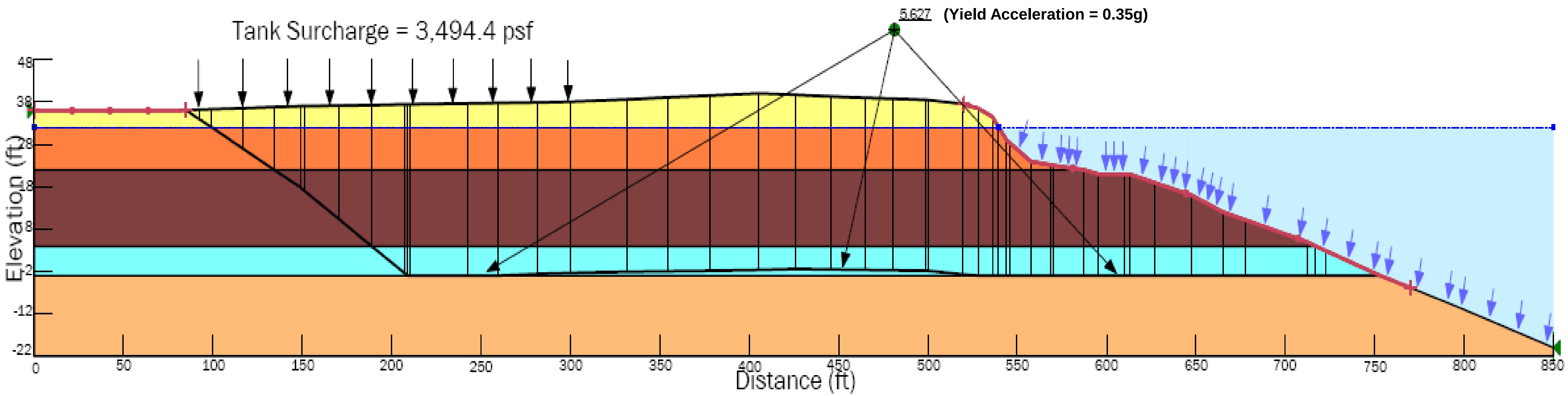


Slope Stability Analysis Results – North Yard (Post-Earthquake)

Willbridge Terminal Tank Replacement Portland, Oregon

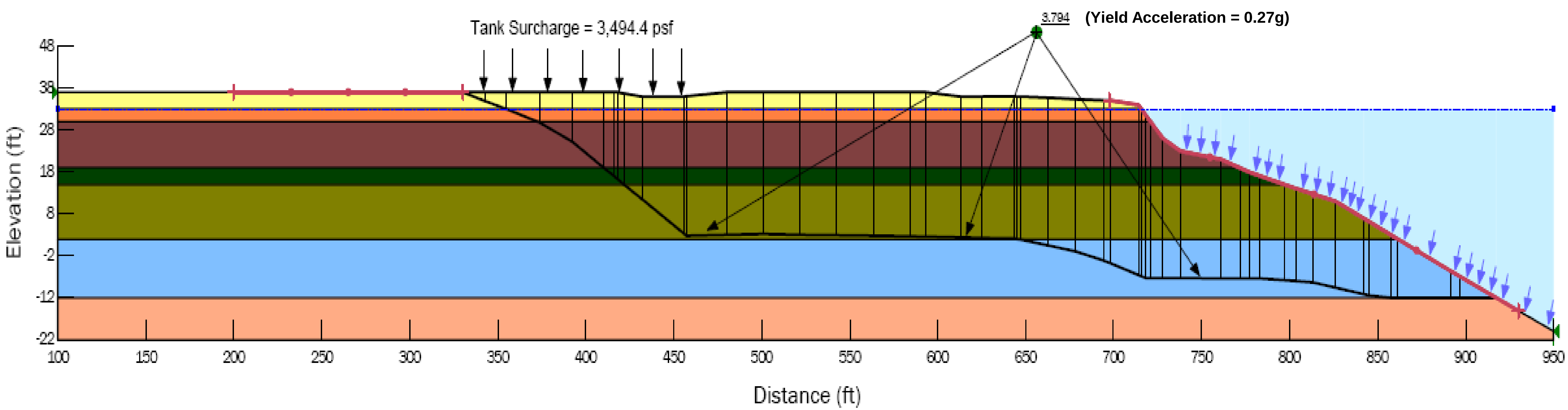
GeoEngineers

Figure 4

Notes:

1. This drawing is not to scale. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

REDM: P:\9\9552014\02\finals\F4_SlopeW_NYard..ppt HPD 07/01/11



Notes:

1. This drawing is not to scale. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

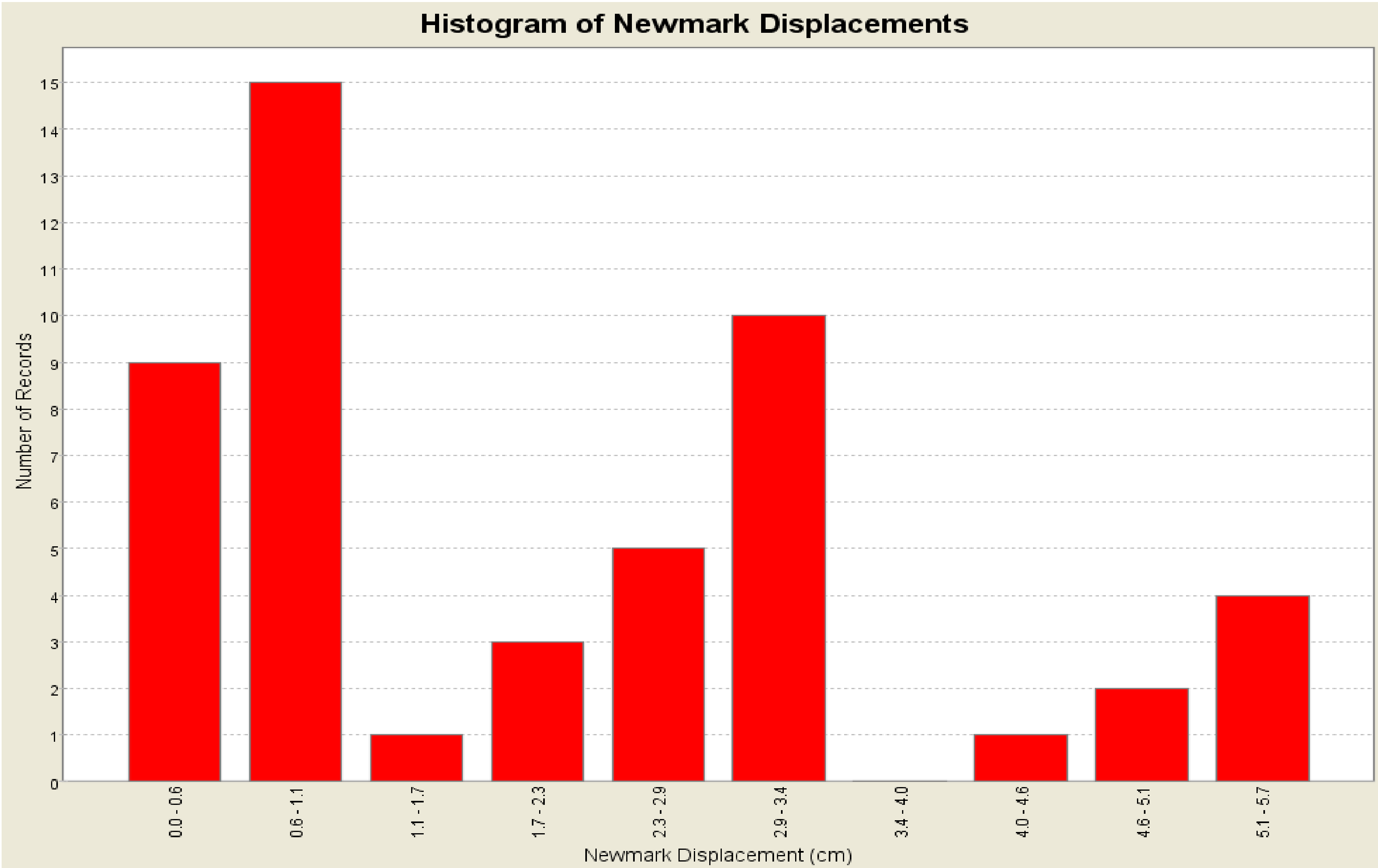
Slope Stability Analysis Results – South Yard (Post-Earthquake)

Willbridge Terminal Tank Replacement Portland, Oregon

GEOENGINEERS

Figure 5

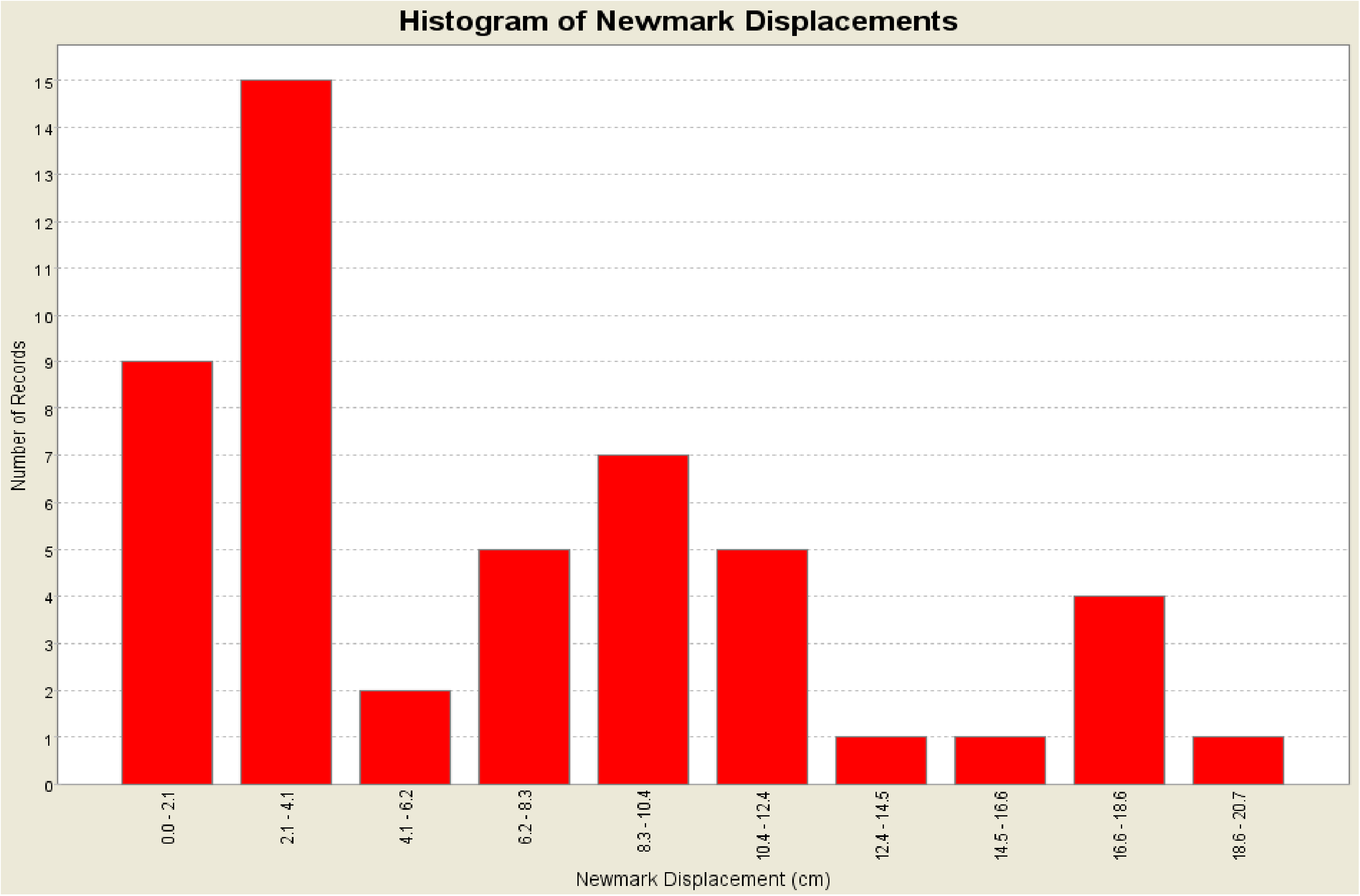
REDM: P:\9\9552014\02\finals\F7_SlopeW_SYard..ppt HPD 07/01/11



Mean Displacement = 2.0 cm

Median Displacement = 1.8 cm

Newmark Analysis Results – North Yard (Portland Hills Fault Event)
Willbridge Terminal Tank Replacement Portland, Oregon
GeoEngineers — **Figure 6**



Mean Displacement = 6.9 cm

Median Displacement = 4.6 cm

Newmark Analysis Results – South Yard (Portland Hills Fault Event)

Willbridge Terminal Tank Replacement
Portland, Oregon

GEOENGINEERS

Figure 7

APPENDICES

APPENDIX A
Field Explorations

APPENDIX A
FIELD EXPLORATIONS

General

Subsurface conditions at the site were explored by advancing two borings (B-1 and B-2) on April 6, 2009 and April 7, 2009, and four Cone Penetrometer Test (CPT) probes (P-1 through P-4) on April 27, 2011 at the approximate locations shown on Figure 2. The approximate exploration locations were established in the field by measuring distances from existing site features. The locations of the explorations should be considered accurate to the degree implied by the method used. The borings were completed to depths of 44 and 49 feet bgs using Mud-rotary drilling techniques; the cones were completed to depths ranging from 34 to 49 feet using truck-mounted equipment, both owned and operated by Subsurface Technologies of North Plains, Oregon.

The borings were continuously monitored by a geotechnical engineer from our firm who examined and classified the soils encountered, obtained representative soil samples, and observed groundwater conditions. Our representative maintained a detailed log of each boring. Disturbed samples of the representative soil types were obtained using a 2-inch outside diameter Standard Penetration Test (SPT) split-spoon sampler, per ASTM Test Method D-1586, and relatively undisturbed samples were collected using a 2.48-inch-diameter Dames and Moore (D&M) Type-U sampler and Shelby tubes (ST). The split-spoon and ring samplers were driven using a 140-pound hammer falling 30 inches, as indicated on the boring logs. The number of blows required for each 6 inches of penetration is recorded. The Standard Penetration Resistance ("N-value") of the soil is calculated as the number of blows required for the final 12 inches of penetration (blows/foot). This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. If the high penetration resistance encountered in the very dense soils precluded driving the total 18-inch sample interval, the penetration resistance for the partial penetration is entered on logs as follows: if the penetration is greater than 6 inches and less than 18 inches, then the number of blows is recorded over the number of inches driven; 30 blows for 6 inches and 50 for 3 inches, for instance, would be recorded as 80/9 inches. The blow counts are shown on the boring logs at the respective sample depths. The Standard Penetration Test is a useful quantitative tool from which soil density/consistency was evaluated.

Soils encountered in the borings were classified in the field in general accordance with ASTM D 2488, the Standard Practice for Classification of Soils, Visual-Manual Procedure, which is summarized in Figure A-1. The boring log symbols are also described in Figure A-1, and logs of the borings are provided as Figures A-2 through A-3. These boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and ground water conditions encountered. They also indicate the depths at which these soils or their characteristics change, although the change might actually be gradual. If the change occurred between samples, it was interpreted.

Since the CPT probe does not collect soil samples, the soil types shown on the CPT plots (Figures A-4 through A-7) are based on correlations between the measured tip and shaft resistance and known soil types (Robertson, P.K. and Campanella, R.G., 1983).

Cone Penetrometer Tests

The CPT is a subsurface exploration technique in which a small-diameter steel tip with adjacent sleeve is continuously advanced with hydraulically operated equipment. Measurements of tip and sleeve resistance allow interpretation of the soil profile and the consistency of the strata penetrated. The tip resistance, friction ratio and pore water pressure are recorded on the CPT logs. The logs of the CPT soundings are presented in Figures A-4 through A-7. The CPT soundings were advanced to depths ranging from 34 to 49 feet below the existing ground surface. The CPT soundings were backfilled in general accordance with procedures outlined by the Washington State Department of Ecology.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Measured groundwater level in exploration, well, or piezometer

Groundwater observed at time of exploration

Perched water observed at time of exploration

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Material Description Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

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FIGURE A-1

Drilled	Start 4/6/2009	End 4/6/2009	Total Depth (ft) 49.2	Logged By MCV / Checked By JMN	Driller Subsurface Technologies	Drilling Method Hollow Stem Auger, Mud Rotary

Surface Elevation (ft) / Vertical Datum: Undetermined	Hammer Data: 140 (lbs) / 30 (in) Drop	Drilling Equipment
Easting (X) / Northing (Y)	System Datum	Groundwater — Date Measured: 4/6/2009; Depth to Water (ft): 5.0; Elevation (ft):
Notes:		

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample No. / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								SP	Brown fine sand with trace silt (fill) (medium dense, moist)			Hollow stem auger from 0 to 5 feet
			15	12		1							
	5		10	14		2	∇			Becomes loose and wet	43	28	Switched to mud rotary at 5 feet
			8	5		3				Becomes gray			Gas/diesel odor
	10		2	11		4				Becomes brown and gray with occasional gray silt seams			
									ML	Gray silt with occasional sand (native) (soft, moist)			
	15		16	4		5					32		
			21			6					38	86	CS PI=9%
	20		2	12		7				Becomes medium stiff			
	25												

Note: Please see Figure A-1 for explanation of symbols.

Log of Boring B-1

GeoEngineers

Project: Willbridge Terminal Tank Replacement
Project Location: Portland, Oregon
Project Number: 9552-014-00

Figure A-2
Sheet 1 of 2

Depth (feet)	Recovered (in)	Blows/foot	Sample No. / Testing	Water Level	Group Classification	Material Description	Moisture Content, %	Dry Density, (pcf)	Remarks
25	15	3	8			Becomes brown and grades with increased sand content (soft, moist)	48		
						Becomes gray			
	20		9						
					SM	Brown silty sand (loose, wet)			
30	10	8	10		ML	Brown silt with clay and sand (medium stiff, moist)	27	91	
35	16	4	11			Becomes soft	33		
	16		12						
40	10	15	13			Becomes stiff			
						Grades to sandy silt			
45	14	17	14			Becomes brown-light gray and clayey (stiff, moist)			
						Becomes dark gray and sandy (very stiff, moist)			
	0	120/2"							Drilling becomes more difficult at 49 feet (bedrock)
						Boring terminated at a depth of 49.2 feet due to auger refusal.			

Note: Please see Figure A-1 for explanation of symbols.

Log of Boring B-1 (continued)

GEOENGINEERS

Project: Willbridge Terminal Tank Replacement
Project Location: Portland, Oregon
Project Number: 9552-014-00

Figure A-2
Sheet 2 of 2

Drilled	Start 4/7/2009	End 4/7/2009	Total Depth (ft)	44.1	Logged By MCV, Checked By JMN	Driller	Subsurface Technologies	Drilling Method	Hollow Stem Auger, Mud Rotary

Surface Elevation (ft) Vertical Datum	Undetermined	Hammer Data	140 (lbs) / 30 (in) Drop
Drilling Equipment			
Easting (X) Northing (Y)		System Datum	

Notes:

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
4/7/2009	2.0	

Depth (feet)	Interval / Recovered (in)	Blows/foot	Sample No.	Water Level	Group Classification	Material Description	Moisture Content, %	Remarks
0					SP	Dark gray fine sand with trace silt (loose, wet) (fill)		Hollow stem auger from 0 to 5 feet
~2				▽				
~2.5	10	15	1					Heavy diesel/gas odor (free product in sample)
5	12	9	2					Switched to mud rotary at 5 feet
~7					CL	Dark gray clay with occasional light gray partially cemented silt (medium stiff, moist) (fill)		
7.5	10	7	3					
10	11	11	4			Becomes brown-gray and grades with sand (native) (stiff, moist)	33	
15	6	7	5			Becomes medium stiff		
~17.5					ML	Gray sandy silt (soft, wet)		
20	14	3	6					
22	4		7					
25								

Note: Please see Figure A-1 for explanation of symbols.

Log of Boring B-2

GEOENGINEERS

Project: Willbridge Terminal Tank Replacement
Project Location: Portland, Oregon
Project Number: 9552-014-00

Figure A-3
Sheet 1 of 2

Portland: Date:7/8/11 Path:C:\USERS\CVOSS\DESKTOP\955201400.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample No. / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25		1	6		8				Becomes brown and grades with clay (soft, moist)			
	30		16	5		9				Grades to with sand (medium stiff, moist)	38		
			24			10					44	82	CS
	35		0	14		11							No recovery
									SM	Brown silty sand (medium dense, moist)			
	40		14	18		12							17% passing #200 sieve
										Becomes dark gray			
													Drilling becomes more difficult at 44 feet (bedrock)
			0	50/1"		13				Boring terminated at a depth of 44.1 feet due to auger refusal.			

Note: Please see Figure A-1 for explanation of symbols.

Log of Boring B-2 (continued)

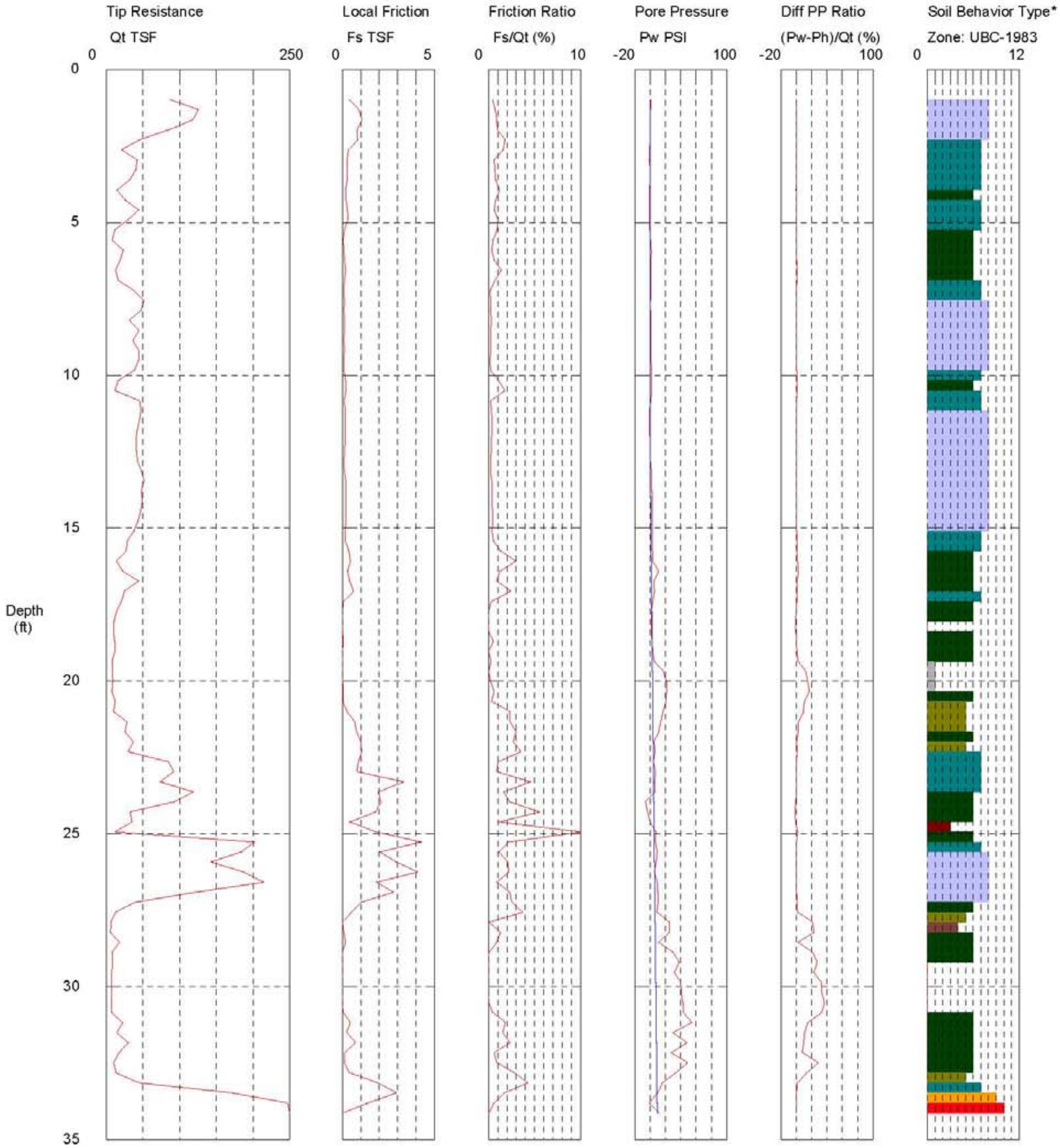
GeoEngineers

Project: Willbridge Terminal Tank Replacement
Project Location: Portland, Oregon
Project Number: 9552-014-00

Subsurface Technologies

Operator: ALEX
Sounding: P-1
Cone Used: DSG1021

CPT Date/Time: 4/27/2011 10:26:39 AM
Location: WILLBRIDGE TERMINAL
Job Number: 9552-014-02



Maximum Depth = 34.12 feet

Depth Increment = 0.328 feet

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

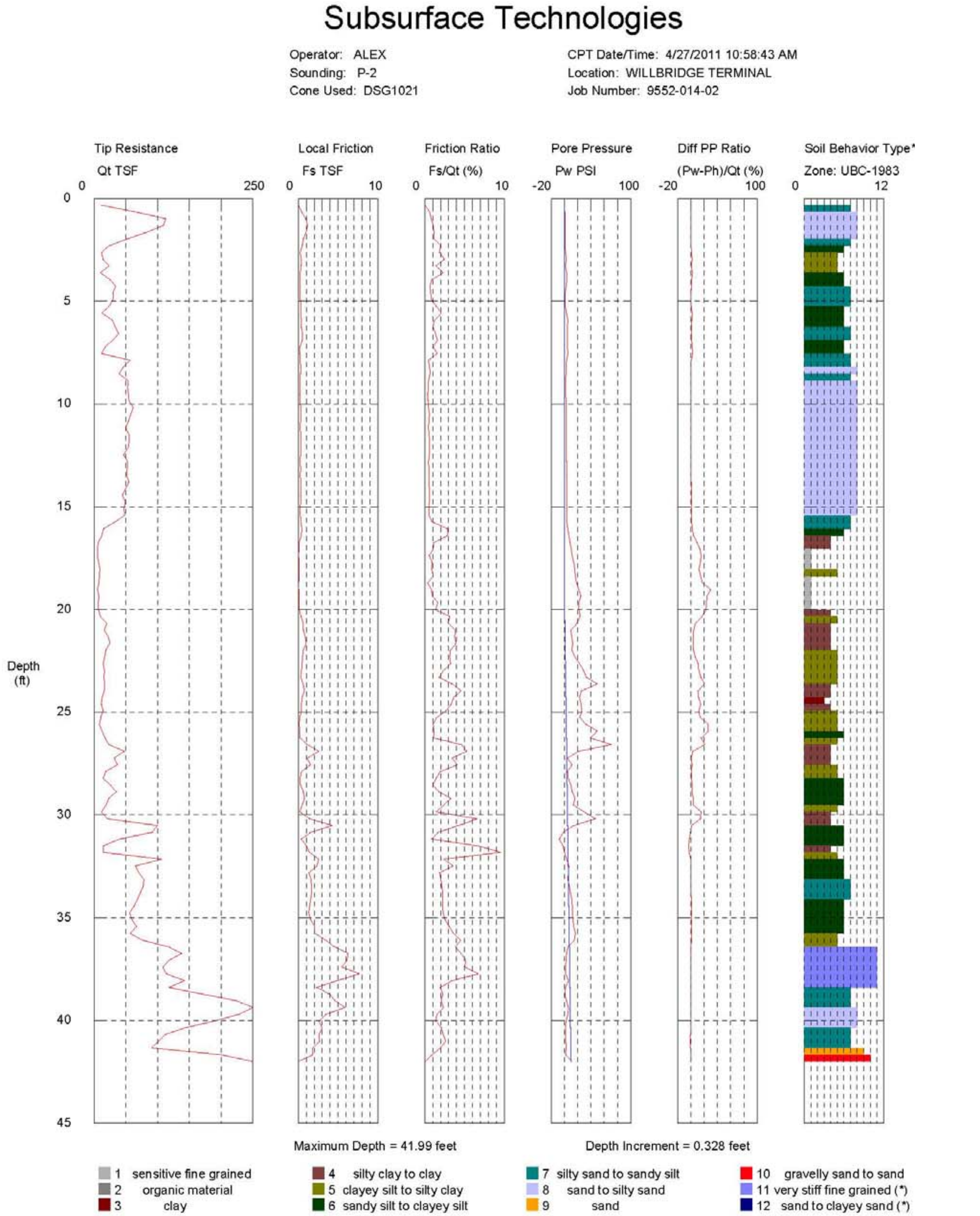
Soil behavior type and SPT based on data from UBC-1983

Log of P- 1

Willbridge Terminal Tank Replacement
Portland, Oregon

GEOENGINEERS

Figure A-4



*Soil behavior type and SPT based on data from UBC-1983

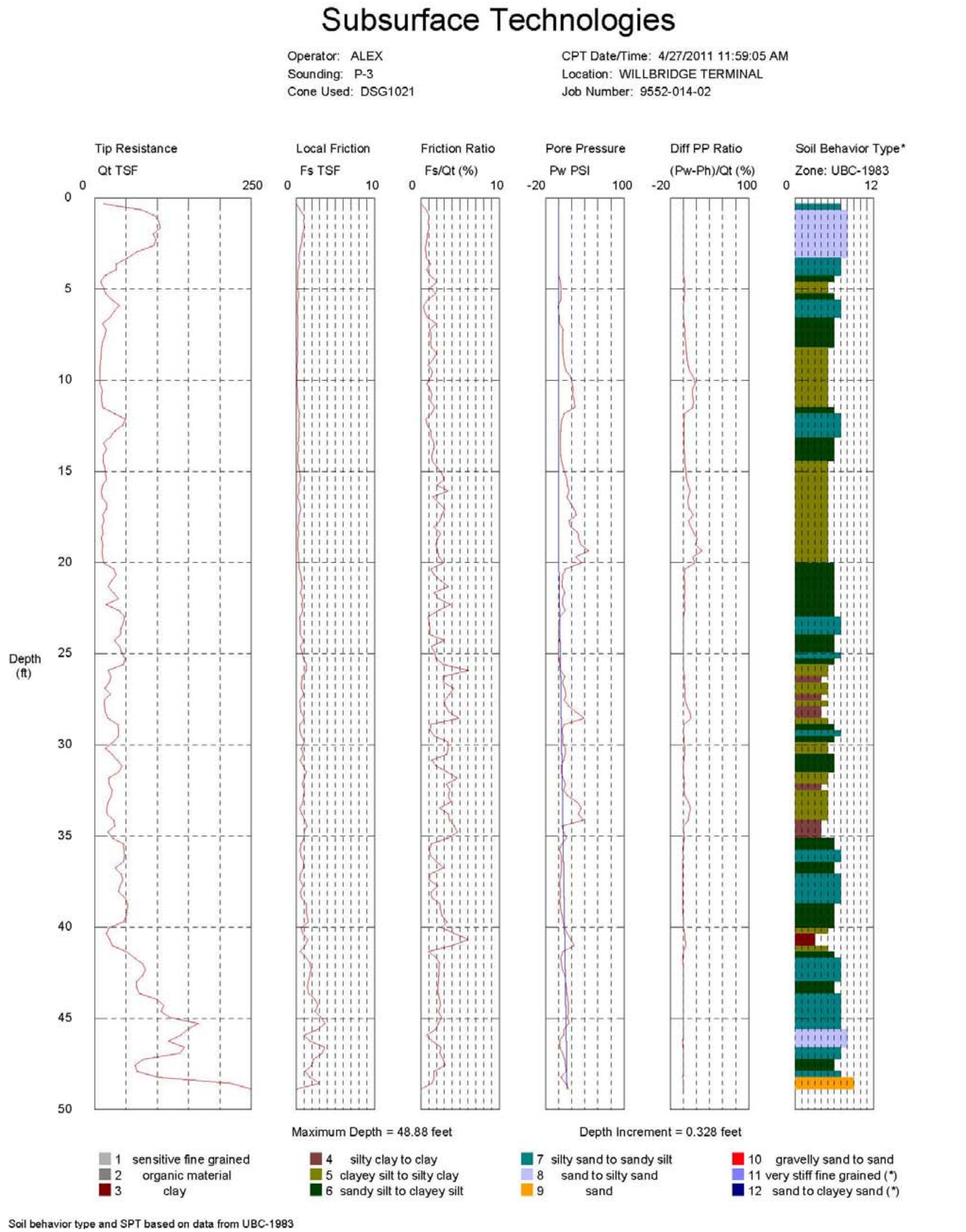
Log of P- 2

Willbridge Terminal Tank Replacement
Portland, Oregon

GeoEngineers

Figure A-5

REDM: P:\9\9552014\02\finals\Log of P-2.ppt HPD 07/13/11



Log of P- 3

Willbridge Terminal Tank Replacement
Portland, Oregon

GeoEngineers

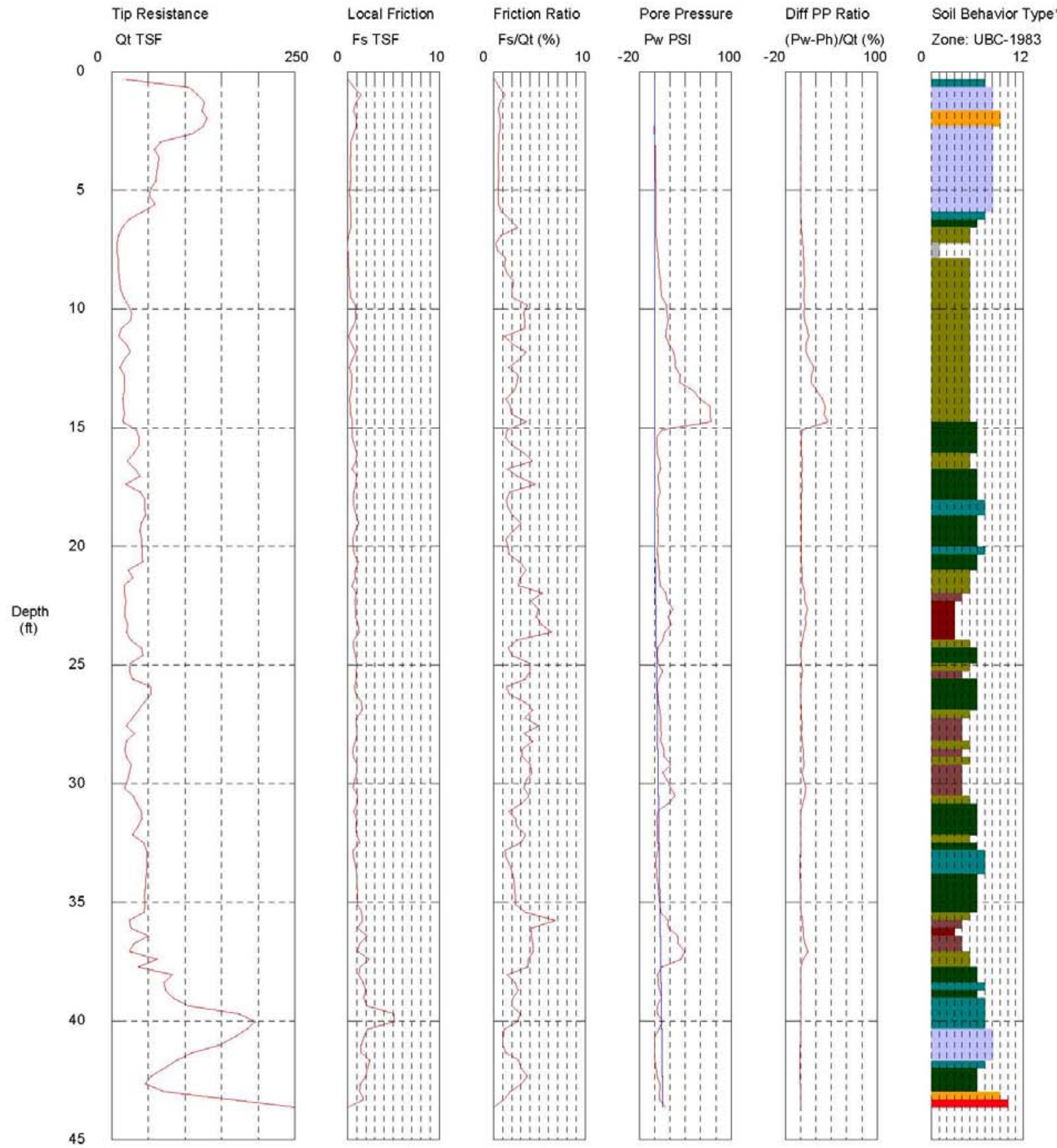
Figure A-6

REDM: P:\9\9552014\02\finals\Log of P-3.ppt HPD 07/13/11

Subsurface Technologies

Operator: ALEX
Sounding: P-4
Cone Used: DSG1021

CPT Date/Time: 4/27/2011 12:44:50 PM
Location: WILLBRIDGE TERMINAL
Job Number: 9552-014-02



Maximum Depth = 43.64 feet

Depth Increment = 0.328 feet

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Log of P- 4

Willbridge Terminal Tank Replacement
Portland, Oregon

GEOENGINEERS

Figure A-7

REDM: P:\9\9552014\02\finals\Log of P-4.ppt HPD 07/13/11

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

General

We transported soil samples obtained from the borings to our Portland, Oregon and Redmond, Washington laboratories and evaluated them to confirm or modify field classifications, as well as to evaluate engineering properties of the soils encountered. We selected representative samples for laboratory testing including moisture content and dry density tests, fines content, Atterberg limits, and consolidation tests. The tests were performed in general accordance with the test methods of the ASTM or other applicable procedures.

Visual Classifications

We visually classified soil samples obtained from the borings in the field and in our geotechnical laboratory based on the Unified Soil Classification System (USCS) and ASTM classification methods. ASTM D 2488 was used to classify soils using visual and manual methods. ASTM D 2487 was used to classify soils based on laboratory test results.

Moisture Content

We obtained moisture contents of samples in general accordance with the ASTM D 2216 test method. The results of the moisture content tests are presented on the boring logs included in Appendix A.

Dry Density

We completed dry density tests on low-disturbance samples obtained with the split-barrel ring sampler. The tests were conducted in general accordance with the ASTM D 2937 test method. Dry density test results are presented on the boring logs included in Appendix A.

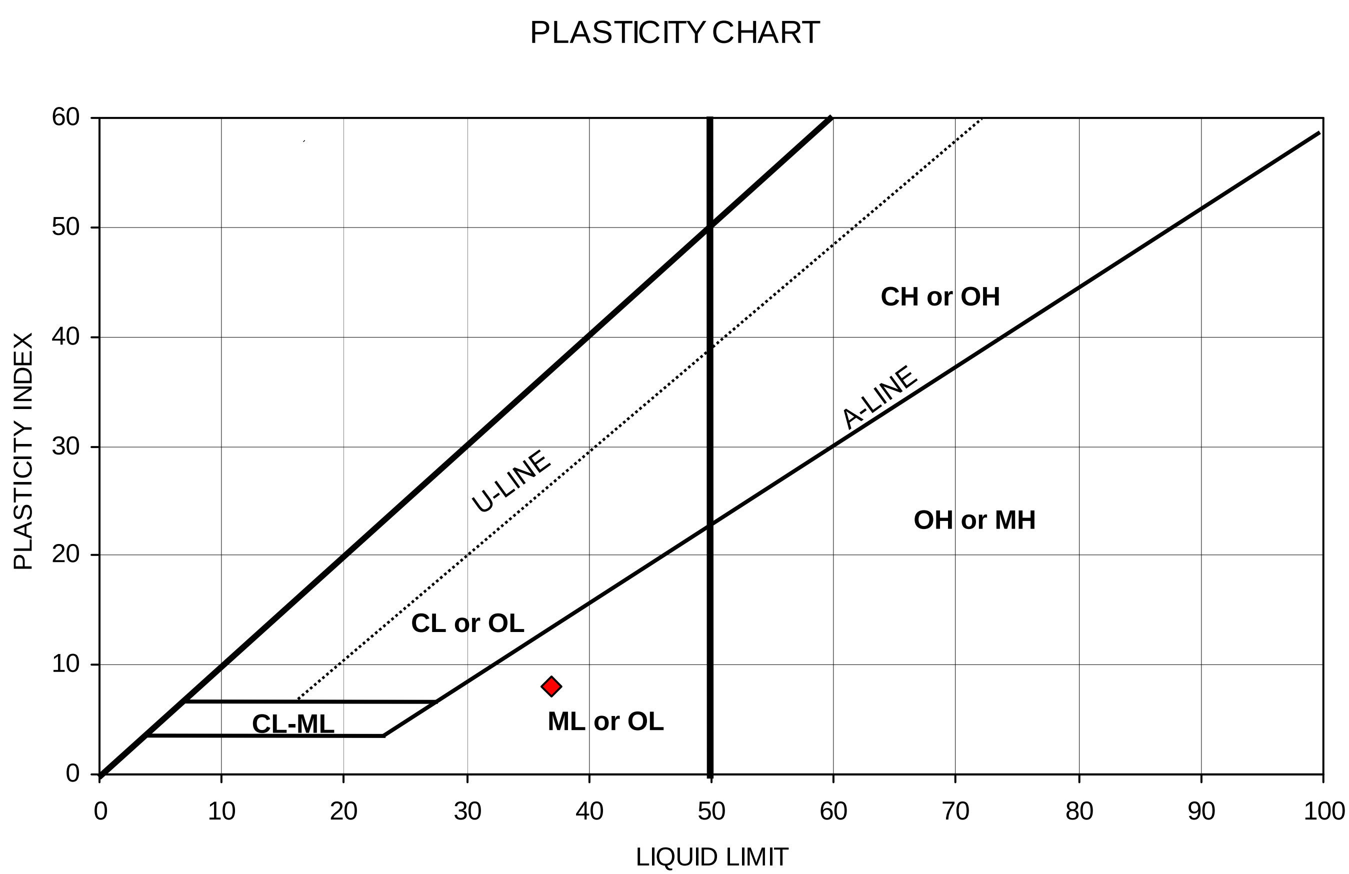
Atterberg Limits

We completed Atterberg limits tests on one fine-grained soil sample. We used the test results to classify the soil as well as to evaluate index properties, swell potential and consolidation characteristics. Liquid limits, plastic limits and plasticity index were obtained in general accordance with ASTM Test Method D 4318. Results of the Atterberg limits tests are summarized in Figure B-1.

Consolidation Tests

We performed two one-dimensional consolidation tests on samples of fine-grained soil in general accordance with the ASTM Test Method D 2435. The results of those tests are included as Figures B-2 and B-3.

9552-014-02 HPD:CSV 7-7-11 (Atterbergs.pptx)



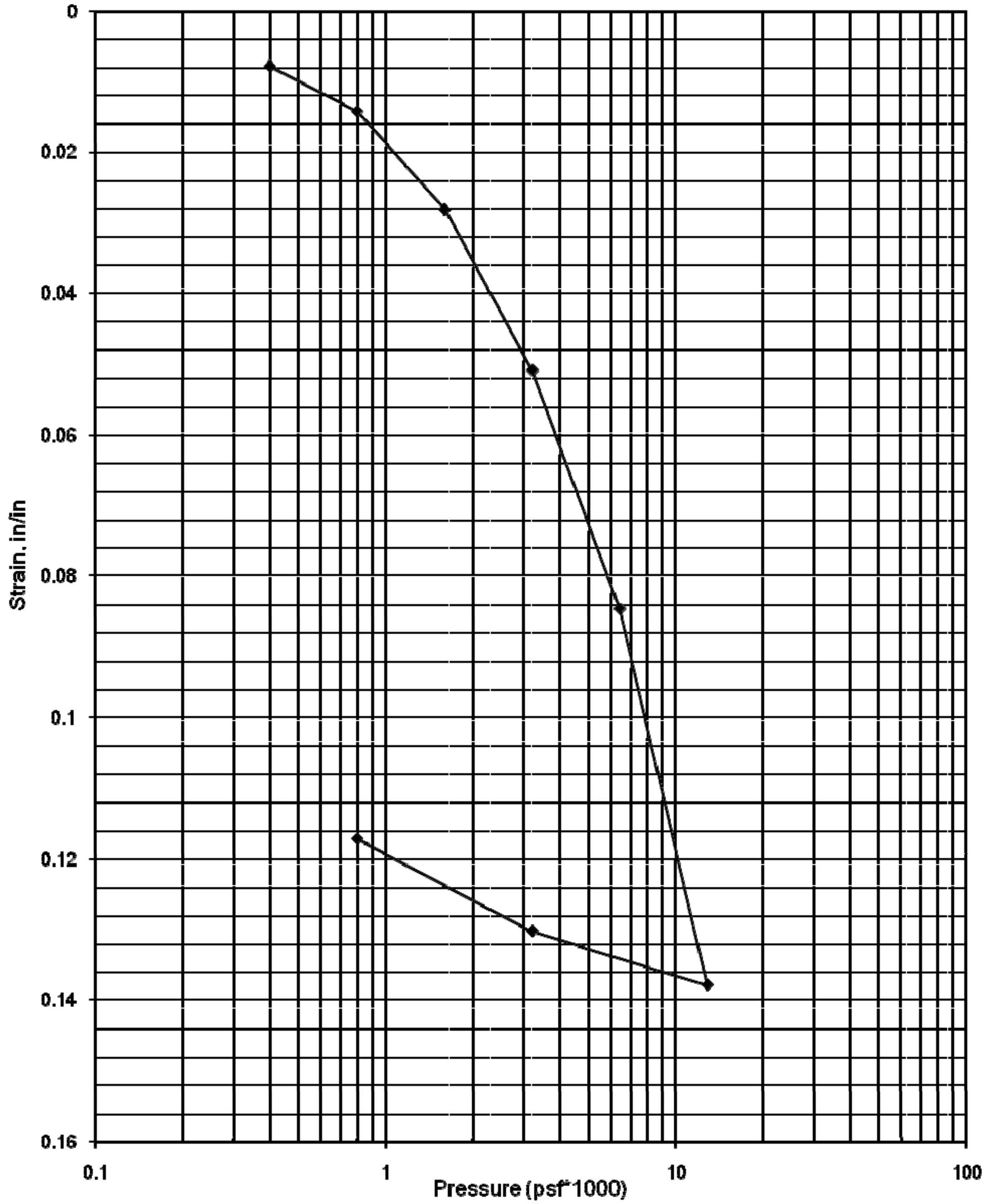
SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOIL DESCRIPTION
◆	B-1	18-20'	38.4	37	9	Gray silt (ML)

Atterberg Limits Test Results

Willbridge Terminal Tank Replacement
Portland, Oregon

GeoEngineers

Figure B-1



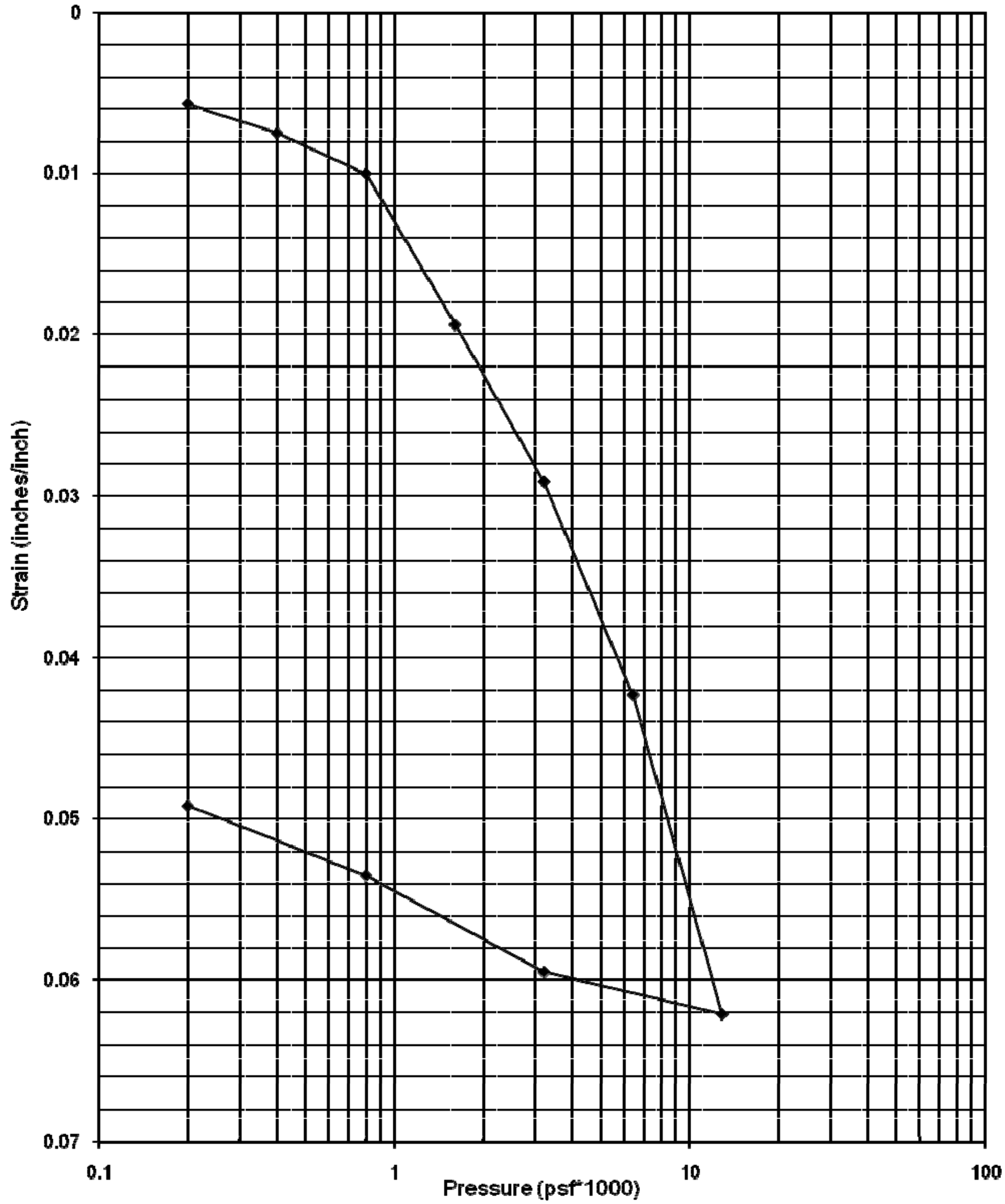
BORING NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION	INITIAL MOISTURE CONTENT	INITIAL DRY DENSITY (LBS/FT^3)
B-1	18-20	Gray silt (ML)	79	86

Consolidation Test Results

Willbridge Terminal Tank Replacement
Portland, Oregon

GEOENGINEERS **Figure B-2**

REDM: \ P:\9\9552014\02\finals\Consolidation test results_Willbridge.ppt HPD 07/06/11



BORING NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION	INITIAL MOISTURE CONTENT	INITIAL DRY DENSITY (LBS/FT^3)
B-2	32-34	Gray silt (ML)	79	82

Consolidation Test Results

Willbridge Terminal Tank Replacement
Portland, Oregon

GeoEngineers | **Figure B-3**

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This final report has been prepared for the exclusive use of the Kinder Morgan, AECOM and Commonwealth Engineering and Construction, and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This draft final report has been prepared for the Willbridge Terminal Tank Replacement project. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject To Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

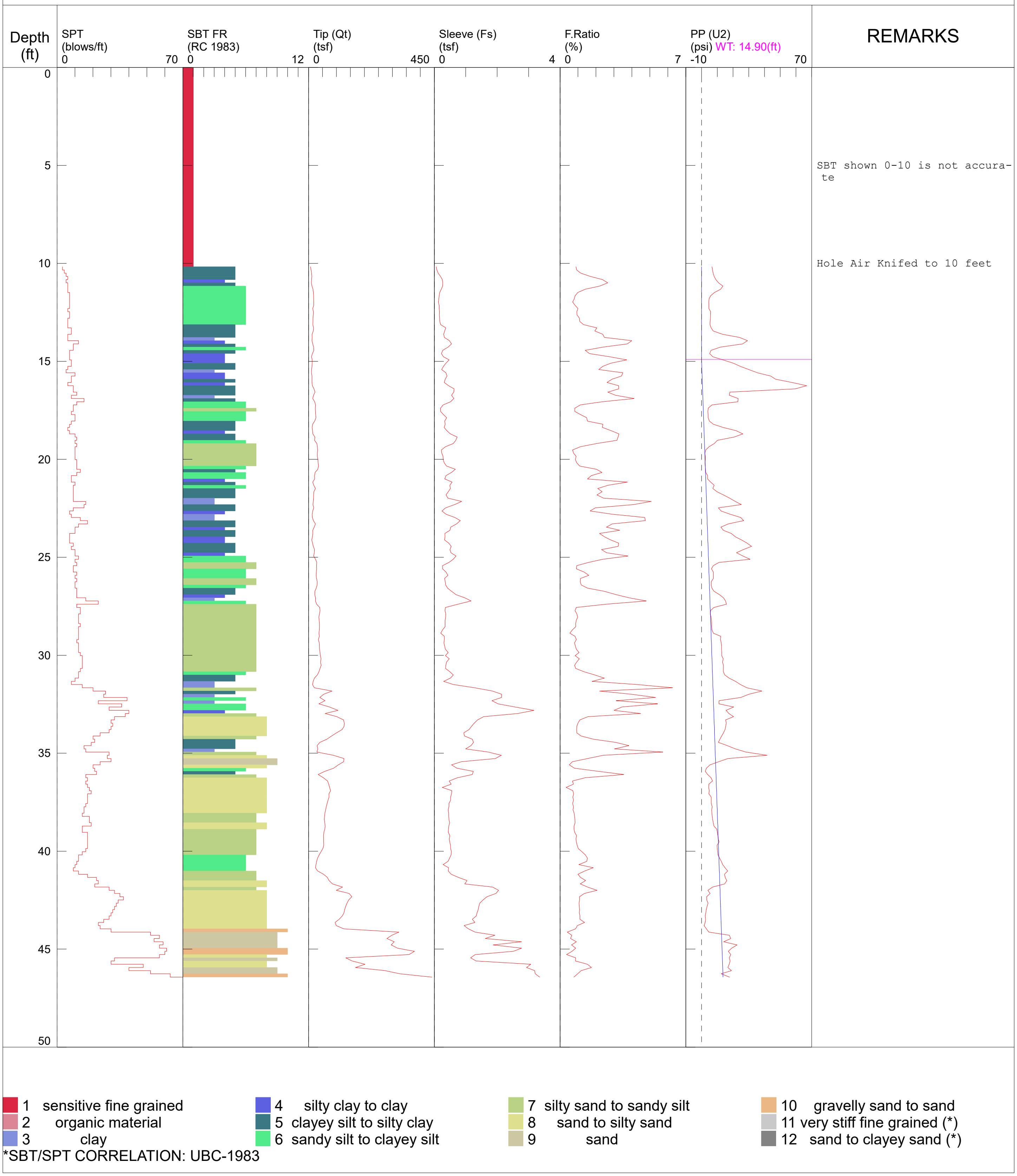
Have we delivered World Class Client Service?

Please let us know by visiting **www. geoengineers.com/feedback**.

GeoEngineers

Sage Geotechnical / CPT-1 / 5880 NW St Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1415
TEST DATE: 3/5/2024 11:39:18 AM
TOTAL DEPTH: 46.424 ft



*SBT/SPT CORRELATION: UBC-1983

Sage Geotechnical / CPT-1 / 5880 NW St Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1415
TEST DATE: 3/5/2024 11:39:18 AM
TOTAL DEPTH: 46.424 ft

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.171	6.60	0.0580	0.879	6.621	3	1	sensitive fine grained
10.335	8.80	0.0813	0.924	6.963	4	5	clayey silt to silty clay
10.499	10.56	0.1212	1.148	7.347	5	5	clayey silt to silty clay
10.663	11.72	0.1974	1.685	8.007	6	5	clayey silt to silty clay
10.827	10.68	0.2519	2.358	9.077	5	5	clayey silt to silty clay
10.991	10.05	0.2668	2.654	10.804	6	4	silty clay to clay
11.155	12.00	0.2645	2.204	13.618	6	5	clayey silt to silty clay
11.319	15.73	0.2205	1.402	12.173	6	6	sandy silt to clayey silt
11.483	17.38	0.1712	0.985	8.224	7	6	sandy silt to clayey silt
11.647	18.25	0.1528	0.837	5.780	7	6	sandy silt to clayey silt
11.811	18.22	0.1429	0.785	4.773	7	6	sandy silt to clayey silt
11.975	18.28	0.1276	0.698	4.506	7	6	sandy silt to clayey silt
12.139	18.49	0.1552	0.839	4.665	7	6	sandy silt to clayey silt
12.303	15.24	0.1508	0.990	4.624	6	6	sandy silt to clayey silt
12.467	17.54	0.1636	0.933	5.773	7	6	sandy silt to clayey silt
12.631	17.01	0.1600	0.941	5.665	7	6	sandy silt to clayey silt
12.795	15.60	0.1676	1.074	5.588	6	6	sandy silt to clayey silt
12.959	15.70	0.1717	1.094	5.417	6	6	sandy silt to clayey silt
13.123	15.34	0.1988	1.296	5.354	6	6	sandy silt to clayey silt
13.287	17.73	0.3624	2.043	6.038	8	5	clayey silt to silty clay
13.451	16.88	0.3266	1.935	7.385	8	5	clayey silt to silty clay
13.615	12.37	0.2940	2.378	13.279	6	5	clayey silt to silty clay
13.780	12.96	0.3186	2.459	24.059	6	5	clayey silt to silty clay
13.944	12.06	0.4807	3.987	29.181	12	3	clay
14.108	14.63	0.5472	3.739	26.109	9	4	silty clay to clay
14.272	18.20	0.4375	2.405	12.096	9	5	clayey silt to silty clay
14.436	19.18	0.2686	1.400	5.947	7	6	sandy silt to clayey silt
14.600	13.59	0.2219	1.633	5.144	7	5	clayey silt to silty clay
14.764	10.53	0.2897	2.752	7.067	7	4	silty clay to clay
14.928	12.69	0.4700	3.704	13.553	8	4	silty clay to clay
15.092	13.06	0.3679	2.816	20.273	8	4	silty clay to clay
15.256	12.15	0.2880	2.371	24.627	6	5	clayey silt to silty clay
15.420	10.72	0.2309	2.155	30.114	5	5	clayey silt to silty clay
15.584	10.48	0.3663	3.497	35.586	10	3	clay
15.748	11.90	0.4064	3.415	43.911	8	4	silty clay to clay
15.912	11.99	0.3468	2.893	47.055	8	4	silty clay to clay
16.076	11.98	0.3120	2.605	57.406	6	5	clayey silt to silty clay
16.240	13.87	0.4520	3.258	66.871	9	4	silty clay to clay
16.404	19.27	0.6285	3.261	59.517	9	5	clayey silt to silty clay
16.568	23.19	0.6160	2.656	17.999	11	5	clayey silt to silty clay
16.732	17.68	0.5450	3.082	17.642	8	5	clayey silt to silty clay
16.896	15.14	0.6239	4.120	23.324	15	3	clay
17.060	21.95	0.5139	2.342	23.064	11	5	clayey silt to silty clay
17.224	24.80	0.2796	1.128	6.535	9	6	sandy silt to clayey silt
17.388	24.08	0.1976	0.820	4.164	9	6	sandy silt to clayey silt
17.552	24.42	0.1999	0.818	3.990	8	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
17.717	25.45	0.2891	1.136	4.091	10	6	sandy silt to clayey silt
17.881	26.63	0.3940	1.479	4.118	10	6	sandy silt to clayey silt
18.045	21.66	0.3287	1.518	4.932	8	6	sandy silt to clayey silt
18.209	14.46	0.3444	2.381	7.467	7	5	clayey silt to silty clay
18.373	13.16	0.3096	2.352	13.515	6	5	clayey silt to silty clay
18.537	13.98	0.3967	2.838	21.934	7	5	clayey silt to silty clay
18.701	15.57	0.5104	3.278	26.242	10	4	silty clay to clay
18.865	22.46	0.7245	3.225	20.712	11	5	clayey silt to silty clay
19.029	21.60	0.6830	3.162	10.048	10	5	clayey silt to silty clay
19.193	29.73	0.5995	2.016	8.065	11	6	sandy silt to clayey silt
19.357	31.42	0.3550	1.130	4.771	10	7	silty sand to sandy silt
19.521	32.21	0.2238	0.695	2.641	10	7	silty sand to sandy silt
19.685	31.53	0.2364	0.750	2.130	10	7	silty sand to sandy silt
19.849	31.44	0.2806	0.893	2.328	10	7	silty sand to sandy silt
20.013	33.38	0.2836	0.850	2.323	11	7	silty sand to sandy silt
20.177	34.06	0.3137	0.921	2.108	11	7	silty sand to sandy silt
20.341	35.40	0.3855	1.089	2.313	11	7	silty sand to sandy silt
20.505	33.07	0.6681	2.020	2.450	13	6	sandy silt to clayey silt
20.669	23.36	0.5439	2.329	2.602	11	5	clayey silt to silty clay
20.833	21.38	0.3734	1.747	3.795	8	6	sandy silt to clayey silt
20.997	21.66	0.3295	1.521	3.829	8	6	sandy silt to clayey silt
21.161	15.12	0.5671	3.750	5.773	10	4	silty clay to clay
21.325	18.44	0.4928	2.673	8.016	9	5	clayey silt to silty clay
21.490	24.46	0.5131	2.098	7.166	9	6	sandy silt to clayey silt
21.654	19.03	0.4439	2.333	9.828	9	5	clayey silt to silty clay
21.818	18.21	0.3726	2.046	13.857	9	5	clayey silt to silty clay
21.982	17.89	0.4327	2.419	17.845	9	5	clayey silt to silty clay
22.146	17.08	0.8664	5.072	21.411	16	3	clay
22.310	15.78	0.6469	4.100	25.276	15	3	clay
22.474	18.39	0.3611	1.963	10.669	9	5	clayey silt to silty clay
22.638	14.60	0.2433	1.667	12.315	7	5	clayey silt to silty clay
22.802	12.75	0.3709	2.909	18.141	8	4	silty clay to clay
22.966	13.85	0.6518	4.707	24.873	13	3	clay
23.130	17.38	0.8254	4.748	26.728	17	3	clay
23.294	24.46	0.7102	2.903	17.004	12	5	clayey silt to silty clay
23.458	20.17	0.5198	2.577	12.252	10	5	clayey silt to silty clay
23.622	15.00	0.4981	3.322	13.835	10	4	silty clay to clay
23.786	15.31	0.3355	2.192	18.801	7	5	clayey silt to silty clay
23.950	13.78	0.3403	2.469	21.522	7	5	clayey silt to silty clay
24.114	11.48	0.3239	2.822	25.468	7	4	silty clay to clay
24.278	13.98	0.4555	3.259	28.858	9	4	silty clay to clay
24.442	16.61	0.5362	3.229	31.735	8	5	clayey silt to silty clay
24.606	21.49	0.4962	2.309	26.541	10	5	clayey silt to silty clay
24.770	20.29	0.5258	2.591	22.208	10	5	clayey silt to silty clay
24.934	18.17	0.6867	3.780	26.268	12	4	silty clay to clay
25.098	25.14	0.5979	2.379	30.839	10	6	sandy silt to clayey silt
25.262	29.37	0.4636	1.579	11.016	11	6	sandy silt to clayey silt
25.427	28.47	0.2629	0.923	7.385	9	7	silty sand to sandy silt
25.591	29.11	0.2635	0.905	6.253	9	7	silty sand to sandy silt
25.755	27.80	0.3721	1.339	7.441	11	6	sandy silt to clayey silt
25.919	27.02	0.4308	1.594	7.530	10	6	sandy silt to clayey silt
26.083	28.63	0.3235	1.130	7.510	11	6	sandy silt to clayey silt
26.247	30.89	0.3446	1.116	6.159	10	7	silty sand to sandy silt
26.411	30.55	0.3594	1.177	6.171	10	7	silty sand to sandy silt
26.575	27.57	0.4205	1.525	6.547	11	6	sandy silt to clayey silt
26.739	22.31	0.5473	2.453	7.915	11	5	clayey silt to silty clay
26.903	22.10	0.6884	3.115	11.349	11	5	clayey silt to silty clay

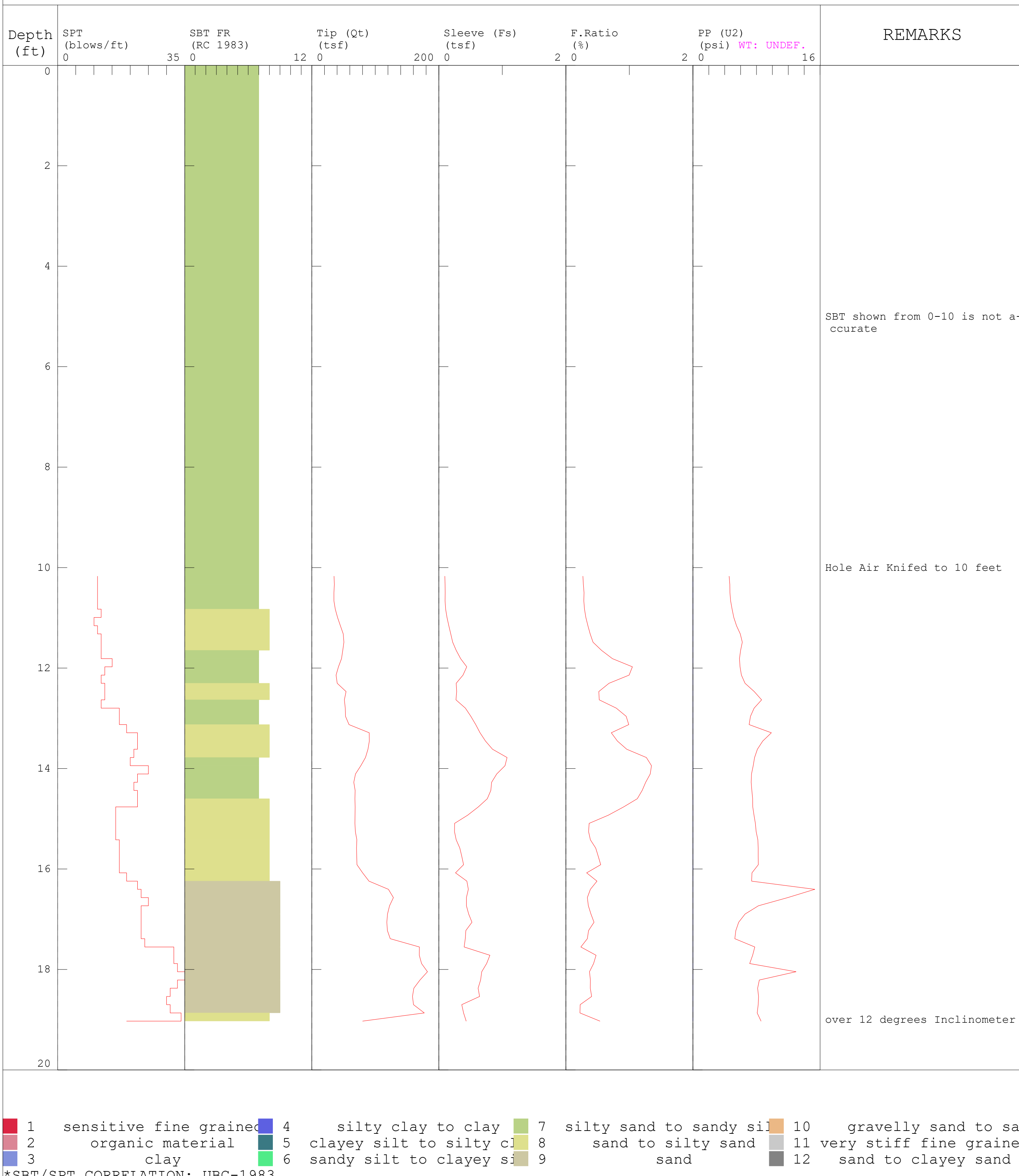
Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
27.067	25.23	0.9679	3.836	13.932	16	4	silty clay to clay
27.231	24.34	1.1671	4.795	15.173	23	3	clay
27.395	29.28	0.7504	2.563	15.850	11	6	sandy silt to clayey silt
27.559	39.71	0.3556	0.896	7.838	13	7	silty sand to sandy silt
27.723	41.01	0.3389	0.826	5.643	13	7	silty sand to sandy silt
27.887	38.75	0.3624	0.935	5.491	12	7	silty sand to sandy silt
28.051	36.62	0.3595	0.982	6.033	12	7	silty sand to sandy silt
28.215	37.89	0.3411	0.900	6.272	12	7	silty sand to sandy silt
28.379	39.30	0.3419	0.870	6.460	13	7	silty sand to sandy silt
28.543	39.11	0.3415	0.873	6.378	12	7	silty sand to sandy silt
28.707	38.40	0.2631	0.685	6.621	12	7	silty sand to sandy silt
28.871	37.36	0.2018	0.540	7.491	12	7	silty sand to sandy silt
29.035	38.63	0.3192	0.826	12.211	12	7	silty sand to sandy silt
29.199	35.11	0.3185	0.907	11.956	11	7	silty sand to sandy silt
29.364	38.18	0.3041	0.797	12.529	12	7	silty sand to sandy silt
29.528	38.73	0.3290	0.850	12.698	12	7	silty sand to sandy silt
29.692	39.10	0.3525	0.901	12.722	12	7	silty sand to sandy silt
29.856	41.22	0.4364	1.059	12.855	13	7	silty sand to sandy silt
30.020	42.30	0.3548	0.839	12.782	14	7	silty sand to sandy silt
30.184	44.71	0.4779	1.069	13.765	14	7	silty sand to sandy silt
30.348	42.40	0.3903	0.920	13.276	14	7	silty sand to sandy silt
30.512	44.94	0.3631	0.808	13.973	14	7	silty sand to sandy silt
30.676	41.05	0.3582	0.873	13.835	13	7	silty sand to sandy silt
30.840	37.15	0.4914	1.323	13.806	12	7	silty sand to sandy silt
31.004	31.41	0.6058	1.929	14.768	12	6	sandy silt to clayey silt
31.168	20.63	0.5080	2.462	17.522	10	5	clayey silt to silty clay
31.332	16.52	0.2941	1.780	21.584	8	5	clayey silt to silty clay
31.496	14.10	0.6034	4.279	24.717	14	3	clay
31.660	20.49	1.2825	6.260	28.803	20	3	clay
31.824	84.02	1.8478	2.199	38.340	27	7	silty sand to sandy silt
31.988	54.29	2.1367	3.936	30.220	26	5	clayey silt to silty clay
32.152	40.27	2.1401	5.314	24.909	39	3	clay
32.316	58.75	1.8325	3.119	11.166	23	6	sandy silt to clayey silt
32.480	37.31	2.0241	5.425	11.079	36	3	clay
32.644	74.60	2.5648	3.438	20.353	29	6	sandy silt to clayey silt
32.808	105.54	3.1683	3.002	15.534	40	6	sandy silt to clayey silt
32.972	59.28	2.6578	4.484	17.363	38	4	silty clay to clay
33.136	100.99	1.5711	1.556	20.392	32	7	silty sand to sandy silt
33.301	125.05	1.3760	1.100	15.254	30	8	sand to silty sand
33.465	127.96	1.2687	0.991	15.744	31	8	sand to silty sand
33.629	126.97	1.1824	0.931	15.300	30	8	sand to silty sand
33.793	120.06	1.1042	0.920	14.929	29	8	sand to silty sand
33.957	100.10	0.9346	0.934	13.944	24	8	sand to silty sand
34.121	82.47	0.9588	1.163	12.782	20	8	sand to silty sand
34.285	65.06	1.2098	1.859	11.647	21	7	silty sand to sandy silt
34.449	40.33	1.2484	3.095	10.676	19	5	clayey silt to silty clay
34.613	30.46	1.1654	3.826	16.303	15	5	clayey silt to silty clay
34.777	33.06	0.9992	3.022	21.483	16	5	clayey silt to silty clay
34.941	29.93	1.7136	5.725	28.133	29	3	clay
35.105	88.76	2.1291	2.399	41.653	28	7	silty sand to sandy silt
35.269	126.56	1.9379	1.531	16.664	30	8	sand to silty sand
35.433	125.33	0.8645	0.690	10.946	24	9	sand
35.597	106.42	0.5450	0.512	5.308	20	9	sand
35.761	89.80	0.7182	0.800	3.062	21	8	sand to silty sand
35.925	57.92	1.2383	2.138	2.352	22	6	sandy silt to clayey silt
36.089	34.15	1.2096	3.542	3.805	16	5	clayey silt to silty clay
36.253	52.87	0.7324	1.385	6.009	17	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
36.417	68.04	0.4691	0.689	6.915	16	8	sand to silty sand
36.581	71.91	0.5362	0.746	4.662	17	8	sand to silty sand
36.745	75.02	0.2518	0.336	4.491	18	8	sand to silty sand
36.909	78.62	0.5557	0.707	4.882	19	8	sand to silty sand
37.073	72.66	0.5466	0.752	4.648	17	8	sand to silty sand
37.238	73.03	0.5192	0.711	6.120	17	8	sand to silty sand
37.402	69.83	0.5185	0.743	6.137	17	8	sand to silty sand
37.566	66.38	0.4639	0.699	6.159	16	8	sand to silty sand
37.730	62.94	0.4647	0.738	6.761	15	8	sand to silty sand
37.894	61.03	0.4375	0.717	6.465	15	8	sand to silty sand
38.058	58.24	0.4544	0.780	6.583	14	8	sand to silty sand
38.222	57.01	0.4584	0.804	6.727	18	7	silty sand to sandy silt
38.386	56.36	0.4651	0.825	7.062	18	7	silty sand to sandy silt
38.550	58.05	0.4842	0.834	7.404	19	7	silty sand to sandy silt
38.714	59.54	0.4612	0.775	7.807	14	8	sand to silty sand
38.878	57.93	0.4501	0.777	9.734	14	8	sand to silty sand
39.042	54.46	0.4430	0.814	9.992	17	7	silty sand to sandy silt
39.206	53.67	0.4920	0.917	10.399	17	7	silty sand to sandy silt
39.370	53.95	0.4750	0.880	10.628	17	7	silty sand to sandy silt
39.534	53.83	0.4882	0.907	11.132	17	7	silty sand to sandy silt
39.698	54.18	0.5145	0.950	9.823	17	7	silty sand to sandy silt
39.862	51.40	0.5195	1.011	9.908	16	7	silty sand to sandy silt
40.026	44.73	0.5412	1.210	10.170	14	7	silty sand to sandy silt
40.190	37.85	0.5327	1.408	10.450	12	7	silty sand to sandy silt
40.354	32.01	0.4852	1.516	11.421	12	6	sandy silt to clayey silt
40.518	29.28	0.4343	1.484	12.563	11	6	sandy silt to clayey silt
40.682	26.55	0.2770	1.043	13.402	10	6	sandy silt to clayey silt
40.846	24.51	0.4522	1.845	14.900	9	6	sandy silt to clayey silt
41.011	32.40	0.4442	1.371	16.647	12	6	sandy silt to clayey silt
41.175	53.70	0.5350	0.996	14.546	17	7	silty sand to sandy silt
41.339	67.44	0.7659	1.136	14.982	22	7	silty sand to sandy silt
41.503	73.26	1.0388	1.418	16.105	23	7	silty sand to sandy silt
41.667	85.92	0.9687	1.127	14.616	21	8	sand to silty sand
41.831	121.26	1.8566	1.531	7.024	29	8	sand to silty sand
41.995	99.40	2.0419	2.054	3.990	32	7	silty sand to sandy silt
42.159	145.09	1.9564	1.348	5.407	35	8	sand to silty sand
42.323	154.81	1.6718	1.080	3.241	37	8	sand to silty sand
42.487	143.42	1.5491	1.080	3.303	34	8	sand to silty sand
42.651	137.28	1.4472	1.054	4.099	33	8	sand to silty sand
42.815	132.64	1.4154	1.067	3.436	32	8	sand to silty sand
42.979	129.05	1.3937	1.080	2.959	31	8	sand to silty sand
43.143	126.73	1.3573	1.071	2.682	30	8	sand to silty sand
43.307	120.52	1.3326	1.106	2.270	29	8	sand to silty sand
43.471	109.31	1.2068	1.104	2.581	26	8	sand to silty sand
43.635	94.74	1.2908	1.362	2.270	23	8	sand to silty sand
43.799	98.89	0.9466	0.957	1.624	24	8	sand to silty sand
43.963	125.90	1.0842	0.861	3.070	30	8	sand to silty sand
44.127	323.29	1.2962	0.401	4.624	52	10	gravelly sand to sand
44.291	298.05	1.9279	0.647	17.630	57	9	sand
44.455	280.23	1.6158	0.577	18.539	54	9	sand
44.619	306.27	2.7744	0.906	14.076	59	9	sand
44.783	295.64	1.8741	0.634	22.562	57	9	sand
44.948	317.84	2.7738	0.873	19.143	61	9	sand
45.112	378.87	2.5137	0.663	16.963	60	10	gravelly sand to sand
45.276	359.63	1.3006	0.362	18.563	57	10	gravelly sand to sand
45.440	132.88	1.1559	0.870	17.618	32	8	sand to silty sand
45.604	155.70	1.3285	0.853	18.124	30	9	sand

