Retaining Walls 9.85L, 9.90L-A and 9.90L-B Geotechnical Design Memorandum - FINAL

WSDOT I-405 Renton to Bellevue Widening and Express Toll Lanes
Renton to Bellevue, Washington

November 30, 2021

WSDOT Contract No. 9242
Terracon Project No. 81215044

Prepared for:
Parsons

Prepared by:
Terracon Consultants, Inc.
Mountlake Terrace, Washington

terracon.com

Terracon

Environmental ■ Facilities ■ Geotechnical ■ Materials

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10/29/21	IR-CR
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November 30, 2021

Parsons Transportation Group
600 University Street, Suite 700
Seattle, WA 98101

Attn: Mr. Paul Dickman
P: (605) 284-3609
E: paul.dickman@parsons.com

RE: Retaining Walls 9.85L, 9.90L-A and 9.90L-B
I-405 Renton to Bellevue Widening and Express Toll Lanes Project
I-405 MP 0.0 to 14.6
King County, WA
WSDOT Contract No. 9242
Terracon Project No. 81215044

Dear Mr. Dickman:

Terracon Consultants, Inc. (Terracon) is pleased to present this Geotechnical Engineering Report for Walls 9.85L, 9.90L-A and 9.90L-B as part of the above referenced project. This report presents our analyses and recommendations for design and construction of the special barrier and mechanically stabilized earth (MSE) retaining walls.

The information evaluated for this report includes data presented in the Request for Proposal (RFP) Documents, prior exploration and geotechnical work completed by Wood Environment & Infrastructure Solutions, Inc. (Wood), and supplemental work completed by Terracon. This report was prepared in accordance with the requirements of RFP Section 2.6.5.3 of the project Technical Requirements. Geotechnical design was performed according to the 2019 Washington State Department of Transportation (WSDOT) Geotechnical Design Manual (GDM), the 2018 AASHTO LRFD Bridge Design Specifications and RFP Section 2.6.

We appreciate the opportunity to be of service to Parsons and the Flatiron-Lane JV. Please let us know if you have any questions regarding this design information.

PETER JOHN PALMERSON
STATE OF WASHINGTON
41745
REGISTERED PROFESSIONAL ENGINEER

11/30/21

Sincerely,
Terracon Consultants, Inc.

Robert W. Sargent, P.E.
Senior Geotechnical Engineer

Pete Palmerson, P.E.
Geotechnical Department Manager

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WALL 9.85L, 9.90L – A and B - GEOTECHNICAL REPORT - FINAL
I-405 Renton to Bellevue Design-Build
Renton to Bellevue, Washington

WSDOT Contract No. 9242
Terracon Project No. 81215044
November 30, 2021

1.0 DESCRIPTION

This Geotechnical Report provides recommendations regarding the design and construction of Retaining Walls 9.85L, 9.90L-A and 9.90L-B. This report is based on our present knowledge of the proposed construction, the retaining wall plans as provided in Appendix A, coordination with other disciplines and construction personnel on the project team.

2.0 PLANNED CONSTRUCTION

Parsons provided the design drawings. The retaining walls plans that formed the basis of our design are included in Appendix A: Retaining Wall Plans and Profiles. We understand that retaining walls 9.90L A & B are planned as mechanically stabilized earth walls (MSE) and Wall 9.85 will be a special design barrier. Retaining walls 9.85L, 9.90L-A and 9.90L-B are to be located on the west side of southbound I-405 to facilitate road widening and a new on-ramp to southbound I-405 from Coal Creek Parkway. Descriptions of the walls are provided below in Table 1.

TABLE 1 - RETAINING WALL LAYOUT INFORMATION

Wall ID	Wall Location				Length of Wall (ft.)	Wall Height (ft.)			
	Roadway Sta.		Wall Sta.						
	From (SB405)	To (SB405)	From	To		Max.	At Sta.	Min.	At Sta.
9.85L	5826+10	5826+33	1+50	1+77	27	4.4	1+70	1.2	1+77
9.90L-A	5823+80	5832+05	3+41	11+85	844	21	10+80	2	3+41 and 11+85
9.90L-B	5834+77	5840+10	1+50	6+80	530	27.5	2+70	2	1+50 and 6+80
Sta. - station									

Retaining wall 9.90L-B will cross two fish passage structures (culverts) (FPS), one at FPS 10.0 at approximate wall station 2+34 and the second at the existing Coal Creek Culvert Crossing at approximate wall station 5+51. In consideration of added loading and settlement of the existing Coal Creek Culvert the planned backfill above and near the culvert is expanded polystyrene (EPS) foam. Additional recommendations regarding the EPS are provided later in this report. Wall foundation and overexcavation recommendations provided by Wood for the FPS 10.0 location have been incorporated into wall plans per recommendations provided in the Geotechnical Engineering Report: Fish Passage 10.0 dated September 15, 2021.

3.0 SUBSURFACE EXPLORATIONS

For project consistency, we have continued the geologic unit descriptions and stratigraphy used by Wood based on the mapped and structural geology (McKnight 1923, Waldron et al. 1962, Mullineaux 1965, Yount et al. 1993, Johnson et al. 1994, Liberty and Pratt 2008, Troost 2012, and WSDOT 2018a and 2018b) and as described by others (Golder 1993, Shannon & Wilson 2000, and GeoEngineers 2008) in the project vicinity. The geologic units have been simplified for converting them into ESUs, which were used for design of the structures. These modifications to the geologic units consisted of combining the Quaternary period Pleistocene and Holocene epoch soils consistent with previous work on the project completed by Wood, Hart Crowser, and GeoEngineers. The geologic units encountered at the subject site, along with a brief discussion of their descriptions used for the project geology are provided in Table 2.

TABLE 2 – PROJECT GEOLOGIC UNITS

Geologic Units	Abbreviation	Geologic Unit Description
Fill	Af	Fill placed by humans, both engineered and uncontrolled fill consisting of various materials, including debris; typically dense or stiff if engineered, but very loose to dense or very soft to stiff if uncontrolled fill.
Alluvium with Organics	Qal	Mainly river or creek deposits, normally associated with historic streams, including overbank deposits consisting of sand, silty sand, and silt/clay; gravelly sand, sandy gravel with organics that range from very loose to very dense or very soft to soft, and includes depressions or lake deposits that consist of silts, clays, and sandy silts that maybe interbedded within the alluvial deposits.
Recent Alluvium	Qal	Mainly river, creek or overbank deposits, consisting of sand, silty sand; gravelly sand and sandy gravel with scattered organics that are typically very loose to dense,

TABLE 2 – PROJECT GEOLOGIC UNITS

Geologic Units	Abbreviation	Geologic Unit Description
		and includes interbedded slack water or lake deposits that consist of silts, clays and sandy silts.
Recessional Lacustrine Deposits	Qvrl	Laminated silt and clay, low to high plasticity with local sand layers, peat, and other organic sediments, deposited in slow-flowing water and ephemeral lakes. Locally includes high-plasticity clay with swell potential. Lenses and layers of ash and diatomite may be present. Very soft to stiff.
Advance Outwash	Qva	Glaciofluvial sediments deposited as the glacial ice advanced through the Puget Lowland and overridden by the weight of glacial ice; typically stratified, light brown to gray, sand, gravelly sand, and sandy gravel; dense to very dense.
Proglacial Lacustrine Deposits (Lawton Clay)	Qgl	Fine-grained glacial sediment deposited in pro-glacial lake in Puget Lowland consisting of interbedded brown, gray to blue-gray silt, clayey silt; silty clay; fine sand; massive to locally laminated or locally disturbed (fractures and slickensides); scattered wood near base; very stiff to hard or dense to very dense.
Landslide Deposits	Qls	Lacustrine sand and silt deposit. Scattered black organics and rootlets, disturbed, loose to medium dense.

3.1 Site Soil Conditions

Subsurface exploration data was provided in the Washington State Department of Transportation's (WSDOT's) Geotechnical Data Report (GDR) contained in the Request for Proposal (RFP). Additional explorations were completed by Wood and records of completed borings were provided as part of the project. Terracon advanced six (6) cone penetration tests (CPTs) and installed a groundwater monitoring well to provide supplemental information to evaluate site conditionals at the retaining wall locations. A Site Exploration Plan and Engineering Soil Unit (ESU) subsurface profile are presented in Appendix A. Copies of CPT logs are provided in Appendix B: Project Exploration Logs. A summary of groundwater monitoring results recorded from wells in the vicinity are provided in Appendix C. Copies of boring logs and laboratory test results provided in the RFP are provided in Appendices D and E, respectively. Tables 3A and 3B

summarizes the explorations we considered for design of retaining walls 9.90L-A and 9.90L-B, respectively.

TABLE 3A –EXPLORATION SUMMARY WALL 9.90L-A

Boring Number	Date Completed	Boring Depth (ft.)	Ground Surface Elevation (ft. MSL)[1]	Groundwater Elevation (ft. MSL)
Terracon Explorations				
T-CPT-5A-21	7/12/21	34.3	83	--[2]
Explorations Completed by Others				
W-27-20	1/8/20	16.5	77.6	69.6[3]
W-35-20	1/8/20	16.5	77.0	70.0[3]
W-106mw-20	8/5/20	51.5	108.5	80.1
W-143-20	5/21/20	26.5	106.8	99.3
W-144-20	5/26/20	26.5	102.8	94.8
W-145-20	5/27/20	26.5	98.6	Not Observed
W-146-20	5/27/20	26.5	94.8	Not Observed
W-149-20	2/20/20	26.5	103.8	Not Observed
W-150-20	2/20/20	31.5	96.0	Not Observed
W-151-20	2/24/20	51.5	87.2	Not Observed

Notes:
1. Ground surface elevations are rounded to the nearest 0.1 feet.
2. Pore water dissipation test results were not considered at this location due to test quality.
3. Based on the review of the boring log, in our opinion, observed ground water is actually perched water.

TABLE 3B –EXPLORATION SUMMARY WALL 9.90L-B

Boring Number	Date Completed	Boring Depth (ft.)	Ground Surface Elevation (ft. MSL)	Groundwater Elevation (ft. MSL)
Terracon Explorations				
T-CPT-01-21	8/6/21	27.2	47	--
T-CPT-2B-21	8/5/21	13.9	41	40
T-CPT-4A-21	7/12/21	28.4	62	43
T-CPT-06-21	9/9/21	26	70.7	42
T-Well01-21	9/2/21	30	65.5	43
Explorations Completed by Others				
GEO-35	10/30/07	45	69.9	46.4
GEO-36	10/30/07	40	63.7	46.7
GEO-37	10/30/07	40	57.0	Not Observed
GEO-38	10/30/07	34	58.6	44.1
R2B-77vw-17	5/16/17	70.5	67.9	47.9
R2B-78-17	5/10/17	74.4	59.3	50.3
R2B-79-17	3/23/17	70.2	77	40
R2B-81vw-17	3/15/17	78.9	76.4	33.4
KP-3-06	11/14/06	51.5	81	60.4
W-29-20	1/8/20	16.5	78.2	Not Observed
H-1-64-CC	3/2/64	35	41.7	38.9
H-2-64-CC	3/3/64	40	43.0	41.5
H-3-64-CC	3/6/64	30	47.3	39.8

Notes:
1. Ground surface elevations are rounded to the nearest 0.1 feet

3.2 Groundwater Conditions

From our review of historical borings, at the beginning of wall 9.90L-A, groundwater is at its shallowest depth and it gradually trends downward as it gets closer to the end of wall. At the beginning of the wall (Sta. 3+41) the groundwater table was approximately at elevation 80 feet, and at the wall end station (11+85), groundwater has an approximate elevation of 70 feet. Our interpretation of the variable groundwater elevations is that the observed groundwater likely represents perched groundwater that has collected in more permeable zones within the glacial soil. Although these localized zones may be water bearing, they likely do not represent the overall

groundwater elevation in the area. When initially cutting into these areas, groundwater seepage may emerge from the slope for a period of time until the accumulated water has drained.

Near the beginning of wall 9.90L-B, the groundwater elevation near the FPS 10.0 outlet is at approximately elevation 47 feet per observed groundwater levels in boring GEO-35 and was interpreted as such in the FPS 10.0 Geotechnical Report. Trending northward along the wall the elevation of the water table continues to decrease. A standpipe piezometer, T-Well01-21, was installed near approximate wall station 3+70 to observe seasonal fluctuation of groundwater. The observed ground water table is at approximately elevation 43 feet based on current readings. This elevation is roughly 5 to 6 feet below the bottom of planned overexcavation depths recommended in this report per Table 11. Continuing northward the historic groundwater level in H-1-64cc was observed at approximate elevation 38.9 feet (adjusted to NAVD88). We also collected piezometer data of nearby borings, R2B-77vw-17 and R2B-81vw-17, from the Geotechnical Data Report. Groundwater level measurements are contained in Appendix C: Groundwater Monitoring.

The occurrence and elevation of groundwater is expected to be variable and to fluctuate seasonally due to variations in the amount of precipitation, evaporation, and surface water run-off.

4.0 GEOLOGIC HAZARDS

4.1 Scour Considerations

Portions of retaining wall 9.90L-B cross two culvert structures, one at Unnamed Tributary Fish Passage 10 culvert extension and the second at an existing culvert for Coal Creek. Per Section 4.1 of the Geotechnical Engineering Report: Fish Passage 10.0 completed by Wood it was indicated that there is the potential for longitudinal scour of the streambed along the wall. The recommended embedment depths of the bottom of wall footing near the location of FPS 10.0 have taken into account the potential for scour and planned placement of streambed gravel materials as shown in Table 8A.

4.2 Seismic Site Class and Design Parameters

Seismic design parameters for the walls are based on the general procedure, as outlined in AASHTO LRFD Bridge Design Specifications (AASHTO) Section 3.10.2.1, are provided in Table 4 below. The parameters are based on a design seismic event with a seven percent probability of being exceeded in 75 years using the USGS National Hazard Maps (2014). The site coefficients have been modified in accordance with Section 4.2.3.1 of the BDM.

The weighted average Standard Penetration Test (SPT) blow count (blows per foot) for the borings, extrapolated to a depth of 100 feet of the soil profiles was used to determine the site class in accordance with the LRFD Bridge Design Specifications (AASHTO 2017). The results of the analyses indicate the site should be classified as Site Class D.

TABLE 4: SEISMIC DESIGN DATA

Parameter	Value
Site Class	D
Peak Ground Acceleration (PGA)	0.425g
F_{PGA}	1.17
Site-Adjusted Peak Ground Acceleration (A_S)	0.50
Mean Magnitude Earthquake (M_w)	7.0

The peak horizontal ground acceleration (PGA) for the Site Class B/C boundary recommended in Table 4 does not include amplification or damping due to the site soils. In order to assess seismic earth pressures and inertial effects on the walls, the PGA for Class B rock needs to be adjusted for the site soil conditions. We have used the site coefficients in the BDM to calculate an effective peak ground acceleration coefficient (As) of 0.50 to be used for seismic design of the walls, global stability and liquefaction to include effects from site soils.

4.3 Liquefaction

Liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Cohesionless sands and silts submerged below the groundwater table with low relative density that lie within approximately 80 feet of the ground surface are the type of soils susceptible to liquefaction. The depth limit is in accordance with the Project GDM Section 6-1.2.3.

Clays are generally not susceptible to liquefaction. Besides a loss of strength, liquefaction can cause settlement of the overlying layers as the liquefying layer densifies following the earthquake shaking.

It was determined that there is a potential for liquefaction at the site within saturated soils with SPT N-value corrected for effective overburden stress ($[N_1]_{60}$) blow counts of fewer than 20. This was generally found within portions of ESUs 2C and 3A for portions of retaining wall 9.90L-B, as discussed below. Risk of liquefaction for soils present at retaining wall 9.90L-A is not anticipated.

Per the GDM Section 6-4.2.2, simplified procedures following the methods in Boulanger and Idriss (2014) were used to evaluate the factor of safety (FS) for liquefaction triggering for all soils at the site. The methods of Youd and Idriss (2001) and Cetin et. al (2004) were also evaluated to check the values obtained from the Boulanger and Idriss (2014) methods. Based on Section 6-4.2.4 of the GDM, the liquefaction-induced settlement evaluations followed the procedures in Ishihara and Yoshimine (1992) and the seismically induced settlement of the unsaturated soils was evaluated using the procedures of Tokimatsu and Seed (1987), as summarized in Kavazanjian et al. (2011).

We performed liquefaction analysis using soil information collected from two SPT logs (GEO 37 and GEO 38) and two CPT logs (T-CPT04A-21 and T-CPT06-21). Based on these evaluations (Appendix G), portions of the 3A, 3A-1 and non-plastic zones of 2C layers are expected to liquefy during the design seismic event.

The evaluated seismically induced settlement for the site is between approximately 1 to 3 inches.

5.0 DESIGN SOIL PROPERTIES

5.1 Engineering Stratigraphic Units

Tables 5A and 5B summarize encountered geologic units and the assigned ESUs used to develop recommendations for the retaining walls. To maintain consistency with previous work completed on the project we have attempted to remain consistent with ESU units and descriptions previously used by Wood and adopted by Hart Crowser.

TABLE 5A – ESU Units and Descriptions for Wall 9.85L and 9.90L-A

Geologic Units	Assigned ESU	ESU Description
Fill	1	New Fill - Common Borrow, dense
Fill	1B	Uncontrolled Fill- Silty Sand and Gravel, medium dense to dense
Alluvium	3A-1	Silty Sand, medium dense to dense
Advanced Outwash	4A	Silty Sand, dense to very dense
Glaciolacustrine Deposits	4E	SILT/CLAY, very stiff to hard
Landslide Deposits	5A	Silty Sand, loose to medium dense
Landslide Deposits	5B	SILT/CLAY, stiff to very stiff

TABLE 5B – ESU Units and Descriptions for Walls 9.90L-B

Geologic Units	Assigned ESU	ESU Description
Fill	1	New Fill - Common Borrow, dense
Fill	1A	Uncontrolled Fill - Silty Sand and Gravel, loose
Fill	1B	Uncontrolled Fill- Silty Sand and Gravel, medium dense to dense
Alluvium with Organics	2C	SILT/CLAY, very soft to soft
Alluvium	3A	Silty Sand, very loose to loose
Alluvium	3A-1	Silty Sand, medium dense to dense

TABLE 5B – ESU Units and Descriptions for Walls 9.90L-B

Geologic Units	Assigned ESU	ESU Description
Advanced Outwash	4A	Silty Sand, dense to very dense
Glaciolacustrine Deposits	4E	SILT/CLAY, very stiff to hard

Appendix A include wall profiles along the wall alignment illustrating interpreted subsurface ESU conditions. Details of the ESU soil property determinations are provided in the attached calculations packages in Appendix G.

5.2 ESU Soil Profiles and Design Soil Properties

The retaining wall plan and profile, ESU cross section, and soil profiles at the wall abutments are presented in Appendix A. Tables 6A and 6B presents the ESU soil properties, which were used in global and external stabilities, and soil bearing resistance calculations. Detailed calculations and procedures for determination of soil properties are provided in the attached calculations packages (Appendix G).

TABLE 6A – Design Soil Properties for Wall 9.90L-A

ESU GROUP	UNIT WEIGHT (pcf)	DRAINED CONDITION		UNDRAINED CONDITION		POST LIQUEFIED
ESU #		FRICTION ANGLE (deg)	Su'(psf)	FRICTION ANGLE (deg)	Su (psf)	$Su_{residual}$ (Sr/σ'_{vo})
1	120	32	0	32	100	NA
1B	125	35	50	35	200	NA
3A-1	120	35	0	35	0	NA
4A	130	38	0	38	0	NA
4E	130	34	0	0	4000 - 6000	NA
5A	115	30	25	30	100	NA
5B	115	28	0	0	1300	NA

TABLE 6B – Design Soil Properties for Wall 9.90L-B

ESU GROUP	UNIT WEIGHT (pcf)	DRAINED CONDITION		UNDRAINED CONDITION		POST LIQUEFIED
ESU #		FRICTION ANGLE (deg)	Su'(psf)	FRICTION ANGLE (deg)	Su (psf)	$Su_{residual}$ (Sr/σ'_{vo})
1	120	32	0	32	100	NA
1A	115	31	50	31	200	NA
1B	125	35	50	35	200	NA
2C	105	28	0	0	300 - 1000	0.2
3A	115	29	0	29	200	0.08
3A-1	120	35	0	35	0	0.12 - 0.15
3B	125	36	0	36	0	NA
3E	115	32	50	0	1200	NA
4A	130	38	0	38	0	NA
4E	130	34	0	0	4000 - 6000	NA

6.0 GEOTECHNICAL ANALYSIS AND DESIGN RECOMMENDATIONS

The following sections provide geotechnical recommendations for design and construction of planned MSE walls.

6.1 MSE Wall Design and Construction

We evaluated the wall using the procedures described in the WSDOT Geotechnical Manual (2019a), the AASHTO LRFD Bridge Design Specifications (BDS) (AASHTO, 2017), and FHWA GEC 11 (2009). Our evaluations are to determine the minimum strap lengths for external stability of the wall system, including global (rotational) stability, sliding, bearing capacity, eccentricity, overturning, and settlement. The wall vendor will evaluate internal stability and provide final design of the walls. Retaining wall's reinforced select backfill shall conform to Gravel Borrow for Structural Earth Wall per WSDOT (2019a) section 15-5.3.3 and WSDOT (2018c) section 9-03.14(4). The backfill should be adequately drained to prevent any water from collecting behind the wall, as shown on the wall detail sheet.

We used the retaining wall design plan and profile sheets and the available cross sections for our evaluations. We selected representative locations along the wall for detailed analyses considering wall height, slope and wall geometry, and locations with different soil profiles, as applicable.

6.2 MSE Wall Bearing Resistance

Bearing resistance of the foundation soils for MSE walls is based on AASHTO LRFD procedures and the following criteria:

- Bearing resistance values are provided for Static (Drained Soil Parameters), Pseudostatic (Undrained Soil Parameters) case. If design level earthquake triggers liquefaction, then a Post liquefied (Reduced Soil Parameters) condition was also evaluated.
- Horizontal seismic acceleration 0.185g was used based on allowable lateral displacements of 8 inches as indicated in GDM Section Appendix 15-E-3 as detailed in Appendix G.
- The following bearing resistance factors are used in our design: Static case 0.65, Pseudo-static case 0.90 and Post liquefied case 1.0.
- We used a minimum embedment depth of 2 feet. For wall sections with steep toe slope, we checked the minimum embedment depth per Table 202 GEC-11 (FHWA 2009). The wall design will provide the final embedment depth on the wall shop drawings.
- Based on the boring logs, at wall 9.90L-A, groundwater is not anticipated to be encountered at this wall location. For wall 9.90L-B, a segment of the wall will have a groundwater table near the planned bottom of wall elevations. For those critical sections which have high ground water table, in our analysis, we will consider water table is at wall footing elevation.

Tables 7A through 8B provides our design parameters and recommendations for critical wall segments along the walls.

TABLE 7A – MSE Wall Design Parameters for Wall 9.90L-A

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	RETAINED SOIL			FOUNDATION SOIL					GROUND IMPROVEMENT DEPTH (FT)	MINIMUM EARTH REINFORCEMENT RATIO OR 8 FEET LENGTH (FT)	MINIIMUM WALL EMBEDMENT (FT)
				FRICTION ANGLE (DEG)	COHESION (PSF)	UNIT WEIGHT (PCF)	TOTAL (UNDRAINED)		EFFECTIVE (DRAINED)		UNIT WEIGHT (PCF)			
							FRICTION ANGLE (DEG)	COHESION (PSF)	FRICTION ANGLE (DEG)	COHESION (PSF)				
9.90L-A	3+41	3+98	6.5	32	50	120	32	100	32	0	120	No	8 feet	2
	3+98	5+08	17.5	32	50	120	35	200	35	50	125	No	0.7H	2
	5+08	6+30	16.0	32	50	120	30	100	32	0	121	5 ft Overexcavation	1.0H	3[1]
	6+30	7+60	12	32	50	120	35	200	35	50	125	No	0.8H	2
	7+60	8+30	14.0	32	50	120	0	4000	34	0	130	No	0.8H	3.5[2]
	8+30	10+08	18.5	32	50	120	0	4000	34	0	130	No	0.8H	2
	10+08	11+35	21	32	50	120	0	4000	34	0	130	No	0.8H	3
	11+35	11+86	16.5	32	50	120	32	100	32	0	120	No	0.8H	2

NOTE:

1. Wall sections located between 5+08 to 6+30 and 7+60+8+30 have steep slope in front of it. Per Table 2-2 GEC-11 (FHWA 2009), minimum embedment at these wall segments is 3.0 feet.
2. The soil at the ground surface is uncontrolled fill. The competent native soil is approximately 3.5 feet below the ground surface. So, instead of minimum 3.0 feet embedment (See Note 1), we recommend extending it up to 3.5 feet bgs.

TABLE 7B – Bearing Resistance for Wall 9.90L-A

Design Critical Section (Station)	5+75			7+80			8+80			10+80		
Wall Height at Critical Section (ft)	13.5			14.4			14.7			21.1		
Soil Condition	Static	Pseudo Static	Post Liquefaction	Static	Pseudo Static	Post Liquefaction	Static	Pseudo Static	Post Liquefaction	Static	Pseudo Static	Post Liquefaction
Bearing Resistance, (ksf)	4.2	3.8	N/A	3.9	15	N/A	8.5	16.5	NA	14.2	16.9	N/A

N/A – not applicable

TABLE 8A – MSE Wall Design Parameters for Wall 9.90L-B

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	RETAINED SOIL			FOUNDATION SOIL					GROUND IMPROVEMENT DEPTH (FT)	MINIMUM EARTH REINFORCEMENT RATIO OR 8 FEET LENGTH (FT)	MINIIMUM WALL EMBEDMENT (FT)
				FRICTION ANGLE (DEG)	COHESION (PSF)	UNIT WEIGHT (PCF)	TOTAL (UNDRAINED)		EFFECTIVE (DRAINED)		UNIT WEIGHT (PCF)			
							FRICTION ANGLE (DEG)	COHESION (PSF)	FRICTION ANGLE (DEG)	COHESION (PSF)				
9.90L-B	1+50.00	2+40	27.5	32	50	120	26	50	32	0	115	None	0.8H	4
	2+40	3+80	27	32	50	120	35	0	38	0	127	5 ft Overexcavation	0.8H	4
	3+80	6+20	22.5	32	50	120	27	150	33	0	117	5 ft Overexcavation	1.0H	2
	6+20	6+80.22	15	32	50	120	31	130	31	0	117	None	0.75H	2

TABLE 8B – Bearing Resistance for Wall 9.90L-B

Design Critical Wall Station	2+70			3+70			5+20			6+20		
Wall Height at Critical Section (ft)	27.5			27			22.5			15		
Soil Condition	Static	Pseudo Static	Post Liquefaction	Static	Pseudo Static	Post Liquefaction	Static	Pseudo Static	Post Liquefaction	Static	Pseudo Static	Post Liquefaction
Bearing Resistance, (ksf)	7.5	6.5	7.2	17.0	10.5	10.2	7.0	6.9	5.9	4.3	13.8	14.5

6.3 Global Wall Stability Analysis

The software Slide2 by Rocscience. was used for global stability analyses. Minimum factor of safety is 1.3 (resistance factor of 0.75) in the static case and 1.1 (resistance factor of 0.9) in the seismic (pseudo-static) and post-liquefied cases per Chapter 15 of the WSDOT GDM and Appendix G updates and Section 11.6.2.3 of the AASHTO BDS. A minimum factor of safety in the post-liquefied condition where liquefiable soils are present is also 1.1.

Global stability analyses assumed the following:

- Live Load traffic surcharge was taken to be 250 psf for static conditions
- Live Load traffic surcharge was taken to be 125 psf for post-liquefied conditions
- No Live Load applied during pseudostatic conditions, decoupled analysis
- MSE reinforced zone was modeled with readily available geogrid reinforcement using default parameters of the Slide2 software

For pseudostatic analysis the maximum allowable lateral displacement of the wall mass was assumed to be 8 inches per GDM. Detailed analysis of reductions for horizontal seismic parameters are presented in Appendix G.

TABLE 9: SUMMARY OF GLOBAL STABILITY ANALYSIS RESULTS

Structure	Analysis	Factor of Safety
[1]Wall 9.90L-A – Station 5+75 (as designed)	Static [2]Seismic	1.4 1.3
Wall 9.90L-A – Station 7+80 (as designed)	Static [2]Seismic	1.7 2.0
Wall 9.90L-A – Station 8+80 (as designed)	Static [2]Seismic	1.4 1.6
Wall 9.90L-A – Station 10+80 (as designed)	Static [2]Seismic	1.6 1.6
Wall 9.90L-B – Station 2+70 (as designed)	Static [2]Seismic Post Liquefied	1.9 1.4 1.6
[1]Wall 9.90L-B – Station 3+70 (as designed)	Static [2]Seismic Post Liquefied	1.9 1.2 1.5
[1]Wall 9.90L-B – Station 5+20 (as designed)	Static [2]Seismic Post Liquefied	1.5 1.1 1.2

TABLE 9: SUMMARY OF GLOBAL STABILITY ANALYSIS RESULTS

Structure	Analysis	Factor of Safety
Wall 9.90L-B – Station 6+20 (as designed)	Static	1.5
	[2]Seismic	1.1
	Post Liquefied	1.1

Notes:
[1]Proposed 5 feet of overexcavation and replacement at these stations.
[2]Horizontal seismic acceleration 0.185g was used.

6.4 Settlement and Differential Settlement

Settlement is calculated up to a depth below the bottom of wall where stress increase due to wall foundation load is less than 10% of the existing overburden stress. We used Hough method to estimate settlement within the coarse grain soil layers and one dimensional consolidation method to estimate settlement within the fine grain soil layers with high moisture contents and present below the observed water table.

Time rate of consolidation was estimated for wall 9.90 L-B. Based on the provided soil exploration reports and our observation, we estimate 90% consolidation can be achieved within 30 days after completion of the wall. The majority of settlement will occur during the construction phase and prior to final paving.

With overexcavation of replacement as noted in recommended areas and proper placement and compaction of fill materials the estimated total and differential settlements, based on criteria in Table 15-4 of the Project GDM, are as follows:

- Table 10 and 11 shows summary of our estimated settlement of foundation soil at both wall locations with maximum settlement less than 4 inches.
- The differential settlement along the wall face is anticipated to be less than the indicated

TABLE 10– Design Soil Properties for Wall 9.90L-A

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	GROUND IMPROVEMENT DEPTH (FT)	BORING LOG USED FOR ANALYSIS	ESTIMATED SETTLEMENT (IN)
09.90L-A	3+41	3+98	6.5	No	See Note 1	1 to 2 inches
	3+98	5+08	17.5	No	See Note 1	1 to 2 inches
	5+08	6+30	16.0	5 ft overexcavation	W-149-20	1 to 3 inches
	6+30	7+60	12	No	See Note 1	1 to 3 inches
	7+60	8+30	14.0	No	W-150-20	1 to 4 inches
	8+30	10+08	18.5	No	W-150-20	1 to 4 inches
	10+08	11+35	21	No	W-27-20 and W-151-20	1 to 3 ½ inches
	11+35	11+86	16.5	No	See Note 1	1 to 3 inches

NOTE:

1. We estimated settlement based on our previous experience on similar soils.

TABLE 11– Design Soil Properties for Wall 9.90L-B

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	GROUND IMPROVEMENT DEPTH (FT)	BORING LOG USED FOR ANALYSIS	ESTIMATED SETTLEMENT (IN)
9.90L-B	1+50.00	2+40	27.5	None	GEO 36	2 to 4 inches
	2+40	3+80	27	5 ft overexcavation	R2B-78-17	2 to 4 inches
	3+80	6+20	22.5	5 ft overexcavation	GEO 37	2 to 4 inches
	6+20	6+80.22	15	None	GEO 38	1 to 2 inches

6.5 EPS Backfill at Coal Creek Culvert Design Recommendations

In order to prevent exceeding the existing structural capacity of the Coal Creek Culvert from the additional fill, we recommend that backfill planned above and around the existing Coal Creek Culvert as it passes through Wall 9.90L-B consist of EPS to avoid additional loading on the existing culvert. Wall panels are indicated to be full height, concrete panels in this region of the wall and will include slip joints at the outer extents of the transition of EPS and full weight fills occur to accommodate any differential settlements that may occur. Where EPS blocks support a pavement system, a concrete load distribution slab should be incorporated into the design. This slab should be a minimum of 6 inches thick reinforced concrete slab constructed with concrete meeting the requirements of Concrete Class 4000.

We recommend embankment side slopes may be constructed with a maximum stepped-face at a 1H:1V. In the attached table, we have identified several types of blocks that would satisfy the minimum compressive resistance and density for the current design based on a 2 percent strain limit in accordance with ASTM D6817. We recommend the following types of blocks with respect to the thickness of full weight fill placed on top of EPS blocks:

EPS Type	NWF and Pavement Cover Thickness (feet)
EPS19	< 3
EPS39	3 to 10
EPS46	> 10

Per wall plans the footing for the full-height concrete facing panels is indicated to be 2 feet in width. Unsuitable soils beyond lateral extents of the existing culvert should be removed in accordance with recommended overexcavation depths and replacement with approved backfill as indicated in Section 6.6 of this report. For wall foundations foudations founded on improved replacement soils and above the culvert we recommend a strength limit state bearing resistance of 3.3 ksf and a service limit bearing resistance of 5 ksf.

6.6 Wall 9.85L Design Recommendations

Wall 9.85L is planned as a special design retaining barrier located down slope of Wall 9.90L-A. For design and construction of the wall we have the following recommendations.

Retained/Bearing Soil (ESU 1B)	**VALUE**
Moist Unit Weight (PCF)	125
Friction Angle (DEG)	35
Active Earth Pressure Coefficient[1], Ka (DIM)	0.24
Passive Earth Pressure Coefficient[2], Kp (DIM)[2]	5.6
M-O Earth Pressure Coefficient[3], Kae (DIM)	0.37
Sliding Coefficient[4] (DIM)	0.7
Minimum Embedment (FT)	2
Nominal Bearing Resistance[5,8] (KSF)	11
Service Limit State Bearing Resistance[6, 7](KSF)	13

1. Active EP for level backslope using Coulomb's method where δ=2/3ϕ 2. Passive EP for level toeslope using Coulomb's method where δ=1/3ϕ 3. Mononobe Okabe EP coefficient 4. Sliding coefficient based on Eqn 10.6.3.4-2 in the AASHTO LRFD Bridge Design Specifications (assuming precast barrier) 5. Nominal bearing resistance must be factored by a resisitance factor of 0.45 6. Resistance factor for service limit state is 1.0 . 7. Based on 1-inch of allowable settlement using Hough's method. 8. Based on 2.8 foot wide footing.

6.7 Construction Considerations

Upon completion of grading and foundation excavation, care should be taken to maintain the subgrade density and condition prior to construction of footings. The glacially consolidated soil at the site is dominated by silty sand which is very sensitive to water content change and disturbance from equipment. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades, in excavations, and/or adjacent to the wall face. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material shall be removed and replaced in accordance with WSDOT Standard Specification Section 2-09.3(1)c and the recommendations of the Geotechnical Engineer of Record as noted above. The contractor should be prepared to deal with potential perched water in the back-cut for the wall foundations. Perched water may lead to short term surface erosion and any water should be collected or diverted from the subgrade for the wall foundation.

In the event that unsuitable soil is present in the retaining wall foundation excavation, the unsuitable soil requires removal and replacement with either Quarry Spalls per WSDOT Standard Specifications 9-13.1(5) with an upper 6 inch minimum course of Gravel Backfill for Foundations Class A 9-03.12(1)A below the footing of wall facing panels. (more is acceptable, but 6 inch minimum to fill in gaps in the spalls and level out the surface) or Ballast per 9-03.9(1) (No gravel backfill needed on top) and the recommendations of the Geotechnical Engineer of Record (GER). In zones that appear exceedingly soft after overexcavation to the recommended depth, placement of a non-woven geotextile such as Mirafi 140N, or equivalent, may be required as recommended by the on site geotechnical special inspector or GER.

7.0 GEOTECHNICAL INSTRUMENTATION PLAN (GIP)

The following bullet points identified in Section 2.6.7.5 requiring geotechnical instrumentation are either not currently proposed under the current work plan or not applicable to the project at retaining walls covered in this report:

- Sensitive facilities (none identified in RFP)
- Temporary Shoring (none currently proposed)
- Dewatering operations
- Staged embankment construction (not currently proposed)

- Ground structure vibrations during shaft casing or pile driving (no piles or casing currently proposed)
- Vibrations for freshly placed concrete (all concrete currently proposed as precast)

Should unanticipated conditions be encountered, or unanticipated construction means and methods be used that require additional geotechnical instrumentation, we will issue an addendum to this plan.

Currently, the work plan includes settlement and settlement rates where settlements are predicted to be greater than 2 inches and Section 2.6.7.5 requires monitoring of settlement during construction operations. We recommend that wall facing panels be surveyed at approximate 50-foot intervals for settlement monitoring purposes for the walls from approximately:

Wall 9.90L-A: Wall Station 5+08 to Wall Station 11+50

Wall 9.90L-B: Wall Station 2+00 to Wall Station 6+00

Survey information should be forwarded to the GER at regular intervals during construction of the walls.

7.1 Alert and Action Levels

The purpose the proposed geotechnical instrumentation is to monitor the rate and magnitude of settlement of the retaining walls. This GIP establishes limits of settlement magnitudes for alert and action levels for which additional consideration will be given to the construction of the MSE retaining walls.

Alert Level: Settlement magnitude of 5 inches. Additonal scrutiny of the settlement data will begin if the survey settlement data reach the aforementioned settlement.

Action Level: Settlement magnitude of 6 inches. At the point total settlement magnitudes reach this level the EOR, design team, and design-builder will be confer to incorporate the corrective action plan outlined below.

7.2 Corrective Action Plan

The corrective action plan items below shall be implemented in accordance with Sections 2.6.7.1 and 2.6.7.5.1 and will include the following steps:

- Identification of the work areas where the action level has been reached
- Notify the EOR that action levels have been reached and corrective action is necessary
- Provide a revised work plan in consultation with the design team and design-builder
- Provide a revised work plan to the WSDOT Engineer for Review and Comment

- Work in areas where action levels were reached will be halted until the revised work plan has been accepted by the WSDOT EOR
- Identify circumstances where the corrective actions were needed and revise the retaining wall design and/or incorporate revised construction procedures to keep observed settlements below the action level
- Notify the WSDOT EOR immediately when the observed movement meets or exceeds the allowable settlement and in writing within 24 hours

8.0 GEOTECHNICAL SPECIAL INSPECTIONS (GSIP)

8.1 Introduction

This Geotechnical Special Inspection Plan (GSIP) is intended to describe how the design-builder will validate geotechnical design assumptions and requirements of the Work through inspection, as required by Section 2.6 of the Request for Proposal (RFP). This GSIP includes the following:

- Elements of the project requiring geotechnical special inspection
- Hold points as defined in the RFP

8.2 Special Inspection

Documentation, requirements, and the frequency of special inspections shall be in accordance with Section 2.6 of the RFP and the Mandatory Standards listed in the same Section. Geotechnical special inspection shall be performed by a Geotechnical Special Inspector (GSI) except where the RFP allows special inspection to be performed by a Quality Assurance Inspection Technician (QAI) under the direct supervision of the GSI. Report review and submittal requirements are described in RFP Sections 2.6.8.1 and 2.12. Note that the GSI shall have at least 2 years of geotechnical inspection experience or be the EOR for the Project element being inspected (see Technical Requirements section 2.6.3.6).

8.2.1 Soil Bearing Verification – Periodic Inspection

Each of the soil bearing verifications described in this section shall be considered a Hold Point. Inspections of the foundation subgrades shall be performed by the Engineer of Record (EOR) or the EOR's representative for that element of the project.

Inspect the subgrade of embankments, including backfill behind walls and abutments:

- After clearing and grubbing, but prior to placing fill.
- Completion of embankment subgrade including overexcavation, where applicable.
- Prior to construction of foundations or structures supported in or on the embankment.

Inspect retaining wall subgrades:

- At completion of excavation to bearing elevation, but prior to placement of the leveling pad for Structural Earth Walls (SEW) or foundation of any other wall type.

For structures, materials at the bearing elevation shall be inspected to ensure that the materials meet the design and construction requirements. The GSI shall document observations regarding soil type, density and moisture condition of the subgrade, and groundwater conditions as encountered at the bearing elevation in the associated excavation.

8.2.2 Review of Collected Survey and Settlement Monitoring Data

Survey information should be forwarded to the GER at regular intervals during construction of the walls within 5 days of data collection. The GER will review the collected data and evaluate the information compared to the maximum settlement magnitudes indicated in Tables 10 and 11 above. Settlement information and monitoring will be shared with the design team to evaluate impacts to the construction and performance of the retaining walls as the project progresses. Corrective action plans will be determined on a case by case basis depening on the structure and hazard level.

9.0 USE OF THIS REPORT

This geotechnical report has been prepared to support the design of Retaining Walls 9.90L-A and 9.90L-B. The analyses and recommendations presented in this report are based on the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

This report has been prepared for the exclusive use of Parsons, FlatIron JV, and WSDOT and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

10.0 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO) (2017). AASHTO LRFD Bridge Design Specifications (7th edition). Washington, DC.

Boulanger, R. W. and Idriss, I. M., (2014), CPT and SPT based liquefaction triggering procedures: Davis, Calif., University of California Davis, report no. UCD/CGM-14/01, 134 p.

Cetin, K. O.; Seed, R. B.; Der Kiureghian, Armen; and others, (2004), Standard penetration test-based probabilistic and deterministic assessment of seismic soil liquefaction potential: Journal of Geotechnical and Geoenvironmental Engineering, v. 130, no. 12, p. 1314-1340.

FHWA (2009). GEC No. 11: Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.

FHWA (2011). GEC No. 3: LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations.

GeoEngineers, Inc. (2008). Geotechnical Engineering Services I-405 112th Avenue SE to SE 8th Street Widening Project, Bellevue, Washington. File No. 0180-197-01. July

Geotechnical Engineering Report: Fish Passage 10.0 dated September 15, 2021. Wood Environtment and Infrastructure Solutions, Inc.

Golder Associates, Inc. (Golder). (1993). Revised Report to Tudor Company on Geotechnical Engineering Study, Proposed Shoulder Widening SR-405 Sunset Boulevard to Coal Creek Parkway Stage 2, 913-1149.808. September 28.

Ishihara, K., and Yoshimine, M., (1992). “Evaluation of settlements in sand deposits following liq uefaction during earthquakes.” Soils and Foundations, JSSMFE, Vol. 32, No. 1, March, pp. 173-188.

Mullineaux, D.R. 1965. Geologic Map of the Renton Quadrangle, King County, Washington. USGS Geologic Quadrangle Map GQ-405.

Shannon & Wilson. (2000). Draft Geotechnical Data Report, Interstate 405/NE 44th Street Interchange and Access Revisions, Renton, Washington. 21-1-09054-006. September.

Tokimatsu, K. and Seed, H.B., (August 1987). “Evaluation of Settlement in Sands Due to Earthq uake Shaking.” ASCE Journal of Geotechnical Engineering, Vol. 113, No. 8.

Troost, K.G. (2012). Geologic Map of Bellevue, Washington. GeoMap Northwest Production Map. April.

Waldron, H.H., B.A. Liesch, D.R. Mullineaux, and D.R. Crandell. (1962). Preliminary Geologic Map of Seattle and Vicinity, Washington. USGS Miscellaneous Map I-354.

WOOD (2021), Geotechnical Engineering Report: Fish Passage 10.0, Project # PS19-20316-0, Kirkland, Washington

WSDOT (February 1, 2016) I-5/SR16 project Request for Proposal (RFP).

WSDOT (December 14, 2018a) Geotechnical Data Report, I-405 Renton to Bellevue Widening and Express Toll Lanes Project. XL-4653/XL-5467, I-405, MP 0.0–14.6.

WSDOT (December 14, 2018b). General Geologic Characterization and Unstable Slope Evaluation, I-405 Renton to Bellevue Widening and Express Toll Lanes Project.

WSDOT (July, 2019a). Geotechnical Design Manual (GDM).

WSDOT (July, 2019b). Bridge Design Manual (GDM).

WSDOT (2018c). Standard Specifications for Road, Bridge, and Municipal Construction.

Youd, T. L.; Idriss, I. M.; Andrus, R. D.; and others, (2001), Liquefaction resistance of soils: summary report from the 1996 NCEER and 1998 NCEER/NSF workshops on evaluation of liquefaction resistance of soils: Journal of Geotechnical and Geoenvironmental Engineering, v. 127, no. 10, p. 817-833.

Yount, J.C., J.P. Minard, and G.R. Dembroff. (1993). Geologic Map of Surficial Deposits in the Seattle 30’ X 60’ Quadrangle, Washington. USGS Open-File Report 93-233.

APPENDIX A
RETAINING WALL PLANS

CONTRACT PLANS
SEG 2B RETAINING WALLS (W56 & W57) WALL 9.90L (A&B)

I-405 MP 9.83 TO MP 10.14

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT
VOLUME 7
FINAL

KING COUNTY

Washington State
Department of Transportation

11/19/2021

WALL 09.90L-A NOTES:

1. STRUCTURAL EARTH WALLS (SEW) HAVE BEEN DESIGNED FOR GLOBAL STABILITY IN ACCORDANCE WITH THE FOLLOWING REQUIREMENTS:

   AASHTO LRFD BRIDGE DESIGN SPECIFICATONS 8TH EDITION (2017), WSDOT GEOTECHNICAL DESIGN MANUAL (2015), AND WSDOT BRIDGE DESIGN MANUAL (2018).

2. SEW SHALL BE DESIGNED BY THE MANUFACTURER IN ACCORDANCE WITH THE SE WALL SOIL PARAMETER RECOMMENDATIONS AND THE EXTERNAL GLOBAL STABILITY REQUIRMENTS PROVIDED IN THE GEOTECHNICAL ENGINEERING REPORT: WALL PACKAGE 1 - RETAINING WALLS 9.90L-A AND 9.90L-B GEOTECHNICAL DESIGN MEMORANDUM - DATE: 11/19/21.

3. SEE SHEET W56-6 FOR WALL FINISH REQUIREMENTS.

4. STATION AND W-ELEVATIONS SHOWN ALONG WALL REPRESENT WALL 09.90L-A STATIONING AND TOP OF WALL AT FACE OF TRAFFIC BARRIER. SEE WALL TYPICAL SECTION ON SHEET W56-6.

5. STATION AND F-ELEVATIONS REPRESENT FINISHED GRADE AT FRONT FACE OF WALL.

6. CONTRACTOR PROPOSED BOTTOM OF WALL AND STEPPING OF THE LEVELING PAD TO FIT THE MANUFACTURER'S SEW SYSTEM SHALL BE SHOWN ON THE WALL SHOP DRAWINGS.

7. ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATIONS FOR ROADS, BRIDGE, AND MUNICIPAL CONSTRUCTION", ENGLISH UNITS, DATED 2018, AMENDED JANUARY 7, 2019 AND THE GENERAL SPECIAL PROVISIONS AS INCLUDED IN THE REQUEST FOR PROPOSAL, I-405, RENTON TO BELLEVUE WIDENING AND ETL PROJECT, DATED DECEMBER 2018, INCLUDING SECTIONS:

   6-02.3(14).GR6 FINISHING CONCRETE SURFACES
   6-13.GR6 STRUCTURAL EARTH WALLS

8. WALL 09.90L-A LAYOUT STATIONING IS PROVIDED AS OFFSET FROM SB I-405 LINE.

9. SEE SHEETS AL-36, RS-19 & RS-20, PR-44 & PV-36 FOR ROADWAY ALIGNMENT, SECTIONS, PROFILE AND PAVING, RESPECTIVELY.

10. SEE TRAFFIC CONTROL PLAN SEGMENT 2A SHEET MOT-36, STAGE 1, PHASE 2 FOR WORK ZONE AND TRAFFIC STAGE.

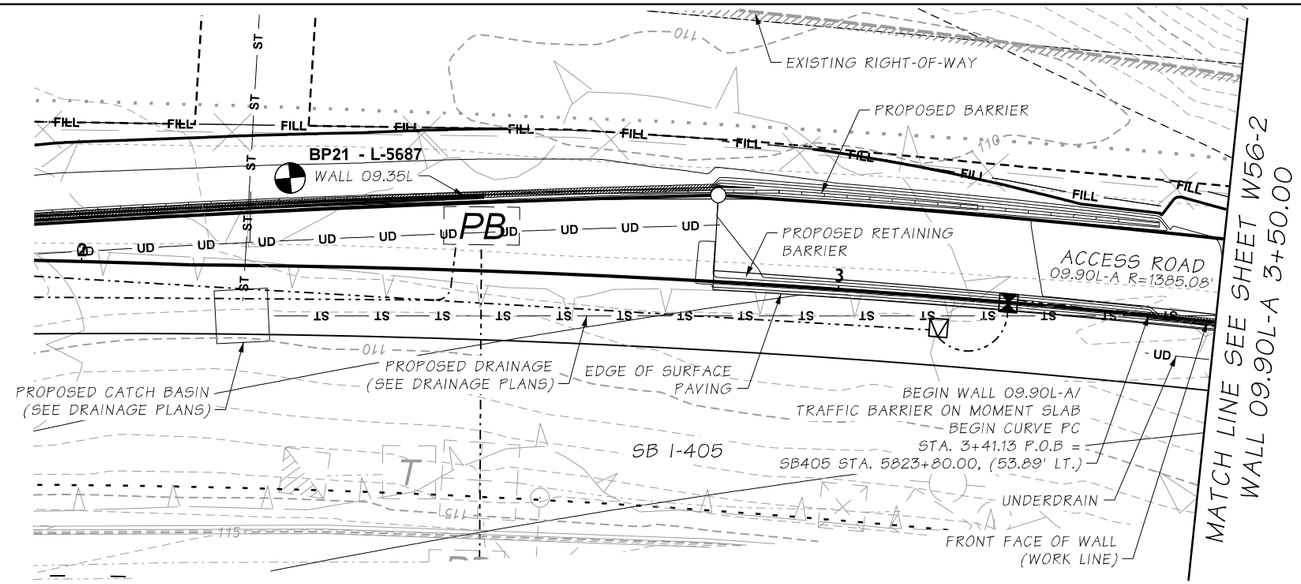
11. SEE SHEET DR-36 FOR DRAINAGE PLAN.

12. SEE SHEETS TS-36 AND IL-36 FOR ITS AND ILLUMINATION PLANS, RESPECTIVELY.

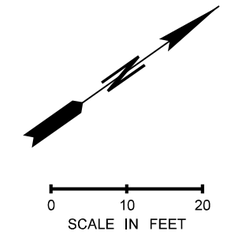
13. SEE SHEET SN-36 FOR SIGNING PLAN.

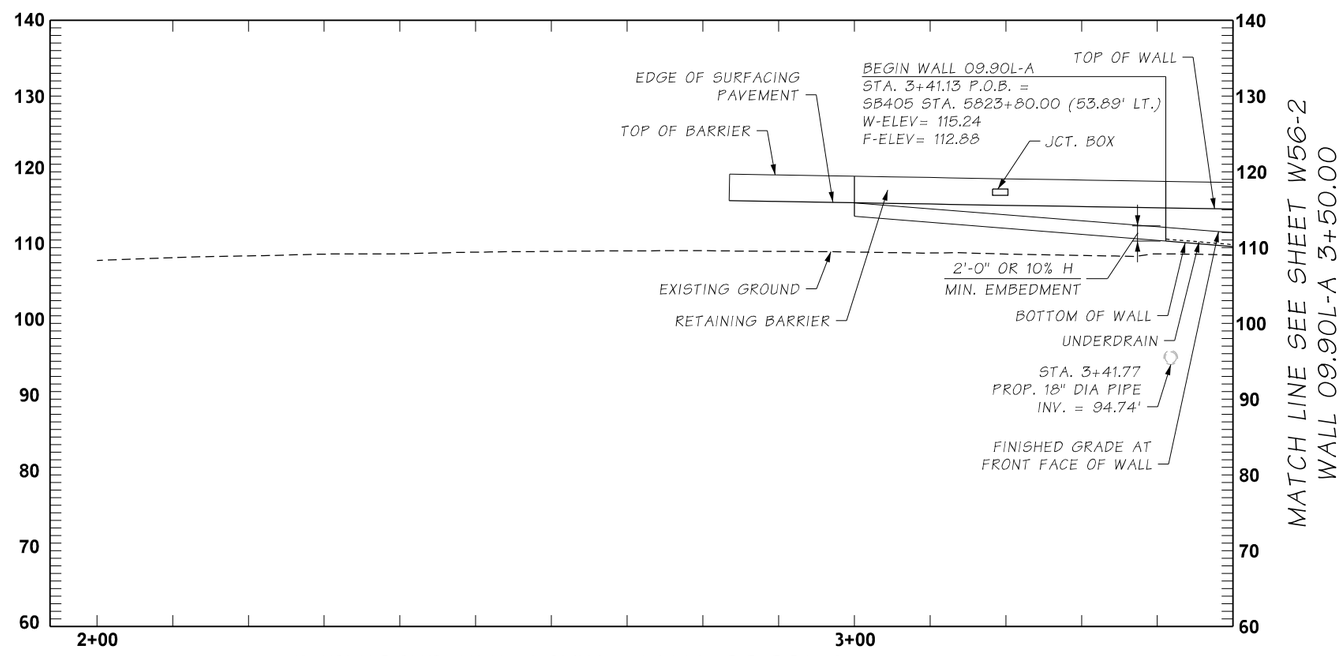
DATUM

(NAVD) 88



PLAN - WALL 09.90L-A





REFLECTED ELEVATION - WALL 09.90L-A

WALL TYPE: STRUCTURAL EARTH (SEW)

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TIME	4:30:05 PM				JOB NUMBER XL5467		
DATE	11/17/2021						
PLOTTED BY	p005295D						
DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY, STATE OF WASHINGTON, 44060, STRUCTURAL ENGINEER, PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

DATE

P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

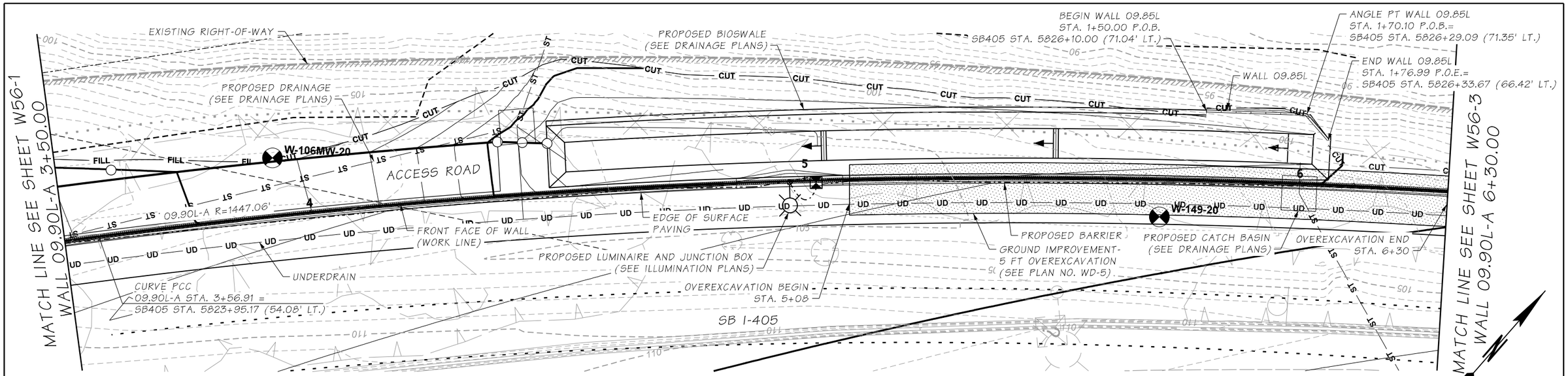
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

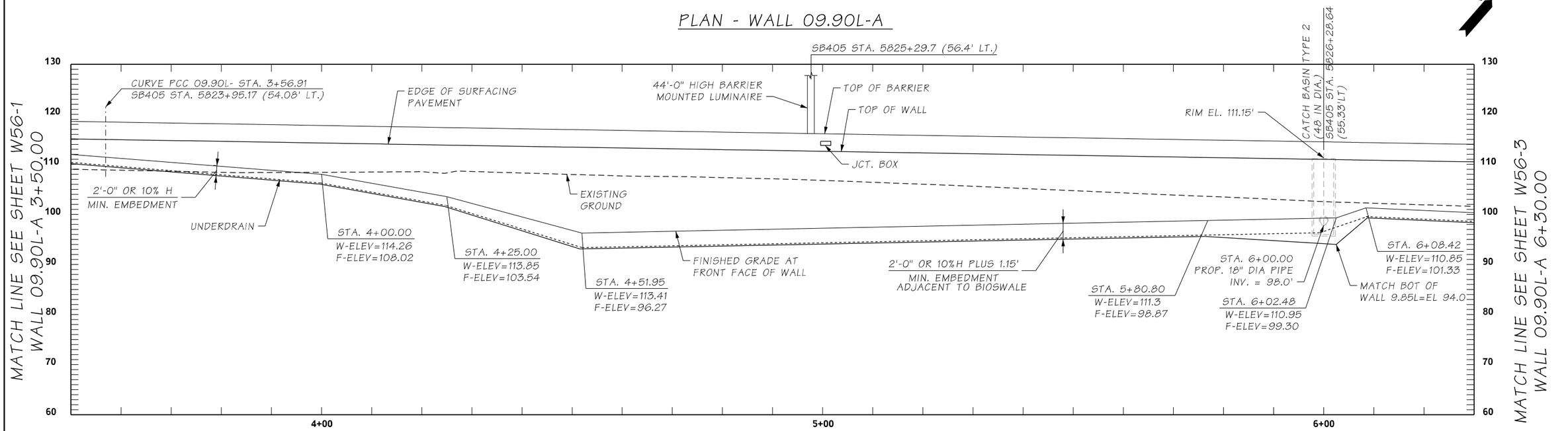
RETAINING WALL PLAN AND PROFILE
WALL 09.90L-A (1 OF 4)

PLAN REF NO W56-1

SHEET OF SHEETS



PLAN - WALL 09.90L-A



REFLECTED ELEVATION - WALL 09.90L-A

NOTES:

1. SEE SHEET W56-1 FOR NOTES.
2. SEE SHEET W56-7 FOR WALL 09.85L.

WALL TYPE: STRUCTURAL EARTH (SEW)

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TIME	5:02:27 PM						
DATE	11/22/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44000 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

DATE

P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

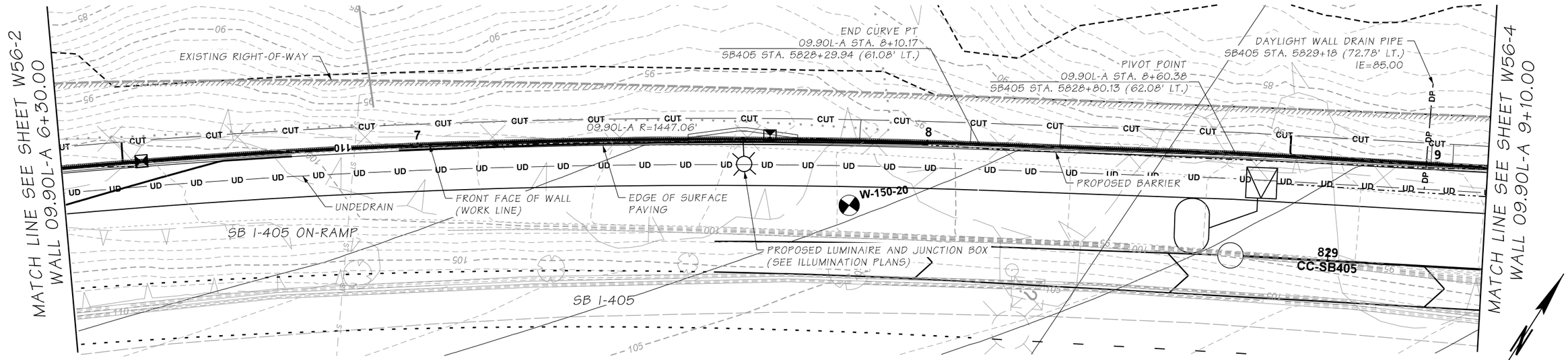
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

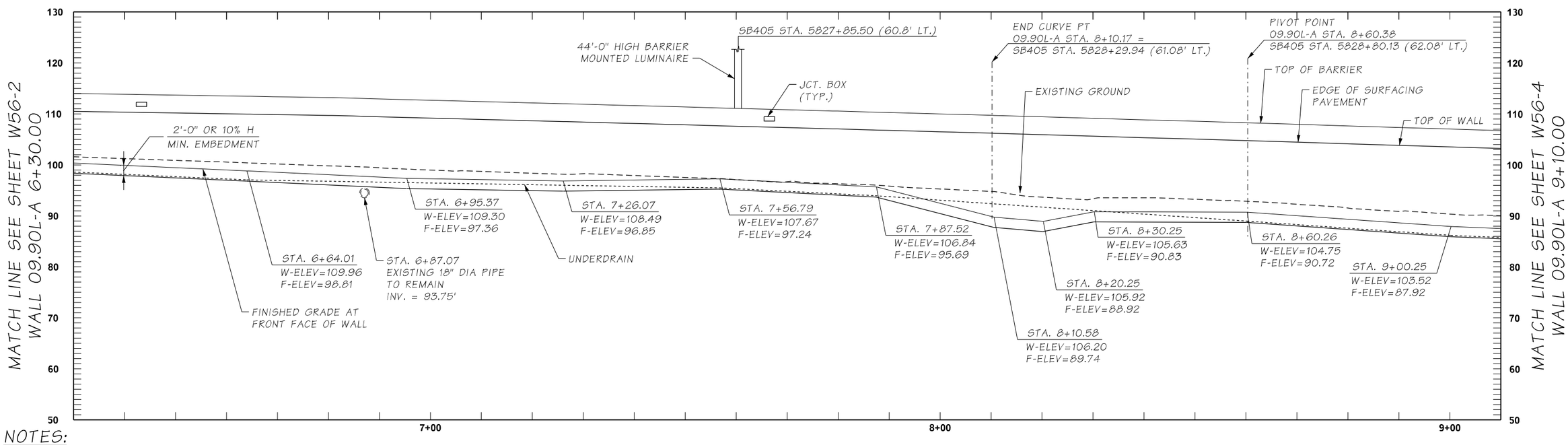
RETAINING WALL PLAN AND PROFILE WALL 09.90L-A (2 OF 4)

PLAN REF NO W56-2

SHEET OF SHEETS



PLAN - WALL 09.90L-A



NOTES:

1. SEE SHEET W56-1 FOR NOTES

REFLECTED ELEVATION - WALL 09.90L-A

WALL TYPE: STRUCTURAL EARTH (SEW)

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DATE	11/17/2021						
PLOTTED BY	p005295D						
DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 34060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

DATE

P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

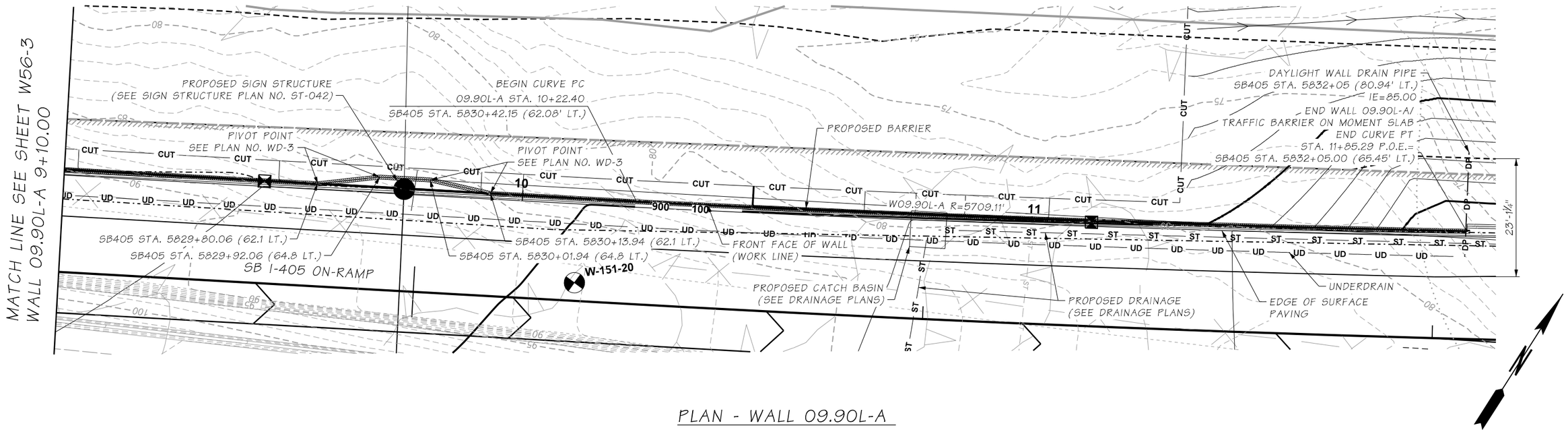
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

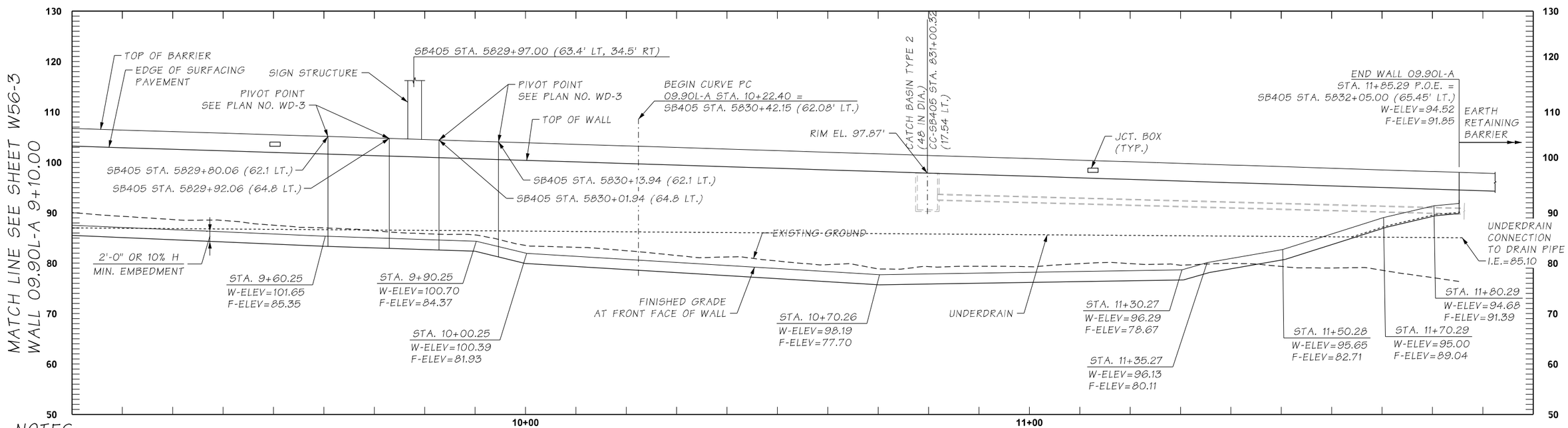
RETAINING WALL PLAN AND PROFILE
WALL 09.90L-A (3 OF 4)

PLAN REF NO W56-3

SHEET OF SHEETS



PLAN - WALL 09.90L-A



NOTES:

1. SEE SHEET W56-1 FOR NOTES

REFLECTED ELEVATION - WALL 09.90L-A

WALL TYPE: STRUCTURAL EARTH (SEW)

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PLOTTED BY	p005295D						
DESIGNED BY	W. METWALLY				CONTRACT NO. C9242		LOCATION NO.
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY						
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

P.E. STAMP BOX — DATE

P.E. STAMP BOX — DATE

Washington State Department of Transportation

FLATIRON LANE

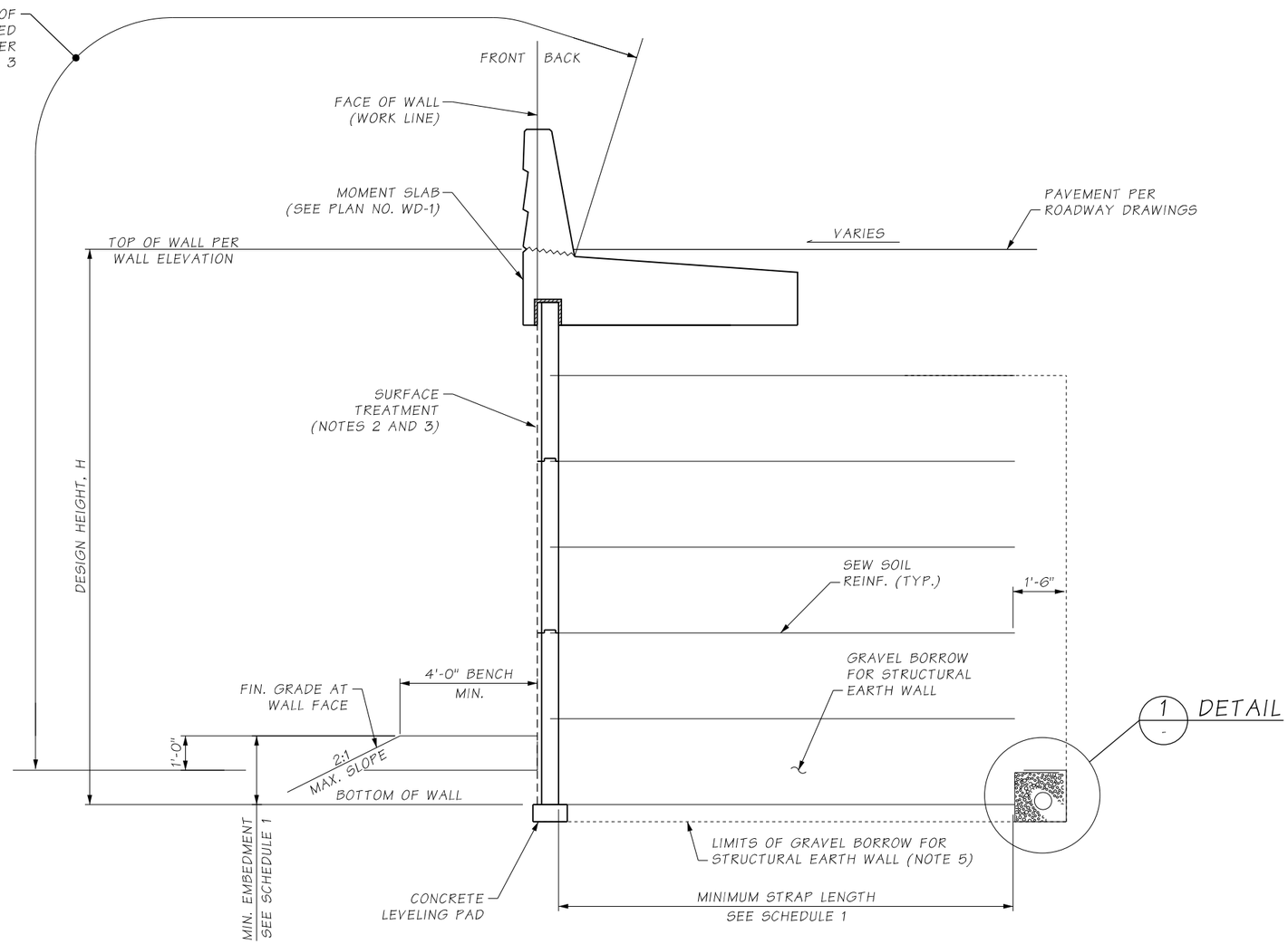
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

RETAINING WALL PLAN AND PROFILE
WALL 09.90L-A (4 OF 4)

PLAN REF NO W56-4

SHEET OF SHEETS



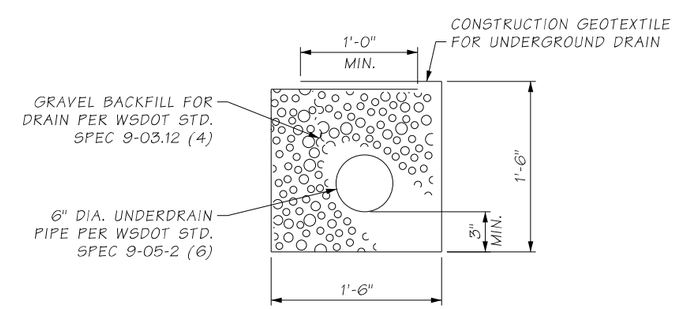
TYPICAL SECTION

NOTES:

1. ALL CAST-IN-PLACE CONCRETE SHALL BE CLASS 4000, UNLESS OTHERWISE NOTED.
2. CONCRETE WALL PANEL FINISH SHALL BE ASHLAR STONE PATTERN SURFACE TEXTURE IN ACCORDANCE WITH THE INTERSTATE-405 URBAN DESIGN CRITERIA AND STANDARD SPECIFICATIONS.
3. WALL SURFACES SHALL BE FINISHED WITH WSDOT STANDARD COLOR: MT. ST. HELENS PIGMENTED SEALER FROM TOP OF WALL TO MIN. 1-FT BELOW GRADE. SEW BARRIER SHALL BE FINISHED WITH WSDOT STANDARD COLOR MT. BAKER PIGMENTED SEALER.
4. SEE ELEVATONS FOR PROFILES OF UNDERDRAINS. THE WALL DESIGN SHALL INCLUDE WATER LOADING FROM THE BASE OF THE WALL UP TO THE ELEVATIONS OF THE UNDERDRAIN SYSTEM.
5. WSDOT SPECIFIED GRAVEL BORROW FOR SEWS SHALL BE USED. SILT CONTENT OF THE WALL FILL SHALL BE LESS THAN 15% IF STEEL REINFORCED SYSTEMS ARE USED. THE FILL MATERIAL SHALL EXTEND AT LEAST 18 INCH BEHIND THE STEEL REINFORCEMENT FOR CORROSION PROTECTION.
6. WSDOT GRAVEL BORROW SHALL BE USED IN THE BACKFILL WEDGE AREA BEHIND THE SEW. THE BACKFILL WEDGE BACKSLOPE SHALL BE CONSTRUCTED AT A MINIMUM INCLINATION OF 1H:1V.
7. PRECAST WALL PANELS ARE CONSIDERED TO BE RIGID CONCRETE FACING PANELS. THE WALL DESIGNER SHALL SELECT THE APPROPRIATE JOINT WIDTH BASED ON THE ESTIMATED DIFFERENTIAL SETTLEMENTS AS PROVIDED IN THE GEOTECHNICAL ENGINEERING REPORT: WALL PACKAGE 1 - RETAINING WALLS 9.90L-A AND 9.90L-B GEOTECHNICAL DESIGN MEMORANDUM - DRAFT DATE: 10/29/21. DIFFERENTIAL SETTLEMENT LIMITS SHALL BE BASED ON THE AREA OF THE PANEL AND THE JOINT WIDTH AS GIVEN IN AASHTO TABLE C11.10.4.1-1.

UNDERDRAIN NOTES:

1. ALL UNDERDRAIN OUTLETS THAT DAYLIGHT TO SURFACE SHALL BE FITTED WITH A FLAP TYPE ANTI-RODENT ENTRY FITTING. EXTEND PIPE A MIN. 1'-0" AT OUTLET, AS REQUIRED TO ATTACH FITTING.
2. CORE HOLE IN PANEL FOR UNDERDRAIN OUTLET. LOCATION OF OUTLET MAY BE FIELD ADJUSTED TO CORE PANEL. PROVIDE SEALANT AROUND PIPE ON EXTERIOR OF WALL.
3. UNDERDRAIN ALIGNMENTS AND ELEVATIONS PROVIDED MAY BE ADJUSTED IF REQUIRED WITH WALL DESIGN IN THE FIELD. UNDERDRAIN OUTLETS SHALL BE PLACED ON MIN. SLOPE OF 0.2% AND MAX. SLOPE OF 2.0%.
4. UNDERDRAIN OUTLETS SHALL BE SPACED AT NO MORE THAN 300 FT. SEE DRAINAGE PLANS FOR UNDERDRAIN CLEANOUT REQUIRMENTS AND DETAILS.



DETAIL 1

SCHEDULE 1

BEGIN STATION	END STATION	MINIMUM STRAP LENGTH	MINIMUM WALL EMBEDMENT
3+41.13	3+98	8.0 FT	2.0 FT
3+98	5+08	0.7H OR 8.0 FT	2.0 FT
5+08	6+30	1.0H OR 8.0 FT	3.0 FT
6+30	7+60	0.8H OR 8.0 FT	2.0 FT
7+60	8+30	0.8H OR 8.0 FT	3.5 FT
8+30	10+08	0.8H OR 8.0 FT	2.0 FT
10+08	11+35	0.8H OR 8.0 FT	3.0 FT
11+35	11+85.29	0.8H OR 8.0 FT	2.0 FT

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PLOTTED BY	p005295D
DESIGNED BY	W. METWALLY
ENTERED BY	M. ALEKSANYAN
CHECKED BY	E. KELLEY
PROJ. ENGR.	J. LEFOTU
REGIONAL ADM.	L. HODGSON

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER XL5467

CONTRACT NO. C9242 | LOCATION NO.

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE — P.E. STAMP BOX

DATE — P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

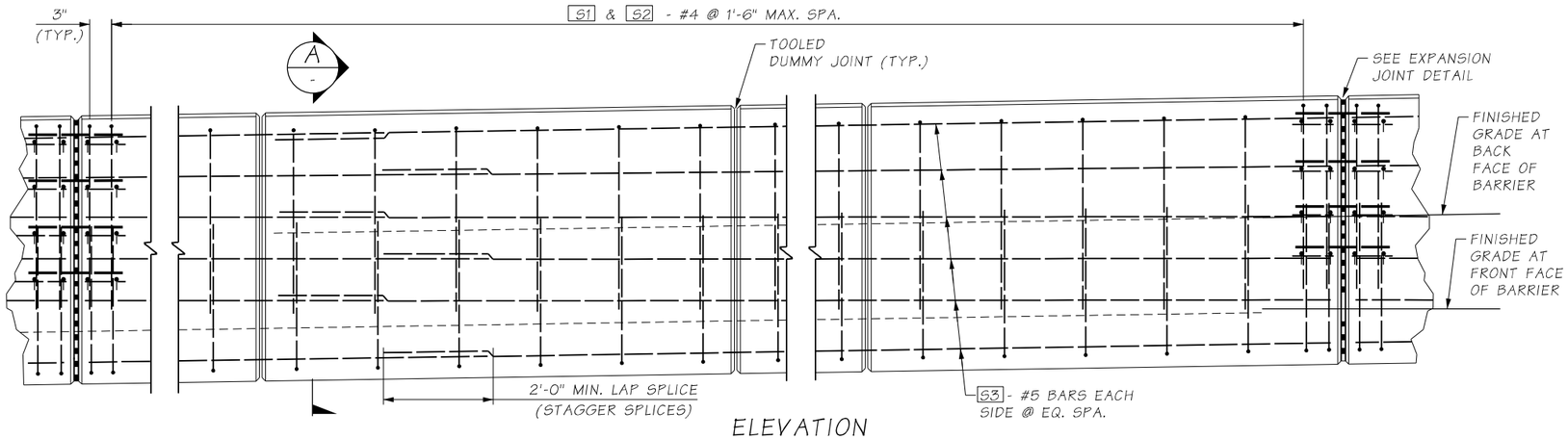
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

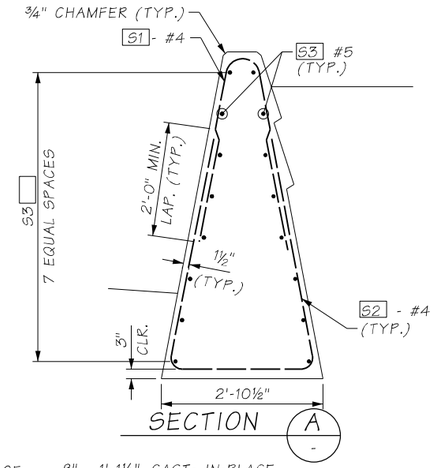
RETAINING WALL DETAILS
WALL 9.90L-A

PLAN REF NO W56-6

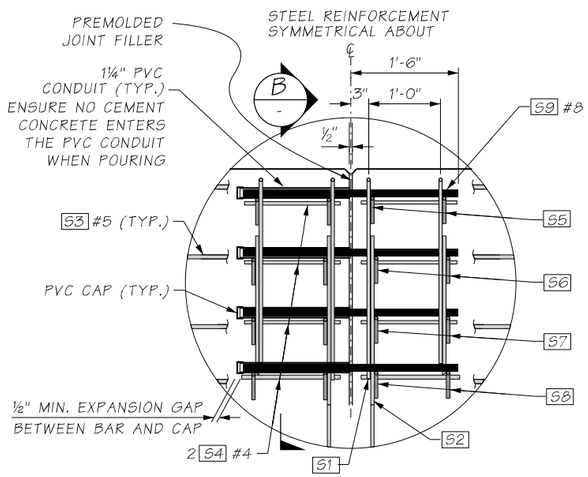
SHEET OF SHEETS



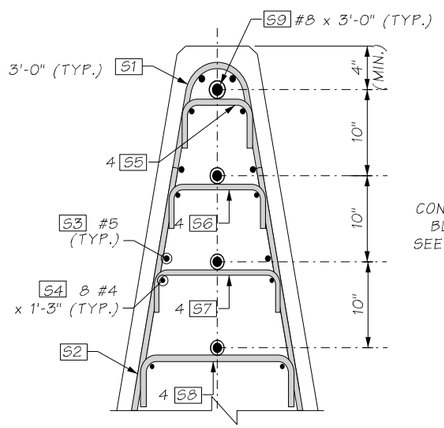
ELEVATION



SECTION

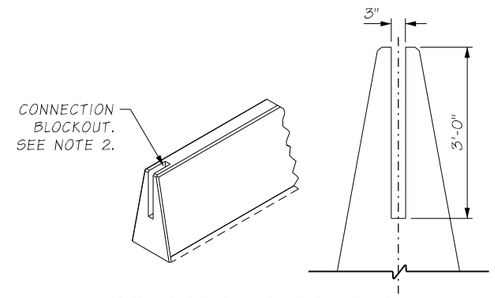


EXPANSION JOINT DETAIL



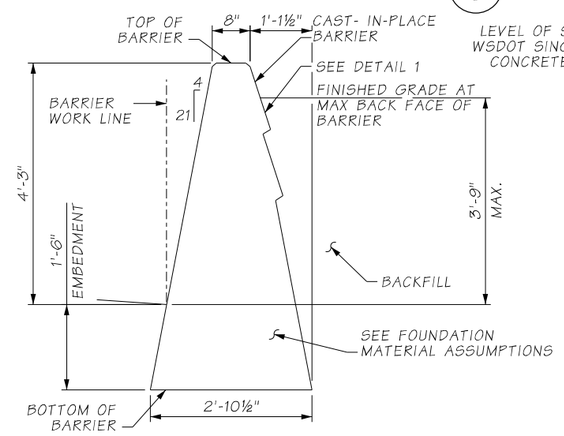
SECTION B

(AESTHETIC PATTERN NOT SHOWN)

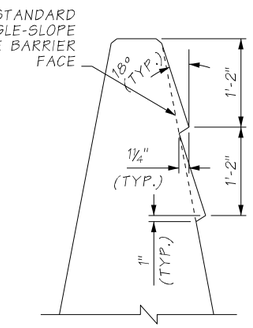


CONCRETE BLOCKOUT

(AESTHETIC PATTERN NOT SHOWN)



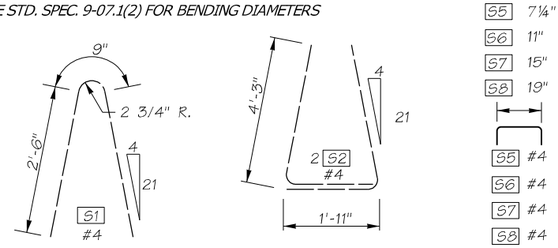
TYPICAL SECTION



DETAIL 1

REINFORCING STEEL BENDING DIAGRAM

SEE STD. SPEC. 9-07.1(2) FOR BENDING DIAMETERS



S5	7¼"
S6	11"
S7	15"
S8	19"

S5 #4
S6 #4
S7 #4
S8 #4

W56-7

NOTES:

1. ALL CONCRETE SHALL BE CLASS 4000, EXCEPT AS NOTED.
2. PROVIDE ROUGHENED SURFACE AT CONSTRUCTION JOINTS.

WALL 09.85 SCHEDULE

STATION	TOP WALL ELEV	W-ELEV	F-ELEV
1+50.00	99.8	99.23	97.10
1+70.10	99.8	99.31	95.48
1+76.99	99.8	98.96	98.46

WALL 09.85L GEOTECHNICAL PARAMETERS:

NATIVE MATERIAL.

BACKFILL UNIT WEIGHT: γ = 125 PCF

BACKFILL ANGLE OF INTERNAL FRICTION: v, = 36°

EARTH PRESSURE COEFFICIENTS = Ka = 0.35, Kae= 0.79, Kp = 6.00

FOUNDATION MATERIAL

ASSUMPTIONS:
1. BARRIER IS BEARING ON EXISTING SOIL
2. ϕ = 36°, OR BETTER
3. SLIDING COEFFICIENT μ = 0.8xTAN(ϕ) = 0.58

EMBEDMENT BEARING RESISTANCE, KSF

EFF. BASE WIDTH, B':	NOMINAL	EXTREME	STRENGTH	SERVICE (1" SETTLEMENT)
2'-10½"	11	13	6	13

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DATE	11/23/2021
PLOTTED BY	p005295D
DESIGNED BY	N. ALA
ENTERED BY	C. FUNG
CHECKED BY	E. KELLEY
PROJ. ENGR.	J. LEFOTU
REGIONAL ADM.	L. HODGSON

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER XL5467

CONTRACT NO. C9242 | LOCATION NO.

ERIC R. KELLEY, STATE OF WASHINGTON, 44060, STRUCTURAL ENGINEER, PROFESSIONAL ENGINEER

DATE — P.E. STAMP BOX

DATE — P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

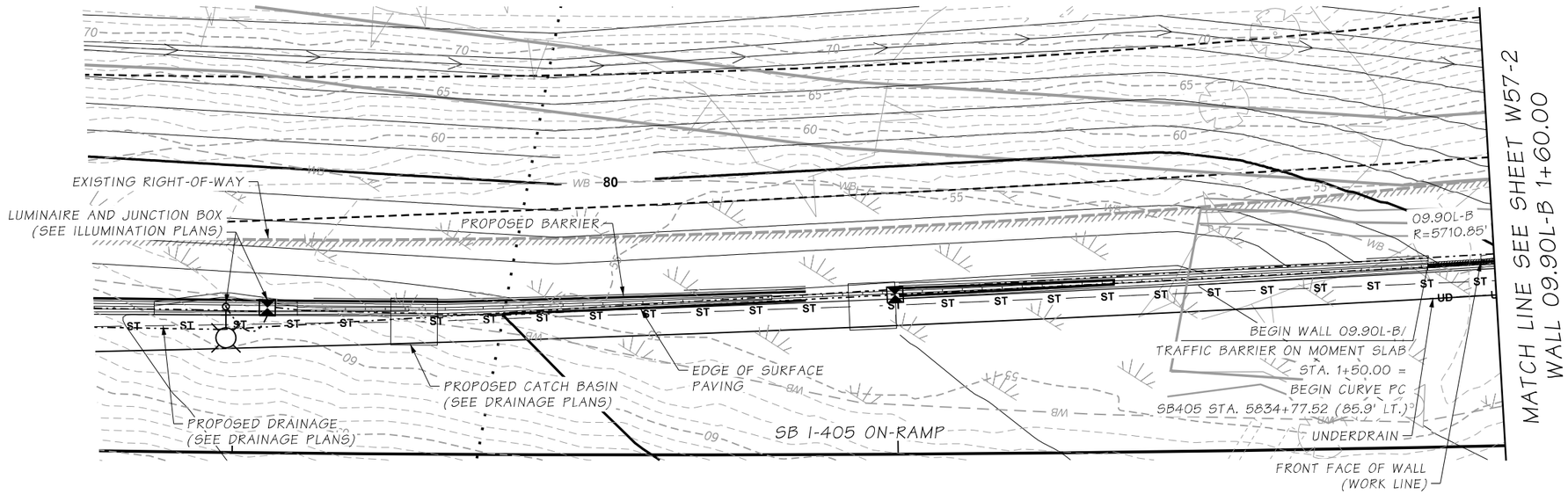
RETAINING BARRIER DETAILS
WALL 09.85L

PLAN REF NO W56-7

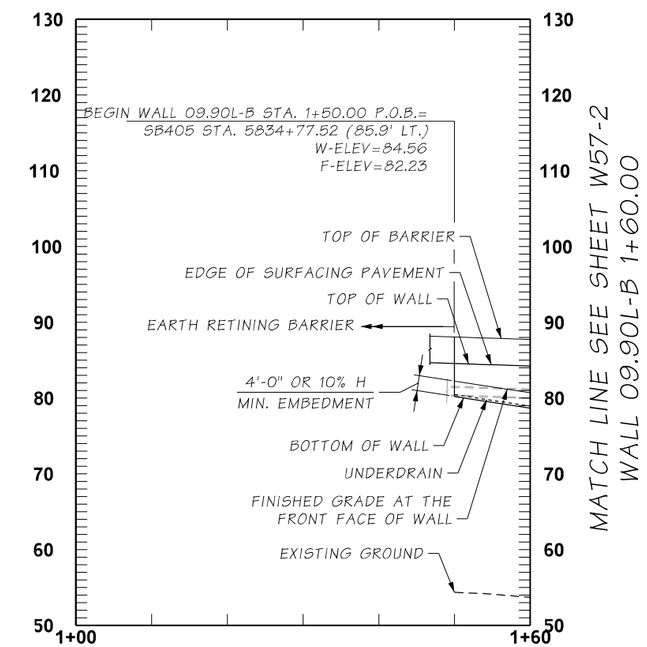
SHEET OF SHEETS

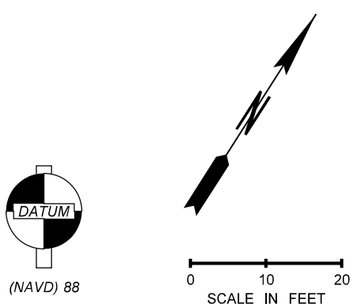
WALL 09.90L-B NOTES:

1. SEE PLAN NO. W56-1 FOR ADDITIONAL NOTES.
2. WALL 09.90L-B LAYOUT STATIONING IS PROVIDED AS OFFSET FROM SB I-405 LINE.
3. SEE SHEETS AL-36 & AL-37, RS-21 & RS-52, PR-44 & PV-45, AND PV-36 & PV-37 FOR ROADWAY ALIGNMENT, SECTIONS, PROFILE, AND PAVING, RESPECTIVELY.
4. SEE TRAFFIC CONTROL PLAN SEGMENT 2A SHEET MOT-36 & MOT-37, STAGE 1, PHASE 2 FOR WORK ZONE AND TRAFFIC STAGE.
5. SEE SHEET DR-36 & DR-37 FOR DRAINAGE PLANS.
6. SEE SHEETS TS-36 & TS-37 AND IL-36 & IL-37 FOR ITS AND ILLUMINATION PLANS, RESPECTIVELY.
7. SEE SHEET SN-36 & SN-37 FOR SIGNING PLANS.



PLAN - WALL 09.90L-B





REFLECTED ELEVATION - WALL 09.90L-B

WALL TYPE: STRUCTURAL EARTH (SEW)

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DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN				CONTRACT NO. C9242		LOCATION NO.
CHECKED BY	E. KELLEY						
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

FLATIRON LANE

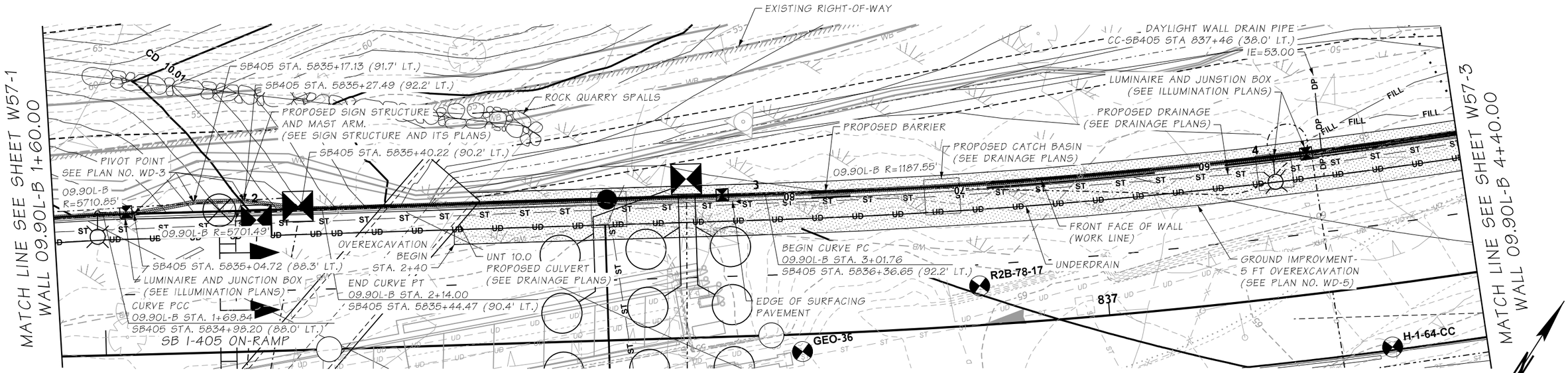
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

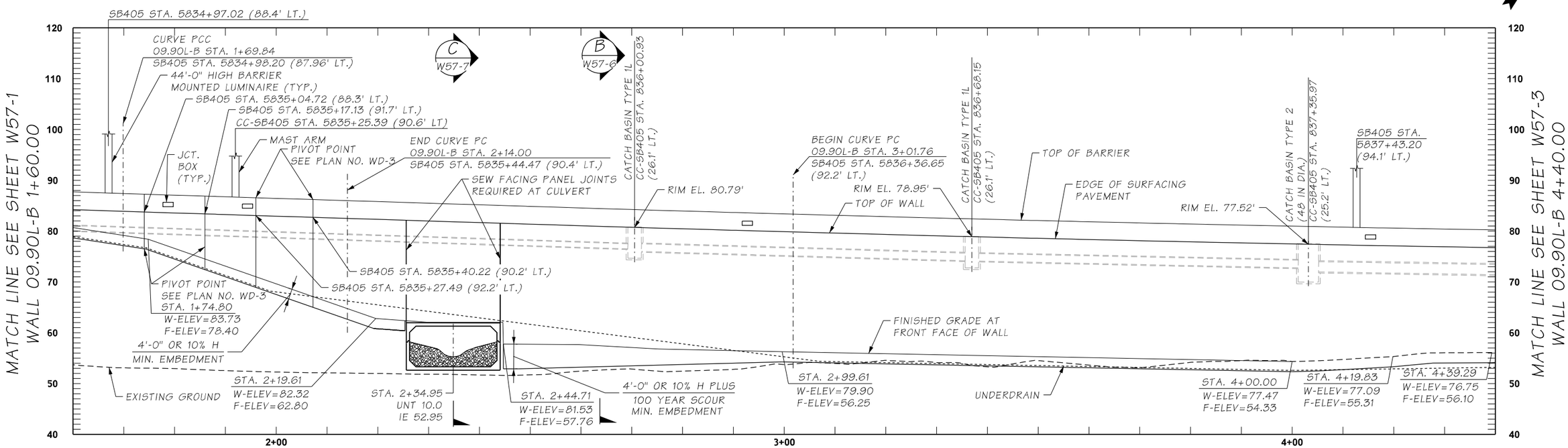
RETAINING WALL PLAN AND PROFILE WALL 09.90L-B (1 OF 3)

PLAN REF NO W57-1

SHEET OF SHEETS



PLAN - WALL 09.90L-B



REFLECTED ELEVATION - WALL 09.90L-B

NOTES:

1. SEE SHEET W57-1 FOR NOTES

WALL TYPE: STRUCTURAL EARTH (SEW)

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DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY						
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 40069 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

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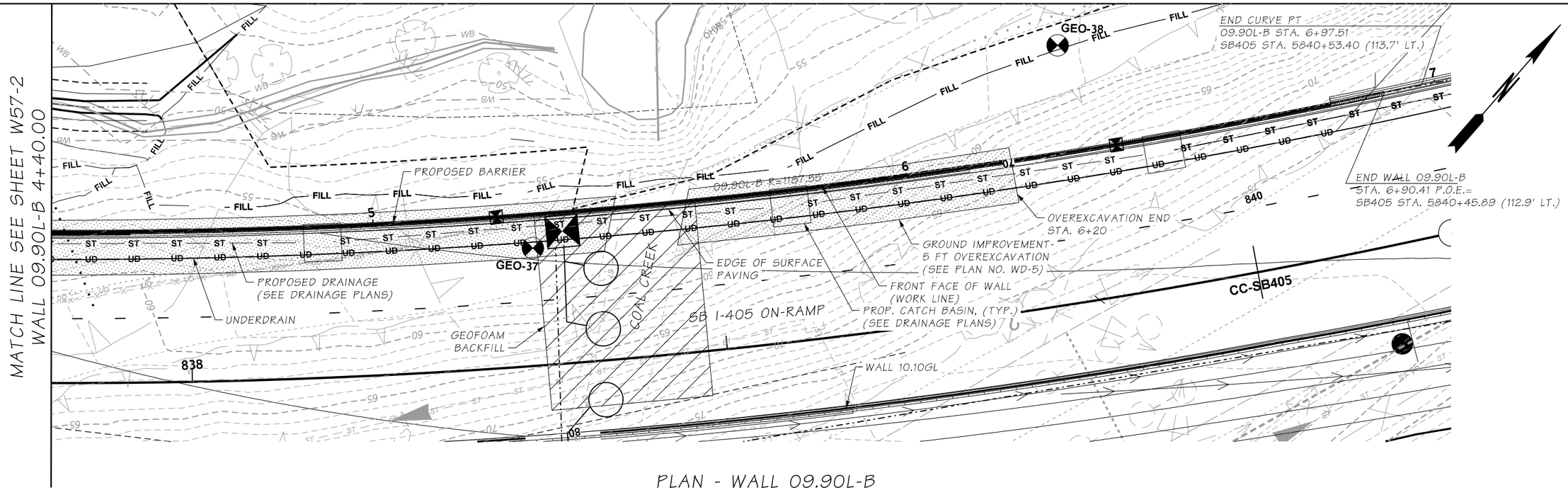
I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

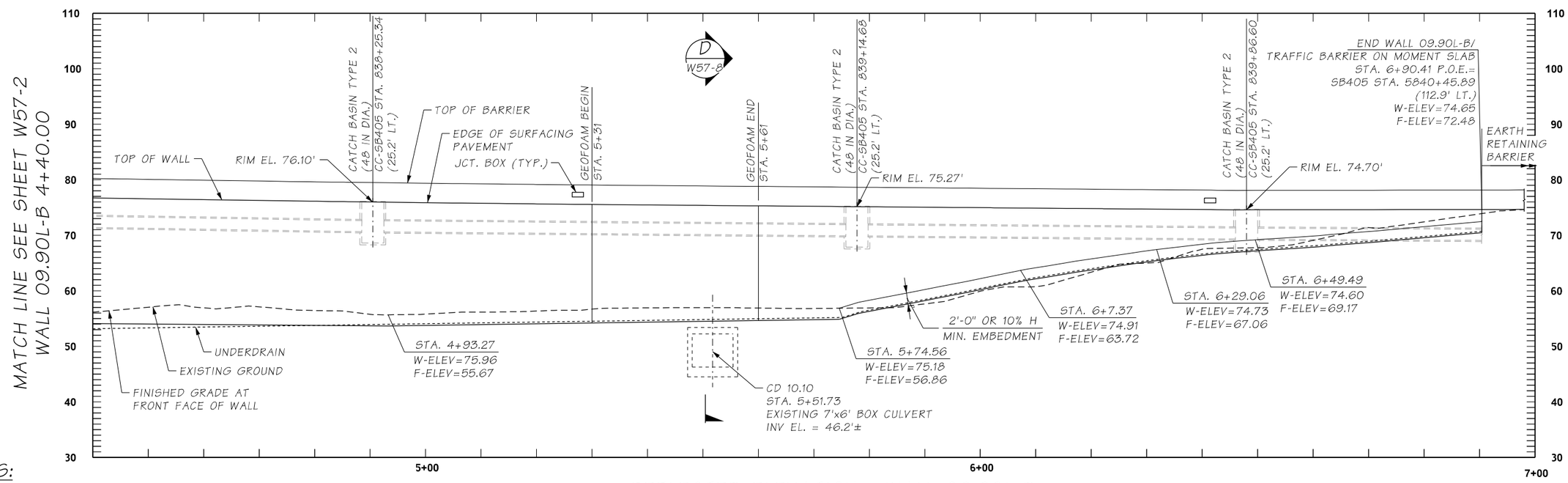
RETAINING WALL PLAN AND PROFILE
WALL 09.90L-B (2 OF 3)

PLAN REF NO W57-2

SHEET OF SHEETS



PLAN - WALL 09.90L-B



NOTES:

1. SEE SHEET W57-1 FOR NOTES

REFLECTED ELEVATION - WALL 09.90L-B

WALL TYPE: STRUCTURAL EARTH (SEW)

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DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

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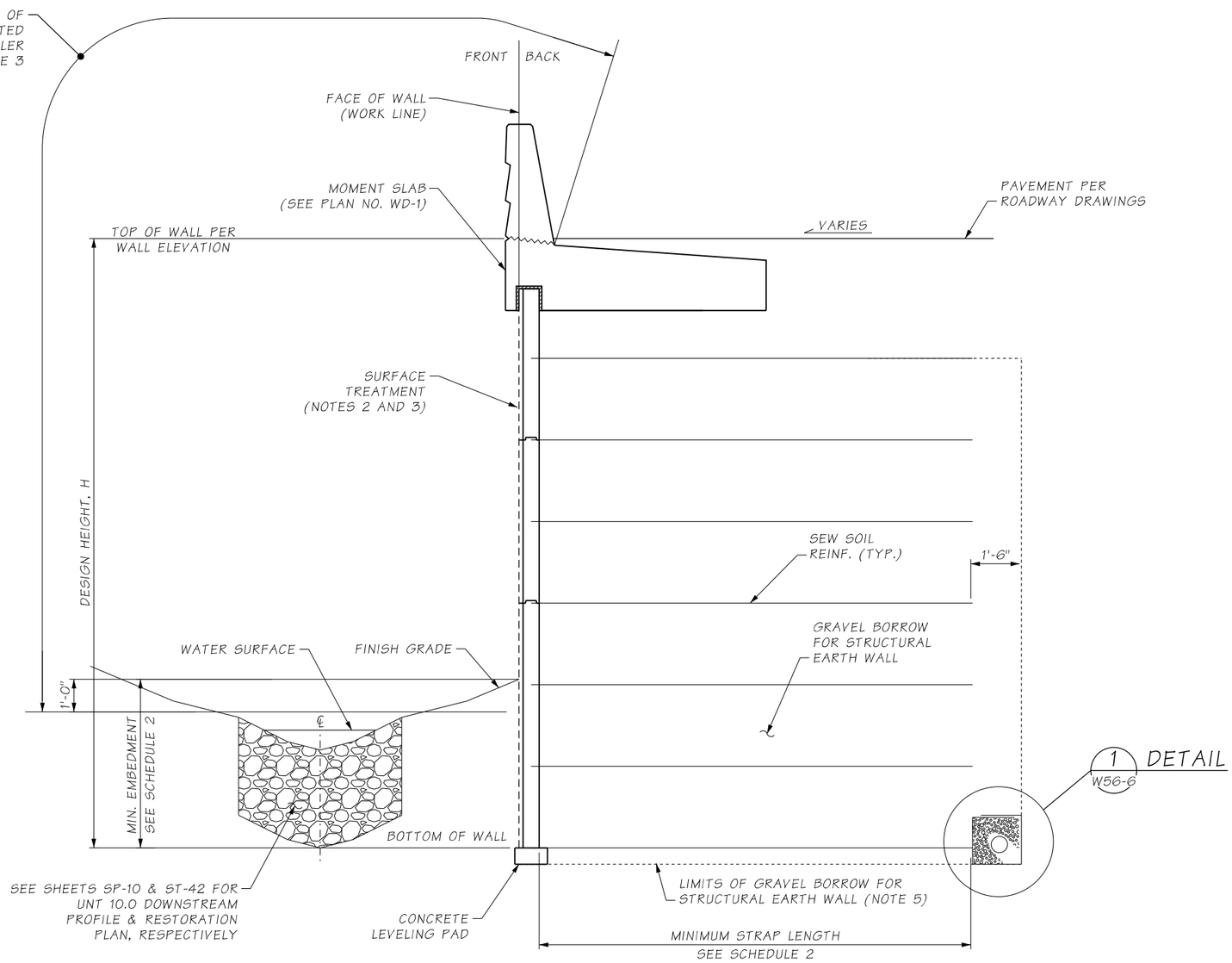
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

RETAINING WALL PLAN AND PROFILE
WALL 09.90L-B (3 OF 3)

PLAN REF NO W57-3

SHEET OF SHEETS



SECTION B W57-2

NOTES:

1. SEE PLAN NO. W56-6 FOR ADDITIONAL NOTES AND DETAILS.

SCHEDULE 2

BEGIN STATION	END STATION	MINIMUM STRAP LENGTH	MINIMUM WALL EMBEDMENT
1+50	2+40	0.8H OR 8.0 FT	4.0 FT
2+40	3+80	0.8H OR 8.0 FT	4.0 FT
3+80	6+20	1.0H OR 8.0 FT	2.0 FT
6+20	6+90.41	0.75H OR 8.0 FT	2.0 FT

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ENTERED BY	M. ALEKSANYAN
CHECKED BY	E. KELLEY
PROJ. ENGR.	J. LEFOTU
REGIONAL ADM.	L. HODGSON

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER XL5467

CONTRACT NO. C9242 | LOCATION NO.

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE — P.E. STAMP BOX

DATE — P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

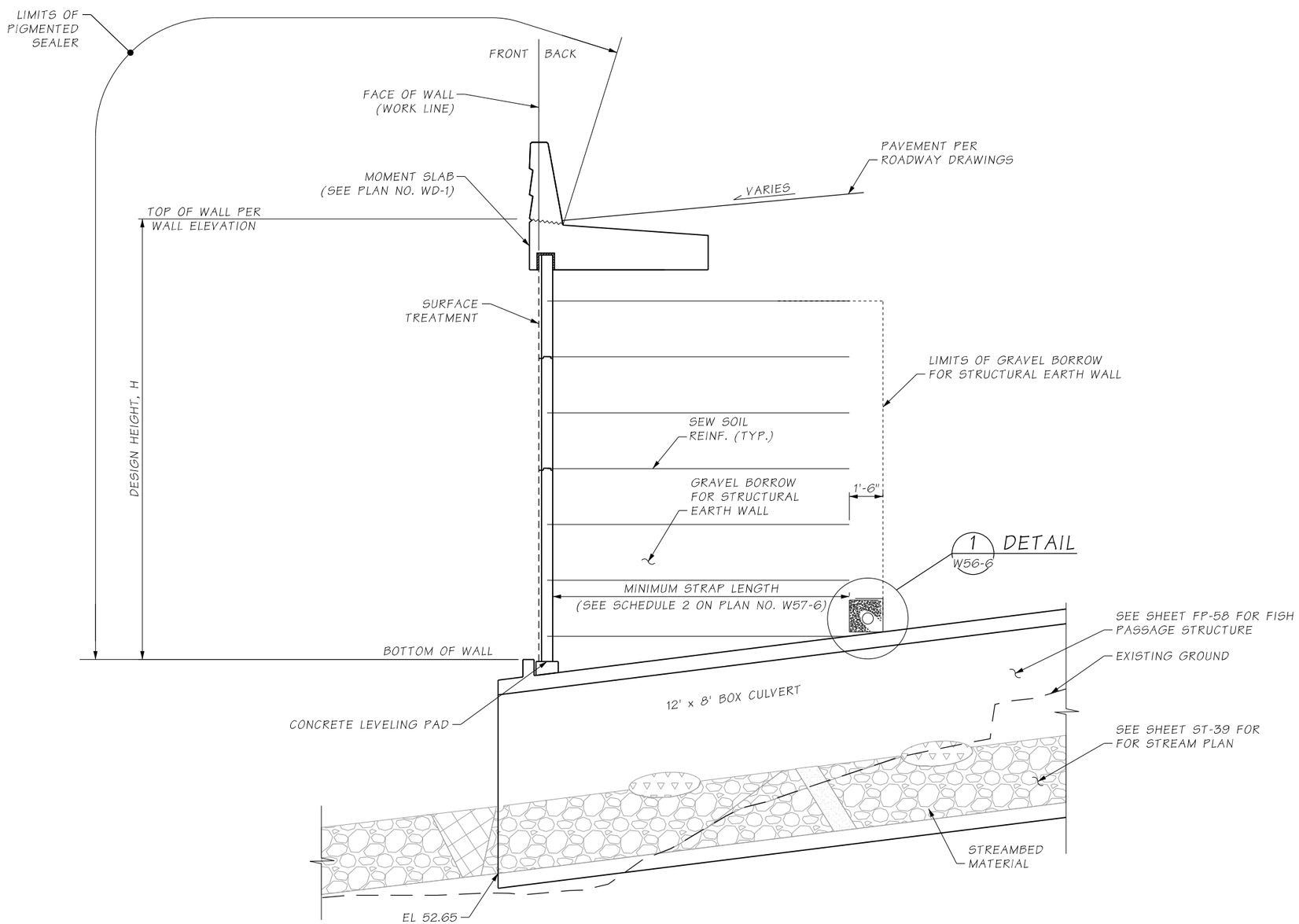
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

RETAINING WALL DETAILS
WALL 9.90L-B (1 OF 4)

PLAN REF NO W57-6

SHEET OF SHEETS



TYPICAL SECTION AT NEW UNT 10.00 FISH PASSAGE C W57-2

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DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

P.E. STAMP BOX — DATE

P.E. STAMP BOX — DATE

Washington State Department of Transportation

FLATIRON LANE

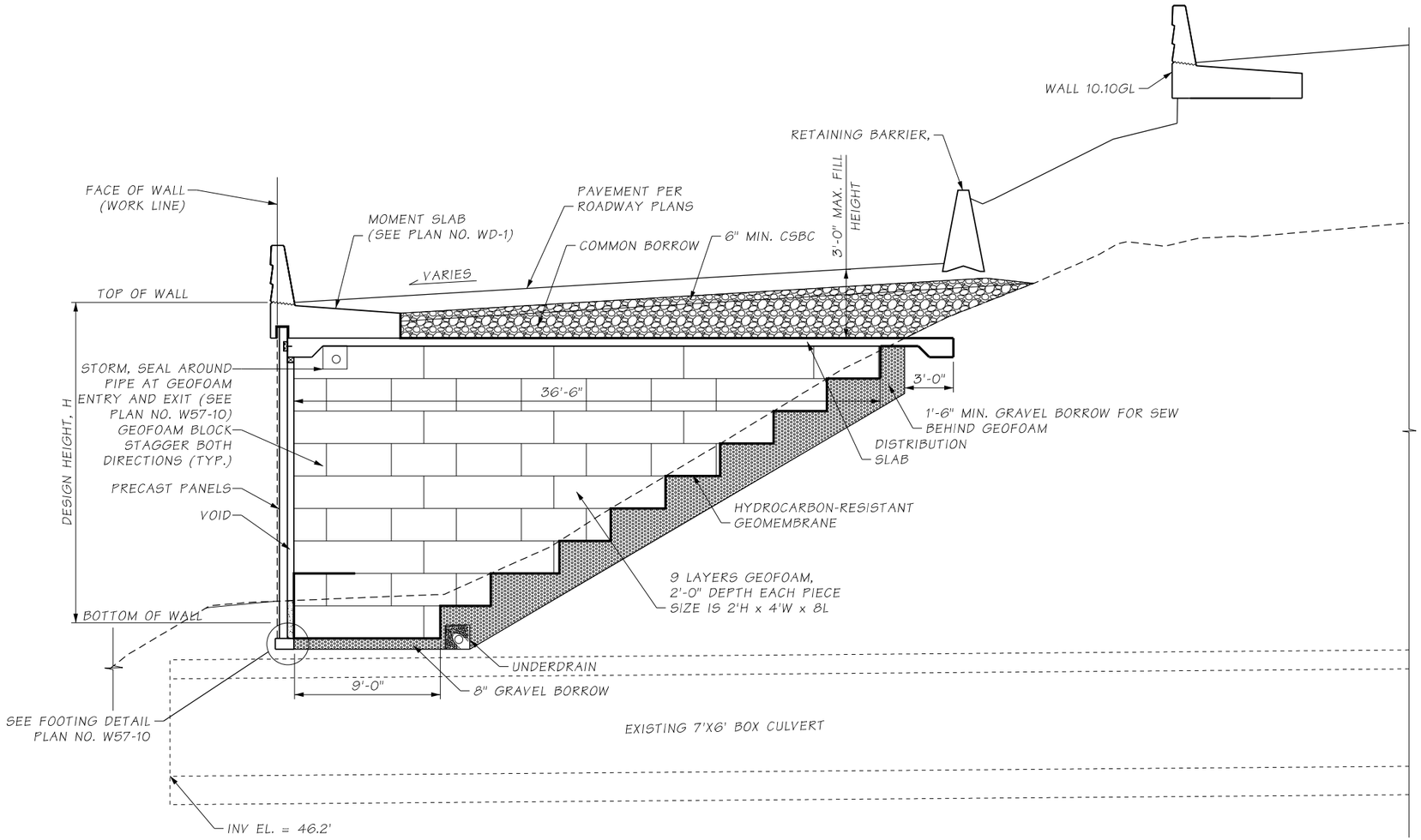
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

RETAINING WALL DETAILS
WALL 9.90L-B (2 OF 4)

PLAN REF NO W57-7

SHEET OF SHEETS



SECTION AT EXISTING UNT 10.10 (D) W57-3

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DATE	11/22/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN				CONTRACT NO. C9242		LOCATION NO.
CHECKED BY	E. KELLEY						
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

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Washington State Department of Transportation

FLATIRON LANE

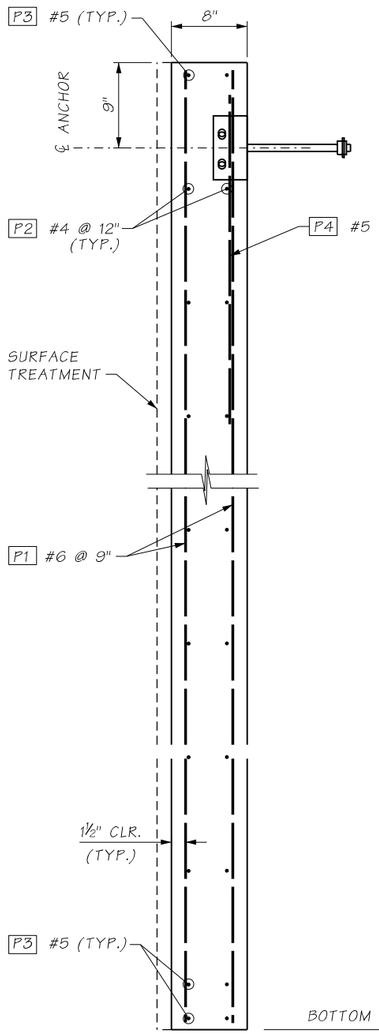
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

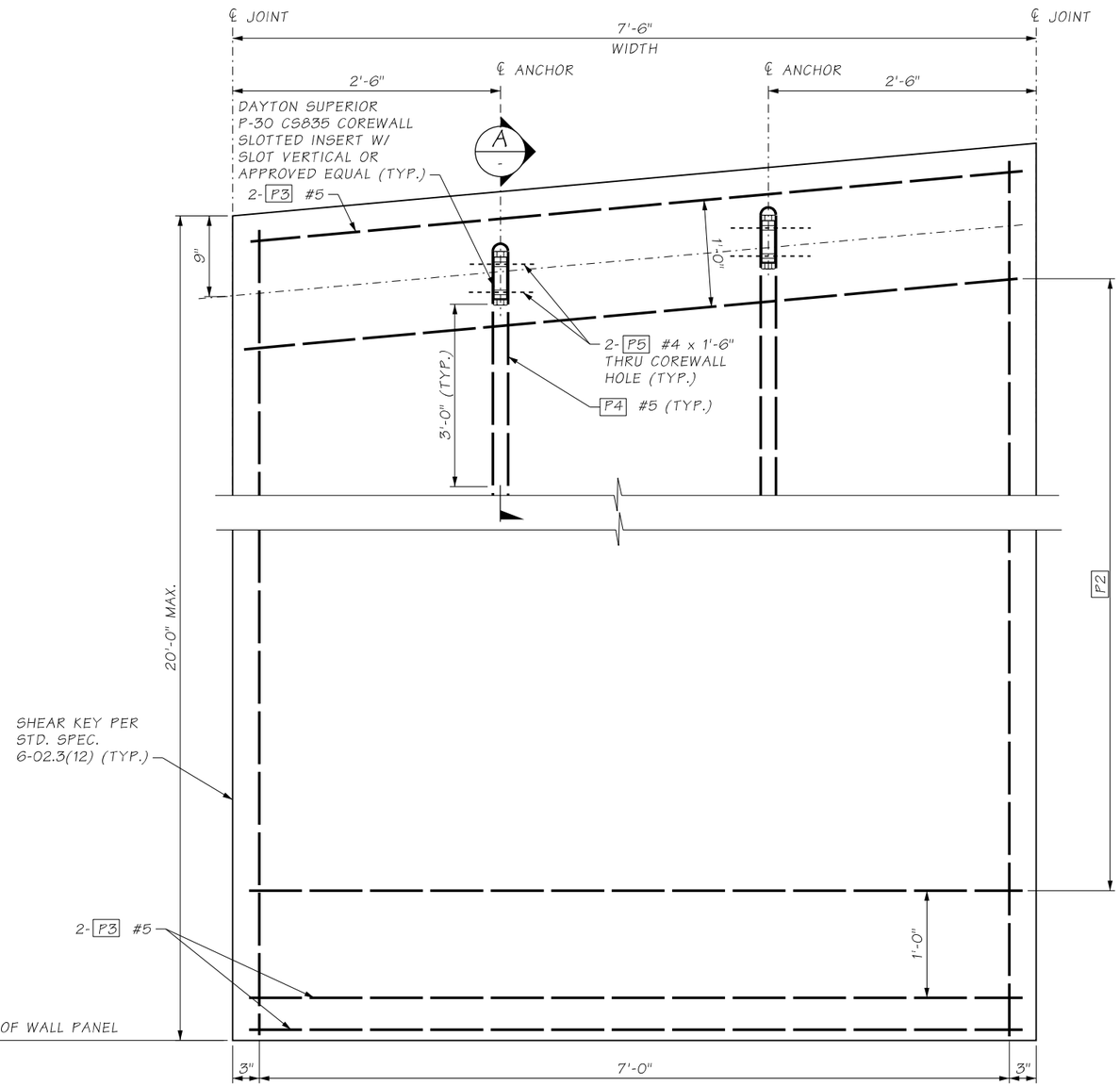
RETAINING WALL DETAILS
WALL 9.90L-B (3 OF 4)

PLAN REF NO W57-8

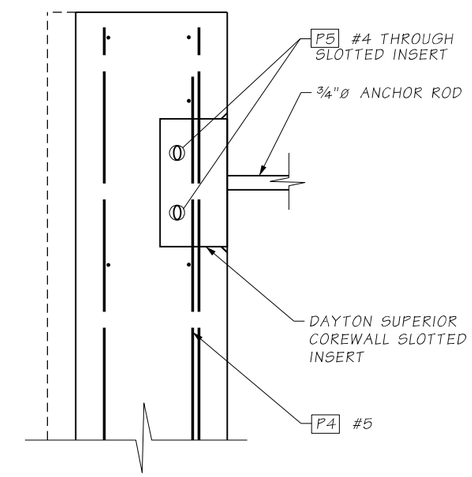
SHEET OF SHEETS



PANEL SECTION



PANEL ELEVATION



SECTION A
-

LOAD DISTRIBUTION SLAB NOT SHOWN FOR CLARITY

NOTES:

1. THE WALL PANELS SHOWN HAVE NOT BEEN EVALUATED FOR SHIPPING AND ERECTION LOADS. THE CONTRACTOR SHALL PROVIDE ADDITIONAL BRACING OR REINFORCING AS REQUIRED FOR SHIPPING AND ERECTION.
2. ERECTION INSERTS SHALL NOT INTERFERE WITH GEOFOAM OR SHALL BE REMOVED PRIOR TO GEOFOAM PLACEMENT.
3. PANEL CONNECTION TO LOAD DISTRIBUTION SLAB SHALL NOT BE USED FOR LIFTING.
4. PANELS SHALL HAVE A KEYED JOINT. A SMOOTH JOINT SHALL BE PROVIDED AT THE FIRST AND LAST PANELS.
5. THE WALL PANEL TO DISTRIBUTION SLAB CONNECTION ASSEMBLY SHALL BE HOT DIP GALVANIZED.

W57-9

FILE NAME	c:\pw_working\wastate\parsons_p005295d\dms32768\XL5467_DE_W57-9.dgn						
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DATE	11/23/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN				CONTRACT NO. C9242		LOCATION NO.
CHECKED BY	E. KELLEY						
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

DATE

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Washington State Department of Transportation

FLATIRON LANE

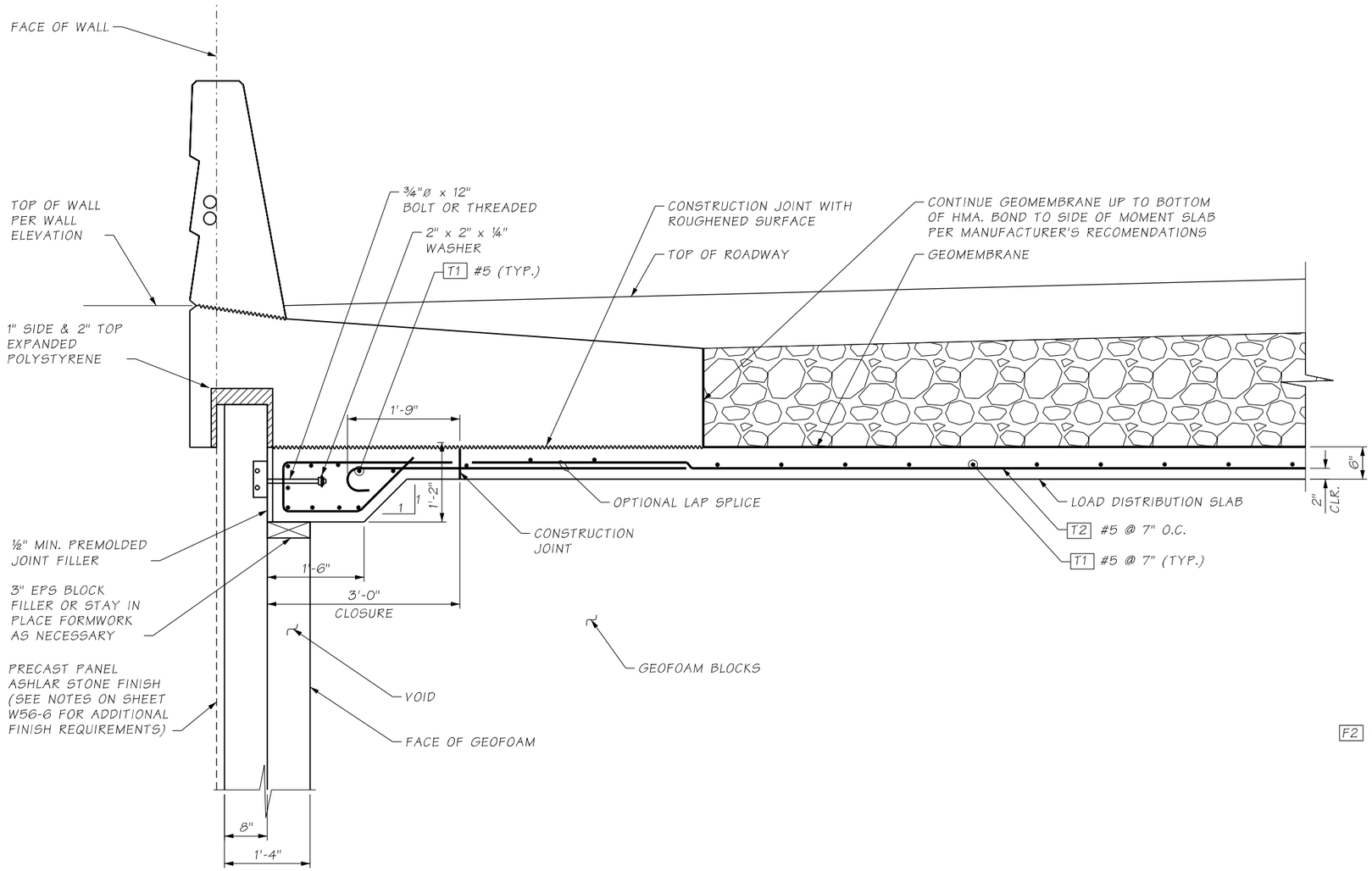
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

GEOFOAM TYPICAL DETAILS (1 OF 2) (W57) ON WALL 9.90L-B

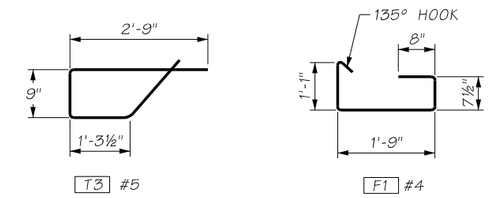
PLAN REF NO W57-9

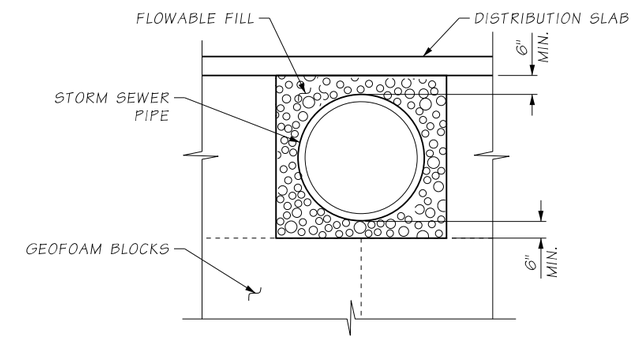
SHEET OF SHEETS



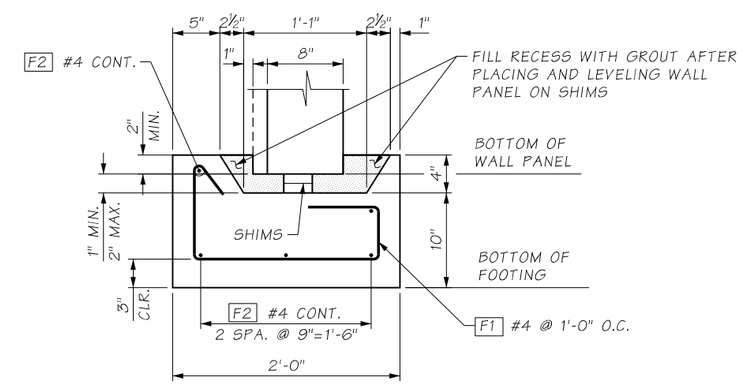
GEOFOAM WALLS WITH MOMENT SLAB BARRIER DETAIL

BENDING DIAGRAM





PIPE SECTION IN GEOFOAM



FOOTING DETAIL FOR PRECAST PANEL

W57-10

FILE NAME	c:\pw_working\wastate\parsons_p005295d\dms32768\XL5467_DE_W57-10.dgn						
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DATE	11/23/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

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Washington State Department of Transportation

FLATIRON LANE

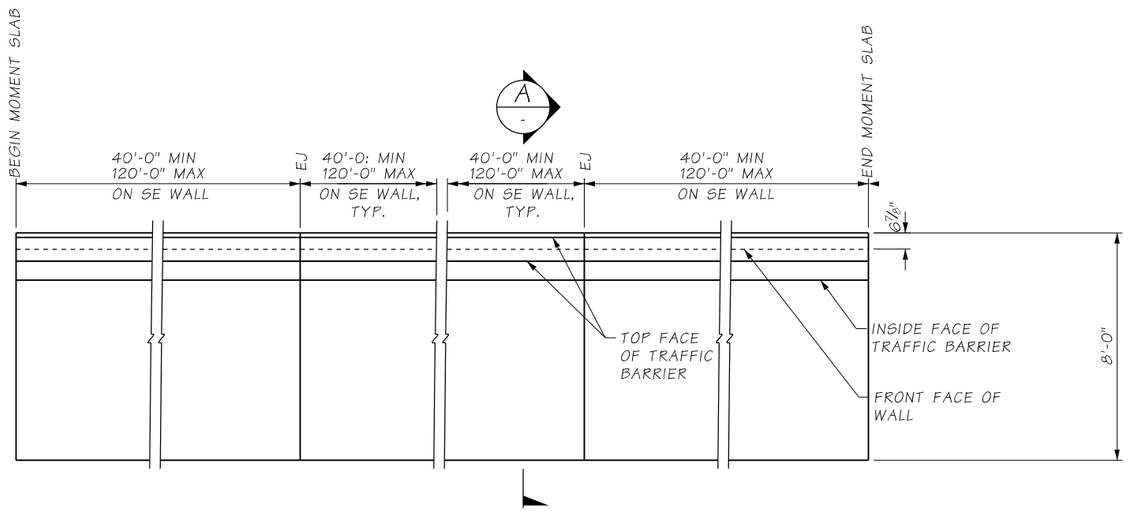
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

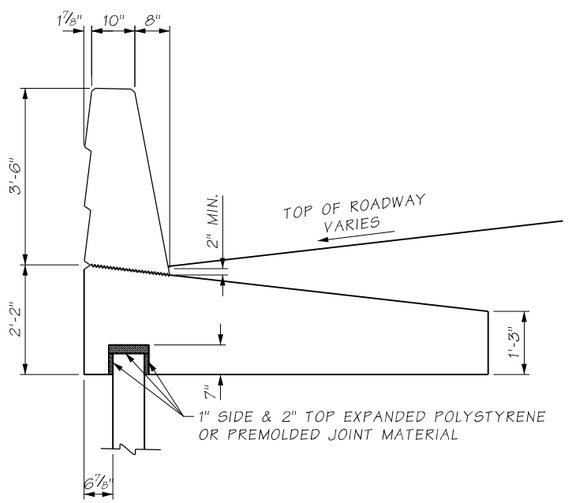
GEOFOAM TYPICAL DETAILS (2 OF 2) (W57) ON WALL 9.90L-B

PLAN REF NO W57-10

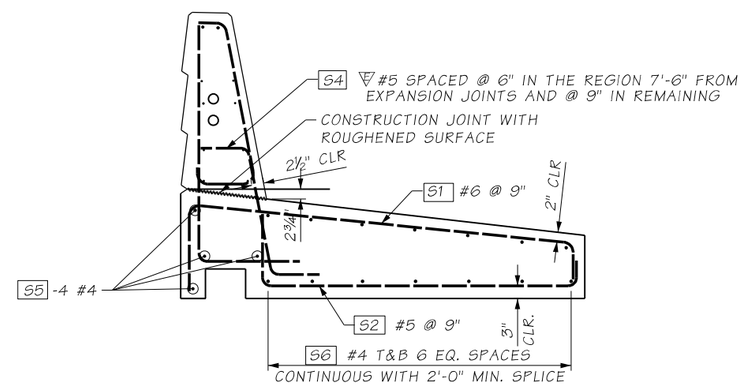
SHEET OF SHEETS



TYPICAL PLAN - MOMENT SLAB ON SE WALL

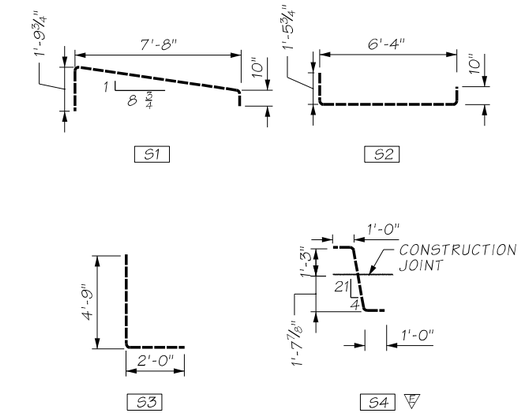


SECTION A -



SECTION A -

BENDING DIAGRAM



ALL DIMENSIONS ARE OUT TO OUT
▽ = EPOXY COATED REINFORCING STEEL

NOTES:

1. ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATION FOR ROADS, BRIDGES AND MUNICIPAL CONSTRUCTION, ENGLISH UNITS, DATED 2018 AND AMENDED JANUARY 7, 2019.
2. MOMENT SLAB BARRIER HAS BEEN DESIGN FOR TL-4 LOADING.
3. THE CONCRETE SHALL BE CLASS 4000 UNLESS OTHERWISE NOTED.
4. REINFORCING BARS SHALL CONFORM TO ASTM A706 GRADE 60 UNLESS OTHERWISE NOTED.
5. ALL LONGITUDINAL REINFORCING BARS IN THE MOMENT SLAB AND BARRIERS SHALL BE CUT AT EXPANSION JOINTS AND ½" PERMOLDED JOINT FILLER SHALL BE USED TO FORM EXPANSION JOINTS.
6. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4", UNLESS NOTED OTHERWISE.