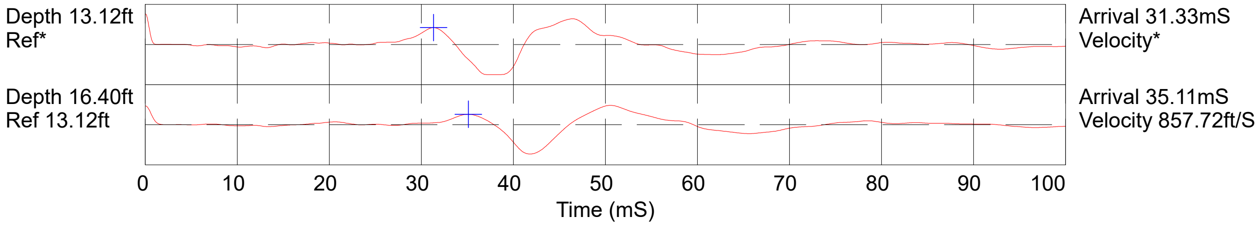
Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
45.768	202.01	3.0662	1.518	17.580	48	8	sand to silty sand
45.932	168.31	2.9348	1.744	16.703	40	8	sand to silty sand
46.096	273.91	3.1929	1.166	19.028	52	9	sand
46.260	327.17	3.2108	0.981	12.522	63	9	sand
46.424	441.58	3.3508	0.759	17.758	70	10	gravelly sand to sand

Sage Geotechnical / CPT-2 / 5880 NW St Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1296
TEST DATE: 3/5/2024 4:19:49 PM
TOTAL DEPTH: 19.029 ft



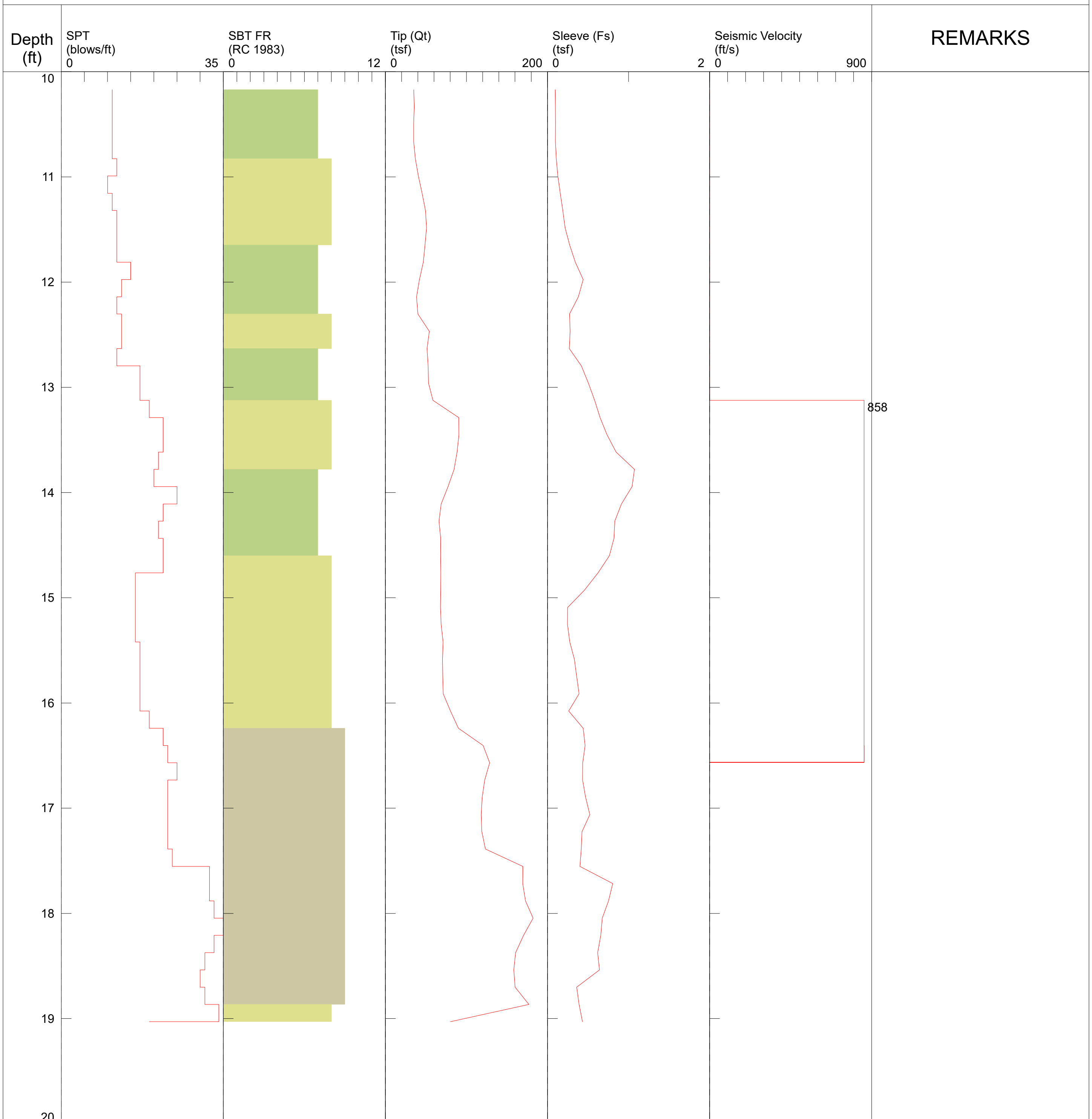
COMMENT: Sage Geotechnical / CPT-2 / 5880 NW St Helens Road Portland



Hammer to Rod String Distance (ft): 2.03
* = Not Determined

Sage Geotechnical / CPT-2 / 5880 NW St Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1296
TEST DATE: 3/5/2024 4:19:49 PM
TOTAL DEPTH: 19.029 ft

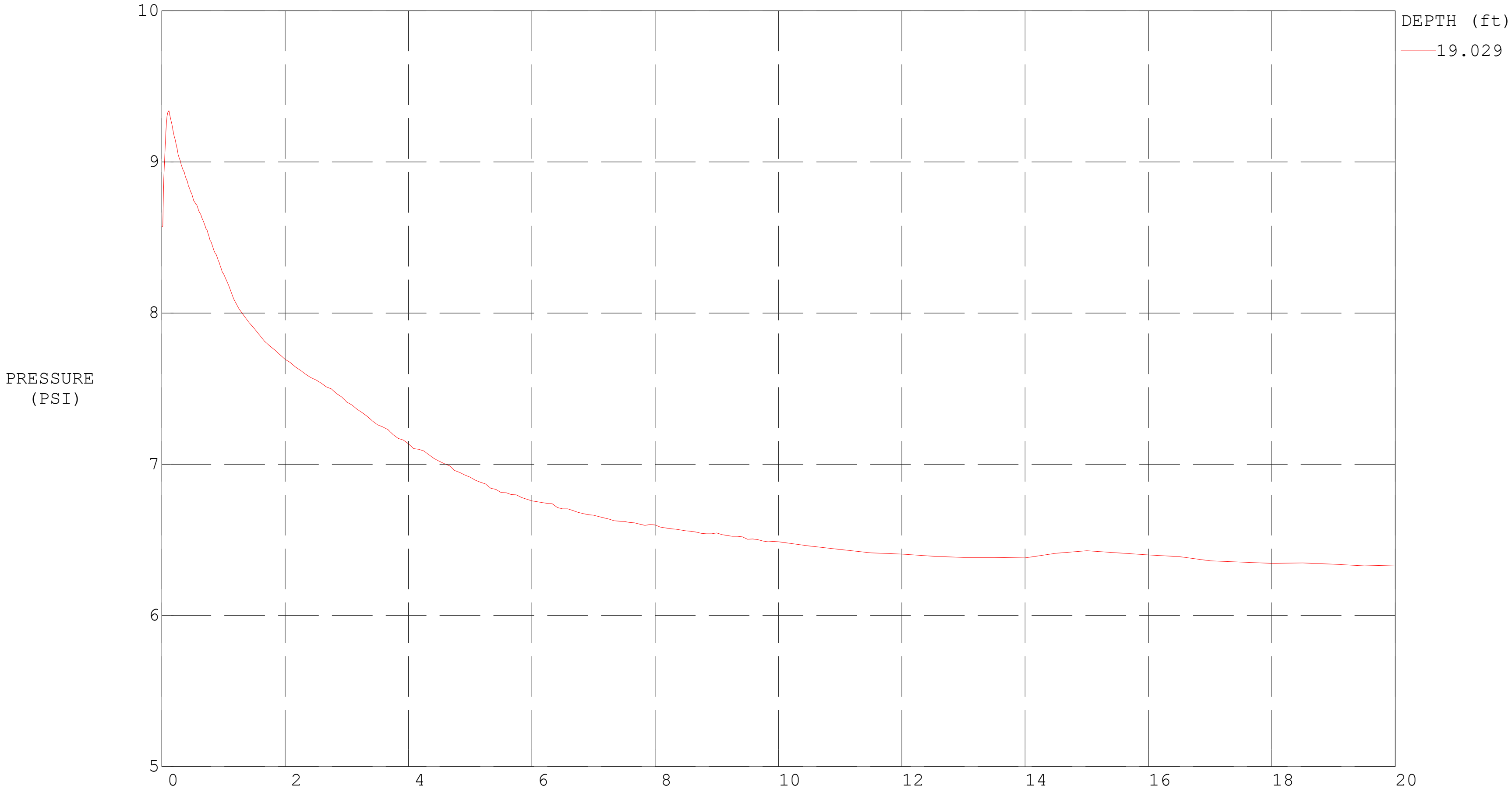


1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

COMMENT: Sage Geotechnical / CPT-2 / 5880 NW St Helens Road Portland

CONE ID: DDG1296
TEST DATE: 3/5/2024 4:19:49 PM



MAXIMUM PRESSURE = 9.34 (PSI) TIME: (MINUTES)
HYDROSTATIC PRESSURE = 8.247 (PSI), WATER TABLE: 0.00 ft

Sage Geotechnical / CPT-2 / 5880 NW St Helens Road Portland

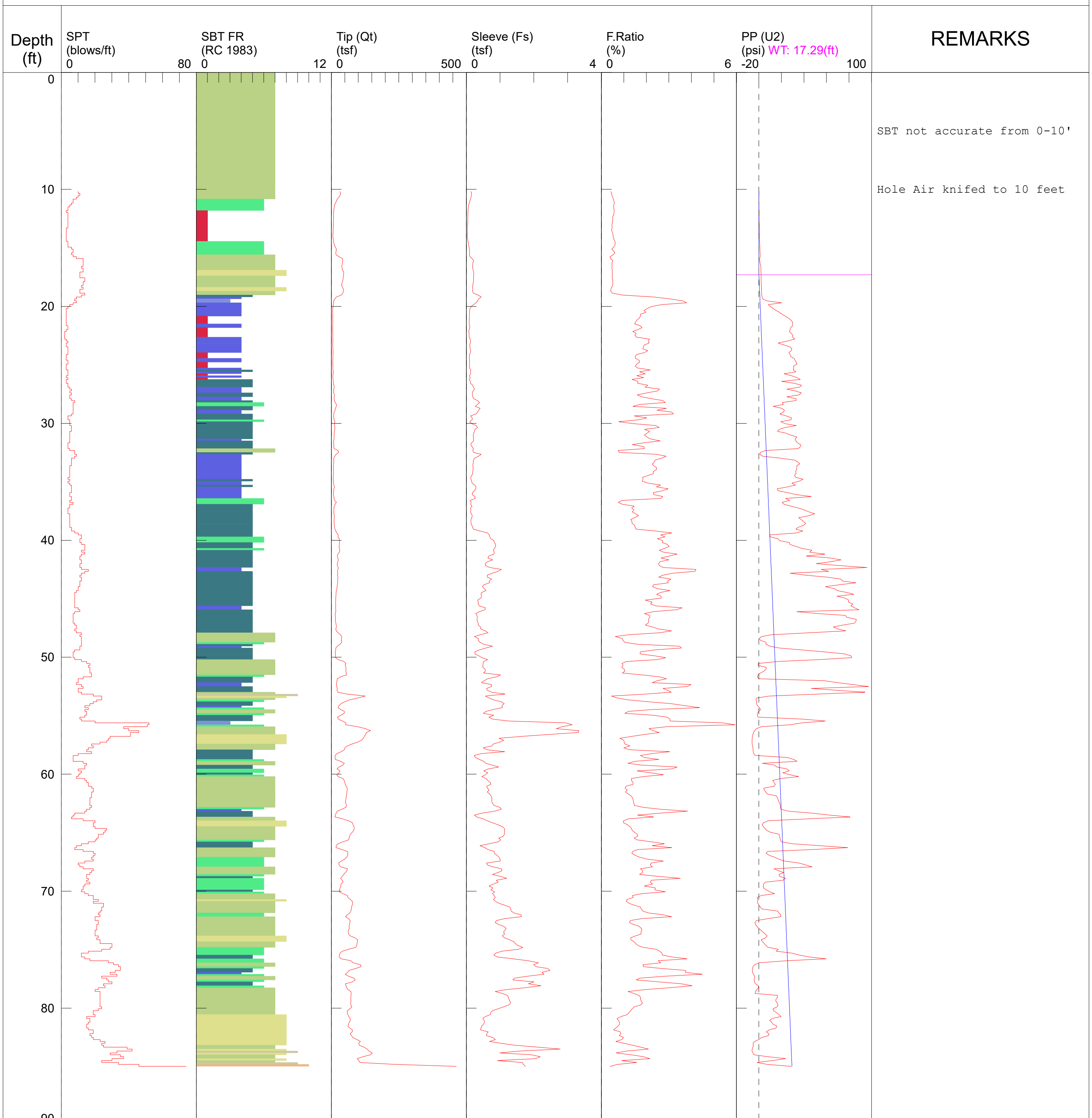
OPERATOR: OGE BAK
CONE ID: DDG1296
TEST DATE: 3/5/2024 4:19:49 PM
TOTAL DEPTH: 19.029 ft

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.171	34.99	0.0939	0.268	4.548	11	7	silty sand to sandy silt
10.335	35.65	0.0980	0.275	4.632	11	7	silty sand to sandy silt
10.499	34.85	0.0999	0.287	4.663	11	7	silty sand to sandy silt
10.663	34.82	0.0980	0.281	4.741	11	7	silty sand to sandy silt
10.827	36.89	0.1077	0.292	4.917	12	7	silty sand to sandy silt
10.991	40.54	0.1274	0.314	5.149	10	8	sand to silty sand
11.155	45.18	0.1565	0.346	5.482	11	8	sand to silty sand
11.319	49.38	0.1882	0.381	5.954	12	8	sand to silty sand
11.483	50.70	0.2169	0.428	6.205	12	8	sand to silty sand
11.647	48.79	0.2731	0.560	6.001	12	8	sand to silty sand
11.811	46.72	0.3421	0.732	5.862	15	7	silty sand to sandy silt
11.975	41.99	0.4397	1.047	5.937	13	7	silty sand to sandy silt
12.139	38.30	0.3809	0.994	6.105	12	7	silty sand to sandy silt
12.303	40.03	0.2720	0.679	6.552	13	7	silty sand to sandy silt
12.467	54.05	0.2797	0.518	7.711	13	8	sand to silty sand
12.631	51.33	0.2691	0.524	8.644	12	8	sand to silty sand
12.795	52.78	0.4184	0.793	7.700	17	7	silty sand to sandy silt
12.959	53.15	0.5039	0.948	7.244	17	7	silty sand to sandy silt
13.123	58.67	0.5801	0.989	7.077	19	7	silty sand to sandy silt
13.287	90.45	0.6472	0.715	9.882	22	8	sand to silty sand
13.451	90.55	0.7343	0.811	8.784	22	8	sand to silty sand
13.615	88.39	0.8465	0.958	8.119	21	8	sand to silty sand
13.780	84.65	1.0730	1.268	7.753	20	8	sand to silty sand
13.944	77.34	1.0417	1.347	7.594	25	7	silty sand to sandy silt
14.108	68.75	0.9121	1.327	7.370	22	7	silty sand to sandy silt
14.272	66.18	0.8306	1.255	7.331	21	7	silty sand to sandy silt
14.436	68.16	0.8183	1.201	7.415	22	7	silty sand to sandy silt
14.600	67.94	0.7632	1.123	7.513	22	7	silty sand to sandy silt
14.764	68.42	0.6230	0.910	7.535	16	8	sand to silty sand
14.928	68.10	0.4542	0.667	7.689	16	8	sand to silty sand
15.092	67.92	0.2486	0.366	7.859	16	8	sand to silty sand
15.256	68.69	0.2460	0.358	7.954	16	8	sand to silty sand
15.420	71.07	0.2741	0.386	8.172	17	8	sand to silty sand
15.584	70.38	0.3307	0.470	8.225	17	8	sand to silty sand
15.748	70.74	0.3601	0.509	8.225	17	8	sand to silty sand
15.912	71.25	0.3901	0.547	8.236	17	8	sand to silty sand
16.076	80.13	0.2614	0.326	7.418	19	8	sand to silty sand
16.240	90.13	0.4404	0.489	7.390	22	8	sand to silty sand
16.404	120.61	0.4644	0.385	15.330	23	9	sand
16.568	128.56	0.4337	0.337	11.927	25	9	sand
16.732	122.45	0.4330	0.354	8.239	23	9	sand
16.896	119.30	0.4705	0.394	6.554	23	9	sand
17.060	118.08	0.5220	0.442	5.753	23	9	sand
17.224	118.94	0.4257	0.358	5.398	23	9	sand
17.388	123.50	0.4158	0.337	5.269	24	9	sand
17.552	169.46	0.3993	0.236	7.781	32	9	sand

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
17.717	169.36	0.8043	0.475	7.515	32	9	sand
17.881	172.81	0.7517	0.435	7.136	33	9	sand
18.045	182.12	0.6755	0.371	12.969	35	9	sand
18.209	170.43	0.6581	0.386	8.365	33	9	sand
18.373	160.70	0.6176	0.384	8.147	31	9	sand
18.537	158.39	0.6420	0.405	8.256	30	9	sand
18.701	160.10	0.3601	0.225	8.211	31	9	sand
18.865	177.01	0.3901	0.220	8.085	34	9	sand
19.029	80.14	0.4301	0.537	8.572	19	8	sand to silty sand

Sage Geotechnical / CPT-3 / 5880 NW St Helens Road Portland

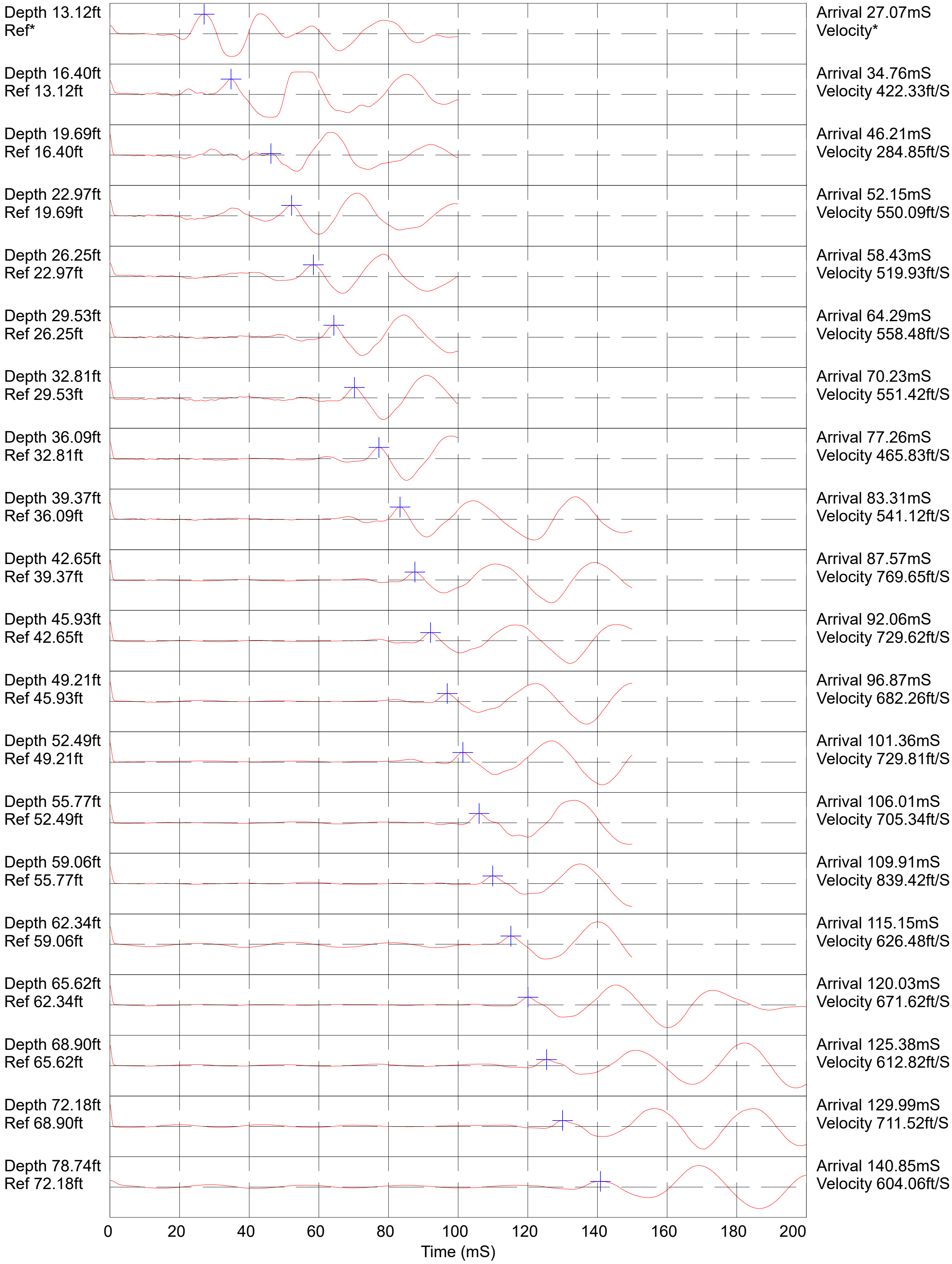
OPERATOR: OGE BAK
CONE ID: DDG1296
TEST DATE: 3/5/2024 2:21:07 PM
TOTAL DEPTH: 84.974 ft



1 sensitive fine grained
2 organic material
3 clay
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 (*)

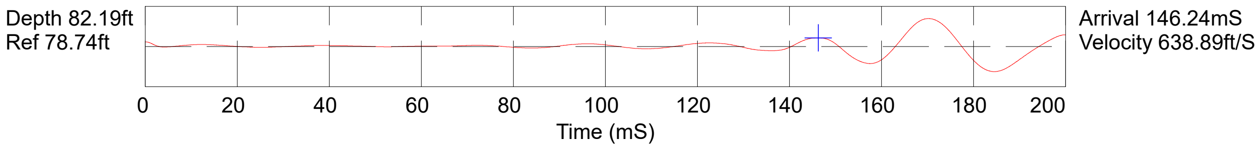
*SBT/SPT CORRELATION: UBC-1983

COMMENT: Sage Geotechnical / CPT-3 / 5880 NW St Helens Road Portland



Hammer to Rod String Distance (ft): 2.03
* = Not Determined

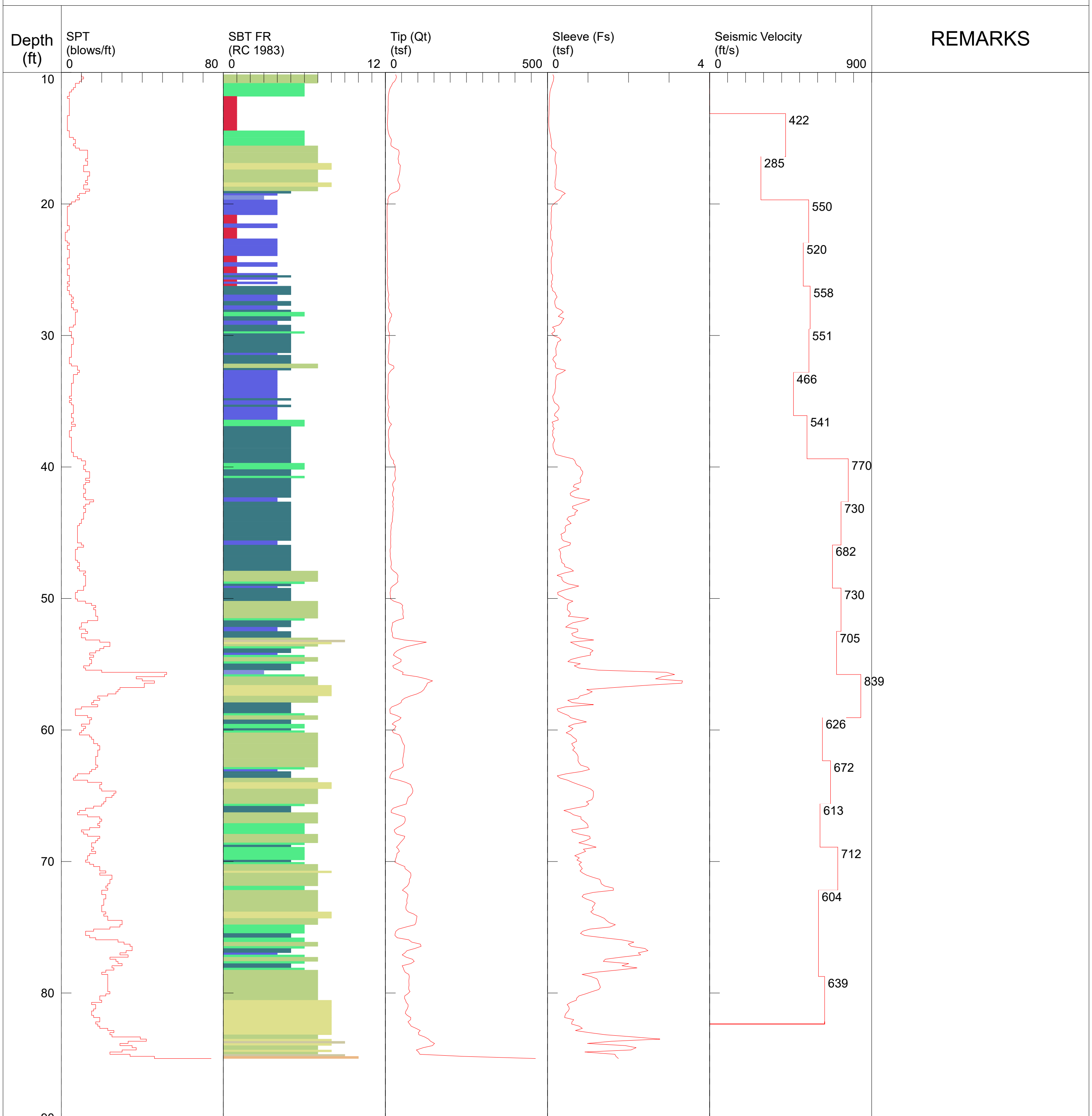
COMMENT: Sage Geotechnical / CPT-3 / 5880 NW St Helens Road Portland



Hammer to Rod String Distance (ft): 2.03
* = Not Determined

Sage Geotechnical / CPT-3 / 5880 NW St Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1296
TEST DATE: 3/5/2024 2:21:07 PM
TOTAL DEPTH: 84.974 ft



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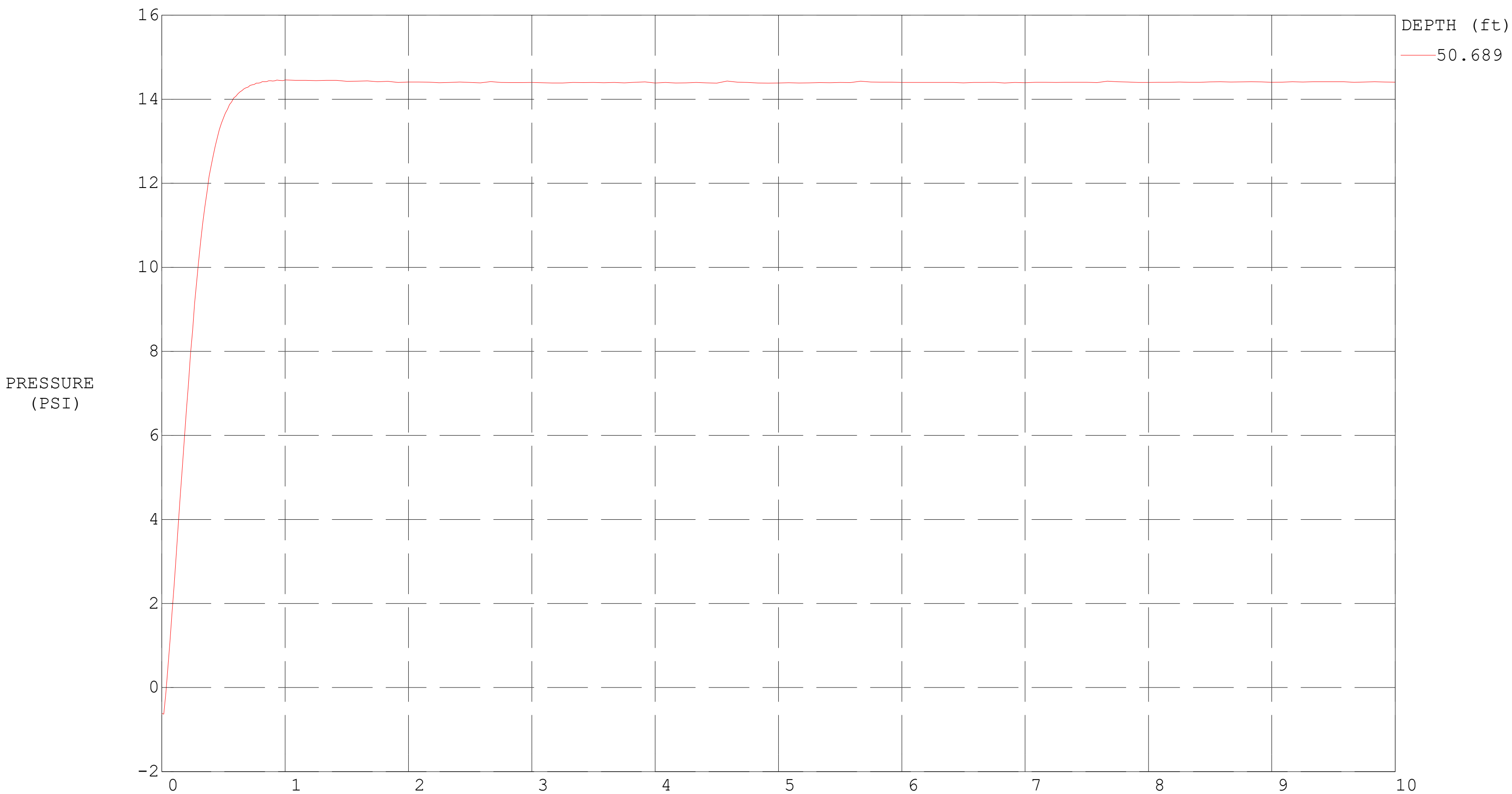
COMMENT: Sage Geotechnical / CPT-3 / 5880 NW St Helens Road Portland

CONE ID: DDG1296
TEST DATE: 3/5/2024 2:21:07 PM



MAXIMUM PRESSURE = 14.458 (PSI)

HYDROSTATIC PRESSURE = 14.473 (PSI), WATER TABLE: 17.29 ft

Sage Geotechnical / CPT-3 / 5880 NW St Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1296
TEST DATE: 3/5/2024 2:21:07 PM
TOTAL DEPTH: 84.974 ft

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.171	31.64	0.1320	0.417	0.053	10	7	silty sand to sandy silt
10.335	34.07	0.1572	0.462	0.014	11	7	silty sand to sandy silt
10.499	32.23	0.1497	0.465	-0.006	10	7	silty sand to sandy silt
10.663	28.63	0.1413	0.493	0.008	9	7	silty sand to sandy silt
10.827	22.07	0.1184	0.536	-0.070	7	7	silty sand to sandy silt
10.991	19.34	0.1059	0.547	-0.045	7	6	sandy silt to clayey silt
11.155	15.18	0.0872	0.575	-0.003	6	6	sandy silt to clayey silt
11.319	12.78	0.0703	0.550	0.014	5	6	sandy silt to clayey silt
11.483	11.17	0.0603	0.540	0.031	4	6	sandy silt to clayey silt
11.647	10.03	0.0551	0.549	0.050	4	6	sandy silt to clayey silt
11.811	9.10	0.0520	0.572	0.073	3	6	sandy silt to clayey silt
11.975	8.54	0.0482	0.565	0.075	4	1	sensitive fine grained
12.139	8.31	0.0456	0.549	0.075	4	1	sensitive fine grained
12.303	8.39	0.0421	0.502	0.084	4	1	sensitive fine grained
12.467	8.28	0.0416	0.502	0.084	4	1	sensitive fine grained
12.631	7.99	0.0400	0.501	0.134	4	1	sensitive fine grained
12.795	8.24	0.0404	0.490	0.142	4	1	sensitive fine grained
12.959	7.94	0.0373	0.469	0.151	4	1	sensitive fine grained
13.123	7.73	0.0364	0.471	0.165	4	1	sensitive fine grained
13.287	7.07	0.0337	0.477	0.296	3	1	sensitive fine grained
13.451	6.79	0.0305	0.449	0.316	3	1	sensitive fine grained
13.615	6.49	0.0308	0.475	0.341	3	1	sensitive fine grained
13.780	6.14	0.0314	0.511	0.372	3	1	sensitive fine grained
13.944	5.98	0.0311	0.520	0.405	3	1	sensitive fine grained
14.108	6.40	0.0342	0.534	0.453	3	1	sensitive fine grained
14.272	7.17	0.0402	0.560	0.511	3	1	sensitive fine grained
14.436	8.13	0.0486	0.598	0.564	4	1	sensitive fine grained
14.600	9.68	0.0598	0.618	0.626	4	6	sandy silt to clayey silt
14.764	11.62	0.0692	0.596	0.696	4	6	sandy silt to clayey silt
14.928	14.80	0.0805	0.544	0.771	6	6	sandy silt to clayey silt
15.092	18.68	0.0862	0.461	0.841	7	6	sandy silt to clayey silt
15.256	17.72	0.0949	0.535	0.919	7	6	sandy silt to clayey silt
15.420	16.88	0.1013	0.600	0.978	6	6	sandy silt to clayey silt
15.584	17.33	0.0898	0.518	1.045	7	6	sandy silt to clayey silt
15.748	28.28	0.1082	0.382	1.106	9	7	silty sand to sandy silt
15.912	40.93	0.1667	0.407	0.522	13	7	silty sand to sandy silt
16.076	42.08	0.2135	0.507	0.629	13	7	silty sand to sandy silt
16.240	41.77	0.1976	0.473	0.908	13	7	silty sand to sandy silt
16.404	40.07	0.1886	0.471	1.162	13	7	silty sand to sandy silt
16.568	38.94	0.1860	0.478	1.671	12	7	silty sand to sandy silt
16.732	40.27	0.1867	0.464	1.715	13	7	silty sand to sandy silt
16.896	40.95	0.1988	0.485	1.746	13	7	silty sand to sandy silt
17.060	46.12	0.2179	0.472	1.763	11	8	sand to silty sand
17.224	45.30	0.2202	0.486	1.827	11	8	sand to silty sand
17.388	45.13	0.2142	0.475	1.841	11	8	sand to silty sand
17.552	43.96	0.2127	0.484	1.855	14	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
17.717	42.98	0.2144	0.499	1.917	14	7	silty sand to sandy silt
17.881	41.37	0.2067	0.500	2.000	13	7	silty sand to sandy silt
18.045	39.18	0.2004	0.512	2.065	13	7	silty sand to sandy silt
18.209	38.16	0.1896	0.497	2.143	12	7	silty sand to sandy silt
18.373	40.88	0.1845	0.451	2.216	13	7	silty sand to sandy silt
18.537	44.51	0.1881	0.423	2.249	11	8	sand to silty sand
18.701	44.25	0.1846	0.417	2.291	11	8	sand to silty sand
18.865	42.56	0.2072	0.487	2.322	14	7	silty sand to sandy silt
19.029	36.99	0.3473	0.939	2.392	12	7	silty sand to sandy silt
19.193	18.79	0.4384	2.333	2.822	9	5	clayey silt to silty clay
19.357	11.86	0.3610	3.045	3.336	8	4	silty clay to clay
19.521	9.21	0.3334	3.621	6.753	9	3	clay
19.685	7.57	0.2861	3.779	20.024	7	3	clay
19.849	7.95	0.2133	2.683	8.348	5	4	silty clay to clay
20.013	6.40	0.1429	2.232	10.147	4	4	silty clay to clay
20.177	5.22	0.1064	2.040	12.720	3	4	silty clay to clay
20.341	4.96	0.0939	1.894	15.129	3	4	silty clay to clay
20.505	5.01	0.0988	1.971	18.174	3	4	silty clay to clay
20.669	5.15	0.0893	1.733	20.557	3	4	silty clay to clay
20.833	5.35	0.0927	1.732	23.276	3	4	silty clay to clay
20.997	5.37	0.0902	1.681	26.165	3	1	sensitive fine grained
21.161	5.46	0.0857	1.571	28.439	3	1	sensitive fine grained
21.325	5.54	0.0846	1.527	29.869	3	1	sensitive fine grained
21.490	5.69	0.0839	1.476	29.875	3	1	sensitive fine grained
21.654	5.63	0.0969	1.722	29.914	4	4	silty clay to clay
21.818	5.64	0.1018	1.806	28.076	4	4	silty clay to clay
21.982	5.40	0.0875	1.619	27.662	3	1	sensitive fine grained
22.146	5.18	0.0721	1.392	26.994	2	1	sensitive fine grained
22.310	5.12	0.0792	1.545	28.916	2	1	sensitive fine grained
22.474	5.16	0.0766	1.484	30.090	2	1	sensitive fine grained
22.638	5.11	0.0799	1.563	29.950	2	1	sensitive fine grained
22.802	5.33	0.1138	2.134	31.738	3	4	silty clay to clay
22.966	5.82	0.1213	2.084	25.229	4	4	silty clay to clay
23.130	5.46	0.1159	2.122	16.875	3	4	silty clay to clay
23.294	5.38	0.1026	1.908	22.474	3	4	silty clay to clay
23.458	5.67	0.1062	1.872	27.531	4	4	silty clay to clay
23.622	5.99	0.1100	1.836	29.255	4	4	silty clay to clay
23.786	6.23	0.1279	2.053	28.537	4	4	silty clay to clay
23.950	6.21	0.1178	1.896	26.617	4	4	silty clay to clay
24.114	6.21	0.0972	1.564	27.587	3	1	sensitive fine grained
24.278	5.98	0.0899	1.503	28.148	3	1	sensitive fine grained
24.442	5.83	0.0883	1.515	31.241	3	1	sensitive fine grained
24.606	5.58	0.0935	1.674	32.079	4	4	silty clay to clay
24.770	5.61	0.0952	1.697	32.903	4	4	silty clay to clay
24.934	6.06	0.0951	1.568	33.890	3	1	sensitive fine grained
25.098	5.92	0.0891	1.506	30.649	3	1	sensitive fine grained
25.262	6.01	0.0962	1.600	31.017	3	1	sensitive fine grained
25.427	5.90	0.1279	2.170	30.461	4	4	silty clay to clay
25.591	7.35	0.1250	1.699	32.822	4	5	clayey silt to silty clay
25.755	6.22	0.1209	1.943	22.429	4	4	silty clay to clay
25.919	5.95	0.0937	1.576	28.897	3	1	sensitive fine grained
26.083	5.92	0.1106	1.867	33.786	4	4	silty clay to clay
26.247	6.41	0.0871	1.359	36.664	3	1	sensitive fine grained
26.411	7.31	0.1184	1.620	20.188	3	5	clayey silt to silty clay
26.575	7.64	0.1232	1.613	31.504	4	5	clayey silt to silty clay
26.739	9.15	0.1888	2.062	37.932	4	5	clayey silt to silty clay
26.903	10.66	0.2069	1.941	36.153	5	5	clayey silt to silty clay

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
27.067	9.16	0.2365	2.581	24.782	6	4	silty clay to clay
27.231	7.98	0.1997	2.502	32.088	5	4	silty clay to clay
27.395	8.68	0.1759	2.027	37.605	6	4	silty clay to clay
27.559	11.25	0.1791	1.593	35.650	5	5	clayey silt to silty clay
27.723	10.70	0.1909	1.785	24.837	5	5	clayey silt to silty clay
27.887	9.68	0.2169	2.239	33.009	6	4	silty clay to clay
28.051	11.98	0.3269	2.729	33.113	8	4	silty clay to clay
28.215	13.76	0.3908	2.839	20.658	7	5	clayey silt to silty clay
28.379	19.15	0.3286	1.716	21.599	7	6	sandy silt to clayey silt
28.543	18.95	0.2659	1.404	12.720	7	6	sandy silt to clayey silt
28.707	14.09	0.4075	2.892	20.163	7	5	clayey silt to silty clay
28.871	14.57	0.3595	2.467	22.594	7	5	clayey silt to silty clay
29.035	10.80	0.3365	3.116	21.731	7	4	silty clay to clay
29.199	8.96	0.2865	3.197	18.515	6	4	silty clay to clay
29.364	8.52	0.1241	1.458	24.184	4	5	clayey silt to silty clay
29.528	8.78	0.1769	2.015	28.883	4	5	clayey silt to silty clay
29.692	10.38	0.1733	1.669	28.520	5	5	clayey silt to silty clay
29.856	13.12	0.1022	0.778	19.459	5	6	sandy silt to clayey silt
30.020	11.12	0.1560	1.403	23.021	5	5	clayey silt to silty clay
30.184	11.89	0.2875	2.418	33.188	6	5	clayey silt to silty clay
30.348	12.94	0.3326	2.570	23.382	6	5	clayey silt to silty clay
30.512	13.12	0.2512	1.915	17.808	6	5	clayey silt to silty clay
30.676	11.20	0.2400	2.143	16.540	5	5	clayey silt to silty clay
30.840	10.73	0.2177	2.028	23.988	5	5	clayey silt to silty clay
31.004	10.52	0.2012	1.913	28.070	5	5	clayey silt to silty clay
31.168	10.38	0.2097	2.021	33.767	5	5	clayey silt to silty clay
31.332	9.55	0.2089	2.187	32.057	5	5	clayey silt to silty clay
31.496	8.38	0.2183	2.605	32.808	5	4	silty clay to clay
31.660	8.19	0.1549	1.891	34.121	4	5	clayey silt to silty clay
31.824	9.31	0.1279	1.374	37.030	4	5	clayey silt to silty clay
31.988	8.96	0.1693	1.891	36.854	4	5	clayey silt to silty clay
32.152	10.78	0.2054	1.906	34.851	5	5	clayey silt to silty clay
32.316	25.50	0.1877	0.736	5.618	8	7	silty sand to sandy silt
32.480	26.44	0.2144	0.811	1.235	8	7	silty sand to sandy silt
32.644	18.02	0.4407	2.445	0.696	9	5	clayey silt to silty clay
32.808	12.55	0.3609	2.876	3.227	8	4	silty clay to clay
32.972	9.08	0.2432	2.678	18.713	6	4	silty clay to clay
33.136	8.87	0.2110	2.379	31.607	6	4	silty clay to clay
33.301	8.84	0.2077	2.350	34.675	6	4	silty clay to clay
33.465	8.74	0.1978	2.262	36.169	6	4	silty clay to clay
33.629	8.38	0.1950	2.327	33.535	5	4	silty clay to clay
33.793	8.10	0.1985	2.451	33.669	5	4	silty clay to clay
33.957	8.13	0.1991	2.450	33.398	5	4	silty clay to clay
34.121	8.13	0.1867	2.296	32.671	5	4	silty clay to clay
34.285	7.97	0.1842	2.311	32.954	5	4	silty clay to clay
34.449	7.68	0.1604	2.088	31.546	5	4	silty clay to clay
34.613	7.05	0.1291	1.832	32.585	4	4	silty clay to clay
34.777	7.20	0.1333	1.851	39.120	5	4	silty clay to clay
34.941	8.22	0.1492	1.815	35.594	4	5	clayey silt to silty clay
35.105	8.31	0.1727	2.077	29.196	5	4	silty clay to clay
35.269	9.42	0.2469	2.620	32.333	6	4	silty clay to clay
35.433	11.65	0.2849	2.445	25.776	6	5	clayey silt to silty clay
35.597	9.49	0.2811	2.963	16.199	6	4	silty clay to clay
35.761	8.76	0.2382	2.718	16.956	6	4	silty clay to clay
35.925	7.96	0.1828	2.296	25.530	5	4	silty clay to clay
36.089	7.38	0.1723	2.334	32.990	5	4	silty clay to clay
36.253	9.19	0.2501	2.722	46.543	6	4	silty clay to clay

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
36.417	10.07	0.2658	2.640	23.653	6	4	silty clay to clay
36.581	12.17	0.1127	0.926	27.240	5	6	sandy silt to clayey silt
36.745	18.97	0.1423	0.750	20.540	7	6	sandy silt to clayey silt
36.909	13.88	0.1282	0.924	22.337	5	6	sandy silt to clayey silt
37.073	11.45	0.1671	1.460	28.626	5	5	clayey silt to silty clay
37.238	9.38	0.1262	1.345	34.968	4	5	clayey silt to silty clay
37.402	9.21	0.1333	1.447	40.257	4	5	clayey silt to silty clay
37.566	8.82	0.1206	1.367	44.333	4	5	clayey silt to silty clay
37.730	9.50	0.1447	1.523	49.510	5	5	clayey silt to silty clay
37.894	10.63	0.1755	1.651	44.367	5	5	clayey silt to silty clay
38.058	10.95	0.1619	1.478	35.273	5	5	clayey silt to silty clay
38.222	10.39	0.1349	1.299	37.563	5	5	clayey silt to silty clay
38.386	10.03	0.1356	1.352	39.301	5	5	clayey silt to silty clay
38.550	10.41	0.1413	1.357	41.542	5	5	clayey silt to silty clay
38.714	10.97	0.1626	1.482	39.642	5	5	clayey silt to silty clay
38.878	12.35	0.1847	1.495	34.870	6	5	clayey silt to silty clay
39.042	13.50	0.2083	1.544	32.850	6	5	clayey silt to silty clay
39.206	16.49	0.4002	2.427	38.879	8	5	clayey silt to silty clay
39.370	20.12	0.6275	3.118	32.998	10	5	clayey silt to silty clay
39.534	25.73	0.6784	2.636	9.438	12	5	clayey silt to silty clay
39.698	24.60	0.6933	2.819	10.181	12	5	clayey silt to silty clay
39.862	29.19	0.7259	2.487	17.096	11	6	sandy silt to clayey silt
40.026	29.79	0.8122	2.727	18.213	11	6	sandy silt to clayey silt
40.190	30.65	0.8271	2.698	26.899	12	6	sandy silt to clayey silt
40.354	29.73	0.8710	2.930	27.564	14	5	clayey silt to silty clay
40.518	28.70	0.8638	3.010	32.713	14	5	clayey silt to silty clay
40.682	29.54	0.8328	2.819	37.851	14	5	clayey silt to silty clay
40.846	31.14	0.8008	2.572	46.934	12	6	sandy silt to clayey silt
41.011	29.92	0.8245	2.756	45.048	14	5	clayey silt to silty clay
41.175	24.21	0.8128	3.357	58.459	12	5	clayey silt to silty clay
41.339	22.00	0.6635	3.015	42.199	11	5	clayey silt to silty clay
41.503	23.89	0.6341	2.654	63.239	11	5	clayey silt to silty clay
41.667	26.05	0.7795	2.992	72.962	12	5	clayey silt to silty clay
41.831	24.18	0.6294	2.603	63.993	12	5	clayey silt to silty clay
41.995	21.94	0.5581	2.544	51.010	11	5	clayey silt to silty clay
42.159	22.12	0.5701	2.578	71.333	11	5	clayey silt to silty clay
42.323	25.16	0.6905	2.745	96.031	12	5	clayey silt to silty clay
42.487	24.73	1.0398	4.205	55.291	16	4	silty clay to clay
42.651	22.46	0.9338	4.158	61.904	14	4	silty clay to clay
42.815	24.23	0.7716	3.184	27.520	12	5	clayey silt to silty clay
42.979	22.60	0.6170	2.729	41.824	11	5	clayey silt to silty clay
43.143	24.36	0.6218	2.552	60.596	12	5	clayey silt to silty clay
43.307	24.18	0.7461	3.086	72.825	12	5	clayey silt to silty clay
43.471	23.04	0.6770	2.939	74.138	11	5	clayey silt to silty clay
43.635	22.97	0.6811	2.965	85.981	11	5	clayey silt to silty clay
43.799	22.37	0.5187	2.318	71.537	11	5	clayey silt to silty clay
43.963	20.94	0.4765	2.275	59.034	10	5	clayey silt to silty clay
44.127	21.33	0.5303	2.486	66.955	10	5	clayey silt to silty clay
44.291	19.00	0.5795	3.051	69.528	9	5	clayey silt to silty clay
44.455	17.38	0.4563	2.626	77.980	8	5	clayey silt to silty clay
44.619	17.54	0.4305	2.454	84.241	8	5	clayey silt to silty clay
44.783	17.03	0.4501	2.643	69.366	8	5	clayey silt to silty clay
44.948	16.14	0.4282	2.654	76.636	8	5	clayey silt to silty clay
45.112	16.90	0.3304	1.955	79.611	8	5	clayey silt to silty clay
45.276	15.70	0.3534	2.250	79.522	8	5	clayey silt to silty clay
45.440	15.99	0.3488	2.182	83.455	8	5	clayey silt to silty clay
45.604	16.05	0.3882	2.419	81.626	8	5	clayey silt to silty clay

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
45.768	15.78	0.5659	3.586	84.875	10	4	silty clay to clay
45.932	16.52	0.5503	3.332	88.929	11	4	silty clay to clay
46.096	16.72	0.3830	2.290	33.688	8	5	clayey silt to silty clay
46.260	14.49	0.2773	1.913	53.195	7	5	clayey silt to silty clay
46.424	14.66	0.3144	2.144	76.884	7	5	clayey silt to silty clay
46.588	15.11	0.3248	2.149	78.142	7	5	clayey silt to silty clay
46.752	14.94	0.3126	2.092	86.442	7	5	clayey silt to silty clay
46.916	15.43	0.3238	2.099	86.221	7	5	clayey silt to silty clay
47.080	16.96	0.3514	2.072	84.925	8	5	clayey silt to silty clay
47.244	17.93	0.3508	1.957	74.630	9	5	clayey silt to silty clay
47.408	18.60	0.4229	2.273	66.013	9	5	clayey silt to silty clay
47.572	16.81	0.4251	2.528	70.176	8	5	clayey silt to silty clay
47.736	18.11	0.5643	3.117	77.197	9	5	clayey silt to silty clay
47.900	24.86	0.6410	2.579	44.143	12	5	clayey silt to silty clay
48.064	33.73	0.4130	1.225	11.371	11	7	silty sand to sandy silt
48.228	38.47	0.2369	0.616	2.380	12	7	silty sand to sandy silt
48.392	38.25	0.3539	0.925	0.405	12	7	silty sand to sandy silt
48.556	37.23	0.3557	0.955	1.397	12	7	silty sand to sandy silt
48.720	38.45	0.4006	1.042	6.328	12	7	silty sand to sandy silt
48.885	32.01	0.5144	1.607	6.283	12	6	sandy silt to clayey silt
49.049	22.21	0.7712	3.473	9.765	11	5	clayey silt to silty clay
49.213	16.46	0.5848	3.553	18.085	11	4	silty clay to clay
49.377	16.22	0.3822	2.355	37.969	8	5	clayey silt to silty clay
49.541	14.41	0.2493	1.729	58.104	7	5	clayey silt to silty clay
49.705	15.00	0.2570	1.714	76.166	7	5	clayey silt to silty clay
49.869	15.41	0.3657	2.373	81.788	7	5	clayey silt to silty clay
50.033	15.78	0.4518	2.862	82.447	8	5	clayey silt to silty clay
50.197	25.33	0.6276	2.478	53.924	12	5	clayey silt to silty clay
50.361	46.61	0.5168	1.109	16.562	15	7	silty sand to sandy silt
50.525	53.56	0.4904	0.916	-0.827	17	7	silty sand to sandy silt
50.689	51.18	0.4944	0.966	-0.626	16	7	silty sand to sandy silt
50.853	53.86	0.4865	0.903	6.423	17	7	silty sand to sandy silt
51.017	54.51	0.5528	1.014	6.197	17	7	silty sand to sandy silt
51.181	53.74	0.5629	1.047	4.540	17	7	silty sand to sandy silt
51.345	54.92	0.5137	0.935	1.389	18	7	silty sand to sandy silt
51.509	56.01	1.0127	1.808	-0.676	18	7	silty sand to sandy silt
51.673	34.42	0.8924	2.593	-1.523	13	6	sandy silt to clayey silt
51.837	21.78	0.6289	2.887	0.204	10	5	clayey silt to silty clay
52.001	21.40	0.5296	2.475	58.093	10	5	clayey silt to silty clay
52.165	19.84	0.4476	2.256	69.858	9	5	clayey silt to silty clay
52.329	18.75	0.7456	3.977	83.556	12	4	silty clay to clay
52.493	19.64	0.7494	3.816	97.254	13	4	silty clay to clay
52.657	21.84	0.5980	2.738	46.632	10	5	clayey silt to silty clay
52.822	21.17	0.6200	2.929	68.654	10	5	clayey silt to silty clay
52.986	24.14	0.7483	3.100	94.271	12	5	clayey silt to silty clay
53.150	58.76	1.1427	1.945	52.013	19	7	silty sand to sandy silt
53.314	125.88	0.5656	0.449	9.301	24	9	sand
53.478	98.25	0.6771	0.689	-2.109	24	8	sand to silty sand
53.642	67.08	0.8087	1.206	-2.772	21	7	silty sand to sandy silt
53.806	49.83	1.0310	2.069	-1.995	19	6	sandy silt to clayey silt
53.970	36.27	1.1232	3.097	-2.165	17	5	clayey silt to silty clay
54.134	28.29	1.0530	3.722	-1.324	14	5	clayey silt to silty clay
54.298	24.43	1.0639	4.356	0.201	16	4	silty clay to clay
54.462	35.26	0.7912	2.244	1.414	14	6	sandy silt to clayey silt
54.626	48.42	0.5837	1.205	-0.084	15	7	silty sand to sandy silt
54.790	48.11	0.5022	1.044	-1.361	15	7	silty sand to sandy silt
54.954	35.51	0.8103	2.282	-1.539	14	6	sandy silt to clayey silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
55.118	22.68	0.6635	2.925	-0.908	11	5	clayey silt to silty clay
55.282	25.48	0.7751	3.042	38.740	12	5	clayey silt to silty clay
55.446	41.07	1.2516	3.048	59.110	20	5	clayey silt to silty clay
55.610	54.51	2.9356	5.386	38.363	52	3	clay
55.774	52.77	3.1342	5.939	27.330	51	3	clay
55.938	97.69	2.8321	2.899	2.213	37	6	sandy silt to clayey silt
56.102	125.91	2.6639	2.116	-2.148	40	7	silty sand to sandy silt
56.266	145.04	3.3308	2.296	-3.881	46	7	silty sand to sandy silt
56.430	129.02	3.3141	2.569	-4.738	41	7	silty sand to sandy silt
56.594	127.25	2.4604	1.934	-5.428	41	7	silty sand to sandy silt
56.759	122.01	1.6508	1.353	-5.761	29	8	sand to silty sand
56.923	118.55	0.9669	0.816	-5.987	28	8	sand to silty sand
57.087	111.37	1.1051	0.992	-6.188	27	8	sand to silty sand
57.251	97.07	0.9879	1.018	-6.183	23	8	sand to silty sand
57.415	76.78	0.8005	1.043	-6.060	18	8	sand to silty sand
57.579	59.33	0.7533	1.270	-5.733	19	7	silty sand to sandy silt
57.743	50.42	0.4998	0.991	-5.367	16	7	silty sand to sandy silt
57.907	48.47	0.6097	1.258	-5.233	15	7	silty sand to sandy silt
58.071	37.36	1.1322	3.030	-5.157	18	5	clayey silt to silty clay
58.235	19.93	0.4419	2.218	-4.705	10	5	clayey silt to silty clay
58.399	13.61	0.2362	1.735	-3.104	7	5	clayey silt to silty clay
58.563	13.93	0.2637	1.893	25.033	7	5	clayey silt to silty clay
58.727	15.01	0.3830	2.551	30.892	7	5	clayey silt to silty clay
58.891	34.64	0.5166	1.491	33.769	13	6	sandy silt to clayey silt
59.055	48.52	0.5720	1.179	3.076	15	7	silty sand to sandy silt
59.219	42.89	0.7599	1.772	13.704	14	7	silty sand to sandy silt
59.383	28.55	0.9604	3.364	16.034	14	5	clayey silt to silty clay
59.547	20.82	0.6500	3.122	24.754	10	5	clayey silt to silty clay
59.711	32.54	0.5156	1.584	26.922	12	6	sandy silt to clayey silt
59.875	28.77	0.6310	2.193	21.175	11	6	sandy silt to clayey silt
60.039	20.63	0.5671	2.748	27.472	10	5	clayey silt to silty clay
60.203	24.63	0.4600	1.868	35.354	9	6	sandy silt to clayey silt
60.367	43.29	0.5764	1.332	19.582	14	7	silty sand to sandy silt
60.532	47.21	0.6307	1.336	12.064	15	7	silty sand to sandy silt
60.696	50.28	0.7083	1.409	13.480	16	7	silty sand to sandy silt
60.860	51.51	0.7207	1.399	14.548	16	7	silty sand to sandy silt
61.024	55.01	0.5985	1.088	13.411	18	7	silty sand to sandy silt
61.188	59.18	0.6224	1.052	4.283	19	7	silty sand to sandy silt
61.352	58.28	0.6715	1.152	4.613	19	7	silty sand to sandy silt
61.516	57.72	0.6193	1.073	6.024	18	7	silty sand to sandy silt
61.680	57.35	0.6843	1.193	7.460	18	7	silty sand to sandy silt
61.844	55.83	0.7324	1.312	15.607	18	7	silty sand to sandy silt
62.008	54.80	0.7549	1.378	16.288	17	7	silty sand to sandy silt
62.172	53.54	0.7545	1.409	16.903	17	7	silty sand to sandy silt
62.336	52.95	0.7519	1.420	17.585	17	7	silty sand to sandy silt
62.500	53.78	0.7795	1.449	18.674	17	7	silty sand to sandy silt
62.664	56.04	0.8192	1.462	18.895	18	7	silty sand to sandy silt
62.828	53.52	0.9908	1.851	18.976	17	7	silty sand to sandy silt
62.992	39.26	1.0353	2.637	19.602	15	6	sandy silt to clayey silt
63.156	21.86	0.8361	3.824	26.248	14	4	silty clay to clay
63.320	17.73	0.4649	2.622	47.007	8	5	clayey silt to silty clay
63.484	14.73	0.2371	1.610	62.334	7	5	clayey silt to silty clay
63.648	13.28	0.3075	2.315	80.969	6	5	clayey silt to silty clay
63.812	41.28	0.4953	1.200	44.548	13	7	silty sand to sandy silt
63.976	63.02	0.6170	0.979	8.546	20	7	silty sand to sandy silt
64.140	77.85	0.7632	0.980	4.099	19	8	sand to silty sand
64.304	80.34	0.9199	1.145	2.755	19	8	sand to silty sand

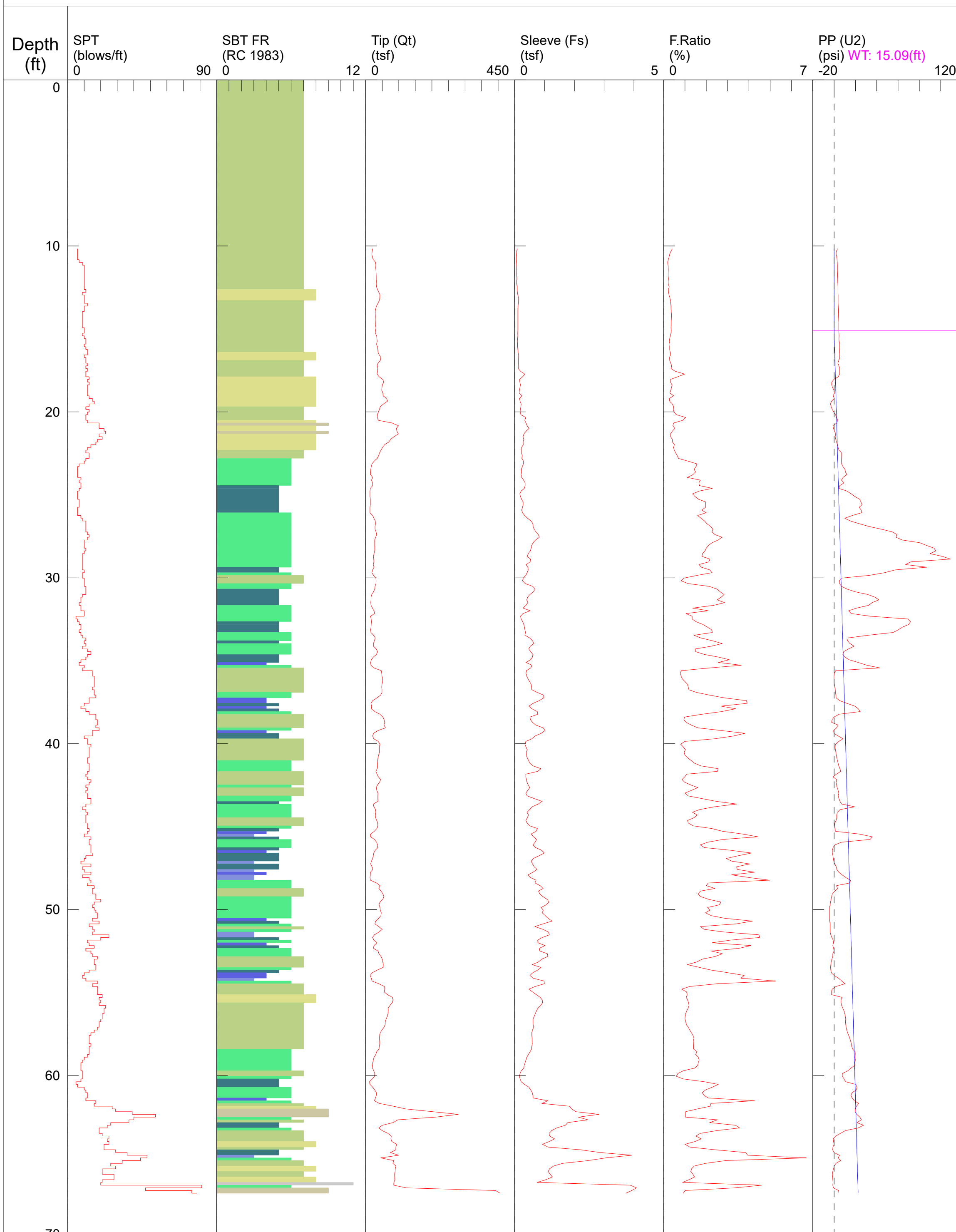
Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
64.469	83.71	1.0574	1.263	3.872	20	8	sand to silty sand
64.633	84.74	1.1275	1.330	5.356	27	7	silty sand to sandy silt
64.797	82.91	1.1330	1.367	6.767	26	7	silty sand to sandy silt
64.961	77.79	1.1341	1.458	9.896	25	7	silty sand to sandy silt
65.125	70.18	1.1246	1.602	17.925	22	7	silty sand to sandy silt
65.289	67.82	1.0939	1.613	18.305	22	7	silty sand to sandy silt
65.453	66.00	0.9603	1.455	18.685	21	7	silty sand to sandy silt
65.617	64.12	1.0200	1.591	19.004	20	7	silty sand to sandy silt
65.781	42.15	0.9450	2.242	19.965	16	6	sandy silt to clayey silt
65.945	24.09	0.6727	2.793	29.822	12	5	clayey silt to silty clay
66.109	17.77	0.4016	2.259	54.494	9	5	clayey silt to silty clay
66.273	17.60	0.5500	3.125	78.812	8	5	clayey silt to silty clay
66.437	39.66	0.6399	1.614	47.135	13	7	silty sand to sandy silt
66.601	59.24	0.8262	1.395	7.842	19	7	silty sand to sandy silt
66.765	61.26	0.8268	1.350	6.398	20	7	silty sand to sandy silt
66.929	60.53	0.9031	1.492	9.060	19	7	silty sand to sandy silt
67.093	57.29	0.9695	1.692	13.883	18	7	silty sand to sandy silt
67.257	48.81	0.9996	2.048	17.682	19	6	sandy silt to clayey silt
67.421	36.46	1.0026	2.750	22.493	14	6	sandy silt to clayey silt
67.585	27.10	0.5986	2.209	35.317	10	6	sandy silt to clayey silt
67.749	28.68	0.6211	2.166	41.450	11	6	sandy silt to clayey silt
67.913	34.53	0.7812	2.262	46.926	13	6	sandy silt to clayey silt
68.077	59.88	1.0395	1.736	13.416	19	7	silty sand to sandy silt
68.241	57.59	1.0542	1.831	17.160	18	7	silty sand to sandy silt
68.406	51.82	0.9455	1.825	21.736	17	7	silty sand to sandy silt
68.570	45.51	0.7718	1.696	17.830	15	7	silty sand to sandy silt
68.734	40.21	1.0133	2.520	18.303	15	6	sandy silt to clayey silt
68.898	34.20	1.1987	3.504	23.639	16	5	clayey silt to silty clay
69.062	40.09	0.8862	2.211	21.186	15	6	sandy silt to clayey silt
69.226	43.19	0.9382	2.172	5.666	17	6	sandy silt to clayey silt
69.390	35.58	0.8068	2.267	4.059	14	6	sandy silt to clayey silt
69.554	35.20	0.6731	1.912	3.783	13	6	sandy silt to clayey silt
69.718	32.71	0.7840	2.397	4.009	13	6	sandy silt to clayey silt
69.882	30.41	0.7247	2.383	6.580	12	6	sandy silt to clayey silt
70.046	29.47	0.8377	2.843	9.720	14	5	clayey silt to silty clay
70.210	42.83	0.7733	1.805	13.894	16	6	sandy silt to clayey silt
70.374	59.86	0.8248	1.378	1.925	19	7	silty sand to sandy silt
70.538	60.61	0.8582	1.416	-1.593	19	7	silty sand to sandy silt
70.702	70.17	0.8025	1.144	-0.916	22	7	silty sand to sandy silt
70.866	78.00	0.8637	1.107	-1.193	19	8	sand to silty sand
71.030	78.88	0.9657	1.224	-1.025	25	7	silty sand to sandy silt
71.194	77.47	1.1215	1.448	0.006	25	7	silty sand to sandy silt
71.358	74.28	1.2891	1.735	1.185	24	7	silty sand to sandy silt
71.522	74.20	1.3140	1.771	2.716	24	7	silty sand to sandy silt
71.686	72.19	1.3242	1.834	16.436	23	7	silty sand to sandy silt
71.850	67.72	1.4104	2.083	17.727	22	7	silty sand to sandy silt
72.014	59.49	1.6207	2.724	19.403	23	6	sandy silt to clayey silt
72.178	52.30	1.6280	3.113	19.409	20	6	sandy silt to clayey silt
72.343	63.20	1.1364	1.798	8.326	20	7	silty sand to sandy silt
72.507	69.51	0.8905	1.281	-2.112	22	7	silty sand to sandy silt
72.671	68.83	0.8537	1.240	-3.691	22	7	silty sand to sandy silt
72.835	66.57	0.9495	1.426	-2.995	21	7	silty sand to sandy silt
72.999	65.85	1.0995	1.670	-1.908	21	7	silty sand to sandy silt
73.163	66.86	1.1793	1.764	-0.522	21	7	silty sand to sandy silt
73.327	63.79	1.1497	1.802	1.444	20	7	silty sand to sandy silt
73.491	62.73	1.1017	1.756	3.498	20	7	silty sand to sandy silt
73.655	63.89	1.1313	1.771	5.431	20	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
73.819	70.43	1.0662	1.514	7.328	22	7	silty sand to sandy silt
73.983	87.06	1.1316	1.300	5.873	21	8	sand to silty sand
74.147	97.39	1.2793	1.314	1.998	23	8	sand to silty sand
74.311	96.55	1.4022	1.452	3.199	23	8	sand to silty sand
74.475	95.18	1.4524	1.526	4.727	30	7	silty sand to sandy silt
74.639	94.13	1.5271	1.622	6.320	30	7	silty sand to sandy silt
74.803	90.56	1.6751	1.850	8.032	29	7	silty sand to sandy silt
74.967	63.26	1.5404	2.435	17.179	24	6	sandy silt to clayey silt
75.131	40.49	1.0486	2.590	15.338	16	6	sandy silt to clayey silt
75.295	32.20	0.8680	2.696	29.316	12	6	sandy silt to clayey silt
75.459	30.10	0.8130	2.701	35.896	12	6	sandy silt to clayey silt
75.623	29.09	0.9193	3.160	45.073	14	5	clayey silt to silty clay
75.787	36.40	1.3828	3.799	59.588	17	5	clayey silt to silty clay
75.951	72.36	1.8278	2.526	24.687	28	6	sandy silt to clayey silt
76.115	80.88	2.1327	2.637	-0.103	31	6	sandy silt to clayey silt
76.280	108.07	1.9923	1.844	-3.959	34	7	silty sand to sandy silt
76.444	110.09	2.0625	1.873	-5.322	35	7	silty sand to sandy silt
76.608	90.42	2.4054	2.660	-5.669	35	6	sandy silt to clayey silt
76.772	66.34	2.4780	3.735	-5.892	32	5	clayey silt to silty clay
76.936	60.05	2.2404	3.731	-5.750	29	5	clayey silt to silty clay
77.100	51.38	2.2994	4.476	-5.076	33	4	silty clay to clay
77.264	63.81	1.8140	2.843	-3.797	24	6	sandy silt to clayey silt
77.428	83.52	1.4262	1.708	-3.992	27	7	silty sand to sandy silt
77.592	88.61	1.3769	1.554	-4.311	28	7	silty sand to sandy silt
77.756	78.55	2.0014	2.548	-4.018	30	6	sandy silt to clayey silt
77.920	51.80	1.8393	3.551	-3.193	25	5	clayey silt to silty clay
78.084	54.85	2.2085	4.026	-0.305	26	5	clayey silt to silty clay
78.248	57.42	1.7239	3.002	-0.458	22	6	sandy silt to clayey silt
78.412	61.09	1.1862	1.942	-1.891	20	7	silty sand to sandy silt
78.576	72.07	0.8538	1.185	-3.096	23	7	silty sand to sandy silt
78.740	73.52	1.0687	1.454	-3.375	23	7	silty sand to sandy silt
78.904	72.82	1.2169	1.671	16.461	23	7	silty sand to sandy silt
79.068	72.03	1.2476	1.732	16.333	23	7	silty sand to sandy silt
79.232	72.61	1.2635	1.740	15.112	23	7	silty sand to sandy silt
79.396	72.86	1.2877	1.767	14.936	23	7	silty sand to sandy silt
79.560	71.57	1.3061	1.825	16.210	23	7	silty sand to sandy silt
79.724	72.28	1.2634	1.748	16.953	23	7	silty sand to sandy silt
79.888	75.82	1.1050	1.457	16.174	24	7	silty sand to sandy silt
80.052	68.76	0.9387	1.365	12.449	22	7	silty sand to sandy silt
80.217	59.56	0.7753	1.302	13.059	19	7	silty sand to sandy silt
80.381	58.51	0.7197	1.230	15.310	19	7	silty sand to sandy silt
80.545	61.98	0.7100	1.146	17.836	20	7	silty sand to sandy silt
80.709	64.27	0.5687	0.885	19.616	15	8	sand to silty sand
80.873	69.74	0.4849	0.695	11.941	17	8	sand to silty sand
81.037	69.72	0.5268	0.756	9.524	17	8	sand to silty sand
81.201	67.16	0.5375	0.800	11.262	16	8	sand to silty sand
81.365	63.17	0.5109	0.809	12.455	15	8	sand to silty sand
81.529	61.46	0.4565	0.743	15.749	15	8	sand to silty sand
81.693	67.36	0.4311	0.640	15.182	16	8	sand to silty sand
81.857	78.19	0.4226	0.541	9.111	19	8	sand to silty sand
82.021	77.59	0.6475	0.835	6.412	19	8	sand to silty sand
82.185	69.56	0.6038	0.868	8.820	17	8	sand to silty sand
82.349	74.73	0.5923	0.792	8.493	18	8	sand to silty sand
82.513	79.25	0.7842	0.989	2.361	19	8	sand to silty sand
82.677	94.54	0.8589	0.909	-0.156	23	8	sand to silty sand
82.841	107.54	0.6909	0.642	-3.923	26	8	sand to silty sand
83.005	101.54	1.0232	1.008	-5.294	24	8	sand to silty sand

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
83.169	103.02	1.4329	1.391	-5.037	25	8	sand to silty sand
83.333	121.12	2.1239	1.754	-5.303	39	7	silty sand to sandy silt
83.497	132.65	2.7745	2.092	-5.968	42	7	silty sand to sandy silt
83.661	139.64	1.5851	1.135	-6.250	33	8	sand to silty sand
83.825	151.42	0.9847	0.650	-5.361	29	9	sand
83.990	145.28	1.9232	1.324	-4.328	35	8	sand to silty sand
84.154	116.73	2.1852	1.872	7.868	37	7	silty sand to sandy silt
84.318	95.52	2.0589	2.155	23.706	30	7	silty sand to sandy silt
84.482	101.85	0.9213	0.905	11.860	24	8	sand to silty sand
84.646	106.27	1.6624	1.564	-1.562	34	7	silty sand to sandy silt
84.810	238.39	1.6904	0.709	7.471	46	9	sand
84.974	462.91	1.7504	0.378	28.592	74	10	gravelly sand to sand

Sage Geotechnical / CPT-4 / 5880 NW St Helens Road Portland

OPERATOR: OGE BAK
CONE ID: DDG1654
TEST DATE: 3/5/2024 10:14:31 AM
TOTAL DEPTH: 67.093 ft



REMARKS

SBT Depicted is not accurate

Hole Air Knifed to 10 feet

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

Sage Geotechnical / CPT-4 / 5880 NW St Helens Road Portland

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TOTAL DEPTH: 67.093 ft

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
10.171	20.26	0.0795	0.393	3.034	6	7	silty sand to sandy silt
10.335	19.50	0.0637	0.327	2.030	6	7	silty sand to sandy silt
10.499	18.45	0.0511	0.277	1.809	6	7	silty sand to sandy silt
10.663	19.78	0.0494	0.250	2.457	6	7	silty sand to sandy silt
10.827	22.89	0.0490	0.214	2.750	7	7	silty sand to sandy silt
10.991	29.76	0.0531	0.178	2.905	9	7	silty sand to sandy silt
11.155	30.55	0.0599	0.196	3.047	10	7	silty sand to sandy silt
11.319	30.28	0.0643	0.212	3.123	10	7	silty sand to sandy silt
11.483	30.95	0.0654	0.211	3.169	10	7	silty sand to sandy silt
11.647	31.63	0.0636	0.201	3.212	10	7	silty sand to sandy silt
11.811	31.86	0.0654	0.205	3.276	10	7	silty sand to sandy silt
11.975	31.98	0.0710	0.222	3.319	10	7	silty sand to sandy silt
12.139	32.01	0.0643	0.201	3.377	10	7	silty sand to sandy silt
12.303	31.77	0.0657	0.207	3.436	10	7	silty sand to sandy silt
12.467	32.57	0.0834	0.256	3.542	10	7	silty sand to sandy silt
12.631	35.39	0.0769	0.217	3.588	11	7	silty sand to sandy silt
12.795	39.52	0.0879	0.222	3.606	9	8	sand to silty sand
12.959	43.04	0.1058	0.246	3.641	10	8	sand to silty sand
13.123	42.50	0.1214	0.286	3.710	10	8	sand to silty sand
13.287	40.96	0.1249	0.305	3.761	10	8	sand to silty sand
13.451	36.97	0.1202	0.325	3.819	12	7	silty sand to sandy silt
13.615	32.62	0.1107	0.339	3.893	10	7	silty sand to sandy silt
13.780	30.09	0.1021	0.339	3.967	10	7	silty sand to sandy silt
13.944	29.25	0.1019	0.348	4.020	9	7	silty sand to sandy silt
14.108	29.30	0.1046	0.357	4.076	9	7	silty sand to sandy silt
14.272	29.63	0.1060	0.358	4.119	9	7	silty sand to sandy silt
14.436	29.27	0.1043	0.356	4.198	9	7	silty sand to sandy silt
14.600	29.40	0.1008	0.343	4.277	9	7	silty sand to sandy silt
14.764	29.62	0.1014	0.342	4.358	9	7	silty sand to sandy silt
14.928	31.15	0.1037	0.333	4.378	10	7	silty sand to sandy silt
15.092	29.79	0.1034	0.347	4.396	10	7	silty sand to sandy silt
15.256	29.27	0.0981	0.335	4.470	9	7	silty sand to sandy silt
15.420	32.72	0.1006	0.307	4.574	10	7	silty sand to sandy silt
15.584	33.99	0.0916	0.270	4.455	11	7	silty sand to sandy silt
15.748	34.58	0.0892	0.258	4.602	11	7	silty sand to sandy silt
15.912	32.33	0.0928	0.287	4.953	10	7	silty sand to sandy silt
16.076	34.85	0.0946	0.272	4.955	11	7	silty sand to sandy silt
16.240	36.69	0.0996	0.272	4.803	12	7	silty sand to sandy silt
16.404	37.09	0.1106	0.298	4.760	12	7	silty sand to sandy silt
16.568	40.49	0.1275	0.315	4.983	10	8	sand to silty sand
16.732	45.99	0.1220	0.265	5.108	11	8	sand to silty sand
16.896	44.18	0.1197	0.271	4.305	11	8	sand to silty sand
17.060	36.71	0.1178	0.321	3.479	12	7	silty sand to sandy silt
17.224	34.33	0.1247	0.363	4.457	11	7	silty sand to sandy silt
17.388	36.43	0.1248	0.343	4.899	12	7	silty sand to sandy silt
17.552	35.20	0.1893	0.538	4.912	11	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
17.717	34.34	0.3368	0.981	4.958	11	7	silty sand to sandy silt
17.881	40.39	0.2662	0.659	4.015	13	7	silty sand to sandy silt
18.045	51.66	0.1655	0.320	-0.320	12	8	sand to silty sand
18.209	54.51	0.1700	0.312	-2.206	13	8	sand to silty sand
18.373	49.98	0.1920	0.384	-2.229	12	8	sand to silty sand
18.537	48.78	0.1756	0.360	-1.588	12	8	sand to silty sand
18.701	48.29	0.1553	0.322	-0.155	12	8	sand to silty sand
18.865	51.84	0.1460	0.282	0.333	12	8	sand to silty sand
19.029	52.36	0.2436	0.465	-1.057	13	8	sand to silty sand
19.193	63.70	0.1610	0.253	0.206	15	8	sand to silty sand
19.357	65.61	0.1792	0.273	-2.470	16	8	sand to silty sand
19.521	53.81	0.2148	0.399	-3.560	13	8	sand to silty sand
19.685	43.93	0.2032	0.462	-2.780	11	8	sand to silty sand
19.849	41.71	0.1861	0.446	-1.748	13	7	silty sand to sandy silt
20.013	38.31	0.1842	0.481	-0.358	12	7	silty sand to sandy silt
20.177	35.07	0.2054	0.586	1.133	11	7	silty sand to sandy silt
20.341	35.92	0.3712	1.033	2.218	11	7	silty sand to sandy silt
20.505	37.38	0.3333	0.892	3.474	12	7	silty sand to sandy silt
20.669	79.52	0.3751	0.472	2.282	19	8	sand to silty sand
20.833	98.75	0.4171	0.422	-1.159	19	9	sand
20.997	92.58	0.4756	0.514	-0.592	22	8	sand to silty sand
21.161	94.04	0.3780	0.402	0.318	23	8	sand to silty sand
21.325	98.53	0.3088	0.313	1.438	19	9	sand
21.490	85.75	0.2744	0.320	0.950	21	8	sand to silty sand
21.654	75.02	0.2964	0.395	1.494	18	8	sand to silty sand
21.818	69.53	0.2838	0.408	2.231	17	8	sand to silty sand
21.982	56.80	0.2850	0.502	3.032	14	8	sand to silty sand
22.146	50.51	0.2283	0.452	3.669	12	8	sand to silty sand
22.310	46.23	0.2262	0.489	4.518	11	8	sand to silty sand
22.474	41.53	0.2288	0.551	6.970	13	7	silty sand to sandy silt
22.638	39.33	0.2487	0.632	6.960	13	7	silty sand to sandy silt
22.802	34.58	0.2380	0.688	6.851	11	7	silty sand to sandy silt
22.966	25.96	0.2910	1.121	6.635	10	6	sandy silt to clayey silt
23.130	18.65	0.2899	1.554	6.953	7	6	sandy silt to clayey silt
23.294	16.75	0.2532	1.512	8.259	6	6	sandy silt to clayey silt
23.458	15.49	0.2203	1.422	10.165	6	6	sandy silt to clayey silt
23.622	15.09	0.2244	1.486	10.614	6	6	sandy silt to clayey silt
23.786	15.17	0.2069	1.364	11.895	6	6	sandy silt to clayey silt
23.950	20.95	0.2312	1.103	8.391	8	6	sandy silt to clayey silt
24.114	17.26	0.2954	1.711	6.917	7	6	sandy silt to clayey silt
24.278	21.23	0.3495	1.646	9.151	8	6	sandy silt to clayey silt
24.442	20.99	0.3502	1.669	5.382	8	6	sandy silt to clayey silt
24.606	14.13	0.3214	2.275	4.424	7	5	clayey silt to silty clay
24.770	12.77	0.2135	1.672	11.882	6	5	clayey silt to silty clay
24.934	12.78	0.1728	1.352	15.940	6	5	clayey silt to silty clay
25.098	13.20	0.1923	1.457	19.287	6	5	clayey silt to silty clay
25.262	13.96	0.2280	1.633	23.978	7	5	clayey silt to silty clay
25.427	14.09	0.2776	1.970	25.109	7	5	clayey silt to silty clay
25.591	14.23	0.2796	1.965	26.301	7	5	clayey silt to silty clay
25.755	13.08	0.2561	1.958	23.483	6	5	clayey silt to silty clay
25.919	13.05	0.2325	1.782	25.381	6	5	clayey silt to silty clay
26.083	13.18	0.2616	1.985	25.818	6	5	clayey silt to silty clay
26.247	21.02	0.3334	1.586	17.036	8	6	sandy silt to clayey silt
26.411	24.43	0.4251	1.740	10.055	9	6	sandy silt to clayey silt
26.575	28.73	0.5493	1.912	15.262	11	6	sandy silt to clayey silt
26.739	29.83	0.6015	2.016	23.399	11	6	sandy silt to clayey silt
26.903	28.15	0.6175	2.193	32.603	11	6	sandy silt to clayey silt

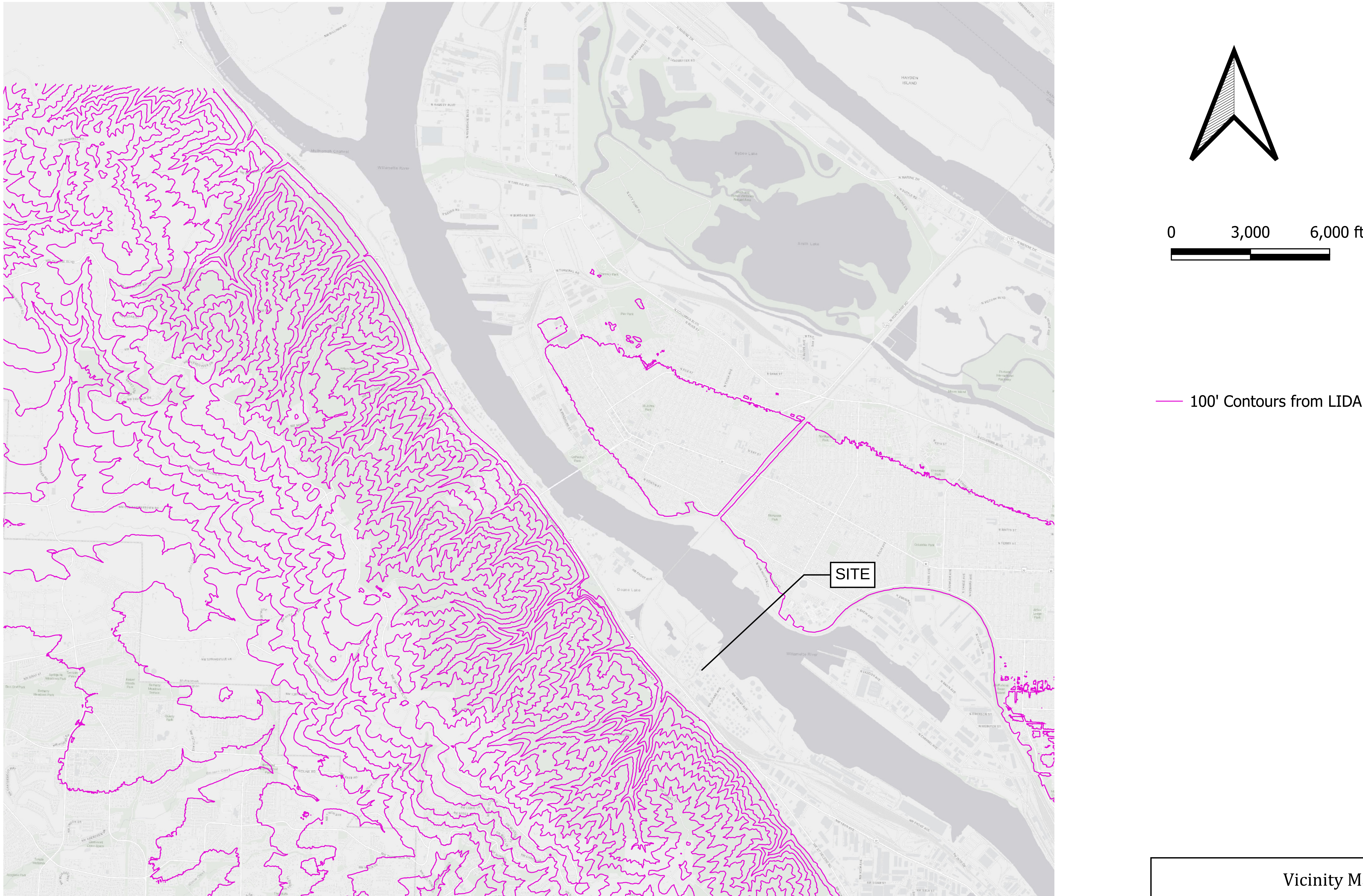
Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
27.067	28.17	0.6511	2.311	44.518	11	6	sandy silt to clayey silt
27.231	31.38	0.7095	2.261	54.751	12	6	sandy silt to clayey silt
27.395	32.87	0.7890	2.400	58.995	13	6	sandy silt to clayey silt
27.559	30.23	0.8264	2.734	57.933	12	6	sandy silt to clayey silt
27.723	27.25	0.6947	2.549	64.064	10	6	sandy silt to clayey silt
27.887	27.06	0.6132	2.266	80.333	10	6	sandy silt to clayey silt
28.051	27.10	0.5670	2.092	87.001	10	6	sandy silt to clayey silt
28.215	27.44	0.5467	1.993	93.752	11	6	sandy silt to clayey silt
28.379	26.97	0.5203	1.929	95.363	10	6	sandy silt to clayey silt
28.543	24.80	0.4497	1.813	90.086	9	6	sandy silt to clayey silt
28.707	23.30	0.4174	1.791	101.625	9	6	sandy silt to clayey silt
28.871	24.26	0.5251	2.164	109.134	9	6	sandy silt to clayey silt
29.035	24.59	0.5186	2.108	71.932	9	6	sandy silt to clayey silt
29.199	23.08	0.3805	1.649	67.083	9	6	sandy silt to clayey silt
29.364	24.69	0.4345	1.760	86.937	9	6	sandy silt to clayey silt
29.528	20.92	0.4513	2.157	57.480	10	5	clayey silt to silty clay
29.692	18.49	0.4180	2.260	47.290	9	5	clayey silt to silty clay
29.856	23.46	0.3709	1.581	33.413	9	6	sandy silt to clayey silt
30.020	30.51	0.2873	0.942	6.780	10	7	silty sand to sandy silt
30.184	31.54	0.2564	0.813	4.737	10	7	silty sand to sandy silt
30.348	31.05	0.3534	1.138	5.098	10	7	silty sand to sandy silt
30.512	28.24	0.6015	2.130	7.019	11	6	sandy silt to clayey silt
30.676	27.63	0.6889	2.493	11.974	11	6	sandy silt to clayey silt
30.840	23.39	0.6206	2.654	20.060	11	5	clayey silt to silty clay
31.004	18.09	0.5118	2.829	31.612	9	5	clayey silt to silty clay
31.168	16.06	0.4327	2.694	38.305	8	5	clayey silt to silty clay
31.332	16.03	0.4016	2.505	41.995	8	5	clayey silt to silty clay
31.496	15.41	0.4392	2.850	35.627	7	5	clayey silt to silty clay
31.660	15.95	0.3749	2.351	32.504	8	5	clayey silt to silty clay
31.824	20.22	0.2737	1.354	21.119	8	6	sandy silt to clayey silt
31.988	24.94	0.5185	2.079	13.524	10	6	sandy silt to clayey silt
32.152	26.69	0.2769	1.038	15.948	10	6	sandy silt to clayey silt
32.316	14.27	0.1898	1.330	33.927	5	6	sandy silt to clayey silt
32.480	16.31	0.2170	1.330	69.365	6	6	sandy silt to clayey silt
32.644	17.46	0.2636	1.510	71.678	7	6	sandy silt to clayey silt
32.808	16.40	0.3007	1.834	70.061	8	5	clayey silt to silty clay
32.972	15.98	0.3273	2.049	64.082	8	5	clayey silt to silty clay
33.136	15.07	0.3379	2.242	60.286	7	5	clayey silt to silty clay
33.301	15.84	0.3616	2.282	55.323	8	5	clayey silt to silty clay
33.465	23.92	0.3386	1.416	31.777	9	6	sandy silt to clayey silt
33.629	28.84	0.4994	1.732	13.191	11	6	sandy silt to clayey silt
33.793	25.99	0.5906	2.272	12.594	10	6	sandy silt to clayey silt
33.957	23.44	0.6409	2.735	14.680	11	5	clayey silt to silty clay
34.121	23.41	0.5219	2.229	18.787	9	6	sandy silt to clayey silt
34.285	31.84	0.4679	1.469	13.379	12	6	sandy silt to clayey silt
34.449	35.77	0.5346	1.494	8.930	14	6	sandy silt to clayey silt
34.613	32.01	0.6072	1.897	8.193	12	6	sandy silt to clayey silt
34.777	23.00	0.5917	2.573	10.104	11	5	clayey silt to silty clay
34.941	17.21	0.5293	3.075	14.065	8	5	clayey silt to silty clay
35.105	14.66	0.3749	2.558	22.492	7	5	clayey silt to silty clay
35.269	15.90	0.5787	3.639	30.593	10	4	silty clay to clay
35.433	24.54	0.5363	2.185	42.772	9	6	sandy silt to clayey silt
35.597	47.41	0.3858	0.814	1.502	15	7	silty sand to sandy silt
35.761	48.20	0.3765	0.781	0.140	15	7	silty sand to sandy silt
35.925	49.29	0.4013	0.814	-0.193	16	7	silty sand to sandy silt
36.089	50.83	0.4416	0.869	-0.226	16	7	silty sand to sandy silt
36.253	50.13	0.4988	0.995	-0.165	16	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
36.417	49.41	0.5478	1.109	0.196	16	7	silty sand to sandy silt
36.581	48.37	0.5538	1.145	0.605	15	7	silty sand to sandy silt
36.745	49.04	0.5744	1.171	1.016	16	7	silty sand to sandy silt
36.909	48.97	0.7495	1.531	1.271	16	7	silty sand to sandy silt
37.073	45.21	0.9654	2.135	1.532	17	6	sandy silt to clayey silt
37.238	34.19	0.9706	2.839	1.898	13	6	sandy silt to clayey silt
37.402	20.98	0.8144	3.882	5.255	13	4	silty clay to clay
37.566	15.68	0.6139	3.916	11.882	10	4	silty clay to clay
37.730	17.65	0.4743	2.688	19.427	8	5	clayey silt to silty clay
37.894	16.91	0.5705	3.374	22.591	11	4	silty clay to clay
38.058	27.80	0.7542	2.713	24.319	13	5	clayey silt to silty clay
38.222	43.13	0.7760	1.799	4.564	17	6	sandy silt to clayey silt
38.386	52.07	0.5089	0.977	-0.216	17	7	silty sand to sandy silt
38.550	55.63	0.5245	0.943	-1.814	18	7	silty sand to sandy silt
38.714	56.90	0.5967	1.049	-2.419	18	7	silty sand to sandy silt
38.878	54.81	0.7058	1.288	3.756	17	7	silty sand to sandy silt
39.042	59.67	0.9503	1.593	2.162	19	7	silty sand to sandy silt
39.206	37.98	1.0198	2.685	-0.516	15	6	sandy silt to clayey silt
39.370	23.36	0.8887	3.804	-0.287	15	4	silty clay to clay
39.534	20.83	0.6839	3.284	3.654	10	5	clayey silt to silty clay
39.698	24.12	0.5787	2.399	8.391	12	5	clayey silt to silty clay
39.862	37.71	0.3711	0.984	4.348	12	7	silty sand to sandy silt
40.026	43.07	0.3401	0.790	1.319	14	7	silty sand to sandy silt
40.190	41.20	0.3753	0.911	0.785	13	7	silty sand to sandy silt
40.354	41.02	0.4146	1.011	1.116	13	7	silty sand to sandy silt
40.518	41.46	0.3960	0.955	1.568	13	7	silty sand to sandy silt
40.682	39.26	0.3873	0.987	2.013	13	7	silty sand to sandy silt
40.846	37.25	0.4177	1.122	2.465	12	7	silty sand to sandy silt
41.011	36.16	0.4644	1.284	3.062	12	7	silty sand to sandy silt
41.175	34.95	0.5047	1.444	3.730	13	6	sandy silt to clayey silt
41.339	35.22	0.6174	1.753	4.442	13	6	sandy silt to clayey silt
41.503	34.45	0.8799	2.554	5.341	13	6	sandy silt to clayey silt
41.667	30.56	0.7683	2.514	6.160	12	6	sandy silt to clayey silt
41.831	34.22	0.3678	1.075	2.071	11	7	silty sand to sandy silt
41.995	38.20	0.3735	0.978	-1.164	12	7	silty sand to sandy silt
42.159	45.01	0.3858	0.857	2.297	14	7	silty sand to sandy silt
42.323	41.72	0.4110	0.985	1.814	13	7	silty sand to sandy silt
42.487	35.66	0.4499	1.262	2.180	11	7	silty sand to sandy silt
42.651	31.67	0.5059	1.598	2.833	12	6	sandy silt to clayey silt
42.815	33.57	0.4314	1.285	3.807	11	7	silty sand to sandy silt
42.979	37.19	0.3690	0.992	4.246	12	7	silty sand to sandy silt
43.143	36.45	0.4161	1.141	3.802	12	7	silty sand to sandy silt
43.307	36.61	0.6517	1.780	4.498	14	6	sandy silt to clayey silt
43.471	37.13	0.9155	2.466	5.446	14	6	sandy silt to clayey silt
43.635	23.11	0.7907	3.421	7.003	11	5	clayey silt to silty clay
43.799	24.47	0.5800	2.371	19.419	9	6	sandy silt to clayey silt
43.963	29.88	0.4997	1.672	5.532	11	6	sandy silt to clayey silt
44.127	30.41	0.4083	1.343	2.930	12	6	sandy silt to clayey silt
44.291	29.43	0.4623	1.570	2.361	11	6	sandy silt to clayey silt
44.455	29.74	0.4254	1.430	2.544	11	6	sandy silt to clayey silt
44.619	32.91	0.3674	1.116	1.919	11	7	silty sand to sandy silt
44.783	36.24	0.4149	1.145	0.620	12	7	silty sand to sandy silt
44.948	36.54	0.5040	1.379	0.318	12	7	silty sand to sandy silt
45.112	33.87	0.7594	2.242	0.734	13	6	sandy silt to clayey silt
45.276	25.83	0.7136	2.762	1.174	12	5	clayey silt to silty clay
45.440	14.92	0.5502	3.687	23.071	10	4	silty clay to clay
45.604	14.29	0.6307	4.415	35.893	14	3	clay

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
45.768	26.51	0.7345	2.771	33.708	13	5	clayey silt to silty clay
45.932	33.16	0.6823	2.057	6.879	13	6	sandy silt to clayey silt
46.096	35.39	0.6066	1.714	0.605	14	6	sandy silt to clayey silt
46.260	36.61	0.6963	1.902	-1.049	14	6	sandy silt to clayey silt
46.424	28.73	0.8981	3.126	-1.644	14	5	clayey silt to silty clay
46.588	24.08	0.9896	4.110	-1.609	15	4	silty clay to clay
46.752	23.23	0.8143	3.506	-1.133	11	5	clayey silt to silty clay
46.916	21.23	0.6221	2.930	-0.816	10	5	clayey silt to silty clay
47.080	17.43	0.5560	3.189	-0.452	8	5	clayey silt to silty clay
47.244	14.69	0.5927	4.035	0.513	14	3	clay
47.408	19.05	0.6509	3.418	2.035	9	5	clayey silt to silty clay
47.572	21.60	0.7429	3.440	2.465	10	5	clayey silt to silty clay
47.736	14.33	0.6099	4.257	4.295	14	3	clay
47.900	13.95	0.4439	3.181	7.448	9	4	silty clay to clay
48.064	13.09	0.5242	4.005	10.940	13	3	clay
48.228	14.40	0.7134	4.956	15.326	14	3	clay
48.392	32.53	0.6762	2.079	14.624	12	6	sandy silt to clayey silt
48.556	42.81	0.8543	1.996	2.190	16	6	sandy silt to clayey silt
48.720	39.67	0.9530	2.402	3.222	15	6	sandy silt to clayey silt
48.885	46.17	0.7934	1.719	0.600	15	7	silty sand to sandy silt
49.049	51.84	0.8360	1.613	-1.636	17	7	silty sand to sandy silt
49.213	54.48	0.9410	1.727	-2.427	17	7	silty sand to sandy silt
49.377	51.49	1.0879	2.113	-2.932	20	6	sandy silt to clayey silt
49.541	42.95	1.1509	2.679	-3.443	16	6	sandy silt to clayey silt
49.705	40.30	1.0483	2.601	-3.807	15	6	sandy silt to clayey silt
49.869	42.91	0.8809	2.053	-4.315	16	6	sandy silt to clayey silt
50.033	44.20	0.9570	2.165	-4.348	17	6	sandy silt to clayey silt
50.197	47.13	0.9211	1.954	-4.378	18	6	sandy silt to clayey silt
50.361	46.02	1.0241	2.226	-4.498	18	6	sandy silt to clayey silt
50.525	39.01	1.1152	2.859	-4.444	15	6	sandy silt to clayey silt
50.689	30.04	1.2499	4.161	-4.160	19	4	silty clay to clay
50.853	27.76	0.9446	3.403	-3.845	13	5	clayey silt to silty clay
51.017	39.15	0.6724	1.718	-3.873	15	6	sandy silt to clayey silt
51.181	49.87	0.9427	1.890	-3.870	16	7	silty sand to sandy silt
51.345	40.06	1.1306	2.822	-3.715	15	6	sandy silt to clayey silt
51.509	26.00	1.1627	4.472	-3.115	25	3	clay
51.673	20.56	0.9235	4.491	-2.201	20	3	clay
51.837	24.54	0.7673	3.126	-0.966	12	5	clayey silt to silty clay
52.001	34.21	0.7770	2.271	-0.722	13	6	sandy silt to clayey silt
52.165	24.92	1.0202	4.094	-1.329	16	4	silty clay to clay
52.329	23.28	0.8256	3.547	-0.455	11	5	clayey silt to silty clay
52.493	37.21	0.8367	2.249	-0.241	14	6	sandy silt to clayey silt
52.657	39.76	1.0936	2.750	-1.199	15	6	sandy silt to clayey silt
52.822	46.14	1.1109	2.408	-1.375	18	6	sandy silt to clayey silt
52.986	50.09	0.8994	1.796	-2.180	16	7	silty sand to sandy silt
53.150	51.61	0.7969	1.544	-2.777	16	7	silty sand to sandy silt
53.314	53.03	0.5853	1.104	-3.192	17	7	silty sand to sandy silt
53.478	52.36	0.8802	1.681	-3.400	17	7	silty sand to sandy silt
53.642	34.52	0.7686	2.227	-3.242	13	6	sandy silt to clayey silt
53.806	19.87	0.6018	3.029	-2.744	10	5	clayey silt to silty clay
53.970	13.54	0.5114	3.778	0.041	9	4	silty clay to clay
54.134	16.97	0.6151	3.624	4.089	11	4	silty clay to clay
54.298	18.74	0.9833	5.246	7.130	18	3	clay
54.462	39.31	0.9986	2.540	10.246	15	6	sandy silt to clayey silt
54.626	56.71	0.6904	1.217	1.636	18	7	silty sand to sandy silt
54.790	56.93	0.4735	0.832	-1.817	18	7	silty sand to sandy silt
54.954	55.81	0.5968	1.069	-2.536	18	7	silty sand to sandy silt

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
55.118	65.71	0.7233	1.101	-2.450	21	7	silty sand to sandy silt
55.282	80.64	0.8534	1.058	7.374	19	8	sand to silty sand
55.446	82.48	0.9242	1.120	6.330	20	8	sand to silty sand
55.610	80.15	0.9326	1.164	6.460	19	8	sand to silty sand
55.774	73.33	0.8719	1.189	7.006	23	7	silty sand to sandy silt
55.938	68.19	0.7773	1.140	8.142	22	7	silty sand to sandy silt
56.102	67.96	0.7285	1.072	9.240	22	7	silty sand to sandy silt
56.266	67.30	0.6892	1.024	10.058	21	7	silty sand to sandy silt
56.430	65.28	0.6524	0.999	10.457	21	7	silty sand to sandy silt
56.594	61.80	0.6122	0.991	10.823	20	7	silty sand to sandy silt
56.759	59.20	0.6100	1.030	10.698	19	7	silty sand to sandy silt
56.923	58.62	0.6167	1.052	10.899	19	7	silty sand to sandy silt
57.087	55.05	0.6319	1.148	11.239	18	7	silty sand to sandy silt
57.251	49.02	0.5973	1.218	11.831	16	7	silty sand to sandy silt
57.415	43.96	0.5686	1.294	12.665	14	7	silty sand to sandy silt
57.579	41.77	0.5720	1.369	13.575	13	7	silty sand to sandy silt
57.743	41.00	0.5812	1.417	14.632	13	7	silty sand to sandy silt
57.907	41.88	0.5807	1.387	15.326	13	7	silty sand to sandy silt
58.071	42.30	0.5877	1.389	16.055	14	7	silty sand to sandy silt
58.235	41.24	0.5751	1.395	16.512	13	7	silty sand to sandy silt
58.399	40.16	0.5606	1.396	17.280	13	7	silty sand to sandy silt
58.563	32.87	0.5130	1.561	19.691	13	6	sandy silt to clayey silt
58.727	30.38	0.4537	1.493	19.806	12	6	sandy silt to clayey silt
58.891	25.14	0.4070	1.619	19.496	10	6	sandy silt to clayey silt
59.055	22.69	0.3778	1.665	19.961	9	6	sandy silt to clayey silt
59.219	21.37	0.3454	1.616	19.234	8	6	sandy silt to clayey silt
59.383	19.91	0.3180	1.597	19.511	8	6	sandy silt to clayey silt
59.547	20.58	0.3012	1.464	15.826	8	6	sandy silt to clayey silt
59.711	24.03	0.2191	0.912	12.828	9	6	sandy silt to clayey silt
59.875	26.95	0.1783	0.662	7.880	9	7	silty sand to sandy silt
60.039	26.63	0.1565	0.588	7.606	9	7	silty sand to sandy silt
60.203	19.77	0.1792	0.906	9.255	8	6	sandy silt to clayey silt
60.367	11.49	0.2170	1.890	10.693	5	5	clayey silt to silty clay
60.532	12.63	0.3225	2.554	20.268	6	5	clayey silt to silty clay
60.696	20.77	0.4729	2.276	21.450	10	5	clayey silt to silty clay
60.860	27.49	0.5379	1.957	20.880	11	6	sandy silt to clayey silt
61.024	32.28	0.5831	1.807	16.761	12	6	sandy silt to clayey silt
61.188	32.16	0.6061	1.885	15.798	12	6	sandy silt to clayey silt
61.352	29.41	0.6109	2.077	16.838	11	6	sandy silt to clayey silt
61.516	26.11	1.1116	4.257	18.858	17	4	silty clay to clay
61.680	41.22	0.9093	2.206	23.000	16	6	sandy silt to clayey silt
61.844	83.72	1.8300	2.186	20.947	27	7	silty sand to sandy silt
62.008	119.92	1.9069	1.590	19.765	29	8	sand to silty sand
62.172	201.75	2.0466	1.014	19.663	39	9	sand
62.336	279.24	2.8168	1.009	21.155	53	9	sand
62.500	210.43	2.1386	1.016	24.064	40	9	sand
62.664	97.35	2.4543	2.521	25.686	37	6	sandy silt to clayey silt
62.828	82.48	1.7766	2.154	21.414	26	7	silty sand to sandy silt
62.992	50.41	1.6971	3.366	27.589	24	5	clayey silt to silty clay
63.156	39.67	1.4079	3.549	22.431	19	5	clayey silt to silty clay
63.320	49.72	1.2350	2.484	10.663	19	6	sandy silt to clayey silt
63.484	67.24	1.1519	1.713	5.829	21	7	silty sand to sandy silt
63.648	77.50	1.1674	1.506	1.504	25	7	silty sand to sandy silt
63.812	76.13	1.3358	1.755	-0.912	24	7	silty sand to sandy silt
63.976	78.77	1.1593	1.472	-0.656	25	7	silty sand to sandy silt
64.140	93.83	0.9302	0.991	0.061	22	8	sand to silty sand
64.304	90.83	1.1188	1.232	-1.179	22	8	sand to silty sand

Depth ft	Tip (Qt) (tsf)	Sleeve (Fs) (tsf)	F.Ratio (%)	PP (U2) (psi)	SPT (blows/ft)	Zone	Soil Behavior Type UBC-1983
64.469	90.97	2.1957	2.414	-1.448	29	7	silty sand to sandy silt
64.633	74.81	2.8777	3.847	-0.155	36	5	clayey silt to silty clay
64.797	99.40	3.9180	3.942	4.907	48	5	clayey silt to silty clay
64.961	45.48	3.0441	6.693	3.840	44	3	clay
65.125	84.87	2.4668	2.907	6.099	33	6	sandy silt to clayey silt
65.289	82.14	1.6037	1.952	1.659	26	7	silty sand to sandy silt
65.453	91.32	1.3036	1.427	0.135	29	7	silty sand to sandy silt
65.617	89.40	1.1649	1.303	-0.706	21	8	sand to silty sand
65.781	88.73	1.1212	1.264	-1.293	21	8	sand to silty sand
65.945	86.72	1.1870	1.369	-1.670	28	7	silty sand to sandy silt
66.109	87.53	1.2655	1.446	-1.471	28	7	silty sand to sandy silt
66.273	88.17	1.0423	1.182	-1.212	21	8	sand to silty sand
66.437	84.66	0.7479	0.883	-1.047	20	8	sand to silty sand
66.601	84.36	3.8708	4.589	-1.293	81	11	very stiff fine grained (*)
66.765	122.20	4.0834	3.342	-0.612	47	6	sandy silt to clayey silt
66.929	392.15	3.9210	1.000	4.030	75	9	sand
67.093	405.58	3.7310	0.920	4.460	78	9	sand



SAGE
GEOTECHNICAL

Vicinity Map

Kinder Morgan Willbridge Terminal SVA

Portland, Oregon

Figure G-1

G-3-1
Site Class Determination

Site Class Calculation
Kinder Morgan Willbridge Terminal SVA

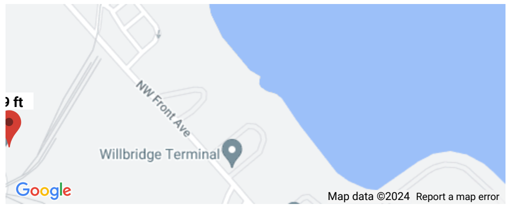
	A	B	C	D	E
1	**CPT-3**	**Shear Wave Vel. for Layer i**	**Layer Thickness**		
2	**CPT Measurement Depth (ft)**	**Vs,i (ft/s)**	**di (ft)**	**di/vsi**	**Notes**
3	**16.4**	**422.33**	**16.4**		Measured, required to Vac top 10'
4	19.69	284.85	3.29	0.01155	Measured
5	22.97	550.09	3.28	0.005963	Measured
6	26.25	519.93	3.28	0.006309	Measured
7	29.53	558.48	3.28	0.005873	Measured
8	32.81	551.42	3.28	0.005948	Measured
9	36.09	465.83	3.28	0.007041	Measured
10	39.37	541.12	3.28	0.006062	Measured
11	42.65	769.65	3.28	0.004262	Measured
12	45.93	729.62	3.28	0.004495	Measured
13	49.21	682.26	3.28	0.004808	Measured
14	52.49	729.81	3.28	0.004494	Measured
15	55.77	705.34	3.28	0.00465	Measured
16	59.06	839.42	3.29	0.003919	Measured
17	62.34	626.48	3.28	0.005236	Measured
18	65.62	671.62	3.28	0.004884	Measured
19	68.9	612.82	3.28	0.005352	Measured
20	72.18	711.52	3.28	0.00461	Measured
21	78.74	604.06	6.56	0.01086	Measured
22	82.19	638.89	3.45	0.0054	Measured
23	100	12000.0	17.81	0.001484	Sowers and Boyd (2019)
24					
25			=SUM(D4:D23)	0.113199	**Sum**
26				**Vs,30**	
27			=100/D25	883.3975	**(ft/s)**
28			=D27/3.28	269.3285	(m/s)

G-3-2
Building Code Seismic Design Parameters

ATC Hazards by Location

Search Information

Address:	5880 NW St Helens Rd, Portland, OR 97210, USA
Coordinates:	45.5653723, -122.7450565
Elevation:	39 ft
Timestamp:	2024-03-08T18:20:46.992Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	III
Site Class:	D



Basic Parameters

Name	Value	Description
S_S	0.894	MCE_R ground motion (period=0.2s)
S_1	0.407	MCE_R ground motion (period=1.0s)
S_{MS}	1.022	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	0.681	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	1.142	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.891	Coefficient of risk (0.2s)
CR_1	0.871	Coefficient of risk (1.0s)
PGA	0.404	MCE_G peak ground acceleration
F_{PGA}	1.196	Site amplification factor at PGA
PGA_M	0.483	Site modified peak ground acceleration
T_L	16	Long-period transition period (s)
SsRT	0.894	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.004	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.407	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.467	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	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.

TABLE 1613.2.3(2) VALUES OF SITE COEFFICIENT F_V[a]

SITE CLASS	MAPPED RISK TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) SPECTRAL RESPONSE ACCELERATION PARAMETER AT 1-SECOND PERIOD					
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 = 0.5$	$S_1 \geq 0.6$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.8	0.8	0.8	0.8	0.8	0.8
C	1.5	1.5	1.5	1.5	1.5	1.4
D	2.4	2.2[c]	2.0[c]	1.9[c]	1.8[c]	1.7[c]
E	4.2	3.3[c]	2.8[c]	2.4[c]	2.2[c]	2.0[c]
F	Note b	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at 1-second period, S_1.

b. Values shall be determined in accordance with Section 11.4.8 of ASCE 7.

c. See requirements for site-specific ground motions in Section 11.4.8 of ASCE 7.

S1 = 0.407g
Fv =
1.9-0.1*(0.007/0.1)
Fv = 1.893

G-3-3
PGA Hazard 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: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr⁻¹
Totals:
  Binned: 100 %
  Residual: 0 %
  Trace: 0.51 %
Mean (over all sources):
  m: 7.84
  r: 59.35 km
  ε□: 1.01 σ
Mode (largest m-r bin):
  m: 9.34
  r: 73.54 km
  ε□: 0.55 σ
  Contribution: 13.33 %
Mode (largest m-r-ε□ bin):
  m: 9.01
  r: 73.5 km
  ε□: 0.79 σ
  Contribution: 10.31 %
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	7.7	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
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
270	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
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	8.1	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
250	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
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	7.3	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	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
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	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
230	8.7	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	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	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
210	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	0.000
210	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
210	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
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	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.002
190	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
190	7.3	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
190	7.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.003
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	0.003	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	8.1	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003
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	0.002	0.000
190	8.5	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.001
170	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
170	7.1	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019
170	7.3	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.007
170	7.5	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.001
170	7.7	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
170	7.9	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.004	0.001
170	8.1	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000
170	8.3	0.005	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	8.5	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	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	0.001	0.000	0.000
150	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
150	6.9	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
150	7.1	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.049
150	7.3	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.020	0.001
150	7.5	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.011	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	0.004	0.001	0.000
150	7.9	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.014	0.001

150	8.1	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.004
150	8.3	0.243	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.224	0.013
150	8.5	0.174	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.106	0.000
150	8.7	1.514	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.225	0.289	0.000
150	9.1	1.156	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.128	0.000	0.028
130	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
130	6.7	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
130	6.9	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.030
130	7.1	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.100	0.019
130	7.3	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.011	0.001
130	7.5	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.003	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	0.005	0.001	0.000
130	7.9	0.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.032	0.017	0.002
130	8.1	0.118	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.041	0.001
130	8.3	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.066	0.030	0.000
130	8.5	0.790	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.701	0.084	0.005
130	8.7	3.372	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.296	0.000	0.076
130	8.9	3.415	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.295	0.000	0.120
130	9.1	5.290	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.886	0.000	0.404	0.000
110	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
110	6.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
110	6.7	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.020
110	6.9	0.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.072	0.011
110	7.1	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.099	0.012
110	7.3	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.026	0.005	0.001
110	7.5	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.002	0.000
110	7.7	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.001	0.000	0.000
110	7.9	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.008	0.007	0.002	0.000
110	8.1	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.003	0.000
110	8.3	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000
110	8.5	0.507	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.379	0.100	0.026	0.001
110	8.7	0.545	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.508	0.002	0.035	0.000
110	8.9	0.754	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.677	0.077	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	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
90	6.5	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.014
90	6.7	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.109	0.017
90	6.9	0.307	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.176	0.116	0.013
90	7.1	0.593	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126	0.399	0.067	0.002
90	7.3	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.055	0.025	0.001	0.000
90	7.5	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.041	0.005	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	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.007	0.010	0.013	0.002	0.000
90	8.1	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.020	0.004	0.000
90	8.3	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.005	0.001	0.000
90	8.5	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.110	0.011	0.003	0.000
90	8.7	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.051	0.008	0.001	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	0.001	0.000
70	6.5	0.216	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.090	0.006
70	6.7	0.698	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.095	0.489	0.110	0.004

70	6.9	1.162	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.670	0.452	0.040	0.000
70	7.1	1.652	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.310	1.163	0.179	0.000	0.000
70	7.3	0.229	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.150	0.073	0.002	0.000	0.001
70	7.5	0.146	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.108	0.008	0.000	0.000	0.003
70	7.7	0.027	0.000	0.000	0.000	0.000	0.000	0.004	0.012	0.010	0.000	0.000	0.000	0.001
70	7.9	0.161	0.000	0.000	0.000	0.000	0.002	0.011	0.008	0.005	0.092	0.041	0.001	0.000
70	8.1	0.304	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.256	0.047	0.000	0.000
70	8.3	0.181	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.152	0.029	0.000	0.000
70	8.5	0.826	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.145	0.615	0.066	0.000	0.000
70	8.7	1.298	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.007	0.291	0.000	0.000	0.000
70	8.9	8.305	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.404	1.901	0.000	0.000	0.000
70	9.1	10.310	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.310	0.000	0.000	0.000	0.000
70	9.3	13.333	0.000	0.000	0.000	0.000	0.000	0.000	5.371	7.963	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	0.353	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126	0.221	0.003	0.003
50	6.7	1.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.831	0.166	0.000	0.010
50	6.9	1.550	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.640	0.888	0.005	0.001	0.015
50	7.1	2.372	0.000	0.000	0.000	0.000	0.000	0.000	0.111	2.080	0.158	0.000	0.007	0.016
50	7.3	0.318	0.000	0.000	0.000	0.000	0.000	0.000	0.155	0.126	0.000	0.000	0.023	0.013
50	7.5	0.190	0.000	0.000	0.000	0.000	0.000	0.028	0.128	0.004	0.000	0.000	0.023	0.005
50	7.7	0.034	0.000	0.000	0.000	0.000	0.003	0.014	0.012	0.000	0.000	0.002	0.004	0.000
50	7.9	0.026	0.000	0.000	0.000	0.001	0.013	0.002	0.009	0.000	0.000	0.001	0.001	0.000
30	5.1	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
30	5.3	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026
30	5.5	0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.055
30	5.7	0.097	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.046
30	5.9	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.085	0.040
30	6.1	0.131	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.085	0.043
30	6.3	0.207	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.139	0.043
30	6.5	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.059	0.151	0.039
30	6.7	0.230	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.072	0.131	0.025
30	6.9	0.179	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.078	0.083	0.012
30	7.1	0.195	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.103	0.065	0.005
30	7.3	0.227	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.122	0.051	0.003
30	7.5	0.141	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.045	0.078	0.016	0.001
30	7.7	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.011	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	1.488	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.907	0.376	0.085
10	5.3	1.676	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.604	0.700	0.310	0.062
10	5.5	1.868	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.305	0.807	0.419	0.300	0.036
10	5.7	1.645	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.365	0.616	0.445	0.202	0.016
10	5.9	1.535	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.280	0.581	0.474	0.180	0.019
10	6.1	2.877	0.000	0.000	0.000	0.000	0.000	0.000	0.293	0.809	0.657	0.798	0.286	0.035
10	6.3	2.922	0.000	0.000	0.000	0.000	0.000	0.000	0.214	0.936	0.829	0.760	0.176	0.006
10	6.5	4.102	0.000	0.000	0.000	0.000	0.000	0.435	1.582	1.135	0.578	0.305	0.067	0.000
10	6.7	5.240	0.000	0.000	0.000	0.000	0.000	1.030	2.699	1.099	0.293	0.108	0.011	0.000
10	6.9	4.960	0.000	0.000	0.000	0.000	0.000	1.501	2.230	0.961	0.203	0.060	0.005	0.000
10	7.1	3.341	0.000	0.000	0.000	0.000	0.228	0.818	1.450	0.664	0.150	0.028	0.002	0.000
10	7.3	0.863	0.000	0.000	0.000	0.000	0.158	0.021	0.304	0.243	0.122	0.015	0.001	0.000

```
10  7.5 0.240   0.000   0.000   0.000   0.000   0.010   0.022   0.062   0.088   0.052   0.006   0.000   0.000
10  7.7 0.037   0.000   0.000   0.000   0.000   0.000   0.003   0.011   0.015   0.007   0.001   0.000   0.000
10  7.9 0.008   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: 31.37
  Distance (km): 73.54081
  Magnitude: 9.1078963
  Epsilon (mean values): 0.71762848
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 31.37
  Distance (km): 73.54081
  Magnitude: 9.1078963
  Epsilon (mean values): 0.71762848
  Azimuth: 264.20897
  Latitude: 45.50147
  Longitude: -123.59924
sub0_ch_mid.in:
  Percent Contributed: 11.5
  Distance (km): 122.51666
  Magnitude: 8.926499
  Epsilon (mean values): 1.4915873
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 11.5
  Distance (km): 122.51666
  Magnitude: 8.926499
  Epsilon (mean values): 1.4915873
  Azimuth: 266.64641
  Latitude: 45.48932
  Longitude: -124.32961
Geologic Model Partial Rupture:
  Percent Contributed: 7.63
  Distance (km): 2.1460296
  Magnitude: 6.7338375
  Epsilon (mean values): 0.17149488
Portland Hills:
  Percent Contributed: 7.56
  Distance (km): 1.9256939
  Magnitude: 6.7349261
  Epsilon (mean values): 0.15272126
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
coastalOR_deep.in:
  Percent Contributed: 6.91
  Distance (km): 59.695136
  Magnitude: 6.9289304
  Epsilon (mean values): 1.161641
Geologic Model Full Rupture:
  Percent Contributed: 3.38
  Distance (km): 0.78949246
  Magnitude: 6.9944913
```

```
    Epsilon (mean values): 0.022398055
  Portland Hills:
    Percent Contributed: 3.32
    Distance (km): 0.3582992
    Magnitude: 6.9988122
    Epsilon (mean values): -0.013821236
    Azimuth: 313.00196
    Latitude: 45.58227
    Longitude: -122.77095
  WUSmap_2014_fixSm.ch.in (opt):
    Percent Contributed: 3.35
    Distance (km): 11.632777
    Magnitude: 6.0495508
    Epsilon (mean values): 1.3635173
  PointSourceFinite: -122.745, 45.615:
    Percent Contributed: 1.18
    Distance (km): 7.39035
    Magnitude: 5.7946733
    Epsilon (mean values): 1.0569245
    Azimuth: 0
    Latitude: 45.614835
    Longitude: -122.74506
  noPuget_2014_fixSm.ch.in (opt):
    Percent Contributed: 3.35
    Distance (km): 11.631814
    Magnitude: 6.0495075
    Epsilon (mean values): 1.3634849
  PointSourceFinite: -122.745, 45.615:
    Percent Contributed: 1.18
    Distance (km): 7.3903504
    Magnitude: 5.7946731
    Epsilon (mean values): 1.0569247
    Azimuth: 0
    Latitude: 45.614835
    Longitude: -122.74506
  WUSmap_2014_fixSm.gr.in (opt):
    Percent Contributed: 3.15
    Distance (km): 11.675979
    Magnitude: 6.0065616
    Epsilon (mean values): 1.3874806
  PointSourceFinite: -122.745, 45.615:
    Percent Contributed: 1.18
    Distance (km): 7.39035
    Magnitude: 5.7946733
    Epsilon (mean values): 1.0569245
    Azimuth: 0
    Latitude: 45.614835
    Longitude: -122.74506
  noPuget_2014_fixSm.gr.in (opt):
    Percent Contributed: 3.15
    Distance (km): 11.674962
    Magnitude: 6.0065132
```

```
    Epsilon (mean values): 1.387448
  PointSourceFinite: -122.745, 45.615:
    Percent Contributed: 1.18
    Distance (km): 7.3903504
    Magnitude: 5.7946731
    Epsilon (mean values): 1.0569247
    Azimuth: 0
    Latitude: 45.614835
    Longitude: -122.74506
  coastalOR_deep.in:
    Percent Contributed: 2.52
    Distance (km): 71.78021
    Magnitude: 6.9692637
    Epsilon (mean values): 1.5675815
  sub0_ch_top.in:
    Percent Contributed: 2.45
    Distance (km): 140.22326
    Magnitude: 8.830465
    Epsilon (mean values): 1.7369915
  Cascadia Megathrust - whole CSZ Characteristic:
    Percent Contributed: 2.45
    Distance (km): 140.22326
    Magnitude: 8.830465
    Epsilon (mean values): 1.7369915
    Azimuth: 266.99056
    Latitude: 45.48466
    Longitude: -124.54931
  Geologic Model Small Mag:
    Percent Contributed: 2.12
    Distance (km): 14.272752
    Magnitude: 6.2726706
    Epsilon (mean values): 1.5265489
  Zeng Model Partial Rupture:
    Percent Contributed: 1.4
    Distance (km): 2.1403766
    Magnitude: 6.7338234
    Epsilon (mean values): 0.1711493
  Portland Hills:
    Percent Contributed: 1.39
    Distance (km): 1.9256939
    Magnitude: 6.7349261
    Epsilon (mean values): 0.15272126
    Azimuth: 313.00196
    Latitude: 45.58227
    Longitude: -122.77095
  sub1_ch_bot.in:
    Percent Contributed: 1.38
    Distance (km): 72.881464
    Magnitude: 8.8626142
    Epsilon (mean values): 0.87545776
  Cascadia Megathrust - Goldfinger Case B Characteristic:
    Percent Contributed: 1.38
```

```
  Distance (km): 72.881464
  Magnitude: 8.8626142
  Epsilon (mean values): 0.87545776
  Azimuth: 264.20897
  Latitude: 45.50147
  Longitude: -123.59924
sub2_ch_bot.in:
  Percent Contributed: 1.16
  Distance (km): 101.90635
  Magnitude: 8.7413673
  Epsilon (mean values): 1.3690468
Cascadia Megathrust - Goldfinger Case C Characteristic:
  Percent Contributed: 1.16
  Distance (km): 101.90635
  Magnitude: 8.7413673
  Epsilon (mean values): 1.3690468
  Azimuth: 230.32914
  Latitude: 45
  Longitude: -123.70227
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr^-1
Totals:
  Binned: 9.1 %
  Residual: 0 %
  Trace: 0.08 %
Mean (over all sources):
  m: 6.3
  r: 8.85 km
  ε□: 1.1 σ
Mode (largest m-r bin):
  m: 6.69
  r: 3.84 km
  ε□: 0.45 σ
  Contribution: 1.23 %
Mode (largest m-r-ε□ bin):
  m: 6.69
  r: 2.23 km
  ε□: 0.31 σ
```

Contribution: 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,∞)
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	7.5	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
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	7.1	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	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
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	0.001	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	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
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	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	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	0.005
50	7.5	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.001
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	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
30	5.3	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020
30	5.5	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025
30	5.7	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.020
30	5.9	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.013
30	6.1	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.015
30	6.3	0.078	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.056	0.015
30	6.5	0.085	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.054	0.014
30	6.7	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.050	0.008
30	6.9	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.026	0.003
30	7.1	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.022	0.000
30	7.3	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.042	0.016	0.000
30	7.5	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.027	0.004	0.000
30	7.7	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.004	0.000	0.000

30	7.9	0.001	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	0.708	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.418	0.149	0.022
10	5.3	0.594	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.203	0.247	0.125	0.019
10	5.5	0.498	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.227	0.166	0.096	0.010
10	5.7	0.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.218	0.124	0.073	0.000
10	5.9	0.385	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.211	0.106	0.065	0.002
10	6.1	0.718	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.214	0.167	0.220	0.117	0.000
10	6.3	0.753	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.218	0.235	0.274	0.026	0.000
10	6.5	0.967	0.000	0.000	0.000	0.000	0.000	0.000	0.457	0.195	0.204	0.104	0.007	0.000
10	6.7	1.234	0.000	0.000	0.000	0.000	0.000	0.000	0.999	0.110	0.091	0.034	0.000	0.000
10	6.9	1.144	0.000	0.000	0.000	0.000	0.000	0.000	0.988	0.073	0.065	0.017	0.000	0.000
10	7.1	0.750	0.000	0.000	0.000	0.000	0.000	0.000	0.644	0.055	0.044	0.007	0.000	0.000
10	7.3	0.197	0.000	0.000	0.000	0.000	0.000	0.000	0.115	0.040	0.039	0.002	0.000	0.000
10	7.5	0.056	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.022	0.017	0.000	0.000	0.000
10	7.7	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.002	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	0.000	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: 1.78
  Distance (km): 2.3164806
  Magnitude: 6.731982
  Epsilon (mean values): 0.32757367
Portland Hills:
  Percent Contributed: 1.76
  Distance (km): 1.9863133
  Magnitude: 6.733553
  Epsilon (mean values): 0.30221088
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr^{-1}
Totals:
  Binned: 11.85 %
  Residual: 0 %
  Trace: 0.09 %
Mean (over all sources):
  m: 6.31

```
    r: 9.23 km
    ε□: 0.91 σ
  Mode (largest m-r bin):
    m: 6.68
    r: 4.23 km
    ε□: 0.32 σ
    Contribution: 1.46 %
  Mode (largest m-r-ε□ bin):
    m: 6.68
    r: 2.77 km
    ε□: 0.2 σ
    Contribution: 1.22 %
  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	7.1	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	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
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	0.001	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	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
50	6.9	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.008
50	7.1	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.006
50	7.3	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.004
50	7.5	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.001
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	0.004	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	5.5	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.023
30	5.7	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.014
30	5.9	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.015
30	6.1	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.044	0.014

30	6.3	0.085	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.055	0.012
30	6.5	0.109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.063	0.010
30	6.7	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.052	0.047	0.004
30	6.9	0.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.037	0.033	0.001
30	7.1	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.044	0.019	0.000
30	7.3	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.045	0.012	0.000
30	7.5	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.029	0.002	0.000
30	7.7	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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	0.001	0.000	0.000
10	5.1	0.369	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.246	0.099	0.024
10	5.3	0.614	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.356	0.159	0.082	0.016
10	5.5	0.885	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.305	0.368	0.120	0.084	0.007
10	5.7	0.764	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.364	0.192	0.169	0.038	0.000
10	5.9	0.689	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.278	0.158	0.213	0.039	0.000
10	6.1	1.235	0.000	0.000	0.000	0.000	0.000	0.000	0.293	0.328	0.208	0.377	0.029	0.000
10	6.3	1.159	0.000	0.000	0.000	0.000	0.000	0.000	0.213	0.429	0.172	0.344	0.000	0.000
10	6.5	1.302	0.000	0.000	0.000	0.000	0.000	0.000	0.817	0.268	0.102	0.115	0.000	0.000
10	6.7	1.459	0.000	0.000	0.000	0.000	0.000	0.000	1.225	0.137	0.074	0.024	0.000	0.000
10	6.9	1.310	0.000	0.000	0.000	0.000	0.000	0.000	1.159	0.088	0.053	0.011	0.000	0.000
10	7.1	0.878	0.000	0.000	0.000	0.000	0.000	0.000	0.757	0.077	0.043	0.001	0.000	0.000
10	7.3	0.239	0.000	0.000	0.000	0.000	0.000	0.000	0.140	0.067	0.031	0.000	0.000	0.000
10	7.5	0.069	0.000	0.000	0.000	0.000	0.000	0.007	0.020	0.028	0.013	0.000	0.000	0.000
10	7.7	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.005	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: 2.03
  Distance (km): 2.3786105
  Magnitude: 6.7293326
  Epsilon (mean values): 0.19845387
Portland Hills:
  Percent Contributed: 2
  Distance (km): 2.0029772
  Magnitude: 6.7310503
  Epsilon (mean values): 0.16863672
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
WUSmap_2014_fixSm.ch.in (opt):
  Percent Contributed: 1.26
  Distance (km): 11.907837
  Magnitude: 6.0253682
  Epsilon (mean values): 1.230025
noPuget_2014_fixSm.ch.in (opt):
  Percent Contributed: 1.26
  Distance (km): 11.906823
  Magnitude: 6.025323
  Epsilon (mean values): 1.2299865
WUSmap_2014_fixSm.gr.in (opt):
  Percent Contributed: 1.2
  Distance (km): 11.899156
  Magnitude: 5.9868162

```
  Epsilon (mean values): 1.2461909
noPuget_2014_fixSm.gr.in (opt):
  Percent Contributed: 1.2
  Distance (km): 11.898089
  Magnitude: 5.9867666
  Epsilon (mean values): 1.2461516
Geologic Model Small Mag:
  Percent Contributed: 1.01
  Distance (km): 14.360617
  Magnitude: 6.2533941
  Epsilon (mean values): 1.3155668
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr⁻¹
Totals:
  Binned: 3.92 %
  Residual: 0 %
  Trace: 0.09 %
Mean (over all sources):
  m: 6.61
  r: 5.55 km
  ε□: 1.05 σ
Mode (largest m-r bin):
  m: 6.68
  r: 3.49 km
  ε□: 0.74 σ
  Contribution: 0.83 %
Mode (largest m-r-ε□ bin):
  m: 6.68
  r: 2.38 km
  ε□: 0.64 σ
  Contribution: 0.74 %
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	0.000	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	7.7	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	0.002	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	6.3	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.007
30	6.5	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.008
30	6.7	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.006
30	6.9	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.004
30	7.1	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.003
30	7.3	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.003
30	7.5	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.001
30	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
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	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.016
10	5.3	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.040	0.010
10	5.5	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.046	0.007
10	5.7	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.035	0.009
10	5.9	0.098	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.061	0.024	0.012
10	6.1	0.253	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.091	0.093	0.039	0.029
10	6.3	0.331	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.181	0.077	0.068	0.004
10	6.5	0.643	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.407	0.162	0.040	0.034	0.000
10	6.7	0.835	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.735	0.066	0.025	0.008	0.000
10	6.9	0.773	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.707	0.040	0.021	0.005	0.000
10	7.1	0.503	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.455	0.029	0.016	0.002	0.000
10	7.3	0.117	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.079	0.025	0.011	0.001	0.000
10	7.5	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.012	0.006	0.000	0.000
10	7.7	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.001	0.000	0.000
10	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

Principal Sources (faults, subduction, random seismicity having > 3% contribution
Geologic Model Partial Rupture:
  Percent Contributed: 1.24
  Distance (km): 2.0310304
  Magnitude: 6.7301157
  Epsilon (mean values): 0.62741015
Portland Hills:
  Percent Contributed: 1.23

```
  Distance (km): 1.9267184
  Magnitude: 6.7307386
  Epsilon (mean values): 0.61849416
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr⁻¹
Totals:
  Binned: 9.98 %
  Residual: 0 %
  Trace: 0.11 %
Mean (over all sources):
  m: 6.48
  r: 6.7 km
  ε□: 0.57 σ
Mode (largest m-r bin):
  m: 6.87
  r: 2.12 km
  ε□: -0.22 σ
  Contribution: 1.73 %
Mode (largest m-r-ε□ bin):
  m: 6.87
  r: 0.87 km
  ε□: -0.36 σ
  Contribution: 1.5 %
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	7.5	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
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	6.7	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	0.001	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	7.1	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
50	7.3	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.004
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	0.001	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	0.001	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	0.006	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	5.7	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013
30	5.9	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.012
30	6.1	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.013
30	6.3	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.025	0.009
30	6.5	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.024	0.007
30	6.7	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.023	0.007
30	6.9	0.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.018	0.016	0.005
30	7.1	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.027	0.016	0.002
30	7.3	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.033	0.013	0.000
30	7.5	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.022	0.021	0.004	0.000
30	7.7	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	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	0.001	0.001	0.000	0.000	0.000
10	5.1	0.377	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.244	0.110	0.023
10	5.3	0.418	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.294	0.063	0.016
10	5.5	0.413	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.212	0.113	0.074	0.013
10	5.7	0.382	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.205	0.113	0.056	0.007
10	5.9	0.363	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.211	0.094	0.052	0.006
10	6.1	0.671	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.267	0.191	0.107	0.101	0.006
10	6.3	0.679	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.290	0.240	0.065	0.082	0.002
10	6.5	1.189	0.000	0.000	0.000	0.000	0.000	0.435	0.306	0.264	0.111	0.046	0.027	0.000
10	6.7	1.712	0.000	0.000	0.000	0.000	0.000	1.030	0.475	0.117	0.062	0.026	0.003	0.000
10	6.9	1.732	0.000	0.000	0.000	0.000	0.000	1.501	0.082	0.093	0.046	0.011	0.000	0.000
10	7.1	1.210	0.000	0.000	0.000	0.000	0.228	0.818	0.049	0.077	0.034	0.004	0.000	0.000
10	7.3	0.311	0.000	0.000	0.000	0.000	0.158	0.020	0.049	0.056	0.027	0.001	0.000	0.000
10	7.5	0.087	0.000	0.000	0.000	0.000	0.010	0.015	0.025	0.026	0.010	0.000	0.000	0.000
10	7.7	0.014	0.000	0.000	0.000	0.000	0.000	0.003	0.005	0.005	0.001	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: 2.58
  Distance (km): 1.9006766
  Magnitude: 6.7404417
  Epsilon (mean values): -0.17553838
Portland Hills:
  Percent Contributed: 2.57
  Distance (km): 1.8237898
  Magnitude: 6.7408772
  Epsilon (mean values): -0.18430387
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
Geologic Model Full Rupture:
  Percent Contributed: 1.22
  Distance (km): 0.50382576
  Magnitude: 6.9991892
  Epsilon (mean values): -0.44026222
Portland Hills:
  Percent Contributed: 1.21
  Distance (km): 0.3582992
  Magnitude: 7.00055
  Epsilon (mean values): -0.45676539
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr^{-1}
Totals:
  Binned: 10.43 %
  Residual: 0 %
  Trace: 0.03 %
Mean (over all sources):
  m: 9.1
  r: 76.97 km
  ε□: 0.95 σ
Mode (largest m-r bin):
  m: 9.34

r: 73.54 km
ε□: 0.56 σ
Contribution: 4.52 %
Mode (largest m-r-ε□ bin):
m: 9.34
r: 73.54 km
ε□: 0.56 σ
Contribution: 4.52 %
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,∞)
150	9.1	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028
130	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
130	8.7	0.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076
130	8.9	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120
130	9.1	0.404	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.404	0.000
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
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	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.001
110	8.7	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.035	0.000
110	8.9	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.077	0.000	0.000
90	7.9	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
90	8.1	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000
90	8.3	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000
90	8.5	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.003	0.000
90	8.7	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.001	0.000
70	7.9	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.001	0.000
70	8.1	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.045	0.000	0.000
70	8.3	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.000	0.000
70	8.5	0.148	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.082	0.066	0.000	0.000
70	8.7	0.269	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.269	0.000	0.000	0.000
70	8.9	1.901	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.901	0.000	0.000	0.000
70	9.1	2.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.700	0.000	0.000	0.000	0.000
70	9.3	4.519	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.519	0.000	0.000	0.000	0.000

Principal Sources (faults, subduction, random seismicity having > 3% contribution

```
sub0_ch_bot.in:
  Percent Contributed: 8.96
  Distance (km): 73.54081
  Magnitude: 9.142498
  Epsilon (mean values): 0.80806925
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 8.96
  Distance (km): 73.54081
  Magnitude: 9.142498
  Epsilon (mean values): 0.80806925
  Azimuth: 264.20897
  Latitude: 45.50147
  Longitude: -123.59924
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr⁻¹
Totals:
  Binned: 19.59 %
  Residual: 0 %
  Trace: 0.06 %
Mean (over all sources):
  m: 8.92
  r: 97.95 km
  ε□: 1.2 σ
Mode (largest m-r bin):
  m: 9.34
  r: 73.54 km
  ε□: 0.77 σ
  Contribution: 3.44 %
Mode (largest m-r-ε□ bin):
  m: 9.34
  r: 73.54 km
  ε□: 0.77 σ
  Contribution: 3.44 %
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	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
250	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
250	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
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	7.9	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	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	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
230	8.7	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000
210	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
210	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
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	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	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	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003
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	0.002	0.000
190	8.5	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	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	0.000	0.003	0.001
170	8.1	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000
170	8.3	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000
170	8.5	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	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	0.001	0.000	0.000
150	7.9	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000
150	8.1	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.000
150	8.3	0.188	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.181	0.000
150	8.5	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.053	0.000
150	8.7	0.911	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.911	0.000	0.000
150	9.1	0.565	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.565	0.000	0.000
130	7.9	0.039	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.010	0.000
130	8.1	0.088	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.012	0.000
130	8.3	0.066	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.066	0.000	0.000
130	8.5	0.483	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.483	0.000	0.000
130	8.7	1.775	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.775	0.000	0.000
130	8.9	1.663	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.663	0.000	0.000
130	9.1	2.183	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.183	0.000	0.000	0.000
110	7.9	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000
110	8.1	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.000
110	8.3	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000

110	8.5	0.255	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.238	0.017	0.000	0.000
110	8.7	0.257	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.257	0.000	0.000	0.000
110	8.9	0.304	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.304	0.000	0.000	0.000
90	7.9	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.005	0.000	0.000
90	8.1	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.005	0.000	0.000
90	8.3	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.000	0.000
90	8.5	0.056	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.000	0.000	0.000
90	8.7	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.000	0.000	0.000
70	7.9	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.071	0.000	0.000	0.000
70	8.1	0.147	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.147	0.000	0.000	0.000
70	8.3	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.000	0.000	0.000
70	8.5	0.326	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.326	0.000	0.000	0.000
70	8.7	0.459	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.437	0.022	0.000	0.000	0.000
70	8.9	2.740	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.740	0.000	0.000	0.000	0.000
70	9.1	3.130	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.130	0.000	0.000	0.000	0.000
70	9.3	3.443	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.443	0.000	0.000	0.000	0.000

```
Principal Sources (faults, subduction, random seismicity having > 3% contribution
sub0_ch_bot.in:
  Percent Contributed: 9.14
  Distance (km): 73.54081
  Magnitude: 9.0863164
  Epsilon (mean values): 0.8563853
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 9.14
  Distance (km): 73.54081
  Magnitude: 9.0863164
  Epsilon (mean values): 0.8563853
  Azimuth: 264.20897
  Latitude: 45.50147
  Longitude: -123.59924
sub0_ch_mid.in:
  Percent Contributed: 5.31
  Distance (km): 122.51666
  Magnitude: 8.9073624
  Epsilon (mean values): 1.4762317
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 5.31
  Distance (km): 122.51666
  Magnitude: 8.9073624
  Epsilon (mean values): 1.4762317
  Azimuth: 266.64641
  Latitude: 45.48932
  Longitude: -124.32961
sub0_ch_top.in:
  Percent Contributed: 1.34
  Distance (km): 140.22326
  Magnitude: 8.812975
  Epsilon (mean values): 1.6985476
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 1.34
  Distance (km): 140.22326
  Magnitude: 8.812975
```

```
  Epsilon (mean values): 1.6985476
  Azimuth: 266.99056
  Latitude: 45.48466
  Longitude: -124.54931
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr⁻¹
Totals:
  Binned: 7.28 %
  Residual: 0 %
  Trace: 0.12 %
Mean (over all sources):
  m: 6.99
  r: 71.39 km
  ε□: 1.33 σ
Mode (largest m-r bin):
  m: 7.1
  r: 54.44 km
  ε□: 0.78 σ
  Contribution: 1.16 %
Mode (largest m-r-ε□ bin):
  m: 7.1
  r: 54.29 km
  ε□: 0.77 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	7.7	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	
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	7.3	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	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	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	
210	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	0.000	
210	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	
190	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	
190	7.3	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	
190	7.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.003	
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	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	
170	7.1	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	
170	7.3	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.007	
170	7.5	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.001	
170	7.7	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	
170	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	
150	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	
150	6.9	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	
150	7.1	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.049	
150	7.3	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.020	0.001	
150	7.5	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.011	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	0.004	0.000	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	0.004	0.000	0.000	
130	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	
130	6.7	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	
130	6.9	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.030	
130	7.1	0.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.100	0.018	
130	7.3	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.010	0.000	
130	7.5	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	
130	7.7	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	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	0.003	0.002	0.000	0.000	
110	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	
110	6.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	
110	6.7	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.020	
110	6.9	0.083	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.072	0.009	
110	7.1	0.178	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.089	0.000	
110	7.3	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.025	0.000	0.000	
110	7.5	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.009	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	0.000	0.000	0.000	

110	7.9	0.005	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	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
90	6.5	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.012
90	6.7	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.106	0.005
90	6.9	0.249	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.173	0.074	0.000
90	7.1	0.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125	0.313	0.000	0.000
90	7.3	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.047	0.007	0.000	0.000
90	7.5	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	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	0.001	0.000
70	6.5	0.159	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.048	0.000
70	6.7	0.484	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.095	0.359	0.030	0.000
70	6.9	0.745	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.526	0.219	0.000	0.000
70	7.1	0.973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.222	0.727	0.025	0.000	0.000
70	7.3	0.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.034	0.000	0.000	0.000
70	7.5	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.065	0.001	0.000	0.000	0.000
70	7.7	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.008	0.000	0.000	0.000	0.000
70	7.9	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.005	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	0.214	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.118	0.096	0.000	0.000
50	6.7	0.574	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.539	0.035	0.000	0.000
50	6.9	0.817	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.394	0.423	0.000	0.000	0.000
50	7.1	1.162	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.127	0.035	0.000	0.000	0.000
50	7.3	0.129	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.086	0.000	0.000	0.000	0.000
50	7.5	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.066	0.004	0.000	0.000	0.000	0.000
50	7.7	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.011	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: 3.93
  Distance (km): 61.263813
  Magnitude: 6.9163165
  Epsilon (mean values): 1.1755062
coastalOR_deep.in:
  Percent Contributed: 1.72
  Distance (km): 73.964556
  Magnitude: 6.9569994
  Epsilon (mean values): 1.5521807
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g

Recovered targets:
- Return period: 2486.3888 yrs
- Exceedance rate: 0.00040218972 yr^{-1}

Totals:
- Binned: 23.17 %
- Residual: 0 %
- Trace: 0.06 %

Mean (over all sources):
- m: 8.98
- r: 91.81 km
- ε□: 0.93 σ

Mode (largest m-r bin):
- m: 9.34
- r: 73.54 km
- ε□: 0.41 σ
- Contribution: 5.37 %

Mode (largest m-r-ε□ bin):
- m: 9.34
- r: 73.54 km
- ε□: 0.41 σ
- Contribution: 5.37 %

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	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
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	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
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	0.043	0.013
150	8.5	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.053	0.000
150	8.7	0.603	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.314	0.289	0.000
150	9.1	0.562	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.562	0.000	0.000
130	7.9	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.002
130	8.1	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.001
130	8.3	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.000
130	8.5	0.303	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.219	0.084	0.000
130	8.7	1.521	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.521	0.000	0.000
130	8.9	1.632	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.632	0.000	0.000
130	9.1	2.703	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.703	0.000	0.000	0.000
110	7.9	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
110	8.1	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.003	0.000
110	8.3	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000
110	8.5	0.225	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.141	0.084	0.000	0.000
110	8.7	0.253	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.251	0.002	0.000	0.000
110	8.9	0.373	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.373	0.000	0.000	0.000
90	7.9	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000
90	8.1	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.015	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	0.008	0.004	0.000	0.000
90	8.5	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.053	0.002	0.000	0.000
90	8.7	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.025	0.000	0.000	0.000
70	7.9	0.044	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.023	0.000	0.000
70	8.1	0.111	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.109	0.002	0.000	0.000
70	8.3	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.000	0.000	0.000
70	8.5	0.352	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.145	0.207	0.000	0.000	0.000
70	8.7	0.570	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.570	0.000	0.000	0.000	0.000
70	8.9	3.664	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.664	0.000	0.000	0.000	0.000
70	9.1	4.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.480	0.000	0.000	0.000	0.000
70	9.3	5.371	0.000	0.000	0.000	0.000	0.000	0.000	5.371	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: 13.27
  Distance (km): 73.54081
  Magnitude: 9.0994019
  Epsilon (mean values): 0.56091387

Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 13.27
  Distance (km): 73.54081
  Magnitude: 9.0994019
  Epsilon (mean values): 0.56091387
  Azimuth: 264.20897
  Latitude: 45.50147
  Longitude: -123.59924

sub0_ch_mid.in:
  Percent Contributed: 5.59
  Distance (km): 122.51666
  Magnitude: 8.9356964

  Epsilon (mean values): 1.4247428
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 5.59
  Distance (km): 122.51666
  Magnitude: 8.9356964
  Epsilon (mean values): 1.4247428
  Azimuth: 266.64641
  Latitude: 45.48932
  Longitude: -124.32961
sub0_ch_top.in:
  Percent Contributed: 1.09
  Distance (km): 140.22326
  Magnitude: 8.8473464
  Epsilon (mean values): 1.7606898
Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 1.09
  Distance (km): 140.22326
  Magnitude: 8.8473464
  Epsilon (mean values): 1.7606898
  Azimuth: 266.99056
  Latitude: 45.48466
  Longitude: -124.54931
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr^{-1}
Totals:
  Binned: 4.68 %
  Residual: 0 %
  Trace: 0.07 %
Mean (over all sources):
  m: 7.02
  r: 61.55 km
  ε□: 1.18 σ
Mode (largest m-r bin):
  m: 7.1
  r: 54.19 km
  ε□: 0.75 σ
  Contribution: 1.19 %
Mode (largest m-r-ε□ bin):

m: 7.1
r: 54.03 km
ε□: 0.73 σ
Contribution: 0.95 %

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	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
130	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
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	0.001	0.001
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	0.005	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	0.003
110	7.1	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.012
110	7.3	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.005	0.001
110	7.5	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.002	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	0.001	0.000	0.000
110	7.9	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	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	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
90	6.7	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.011
90	6.9	0.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.042	0.013
90	7.1	0.155	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.085	0.067	0.002

90	7.3	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.017	0.001	0.000
90	7.5	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.015	0.005	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	0.004	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	0.057	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.042	0.006
70	6.7	0.214	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.130	0.080	0.004
70	6.9	0.417	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.144	0.233	0.040	0.000
70	7.1	0.679	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.088	0.436	0.155	0.000	0.000
70	7.3	0.105	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.061	0.039	0.002	0.000	0.000
70	7.5	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.043	0.008	0.000	0.000	0.000
70	7.7	0.015	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.002	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	5.9	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	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.125	0.003	0.000
50	6.7	0.422	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.292	0.131	0.000	0.000
50	6.9	0.717	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.246	0.465	0.005	0.000	0.000
50	7.1	1.187	0.000	0.000	0.000	0.000	0.000	0.000	0.111	0.953	0.123	0.000	0.000	0.000
50	7.3	0.152	0.000	0.000	0.000	0.000	0.000	0.000	0.112	0.040	0.000	0.000	0.000	0.000
50	7.5	0.091	0.000	0.000	0.000	0.000	0.000	0.028	0.063	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	0.001	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: 2.98

  Distance (km): 57.627836

  Magnitude: 6.9455539

  Epsilon (mean values): 1.1433687

PSHA Deaggregation. %contributions.

site: Test

longitude: 122.745°W

latitude: 45.565°E

imt: Peak Ground Acceleration

vs30 = 259 m/s (Site class D)

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: 0.53464019 g

Recovered targets:

  Return period: 2486.3888 yrs

  Exceedance rate: 0.00040218972 yr^{-1}

Totals:

  Binned: 17.97 %

  Residual: 0 %

  Trace: 0.15 %

Mean (over all sources):