WD-1

FILE NAME	c:\pw_working\wastate\parsons_p005295d\dms32768\XL5467_DE_WD-1.dgn						
TIME	8:29:10 PM				REGION NO. 10	STATE WASH	FED.AID PROJ.NO.
DATE	11/18/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	K. KRONBAUER						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER
DATE
P.E. STAMP BOX

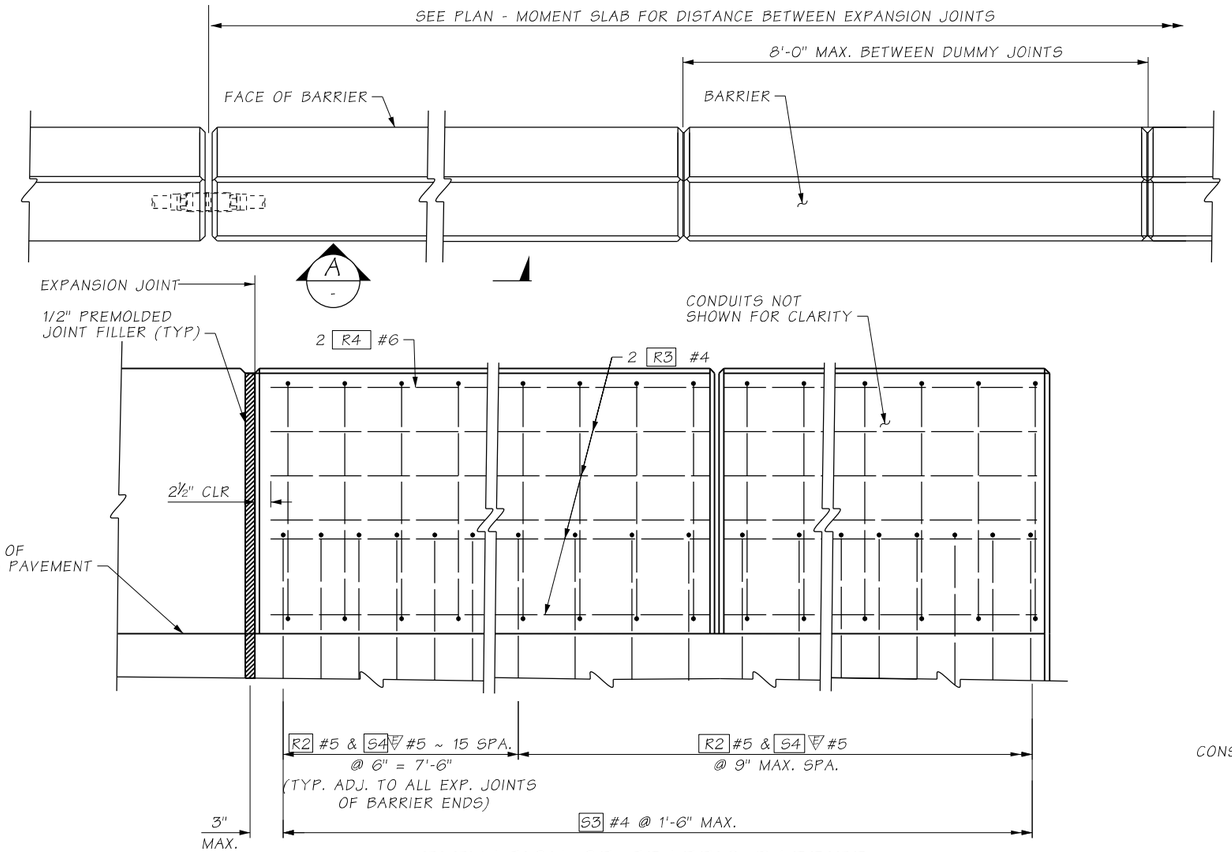
DATE
P.E. STAMP BOX

Washington State Department of Transportation
FLATIRON LANE
PARSONS

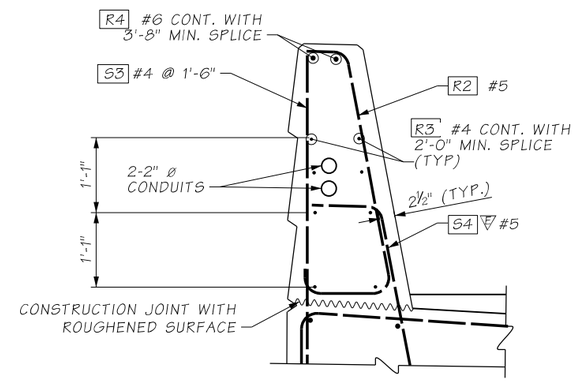
I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

MOMENT SLAB DETAILS (1 OF 4)
(W56) ON WALL 09.90L-A &
(W57) ON WALL 9.90L-B

PLAN REF NO
WD-1
SHEET
OF
SHEETS

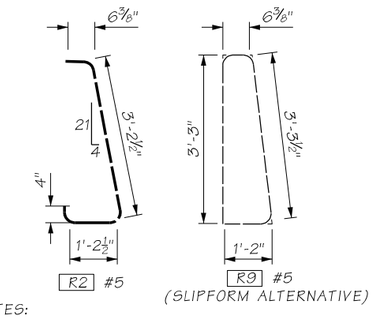


ELEVATION OF TRAFFIC BARRIER



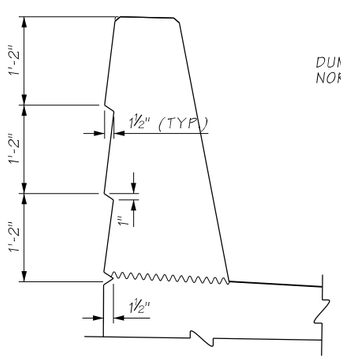
REINF. SECTION-TRAFFIC BARRIER

BENDING DIAGRAM

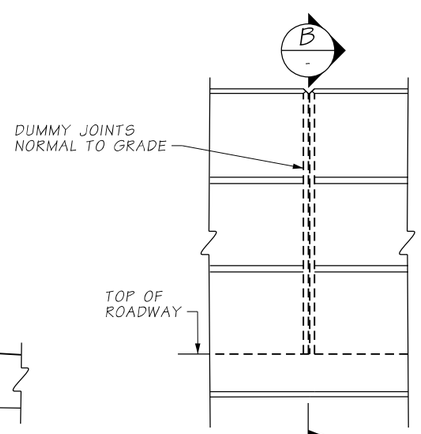


NOTES:

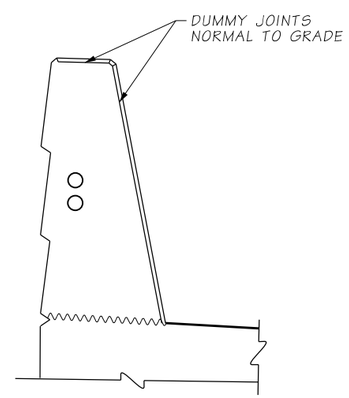
1. DIMENSIONS TO POINT OF INTERSECTION.
2. BARS R1, R5, R6, R7, AND R8 ARE NOT USED.
3. ALL DIMENSIONS ARE OUT TO OUT.



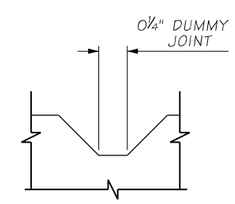
BARRIER FINISH DETAIL



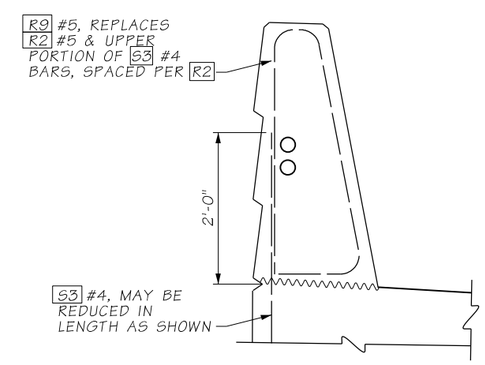
VIEW A



SECTION B



DUMMY JOINT DETAIL



SLIPFORM ALTERNATIVE

WD-2

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TIME	8:10:25 PM						
DATE	11/18/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	K. KRONBAUER						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE
P.E. STAMP BOX

DATE
P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

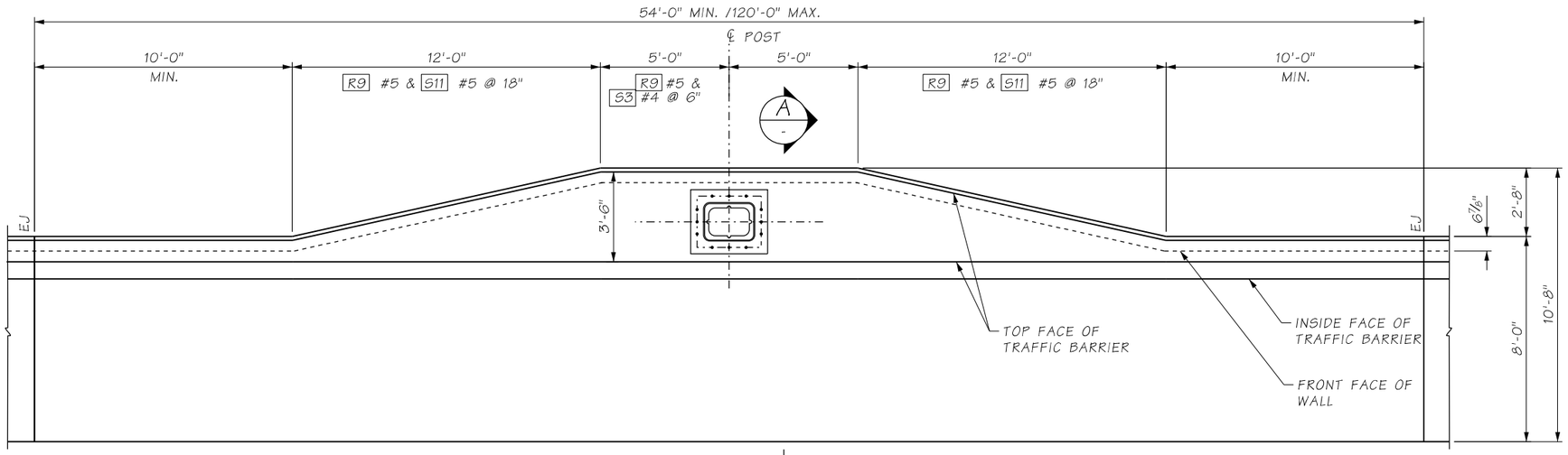
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

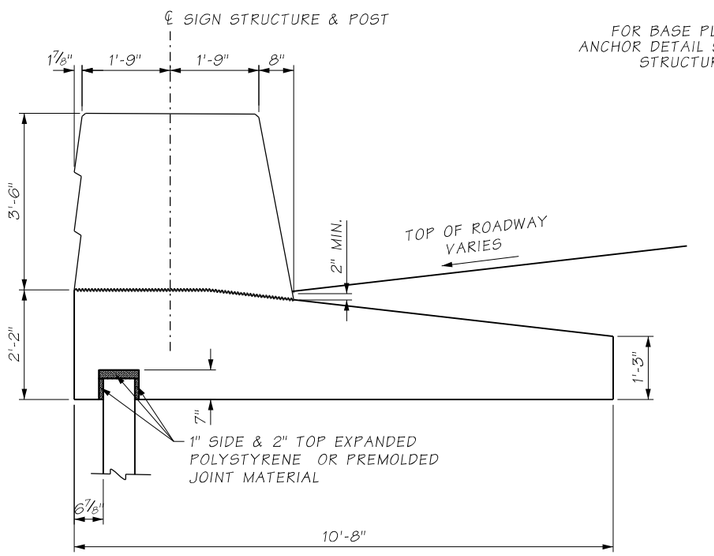
MOMENT SLAB DETAILS (2 OF 4)
(W56) ON WALL 09.90L-A &
(W57) ON WALL 9.90L-B

PLAN REF NO
WD-2

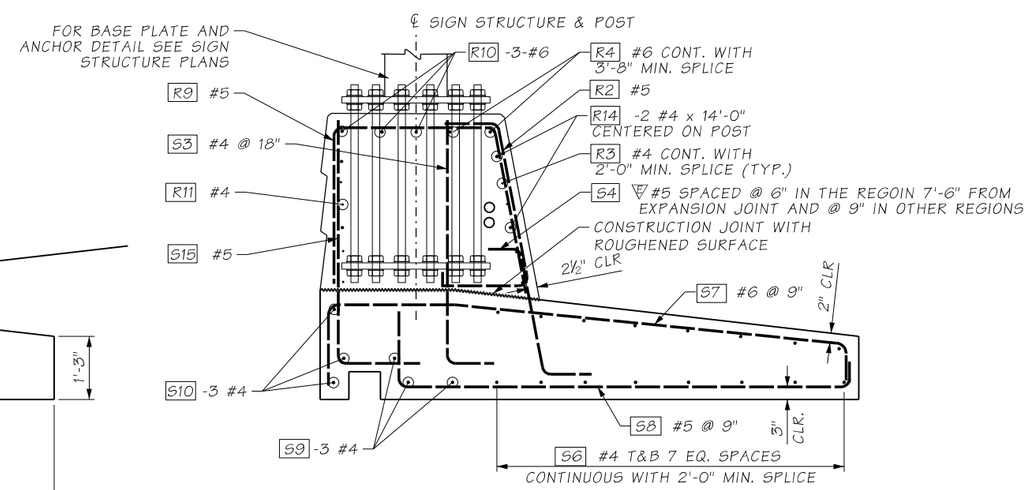
SHEET
OF
SHEETS



TYPICAL PLAN - MOMENT SLAB W/ SIGN STRUCTURE OR MAST ARM

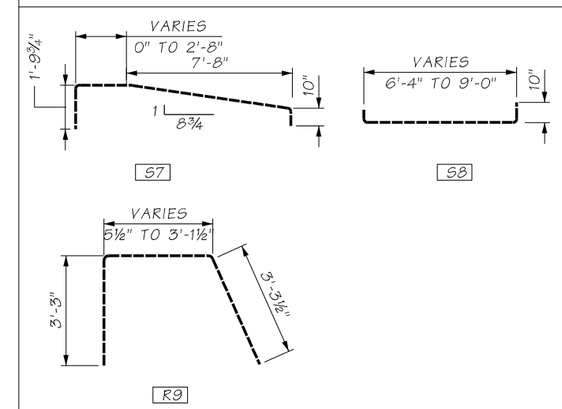


SECTION A



SECTION A

BENDING DIAGRAM



ALL DIMENSIONS ARE OUT TO OUT

NOTE:

1. THE REINFORCEMENT SHOWN FOR THE SIGN STRUCTURE SHALL BE VERIFIED BY THE SIGN STRUCTURE ENGINEER OR RECORD AND MODIFIED IF REQUIRED.

WD-3

FILE NAME	c:\pw_working\wastate\parsons_p005295d\dms32768\XL5467_DE_WD-3.dgn				REGION NO. 10	STATE WASH	FED.AID PROJ.NO.
TIME	9:19:31 PM						
DATE	11/19/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	K. KRONBAUER						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44066 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

DATE

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Washington State Department of Transportation

FLATIRON LANE

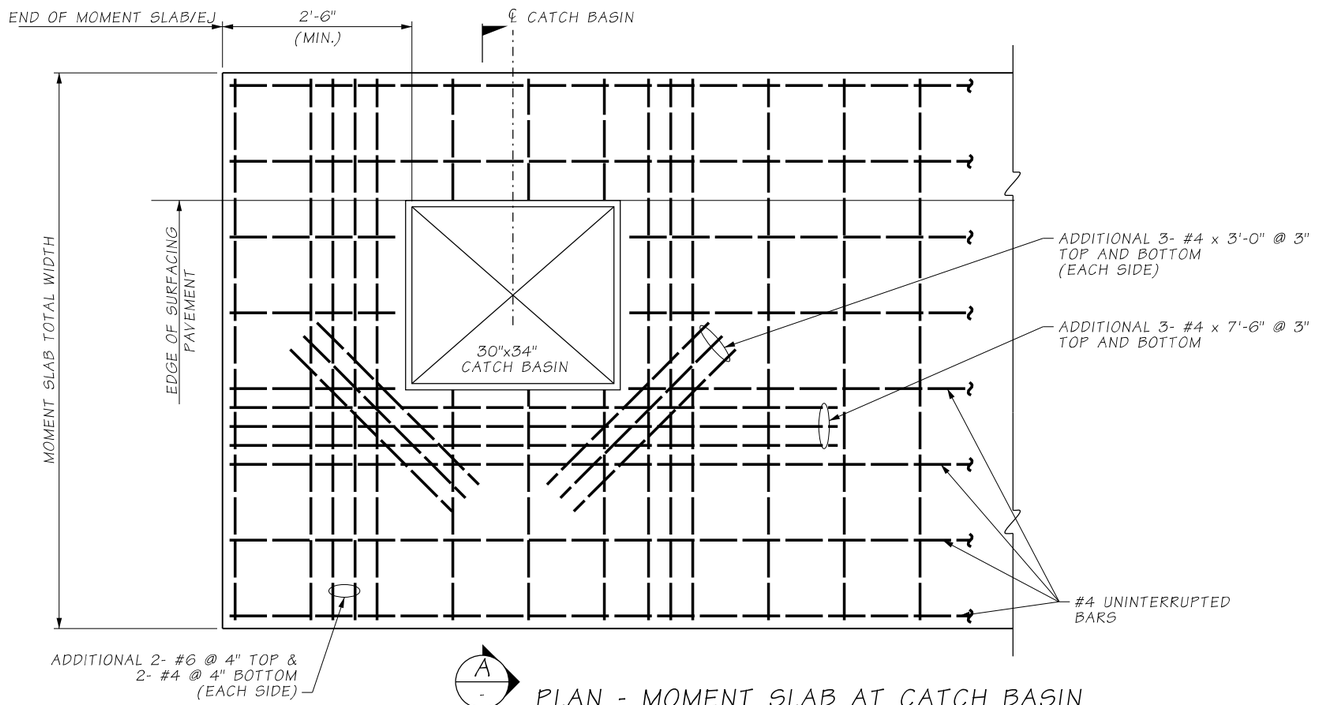
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

MOMENT SLAB DETAILS (3 OF 4)
(W56) ON WALL 09.90L-A &
(W57) ON WALL 9.90L-B

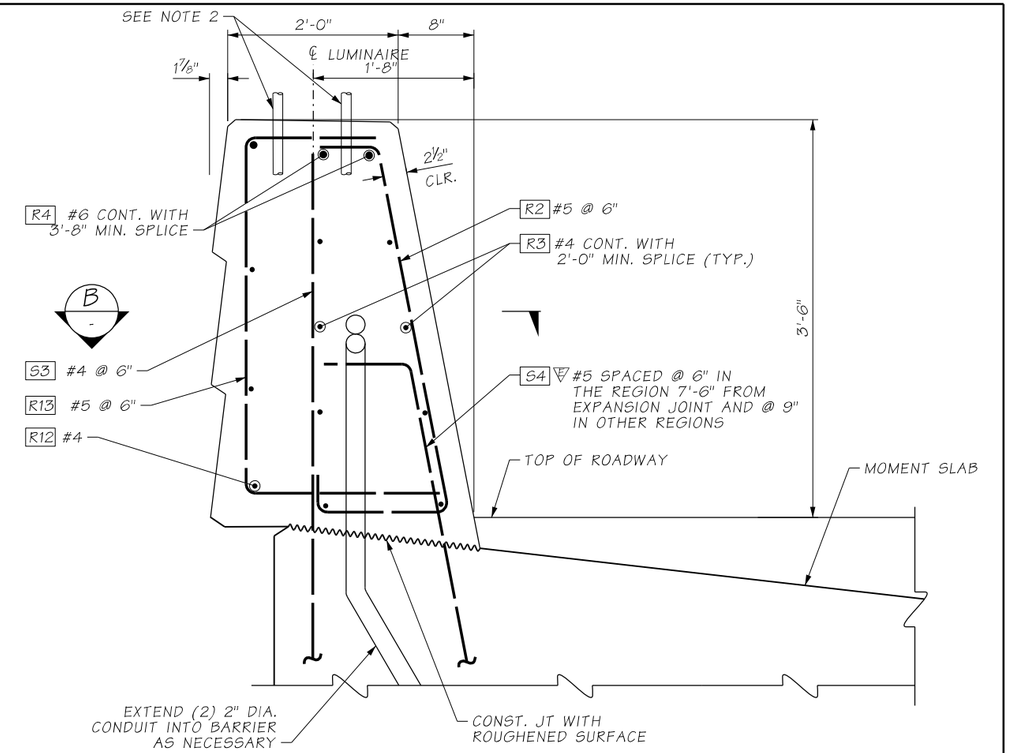
PLAN REF NO WD-3

SHEET OF SHEETS



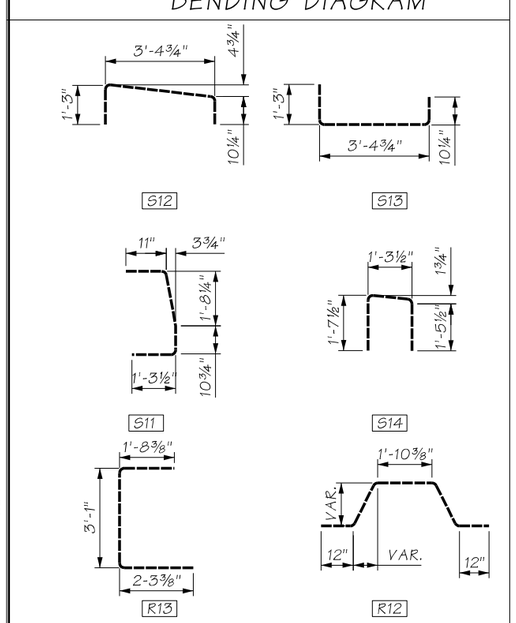
A

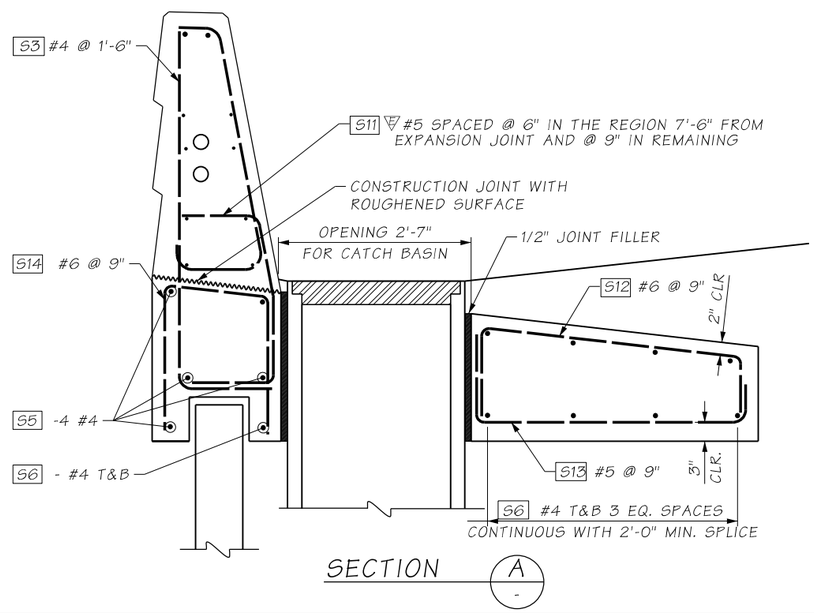
PLAN - MOMENT SLAB AT CATCH BASIN



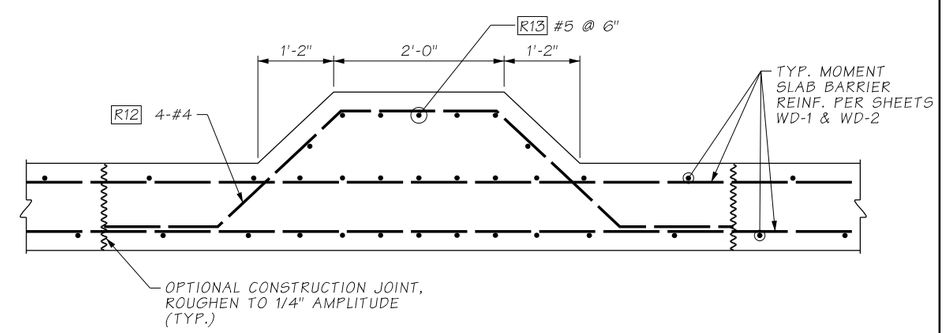
SECTION - TRAFFIC BARRIER W/ LUMINAIRE

BENDING DIAGRAM





SECTION A



SECTION B

NOTES:

1. SEE WD-1 & WD-2 FOR ADDITIONAL INFO.
2. REFER TO WSDOT STANDARD PLAN J-28.60 FOR STEEL LIGHT STANDARD BARRIER MOUNTED BASE REQUIREMENTS.

WD-4

FILE NAME	c:\pw_working\wastate\parsons_p005295d\dms32768\XL5467_DE_WD-4.dgn					
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DATE	11/19/2021					
PLOTTED BY	p005295D					
DESIGNED BY	B. CHRISTOPHERSEN					
ENTERED BY	M. ALEKSANYAN					
CHECKED BY	E. KELLEY					
PROJ. ENGR.	J. LEFOTU					
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY		

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER XL5467		
CONTRACT NO. C9242		LOCATION NO.

ERIC R. KELLEY — STATE OF WASHINGTON — 44086 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

FLATIRON LANE

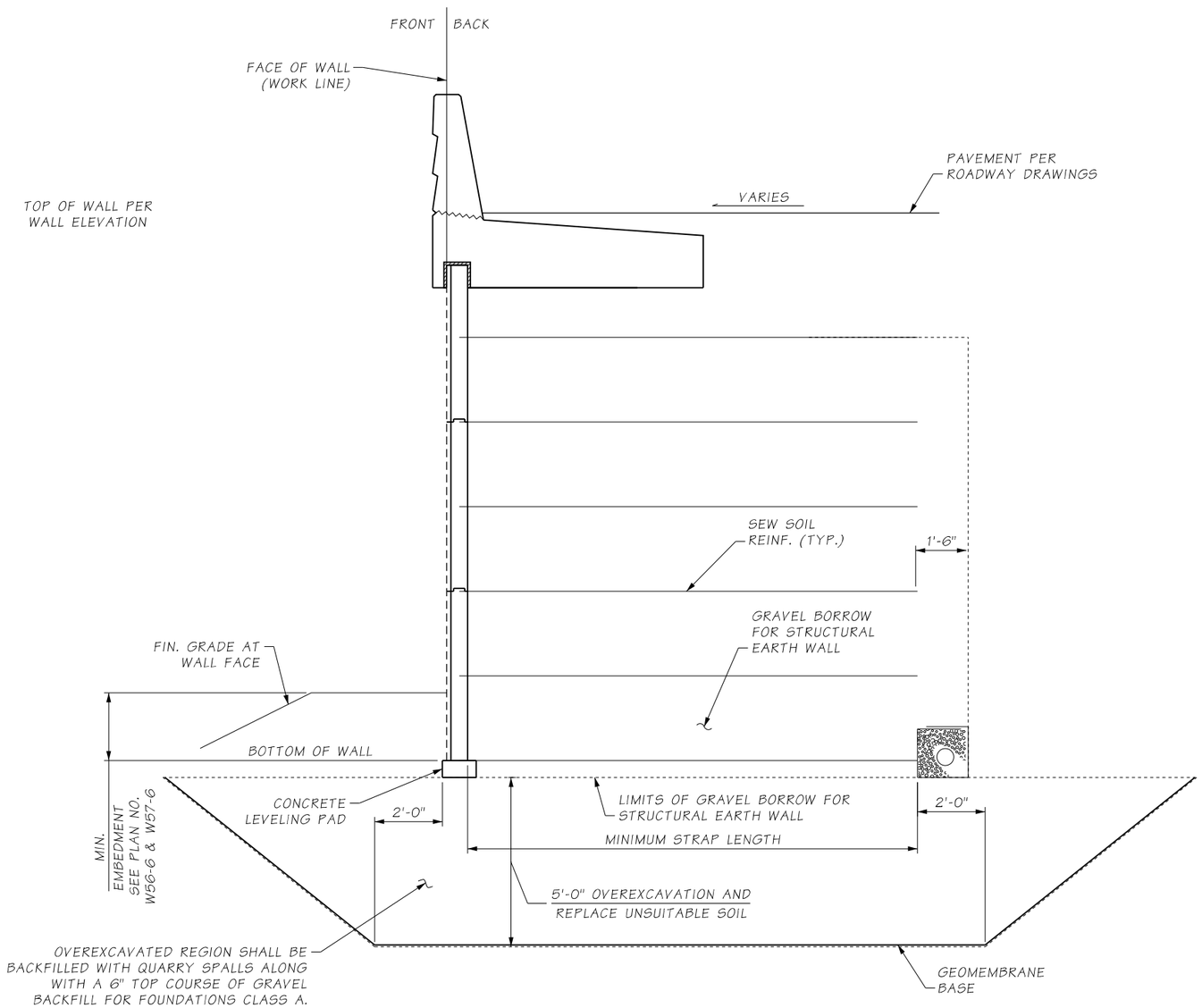
PARSONS

I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

MOMENT SLAB DETAILS (4 OF 4)
(W56) ON WALL 09.90L-A &
(W57) ON WALL 9.90L-B

PLAN REF NO **WD-4**

SHEET OF SHEETS



TYPICAL SECTION AT OVEREXCAVATION

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DATE	11/22/2021						
PLOTTED BY	p005295D				JOB NUMBER XL5467		
DESIGNED BY	W. METWALLY						
ENTERED BY	M. ALEKSANYAN						
CHECKED BY	E. KELLEY				CONTRACT NO. C9242		LOCATION NO.
PROJ. ENGR.	J. LEFOTU						
REGIONAL ADM.	L. HODGSON	REVISION	DATE	BY			

ERIC R. KELLEY — STATE OF WASHINGTON — 44060 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

DATE

P.E. STAMP BOX

DATE

P.E. STAMP BOX

Washington State Department of Transportation

FLATIRON LANE

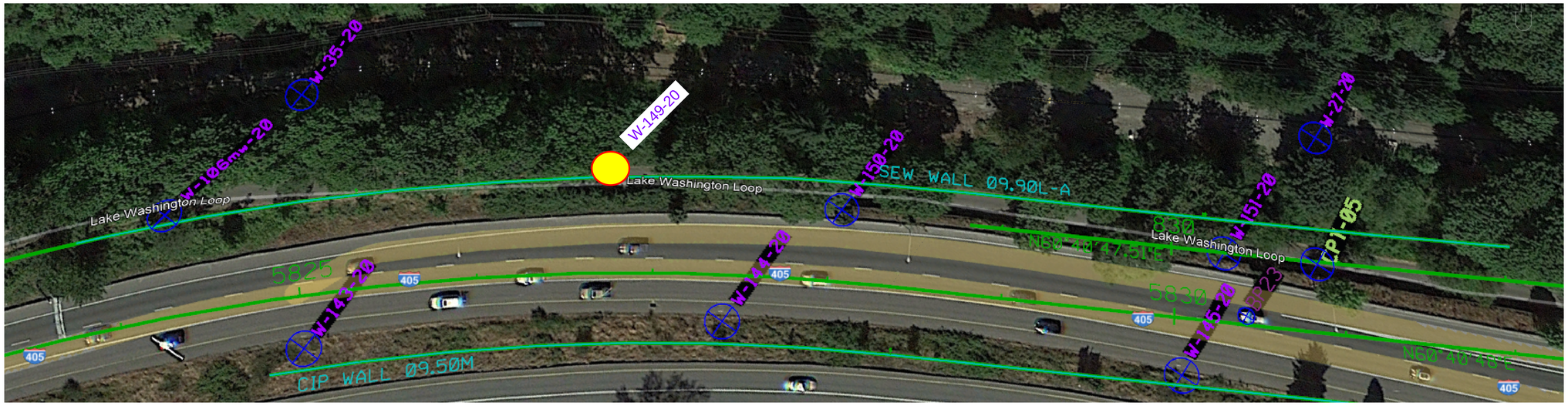
PARSONS

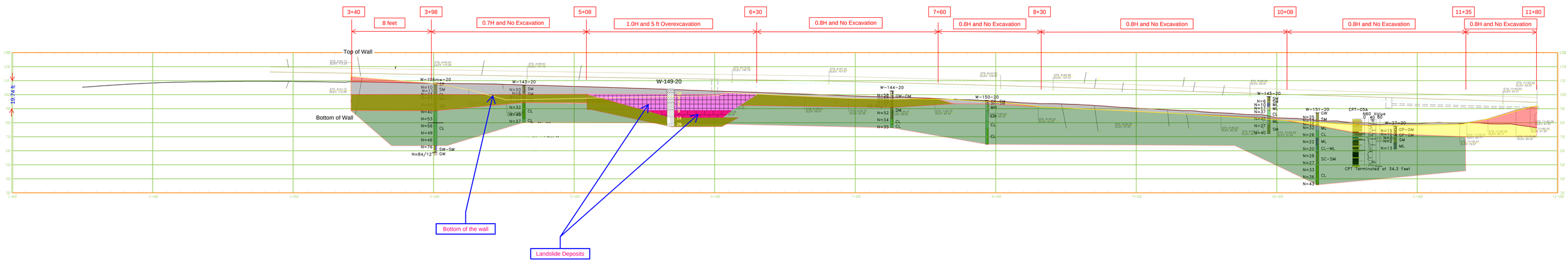
I-405; RENTON TO BELLEVUE WIDENING AND EXPRESS TOLL LANES PROJECT

RETAINING WALL OVEREXCAVATION DETAILS
WALL 9.90L-A & WALL 9.90L-B

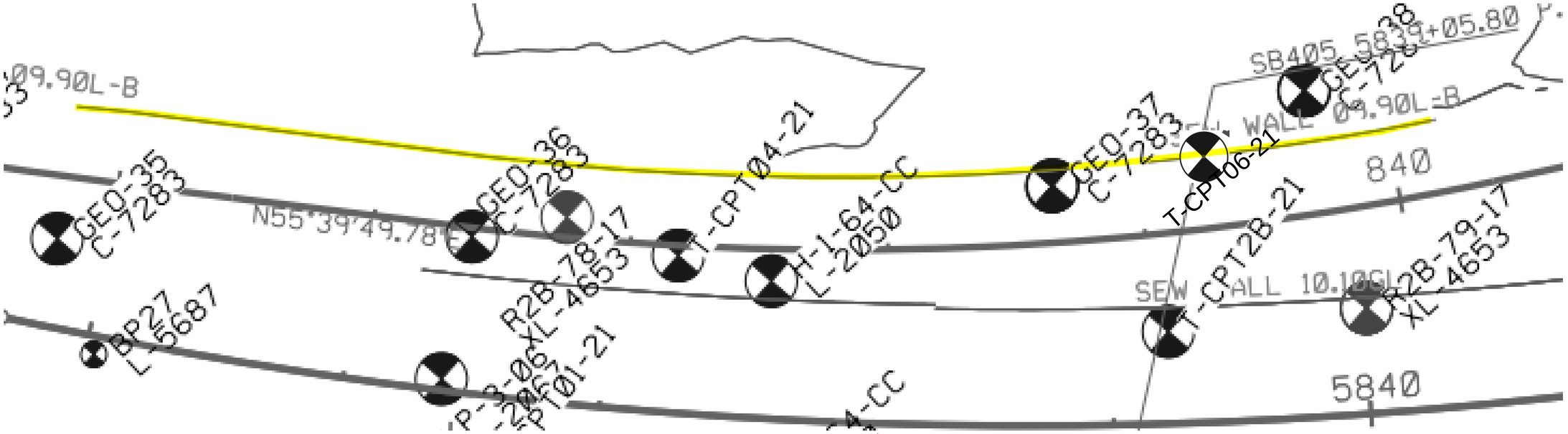
PLAN REF NO WD-5

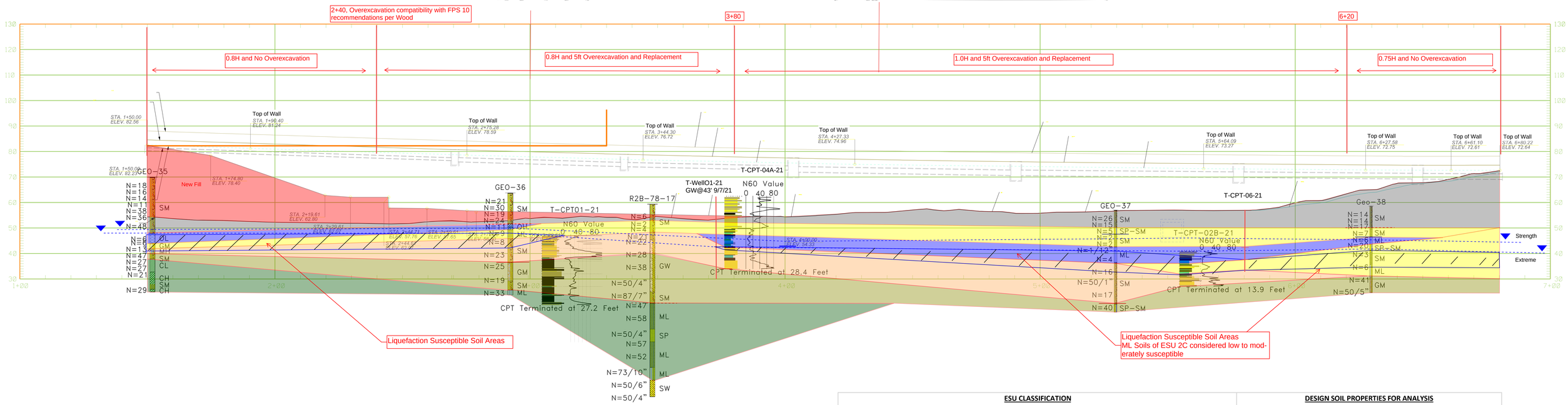
SHEET OF SHEETS



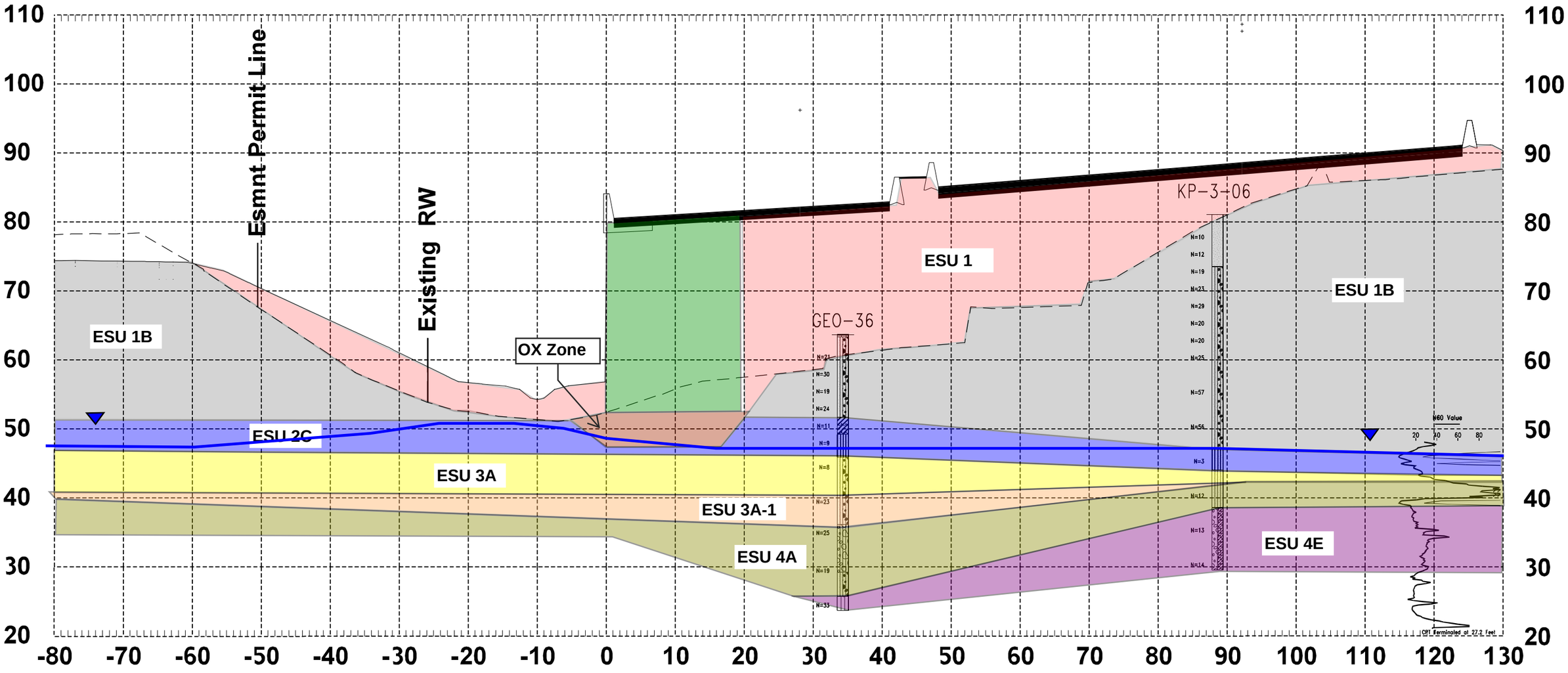


ESU CLASSIFICATION					DESIGN SOIL PROPERTIES FOR ANALYSIS					
ESU GROUP		SOIL MATERIAL				DRAINED CONDITION		UNDRAINED CONDITION		POST LIQUEFIED
COLOR	ESU #	DESCRIPTION	DENSITY/CONSISTENCY	PRIMARY CONSTITUENT	UNIT WEIGHT (pcf)	FRICTION ANGLE (deg)	Su'(psf)	FRICTION ANGLE (deg)	Su (psf)	$Su_{residual}$ (Sr/σ'_{vo})
	1	NEW FILL - COMMON BORROW	DENSE	SAND AND GRAVEL	120	32	0	32	100	NA
	1B	UNCONTROLLED FILL	MEDIUM DENSE TO DENSE	SAND AND GRAVEL	125	35	50	35	200	NA
	3A-1	ALLUVIUM	MEDIUM DENSE TO DENSE	SAND	120	35	0	35	0	NA
	4A	ADVANCE OUTWASH	DENSE TO VERY DENSE	SAND	130	38	0	38	0	NA
	4E	GLACIOLACUSTRINE	VERY STIFF TO HARD	SILT / CLAY	130	34	0	0	4000 - 6000	NA
	5A	LANDSLIDE DEPOSITS	LOOSE TO MEDIUM DENSE	SAND	115	30	25	30	100	NA
	5B	LANDSLIDE DEPOSITS	STIFF TO VERY STIFF	SILT/CLAY	115	28	0	0	1300	NA





ESU CLASSIFICATION					DESIGN SOIL PROPERTIES FOR ANALYSIS					
ESU GROUP		SOIL MATERIAL				DRAINED CONDITION		UNDRAINED CONDITION		POST LIQUEFIED
COLOR	ESU #	DESCRIPTION	DENSITY/CONSISTENCY	PRIMARY CONSTITUENT	UNIT WEIGHT (pcf)	FRICTION ANGLE (deg)	Su'(psf)	FRICTION ANGLE (deg)	Su (psf)	$Su_{residual}$ (Sr/σ'_{vo})
	1	NEW FILL - COMMON BORROW	DENSE	SAND AND GRAVEL	120	32	0	32	100	NA
	1A	UNCONTROLLED FILL	LOOSE	SAND AND GRAVEL	115	31	50	31	200	NA
	1B	UNCONTROLLED FILL	MEDIUM DENSE TO DENSE	SAND AND GRAVEL	125	35	50	35	200	NA
	2C	ORGANIC SOIL	SOFT TO MEDIUM STIFF	SILT / CLAY	105	28	0	0	300 - 1000	0.2
	3A	ALLUVIUM	VERY LOOSE TO LOOSE	SAND	115	29	0	29	200	0.1
	3A-1	ALLUVIUM	MEDIUM DENSE TO DENSE	SAND	120	35	0	35	0	0.12 - 0.15
	4A	ADVANCE OUTWASH	DENSE TO VERY DENSE	SAND	130	38	0	38	0	NA
	4E	GLACIOLACUSTRINE	VERY STIFF TO HARD	SILT / CLAY	130	34	0	0	4000 - 6000	NA



2+70

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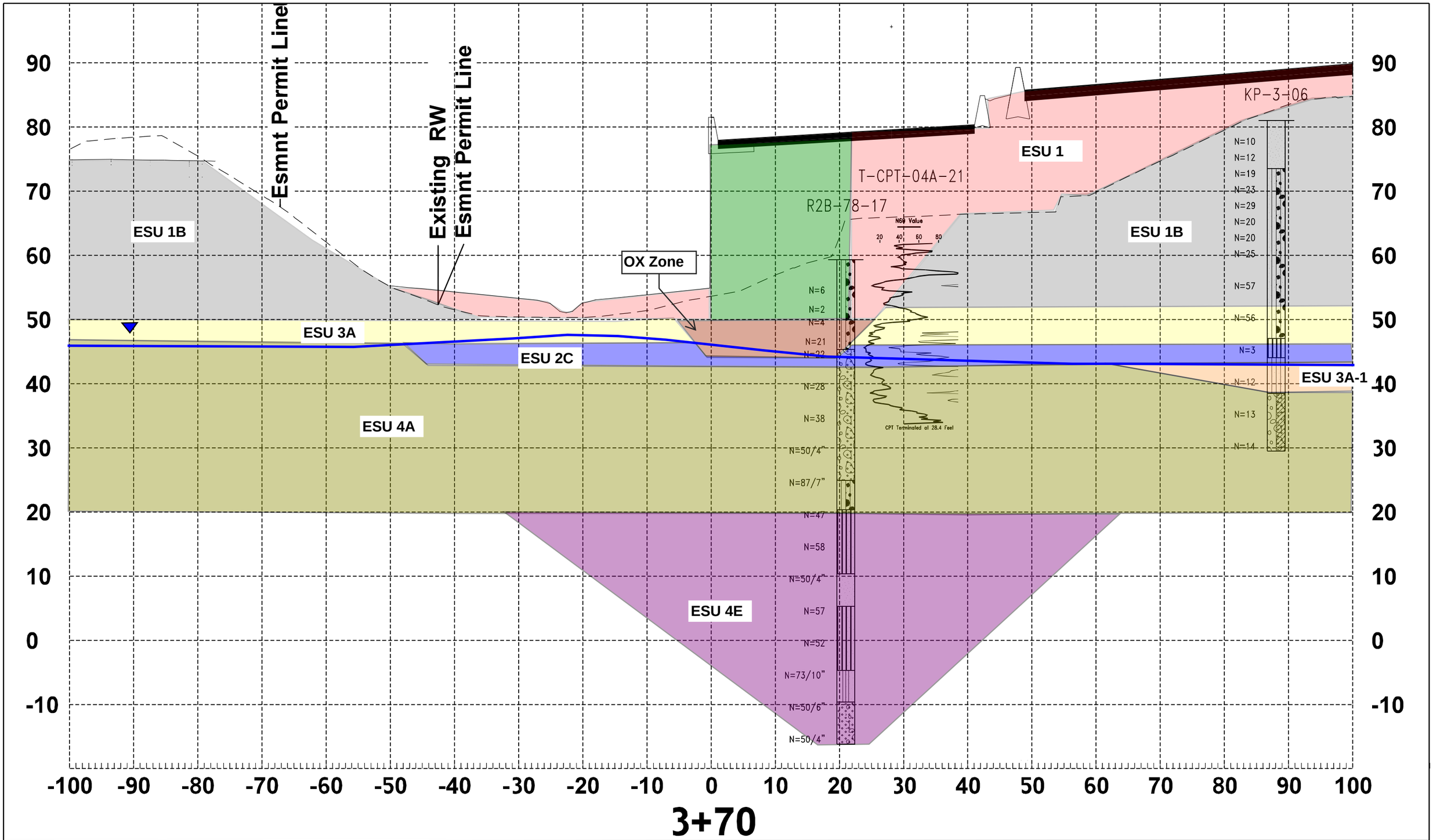
TIME	$TIME$
DATE	$$$$DATE$$$
DESIGNED BY	$$USERNAME$$

Informational use only
Not intended for Contract Plans

Washington State Department of Transportation

Terracon
Consulting Engineers and Scientists

WALL 09.90L-B
Cross Sections



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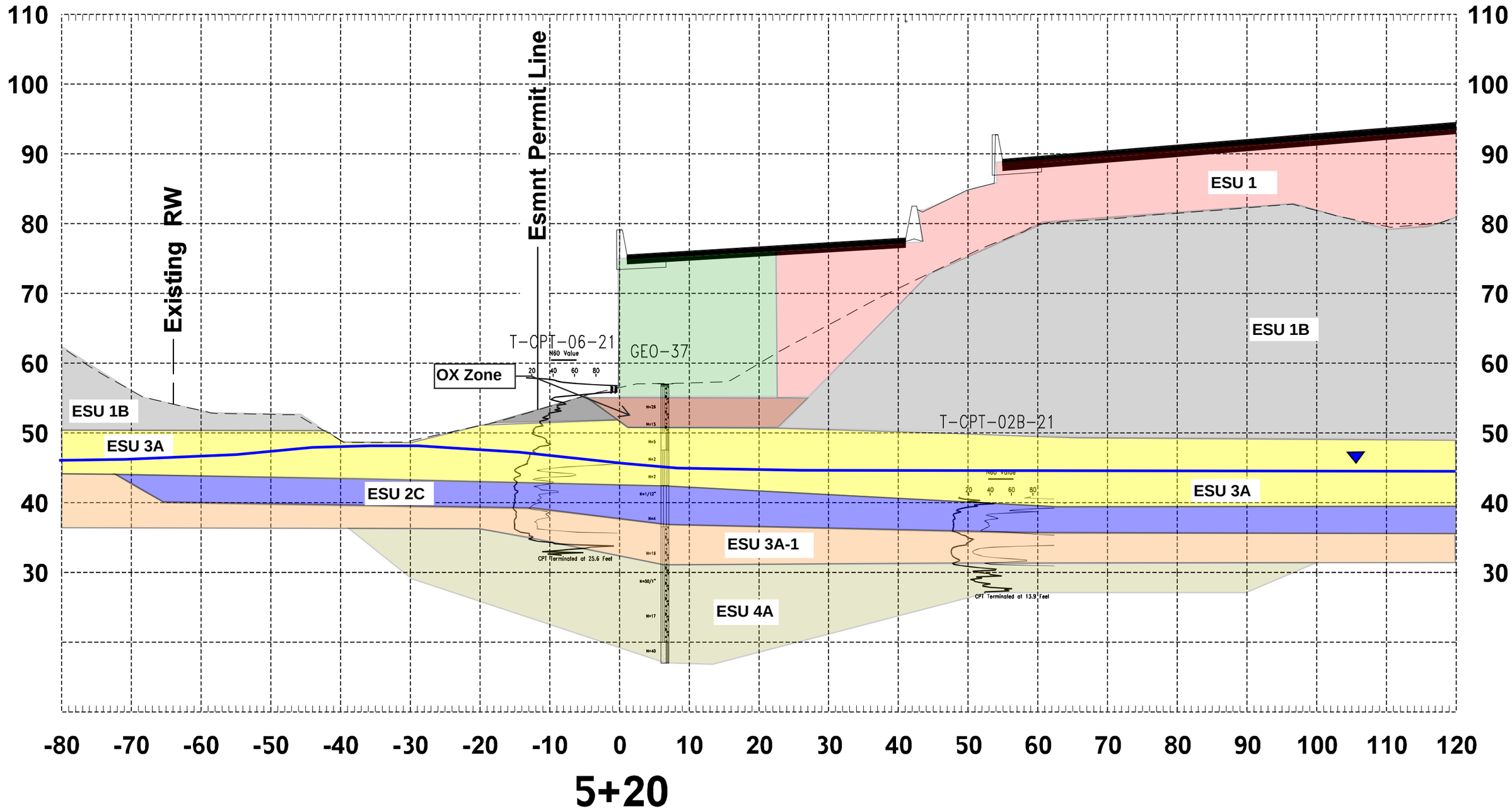
DATE	$$$$DATE$$$
DESIGNED BY	$$USERNAME$$

Informational use only
Not intended for Contract Plans

Washington State Department of Transportation

Terracon
Consulting Engineers and Scientists

WALL 09.90L-B
Cross Sections



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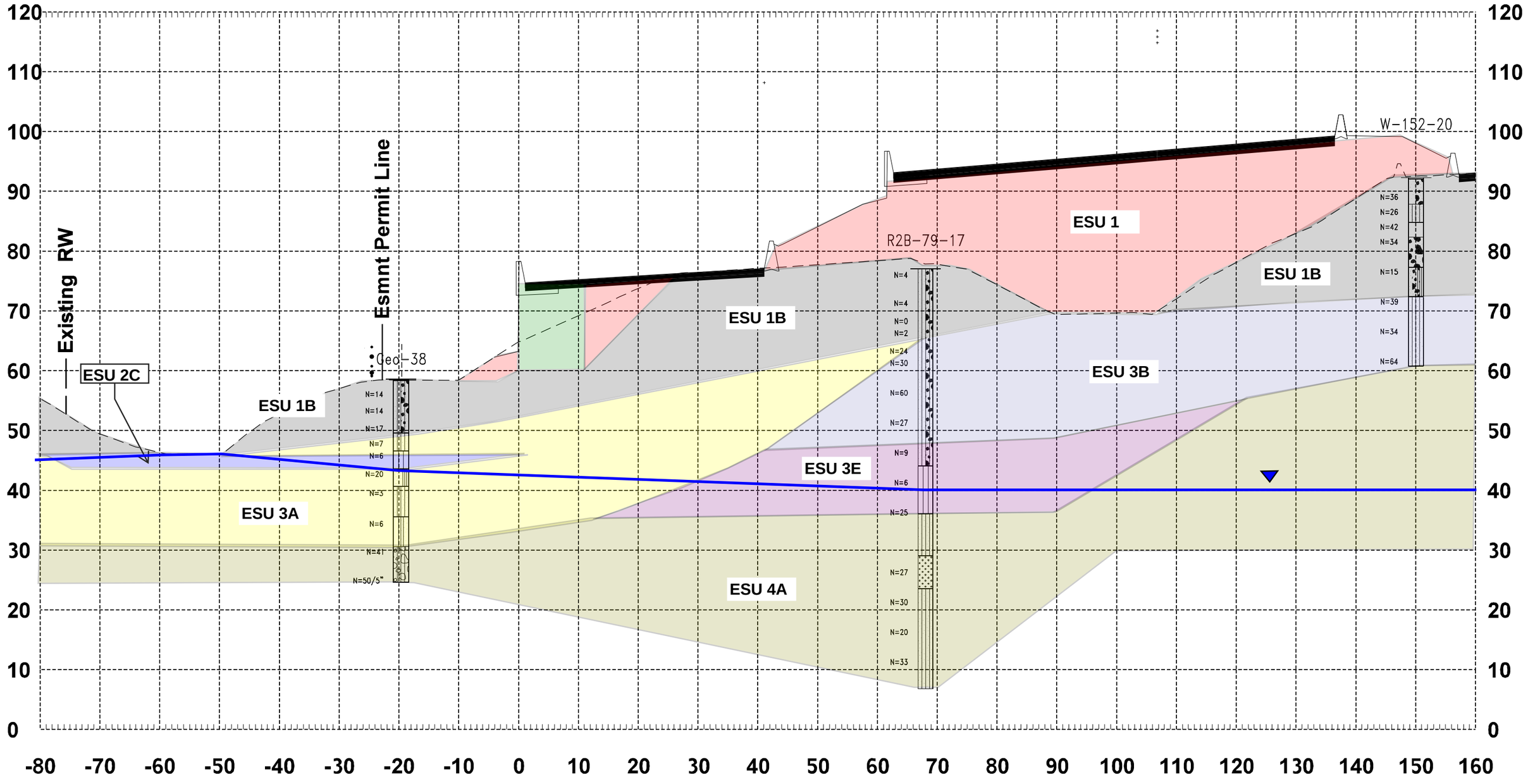
DESIGNED BY	$$USERNAME$$

Informational use only
Not intended for Contract Plans

Washington State Department of Transportation

Terracon
Consulting Engineers and Scientists

WALL 09.90L-B
Cross Sections



6+20

FILE NAME	$$$$$$$$DESIGNFILENAME$$$$$$
TIME	$TIME$
DATE	$$$$DATE$$$
DESIGNED BY	$$USERNAME$$

Informational use only
Not intended for Contract Plans

Washington State Department of Transportation

Terracon
Consulting Engineers and Scientists

WALL 09.90L-B
Cross Sections

APPENDIX B
PROJECT EXPLORATION LOGS

FIELD EXPLORATION DESCRIPTION

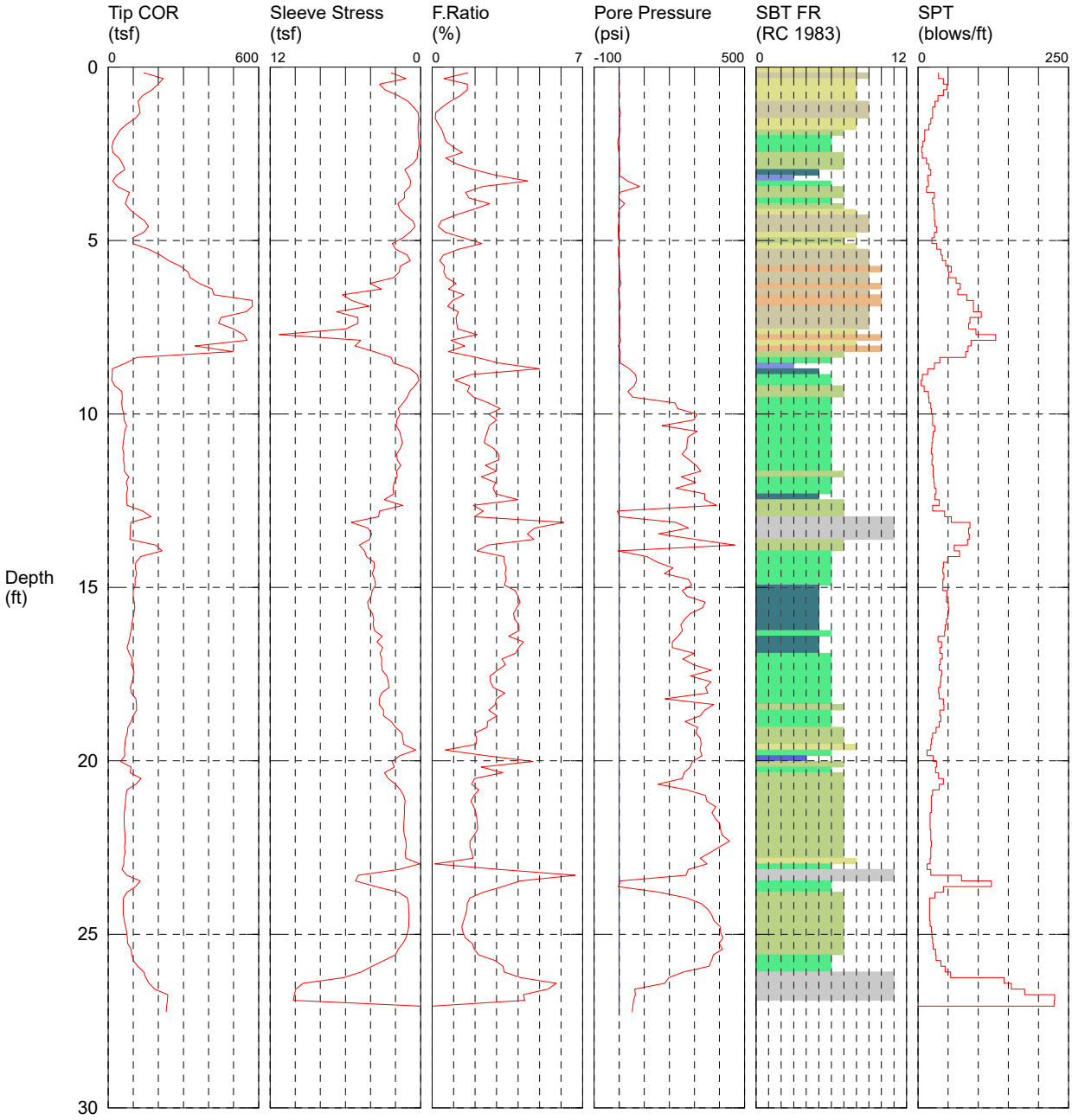
Cone Penetration Testing (CPT) Procedures: The cone instrument was advanced using a track rig by a subcontractor to Terracon in general accordance with ASTM D 5778. The rig is outfitted with a hydraulic press that continuously advances a standardized and calibrated cone at a constant rate. During advancement, a near-continuous profile of data was collected for cone tip and side friction resistance exerted on the cone by the soils as well as the in-situ pore water pressure generated during cone advancement. The tip resistance, side friction, and pore water pressure measurements are shown on the CPT log contained herein. Additionally, estimates of groundwater level were made through measuring the dissipation of excess pore water pressure that is generated during cone advancement. The data collected was used to estimate a soil behavior type which is used to infer the classification of the soils encountered (i.e. sand, silt, clay, etc.) and to estimate geotechnical engineering parameters as well as to performed liquefaction analysis.
Due to the existing fill at CPT locations, CPT1 to CPT5 were started at lower elevation than the ground surface. For these CPT's, boring was advanced to the bottom of the existing fill layer and a casing was installed to prevent caving. See Table 3A and Table 3B for the ground surface elevation and top of CPT elevations.

Groundwater Monitoring Well: Groundwater monitoring well was installed in the boring T-Well01-21.