```
  m: 6.08
  r: 11.9 km
  ε□: 1.37 σ
Mode (largest m-r bin):
  m: 6.1
  r: 10.12 km
  ε□: 1.15 σ
  Contribution: 2.12 %
Mode (largest m-r-ε□ bin):
  m: 5.09
  r: 8.19 km
  ε□: 1.69 σ
  Contribution: 0.91 %
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	7.5	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
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	7.1	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	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
70	7.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
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	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
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	0.002	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	6.7	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
50	6.9	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
50	7.1	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.015
50	7.3	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.013
50	7.5	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	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	0.002	0.004	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	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
30	5.3	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026

```
30  5.5 0.064   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.009   0.055
30  5.7 0.097   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.051   0.046
30  5.9 0.125   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.085   0.040
30  6.1 0.130   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.003   0.085   0.043
30  6.3 0.203   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.026   0.135   0.041
30  6.5 0.186   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.043   0.114   0.029
30  6.7 0.144   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.048   0.076   0.018
30  6.9 0.153   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.006   0.072   0.066   0.009
30  7.1 0.191   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.023   0.101   0.063   0.005
30  7.3 0.227   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.051   0.122   0.051   0.003
30  7.5 0.141   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.045   0.078   0.016   0.001
30  7.7 0.023   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.002   0.011   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 1.488   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.120   0.907   0.376   0.085
10  5.3 1.676   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.604   0.700   0.310   0.062
10  5.5 1.868   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.305   0.807   0.419   0.300   0.036
10  5.7 1.638   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.365   0.616   0.442   0.199   0.015
10  5.9 1.381   0.000   0.000   0.000   0.000   0.000   0.000   0.001   0.275   0.580   0.401   0.117   0.008
10  6.1 2.120   0.000   0.000   0.000   0.000   0.000   0.000   0.293   0.680   0.590   0.443   0.108   0.006
10  6.3 1.851   0.000   0.000   0.000   0.000   0.000   0.000   0.214   0.709   0.617   0.282   0.029   0.000
10  6.5 1.185   0.000   0.000   0.000   0.000   0.000   0.000   0.177   0.473   0.341   0.177   0.016   0.000
10  6.7 0.921   0.000   0.000   0.000   0.000   0.000   0.001   0.203   0.354   0.261   0.095   0.008   0.000
10  6.9 0.762   0.000   0.000   0.000   0.000   0.000   0.010   0.193   0.291   0.203   0.060   0.005   0.000
10  7.1 0.533   0.000   0.000   0.000   0.000   0.000   0.016   0.108   0.229   0.150   0.028   0.002   0.000
10  7.3 0.438   0.000   0.000   0.000   0.000   0.000   0.021   0.101   0.178   0.122   0.015   0.001   0.000
10  7.5 0.213   0.000   0.000   0.000   0.000   0.000   0.015   0.056   0.084   0.052   0.006   0.000   0.000
10  7.7 0.037   0.000   0.000   0.000   0.000   0.000   0.003   0.011   0.015   0.007   0.001   0.000   0.000
10  7.9 0.008   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: 3.35
  Distance (km): 11.632777
  Magnitude: 6.0495508
  Epsilon (mean values): 1.3635173
PointSourceFinite: -122.745, 45.615:
  Percent Contributed: 1.18
  Distance (km): 7.39035
  Magnitude: 5.7946733
  Epsilon (mean values): 1.0569245
  Azimuth: 0
  Latitude: 45.614835
  Longitude: -122.74506
noPuget_2014_fixSm.ch.in (opt):
  Percent Contributed: 3.35
  Distance (km): 11.631814
  Magnitude: 6.0495075
  Epsilon (mean values): 1.3634849
PointSourceFinite: -122.745, 45.615:
  Percent Contributed: 1.18
  Distance (km): 7.3903504
  Magnitude: 5.7946731
  Epsilon (mean values): 1.0569247
```

  Azimuth: 0
  Latitude: 45.614835
  Longitude: -122.74506
WUSmap_2014_fixSm.gr.in (opt):
  Percent Contributed: 3.15
  Distance (km): 11.675979
  Magnitude: 6.0065616
  Epsilon (mean values): 1.3874806
PointSourceFinite: -122.745, 45.615:
  Percent Contributed: 1.18
  Distance (km): 7.39035
  Magnitude: 5.7946733
  Epsilon (mean values): 1.0569245
  Azimuth: 0
  Latitude: 45.614835
  Longitude: -122.74506
noPuget_2014_fixSm.gr.in (opt):
  Percent Contributed: 3.15
  Distance (km): 11.674962
  Magnitude: 6.0065132
  Epsilon (mean values): 1.387448
PointSourceFinite: -122.745, 45.615:
  Percent Contributed: 1.18
  Distance (km): 7.3903504
  Magnitude: 5.7946731
  Epsilon (mean values): 1.0569247
  Azimuth: 0
  Latitude: 45.614835
  Longitude: -122.74506
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr^{-1}
Totals:
  Binned: 11.96 %
  Residual: 0 %
  Trace: 0.14 %
Mean (over all sources):
  m: 7
  r: 67.54 km

```
  ε□: 1.27 σ
Mode (largest m-r bin):
  m: 7.1
  r: 54.32 km
  ε□: 0.76 σ
  Contribution: 2.35 %
Mode (largest m-r-ε□ bin):
  m: 7.1
  r: 54.17 km
  ε□: 0.75 σ
  Contribution: 2.08 %
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	7.7	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
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	7.3	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	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	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
210	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	0.000
210	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
190	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
190	7.3	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
190	7.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.003
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	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
170	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
170	7.1	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019
170	7.3	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.007
170	7.5	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.001

170	7.7	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
170	7.9	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
150	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
150	6.9	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
150	7.1	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.049
150	7.3	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.020	0.001
150	7.5	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.011	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	0.004	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	0.006	0.001	0.000
130	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
130	6.7	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
130	6.9	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.030
130	7.1	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.100	0.019
130	7.3	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.011	0.001
130	7.5	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.003	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	0.005	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	0.007	0.004	0.000	0.000
110	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
110	6.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
110	6.7	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.020
110	6.9	0.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.072	0.011
110	7.1	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.099	0.012
110	7.3	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.026	0.005	0.001
110	7.5	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.002	0.000
110	7.7	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.001	0.000	0.000
110	7.9	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.008	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	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
90	6.5	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.014
90	6.7	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.109	0.017
90	6.9	0.307	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.176	0.116	0.013
90	7.1	0.593	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126	0.399	0.067	0.002
90	7.3	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.055	0.025	0.001	0.000
90	7.5	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.041	0.005	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	0.001	0.000
70	6.5	0.216	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.090	0.006
70	6.7	0.698	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.095	0.489	0.110	0.004
70	6.9	1.162	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.670	0.452	0.040	0.000
70	7.1	1.652	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.310	1.163	0.179	0.000	0.000
70	7.3	0.228	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.150	0.073	0.002	0.000	0.000
70	7.5	0.144	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.108	0.008	0.000	0.000	0.000
70	7.7	0.026	0.000	0.000	0.000	0.000	0.000	0.004	0.012	0.010	0.000	0.000	0.000	0.000
70	7.9	0.026	0.000	0.000	0.000	0.000	0.002	0.011	0.008	0.005	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	0.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126	0.221	0.003	0.000

50	6.7	0.996	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.831	0.166	0.000	0.000
50	6.9	1.533	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.640	0.888	0.005	0.000	0.000
50	7.1	2.349	0.000	0.000	0.000	0.000	0.000	0.000	0.111	2.080	0.158	0.000	0.000	0.000
50	7.3	0.281	0.000	0.000	0.000	0.000	0.000	0.000	0.155	0.126	0.000	0.000	0.000	0.000
50	7.5	0.161	0.000	0.000	0.000	0.000	0.000	0.028	0.128	0.004	0.000	0.000	0.000	0.000
50	7.7	0.029	0.000	0.000	0.000	0.000	0.003	0.014	0.012	0.000	0.000	0.000	0.000	0.000
50	7.9	0.025	0.000	0.000	0.000	0.001	0.013	0.002	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: 6.91
  Distance (km): 59.695136
  Magnitude: 6.9289304
  Epsilon (mean values): 1.161641
coastalOR_deep.in:
  Percent Contributed: 2.52
  Distance (km): 71.78021
  Magnitude: 6.9692637
  Epsilon (mean values): 1.5675815
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
  Return period: 2486.3888 yrs
  Exceedance rate: 0.00040218972 yr^{-1}
Totals:
  Binned: 53.2 %
  Residual: 0 %
  Trace: 0.14 %
Mean (over all sources):
  m: 8.98
  r: 91.16 km
  ε□: 1.03 σ
Mode (largest m-r bin):
  m: 9.34
  r: 73.54 km
  ε□: 0.55 σ
  Contribution: 13.33 %
Mode (largest m-r-ε□ bin):
  m: 9.01
  r: 73.5 km
  ε□: 0.79 σ
  Contribution: 10.31 %

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	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
250	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
250	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
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	7.9	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	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	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
230	8.7	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000
210	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
210	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
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	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.002
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	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003
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	0.002	0.000
190	8.5	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.001
170	7.9	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.001
170	8.1	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000
170	8.3	0.005	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	8.5	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	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	0.001	0.000	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	0.000	0.013	0.001
150	8.1	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.004
150	8.3	0.243	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.224	0.013
150	8.5	0.174	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.106	0.000
150	8.7	1.514	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.225	0.289	0.000
150	9.1	1.156	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.128	0.000	0.028
130	7.9	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.017	0.002
130	8.1	0.118	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.041	0.001
130	8.3	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.066	0.030	0.000
130	8.5	0.790	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.701	0.084	0.005
130	8.7	3.372	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.296	0.000	0.076

130	8.9	3.415	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.295	0.000	0.120
130	9.1	5.290	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.886	0.000	0.404	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	0.007	0.002	0.000
110	8.1	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.003	0.000
110	8.3	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000
110	8.5	0.507	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.379	0.100	0.026	0.001
110	8.7	0.545	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.508	0.002	0.035	0.000
110	8.9	0.754	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.677	0.077	0.000	0.000
90	7.9	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.013	0.002	0.000
90	8.1	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.020	0.004	0.000
90	8.3	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.005	0.001	0.000
90	8.5	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.110	0.011	0.003	0.000
90	8.7	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.051	0.008	0.001	0.000
70	7.9	0.134	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.092	0.041	0.001	0.000
70	8.1	0.304	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.256	0.047	0.000	0.000
70	8.3	0.181	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.152	0.029	0.000	0.000
70	8.5	0.826	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.145	0.615	0.066	0.000	0.000
70	8.7	1.298	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.007	0.291	0.000	0.000	0.000
70	8.9	8.305	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.404	1.901	0.000	0.000	0.000
70	9.1	10.310	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.310	0.000	0.000	0.000	0.000
70	9.3	13.333	0.000	0.000	0.000	0.000	0.000	0.000	5.371	7.963	0.000	0.000	0.000	0.000

Principal Sources (faults, subduction, random seismicity having > 3% contribution

sub0_ch_bot.in:
  Percent Contributed: 31.37
  Distance (km): 73.54081
  Magnitude: 9.1078963
  Epsilon (mean values): 0.71762848

Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 31.37
  Distance (km): 73.54081
  Magnitude: 9.1078963
  Epsilon (mean values): 0.71762848
  Azimuth: 264.20897
  Latitude: 45.50147
  Longitude: -123.59924

sub0_ch_mid.in:
  Percent Contributed: 11.5
  Distance (km): 122.51666
  Magnitude: 8.926499
  Epsilon (mean values): 1.4915873

Cascadia Megathrust - whole CSZ Characteristic:
  Percent Contributed: 11.5
  Distance (km): 122.51666
  Magnitude: 8.926499
  Epsilon (mean values): 1.4915873
  Azimuth: 266.64641
  Latitude: 45.48932
  Longitude: -124.32961

sub0_ch_top.in:
  Percent Contributed: 2.45
  Distance (km): 140.22326
  Magnitude: 8.830465

Epsilon (mean values): 1.7369915
Cascadia Megathrust - whole CSZ Characteristic:
Percent Contributed: 2.45
Distance (km): 140.22326
Magnitude: 8.830465
Epsilon (mean values): 1.7369915
Azimuth: 266.99056
Latitude: 45.48466
Longitude: -124.54931
sub1_ch_bot.in:
Percent Contributed: 1.38
Distance (km): 72.881464
Magnitude: 8.8626142
Epsilon (mean values): 0.87545776
Cascadia Megathrust - Goldfinger Case B Characteristic:
Percent Contributed: 1.38
Distance (km): 72.881464
Magnitude: 8.8626142
Epsilon (mean values): 0.87545776
Azimuth: 264.20897
Latitude: 45.50147
Longitude: -123.59924
sub2_ch_bot.in:
Percent Contributed: 1.16
Distance (km): 101.90635
Magnitude: 8.7413673
Epsilon (mean values): 1.3690468
Cascadia Megathrust - Goldfinger Case C Characteristic:
Percent Contributed: 1.16
Distance (km): 101.90635
Magnitude: 8.7413673
Epsilon (mean values): 1.3690468
Azimuth: 230.32914
Latitude: 45
Longitude: -123.70227
PSHA Deaggregation. %contributions.
site: Test
longitude: 122.745°W
latitude: 45.565°E
imt: Peak Ground Acceleration
vs30 = 259 m/s (Site class D)
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: 0.53464019 g
Recovered targets:
Return period: 2486.3888 yrs
Exceedance rate: 0.00040218972 yr^{-1}
Totals:

```
    Binned: 16.88 %
    Residual: 0 %
    Trace: 0.05 %
  Mean (over all sources):
    m: 6.72
    r: 3.84 km
    ε□: 0.35 σ
  Mode (largest m-r bin):
    m: 6.68
    r: 2.47 km
    ε□: 0.2 σ
    Contribution: 4.32 %
  Mode (largest m-r-ε□ bin):
    m: 6.68
    r: 2.78 km
    ε□: 0.23 σ
    Contribution: 2.5 %
  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	6.3	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	0.006	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	6.9	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
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	0.001	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	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
30	6.3	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
30	6.5	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.037	0.010
30	6.7	0.086	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.054	0.007
30	6.9	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.017	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	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.001
10	5.9	0.154	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.001	0.073	0.063	0.012
10	6.1	0.757	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.129	0.066	0.354	0.178	0.029

10	6.3	1.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.227	0.211	0.478	0.148	0.006
10	6.5	2.917	0.000	0.000	0.000	0.000	0.000	0.435	1.405	0.661	0.237	0.127	0.051	0.000
10	6.7	4.320	0.000	0.000	0.000	0.000	0.000	1.030	2.496	0.745	0.032	0.014	0.003	0.000
10	6.9	4.198	0.000	0.000	0.000	0.000	0.000	1.491	2.037	0.670	0.001	0.000	0.000	0.000
10	7.1	2.808	0.000	0.000	0.000	0.000	0.228	0.803	1.342	0.435	0.000	0.000	0.000	0.000
10	7.3	0.425	0.000	0.000	0.000	0.000	0.158	0.000	0.203	0.065	0.000	0.000	0.000	0.000
10	7.5	0.027	0.000	0.000	0.000	0.000	0.010	0.007	0.006	0.004	0.000	0.000	0.000	0.000

Principal Sources (faults, subduction, random seismicity having > 3% contribution
Geologic Model Partial Rupture:
  Percent Contributed: 7.63
  Distance (km): 2.1460296
  Magnitude: 6.7338375
  Epsilon (mean values): 0.17149488
Portland Hills:
  Percent Contributed: 7.56
  Distance (km): 1.9256939
  Magnitude: 6.7349261
  Epsilon (mean values): 0.15272126
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
Geologic Model Full Rupture:
  Percent Contributed: 3.38
  Distance (km): 0.78949246
  Magnitude: 6.9944913
  Epsilon (mean values): 0.022398055
Portland Hills:
  Percent Contributed: 3.32
  Distance (km): 0.3582992
  Magnitude: 6.9988122
  Epsilon (mean values): -0.013821236
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095
Geologic Model Small Mag:
  Percent Contributed: 2.12
  Distance (km): 14.272752
  Magnitude: 6.2726706
  Epsilon (mean values): 1.5265489
Zeng Model Partial Rupture:
  Percent Contributed: 1.4
  Distance (km): 2.1403766
  Magnitude: 6.7338234
  Epsilon (mean values): 0.1711493
Portland Hills:
  Percent Contributed: 1.39
  Distance (km): 1.9256939
  Magnitude: 6.7349261
  Epsilon (mean values): 0.15272126
  Azimuth: 313.00196
  Latitude: 45.58227
  Longitude: -122.77095

G-3-4
Liquefaction and Residual Strength Calculations

T A B L E   O F   C O N T E N T S

Sage Geotechnical

Olympia, WA
www.sagegeotechnical.com

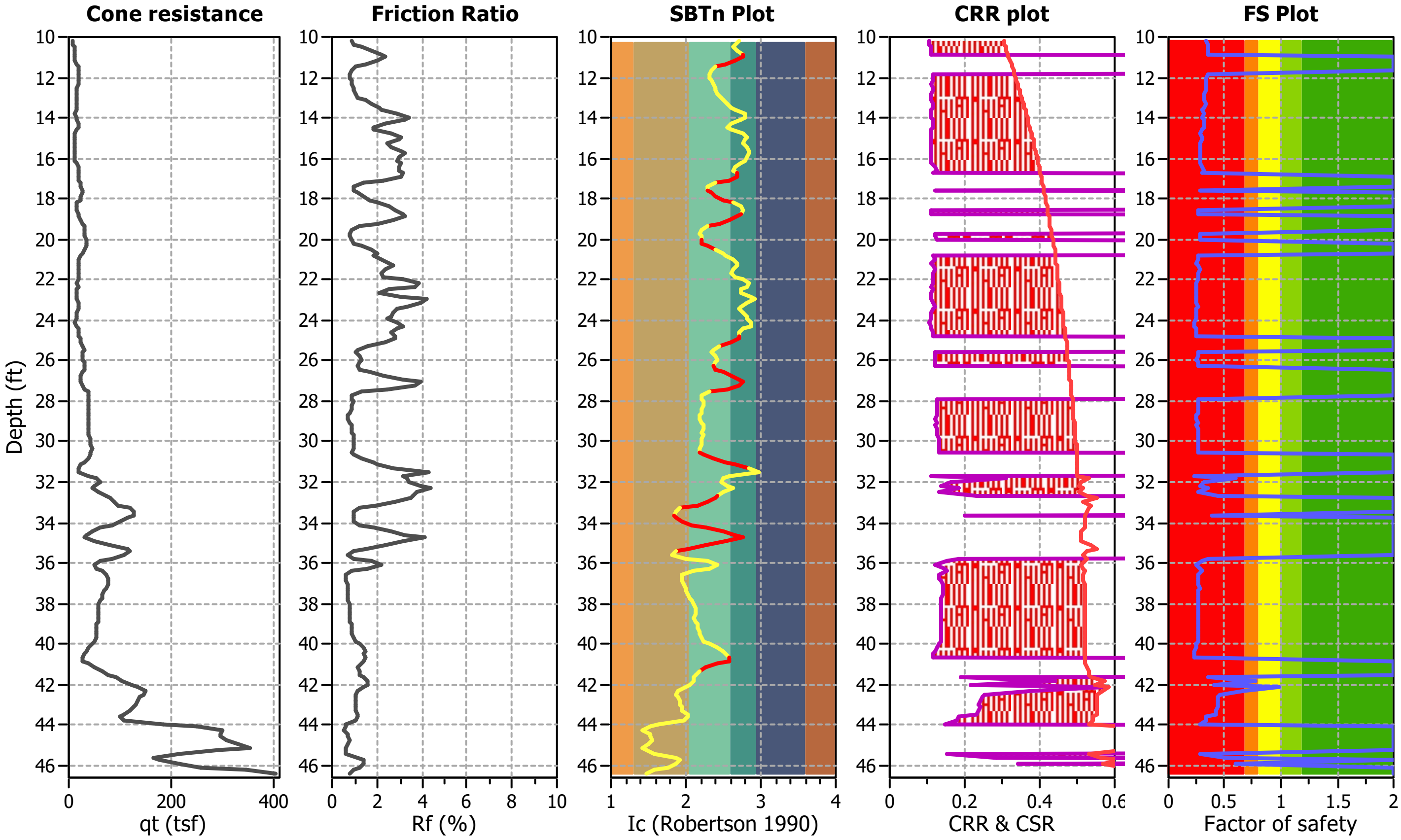
LIQUEFACTION ANALYSIS REPORT

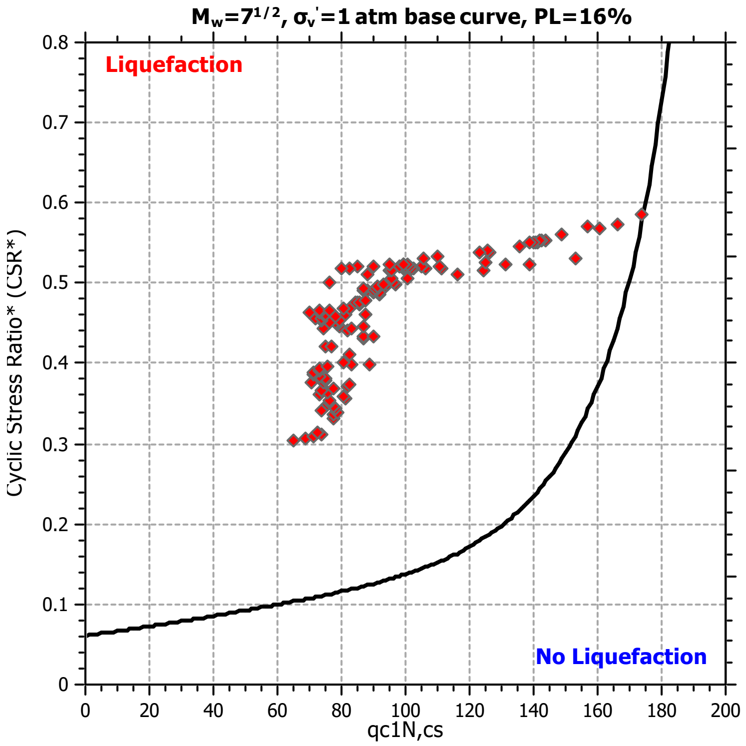
Project title : Kinder Morgan Willbridge Terminal SVA **Location : Portland, Oregon**

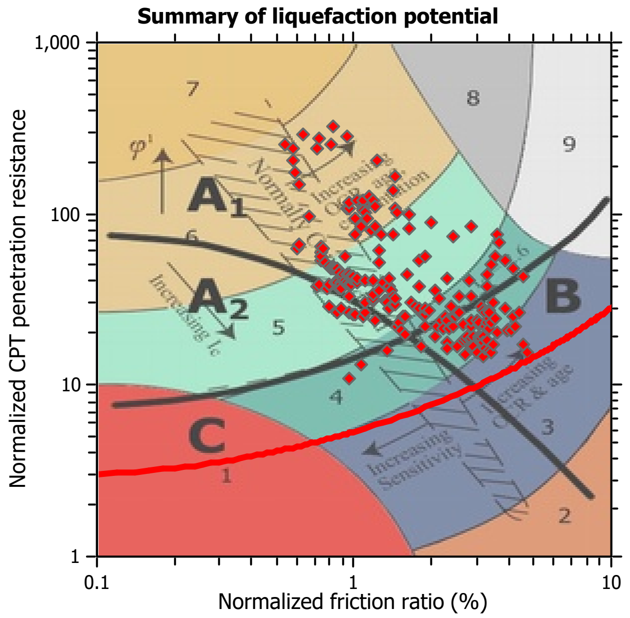
CPT file : CPT-01

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	10.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	10.00 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:	7.84	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.49	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

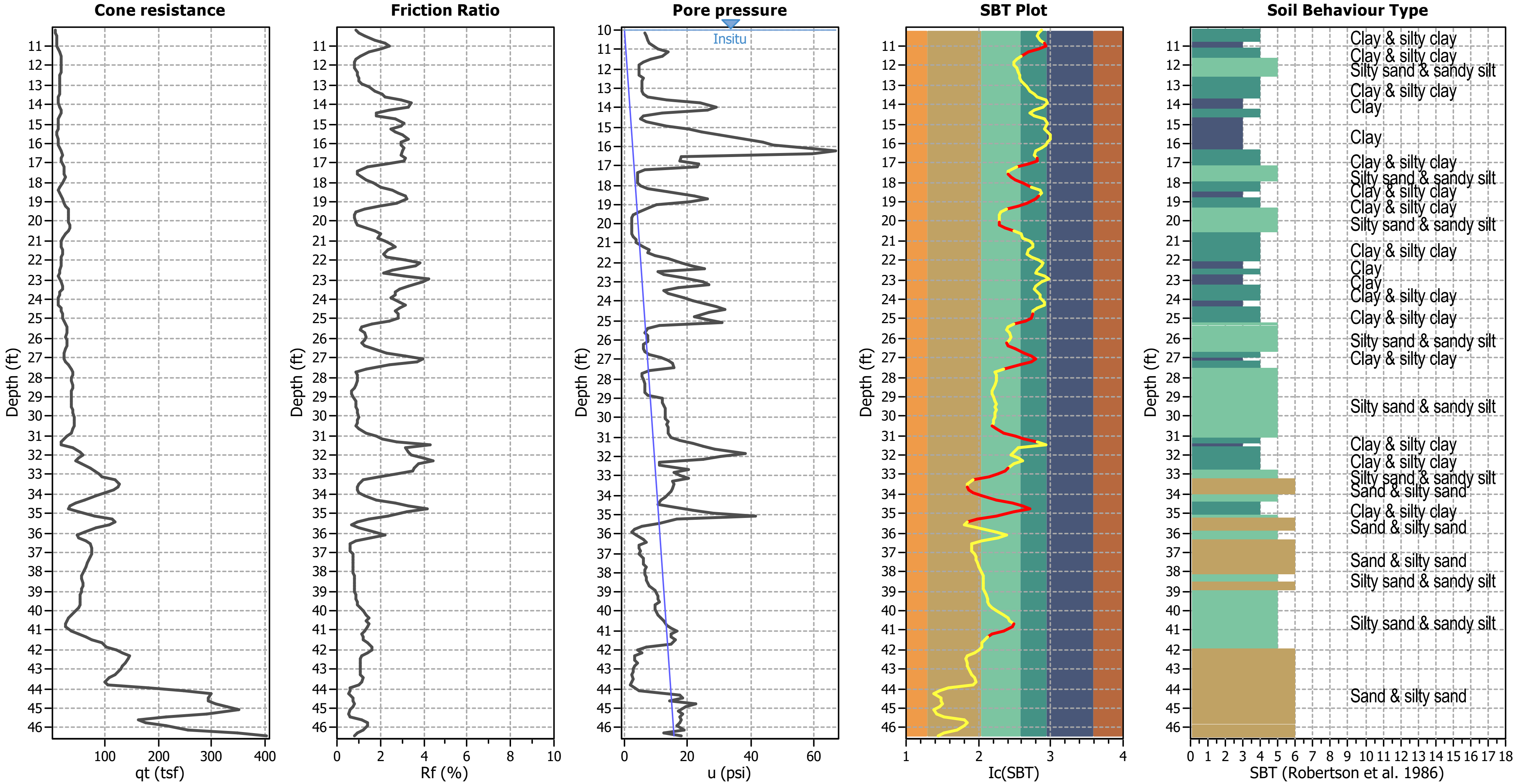






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



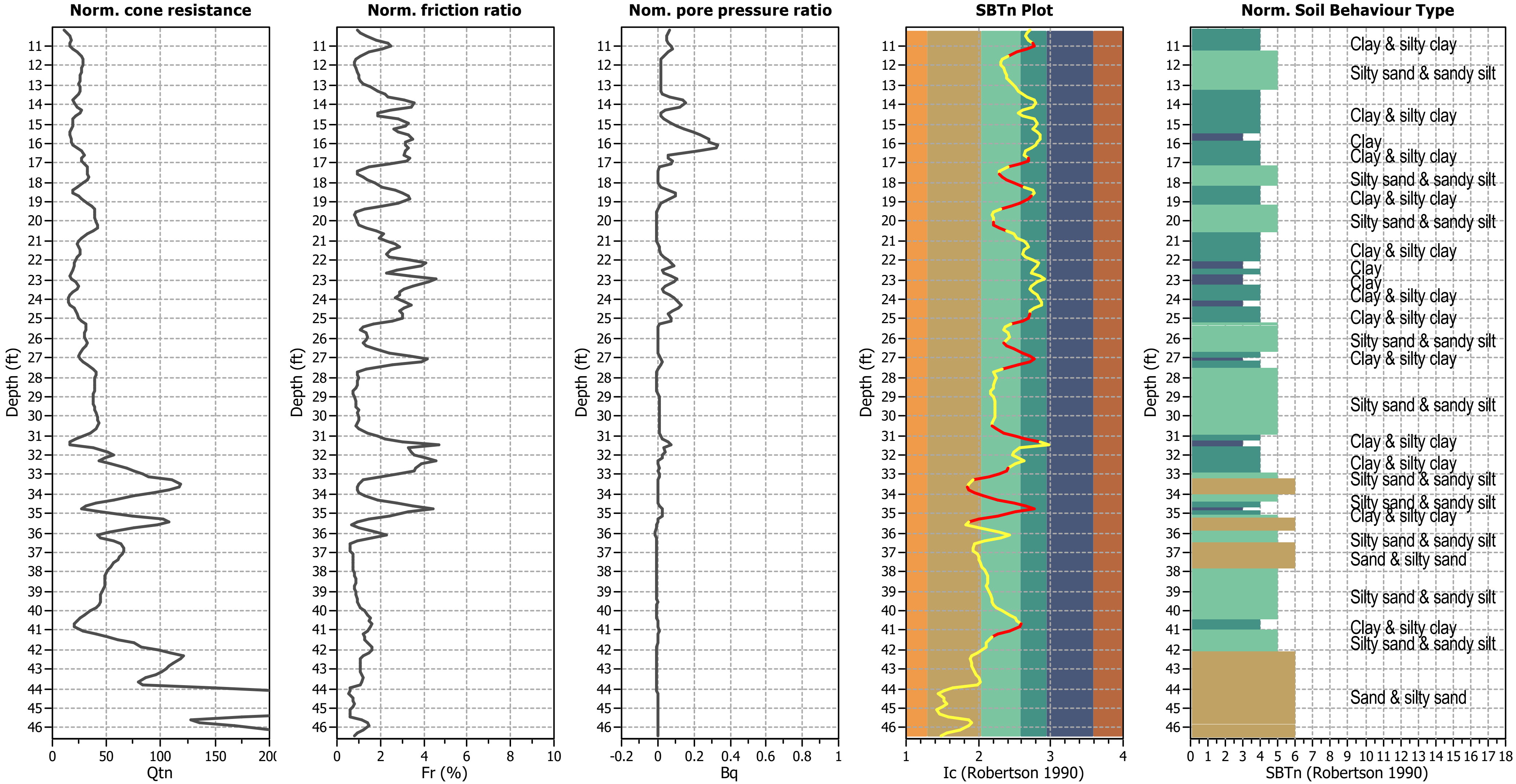
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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)



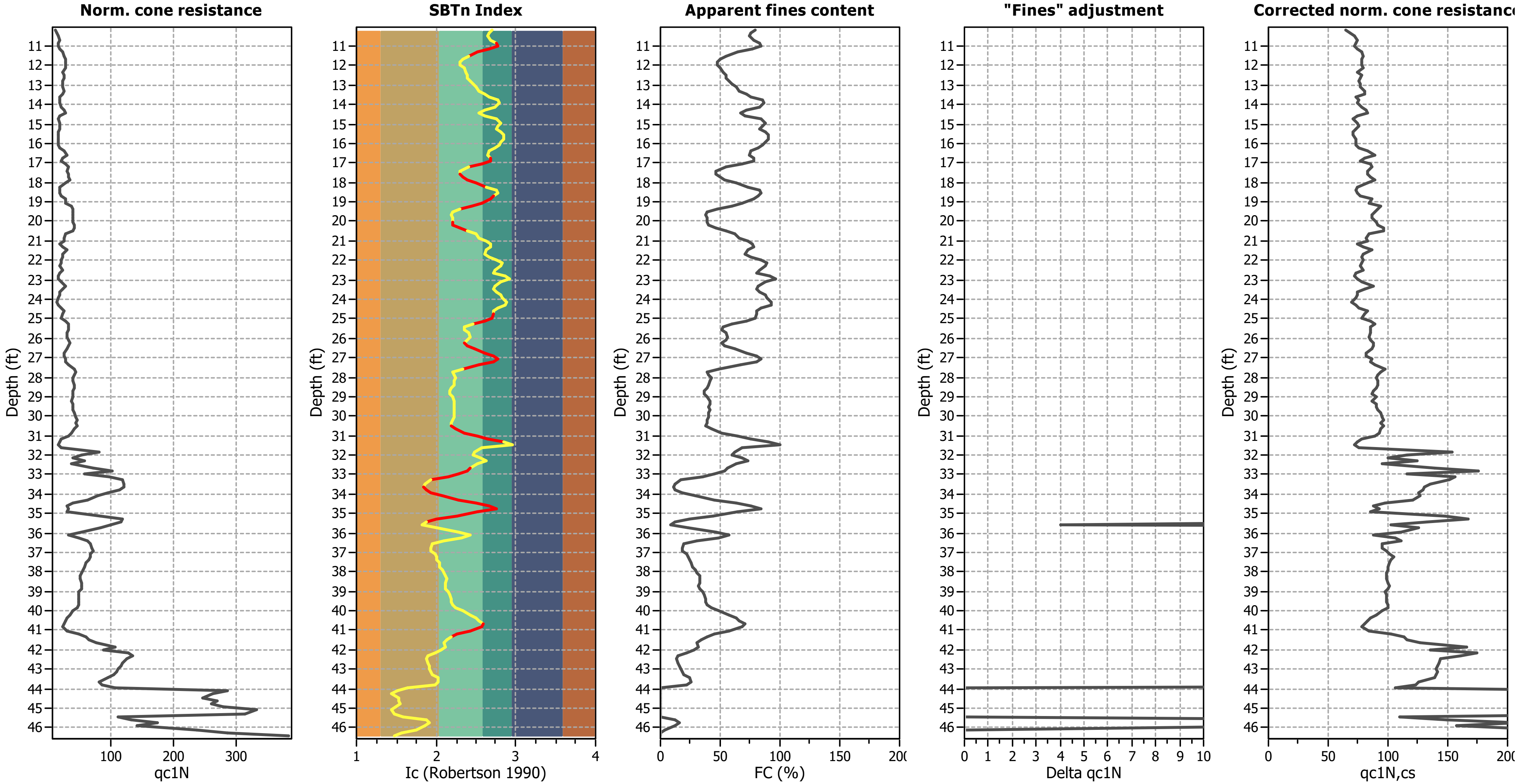
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	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

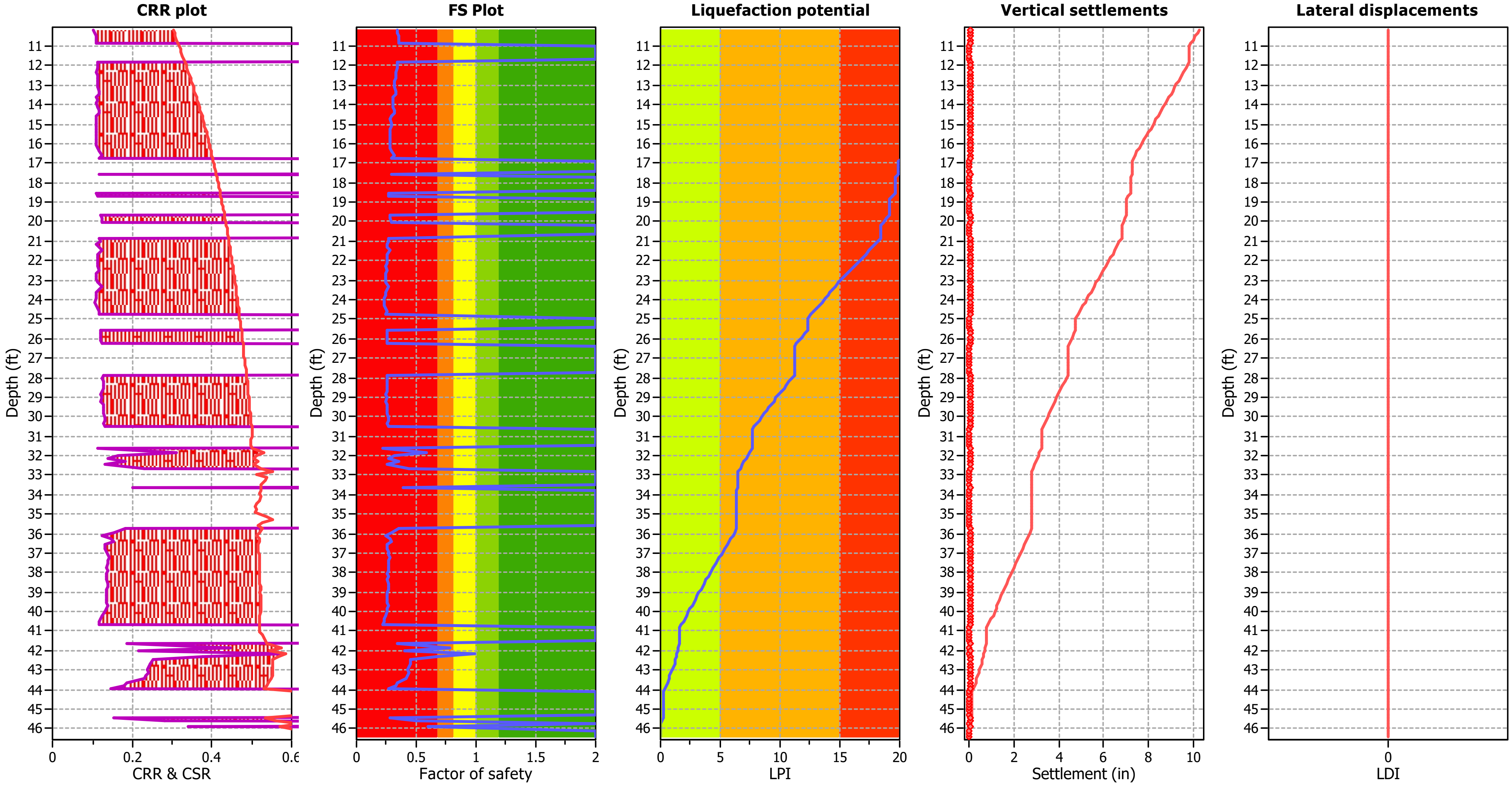
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

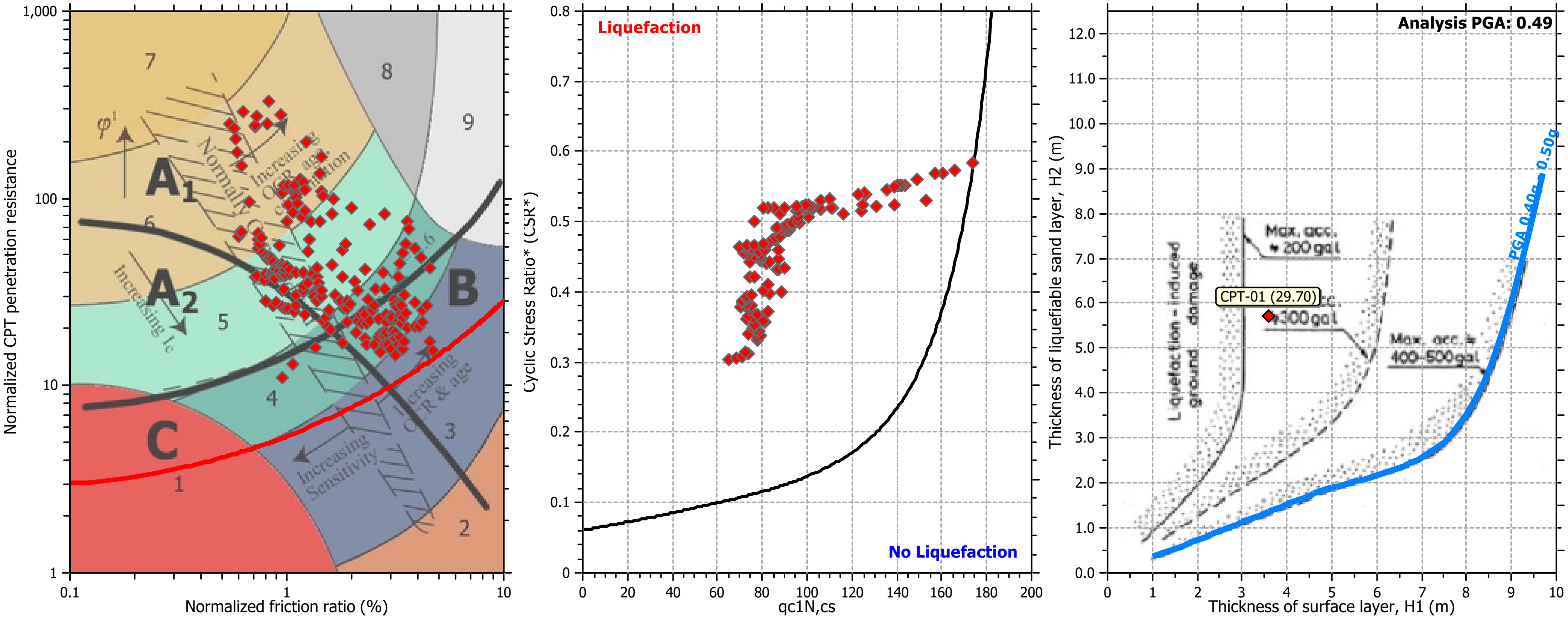
F.S. color scheme

- 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

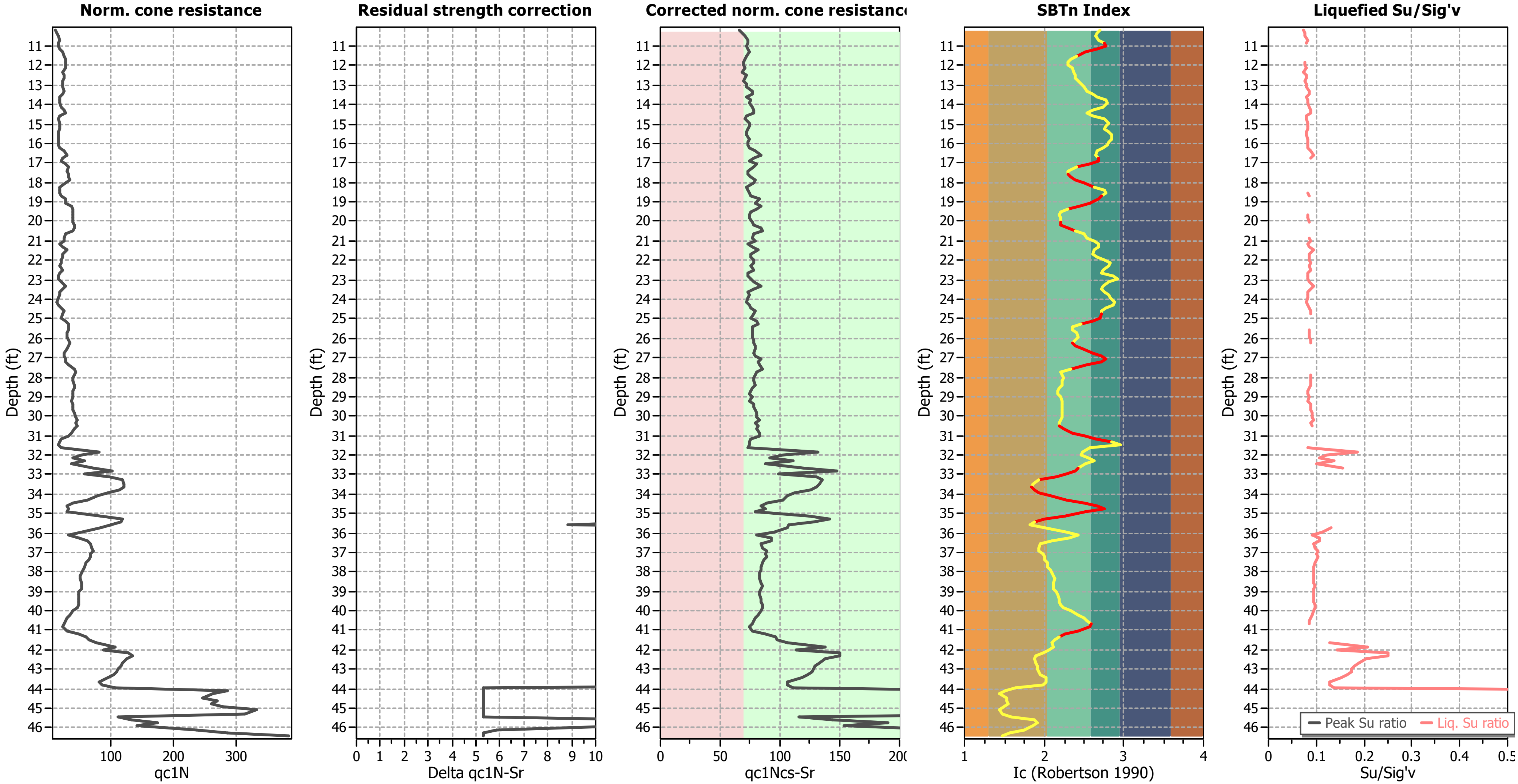
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

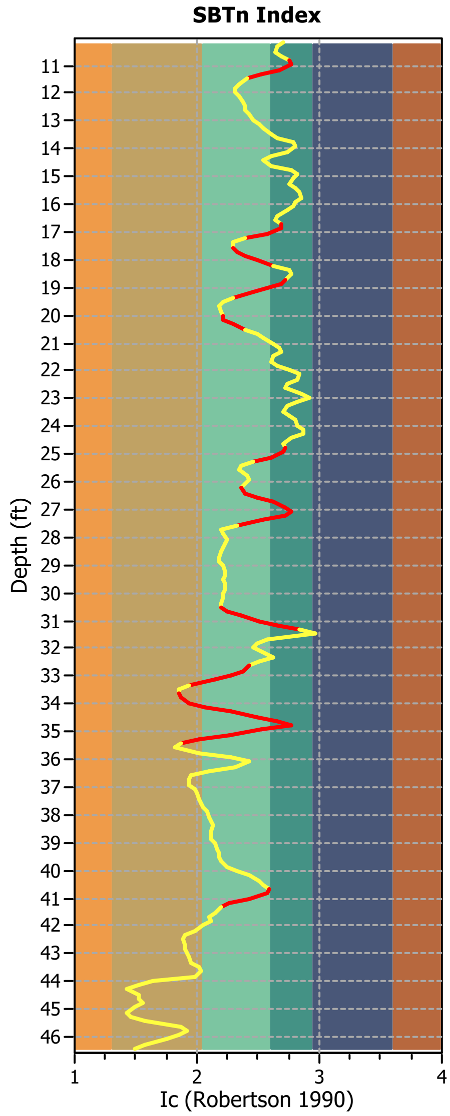
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

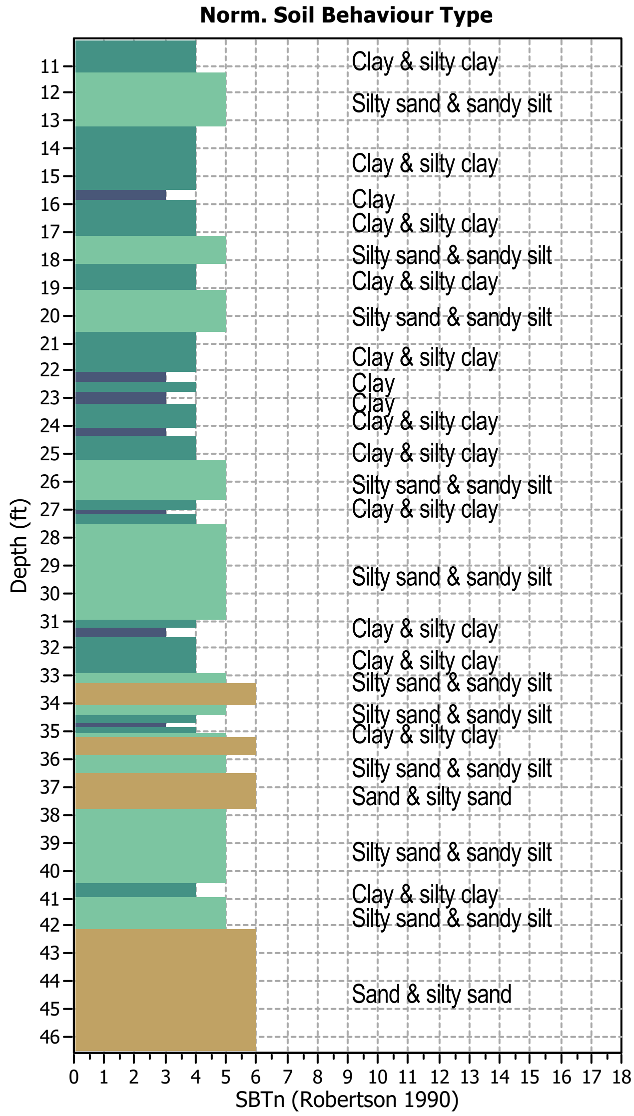
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	222
Total points excluded:	66
Exclusion percentage:	29.73%
Number of layers detected:	13

Transition layer No	Number of points	Depth	SBT_n number	SBT_n description
Transition layer 1	5	Start depth: 10.99 (ft)	4	Clay & silty clay
		End depth: 11.65 (ft)	5	Silty sand & sandy silt
Transition layer 2	4	Start depth: 16.90 (ft)	4	Clay & silty clay
		End depth: 17.39 (ft)	5	Silty sand & sandy silt
Transition layer 3	5	Start depth: 17.72 (ft)	5	Silty sand & sandy silt
		End depth: 18.37 (ft)	4	Clay & silty clay
Transition layer 4	5	Start depth: 18.86 (ft)	4	Clay & silty clay
		End depth: 19.52 (ft)	5	Silty sand & sandy silt
Transition layer 5	4	Start depth: 20.18 (ft)	5	Silty sand & sandy silt
		End depth: 20.67 (ft)	4	Clay & silty clay
Transition layer 6	4	Start depth: 24.93 (ft)	4	Clay & silty clay
		End depth: 25.43 (ft)	5	Silty sand & sandy silt
Transition layer 7	5	Start depth: 26.41 (ft)	5	Silty sand & sandy silt
		End depth: 27.07 (ft)	3	Clay
Transition layer 8	5	Start depth: 27.07 (ft)	3	Clay
		End depth: 27.72 (ft)	5	Silty sand & sandy silt
Transition layer 9	6	Start depth: 30.68 (ft)	5	Silty sand & sandy silt
		End depth: 31.50 (ft)	3	Clay
Transition layer 10	5	Start depth: 32.81 (ft)	4	Clay & silty clay
		End depth: 33.47 (ft)	6	Sand & silty sand
Transition layer 11	7	Start depth: 33.79 (ft)	6	Sand & silty sand
		End depth: 34.78 (ft)	3	Clay
Transition layer 12	6	Start depth: 34.78 (ft)	3	Clay
		End depth: 35.60 (ft)	6	Sand & silty sand
Transition layer 13	5	Start depth: 40.85 (ft)	4	Clay & silty clay
		End depth: 41.50 (ft)	5	Silty sand & sandy silt

Start depth: Depth where the transition layer begins
End depth: Depth where the transition layer ends

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	10.17	6.60	0.06	6.62	40.98	95.22
2	10.34	8.80	0.08	6.96	38.49	97.65
3	10.50	10.56	0.12	7.35	37.43	101.23
4	10.66	11.72	0.20	8.01	39.78	103.97
5	10.83	10.68	0.25	9.08	43.35	105.60
6	10.99	10.05	0.27	10.80	44.34	106.27
7	11.15	12.00	0.26	13.62	38.88	106.32
8	11.32	15.73	0.22	12.17	31.84	105.76
9	11.48	17.38	0.17	8.22	26.48	104.71
10	11.65	18.25	0.15	5.78	23.98	103.70
11	11.81	18.22	0.14	4.77	22.81	103.03
12	11.97	18.28	0.13	4.51	22.76	103.08
13	12.14	18.49	0.16	4.67	24.22	103.08
14	12.30	15.24	0.15	4.62	25.25	103.63
15	12.47	17.54	0.16	5.77	26.08	103.63
16	12.63	17.01	0.16	5.67	26.22	103.90
17	12.79	15.60	0.17	5.59	27.34	103.93
18	12.96	15.70	0.17	5.42	29.00	104.39
19	13.12	15.34	0.20	5.35	31.01	106.76
20	13.29	17.73	0.36	6.04	32.53	108.22
21	13.45	16.88	0.33	7.38	35.64	108.82
22	13.62	12.37	0.29	13.28	38.49	108.22
23	13.78	12.96	0.32	24.06	44.88	109.04
24	13.94	12.06	0.48	29.18	45.98	110.71
25	14.11	14.63	0.55	26.11	42.82	111.63
26	14.27	18.20	0.44	12.10	35.71	110.84
27	14.44	19.18	0.27	5.95	32.71	108.59
28	14.60	13.59	0.22	5.14	35.44	106.93
29	14.76	10.53	0.29	7.07	44.00	108.21
30	14.93	12.69	0.47	13.55	46.67	109.19
31	15.09	13.06	0.37	20.27	45.04	109.29
32	15.26	12.15	0.29	24.63	43.48	107.41
33	15.42	10.72	0.23	30.11	46.23	107.21
34	15.58	10.48	0.37	35.59	48.48	108.11
35	15.75	11.90	0.41	43.91	48.78	109.01
36	15.91	11.99	0.35	47.05	46.39	108.75
37	16.08	11.98	0.31	57.41	45.26	109.18
38	16.24	13.87	0.45	66.87	42.62	111.27
39	16.40	19.27	0.63	59.52	38.38	113.25
40	16.57	23.19	0.62	18.00	37.20	113.80
41	16.73	17.68	0.55	17.64	39.47	113.61
42	16.90	15.14	0.62	23.32	39.47	113.13
43	17.06	21.95	0.51	23.06	33.72	112.17
44	17.22	24.80	0.28	6.54	26.43	109.88
45	17.39	24.08	0.20	4.16	22.42	107.17
46	17.55	24.42	0.20	3.99	22.40	107.30
47	17.72	25.45	0.29	4.09	23.80	109.22
48	17.88	26.63	0.39	4.12	25.95	110.13

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	18.05	21.66	0.33	4.93	30.62	110.12
50	18.21	14.46	0.34	7.47	36.63	108.93
51	18.37	13.16	0.31	13.52	43.02	109.01
52	18.54	13.98	0.40	21.93	44.27	110.15
53	18.70	15.57	0.51	26.24	41.88	112.77
54	18.86	22.46	0.72	20.71	39.82	114.29
55	19.03	21.60	0.68	10.05	34.05	115.14
56	19.19	29.73	0.60	8.06	28.61	113.93
57	19.36	31.42	0.35	4.77	22.55	111.82
58	19.52	32.21	0.22	2.64	19.24	109.17
59	19.68	31.53	0.24	2.13	18.60	108.47
60	19.85	31.44	0.28	2.33	18.97	109.07
61	20.01	33.38	0.28	2.32	19.19	109.81
62	20.18	34.06	0.31	2.11	19.31	110.73
63	20.34	35.40	0.39	2.31	22.17	113.14
64	20.50	33.07	0.67	2.45	26.29	114.01
65	20.67	23.36	0.54	2.60	30.53	113.55
66	20.83	21.38	0.37	3.79	32.23	111.40
67	21.00	21.66	0.33	3.83	36.41	111.21
68	21.16	15.12	0.57	5.77	39.29	111.74
69	21.32	18.44	0.49	8.02	39.46	112.77
70	21.49	24.46	0.51	7.17	36.44	112.33
71	21.65	19.03	0.44	9.83	35.56	111.69
72	21.82	18.21	0.37	13.86	38.35	110.96
73	21.98	17.89	0.43	17.84	43.67	113.00
74	22.15	17.08	0.87	21.41	47.80	114.00
75	22.31	15.78	0.65	25.28	46.96	113.75
76	22.47	18.39	0.36	10.67	42.86	110.67
77	22.64	14.60	0.24	12.31	41.80	108.69
78	22.80	12.75	0.37	18.14	49.44	110.35
79	22.97	13.85	0.65	24.87	53.12	113.28
80	23.13	17.38	0.83	26.73	46.90	115.08
81	23.29	24.46	0.71	17.00	42.24	114.89
82	23.46	20.17	0.52	12.25	41.15	113.53
83	23.62	15.00	0.50	13.84	43.52	111.33
84	23.79	15.31	0.34	18.80	46.48	109.96
85	23.95	13.78	0.34	21.52	47.38	108.58
86	24.11	11.48	0.32	25.47	50.48	109.33
87	24.28	13.98	0.46	28.86	50.35	110.68
88	24.44	16.61	0.54	31.73	44.29	112.10
89	24.61	21.49	0.50	26.54	41.07	112.72
90	24.77	20.29	0.53	22.21	41.57	113.46
91	24.93	18.17	0.69	26.27	40.49	114.02
92	25.10	25.14	0.60	30.84	35.82	114.09
93	25.26	29.37	0.46	11.02	28.83	112.39
94	25.43	28.47	0.26	7.38	24.85	110.37
95	25.59	29.11	0.26	6.25	24.47	109.62
96	25.75	27.80	0.37	7.44	26.53	110.83

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	25.92	27.02	0.43	7.53	27.28	111.21
98	26.08	28.63	0.32	7.51	26.18	111.12
99	26.25	30.89	0.34	6.16	24.63	110.73
100	26.41	30.55	0.36	6.17	25.82	111.36
101	26.57	27.57	0.42	6.55	30.23	112.33
102	26.74	22.31	0.55	7.92	36.22	113.68
103	26.90	22.10	0.69	11.35	41.32	115.68
104	27.07	25.23	0.97	13.93	44.21	117.57
105	27.23	24.34	1.17	15.17	41.30	117.96
106	27.39	29.28	0.75	15.85	32.73	116.63
107	27.56	39.71	0.36	7.84	23.51	113.71
108	27.72	41.01	0.34	5.64	19.08	111.62
109	27.89	38.75	0.36	5.49	19.70	111.59
110	28.05	36.62	0.36	6.03	20.33	111.54
111	28.21	37.89	0.34	6.27	20.12	111.41
112	28.38	39.30	0.34	6.46	19.58	111.33
113	28.54	39.11	0.34	6.38	18.93	110.76
114	28.71	38.40	0.26	6.62	18.16	109.55
115	28.87	37.36	0.20	7.49	18.09	109.33
116	29.04	38.63	0.32	12.21	19.20	109.76
117	29.20	35.11	0.32	11.96	19.95	110.62
118	29.36	38.18	0.30	12.53	20.05	110.70
119	29.53	38.73	0.33	12.70	19.63	111.04
120	29.69	39.10	0.35	12.72	20.12	112.03
121	29.86	41.22	0.44	12.86	19.72	112.27
122	30.02	42.30	0.35	12.78	19.66	113.14
123	30.18	44.71	0.48	13.77	19.21	112.89
124	30.35	42.40	0.39	13.28	18.89	112.99
125	30.51	44.94	0.36	13.97	18.71	112.17
126	30.68	41.05	0.36	13.84	20.33	112.70
127	30.84	37.15	0.49	13.81	24.69	113.76
128	31.00	31.41	0.61	14.77	31.28	113.97
129	31.17	20.63	0.51	17.52	37.85	112.37
130	31.33	16.52	0.29	21.58	48.48	111.65
131	31.50	14.10	0.60	24.72	56.07	114.85
132	31.66	20.49	1.28	28.80	33.87	120.84
133	31.82	84.02	1.85	38.34	30.16	124.07
134	31.99	54.29	2.14	30.22	29.02	125.46
135	32.15	40.27	2.14	24.91	33.39	125.07
136	32.32	58.75	1.83	11.17	36.79	124.65
137	32.48	37.31	2.02	11.08	31.11	125.70
138	32.64	74.60	2.56	20.35	27.16	127.67
139	32.81	105.54	3.17	15.53	25.79	128.48
140	32.97	59.28	2.66	17.36	21.79	127.81
141	33.14	100.99	1.57	20.39	17.37	125.95
142	33.30	125.05	1.38	15.25	11.17	124.40
143	33.47	127.96	1.27	15.74	9.46	123.86
144	33.63	126.97	1.18	15.30	9.20	123.29

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	33.79	120.06	1.10	14.93	9.68	122.38
146	33.96	100.10	0.93	13.94	11.29	121.52
147	34.12	82.47	0.96	12.78	14.99	121.28
148	34.28	65.06	1.21	11.65	21.60	121.31
149	34.45	40.33	1.25	10.68	30.66	120.95
150	34.61	30.46	1.17	16.30	38.20	119.86
151	34.78	33.06	1.00	21.48	43.97	120.54
152	34.94	29.93	1.71	28.13	31.50	123.34
153	35.10	88.76	2.13	41.65	21.37	125.81
154	35.27	126.56	1.94	16.66	13.34	125.45
155	35.43	125.33	0.86	10.95	9.70	122.74
156	35.60	106.42	0.55	5.31	8.53	119.16
157	35.76	89.80	0.72	3.06	13.18	119.77
158	35.92	57.92	1.24	2.35	22.01	120.68
159	36.09	34.15	1.21	3.81	27.82	120.16
160	36.25	52.87	0.73	6.01	23.08	118.29
161	36.42	68.04	0.47	6.92	15.59	116.43
162	36.58	71.91	0.54	4.66	11.60	114.33
163	36.74	75.02	0.25	4.49	11.26	114.93
164	36.91	78.62	0.56	4.88	11.28	115.00
165	37.07	72.66	0.55	4.65	12.54	116.29
166	37.24	73.03	0.52	6.12	13.09	116.03
167	37.40	69.83	0.52	6.14	13.27	115.56
168	37.57	66.38	0.46	6.16	13.92	115.17
169	37.73	62.94	0.46	6.76	14.37	114.64
170	37.89	61.03	0.44	6.46	15.15	114.48
171	38.06	58.24	0.45	6.58	15.77	114.37
172	38.22	57.01	0.46	6.73	16.47	114.45
173	38.39	56.36	0.47	7.06	16.68	114.60
174	38.55	58.05	0.48	7.40	16.44	114.65
175	38.71	59.54	0.46	7.81	16.22	114.60
176	38.88	57.93	0.45	9.73	16.43	114.33
177	39.04	54.46	0.44	9.99	17.33	114.41
178	39.21	53.67	0.49	10.40	17.99	114.48
179	39.37	53.95	0.47	10.63	18.36	114.70
180	39.53	53.83	0.49	11.13	18.45	114.82
181	39.70	54.18	0.51	9.82	19.07	115.00
182	39.86	51.40	0.52	9.91	20.69	115.10
183	40.03	44.73	0.54	10.17	23.56	114.91
184	40.19	37.85	0.53	10.45	27.45	114.37
185	40.35	32.01	0.49	11.42	30.86	113.49
186	40.52	29.28	0.43	12.56	32.39	111.78
187	40.68	26.55	0.28	13.40	34.95	111.36
188	40.85	24.51	0.45	14.90	33.89	111.51
189	41.01	32.40	0.44	16.65	27.78	113.66
190	41.17	53.70	0.54	14.55	21.43	115.91
191	41.34	67.44	0.77	14.98	18.83	118.63
192	41.50	73.26	1.04	16.11	17.14	120.24

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	41.67	85.92	0.97	14.62	15.83	123.19
194	41.83	121.26	1.86	7.02	16.20	125.10
195	41.99	99.40	2.04	3.99	14.54	126.88
196	42.16	145.09	1.96	5.41	12.73	126.86
197	42.32	154.81	1.67	3.24	10.34	126.45
198	42.49	143.42	1.55	3.30	9.89	125.65
199	42.65	137.28	1.45	4.10	10.31	125.11
200	42.81	132.64	1.42	3.44	10.63	124.76
201	42.98	129.05	1.39	2.96	10.92	124.54
202	43.14	126.73	1.36	2.68	11.30	124.31
203	43.31	120.52	1.33	2.27	11.86	123.84
204	43.47	109.31	1.21	2.58	13.37	123.48
205	43.63	94.74	1.29	2.27	13.78	122.54
206	43.80	98.89	0.95	1.62	12.59	122.40
207	43.96	125.90	1.08	3.07	5.07	123.73
208	44.13	323.29	1.30	4.62	3.10	126.38
209	44.29	298.05	1.93	17.63	1.94	127.69
210	44.45	280.23	1.62	18.54	3.24	129.59
211	44.62	306.27	2.77	14.08	3.24	129.52
212	44.78	295.64	1.87	22.56	3.67	130.86
213	44.95	317.84	2.77	19.14	2.79	130.79
214	45.11	378.87	2.51	16.96	1.90	130.33
215	45.28	359.63	1.30	18.56	2.38	127.80
216	45.44	132.88	1.16	17.62	4.01	125.08
217	45.60	155.70	1.33	18.12	9.71	127.21
218	45.77	202.01	3.07	17.58	10.75	129.41
219	45.93	168.31	2.93	16.70	9.44	131.56
220	46.10	273.91	3.19	19.03	7.12	132.11
221	46.26	327.17	3.21	12.52	3.93	133.17
222	46.42	441.58	3.35	17.76	2.61	133.65

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_c: Measured cone resistance (tsf)
f_s: Sleeve friction resistance (tsf)
u: Pore pressure (tsf)
Fines content: Percentage of fines in soil (%)
Unit weight: Bulk soil unit weight (pcf)

:: Strength loss calculation Idriss & Boulanger (2008) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.17	7.33	11.00	4.81	52.93	2.71	0.07	0.67
10.34	8.65	13.11	4.33	56.72	2.66	0.08	0.68
10.50	10.36	15.84	4.13	65.40	2.64	0.08	0.69
10.66	10.99	16.83	4.58	77.02	2.69	0.08	0.69
10.83	10.82	16.55	5.29	87.58	2.75	0.08	0.69
10.99	10.91	16.68	5.50	91.74	2.77	0.08	0.69
11.15	12.59	19.37	4.40	85.26	2.67	0.08	0.69
11.32	15.04	23.28	3.16	73.59	2.53	0.08	0.70
11.48	17.12	26.62	2.38	63.41	2.40	0.08	0.70
11.65	17.95	27.94	2.08	58.12	2.34	0.08	0.70
11.81	18.25	28.41	1.95	55.51	2.31	0.08	0.70
11.97	18.33	28.52	1.95	55.60	2.31	0.08	0.70
12.14	17.34	26.91	2.11	56.72	2.34	0.08	0.70
12.30	17.09	26.50	2.23	59.07	2.37	0.07	0.69
12.47	16.60	25.70	2.33	59.90	2.39	0.08	0.70
12.63	16.72	25.87	2.35	60.79	2.40	0.08	0.70
12.79	16.10	24.88	2.50	62.08	2.42	0.08	0.70
12.96	15.55	23.97	2.73	65.37	2.46	0.08	0.70
13.12	16.26	25.09	3.03	76.03	2.51	0.08	0.70
13.29	16.65	25.71	3.27	84.10	2.54	0.09	0.71
13.45	15.66	24.11	3.80	91.68	2.61	0.09	0.71
13.62	14.07	21.54	4.33	93.19	2.66	0.08	0.69
13.78	12.46	18.94	5.61	106.36	2.78	0.08	0.70
13.94	13.22	20.14	5.85	117.79	2.80	0.08	0.69
14.11	14.96	22.93	5.18	118.86	2.74	0.09	0.70
14.27	17.34	26.73	3.82	101.99	2.61	0.09	0.71
14.44	16.99	25.93	3.30	85.60	2.54	0.09	0.71
14.60	14.43	22.02	3.77	82.94	2.60	0.08	0.69
14.76	12.27	18.55	5.43	100.67	2.76	0.08	0.69
14.93	12.09	18.25	6.00	109.48	2.81	0.08	0.69
15.09	12.63	19.10	5.65	107.89	2.78	0.08	0.70
15.26	11.98	18.03	5.32	95.91	2.76	0.08	0.69
15.42	11.12	16.64	5.90	98.21	2.80	0.08	0.69
15.58	11.03	16.49	6.40	105.52	2.84	0.08	0.69
15.75	11.46	17.15	6.47	110.94	2.85	0.08	0.69
15.91	11.96	17.93	5.94	106.51	2.81	0.08	0.69
16.08	12.61	18.78	5.69	106.96	2.79	0.08	0.69
16.24	15.04	22.27	5.14	114.55	2.74	0.08	0.70
16.40	18.78	27.48	4.30	118.30	2.66	0.09	0.71
16.57	20.05	29.10	4.09	118.89	2.64	0.10	0.73
16.73	18.67	27.08	4.51	122.25	2.68	0.09	0.71
16.90	18.26	26.28	4.51	118.67	2.68	0.08	0.70
17.06	20.63	29.01	3.47	100.65	2.57	0.09	0.72
17.22	23.61	32.16	2.38	76.41	2.40	0.09	0.72
17.39	24.43	32.51	1.91	62.22	2.30	0.08	0.71
17.55	24.65	32.66	1.91	62.44	2.30	0.08	0.71
17.72	25.50	33.90	2.06	69.84	2.33	0.08	0.72
17.88	24.58	32.80	2.31	75.92	2.39	0.09	0.73

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.05	20.92	28.14	2.97	83.57	2.50	0.09	0.71
18.21	16.43	22.22	3.98	88.43	2.63	0.08	0.69
18.37	13.87	18.85	5.22	98.44	2.75	0.08	0.69
18.54	14.24	19.34	5.49	106.10	2.77	0.08	0.70
18.70	17.34	23.53	4.99	117.43	2.73	0.08	0.70
18.86	19.88	26.83	4.58	122.93	2.69	0.09	0.72
19.03	24.60	32.68	3.53	115.22	2.57	0.09	0.72
19.19	27.58	35.87	2.67	95.83	2.45	0.10	0.74
19.36	31.12	39.45	1.93	76.05	2.30	0.09	0.73
19.52	31.72	39.45	1.63	64.41	2.21	0.09	0.73
19.68	31.73	39.18	1.59	62.13	2.19	0.08	0.72
19.85	32.12	39.58	1.61	63.81	2.20	0.08	0.72
20.01	32.96	40.52	1.63	65.99	2.21	0.09	0.73
20.18	34.28	42.04	1.64	68.86	2.21	0.09	0.73
20.34	34.18	42.24	1.89	79.81	2.29	0.10	0.74
20.50	30.61	38.11	2.36	89.86	2.40	0.10	0.74
20.67	25.94	32.41	2.95	95.76	2.50	0.09	0.72
20.83	22.13	27.46	3.22	88.49	2.53	0.09	0.71
21.00	19.39	24.06	3.94	94.80	2.62	0.09	0.71
21.16	18.41	22.83	4.48	102.26	2.68	0.08	0.69
21.32	19.34	23.94	4.51	108.02	2.68	0.09	0.71
21.49	20.64	25.30	3.95	99.82	2.62	0.09	0.72
21.65	20.57	25.01	3.79	94.73	2.60	0.08	0.70
21.82	18.38	22.24	4.30	95.65	2.66	0.08	0.70
21.98	17.73	21.56	5.36	115.55	2.76	0.09	0.70
22.15	16.92	20.58	6.25	128.58	2.83	0.09	0.70
22.31	17.08	20.64	6.06	125.14	2.82	0.08	0.70
22.47	16.26	19.29	5.19	100.16	2.74	0.09	0.71
22.64	15.25	17.86	4.98	88.90	2.73	0.08	0.69
22.80	13.73	16.11	6.62	106.59	2.86	0.08	0.69
22.97	14.66	17.32	7.47	129.37	2.92	0.08	0.69
23.13	18.56	21.94	6.05	132.76	2.82	0.09	0.70
23.29	20.67	24.24	5.06	122.73	2.73	0.10	0.72
23.46	19.88	23.07	4.85	111.81	2.71	0.09	0.71
23.62	16.83	19.30	5.33	102.82	2.76	0.08	0.69
23.79	14.70	16.67	5.96	99.31	2.81	0.08	0.70
23.95	13.52	15.16	6.16	93.34	2.82	0.08	0.69
24.11	13.08	14.61	6.85	100.17	2.88	0.08	0.68
24.28	14.02	15.69	6.82	107.06	2.87	0.08	0.69
24.44	17.36	19.48	5.49	106.95	2.77	0.08	0.70
24.61	19.46	21.79	4.83	105.21	2.71	0.09	0.71
24.77	19.98	22.31	4.93	109.99	2.72	0.09	0.71
24.93	21.20	23.60	4.71	111.23	2.70	0.08	0.70
25.10	24.23	26.82	3.83	102.84	2.61	0.09	0.72
25.26	27.66	30.28	2.70	81.87	2.46	0.09	0.73
25.43	28.98	31.40	2.18	68.47	2.36	0.09	0.72
25.59	28.46	30.66	2.14	65.51	2.35	0.09	0.72
25.75	27.98	30.12	2.39	71.98	2.40	0.09	0.72

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
25.92	27.82	29.87	2.49	74.29	2.42	0.09	0.72
26.08	28.85	30.83	2.34	72.27	2.39	0.09	0.72
26.25	30.02	31.93	2.15	68.80	2.36	0.09	0.72
26.41	29.67	31.48	2.30	72.36	2.39	0.09	0.72
26.57	26.81	28.41	2.91	82.67	2.49	0.09	0.72
26.74	23.99	25.39	3.91	99.15	2.62	0.09	0.71
26.90	23.21	24.57	4.88	119.88	2.72	0.09	0.71
27.07	23.89	25.29	5.47	138.38	2.77	0.10	0.72
27.23	26.28	27.74	4.87	135.22	2.72	0.09	0.72
27.39	31.11	32.59	3.30	107.71	2.54	0.09	0.73
27.56	36.67	37.99	2.03	77.06	2.33	0.10	0.74
27.72	39.82	40.92	1.62	66.31	2.20	0.09	0.74
27.89	38.79	39.72	1.67	66.27	2.22	0.09	0.73
28.05	37.75	38.52	1.72	66.28	2.24	0.09	0.73
28.21	37.94	38.57	1.70	65.67	2.23	0.09	0.73
28.38	38.77	39.27	1.66	65.13	2.22	0.09	0.73
28.54	38.94	39.28	1.61	63.20	2.20	0.09	0.73
28.71	38.29	38.42	1.55	59.74	2.17	0.08	0.73
28.87	38.13	38.13	1.55	59.10	2.17	0.08	0.72
29.04	37.03	36.93	1.63	60.17	2.21	0.09	0.73
29.20	37.31	37.13	1.69	62.69	2.23	0.08	0.72
29.36	37.34	37.04	1.70	62.86	2.23	0.09	0.73
29.53	38.67	38.27	1.66	63.63	2.22	0.09	0.73
29.69	39.68	39.20	1.70	66.74	2.23	0.09	0.73
29.86	40.87	40.27	1.67	67.24	2.22	0.09	0.74
30.02	42.74	42.04	1.66	69.99	2.22	0.09	0.74
30.18	43.14	42.27	1.63	68.92	2.21	0.09	0.74
30.35	44.02	43.01	1.61	69.08	2.20	0.09	0.74
30.51	42.80	41.62	1.59	66.33	2.19	0.09	0.74
30.68	41.05	39.78	1.72	68.42	2.24	0.09	0.74
30.84	36.54	35.24	2.16	76.20	2.36	0.09	0.73
31.00	29.73	28.40	3.07	87.21	2.51	0.09	0.73
31.17	22.85	21.45	4.21	90.21	2.65	0.08	0.70
31.33	17.08	15.62	6.40	99.98	2.84	0.08	0.69
31.50	17.04	15.52	8.18	127.01	2.96	0.08	0.69
31.66	39.54	37.76	3.49	131.92	2.57	0.08	0.70
31.82	52.93	50.79	2.90	147.25	2.49	0.19	0.83
31.99	59.53	57.04	2.73	155.74	2.46	0.12	0.78
32.15	51.10	48.60	3.41	165.88	2.56	0.11	0.75
32.32	45.44	42.88	4.01	171.95	2.63	0.14	0.79
32.48	56.89	53.75	3.05	163.70	2.51	0.10	0.74
32.64	72.48	68.56	2.47	169.51	2.42	0.16	0.81
32.81	79.81	75.29	2.29	172.78	2.38	0.24	0.86
32.97	88.60	83.35	1.85	154.42	2.28	0.12	0.78
33.14	95.11	89.17	1.50	134.17	2.15	0.18	0.84
33.30	118.00	110.55	1.26	139.05	1.93	0.20	0.83
33.47	126.66	118.40	1.21	143.15	1.86	0.19	0.81
33.63	125.00	116.48	1.20	139.74	1.85	0.18	0.80

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
33.79	115.71	107.38	1.22	130.59	1.87	0.17	0.80
33.96	100.88	93.11	1.26	117.42	1.94	0.14	0.79
34.12	82.54	75.60	1.38	104.44	2.07	0.13	0.79
34.28	62.62	56.68	1.83	103.96	2.27	0.12	0.78
34.45	45.28	40.29	2.97	119.83	2.50	0.10	0.74
34.61	34.62	30.23	4.27	129.10	2.66	0.09	0.72
34.78	31.15	26.88	5.42	145.71	2.76	0.10	0.73
34.94	50.58	44.65	3.11	138.73	2.52	0.09	0.72
35.10	81.75	73.20	1.81	132.66	2.27	0.17	0.82
35.27	113.55	102.41	1.32	135.12	2.01	0.22	0.85
35.43	119.44	107.76	1.22	131.12	1.87	0.18	0.80
35.60	107.18	96.37	1.17	113.01	1.82	0.13	0.75
35.76	84.71	75.29	1.31	98.97	2.01	0.13	0.79
35.92	60.62	52.87	1.87	99.06	2.29	0.11	0.77
36.09	48.31	41.48	2.56	106.23	2.43	0.09	0.72
36.25	51.69	44.48	1.98	88.20	2.32	0.11	0.76
36.42	64.27	55.91	1.41	78.73	2.09	0.11	0.77
36.58	71.66	62.63	1.27	79.49	1.95	0.10	0.74
36.74	75.18	65.66	1.26	82.73	1.94	0.10	0.74
36.91	75.43	65.71	1.26	82.83	1.94	0.10	0.75
37.07	74.77	64.84	1.30	83.97	1.98	0.10	0.75
37.24	71.84	62.02	1.31	81.34	2.01	0.10	0.76
37.40	69.75	59.98	1.32	79.03	2.01	0.10	0.75
37.57	66.38	56.80	1.34	76.08	2.04	0.10	0.75
37.73	63.45	54.04	1.36	73.28	2.05	0.10	0.75
37.89	60.74	51.45	1.39	71.43	2.08	0.10	0.75
38.06	58.76	49.54	1.42	70.20	2.10	0.09	0.75
38.22	57.20	48.00	1.45	69.72	2.12	0.09	0.75
38.39	57.14	47.80	1.46	69.99	2.13	0.09	0.75
38.55	57.98	48.42	1.45	70.25	2.12	0.10	0.75
38.71	58.51	48.75	1.44	70.17	2.11	0.10	0.75
38.88	57.31	47.57	1.45	69.02	2.12	0.10	0.75
39.04	55.35	45.70	1.50	68.62	2.15	0.09	0.74
39.21	54.03	44.39	1.54	68.53	2.17	0.09	0.74
39.37	53.82	44.06	1.57	69.11	2.18	0.10	0.75
39.53	53.99	44.07	1.57	69.41	2.18	0.10	0.75
39.70	53.14	43.18	1.62	69.93	2.20	0.10	0.75
39.86	50.10	40.39	1.75	70.74	2.25	0.10	0.75
40.03	44.66	35.53	2.03	72.29	2.33	0.10	0.74
40.19	38.20	29.86	2.51	74.99	2.43	0.09	0.73
40.35	33.05	25.39	3.01	76.31	2.50	0.09	0.72
40.52	29.28	22.17	3.25	72.03	2.54	0.09	0.71
40.68	26.78	19.99	3.68	73.59	2.59	0.09	0.71
40.85	27.82	20.80	3.50	72.75	2.57	0.08	0.70
41.01	36.87	28.31	2.56	72.34	2.43	0.09	0.72
41.17	51.18	40.32	1.82	73.31	2.27	0.10	0.75
41.34	64.80	51.66	1.60	82.74	2.19	0.11	0.77
41.50	75.54	60.57	1.49	90.29	2.14	0.12	0.78

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
41.67	93.48	75.40	1.42	107.05	2.10	0.13	0.79
41.83	102.19	82.28	1.44	118.33	2.11	0.21	0.85
41.99	121.92	98.63	1.36	134.40	2.06	0.14	0.81
42.16	133.10	108.07	1.30	140.54	1.99	0.25	0.86
42.32	147.77	120.73	1.24	149.16	1.90	0.25	0.84
42.49	145.17	118.43	1.22	144.79	1.88	0.20	0.82
42.65	137.78	111.85	1.23	138.10	1.90	0.19	0.82
42.81	132.99	107.50	1.24	133.65	1.91	0.18	0.81
42.98	129.47	104.23	1.25	130.40	1.92	0.17	0.81
43.14	125.43	100.52	1.26	126.78	1.94	0.17	0.82
43.31	118.85	94.72	1.28	120.87	1.96	0.16	0.81
43.47	108.19	85.39	1.32	112.75	2.02	0.15	0.81
43.63	100.98	79.26	1.33	105.77	2.03	0.13	0.79
43.80	106.51	83.81	1.30	108.66	1.99	0.13	0.79
43.96	182.69	149.46	1.00	149.46	1.64	0.14	0.76
44.13	249.08	206.44	1.00	206.44	1.52	0.93	0.97
44.29	300.52	251.01	1.00	251.01	1.43	0.97	0.95
44.45	294.85	243.50	1.00	243.50	1.53	0.96	0.93
44.62	294.05	242.33	1.00	242.33	1.53	0.96	0.95
44.78	306.58	251.49	1.00	251.49	1.56	0.97	0.95
44.95	330.78	272.56	1.00	272.56	1.50	0.98	0.96
45.11	352.11	291.65	1.00	291.65	1.43	0.99	1.00
45.28	290.46	238.86	1.00	238.86	1.47	0.96	0.99
45.44	216.07	174.76	1.00	174.76	1.58	0.15	0.77
45.60	163.53	127.40	1.22	155.05	1.87	0.23	0.83
45.77	175.34	135.75	1.25	169.23	1.91	0.68	0.90
45.93	214.74	167.27	1.21	202.07	1.86	0.27	0.84
46.10	256.46	202.05	1.09	219.67	1.75	0.93	0.93
46.26	347.55	279.47	1.00	279.47	1.57	0.98	0.97
46.42	403.44	327.35	1.00	327.35	1.48	1.01	1.04

Abbreviations

q_t: Total cone resistance
K_c: Cone resistance correction factor due to fines
$Q_{tn,cs}$: Adjusted and corrected cone resistance due to fines
I_c: Soil behavior type index
$S_{u(liq)}/\sigma'_v$: Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$: Calculated peak undrained strength ratio

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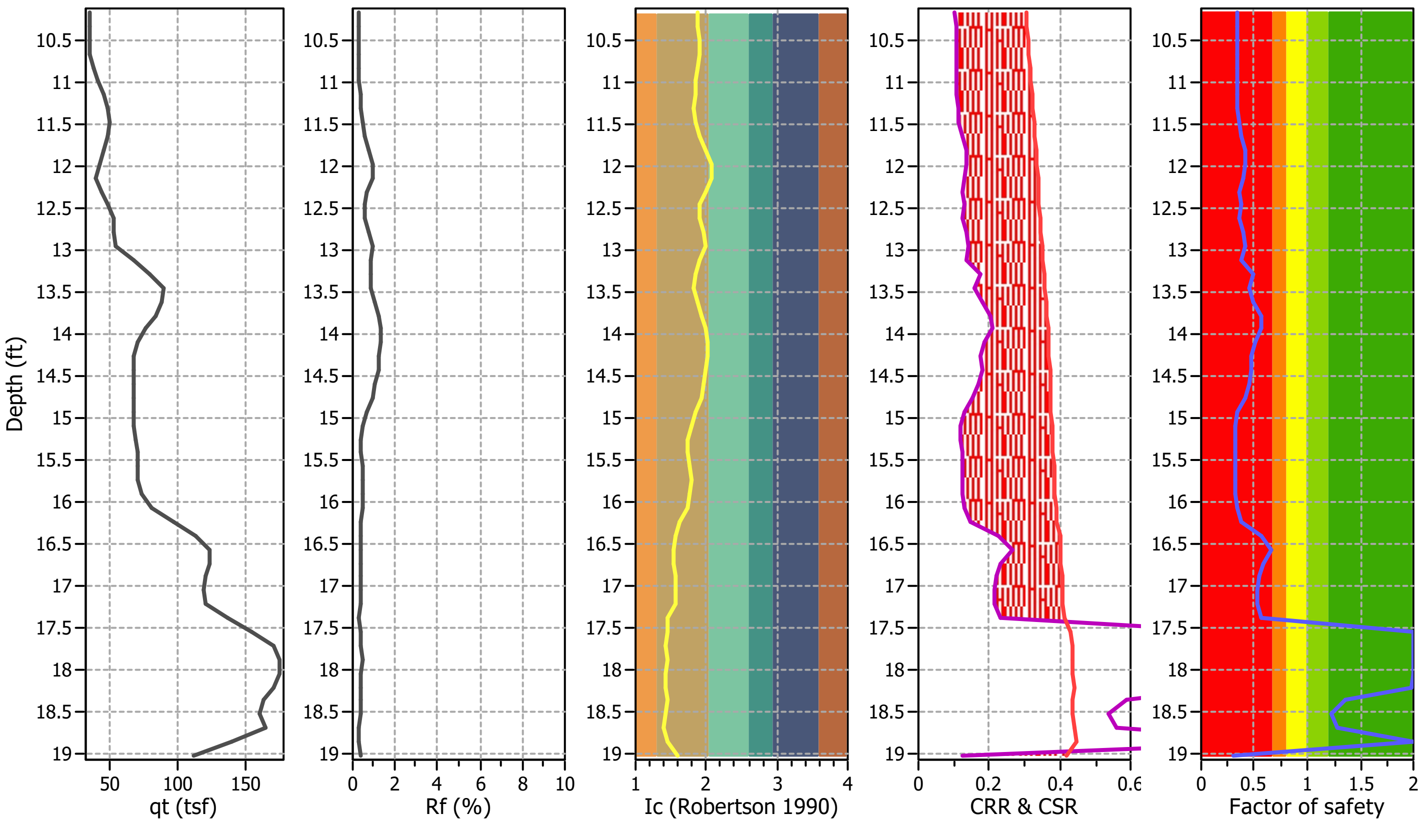
LIQUEFACTION ANALYSIS REPORT

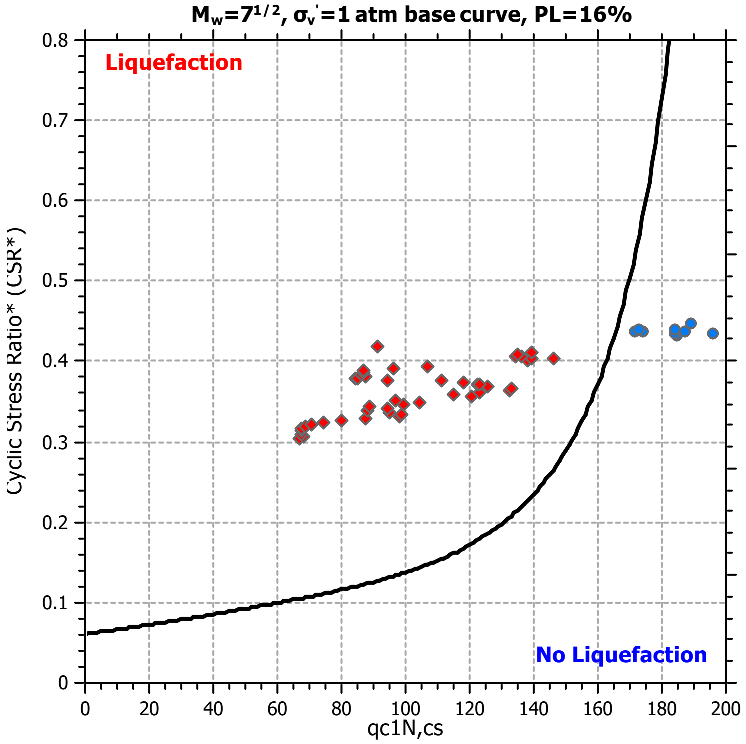
Project title : Kinder Morgan Willbridge Terminal SVA **Location : Portland, Oregon**

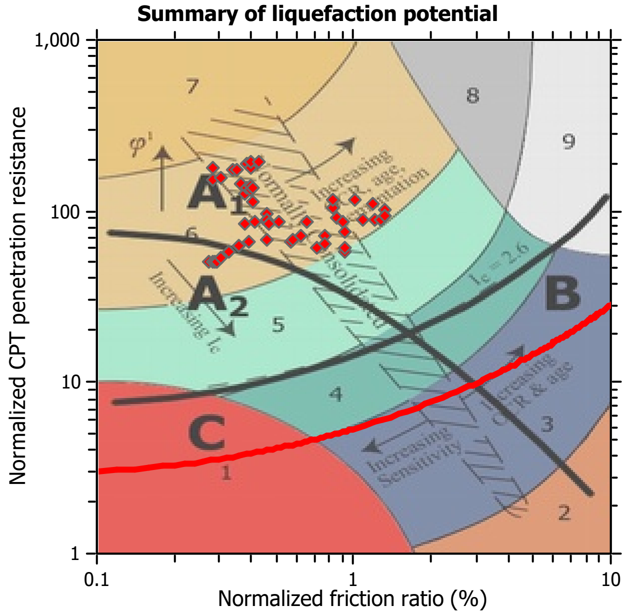
CPT file : CPT-02

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	10.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	10.00 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:	7.84	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.49	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

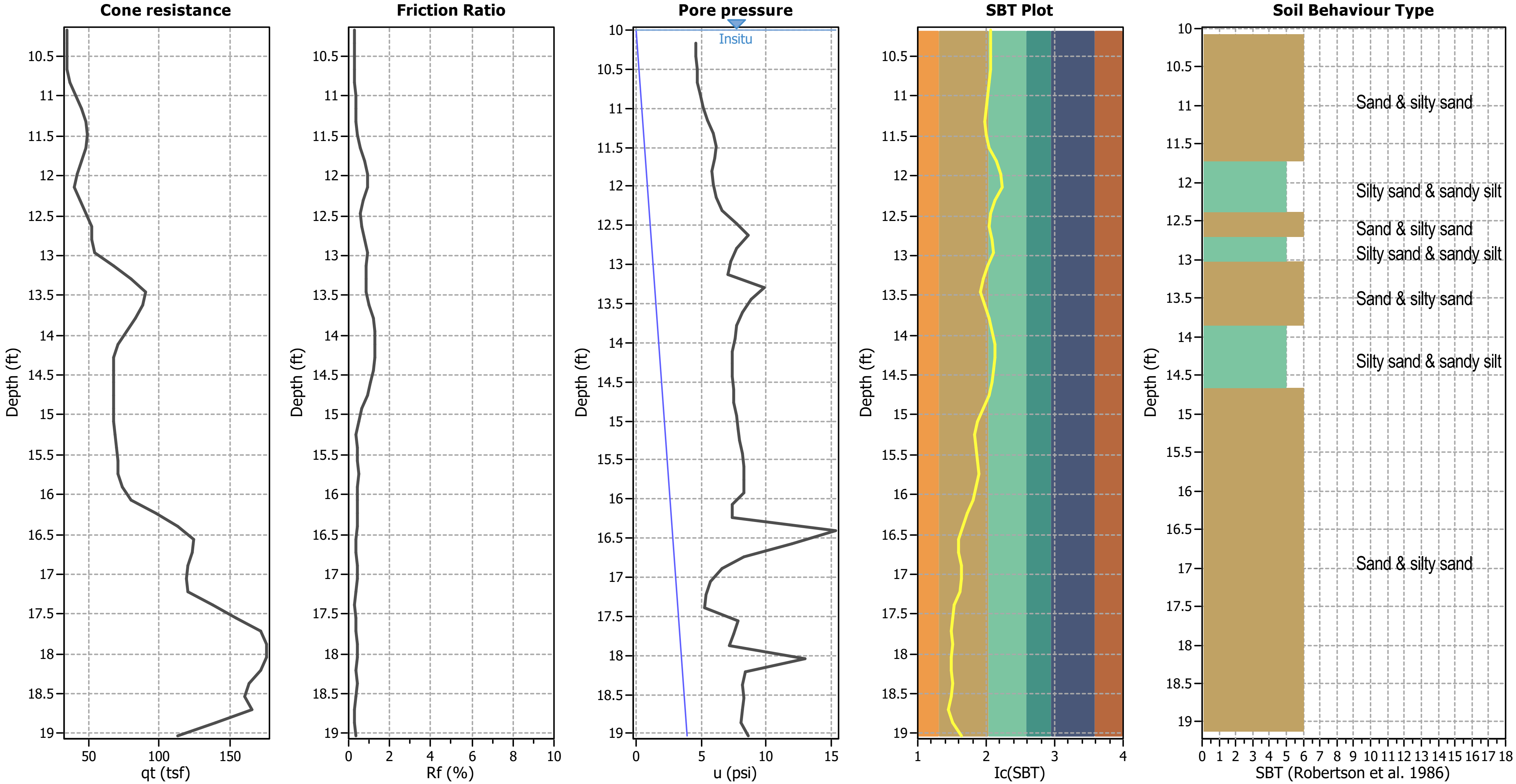






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



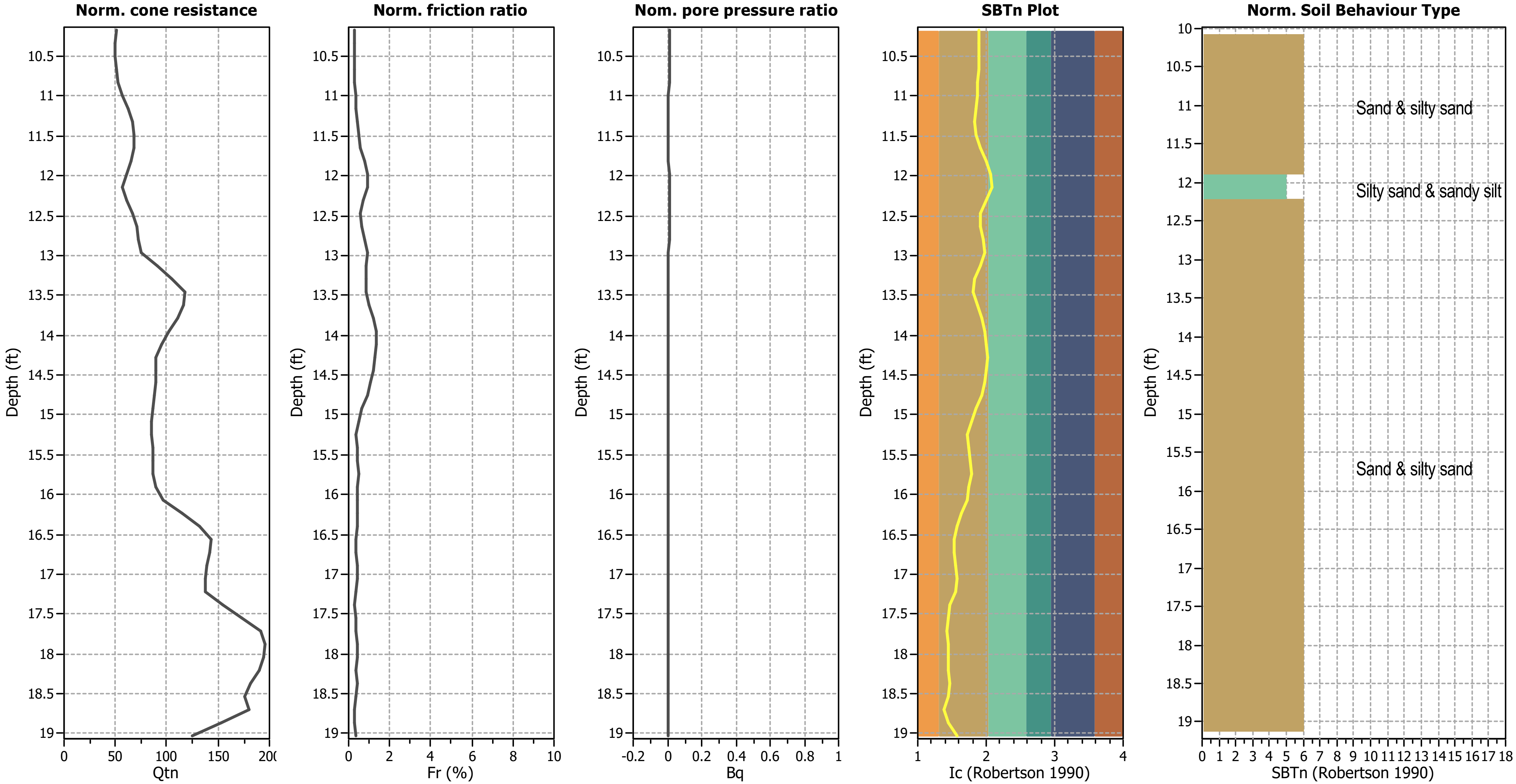
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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)



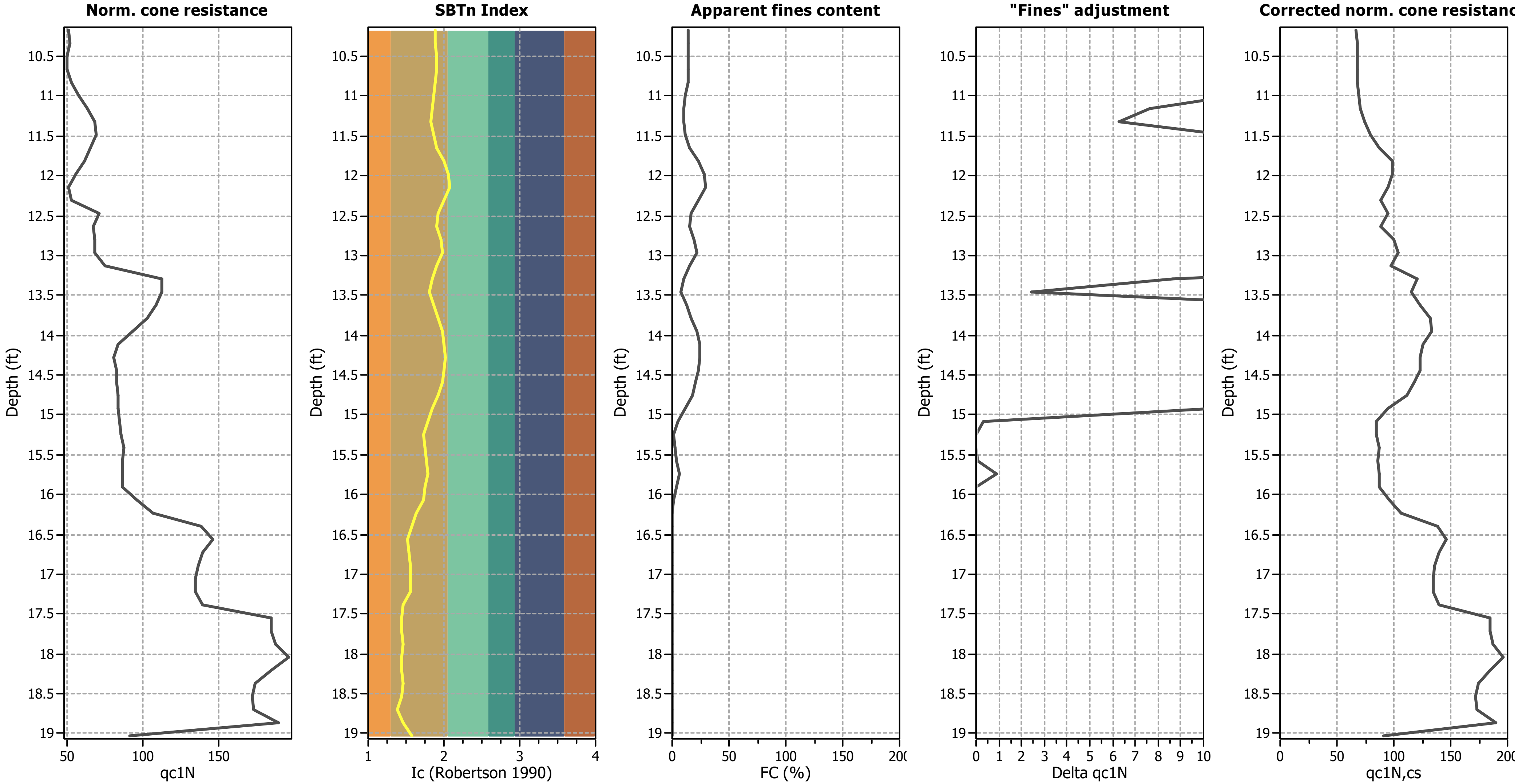
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	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

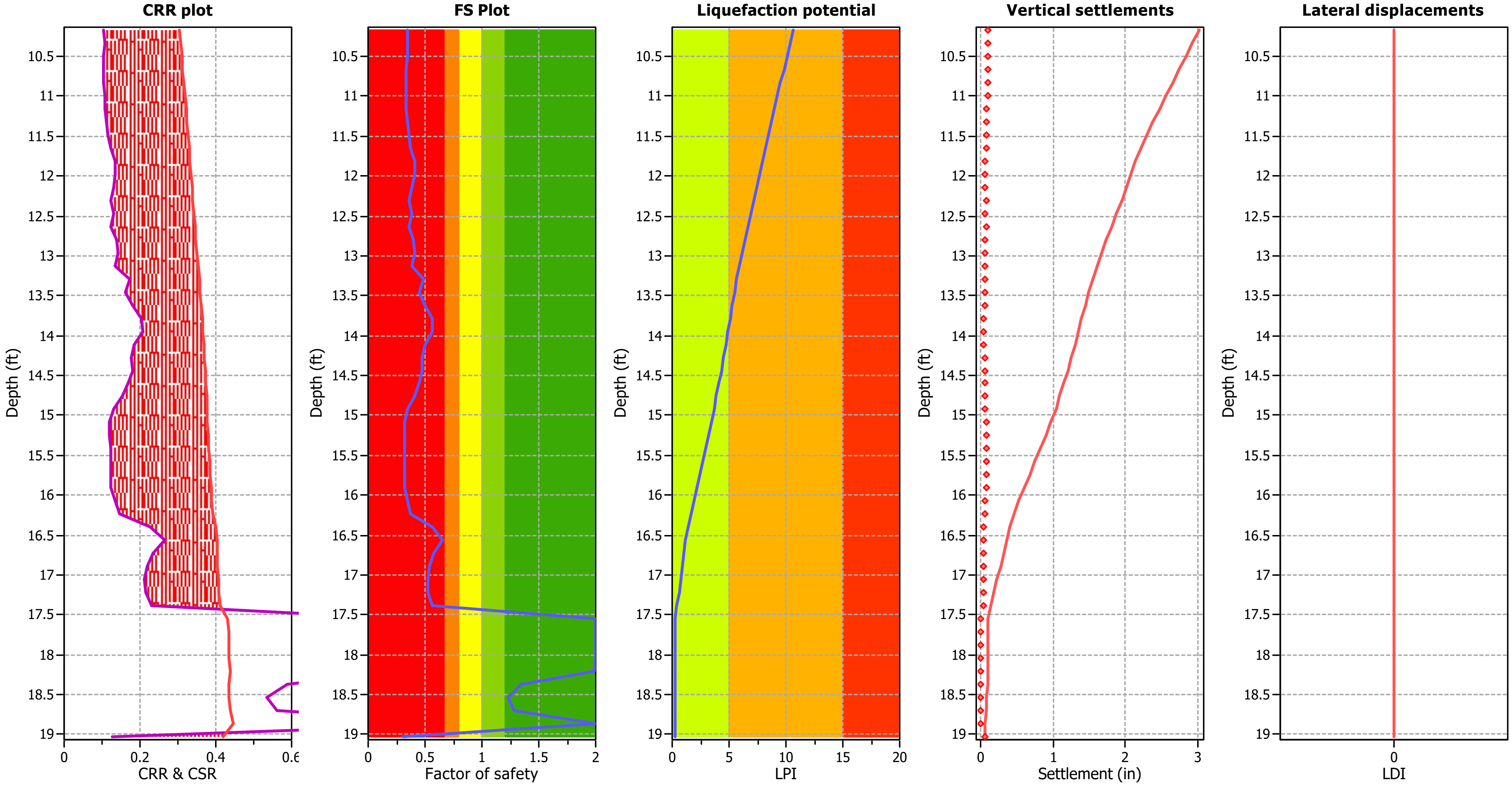
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

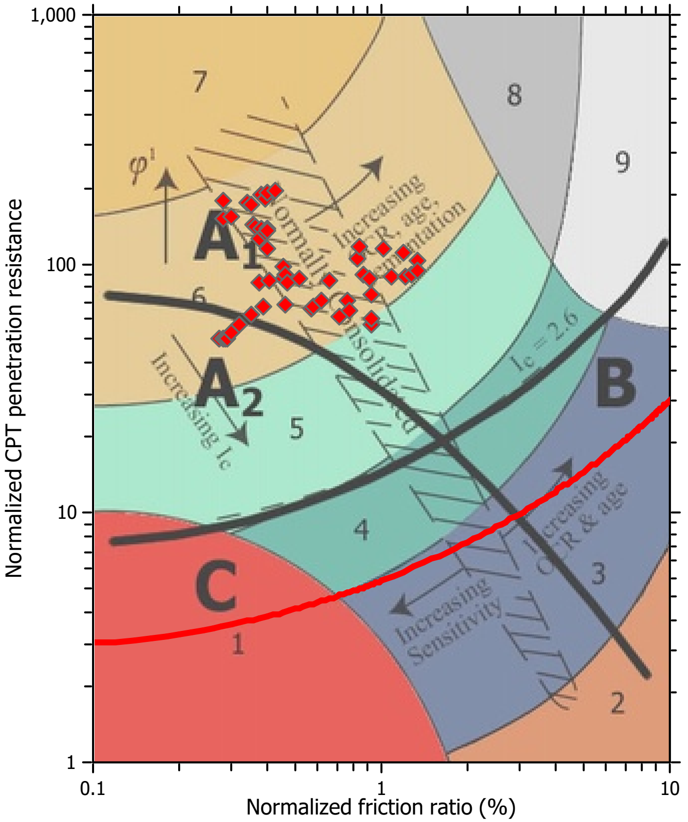
F.S. color scheme

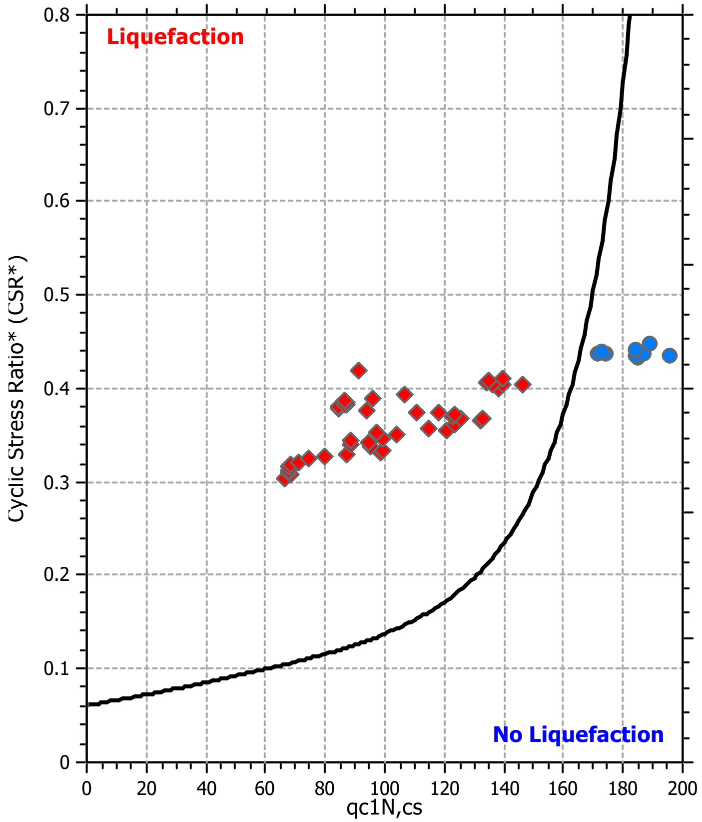
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

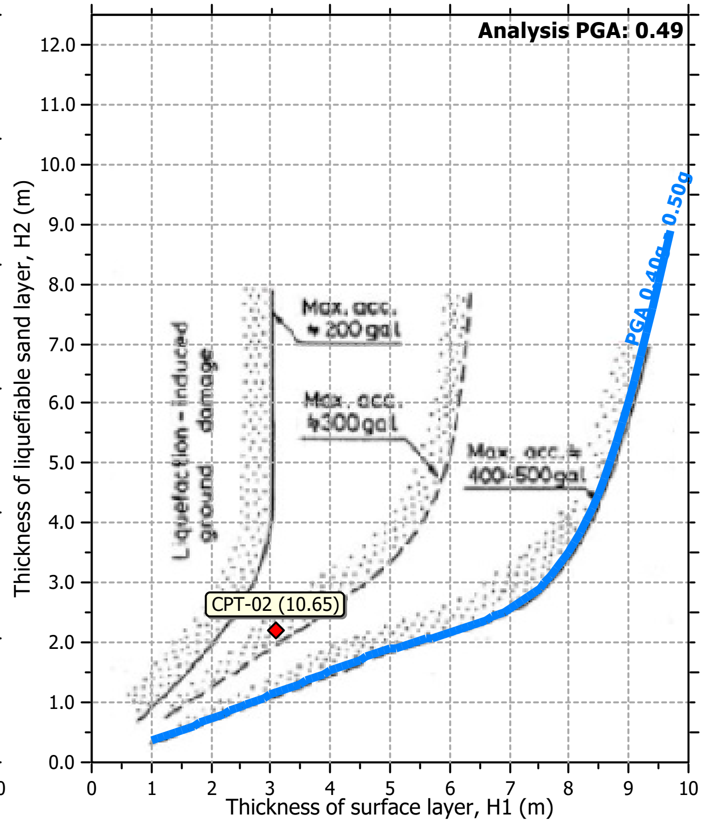
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



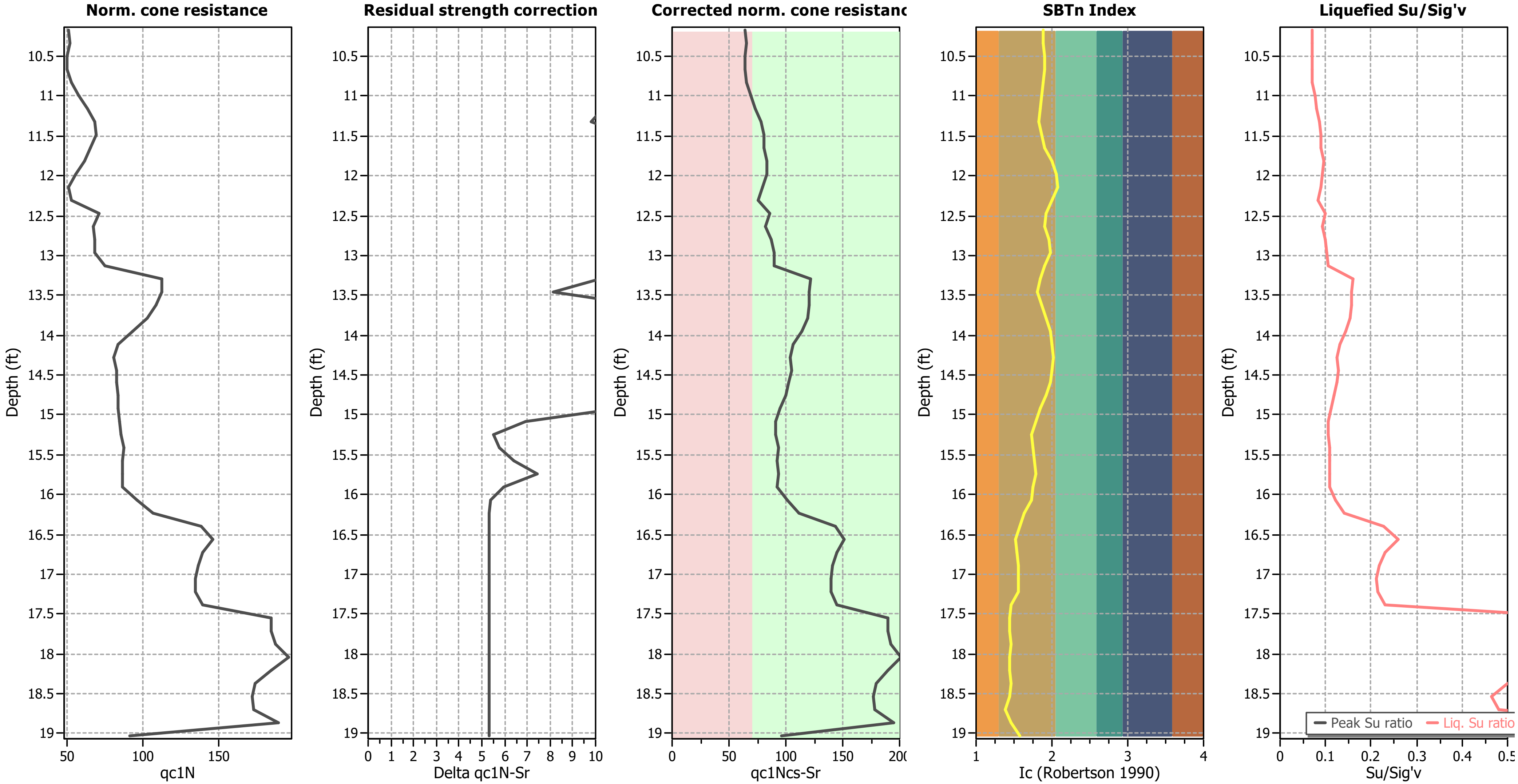




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

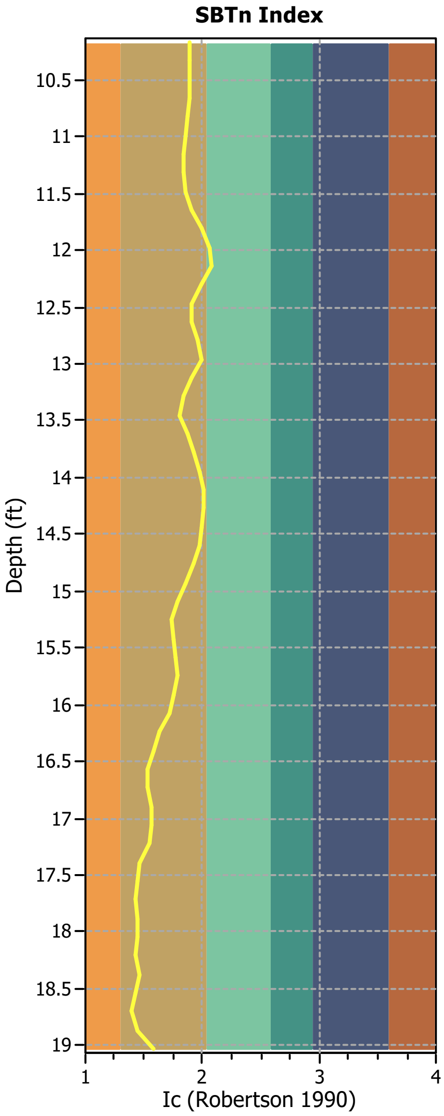
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

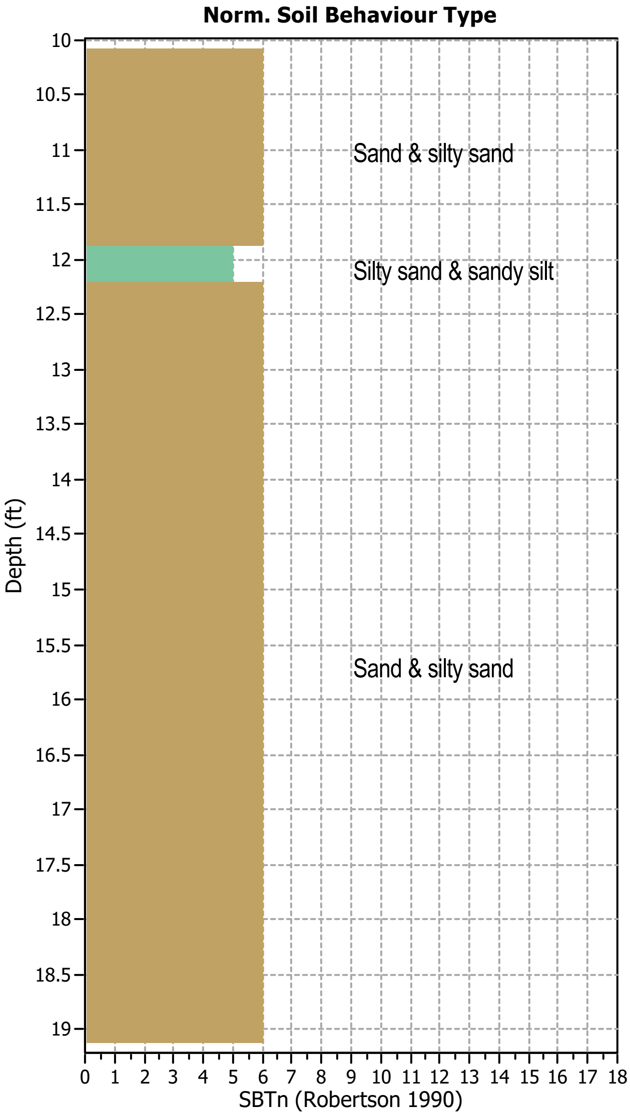
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	55
Total points excluded:	0
Exclusion percentage:	0.00%
Number of layers detected:	0

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	10.17	34.99	0.09	4.55	5.00	101.75
2	10.34	35.65	0.10	4.63	5.00	101.90
3	10.50	34.85	0.10	4.66	5.00	102.00
4	10.66	34.82	0.10	4.74	5.00	102.27
5	10.83	36.89	0.11	4.92	5.00	103.02
6	10.99	40.54	0.13	5.15	5.00	104.42
7	11.15	45.18	0.16	5.48	5.00	106.03
8	11.32	49.38	0.19	5.95	5.00	107.47
9	11.48	50.70	0.22	6.21	5.00	108.91
10	11.65	48.79	0.27	6.00	10.61	110.37
11	11.81	46.72	0.34	5.86	12.82	111.95
12	11.97	41.99	0.44	5.94	14.72	112.47
13	12.14	38.30	0.38	6.11	15.25	111.88
14	12.30	40.03	0.27	6.55	12.79	110.96
15	12.47	54.05	0.28	7.71	10.80	110.25
16	12.63	51.33	0.27	8.64	10.53	111.66
17	12.79	52.78	0.42	7.70	11.79	113.17
18	12.96	53.15	0.50	7.24	12.58	114.98
19	13.12	58.67	0.58	7.08	10.50	116.52
20	13.29	90.45	0.65	9.88	9.00	117.85
21	13.45	90.55	0.73	8.78	8.27	119.06
22	13.62	88.39	0.85	8.12	9.60	120.29
23	13.78	84.65	1.07	7.75	11.06	120.97
24	13.94	77.34	1.04	7.59	12.47	120.93
25	14.11	68.75	0.91	7.37	13.20	120.11
26	14.27	66.18	0.83	7.33	13.32	119.39
27	14.44	68.16	0.82	7.42	12.99	118.95
28	14.60	67.94	0.76	7.51	12.24	118.31
29	14.76	68.42	0.62	7.54	11.10	116.99
30	14.93	68.10	0.45	7.69	9.28	114.59
31	15.09	67.92	0.25	7.86	5.00	112.15
32	15.26	68.69	0.25	7.95	5.00	110.64
33	15.42	71.07	0.27	8.17	5.00	111.41
34	15.58	70.38	0.33	8.22	5.00	112.36
35	15.75	70.74	0.36	8.22	7.96	113.19
36	15.91	71.25	0.39	8.24	5.00	112.82
37	16.08	80.13	0.26	7.42	5.00	113.58
38	16.24	90.13	0.44	7.39	4.94	114.51
39	16.40	120.61	0.46	15.33	4.00	115.90
40	16.57	128.56	0.43	11.93	3.22	116.08
41	16.73	122.45	0.43	8.24	3.28	116.10
42	16.90	119.30	0.47	6.55	3.74	116.50
43	17.06	118.08	0.52	5.75	3.83	116.44
44	17.22	118.94	0.43	5.40	3.62	116.18
45	17.39	123.50	0.42	5.27	2.28	115.82
46	17.55	169.46	0.40	7.78	2.16	118.05
47	17.72	169.36	0.80	7.51	1.97	119.67
48	17.88	172.81	0.75	7.14	2.21	120.70

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	18.05	182.12	0.68	12.97	1.99	120.21
50	18.21	170.43	0.66	8.37	1.98	119.67
51	18.37	160.70	0.62	8.15	2.30	119.42
52	18.54	158.39	0.64	8.26	1.98	118.14
53	18.70	160.10	0.36	8.21	1.36	117.11
54	18.86	177.01	0.39	8.09	2.18	115.48
55	19.03	80.14	0.43	8.57	4.12	115.39

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_c: Measured cone resistance (tsf)
f_s: Sleeve friction resistance (tsf)
u: Pore pressure (tsf)
Fines content: Percentage of fines in soil (%)
Unit weight: Bulk soil unit weight (pcf)

:: Strength loss calculation Idriss & Boulanger (2008) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.17	35.21	50.41	1.00	50.41	1.89	0.07	0.67
10.34	35.16	50.21	1.00	50.21	1.89	0.07	0.68
10.50	35.11	49.99	1.00	49.99	1.90	0.07	0.68
10.66	35.52	50.39	1.00	50.39	1.90	0.07	0.68
10.83	37.42	52.74	1.00	52.74	1.88	0.07	0.68
10.99	40.87	57.14	1.00	57.14	1.86	0.08	0.68
11.15	45.03	62.47	1.00	62.47	1.84	0.08	0.69
11.32	48.42	66.82	1.00	66.82	1.83	0.09	0.69
11.48	49.62	68.61	1.00	68.61	1.86	0.09	0.71
11.65	48.74	67.97	1.24	84.47	1.91	0.09	0.72
11.81	45.83	64.97	1.30	84.66	2.00	0.10	0.74
11.97	42.34	60.68	1.37	83.13	2.06	0.09	0.75
12.14	40.11	57.40	1.39	79.94	2.08	0.09	0.74
12.30	44.13	61.62	1.30	80.26	1.99	0.08	0.72
12.47	48.47	66.23	1.25	82.66	1.92	0.10	0.74
12.63	52.72	71.61	1.24	88.85	1.91	0.09	0.73
12.79	52.42	71.73	1.27	91.40	1.96	0.10	0.75
12.96	54.87	75.28	1.30	97.57	1.99	0.10	0.76
13.12	67.42	90.57	1.24	112.30	1.90	0.10	0.74
13.29	79.89	105.43	1.19	125.72	1.84	0.16	0.78
13.45	89.80	117.21	1.16	136.02	1.81	0.16	0.77
13.62	87.86	115.65	1.21	140.33	1.87	0.16	0.79
13.78	83.46	110.74	1.25	138.95	1.93	0.15	0.80
13.94	76.91	102.67	1.29	132.75	1.98	0.15	0.80
14.11	70.76	94.45	1.31	124.19	2.01	0.13	0.79
14.27	67.70	89.96	1.32	118.66	2.01	0.13	0.79
14.44	67.43	88.94	1.31	116.39	2.00	0.13	0.79
14.60	68.17	89.00	1.29	114.48	1.97	0.12	0.78
14.76	68.15	87.79	1.26	110.26	1.93	0.12	0.77
14.93	68.15	86.10	1.20	103.55	1.85	0.11	0.74
15.09	68.24	84.71	1.00	84.71	1.78	0.11	0.72
15.26	69.23	84.87	1.00	84.87	1.73	0.10	0.72
15.42	70.05	85.82	1.00	85.82	1.75	0.11	0.72
15.58	70.73	86.70	1.00	86.70	1.77	0.11	0.72
15.75	70.79	86.86	1.14	99.38	1.79	0.11	0.72
15.91	74.04	89.94	1.00	89.94	1.75	0.11	0.72
16.08	80.50	97.02	1.00	97.02	1.72	0.12	0.74
16.24	96.96	114.81	1.00	114.81	1.63	0.14	0.76
16.40	113.10	132.33	1.00	132.33	1.58	0.23	0.81
16.57	123.87	143.30	1.00	143.30	1.53	0.26	0.82
16.73	123.44	142.46	1.00	142.46	1.53	0.23	0.81
16.90	119.94	138.70	1.00	138.70	1.56	0.22	0.81
17.06	118.77	137.04	1.00	137.04	1.57	0.21	0.81
17.22	120.17	137.93	1.00	137.93	1.55	0.21	0.81
17.39	137.30	154.94	1.00	154.94	1.46	0.23	0.81
17.55	154.11	173.30	1.00	173.30	1.45	0.69	0.87
17.72	170.54	190.91	1.00	190.91	1.44	0.68	0.87
17.88	174.76	195.63	1.00	195.63	1.45	0.74	0.87

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.05	175.12	194.99	1.00	194.99	1.44	0.93	0.88
18.21	171.08	189.91	1.00	189.91	1.44	0.67	0.87
18.37	163.17	181.21	1.00	181.21	1.46	0.50	0.86
18.54	159.73	176.26	1.00	176.26	1.44	0.47	0.85
18.70	165.17	180.56	1.00	180.56	1.39	0.48	0.86
18.86	139.08	152.87	1.00	152.87	1.45	0.79	0.88
19.03	112.43	125.28	1.00	125.28	1.58	0.11	0.73

Abbreviations

q_t: Total cone resistance
K_c: Cone resistance correction factor due to fines
$Q_{tn,cs}$: Adjusted and corrected cone resistance due to fines
I_c: Soil behavior type index
$S_{u(liq)}/\sigma'_v$: Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$: Calculated peak undrained strength ratio

Sage Geotechnical

Olympia, WA
www.sagegeotechnical.com

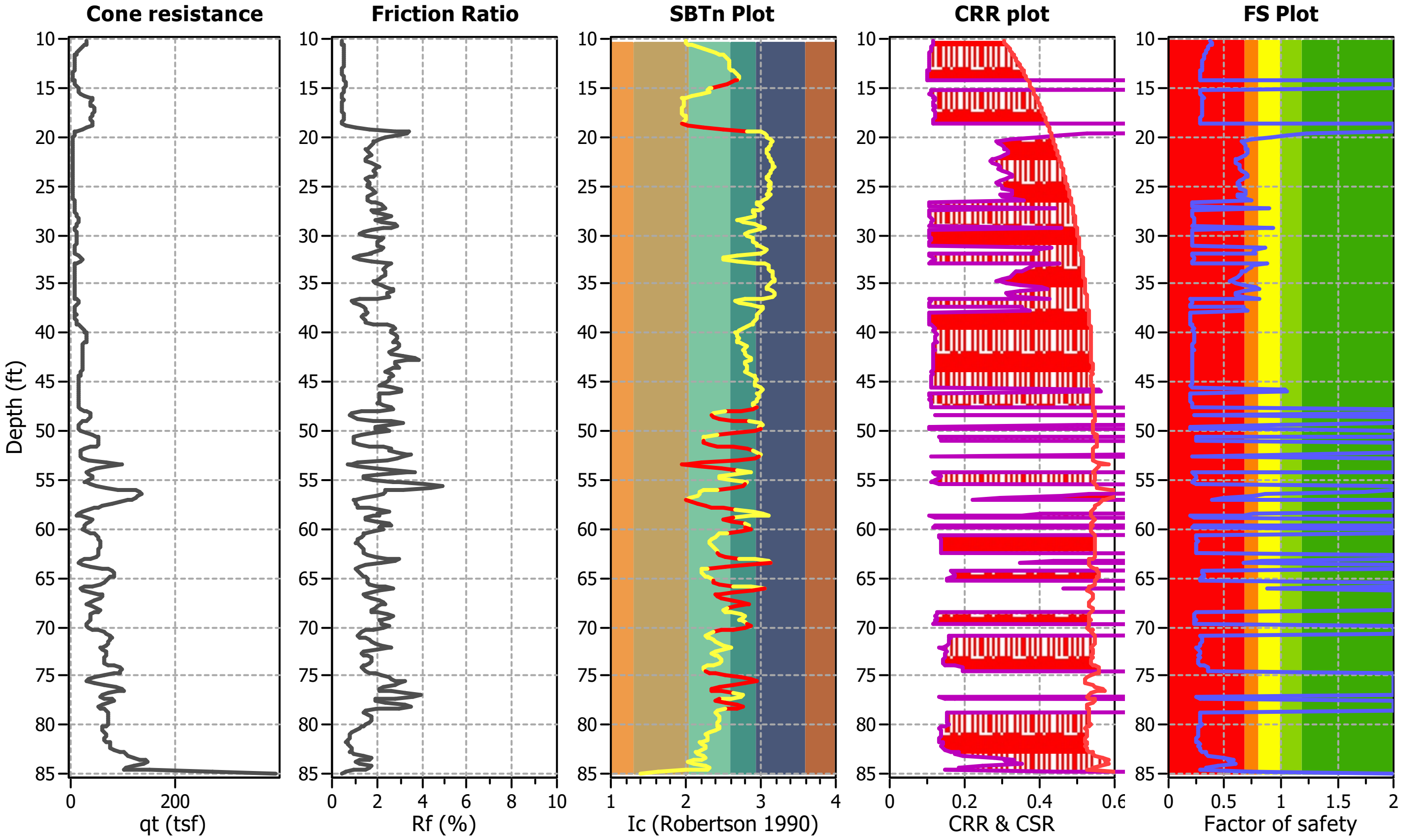
LIQUEFACTION ANALYSIS REPORT

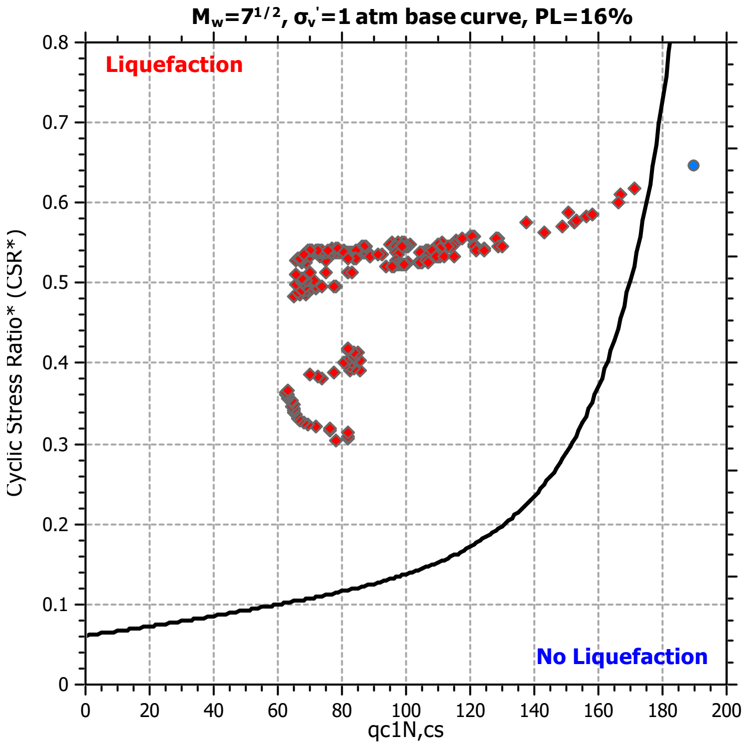
Project title : Kinder Morgan Willbridge Terminal SVA **Location : Portland, Oregon**

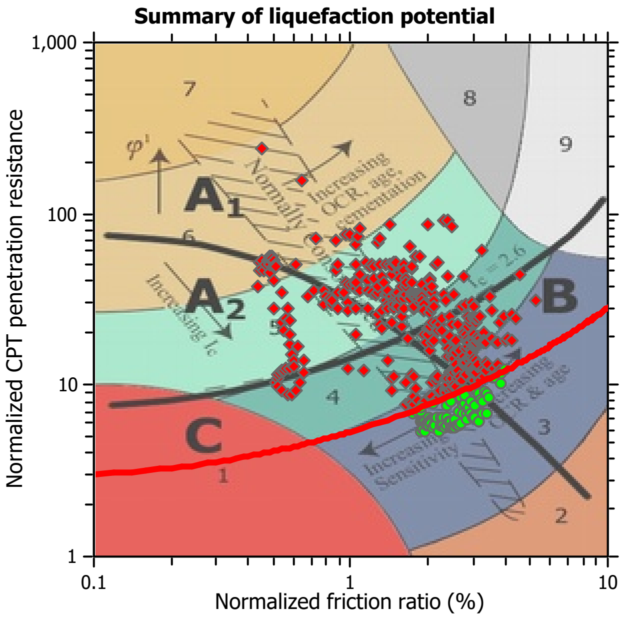
CPT file : CPT-03

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	10.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	10.00 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:	7.84	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.49	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

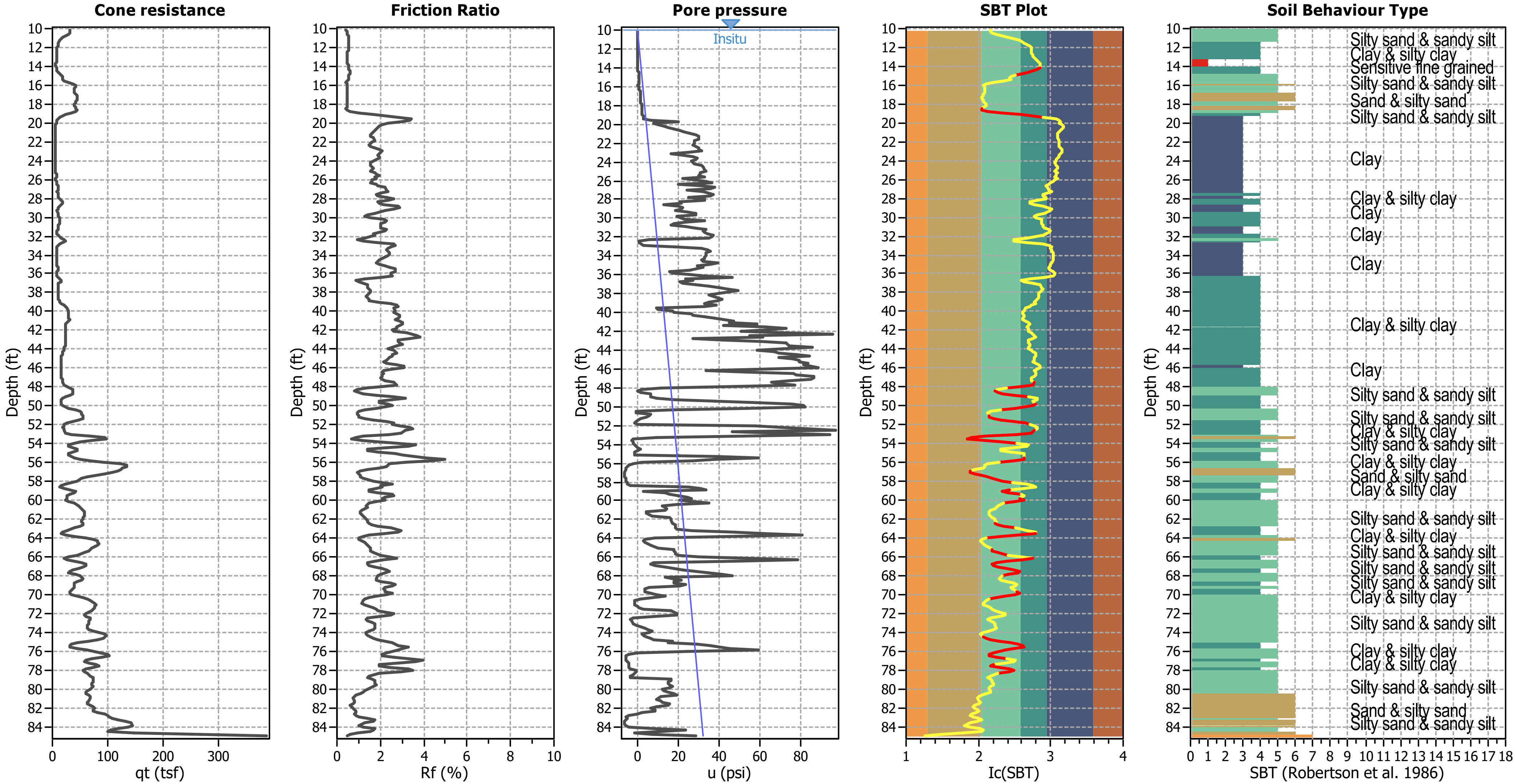






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



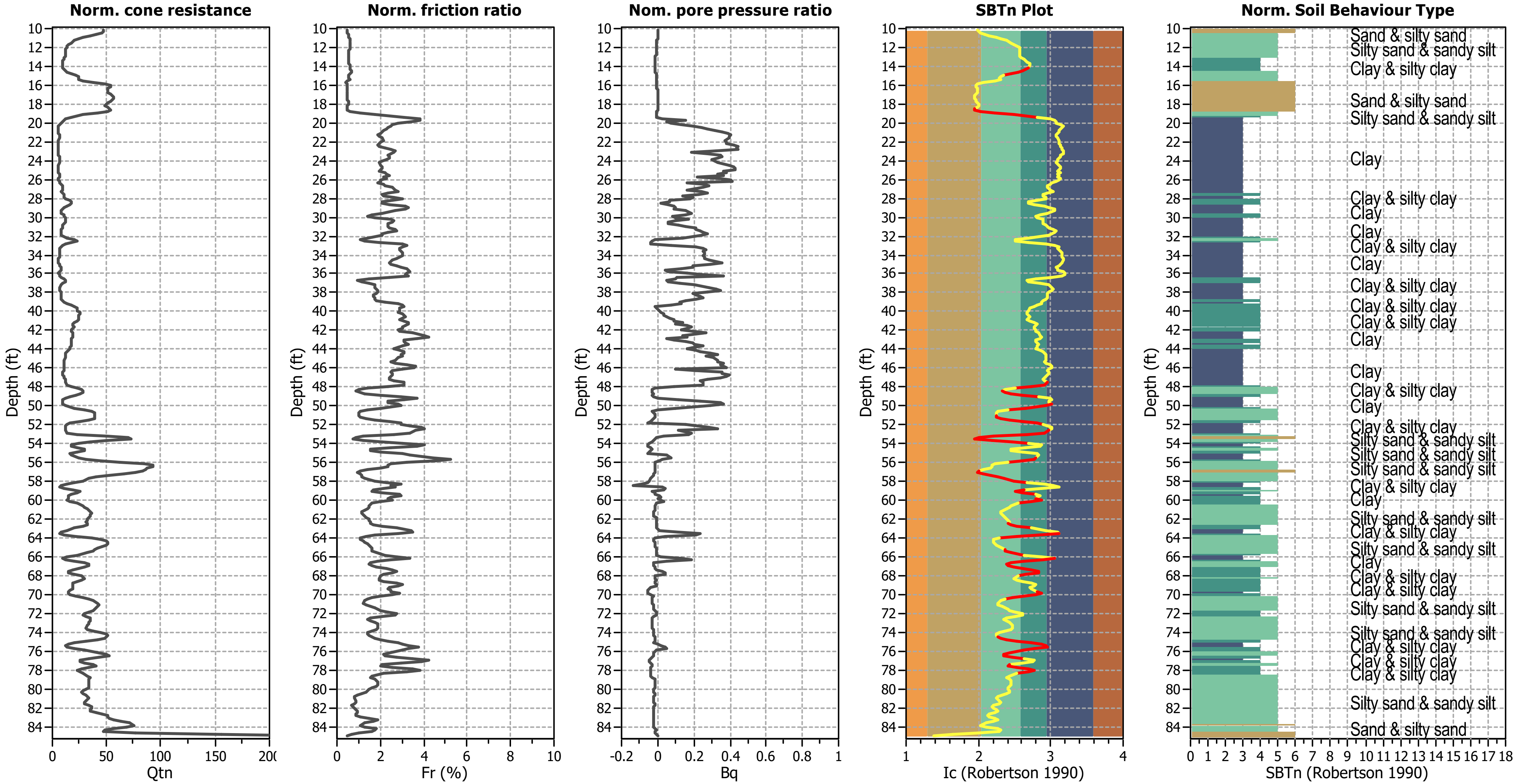
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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)



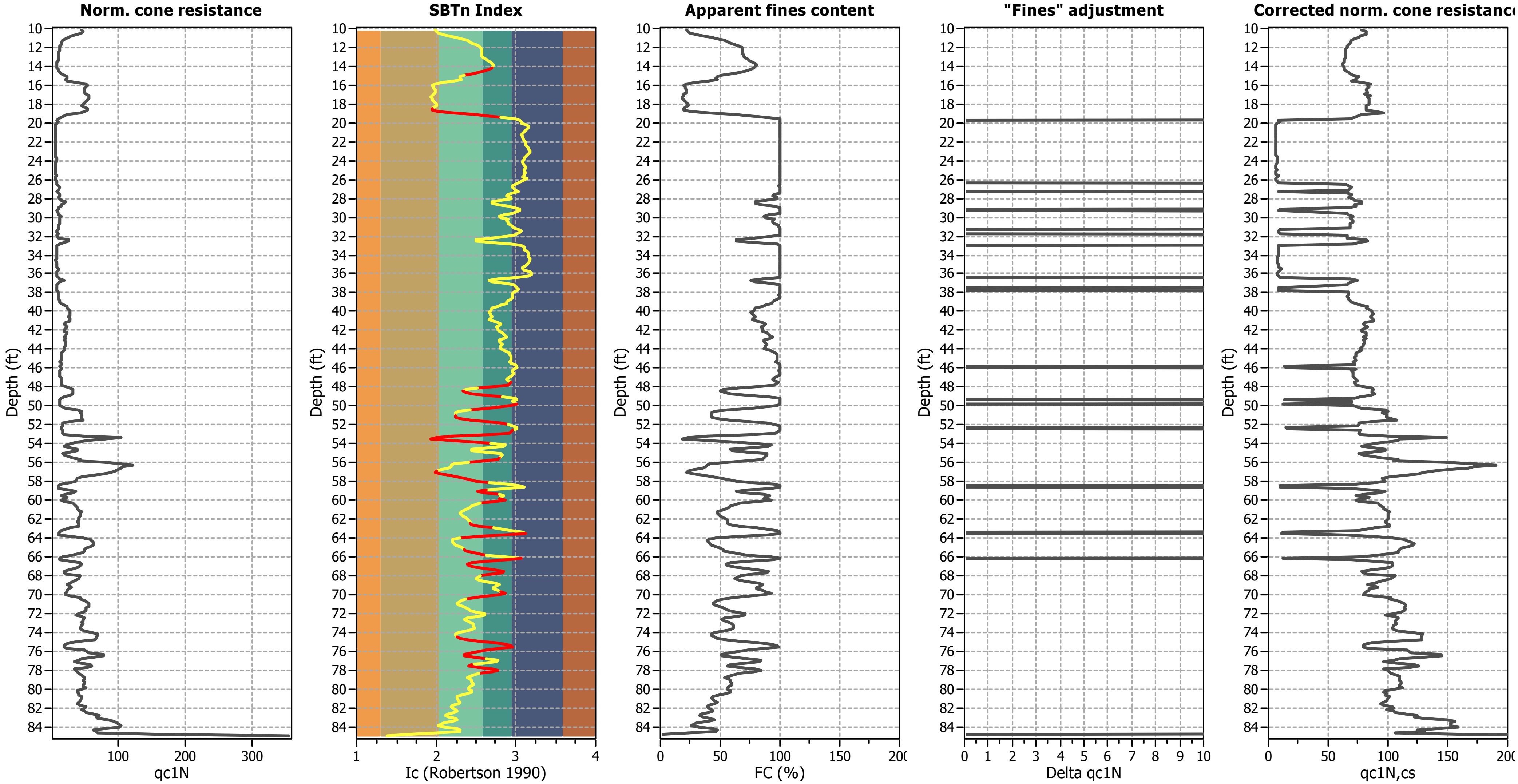
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	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

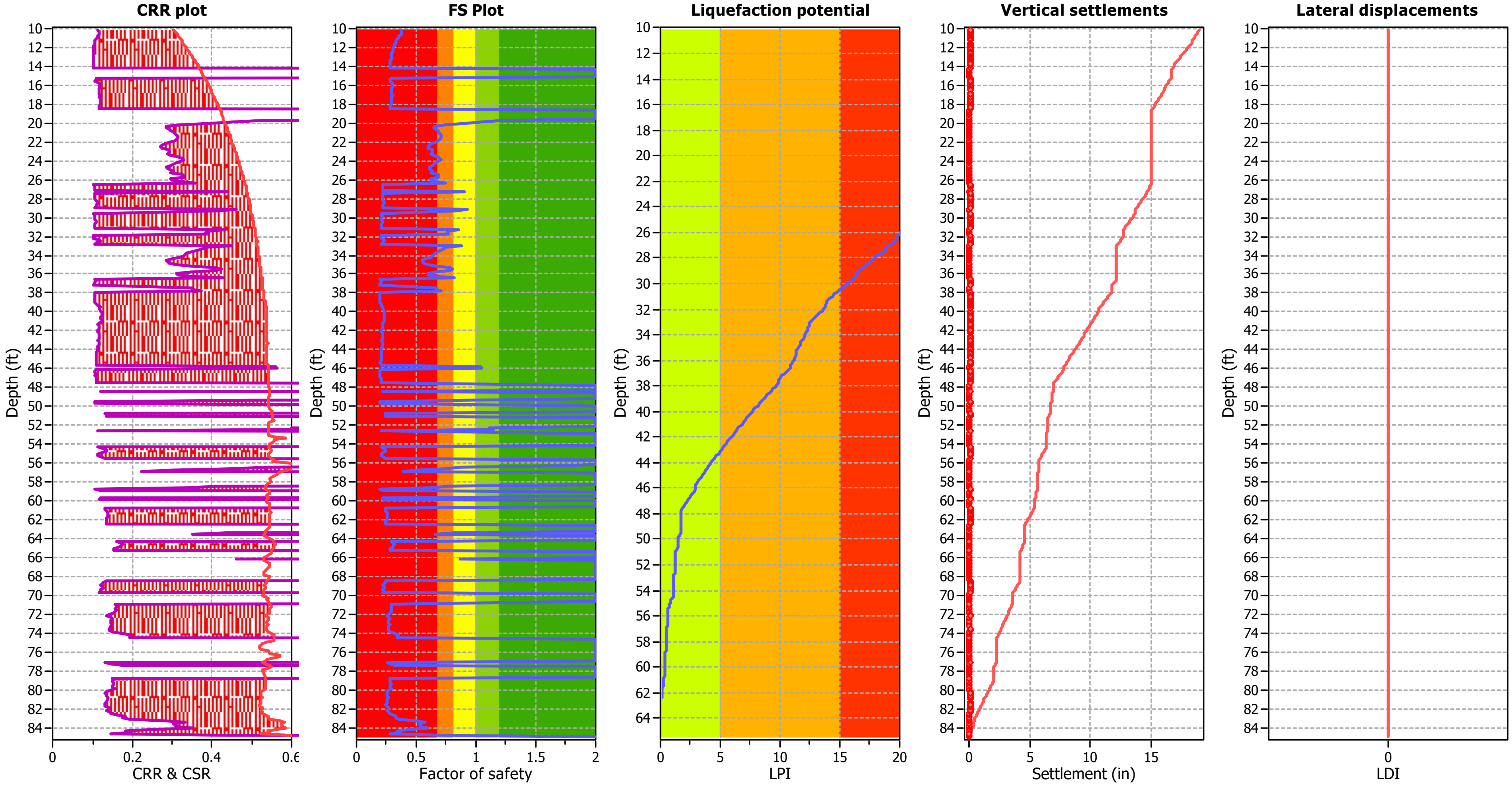
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

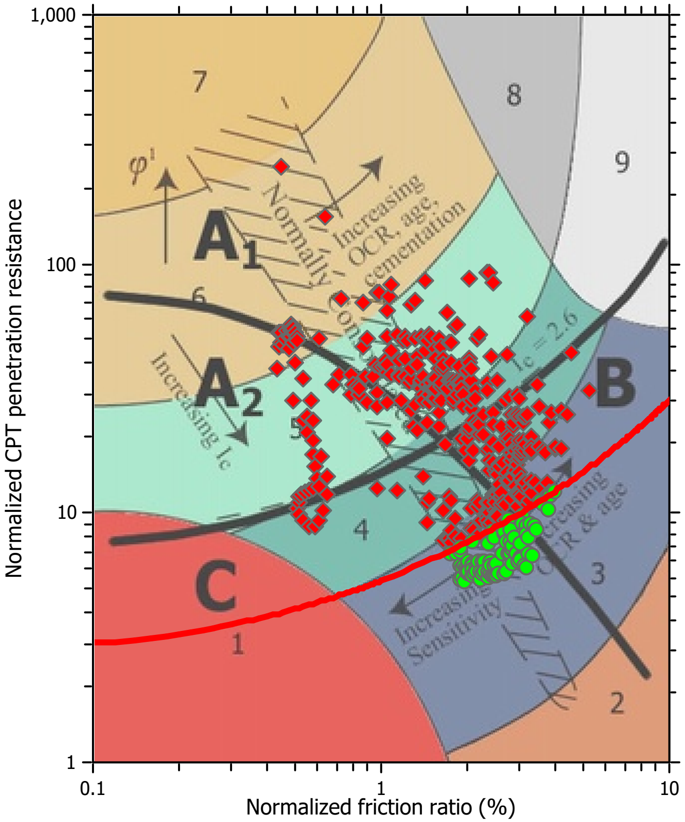
F.S. color scheme

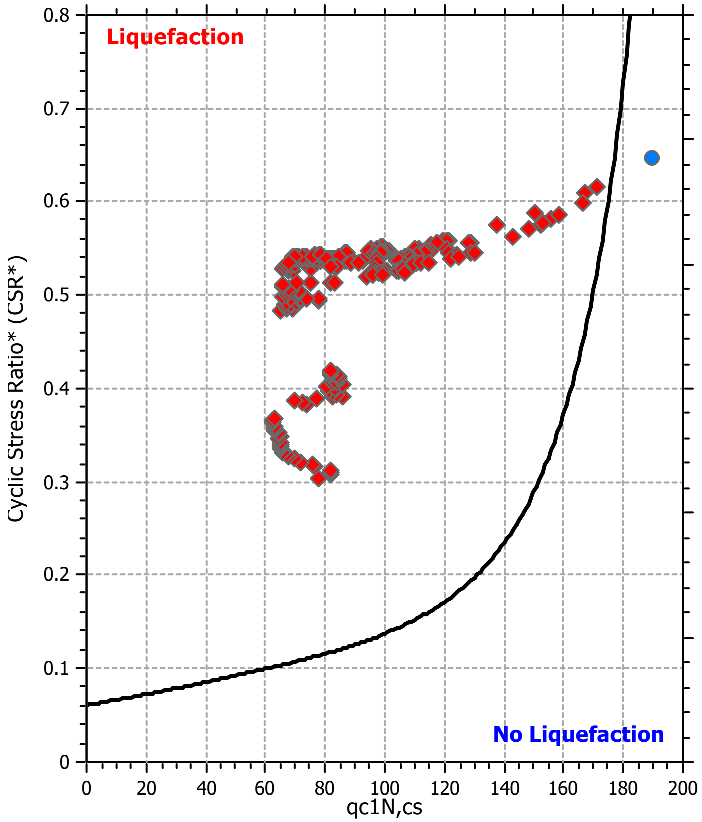
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