T-CPT01-21

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon Consultants
LOCATION: Belleveu
JOB NUMBER: 81215044 Task 6
COMMENT: I 405 Widening & ETL
COMMENT:

OPERATOR: Okbay
CONE ID: DDG1263
TEST DATE: 8/6/2021 1:43:52 AM
PREDRILL: 40ft PVC Casing
BACK FILL: None
SURFACE PATCH: None



TOTAL DEPTH: 27.231 ft

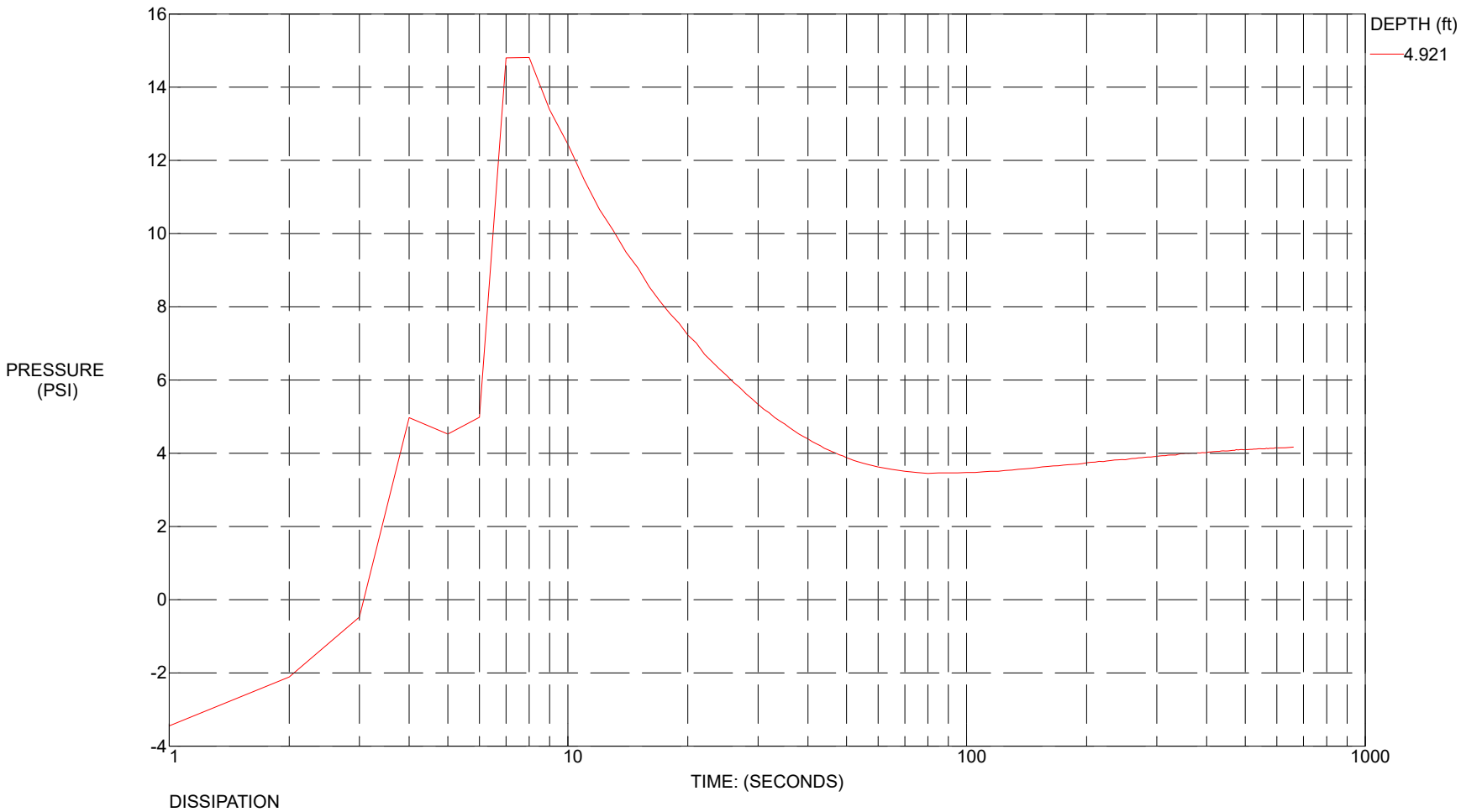
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

T-CPT01-21

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon Consultants
LOCATION: Belleveu
JOB NUMBER: 81215044 Task 6

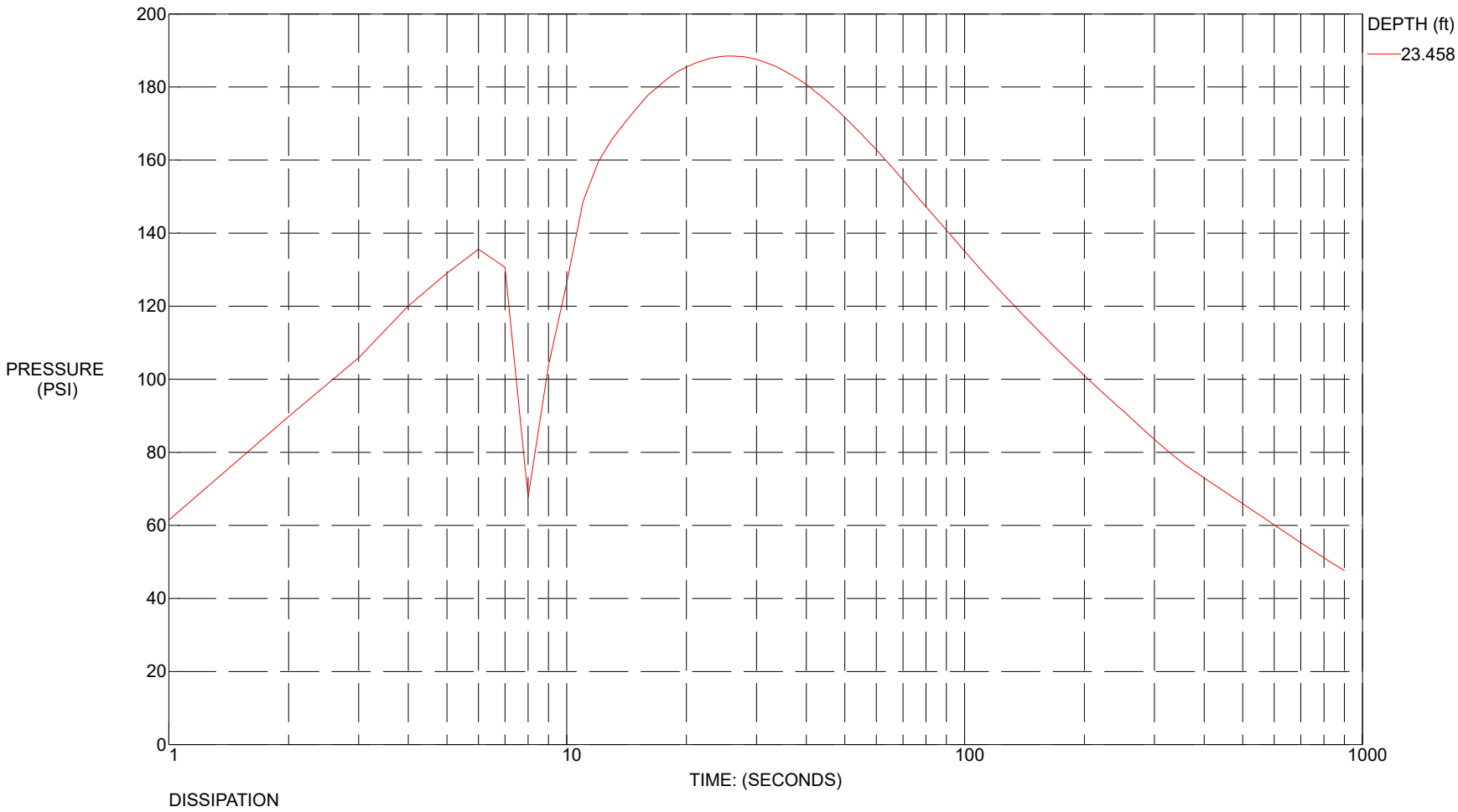
OPERATOR: Okbay
CONE ID: DDG1263
TEST DATE:
PREDRILL: 15.4ft PVC Casing
BACK FILL: None
SURFACE PATCH: None



T-CPT01-21

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon Consultants
LOCATION: Belleveu
JOB NUMBER: 81215044 Task 6

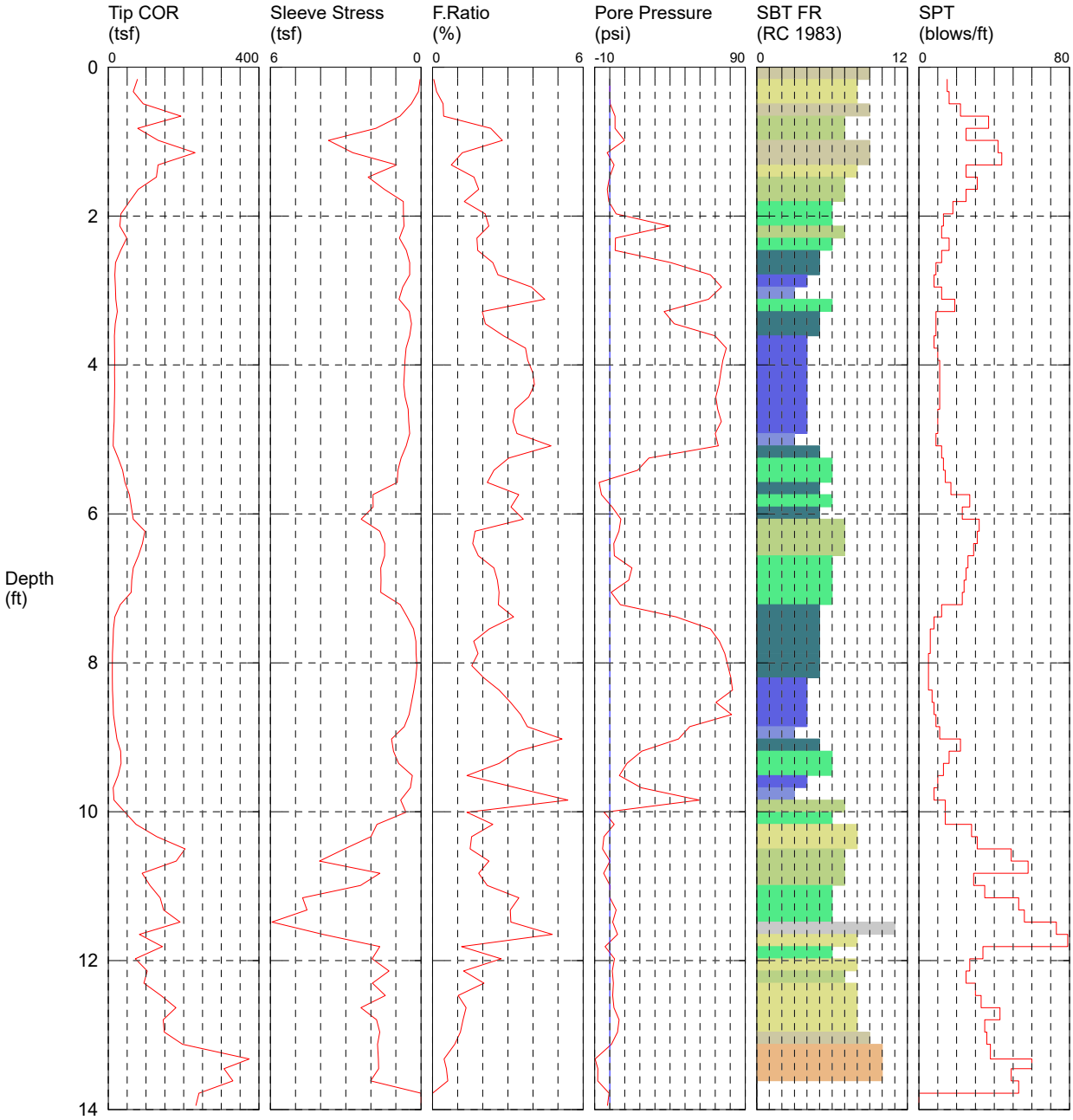
OPERATOR: Okbay
CONE ID: DDG1263
TEST DATE:
PREDRILL: 15.4ft PVC Casing
BACK FILL: None
SURFACE PATCH: None



T-CPT02B-21

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon Consultants
LOCATION: Belleveu
JOB NUMBER: 81215044 Task 6
COMMENT: I 405 Widening & ETL
COMMENT:

OPERATOR: Okbay
CONE ID: DDG1263
TEST DATE: 8/5/2021 11:34:50 PM
PREDRILL: 35ft PVC Casing
BACK FILL: None
SURFACE PATCH: None



TOTAL DEPTH: 13.944 ft

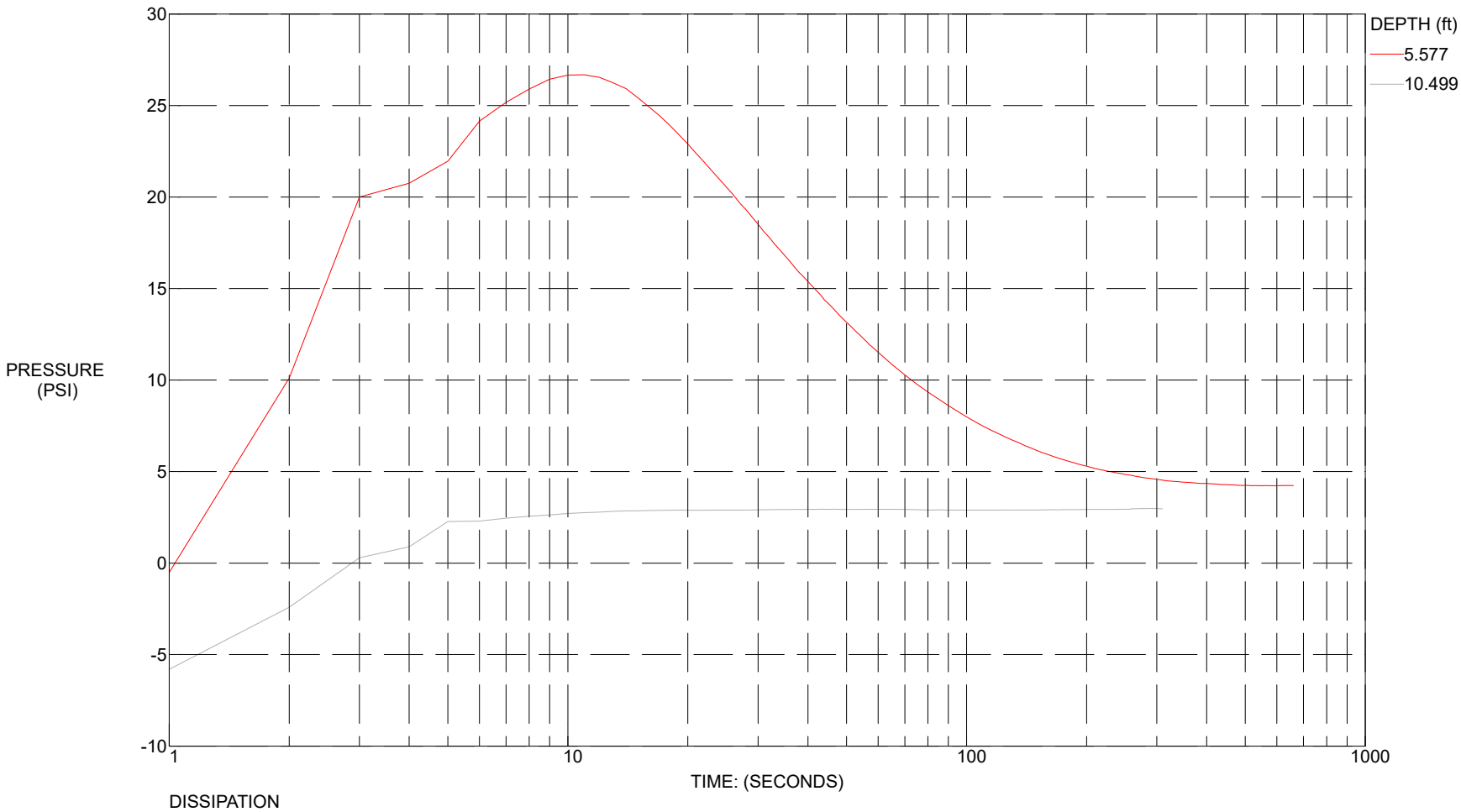
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

HOLE NUMBERT-CPT02B-21

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon Consultants
LOCATION: Belleveu
JOB NUMBER: 81215044 Task 6

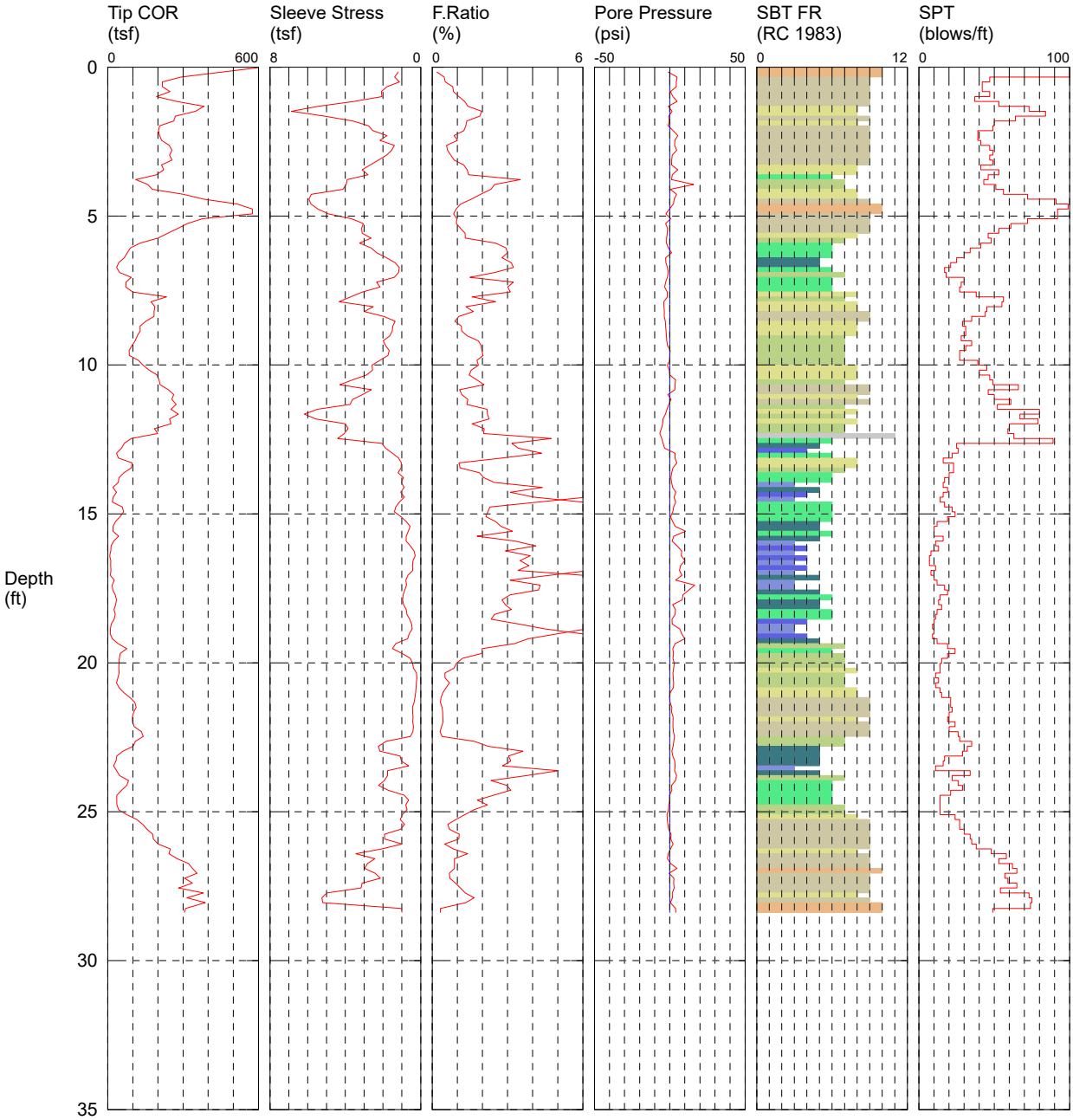
OPERATOR: Okbay
CONE ID: DDG1263
TEST DATE: 8/5/2021 11:34:50 PM
PREDRILL: 35ft PVC Casing
BACK FILL: None
SURFACE PATCH: None



CPT-04A

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon
LOCATION: Renton
JOB NUMBER:
COMMENT: I-405 Project
COMMENT: 47.567286
COMMENT: -122.181539

OPERATOR: Okbay
CONE ID: DDG1394
TEST DATE: 7/12/2021 12:00:25 PM
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: Cold Patch



TOTAL DEPTH: 28.379 ft

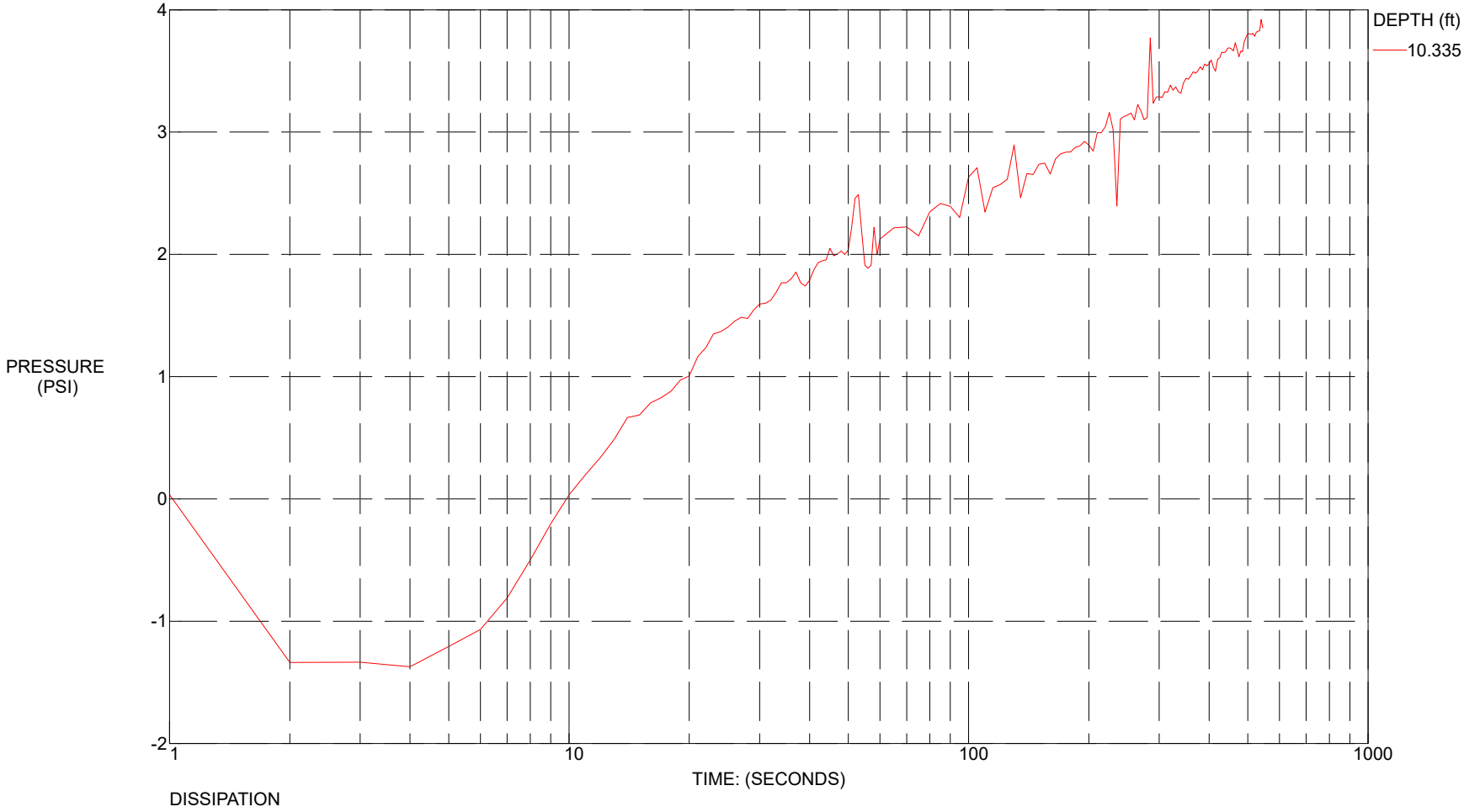
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

CPT - 04A

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon
LOCATION: Renton
JOB NUMBER:

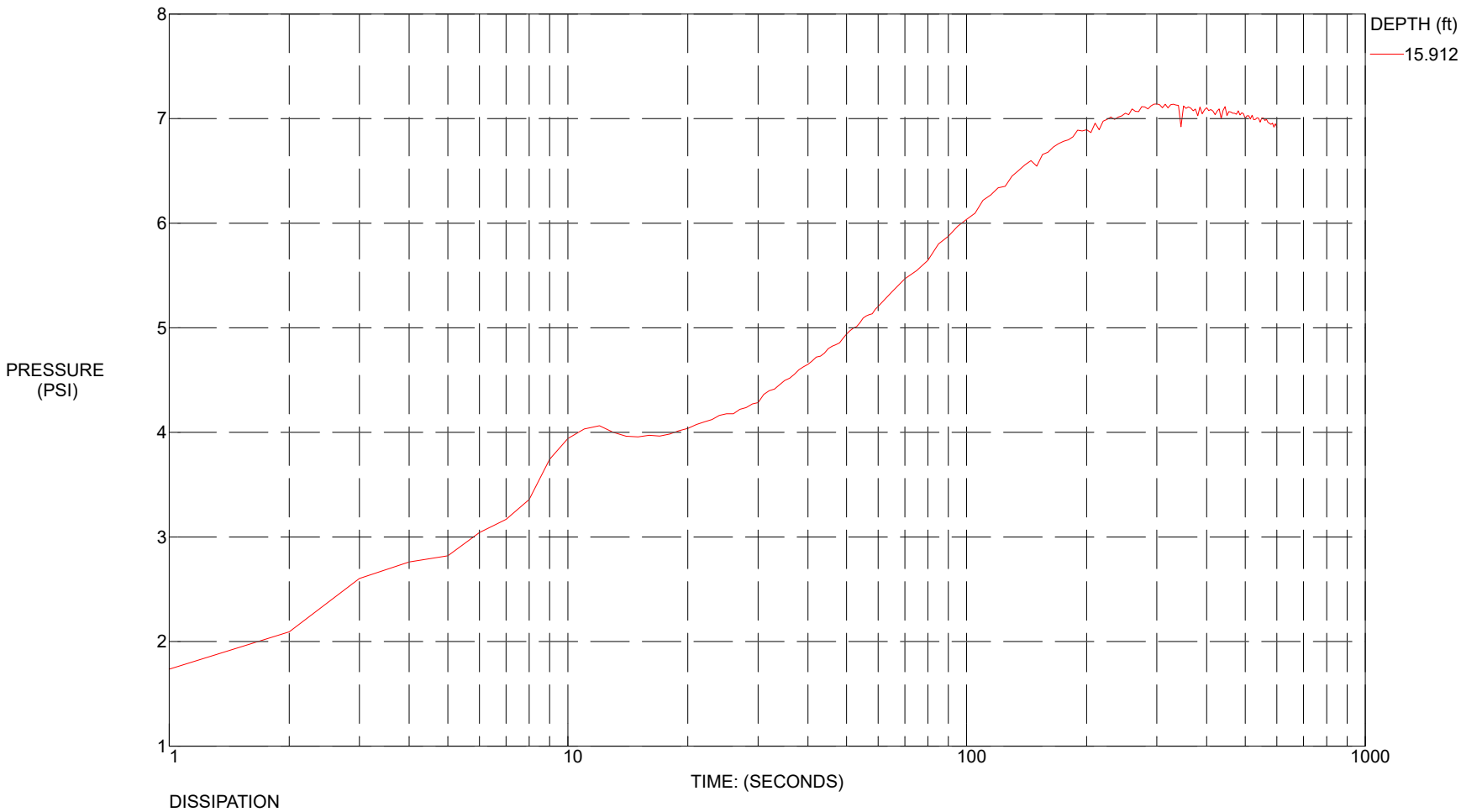
OPERATOR: Okbay
CONE ID: DDG1394
TEST DATE:
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: Cold Patch



CPT - 04A

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon
LOCATION: Renton
JOB NUMBER:

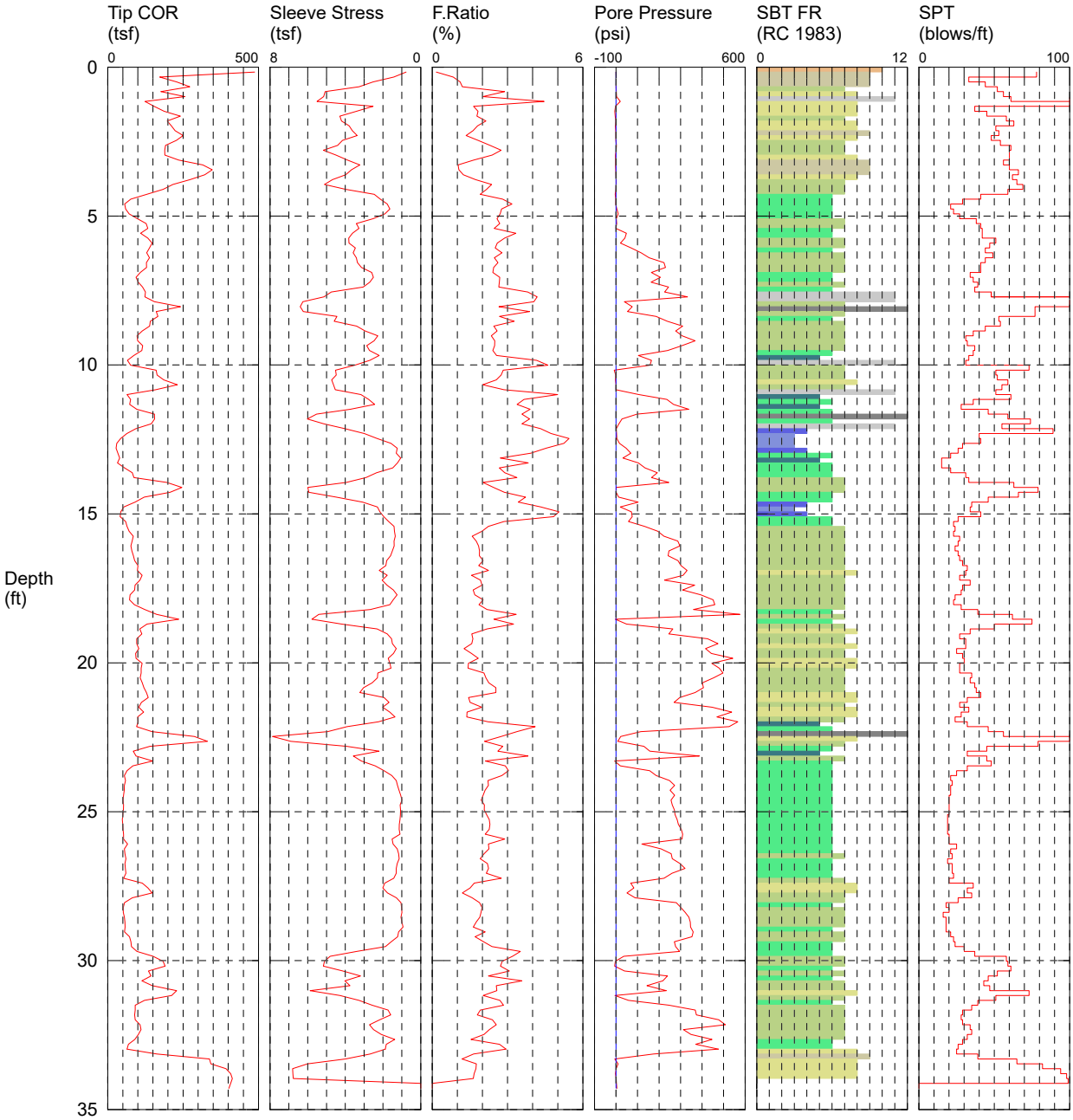
OPERATOR: Okbay
CONE ID: DDG1394
TEST DATE:
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: Cold Patch



CPT-05A

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon
LOCATION: Renton
JOB NUMBER:
COMMENT: I-405 Project
COMMENT: 47.566332
COMMENT: -122.183672

OPERATOR: Okbay
CONE ID: DDG1394
TEST DATE: 7/12/2021 1:23:55 PM
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: Cold Patch



TOTAL DEPTH: 34.285 ft

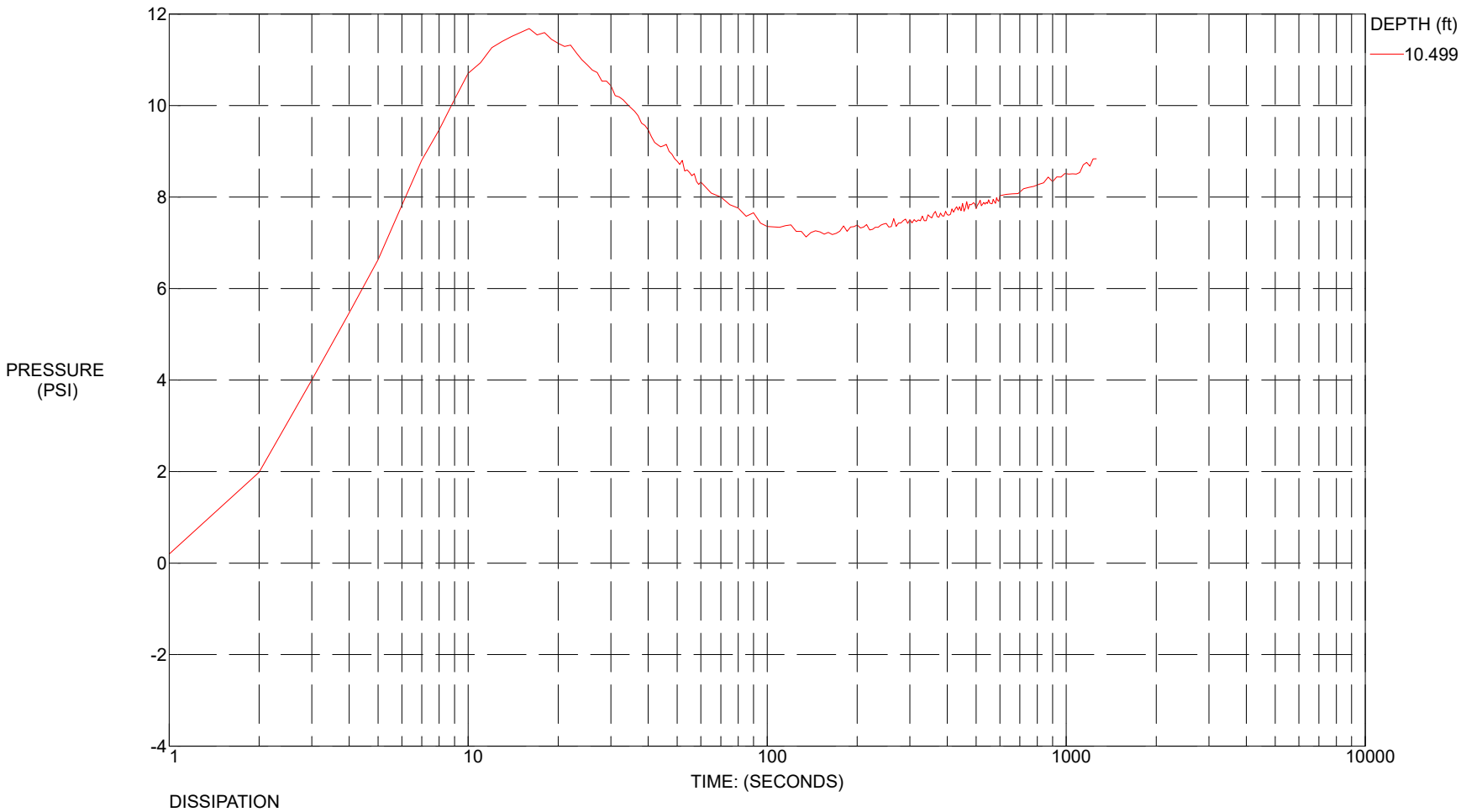
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

CPT - 05A

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon
LOCATION: Renton
JOB NUMBER:

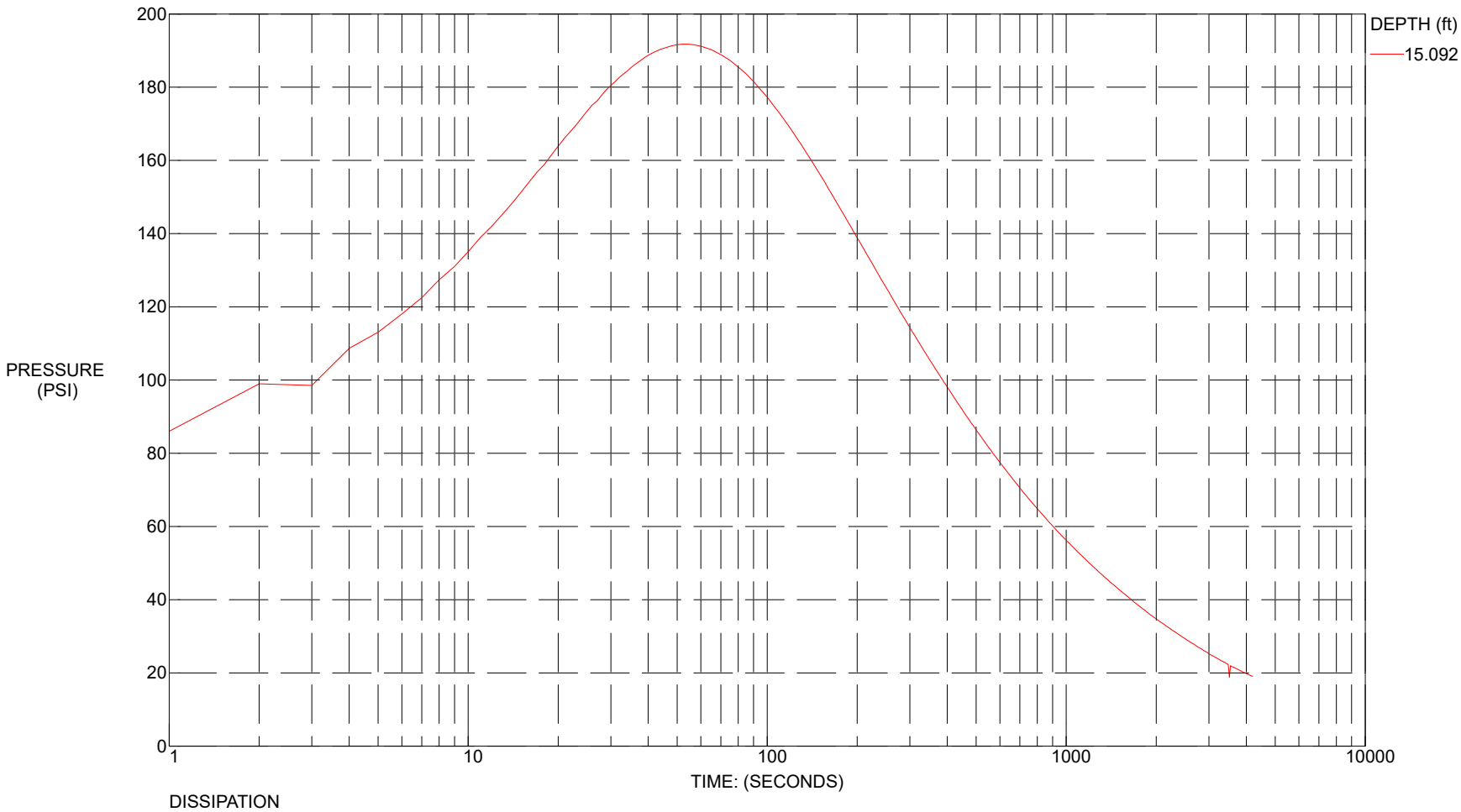
OPERATOR: Okbay
CONE ID: DDG1394
TEST DATE:
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: Cold Patch



CPT - 05A

CPT CONTRUCTOR: In Situ Engineering
CUSTOMER: Terracon
LOCATION: Renton
JOB NUMBER:

OPERATOR: Okbay
CONE ID: DDG1394
TEST DATE:
PREDRILL: 0 ft
BACK FILL: 20% Grout + Bentonite Chips
SURFACE PATCH: Cold Patch

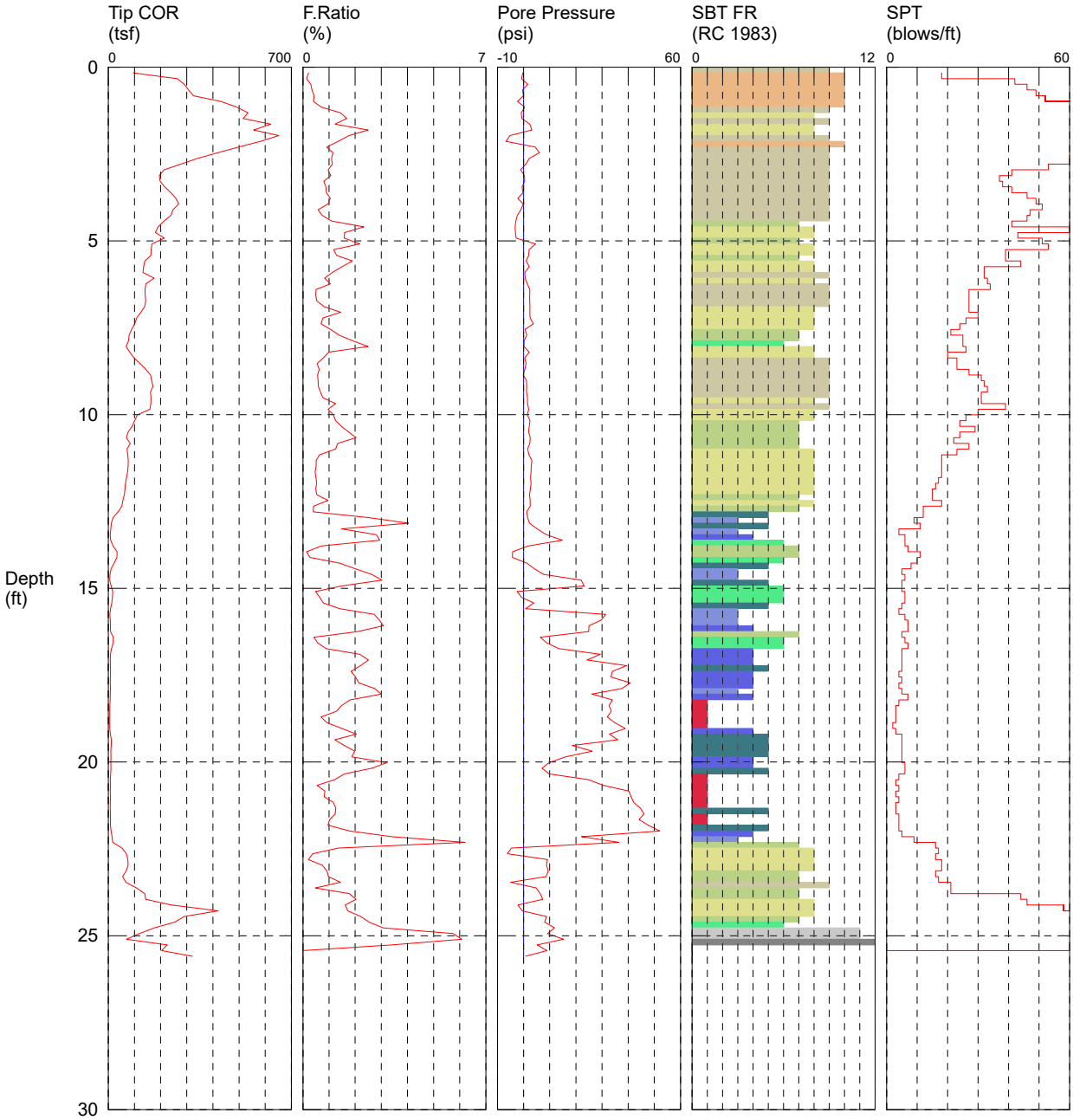


DISSIPATION

CPT-06

CPT CONTRACTOR: In Situ Engineering
CUSTOMER: Terracon
LOCATION: Bellevue
JOB NUMBER: 8215044 Task 6

OPERATOR: Mayfield
CONE ID: DDG1263
TEST DATE: 9/9/2021 9:12:00 AM
PREDRILL:
BACKFILL: 20% Bentonite Grout + Bentonite Chip
SURFACE PATCH:



COMMENT:

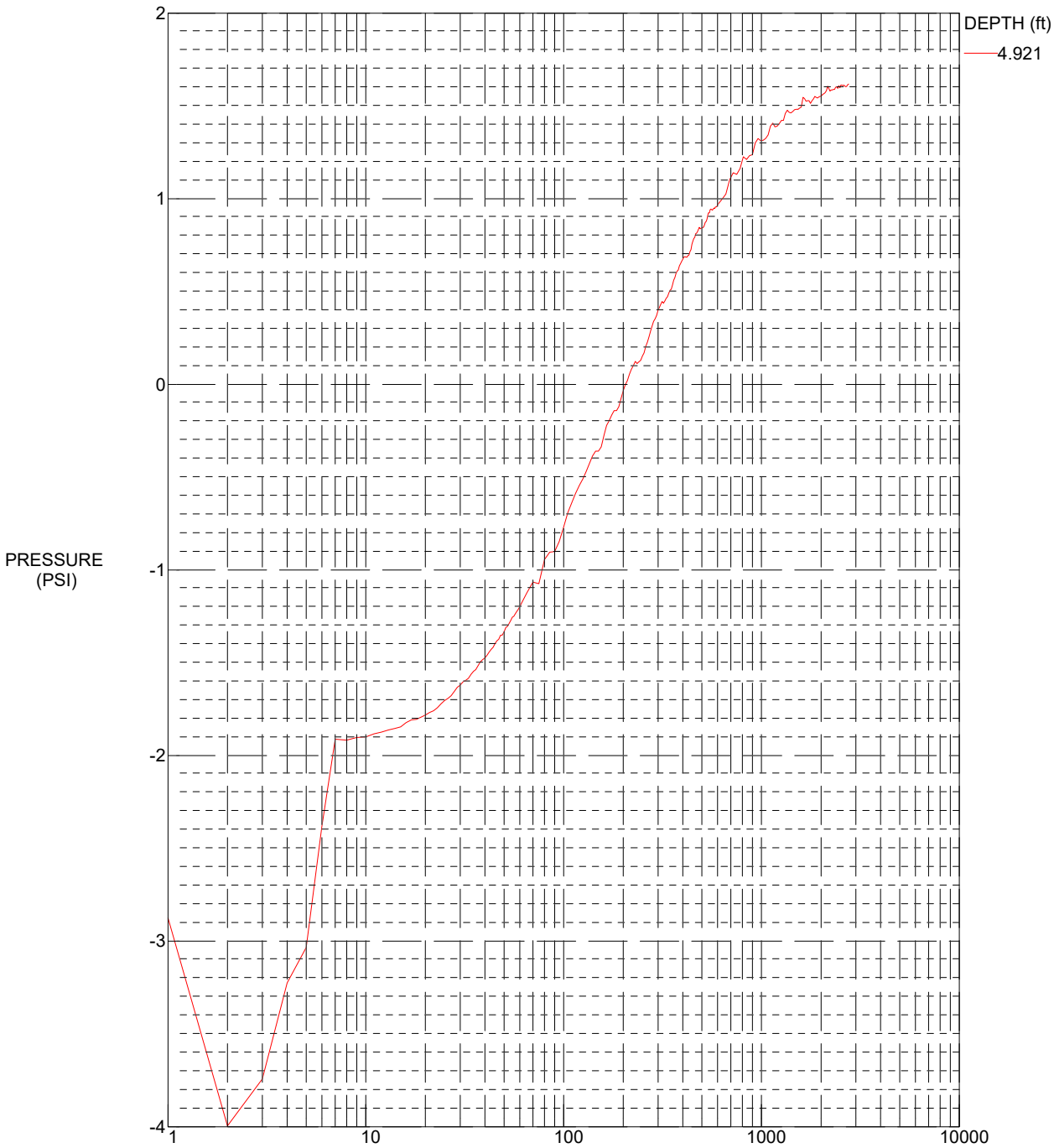
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

CPT-06

OPERATOR: Mayfield
CUSTOMER: Terracon
LOCATION: Bellevue
JOB NUMBER: 8215044 Task 6

CPT CONTRACTOR: In Situ Engineering
CONE ID: DDG1263
TEST DATE: 9/9/2021 9:12:00 AM

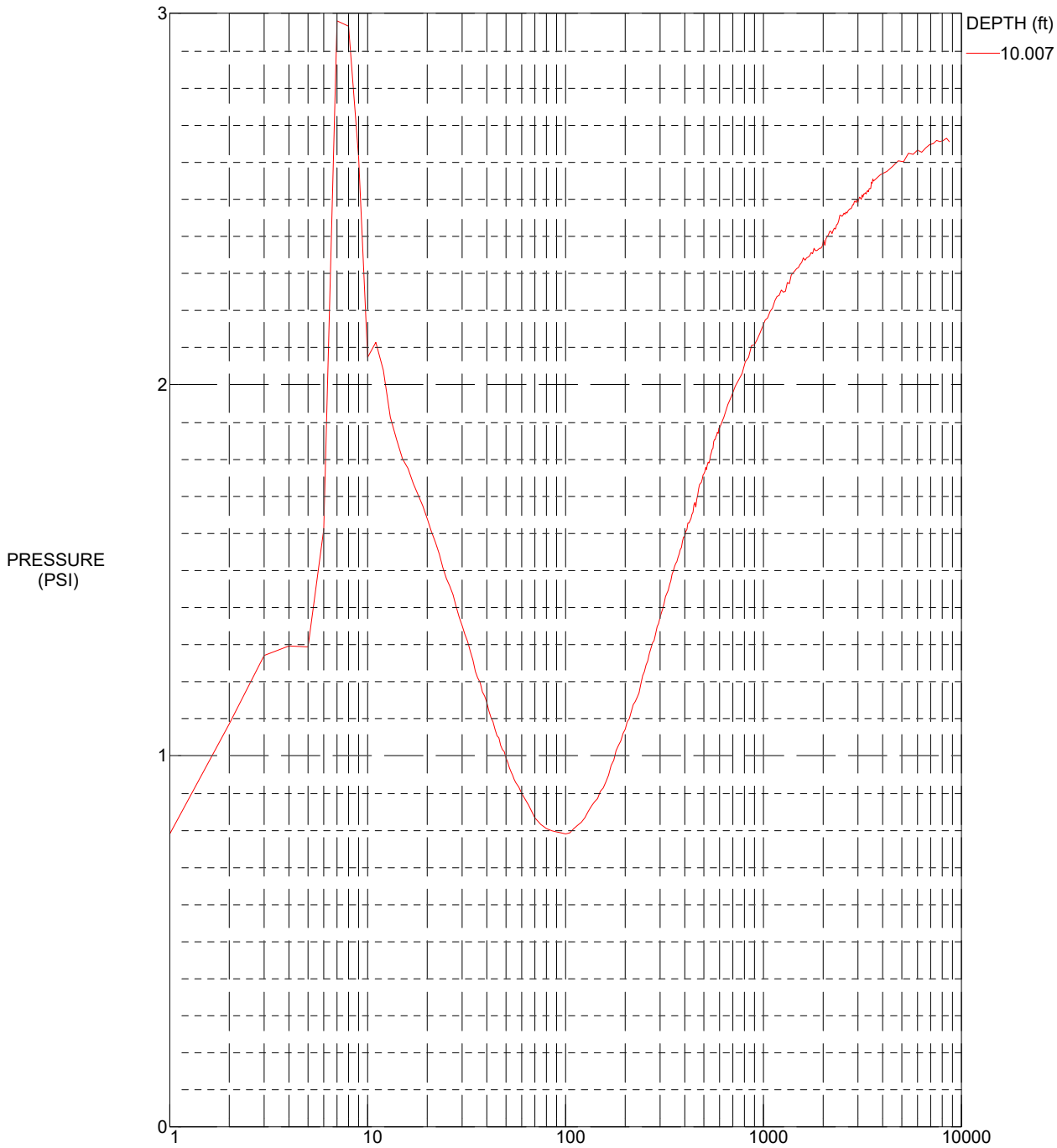


MAXIMUM PRESSURE = 1.618 (PSI) TIME: (SECONDS)
HYDROSTATIC PRESSURE = 2.133 (PSI), WATER TABLE: 0.00 ft

CPT-06

OPERATOR: Mayfield
CUSTOMER: Terracon
LOCATION: Bellevue
JOB NUMBER: 8215044 Task 6

CPT CONTRACTOR: In Situ Engineering
CONE ID: DDG1263
TEST DATE: 9/9/2021 9:12:00 AM



MAXIMUM PRESSURE = 2.979 (PSI) TIME: (SECONDS)
HYDROSTATIC PRESSURE = 4.337 (PSI), WATER TABLE: 0.00 ft

APPENDIX C
GROUNDWATER MONITORING

WELL LOG NO. Well-01

PROJECT: I-405/Renton to Bellevue-Corridor Widening and ETL

CLIENT: Parsons Transportation Group Inc
Phoenix, AZ

SITE: I-405 Renton to Bellevue
Renton, WA

GRAPHIC LOG

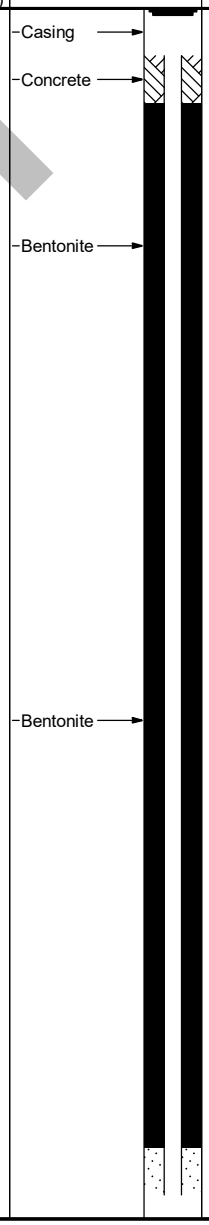
LOCATION See Exploration Plan

Latitude: 47.5672° Longitude: -122.1816°

Approximate Surface Elev.: 65.54 (Ft.) +/-

DEPTH | ELEVATION (Ft.)

INSTALLATION DETAILS | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE



Groundwater Elevation: approximately 43-1/2 ft on 09-29-2021

Groundwater Elevation: approximately 43 ft on 09-02-2021

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Sonic Drilling Method

Abandonment Method:
Well installed

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations measured in the field

Notes:

Well Started: 09-02-2021

Well Completed: 09-02-2021

Drill Rig:

Driller:

Project No.: 81215044

21905 64th Ave W, Ste 100
Mountlake Terrace, WA

DRAFT

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-WELL 81215044 I-405RENTON TO B.GPJ TERRACON_DATATEMPLATE.GDT 9/29/21

WELL LOG NO. Well-01

PROJECT: I-405/Renton to Bellevue-Corridor Widening and ETL

CLIENT: Parsons Transportation Group Inc
Phoenix, AZ

SITE: I-405 Renton to Bellevue
Renton, WA

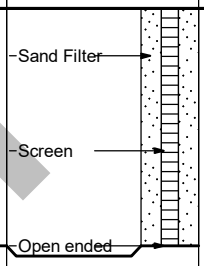
GRAPHIC LOG

LOCATION See Exploration Plan

Latitude: 47.5672° Longitude: -122.1816°

Approximate Surface Elev.: 65.54 (Ft.) +/-

DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE



30

Boring Terminated at 30 Feet

DRAFT

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Sonic Drilling Method

Abandonment Method:
Well installed

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations measured in the field

Notes:

Well Started: 09-02-2021	Well Completed: 09-02-2021
Drill Rig:	Driller:
Project No.: 81215044	

21905 64th Ave W, Ste 100
Mountlake Terrace, WA

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-WELL 81215044 I-405RENTON TO B.GPJ TERRACON_DATATEMPLATE.GDT 9/29/21

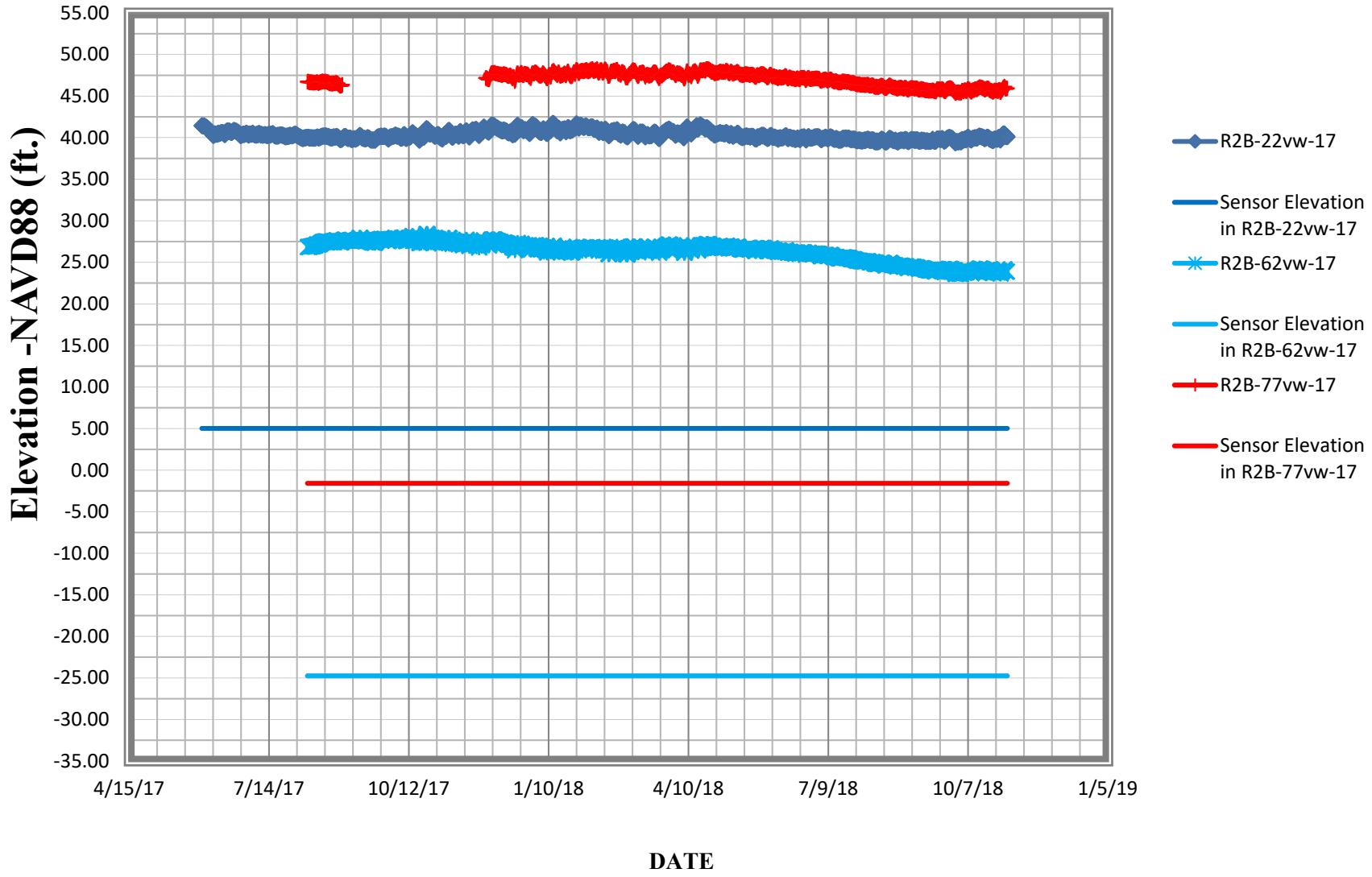
Table C-3. Summary of VW Piezometer Groundwater Monitoring Results (XL 4653&XL 5467)

Boring ID	Sensor Elev. (ft)	Water Level Elevation (ft)				Reading Period	
		Min.	Max.	Average	Standard Deviation (SD)	From	To
R2B-22vw-17	5.0	39.4	41.7	40.3	0.50	5/31/2017	11/1/2018
R2B-23vw-17	-34.0	42.9	45.2	43.9	0.52	5/31/2017	11/1/2018
R2B-40vw-17	-45.0	71.7	74.6	73.3	0.70	5/31/2017	9/13/2018
R2B-62vw-17	-24.7	23.6	28.4	26.3	1.22	8/7/2017	11/1/2018
R2B-68vw-17	73.3	80.3	103.3	96.2	5.40	2/22/2017	11/1/2018
R2B-70vw-17	18.2	61.0	63.2	62.1	0.46	2/22/2017	11/1/2018
R2B-71vw-17	69.4	75.7	122.3	108.8	14.81	4/25/2017	11/1/2018
R2B-77vw-17	-1.6	45.3	48.3	47.0	0.82	8/7/2017	11/1/2018
R2B-81vw-17	-1.1	28.8	33.6	31.4	1.39	3/16/2017	11/1/2018
R2B-82vw-17	-5.9	28.2	32.9	30.6	1.28	3/22/2017	11/1/2018
R2B-S16vw-17	-14.2	26.3	28.8	27.7	0.61	9/21/2017	11/1/2018
R2B-S24vw-17	-4.7	56.0	58.3	57.4	0.41	11/8/2017	11/1/2018
R2B-S25vw-17	-23.0	54.5	56.7	55.6	0.59	11/7/2017	11/1/2018
R2B-S27vw-17	-5.6	27.9	30.6	29.2	0.62	11/7/2017	11/1/2018
R2B-S28vw-17	-15.3	24.0	29.3	27.5	1.07	11/7/2017	11/1/2018

Note: Refer to boring logs for the well construction details.

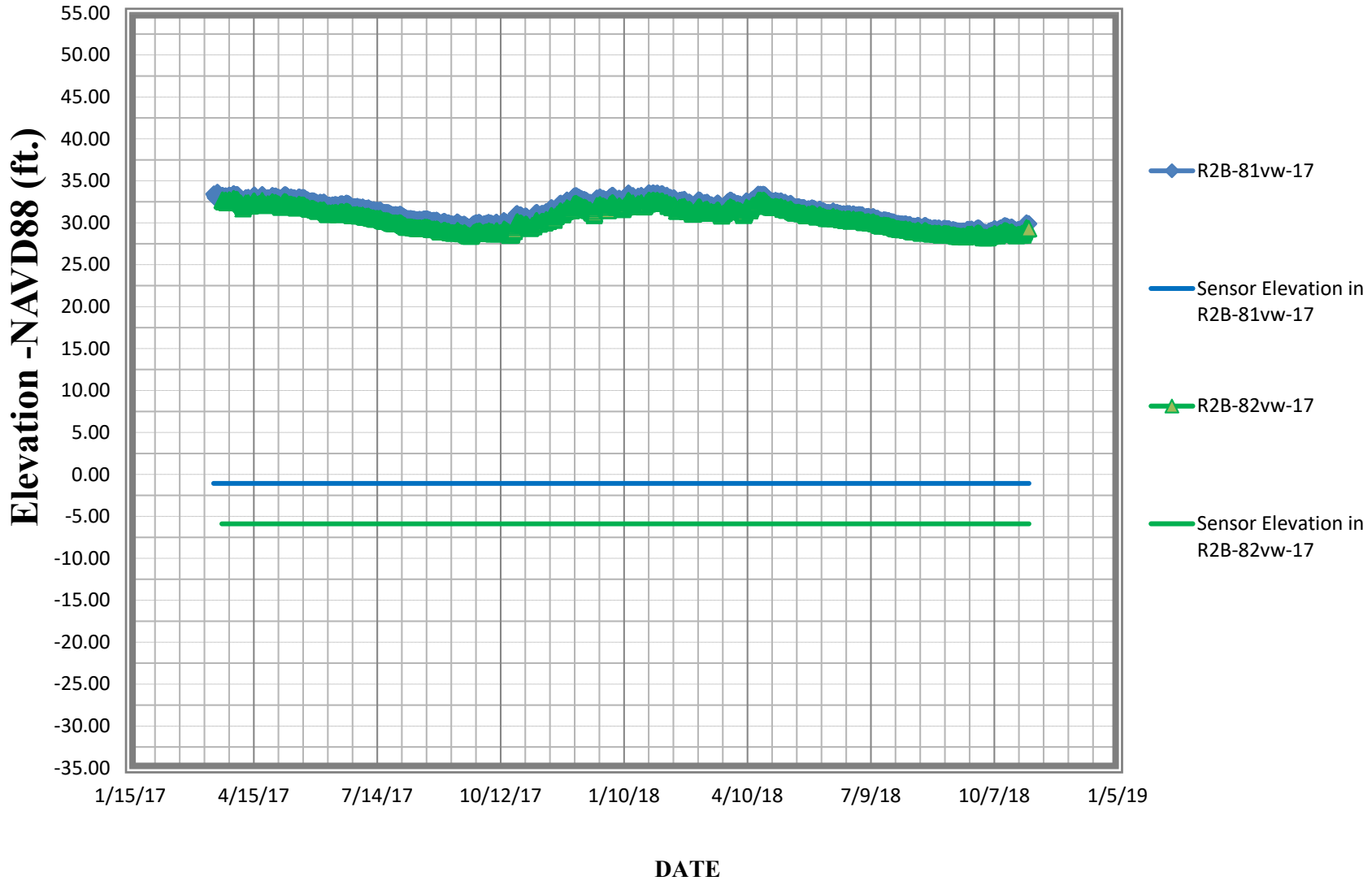
R2B-77vw-17

Figure C-3. Measured groundwater elevation versus time
Plot_VW Piezometer (Plot 3 of 7)



R2B-81vw-17

Figure C-6. Measured groundwater elevation versus time Plot_VW Piezometer (Plot 6 of 7)



APPENDIX D
HISTORIC BORINGS

Date(s) Drilled	10/30/07	Logged By	SRR	Checked By	KGO
Drilling Contractor	Geologic Drill	Drilling Method	Hollow-stem Auger	Sampling Methods	SPT
Auger Data	3¼-inch OD	Hammer Data	140 lb hammer/30 in drop rope and cathead	Drilling Equipment	Deep Rock XL Rig
Total Depth (ft)	45	Surface Elevation (ft)	69.9	Groundwater Elevation (ft)	46.4
Vertical Datum	NAVD 88	Datum/ System	WSDOT Project Coordinates	Easting(x): Northing(y):	1635536.1 537766.8

Elevation feet	Depth feet	SAMPLES Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
0								AC	2 inches asphalt concrete pavement			
								CR	2 inches crushed rock base course			
								SM	Light brown silty fine to medium sand with gravel (medium dense, moist) (fill)			
			18	18	1							
65	5		12	16	2							
			18	14	3				Grades to gray Lenses of sandy silt			
60	10		18	11	4				Trace organic matter			
			18	38	5				Grades to dense			
55	15		18	36	6							
			6	48	7							
50	20											
								OL	Gray and brown silt with wood debris and layers of sandy silt and organic silt (medium stiff, moist to wet) (alluvium)			Oxidation staining
			18	6	8							
45	25		18	9	9							
								GM	Gray silty fine to coarse gravel with sand (loose, wet)			
			12	13	10							
								MH	Brown elastic silt with layers of silty fine to coarse sand with gravel (stiff, moist)			
40	30											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING GEO-35

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-36
Sheet 1 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/10/08

Elevation feet	Depth feet	Interval	Recovered (in)	Blows/foot	Sub-Sample	Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	30		18	47		11			SM	Brown silty fine to medium sand with gravel (dense, moist) (till-like material)			
			18	27		12			CL	Gray clay (very stiff, moist) (transitional bed deposits)			Oxidation staining
-35	35		18	27		13							
			18	21		14			CH	Gray fat clay (very stiff, moist)			Shell fragment
-30	40												
									SM	Gray silty fine to coarse sand with occasional gravel (dense, wet)			
			18	29		15			CH	Gray fat clay (very stiff, moist)			
-25	45												
-20	50												
-15	55												
-10	60												
-5	65												

LOG OF BORING GEO-35 (continued)

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-36
Sheet 2 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/10/08

Date(s) Drilled	10/30/07	Logged By	SRR	Checked By	KGO
Drilling Contractor	Geologic Drill	Drilling Method	Hollow-stem Auger	Sampling Methods	SPT
Auger Data	3¼-inch OD	Hammer Data	140 lb hammer/30 in drop rope and cathead	Drilling Equipment	Deep Rock XL Rig
Total Depth (ft)	40	Surface Elevation (ft)	63.7	Groundwater Elevation (ft)	46.7
Vertical Datum	NAVD 88	Datum/ System	WSDOT Project Coordinates	Easting(x): Northing(y):	1635652.1 537878.1

Elevation feet	Depth feet	SAMPLES Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							AC	2 inches asphalt concrete pavement			
								CR	2 inches crushed rock base course			
								SM	Brown silty fine to medium sand with gravel and trace organics (medium dense, moist) (fill)			
60			12	21	1					10		SA
	5		2	30	2							Pounding on rock-blow count not necessarily indicative of density of soil
									Grades to brownish gray			
55			12	19	3					9		
	10		12	24	4							
									Grades to wet (perched groundwater)			
			18	11	5			OH	Brown organic silt with wood debris and variable sand content (medium stiff, moist) (alluvium)	26		AL
50												
	15		18	9	6			ML	Brownish gray interbedded sandy silt/silty fine sand with trace organics (medium stiff/loose, moist)			
						▼						
45			18	8	7			SM	Brown/gray silty fine to coarse sand with gravel (loose, wet)			
	20											
									Lenses of fine to coarse gravel			
40			18	23	8							
	25											
35			18	25	9			GM	Brown silty fine to coarse gravel with sand (medium dense, wet)			
	30											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING GEO-36

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-37
Sheet 1 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/9/08

Elevation feet	Depth feet	SAMPLES Interval Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	30										
30		18	19	10							
	35						SM	Gray silty fine to coarse sand with gravel (medium dense, moist)			
25		6	33	11			ML	Gray silt (hard, moist) (transitional bed deposit)			
	40										
20	45										
15	50										
10	55										
5	60										
0	65										

LOG OF BORING GEO-36 (continued)

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-37
Sheet 2 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/9/08

Date(s) Drilled	10/30/07	Logged By	SRR	Checked By	KGO
Drilling Contractor	Geologic Drill	Drilling Method	Hollow-stem Auger	Sampling Methods	SPT
Auger Data	3¼-inch OD	Hammer Data	140 lb hammer/30 in drop rope and cathead	Drilling Equipment	Deep Rock XL Rig
Total Depth (ft)	40	Surface Elevation (ft)	57.0	Groundwater Elevation (ft)	Not Encountered
Vertical Datum	NAVD 88	Datum/ System	WSDOT Project Coordinates	Easting(x): Northing(y):	1635801.6 538047.2

Elevation feet	Depth feet	SAMPLES Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							AC	2 inches asphalt concrete pavement			
								CR	2 inches crushed rock base course			
								SM	Brown silty fine to medium sand with gravel (medium dense, moist) (fill)			
55			6	26	1			SM	Gray silty fine sand with occasional gravel (medium dense, moist)	6		
	5		18	15	2							
50			18	5	3			SP-SM	Gray fine to medium sand with silt (loose, moist)	14		%F = 9
	10		18	2	4			SM	Gray silty fine to medium sand with occasional gravel (very loose, wet) (alluvium)			Oxidation staining
									Layer of sandy silt			
45			18	2	5							
	15		18	1/12"	6			ML	Gray silt with organics (very stiff, moist)	40		Oxidation staining AL
40												
			18	4	7				Grades to soft			
	20							SM	Brown silty fine to coarse sand with gravel (medium dense, wet)			
35												
			18	16	8							
	25											
30												
			18	50/1"	9							Pounding on rock Heave
	30											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING GEO-37

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-38
Sheet 1 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/9/08

Elevation feet	Depth feet	SAMPLES: Interval Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	30										
25											
		6	17	10							
	35										Heave
20							SP-SM	Gray fine to medium sand with silt (dense, moist) (advance outwash)			
		12	40	11							
	40										
15											
	45										
10											
	50										
5											
	55										
0											
	60										
-5											
	65										
-10											

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/9/08

LOG OF BORING GEO-37 (continued)

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-38
Sheet 2 of 2

Date(s) Drilled	10/30/07	Logged By	SRR	Checked By	KGO
Drilling Contractor	Geologic Drill	Drilling Method	Hollow-stem Auger	Sampling Methods	SPT
Auger Data	3¼-inch OD	Hammer Data	140 lb hammer/30 in drop rope and cathead	Drilling Equipment	Deep Rock XL Rig
Total Depth (ft)	34	Surface Elevation (ft)	58.6	Groundwater Elevation (ft)	44.1
Vertical Datum	NAVD 88	Datum/ System	WSDOT Project Coordinates	Easting(x): Northing(y):	1635846.7 538141.4

Elevation feet	Depth feet	SAMPLES Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							AC	2 inches asphalt concrete pavement			
								CR	2 inches crushed rock base course			
								SM	Gray silty fine to medium sand with gravel (medium dense, moist) (fill)			
55			18	14	1							
	5		18	14	2					11		
			12	17	3							
50									With trace organic matter			
								SM	Black silty fine to medium sand with abundant organic matter, wood debris, charcoal and glass (loose, moist)			
	10		18	7	4					36		
			18	6	5			ML	Gray silt with organic matter and lenses of coal (soft, moist) (alluvium)	38		AL
45												
	15		12	20	6			SP-SM	Gray fine to medium sand with silt and gravel (medium dense, wet)			
40			12	3	7			SM	Brown gray silty fine to medium sand with interbedded layers of sandy silt (very loose, wet)			Oxidation staining
	20											
35			12	6	8			ML	Brownish gray silt with sand (medium stiff, wet)	31		Oxidation staining
	25											
								GM	Brown silty fine to coarse gravel with sand (dense, moist) (advance outwash)			
30			12	41	9							
	30											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING GEO-38

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-39
Sheet 1 of 2

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/9/08

Elevation feet	Depth feet	SAMPLES Interval Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	30										
		0	50/5"	10							
25											
	35										
20											
	40										
15											
	45										
10											
	50										
5											
	55										
0											
	60										
-5											
	65										

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/9/08

LOG OF BORING GEO-38 (continued)