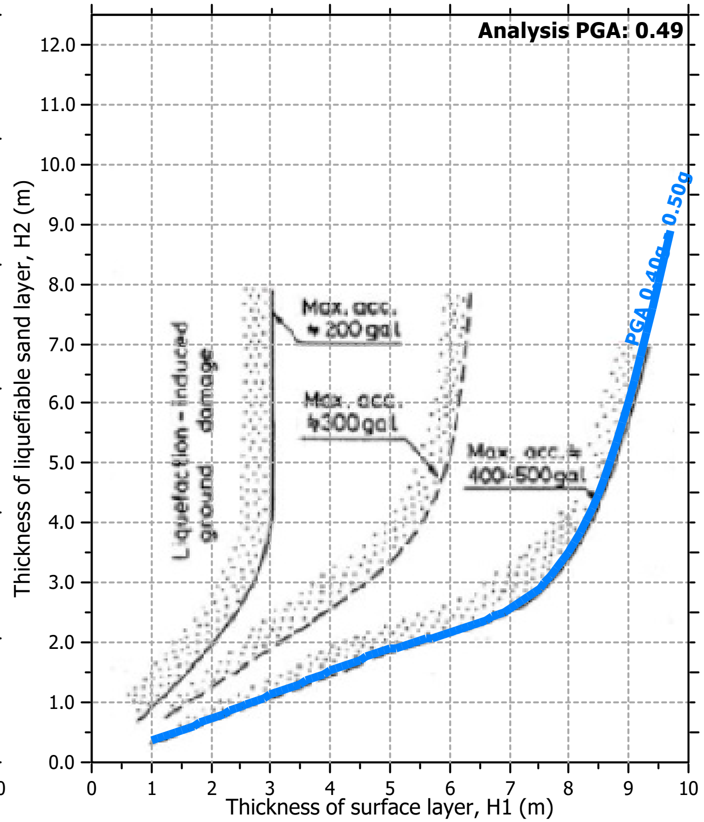
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



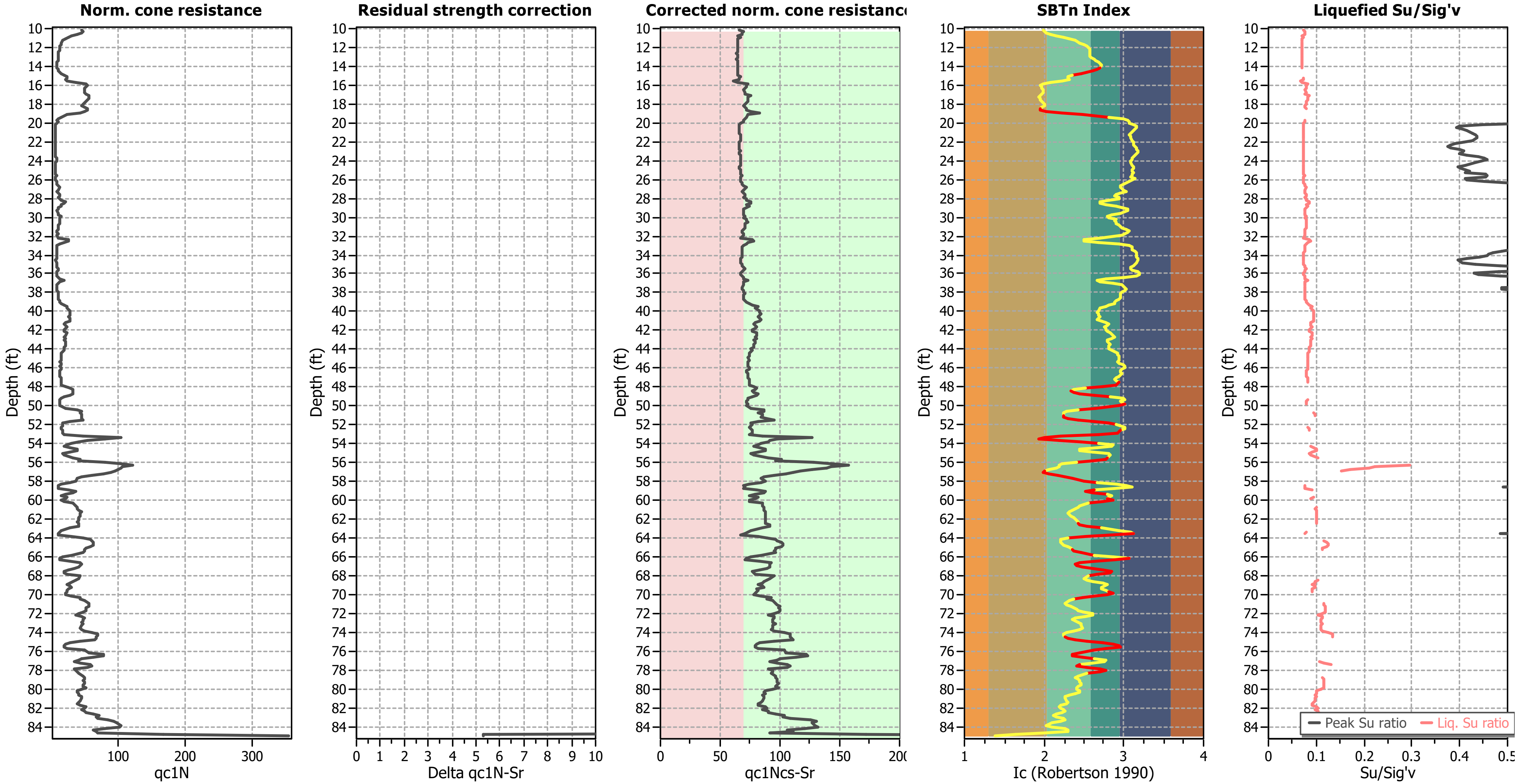




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

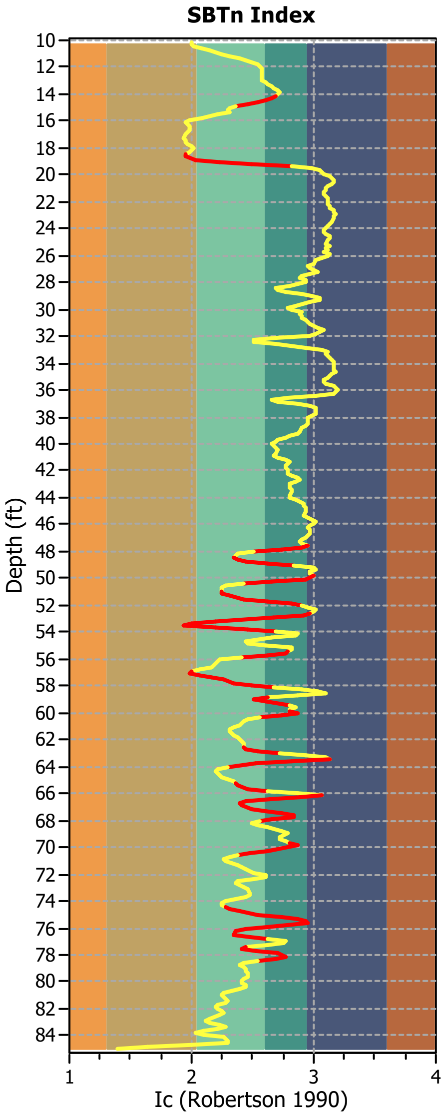
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

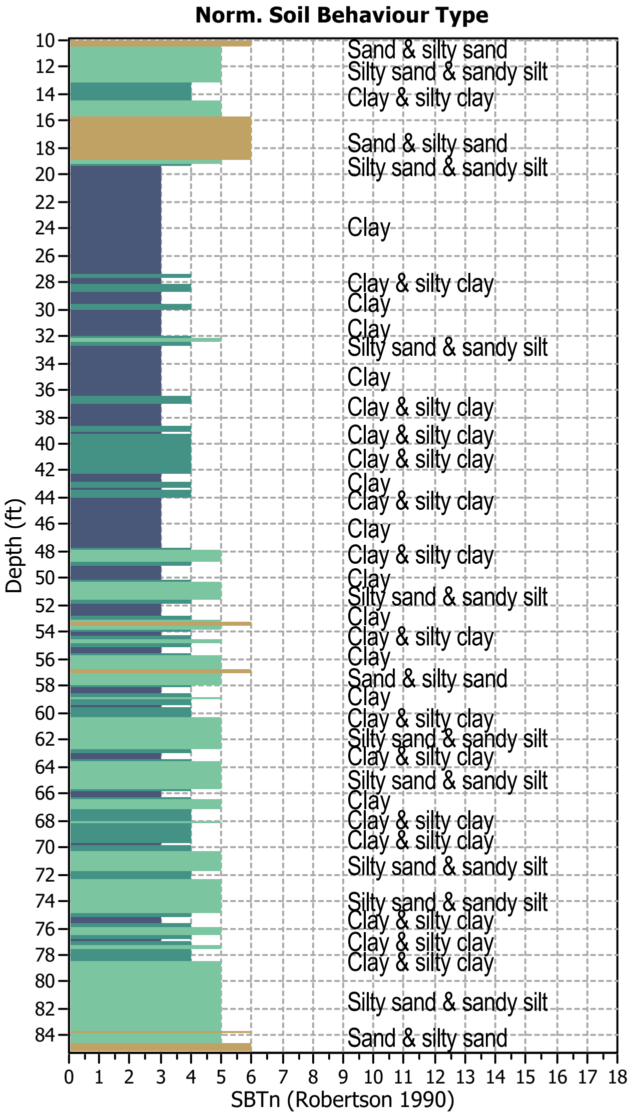
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	457
Total points excluded:	116
Exclusion percentage:	25.38%
Number of layers detected:	24

Transition layer No	Number of points	Depth	SBT_n number	SBT_n description
Transition layer 1	6	Start depth: 14.27 (ft)	4	Clay & silty clay
		End depth: 15.09 (ft)	5	Silty sand & sandy silt
Transition layer 2	6	Start depth: 18.70 (ft)	6	Sand & silty sand
		End depth: 19.52 (ft)	3	Clay
Transition layer 3	4	Start depth: 47.74 (ft)	3	Clay
		End depth: 48.23 (ft)	5	Silty sand & sandy silt
Transition layer 4	5	Start depth: 48.56 (ft)	5	Silty sand & sandy silt
		End depth: 49.21 (ft)	3	Clay
Transition layer 5	4	Start depth: 50.03 (ft)	3	Clay
		End depth: 50.52 (ft)	5	Silty sand & sandy silt
Transition layer 6	7	Start depth: 51.18 (ft)	5	Silty sand & sandy silt
		End depth: 52.16 (ft)	3	Clay
Transition layer 7	5	Start depth: 52.82 (ft)	3	Clay
		End depth: 53.48 (ft)	6	Sand & silty sand
Transition layer 8	5	Start depth: 53.48 (ft)	6	Sand & silty sand
		End depth: 54.13 (ft)	3	Clay
Transition layer 9	4	Start depth: 55.61 (ft)	3	Clay
		End depth: 56.10 (ft)	5	Silty sand & sandy silt
Transition layer 10	8	Start depth: 57.09 (ft)	6	Sand & silty sand
		End depth: 58.23 (ft)	3	Clay
Transition layer 11	4	Start depth: 59.05 (ft)	5	Silty sand & sandy silt
		End depth: 59.55 (ft)	3	Clay
Transition layer 12	4	Start depth: 60.04 (ft)	4	Clay & silty clay
		End depth: 60.53 (ft)	5	Silty sand & sandy silt
Transition layer 13	4	Start depth: 62.66 (ft)	5	Silty sand & sandy silt
		End depth: 63.16 (ft)	3	Clay
Transition layer 14	4	Start depth: 63.65 (ft)	4	Clay & silty clay
		End depth: 64.14 (ft)	5	Silty sand & sandy silt
Transition layer 15	4	Start depth: 65.45 (ft)	5	Silty sand & sandy silt
		End depth: 65.94 (ft)	3	Clay
Transition layer 16	4	Start depth: 66.27 (ft)	3	Clay
		End depth: 66.77 (ft)	5	Silty sand & sandy silt
Transition layer 17	5	Start depth: 66.93 (ft)	5	Silty sand & sandy silt
		End depth: 67.58 (ft)	4	Clay & silty clay
Transition layer 18	4	Start depth: 67.75 (ft)	4	Clay & silty clay
		End depth: 68.24 (ft)	5	Silty sand & sandy silt
Transition layer 19	6	Start depth: 69.88 (ft)	3	Clay
		End depth: 70.70 (ft)	5	Silty sand & sandy silt
Transition layer 20	6	Start depth: 74.64 (ft)	5	Silty sand & sandy silt
		End depth: 75.46 (ft)	3	Clay
Transition layer 21	5	Start depth: 75.62 (ft)	3	Clay
		End depth: 76.28 (ft)	5	Silty sand & sandy silt
Transition layer 22	4	Start depth: 76.44 (ft)	5	Silty sand & sandy silt
		End depth: 76.94 (ft)	3	Clay
Transition layer 23	4	Start depth: 77.59 (ft)	5	Silty sand & sandy silt
		End depth: 78.08 (ft)	4	Clay & silty clay

Transition layer No	Number of points	Depth	SBT_n number	SBT_n description
Transition layer 24	4	Start depth: 78.08 (ft)	4	Clay & silty clay
		End depth: 78.58 (ft)	5	Silty sand & sandy silt

Start depth: Depth where the transition layer begins
End depth: Depth where the transition layer ends

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	10.17	31.64	0.13	0.05	5.00	104.39
2	10.34	34.07	0.16	0.01	5.00	104.71
3	10.50	32.23	0.15	-0.01	5.00	104.79
4	10.66	28.63	0.14	0.01	15.22	103.79
5	10.83	22.07	0.12	-0.07	17.47	102.55
6	10.99	19.34	0.11	-0.04	20.46	100.86
7	11.15	15.18	0.09	0.00	23.03	99.20
8	11.32	12.78	0.07	0.01	25.91	97.34
9	11.48	11.17	0.06	0.03	28.13	95.83
10	11.65	10.03	0.06	0.05	30.30	94.79
11	11.81	9.10	0.05	0.07	32.24	94.02
12	11.97	8.54	0.05	0.07	33.59	93.41
13	12.14	8.31	0.05	0.07	33.87	92.82
14	12.30	8.39	0.04	0.08	33.80	92.43
15	12.47	8.28	0.04	0.08	33.86	92.08
16	12.63	7.99	0.04	0.13	33.96	91.96
17	12.79	8.24	0.04	0.14	34.15	91.67
18	12.96	7.94	0.04	0.15	34.31	91.41
19	13.12	7.73	0.04	0.17	35.34	90.85
20	13.29	7.07	0.03	0.30	36.42	90.24
21	13.45	6.79	0.03	0.32	37.84	89.68
22	13.62	6.49	0.03	0.34	39.19	89.39
23	13.78	6.14	0.03	0.37	40.69	89.33
24	13.94	5.98	0.03	0.41	41.20	89.58
25	14.11	6.40	0.03	0.45	40.17	90.35
26	14.27	7.17	0.04	0.51	38.32	91.73
27	14.44	8.13	0.05	0.56	35.81	93.45
28	14.60	9.68	0.06	0.63	32.77	95.16
29	14.76	11.62	0.07	0.70	28.87	96.86
30	14.93	14.80	0.08	0.77	24.62	98.27
31	15.09	18.68	0.09	0.84	22.64	99.34
32	15.26	17.72	0.09	0.92	22.36	100.00
33	15.42	16.88	0.10	0.98	23.03	100.03
34	15.58	17.33	0.09	1.04	5.00	100.81
35	15.75	28.28	0.11	1.11	5.00	103.05
36	15.91	40.93	0.17	0.52	5.00	105.80
37	16.08	42.08	0.21	0.63	5.00	107.31
38	16.24	41.77	0.20	0.91	5.00	107.57
39	16.40	40.07	0.19	1.16	5.00	107.16
40	16.57	38.94	0.19	1.67	5.00	106.99
41	16.73	40.27	0.19	1.72	5.00	107.14
42	16.90	40.95	0.20	1.75	5.00	107.68
43	17.06	46.12	0.22	1.76	5.00	108.17
44	17.22	45.30	0.22	1.83	5.00	108.42
45	17.39	45.13	0.21	1.84	5.00	108.32
46	17.55	43.96	0.21	1.85	5.00	108.21
47	17.72	42.98	0.21	1.92	12.23	108.06
48	17.88	41.37	0.21	2.00	12.74	107.82

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	18.05	39.18	0.20	2.06	13.17	107.43
50	18.21	38.16	0.19	2.14	5.00	107.14
51	18.37	40.88	0.18	2.22	5.00	107.09
52	18.54	44.51	0.19	2.25	5.00	107.14
53	18.70	44.25	0.18	2.29	5.00	107.46
54	18.86	42.56	0.21	2.32	13.86	109.09
55	19.03	36.99	0.35	2.39	20.07	110.69
56	19.19	18.79	0.44	2.82	30.20	110.83
57	19.36	11.86	0.36	3.34	46.66	109.45
58	19.52	9.21	0.33	6.75	57.83	107.59
59	19.68	7.57	0.29	20.02	61.99	106.04
60	19.85	7.95	0.21	8.35	63.47	103.84
61	20.01	6.40	0.14	10.15	63.71	101.17
62	20.18	5.22	0.11	12.72	67.60	98.58
63	20.34	4.96	0.09	15.13	70.36	97.36
64	20.50	5.01	0.10	18.17	69.84	96.92
65	20.67	5.15	0.09	20.56	68.53	96.95
66	20.83	5.35	0.09	23.28	66.96	96.77
67	21.00	5.37	0.09	26.16	65.89	96.72
68	21.16	5.46	0.09	28.44	64.97	96.53
69	21.32	5.54	0.08	29.87	63.75	96.40
70	21.49	5.69	0.08	29.88	64.05	96.74
71	21.65	5.63	0.10	29.91	64.89	97.21
72	21.82	5.64	0.10	28.08	66.19	97.26
73	21.98	5.40	0.09	27.66	66.44	96.53
74	22.15	5.18	0.07	26.99	67.01	95.79
75	22.31	5.12	0.08	28.92	67.33	95.41
76	22.47	5.16	0.08	30.09	68.30	95.65
77	22.64	5.11	0.08	29.95	69.90	96.68
78	22.80	5.33	0.11	31.74	70.25	97.90
79	22.97	5.82	0.12	25.23	71.06	98.75
80	23.13	5.46	0.12	16.88	70.52	98.52
81	23.29	5.38	0.10	22.47	70.46	98.16
82	23.46	5.67	0.11	27.53	68.54	98.10
83	23.62	5.99	0.11	29.25	67.27	98.78
84	23.79	6.23	0.13	28.54	66.37	99.10
85	23.95	6.21	0.12	26.62	65.31	98.86
86	24.11	6.21	0.10	27.59	64.35	97.97
87	24.28	5.98	0.09	28.15	64.07	97.17
88	24.44	5.83	0.09	31.24	65.95	96.98
89	24.61	5.58	0.09	32.08	67.63	97.07
90	24.77	5.61	0.10	32.90	67.44	97.28
91	24.93	6.06	0.10	33.89	66.28	97.22
92	25.10	5.92	0.09	30.65	65.28	97.30
93	25.26	6.01	0.10	31.02	67.69	98.09
94	25.43	5.90	0.13	30.46	65.37	99.07
95	25.59	7.35	0.13	32.82	66.05	99.59
96	25.75	6.22	0.12	22.43	64.54	98.90

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	25.92	5.95	0.09	28.90	68.20	98.40
98	26.08	5.92	0.11	33.79	66.04	97.62
99	26.25	6.41	0.09	36.66	63.59	98.39
100	26.41	7.31	0.12	20.19	60.02	98.88
101	26.57	7.64	0.12	31.50	58.27	101.15
102	26.74	9.15	0.19	37.93	55.13	102.83
103	26.90	10.66	0.21	36.15	55.82	104.41
104	27.07	9.16	0.24	24.78	58.16	104.43
105	27.23	7.98	0.20	32.09	61.08	103.89
106	27.39	8.68	0.18	37.60	55.93	103.36
107	27.56	11.25	0.18	35.65	51.72	103.47
108	27.72	10.70	0.19	24.84	51.51	104.08
109	27.89	9.68	0.22	33.01	53.97	105.78
110	28.05	11.98	0.33	33.11	53.91	107.76
111	28.21	13.76	0.39	20.66	46.16	109.16
112	28.38	19.15	0.33	21.60	40.27	109.08
113	28.54	18.95	0.27	12.72	40.36	109.21
114	28.71	14.09	0.41	20.16	44.10	109.21
115	28.87	14.57	0.36	22.59	52.54	109.24
116	29.04	10.80	0.34	21.73	56.95	108.05
117	29.20	8.96	0.29	18.52	61.75	105.57
118	29.36	8.52	0.12	24.18	61.60	103.63
119	29.53	8.78	0.18	28.88	55.85	102.19
120	29.69	10.38	0.17	28.52	48.66	102.22
121	29.86	13.12	0.10	19.46	45.43	102.05
122	30.02	11.12	0.16	23.02	46.81	103.87
123	30.18	11.89	0.29	33.19	51.98	106.44
124	30.35	12.94	0.33	23.38	51.54	107.41
125	30.51	13.12	0.25	17.81	51.59	106.96
126	30.68	11.20	0.24	16.54	52.08	105.71
127	30.84	10.73	0.22	23.99	54.52	104.99
128	31.00	10.52	0.20	28.07	55.09	104.58
129	31.17	10.38	0.21	33.77	56.76	104.38
130	31.33	9.55	0.21	32.06	60.86	104.41
131	31.50	8.38	0.22	32.81	63.64	103.55
132	31.66	8.19	0.15	34.12	61.82	102.43
133	31.82	9.31	0.13	37.03	59.24	101.73
134	31.99	8.96	0.17	36.85	56.44	102.74
135	32.15	10.78	0.21	34.85	40.13	104.64
136	32.32	25.50	0.19	5.62	30.74	106.00
137	32.48	26.44	0.21	1.24	30.93	108.66
138	32.64	18.02	0.44	0.70	39.55	109.53
139	32.81	12.55	0.36	3.23	54.17	108.85
140	32.97	9.08	0.24	18.71	62.63	106.39
141	33.14	8.87	0.21	31.61	65.97	104.55
142	33.30	8.84	0.21	34.67	65.59	104.00
143	33.47	8.74	0.20	36.17	66.30	103.76
144	33.63	8.38	0.20	33.53	67.78	103.58

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	33.79	8.10	0.20	33.67	69.35	103.54
146	33.96	8.13	0.20	33.40	69.84	103.41
147	34.12	8.13	0.19	32.67	69.87	103.21
148	34.28	7.97	0.18	32.95	69.88	102.65
149	34.45	7.68	0.16	31.55	70.77	101.70
150	34.61	7.05	0.13	32.59	71.04	100.79
151	34.78	7.20	0.13	39.12	69.30	100.65
152	34.94	8.22	0.15	35.59	67.96	101.52
153	35.10	8.31	0.17	29.20	66.81	103.37
154	35.27	9.42	0.25	32.33	63.89	105.23
155	35.43	11.65	0.28	25.78	64.42	106.38
156	35.60	9.49	0.28	16.20	65.53	106.25
157	35.76	8.76	0.24	16.96	70.57	104.93
158	35.92	7.96	0.18	25.53	72.62	103.49
159	36.09	7.38	0.17	32.99	72.07	103.68
160	36.25	9.19	0.25	46.54	69.71	104.82
161	36.42	10.07	0.27	23.65	59.48	104.57
162	36.58	12.17	0.11	27.24	45.03	103.85
163	36.74	18.97	0.14	20.54	38.44	101.82
164	36.91	13.88	0.13	22.34	40.48	102.75
165	37.07	11.45	0.17	28.63	49.67	101.88
166	37.24	9.38	0.13	34.97	56.50	101.62
167	37.40	9.21	0.13	40.26	59.51	100.55
168	37.57	8.82	0.12	44.33	60.10	100.91
169	37.73	9.50	0.14	49.51	59.14	101.77
170	37.89	10.63	0.18	44.37	57.06	102.60
171	38.06	10.95	0.16	35.27	55.53	102.52
172	38.22	10.39	0.13	37.56	55.31	101.82
173	38.39	10.03	0.14	39.30	55.57	101.42
174	38.55	10.41	0.14	41.54	55.69	101.95
175	38.71	10.97	0.16	39.64	53.94	102.89
176	38.88	12.35	0.18	34.87	51.87	104.05
177	39.04	13.50	0.21	32.85	50.91	106.99
178	39.21	16.49	0.40	38.88	50.47	110.65
179	39.37	20.12	0.63	33.00	46.63	113.54
180	39.53	25.73	0.68	9.44	44.42	115.00
181	39.70	24.60	0.69	10.18	40.78	115.65
182	39.86	29.19	0.73	17.10	39.99	116.22
183	40.03	29.79	0.81	18.21	38.49	116.82
184	40.19	30.65	0.83	26.90	39.21	117.27
185	40.35	29.73	0.87	27.56	40.01	117.39
186	40.52	28.70	0.86	32.71	40.56	117.37
187	40.68	29.54	0.83	37.85	39.67	117.21
188	40.85	31.14	0.80	46.93	39.05	117.13
189	41.01	29.92	0.82	45.05	41.14	116.92
190	41.17	24.21	0.81	58.46	44.53	116.22
191	41.34	22.00	0.66	42.20	46.45	115.38
192	41.50	23.89	0.63	63.24	45.28	115.33

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	41.67	26.05	0.78	72.96	43.97	115.28
194	41.83	24.18	0.63	63.99	44.50	114.94
195	41.99	21.94	0.56	51.01	45.03	113.98
196	42.16	22.12	0.57	71.33	45.08	114.26
197	42.32	25.16	0.69	96.03	47.30	116.08
198	42.49	24.73	1.04	55.29	49.64	117.17
199	42.65	22.46	0.93	61.90	50.78	117.35
200	42.81	24.23	0.77	27.52	49.30	116.06
201	42.98	22.60	0.62	41.82	45.97	115.07
202	43.14	24.36	0.62	60.60	45.89	114.97
203	43.31	24.18	0.75	72.83	46.20	115.20
204	43.47	23.04	0.68	74.14	47.52	115.37
205	43.63	22.97	0.68	85.98	46.85	114.46
206	43.80	22.37	0.52	71.54	46.44	113.56
207	43.96	20.94	0.48	59.03	46.11	112.81
208	44.13	21.33	0.53	66.95	48.99	112.97
209	44.29	19.00	0.58	69.53	51.40	112.73
210	44.45	17.38	0.46	77.98	53.39	112.08
211	44.62	17.54	0.43	84.24	53.65	111.31
212	44.78	17.03	0.45	69.37	54.49	111.10
213	44.95	16.14	0.43	76.64	53.89	110.49
214	45.11	16.90	0.33	79.61	53.89	109.81
215	45.28	15.70	0.35	79.52	52.98	109.26
216	45.44	15.99	0.35	83.45	54.71	109.62
217	45.60	16.05	0.39	81.63	57.62	110.92
218	45.77	15.78	0.57	84.88	59.66	112.00
219	45.93	16.52	0.55	88.93	59.04	112.01
220	46.10	16.72	0.38	33.69	56.80	110.38
221	46.26	14.49	0.28	53.20	55.30	108.70
222	46.42	14.66	0.31	76.88	56.12	108.16
223	46.59	15.11	0.32	78.14	56.33	108.46
224	46.75	14.94	0.31	86.44	55.77	108.57
225	46.92	15.43	0.32	86.22	54.45	108.87
226	47.08	16.96	0.35	84.92	52.36	109.30
227	47.24	17.93	0.35	74.63	51.16	110.12
228	47.41	18.60	0.42	66.01	52.33	110.58
229	47.57	16.81	0.43	70.18	54.87	111.79
230	47.74	18.11	0.56	77.20	52.36	113.11
231	47.90	24.86	0.64	44.14	42.16	113.66
232	48.06	33.73	0.41	11.37	31.37	112.58
233	48.23	38.47	0.24	2.38	25.23	111.06
234	48.39	38.25	0.35	0.41	23.95	110.70
235	48.56	37.23	0.36	1.40	25.43	111.87
236	48.72	38.45	0.40	6.33	28.35	112.72
237	48.88	32.01	0.51	6.28	36.36	114.42
238	49.05	22.21	0.77	9.77	48.14	114.52
239	49.21	16.46	0.58	18.09	58.14	113.37
240	49.38	16.22	0.38	37.97	59.55	110.38

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
241	49.54	14.41	0.25	58.10	56.13	108.01
242	49.70	15.00	0.26	76.17	56.79	107.83
243	49.87	15.41	0.37	81.79	58.73	109.43
244	50.03	15.78	0.45	82.45	54.14	112.09
245	50.20	25.33	0.63	53.92	38.03	113.89
246	50.36	46.61	0.52	16.56	27.15	114.94
247	50.52	53.56	0.49	-0.83	21.56	114.77
248	50.69	51.18	0.49	-0.63	20.33	114.74
249	50.85	53.86	0.49	6.42	20.58	115.05
250	51.02	54.51	0.55	6.20	20.63	115.41
251	51.18	53.74	0.56	4.54	20.66	115.55
252	51.34	54.92	0.51	1.39	22.79	117.39
253	51.51	56.01	1.01	-0.68	27.69	118.16
254	51.67	34.42	0.89	-1.52	36.33	117.87
255	51.84	21.78	0.63	0.20	47.10	115.42
256	52.00	21.40	0.53	58.09	52.10	113.13
257	52.16	19.84	0.45	69.86	55.52	113.52
258	52.33	18.75	0.75	83.56	59.07	114.33
259	52.49	19.64	0.75	97.25	58.88	114.95
260	52.66	21.84	0.60	46.63	56.04	114.60
261	52.82	21.17	0.62	68.65	53.00	114.76
262	52.99	24.14	0.75	94.27	39.32	117.62
263	53.15	58.76	1.14	52.01	19.14	119.16
264	53.31	125.88	0.57	9.30	12.90	119.68
265	53.48	98.25	0.68	-2.11	11.41	118.65
266	53.64	67.08	0.81	-2.77	18.79	119.41
267	53.81	49.83	1.03	-2.00	29.23	119.77
268	53.97	36.27	1.12	-2.17	39.92	119.64
269	54.13	28.29	1.05	-1.32	50.02	119.10
270	54.30	24.43	1.06	0.20	48.77	118.28
271	54.46	35.26	0.79	1.41	38.14	117.50
272	54.63	48.42	0.58	-0.08	28.53	116.07
273	54.79	48.11	0.50	-1.36	28.63	116.14
274	54.95	35.51	0.81	-1.54	36.04	115.92
275	55.12	22.68	0.66	-0.91	47.06	116.28
276	55.28	25.48	0.78	38.74	47.37	117.75
277	55.45	41.07	1.25	59.11	45.45	122.97
278	55.61	54.51	2.94	38.36	44.45	126.31
279	55.77	52.77	3.13	27.33	36.27	128.53
280	55.94	97.69	2.83	2.21	26.84	129.03
281	56.10	125.91	2.66	-2.15	19.97	129.90
282	56.27	145.04	3.33	-3.88	18.78	130.49
283	56.43	129.02	3.31	-4.74	18.49	130.34
284	56.59	127.25	2.46	-5.43	17.63	128.70
285	56.76	122.01	1.65	-5.76	14.60	125.85
286	56.92	118.55	0.97	-5.99	12.87	123.47
287	57.09	111.37	1.11	-6.19	12.71	121.86
288	57.25	97.07	0.99	-6.18	14.83	121.12

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
289	57.41	76.78	0.80	-6.06	17.89	119.68
290	57.58	59.33	0.75	-5.73	21.08	117.57
291	57.74	50.42	0.50	-5.37	24.32	116.46
292	57.91	48.47	0.61	-5.23	30.66	117.45
293	58.07	37.36	1.13	-5.16	38.87	116.64
294	58.23	19.93	0.44	-4.71	52.22	114.29
295	58.40	13.61	0.24	-3.10	60.90	108.53
296	58.56	13.93	0.26	25.03	65.80	107.79
297	58.73	15.01	0.38	30.89	50.49	110.79
298	58.89	34.64	0.52	33.77	36.56	113.57
299	59.05	48.52	0.57	3.08	31.10	115.85
300	59.22	42.89	0.76	13.70	35.46	117.30
301	59.38	28.55	0.96	16.03	45.91	116.90
302	59.55	20.82	0.65	24.75	49.16	115.82
303	59.71	32.54	0.52	26.92	46.59	114.59
304	59.88	28.77	0.63	21.18	46.04	114.24
305	60.04	20.63	0.57	27.47	49.81	113.75
306	60.20	24.63	0.46	35.35	42.05	113.94
307	60.37	43.29	0.58	19.58	33.18	114.87
308	60.53	47.21	0.63	12.06	28.57	116.38
309	60.70	50.28	0.71	13.48	27.76	117.04
310	60.86	51.51	0.72	14.55	26.18	117.05
311	61.02	55.01	0.60	13.41	24.27	116.87
312	61.19	59.18	0.62	4.28	23.01	116.78
313	61.35	58.28	0.67	4.61	22.76	116.90
314	61.52	57.72	0.62	6.02	23.37	117.11
315	61.68	57.35	0.68	7.46	24.08	117.29
316	61.84	55.83	0.73	15.61	25.25	117.72
317	62.01	54.80	0.75	16.29	26.27	117.90
318	62.17	53.54	0.75	16.90	26.91	117.92
319	62.34	52.95	0.75	17.59	27.25	117.99
320	62.50	53.78	0.78	18.67	27.16	118.23
321	62.66	56.04	0.82	18.89	28.21	118.94
322	62.83	53.52	0.99	18.98	32.28	119.41
323	62.99	39.26	1.04	19.60	41.63	118.81
324	63.16	21.86	0.84	26.25	53.91	116.41
325	63.32	17.73	0.46	47.01	65.00	112.45
326	63.48	14.73	0.24	62.33	67.22	108.95
327	63.65	13.28	0.31	80.97	47.59	110.18
328	63.81	41.28	0.50	44.55	31.70	113.75
329	63.98	63.02	0.62	8.55	22.14	116.85
330	64.14	77.85	0.76	4.10	19.37	118.82
331	64.30	80.34	0.92	2.75	18.95	120.32
332	64.47	83.71	1.06	3.87	19.50	121.30
333	64.63	84.74	1.13	5.36	19.93	121.81
334	64.80	82.91	1.13	6.77	20.76	121.92
335	64.96	77.79	1.13	9.90	22.30	121.76
336	65.13	70.18	1.12	17.93	23.95	121.51

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
337	65.29	67.82	1.09	18.30	24.91	120.99
338	65.45	66.00	0.96	18.68	25.39	120.67
339	65.62	64.12	1.02	19.00	28.85	119.97
340	65.78	42.15	0.94	19.96	36.67	118.53
341	65.94	24.09	0.67	29.82	50.06	115.50
342	66.11	17.77	0.40	54.49	62.76	113.07
343	66.27	17.60	0.55	78.81	51.43	113.48
344	66.44	39.66	0.64	47.13	37.24	116.29
345	66.60	59.24	0.83	7.84	28.41	118.01
346	66.77	61.26	0.83	6.40	26.12	119.10
347	66.93	60.53	0.90	9.06	27.09	119.47
348	67.09	57.29	0.97	13.88	30.02	119.75
349	67.26	48.81	1.00	17.68	35.65	119.62
350	67.42	36.46	1.00	22.49	42.64	118.06
351	67.58	27.10	0.60	35.32	48.29	116.43
352	67.75	28.68	0.62	41.45	47.65	115.61
353	67.91	34.53	0.78	46.93	38.38	117.82
354	68.08	59.88	1.04	13.42	33.26	119.53
355	68.24	57.59	1.05	17.16	30.54	120.20
356	68.41	51.82	0.95	21.74	32.25	119.31
357	68.57	45.51	0.77	17.83	36.15	118.91
358	68.73	40.21	1.01	18.30	42.67	119.23
359	68.90	34.20	1.20	23.64	45.21	119.39
360	69.06	40.09	0.89	21.19	43.84	119.27
361	69.23	43.19	0.94	5.67	41.28	118.29
362	69.39	35.58	0.81	4.06	41.73	117.57
363	69.55	35.20	0.67	3.78	44.72	116.85
364	69.72	32.71	0.78	4.01	46.26	116.45
365	69.88	30.41	0.72	6.58	49.86	116.84
366	70.05	29.47	0.84	9.72	45.65	117.06
367	70.21	42.83	0.77	13.89	36.53	117.98
368	70.37	59.86	0.82	1.93	29.62	118.56
369	70.54	60.61	0.86	-1.59	25.24	119.02
370	70.70	70.17	0.80	-0.92	22.99	119.36
371	70.87	78.00	0.86	-1.19	21.29	119.87
372	71.03	78.88	0.97	-1.02	21.67	120.78
373	71.19	77.47	1.12	0.01	23.53	121.73
374	71.36	74.28	1.29	1.19	25.22	122.39
375	71.52	74.20	1.31	2.72	26.55	122.73
376	71.69	72.19	1.32	16.44	27.85	122.87
377	71.85	67.72	1.41	17.73	31.01	123.23
378	72.01	59.49	1.62	19.40	35.50	123.47
379	72.18	52.30	1.63	19.41	35.55	122.97
380	72.34	63.20	1.14	8.33	31.21	121.77
381	72.51	69.51	0.89	-2.11	25.77	120.24
382	72.67	68.83	0.85	-3.69	24.60	119.79
383	72.83	66.57	0.95	-3.00	25.97	120.29
384	73.00	65.85	1.10	-1.91	27.53	121.04

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
385	73.16	66.86	1.18	-0.52	28.72	121.45
386	73.33	63.79	1.15	1.44	29.26	121.41
387	73.49	62.73	1.10	3.50	29.61	121.27
388	73.66	63.89	1.13	5.43	28.29	121.17
389	73.82	70.43	1.07	7.33	25.06	121.52
390	73.98	87.06	1.13	5.87	21.81	122.19
391	74.15	97.39	1.28	2.00	20.37	123.10
392	74.31	96.55	1.40	3.20	20.53	123.76
393	74.47	95.18	1.45	4.73	21.46	124.16
394	74.64	94.13	1.53	6.32	22.69	124.55
395	74.80	90.56	1.68	8.03	26.25	124.39
396	74.97	63.26	1.54	17.18	32.41	123.02
397	75.13	40.49	1.05	15.34	42.38	120.61
398	75.30	32.20	0.87	29.32	49.96	118.20
399	75.46	30.10	0.81	35.90	54.35	117.56
400	75.62	29.09	0.92	45.07	55.42	118.99
401	75.79	36.40	1.38	59.59	44.83	121.95
402	75.95	72.36	1.83	24.69	36.80	124.61
403	76.11	80.88	2.13	-0.10	27.91	126.18
404	76.28	108.07	1.99	-3.96	24.58	126.79
405	76.44	110.09	2.06	-5.32	24.29	127.18
406	76.61	90.42	2.41	-5.67	29.48	127.36
407	76.77	66.34	2.48	-5.89	36.77	127.04
408	76.94	60.05	2.24	-5.75	44.06	126.45
409	77.10	51.38	2.30	-5.08	43.02	125.68
410	77.26	63.81	1.81	-3.80	36.10	124.99
411	77.43	83.52	1.43	-3.99	27.99	124.07
412	77.59	88.61	1.38	-4.31	26.73	124.51
413	77.76	78.55	2.00	-4.02	32.05	124.78
414	77.92	51.80	1.84	-3.19	40.30	125.46
415	78.08	54.85	2.21	-0.30	44.25	124.82
416	78.25	57.42	1.72	-0.46	40.21	124.08
417	78.41	61.09	1.19	-1.89	32.31	122.06
418	78.58	72.07	0.85	-3.10	27.37	120.85
419	78.74	73.52	1.07	-3.38	25.90	121.06
420	78.90	72.82	1.22	16.46	27.33	121.93
421	79.07	72.03	1.25	16.33	28.15	122.31
422	79.23	72.61	1.26	15.11	28.43	122.45
423	79.40	72.86	1.29	14.94	28.72	122.55
424	79.56	71.57	1.31	16.21	28.81	122.55
425	79.72	72.28	1.26	16.95	27.82	122.23
426	79.89	75.82	1.10	16.17	26.98	121.42
427	80.05	68.76	0.94	12.45	26.95	120.11
428	80.22	59.56	0.78	13.06	27.97	118.82
429	80.38	58.51	0.72	15.31	28.02	118.01
430	80.55	61.98	0.71	17.84	26.21	117.35
431	80.71	64.27	0.57	19.62	23.32	116.58
432	80.87	69.74	0.48	11.94	21.33	115.87

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
433	81.04	69.72	0.53	9.52	20.83	115.76
434	81.20	67.16	0.54	11.26	21.83	115.80
435	81.36	63.17	0.51	12.46	22.56	115.36
436	81.53	61.46	0.46	15.75	21.92	114.83
437	81.69	67.36	0.43	15.18	19.52	114.54
438	81.86	78.19	0.42	9.11	18.84	115.72
439	82.02	77.59	0.65	6.41	19.52	116.54
440	82.19	69.56	0.60	8.82	20.76	117.21
441	82.35	74.73	0.59	8.49	21.25	117.75
442	82.51	79.25	0.78	2.36	19.74	118.89
443	82.68	94.54	0.86	-0.16	17.24	119.51
444	82.84	107.54	0.69	-3.92	16.39	120.41
445	83.00	101.54	1.02	-5.29	17.54	121.95
446	83.17	103.02	1.43	-5.04	20.19	124.80
447	83.33	121.12	2.12	-5.30	21.46	127.39
448	83.50	132.65	2.77	-5.97	19.34	127.80
449	83.66	139.64	1.59	-6.25	15.77	126.57
450	83.83	151.42	0.98	-5.36	13.67	125.37
451	83.99	145.28	1.92	-4.33	15.89	126.16
452	84.15	116.73	2.19	7.87	21.26	127.20
453	84.32	95.52	2.06	23.71	22.64	125.59
454	84.48	101.85	0.92	11.86	22.36	124.73
455	84.65	106.27	1.66	-1.56	12.92	125.06
456	84.81	238.39	1.69	7.47	5.03	127.81
457	84.97	462.91	1.75	28.59	1.43	128.82

Abbreviations

Depth:	Depth from free surface, at which CPT was performed (ft)
q_c:	Measured cone resistance (tsf)
f_s:	Sleeve friction resistance (tsf)
u:	Pore pressure (tsf)
Fines content:	Percentage of fines in soil (%)
Unit weight:	Bulk soil unit weight (pcf)

:: Strength loss calculation Idriss & Boulanger (2008) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/σ'_v$	$S_{u(peak)}/σ'_v$
10.17	32.45	47.03	1.00	47.03	1.99	0.07	0.70
10.34	32.65	47.18	1.00	47.18	2.00	0.08	0.71
10.50	31.64	45.77	1.00	45.77	2.02	0.08	0.71
10.66	27.64	40.32	1.39	56.09	2.08	0.08	0.71
10.83	23.35	34.42	1.51	51.98	2.15	0.07	0.70
10.99	18.86	28.17	1.73	48.77	2.24	0.07	0.70
11.15	15.77	23.71	1.98	46.90	2.31	0.07	0.69
11.32	13.04	19.73	2.31	45.59	2.39	0.07	0.68
11.48	11.33	17.16	2.60	44.68	2.44	0.07	0.68
11.65	10.10	15.26	2.92	44.54	2.49	0.07	0.68
11.81	9.22	13.83	3.22	44.60	2.53	0.07	0.67
11.97	8.65	12.90	3.45	44.48	2.56	0.07	0.67
12.14	8.41	12.51	3.49	43.71	2.57	0.07	0.67
12.30	8.33	12.36	3.48	43.05	2.57	0.07	0.67
12.47	8.22	12.17	3.49	42.53	2.57	0.07	0.67
12.63	8.17	12.08	3.51	42.41	2.57	0.07	0.67
12.79	8.06	11.87	3.54	42.05	2.57	0.07	0.67
12.96	7.97	11.69	3.57	41.73	2.58	0.07	0.67
13.12	7.58	11.07	3.75	41.51	2.60	0.07	0.67
13.29	7.20	10.46	3.94	41.24	2.62	0.07	0.67
13.45	6.78	9.79	4.20	41.17	2.65	0.07	0.67
13.62	6.47	9.28	4.46	41.40	2.68	0.07	0.66
13.78	6.20	8.84	4.75	42.01	2.70	0.07	0.66
13.94	6.17	8.78	4.85	42.61	2.71	0.07	0.66
14.11	6.52	9.31	4.65	43.29	2.69	0.07	0.66
14.27	7.23	10.33	4.29	44.35	2.66	0.07	0.67
14.44	8.33	11.88	3.83	45.51	2.61	0.07	0.67
14.60	9.81	13.94	3.31	46.13	2.55	0.07	0.67
14.76	12.03	16.94	2.71	45.90	2.46	0.07	0.68
14.93	15.03	20.88	2.15	44.98	2.36	0.07	0.69
15.09	17.07	23.49	1.94	45.51	2.30	0.07	0.70
15.26	17.76	24.35	1.91	46.46	2.30	0.07	0.69
15.42	17.31	23.69	1.98	46.85	2.31	0.07	0.69
15.58	20.83	28.07	1.00	28.07	2.22	0.07	0.68
15.75	28.85	37.99	1.00	37.99	2.08	0.07	0.70
15.91	37.10	48.12	1.00	48.12	1.99	0.08	0.72
16.08	41.59	53.54	1.00	53.54	1.96	0.08	0.71
16.24	41.31	53.08	1.00	53.08	1.97	0.08	0.72
16.40	40.26	51.59	1.00	51.59	1.98	0.08	0.71
16.57	39.76	50.79	1.00	50.79	1.98	0.08	0.71
16.73	40.05	50.98	1.00	50.98	1.98	0.08	0.71
16.90	42.45	53.68	1.00	53.68	1.96	0.08	0.71
17.06	44.12	55.53	1.00	55.53	1.95	0.08	0.72
17.22	45.52	56.98	1.00	56.98	1.94	0.08	0.71
17.39	44.80	55.95	1.00	55.95	1.95	0.08	0.72
17.55	44.02	54.85	1.00	54.85	1.96	0.08	0.71
17.72	42.77	53.21	1.29	68.44	1.97	0.08	0.72
17.88	41.18	51.16	1.30	66.56	1.99	0.08	0.72

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.05	39.57	49.08	1.31	64.50	2.01	0.08	0.72
18.21	39.41	48.66	1.00	48.66	2.00	0.08	0.71
18.37	41.18	50.49	1.00	50.49	1.98	0.08	0.71
18.54	43.21	52.61	1.00	52.61	1.95	0.08	0.71
18.70	43.77	53.13	1.00	53.13	1.95	0.08	0.71
18.86	41.27	50.51	1.34	67.54	2.03	0.08	0.73
19.03	32.78	41.01	1.70	69.64	2.23	0.09	0.74
19.19	22.55	28.85	2.91	83.83	2.49	0.08	0.70
19.36	13.29	17.23	6.00	103.32	2.81	0.08	0.69
19.52	9.55	12.14	8.62	104.62	2.99	0.08	0.68
19.68	8.24	10.22	9.68	98.98	3.05	0.08	0.73
19.85	7.31	8.84	10.08	89.09	3.07	0.08	0.63
20.01	6.52	7.70	10.14	78.02	3.08	0.07	0.55
20.18	5.53	6.26	11.20	70.11	3.13	0.07	0.45
20.34	5.06	5.58	11.97	66.84	3.17	0.07	0.40
20.50	5.04	5.52	11.82	65.24	3.16	0.07	0.39
20.67	5.17	5.66	11.46	64.89	3.14	0.07	0.40
20.83	5.29	5.80	11.02	63.87	3.12	0.07	0.41
21.00	5.39	5.90	10.73	63.33	3.11	0.07	0.42
21.16	5.46	5.96	10.48	62.41	3.09	0.07	0.43
21.32	5.56	6.07	10.15	61.60	3.08	0.07	0.43
21.49	5.62	6.11	10.23	62.52	3.08	0.07	0.44
21.65	5.65	6.12	10.45	64.00	3.09	0.07	0.44
21.82	5.56	5.96	10.81	64.40	3.11	0.07	0.43
21.98	5.41	5.73	10.88	62.26	3.11	0.07	0.41
22.15	5.23	5.46	11.03	60.27	3.12	0.07	0.39
22.31	5.15	5.33	11.12	59.24	3.13	0.07	0.38
22.47	5.13	5.27	11.39	59.98	3.14	0.07	0.38
22.64	5.20	5.33	11.84	63.10	3.16	0.07	0.38
22.80	5.42	5.59	11.94	66.70	3.16	0.07	0.40
22.97	5.54	5.71	12.17	69.45	3.17	0.07	0.41
23.13	5.55	5.70	12.02	68.45	3.17	0.07	0.41
23.29	5.50	5.60	12.00	67.19	3.17	0.07	0.40
23.46	5.68	5.80	11.46	66.41	3.14	0.07	0.41
23.62	5.96	6.13	11.11	68.05	3.12	0.07	0.44
23.79	6.14	6.32	10.86	68.67	3.11	0.07	0.45
23.95	6.22	6.38	10.57	67.47	3.10	0.07	0.46
24.11	6.13	6.24	10.31	64.37	3.08	0.07	0.45
24.28	6.01	6.05	10.23	61.92	3.08	0.07	0.43
24.44	5.80	5.75	10.74	61.81	3.11	0.07	0.41
24.61	5.67	5.57	11.20	62.37	3.13	0.07	0.40
24.77	5.75	5.63	11.15	62.82	3.13	0.07	0.40
24.93	5.86	5.74	10.83	62.24	3.11	0.07	0.41
25.10	6.00	5.88	10.56	62.10	3.10	0.07	0.42
25.26	5.94	5.78	11.22	64.89	3.13	0.07	0.41
25.43	6.42	6.34	10.58	67.11	3.10	0.07	0.45
25.59	6.49	6.39	10.77	68.86	3.11	0.07	0.46
25.75	6.51	6.38	10.36	66.11	3.09	0.07	0.46

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
25.92	6.03	5.76	11.36	65.50	3.14	0.07	0.41
26.08	6.09	5.81	10.77	62.58	3.11	0.07	0.42
26.25	6.55	6.33	10.11	63.99	3.07	0.07	0.45
26.41	7.12	6.99	9.17	64.14	3.02	0.07	0.50
26.57	8.03	8.06	8.73	70.32	3.00	0.08	0.67
26.74	9.15	9.35	7.95	74.39	2.95	0.08	0.68
26.90	9.66	9.91	8.12	80.49	2.96	0.08	0.68
27.07	9.27	9.39	8.70	81.75	3.00	0.08	0.68
27.23	8.61	8.56	9.45	80.92	3.04	0.08	0.61
27.39	9.30	9.34	8.15	76.14	2.96	0.08	0.67
27.56	10.21	10.35	7.14	73.88	2.90	0.08	0.68
27.72	10.54	10.68	7.09	75.76	2.89	0.08	0.68
27.89	10.79	10.93	7.67	83.86	2.93	0.08	0.68
28.05	11.81	12.06	7.66	92.34	2.93	0.08	0.68
28.21	14.96	15.51	5.89	91.35	2.80	0.08	0.69
28.38	17.29	17.95	4.67	83.83	2.70	0.09	0.70
28.54	17.40	17.99	4.69	84.36	2.70	0.08	0.70
28.71	15.87	16.27	5.45	88.70	2.77	0.08	0.69
28.87	13.15	13.27	7.33	97.33	2.91	0.08	0.69
29.04	11.44	11.27	8.40	94.69	2.98	0.08	0.68
29.20	9.43	8.95	9.62	86.09	3.05	0.08	0.64
29.36	8.75	8.15	9.58	78.06	3.05	0.08	0.58
29.53	9.23	8.64	8.13	70.21	2.96	0.08	0.67
29.69	10.76	10.27	6.44	66.11	2.85	0.08	0.68
29.86	11.54	11.05	5.73	63.32	2.79	0.08	0.68
30.02	12.04	11.57	6.03	69.74	2.81	0.08	0.68
30.18	11.98	11.50	7.20	82.85	2.90	0.08	0.68
30.35	12.65	12.17	7.10	86.43	2.89	0.08	0.69
30.51	12.42	11.87	7.11	84.38	2.89	0.08	0.69
30.68	11.68	11.01	7.23	79.59	2.90	0.08	0.68
30.84	10.82	10.03	7.80	78.24	2.94	0.08	0.68
31.00	10.54	9.68	7.94	76.92	2.95	0.08	0.68
31.17	10.15	9.21	8.35	76.98	2.97	0.08	0.68
31.33	9.44	8.41	9.39	78.95	3.03	0.08	0.60
31.50	8.71	7.59	10.12	76.78	3.07	0.08	0.54
31.66	8.63	7.47	9.64	71.98	3.05	0.08	0.53
31.82	8.82	7.64	8.98	68.55	3.01	0.08	0.55
31.99	9.68	8.51	8.27	70.45	2.97	0.08	0.67
32.15	15.08	14.04	4.64	65.17	2.69	0.07	0.67
32.32	20.91	19.89	2.99	59.44	2.50	0.09	0.71
32.48	23.32	22.31	3.02	67.30	2.51	0.09	0.71
32.64	19.00	17.91	4.53	81.11	2.68	0.08	0.70
32.81	13.22	11.97	7.72	92.41	2.93	0.08	0.68
32.97	10.17	8.76	9.85	86.36	3.06	0.08	0.63
33.14	8.93	7.45	10.75	80.10	3.11	0.08	0.53
33.30	8.82	7.30	10.64	77.70	3.10	0.08	0.52
33.47	8.65	7.10	10.84	76.94	3.11	0.08	0.51
33.63	8.41	6.81	11.25	76.64	3.13	0.08	0.49

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
33.79	8.20	6.58	11.69	76.85	3.15	0.07	0.47
33.96	8.12	6.46	11.83	76.40	3.16	0.07	0.46
34.12	8.08	6.39	11.83	75.57	3.16	0.07	0.46
34.28	7.93	6.21	11.83	73.45	3.16	0.07	0.44
34.45	7.57	5.82	12.09	70.32	3.17	0.07	0.42
34.61	7.31	5.53	12.16	67.33	3.17	0.07	0.40
34.78	7.49	5.69	11.67	66.38	3.15	0.07	0.41
34.94	7.91	6.08	11.30	68.66	3.13	0.07	0.43
35.10	8.65	6.78	10.98	74.46	3.12	0.07	0.48
35.27	9.79	7.88	10.19	80.24	3.08	0.08	0.56
35.43	10.19	8.23	10.33	84.98	3.09	0.08	0.59
35.60	9.97	7.97	10.63	84.75	3.10	0.08	0.57
35.76	8.74	6.74	12.03	81.08	3.17	0.08	0.48
35.92	8.03	6.02	12.62	76.04	3.20	0.07	0.43
36.09	8.18	6.14	12.46	76.47	3.19	0.07	0.44
36.25	8.88	6.79	11.79	79.98	3.16	0.08	0.48
36.42	10.48	8.29	9.04	74.94	3.01	0.08	0.59
36.58	13.74	11.38	5.65	64.24	2.78	0.08	0.68
36.74	15.01	12.54	4.32	54.16	2.66	0.08	0.70
36.91	14.77	12.27	4.71	57.83	2.70	0.08	0.68
37.07	11.57	9.20	6.67	61.33	2.86	0.08	0.68
37.24	10.01	7.68	8.29	63.70	2.97	0.08	0.67
37.40	9.14	6.83	9.04	61.73	3.02	0.08	0.49
37.57	9.18	6.84	9.19	62.85	3.02	0.08	0.49
37.73	9.65	7.25	8.95	64.90	3.01	0.08	0.52
37.89	10.36	7.89	8.43	66.46	2.98	0.08	0.68
38.06	10.66	8.13	8.05	65.46	2.96	0.08	0.68
38.22	10.46	7.91	8.00	63.26	2.95	0.08	0.67
38.39	10.28	7.71	8.06	62.17	2.96	0.08	0.67
38.55	10.47	7.86	8.09	63.61	2.96	0.08	0.67
38.71	11.24	8.54	7.67	65.50	2.93	0.08	0.68
38.88	12.27	9.46	7.18	67.86	2.90	0.08	0.68
39.04	14.11	11.10	6.95	77.19	2.88	0.08	0.68
39.21	16.70	13.42	6.85	91.94	2.88	0.08	0.69
39.37	20.78	17.08	5.99	102.33	2.81	0.09	0.70
39.53	23.48	19.47	5.52	107.43	2.77	0.09	0.71
39.70	26.51	22.15	4.77	105.67	2.71	0.09	0.71
39.86	27.86	23.29	4.62	107.49	2.69	0.09	0.72
40.03	29.88	25.02	4.33	108.25	2.66	0.09	0.72
40.19	30.06	25.07	4.46	111.94	2.68	0.10	0.72
40.35	29.69	24.64	4.62	113.80	2.69	0.09	0.72
40.52	29.32	24.20	4.73	114.41	2.70	0.09	0.72
40.68	29.79	24.53	4.55	111.70	2.69	0.09	0.72
40.85	30.20	24.80	4.43	109.95	2.67	0.10	0.73
41.01	28.42	23.11	4.84	111.91	2.71	0.09	0.72
41.17	25.38	20.31	5.54	112.51	2.77	0.09	0.71
41.34	23.37	18.46	5.95	109.89	2.81	0.09	0.70
41.50	23.98	18.93	5.70	107.90	2.79	0.09	0.71

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
41.67	24.71	19.50	5.42	105.72	2.76	0.09	0.71
41.83	24.06	18.85	5.53	104.31	2.77	0.09	0.71
41.99	22.75	17.65	5.65	99.66	2.78	0.09	0.70
42.16	23.07	17.86	5.66	101.03	2.78	0.09	0.70
42.32	24.00	18.55	6.14	113.83	2.82	0.09	0.71
42.49	24.12	18.53	6.66	123.46	2.86	0.09	0.71
42.65	23.81	18.19	6.92	125.90	2.88	0.09	0.71
42.81	23.10	17.53	6.58	115.41	2.86	0.09	0.71
42.98	23.73	18.03	5.85	105.46	2.80	0.09	0.70
43.14	23.71	17.95	5.83	104.65	2.80	0.09	0.71
43.31	23.86	18.00	5.90	106.11	2.80	0.09	0.71
43.47	23.40	17.52	6.19	108.39	2.83	0.09	0.71
43.63	22.79	16.96	6.04	102.45	2.81	0.09	0.71
43.80	22.09	16.33	5.95	97.15	2.81	0.09	0.70
43.96	21.55	15.82	5.88	92.98	2.80	0.09	0.70
44.13	20.42	14.80	6.51	96.40	2.85	0.09	0.70
44.29	19.24	13.77	7.07	97.28	2.89	0.08	0.70
44.45	17.97	12.69	7.53	95.62	2.92	0.08	0.69
44.62	17.32	12.11	7.60	92.01	2.93	0.08	0.69
44.78	16.90	11.73	7.80	91.49	2.94	0.08	0.69
44.95	16.69	11.52	7.65	88.15	2.93	0.08	0.69
45.11	16.25	11.12	7.65	85.10	2.93	0.08	0.69
45.28	16.20	11.04	7.44	82.09	2.92	0.08	0.69
45.44	15.91	10.77	7.85	84.58	2.94	0.08	0.69
45.60	15.94	10.75	8.57	92.11	2.99	0.08	0.69
45.77	16.12	10.85	9.08	98.54	3.02	0.08	0.77
45.93	16.34	10.98	8.92	98.01	3.01	0.08	0.78
46.10	15.91	10.60	8.36	88.69	2.97	0.08	0.69
46.26	15.29	10.08	8.00	80.60	2.95	0.08	0.68
46.42	14.75	9.63	8.19	78.88	2.96	0.08	0.68
46.59	14.90	9.71	8.25	80.04	2.97	0.08	0.69
46.75	15.16	9.87	8.11	80.06	2.96	0.08	0.68
46.92	15.78	10.31	7.79	80.31	2.94	0.08	0.69
47.08	16.77	11.04	7.29	80.51	2.91	0.08	0.69
47.24	17.83	11.82	7.01	82.84	2.89	0.08	0.69
47.41	17.78	11.73	7.28	85.48	2.91	0.08	0.69
47.57	17.84	11.74	7.89	92.59	2.95	0.08	0.69
47.74	19.93	13.28	7.29	96.84	2.91	0.08	0.69
47.90	25.57	17.70	5.05	89.35	2.73	0.09	0.71
48.06	32.35	23.25	3.09	71.73	2.52	0.09	0.72
48.23	36.82	26.98	2.23	60.06	2.37	0.09	0.72
48.39	37.98	27.90	2.08	57.95	2.34	0.09	0.72
48.56	37.98	27.72	2.25	62.40	2.38	0.09	0.72
48.72	35.90	25.86	2.63	68.13	2.45	0.09	0.73
48.88	30.89	21.57	3.93	84.79	2.62	0.09	0.72
49.05	23.56	15.62	6.32	98.78	2.84	0.09	0.70
49.21	18.30	11.65	8.70	101.30	2.99	0.08	0.69
49.38	15.70	9.69	9.05	87.69	3.02	0.08	0.69

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
49.54	15.21	9.29	8.20	76.19	2.96	0.08	0.68
49.70	14.94	9.06	8.36	75.78	2.97	0.08	0.68
49.87	15.40	9.37	8.85	82.86	3.00	0.08	0.67
50.03	18.84	11.85	7.71	91.39	2.93	0.08	0.68
50.20	29.24	19.75	4.24	83.74	2.65	0.08	0.70
50.36	41.83	29.70	2.47	73.39	2.42	0.10	0.74
50.52	50.45	36.66	1.83	67.10	2.27	0.10	0.75
50.69	52.87	38.55	1.72	66.30	2.24	0.09	0.74
50.85	53.18	38.66	1.74	67.34	2.25	0.10	0.75
51.02	54.04	39.21	1.75	68.45	2.25	0.10	0.75
51.18	54.39	39.37	1.75	68.85	2.25	0.10	0.75
51.34	54.89	39.39	1.95	76.91	2.31	0.10	0.75
51.51	48.45	33.97	2.54	86.38	2.43	0.11	0.76
51.67	37.40	25.16	3.93	98.77	2.62	0.09	0.72
51.84	25.87	16.37	6.09	99.74	2.82	0.08	0.70
52.00	21.01	12.86	7.23	92.93	2.90	0.09	0.70
52.16	20.00	12.10	8.05	97.40	2.96	0.08	0.69
52.33	19.41	11.65	8.93	104.07	3.01	0.08	0.83
52.49	20.08	12.07	8.88	107.24	3.01	0.08	0.86
52.66	20.88	12.59	8.18	102.94	2.96	0.09	0.70
52.82	22.38	13.59	7.44	101.12	2.92	0.09	0.70
52.99	34.69	22.46	4.49	100.76	2.68	0.08	0.70
53.15	69.59	49.65	1.63	80.68	2.20	0.10	0.75
53.31	94.30	69.56	1.31	90.83	2.00	0.17	0.83
53.48	97.07	72.01	1.26	91.03	1.94	0.12	0.77
53.64	71.72	50.90	1.60	81.40	2.19	0.11	0.76
53.81	51.06	34.34	2.76	94.81	2.47	0.10	0.75
53.97	38.13	24.36	4.60	112.07	2.69	0.10	0.73
54.13	29.66	18.11	6.75	122.19	2.87	0.09	0.71
54.30	29.33	17.82	6.46	115.20	2.85	0.09	0.70
54.46	36.04	22.79	4.26	97.07	2.66	0.09	0.72
54.63	43.93	28.89	2.66	76.85	2.45	0.10	0.74
54.79	44.01	28.86	2.67	77.19	2.45	0.10	0.74
54.95	35.43	22.29	3.87	86.34	2.61	0.09	0.72
55.12	27.89	16.60	6.08	101.01	2.82	0.08	0.70
55.28	29.74	17.76	6.15	109.29	2.82	0.09	0.70
55.45	40.35	24.81	5.74	142.31	2.79	0.10	0.74
55.61	49.45	30.80	5.52	170.14	2.77	0.12	0.76
55.77	68.32	44.08	3.91	172.57	2.62	0.11	0.76
55.94	92.12	61.71	2.43	149.88	2.41	0.17	0.83
56.10	122.88	84.89	1.69	143.46	2.23	0.22	0.85
56.27	133.32	92.48	1.60	147.79	2.19	0.29	0.88
56.43	133.77	92.65	1.58	146.19	2.18	0.22	0.85
56.59	126.09	87.31	1.52	132.73	2.16	0.21	0.85
56.76	122.60	85.86	1.37	117.20	2.06	0.17	0.83
56.92	117.31	82.61	1.30	107.80	2.00	0.15	0.81
57.09	109.00	76.49	1.30	99.45	1.99	0.14	0.80
57.25	95.07	65.53	1.37	90.09	2.07	0.13	0.79

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
57.41	77.73	52.26	1.54	80.34	2.17	0.11	0.77
57.58	62.18	40.68	1.79	72.68	2.26	0.10	0.75
57.74	52.74	33.64	2.12	71.29	2.35	0.10	0.74
57.91	45.42	27.94	2.97	83.11	2.50	0.10	0.74
58.07	35.25	20.61	4.40	90.67	2.67	0.10	0.73
58.23	23.63	12.82	7.26	93.01	2.90	0.08	0.69
58.40	15.82	7.92	9.40	74.42	3.04	0.08	0.57
58.56	14.18	6.87	10.70	73.57	3.10	0.08	0.49
58.73	21.19	11.20	6.85	76.76	2.88	0.08	0.68
58.89	32.72	18.87	3.97	74.87	2.62	0.09	0.72
59.05	42.02	25.20	3.04	76.66	2.51	0.10	0.74
59.22	39.99	23.45	3.77	88.46	2.60	0.10	0.73
59.38	30.75	16.96	5.84	98.99	2.80	0.09	0.71
59.55	27.30	14.76	6.55	96.70	2.85	0.08	0.69
59.71	27.38	14.77	5.98	88.33	2.81	0.09	0.72
59.88	27.31	14.71	5.86	86.20	2.80	0.09	0.71
60.04	24.68	13.03	6.70	87.31	2.86	0.08	0.69
60.20	29.52	16.15	5.03	81.15	2.73	0.08	0.70
60.37	38.38	22.18	3.38	74.92	2.55	0.10	0.73
60.53	46.93	27.99	2.67	74.60	2.45	0.10	0.74
60.70	49.67	29.76	2.55	75.98	2.43	0.10	0.74
60.86	52.27	31.55	2.34	73.98	2.39	0.10	0.74
61.02	55.23	33.67	2.11	71.16	2.35	0.10	0.75
61.19	57.49	35.25	1.98	69.62	2.31	0.10	0.75
61.35	58.39	35.79	1.95	69.74	2.31	0.10	0.75
61.52	57.78	35.21	2.01	70.90	2.32	0.10	0.75
61.68	56.97	34.48	2.09	72.15	2.34	0.10	0.75
61.84	55.99	33.59	2.23	74.87	2.37	0.10	0.75
62.01	54.72	32.54	2.36	76.65	2.40	0.10	0.75
62.17	53.76	31.76	2.44	77.44	2.41	0.10	0.75
62.34	53.42	31.42	2.48	78.04	2.42	0.10	0.74
62.50	54.26	31.87	2.47	78.79	2.42	0.10	0.75
62.66	54.45	31.76	2.62	83.07	2.44	0.11	0.75
62.83	49.61	28.19	3.23	91.08	2.54	0.11	0.75
62.99	38.21	20.46	4.94	101.11	2.72	0.10	0.73
63.16	26.28	13.21	7.66	101.17	2.93	0.08	0.69
63.32	18.11	8.47	10.49	88.77	3.09	0.08	0.60
63.48	15.25	6.80	11.09	75.41	3.12	0.08	0.49
63.65	23.10	11.28	6.20	69.95	2.83	0.07	0.67
63.81	39.19	21.56	3.14	67.68	2.52	0.09	0.72
63.98	60.72	36.04	1.89	68.00	2.29	0.10	0.75
64.14	73.74	44.80	1.64	73.60	2.21	0.11	0.77
64.30	80.63	49.21	1.61	79.24	2.20	0.12	0.78
64.47	82.93	50.39	1.65	83.27	2.21	0.12	0.78
64.63	83.79	50.68	1.69	85.52	2.23	0.12	0.79
64.80	81.81	49.09	1.76	86.27	2.25	0.12	0.78
64.96	76.96	45.55	1.90	86.62	2.29	0.12	0.78
65.13	71.93	41.96	2.08	87.16	2.34	0.11	0.77

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
65.29	68.00	39.25	2.19	85.87	2.36	0.11	0.77
65.45	65.98	37.84	2.25	84.99	2.37	0.11	0.76
65.62	57.42	32.01	2.71	86.64	2.46	0.11	0.76
65.78	43.45	22.86	3.99	91.17	2.63	0.10	0.73
65.94	28.00	13.50	6.76	91.24	2.87	0.08	0.70
66.11	19.82	8.96	9.89	88.56	3.06	0.08	0.64
66.27	25.01	11.79	7.07	83.35	2.89	0.08	0.68
66.44	38.83	19.96	4.09	81.69	2.64	0.09	0.72
66.60	53.39	29.25	2.64	77.33	2.45	0.11	0.75
66.77	60.34	33.65	2.34	78.63	2.39	0.11	0.75
66.93	59.69	33.01	2.46	81.28	2.42	0.11	0.75
67.09	55.54	30.05	2.88	86.50	2.49	0.11	0.75
67.26	47.52	24.71	3.80	93.97	2.61	0.10	0.74
67.42	37.46	18.45	5.15	94.99	2.74	0.09	0.72
67.58	30.75	14.60	6.36	92.82	2.84	0.09	0.70
67.75	30.10	14.22	6.21	88.35	2.83	0.09	0.70
67.91	41.03	20.59	4.31	88.67	2.66	0.09	0.71
68.08	50.67	26.42	3.39	89.61	2.56	0.11	0.76
68.24	56.43	29.96	2.96	88.60	2.50	0.11	0.75
68.41	51.64	26.95	3.23	86.95	2.53	0.10	0.74
68.57	45.85	23.21	3.89	90.40	2.62	0.10	0.73
68.73	39.97	19.39	5.15	99.90	2.74	0.10	0.73
68.90	38.17	18.20	5.68	103.44	2.79	0.09	0.71
69.06	39.16	18.75	5.40	101.16	2.76	0.10	0.73
69.23	39.62	19.14	4.87	93.25	2.72	0.10	0.73
69.39	37.99	18.19	4.96	90.25	2.72	0.09	0.72
69.55	34.50	16.09	5.58	89.79	2.78	0.09	0.72
69.72	32.77	15.14	5.91	89.48	2.80	0.09	0.71
69.88	30.86	14.10	6.71	94.67	2.87	0.09	0.71
70.05	34.24	15.82	5.78	91.41	2.79	0.09	0.70
70.21	44.05	21.62	3.96	85.65	2.62	0.10	0.73
70.37	54.43	28.05	2.82	79.05	2.48	0.11	0.75
70.54	63.55	33.85	2.23	75.39	2.37	0.10	0.75
70.70	69.59	37.69	1.97	74.35	2.31	0.11	0.76
70.87	75.68	41.53	1.81	74.99	2.27	0.11	0.77
71.03	78.12	42.74	1.84	78.68	2.28	0.12	0.77
71.19	76.88	41.44	2.03	84.16	2.33	0.12	0.77
71.36	75.32	40.05	2.23	89.12	2.37	0.12	0.77
71.52	73.56	38.66	2.39	92.47	2.40	0.12	0.77
71.69	71.37	37.07	2.56	95.07	2.43	0.12	0.77
71.85	66.47	33.70	3.03	102.10	2.51	0.12	0.77
72.01	59.84	29.38	3.78	111.00	2.60	0.11	0.76
72.18	58.33	28.50	3.79	107.93	2.60	0.10	0.74
72.34	61.67	30.85	3.06	94.39	2.51	0.11	0.76
72.51	67.18	34.78	2.29	79.72	2.38	0.11	0.76
72.67	68.30	35.57	2.15	76.54	2.35	0.11	0.76
72.83	67.08	34.52	2.32	80.00	2.39	0.11	0.76
73.00	66.43	33.77	2.52	85.13	2.43	0.11	0.76

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
73.16	65.50	32.94	2.69	88.55	2.46	0.11	0.76
73.33	64.46	32.21	2.77	89.08	2.47	0.11	0.76
73.49	63.47	31.54	2.82	88.83	2.48	0.11	0.76
73.66	65.68	32.88	2.63	86.38	2.45	0.11	0.76
73.82	73.79	37.87	2.21	83.53	2.37	0.11	0.76
73.98	84.96	44.78	1.85	83.05	2.28	0.12	0.78
74.15	93.67	49.99	1.72	86.16	2.24	0.13	0.80
74.31	96.37	51.33	1.74	89.19	2.24	0.13	0.80
74.47	95.29	50.28	1.82	91.55	2.27	0.13	0.80
74.64	93.29	48.65	1.94	94.48	2.30	0.14	0.80
74.80	82.65	41.76	2.35	98.28	2.40	0.14	0.80
74.97	64.77	31.02	3.25	100.87	2.54	0.11	0.76
75.13	45.32	19.98	5.09	101.75	2.74	0.09	0.72
75.30	34.26	14.50	6.73	97.63	2.87	0.09	0.71
75.46	30.46	12.64	7.77	98.14	2.94	0.09	0.71
75.62	31.86	13.28	8.02	106.53	2.95	0.09	0.70
75.79	45.95	19.97	5.60	111.90	2.78	0.09	0.72
75.95	63.21	29.10	4.01	116.73	2.63	0.13	0.78
76.11	87.10	42.86	2.57	110.28	2.44	0.13	0.78
76.28	99.68	50.33	2.15	108.20	2.35	0.16	0.82
76.44	102.86	51.99	2.12	110.01	2.35	0.16	0.82
76.61	88.95	43.07	2.80	120.47	2.47	0.14	0.80
76.77	72.27	33.11	4.01	132.67	2.63	0.12	0.76
76.94	59.26	25.84	5.44	140.58	2.77	0.12	0.76
77.10	58.41	25.41	5.22	132.75	2.75	0.11	0.74
77.26	66.24	30.05	3.88	116.71	2.62	0.11	0.76
77.43	78.65	37.71	2.58	97.46	2.44	0.13	0.79
77.59	83.56	40.46	2.41	97.70	2.41	0.13	0.79
77.76	72.99	33.83	3.19	108.02	2.53	0.13	0.78
77.92	61.73	26.97	4.68	126.11	2.70	0.10	0.74
78.08	54.69	23.27	5.48	127.54	2.77	0.11	0.75
78.25	57.79	25.00	4.66	116.44	2.70	0.11	0.75
78.41	63.53	28.84	3.24	93.32	2.54	0.11	0.75
78.58	68.89	32.38	2.50	80.95	2.42	0.11	0.77
78.74	72.80	34.60	2.31	79.91	2.39	0.11	0.77
78.90	72.79	34.19	2.49	85.29	2.42	0.11	0.77
79.07	72.49	33.77	2.61	88.04	2.44	0.11	0.77
79.23	72.50	33.62	2.65	88.95	2.45	0.12	0.77
79.40	72.35	33.40	2.69	89.78	2.46	0.12	0.77
79.56	72.24	33.25	2.70	89.78	2.46	0.12	0.77
79.72	73.22	33.90	2.56	86.83	2.43	0.11	0.77
79.89	72.29	33.56	2.45	82.13	2.41	0.12	0.77
80.05	68.05	31.40	2.44	76.73	2.41	0.11	0.76
80.22	62.28	28.29	2.58	73.05	2.44	0.10	0.74
80.38	60.02	27.12	2.59	70.20	2.44	0.10	0.74
80.55	61.59	28.18	2.35	66.15	2.40	0.10	0.75
80.71	65.33	30.60	2.01	61.45	2.32	0.10	0.74
80.87	67.91	32.33	1.81	58.48	2.27	0.10	0.75

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
81.04	68.87	32.89	1.76	58.00	2.25	0.10	0.75
81.20	66.68	31.46	1.86	58.40	2.28	0.10	0.75
81.36	63.93	29.84	1.93	57.54	2.30	0.10	0.74
81.53	64.00	29.96	1.86	55.87	2.28	0.09	0.74
81.69	69.00	33.07	1.65	54.70	2.22	0.09	0.74
81.86	74.38	35.97	1.60	57.65	2.20	0.10	0.76
82.02	75.11	36.07	1.65	59.66	2.22	0.10	0.76
82.19	73.96	35.05	1.76	61.60	2.25	0.10	0.75
82.35	74.51	35.12	1.80	63.27	2.27	0.10	0.76
82.51	82.84	39.72	1.67	66.39	2.22	0.10	0.76
82.68	93.78	46.20	1.50	69.14	2.15	0.11	0.77
82.84	101.21	50.36	1.45	72.94	2.12	0.13	0.79
83.00	104.03	51.18	1.51	77.51	2.16	0.12	0.79
83.17	108.56	52.15	1.71	89.09	2.24	0.13	0.80
83.33	118.93	56.62	1.82	103.10	2.27	0.17	0.82
83.50	131.14	63.67	1.64	104.44	2.21	0.18	0.83
83.66	141.24	70.95	1.42	100.52	2.10	0.17	0.83
83.83	145.45	74.60	1.33	99.26	2.03	0.18	0.83
83.99	137.81	68.81	1.42	97.91	2.10	0.19	0.84
84.15	119.18	56.23	1.80	101.33	2.27	0.16	0.82
84.32	104.70	48.46	1.94	93.83	2.30	0.13	0.79
84.48	101.21	46.77	1.91	89.28	2.30	0.14	0.80
84.65	148.84	76.31	1.31	99.68	2.00	0.11	0.76
84.81	269.19	156.00	1.00	156.00	1.64	0.40	0.85
84.97	388.07	243.53	1.00	243.53	1.39	0.96	1.02

Abbreviations

q_t: Total cone resistance
K_c: Cone resistance correction factor due to fines
$Q_{tn,cs}$: Adjusted and corrected cone resistance due to fines
I_c: Soil behavior type index
$S_{u(liq)}/\sigma'_v$: Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$: Calculated peak undrained strength ratio

Sage Geotechnical

Olympia, WA
www.sagegeotechnical.com

LIQUEFACTION ANALYSIS REPORT

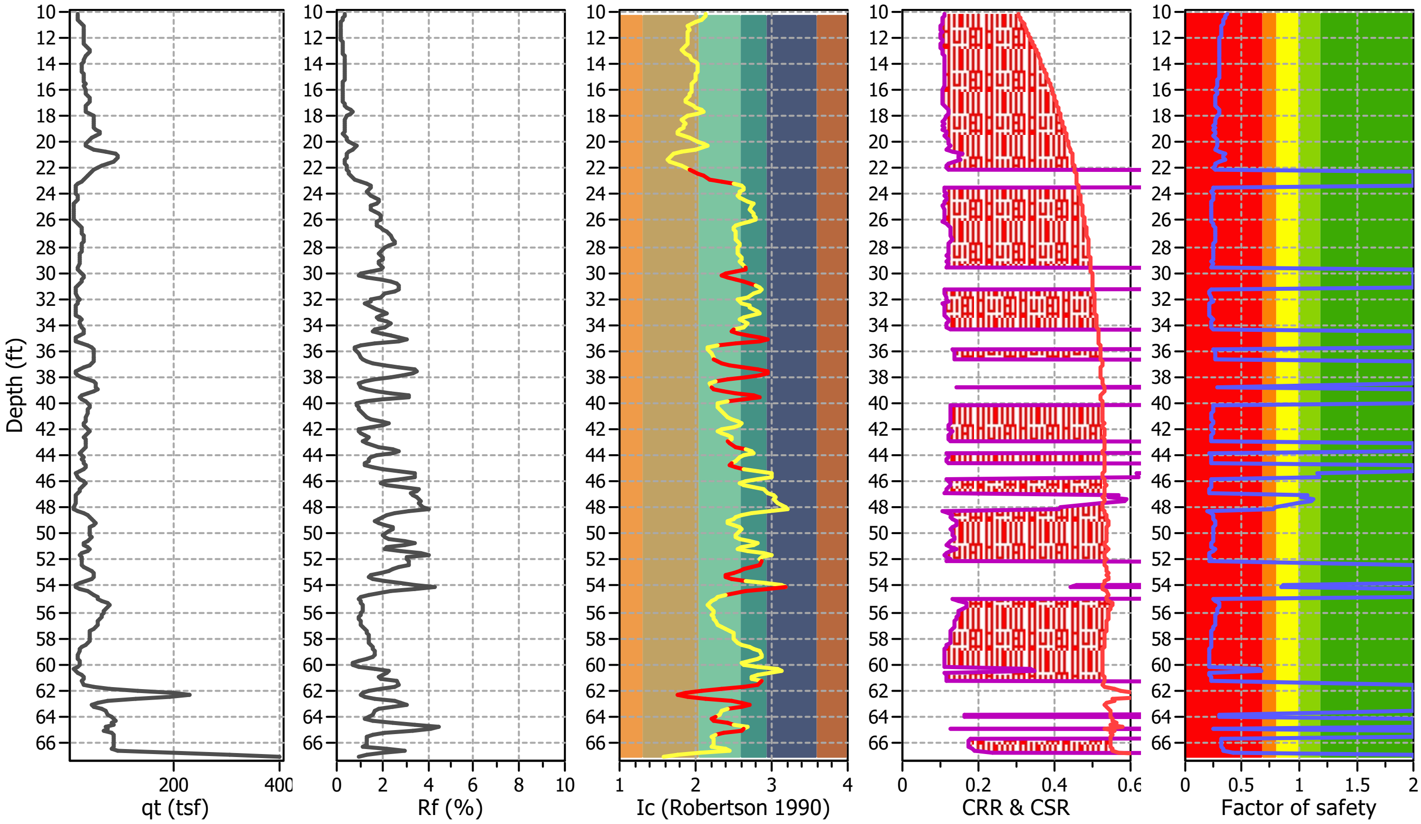
Project title : Kinder Morgan Willbridge Terminal SVA **Location : Portland, Oregon**

CPT file : CPT-04

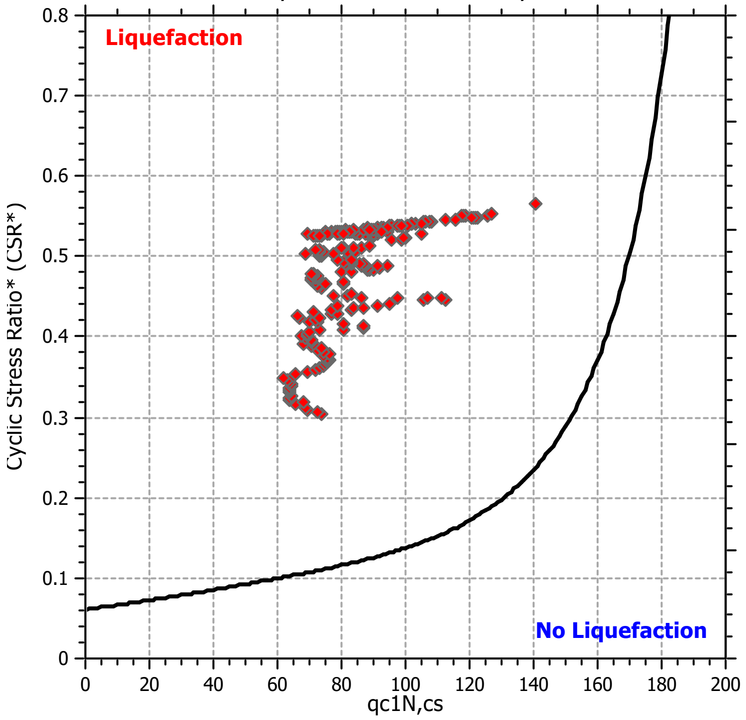
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	10.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	10.00 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:	7.84	Ic cut-off value:	3.00	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.49	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

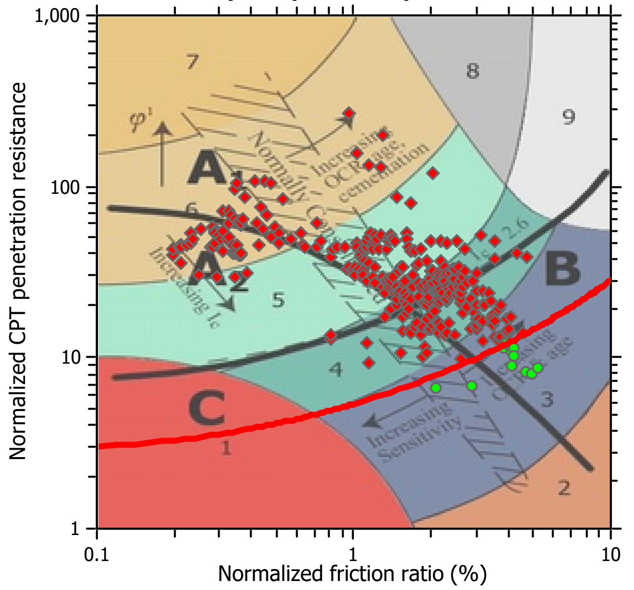
Cone resistance **Friction Ratio** **SBTn Plot** **CRR plot** **FS Plot**



$M_w=7^{1/2}$, $\sigma_v'=1$ atm base curve, PL=16%

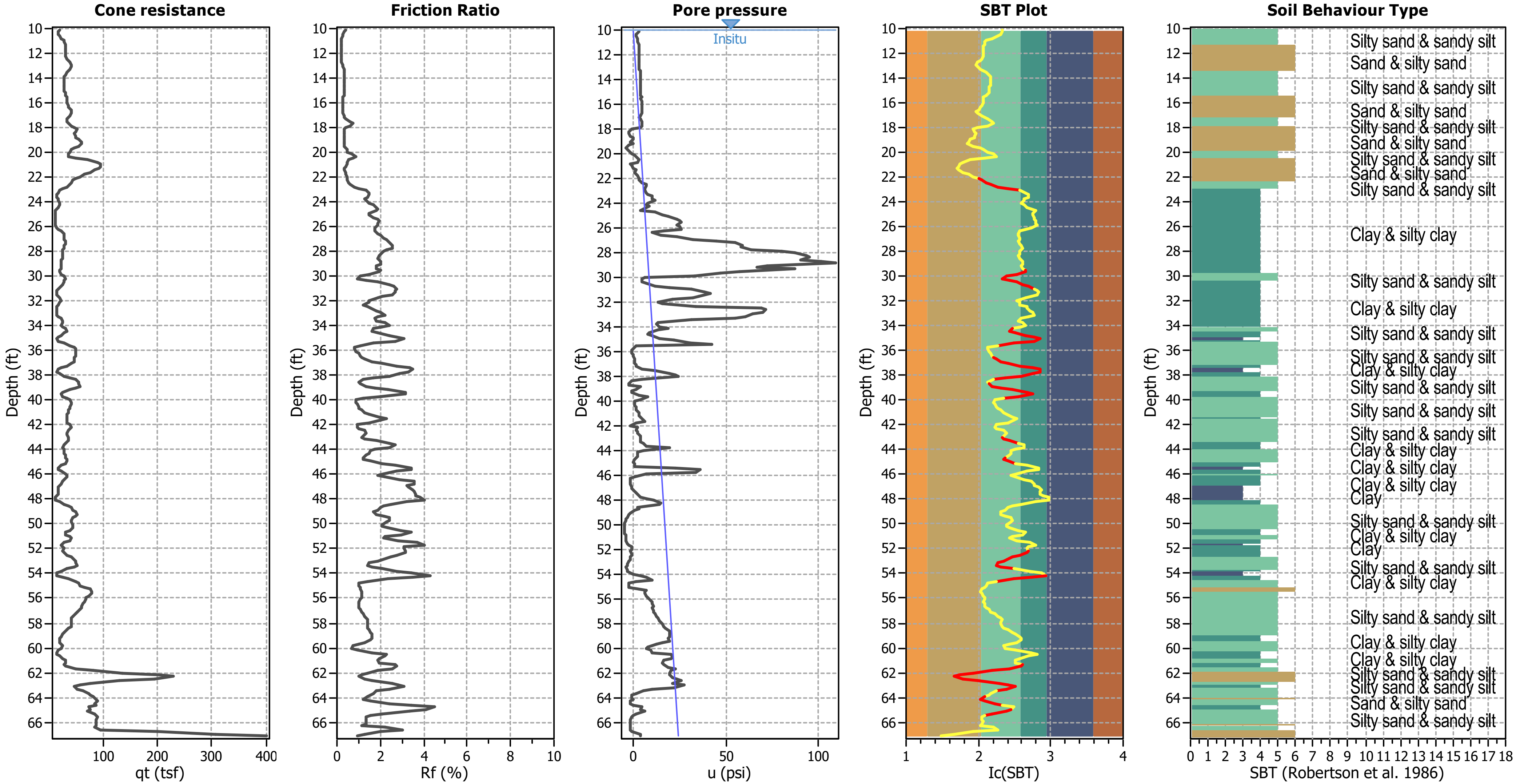


Summary of liquefaction potential



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



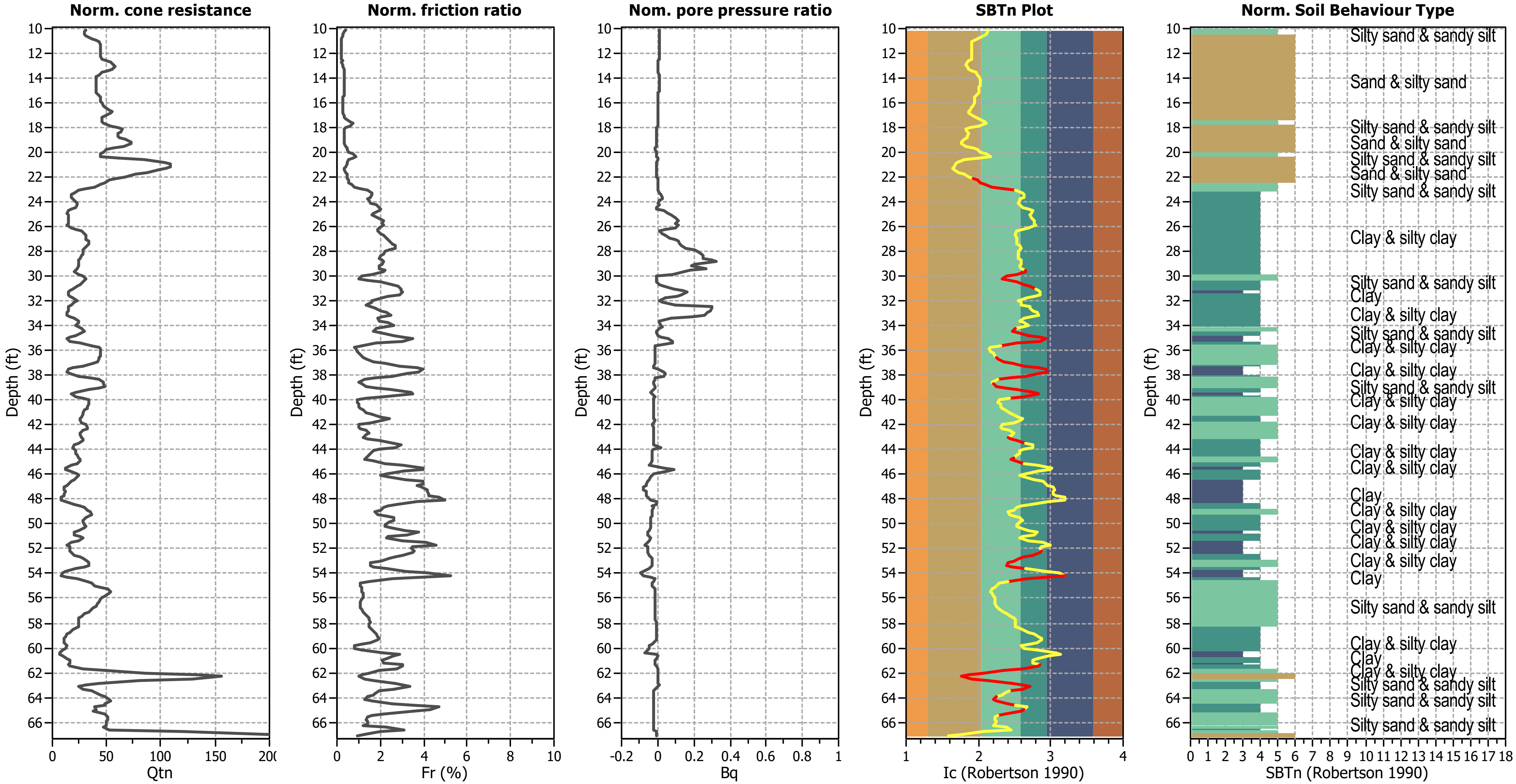
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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)



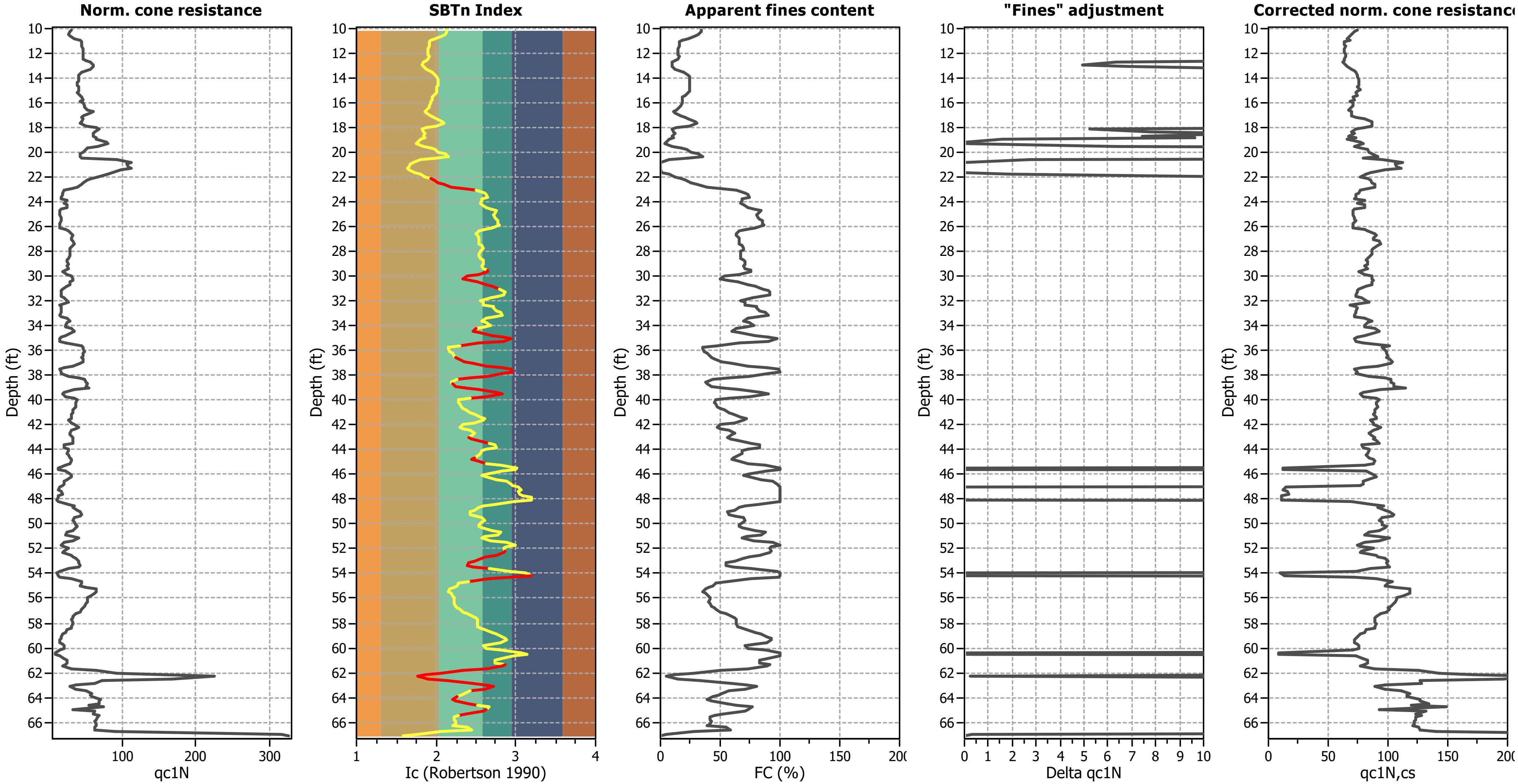
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	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

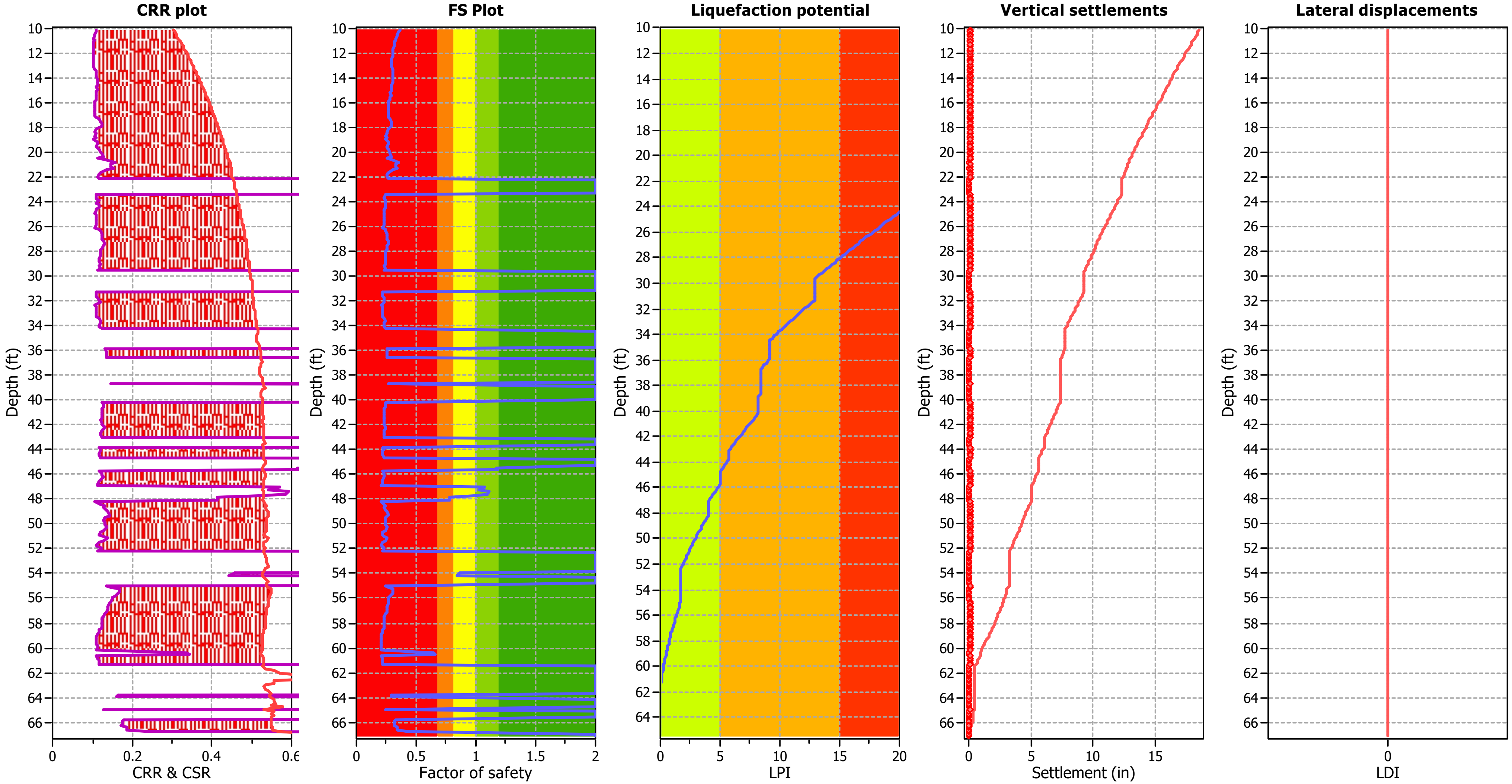
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 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.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

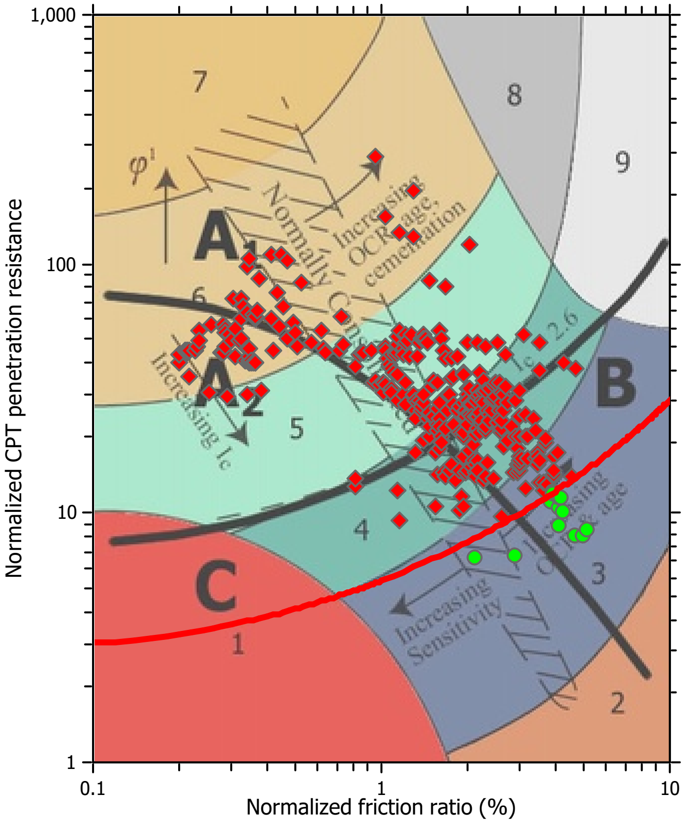
F.S. color scheme

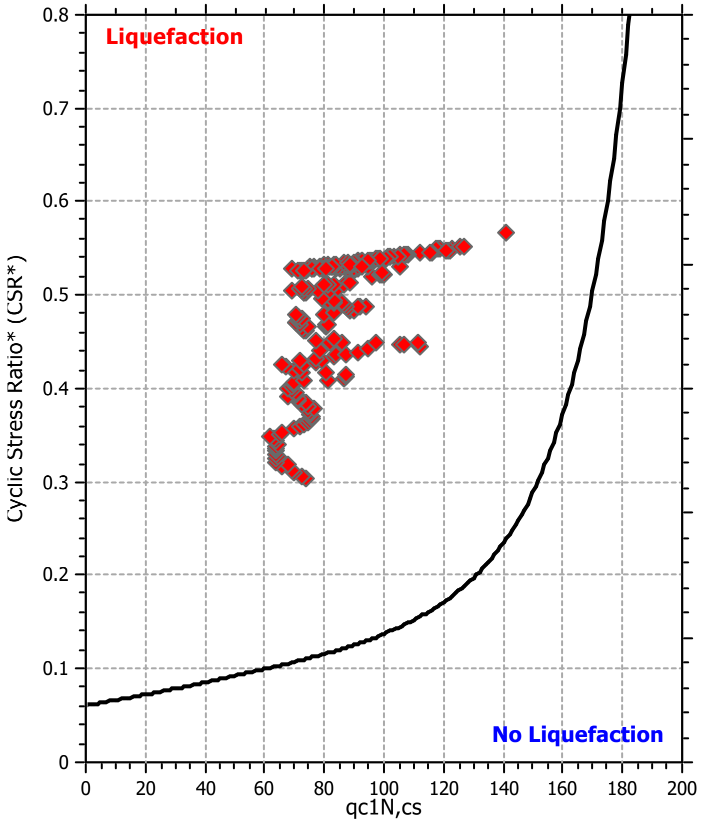
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

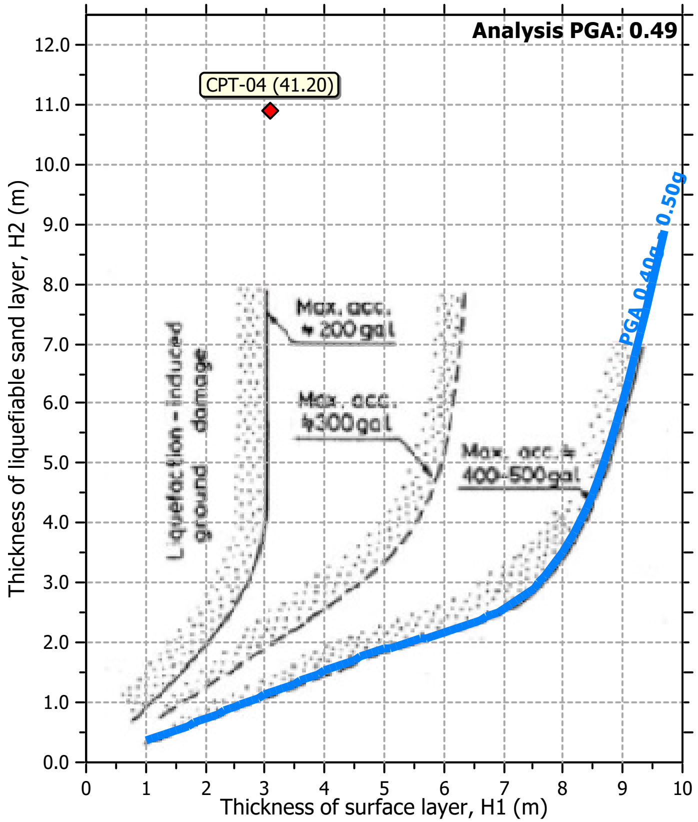
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



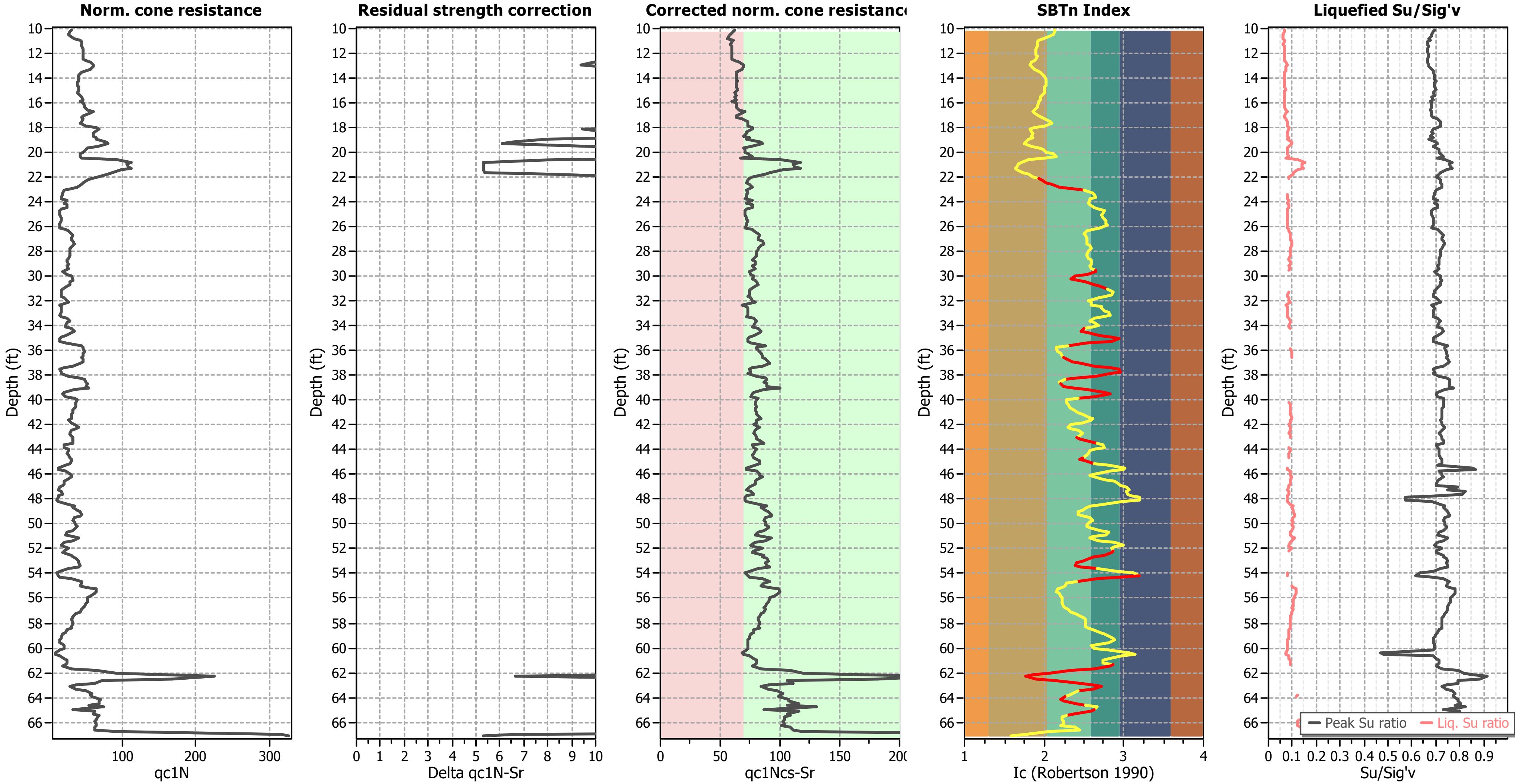




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 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:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

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



Input parameters and analysis data

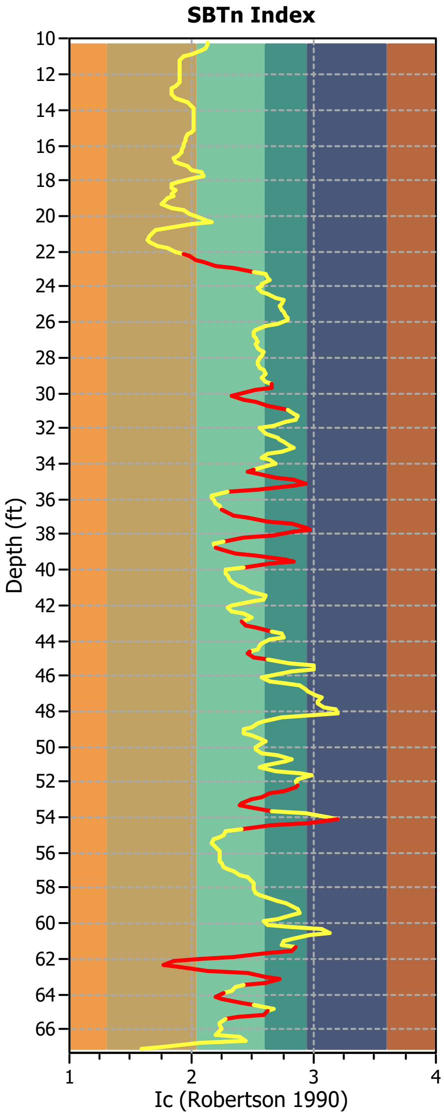
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	3.00	K_σ applied:	Yes
Earthquake magnitude M_w:	7.84	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.49	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.00 ft	Fill height:	N/A	Limit depth:	N/A

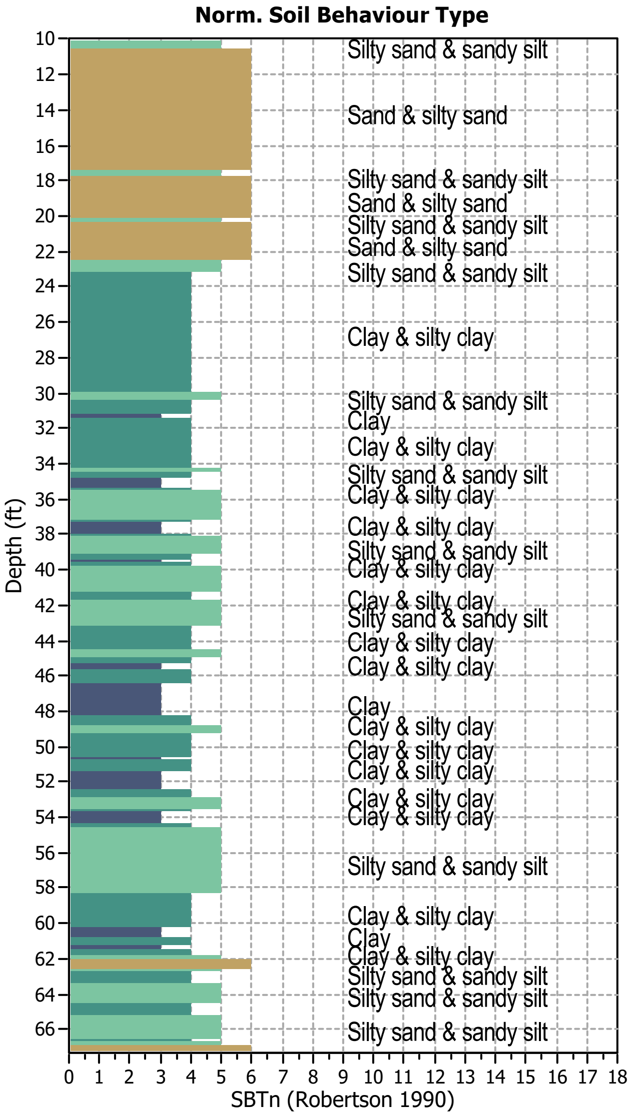
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	348
I_c maximum check value:	3.00	Total points excluded:	96
I_c change ratio value:	0.0250	Exclusion percentage:	27.59%
Minimum number of points in layer:	4	Number of layers detected:	19

Transition layer No	Number of points	Depth	SBT_n number	SBT_n description
Transition layer 1	7	Start depth: 22.31 (ft)	6	Sand & silty sand
		End depth: 23.29 (ft)	4	Clay & silty clay
Transition layer 2	4	Start depth: 29.69 (ft)	4	Clay & silty clay
		End depth: 30.18 (ft)	5	Silty sand & sandy silt
Transition layer 3	7	Start depth: 30.18 (ft)	5	Silty sand & sandy silt
		End depth: 31.17 (ft)	4	Clay & silty clay
Transition layer 4	5	Start depth: 34.45 (ft)	5	Silty sand & sandy silt
		End depth: 35.10 (ft)	3	Clay
Transition layer 5	5	Start depth: 35.10 (ft)	3	Clay
		End depth: 35.76 (ft)	5	Silty sand & sandy silt
Transition layer 6	6	Start depth: 36.74 (ft)	5	Silty sand & sandy silt
		End depth: 37.57 (ft)	3	Clay
Transition layer 7	6	Start depth: 37.73 (ft)	3	Clay
		End depth: 38.55 (ft)	5	Silty sand & sandy silt
Transition layer 8	5	Start depth: 38.88 (ft)	5	Silty sand & sandy silt
		End depth: 39.53 (ft)	3	Clay
Transition layer 9	4	Start depth: 39.53 (ft)	3	Clay
		End depth: 40.03 (ft)	5	Silty sand & sandy silt
Transition layer 10	4	Start depth: 43.14 (ft)	5	Silty sand & sandy silt
		End depth: 43.63 (ft)	4	Clay & silty clay
Transition layer 11	4	Start depth: 44.78 (ft)	5	Silty sand & sandy silt
		End depth: 45.28 (ft)	4	Clay & silty clay
Transition layer 12	6	Start depth: 52.33 (ft)	3	Clay
		End depth: 53.15 (ft)	5	Silty sand & sandy silt
Transition layer 13	4	Start depth: 53.31 (ft)	5	Silty sand & sandy silt
		End depth: 53.81 (ft)	3	Clay
Transition layer 14	4	Start depth: 54.30 (ft)	3	Clay
		End depth: 54.79 (ft)	5	Silty sand & sandy silt
Transition layer 15	6	Start depth: 61.52 (ft)	4	Clay & silty clay
		End depth: 62.34 (ft)	6	Sand & silty sand
Transition layer 16	6	Start depth: 62.34 (ft)	6	Sand & silty sand
		End depth: 63.16 (ft)	4	Clay & silty clay
Transition layer 17	4	Start depth: 63.16 (ft)	4	Clay & silty clay
		End depth: 63.65 (ft)	5	Silty sand & sandy silt
Transition layer 18	5	Start depth: 64.14 (ft)	5	Silty sand & sandy silt
		End depth: 64.80 (ft)	4	Clay & silty clay
Transition layer 19	4	Start depth: 65.13 (ft)	4	Clay & silty clay
		End depth: 65.62 (ft)	5	Silty sand & sandy silt

Start depth: Depth where the transition layer begins
End depth: Depth where the transition layer ends

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	10.17	20.26	0.08	3.03	5.00	98.55
2	10.34	19.50	0.06	2.03	5.00	97.48
3	10.50	18.45	0.05	1.81	5.00	96.23
4	10.66	19.78	0.05	2.46	5.00	95.68
5	10.83	22.89	0.05	2.75	5.00	96.19
6	10.99	29.76	0.05	2.90	5.00	97.02
7	11.15	30.55	0.06	3.05	5.00	97.89
8	11.32	30.28	0.06	3.12	5.00	98.41
9	11.48	30.95	0.07	3.17	5.00	98.58
10	11.65	31.63	0.06	3.21	5.00	98.66
11	11.81	31.86	0.07	3.28	5.00	98.90
12	11.97	31.98	0.07	3.32	5.00	98.93
13	12.14	32.01	0.06	3.38	5.00	98.94
14	12.30	31.77	0.07	3.44	5.00	99.39
15	12.47	32.57	0.08	3.54	5.00	99.90
16	12.63	35.39	0.08	3.59	5.00	100.76
17	12.79	39.52	0.09	3.61	5.00	101.62
18	12.96	43.04	0.11	3.64	5.00	102.88
19	13.12	42.50	0.12	3.71	5.00	103.72
20	13.29	40.96	0.12	3.76	5.00	103.89
21	13.45	36.97	0.12	3.82	5.00	103.47
22	13.62	32.62	0.11	3.89	5.00	102.73
23	13.78	30.09	0.10	3.97	5.00	102.12
24	13.94	29.25	0.10	4.02	5.00	101.89
25	14.11	29.30	0.10	4.08	5.00	101.97
26	14.27	29.63	0.11	4.12	5.00	102.02
27	14.44	29.27	0.10	4.20	5.00	101.94
28	14.60	29.40	0.10	4.28	5.00	101.83
29	14.76	29.62	0.10	4.36	5.00	101.87
30	14.93	31.15	0.10	4.38	5.00	101.94
31	15.09	29.79	0.10	4.40	5.00	101.85
32	15.26	29.27	0.10	4.47	5.00	101.82
33	15.42	32.72	0.10	4.57	5.00	101.64
34	15.58	33.99	0.09	4.46	5.00	101.54
35	15.75	34.58	0.09	4.60	5.00	101.32
36	15.91	32.33	0.09	4.95	5.00	101.42
37	16.08	34.85	0.09	4.96	5.00	101.74
38	16.24	36.69	0.10	4.80	5.00	102.29
39	16.40	37.09	0.11	4.76	5.00	103.17
40	16.57	40.49	0.13	4.98	5.00	103.83
41	16.73	45.99	0.12	5.11	5.00	104.15
42	16.90	44.18	0.12	4.30	5.00	103.88
43	17.06	36.71	0.12	3.48	5.00	103.70
44	17.22	34.33	0.12	4.46	5.00	103.63
45	17.39	36.43	0.12	4.90	5.00	104.90
46	17.55	35.20	0.19	4.91	15.14	107.78
47	17.72	34.34	0.34	4.96	15.76	109.31
48	17.88	40.39	0.27	4.01	13.34	109.43

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	18.05	51.66	0.17	-0.32	5.00	108.00
50	18.21	54.51	0.17	-2.21	5.00	107.19
51	18.37	49.98	0.19	-2.23	5.00	107.29
52	18.54	48.78	0.18	-1.59	5.00	106.98
53	18.70	48.29	0.16	-0.15	5.00	106.34
54	18.86	51.84	0.15	0.33	5.00	107.37
55	19.03	52.36	0.24	-1.06	5.00	107.68
56	19.19	63.70	0.16	0.21	5.00	108.30
57	19.36	65.61	0.18	-2.47	5.00	107.95
58	19.52	53.81	0.21	-3.56	5.00	108.21
59	19.68	43.93	0.20	-2.78	5.00	107.91
60	19.85	41.71	0.19	-1.75	5.00	107.24
61	20.01	38.31	0.18	-0.36	13.73	107.09
62	20.18	35.07	0.21	1.13	16.26	109.00
63	20.34	35.92	0.37	2.22	17.67	110.29
64	20.50	37.38	0.33	3.47	12.92	112.38
65	20.67	79.52	0.38	2.28	8.35	113.52
66	20.83	98.75	0.42	-1.16	5.00	114.95
67	21.00	92.58	0.48	-0.59	5.00	115.10
68	21.16	94.04	0.38	0.32	5.00	114.44
69	21.32	98.53	0.31	1.44	5.01	112.99
70	21.49	85.75	0.27	0.95	5.00	112.17
71	21.65	75.02	0.30	1.49	5.00	111.67
72	21.82	69.53	0.28	2.23	5.00	111.43
73	21.98	56.80	0.28	3.03	5.00	110.52
74	22.15	50.51	0.23	3.67	5.00	109.62
75	22.31	46.23	0.23	4.52	12.33	108.79
76	22.47	41.53	0.23	6.97	13.84	108.80
77	22.64	39.33	0.25	6.96	15.59	108.69
78	22.80	34.58	0.24	6.85	18.87	108.94
79	22.97	25.96	0.29	6.63	24.30	108.75
80	23.13	18.65	0.29	6.95	31.00	108.27
81	23.29	16.75	0.25	8.26	35.54	107.16
82	23.46	15.49	0.22	10.16	36.85	106.33
83	23.62	15.09	0.22	10.61	37.23	105.74
84	23.79	15.17	0.21	11.89	34.06	106.14
85	23.95	20.95	0.23	8.39	34.00	106.99
86	24.11	17.26	0.30	6.92	32.87	108.55
87	24.28	21.23	0.35	9.15	34.34	109.48
88	24.44	20.99	0.35	5.38	36.37	109.54
89	24.61	14.13	0.32	4.42	39.95	108.10
90	24.77	12.77	0.21	11.88	43.71	106.00
91	24.93	12.78	0.17	15.94	42.14	104.47
92	25.10	13.20	0.19	19.29	41.49	104.72
93	25.26	13.96	0.23	23.98	42.46	105.99
94	25.43	14.09	0.28	25.11	43.19	106.92
95	25.59	14.23	0.28	26.30	44.51	107.12
96	25.75	13.08	0.26	23.48	44.79	106.64

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	25.92	13.05	0.23	25.38	45.55	106.41
98	26.08	13.18	0.26	25.82	40.38	107.57
99	26.25	21.02	0.33	17.04	36.01	109.63
100	26.41	24.43	0.43	10.05	31.97	112.02
101	26.57	28.73	0.55	15.26	31.01	113.66
102	26.74	29.83	0.60	23.40	31.19	114.61
103	26.90	28.15	0.62	32.60	32.12	115.00
104	27.07	28.17	0.65	44.52	32.37	115.46
105	27.23	31.38	0.71	54.75	31.96	116.19
106	27.39	32.87	0.79	58.99	32.37	116.82
107	27.56	30.23	0.83	57.93	33.68	116.66
108	27.72	27.25	0.69	64.06	34.72	115.92
109	27.89	27.06	0.61	80.33	34.28	114.88
110	28.05	27.10	0.57	87.00	33.26	114.29
111	28.21	27.44	0.55	93.75	32.70	113.88
112	28.38	26.97	0.52	95.36	32.72	113.26
113	28.54	24.80	0.45	90.09	33.32	112.48
114	28.71	23.30	0.42	101.63	34.55	112.42
115	28.87	24.26	0.53	109.13	35.31	112.76
116	29.04	24.59	0.52	71.93	35.16	112.57
117	29.20	23.08	0.38	67.08	34.26	112.10
118	29.36	24.69	0.43	86.94	35.31	111.60
119	29.53	20.92	0.45	57.48	37.96	111.64
120	29.69	18.49	0.42	47.29	38.04	111.23
121	29.86	23.46	0.37	33.41	32.04	110.54
122	30.02	30.51	0.29	6.78	25.98	109.75
123	30.18	31.54	0.26	4.74	23.78	109.82
124	30.35	31.05	0.35	5.10	27.25	111.95
125	30.51	28.24	0.60	7.02	31.86	114.08
126	30.68	27.63	0.69	11.97	36.63	114.96
127	30.84	23.39	0.62	20.06	40.60	114.27
128	31.00	18.09	0.51	31.61	45.08	112.71
129	31.17	16.06	0.43	38.30	48.17	111.28
130	31.33	16.03	0.40	41.99	49.62	110.74
131	31.50	15.41	0.44	35.63	49.11	110.39
132	31.66	15.95	0.37	32.50	44.31	109.79
133	31.82	20.22	0.27	21.12	39.30	110.71
134	31.99	24.94	0.52	13.52	33.14	110.47
135	32.15	26.69	0.28	15.95	34.93	109.66
136	32.32	14.27	0.19	33.93	35.34	106.64
137	32.48	16.31	0.22	69.36	41.09	106.07
138	32.64	17.46	0.26	71.68	41.51	107.30
139	32.81	16.40	0.30	70.06	43.53	108.25
140	32.97	15.98	0.33	64.08	46.59	108.71
141	33.14	15.07	0.34	60.29	48.04	109.13
142	33.30	15.84	0.36	55.32	42.32	109.59
143	33.47	23.92	0.34	31.78	36.56	111.20
144	33.63	28.84	0.50	13.19	34.39	112.81

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	33.79	25.99	0.59	12.59	37.09	114.20
146	33.96	23.44	0.64	14.68	39.75	114.12
147	34.12	23.41	0.52	18.79	36.29	113.78
148	34.28	31.84	0.47	13.38	31.08	113.64
149	34.45	35.77	0.53	8.93	29.20	114.26
150	34.61	32.01	0.61	8.19	32.81	114.57
151	34.78	23.00	0.59	10.10	40.26	113.99
152	34.94	17.21	0.53	14.06	48.53	112.27
153	35.10	14.66	0.37	22.49	54.34	111.87
154	35.27	15.90	0.58	30.59	48.50	112.25
155	35.43	24.54	0.54	42.77	32.39	113.44
156	35.60	47.41	0.39	1.50	22.62	113.14
157	35.76	48.20	0.38	0.14	17.69	112.80
158	35.92	49.29	0.40	-0.19	17.60	113.20
159	36.09	50.83	0.44	-0.23	18.11	113.93
160	36.25	50.13	0.50	-0.17	18.96	114.69
161	36.42	49.41	0.55	0.20	19.96	115.18
162	36.58	48.37	0.55	0.60	20.57	115.50
163	36.74	49.04	0.57	1.02	21.71	116.32
164	36.91	48.97	0.75	1.27	24.24	117.72
165	37.07	45.21	0.97	1.53	28.94	118.62
166	37.24	34.19	0.97	1.90	36.75	118.20
167	37.40	20.98	0.81	5.25	47.30	116.35
168	37.57	15.68	0.61	11.88	54.60	114.00
169	37.73	17.65	0.47	19.43	55.82	112.81
170	37.89	16.91	0.57	22.59	48.05	113.93
171	38.06	27.80	0.75	24.32	37.79	115.90
172	38.22	43.13	0.78	4.56	27.32	116.50
173	38.39	52.07	0.51	-0.22	21.11	116.13
174	38.55	55.63	0.52	-1.81	18.34	115.58
175	38.71	56.90	0.60	-2.42	18.99	116.45
176	38.88	54.81	0.71	3.76	20.37	118.04
177	39.04	59.67	0.95	2.16	24.94	119.02
178	39.21	37.98	1.02	-0.52	32.17	118.94
179	39.37	23.36	0.89	-0.29	43.88	117.28
180	39.53	20.83	0.68	3.65	48.19	115.46
181	39.70	24.12	0.58	8.39	37.20	113.91
182	39.86	37.71	0.37	4.35	27.32	112.76
183	40.03	43.07	0.34	1.32	21.97	111.88
184	40.19	41.20	0.38	0.79	21.72	112.23
185	40.35	41.02	0.41	1.12	22.48	112.55
186	40.52	41.46	0.40	1.57	22.99	112.59
187	40.68	39.26	0.39	2.01	23.83	112.53
188	40.85	37.25	0.42	2.46	25.56	112.82
189	41.01	36.16	0.46	3.06	27.53	113.37
190	41.17	34.95	0.50	3.73	29.56	114.31
191	41.34	35.22	0.62	4.44	32.83	115.97
192	41.50	34.45	0.88	5.34	35.86	116.78

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
193	41.67	30.56	0.77	6.16	34.71	115.90
194	41.83	34.22	0.37	2.07	30.16	113.87
195	41.99	38.20	0.37	-1.16	23.74	112.05
196	42.16	45.01	0.39	2.30	22.60	112.48
197	42.32	41.72	0.41	1.81	23.71	112.89
198	42.49	35.66	0.45	2.18	27.67	113.28
199	42.65	31.67	0.51	2.83	30.09	113.20
200	42.81	33.57	0.43	3.81	29.06	112.80
201	42.98	37.19	0.37	4.25	27.11	112.39
202	43.14	36.45	0.42	3.80	28.09	113.68
203	43.31	36.61	0.65	4.50	31.81	116.03
204	43.47	37.13	0.92	5.45	38.33	116.98
205	43.63	23.11	0.79	7.00	42.78	116.43
206	43.80	24.47	0.58	19.42	43.24	114.74
207	43.96	29.88	0.50	5.53	36.92	113.29
208	44.13	30.41	0.41	2.93	34.09	112.83
209	44.29	29.43	0.46	2.36	33.54	112.41
210	44.45	29.74	0.43	2.54	32.36	112.25
211	44.62	32.91	0.37	1.92	29.85	112.14
212	44.78	36.24	0.41	0.62	28.64	112.76
213	44.95	36.54	0.50	0.32	31.37	114.73
214	45.11	33.87	0.76	0.73	36.77	115.68
215	45.28	25.83	0.71	1.17	46.61	115.23
216	45.44	14.92	0.55	23.07	58.83	114.00
217	45.60	14.29	0.63	35.89	58.55	114.11
218	45.77	26.51	0.73	33.71	47.41	115.29
219	45.93	33.16	0.68	6.88	37.83	115.82
220	46.10	35.39	0.61	0.60	34.26	115.93
221	46.26	36.61	0.70	-1.05	37.12	116.58
222	46.42	28.73	0.90	-1.64	43.86	117.46
223	46.59	24.08	0.99	-1.61	51.23	117.39
224	46.75	23.23	0.81	-1.13	53.92	116.35
225	46.92	21.23	0.62	-0.82	55.17	114.66
226	47.08	17.43	0.56	-0.45	60.15	113.43
227	47.24	14.69	0.59	0.51	62.60	113.45
228	47.41	19.05	0.65	2.04	60.63	114.36
229	47.57	21.60	0.74	2.46	61.20	114.41
230	47.74	14.33	0.61	4.29	64.18	113.38
231	47.90	13.95	0.44	7.45	71.98	111.97
232	48.06	13.09	0.52	10.94	73.28	112.44
233	48.23	14.40	0.71	15.33	56.59	114.29
234	48.39	32.53	0.68	14.62	42.42	116.43
235	48.56	42.81	0.85	2.19	35.14	117.78
236	48.72	39.67	0.95	3.22	32.20	118.39
237	48.88	46.17	0.79	0.60	30.11	118.51
238	49.05	51.84	0.84	-1.64	27.17	118.72
239	49.21	54.48	0.94	-2.43	27.52	119.60
240	49.38	51.49	1.09	-2.93	30.51	120.22

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
241	49.54	42.95	1.15	-3.44	34.12	120.22
242	49.70	40.30	1.05	-3.81	35.43	119.58
243	49.87	42.91	0.88	-4.32	34.28	119.13
244	50.03	44.20	0.96	-4.35	32.08	118.93
245	50.20	47.13	0.92	-4.38	32.07	119.36
246	50.36	46.02	1.02	-4.50	34.05	119.65
247	50.52	39.01	1.12	-4.44	40.35	120.06
248	50.69	30.04	1.25	-4.16	46.70	119.46
249	50.85	27.76	0.94	-3.85	44.36	118.42
250	51.02	39.15	0.67	-3.87	35.95	118.04
251	51.18	49.87	0.94	-3.87	33.65	118.80
252	51.34	40.06	1.13	-3.71	39.70	119.74
253	51.51	26.00	1.16	-3.12	51.15	118.98
254	51.67	20.56	0.92	-2.20	57.80	117.63
255	51.84	24.54	0.77	-0.97	50.57	116.83
256	52.00	34.21	0.78	-0.72	49.06	117.24
257	52.16	24.92	1.02	-1.33	50.12	117.37
258	52.33	23.28	0.83	-0.46	49.09	117.62
259	52.49	37.21	0.84	-0.24	43.15	118.21
260	52.66	39.76	1.09	-1.20	37.15	119.43
261	52.82	46.14	1.11	-1.38	34.15	119.82
262	52.99	50.09	0.90	-2.18	30.27	119.29
263	53.15	51.61	0.80	-2.78	26.58	117.89
264	53.31	53.03	0.59	-3.19	26.13	117.86
265	53.48	52.36	0.88	-3.40	29.31	117.49
266	53.64	34.52	0.77	-3.24	38.29	116.88
267	53.81	19.87	0.60	-2.74	53.80	114.47
268	53.97	13.54	0.51	0.04	67.06	113.12
269	54.13	16.97	0.62	4.09	72.35	114.52
270	54.30	18.74	0.98	7.13	55.02	117.07
271	54.46	39.31	1.00	10.25	38.43	118.31
272	54.63	56.71	0.69	1.64	26.69	117.47
273	54.79	56.93	0.47	-1.82	21.97	116.21
274	54.95	55.81	0.60	-2.54	20.92	116.47
275	55.12	65.71	0.72	-2.45	19.77	118.18
276	55.28	80.64	0.85	7.37	18.27	119.51
277	55.45	82.48	0.92	6.33	17.68	120.25
278	55.61	80.15	0.93	6.46	18.44	120.22
279	55.77	73.33	0.87	7.01	19.37	119.67
280	55.94	68.19	0.78	8.14	19.94	118.93
281	56.10	67.96	0.73	9.24	19.92	118.27
282	56.27	67.30	0.69	10.06	19.75	117.81
283	56.43	65.28	0.65	10.46	19.99	117.31
284	56.59	61.80	0.61	10.82	20.66	116.90
285	56.76	59.20	0.61	10.70	21.39	116.67
286	56.92	58.62	0.62	10.90	22.47	116.66
287	57.09	55.05	0.63	11.24	24.00	116.46
288	57.25	49.02	0.60	11.83	26.33	116.03

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
289	57.41	43.96	0.57	12.66	28.71	115.56
290	57.58	41.77	0.57	13.57	30.50	115.34
291	57.74	41.00	0.58	14.63	31.15	115.35
292	57.91	41.88	0.58	15.33	31.17	115.43
293	58.07	42.30	0.59	16.05	31.12	115.41
294	58.23	41.24	0.58	16.51	31.47	115.29
295	58.40	40.16	0.56	17.28	33.56	114.77
296	58.56	32.87	0.51	19.69	36.07	113.97
297	58.73	30.38	0.45	19.81	40.51	112.81
298	58.89	25.14	0.41	19.50	44.01	111.75
299	59.05	22.69	0.38	19.96	47.89	110.78
300	59.22	21.37	0.35	19.23	50.13	109.99
301	59.38	19.91	0.32	19.51	50.59	109.35
302	59.55	20.58	0.30	15.83	47.03	108.43
303	59.71	24.03	0.22	12.83	40.55	107.34
304	59.88	26.95	0.18	7.88	35.11	105.84
305	60.04	26.63	0.16	7.61	36.41	105.16
306	60.20	19.77	0.18	9.26	46.69	105.11
307	60.37	11.49	0.22	10.69	63.41	106.36
308	60.53	12.63	0.32	20.27	67.87	108.92
309	60.70	20.77	0.47	21.45	56.65	111.68
310	60.86	27.49	0.54	20.88	47.16	113.67
311	61.02	32.28	0.58	16.76	42.98	114.58
312	61.19	32.16	0.61	15.80	42.82	114.93
313	61.35	29.41	0.61	16.84	49.53	116.65
314	61.52	26.11	1.11	18.86	47.49	117.78
315	61.68	41.22	0.91	23.00	36.35	121.66
316	61.84	83.72	1.83	20.95	24.15	124.21
317	62.01	119.92	1.91	19.77	14.90	127.04
318	62.17	201.75	2.05	19.66	9.37	129.15
319	62.34	279.24	2.82	21.16	7.59	129.74
320	62.50	210.43	2.14	24.06	10.46	129.76
321	62.66	97.35	2.45	25.69	16.69	127.65
322	62.83	82.48	1.78	21.41	29.19	125.84
323	62.99	50.41	1.70	27.59	35.70	123.72
324	63.16	39.67	1.41	22.43	41.58	122.34
325	63.32	49.72	1.24	10.66	35.45	121.64
326	63.48	67.24	1.15	5.83	27.78	121.69
327	63.65	77.50	1.17	1.50	24.57	122.20
328	63.81	76.13	1.34	-0.91	23.28	122.34
329	63.98	78.77	1.16	-0.66	20.90	122.02
330	64.14	93.83	0.93	0.06	18.94	121.68
331	64.30	90.83	1.12	-1.18	20.69	123.84
332	64.47	90.97	2.20	-1.45	27.01	126.42
333	64.63	74.81	2.88	-0.15	31.24	129.23
334	64.80	99.40	3.92	4.91	39.01	129.43
335	64.96	45.48	3.04	3.84	36.77	129.23
336	65.13	84.87	2.47	6.10	35.01	126.98

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
337	65.29	82.14	1.60	1.66	25.24	125.40
338	65.45	91.32	1.30	0.14	21.65	123.42
339	65.62	89.40	1.16	-0.71	19.79	122.55
340	65.78	88.73	1.12	-1.29	19.90	122.27
341	65.94	86.72	1.19	-1.67	20.39	122.46
342	66.11	87.53	1.27	-1.47	20.24	122.29
343	66.27	88.17	1.04	-1.21	19.16	121.29
344	66.44	84.66	0.75	-1.05	26.26	125.77
345	66.60	84.36	3.87	-1.29	28.44	129.22
346	66.77	122.20	4.08	-0.61	14.77	133.26
347	66.93	392.15	3.92	4.03	7.60	134.22
348	67.09	405.58	3.73	4.46	4.15	134.65

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_c: Measured cone resistance (tsf)
f_s: Sleeve friction resistance (tsf)
u: Pore pressure (tsf)
Fines content: Percentage of fines in soil (%)
Unit weight: Bulk soil unit weight (pcf)

:: Strength loss calculation Idriss & Boulanger (2008) ::

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.17	20.01	31.02	1.00	31.02	2.13	0.07	0.69
10.34	19.40	29.92	1.00	29.92	2.13	0.07	0.69
10.50	19.24	29.41	1.00	29.41	2.12	0.06	0.68
10.66	20.37	30.73	1.00	30.73	2.08	0.06	0.68
10.83	24.14	35.58	1.00	35.58	2.00	0.06	0.67
10.99	27.73	40.17	1.00	40.17	1.94	0.07	0.68
11.15	30.20	43.28	1.00	43.28	1.91	0.06	0.67
11.32	30.59	43.73	1.00	43.73	1.91	0.06	0.67
11.48	30.95	44.07	1.00	44.07	1.91	0.06	0.67
11.65	31.48	44.59	1.00	44.59	1.90	0.06	0.67
11.81	31.82	44.92	1.00	44.92	1.90	0.07	0.67
11.97	31.95	44.94	1.00	44.94	1.90	0.07	0.67
12.14	31.92	44.76	1.00	44.76	1.90	0.07	0.67
12.30	32.12	44.94	1.00	44.94	1.91	0.06	0.67
12.47	33.24	46.27	1.00	46.27	1.90	0.07	0.67
12.63	35.83	49.43	1.00	49.43	1.87	0.07	0.66
12.79	39.32	53.66	1.00	53.66	1.84	0.07	0.66
12.96	41.69	56.62	1.00	56.62	1.83	0.08	0.67
13.12	42.17	57.23	1.00	57.23	1.84	0.08	0.67
13.29	40.14	54.69	1.00	54.69	1.87	0.08	0.68
13.45	36.85	50.45	1.00	50.45	1.91	0.07	0.69
13.62	33.23	45.74	1.00	45.74	1.96	0.07	0.69
13.78	30.65	42.32	1.00	42.32	2.00	0.07	0.69
13.94	29.55	40.78	1.00	40.78	2.01	0.07	0.70
14.11	29.39	40.46	1.00	40.46	2.02	0.07	0.70
14.27	29.40	40.34	1.00	40.34	2.02	0.07	0.70
14.44	29.43	40.22	1.00	40.22	2.02	0.07	0.70
14.60	29.43	40.06	1.00	40.06	2.02	0.07	0.70
14.76	30.06	40.68	1.00	40.68	2.01	0.07	0.69
14.93	30.19	40.71	1.00	40.71	2.01	0.07	0.70
15.09	30.07	40.42	1.00	40.42	2.01	0.07	0.69
15.26	30.59	40.90	1.00	40.90	2.00	0.07	0.69
15.42	31.99	42.40	1.00	42.40	1.98	0.07	0.69
15.58	33.76	44.34	1.00	44.34	1.94	0.07	0.69
15.75	33.63	44.01	1.00	44.01	1.94	0.07	0.69
15.91	33.92	44.23	1.00	44.23	1.94	0.07	0.68
16.08	34.62	44.97	1.00	44.97	1.94	0.07	0.68
16.24	36.21	46.78	1.00	46.78	1.92	0.07	0.68
16.40	38.09	48.99	1.00	48.99	1.91	0.07	0.68
16.57	41.19	52.54	1.00	52.54	1.88	0.07	0.68
16.73	43.55	55.16	1.00	55.16	1.86	0.08	0.68
16.90	42.29	53.49	1.00	53.49	1.87	0.08	0.68
17.06	38.41	48.83	1.00	48.83	1.92	0.07	0.68
17.22	35.82	45.68	1.00	45.68	1.96	0.07	0.69
17.39	35.32	45.20	1.00	45.20	2.00	0.08	0.71
17.55	35.32	45.67	1.39	63.38	2.08	0.08	0.72
17.72	36.64	47.41	1.42	67.16	2.10	0.08	0.72
17.88	42.13	53.61	1.32	70.73	2.01	0.08	0.72

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.05	48.85	60.64	1.00	60.64	1.89	0.09	0.71
18.21	52.05	63.80	1.00	63.80	1.83	0.09	0.69
18.37	51.09	62.56	1.00	62.56	1.84	0.08	0.68
18.54	49.02	59.98	1.00	59.98	1.86	0.08	0.69
18.70	49.64	60.33	1.00	60.33	1.84	0.08	0.68
18.86	50.83	61.71	1.00	61.71	1.85	0.08	0.69
19.03	55.97	67.26	1.00	67.26	1.80	0.08	0.67
19.19	60.56	72.24	1.00	72.24	1.77	0.10	0.70
19.36	61.04	72.46	1.00	72.46	1.76	0.10	0.70
19.52	54.45	65.13	1.00	65.13	1.84	0.08	0.69
19.68	46.48	56.08	1.00	56.08	1.93	0.08	0.70
19.85	41.32	50.01	1.00	50.01	1.98	0.08	0.71
20.01	38.36	46.51	1.33	61.99	2.03	0.08	0.72
20.18	36.43	44.54	1.44	64.21	2.11	0.08	0.72
20.34	36.12	44.28	1.52	67.43	2.16	0.09	0.73
20.50	50.94	61.18	1.31	79.92	2.00	0.07	0.70
20.67	71.88	84.09	1.16	97.93	1.81	0.12	0.74
20.83	90.28	103.94	1.00	103.94	1.71	0.15	0.77
21.00	95.12	108.77	1.00	108.77	1.68	0.14	0.76
21.16	95.05	108.08	1.00	108.08	1.66	0.14	0.76
21.32	92.77	104.80	1.00	104.80	1.64	0.15	0.77
21.49	86.43	97.60	1.00	97.60	1.66	0.12	0.74
21.65	76.77	87.04	1.00	87.04	1.72	0.11	0.72
21.82	67.12	76.54	1.00	76.54	1.80	0.10	0.71
21.98	58.95	67.39	1.00	67.39	1.86	0.09	0.70
22.15	51.18	58.67	1.00	58.67	1.93	0.08	0.71
22.31	46.09	52.85	1.29	68.11	1.98	0.08	0.72
22.47	42.36	48.65	1.34	65.01	2.03	0.08	0.72
22.64	38.48	44.25	1.41	62.31	2.09	0.08	0.73
22.80	33.29	38.45	1.60	61.70	2.20	0.09	0.73
22.97	26.40	30.64	2.12	64.87	2.35	0.08	0.71
23.13	20.45	23.78	3.03	72.02	2.51	0.08	0.70
23.29	16.96	19.61	3.79	74.23	2.60	0.08	0.70
23.46	15.78	18.11	4.02	72.82	2.63	0.08	0.69
23.62	15.25	17.39	4.09	71.14	2.64	0.08	0.69
23.79	17.07	19.41	3.53	68.47	2.57	0.08	0.69
23.95	17.79	20.20	3.52	71.06	2.57	0.09	0.71
24.11	19.81	22.50	3.33	74.85	2.55	0.08	0.70
24.28	19.83	22.49	3.58	80.42	2.58	0.09	0.71
24.44	18.78	21.22	3.93	83.49	2.62	0.09	0.71
24.61	15.96	17.85	4.61	82.26	2.69	0.08	0.69
24.77	13.23	14.57	5.37	78.18	2.76	0.08	0.69
24.93	12.92	14.08	5.04	71.04	2.73	0.08	0.68
25.10	13.31	14.48	4.91	71.11	2.72	0.08	0.69
25.26	13.75	14.96	5.11	76.41	2.74	0.08	0.69
25.43	14.09	15.32	5.26	80.54	2.75	0.08	0.69
25.59	13.80	14.93	5.54	82.62	2.77	0.08	0.69
25.75	13.45	14.45	5.59	80.82	2.78	0.08	0.69

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
25.92	13.10	13.98	5.76	80.49	2.79	0.08	0.69
26.08	15.75	16.90	4.69	79.31	2.70	0.08	0.68
26.25	19.54	21.09	3.87	81.60	2.61	0.09	0.71
26.41	24.73	26.78	3.18	85.18	2.53	0.09	0.71
26.57	27.66	29.95	3.03	90.72	2.51	0.09	0.73
26.74	28.90	31.23	3.06	95.49	2.51	0.09	0.73
26.90	28.72	30.93	3.20	99.12	2.53	0.09	0.72
27.07	29.23	31.38	3.24	101.82	2.54	0.09	0.72
27.23	30.81	32.98	3.18	104.82	2.53	0.10	0.73
27.39	31.49	33.61	3.25	109.11	2.54	0.10	0.74
27.56	30.12	31.99	3.46	110.75	2.57	0.10	0.73
27.72	28.18	29.74	3.64	108.29	2.59	0.09	0.72
27.89	27.14	28.43	3.56	101.33	2.58	0.09	0.72
28.05	27.20	28.33	3.39	96.10	2.56	0.09	0.72
28.21	27.17	28.15	3.30	92.86	2.54	0.09	0.72
28.38	26.40	27.19	3.30	89.80	2.54	0.09	0.72
28.54	25.02	25.59	3.40	87.08	2.56	0.09	0.71
28.71	24.12	24.54	3.61	88.62	2.58	0.09	0.71
28.87	24.05	24.38	3.74	91.28	2.60	0.09	0.71
29.04	23.98	24.19	3.72	89.95	2.60	0.09	0.71
29.20	24.12	24.22	3.56	86.24	2.58	0.09	0.71
29.36	22.90	22.84	3.74	85.50	2.60	0.09	0.71
29.53	21.37	21.17	4.23	89.47	2.65	0.09	0.70
29.69	20.96	20.64	4.24	87.56	2.65	0.08	0.70
29.86	24.15	23.80	3.19	75.97	2.53	0.08	0.71
30.02	28.50	28.09	2.32	65.12	2.39	0.09	0.72
30.18	31.03	30.54	2.06	62.86	2.33	0.09	0.72
30.35	30.28	29.75	2.48	73.90	2.42	0.09	0.72
30.51	28.97	28.41	3.16	89.86	2.53	0.09	0.72
30.68	26.42	25.76	3.98	102.52	2.63	0.09	0.72
30.84	23.04	22.21	4.74	105.20	2.70	0.09	0.71
31.00	19.18	18.19	5.66	102.87	2.78	0.08	0.70
31.17	16.73	15.61	6.33	98.79	2.84	0.08	0.69
31.33	15.83	14.63	6.66	97.38	2.86	0.08	0.69
31.50	15.80	14.52	6.54	94.97	2.85	0.08	0.69
31.66	17.19	15.84	5.49	87.02	2.77	0.08	0.69
31.82	20.37	18.94	4.48	84.91	2.68	0.08	0.70
31.99	23.95	22.40	3.37	75.53	2.55	0.09	0.71
32.15	21.97	20.35	3.68	74.83	2.59	0.09	0.72
32.32	19.09	17.40	3.75	65.25	2.60	0.07	0.68
32.48	16.01	14.31	4.83	69.14	2.71	0.08	0.69
32.64	16.72	14.96	4.92	73.54	2.72	0.08	0.69
32.81	16.61	14.80	5.33	78.90	2.76	0.08	0.69
32.97	15.82	13.96	5.98	83.55	2.81	0.08	0.69
33.14	15.63	13.73	6.30	86.49	2.83	0.08	0.69
33.30	18.28	16.24	5.08	82.54	2.73	0.08	0.69
33.47	22.87	20.64	3.97	81.89	2.62	0.09	0.71
33.63	26.25	23.83	3.58	85.41	2.58	0.09	0.72

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
33.79	26.09	23.60	4.06	95.90	2.63	0.09	0.71
33.96	24.28	21.76	4.57	99.43	2.69	0.09	0.71
34.12	26.23	23.54	3.92	92.23	2.62	0.09	0.71
34.28	30.34	27.37	3.04	83.21	2.51	0.09	0.73
34.45	33.21	30.00	2.76	82.66	2.47	0.10	0.73
34.61	30.26	27.09	3.32	89.84	2.55	0.09	0.73
34.78	24.07	21.12	4.67	98.57	2.70	0.09	0.71
34.94	18.29	15.56	6.41	99.78	2.84	0.08	0.69
35.10	15.92	13.27	7.76	102.98	2.94	0.08	0.69
35.27	18.37	15.50	6.40	99.26	2.84	0.08	0.69
35.43	29.28	25.67	3.25	83.42	2.54	0.08	0.71
35.60	40.05	35.67	1.93	69.00	2.30	0.10	0.75
35.76	48.30	43.29	1.52	65.97	2.16	0.09	0.74
35.92	49.44	44.22	1.52	67.16	2.16	0.09	0.74
36.09	50.08	44.67	1.55	69.31	2.17	0.09	0.75
36.25	50.12	44.56	1.61	71.80	2.20	0.10	0.75
36.42	49.30	43.65	1.69	73.73	2.23	0.10	0.75
36.58	48.94	43.17	1.74	75.12	2.25	0.10	0.75
36.74	48.79	42.87	1.84	79.08	2.28	0.10	0.75
36.91	47.74	41.71	2.11	88.00	2.35	0.10	0.75
37.07	42.79	36.99	2.72	100.60	2.46	0.11	0.75
37.24	33.46	28.33	4.00	113.40	2.63	0.10	0.73
37.40	23.62	19.31	6.14	118.54	2.82	0.09	0.70
37.57	18.10	14.31	7.82	112.00	2.94	0.08	0.69
37.73	16.75	13.05	8.12	106.00	2.96	0.08	0.70
37.89	20.79	16.58	6.30	104.47	2.84	0.08	0.69
38.06	29.28	24.10	4.19	101.06	2.65	0.09	0.72
38.22	41.00	34.55	2.49	86.17	2.42	0.10	0.74
38.39	50.28	42.85	1.79	76.64	2.26	0.10	0.75
38.55	54.87	46.90	1.57	73.52	2.18	0.10	0.75
38.71	55.78	47.53	1.61	76.69	2.20	0.10	0.76
38.88	57.13	48.50	1.72	83.61	2.24	0.10	0.76
39.04	50.82	42.62	2.19	93.37	2.36	0.12	0.77
39.21	40.34	33.12	3.21	106.41	2.53	0.10	0.74
39.37	27.39	21.63	5.40	116.85	2.76	0.09	0.71
39.53	22.77	17.55	6.34	111.22	2.84	0.09	0.70
39.70	27.55	21.72	4.09	88.72	2.64	0.09	0.70
39.86	34.97	28.21	2.49	70.33	2.42	0.09	0.73
40.03	40.66	33.21	1.87	62.08	2.28	0.09	0.73
40.19	41.76	34.07	1.85	62.87	2.28	0.09	0.73
40.35	41.23	33.48	1.92	64.28	2.30	0.09	0.73
40.52	40.58	32.80	1.97	64.72	2.31	0.09	0.73
40.68	39.32	31.60	2.06	65.21	2.33	0.09	0.73
40.85	37.56	29.94	2.27	67.85	2.38	0.09	0.73
41.01	36.12	28.56	2.52	72.03	2.43	0.09	0.73
41.17	35.44	27.83	2.81	78.17	2.47	0.09	0.72
41.34	34.87	27.15	3.32	90.17	2.55	0.09	0.73
41.50	33.41	25.75	3.84	98.91	2.61	0.10	0.73