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-39
Sheet 2 of 2

H. F. 26.66 (Rev. 12-61)

3

WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

LOG OF TEST BORING

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H-1-64-CC

C.S. 1744

P. S. H. / S. S. H. No. 1-RE Section May Creek to Bagley Lane; Coal Creek Box Culvert Job No. L-2050

Hole No. H-1 Station C 7+52 Offset ℄ Ground Elev. 41.7

Type of Boring Det and Coop Water Table -1.8' below Ground Casing 3" - 44'

Inspector James D. Lance Date March 2, 1964 Sheet No. 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
	A-4 9 9 2		A B	U-1 (0 to 2.0') Ground Surf. to 2'0": Very Loose Brown Silty, Clayey Fine Sand; high % Forest Duff, top 8". 2 Tubes Submitted
				2'0" to 3'0": Very Loose Brown & Gray Mottled Fine Sandy
	43 W.T.		1 1	D-2 (2.0' to 4.0') Clayey Silt. Retained 14"
				3'0" to 9'0": Very Loose, Saturated, Silty Mucky Med.
5				Fine Sand, w/ Layer of Saturated Fine to Coarse Sand from 5'6" to 6'0".
	44	1 2 3 4	A B C D	U-3 (5.0' to 6.8') 4 Tubes Submitted
	3 4 5		1 2 1	D-4 (7.0' to 9.0') Retained 3"
	1			9'0" to 15'0": Very Loose, Saturated Mucky Med.
10				Fine Sand, w/ scattered Fine Gravel.
	46		1 1	D-5 (10.0' to 12.0') Retained 12"
	47	5 1 2 3	A B C	U-6 (13.3' to 15.0') 3 Tubes Submitted
15				15'0" to 19'0": Loose to Slightly Compact Saturated
7	13 48		7 6 1 7	D-7 (15.0' to 17.0') Med. Fine Sand w/ Layers of Med. Retained 4" Fine Gravel.
				19'0" to 29'0": Dense, Very Moist Silty Fine to Coarse
20				Sand and Fine to Med. Gravel, alternating with
	83 49		25 40 43 16	D-8 (20.0' to 22.0') Compact Med. Fine Sand. Sand Retained 8" Layers are about a foot thick & occur about every
				two to three feet.
25				
	32 50		22 20 12 8	D-9 (25.0' to 27.0') Retained 12"
	22 51		19 13 9 11	D-10 (28.0' to 30.0') Retained 10"
30				29'0" to 44'0": Compact to Dense Gray Silty
				Fine to Coarse Sub-Angular Sand.
				% Silt increases with depth.
35	40 52		10 18	D-11 (34.0' to 36.0') Retained 14"

(Rev. 12-61)

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C.S. 1744

H-2-64-CC

P. S. H. ~~S. S. H.~~ No. IRE Section Mar Creek to Bagley Lane - Coal Creek Box Culvert Job No. 1-2050

Hole No. H-2 Station C.8+48 Offset 3.5' Rt ℄ Ground Elev. 43.0'

Type of Boring Wash-Chop Water Table 3.7' below surface Casing 39' of 3"

Inspector Thomas E. Crisp Date 3-3-64 Sheet No. 1 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				Very soft mottled brown & gray silty sandy clay, saturated
				#1 Undisturbed 3.0'-5.0' 2 tubes 3'4"-4'0"
A-5020		1, 2	B, C	
5	21			#2 Standard Penetrometer Test 5.0'-7.0'
	1-2'		1	
				#3 Undisturbed 9.0'-11.0' 4 tubes 9'4"-10'8"
10	22	1, 2, 3, 4	B, C, D, E	
	23			#4 Undisturbed 14'0"-16'0" - no recovery
15				Compact gray silty sand, approximately 30% gravel 1½" minus
	23			#5 Standard Penetrometer Test 19.0'-21.0'
20	9		8, 4, 5, 3	Gray silty, sandy clay, traces of coal & organic matter
	24			#6 Standard Penetrometer Test 25.0'-27.0'
25				Dense poorly sorted silty sand, clay, soft shale, rounded fine gravel (1" minus)
	38		15, 22, 16, 19	
	25			#7 Standard Penetrometer Test 29.0'-31.0'
30	31		15, 17, 14, 11	Compact silty fine angular sand, trace of clay, 15% fine gravel (1"-)
				Dense gray silty, clayey fine sand, occasional fine gravel (1"-)
35	49	26	17, 17	#8 Standard Penetrometer Test 34.0'-36.0'

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P. S. H.
~~S. S. H.~~ No. 1 RE Section Mag Creek to Bagley Lane - Coal Creek Box Culvert Job No. L-2050

Hole No. A-2 Station C 8+48 Offset 3.5' Rt ℄ Ground Elev. 43.0'

Type of Boring Water Table Casing

Inspector Thomas E. Crisp Date Sheet No. 2 of 2

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
			32 / 82	
A-5027 40	116/0.5		75 / 116	#9 Standard Penetrometer Test 39.0' - 40.0'
				Final depth of drilling 40.0'
				Bumped out 15' of casing, pulled 25' with single line

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DEPARTMENT OF HIGHWAYS

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H-3-64-CC

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P. S. H. / ~~S. S. H.~~ No. I R E Section May Creek to Bagley Lane - Cool Creek Box Culvert C.S. 1744 Job No. L-2050

Hole No. H-3 Station C 9+16 Offset 18.9' Rt ℄ Ground Elev. 47.3'

Type of Boring Wash-chop Water Table 7.5' below surface Casing 29' of 3"

Inspector Thomas E. Crisp Date 3-6-64 Sheet No. 1 of 1

DEPTH	BLOWS PER FT.	PROFILE	SAMPLE TUBE NOS.	DESCRIPTION OF MATERIAL
				Poorly sorted silt, sand, & gravel - slide from highway fill
				Original ground surface - red-brown silty fine sand; roots - Very loose
A-3 5028				#1 Undisturbed 5.0'-7.0' 1 tube 5'4"-5'8"
			B.	Mottled red-brown, gray, sandy clay with organic content - very soft
	29			#2 Standard Penetrometer Test 7.0'-9.0'
	1/1.5'		1	
		1	1	#3 Undisturbed 9.0'-11.0' - 4 tubes 9'3"-9'7"
10	30	2 3 4	A_B C_D	
				Loose gray silty fine sand - 1.5% organic matter
	31	1 2		#4 Undisturbed 14.0'-16.0' - 2 tubes 14'0"-14'8"
15			A_B	
	32			#5 Standard Penetrometer Test 16.0'-18.0'
	38		11 12 16 15	Compact gray silty fine sand - 30% gravel 1½" minus percentage of gravel increases with depth of hole
	33			#6 Standard Penetrometer Test 19.0-21.0'
20	61		22 39 22 21	60% gravel - 40% silty sand
				3" bed silty clay - 17.9'-18'
				Dense gray silty, sandy coarse gravel; frequent small boulders (super-saturated)
	34			#7 Standard Penetrometer Test 24.0'-26.0'
25	54		66 31 23 18	Very dense silty, sandy coarse gravel (super-saturated) 80% gravel
	35			#8 Standard Penetrometer Test 29.0'-31.0'
30	102		56 78 24 69	
				Final depth of drilling 31.0'
				Bumped out 5' of casing - pulled 24' with single line

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-68365

HOLE No. KP-3-06

Sheet 1 of 3

Job No. XL-2067 SR 405 Elevation 81.0 ft

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Harvey, Thomas Lic# 2599

Site Address Vic. 0f I-405 & Coal Creek Parkway SE

Inspector Joe Judd

Start November 14, 2006 Completion November 14, 2006 Well ID#

Equipment CME 45 with Autohammer

Station Offset Hole Dia (inches) 4

Method Wet Rotary

Northing 209747.00 Easting 1307567.00 Latitude Longitude

County King Subsection NW1/4 of SE1/4 Section 16 Range 5 EWM Township 24 N

Field SPT (N) / Moisture Content / RQD — 20 40 60 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
	80.0					
		3 5 5 (10)		D-1		Poorly graded SAND with gravel, loose, medium dense, dark brown, moist, homogenous, HCl not tested, Trace silt. Length Recovered 0.7 ft. Length Retained 0.7 ft.
5	75.0	5 5 7 (12)		D-2		Poorly graded SAND with gravel, medium dense, dark grayish brown, moist, homogenous, HCl not tested, Trace silt. Length Recovered 0.8 ft. Length Retained 0.8 ft.
		4 8 11 (19)		D-3		Silty SAND, medium dense, dark grayish brown, moist, stratified, HCl not tested, Material mottled, with Fe0 stains present. Native soil. Length Recovered 0.9 ft. Length Retained 0.9 ft.
10	70.0	3 8 15 (23)		D-4		Silty SAND with gravel, medium dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.9 ft. Length Retained 0.9 ft.
		10 11 18 (29)		D-5		Silty SAND with gravel, dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 1.0 ft. Length Retained 1.0 ft.
15	65.0	10 11 9 (20)		D-6		Silty SAND with gravel, medium dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.9 ft. Length Retained 0.9 ft.
		10 10 10 (20)		D-7		Silty SAND with gravel, medium dense, grayish brown, moist, homogenous, HCl not tested. Length Recovered 0.2 ft. Length Retained 0.2 ft.
20						

Groundwater / Instrument

SOILA XL-2067 SR-405 BEVELLUE DESIGN BUILD.GPJ SOIL.GDT 11/20/06,8:54:13 A11

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68365

HOLE No. KP-3-06

Job No. XL-2067 SR 405 Elevation 81.0 ft

Sheet 2 of 3

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Harvey, Thomas Lic# 2599

◆ Field SPT (N)
✚ Moisture Content
▨ RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	60	14 11 14 (25)		D-8		Silty SAND, dense, grayish brown, moist, homogenous, HCl not tested, Stratified in color.. Length Recovered 0.8 ft. Length Retained 0.8 ft.		
25	55	14 25 32 (57)		D-9		Silty SAND with gravel, very dense, gray, moist, homogenous, HCl not tested, Encountered Till about 22.0'. Length Recovered 0.5 ft. Length Retained 0.5 ft.		
30	50	22 22 34 (56)		D-10		Silty SAND with gravel, very dense, gray, moist, homogenous, HCl not tested, Material became loose at 34.0' as indicated by drilling. Length Recovered 0.7 ft. Length Retained 0.7 ft.		
35	45	1 2 1 (3)		D-11		Sandy SILT, very loose, dark gray, wet, stratified, HCl not tested, 35.0' - 36.0' ML, 36.0' - 36.2' SP Black. Length Recovered 1.2 ft. Length Retained 1.2 ft.		
40	40	4 4 8 (12)		D-12		Silty SAND, medium dense, grayish brown, moist, stratified, HCl not tested, FeO stains throughout sample. Last 5 mm of sample sand with gravel. Length Recovered 1.1ft. Length Retained 1.1 ft.		
45								

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card R-68365

HOLE No. KP-3-06

Job No. XL-2067 SR 405 Elevation 81.0 ft

Sheet 3 of 3

Project 112th Ave SE I/C to SE 8th Street I/C

Driller Harvey, Thomas Lic# 2599

◆ Field SPT (N)
✚ Moisture Content
▨ RQD

Depth (ft)	Elevation (ft)	Profile	Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	35			18 27 25		D-13		Well graded GRAVEL with sand, subrounded - subangular, very dense, gray, moist, wet, homogenous, Length Recovered 0.4 ft. Length Retained 0.4 ft.		
50	30			18 27 26		D-14		Silty GRAVEL with sand, subrounded - subangular, very dense, gray, moist, homogenous. Length Recovered 0.5 ft. Length Retained 0.5 ft.		
55	25							End of test hole boring at 51.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal Water level before bailing 12' Bailed bore hole water level to 19.6' Recharge after 6 minutes 20.6'		
60	20									
65	15									
70										

LOG OF TEST BORING

WSDOT

Start Card SE-62038 / AE-42882

HOLE No. R2B-78-17

Sheet 1 of 4

Job No. XL-4653 SR 405 Elevation 59.3 ft

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted Lic# 2902

Component Fill Wall 09.90L

Inspector Harvey, Thomas #2599

Start May 10, 2017 Completion May 11, 2017 Well ID# N/A

Equipment CME 45C (9A4-7)

Station SB405 5836+83.635 Offset 72.1 feet left Hole Dia (inches) 4

Historical SPT Efficiency 88.4%

Northing 209826.249 Easting 1307562.027 Collected by Region Survey Crew

Method Casing Advancer

Lat 47.5672327 Long -122.1816980 Datum NAD 83/91 HARN, NAVD88, SPN (ft)

Drill Fluid Bentonite

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	55.0			1 3 3 (6)		D-1		Silty SAND with gravel trace organics, sub-rounded, loose, grayish brown, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft		
5										
				1 1 1 (2)		D-2	MC GS	SM, MC=17% Silty SAND with gravel, sub-rounded, very loose, gray, wet, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft		
	50.0			1 2 2 (4)		D-3		Silty SAND with gravel, sub-rounded, very loose, grayish brown, wet, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft		
10										
				4 8 13 (21)		D-4	MC LOI	MC=30%, LOI=10.3% Silty SAND with gravel and organics, sub-rounded, medium dense, dark brown, wet, stratified. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft		
	45.0			14 13 9 (22)		D-5		Well graded GRAVEL with sand, sub-rounded, medium dense, olive brown, wet, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft		
15										
	40.0			12 14		D-6		Well graded GRAVEL with sand, sub-rounded, dense, greenish gray, wet, homogeneous. HCl not tested.		
20										

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/11/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 59.3 ft HOLE No. R2B-78-17

Sheet 2 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff Driller Henderson, Ted

SPT Efficiency / Field SPT (N) / Moisture Content / RQD — 20 40 60 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		14 (28)				Recovered: 0.7 ft Retained: 0.7 ft		
25	35	11 18 20 (38)		D-7		Well graded GRAVEL with sand, sub-rounded, dense, gray, wet, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft		
						Very hard drilling at 27 ft.		
30	30	>> 50/4" (REF)		D-8		No Recovery. Sampler OD = 2.5 in, ID = 2 in		
35	25	>> 16 37 50/1" (REF)		D-9	MC GS AL	SM, MC=12%, LL=NA, PL=NP Silty SAND with gravel, sub-rounded, very dense, gray, moist, stratified. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft		
40	20	15 21 26 (47)		D-10		Sandy SILT, dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
45	15	18 24		D-11		Sandy SILT, very dense, gray, moist, stratified, laminated. HCl not tested.		

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/11/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 59.3 ft HOLE No. R2B-78-17

Sheet 3 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff Driller Henderson, Ted

SPT Efficiency / Field SPT (N) / Moisture Content / RQD — 20 40 60 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		34 (58)				Recovered: 1.5 ft Retained: 1.5 ft		
50	10	>> 37 50/4" (REF)		D-12		Poorly graded SAND, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft		
55	5	17 25 32 (57)		D-13		Sandy SILT, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
60	0	18 21 31 (52)		D-14		Sandy SILT, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
						Drilling behavior indicated some gravel presented at 61.5 ft.		
65	-5	>> 17 23 50/4" (REF)		D-15	MC GS AL HT SG	ML, MC=26%, PI=12 SILT with sand, very dense, gray, moist, stratified. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft		
70	-10	>> 50/6" (REF)		D-16		Well graded SAND with gravel, sub-rounded, very dense, gray, wet, homogeneous. HCl not tested.		

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 59.3 ft

HOLE No. R2B-78-17

Sheet 4 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted

SPT Efficiency
Field SPT (N)
Moisture Content
RQD

Depth (ft)	Elevation (ft)	Profile	20 40 60 80	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								Recovered: 0.4 ft Retained: 0.4 ft		
	-15		>>	50/4" (REF)		D-17		Well graded SAND with gravel, sub-rounded, very dense, gray, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft		
75										
	-20							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
80										
								End of test hole boring at 74.4 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
	-25									
85								Bail/Recharge test: Hole Diameter: 4 inches Depth of boring during bail test: 74.4 ft. Depth of casing during bail test: 69 ft. Water depth before bailing: 4.7 ft. Bailed bore hole water level to 27.7 ft. Recharge after 5 minutes: 20 ft. Recharge after 10 minutes: 11.7 ft. Recharge after 15 minutes: 10.5 ft. Recharge after 20 minutes: 9.9 ft. Recharge after 25 minutes: 9.6 ft. Recharge after 30 minutes: 9.5 ft. Recharge after 35 minutes: 9.5 ft.		
	-30									
90										
	-35									
95										

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/11/18

LOG OF TEST BORING

WSDOT

Start Card SE-61473 / AE-42012

HOLE No. R2B-79-17

Sheet 1 of 4

Job No. XL-4653 SR 405 Elevation 77.0 ft

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted Lic# 2902

Component Fill Wall 10.10GL

Inspector Shepherd, Robert #2710

Start March 22, 2017 Completion March 23, 2017 Well ID# N/A

Equipment CME 45C (9A4-7)

Station SB405 5840+07.526 Offset 41.1 feet left Hole Dia (inches) 6

Historical SPT Efficiency 88.4%

Northing 210005.228 Easting 1307817.99 Collected by Region Survey Crew

Method Casing Advancer

Lat 47.5677356 Long -122.1806740 Datum NAD 83/91 HARN, NAVD88, SPN (ft)

Drill Fluid Bentonite

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				2 1 3 1 (4)		D-1		Silty SAND with gravel, sub-rounded, very loose, light gray, moist, homogeneous. HCl not tested. Recovered: 0.8 ft Retained: 0.8 ft		
	75.0									
5				0 2 2 (4)		D-2		Silty SAND with gravel, sub-rounded, very loose, olive gray, wet, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft		
	70.0									
				0 0 0 (0)		D-3	MC GS AL	SM, MC=13%, LL=NA, PL=NP Silty SAND with gravel, sub-rounded, very loose, olive gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
10				1 1 1 (2)		D-4		Silty SAND with gravel, sub-rounded, very loose, olive gray, wet, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft		
	65.0									
				7 9 15 (24)		D-5		Silty SAND, medium dense, olive gray, wet, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft		
15				15 16 14 (30)		D-6		Silty SAND, dense, light gray, moist, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft		
	60.0									
20										

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/11/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 77.0 ft

HOLE No. R2B-79-17

Sheet 2 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted

SPT Efficiency
Field SPT (N)
Moisture Content
RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		7 29 31 (60)		D-7		Silty SAND, very dense, light gray, moist, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft		
25	55	9 12 15 (27)		D-8	MC GS AL	SM, MC=14%, LL=NA, PL=NP Silty SAND with organics, dense, light gray, moist, homogeneous. HCl not tested. Recovered: 1.4 ft Retained: 1.4 ft		
30	50	3 3 6 (9)		D-9	MC GS AL LOI	SM, MC=42%, LL=NA, PL=NP, LOI=22.3% Silty SAND with organics, loose, black, moist, stratified. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft		
35	45	3 3 3 (6)		D-10		Sandy SILT with organics, loose, greenish gray, moist, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft		
40	40	2 4 21 (25)		D-11		Sandy SILT, dense, light brown, moist, stratified, laminated. HCl not tested. FeO staining present. Recovered: 1.2 ft Retained: 1.2 ft		
45	35							

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 77.0 ft HOLE No. R2B-79-17

Sheet 3 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff Driller Henderson, Ted

SPT Efficiency
Field SPT (N)
Moisture Content
RQD

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			15 50/6" (REF)		D-12		Silty SAND with gravel, sub-rounded, very dense, light gray, moist, stratified. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft		
30									
50			17 15 12 (27)		D-13		Well graded SAND with gravel, sub-rounded, dense, light gray, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft		
25									
55			13 12 18 (30)		D-14		Silty SAND, dense, light gray, moist, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft		
20									
60			8 8 12 (20)		D-15		Silty SAND, medium dense, light gray, moist, homogeneous. HCl not tested. Recovered: 0.8 ft Retained: 0.8 ft		
15									
65			10 11 22 (33)		D-16	MC GS AL	SM, MC=25%, LL=NA, PL=NP Silty SAND, dense, light brown, moist, stratified with dry silt. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft		
10									
70									

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/11/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 77.0 ft

HOLE No. R2B-79-17

Sheet 4 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				50/2" (REF)		D-17		Silty SAND, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 0.2 ft Retained: 0.2 ft		
	5									
75								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
	0							End of test hole boring at 70.2 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
80								Water level was at 37 ft. on the morning of March 23, 2017, after pulling 20 ft. of caseing the night before. After pulling the remaining casing, the water was at 7 ft.		
	-5									
85										
	-10									
90										
	-15									
95										

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/11/18

LOG OF TEST BORING

WSDOT

Start Card RE-14068
HOLE No. R2B-81vw-17
Sheet 1 of 4

Job No. XL-4653 SR 405 Elevation 76.4 ft

Project I-405 Renton to Bellevue - ETL - Envir & Traff
Driller Henderson, Danny Lic# 2742

Component New Bridge at I-405 Over Coal Creek PKWY SE
Inspector Mike Mulhern

Start March 14, 2017 Completion March 15, 2017 Well ID# BJT-558
Equipment CME 55 (9C7-1)

Station SB405 5881+77.365 Offset 35.9 feet left Hole Dia (inches) 4
Historical SPT Efficiency 89.2%

Northing 210126.519 Easting 1307933.846 Collected by Region Survey Crew
Method Casing Advancer

Lat 47.5680737 Long -122.1802134 Datum NAD 83/91 HARN, NAVD88, SPN (ft)
Drill Fluid Bentonite

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	75.0			10 14 20 (34)		D-1		Silty SAND with gravel, sub-rounded, dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft	Groundwater readings were taken from 03-16-2017 to 05-17-2018	
5	70.0			7 8 7 (15)		D-2		Poorly graded SAND with gravel, sub-rounded, medium dense, olive brown, wet, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft		
				2 5 10 (15)		D-3	MC AL	MC=18%, PI=3 Sandy SILT, medium dense, gray, moist, stratified. HCl not tested. Recovered: 0.7 ft Retained: 0.7 ft		
10	65.0			23 33 33 (66)		D-4	MC GS AL	SM, MC=10%, LL=NA, PL=NP Silty SAND, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft		
				22 24 28 (52)		D-5		Silty SAND, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.1 ft Retained: 1.1 ft		
15	60.0			12 11 9 (16)		D-6		Silty SAND with gravel, sub-rounded, medium dense, grayish brown, wet, homogeneous. HCl not tested. Recovered: 0.5 ft Retained: 0.5 ft Sampler OD = 2.5 in, ID = 2 in		
20										

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/31/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 76.4 ft

HOLE No. R2B-81vw-17

Sheet 2 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Danny

SPT Efficiency
Field SPT (N)
Moisture Content
RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	55							
		3 3 3 (6)		D-7		Poorly graded SAND, loose, grayish brown, moist, homogeneous. HCl not tested. Recovered: 0.7 ft Retained: 0.7 ft		
25								
	50							
		2 2 6 (8)		D-8		Poorly graded SAND with organics, loose, gray, wet, homogeneous. HCl not tested. Recovered: 0.8 ft Retained: 0.8 ft		
30								
	45							
		11 31 44 (75)		D-9	MC GS AL	SM, MC=10%, PI=1 Silty SAND with gravel, sub-rounded, very dense, grayish brown, moist, stratified. HCl not tested. The upper 4 inches of the sample was gray. Recovered: 1.0 ft Retained: 1.0 ft		
35								
	40							
		>>50/5" (REF)		D-10		Silty SAND with gravel, sub-rounded, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft		
40								
	35						03-19-2017	
		>>50/5" (REF)		D-11		Silty SAND with gravel, sub-rounded, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft		
45								

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/31/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 76.4 ft

HOLE No. R2B-81vw-17

Sheet 3 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Danny

SPT Efficiency
Field SPT (N)
Moisture Content
RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
	30					
		>> 26 50/5" (REF)		D-12		SILT, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 0.7 ft Retained: 0.7 ft
50	25					
		15 26 40 (66)		D-13	MC GS AL	CL, MC=13%, PI=11 Sandy lean CLAY, very hard, gray, moist, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
55	20					
		>> 17 45 50/5" (REF)		D-14		Silty SAND, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 0.5 ft Retained: 0.5 ft
60	15					
		>> 10 23 50/4" (REF)		D-15		Silty SAND, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft
65	10					
		>> 43 50/5" (REF)		D-16	MC GS AL	SM, MC=19%, LL=NA, PL=NP Silty SAND, very dense, gray, moist, stratified. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft
70						

Groundwater: 09-20-2017

Instrument

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/31/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 76.4 ft

HOLE No. R2B-81vw-17

Sheet 4 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Danny

SPT Efficiency
Field SPT (N)
Moisture Content
RQD
20 40 60 80

Depth (ft)	Elevation (ft)	Profile	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	5		>> 50/5" (REF)		D-17		Silty SAND, very dense, gray, moist, homogeneous. HCl not tested. Recovered: 0.4 ft Retained: 0.4 ft		
75	0		>> 45 50/5" (REF)		D-18		Well graded SAND, very dense, gray, moist, homogeneous. HCl not tested. Vibrating Wire Piezometer installed at 77.5 ft. (SN: 1602233). Recovered: 0.7 ft Retained: 0.7 ft		
80	-5						A flush mount monument was installed on this boring.		
85	-10						The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
90	-15						End of test hole boring at 78.9 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
95									

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/31/18

LOG OF TEST BORING

WSDOT

Start Card RE-14302
HOLE No. R2B-77vw-17
Sheet 1 of 4

Job No. XL-4653 SR 405 Elevation 67.9 ft

Project I-405 Renton to Bellevue - ETL - Envir & Traff
Driller Henderson, Ted Lic# 2902

Component Fill Wall 09.90L
Inspector Harvey, Thomas #2599

Start May 12, 2017 Completion May 16, 2017 Well ID# BJT-546 Equipment CME 45C (9A4-7)

Station SB405 5833+46.8 Offset 43.7 feet left Hole Dia (inches) 4 Historical SPT Efficiency 88.4%

Northing 209628.368 Easting 1307292.271 Collected by Region Survey Crew Method Casing Advancer

Lat 47.5666774 Long -122.1827765 Datum NAD 83/91 HARN, NAVD88, SPN (ft) Drill Fluid Bentonite

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater
	65.0						Groundwater readings were taken from 08-07-2017 to 05-17-2018
5		8 10 11 (21)		D-1		Silty SAND with organics, medium dense, grayish brown, moist, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
	60.0	6 10 11 (21)		D-2	MC GS AL	SM, MC=18%, LL=NA, PL=NP Silty SAND, medium dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
10		11 14 14 (28)		D-3		Silty SAND, dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
	55.0	12 10 5 (15)		D-4		Silty SAND with gravel, sub-angular, medium dense, gray, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft Lost drilling fluid return at 14 ft.	
15		>> 1 2 50/4" (REF)		D-5		Silty SAND with gravel, sub-angular, very dense, gray, wet, stratified. HCl not tested. Recovered: 0.8 ft Retained: 0.8 ft Drilling behavior indicated a 9-inch cobble present at 15 ft.	
	50.0						04-22-2018
20		10 7		D-6		Silty SAND with gravel, sub-angular, loose, gray, wet, homogeneous. HCl not tested.	

Profile: SPT Efficiency, Field SPT (N), Moisture Content, RQD; 20 40 60 80

Instrument

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 67.9 ft

HOLE No. R2B-77vw-17

Sheet 2 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted

SPT Efficiency
Field SPT (N)
Moisture Content
RQD

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		3 (10)				Recovered: 0.4 ft Retained: 0.4 ft	08-28-2017	
25	45	3 4 8 (12)		D-7	MC GS AL HT SG	CL, MC=27%, PI=9 Lean CLAY with sand, stiff, grayish brown, moist, stratified. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
30	40	12 22 30 (52)		D-8	MC GS AL	SM, MC=24%, LL=NA, PL=NP Silty SAND, very dense, grayish brown, moist, stratified. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
35	35	8 12 15 (27)		D-9		Sandy SILT, dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
40	30	14 15 15 (30)		D-10		Sandy SILT, dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
45	25	9 15		D-11	MC GS	ML, MC=21%, PI=14 SILT, dense, gray, moist, homogeneous, laminated. HCl		

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/18/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 67.9 ft

HOLE No. R2B-77vw-17

Sheet 3 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted

SPT Efficiency
Field SPT (N)
Moisture Content
RQD
20 40 60 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		15 (30)			AL	not tested. Recovered: 1.5 ft Retained: 1.5 ft		
	20							
50		8 8 13 (21)		D-12		SILT, medium dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
						Drilling behavior indicated gravel present at 52 ft.		
	15							
55		12 20 22 (42)		D-13		Silty CLAY, hard, gray, moist, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
	10							
60		17 50/6"		D-14		Silty CLAY, very hard, gray, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft		
						Very hard drilling		
	5							
65		19 21 25 (46)		D-15	MC GS AL	CL-ML, MC=24%, PI=6 Silty CLAY, hard, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
	0							
70		13 16		D-16		SILT, dense, gray, moist, homogeneous, laminated. HCl not tested.		

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/18/18

LOG OF TEST BORING

WSDOT

Job No. XL-4653 SR 405 Elevation 67.9 ft

HOLE No. R2B-77vw-17

Sheet 4 of 4

Project I-405 Renton to Bellevue - ETL - Envir & Traff

Driller Henderson, Ted

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				18 (34)				Recovered: 1.5 ft Retained: 1.5 ft		
								Vibrating Wire Piezometer installed at 69.5ft SN:1602240		
								A standpipe monument was installed on this boring.		
	-5									
75								The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
	-10							End of test hole boring at 70.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal		
80										
	-15									
85										
	-20									
90										
	-25									
95										

ENTERPRISE BORING LOG XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ ENTERPRISE DATA TEMPLATE.GDT 5/18/18

wood.

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-27-20
CLIENT WSDOT **PROJECT LOCATION** Renton, WA
DATE STARTED 1/8/20 **COMPLETED** 1/8/20 **GROUND ELEVATION** 77.6 ft NAVD88 **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Gregory Drilling **DRILL RIG** LAR ID: #309 **SPT HAMMER EFFICIENCY** 80%
DRILLING METHOD HSA **STATION (FT)** 1109+62.65 **OFFSET (FT)** 0.1 L
LOGGED BY Joe Fassio **CHECKED BY** H. Brenniman **NORTHING** 209574.556 **EASTING** 1307032.764
NOTES ERC Trail **GW LEVEL (ATD)** 8.00 ft / Elev 69.61 ft Perched Water

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ (20 40 60 80) / PL MC LL (20 40 60 80) / ☐ FINES CONTENT (%) ☐ (20 40 60 80)	TESTS AND REMARKS
0		Poorly graded GRAVEL with silt and sand, medium dense, grayish to olive brown, moist, with cobbles and boulders, [FILL] (GP-GM)				Note: Three attempts at this boring. Could not penetrate shallow cobbles/boulders at 1 to 2 feet in first two attempts. Had to move boring ~20 feet to south.
75			33	SPT-1 6 7 8	▲ 15	
5		Poorly graded SAND with silt and gravel, loose, grayish to olive brown, moist, [FILL] (SP-SM)	47	SPT-2 3 4 6	▲ 10	
70		Silty SAND, very loose, olive to reddish brown, moist, [FILL] (SM) Becomes wet at 8.0 feet	73	SPT-3 3 1 2	▲ 3 ■	MC = 16% Fines = 16%
10			100	SPT-4 1 1 1	▲ 2	
		Silty SAND, very loose, olive to grayish brown, moist, mixed native silty fine SAND, with scattered organics, [FILL] (SM)				
65		Sandy SILT, medium dense, olive to grayish brown, moist, with reddish brown mottling on laminae, [Qgl] (ML)				
15			100	SPT-5 3 5 8	▲ 13 ● ☐	MC = 25% Fines = 52%

Bottom of borehole at 16.5 feet.

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wood.

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-29-20
CLIENT WSDOT **PROJECT LOCATION** Renton, WA
DATE STARTED 1/8/20 **COMPLETED** 1/8/20 **GROUND ELEVATION** 78.2 ft NAVD88 **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Gregory Drilling **DRILL RIG** LAR ID: #309 **SPT HAMMER EFFICIENCY** 80%
DRILLING METHOD HSA **STATION (FT)** 1115+40.35 **OFFSET (FT)** 2.3 L
LOGGED BY Joe Fassio **CHECKED BY** H. Brenniman **NORTHING** 209913.586 **EASTING** 1307497.036
NOTES ERC Trail **GW LEVEL (ATD)** Dry

ELEVATION (ft)	DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ (20 40 60 80) / PL MC LL (20 40 60 80) / ☐ FINES CONTENT (%) ☐ (20 40 60 80)	TESTS AND REMARKS
	0		Poorly graded GRAVEL with silt and sand, medium dense, grayish brown, moist, [FILL] (GP-GM)				
75			Poorly graded SAND with silt and gravel, loose, olive to yellowish brown, moist, [FILL] (SP-SM)	67	SPT-1 4 5 4	▲ 9	
	5		Grades to poorly graded SAND with silt and becomes medium dense at 5 feet	67	SPT-2 3 5 6	● ▲ 11	MC = 9% Fines = 10%
70			Silty SAND, loose, olive to yellowish brown, moist, with scattered rootlets, uniform, [FILL] (SM)	73	SPT-3 3 4 4	▲ 8	
	10			67	SPT-4 4 4 4	● ▲ 8 ☐	MC = 6% Fines = 23%
65							
	15			47	SPT-5 3 4 4	▲ 8	

Bottom of borehole at 16.5 feet.

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wood.
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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-106mw-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 8/4/20 **COMPLETED** 8/5/20 **GROUND ELEVATION** 108.5 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Holt Services **DRILL RIG** CME 85 ID: #10 **SPT HAMMER EFFICIENCY** 88%

DRILLING METHOD HSA **Well Tag #** BMP-172 **STATION (FT)** 5824+33.19 **OFFSET (FT)** 75.8 L

LOGGED BY Carlos Mendoza **CHECKED BY** Pat Reed **NORTHING** 209142.43 **EASTING** 1306506.587

NOTES **GW LEVEL (ATD)** Elev 63.5 ft **GW LEVEL (8/5/2020)** Elev 80.1 ft

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE / PL MC LL / FINES CONTENT (%)	TESTS AND REMARKS
0		ASPHALT (2 inches) over Poorly graded SAND with gravel, brownish yellow, dry, [FILL] (SP)				
105		Silty SAND, loose, light yellow to grayish brown, dry to moist, [FILL] (SM)	44	SPT-1 3 4 6	10	MC = 10% Fines = 41%
5		Becomes medium dense, reddish brown, moist, scattered organics, oxidation stains	61	SPT-2A 4 5 6 2B	11	
100		Lean CLAY with sand, very stiff, olive yellow to grayish brown, moist, [Qvr] (CL)	78	SPT-3 6 10 13	23	MC = 15% LL = 29 PL = 22 Fines = 77%
10		SILT with sand, hard, olive yellow to light olive brown, moist, oxidation in veins, [Qva] (ML)	100	SPT-4 6 16 27	43	MC = 20% Fines = 80%
95		Silty SAND, very dense, grayish brown, moist, [Qva] (SM)				Drilling gets hard from 12 to 12.5 feet
15			100	SPT-5 14 24 26	50	MC = 9% Fines = 30% Hard/tight drilling from 15 feet
90						
20						

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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-106mw-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	WELL DIAGRAM	▲ SPT N VALUE ▲ (20 40 60 80) / PL MC LL (20 40 60 80) / ☐ FINES CONTENT (%) ☐ (20 40 60 80)	TESTS AND REMARKS
20		Lean CLAY, hard, bluish gray, moist, varves, [Qgl] (CL)	100	SPT-6 4 17 23		▲ 40	MC = 18% LL = 31 PL = 22 Fines = 88%
85							
25			100	SPT-7 9 19 34		▲ 53	
80					▽		
30		Become with sand	100	SPT-8 14 22 34		▲ 56	MC = 17% LL = 32 PL = 23 Fines = 78%
75							
35			100	SPT-9 7 21 28		▲ 49	
70							
40			100	SPT-10 10 22 24		▲ 46	Hit something between 42 to 44

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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-106mw-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	WELL DIAGRAM	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	TESTS AND REMARKS
65		Lean CLAY with sand, hard, bluish gray, moist, varves, [Qgl] (CL)					feet
45		Well graded SAND with silt and gravel, very dense, bluish gray, wet, subrounded gravel (SW-SM)	100	SPT-11 13 34 42		☐● ▲76	MC = 15% Fines = 11%
60							
50		Well graded GRAVEL, very dense, bluish gray, wet, (GW)	100	SPT-12 21 34 50/6"		50/5.5"	

Bottom of borehole at 51.5 feet.

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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-143-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 5/21/20 **COMPLETED** 5/21/20 **GROUND ELEVATION** 106.8 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Holt Services **DRILL RIG** CME 85 ID: #7 **SPT HAMMER EFFICIENCY** 88%

DRILLING METHOD HSA **STATION (FT)** 5825+02.17 **OFFSET (FT)** 16.0 R

LOGGED BY Patricia Reed **CHECKED BY** H. Brenniman **NORTHING** 209129.246 **EASTING** 1306621.524

NOTES **GW LEVEL (ATD)** 7.5 ft / Elev 99.3 ft

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ (20 40 60 80) / PL MC LL (20 40 60 80) / ☐ FINES CONTENT (%) ☐ (20 40 60 80)	TESTS AND REMARKS
0		ASPHALT (3 inches) over Silty SAND with gravel, medium dense, grayish brown, dry to moist, [FILL] (SM)				
105			22	SPT-1 15 12 8	▲ 20	
5		Silty SAND, loose, dark yellowish brown, moist, [FILL] (SM)	33	SPT-2 6 4 2	▲ 6	
100						
		Silty SAND, medium dense, yellowish brown, wet, [Qva] (SM)	67	SPT-3 6 8 9	▲ 17	MC = 23% LL = NP PL = NP Fines = 17%
10			78	SPT-4 6 10 12	▲ 22	
95						
		Sandy lean CLAY, hard, dark gray, moist, [Qgl] (CL)				
15				SPT-5 7 13 19	▲ 32	
90						
20						

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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-143-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	TESTS AND REMARKS
20		Sandy lean CLAY, hard, dark gray, moist to wet, with ribbons of yellowish brown silty SAND (SM), blocky texture, disturbed, healed fracture zones, [Qls/Qgl] (CL)	100	SPT-6 10 24 24	48	MC = 17% LL = 25 PL = 15 Fines = 61%
85						
		Lean CLAY, hard, dark gray, moist, [Qgl] (CL)				
25			89	SPT-7 10 14 23	37	MC = 27% LL = 33 PL = 22 Fines = 97%

Bottom of borehole at 26.5 feet.

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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-144-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 5/26/20 **COMPLETED** 5/26/20 **GROUND ELEVATION** 102.8 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Holt Services **DRILL RIG** CME 85 ID: #7 **SPT HAMMER EFFICIENCY** 88%

DRILLING METHOD HSA **STATION (FT)** 5827+41.43 **OFFSET (FT)** 18.1 R

LOGGED BY Patricia Reed **CHECKED BY** H. Brenniman **NORTHING** 209277.037 **EASTING** 1306805.401

NOTES **GW LEVEL (ATD)** 8.0 ft / Elev 94.8 ft Perched water

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE (20 40 60 80) / PL MC LL / FINES CONTENT (%)	TESTS AND REMARKS
0		ASPHALT (3 inches) over				
		Well graded GRAVEL with silt and sand, very dense, yellowish brown, moist, [Qva] (GW-GM)				
100			72	SPT-1 30 24 34	58	MC = 5% Fines = 7%
5			83	SPT-2 21 33 26	59	
95		Silty SAND with gravel, very dense, yellowish brown, wet, [Qva] (SM)	50	SPT-3 12 23 36	59	MC = 8%
10		Becomes wet to moist	0	SPT-4 13 50/3"	50/3"	
90						
15				SPT-5 18 29 23	52	
85						
20						

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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-144-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	TESTS AND REMARKS
20		Sandy lean CLAY, hard, brownish yellow, moist to wet, interbedded with silty SAND (SM), dense, yellowish brown, moist to wet, [Qva/Qgl] (CL)	39	SPT-6 14 16 18	● ▲ 34 ☐	MC = 22% Fines = 67%
80						
		Lean CLAY, hard, gray, moist, [Qgl] (CL)				
25				SPT-7 7 12 23	●⊢▲⊣ 35 ☐	MC = 22% LL = 43 PL = 26 Fines = 99%

Bottom of borehole at 26.5 feet.

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PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-145-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 5/26/20 **COMPLETED** 5/27/20 **GROUND ELEVATION** 98.6 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Holt Services **DRILL RIG** CME 85 ID: #7 **SPT HAMMER EFFICIENCY** 88%

DRILLING METHOD HSA **STATION (FT)** 5830+05.60 **OFFSET (FT)** 27.8 R

LOGGED BY Patricia Reed **CHECKED BY** H. Brenniman **NORTHING** 209401.74 **EASTING** 1307036.493

NOTES **GW LEVEL (ATD)** Dry

ELEVATION (ft) / DEPTH	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE (20 40 60 80) / PL MC LL / FINES CONTENT (%)	TESTS AND REMARKS
0	ASPHALT (3 inches) over Silty SAND with gravel, medium dense, light grayish brown, dry to moist, [Fill] (SM)				
95	Silty SAND, loose, yellowish brown, moist, with mixed bluish gray, with scattered organics, [Fill] (SM)	78	SPT-1 3 3 3	6	
5	Sandy SILT, loose, bluish gray, moist, with olive brown mottling, with scattered rootlets, [Qgl] (ML)	94	SPT-2 2 4 6	10	MC = 29% LL = 45 PL = 31 Fines = 60%
90	SILT with sand, medium dense, yellowish brown, moist, with scattered rootlets and reddish brown oxidized fracture with faint slickensides, [Qls/Qgl] (ML)	100	SPT-3 4 6 11	17	
10	Lean CLAY with sand, hard, brown, moist, mottled with bluish gray frequent whitish gray silt varves and faint slickensides, healed fracture, [Qls/Qgl] (CL)	100	SPT-4 6 16 21	37	MC = 19% LL = 44 PL = 23 Fines = 84%
85					
15	SILT with sand, dense, yellowish brown with gray, moist, mottled, chaotic structure, healed fracture zone, [Qls/Qgl] (ML)	100	SPT-5 5 17 25	42	MC = 19%
80					
20					

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4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-145-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	TESTS AND REMARKS
20		Silty SAND, dense, bluish gray, moist, with gray clasts throughout, disturbed, [Qls/Qgl] (SM)	100	SPT-6 9 12 15	▲ 27	
75						
25		Silty SAND, dense, dark bluish gray, moist, with silty fine SAND (SM) fracture infilling, healed fracture zone, [Qls/Qgl] (SM)		SPT-7 15 17 23	● ▲ ☐ 40	MC = 19% Fines = 50%

Bottom of borehole at 26.5 feet.

WSDOT GEOTECH DRILLING - I405 WSDOT.GDT - 2/8/21 09:49 - C:\USERS\CHELSEA.FOSTER\DOCUMENTS\PROJECTWISE\WORKINGDIR\WSDOT\DMS08722\I405 WSDOT - SEG.2.GPJ

wood.
4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-149-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 2/20/20 **COMPLETED** 2/20/20 **GROUND ELEVATION** 103.8 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Gregory Drilling **DRILL RIG** CME 55 ID: #310 **SPT HAMMER EFFICIENCY** 88%

DRILLING METHOD HSA **STATION (FT)** 5826+03.29 **OFFSET (FT)** 55.6 L

LOGGED BY Joe Fassio **CHECKED BY** H. Brenniman **NORTHING** 209251.163 **EASTING** 1306649.351

NOTES SEW Wall 09.90 L - Wall 1 **GW LEVEL (ATD)** Dry

ELEVATION (ft)	DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE (20 40 60 80) / PL MC LL / FINES CONTENT (%)	TESTS AND REMARKS
	0		ASPHALT (3 inches) over Well graded SAND with gravel, medium dense, grayish brown, moist, [FILL] Silty SAND, medium dense, light olive brown, moist, [FILL] (SM)				
100			Silty SAND, loose, light olive brown, moist, with interbedded silt layers (up to 3 inches in thickness), [FILL/Qls] (SM)	53	SPT-1 4 5 5	10	MC = 16% Fines = 43%
	5		Grades to silty SAND with gravel, brownish yellow, with scattered rootlets at 5 feet	53	SPT-2 3 3 2	5	MC = 10%
95			Clayey SAND, very loose, brownish yellow, moist, with scattered rootlets, [FILL/Qls] (SC)	53	SPT-3 2 1 3	4	MC = 18% LL = 21 PL = 17 Fines = 35%
	10		Sandy SILT, loose, brownish yellow, moist, with scattered black organics and rootlets, distubed at 10 feet. [FILL/Qls] (ML)	40	SPT-4 2 3 3	6	MC = 21% Fines = 52% Organic Content = 2.5%
90							
	15		Sandy lean CLAY, stiff, grayish brown, moist, blocky to fractured, [Qls/Qgl] (CL)	87	SPT-5 2 3 6	9	MC = 19% LL = 31 PL = 22 Fines = 62%
85							
	20						

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WSDOT GEOTECH DRILLING - I405 WSDOT.GDT - 7/9/20 08:43 - C:\USERS\CHELSEA.FOSTER\DOCUMENTS\PROJECTWISE\WORKINGDIR\WSDOT\DMS08721\I405 WSDOT - SEG. 1.GPJ

wood.
4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-149-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	TESTS AND REMARKS
20		Poorly graded SAND with silt, medium dense, light yellowish brown, moist, [Qva] (SP-SM)	80	SPT-6 7 7 7	14	MC = 6% Fines = 10%
80						
25		Silty SAND, dense, grayish brown, moist, [Qva] (SM)	67	SPT-7 9 13 13	26	MC = 18% Fines = 20%

Bottom of borehole at 26.5 feet.

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wood.
4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-150-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 2/20/20 **COMPLETED** 2/20/20 **GROUND ELEVATION** 96.0 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Gregory Drilling **DRILL RIG** CME 55 ID: #310 **SPT HAMMER EFFICIENCY** 88%

DRILLING METHOD HSA **STATION (FT)** 5828+06.91 **OFFSET (FT)** 50.1 L

LOGGED BY Joe Fassio **CHECKED BY** H. Brenniman **NORTHING** 209370.292 **EASTING** 1306824.13

NOTES **GW LEVEL (ATD)** Dry

ELEVATION (ft)	DEPTH	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE / PL MC LL / FINES CONTENT (%)	TESTS AND REMARKS
	0	ASPHALT (3 inches)				
95		Poorly graded GRAVEL with silt and sand, medium dense, grayish brown, moist, [FILL] (GP-GM)				
		Poorly graded SAND with silt, medium dense, grayish brown, moist, [FILL] (SP-SM)				
		Elastic SILT with sand, very stiff, light brown, moist, with slight mottling and fractured, [Qls/Qgl] (MH)	100	SPT-1 3 7 14	21	MC = 26% LL = 52 PL = 29 Fines = 85%
	5					
90		Lean CLAY, hard, light brown, moist, [Qgl] (CL)	100	SPT-2 7 13 21	34	MC = 21% Fines = 88%
		Fat CLAY, very stiff, light brown, moist, with reddish brown oxidation on fractures [Qls/Qgl] (CH)	100	SPT-3 5 9 13	22	MC = 25% LL = 61 PL = 26 Fines = 91%
	10					
85		Fat CLAY, very stiff, grayish brown, moist, [Qgl] (CH)	100	SPT-4 6 12 13	25	MC = 25% LL = 63 PL = 28 Fines = 93%
	15					
80		Lean CLAY, hard, gray, moist, [Qgl] (CL)	100	SPT-5 6 16 21	37	
	20					

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wood.
4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-150-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft)	DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE (20 40 60 80) / PL MC LL (20 40 60 80) / FINES CONTENT (%) (20 40 60 80)	TESTS AND REMARKS
	20		Lean CLAY with sand, hard, gray, moist, [Qgl] (CL)	100	SPT-6 6 15 21	36	MC = 21% LL = 40 PL = 19 Fines = 84%
75							
	25		Interval laminated with whitish gray silt varves	100	SPT-7 5 13 20	33	MC = 21% LL = 36 PL = 20 Fines = 98% Sample appears fissured, could be due to SPT sampling
70							
	30		Scattered gravel dropstones		SPT-8 9 13 13 18	31	MC = 24%
65							

Bottom of borehole at 31.5 feet.

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wood. 4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-151-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

DATE STARTED 2/24/20 **COMPLETED** 2/24/20 **GROUND ELEVATION** 87.2 ft NAVD88 **HOLE SIZE** 8 inches

DRILLING CONTRACTOR Gregory Drilling **DRILL RIG** CME 55 ID: #310 **SPT HAMMER EFFICIENCY** 88%

DRILLING METHOD HSA **STATION (FT)** 5830+30.96 **OFFSET (FT)** 46.7 L

LOGGED BY Sierra Sirmans **CHECKED BY** H Brenniman **NORTHING** 209479.048 **EASTING** 1307021.94

NOTES **GW LEVEL (ATD)** Dry

ELEVATION (ft)	DEPTH	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE (20 40 60 80) / PL MC LL / FINES CONTENT (%)	TESTS AND REMARKS
	0	Well graded GRAVEL with sand, medium dense, brown, dry, [FILL] (GW)				
		Silty SAND, dense, brownish gray, moist, [FILL] (SM)				
85			100	SPT-1 11 10 15	25	MC = 11% Fines = 37%
	5	Silty SAND, medium dense, dark brown, moist, with black organics [Qgl] (SM)	100	SPT-2 4 6 7	13	
80		Becomes dense	100	SPT-3 8 18 20	38	MC = 13% Fines = 44%
		SILT, dense, light yellowish brown, moist, [Qgl] (ML)				
	10		100	SPT-4 7 14 18	32	MC = 21%
75		Lean CLAY, very stiff, gray, moist, [Qgl] (CL)				
	15		100	SPT-5 5 10 16	26	MC = 19% LL = 34 PL = 20
70		Sandy SILT, medium dense, gray, moist, [Qgl] (ML)				
	20					

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wood. 4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-151-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	SPT N VALUE (20 40 60 80) / PL MC LL (20 40 60 80) / FINES CONTENT (%) (20 40 60 80)	TESTS AND REMARKS
20	Sandy SILT, medium dense, gray, moist, [Qgl] (ML) *(continued)*	100	SPT-6 12 8 14	22	MC = 21% Fines = 59%
65					
	Silty CLAY with sand, very stiff, gray, moist, [Qgl] (CL-ML)				
25		100	SPT-7 8 11 9	20	MC = 21% LL = 30 PL = 23 Fines = 82%
60					
	Silty clayey SAND, dense, gray, moist, [Qgl] (SC-SM)				
30		100	SPT-8 6 11 17	28	MC = 15% LL = 20 PL = 15 Fines = 43%
55					
35		100	SPT-9 6 11 16	27	
50					
	Sandy lean CLAY, hard, gray, moist, [Qgl] (CL)				
40		100	SPT-10 8 12 21	33	MC = 18% LL = 23 PL = 14 Fines = 54%
45					

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wood.
4020 Lake Washington Blvd Suite 200
Kirkland, WA 98033

PROJECT NAME I-405 Renton to Bellevue Widening **PROJECT NUMBER** 20316 **BORING NUMBER** W-151-20

CLIENT WSDOT **PROJECT LOCATION** Renton, WA

ELEVATION (ft) / DEPTH	GRAPHIC LOG	SOIL & ROCK DESCRIPTION	RECOVERY % (RQD)	SAMPLE TYPE NUMBER	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80	TESTS AND REMARKS
		Sandy lean CLAY, hard, gray, moist, [Qgl] (CL) *(continued)*				
45			100	SPT-11 9 15 21	● ▲ 36 ☐	MC = 20% Fines = 69%
40						
50			100	SPT-12 12 19 24	▲ 43	

Bottom of borehole at 51.5 feet.

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APPENDIX E
HISTORIC LABORATORY DATA

W-106mw-20, W-143-20, W-144-20. W-145-20, W-149-20

PointID	PointID (Historic, WSDOT R2B, WOOD)	Top Depth (ft)	Sample Number	Blow Counts[1]			Length[1]			Field N	USCS from Lab	Lab Description	Estimated USCS	Water Content (%)	Atterberg Limits			Total Wet Unit Weight	Estimated Total Unit Weight (pcf)	Dry Density (pcf)	Specific Gravity	Sieve analysis					% Organics
				1	2	3	1	2	3						Liquid Limit	Plastic Limit	Plasticity Index					% Gravel	% Sand	Fines Content From Lab	% Silt	% Clay	
W-106mw-20	WOOD	2.5	SPT-1	3	4	6	6	6	6	10	SM		SM	--	--	--	--	--	--	--	--	1.0	58.0	41.0	--	--	--
W-106mw-20	WOOD	5	SPT-2A	4	5	6	6	6	6	11	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-106mw-20	WOOD	6	SPT-2B								SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-106mw-20	WOOD	7.5	SPT-3	6	10	13	6	6	6	23	CL	Lean CLAY (CL)	CL	--	29	22	7	--	--	--	--	0.1	23.0	76.9	66.7	10.2	--
W-106mw-20	WOOD	10	SPT-4	6	16	27	6	6	6	43	ML		ML	--	--	--	--	--	--	--	--	0.0	19.8	80.2	--	--	--
W-106mw-20	WOOD	15	SPT-5	14	24	26	6	6	6	50	SM		SM	--	--	--	--	--	--	--	--	0.1	69.7	30.2	--	--	--
W-106mw-20	WOOD	20	SPT-6	4	17	23	6	6	6	40	CL	Lean CLAY (CL)	CL	--	31	22	9	--	--	--	--	4.8	6.7	88.5	77.4	11.1	--
W-106mw-20	WOOD	25	SPT-7	9	19	34	6	6	6	53	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-106mw-20	WOOD	30	SPT-8	14	22	34	6	6	6	56	CL	Lean CLAY (CL)	CL	--	32	23	9	--	--	--	--	0.4	21.3	78.3	70.3	8	--
W-106mw-20	WOOD	35	SPT-9	7	21	28	6	6	6	49	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-106mw-20	WOOD	40	SPT-10	10	22	24	6	6	6	46	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-106mw-20	WOOD	45	SPT-11	13	34	42	6	6	6	76	SW-SM		SW-SM	--	--	--	--	--	--	--	--	19.8	68.9	11.3	--	--	--
W-106mw-20	WOOD	50	SPT-12	21	34	50	6	6	5.5	88	GW		GW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-142-20	WOOD	2.5	SPT-1	12	28	25	6	6	6	53	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-142-20	WOOD	5	SPT-2	28	15	25	6	6	6	40	CL	Lean CLAY (CL)	CL	--	48	19	29	--	--	--	--	--	--	77.8	--	--	--
W-142-20	WOOD	7.5	SPT-3	10	23	34	6	6	6	57	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-142-20	WOOD	10	SPT-4	19	24	43	6	6	6	67	CL	Lean CLAY (CL)	CL	--	46	26	20	--	--	--	--	--	--	85.3	--	--	--
W-142-20	WOOD	15	SPT-5	10	22	19	6	6	6	41	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-142-20	WOOD	20	SPT-6	22	50		6	4		150	GM		GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-142-20	WOOD	25	SPT-7	19	35	50	6	6	6	85	SM		SM	--	--	--	--	--	--	--	--	--	--	30.1	--	--	--
W-143-20	WOOD	2.5	SPT-1	15	12	8	6	6	6	20	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-143-20	WOOD	5	SPT-2	6	4	2	6	6	6	6	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-143-20	WOOD	7.5	SPT-3	6	8	9	6	6	6	17	SM	Silty SAND (SM)	SM	--	NP	NP	--	--	--	--	--	0.4	82.8	16.8	--	--	--
W-143-20	WOOD	10	SPT-4	6	10	12	6	6	6	22	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-143-20	WOOD	15	SPT-5	7	13	19	6	6	6	32	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-143-20	WOOD	20	SPT-6	10	24	24	6	6	6	48	CL	Lean CLAY (CL)	CL	--	25	15	10	--	--	--	--	--	--	61.0	--	--	--
W-143-20	WOOD	25	SPT-7	10	14	23	6	6	6	37	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-144-20	WOOD	2.5	SPT-1	30	24	34	6	6	6	58	GW-GM		GW-GM	--	--	--	--	--	--	--	--	50.8	41.7	7.5	--	--	--
W-144-20	WOOD	5	SPT-2	21	33	26	6	6	6	59	GW-GM		GW-GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-144-20	WOOD	7.5	SPT-3	12	23	36	6	6	6	59	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-144-20	WOOD	10	SPT-4	13	50		6	3		200	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-144-20	WOOD	15	SPT-5	18	29	23	6	6	6	52	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-144-20	WOOD	20	SPT-6	14	16	18	6	6	6	34	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-144-20	WOOD	25	SPT-7	7	12	23	6	6	6	35	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-145-20	WOOD	2.5	SPT-1	3	3	3	6	6	6	6	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-145-20	WOOD	5	SPT-2	2	4	6	6	6	6	10	ML	Silt (ML)	ML	--	45	31	14	--	--	--	--	0.0	40.4	59.6	--	--	--
W-145-20	WOOD	7.5	SPT-3	4	6	11	6	6	6	17	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-145-20	WOOD	10	SPT-4	6	16	21	6	6	6	37	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-145-20	WOOD	15	SPT-5	5	17	25	6	6	6	42	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-145-20	WOOD	20	SPT-6	9	12	15	6	6	6	27	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-145-20	WOOD	25	SPT-7	15	17	23	6	6	6	40	SM		SM	--	--	--	--	--	--	--	--	--	--	49.5	--	--	--
W-146-20	WOOD	2.5	SPT-1	6	8	12	6	6	6	20	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-146-20	WOOD	5	SPT-2	25	21	19	6	6	6	40	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-146-20	WOOD	7.5	SPT-3	6	16	14	6	6	6	30	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-146-20	WOOD	10	SPT-4	6	7	6	6	6	6	13	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-146-20	WOOD	15	SPT-5	6	8	7	6	6	6	15	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-146-20	WOOD	20	SPT-6	1	1	2	6	6	6	3	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-146-20	WOOD	25	SPT-7	5	2	1	6	6	6	3	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-149-20	WOOD	2.5	SPT-1	4	5	5	6	6	6	10	SM		SM	16	--	--	--	--	--	--	--	3.4	53.7	42.8	--	--	--
W-149-20	WOOD	5	SPT-2	3	3	2	6	6	6	5	SM		SM	10	--	--	--	--	--	--	--	--	--	--	--	--	--
W-149-20	WOOD	7.5	SPT-3	2	1	3	6	6	6	4	SC	Silty, Clayey SAND (SC-SM)	SC	18	21	17	4	--	--	--	--	--	--	34.9	--	--	--
W-149-20	WOOD	10	SPT-4	2	3	3	6	6	6	6	ML		ML	21	--	--	--	--	--	--	--	--	--	52.0	--	--	--
W-149-20	WOOD	15	SPT-5	2	3	6	6	6	6	9	CL	Lean CLAY (CL)	CL	19	31	22	9	--	--	--	--	--	--	62.5	--	--	--
W-149-20	WOOD	20	SPT-6	7	7	7	6	6	6	14	SP-SM		SP-SM	6	--	--	--	--	--	--	--	0.1	89.6	10.2	--	--	--
W-149-20	WOOD	25	SPT-7	9	13	13	6	6	6	26	SM		SM	--	--	--	--	--	--	--	--	--	--	20.0	--	--	--

PointID	PointID (Historic, WSDOT R2B, WOOD)	Top Depth (ft)	Sample Number	Blow Counts[1]			Length[1]			Field N	USCS from Lab	Lab Description	Estimated USCS	Water Content (%)	Atterberg Limits			Total Wet Unit Weight	Estimated Total Unit Weight (pcf)	Dry Density (pcf)	Specific Gravity	Sieve analysis					% Organics
				1	2	3	1	2	3						Liquid Limit	Plastic Limit	Plasticity Index					% Gravel	% Sand	Fines Content From Lab	% Silt	% Clay	
W-150-20	WOOD	2.5	SPT-1	3	7	14	6	6	6	21	MH	Elastic SILT (MH)	MH	26	52	29	23	--	--	--	--	--	--	85.0	--	--	--
W-150-20	WOOD	5	SPT-2	7	13	21	6	6	6	34	MH		MH	21	--	--	--	--	--	--	--	--	--	--	--	--	--
W-150-20	WOOD	7.5	SPT-3	5	9	13	6	6	6	22	CH	Fat CLAY (CH)	CH	25	61	26	35	--	--	--	--	--	--	90.7	--	--	--
W-150-20	WOOD	10	SPT-4	6	12	13	6	6	6	25	CH	Fat CLAY (CH)	CH	25	63	28	35	--	--	--	--	--	--	93.2	--	--	--
W-150-20	WOOD	15	SPT-5	6	16	21	6	6	6	37	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-150-20	WOOD	20	SPT-6	6	15	21	6	6	6	36	CL	Lean CLAY (CL)	CL	21	40	19	21	--	--	--	--	--	--	84.4	--	--	--
W-150-20	WOOD	25	SPT-7	5	13	20	6	6	6	33	CL		CL	18	--	--	--	--	--	--	--	--	--	--	--	--	--
W-150-20	WOOD	30	SPT-8	9	13	18	6	6	6	31	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	2.5	SPT-1	11	10	15	6	6	6	25	SM		SM	11	--	--	--	--	--	--	--	4.2	58.9	36.9	--	--	--
W-151-20	WOOD	5	SPT-2	4	6	7	6	6	6	13	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	7.5	SPT-3	8	18	20	6	6	6	38	SM		SM	13	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	10	SPT-4	7	14	18	6	6	6	32	ML		ML	21	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	15	SPT-5	5	10	16	6	6	6	26	CL		CL	19	34	20	14	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	20	SPT-6	12	8	14	6	6	6	22	ML		ML	21	--	--	--	--	--	--	--	0.4	41.1	58.5	--	--	--
W-151-20	WOOD	25	SPT-7	8	11	9	6	6	6	20	CL-ML	Lean CLAY (CL)	CL-ML	21	30	23	7	--	--	--	--	--	--	81.5	--	--	--
W-151-20	WOOD	30	SPT-8	6	11	17	6	6	6	28	SC-SM	Clayey SAND (SC)	SC-SM	--	20	15	5	--	--	--	--	0.1	56.6	43.3	--	--	--
W-151-20	WOOD	35	SPT-9	6	11	16	6	6	6	27	SC-SM		SC-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	40	SPT-10	8	12	21	6	6	6	33	CL	Lean CLAY (CL)	CL	--	23	14	9	--	--	--	--	--	--	54.4	--	--	--
W-151-20	WOOD	45	SPT-11	9	15	21	6	6	6	36	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	50	SPT-12	12	19	24	6	6	6	43	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	2.5	SPT-1	6	7	8	6	6	6	15	GP-GM		GP-GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	5	SPT-2	3	4	6	6	6	6	10	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	7.5	SPT-3	3	1	2	6	6	6	3	SM		SM	16	--	--	--	--	--	--	--	9.0	75.0	16.0	--	--	--
W-27-20	WOOD	10	SPT-4	1	1	1	6	6	6	2	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	15	SPT-5	3	5	8	6	6	6	13	ML		ML	--	--	--	--	--	--	--	--	0.0	48.0	52.0	--	--	--
W-28-20	WOOD	2.5	SPT-1	5	5	4	6	6	6	9	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	5	SPT-2	5	4	3	6	6	6	7	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	7.5	SPT-3A	4	4	2	6	6	6	6	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	8.5	SPT-3B								CL		CL	26	40	22	18	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	10	SPT-4	3	4	3	6	6	6	7	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	15	SPT-5	3	3	4	6	6	6	7	SM		SM	13	--	--	--	--	--	--	--	11.0	43.0	46.0	--	--	--
W-29-20	WOOD	2.5	SPT-1	4	5	4	6	6	6	9	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	5	SPT-2	3	5	6	6	6	6	11	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	7.5	SPT-3	3	4	4	6	6	6	8	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	10	SPT-4	4	4	4	6	6	6	8	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	15	SPT-5	3	4	4	6	6	6	8	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	2.5	SPT-1	3	4	7	6	6	6	11	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	5	SPT-2	3	7	8	6	6	6	15	ML	Silt (ML)	ML	29	40	27	13	--	--	--	--	0.0	0.9	99.1	99.1	0.0	--
W-34-20	WOOD	7.5	SPT-3	3	7	8	6	6	6	15	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	10	SPT-4	4	10	15	6	6	6	25	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	15	SPT-5	5	10	11	6	6	6	21	CL		CL	--	38	23	15	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	2.5	SPT-1	10	19	7	6	6	6	26	GP-GM		GP-GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	5	SPT-2	2	4	9	6	6	6	13	CL		CL	--	30	19	11	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	7.5	SPT-3	7	12	20	6	6	6	32	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	10	SPT-4	4	13	18	6	6	6	31	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	15	SPT-5	4	21	32	6	6	6	53	SP-SM		SP-SM	33	--	--	--	--	--	--	--	--	--	--	--	--	--

W-29-20

PointID	PointID (Historic, WSDOT R2B, WOOD)	Top Depth (ft)	Sample Number	Blow Counts[1]			Length[1]			Field N	USCS from Lab	Lab Description	Estimated USCS	Water Content (%)	Atterberg Limits			Total Wet Unit Weight	Estimated Total Unit Weight (pcf)	Dry Density (pcf)	Specific Gravity	Sieve analysis					% Organics
				1	2	3	1	2	3						Liquid Limit	Plastic Limit	Plasticity Index					% Gravel	% Sand	Fines Content From Lab	% Silt	% Clay	
W-150-20	WOOD	2.5	SPT-1	3	7	14	6	6	6	21	MH	Elastic SILT (MH)	MH	26	52	29	23	--	--	--	--	--	--	85.0	--	--	--
W-150-20	WOOD	5	SPT-2	7	13	21	6	6	6	34	MH		MH	21	--	--	--	--	--	--	--	--	--	--	--	--	--
W-150-20	WOOD	7.5	SPT-3	5	9	13	6	6	6	22	CH	Fat CLAY (CH)	CH	25	61	26	35	--	--	--	--	--	--	90.7	--	--	--
W-150-20	WOOD	10	SPT-4	6	12	13	6	6	6	25	CH	Fat CLAY (CH)	CH	25	63	28	35	--	--	--	--	--	--	93.2	--	--	--
W-150-20	WOOD	15	SPT-5	6	16	21	6	6	6	37	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-150-20	WOOD	20	SPT-6	6	15	21	6	6	6	36	CL	Lean CLAY (CL)	CL	21	40	19	21	--	--	--	--	--	--	84.4	--	--	--
W-150-20	WOOD	25	SPT-7	5	13	20	6	6	6	33	CL		CL	18	--	--	--	--	--	--	--	--	--	--	--	--	--
W-150-20	WOOD	30	SPT-8	9	13	18	6	6	6	31	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	2.5	SPT-1	11	10	15	6	6	6	25	SM		SM	11	--	--	--	--	--	--	--	4.2	58.9	36.9	--	--	--
W-151-20	WOOD	5	SPT-2	4	6	7	6	6	6	13	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	7.5	SPT-3	8	18	20	6	6	6	38	SM		SM	13	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	10	SPT-4	7	14	18	6	6	6	32	ML		ML	21	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	15	SPT-5	5	10	16	6	6	6	26	CL		CL	19	34	20	14	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	20	SPT-6	12	8	14	6	6	6	22	ML		ML	21	--	--	--	--	--	--	--	0.4	41.1	58.5	--	--	--
W-151-20	WOOD	25	SPT-7	8	11	9	6	6	6	20	CL-ML	Lean CLAY (CL)	CL-ML	21	30	23	7	--	--	--	--	--	--	81.5	--	--	--
W-151-20	WOOD	30	SPT-8	6	11	17	6	6	6	28	SC-SM	Clayey SAND (SC)	SC-SM	--	20	15	5	--	--	--	--	0.1	56.6	43.3	--	--	--
W-151-20	WOOD	35	SPT-9	6	11	16	6	6	6	27	SC-SM		SC-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	40	SPT-10	8	12	21	6	6	6	33	CL	Lean CLAY (CL)	CL	--	23	14	9	--	--	--	--	--	--	54.4	--	--	--
W-151-20	WOOD	45	SPT-11	9	15	21	6	6	6	36	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-151-20	WOOD	50	SPT-12	12	19	24	6	6	6	43	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	2.5	SPT-1	6	7	8	6	6	6	15	GP-GM		GP-GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	5	SPT-2	3	4	6	6	6	6	10	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	7.5	SPT-3	3	1	2	6	6	6	3	SM		SM	16	--	--	--	--	--	--	--	9.0	75.0	16.0	--	--	--
W-27-20	WOOD	10	SPT-4	1	1	1	6	6	6	2	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-27-20	WOOD	15	SPT-5	3	5	8	6	6	6	13	ML		ML	--	--	--	--	--	--	--	--	0.0	48.0	52.0	--	--	--
W-28-20	WOOD	2.5	SPT-1	5	5	4	6	6	6	9	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	5	SPT-2	5	4	3	6	6	6	7	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	7.5	SPT-3A	4	4	2	6	6	6	6	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	8.5	SPT-3B								CL		CL	26	40	22	18	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	10	SPT-4	3	4	3	6	6	6	7	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-28-20	WOOD	15	SPT-5	3	3	4	6	6	6	7	SM		SM	13	--	--	--	--	--	--	--	11.0	43.0	46.0	--	--	--
W-29-20	WOOD	2.5	SPT-1	4	5	4	6	6	6	9	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	5	SPT-2	3	5	6	6	6	6	11	SP-SM		SP-SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	7.5	SPT-3	3	4	4	6	6	6	8	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	10	SPT-4	4	4	4	6	6	6	8	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-29-20	WOOD	15	SPT-5	3	4	4	6	6	6	8	SM		SM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	2.5	SPT-1	3	4	7	6	6	6	11	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	5	SPT-2	3	7	8	6	6	6	15	ML	Silt (ML)	ML	29	40	27	13	--	--	--	--	0.0	0.9	99.1	99.1	0.0	--
W-34-20	WOOD	7.5	SPT-3	3	7	8	6	6	6	15	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	10	SPT-4	4	10	15	6	6	6	25	CL		CL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-34-20	WOOD	15	SPT-5	5	10	11	6	6	6	21	CL		CL	--	38	23	15	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	2.5	SPT-1	10	19	7	6	6	6	26	GP-GM		GP-GM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	5	SPT-2	2	4	9	6	6	6	13	CL		CL	--	30	19	11	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	7.5	SPT-3	7	12	20	6	6	6	32	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	10	SPT-4	4	13	18	6	6	6	31	ML		ML	--	--	--	--	--	--	--	--	--	--	--	--	--	--
W-35-20	WOOD	15	SPT-5	4	21	32	6	6	6	53	SP-SM		SP-SM	33	--	--	--	--	--	--	--	--	--	--	--	--	--

Job No. **XL-4653** Date **May 7, 2018**

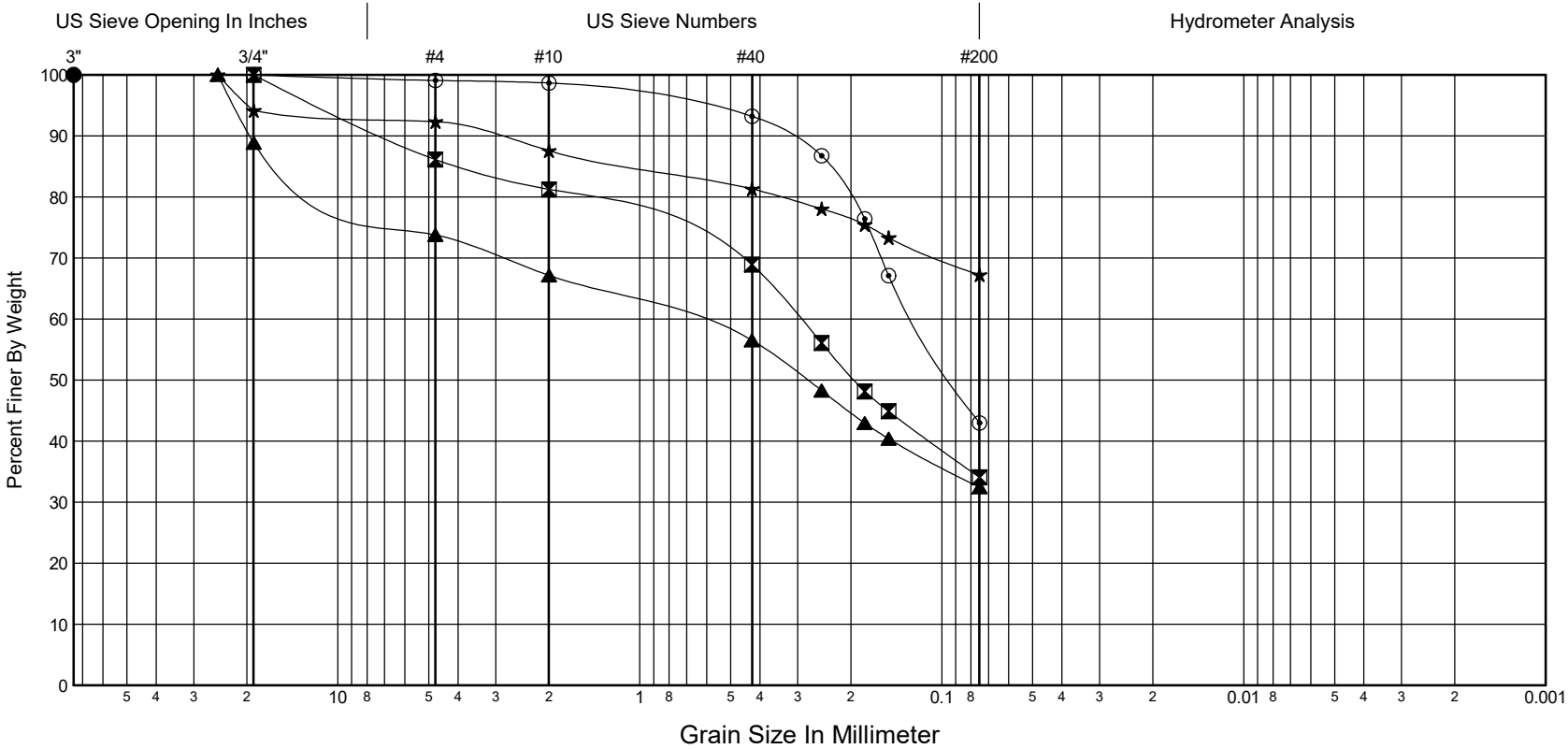
Hole No. **R2B-81vw-17** Sheet **1**

Project **I-405 Renton to Bellevue - ETL - Envir & Traff**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	8.0	D-3		MC & AL Only	18	18	15	3												
⊠	11.0	D-4	SM	SILTY SAND	10	NA	NP	NA			13.9	52.1	34.0			0.294	0.19			
▲	33.0	D-9	SM	SILTY SAND with GRAVEL	10	16	15	1			26.2	41.3	32.4			0.705	0.28			
★	53.0	D-13	CL	SANDY LEAN CLAY	13	30	19	11			7.7	25.1	67.2							
⊙	68.0	D-16	SM	SILTY SAND	19	NA	NP	NA			0.9	56.1	43.0			0.122	0.09			



Gravel	Sand			Silt			Clay
	Coarse	Medium	Fine	Coarse	Medium	Fine	

XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ PUBLIC-COMMON LIBRARY.GLB 5/7/18

Job No. **XL-4653** Date **May 7, 2018**

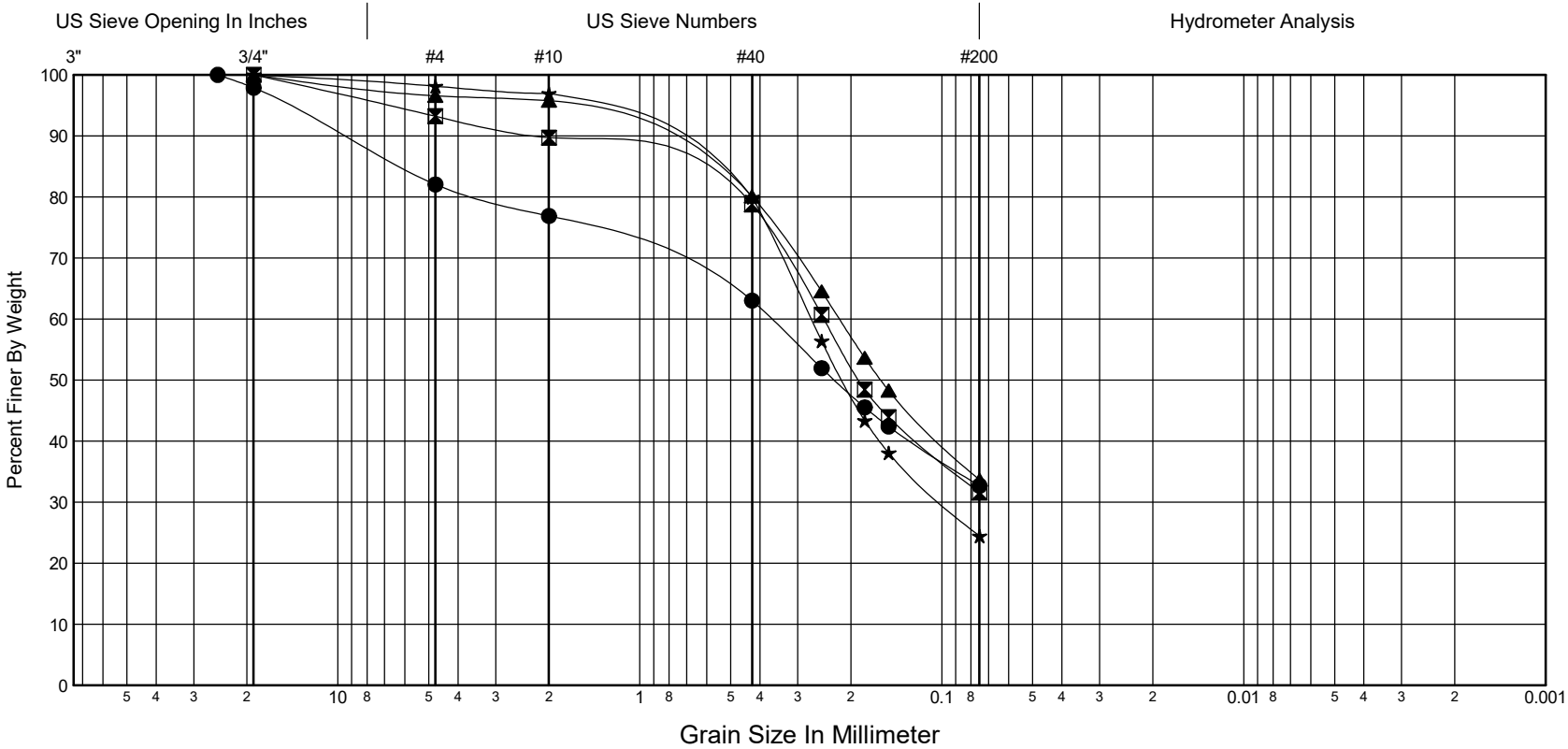
Hole No. **R2B-79-17** Sheet **1**

Project **I-405 Renton to Bellevue - ETL - Envir & Traff**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	8.0	D-3	SM	SILTY SAND with GRAVEL	13	NA	NP	NA			17.9	49.4	32.7			0.368	0.23			
⊠	25.0	D-8	SM	SILTY SAND	14	NA	NP	NA			6.8	61.7	31.6			0.245	0.19			
▲	30.0	D-9	SM	SILTY SAND with Organics	42	NA	NP	NA			3.4	62.9	33.6			0.218	0.16			
★	65.0	D-16	SM	SILTY SAND	25	NA	NP	NA			1.9	73.7	24.4			0.271	0.21	0.10		



Gravel	Sand			Silt			Clay
	Coarse	Medium	Fine	Coarse	Medium	Fine	

XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ PUBLIC-COMMON LIBRARY.GLB 5/7/18

Job No. **XL-4653** Date **May 7, 2018**

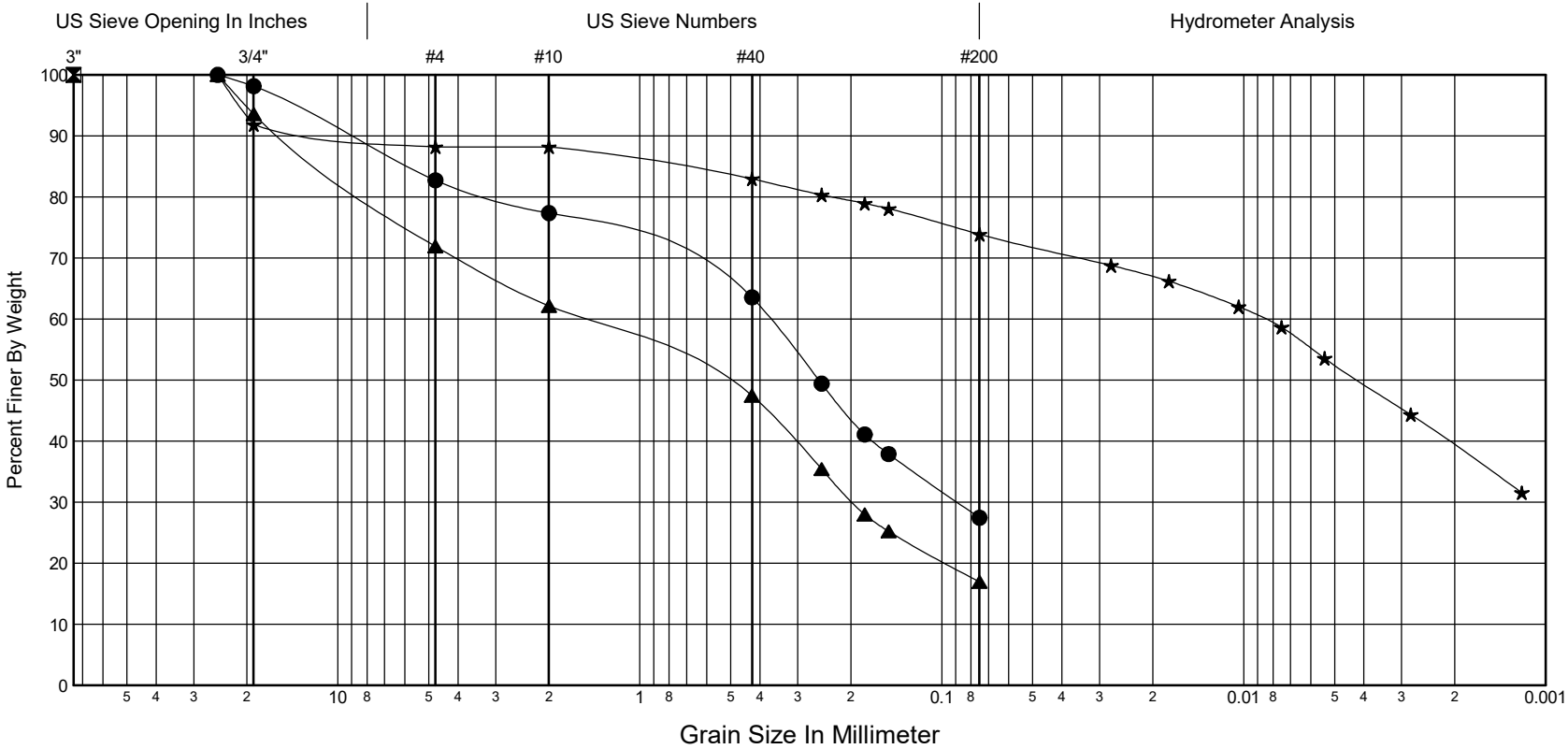
Hole No. **R2B-78-17** Sheet **1**

Project **I-405 Renton to Bellevue - ETL - Envir & Traff**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	7.0	D-2	SM	SILTY SAND with GRAVEL	17						17.3	55.3	27.4			0.372	0.26	0.09		
⧗	12.0	D-4		MC & LOI Only	30															
▲	34.5	D-9	SM	SILTY SAND with GRAVEL	12	NA	NP	NA			28.1	55.0	16.9			1.593	0.56	0.20	0.10	
★	64.0	D-15	ML	SILT with SAND	26	42	30	12		2.73	11.8	14.3	73.9			0.009	0.00			



Gravel	Sand			Silt			Clay
	Coarse	Medium	Fine	Coarse	Medium	Fine	

XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ PUBLIC-COMMON LIBRARY.GLB 5/7/18

Job No. **XL-4653** Date **May 8, 2018**

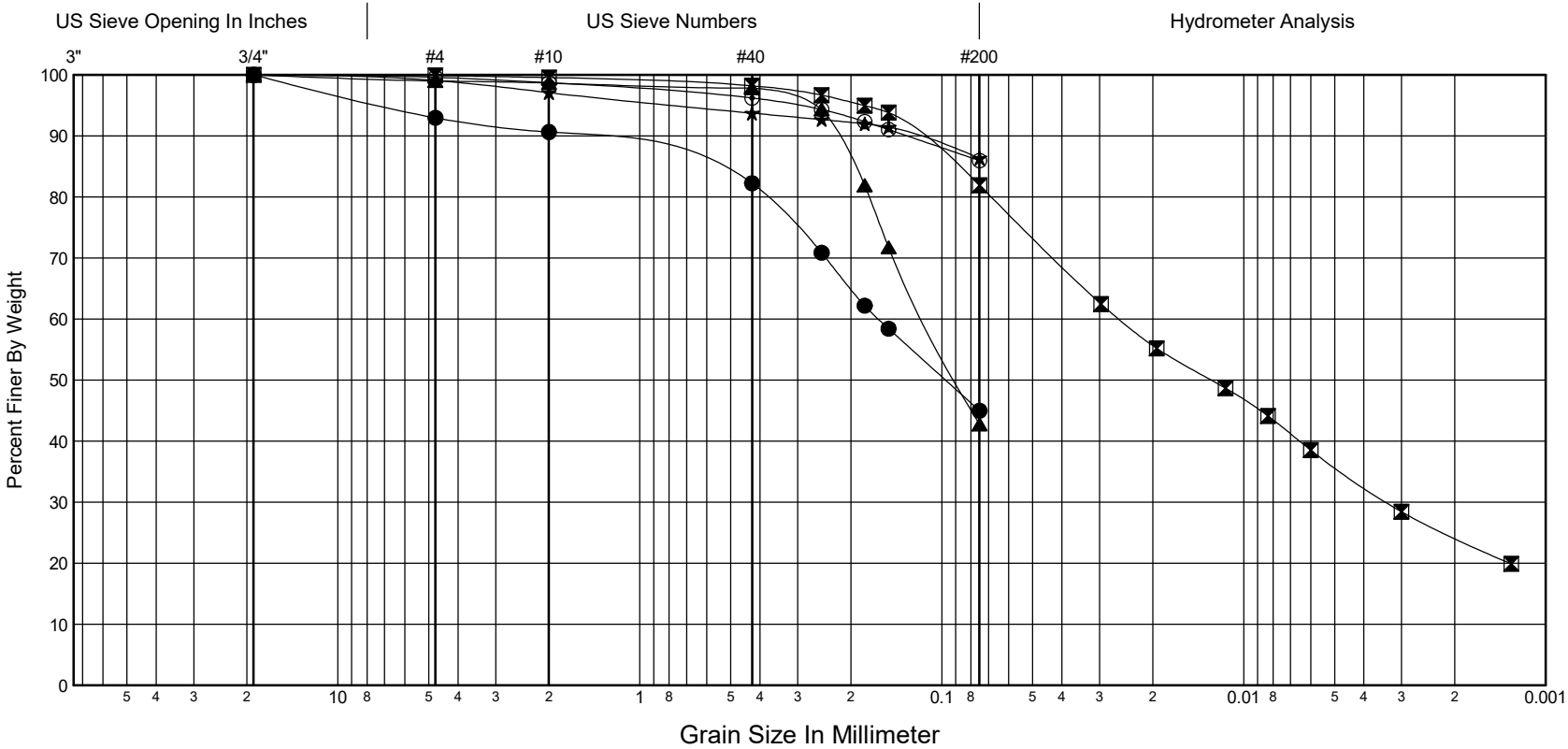
Hole No. **R2B-77vw-17** Sheet **1**

Project **I-405 Renton to Bellevue - ETL - Envir & Traff**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	7.0	D-2	SM	SILTY SAND	18	NA	NP	NA			7.0	48.0	45.0			0.162	0.10			
⧗	24.0	D-7	CL	LEAN CLAY with SAND	27	29	20	9		2.68	0.1	18.0	81.9			0.026	0.01	0.00	0.00	
▲	29.0	D-8	SM	SILTY SAND	24	NA	NP	NA			1.0	56.3	42.7			0.113	0.09			
★	44.0	D-11	ML	SILT	21	42	28	14			0.9	12.7	86.3							
⊙	64.0	D-15	CL-ML	SILTY CLAY	24	28	22	6			0.4	13.6	86.0							



Gravel	Sand			Silt			Clay
	Coarse	Medium	Fine	Coarse	Medium	Fine	

XL-5467 (OLD XL-4653) 405 RENTON TO BELLEVUE ETL - ENVIRO AND TRAFF.GPJ PUBLIC-COMMON LIBRARY.GLB 5/8/18

Job No.	**XL-2067**	Date	**December 6, 2006**
Hole No.	**KP-3-06**	Sheet	**1** of **2**
Project	**112th Ave SE I/C to SE 8th Street I/C**		

Laboratory Summary

Washington State Department of Transportation

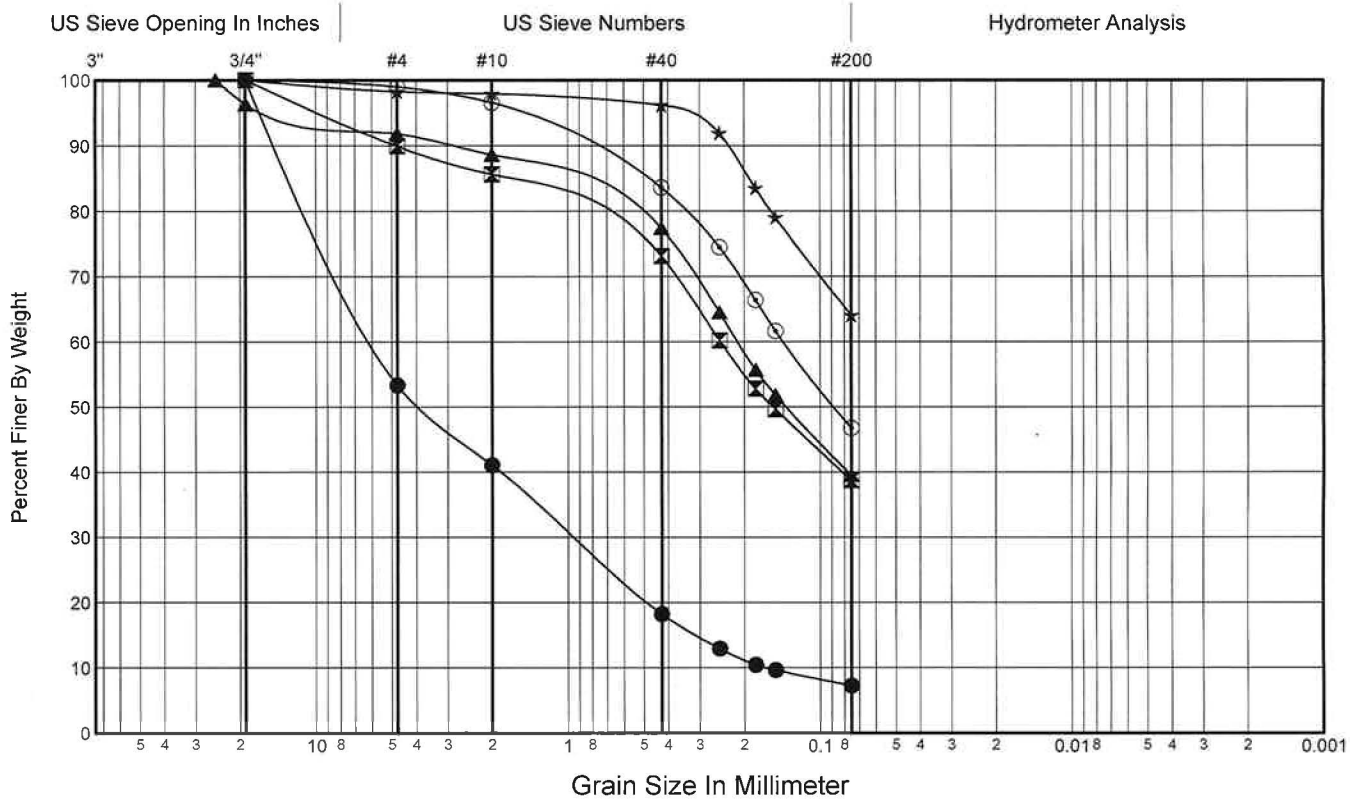
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**2.5**	**0.76**	**D-1**	**GP-GM**	**See Boring Log**	**POORLY GRADED GRAVEL with SILT and SAND**	**6**			
⊠	**10.0**	**3.05**	**D-4**	**SM**	**See Boring Log**	**SILTY SAND**	**12**	**14**	**NP**	**NA**
▲	**20.0**	**6.10**	**D-8**	**SM**	**See Boring Log**	**SILTY SAND**	**15**			
★	**35.0**	**10.67**	**D-11A**	**ML**	**See Boring Log**	**SANDY SILT**	**46**	**37**	**28**	**9**
⊙	**36.0**	**10.97**	**D-11B**	**SM**	**See Boring Log**	**SILTY SAND**	**51**			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**46.7**	**46.1**	**7.2**	**0.9**	**35.4**
⊠	**10.1**	**51.2**	**38.7**		
▲	**8.2**	**52.3**	**39.5**		
★	**1.7**	**34.2**	**64.1**		
⊙	**1.0**	**52.2**	**46.7**		

GRADATION VALUES

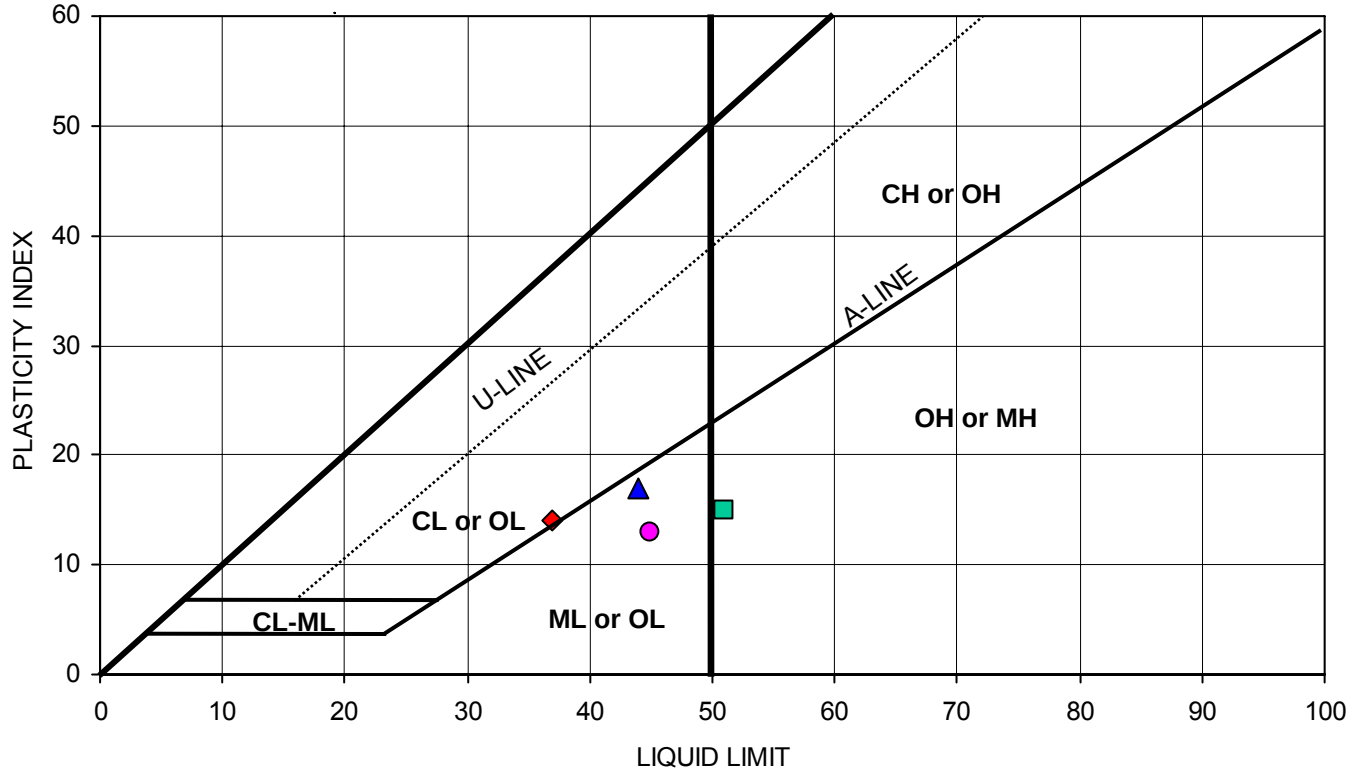
	D60	D50	D30	D20	D10
●	**5.791**	**3.76**	**0.94**	**0.48**	**0.163**
⊠	**0.248**	**0.15**			
▲	**0.211**	**0.14**			
★					
⊙	**0.139**	**0.09**			



Gravel	Sand			Silt and Clay
	Coarse	Medium	Fine	

GEOENGINEERS

PLASTICITY CHART



SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOIL DESCRIPTION
◆	GEO-34	20.0	34	37	12	Gray lean clay (CL)
■	GEO-36	12.5	26	51	10	Brown organic silt (OH)
▲	GEO-37	15.0	40	44	48	Gray silt with organics (ML)
●	GEO-38	12.5	38	45	51	Gray silt with organics (ML)

ATTERBERG LIMITS TEST RESULTS

FIGURE B-38

APPENDIX F
SPECTRA OUTPUT

BEToolbox™

Spectra

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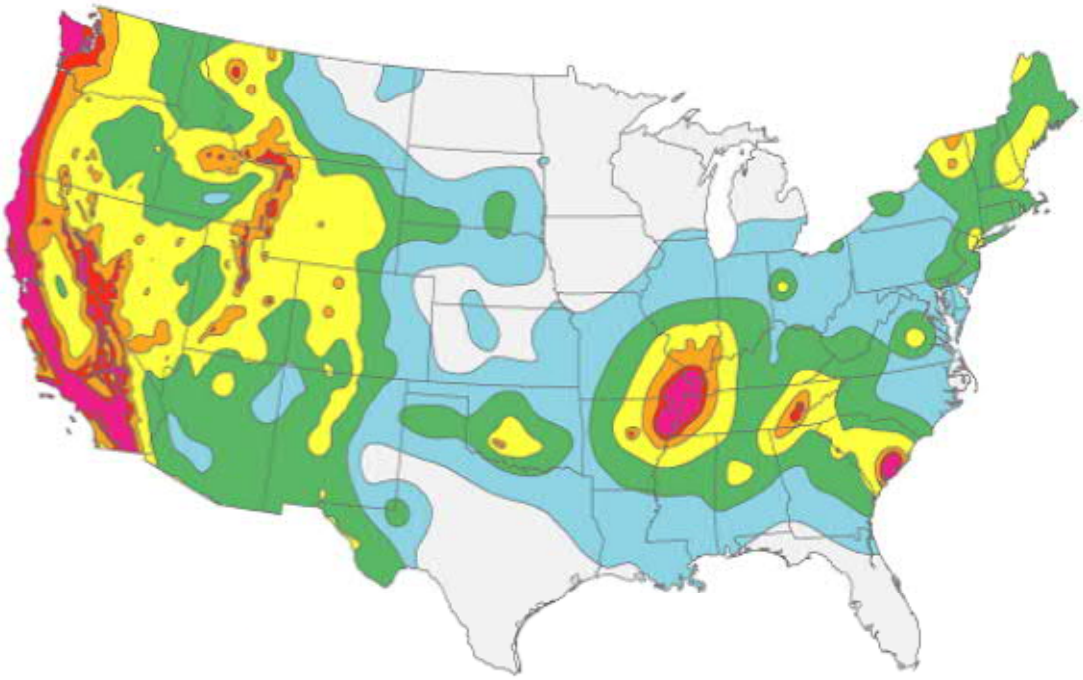
Version 6.1.0 - Built on May 12 2021



WSDOT Bridge Design Manual
2014 Seismic Hazard Map, 7% probability of exceedance in 75 years

Site Coordinates (Latitude,Longitude): 47.568° N, 122.18° W
Site Soil Classification: Site Class D - Stiff Soil

Seismic hazard maps are for sites at the boundary of Site Classes B and C, which is $\bar{v}_s$ = 2500 ft/s (760 m/s). Adjustments for other Site Classes are made as needed.

Period (sec)	Sa (g)	
0.0	0.425	PGA - Site Class B/C Boundary
0.2	0.967	S_s - Site Class B/C Boundary
1.0	0.280	S_1 - Site Class B/C Boundary

Values of Site Coefficient, F_{pga}, for Peak Ground Acceleration

Site Class	Mapped Peak Ground Acceleration Coefficient (PGA)					
	PGA≤ 0.10	PGA= 0.20	PGA= 0.30	PGA= 0.40	PGA= 0.50	PGA≥ 0.60
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.2	1.2	1.2	1.2	1.2
D	1.6	1.4	1.3	1.2	1.1	1.1
E	2.4	1.9	1.6	1.4	1.2	1.1

For Site Class D, F_{pga} = 1.175

Values for Site Coefficient, F_a, for 0.2 sec Period Spectral Acceleration

Site Class	Mapped Spectral Acceleration Coefficient at Period 0.2 sec (S_s)					
	S_s≤ 0.25	S_s= 0.50	S_s= 0.75	S_s= 1.00	S_s= 1.25	S_s≥ 1.50
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.3	1.2	1.2	1.2	1.2
D	1.6	1.4	1.2	1.1	1.0	1.0
E	2.4	1.7	1.3	1.0	0.9	0.9

For Site Class D, F_a = 1.113

Values of Site Coefficient, F_v, for 1.0 sec Period Spectral Acceleration

Site Class	Mapped Spectral Acceleration Coefficient at Period 1.0 sec (S_1)					
	S_1≤ 0.1	S_1= 0.2	S_1= 0.3	S_1= 0.4	S_1= 0.5	S_1≥ 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	2.0	1.9	1.8	1.7
E	4.2	3.3	2.8	2.4	2.2	2.0

For Site Class D, F_v = 2.040

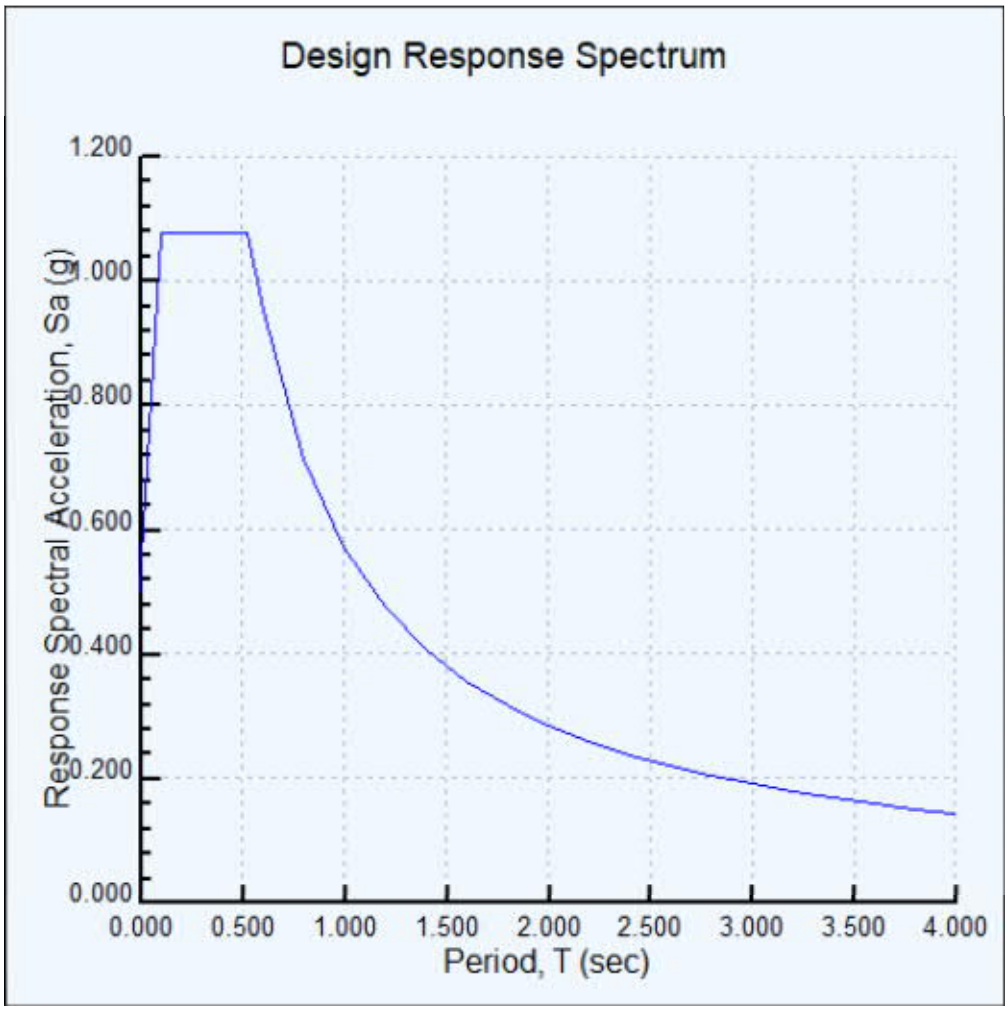
$A_s = F_{pga}$ PGA = (1.175)(0.425g) = 0.500g
$S_{DS} = F_a S_s$ = (1.113)(0.967g) = 1.077g
$S_{D1} = F_v S_1$ = (2.040)(0.280g) = 0.571g
$T_o = 0.2T_s$ = (0.2)(0.530) = 0.106 sec
$T_s = S_{D1}/S_{DS}$ = (0.571)/(1.077) = 0.530 sec

Partitions for Seismic Design Categories A, B, C, and D

S_{D1}	SDC
$S_{D1} < 0.15$	A
$0.15 \le S_{D1} < 0.30$	B
$0.30 \le S_{D1} < 0.50$	C
$0.50 \le S_{D1}$	D

Seismic Design Category (SDC) = D

Period, T (sec)	Sa (g)	
0.000	0.500	
0.106	1.077	T_o
0.200	1.077	
0.400	1.077	
0.530	1.077	T_s
0.600	0.952	
0.800	0.714	
1.000	0.571	
1.200	0.476	
1.400	0.408	
1.600	0.357	
1.800	0.317	
2.000	0.285	
2.200	0.260	
2.400	0.238	
2.600	0.220	
2.800	0.204	
3.000	0.190	
3.200	0.178	
3.400	0.168	
3.600	0.159	
3.800	0.150	
4.000	0.143	



APPENDIX G
WALLS 9.90L-A AND 9.90L-B CALCULATIONS PACKAGES

PURPOSE:

To calculate minimum strap lengths of MSE wall required to provide adequate capacity demand ratio (CDR) against bearing, sliding, overturning, global stability failures and calculate settlement using LRFD Methods per the AASHTO LRFD Bridge Design Specifications, 8th edition 2017 (BDS) and the WSDOT Geotechnical Design Manual (GDM).

REFERENCES:

Wall 9.90A profile and alignment provided by Parsons on 08302021

I-405 Renton to Bellevue project conformed Request for Proposal (RFP)

Appendix G1 GBR20181214

Appendix G2 GDR20181214

Appendix G4 Reference_Info20181214

Appendix G4 ReferenceInfoBridgeSeismic20181214

Appendix G4 ReferenceInfoGeoLandslides20181214

Washington State Department of Transportation (WSDOT) Geotechnical Design Manual (GDM)

AASHTO LRFD Bridge Design Specifications, 8th edition, 2017 (BDS)

FHWA GEC No. 3 – Seismic

Project Geotechnical Soil Properties Methodology, FLJV & Wood (GSPM)

1) GENERAL INFORMATION:

Planned Wall:

The planned 9.90A wall is located to the southwest of the intersection of I-405 and Coal Creek Parkway and parallel to the existing Lake Washington Loop Trail and Coal Creek.

Retaining Wall	9.90A
Type	Mechanically Stabilized Wall
Design Plans and Cross Sections Date	8/30/2021 (Plan) and 08/31/2021 (Cross sections)
Beginning Station	I-405SB 5821+96/ Wall 3+41
End Station	I-405SB 5832+05/ Wall 11+86
Length (ft)	845
Height (ft)	2 to 21
Terracon Explorations	CPT-5A
Existing Borings	W-106mw-20, W-143-20, W-144-20, W-145-20, W-149-20, W-150-20, W-151-20 and W-27-20

Subsurface Conditions:

Understanding of subsurface conditions was developed through review of historical borings as well as through advancement of additional explorations referenced above. We performed porewater pressure dissipation test (PPDT) during the advancement of CPT 05A. PPDT was conducted at approximately sta. 10+60 to evaluate current groundwater table (GWT) conditions. Based on the review of exploration data, we concluded that at the beginning of the wall (Sta. 3+41) GWT is approximately at elevation 80 feet, and GWT slowly dips down as it gets closer to the end station. Based on the boring log W-151-20, at the wall end station, GWT is somewhere below elevation 35 feet.

Boring logs are presented in the geotechnical technical memo. Cone penetrometer tests (CPTs) as used for analysis are presented in this calculations package.

Laboratory testing results, where available, were provided in the project Geotechnical Data Report.

2) SUMMARY OF GROUNDWATER CONDITIONS

Wall 9.90A is planned to be constructed parallel to the drainage of Coal Creek. Several groundwater measurements have been recorded in historic and recent soil explorations. Observed measurements suggest a decreasing groundwater elevation from south to north with the fall in grade of the creek as well as a fall with distance perpendicular to the creek alignment. The collected data suggests that the collected run-off of Coal Creek is contributing to the regional groundwater table rather than groundwater feeding or seeping into the stream channel. A summary of groundwater measurements considered for design are provided below.

Boring/CPT	Ground Surface Elevation (ft)	Observed Groundwater Depth (ft)	Assumed Groundwater Elevation (ft)
W-106mw-20	108.5	80.1	80.1
W-143-20	106.8	99.3	99.3
W-149-20	103.8	Not Observed	77.3
W-144-20	102.8	94.8	94.8
W-150-20	96.0	Not Observed	64.5
W-145-20	98.6	Not Observed	72.1
W-151-20	87.2	Not Observed	35.7
W-27-20	77.6	69.61	69.6[1]
CPT05A	83.0	83.0	83.0[2]

NOTE:
1. Perched water.
2. PPDT data does not match with our observation of GWT from nearby borings.

3) ENGINEERING SOIL UNITS

Subsurface soil profiles for the wall alignment as well as several cross sections were developed for analysis of the planned MSE wall. Soil parameters for design were established using correlations from SPT and CPT

methodologies outlined in the project Geotechnical Soil Properties Methodology (GSPM) contract document. Developed ESU cross sections are included in this calculations package as well as recommended soil properties for design.

ESU Groupings:
ESU Group 1 – Fill materials, either new fill engineered fills or existing fills observed
ESU Group 2 – Alluvium deposits of soft to medium stiff silt and clay layers containing organic materials
ESU Group 3 – Recent deposits not containing organics such as alluvium, recessional outwash, or lacustrine deposits
ESU Group 4 – Glacially overridden deposits consisting or advanced outwash sands and gravels or glaciolacustrine silts and clays
ESU Group 5 – Landslide deposits

Soil Parameter Development

Applicable boring and CPT explorations near the wall location have been reviewed in accordance with the methods explained in the GSPM. USCS soil type of GW, GP, GM, GC, SW, SP, SM, SC and ML soils with little to no plasticity have been assigned internal friction angles according to the figure below and assigned within the range according to their soil type and guidance provided in the WSDOT GDM Section 5.8.3

$N1_{60}$ from SPT (blows/ft)	φ (o)
<4	25-30
4	27-32
10	30-35
30	35-40
50	38-43

Figure 6: Correlation of SPT N values to drained friction angle of granular soils (modified after Bowles, 1977 as reported in AASHTO 2012)

Source: Table 5-1 (WSDOT 2015)

Statistical analysis for each ESU using corrected blow counts, correlated friction angles and unit weights for SPT borings are provided in this calculations package. CPT explorations have been processed using CPeT-IT to determine friction angle correlations.

New fills, that for the reinforced zone of the MSE all and general embankment fill, have been assigned soil properties as follows:

- MSE zone – Gravel backfill for walls
  Unit weight – 130 pcf
  Drained Properties – friction angle 38 degrees, cohesion 0 psf
  Undrained Properties – friction angle 38 degrees, cohesion 0 psf

- Contractor has indicated general fill soils will consist of common borrow per WSDOT GDM Table 5-2.
  Assigned values:
  ESU 1 – Common Borrow
  Unit weight – 120 pcf
  Drained Properties – friction angle 32 degrees, cohesion 0 psf
  Undrained Properties – friction angle 32 degrees, cohesion 100 psf (variable fines content anticipated)

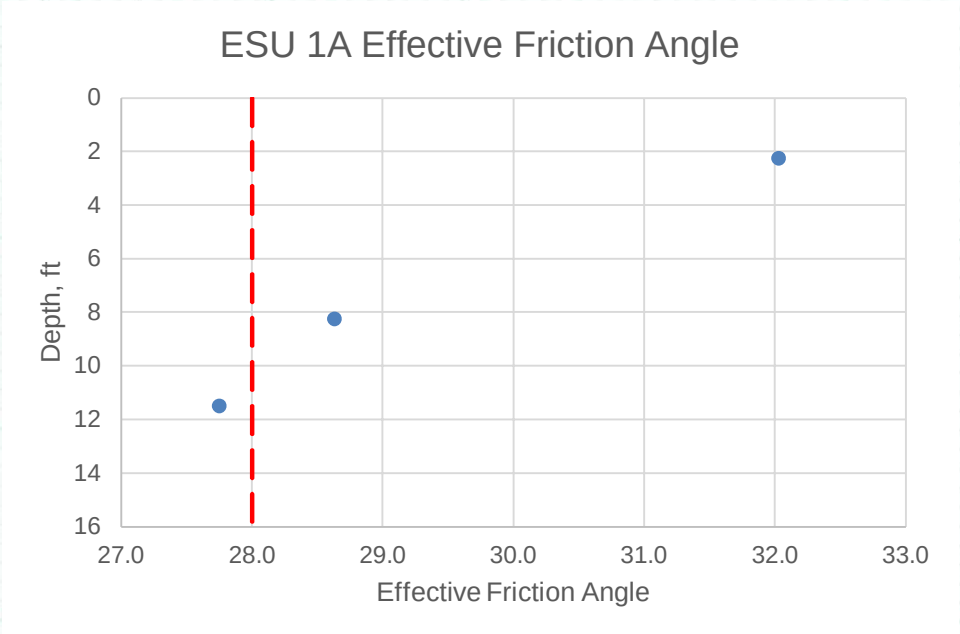
Material	WSDOT Standard Specification	Soil Type (USCS classification)	φ (degrees)	Cohesion (psf)	Total Unit Weight (pcf)
Common Borrow	9-03.14(3)	ML, SM, GM	30 to 34	0	115 to 130
Select Borrow	9-03.14(2)	GP, GP-GM, SP, SP-SM	34 to 38	0	120 to 135
Gravel Borrow	9-03.14(1)	GW, GW-GM, SW, SW-SM	36 to 40	0	130 to 145
Gravel Backfill for Walls	9-03.12(2)	GW, GP, SW, SP	36 to 40	0	125 to 135

Presumptive Design Property Ranges for Compacted Borrow and Other WSDOT *Standard Specification* Materials
Table 5-2

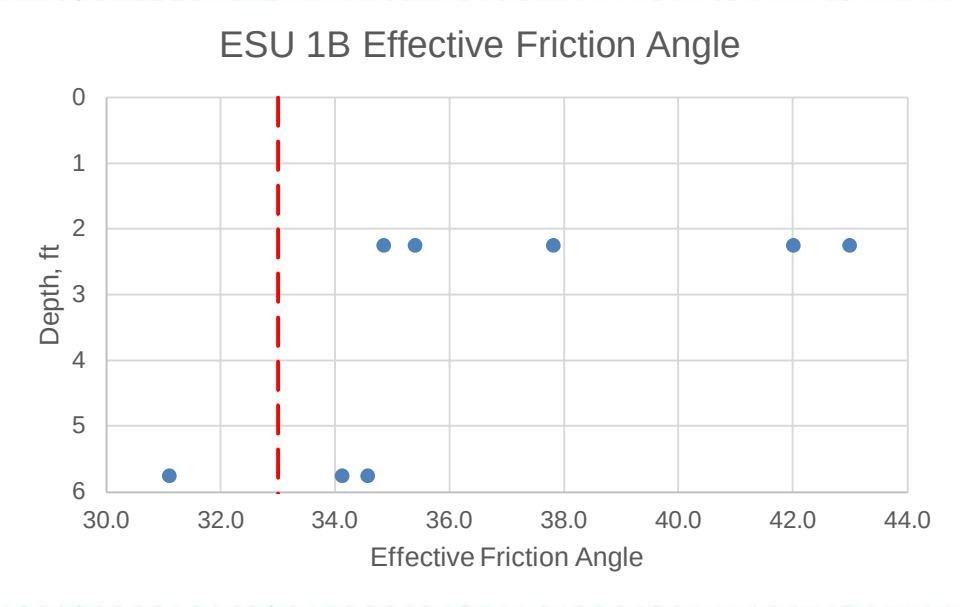
TABLE 11-2 MAXIMUM AMOUNT OF APPARENT COHESION THAT SHOULD BE ASSUMED FOR BACKFILL SOILS (NCHRP, 2008)

% (by weight) passing #200 sieve	maximum apparent cohesion
5 - 15	50 psf
15 - 25	100 psf
25-50	200 psf

Long Term Strength Parameters (Drained Case)



ESU 1A- From review of available grain size analyses the typical fines content for fill soils in ESU 1A at the wall location range from 10 to 49 percent. A value of approximately 50 psf will be assigned for developed cohesion in undrained loading scenarios such as pseudostatic and post-liquefied analyses as suggested in Chapter 6.5.3 of the AASHTO BDS and Table 11-2 of FHWA GEC No 3.

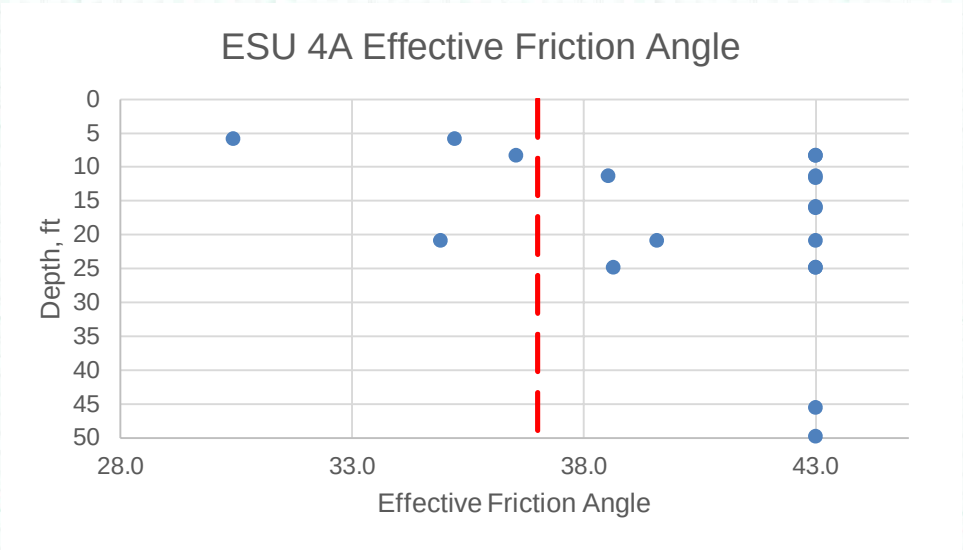


ESU 1B - From review of available grain size analyses the typical fines content for fill soils in ESU 1B at the wall location range from 5 to 42 percent with most fines contents above 16 percent. A value of approximately 50 psf will be assigned for developed cohesion in undrained loading.

ESU 3E - We found one soil sample (Sample 3, CL, from W-106mw-20) that is ESU 3E. The soil sample has PI value 7. Drained friction angle 30 degrees is assigned to this soil unit.

ESU 3A-1 – We did not encounter soils of this soil unit from any of the borings mentioned here. We observed this soil unit at borings closed to wall 9.90B. Calculation package 9.90B shows the estimation of ESU 3A-1 soil parameters and we used those values in our analyses of 9.90A.

ESU 4A - From review of available grain size analyses and Atterberg limit data, the typical fines content for soils in ESU 4A at the wall location range from 5 to 55 percent with most fines contents near 20 percent. We did not assign any apparent cohesion to this soil unit during undrained analyses.



ESU 4D – PI values for this soil unit range from 10 to 35. Drained friction angle 30 degrees is assigned to this soil unit.

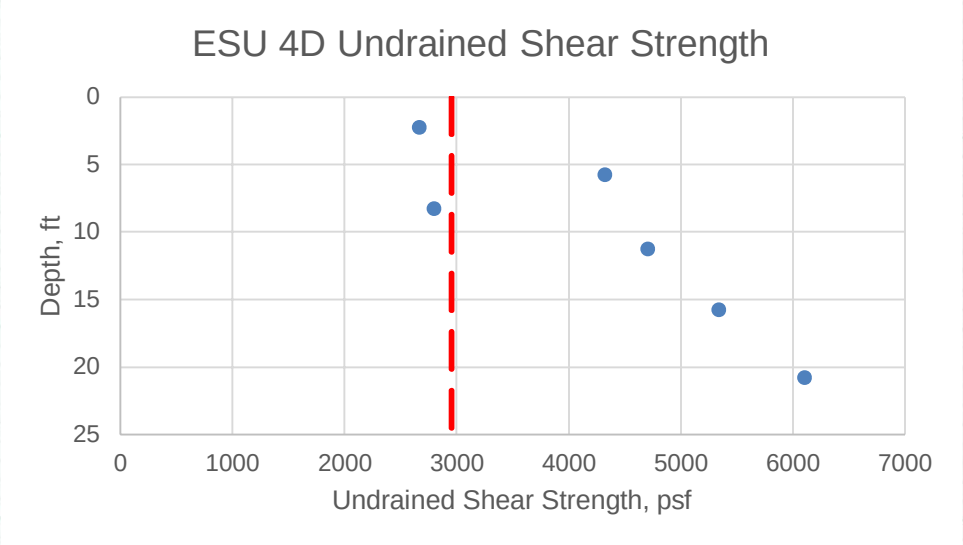
ESU 4E - PI values for this soil unit range from 9 to 35. Drained friction angle 30 degrees is assigned to this soil unit.

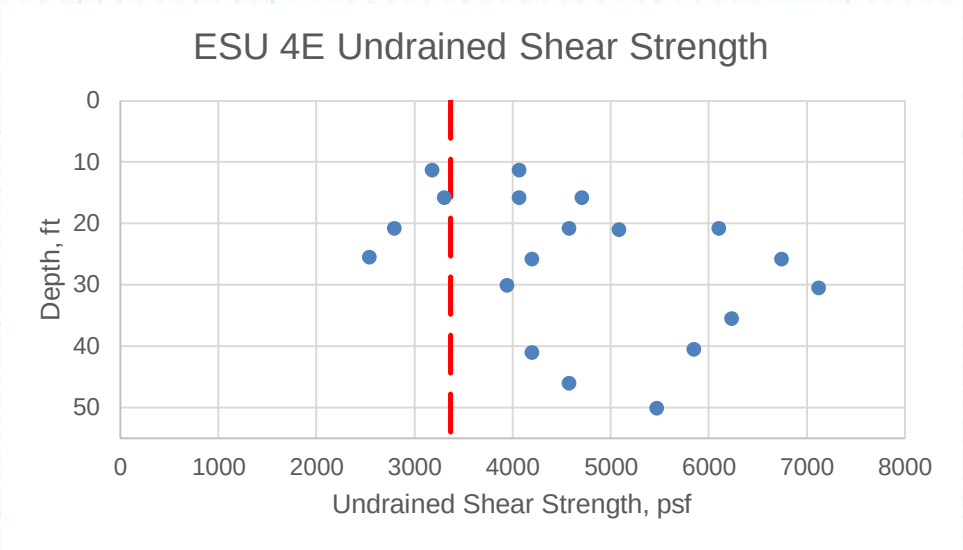
ESU 5A and 5B – These soil units represent soil layers which are a part of previous landslide deposits. Strength parameters of these two soil units are estimated from back-analysis of existing slope. We performed global stability analysis with a target factor of safety 1.1. We assigned reasonable soil strength parameters to 5A and 5B layers and changed them until get our desired FS.

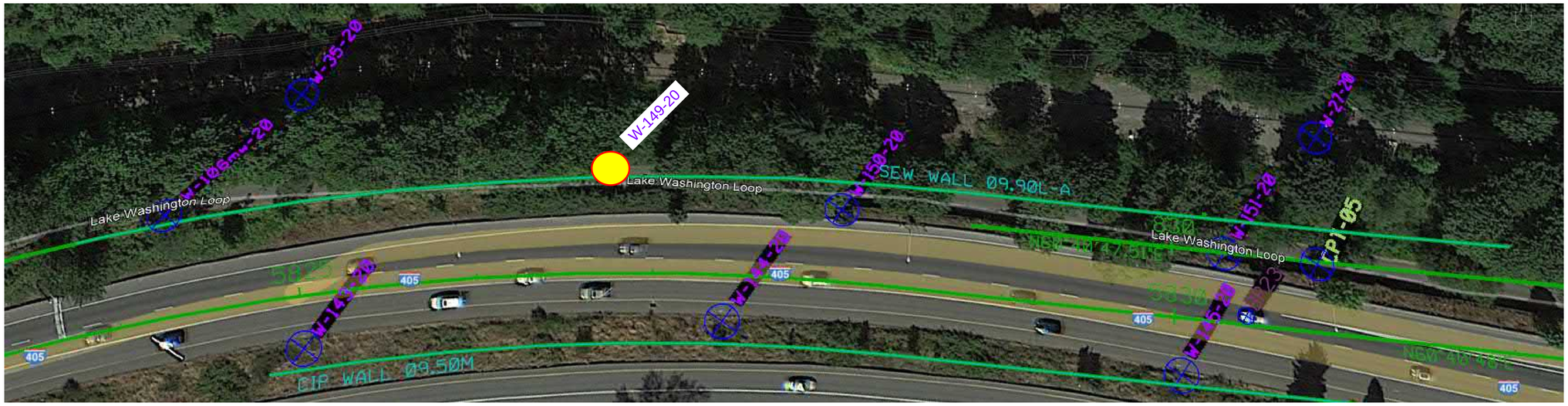
- For ESU 5A – Effective friction angle for this coarse-grained soil is 30 degrees.
- For ESU 5B – Effective friction angle for this fine-grained soil is 28 degrees.

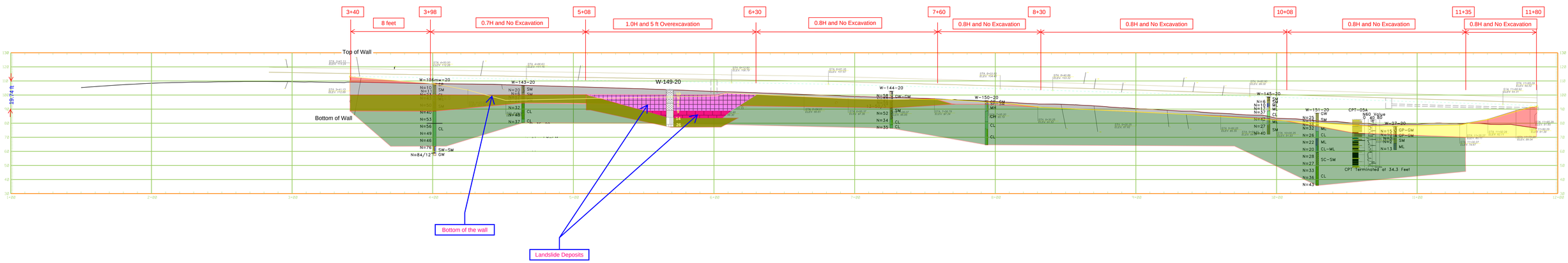
Short Term Strength Parameters (Undrained Case)

Undrained shear strength – the shear strength of soil units with plasticity have been developed from blow count correlations using equation 9 of the GSPM and analysis of CPTs using an N_{kt} value of 14.