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
41.67	33.08	25.42	3.64	92.51	2.59	0.09	0.72
41.83	34.33	26.52	2.90	76.86	2.49	0.09	0.72
41.99	39.14	30.69	2.05	63.03	2.33	0.09	0.72
42.16	41.64	32.74	1.93	63.27	2.30	0.09	0.74
42.32	40.80	31.88	2.05	65.38	2.33	0.09	0.73
42.49	36.35	27.94	2.54	71.00	2.43	0.09	0.72
42.65	33.63	25.54	2.89	73.77	2.49	0.09	0.72
42.81	34.14	25.91	2.74	70.92	2.46	0.09	0.72
42.98	35.74	27.21	2.47	67.08	2.42	0.09	0.73
43.14	36.75	27.91	2.60	72.53	2.44	0.09	0.73
43.31	36.73	27.63	3.16	87.20	2.53	0.09	0.73
43.47	32.28	23.75	4.30	102.03	2.66	0.10	0.73
43.63	28.24	20.34	5.18	105.27	2.74	0.09	0.70
43.80	25.82	18.36	5.27	96.78	2.75	0.09	0.71
43.96	28.25	20.38	4.03	82.22	2.63	0.09	0.72
44.13	29.91	21.71	3.53	76.67	2.57	0.09	0.72
44.29	29.86	21.62	3.44	74.36	2.56	0.09	0.71
44.45	30.69	22.25	3.24	72.20	2.54	0.09	0.71
44.62	32.96	24.07	2.85	68.65	2.48	0.09	0.72
44.78	35.23	25.84	2.68	69.15	2.45	0.09	0.72
44.95	35.55	25.87	3.09	79.84	2.52	0.09	0.73
45.11	32.08	22.87	4.01	91.63	2.63	0.09	0.72
45.28	24.87	16.99	5.99	101.68	2.81	0.09	0.71
45.44	18.35	11.96	8.87	106.08	3.01	0.08	0.85
45.60	18.57	12.08	8.80	106.31	3.00	0.08	0.86
45.77	24.65	16.62	6.16	102.39	2.82	0.09	0.71
45.93	31.69	22.15	4.20	93.10	2.65	0.09	0.72
46.10	35.05	24.79	3.56	88.29	2.58	0.09	0.73
46.26	33.58	23.46	4.07	95.47	2.64	0.10	0.73
46.42	29.81	20.30	5.40	109.57	2.76	0.09	0.71
46.59	25.35	16.78	7.03	117.88	2.89	0.09	0.71
46.75	22.85	14.89	7.66	114.06	2.93	0.09	0.70
46.92	20.63	13.22	7.96	105.22	2.95	0.09	0.70
47.08	17.78	11.10	9.21	102.18	3.02	0.08	0.79
47.24	17.06	10.53	9.85	103.68	3.06	0.08	0.75
47.41	18.45	11.50	9.33	107.27	3.03	0.08	0.82
47.57	18.33	11.37	9.48	107.76	3.04	0.09	0.81
47.74	16.63	10.10	10.27	103.73	3.08	0.08	0.72
47.90	13.79	8.04	12.44	99.93	3.19	0.08	0.57
48.06	13.81	8.02	12.81	102.80	3.20	0.08	0.57
48.23	20.01	12.40	8.31	103.08	2.97	0.08	0.68
48.39	29.91	19.62	5.10	100.09	2.74	0.09	0.72
48.56	38.34	25.98	3.71	96.50	2.60	0.10	0.74
48.72	42.88	29.40	3.22	94.63	2.53	0.10	0.73
48.88	45.89	31.66	2.89	91.54	2.49	0.10	0.74
49.05	50.83	35.44	2.47	87.66	2.42	0.10	0.75
49.21	52.60	36.60	2.52	92.22	2.43	0.11	0.76
49.38	49.64	34.05	2.95	100.53	2.50	0.11	0.75

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
49.54	44.91	30.25	3.54	106.99	2.57	0.10	0.74
49.70	42.05	28.02	3.77	105.52	2.60	0.10	0.73
49.87	42.47	28.30	3.56	100.89	2.58	0.10	0.74
50.03	44.75	30.00	3.20	95.95	2.53	0.10	0.74
50.20	45.78	30.64	3.20	97.98	2.53	0.10	0.75
50.36	44.05	29.17	3.53	102.84	2.57	0.10	0.74
50.52	38.36	24.68	4.69	115.64	2.70	0.10	0.73
50.69	32.27	20.10	6.01	120.70	2.81	0.09	0.72
50.85	32.32	20.17	5.50	110.98	2.77	0.09	0.71
51.02	38.93	25.10	3.86	96.84	2.61	0.10	0.73
51.18	43.03	28.03	3.46	96.89	2.56	0.11	0.75
51.34	38.64	24.51	4.56	111.74	2.69	0.10	0.73
51.51	28.87	17.43	7.01	122.12	2.89	0.09	0.71
51.67	23.70	13.92	8.61	119.90	2.99	0.08	0.70
51.84	26.44	15.69	6.87	107.86	2.88	0.09	0.70
52.00	27.89	16.60	6.53	108.40	2.85	0.10	0.72
52.16	27.47	16.27	6.77	110.15	2.87	0.09	0.70
52.33	28.47	16.87	6.54	110.30	2.85	0.09	0.70
52.49	33.42	20.29	5.25	106.51	2.75	0.10	0.73
52.66	41.04	25.66	4.08	104.61	2.64	0.10	0.73
52.82	45.33	28.70	3.54	101.66	2.57	0.10	0.74
52.99	49.28	31.66	2.92	92.29	2.49	0.10	0.75
53.15	51.58	33.54	2.39	80.33	2.40	0.10	0.75
53.31	52.33	34.02	2.34	79.52	2.39	0.10	0.75
53.48	46.64	29.69	2.77	82.33	2.47	0.11	0.75
53.64	35.58	21.52	4.29	92.26	2.66	0.09	0.72
53.81	22.64	12.64	7.63	96.45	2.93	0.08	0.69
53.97	16.79	8.86	11.05	97.87	3.12	0.08	0.63
54.13	16.42	8.59	12.54	107.72	3.19	0.08	0.61
54.30	25.01	14.02	7.93	111.11	2.95	0.08	0.69
54.46	38.25	22.92	4.31	98.91	2.66	0.10	0.73
54.63	50.98	32.33	2.41	77.93	2.41	0.11	0.75
54.79	56.48	36.63	1.87	68.50	2.29	0.10	0.75
54.95	59.48	38.77	1.77	68.69	2.26	0.10	0.74
55.12	67.39	44.31	1.67	74.17	2.22	0.10	0.76
55.28	76.28	50.66	1.56	79.16	2.18	0.12	0.78
55.45	81.09	54.01	1.52	82.30	2.16	0.12	0.78
55.61	78.65	52.00	1.57	81.86	2.18	0.12	0.78
55.77	73.89	48.39	1.64	79.47	2.21	0.11	0.77
55.94	69.83	45.38	1.69	76.58	2.23	0.11	0.76
56.10	67.82	43.91	1.69	74.02	2.23	0.11	0.76
56.27	66.85	43.18	1.67	72.23	2.22	0.11	0.76
56.43	64.79	41.65	1.69	70.47	2.23	0.10	0.76
56.59	62.09	39.60	1.75	69.24	2.25	0.10	0.75
56.76	59.87	37.89	1.81	68.75	2.27	0.10	0.75
56.92	57.62	36.12	1.92	69.33	2.30	0.10	0.75
57.09	54.23	33.56	2.08	69.89	2.34	0.10	0.75
57.25	49.34	29.97	2.36	70.80	2.40	0.10	0.74

:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
57.41	44.92	26.77	2.69	71.88	2.45	0.09	0.73
57.58	42.24	24.81	2.95	73.23	2.50	0.09	0.73
57.74	41.55	24.25	3.05	73.98	2.51	0.09	0.73
57.91	41.73	24.29	3.05	74.19	2.51	0.09	0.73
58.07	41.81	24.28	3.05	73.97	2.51	0.09	0.73
58.23	41.23	23.83	3.10	73.89	2.52	0.09	0.73
58.40	38.09	21.63	3.44	74.45	2.56	0.09	0.73
58.56	34.47	19.16	3.88	74.32	2.61	0.09	0.71
58.73	29.46	15.80	4.72	74.53	2.70	0.09	0.71
58.89	26.07	13.56	5.43	73.65	2.77	0.08	0.70
59.05	23.07	11.66	6.27	73.05	2.83	0.08	0.69
59.22	21.32	10.60	6.77	71.82	2.87	0.08	0.69
59.38	20.62	10.16	6.88	69.91	2.88	0.08	0.69
59.55	21.51	10.65	6.08	64.75	2.82	0.08	0.69
59.71	23.85	12.22	4.73	57.76	2.70	0.08	0.69
59.88	25.87	13.65	3.71	50.63	2.59	0.08	0.70
60.04	24.45	12.70	3.94	50.05	2.62	0.08	0.70
60.20	19.30	9.26	6.00	55.62	2.81	0.08	0.69
60.37	14.63	6.54	10.06	65.83	3.07	0.07	0.47
60.53	14.96	6.72	11.27	75.70	3.13	0.08	0.48
60.70	20.30	9.76	8.32	81.28	2.97	0.08	0.69
60.86	26.85	13.49	6.11	82.39	2.82	0.09	0.70
61.02	30.64	15.79	5.22	82.37	2.75	0.09	0.71
61.19	31.28	16.12	5.18	83.57	2.74	0.09	0.71
61.35	29.23	14.73	6.64	97.76	2.86	0.09	0.71
61.52	32.25	16.40	6.18	101.35	2.83	0.09	0.70
61.68	50.35	27.55	3.93	108.24	2.62	0.10	0.73
61.84	81.62	48.32	2.10	101.44	2.34	0.13	0.79
62.01	135.13	85.64	1.38	117.98	2.07	0.16	0.82
62.17	200.30	133.22	1.21	160.64	1.86	0.37	0.85
62.34	230.47	155.82	1.12	174.75	1.77	0.89	0.91
62.50	195.67	128.33	1.24	158.96	1.90	0.52	0.88
62.66	130.09	80.60	1.46	118.05	2.13	0.13	0.79
62.83	76.75	43.45	2.75	119.68	2.47	0.14	0.79
62.99	57.52	31.06	3.81	118.46	2.61	0.10	0.74
63.16	46.60	24.15	4.93	119.04	2.72	0.10	0.73
63.32	52.21	27.88	3.77	105.09	2.60	0.10	0.74
63.48	64.82	36.24	2.56	92.59	2.43	0.12	0.77
63.65	73.62	42.03	2.15	90.29	2.35	0.12	0.78
63.81	77.47	44.54	2.00	89.25	2.32	0.12	0.78
63.98	82.91	48.35	1.77	85.59	2.26	0.12	0.78
64.14	87.81	51.84	1.61	83.46	2.20	0.13	0.79
64.30	91.88	53.63	1.75	93.90	2.25	0.13	0.79
64.47	85.54	47.92	2.45	117.47	2.41	0.15	0.80
64.63	88.39	48.43	3.07	148.44	2.51	0.13	0.78
64.80	73.23	38.31	4.43	169.57	2.67	0.18	0.82
64.96	76.58	40.41	4.01	161.94	2.63	0.10	0.73
65.13	70.83	37.41	3.69	138.06	2.59	0.15	0.80

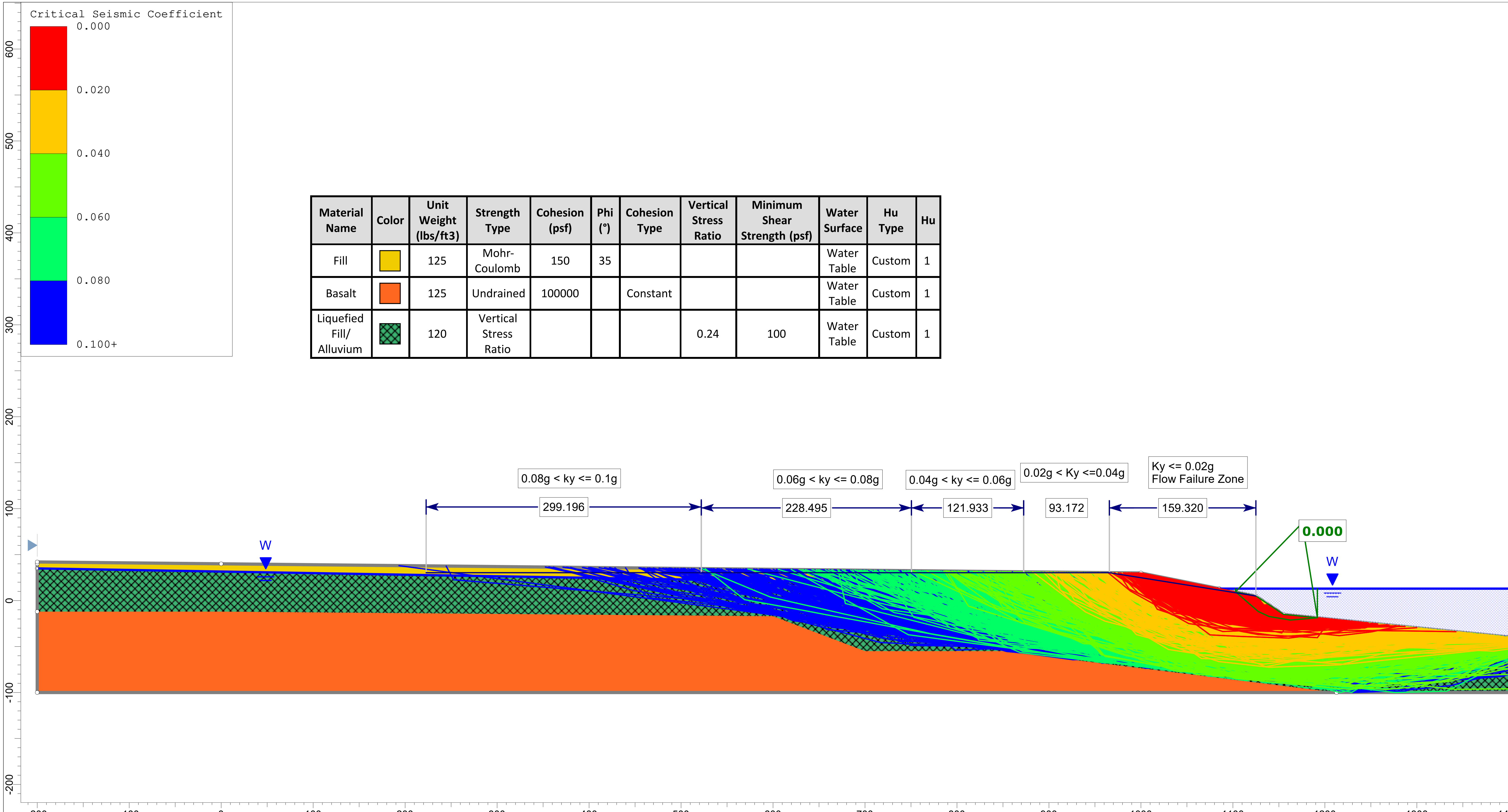
:: Strength loss calculation (Idriss & Boulanger (2008) :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
65.29	86.11	48.07	2.23	107.06	2.37	0.13	0.79
65.45	87.62	49.85	1.84	91.68	2.28	0.13	0.80
65.62	89.82	51.63	1.68	86.51	2.22	0.13	0.79
65.78	88.28	50.56	1.68	85.17	2.23	0.13	0.79
65.94	87.66	49.92	1.72	86.10	2.24	0.12	0.79
66.11	87.47	49.74	1.71	85.19	2.24	0.12	0.79
66.27	86.79	49.57	1.63	80.61	2.20	0.12	0.78
66.44	85.73	46.76	2.35	110.08	2.40	0.13	0.79
66.60	97.07	52.44	2.65	138.80	2.45	0.14	0.79
66.77	199.57	119.73	1.37	164.30	2.07	0.15	0.81
66.93	306.64	197.43	1.12	221.55	1.78	0.93	0.99
67.09	401.10	269.89	1.00	269.89	1.59	0.98	1.00

Abbreviations

q_t:	Total cone resistance
K_c:	Cone resistance correction factor due to fines
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
I_c:	Soil behavior type index
$S_{u(liq)}/\sigma'_v$:	Calculated liquefied undrained strength ratio
$S_{u(peak)}/\sigma'_v$:	Calculated peak undrained strength ratio

G-3-5
Yield Acceleration Calculations



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Hu Type	Hu
Fill		125	Mohr-Coulomb	150	35				Water Table	Custom	1
Basalt		125	Undrained	100000		Constant			Water Table	Custom	1
Liquefied Fill/ Alluvium		120	Vertical Stress Ratio				0.24	100	Water Table	Custom	1

SAGE GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program
Group	Group 1
Scenario	Master Scenario
Drawn By	
Checked By	
Date	3/8/2024, 1:11:17 PM
File Name	KM Willbridge Slide.slmd

G-3-6
Newmark Sliding Block Results

Newmark Calculation Summary

Yield Acceleration = 0.02g

Earthquake	Record	Rigid block (in.)Normal	Rigid block (in.)Inverse	Rigid block (in.)Average	Decoupled (in.)Normal	Decoupled (in.)Inverse	Decoupled (in.)Average	Coupled (in.)Normal	Coupled (in.)Inverse	Coupled (in.)Average
Imperial Valley 1979	E04-140	36.8	31.8	34.3	45.8	42	43.9	29.4	28.8	29.1
Imperial Valley 1979	E05-140	28.8	55.1	41.9	49.6	58.8	54.2	34.2	55.5	44.9
Imperial Valley 1979	E07-230	107.3	144.9	126.1	151.8	134.9	143.4	67.9	100.5	84.2
N. Palm Springs 1986	WWT-180	21.4	17.1	19.2	7.6	9	8.3	8	10.4	9.2
Northridge 1994	LOS-270	40.8	43.7	42.3	28.4	28.5	28.4	18.9	23	20.9
Northridge 1994	STN-020	26.2	17.2	21.7	18.3	13.2	15.8	15.2	10.7	13
Parkfield 1966	C02-065	48.5	69.3	58.9	35.5	34.3	34.9	25.6	27	26.3
Westmorland 1981	WSM-180	28.5	32	30.2	17.1	23.7	20.4	14.8	24.1	19.5
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	161.1	158.7	159.9	148.6	151.6	150.1	123.4	116.8	120.1
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	113.2	122.3	117.7	152.8	149.7	151.3	123.2	119.1	121.2
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	117.2	118.6	117.9	133.3	149.8	141.5	102.9	112.4	107.6
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	124	94.3	109.1	99.6	96	97.8	75.5	65.9	70.7
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	92.7	79.8	86.3	90.1	84.9	87.5	73.6	60.3	66.9
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	117.7	114.5	116.1	119.2	117.3	118.3	99.6	99.9	99.8
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	67.1	61	64.1	60.8	52	56.4	59.4	34.5	46.9
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	102.7	102.1	102.4	114.4	114.6	114.5	95.4	77.5	86.4
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	58.6	47.3	53	47.5	40	43.8	39.7	29.5	34.6
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	112.9	89.9	101.4	98.8	86.6	92.7	79.4	67.5	73.5
	Mean value	78.1	77.8	77.9	78.8	77.1	78	60.3	59.1	59.7
	Median value	79.9	74.6	75.2	75.5	71.8	72	63.7	57.9	56.9
	Standard deviation	41.8	41.9	41.1	48.7	48.5	48.5	37.4	36.7	36.5

Newmark Calculation Summary

Yield Acceleration = 0.04g

Earthquake	Record	Rigid block (in.)Normal	Rigid block (in.)Inverse	Rigid block (in.)Average	Decoupled (in.)Normal	Decoupled (in.)Inverse	Decoupled (in.)Average	Coupled (in.)Normal	Coupled (in.)Inverse	Coupled (in.)Average
Imperial Valley 1979	E04-140	18.7	14.9	16.8	25.2	18.4	21.8	16.9	13	15
Imperial Valley 1979	E05-140	13.1	25.5	19.3	15.7	30.3	23	13.2	27.3	20.2
Imperial Valley 1979	E07-230	67.9	78.6	73.3	86.7	77.6	82.1	46	54.8	50.4
N. Palm Springs 1986	WWT-180	12.8	10.7	11.7	2.6	5.1	3.8	3.8	4.9	4.3
Northridge 1994	LOS-270	21.3	25.6	23.5	12.5	15.4	13.9	8.3	13	10.7
Northridge 1994	STN-020	12	8	10	6.4	2.9	4.7	6.3	3.8	5.1
Parkfield 1966	C02-065	27.5	33.9	30.7	20	15.4	17.7	15.4	11.1	13.2
Westmorland 1981	WSM-180	18.2	17.5	17.9	5.1	11.2	8.2	6.1	10.7	8.4
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	71.7	68	69.9	53.6	41.2	47.4	45.7	37.9	41.8
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	43.1	48.5	45.8	47.4	43.6	45.5	42.1	37.8	40
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	45.5	47.9	46.7	44	50.4	47.2	36.1	38.7	37.4
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	57.8	46.7	52.2	35.8	29.5	32.6	27.5	23.4	25.5
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	44.4	41.2	42.8	32	28.4	30.2	28.5	21.5	25
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	47.1	50.6	48.9	33.6	25.4	29.5	32.8	23.3	28
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	31.2	30.1	30.7	26.5	17.3	21.9	23.6	12.3	18
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	52.7	47.8	50.3	51.8	40.5	46.2	43.8	32	37.9
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	27.4	22	24.7	19.5	12	15.7	16.5	10.4	13.4
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	64.4	45.5	54.9	42.2	43.2	42.7	35.2	32	33.6
	Mean value	37.6	36.8	37.2	31.1	28.2	29.7	24.9	22.7	23.8
	Median value	37.2	37.6	36.7	29.3	26.9	26.3	25.6	22.4	22.6
	Standard deviation	19.4	18.8	18.8	20.6	18.3	19.1	14.2	13.6	13.5

Newmark Calculation Summary

Yield Acceleration = 0.08g

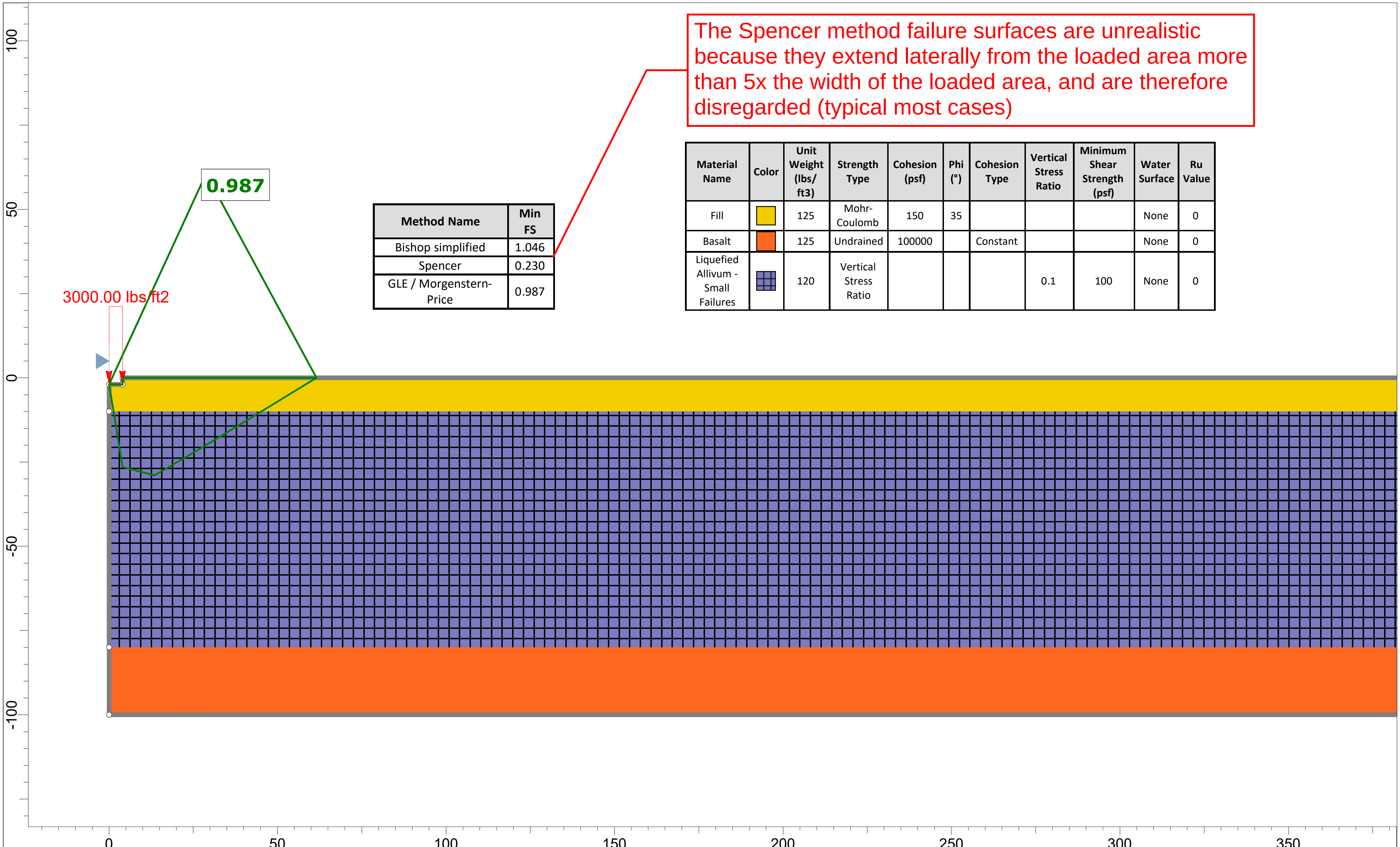
Earthquake	Record	Rigid block (in.)Normal	Rigid block (in.)Inverse	Rigid block (in.)Average	Decoupled (in.)Normal	Decoupled (in.)Inverse	Decoupled (in.)Average	Coupled (in.)Normal	Coupled (in.)Inverse	Coupled (in.)Average
Imperial Valley 1979	E04-140	9.7	5.7	7.7	7.1	3.5	5.3	6.1	3.2	4.7
Imperial Valley 1979	E05-140	3.9	11.3	7.6	2.7	7.1	4.9	2.5	7.4	4.9
Imperial Valley 1979	E07-230	35.3	35.5	35.4	24.5	31.2	27.8	21.1	27.8	24.5
N. Palm Springs 1986	WWT-180	7.3	5.7	6.5	0.5	1.2	0.9	0.8	1.3	1.1
Northridge 1994	LOS-270	10.9	10.8	10.9	2.5	5.1	3.8	2.1	4.7	3.4
Northridge 1994	STN-020	3.9	3.1	3.5	0.9	0.4	0.7	0.9	0.7	0.8
Parkfield 1966	C02-065	14.4	13.3	13.8	7.9	0.6	4.2	8.5	0.8	4.6
Westmorland 1981	WSM-180	9.1	8.5	8.8	0.7	3	1.8	1.1	3.1	2.1
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	25.8	20.7	23.2	6.7	2.3	4.5	8.2	3.8	6
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	13.8	13.4	13.6	7.5	4.2	5.8	7.9	5.6	6.8
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	14.4	16	15.2	5.4	8.6	7	5.6	8.3	7
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	17.7	17.6	17.7	5.7	2.1	3.9	4.8	2.6	3.7
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	15	18.9	17	9.5	5.5	7.5	8.3	5.3	6.8
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	17.4	19.4	18.4	6.9	1.2	4.1	5.9	2.2	4
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	10.9	9.7	10.3	8.5	1.8	5.1	7.4	2.3	4.9
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	16.5	14.4	15.4	11.4	6.6	9	12	6.8	9.4
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	9	7.5	8.3	4.4	1	2.7	4.3	1.4	2.9
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	25.6	17.3	21.5	11.2	11.7	11.4	10.3	9.9	10.1
	Mean value	14.5	13.8	14.1	6.9	5.4	6.1	6.5	5.4	6
	Median value	14.1	13.4	13.7	6.8	3.2	4.7	6	3.5	4.8
	Standard deviation	7.8	7.3	7.4	5.4	6.9	5.9	4.8	6	5.1

Newmark Calculation Summary

Yield Acceleration = 0.12g

Earthquake	Record	Rigid block (in.)Normal	Rigid block (in.)Inverse	Rigid block (in.)Average	Decoupled (in.)Normal	Decoupled (in.)Inverse	Decoupled (in.)Average	Coupled (in.)Normal	Coupled (in.)Inverse	Coupled (in.)Average
Imperial Valley 1979	E04-140	5	1.8	3.4	1.2	0	0.6	1.9	0	1
Imperial Valley 1979	E05-140	1.4	4.3	2.9	0.2	0.7	0.5	0.4	1	0.7
Imperial Valley 1979	E07-230	19.8	10.7	15.2	3.6	10	6.8	6	12	9
N. Palm Springs 1986	WWT-180	4.2	3.8	4	0	0	0	0	0.1	0.1
Northridge 1994	LOS-270	6.5	5.3	5.9	0.2	0.5	0.3	0.4	0.8	0.6
Northridge 1994	STN-020	2.1	1.3	1.7	0	0	0	0	0.1	0.1
Parkfield 1966	C02-065	10.4	6.6	8.5	2.8	0	1.4	4.3	0	2.1
Westmorland 1981	WSM-180	4.8	4.3	4.6	0	0.3	0.2	0.1	0.5	0.3
02NGASUB	NGAsubRSN4000427_IBRH20S2.AT2	11.2	8	9.6	0.5	0	0.2	1	0	0.5
02NGASUB	NGAsubRSN4000756_CHB004EW.AT2	5.4	5.1	5.3	1.8	0	0.9	2.2	0	1.1
02NGASUB	NGAsubRSN4000756_CHB004NS.AT2	5.9	6.6	6.3	0.3	0.5	0.4	0.6	1.2	0.9
02NGASUB	NGAsubRSN4003154_CHBH13NS2.AT2	7.3	7.8	7.5	0.6	0.3	0.4	0.9	0.6	0.7
02NGASUB	NGAsubRSN4022935_NMRH05EW2.AT2	7.1	10	8.6	2.8	0.5	1.7	2.7	1.1	1.9
02NGASUB	NGAsubRSN4028548_HKD068-EW.AT2	8.1	8	8.1	1.6	0	0.8	1.9	0.1	1
02NGASUB	NGAsubRSN4032553_51563-NS.AT2	4.5	4	4.2	1.9	0	0.9	2.2	0	1.1
02NGASUB	NGAsubRSN4040623_CHB004-NS.AT2	6.4	5.2	5.8	1.2	1.1	1.1	1.9	1.6	1.8
02NGASUB	NGAsubRSN4040706_IBR018-NS.AT2	3.5	3.4	3.4	0.5	0	0.2	1	0	0.5
02NGASUB	NGAsubRSN5004270_20161113_110322_SEDS_20_N90W.AT2	10.4	8.5	9.5	1.8	2	1.9	2.5	2.1	2.3
	Mean value	6.9	5.8	6.4	1.2	0.9	1	1.7	1.2	1.4
	Median value	6.1	5.3	5.9	0.9	0.2	0.5	1.4	0.3	0.9
	Standard deviation	4.1	2.6	3.2	1.1	2.3	1.5	1.5	2.7	2

G-3-7
Seismic Bearing Capacity Calculations



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)

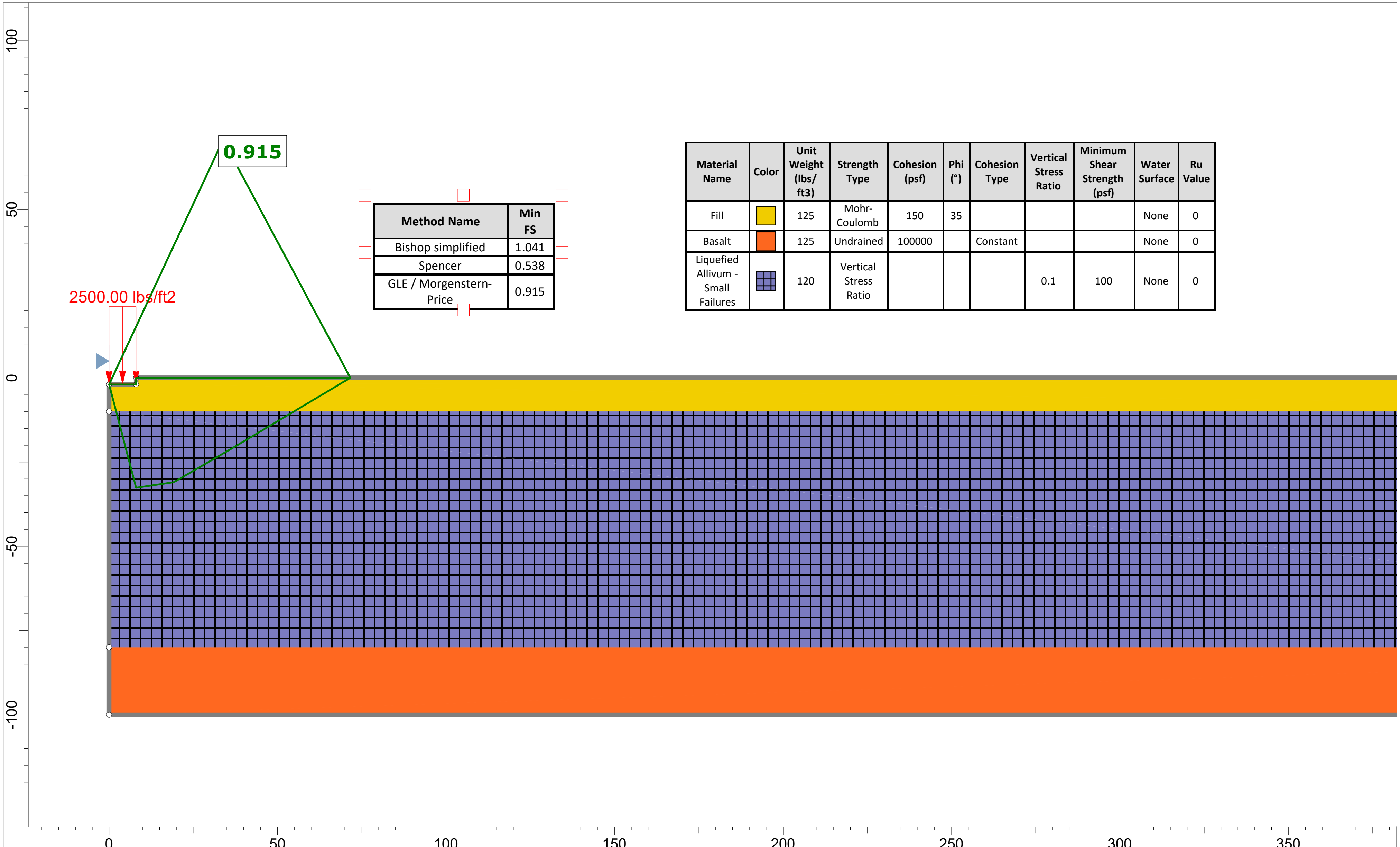
Method Name	Min FS
Bishop simplified	1.046
Spencer	0.230
GLE / Morgenstern-Price	0.987

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		125	Mohr-Coulomb	150	35				None	0
Basalt		125	Undrained	100000		Constant			None	0
Liquefied Allivum - Small Failures		120	Vertical Stress Ratio				0.1	100	None	0

SAGE GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 1	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/19/2024, 10:39:28 AM	*File Name*	KM Willbridge Bearing Cap.slmd



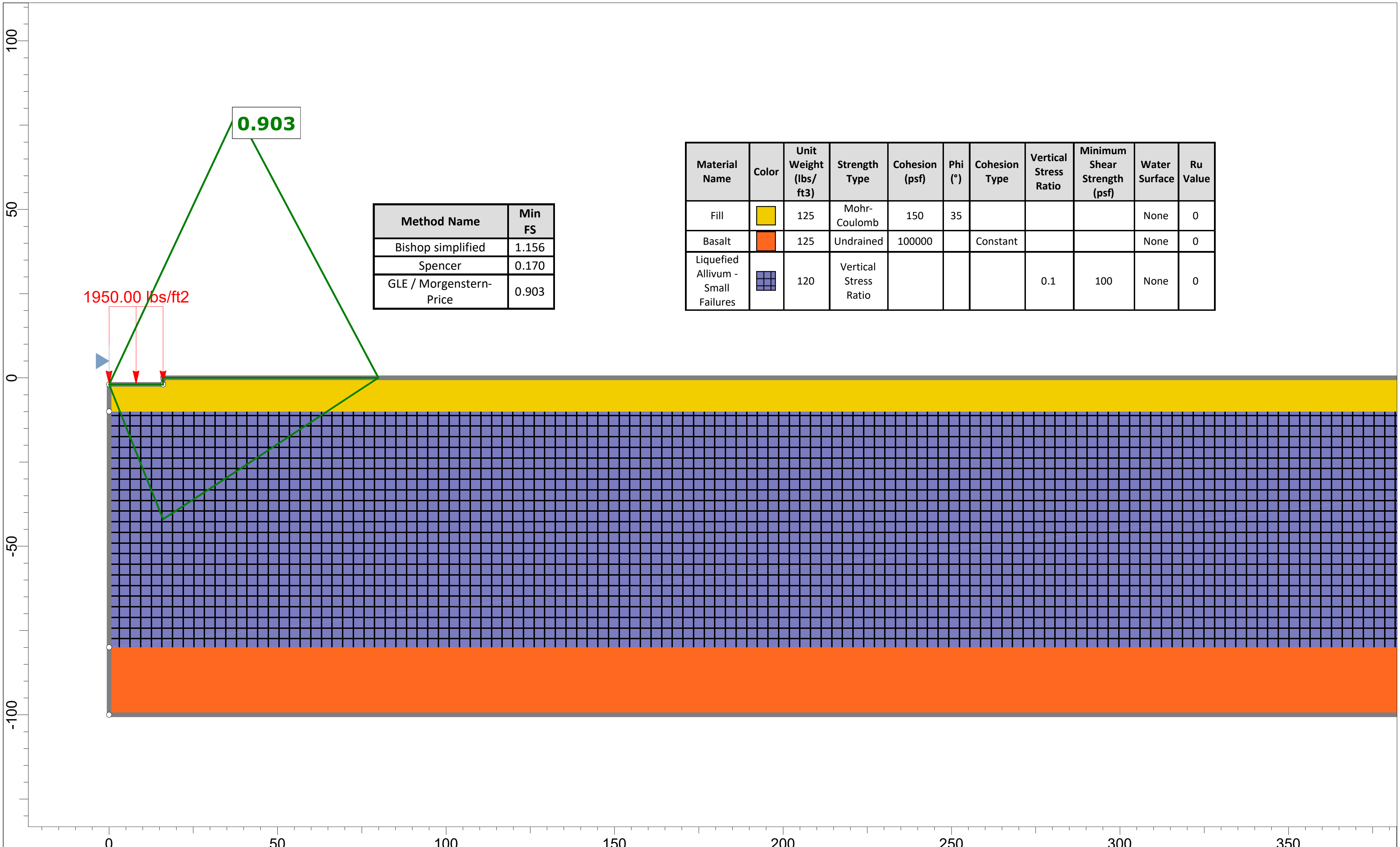
Method Name	Min FS
Bishop simplified	1.041
Spencer	0.538
GLE / Morgenstern-Price	0.915

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		125	Mohr-Coulomb	150	35				None	0
Basalt		125	Undrained	100000		Constant			None	0
Liquefied Allivum - Small Failures		120	Vertical Stress Ratio				0.1	100	None	0

GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 2	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/19/2024, 10:39:28 AM	*File Name*	KM Willbridge Bearing Cap.slmd



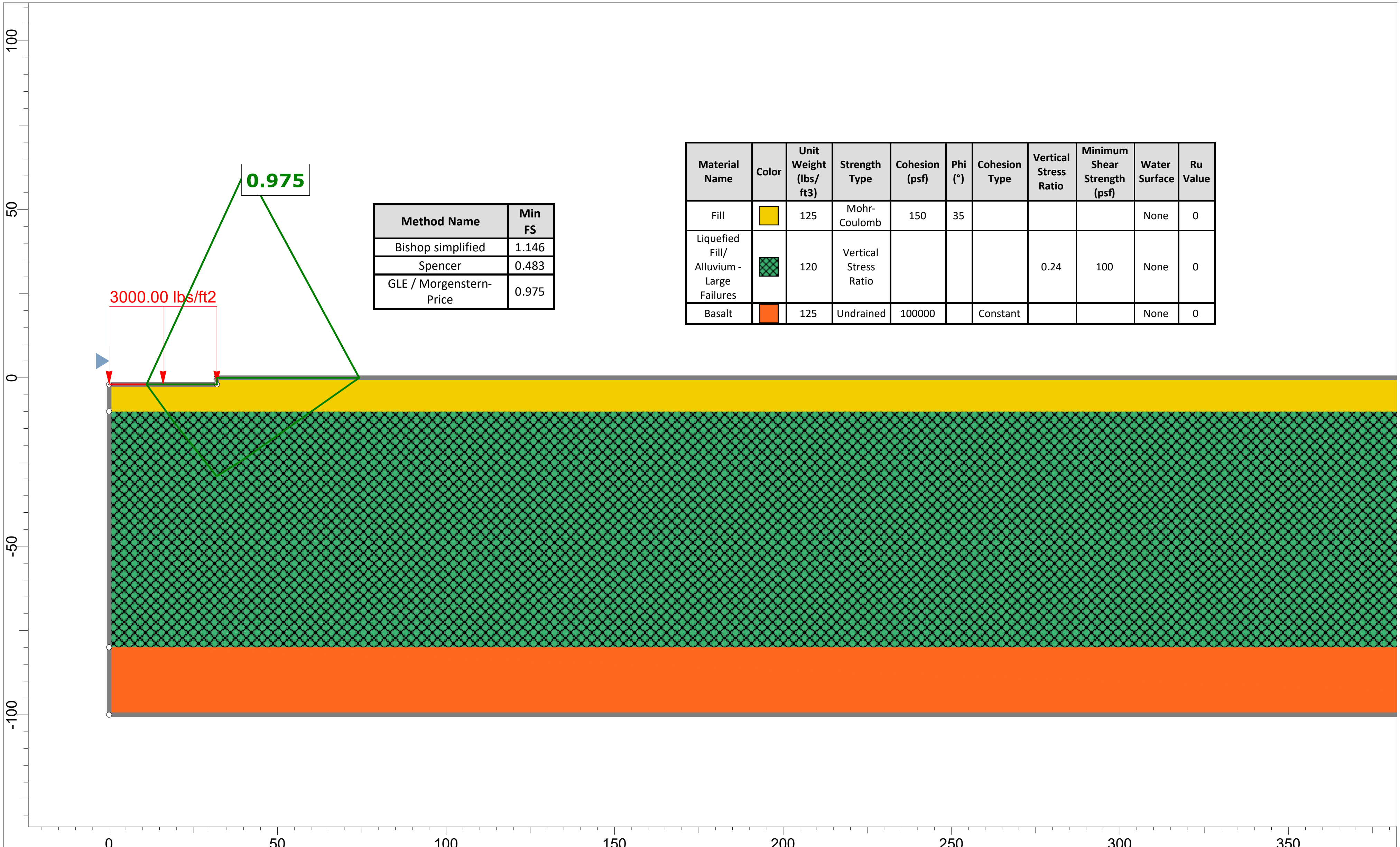
Method Name	Min FS
Bishop simplified	1.156
Spencer	0.170
GLE / Morgenstern-Price	0.903

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		125	Mohr-Coulomb	150	35				None	0
Basalt		125	Undrained	100000		Constant			None	0
Liquefied Allivum - Small Failures		120	Vertical Stress Ratio				0.1	100	None	0

SAGE GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 3	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/19/2024, 10:39:28 AM	*File Name*	KM Willbridge Bearing Cap.slmd



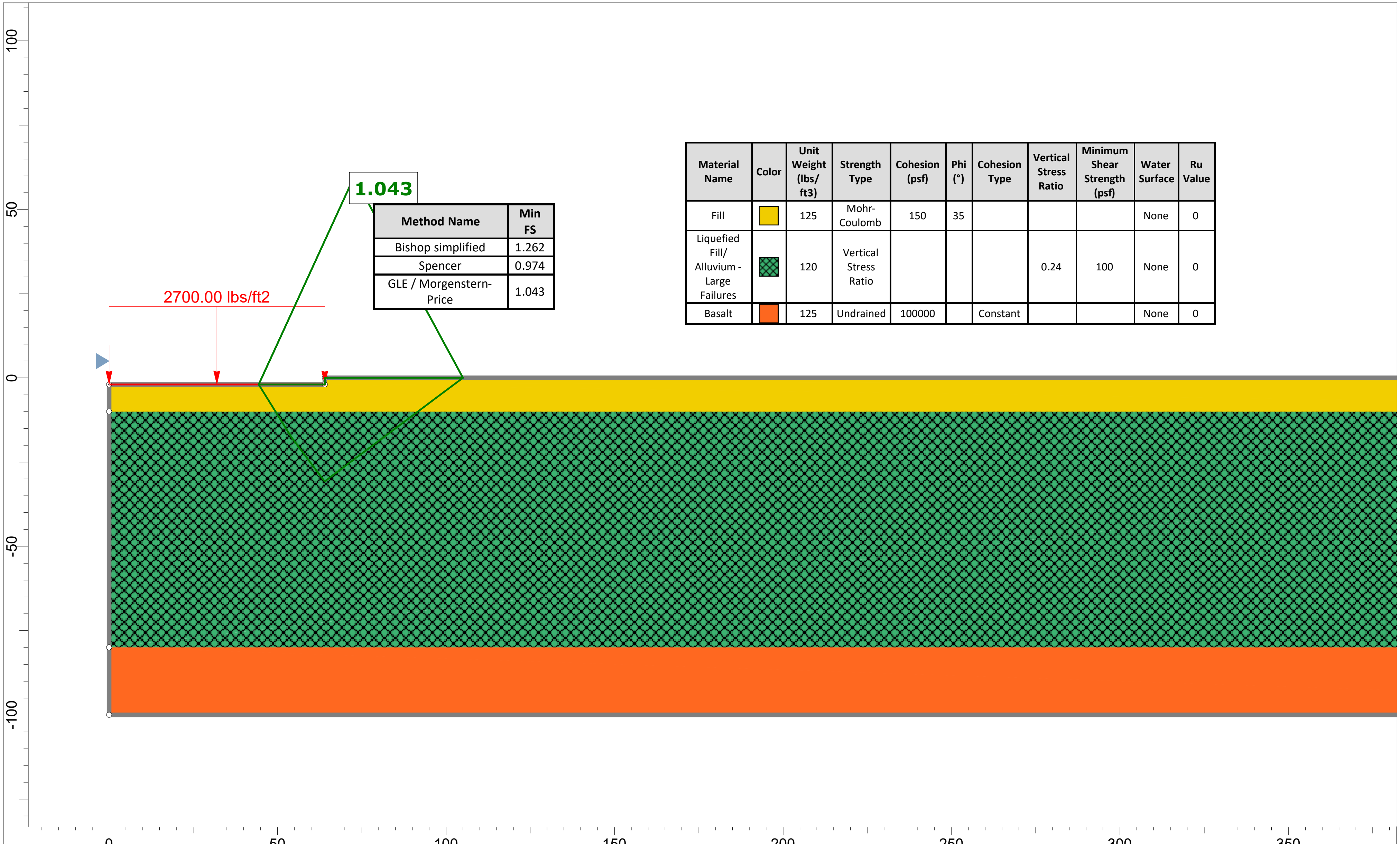
Method Name	Min FS
Bishop simplified	1.146
Spencer	0.483
GLE / Morgenstern-Price	0.975

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		125	Mohr-Coulomb	150	35				None	0
Liquefied Fill/ Alluvium - Large Failures		120	Vertical Stress Ratio				0.24	100	None	0
Basalt		125	Undrained	100000		Constant			None	0

SAGE GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 4	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/19/2024, 10:39:28 AM	*File Name*	KM Willbridge Bearing Cap.slmd



Method Name	Min FS
Bishop simplified	1.262
Spencer	0.974
GLE / Morgenstern-Price	1.043

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		125	Mohr-Coulomb	150	35				None	0
Liquefied Fill/ Alluvium - Large Failures		120	Vertical Stress Ratio				0.24	100	None	0
Basalt		125	Undrained	100000		Constant			None	0

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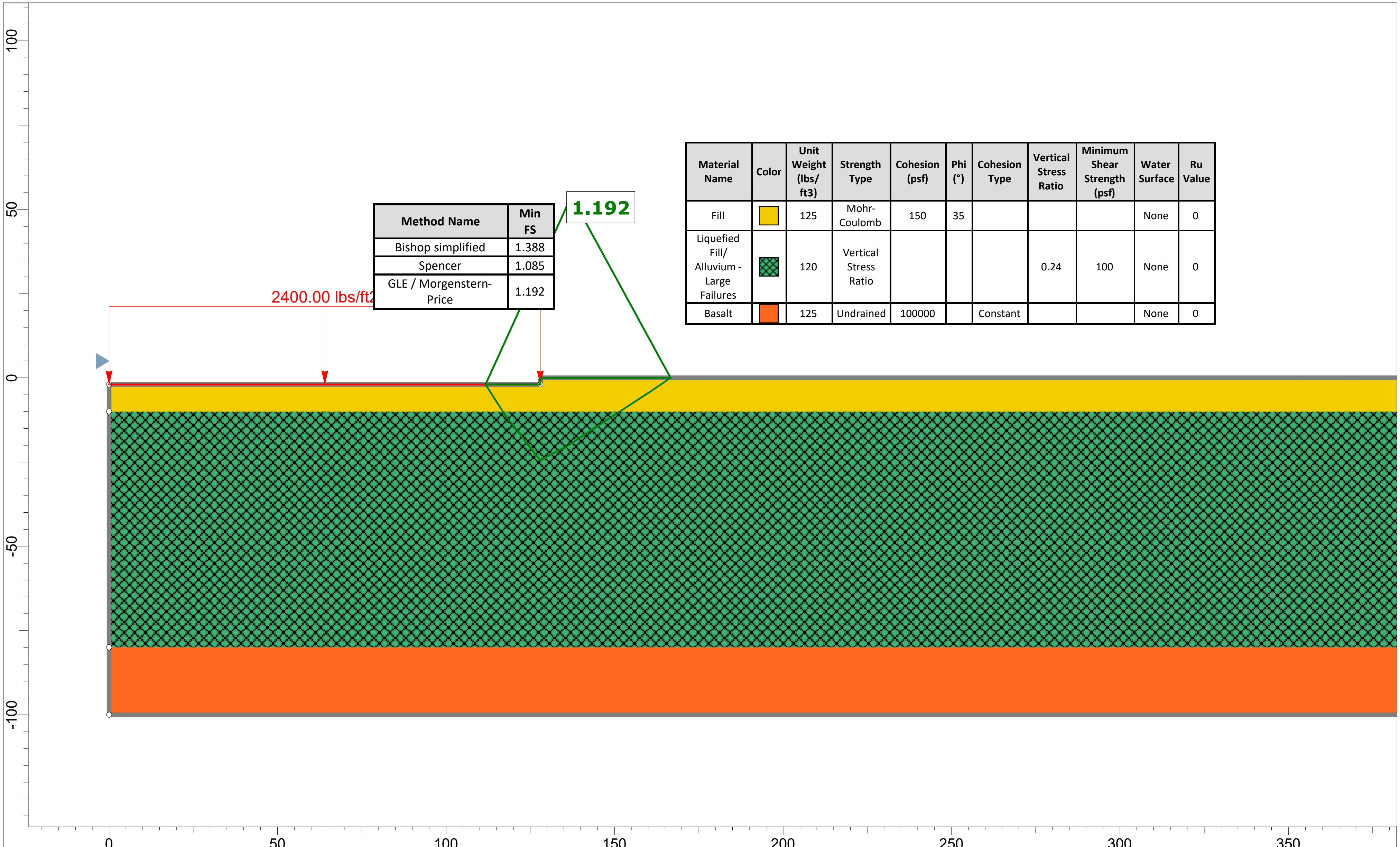
SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program		
Group	Group 5	*Scenario*	Master Scenario
Drawn By		*Checked By*	
Date	3/19/2024, 10:39:28 AM	*File Name*	KM Willbridge Bearing Cap.slmd



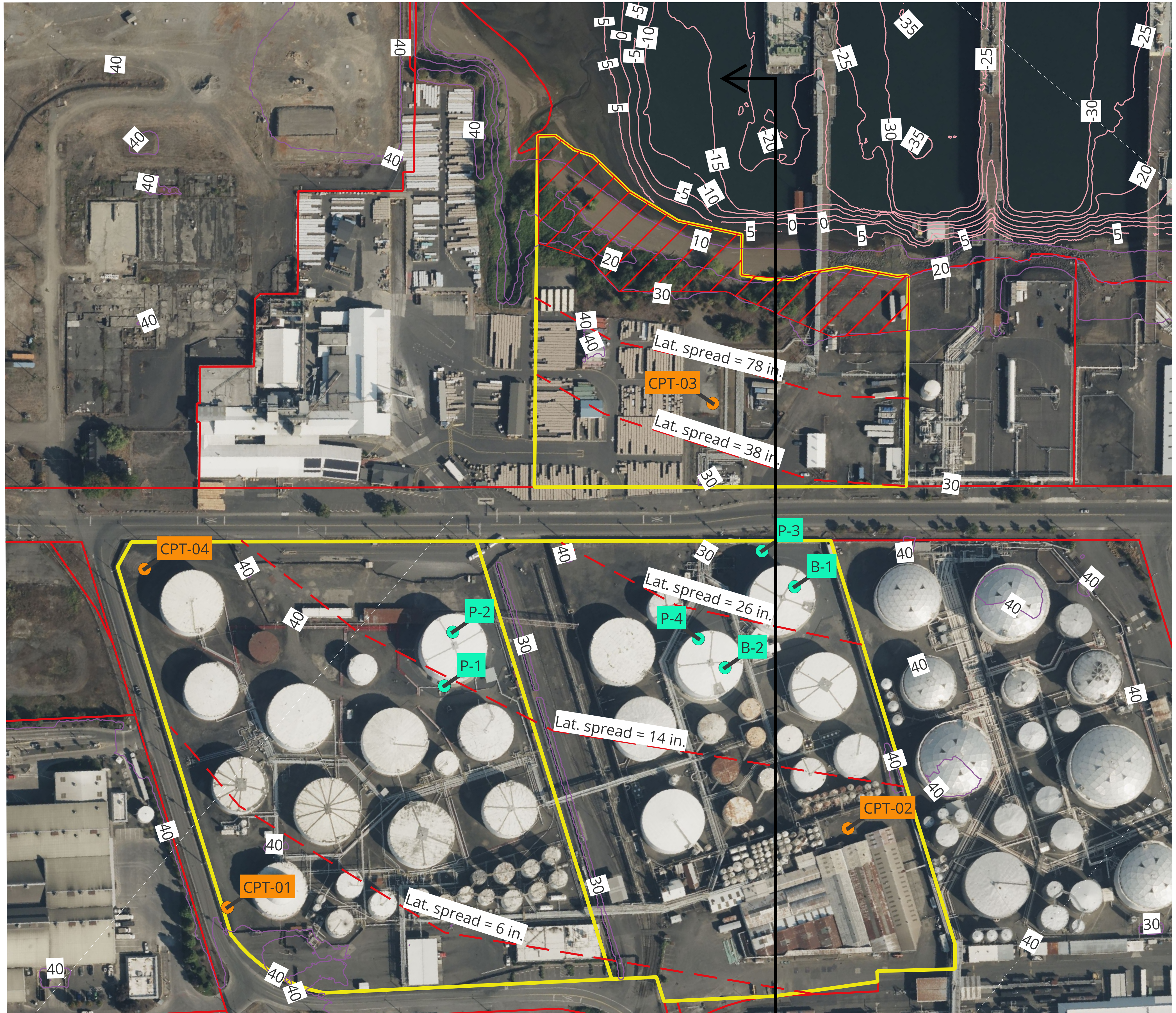
Method Name	Min FS
Bishop simplified	1.388
Spencer	1.085
GLE / Morgenstern-Price	1.192

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		125	Mohr-Coulomb	150	35				None	0
Liquefied Fill/ Alluvium - Large Failures		120	Vertical Stress Ratio				0.24	100	None	0
Basalt		125	Undrained	100000		Constant			None	0

SAGE GEOTECHNICAL

SLIDEINTERPRET 9.028

Project	Slide2 - An Interactive Slope Stability Program
Group	Group 6
Scenario	Master Scenario
Drawn By	
Checked By	
Date	3/19/2024, 10:39:28 AM
File Name	KM Willbridge Bearing Cap.slmd



See Figure G-3 for geotechnical cross section

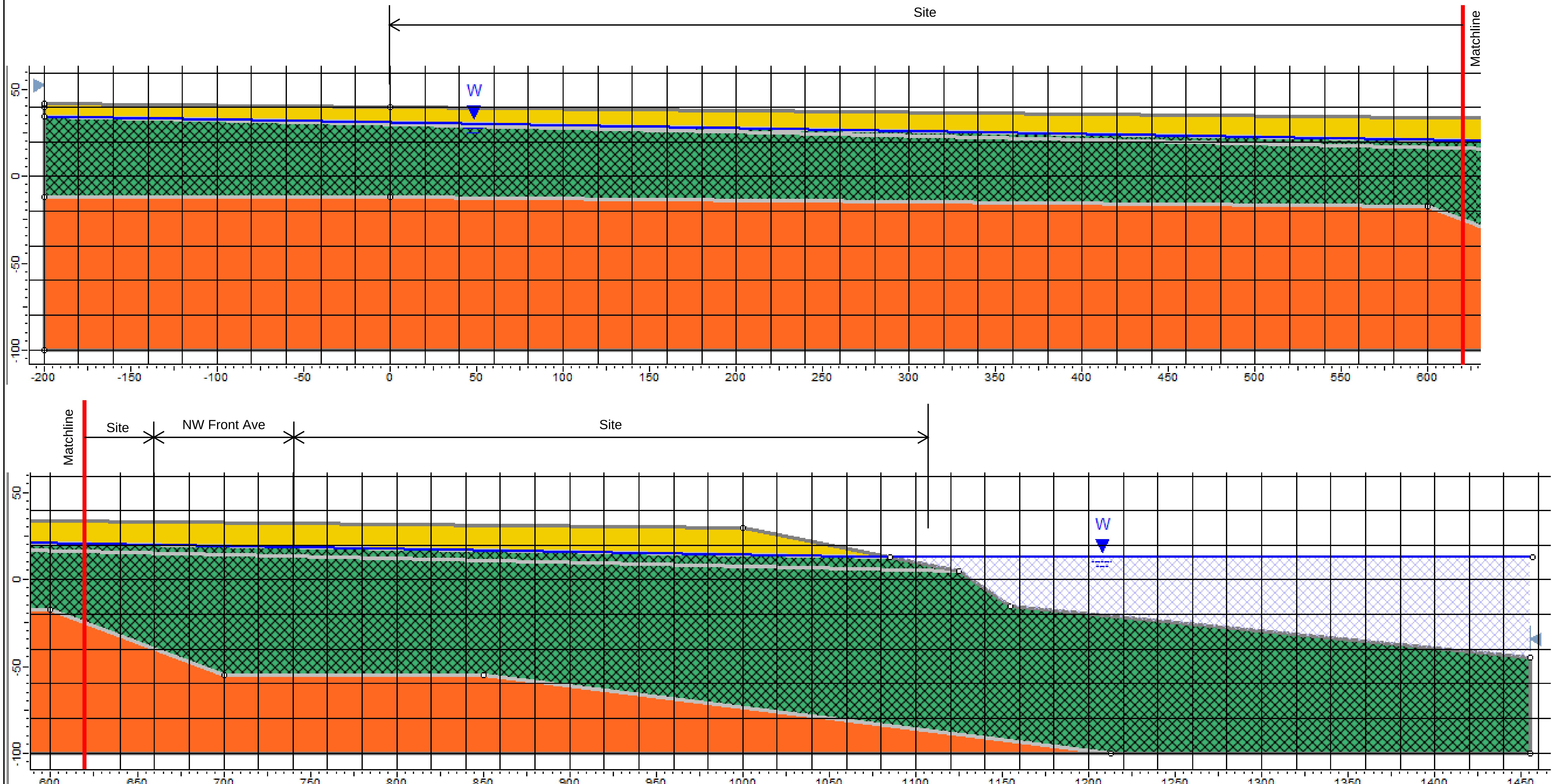
Legend

- Lateral Spreading Displacement Contours
- Flow Failure Zone
- CPT Location and Designation
- GeoEngineers (2011) Exploration Location and Designation
- 2014 Metro LIDAR contours
- Willamette_River_Bathymetry_(2005)
- Site Boundary
- Taxlot_Parcels

Bing Maps Satellite Imagery

SAGE GEOTECHNICAL

Site and Exploration Plan	
Kinder Morgan Willbridge Terminal SVA	
Portland, Oregon	Figure G-2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Cohesion Type	Vertical Stress Ratio	Minimum Shear Strength (psf)	Water Surface	Hu Type	Hu
Fill		125	Mohr-Coulomb	150	35				Water Table	Custom	1
Basalt		125	Undrained	100000		Constant			Water Table	Custom	1
Liquefied Fill/ Alluvium		120	Vertical Stress Ratio				0.24	100	Water Table	Custom	1

SAGE GEOTECHNICAL

Geotechnical Cross Section

Kinder Morgan Willbridge Terminal SVA

Portland, Oregon

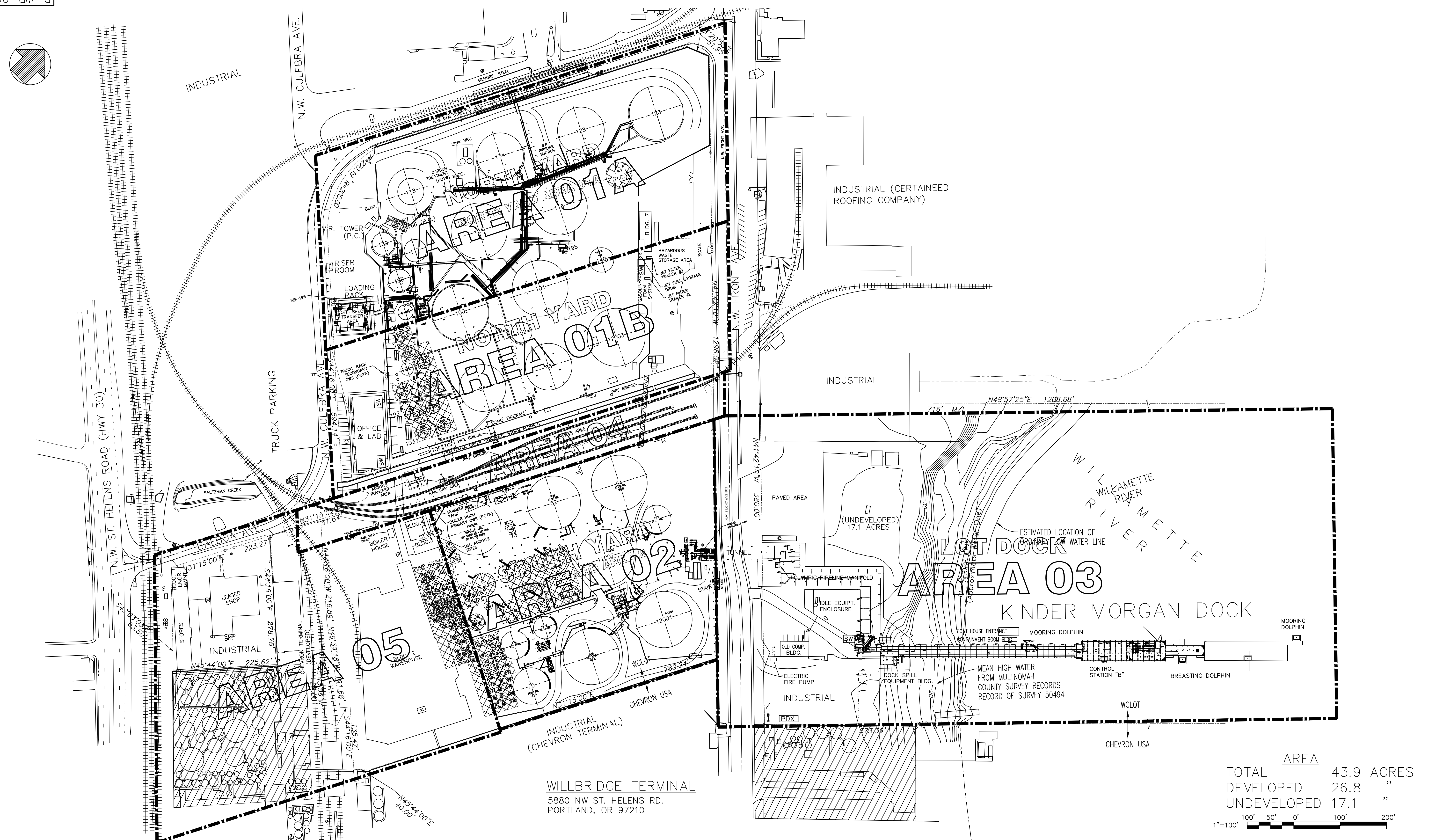
Figure G-3

6.2 Appendix B: Site Plans

B-1 Area Key Plan

B-2 Fire Protection Plan

B-3 Evacuation Plan



AREA

TOTAL	43.9	ACRES
DEVELOPED	26.8	"
UNDEVELOPED	17.1	"

REVISION NUMBER	DATE	REVISION DESCRIPTION	DRAWN BY	CHECKED BY	PROJECT MGR.
10	07/20/16	REVISED PER EHS MARK-UPS DATED 6-28-16	JS	ML	
9	05/20/16	AS-BUILT PER AFE 49976 JET FILTRATION	SJS	SJS	
8	12/14/15	REVISED PER EHS MARK-UPS DATED 12-08-15	SJS	SJS	
7	5/04/15	AS-BUILT PER AFE-66113 (FIRE PROTECTION-ETHANOL LR)	SUN	SUN	

KINDER MORGAN
LIQUIDS TERMINALS — ENERGY PARTNERS, L.P.

DRAWN BY: MW
DATE: 2/8/06
SCALE: 1"=100'-0"
CADFILE: WB00-004.DWG

AREA KEY PLAN

WILLBRIDGE TERMINAL

RECORD DRAWING No. D-WB-00-004

FILE: S:\LQT\WB_REC-WORK_Mechanical\WB00-004(REV10).dwg PLOT BY: lucimau1
DATE: Aug 18, 2016 10:11am

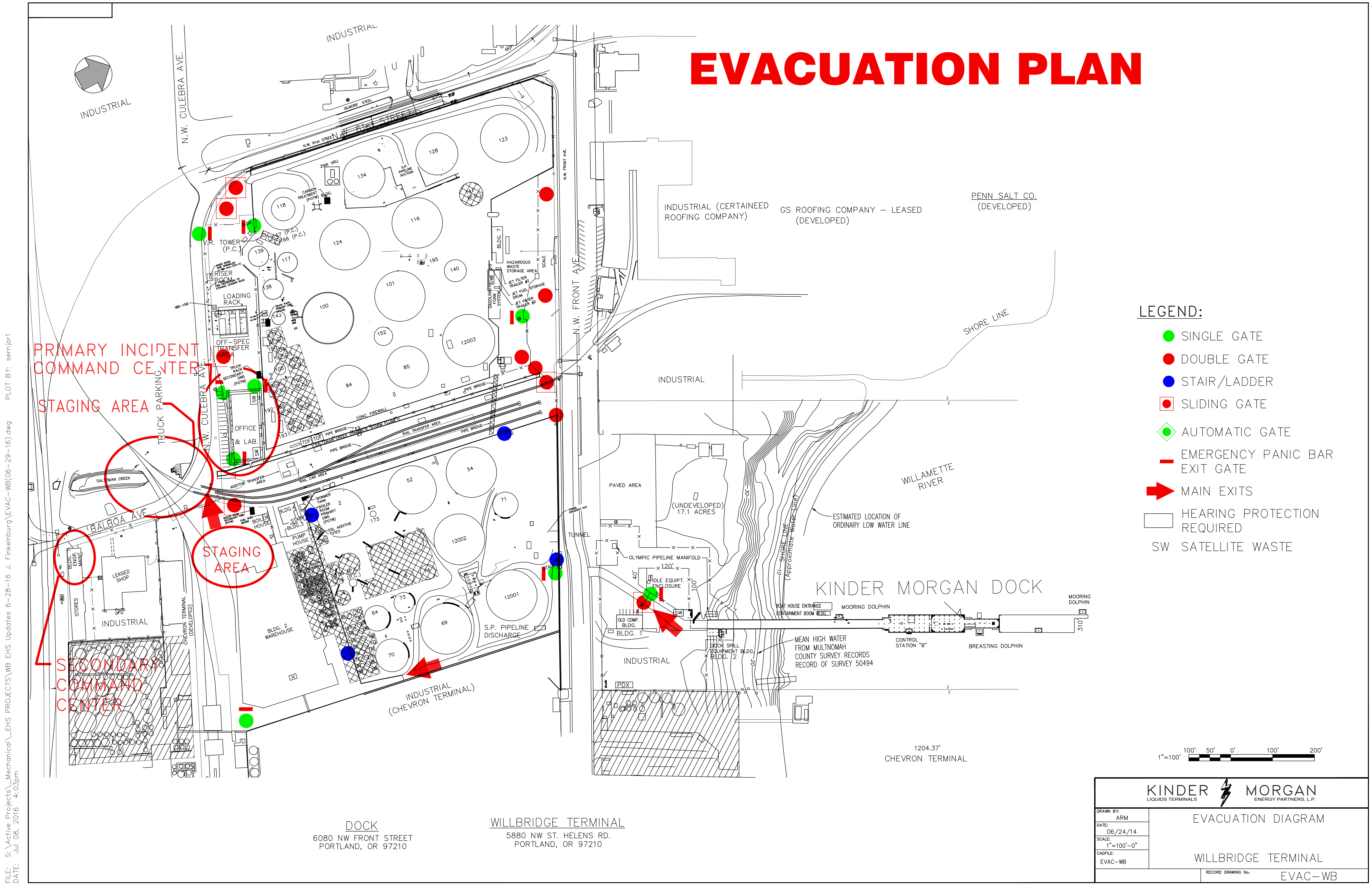
LEGEND:

FH ●	CITY FIRE HYDRANT
FDC ⤙ OR FDC	FIRE DEPT. CONNECTION
F.M.	FIRE MONITOR
(green line)	ETHANOL FOAM LINE
(orange line)	GAS FOAM LINE
●	FIRE EXTINGUISHER

KINDER MORGAN LIQUIDS TERMINALS — ENERGY PARTNERS, L.P.

FIRE PROTECTION
WILBRIDGE TERMINAL

CADD	SCALE: NONE	RECORD DRAWING NO.
FILE: FPD-WB	DESIGN SUPT	FPD-WB
BY: ML	MGR. SAFETY	
DATE: 01-15-16	AREA SUPR.	


EVACUATION PLAN
LEGEND:
SINGLE GATE
DOUBLE GATE
STAIR/LADDER
SLIDING GATE
AUTOMATIC GATE
EMERGENCY PANIC BAR EXIT GATE
MAIN EXITS
HEARING PROTECTION REQUIRED
SW SATELLITE WASTE
PRIMARY INCIDENT COMMAND CENTER
STAGING AREA
STAGING AREA
SECONDARY COMMAND CENTER
TRUCK PARKING
N.W. CULEBRA AVE.
N.W. FRONT AVE.
BALBOA AVE.
INDUSTRIAL
INDUSTRIAL (CERTAINEED ROOFING COMPANY)
GS ROOFING COMPANY - LEASED (DEVELOPED)
PENN SALT CO. (DEVELOPED)
SHORE LINE
WILLAMETTE RIVER
ESTIMATED LOCATION OF ORDINARY LOW WATER LINE
(UNDEVELOPED) 17.1 ACRES
PAVED AREA
TUNNEL
OLYMPIC PIPELINE MANIFOLD
KINDER MORGAN DOCK
MOORING DOLPHIN
BREASTING DOLPHIN
CONTROL STATION "B"
MEAN HIGH WATER FROM MULTNOMAH COUNTY SURVEY RECORDS RECORD OF SURVEY 50494
S.P. PIPELINE DISCHARGE
INDUSTRIAL (CHEVRON TERMINAL)
CHEVRON TERMINAL
OFFICE & LAB.
LOADING RACK
BLDG. 2 WAREHOUSE
LEASED SHOP
STORES
CHEVRON TERMINAL (DEVELOPED)
SALTZMAN CREEK
1"=100'
DOCK
6080 NW FRONT STREET
PORTLAND, OR 97210
WILLBRIDGE TERMINAL
5880 NW ST. HELENS RD.
PORTLAND, OR 97210
KINDER MORGAN
LIQUIDS TERMINALS
ENERGY PARTNERS, L.P.
DRAWN BY: ARM
DATE: 06/24/14
SCALE: 1"=100'-0"
CADFILE: EVAC-WB
EVACUATION DIAGRAM
WILLBRIDGE TERMINAL
RECORD DRAWING No. EVAC-WB
FILE: S:\Active Projects_Mechanical_EHS PROJECTS\WB EHS Updates 6-28-16 J. Finkelnburg\EVAC-WB(06-29-16).dwg
DATE: Jul 08, 2016 4:03pm
PLOT BY: sernjor1

6.3 Appendix C: Photographs

Picture 1. Typical view of North Yard tank farm.

Picture 2. Typical view of pipe runs at North Yard.

Picture 3. Tall slender pipe support at North Yard.

Picture 4. Multiple pipes supported by slender channel framing at North Yard.

Picture 5. Pipe supported by wood and concrete blocks at North Yard.

Picture 6. Pipe bridge adjacent to truck loading rack at North Yard.

Picture 7. North Yard truck loading rack framing.

Picture 8. Containment wall structure at North Yard.

Picture 9. Saltzman Creek storm flume.

Picture 10. Typical view of unanchored additive tank at North Yard.

Picture 11. Unanchored gas foam tank at North Yard.

Picture 12. Typical view of North Yard vapor recovery unit anchorage in hole, no epoxy observed.

Picture 13. Typical view of canopy structure at North Yard.

Picture 14. Typical view of tank farm at South Yard.

Picture 15. View of typical pipe support type at South Yard.

Picture 16. Typical view of containment walls at South Yard.


Picture 17. View of typical canopy structure at South Yard.


Picture 18. Typical view of rail transfer platform.

Picture 19. View of “Pipe Bridge 1” at Rail Transfer Area.

Picture 20. View of “Pipe Bridge 2” at Rail Transfer Area.


Picture 21. View of "Pipe Bridge 3" at Rail Transfer Area.


Picture 22. Typical view of light framed structure at Warehouse area.