ESU CLASSIFICATION					DESIGN SOIL PROPERTIES FOR ANALYSIS					
ESU GROUP		SOIL MATERIAL				DRAINED CONDITION		UNDRAINED CONDITION		POST LIQUEFIED
COLOR	ESU #	DESCRIPTION	DENSITY/CONSISTENCY	PRIMARY CONSTITUENT	UNIT WEIGHT (pcf)	FRICTION ANGLE (deg)	Su'(psf)	FRICTION ANGLE (deg)	Su (psf)	$Su_{residual}$ (Sr/σ'_{vo})
	1	NEW FILL - COMMON BORROW	DENSE	SAND AND GRAVEL	120	32	0	32	100	NA
	1B	UNCONTROLLED FILL	MEDIUM DENSE TO DENSE	SAND AND GRAVEL	125	35	50	35	200	NA
	3A-1	ALLUVIUM	MEDIUM DENSE TO DENSE	SAND	120	35	0	35	0	NA
	4A	ADVANCE OUTWASH	DENSE TO VERY DENSE	SAND	130	38	0	38	0	NA
	4E	GLACIOLACUSTRINE	VERY STIFF TO HARD	SILT / CLAY	130	34	0	0	4000 - 6000	NA
	5A	LANDSLIDE DEPOSITS	LOOSE TO MEDIUM DENSE	SAND	115	30	25	30	100	NA
	5B	LANDSLIDE DEPOSITS	STIFF TO VERY STIFF	SILT/CLAY	115	28	0	0	1300	NA

SOIL PROPERTY ESTIMATION SHEET (FROM SPT AND LABORATORY TESTING)

Project Name:	Renton to Bellvue	Ground Elev. (ft):	77.6
Project Number:	81215044	GW Depth (ft.):	8
Boring No.:	W-27-20	Hammer Energy:	80
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	125	281.25	281.25	15	20.0	1.66	33.2	GP-GM		11		0						10	
2	4.5	7	5.75	71.85	125	718.75	718.75	10	13.3	1.34	17.9	SP		6		0						5	
3	7	9.5	8.25	69.35	125	1031.25	1015.65	3	4.0	1.23	4.9	SM		7		0						16	
4	9.5	13.5	11.5	66.1	125	1437.5	1219.1	2	2.7	1.17	3.1	SM		7		0						20	
5	13.5	17	15.25	62.35	125	1906.25	1453.85	13	17.3	1.11	19.2	ML		18		0						52	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	108.5
Project Number:	81215044	GW Depth (ft.):	28.4
Boring No.:	W-106mw-20	Hammer Energy:	88
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	125	281.25	281.25	10	13.3	1.66	22.1	SP		6		0						5	
2	4.5	7	5.75	71.85	125	718.75	718.75	11	14.7	1.34	19.7	SM		7		0						20	
3	7	9.5	8.25	69.35	115	1006.25	990.65	23	30.7	1.24	37.9	CL		17		0						88	
4	9.5	13.5	11.5	66.1	125	1412.5	1194.1	43	57.3	1.17	67.3	ML		18		0						55	
5	13.5	18.5	16	61.6	125	1975	1475.8	50	66.7	1.10	73.6	SM		7		0						20	
6	18.5	23.5	21	56.6	115	2550	1738.8	40	53.3	1.05	55.9	CL		17	31	22	9		#NUM!			88.5	
7	23.5	28	25.75	51.85	115	3096.25	1988.65	53	70.7	1.00	70.9	CL		17		0						80	
8	28	33	30.5	47.1	115	3642.5	2238.5	56	74.7	0.96	72.0	CL		17	32	23	9		#NUM!			78.3	
9	33	38	35.5	42.1	115	4217.5	2501.5	49	65.3	0.93	60.6	CL		17		0						78	
10	38	43	40.5	37.1	115	4792.5	2764.5	46	61.3	0.89	54.8	CL		17		0						78	
11	43	48	45.5	32.1	125	5417.5	3077.5	76	101.3	0.86	86.9	SW-SM		13		0						10	
12	48	51.5	49.75	27.85	125	5948.75	3343.55	100	133.3	0.83	110.7	GW		1		0						5	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	106.8
Project Number:	81215044	GW Depth (ft.):	7.5
Boring No.:	W-143-20	Hammer Energy:	88
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	125	281.25	281.25	20	26.7	1.66	44.2	SM		7		0						16	
2	4.5	7	5.75	71.85	125	718.75	718.75	6	8.0	1.34	10.8	SM		7		0						16	
3	7	9.5	8.25	69.35	125	1031.25	1015.65	17	22.7	1.23	27.8	SM		7		0						16.8	
4	9.5	13	11.25	66.35	125	1406.25	1203.45	22	29.3	1.17	34.4	SM		7		0						16	
5	13	18.5	15.75	61.85	115	1923.75	1440.15	32	42.7	1.11	47.4	CL		17		0						61	
6	18.5	23	20.75	56.85	115	2498.75	1703.15	48	64.0	1.06	67.6	CL		17	25	15	10		#NUM!			61	
7	23	26.5	24.75	52.85	115	2958.75	1913.55	37	49.3	1.02	50.2	CL		17		0						61	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	102.8

Project Number:	81215044	GW Depth (ft.):	8
Boring No.:	W-144-20	Hammer Energy:	
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	125	281.25	281.25	58	77.3	1.66	128.2	GW-GM		9		0						7.5	
2	4.5	7	5.75	71.85	125	718.75	718.75	59	78.7	1.34	105.7	GW-GM		9		0						7.5	
3	7	9.5	8.25	69.35	125	1031.25	1015.65	59	78.7	1.23	96.6	SM		7		0						20	
4	9.5	13	11.25	66.35	125	1406.25	1203.45	100	133.3	1.17	156.2	SM		7		0						20	
5	13	18.5	15.75	61.85	125	1968.75	1485.15	52	69.3	1.10	76.4	SM		7		0						20	
6	18.5	23	20.75	56.85	125	2593.75	1798.15	34	45.3	1.04	47.0	CL		17		0						60	
7	23	26.5	24.75	52.85	125	3093.75	2048.55	35	46.7	0.99	46.4	CL		17		0						60	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	98.6
Project Number:	81215044	GW Depth (ft.):	100
Boring No.:	W-145-20	Hammer Energy:	88
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	125	281.25	281.25	6	8.0	1.66	13.3	SM		7		0						49	
2	4.5	7	5.75	71.85	125	718.75	718.75	10	13.3	1.34	17.9	ML		18	45	31	14		#NUM!			59.6	
3	7	9.5	8.25	69.35	125	1031.25	1015.65	12	16.0	1.23	19.7	ML		18		0						59	
4	9.5	13	11.25	66.35	115	1376.25	1173.45	37	49.3	1.18	58.2	CL		17		0						80	
5	13	18.5	15.75	61.85	125	1938.75	1455.15	42	56.0	1.11	62.1	ML		18		0						59	
6	18.5	23	20.75	56.85	125	2563.75	1768.15	27	36.0	1.04	37.5	SM		7		0						49.5	
7	23	26.5	24.75	52.85	125	3063.75	2018.55	40	53.3	1.00	53.3	SM		7		0						49.5	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	103.8
Project Number:	81215044	GW Depth (ft.):	100
Boring No.:	W-149-20	Hammer Energy:	88
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	125	281.25	281.25	10	13.3	1.66	22.1	SM		7		0						42.8	
2	4.5	7	5.75	71.85	125	718.75	718.75	5	6.7	1.34	9.0	SM		7		0						42	
3	7	9.5	8.25	69.35	125	1031.25	1015.65	4	5.3	1.23	6.6	SC		8		0						34.9	
4	9.5	13.5	11.5	66.1	125	1437.5	1219.1	6	8.0	1.17	9.3	ML		18		0						52	
5	13.5	18.5	16	61.6	115	1955	1455.8	9	12.0	1.11	13.3	CL		17		0						62.5	
6	18.5	23	20.75	56.85	125	2548.75	1753.15	14	18.7	1.05	19.5	SP		6		0						10.2	
7	23	26.5	24.75	52.85	125	3048.75	2003.55	26	34.7	1.00	34.7	SM		7		0						20	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	96
Project Number:	81215044	GW Depth (ft.):	100
Boring No.:	W-150-20	Hammer Energy:	88
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	115	258.75	258.75	21	28.0	1.69	47.2	MH		20	52	29	23		#NUM!			85	
2	4.5	7	5.75	71.85	115	661.25	661.25	34	45.3	1.37	62.2	CL		17		0						90	
3	7	9.5	8.25	69.35	115	948.75	933.15	22	29.3	1.26	36.9	CH		19	61	26	35		#NUM!			90.7	
4	9.5	13	11.25	66.35	115	1293.75	1090.95	25	33.3	1.20	40.1	CH		19	63	28	35		#NUM!			93.2	
5	13	18.5	15.75	61.85	115	1811.25	1327.65	37	49.3	1.14	56.2	CL		17		0						90	
6	18.5	23	20.75	56.85	115	2386.25	1590.65	36	48.0	1.08	51.8	CL		17	40	19	21		#NUM!			84.4	
7	23	28.5	25.75	51.85	115	2961.25	1853.65	33	44.0	1.03	45.2	CL		17		0						84	
8	28.5	31.5	30	47.6	115	3450	2077.2	31	41.3	0.99	40.9	CL		17		0						84	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	87.2
Project Number:	81215044	GW Depth (ft.):	100
Boring No.:	W-151-20	Hammer Energy:	88
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4.5	2.25	75.35	125	281.25	281.25	25	33.3	1.66	55.3	SM		7		0						36.9	
2	4.5	7	5.75	71.85	125	718.75	718.75	13	17.3	1.34	23.3	SM		7		0						20	
3	7	9.5	8.25	69.35	125	1031.25	1015.65	38	50.7	1.23	62.2	SM		7		0						20	
4	9.5	13	11.25	66.35	125	1406.25	1203.45	32	42.7	1.17	50.0	ML		18		0						20	
5	13	18.5	15.75	61.85	115	1923.75	1440.15	26	34.7	1.11	38.5	CL		17	34	20	14		#NUM!			20	
6	18.5	23	20.75	56.85	125	2548.75	1753.15	22	29.3	1.05	30.7	ML		18		0						58.5	
7	23	28	25.5	52.1	115	3095	2003	20	26.7	1.00	26.7	CL		17	30	23	7		#NUM!			81.5	
8	28	33.5	30.75	46.85	125	3751.25	2331.65	28	37.3	0.95	35.5	SC-SM		16	20	15	5		#NUM!			43.3	
9	33.5	38.5	36	41.6	125	4407.5	2660.3	27	36.0	0.91	32.6	SC-SM		16		0						20	
10	38.5	43.5	41	36.6	115	4982.5	2923.3	33	44.0	0.87	38.5	CL		17	23	14	9		#NUM!			54.4	
11	43.5	48.5	46	31.6	115	5557.5	3186.3	36	48.0	0.85	40.6	CL		17		0						54	
12	48.5	51.5	50	27.6	115	6017.5	3396.7	43	57.3	0.82	47.3	CL		17		0						54	

Point ID	Point ID	Sample ID	Sample Top Depth (ft)	Field N	N60	(N1)60	Estimated USCS	ESU	LL	PI	% Fines	average PI
W-145-20	WOOD	SPT-2	5	10	14	23	ML	5B	45	14	59.6	11.5
W-145-20	WOOD	SPT-3	7.5	17	23	39	ML	5B	--	--	--	
W-149-20	WOOD	SPT-5	15	9	14	17	CL	5B	31	9	62.5	
W-27-20	WOOD	SPT-5	15	13	17	20	ML	5B	--	--	52	
W-142-20	WOOD	SPT-1	2.5	53	67	114	CL	4D	--	--	--	23
W-142-20	WOOD	SPT-2	5	40	54	92	CL	4D	48	29	77.8	
W-142-20	WOOD	SPT-3	7.5	57	77	131	CL	4D	--	--	--	
W-142-20	WOOD	SPT-4	10	67	96	143	CL	4D	46	20	85.3	
W-143-20	WOOD	SPT-6	20	48	77	79	CL	4D	25	10	61	
W-144-20	WOOD	SPT-6	20	34	55	54	CL	4D	--	--	--	
W-145-20	WOOD	SPT-4	10	37	53	78	CL	4D	--	--	--	
W-145-20	WOOD	SPT-5	15	42	67	82	ML	4D	--	--	--	
W-150-20	WOOD	SPT-1	2.5	21	26	45	MH	4D	52	23	85	
W-150-20	WOOD	SPT-2	5	34	45	77	MH	4D	--	--	--	
W-150-20	WOOD	SPT-3	7.5	22	29	50	CH	4D	61	35	90.7	
W-106mw-20	WOOD	SPT-6	20	40	64	66	CL	4E	31	9	88.5	14
W-106mw-20	WOOD	SPT-7	25	53	85	78	CL	4E	--	--	--	
W-106mw-20	WOOD	SPT-8	30	56	95	80	CL	4E	32	9	78.3	
W-106mw-20	WOOD	SPT-9	35	49	83	68	CL	4E	--	--	--	
W-106mw-20	WOOD	SPT-10	40	46	78	62	CL	4E	--	--	--	
W-143-20	WOOD	SPT-5	15	32	51	60	CL	4E	--	--	--	
W-143-20	WOOD	SPT-7	25	37	59	55	CL	4E	--	--	--	
W-144-20	WOOD	SPT-7	25	35	56	50	CL	4E	--	--	--	
W-150-20	WOOD	SPT-4	10	25	35	53	CH	4E	63	35	93.2	
W-150-20	WOOD	SPT-5	15	37	59	72	CL	4E	--	--	--	
W-150-20	WOOD	SPT-6	20	36	57	60	CL	4E	40	21	84.4	
W-150-20	WOOD	SPT-7	25	33	52	49	CL	4E	--	--	--	
W-150-20	WOOD	SPT-8	30	31	52	44	CL	4E	--	--	--	
W-151-20	WOOD	SPT-4	10	32	45	65	ML	4E	--	--	--	
W-151-20	WOOD	SPT-5	15	26	41	49	CL	4E	34	14	--	
W-151-20	WOOD	SPT-6	20	22	35	36	ML	4E	--	--	58.5	
W-151-20	WOOD	SPT-7	25	20	32	29	CL-ML	4E	30	7	81.5	
W-151-20	WOOD	SPT-8	30	28	47	39	SC-SM	4E	20	5	43.3	
W-151-20	WOOD	SPT-9	35	27	45	35	SC-SM	4E	--	--	--	
W-151-20	WOOD	SPT-10	40	33	55	40	CL	4E	23	9	54.4	
W-151-20	WOOD	SPT-11	45	36	60	41	CL	4E	--	--	--	
W-151-20	WOOD	SPT-12	50	43	72	47	CL	4E	--	--	--	

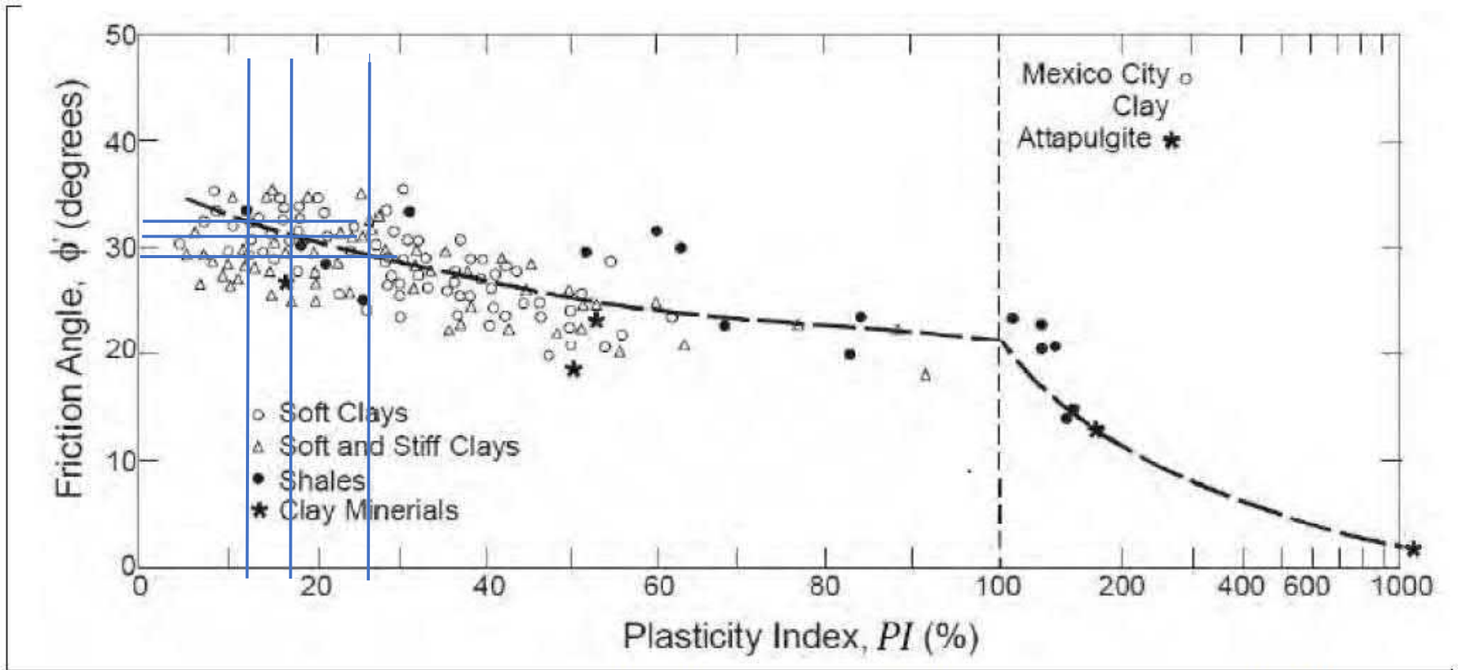


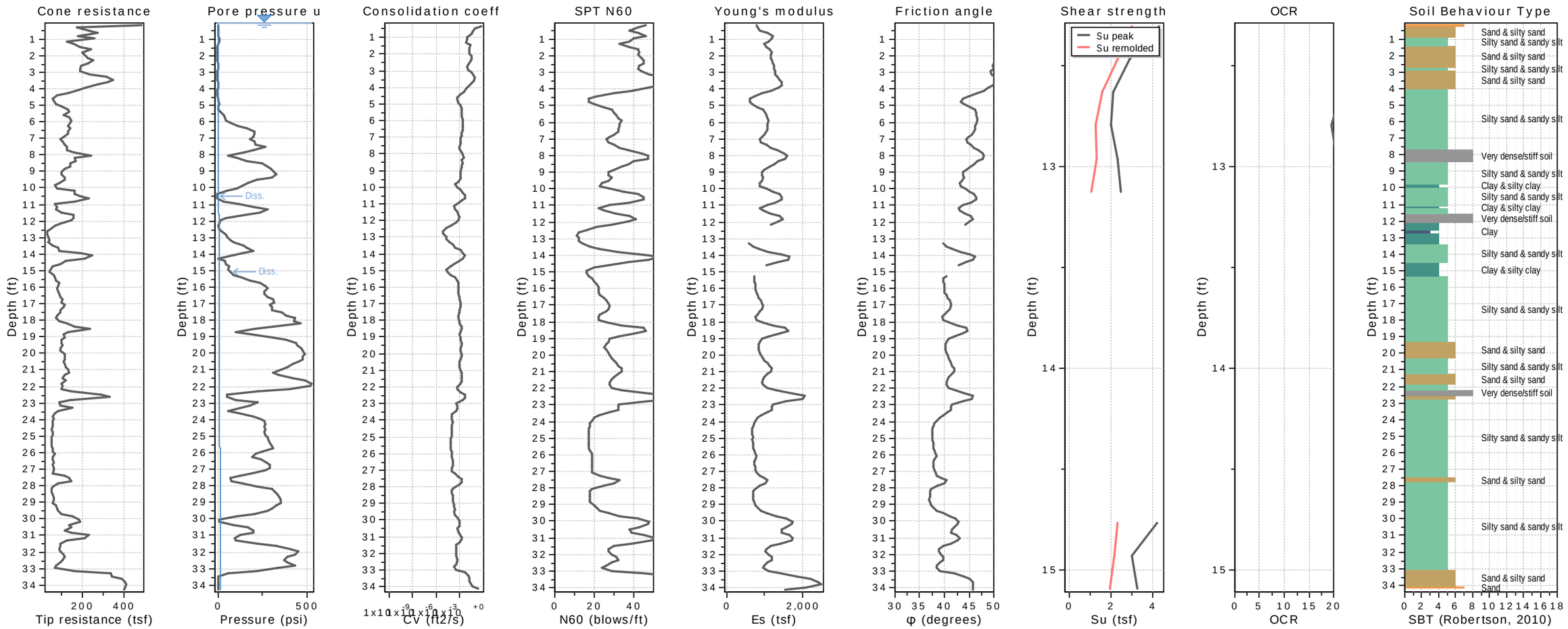
Figure 8: Estimates of friction angle based on plasticity index, PI (adapted from Terzaghi, et al., 1996)

Source: Figure 7-45 (Loehr et al. 2017)

Terracon Consultants Inc.

CPT: CPT - 5A
Total depth: 34.28 ft, Date: 7/12/2021
Surface Elevation: 83.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: 81215044 I-405 Renton to Bellevue Widening and Express Toll Lanes Project
Location: Bellevue, WA



SBTn legend

1. Sensitive fine grained
2. Organic soil
7. Clay & silty clay
3. Clay
5. Silty sand & sandy silt
6. Sand & silty sand
7. Sand
8. Very dense/stiff soil
9. Very dense/stiff soil

4) Seismic Conditions:

Determination of As

The site adjusted seismic acceleration, As, was determined in accordance with GDM Chapter 6 as shown in the attached analysis. A site peak ground acceleration, PGA, of 0.429g and an earthquake magnitude of 7 were developed for the wall location. Based on observed soil conditions a Site Class D was assigned and the PGA adjusted per the following table:

Table 6-4 Values of Site Coefficient, F_{pga}, for Peak Ground Acceleration

Site Class	Mapped Peak Ground Acceleration Coefficient (PGA)					
	PGA ≤ 0.10	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA = 0.5	PGA ≥ 0.6
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.2	1.2	1.2	1.2	1.2
D	1.6	1.4	1.3	1.2	1.1	1.1
E	2.4	1.9	1.6	1.4	1.2	1.1
F	*	*	*	*	*	*

* Site-specific response geotechnical investigation and dynamic site response analysis should be considered.

Note: Use straight line interpolation for intermediate values of PGA.

By interpolation, Fpga = 1.17. As = 0.429g x 1.17 = **0.5g**

5) Liquefaction:

Liquefaction is the phenomenon where saturated soils develop high pore water pressures during seismic shaking and lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is shallow and loose granular soils or relatively non-plastic fine-grained soils are present. Based on the site geology and subsurface groundwater conditions, we do not expect liquefaction of foundation soil during a design level earthquake.

U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Coal Creel PKWY Over I-405 PGA with Deaggregation

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Spectral Period

Peak Ground Acceleration

Latitude

Decimal degrees

47.568

Time Horizon

Return period in years

975

Longitude

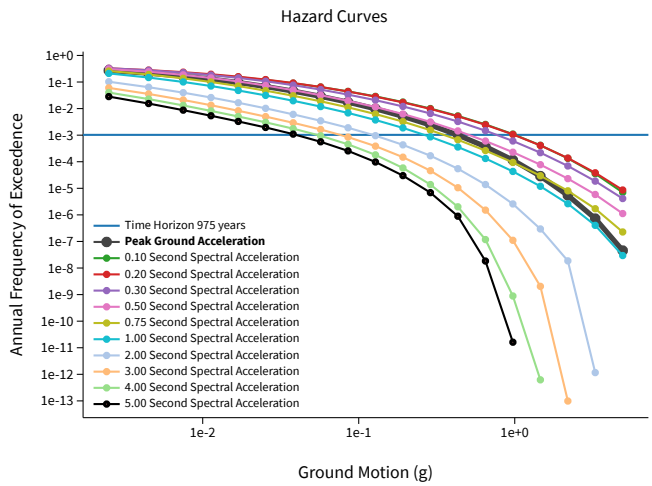
Decimal degrees, negative values for western longitudes

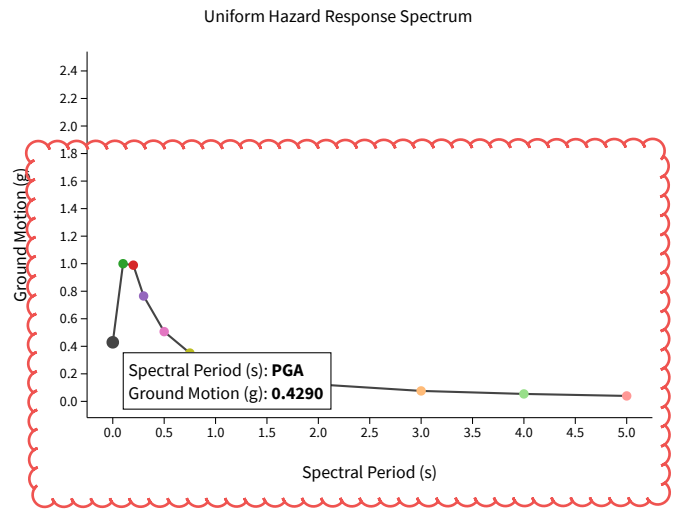
-122.18

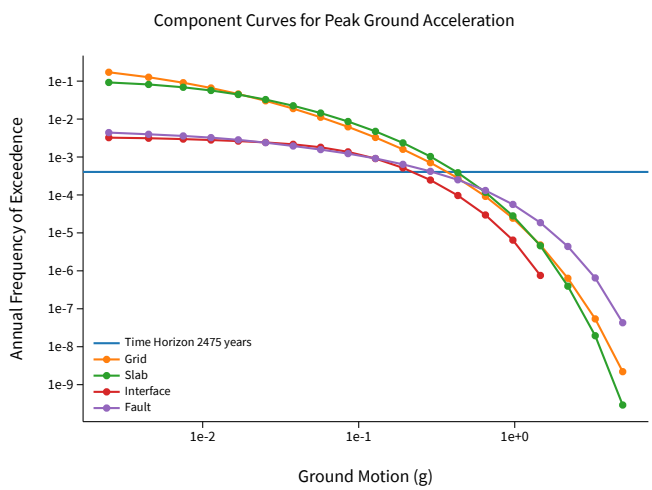
Site Class

760 m/s (B/C boundary)

Hazard Curve







$$A_S = F_{pga}\, PGA \qquad (3.10.4.2\text{-}2)$$

Table 6-4 Values of Site Coefficient, F_{pga}, for Peak Ground Acceleration

Site Class	Mapped Peak Ground Acceleration Coefficient (PGA)					
	PGA ≤ 0.10	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA = 0.5	PGA ≥ 0.6
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.2	1.2	1.2	1.2	1.2
D	1.6	1.4	1.3	1.2	1.1	1.1
E	2.4	1.9	1.6	1.4	1.2	1.1
F	*	*	*	*	*	*

* Site-specific response geotechnical investigation and dynamic site response analysis should be considered.
Note: Use straight line interpolation for intermediate values of *PGA*.

[View Raw Data]

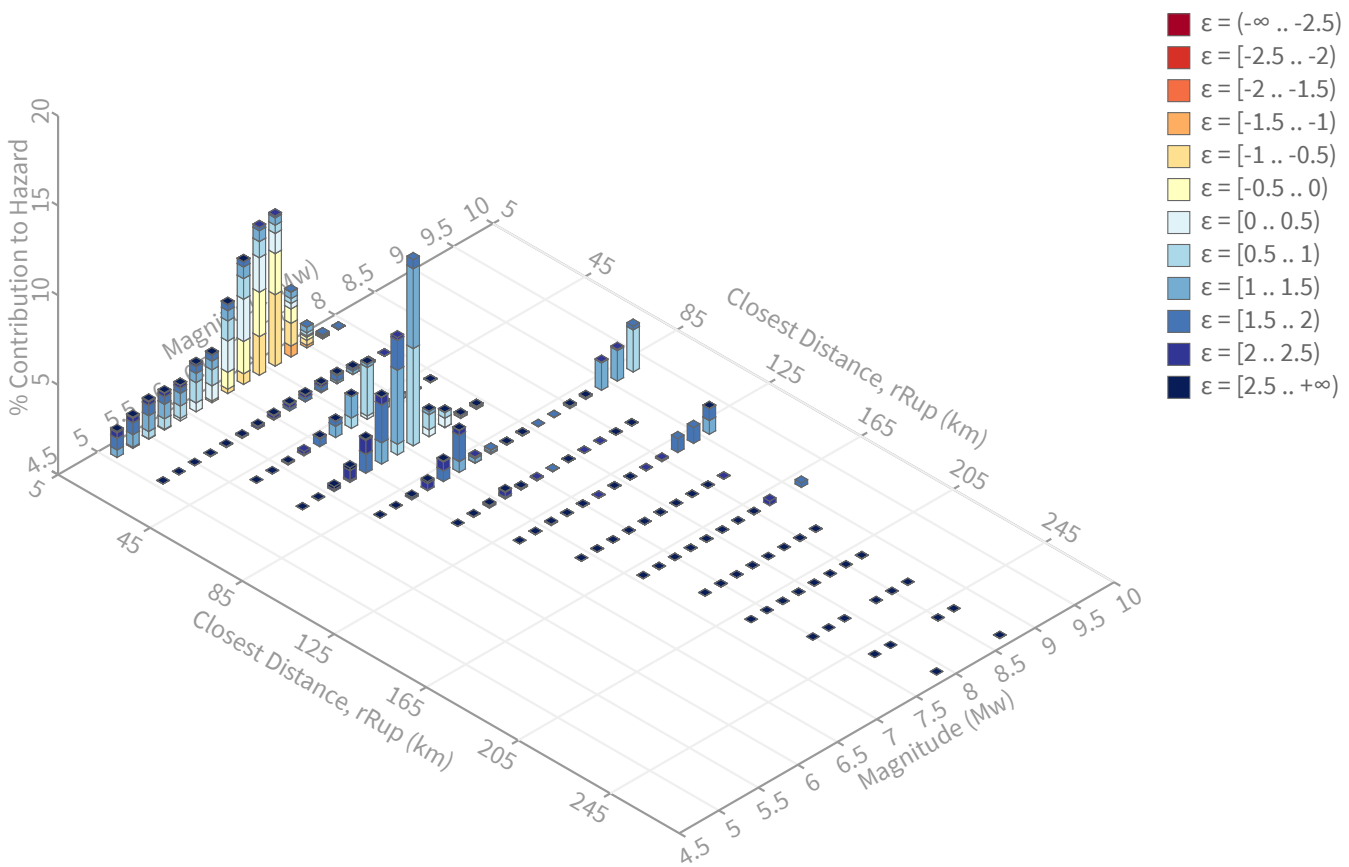
Fpga = 1.17 by interpolation

As = 1.17*0.429 = 0.5

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 975 yrs
Exceedance rate: 0.001025641 yr^{-1}
PGA ground motion: 0.42898465 g

Recovered targets

Return period: 1000.1144 yrs
Exceedance rate: 0.00099988558 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.32 %

Mean (over all sources)

m: 6.98
r: 41.81 km
ε_0: 0.88 σ

Mode (largest m-r bin)

m: 7.1
r: 66.68 km
ε_0: 1.02 σ
Contribution: 10.38 %

Mode (largest m-r-ε_0 bin)

m: 7.11
r: 63.16 km
ε_0: 0.81 σ
Contribution: 5.43 %

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 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
Seattle	Fault							22.78
Seattle - northern		2.12	6.99	-0.47	122.171°W	47.584°N	21.03	14.63
Seattle - middle		4.95	6.84	0.16	122.222°W	47.555°N	245.72	4.92
Seattle - southern		7.61	6.81	0.51	122.203°W	47.533°N	204.09	3.23
pacnwdeep.2014.in	Slab							20.25
pacnwdeep.2014.in	Slab							13.82
puget_2014.ch.in	Grid							6.07
sub0_ch_bot.in	Interface							5.78
Cascadia Megathrust - whole CSZ Characteristic		99.34	9.12	1.08	123.357°W	47.313°N	252.66	5.78
puget_2014.gr.in	Grid							5.19
WUSmap_2014_fixSm.ch.in (opt)	Grid							3.37
sub0_ch_mid.in	Interface							3.02
Cascadia Megathrust - whole CSZ Characteristic		133.84	8.93	1.63	123.916°W	47.709°N	277.51	3.02
WUSmap_2014_fixSm.gr.in (opt)	Grid							2.87
WUSmap_2014_adSm.ch.in (opt)	Grid							2.13
pacnwdeep_Mmax75.2014.in	Slab							1.98
WUSmap_2014_adSm.gr.in (opt)	Grid							1.81
puget_2014_M8.in	Grid							1.72
Geologic Model Partial Rupture	Fault							1.06
pacnwdeep_Mmax75.2014.in	Slab							1.01

U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Coal Creel PKWY with Deaggregation 0.2s (Ss)

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Spectral Period

0.20 Second Spectral Acceleration

Latitude

Decimal degrees

47.568

Time Horizon

Return period in years

975

Longitude

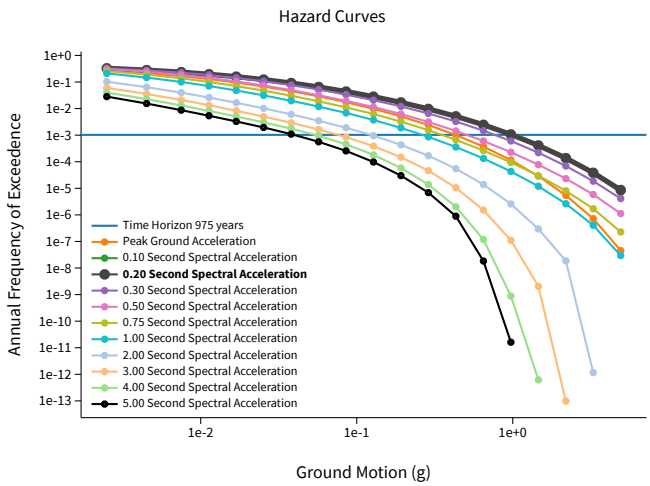
Decimal degrees, negative values for western longitudes

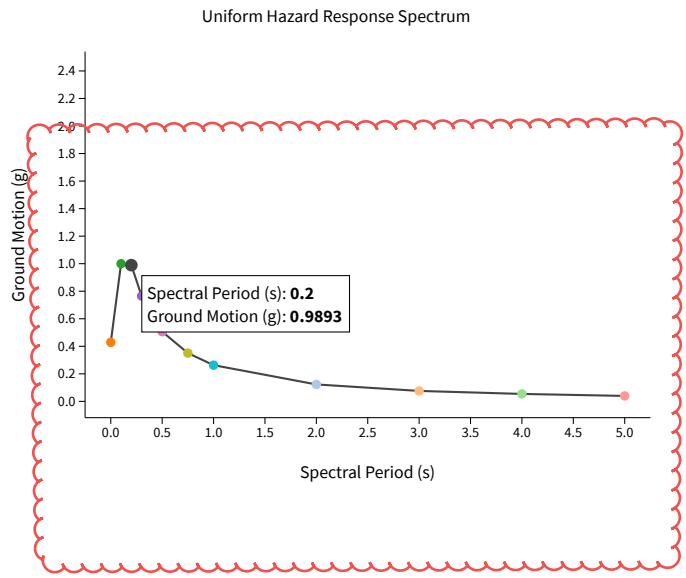
-122.18

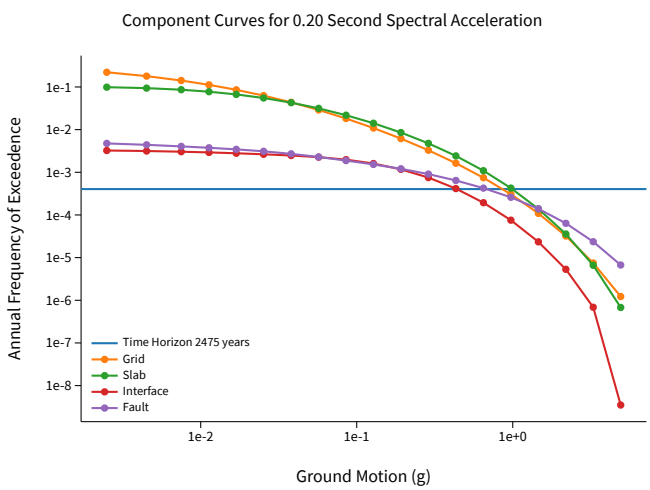
Site Class

760 m/s (B/C boundary)

Hazard Curve







View Raw Data

U.S. Geological Survey - Earthquake Hazards Program

Coal Creek PKWY over I-405 1.0s (S_1)

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Spectral Period

0.10 Second Spectral Acceleration

Latitude

Decimal degrees

47.568

Time Horizon

Return period in years

975

Longitude

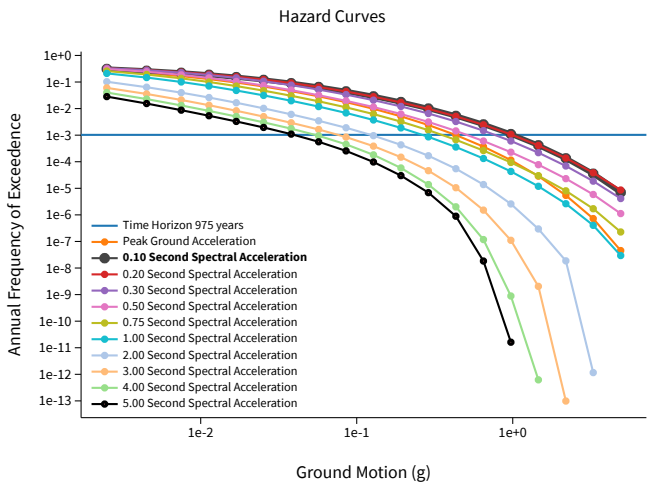
Decimal degrees, negative values for western longitudes

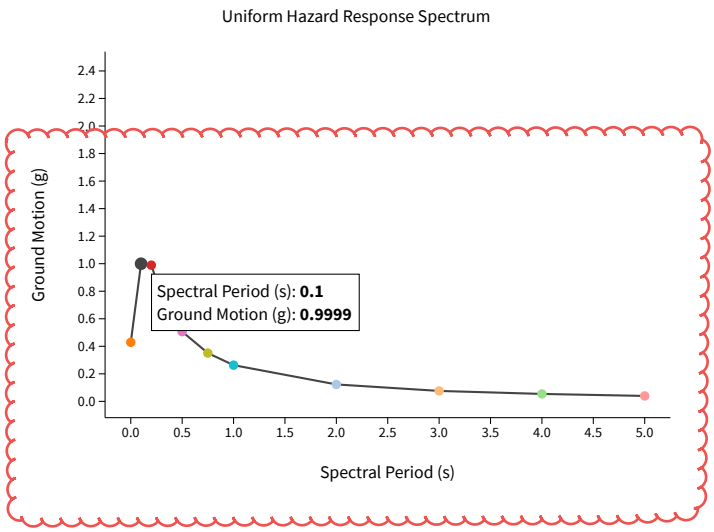
-122.18

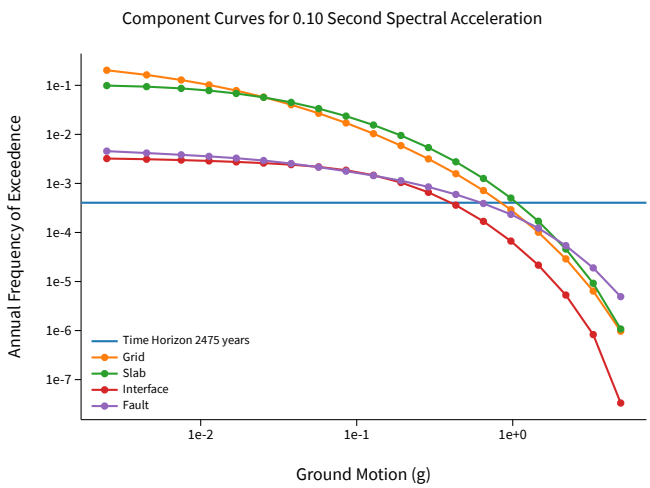
Site Class

760 m/s (B/C boundary)

Hazard Curve







View Raw Data

6) Global Stability:

Global & Compound Stability:

The software Slide2 by Rocscience. was used for these analyses. Minimum factor of safety is 1.3 (resistance factor of 0.75) in the static case and 1.1 in the seismic (pseudo-static) case per Chapter 15 of the WSDOT GDM and Appendix G updates and Section 11.6.2.3 of the AASHTO BDS.

We assumed the following:

- Live Load traffic surcharge was taken to be 250 psf for static conditions
- No Live Load applied during pseudostatic conditions, decoupled analysis
- MSE reinforced zone was modeled with readily available geogrid reinforcement using default parameters of the Slide2 software
- For pseudostatic analysis the maximum allowable lateral displacement of the wall mass was assumed to be 8 inches per GDM Appendix 15-E-3 and to include wave scattering effects. The k_h for pseudostatic stability analysis was determined by:

$$k_h = 0.74 A_s \left(\frac{A_s}{d}\right)^{0.25} \qquad (15\text{-}E\text{-}18)$$

where,

k_h = horizontal seismic acceleration coefficient (dim)

A_s = earthquake ground acceleration coefficient as specified in Equation 3.10.4.2-2 in AASHTO (2020)

d = lateral wall displacement (in.)

k_h = 0.74 * 0.5g (0.5/8)^0.25 = **0.185g**

Results are summarized below. Slide2 output prints are attached.

If the factor of safety (F.S.) of these analyses do not meet WSDOT minimum requirements, improvements such as lengthening of MSE reinforcements, overexcavation and replacement, or ground improvement were investigated.

SUMMARY OF RESULTS:

Wall Designation	**9.90A**			
Station Evaluated	5+75	7+80	8+80	10+80

Active & Passive Earth Pressure Coefficients -- Coulomb's Method

Wall 9.85L Barrier

Spreadsheet Name: RetWall, Notebook = Coulomb

References:

Das (1984), Principles of Foundation Engineering, eqs. 5-18, 5-24

Das (1983), Fundamentals of Soil Dynamics, eq. 9.5 & 9.41

Kramer (1996), Geotechnical Earthquake Engineering, eq. 11.21

Active & At-Rest Earth Pressures

		deg	rad
Friction angle	phi (ϕ)=	35.0	0.6109
Wall friction angle	delta (δ)=	23.1	0.4032
Backfill angle (0 horiz)	alpha (α)=	0.0	0.0000
Wall inclination (90 vert)	beta (β)=	90.0	1.5708

Unit Weight Gamma (γ) = 125.0

Wall Height, H = 0.0

Vertical Seismic Coeff. 0

Horizontal Seismic Coeff. 0.185

	deg	rad	sin
beta + phi =	125.0	2.182	0.819
beta - delta =	66.9	1.168	0.920
phi + delta =	58.1	1.014	0.849
phi - alpha =	35.0	0.611	0.574
beta - delta =	66.9	1.168	0.920
alpha + beta =	90.0	1.571	1.000

	deg	rad	cos	sin
theta =	10.5	0.183	0.983	0.182
i = 90-beta	0.0	0.000	1.000	
phi - theta - i =	24.5	0.428	0.910	
delta + i + theta =	33.6	0.586	0.833	
phi - theta - alpha =	24.5	0.428		0.415
alpha - i =	0.0	0.000	1.000	

Ka =	**0.24**
Ko =	**0.43**
ΔKae (net)=	**0.13**

P (lbs)= 0.00

EFP (pcf) =

Active	**30.55**
At Rest	**53.30**
E'Quake	**15.82**

Kae =	**0.37**
Pae (lbs)=	0.00
EFPae (pcf)=	46.38

$$\theta = \tan^{-1}\left\{\frac{k_h}{1-k_v}\right\}$$

Passive Earth Pressure

		deg	rad
Friction angle	phi (ϕ)=	35.0	0.6109
Wall friction angle	delta (δ)=	11.6	0.2016
Backfill angle (0 horiz)	alpha (α)=	0.0	0.0000
Wall inclination (90 vert)	beta (β)=	90.0	1.5708

Unit Weight Gamma (γ) = 125.0

	deg	rad	sin
beta - phi =	55.0	0.960	0.819
beta + delta =	101.6	1.772	0.980
phi + delta =	46.6	0.812	0.726
phi + alpha =	35.0	0.611	0.574
beta + delta =	101.6	1.772	0.980
alpha + beta =	90.0	1.571	1.000

	deg	rad	cos	sin
theta=	10.5	0.183	0.983	0.182
i=90-beta	0.0	0.000	1.000	
phi+i-theta=	45.5	0.794	0.701	0.713
delta - i + theta =	22.0	0.385	0.927	0.375
phi+delta=	46.6	0.812	0.688	0.726
phi+alpha-theta=	24.5	0.428	0.910	0.415
delta-i+theta=	22.0	0.385	0.927	0.375
alpha-i	0.0	0.000	1.000	0.000

	FS=	1.00
Kp =	**5.65**	**5.65**
ΔKpe=	-2.73	

EFP (pcf) =

Passive	**706.61**

Kpe=	**2.92**

$$Ka = \frac{\sin^2(\beta+\phi)}{\sin^2\beta * \sin(\beta-\delta) * \left[1+\sqrt{\frac{\sin(\phi+\delta)*\sin(\phi-\alpha)}{\sin(\beta-\delta)*\sin(\beta+\alpha)}}\right]^2}$$

$$Kp = \frac{\sin^2(\beta-\phi)}{\sin^2\beta * \sin(\beta+\delta) * \left[1-\sqrt{\frac{\sin(\phi+\delta)*\sin(\phi+\alpha)}{\sin(\beta+\delta)*\sin(\beta+\alpha)}}\right]^2}$$

$$Kae = \frac{\cos^2(\phi-\theta-i)}{\cos\theta * \cos^2 i * \cos(\delta+i+\theta) * \left[1+\sqrt{\frac{\sin(\phi+\delta)*\sin(\phi-\theta-\alpha)}{\cos(\delta+i+\theta)*\cos(\alpha-i)}}\right]^2}$$

$$Kpe = \frac{\cos^2(\phi+i-\theta)}{\cos\theta * \cos^2 i * \cos(\delta-i+\theta) * \left[1-\sqrt{\frac{\sin(\phi+\delta)*\sin(\phi+\alpha-\theta)}{\cos(\delta-i+\theta)*\cos(\alpha-i)}}\right]^2}$$

Wall Designation	9.90A			
Wall Height Evaluated, H_T [1] (ft.)	13.5	14.4	14.7	21.1
Embedment (ft.)	3[2]	3.5[2,3]	2	2
Global Static FOS	1.4	1.7	1.4	1.6
Global Seismic FOS	1.1	2.0	1.6	1.6
Reinforcement to Height Ratio	$1.0H_T$	$0.7H_T$	$0.8H_T$	$0.75H_T$
Comments	5 ft OX and replace	None	None	None

1) Total wall height, H_T = exposed height + embedment
2) Wall with steep toe slope has increased per Table 2-2 GEC-11 (FHWA 2009). Minimum embedment at this wall section is 3.0 feet.
3) At station 7+80, if minimum embedment 3.0 fee (See note 2) is provided then another 0.5 feet of uncontrolled fill will be present between bottom of the wall and the existing soil. We recommend extending the embedment to 3.5 feet and construct the footing on the native soil.

Overexcavation and replacement recommended in some areas with use of Quarry Spalls or similar high friction angle material or geosynthetic reinforcement.

External Stability:

AASHTO typically requires a minimum reinforcement length of 70 percent of the total wall height (HT), or a minimum length of 8 feet, whichever is greater. The commercial software MSEW 3.0 or MSEW Plus, both developed by Adama Engineering, Inc. was used to evaluate the minimum length of reinforcement required for the external stability for the following modes of failure:

- Bearing
- Sliding
- Overturning

Recommended lengths of reinforcement for the wall from MSEW analyses are provided in next page. Final geotechnical design recommendations are provided for the minimum required length of reinforcement when all analyses have been considered and the controlling case and length of reinforcement have been identified.

MSE RETAINING WALL DESIGN DATA

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	RETAINED SOIL			FOUNDATION SOIL					GROUND IMPROVEMENT DEPTH (FT)	MINIMUM EARTH REINFORCEMENT RATIO OR LENGTH (FT)	MINIIMUM WALL EMBEDMENT (FT)
				FRICTION ANGLE (DEG)	COHESION (PSF)	UNIT WEIGHT (PCF)	TOTAL (UNDRAINED)		EFFECTIVE (DRAINED)		UNIT WEIGHT (PCF)			
							FRICTION ANGLE (DEG)	COHESION (PSF)	FRICTION ANGLE (DEG)	COHESION (PSF)				
9.90 L(A)	3+41	3+98	6.5	32	50	120	32	100	32	0	120	No	8 feet	2
	3+98	5+08	17.5	32	50	120	35	200	35	50	125	No	0.7H or 8 feet whichever is greater	2
	5+08	6+30	16.0	32	50	120	30	100	32	0	121	Yes (5 feet)	1.0H or 8 feet whichever is greater	3[1]
	6+30	7+60	12	32	50	120	35	200	35	50	125	No	0.7H or 8 feet whichever is greater	2
	7+60	8+30	14.0	32	50	120	0	4000	34	0	130	No	0.8H or 8 feet whichever is greater	3.5[1,2]
	8+30	10+08	18.5	32	50	120	0	4000	34	0	130	No	0.8H or 8 feet whichever is greater	2
	10+08	11+35	21	32	50	120	0	4000	34	0	130	No	0.75H or 8 feet whichever is greater	3
	11+35	11+86	16.5	32	50	120	32	100	32	0	120	No	0.7H or 8 feet whichever is greater	2

NOTE:

1. Wall sections located between 5+08 to 6+30 and 7+60+8+30 have steep slope in front of it. Per Table 2-2 GEC-11 (FHWA 2009), minimum embedment at these wall segments is 3.0 feet.
2. The soil at the ground surface is uncontrolled fill. The competent native soil is approximately 3.5 feet below the ground surface. So, instead of minimum 3.0 feet embedment (See Note 1), we recommend extending it up to 3.5 feet bgs.

REV.	DATE	BY	DESCRIPTION

SHEET-TITLE

PROJECT
CLIENT
FACILITY NAME

STATE

CITY/COUNTY

Terracon
Consulting Engineers and Scientists

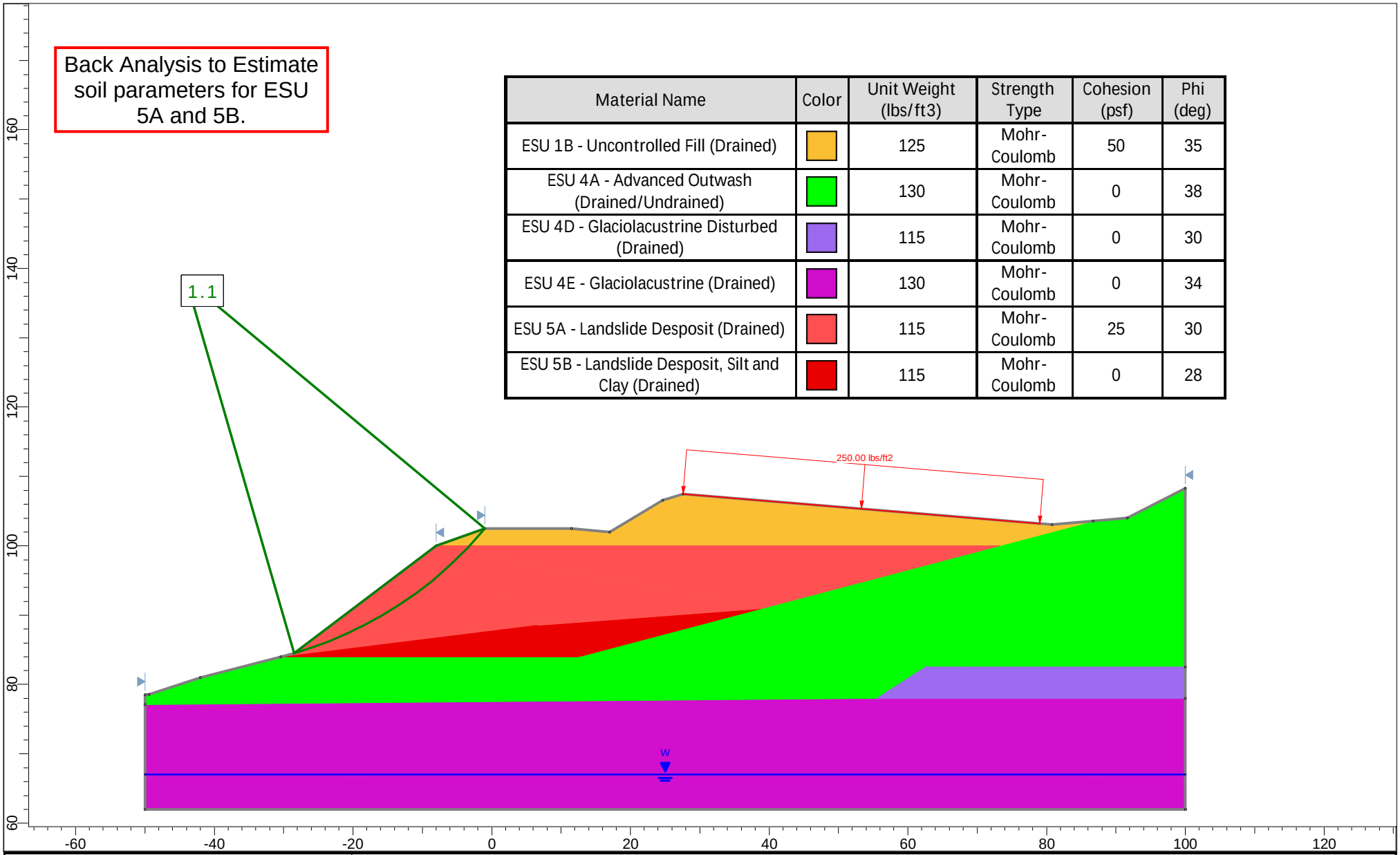
FIG/DRAWING

DESIGNED BY:	XXX
DRAWN BY:	XXX
APPVD. BY:	XXX
SCALE:	AS SHOWN
DATE:	XX-XX-XX
JOB NO.	XXXXXXXX
CAD FILE	SHEET NAME
SHEET NO.:	XX OF XX

Drained Case

Back Analysis to Estimate soil parameters for ESU 5A and 5B.

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
ESU 1B - Uncontrolled Fill (Drained)		125	Mohr-Coulomb	50	35
ESU 4A - Advanced Outwash (Drained/Undrained)		130	Mohr-Coulomb	0	38
ESU 4D - Glaciolacustrine Disturbed (Drained)		115	Mohr-Coulomb	0	30
ESU 4E - Glaciolacustrine (Drained)		130	Mohr-Coulomb	0	34
ESU 5A - Landslide Desposit (Drained)		115	Mohr-Coulomb	25	30
ESU 5B - Landslide Desposit, Silt and Clay (Drained)		115	Mohr-Coulomb	0	28



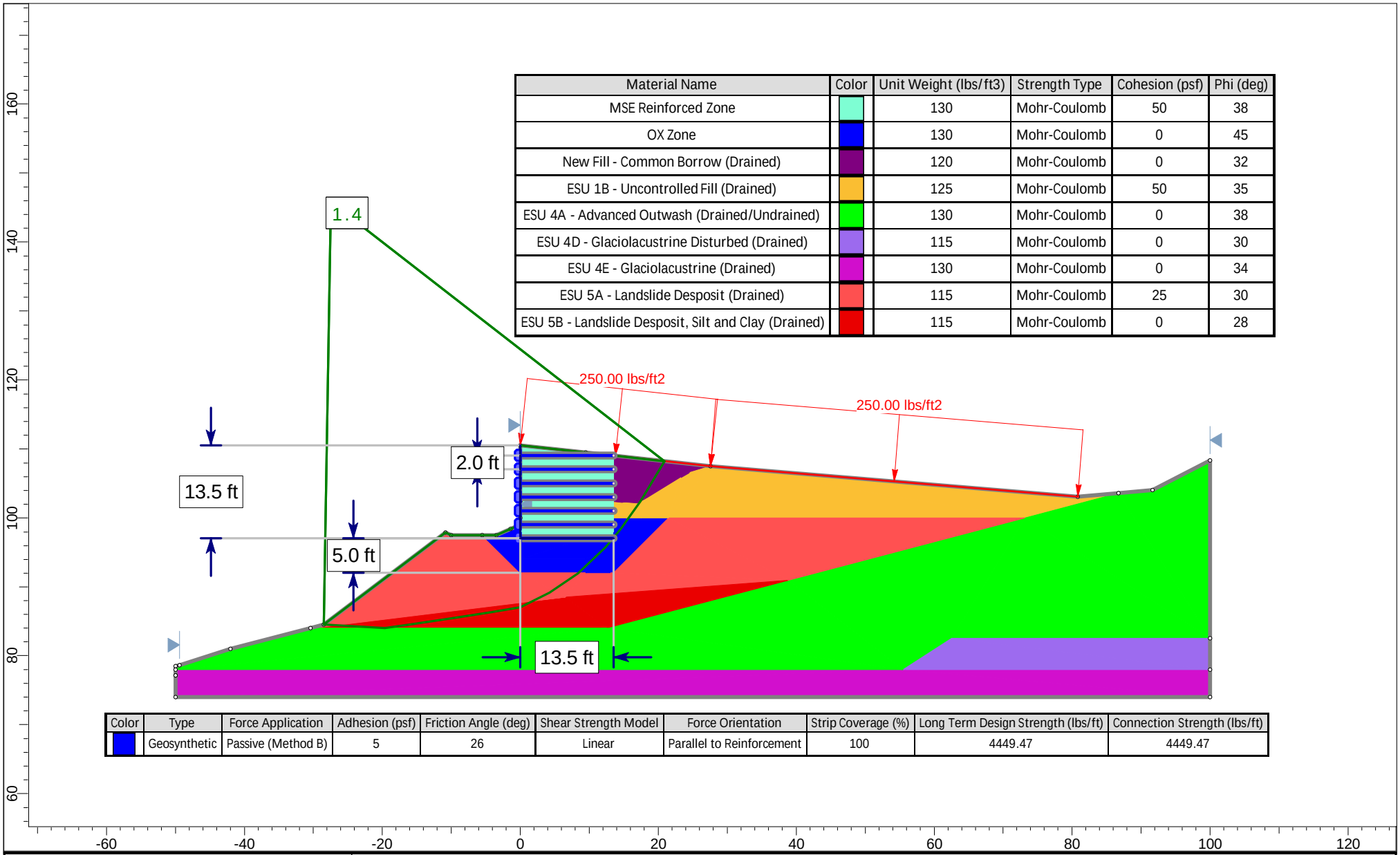
Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5826+00./ ML 5+75)		
Group Name	Sta. 5826+00_ML 5+75 w/ MSE wall (Existing)	Scenario Name	1.1 Static
Drawn By	MAK	Scale	1:230
Analysis Method	Spencer		
Date	9/6/2021, 12:19:18 PM	File Name	Wall 9.90L STA 5826+00.slmd

Terracon

SLIDEINTERPRET 9.018

Drained Case

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Reinforced Zone		130	Mohr-Coulomb	50	38
OX Zone		130	Mohr-Coulomb	0	45
New Fill - Common Borrow (Drained)		120	Mohr-Coulomb	0	32
ESU 1B - Uncontrolled Fill (Drained)		125	Mohr-Coulomb	50	35
ESU 4A - Advanced Outwash (Drained/Undrained)		130	Mohr-Coulomb	0	38
ESU 4D - Glaciolacustrine Disturbed (Drained)		115	Mohr-Coulomb	0	30
ESU 4E - Glaciolacustrine (Drained)		130	Mohr-Coulomb	0	34
ESU 5A - Landslide Desposit (Drained)		115	Mohr-Coulomb	25	30
ESU 5B - Landslide Desposit, Silt and Clay (Drained)		115	Mohr-Coulomb	0	28



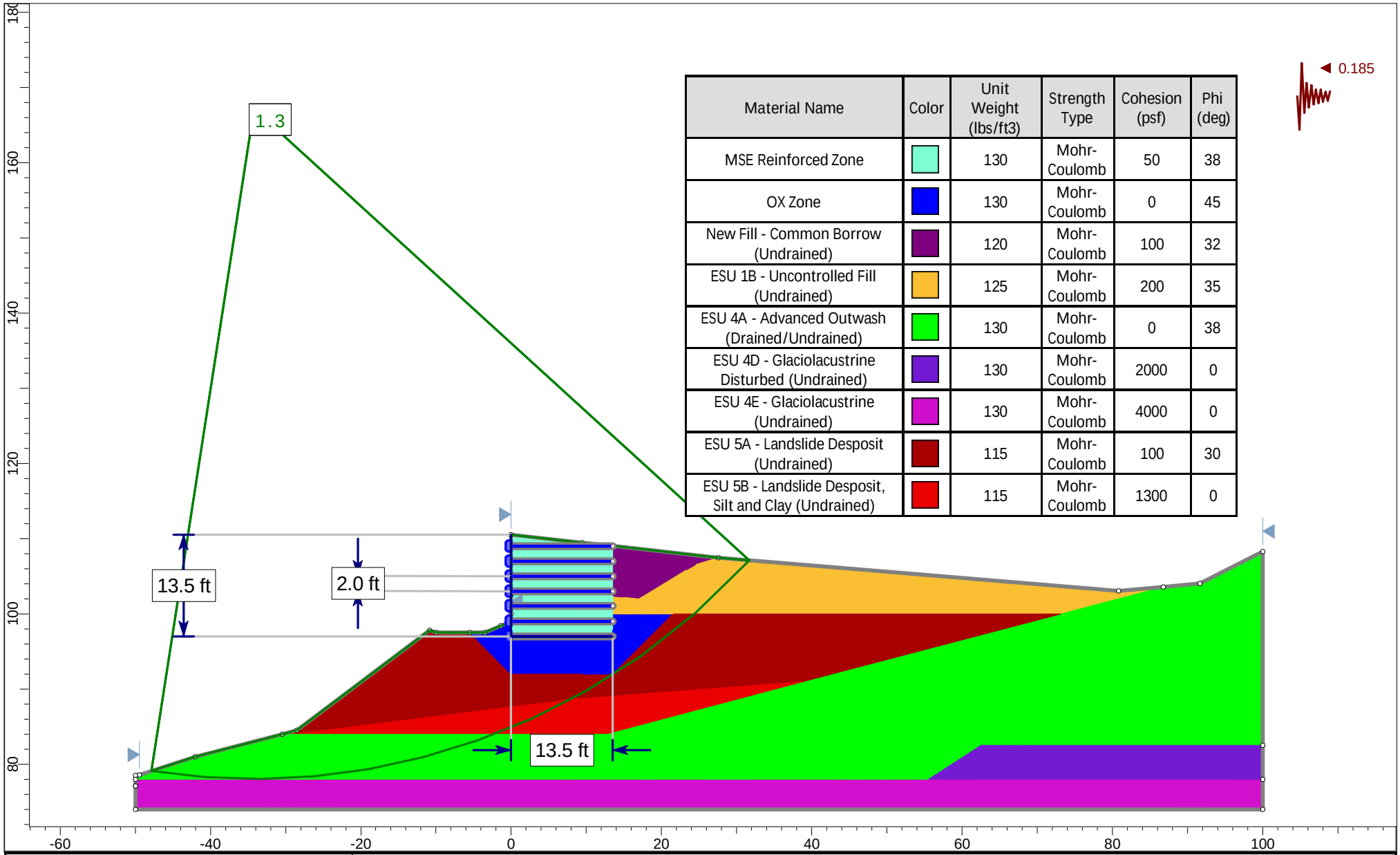
Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Linear	Parallel to Reinforcement	100	4449.47	4449.47

Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5826+00./ ML 5+75)		
Group Name	Sta. 5826+00_ML 5+75 w/ MSE wall (1.0H+OX)	Scenario Name	2.1 Static
Drawn By	MAK	Scale	1:231
Analysis Method	Spencer		
Date	9/6/2021, 12:19:18 PM	File Name	Wall 9.90L STA 5826+00.slmd

Undrained Case



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Reinforced Zone		130	Mohr-Coulomb	50	38
OX Zone		130	Mohr-Coulomb	0	45
New Fill - Common Borrow (Undrained)		120	Mohr-Coulomb	100	32
ESU 1B - Uncontrolled Fill (Undrained)		125	Mohr-Coulomb	200	35
ESU 4A - Advanced Outwash (Drained/Undrained)		130	Mohr-Coulomb	0	38
ESU 4D - Glaciolacustrine Disturbed (Undrained)		130	Mohr-Coulomb	2000	0
ESU 4E - Glaciolacustrine (Undrained)		130	Mohr-Coulomb	4000	0
ESU 5A - Landslide Desposit (Undrained)		115	Mohr-Coulomb	100	30
ESU 5B - Landslide Desposit, Silt and Clay (Undrained)		115	Mohr-Coulomb	1300	0

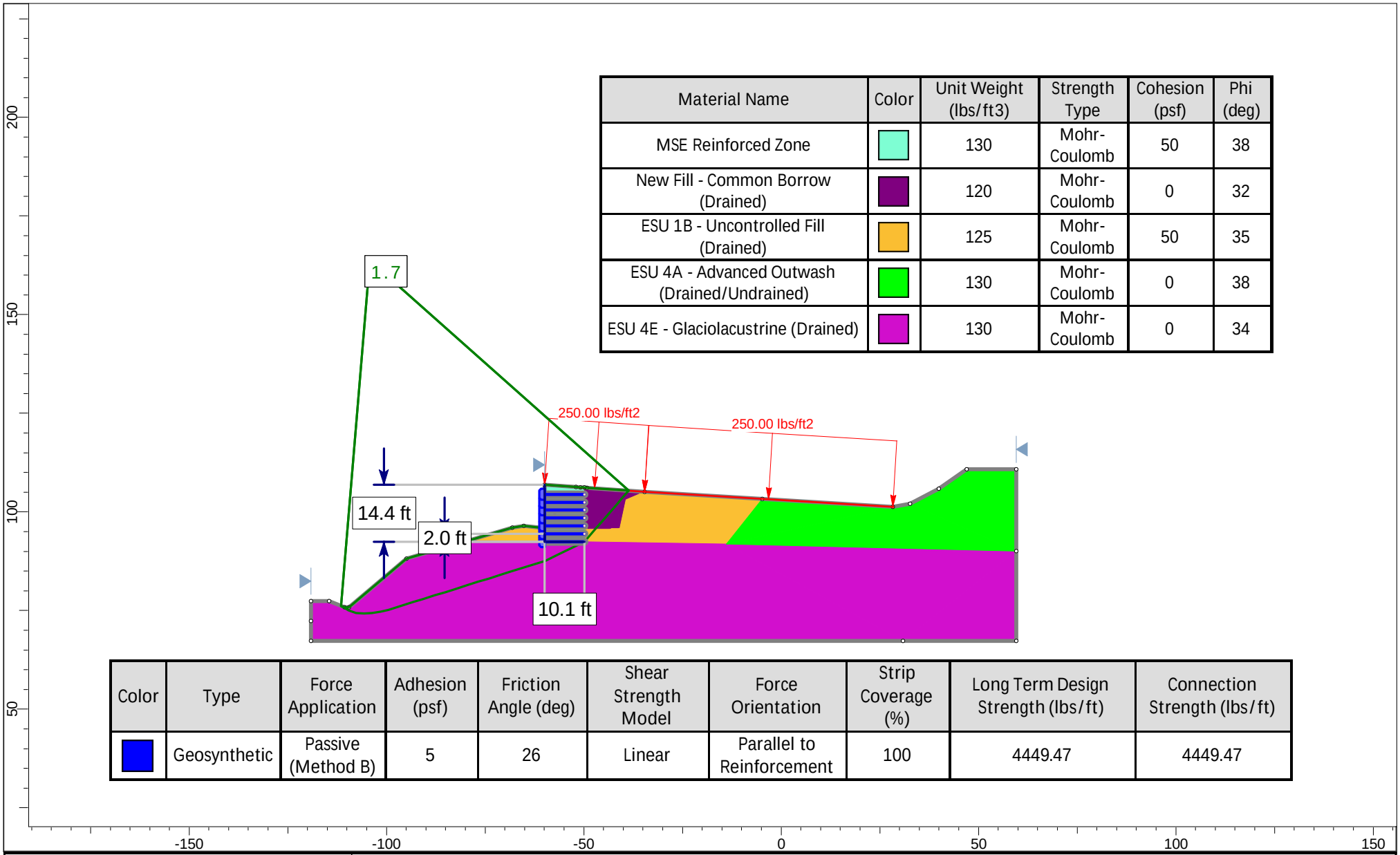
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5826+00./ ML 5+75)		
Group Name	Sta. 5826+00_ML 5+75 w/ MSE wall (1.0H+OX)	Scenario Name	2.2 Pseudostatic
Drawn By	MAK	Scale	1:212
Analysis Method	Spencer		
Date	9/6/2021, 12:19:18 PM	File Name	Wall 9.90L STA 5826+00.slmd

Drained Case

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Reinforced Zone		130	Mohr-Coulomb	50	38
New Fill - Common Borrow (Drained)		120	Mohr-Coulomb	0	32
ESU 1B - Uncontrolled Fill (Drained)		125	Mohr-Coulomb	50	35
ESU 4A - Advanced Outwash (Drained/Undrained)		130	Mohr-Coulomb	0	38
ESU 4E - Glaciolacustrine (Drained)		130	Mohr-Coulomb	0	34



Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Linear	Parallel to Reinforcement	100	4449.47	4449.47

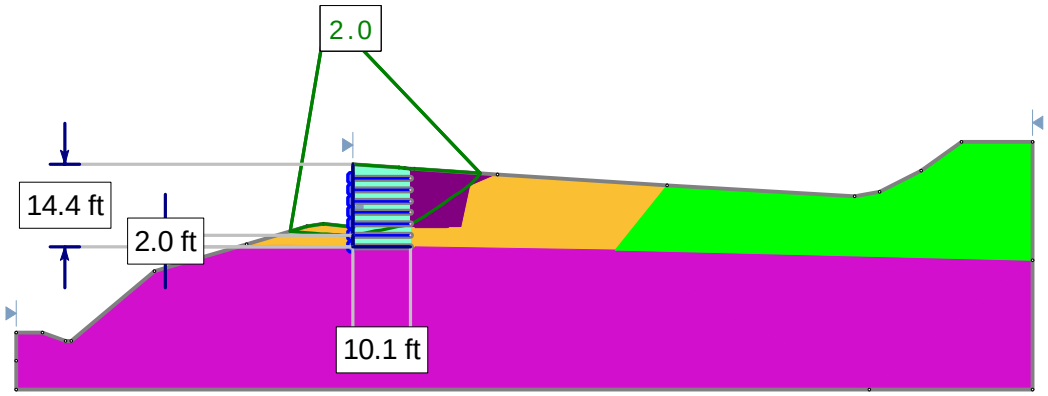
Terracon

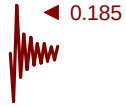
SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5828+00./ ML 7+80)		
Group Name	2.1 Sta. 5828+00 w/ MSE wall (0.7H)	Scenario Name	1. Static
Drawn By	MAK	Scale	1:404
Analysis Method	Spencer		
Date	9/6/2021, 12:19:18 PM	File Name	Wall 9.90L STA 5828+00.slmd

Undrained Case

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Reinforced Zone		130	Mohr-Coulomb	50	38
New Fill - Common Borrow (Undrained)		120	Mohr-Coulomb	100	32
ESU 1B - Uncontrolled Fill (Undrained)		125	Mohr-Coulomb	200	35
ESU 4A - Advanced Outwash (Drained/Undrained)		130	Mohr-Coulomb	0	38
ESU 4E - Glaciolacustrine (Undrained)		130	Mohr-Coulomb	4000	0





Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Linear	Parallel to Reinforcement	100	4449.47	4449.47

200
150
100
50
-200
-150
-100
-50
0
50
100

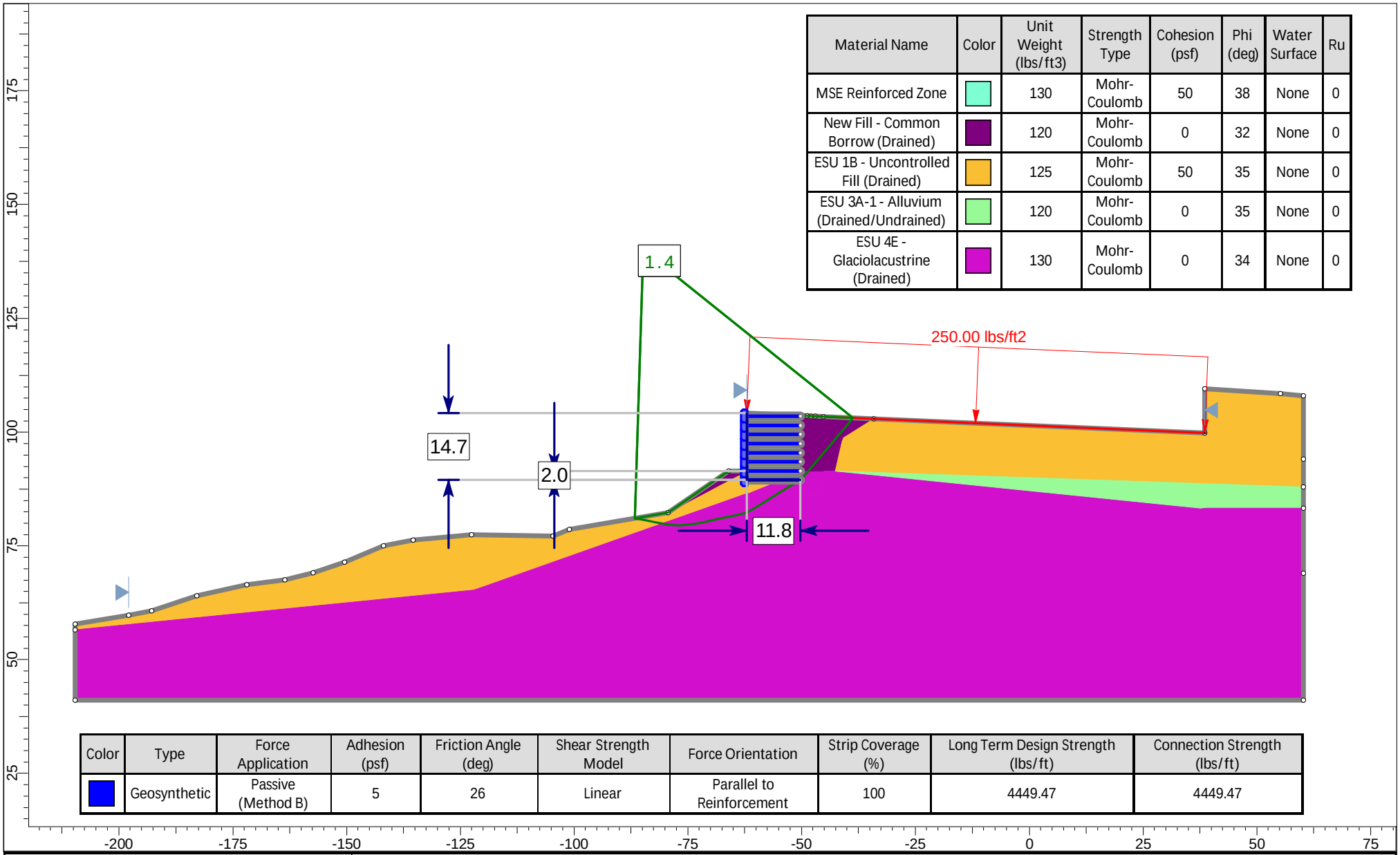
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5828+00./ ML 7+80)		
Group Name	2.1 Sta. 5828+00 w/ MSE wall (0.7H)	Scenario Name	2. Psuedostatic
Drawn By	MAK	Scale	1:405
Analysis Method	Spencer		
Date	9/6/2021, 12:19:18 PM	File Name	Wall 9.90L STA 5828+00.slmd

Drained Case

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
MSE Reinforced Zone		130	Mohr-Coulomb	50	38	None	0
New Fill - Common Borrow (Drained)		120	Mohr-Coulomb	0	32	None	0
ESU 1B - Uncontrolled Fill (Drained)		125	Mohr-Coulomb	50	35	None	0
ESU 3A-1 - Alluvium (Drained/Undrained)		120	Mohr-Coulomb	0	35	None	0
ESU 4E - Glaciolacustrine (Drained)		130	Mohr-Coulomb	0	34	None	0



Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Linear	Parallel to Reinforcement	100	4449.47	4449.47

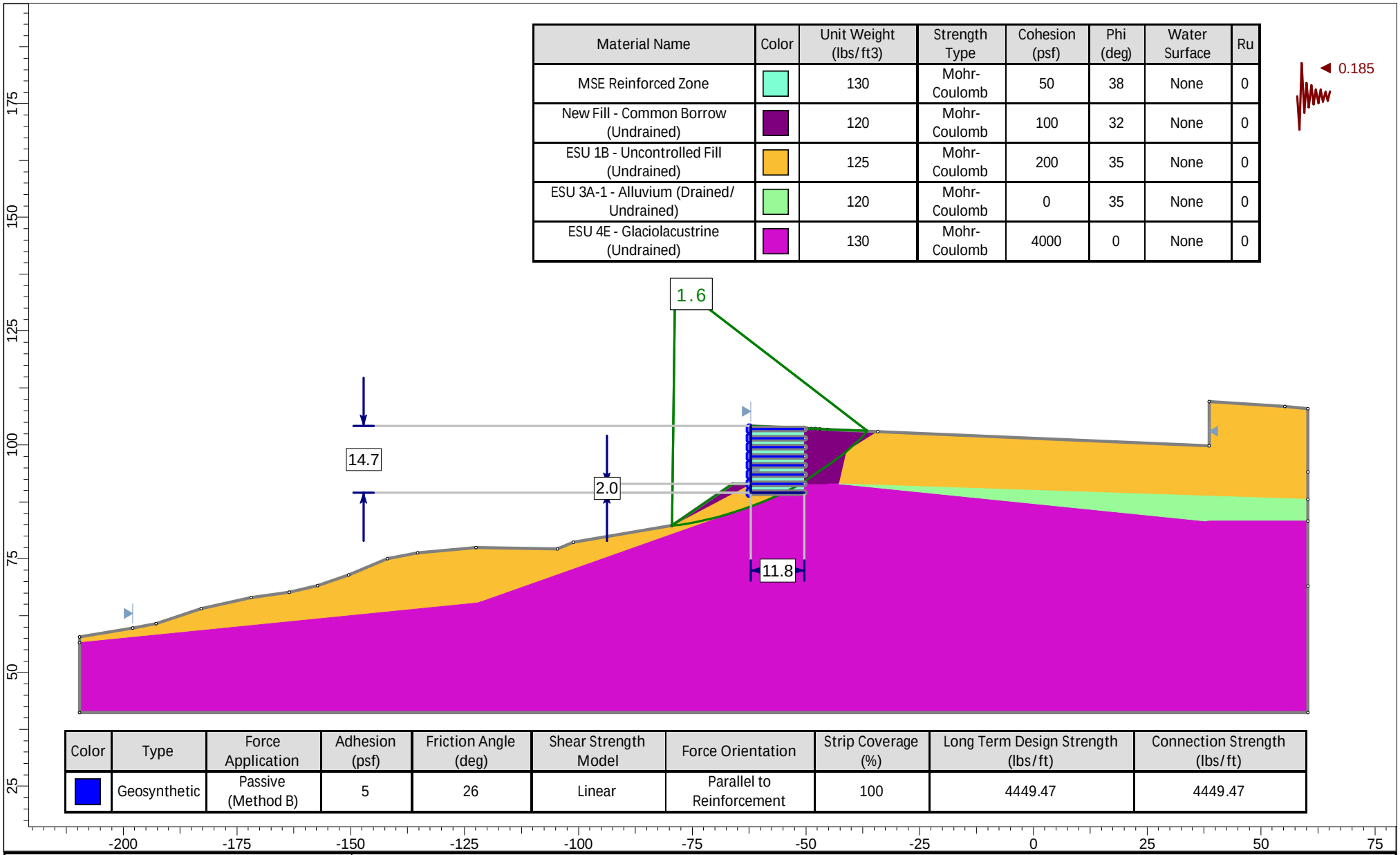
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5829+00./ ML 8+80)		
Group Name	1.1 Sta. 5829+00_ML 8+80 w/ MSE wall (0.8H)	Scenario Name	1. Static
Drawn By	MAK	Scale	1:350
Analysis Method	Spencer		
Date		File Name	Wall 9.90L STA 5829+00.slmd

Undrained Case

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
MSE Reinforced Zone		130	Mohr-Coulomb	50	38	None	0
New Fill - Common Borrow (Undrained)		120	Mohr-Coulomb	100	32	None	0
ESU 1B - Uncontrolled Fill (Undrained)		125	Mohr-Coulomb	200	35	None	0
ESU 3A-1 - Alluvium (Drained/ Undrained)		120	Mohr-Coulomb	0	35	None	0
ESU 4E - Glaciolacustrine (Undrained)		130	Mohr-Coulomb	4000	0	None	0



Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Linear	Parallel to Reinforcement	100	4449.47	4449.47

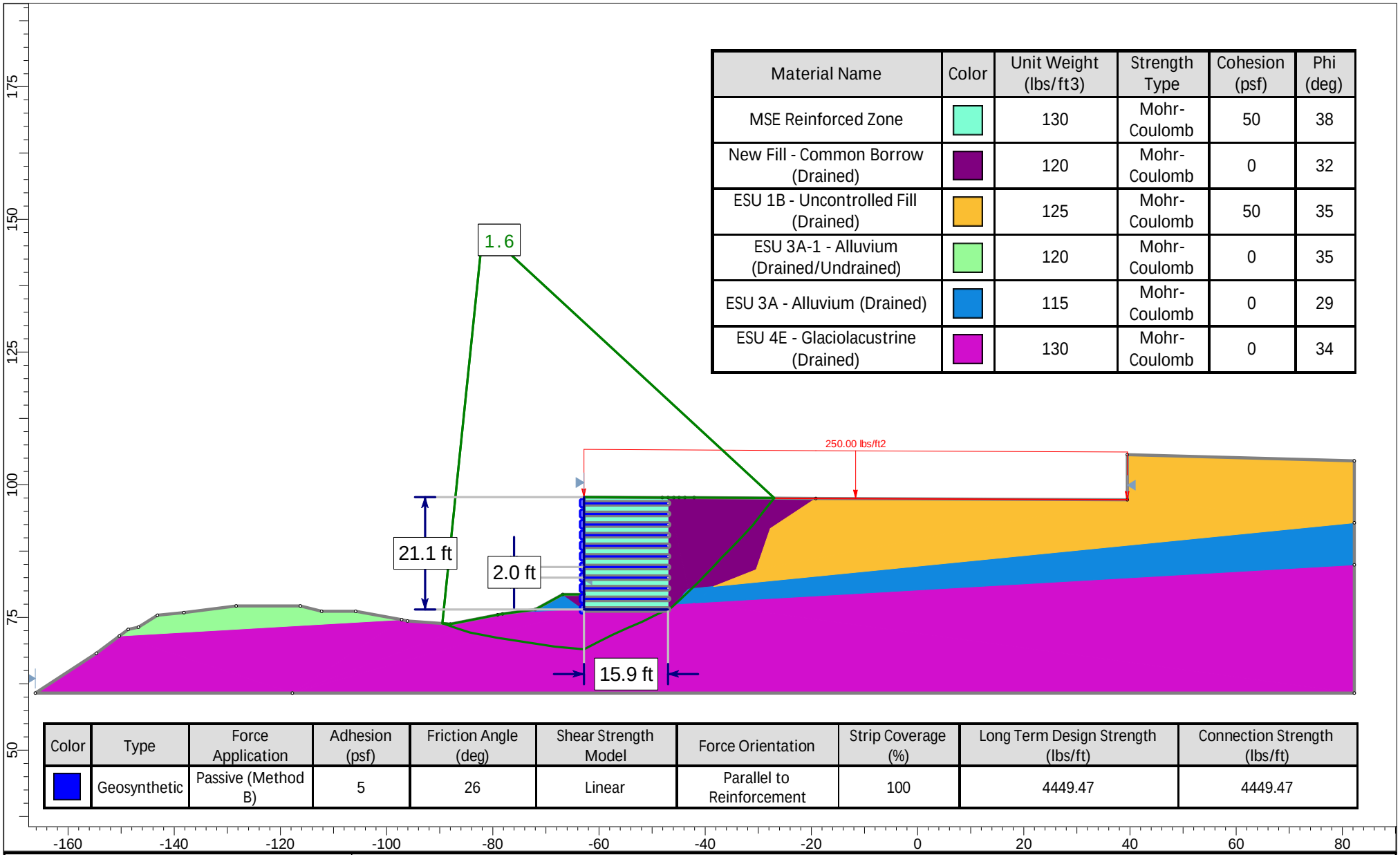
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5829+00./ ML 8+80)		
Group Name	1.1 Sta. 5829+00_ML 8+80 w/ MSE wall (0.8H)	Scenario Name	2. Psuedostatic
Drawn By	MAK	Scale	1:350
Analysis Method	Spencer		
Date		File Name	Wall 9.90L STA 5829+00.slmd

Drained Case

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Reinforced Zone		130	Mohr-Coulomb	50	38
New Fill - Common Borrow (Drained)		120	Mohr-Coulomb	0	32
ESU 1B - Uncontrolled Fill (Drained)		125	Mohr-Coulomb	50	35
ESU 3A-1 - Alluvium (Drained/Undrained)		120	Mohr-Coulomb	0	35
ESU 3A - Alluvium (Drained)		115	Mohr-Coulomb	0	29
ESU 4E - Glaciolacustrine (Drained)		130	Mohr-Coulomb	0	34



Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Linear	Parallel to Reinforcement	100	4449.47	4449.47

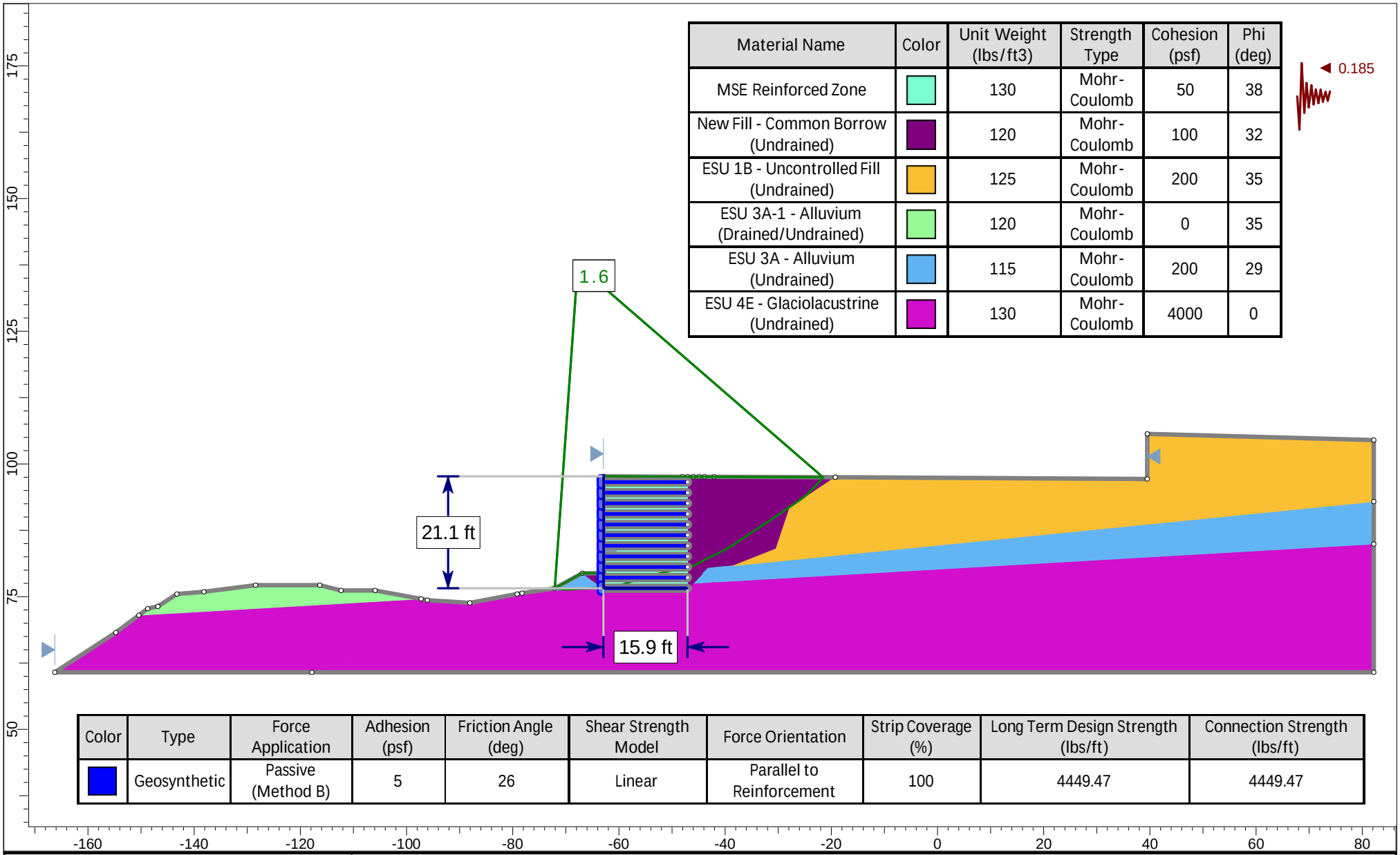
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5831+00./ ML 10+80)		
Group Name	Sta. 5831+00_ML 10+80 w/ MSE wall (0.75H)	Scenario Name	1. Static
Drawn By	MAK	Scale	1:300
Analysis Method	Spencer		
Date		File Name	Wall 9.90L STA 5831+00.slmd

Undrained Case

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
MSE Reinforced Zone		130	Mohr-Coulomb	50	38
New Fill - Common Borrow (Undrained)		120	Mohr-Coulomb	100	32
ESU 1B - Uncontrolled Fill (Undrained)		125	Mohr-Coulomb	200	35
ESU 3A-1 - Alluvium (Drained/Undrained)		120	Mohr-Coulomb	0	35
ESU 3A - Alluvium (Undrained)		115	Mohr-Coulomb	200	29
ESU 4E - Glaciolacustrine (Undrained)		130	Mohr-Coulomb	4000	0



Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Linear	Parallel to Reinforcement	100	4449.47	4449.47

Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90L A (WALL STA. 5831+00./ ML 10+80)		
Group Name	Sta. 5831+00_ML 10+80 w/ MSE wall (0.75H)	Scenario Name	2. Pseudostatic
Drawn By	MAK	Scale	1:300
Analysis Method	Spencer		
Date		File Name	Wall 9.90L STA 5831+00.slmd

7) Settlement Analyses:

We chose 4 representative sections of the wall and estimated settlements of wall at those stations. We used Hough method to estimate settlement of wall footings on cohesionless soils. If the foundation soil has both cohesive soil as well as cohesionless soil, total settlement will be settlement estimated using consolidation theory for fine grained soil and settlement estimated using Hough method for the coarse-grained soil.

We reviewed all the previously submitted report sent to us by FLATIRON. Test data provided in those reports and our previous experience we used the consolidation properties compiled below. Details of settlement analysis and the summary of results are provided in next pages.

Wall	ESU Unit	USCS Soil Type	e_0	$C_c/1+e_0$	C_r
5+75	5B	CL	1.085	0.0906	0.00906
7+80	4D/4E	CL/CH	1.085	0.13	0.04
8+80	4E	CL/CH	1.085	0.13	0.04
10+80	4E	CL	1.085	0.13	0.04

Consolidation Parameters are collected from following Reference Documents:

1. WOOD (2021), Geotechnical Engineering Report: Fish Passage 10.0, Project # PS19-20316-0, Kirkland, Washington
2. WSDOT (2018), I-405 Renton to Bellevue Widening and Express Toll Lanes Project, XL-4653/XL-5467, I-405, MP 0.0-14.6, Olympia, Washington
3. NAVFAC (1982), Soil Mechanics Design Manual 7.1, Alexandria, Virginia

For wall 9.90A, the ground water was not encountered during the soil exploration. But we observed fine grained soil samples with high moisture content. With additional overburden pressure, these soil samples may undergo consolidation. To be conservative, we estimate the settlement within the fine-grained layers using consolidation theory. We did not calculate time rate of consolidation settlement for wall 9.90LA.

SETTLEMENT RESULT SUMMARY

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	GROUND IMPROVEMENT DEPTH (FT)	MINIMUM EARTH REINFORCEMENT RATIO OR LENGTH (FT)	BORING LOG USED FOR HOUGH ANALYSIS	ESTIMATED SETTLEMENT (IN)
09.90 L(A)	3+41	3+98	6.5	No	8 feet	See Note 2	1 to 3 inches
	3+98	5+08	17.5	No	0.7H or 8 feet whichever is greater	See Note 2	1 to 3 inches
	5+08	6+30	16.0	Yes (5 feet)	1.0H or 8 feet whichever is greater	W-149-20	1 to 3 inches
	6+30	7+60	12	No	0.7H or 8 feet whichever is greater	See Note 2	1 to 3 inches
	7+60	8+30	14.0	No	0.8H or 8 feet whichever is greater	W-150-20	2 to 4.5 inches
	8+30	10+08	18.5	No	0.8H or 8 feet whichever is greater	W-150-20	2 to 4.5 inches
	10+08	11+35	21	No	0.8H or 8 feet whichever is greater	W-27-20 and W-151-20	2 to 3.5 inches
	11+35	11+86	16.5	No	0.8H or 8 feet whichever is greater	See Note 2	1 to 3 inches

NOTE:
1. Settlement is calculated up to a depth below the bottom of wall where stress increase due to wall foundation load is less than 10% of the existing overburden stress.
2. We estimated settlement based on our previous experience on similar soils.

REV.	DATE	BY	DESCRIPTION

WALL 9.90 L(A)

81215044: I-405 RENTON TO BELELVUE
PARSONS TRANSPORATION GROUP

OCT 2021

WA

Terracon
Consulting Engineers and Scientists

FIG/DRAWING

DESIGNED BY:	XXX
DRAWN BY:	XXX
APPVD. BY:	XXX
SCALE:	AS SHOWN
DATE:	XX-XX-XX
JOB NO.	XXXXXXXX
CAD FILE	SHEET NAME
SHEET NO.:	XX OF XX

SUMMARY OF LABORATORY RESULTS

wood.

PROJECT NAME I-405/Renton to Bellevue-Corridor Wide **PROJECT NUMBER** 81215044 **BORING NUMBER** W-149-20

CLIENT Parsons Transportation Group Inc **PROJECT LOCATION**

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
W-149-20	2.5				19	43		15.7			
W-149-20	5.0							9.6			
W-149-20	7.5	21	17	4	0.075	35	SC-SM	17.8			
W-149-20	10.0				0.075	52		21.5			
W-149-20	15.0	31	22	9	0.075	62	CL	19.1			
W-149-20	20.0				9.5	10		6.4			
W-149-20	25.0				0.075	20		17.6			

5A

5B

4A

TABLE 3
Estimates of Coefficient of Consolidation (C+c,)

```
+)))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))),
*                                                                          *
*   C+c, = 0.009 (LL - 10%) inorganic soils, with sensitivity less than 4  *
*                                                                          *
*   C+c, = 0.0115 w+n, organic soils, peat                                 *
*                                                                          *
*   C+c, = 1.15 (e+o, - 0.35) all clays                                    *
*                                                                          *
*   C+c, = (1 + e+o,)(0.1 + [w+n, - 25] 0.006) varved clays                *
*                                                                          *
*w+n, is natural moisture content, LL is water content at liquid limit and *
*e+o, is initial void ratio.                                               *
.)))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))))-
```

For 5B Layer

Cc = 0.009*(31-10) = 0.189

Cr = Cc*0.1 = 0.0189

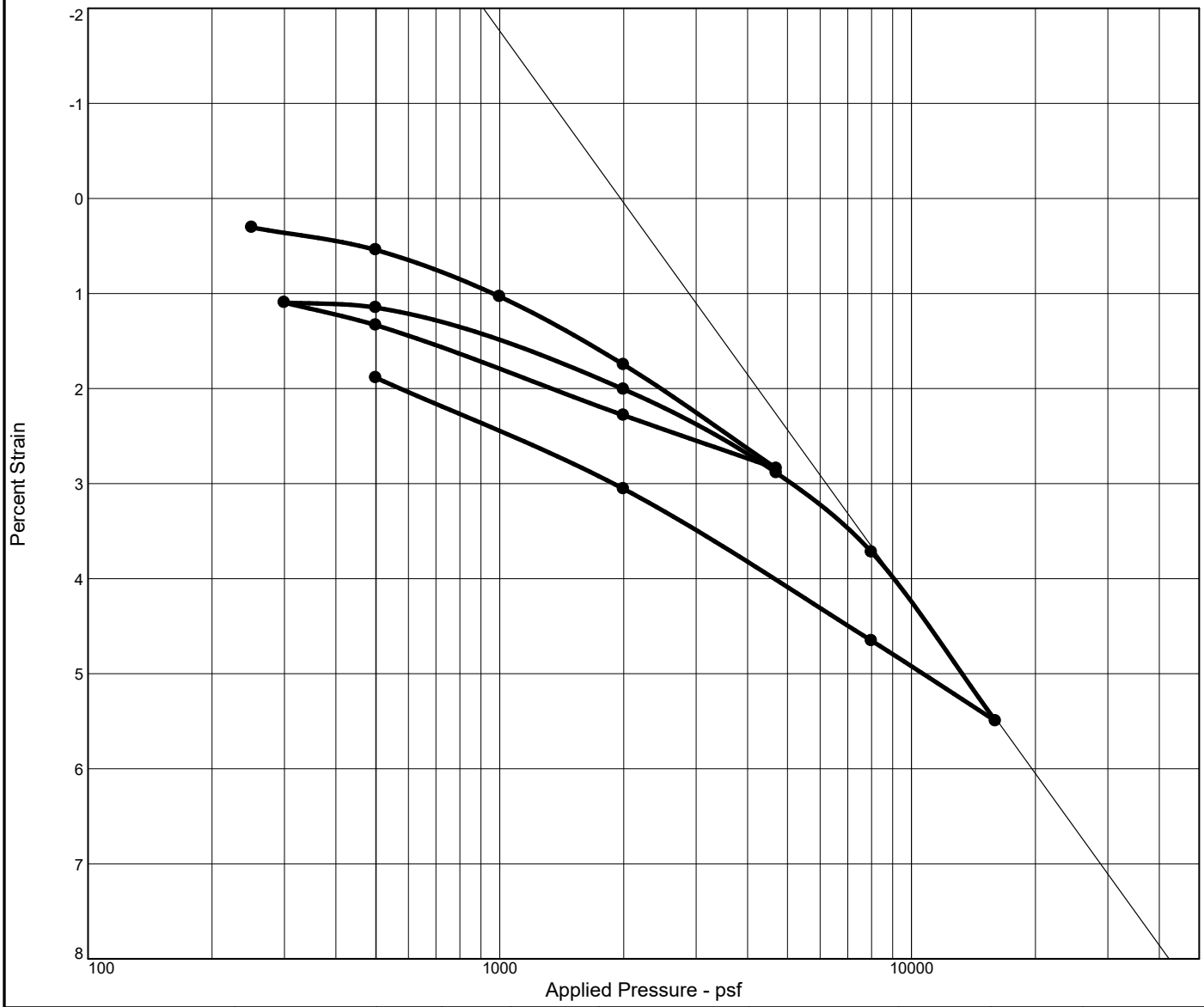
e0 = 1.085

Cce = Cc/(1+e0) = .0906

Cre = .00906

LAB SUMMARY - GINT STD US LAB.GDT - 11/15/21 12:12 - C:\USERS\AKHAN\ONEDRIVE - TERRACON CONSULTANTS INC\DESKTOP\TERRACON GINT FORMAT.GPJ

CONSOLIDATION TEST REPORT



Natural Saturation	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_r	Initial Void Ratio
101.8 %	40.0 %	82.6	67	41	2.76	980	2858	0.13	0.04	1.085

MATERIAL DESCRIPTION	USCS	AASHTO
CH - FAT CLAY	CH	T-216

Project No. XL-4653 **Client:** Jason Qiu

Project: I-405 Renton to Bellevue

Source of Sample: R2B-69-17 **Depth:** 8.0 **Sample Number:** PS-4

Remarks:

WSDOT

Figure

Tested By: DDH **Checked By:** GW

81215044 - RTB
Wall 9.90L-A Sta. 5+75 (W-149-20)

97	Footing Elevation (ft)
1755	Footing Stress (psf)
13.5	Footing Width (ft)
100	Footing Length (ft)

40	Depth to Water (ft)

	Calculated
1.7	Settlement (in)

This is the effect of the fill to retainingt wall subgrade

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γsat (pcf)	Material #	SPT N Iterated	Iterated γsat (pcf)	Iterated Material #	Water γw (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c 1 + e_o (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	97	50	130	2	50	130	2	0	2.00	100	512	0.002				130	0	130	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.0000
2	96				50	130	2	0	2.00	100	512	0.002				260	0	260	1	13.50	0.970	655%	1702.44	0.0017	0.0017	0.0206	0.0200
3	95				50	130	2	0	2.00	100	512	0.002				390	0	390	2	6.75	0.932	419%	1635.14	0.0014	0.0031	0.0373	0.0400
4	94				50	130	2	0	1.98	99	501	0.002				520	0	520	3	4.50	0.887	299%	1556.36	0.0012	0.0043	0.0517	0.0500
5	93				50	130	2	0	1.71	86	380	0.003				650	0	650	4	3.38	0.839	227%	1473.06	0.0014	0.0057	0.0680	0.0700
6	92	50	130	2	50	130	2	0	1.51	76	305	0.003				780	0	780	5	2.70	0.792	178%	1389.40	0.0015	0.0071	0.0854	0.0900
7	91				40	126	2	0	1.36	54	187	0.005				906	0	906	6	2.25	0.745	144%	1307.92	0.0021	0.0092	0.1104	0.1100
8	90				30	123	2	0	1.26	37	123	0.008				1029	0	1029	7	1.93	0.701	120%	1230.09	0.0028	0.0120	0.1438	0.1400
9	89				19	119	2	0	1.18	23	83	0.012				1148	0	1148	8	1.69	0.659	101%	1156.73	0.0037	0.0156	0.1877	0.1900
10	88	9	115	6	9	115	6	0	1.12	10	29	0.091	0.091	1.085	0.009	1263	0	1263	9	1.50	0.620	86%	1088.18	0.0245	0.0401	0.4812	0.4800
11	87				10	117	6	0	1.07	11	29	0.091	0.091	1.085	0.009	1380	0	1380	10	1.35	0.584	74%	1024.51	0.0219	0.0620	0.7435	0.7400
12	86				11	119	6	0	1.04	11	30	0.091	0.091	1.085	0.009	1499	0	1499	11	1.23	0.550	64%	965.59	0.0196	0.0815	0.9783	0.9800
13	85				12	121	6	0	1.01	12	31	0.091	0.091	1.085	0.009	1620	0	1620	12	1.13	0.519	56%	911.21	0.0176	0.0991	1.1891	1.1900
14	84				13	123	6	0	0.98	13	32	0.091	0.091	1.085	0.009	1743	0	1743	13	1.04	0.491	49%	861.06	0.0158	0.1149	1.3787	1.3800
15	83	14	125	4	14	125	4	0	0.96	13	48	0.021				1868	0	1868	14	0.96	0.464	44%	814.86	0.0033	0.1182	1.4184	1.4200
16	82				16	125	4	0	0.95	16	51	0.020				1993	0	1993	15	0.90	0.440	39%	772.30	0.0028	0.1210	1.4520	1.4500
17	81				19	125	4	0	0.93	17	54	0.018				2118	0	2118	16	0.84	0.418	35%	733.05	0.0024	0.1234	1.4806	1.4800
18	80				21	125	4	0	0.91	19	57	0.017				2243	0	2243	17	0.79	0.397	31%	696.85	0.0020	0.1254	1.5052	1.5100
19	79				24	125	4	0	0.90	21	61	0.017				2368	0	2368	18	0.75	0.378	28%	663.41	0.0018	0.1272	1.5265	1.5300
20	78	26	125	3	26	125	3	0	0.88	23	75	0.013				2493	0	2493	19	0.71	0.360	25%	632.50	0.0013	0.1285	1.5422	1.5400
21	77				27	125	3	0	0.87	23	76	0.013				2618	0	2618	20	0.68	0.344	23%	603.89	0.0012	0.1297	1.5564	1.5600
22	76				28	126	3	0	0.85	24	77	0.013				2743	0	2743	21	0.64	0.329	21%	577.36	0.0011	0.1308	1.5694	1.5700
23	75				29	126	3	0	0.84	24	78	0.013				2869	0	2869	22	0.61	0.315	19%	552.74	0.0010	0.1318	1.5812	1.5800
24	74				29	126	3	0	0.83	24	78	0.013				2995	0	2995	23	0.59	0.302	18%	529.85	0.0009	0.1327	1.5920	1.5900
25	73				30	126	3	0	0.82	25	79	0.013				3122	0	3122	24	0.56	0.290	16%	508.55	0.0008	0.1335	1.6020	1.6000
26	72				31	127	3	0	0.81	25	80	0.013				3249	0	3249	25	0.54	0.278	15%	488.69	0.0008	0.1343	1.6111	1.6100
27	71				32	127	3	0	0.80	26	81	0.012				3376	0	3376	26	0.52	0.268	14%	470.15	0.0007	0.1350	1.6195	1.6200
28	70				33	127	3	0	0.79	26	82	0.012				3503	0	3503	27	0.50	0.258	13%	452.81	0.0006	0.1356	1.6273	1.6300
29	69				34	128	3	0	0.78	26	83	0.012				3630	0	3630	28	0.48	0.249	12%	436.59	0.0006	0.1362	1.6344	1.6300
30	68				35	128	3	0	0.77	27	84	0.012				3758	0	3758	29	0.47	0.240	11%	421.38	0.0006	0.1368	1.6410	1.6400
31	67				35	128	3	0	0.77	27	85	0.012				3886	0	3886	30	0.45	0.232	10%	407.11	0.0005	0.1373	1.6472	1.6500
32	66				36	128	3	0	0.76	28	86	0.012				4015	0	4015	31	0.44	0.224	10%	393.69	0.0005	0.1377	1.6529	1.6500
33	65				37	129	3	0	0.75	28	86	0.012				4144	0	4144	32	0.42	0.217	9%	381.07	0.0004	0.1382	1.6582	1.6600
34	64				38	129	3	0	0.74	28	87	0.011				4273	0	4273	33	0.41	0.210	9%	369.17	0.0004	0.1386	1.6632	1.6600
35	63				39	129	3	0	0.73	28	87	0.011				4402	0	4402	34	0.40	0.204	8%	357.96	0.0004	0.1390	1.6678	1.6700
36	62				40	130	3	0	0.72	29	88	0.011				4532	0	4532	35	0.39	0.198	8%	347.37	0.0004	0.1394	1.6722	1.6700
37	61				41	130	3	0	0.70	29	88	0.011				4661	0	4661	36	0.38	0.192	7%	337.35	0.0003	0.1397	1.6764	1.6800
38	60				42	130	3	0	0.69	29	88	0.011				4792	0	4792	37	0.36	0.187	7%	327.88	0.0003	0.1400	1.6803	1.6800
39	59				42	130	3	0	0.67	28	88	0.011				4922	0	4922	38	0.36	0.182	6%	318.90	0.0003	0.1403	1.6840	1.6800
40	58				43	131	3	62.4	0.66	29	88	0.011				5053	62	4990	39	0.35	0.177	6%	310.39	0.0003	0.1406	1.6876	1.6900
41	57				44	131	3	62.4	0.66	29	89	0.011				5184	125	5059	40	0.34	0.172	6%	302.31	0.0003	0.1409	1.6910	1.6900
42	56				45	131	3	62.4	0.65	29	89	0.011				5315	187	5128	41	0.33	0.168	6%	294.63	0.0003	0.1412	1.6943	1.6900
43	55				46	132	3	62.4	0.65	30	90	0.011				5447	250	5197	42	0.32	0.164	5%	287.33	0.0003	0.1414	1.6974	1.7000
44	54				47	132	3	62.4	0.64	30	91	0.011				5579	312	5267	43	0.31	0.160	5%	280.38	0.0002	0.1417	1.7003	1.7000
45	53				48	132	3	62.4	0.65	31	93	0.011				5711	374	5336	44	0.31	0.156	5%	273.77	0.0002	0.1419	1.7032	1.7000
46	52				48	132	3	62.4	0.65	31	94	0.011				5843	437	5407	45	0.30	0.152	5%	267.45	0.0002	0.1422	1.7058	1.7100
47	51				49	133	3	62.4	0.66	32	97	0.010				5976	499	5477	46	0.29	0.149	4%	261.43	0.0002	0.1424	1.7083	1.7100
48	50				50	133	3	62.4	0.60	30	91	0.011				6109	562	5548	47	0.29	0.146	4%	255.68	0.0002	0.1426	1.7109	1.7100
49	49				51	133	3	62.4	0.60	31	92	0.011				6243	624	5619	48	0.28	0.143	4%	250.18	0.0002	0.1428	1.7134	1.7100
50	48				52	134	3	62.4	0.60	31	94	0.011				6376	686	5690	49	0.28	0.140	4%	244.93	0.0002	0.1430	1.7157	1.7200
51	47				53	134	3	62.4	0.60	32	95	0.011				6510	749	5761	50	0.27	0.137	4%	239.89	0.0002	0.1432	1.7180	1.7200
52	46				54	134	3	62.4	0.60	32	96	0.010				6644	811	5833	51	0.26	0.134	4%	235.07	0.0002	0.1433	1.7201	1.7200

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
53	45				54	134	3	62.4	0.60	33	97	0.010				6779	874	5905	52	0.26	0.131	3%	230.46	0.0002	0.1435	1.7222	1.7200
54	44				55	135	3	62.4	0.60	33	98	0.010				6913	936	5977	53	0.25	0.129	3%	226.03	0.0002	0.1437	1.7241	1.7200
55	43				56	135	3	62.4	0.60	34	100	0.010				7049	998	6050	54	0.25	0.126	3%	221.77	0.0002	0.1438	1.7260	1.7300
56	42				57	135	3	62.4	0.60	34	101	0.010				7184	1061	6123	55	0.25	0.124	3%	217.69	0.0002	0.1440	1.7278	1.7300
57	41				58	136	3	62.4	0.60	35	102	0.010				7320	1123	6196	56	0.24	0.122	3%	213.77	0.0001	0.1441	1.7295	1.7300
58	40				59	136	3	62.4	0.60	35	104	0.010				7455	1186	6270	57	0.24	0.120	3%	210.00	0.0001	0.1443	1.7312	1.7300
59	39				60	136	3	62.4	0.60	36	105	0.010				7592	1248	6344	58	0.23	0.118	3%	206.37	0.0001	0.1444	1.7328	1.7300
60	38				60	136	3	62.4	0.60	36	106	0.009				7728	1310	6418	59	0.23	0.116	3%	202.88	0.0001	0.1445	1.7343	1.7300
61	37				61	137	3	62.4	0.60	37	107	0.009				7865	1373	6492	60	0.23	0.114	3%	199.52	0.0001	0.1446	1.7358	1.7400
62	36				62	137	3	62.4	0.60	37	109	0.009				8002	1435	6567	61	0.22	0.112	2%	196.28	0.0001	0.1448	1.7372	1.7400
63	35				63	137	3	62.4	0.60	38	110	0.009				8139	1498	6642	62	0.22	0.110	2%	193.15	0.0001	0.1449	1.7386	1.7400
64	34				64	138	3	62.4	0.60	38	111	0.009				8277	1560	6717	63	0.21	0.108	2%	190.14	0.0001	0.1450	1.7399	1.7400
65	33				65	138	3	62.4	0.60	39	113	0.009				8415	1622	6793	64	0.21	0.107	2%	187.23	0.0001	0.1451	1.7411	1.7400

81215044 - RTB
Wall 9.90L-A Sta. 7+80 (W-150-20)

92	Footing Elevation (ft)
1885	Footing Stress (psf)
10.1	Footing Width (ft)
100	Footing Length (ft)

200	Depth to Water (ft)

This is the effect of the fill to retainingt wall subgrade

	Calculated
1.1	Settlement (in)

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	92	21	125	4	21	125	4	0	2.00	42	101	0.010				125	0	125	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	91				21	125	4	0	2.00	42	101	0.010				250	0	250	1	10.10	0.958	723%	1806.26	0.0091	0.0091	0.1092	0.11
3	90				21	125	4	0	2.00	42	101	0.010				375	0	375	2	5.05	0.902	453%	1700.11	0.0074	0.0165	0.1979	0.20
4	89	21	125	4	21	125	4	0	2.02	43	102	0.010				500	0	500	3	3.37	0.839	316%	1581.28	0.0061	0.0226	0.2711	0.27
5	88				25	123	4	0	1.76	45	106	0.009				623	0	623	4	2.53	0.775	234%	1461.63	0.0049	0.0275	0.3304	0.33
6	87				30	122	4	0	1.56	46	110	0.009				745	0	745	5	2.02	0.715	181%	1347.20	0.0041	0.0316	0.3794	0.38
7	86	34	120	6	34	120	6	0	1.41	48	81	0.012	0.130	1.085	0.040	865	0	865	6	1.68	0.658	143%	1240.91	0.0048	0.0364	0.4370	0.44
8	85				30	120	6	0	1.29	39	67	0.015	0.130	1.085	0.040	985	0	985	7	1.44	0.607	116%	1143.82	0.0050	0.0414	0.4965	0.50
9	84				26	120	6	0	1.20	31	57	0.018	0.130	1.085	0.040	1105	0	1105	8	1.26	0.560	96%	1056.01	0.0051	0.0465	0.5579	0.56
10	83	22	120	6	22	120	6	0	1.13	25	48	0.021	0.130	1.085	0.040	1225	0	1225	9	1.12	0.518	80%	977.04	0.0053	0.0518	0.6212	0.62
11	82				23	120	6	0	1.08	25	48	0.021	0.130	1.085	0.040	1345	0	1345	10	1.01	0.481	67%	906.20	0.0046	0.0564	0.6768	0.68
12	81				24	120	6	0	1.04	25	48	0.021	0.130	1.085	0.040	1465	0	1465	11	0.92	0.447	58%	842.70	0.0041	0.0605	0.7257	0.73
13	80	25	120	6	25	120	6	0	1.01	25	49	0.020	0.130	1.085	0.040	1585	0	1585	12	0.84	0.417	50%	785.75	0.0036	0.0641	0.7686	0.77
14	79				29	120	6	0	0.99	29	53	0.019	0.130	1.085	0.040	1705	0	1705	13	0.78	0.390	43%	734.62	0.0029	0.0670	0.8035	0.80
15	78				33	120	6	0	0.97	32	58	0.017	0.130	1.085	0.040	1825	0	1825	14	0.72	0.365	38%	688.63	0.0024	0.0694	0.8323	0.83
16	77	37	120	6	37	120	6	0	0.95	35	63	0.016	0.130	1.085	0.040	1945	0	1945	15	0.67	0.343	33%	647.16	0.0020	0.0714	0.8562	0.86
17	76				37	120	6	0	0.94	34	61	0.016	0.130	1.085	0.040	2065	0	2065	16	0.63	0.323	30%	609.69	0.0018	0.0732	0.8782	0.88
18	75				37	120	6	0	0.92	34	60	0.017	0.130	1.085	0.040	2185	0	2185	17	0.59	0.305	26%	575.74	0.0017	0.0749	0.8985	0.90
19	74				36	120	6	0	0.91	33	59	0.017	0.130	1.085	0.040	2305	0	2305	18	0.56	0.289	24%	544.91	0.0016	0.0764	0.9172	0.92
20	73	36	120	6	36	120	6	0	0.89	32	58	0.017	0.130	1.085	0.040	2425	0	2425	19	0.53	0.274	21%	516.84	0.0014	0.0779	0.9345	0.93
21	72				35	120	6	0	0.88	31	56	0.018	0.130	1.085	0.040	2545	0	2545	20	0.51	0.261	19%	491.21	0.0014	0.0792	0.9508	0.95
22	71				35	120	6	0	0.86	30	55	0.018	0.130	1.085	0.040	2665	0	2665	21	0.48	0.248	18%	467.76	0.0013	0.0805	0.9661	0.97
23	70				34	120	6	0	0.85	29	53	0.019	0.130	1.085	0.040	2785	0	2785	22	0.46	0.237	16%	446.25	0.0012	0.0817	0.9806	0.98
24	69	33	120	6	33	120	6	0	0.84	28	52	0.019	0.130	1.085	0.040	2905	0	2905	23	0.44	0.226	15%	426.48	0.0011	0.0829	0.9944	0.99
25	68				33	120	6	0	0.82	27	51	0.020	0.130	1.085	0.040	3025	0	3025	24	0.42	0.217	13%	408.25	0.0011	0.0839	1.0073	1.01
26	67				32	120	6	0	0.81	26	50	0.020	0.130	1.085	0.040	3145	0	3145	25	0.40	0.208	12%	391.43	0.0010	0.0850	1.0195	1.02
27	66				32	120	6	0	0.80	26	49	0.020	0.130	1.085	0.040	3265	0	3265	26	0.39	0.199	12%	375.85	0.0010	0.0859	1.0310	1.03
28	65				32	120	6	0	0.80	25	49	0.021	0.130	1.085	0.040	3385	0	3385	27	0.37	0.192	11%	361.41	0.0009	0.0868	1.0419	1.04
29	64				31	120	6	0	0.79	25	48	0.021	0.130	1.085	0.040	3505	0	3505	28	0.36	0.185	10%	348.00	0.0009	0.0877	1.0522	1.05
30	63	31	120	6	31	120	6	0	0.78	24	47	0.021	0.130	1.085	0.040	3625	0	3625	29	0.35	0.178	9%	335.51	0.0008	0.0885	1.0619	1.06
31	62				32	120	6	0	0.77	25	48	0.021				3745	0	3745	30	0.34	0.172	9%	323.87	0.0008	0.0892	1.0709	1.07
32	61				33	121	6	0	0.77	25	49	0.021				3866	0	3866	31	0.33	0.166	8%	312.99	0.0007	0.0899	1.0793	1.08
33	60				34	121	6	0	0.76	26	49	0.020				3987	0	3987	32	0.32	0.161	8%	302.82	0.0006	0.0906	1.0870	1.09
34	59				35	122	6	0	0.75	26	50	0.020				4109	0	4109	33	0.31	0.156	7%	293.29	0.0006	0.0912	1.0942	1.09
35	58				36	122	6	0	0.75	26	50	0.020				4231	0	4231	34	0.30	0.151	7%	284.35	0.0006	0.0917	1.1009	1.10
36	57				36	122	6	0	0.74	27	51	0.020				4353	0	4353	35	0.29	0.146	6%	275.94	0.0005	0.0923	1.1072	1.11
37	56				37	123	6	0	0.72	27	51	0.020				4476	0	4476	36	0.28	0.142	6%	268.03	0.0005	0.0928	1.1132	1.11
38	55				38	123	6	0	0.71	27	51	0.019				4599	0	4599	37	0.27	0.138	6%	260.58	0.0005	0.0932	1.1188	1.12
39	54				39	124	6	0	0.70	27	51	0.019				4723	0	4723	38	0.27	0.135	5%	253.55	0.0004	0.0937	1.1240	1.12
40	53				40	124	6	0	0.68	27	52	0.019				4846	0	4846	39	0.26	0.131	5%	246.90	0.0004	0.0941	1.1291	1.13
41	52				41	124	6	0	0.67	27	52	0.019				4971	0	4971	40	0.25	0.128	5%	240.62	0.0004	0.0945	1.1339	1.13
42	51				42	125	6	0	0.65	27	52	0.019				5095	0	5095	41	0.25	0.124	5%	234.67	0.0004	0.0949	1.1384	1.14
43	50				43	125	6	0	0.65	28	52	0.019				5220	0	5220	42	0.24	0.122	4%	229.03	0.0004	0.0952	1.1427	1.14
44	49				44	125	6	0	0.65	28	53	0.019				5346	0	5346	43	0.23	0.119	4%	223.68	0.0003	0.0956	1.1467	1.15
45	48				45	126	6	0	0.66	29	54	0.018				5472	0	5472	44	0.23	0.116	4%	218.60	0.0003	0.0959	1.1505	1.15
46	47				46	126	6	0	0.60	27	52	0.019				5598	0	5598	45	0.22	0.113	4%	213.77	0.0003	0.0962	1.1543	1.15
47	46				46	127	6	0	0.60	28	52	0.019				5725	0	5725	46	0.22	0.111	4%	209.17	0.0003	0.0965	1.1579	1.16
48	45				47	127	6	0	0.60	28	53	0.019				5852	0	5852	47	0.21	0.109	3%	204.79	0.0003	0.0968	1.1613	1.16
49	44				48	127	6	0	0.60	29	54	0.019				5979	0	5979	48	0.21	0.106	3%	200.62	0.0003	0.0970	1.1645	1.16
50	43				49	128	6	0	0.60	30	55	0.018				6107	0	6107	49	0.21	0.104	3%	196.63	0.0003	0.0973	1.1675	1.17

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
51	42				50	128	6	0	0.60	30	55	0.018				6235	0	6235	50	0.20	0.102	3%	192.83	0.0002	0.0975	1.1704	1.17
52	41				51	129	6	0	0.60	31	56	0.018				6364	0	6364	51	0.20	0.100	3%	189.19	0.0002	0.0978	1.1731	1.17
53	40				52	129	6	0	0.60	31	57	0.018				6493	0	6493	52	0.19	0.099	3%	185.71	0.0002	0.0980	1.1757	1.18
54	39				53	129	6	0	0.60	32	58	0.017				6622	0	6622	53	0.19	0.097	3%	182.38	0.0002	0.0982	1.1781	1.18
55	38				54	130	6	0	0.60	32	58	0.017				6752	0	6752	54	0.19	0.095	3%	179.19	0.0002	0.0984	1.1805	1.18
56	37				55	130	6	0	0.60	33	59	0.017				6882	0	6882	55	0.18	0.093	3%	176.13	0.0002	0.0986	1.1827	1.18
57	36				56	131	6	0	0.60	33	60	0.017				7012	0	7012	56	0.18	0.092	2%	173.20	0.0002	0.0987	1.1848	1.18
58	35				56	131	6	0	0.60	34	61	0.017				7143	0	7143	57	0.18	0.090	2%	170.39	0.0002	0.0989	1.1869	1.19
59	34				57	131	6	0	0.60	34	61	0.016				7274	0	7274	58	0.17	0.089	2%	167.68	0.0002	0.0991	1.1888	1.19
60	33				58	132	6	0	0.60	35	62	0.016				7406	0	7406	59	0.17	0.088	2%	165.08	0.0002	0.0992	1.1906	1.19
61	32				59	132	6	0	0.60	36	63	0.016				7538	0	7538	60	0.17	0.086	2%	162.59	0.0001	0.0994	1.1924	1.19
62	31				60	132	6	0	0.60	36	64	0.016				7671	0	7671	61	0.17	0.085	2%	160.18	0.0001	0.0995	1.1941	1.19
63	30				61	133	6	0	0.60	37	64	0.016				7804	0	7804	62	0.16	0.084	2%	157.87	0.0001	0.0996	1.1957	1.20
64	29				62	133	6	0	0.60	37	65	0.015				7937	0	7937	63	0.16	0.083	2%	155.64	0.0001	0.0998	1.1973	1.20
65	28				63	134	6	0	0.60	38	66	0.015				8070	0	8070	64	0.16	0.081	2%	153.49	0.0001	0.0999	1.1988	1.20

81215044 - RTB
Wall 9.90L-A Sta. 7+80 (W-150-20)

92	Footing Elevation (ft)
1885	Footing Stress (psf)
10.1	Footing Width (ft)
100	Footing Length (ft)

200	Depth to Water (ft)

	Calculated
5.3	Settlement (in)

This is the effect of the fill to retainingt wall subgrade

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γsat (pcf)	Material #	SPT N Iterated	Iterated γsat (pcf)	Iterated Material #	Water γw (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	92	21	125	4	21	125	4	0	2.00	42	101	0.010				125	0	125	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	91				21	125	4	0	2.00	42	101	0.010				250	0	250	1	10.10	0.958	723%	1806.26	0.0091	0.0091	0.1092	0.11
3	90				21	125	4	0	2.00	42	101	0.010				375	0	375	2	5.05	0.902	453%	1700.11	0.0074	0.0165	0.1979	0.20
4	89	21	125	4	21	125	4	0	2.02	43	102	0.010				500	0	500	3	3.37	0.839	316%	1581.28	0.0061	0.0226	0.2711	0.27
5	88				25	123	4	0	1.76	45	106	0.009				623	0	623	4	2.53	0.775	234%	1461.63	0.0049	0.0275	0.3304	0.33
6	87				30	122	4	0	1.56	46	110	0.009				745	0	745	5	2.02	0.715	181%	1347.20	0.0041	0.0316	0.3794	0.38
7	86	34	120	6	34	120	6	0	1.41	48	81	0.130	0.130	1.085	0.040	865	0	865	6	1.68	0.658	143%	1240.91	0.0502	0.0819	0.9822	0.98
8	85				30	120	6	0	1.29	39	67	0.130	0.130	1.085	0.040	985	0	985	7	1.44	0.607	116%	1143.82	0.0435	0.1254	1.5044	1.50
9	84				26	120	6	0	1.20	31	57	0.130	0.130	1.085	0.040	1105	0	1105	8	1.26	0.560	96%	1056.01	0.0379	0.1632	1.9588	1.96
10	83	22	120	6	22	120	6	0	1.13	25	48	0.130	0.130	1.085	0.040	1225	0	1225	9	1.12	0.518	80%	977.04	0.0331	0.1963	2.3561	2.36
11	82				23	120	6	0	1.08	25	48	0.130	0.130	1.085	0.040	1345	0	1345	10	1.01	0.481	67%	906.20	0.0291	0.2254	2.7051	2.71
12	81				24	120	6	0	1.04	25	48	0.130	0.130	1.085	0.040	1465	0	1465	11	0.92	0.447	58%	842.70	0.0257	0.2511	3.0129	3.01
13	80	25	120	6	25	120	6	0	1.01	25	49	0.130	0.130	1.085	0.040	1585	0	1585	12	0.84	0.417	50%	785.75	0.0227	0.2738	3.2857	3.29
14	79				29	120	6	0	0.99	29	53	0.130	0.130	1.085	0.040	1705	0	1705	13	0.78	0.390	43%	734.62	0.0202	0.2940	3.5284	3.53
15	78				33	120	6	0	0.97	32	58	0.130	0.130	1.085	0.040	1825	0	1825	14	0.72	0.365	38%	688.63	0.0181	0.3121	3.7453	3.75
16	77	37	120	6	37	120	6	0	0.95	35	63	0.130	0.130	1.085	0.040	1945	0	1945	15	0.67	0.343	33%	647.16	0.0162	0.3283	3.9399	3.94
17	76				37	120	6	0	0.94	34	61	0.130	0.130	1.085	0.040	2065	0	2065	16	0.63	0.323	30%	609.69	0.0146	0.3429	4.1152	4.12
18	75				37	120	6	0	0.92	34	60	0.130	0.130	1.085	0.040	2185	0	2185	17	0.59	0.305	26%	575.74	0.0132	0.3561	4.2736	4.27
19	74				36	120	6	0	0.91	33	59	0.130	0.130	1.085	0.040	2305	0	2305	18	0.56	0.289	24%	544.91	0.0120	0.3681	4.4174	4.42
20	73	36	120	6	36	120	6	0	0.89	32	58	0.130	0.130	1.085	0.040	2425	0	2425	19	0.53	0.274	21%	516.84	0.0109	0.3790	4.5483	4.55
21	72				35	120	6	0	0.88	31	56	0.130	0.130	1.085	0.040	2545	0	2545	20	0.51	0.261	19%	491.21	0.0100	0.3890	4.6679	4.67
22	71				35	120	6	0	0.86	30	55	0.130	0.130	1.085	0.040	2665	0	2665	21	0.48	0.248	18%	467.76	0.0091	0.3981	4.7774	4.78
23	70				34	120	6	0	0.85	29	53	0.130	0.130	1.085	0.040	2785	0	2785	22	0.46	0.237	16%	446.25	0.0084	0.4065	4.8781	4.88
24	69	33	120	6	33	120	6	0	0.84	28	52	0.130	0.130	1.085	0.040	2905	0	2905	23	0.44	0.226	15%	426.48	0.0077	0.4142	4.9709	4.97
25	68				33	120	6	0	0.82	27	51	0.130	0.130	1.085	0.040	3025	0	3025	24	0.42	0.217	13%	408.25	0.0071	0.4214	5.0567	5.06
26	67				32	120	6	0	0.81	26	50	0.130	0.130	1.085	0.040	3145	0	3145	25	0.40	0.208	12%	391.43	0.0066	0.4280	5.1362	5.14
27	66				32	120	6	0	0.80	26	49	0.130	0.130	1.085	0.040	3265	0	3265	26	0.39	0.199	12%	375.85	0.0062	0.4342	5.2100	5.21
28	65				32	120	6	0	0.80	25	49	0.130	0.130	1.085	0.040	3385	0	3385	27	0.37	0.192	11%	361.41	0.0057	0.4399	5.2787	5.28
29	64				31	120	6	0	0.79	25	48	0.130	0.130	1.085	0.040	3505	0	3505	28	0.36	0.185	10%	348.00	0.0053	0.4452	5.3429	5.34
30	63	31	120	6	31	120	6	0	0.78	24	47	0.130	0.130	1.085	0.040	3625	0	3625	29	0.35	0.178	9%	335.51	0.0050	0.4502	5.4028	5.40
31	62				32	120	6	0	0.77	25	48	0.021				3745	0	3745	30	0.34	0.172	9%	323.87	0.0008	0.4510	5.4118	5.41
32	61				33	121	6	0	0.77	25	49	0.021				3866	0	3866	31	0.33	0.166	8%	312.99	0.0007	0.4517	5.4202	5.42
33	60				34	121	6	0	0.76	26	49	0.020				3987	0	3987	32	0.32	0.161	8%	302.82	0.0006	0.4523	5.4279	5.43
34	59				35	122	6	0	0.75	26	50	0.020				4109	0	4109	33	0.31	0.156	7%	293.29	0.0006	0.4529	5.4351	5.44
35	58				36	122	6	0	0.75	26	50	0.020				4231	0	4231	34	0.30	0.151	7%	284.35	0.0006	0.4535	5.4418	5.44
36	57				36	122	6	0	0.74	27	51	0.020				4353	0	4353	35	0.29	0.146	6%	275.94	0.0005	0.4540	5.4481	5.45
37	56				37	123	6	0	0.72	27	51	0.020				4476	0	4476	36	0.28	0.142	6%	268.03	0.0005	0.4545	5.4541	5.45
38	55				38	123	6	0	0.71	27	51	0.019				4599	0	4599	37	0.27	0.138	6%	260.58	0.0005	0.4550	5.4597	5.46
39	54				39	124	6	0	0.70	27	51	0.019				4723	0	4723	38	0.27	0.135	5%	253.55	0.0004	0.4554	5.4650	5.46
40	53				40	124	6	0	0.68	27	52	0.019				4846	0	4846	39	0.26	0.131	5%	246.90	0.0004	0.4558	5.4700	5.47
41	52				41	124	6	0	0.67	27	52	0.019				4971	0	4971	40	0.25	0.128	5%	240.62	0.0004	0.4562	5.4748	5.47
42	51				42	125	6	0	0.65	27	52	0.019				5095	0	5095	41	0.25	0.124	5%	234.67	0.0004	0.4566	5.4793	5.48
43	50				43	125	6	0	0.65	28	52	0.019				5220	0	5220	42	0.24	0.122	4%	229.03	0.0004	0.4570	5.4836	5.48
44	49				44	125	6	0	0.65	28	53	0.019				5346	0	5346	43	0.23	0.119	4%	223.68	0.0003	0.4573	5.4877	5.49
45	48				45	126	6	0	0.66	29	54	0.018				5472	0	5472	44	0.23	0.116	4%	218.60	0.0003	0.4576	5.4914	5.49
46	47				46	126	6	0	0.60	27	52	0.019				5598	0	5598	45	0.22	0.113	4%	213.77	0.0003	0.4579	5.4952	5.50
47	46				46	127	6	0	0.60	28	52	0.019				5725	0	5725	46	0.22	0.111	4%	209.17	0.0003	0.4582	5.4988	5.50
48	45				47	127	6	0	0.60	28	53	0.019				5852	0	5852	47	0.21	0.109	3%	204.79	0.0003	0.4585	5.5022	5.50
49	44				48	127	6	0	0.60	29	54	0.019				5979	0	5979	48	0.21	0.106	3%	200.62	0.0003	0.4588	5.5054	5.51
50	43				49	128	6	0	0.60	30	55	0.018				6107	0	6107	49	0.21	0.104	3%	196.63	0.0003	0.4590	5.5084	5.51

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
51	42				50	128	6	0	0.60	30	55	0.018				6235	0	6235	50	0.20	0.102	3%	192.83	0.0002	0.4593	5.5113	5.51
52	41				51	129	6	0	0.60	31	56	0.018				6364	0	6364	51	0.20	0.100	3%	189.19	0.0002	0.4595	5.5140	5.51
53	40				52	129	6	0	0.60	31	57	0.018				6493	0	6493	52	0.19	0.099	3%	185.71	0.0002	0.4597	5.5166	5.52
54	39				53	129	6	0	0.60	32	58	0.017				6622	0	6622	53	0.19	0.097	3%	182.38	0.0002	0.4599	5.5190	5.52
55	38				54	130	6	0	0.60	32	58	0.017				6752	0	6752	54	0.19	0.095	3%	179.19	0.0002	0.4601	5.5214	5.52
56	37				55	130	6	0	0.60	33	59	0.017				6882	0	6882	55	0.18	0.093	3%	176.13	0.0002	0.4603	5.5236	5.52
57	36				56	131	6	0	0.60	33	60	0.017				7012	0	7012	56	0.18	0.092	2%	173.20	0.0002	0.4605	5.5257	5.53
58	35				56	131	6	0	0.60	34	61	0.017				7143	0	7143	57	0.18	0.090	2%	170.39	0.0002	0.4606	5.5278	5.53
59	34				57	131	6	0	0.60	34	61	0.016				7274	0	7274	58	0.17	0.089	2%	167.68	0.0002	0.4608	5.5297	5.53
60	33				58	132	6	0	0.60	35	62	0.016				7406	0	7406	59	0.17	0.088	2%	165.08	0.0002	0.4610	5.5315	5.53
61	32				59	132	6	0	0.60	36	63	0.016				7538	0	7538	60	0.17	0.086	2%	162.59	0.0001	0.4611	5.5333	5.53
62	31				60	132	6	0	0.60	36	64	0.016				7671	0	7671	61	0.17	0.085	2%	160.18	0.0001	0.4613	5.5350	5.54
63	30				61	133	6	0	0.60	37	64	0.016				7804	0	7804	62	0.16	0.084	2%	157.87	0.0001	0.4614	5.5366	5.54
64	29				62	133	6	0	0.60	37	65	0.015				7937	0	7937	63	0.16	0.083	2%	155.64	0.0001	0.4615	5.5382	5.54
65	28				63	134	6	0	0.60	38	66	0.015				8070	0	8070	64	0.16	0.081	2%	153.49	0.0001	0.4616	5.5397	5.54

81215044 - RTB
Wall 9.90L-A Sta. 8+80 (W-150-20)

89.5	Footing Elevation (ft)
1911	Footing Stress (psf)
11.8	Footing Width (ft)
100	Footing Length (ft)

200	Depth to Water (ft)

1.2	Calculated Settlement (in)

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γsat (pcf)	Material #	SPT N Iterated	Iterated γsat (pcf)	Iterated Material #	Water γw (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Depth Below Footing (ft)	B/Z	I	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)
1	96	21	125	4	21	125	4	0	2.00	42	101	0.010	125	0	125	N/A	N/A	0.000	0.00	0.0000	0.0000	0.0000
2	95				21	125	4	0	2.00	42	101	0.010	250	0	250	N/A	N/A	0.000	0.00	0.0000	0.0000	0.0000
3	94				21	125	4	0	2.00	42	101	0.010	375	0	375	N/A	N/A	0.000	0.00	0.0000	0.0000	0.0000
4	93	21	125	4	21	125	4	0	2.02	43	102	0.010	500	0	500	N/A	N/A	0.000	0.00	0.0000	0.0000	0.0000
5	92				25	123	4	0	1.76	45	106	0.009	623	0	623	N/A	N/A	0.000	0.00	0.0000	0.0000	0.0000
6	91				30	122	4	0	1.56	46	110	0.009	745	0	745	N/A	N/A	0.000	0.00	0.0000	0.0000	0.0000
7	90	34	120	6	34	120	6	0	1.41	48	81	0.012	865	0	865	N/A	N/A	0.000	0.00	0.0000	0.0000	0.0000
8	89				30	120	6	0	1.29	39	67	0.015	985	0	985	0.5	23.60	0.983	1878.03	0.0069	0.0069	0.0825
9	88				26	120	6	0	1.20	31	57	0.018	1105	0	1105	1.5	7.87	0.943	1803.01	0.0074	0.0143	0.1710
10	87	22	120	6	22	120	6	0	1.13	25	48	0.021	1225	0	1225	2.5	4.72	0.893	1707.12	0.0078	0.0221	0.2652
11	86				23	120	6	0	1.08	25	48	0.021	1345	0	1345	3.5	3.37	0.839	1603.61	0.0071	0.0292	0.3499
12	85				24	120	6	0	1.04	25	48	0.021	1465	0	1465	4.5	2.62	0.785	1499.54	0.0063	0.0355	0.4257
13	84	25	120	6	25	120	6	0	1.01	25	49	0.020	1585	0	1585	5.5	2.15	0.732	1398.94	0.0056	0.0411	0.4932
14	83				29	120	6	0	0.99	29	53	0.019	1705	0	1705	6.5	1.82	0.682	1303.94	0.0046	0.0457	0.5486
15	82				33	120	6	0	0.97	32	58	0.017	1825	0	1825	7.5	1.57	0.636	1215.58	0.0038	0.0495	0.5945
16	81	37	120	6	37	120	6	0	0.95	35	63	0.016	1945	0	1945	8.5	1.39	0.593	1134.15	0.0032	0.0527	0.6328
17	80				37	120	6	0	0.94	34	61	0.016	2065	0	2065	9.5	1.24	0.554	1059.56	0.0029	0.0557	0.6679
18	79				37	120	6	0	0.92	34	60	0.017	2185	0	2185	10.5	1.12	0.519	991.48	0.0027	0.0584	0.7003
19	78				36	120	6	0	0.91	33	59	0.017	2305	0	2305	11.5	1.03	0.486	929.44	0.0025	0.0608	0.7302
20	77	36	120	6	36	120	6	0	0.89	32	58	0.017	2425	0	2425	12.5	0.94	0.457	872.95	0.0023	0.0631	0.7577
21	76				35	120	6	0	0.88	31	56	0.018	2545	0	2545	13.5	0.87	0.430	821.50	0.0022	0.0653	0.7835
22	75				35	120	6	0	0.86	30	55	0.018	2665	0	2665	14.5	0.81	0.405	774.61	0.0020	0.0673	0.8078
23	74				34	120	6	0	0.85	29	53	0.019	2785	0	2785	15.5	0.76	0.383	731.82	0.0019	0.0692	0.8305
24	73	33	120	6	33	120	6	0	0.84	28	52	0.019	2905	0	2905	16.5	0.72	0.362	692.72	0.0018	0.0710	0.8520
25	72				33	120	6	0	0.82	27	51	0.020	3025	0	3025	17.5	0.67	0.344	656.93	0.0017	0.0727	0.8721
26	71				32	120	6	0	0.81	26	50	0.020	3145	0	3145	18.5	0.64	0.327	624.12	0.0016	0.0742	0.8909
27	70				32	120	6	0	0.80	26	49	0.020	3265	0	3265	19.5	0.61	0.311	593.97	0.0015	0.0757	0.9085
28	69				32	120	6	0	0.80	25	49	0.021	3385	0	3385	20.5	0.58	0.296	566.23	0.0014	0.0771	0.9251
29	68				31	120	6	0	0.79	25	48	0.021	3505	0	3505	21.5	0.55	0.283	540.65	0.0013	0.0784	0.9407
30	67	31	120	6	31	120	6	0	0.78	24	47	0.021	3625	0	3625	22.5	0.52	0.271	517.03	0.0012	0.0796	0.9554
31	66				31	120	6	0	0.77	24	47	0.021	3745	0	3745	23.5	0.50	0.259	495.16	0.0011	0.0808	0.9692
32	65				31	120	6	0	0.77	24	47	0.021	3865	0	3865	24.5	0.48	0.249	474.89	0.0011	0.0818	0.9821
33	64				31	120	6	0	0.76	24	46	0.022	3985	0	3985	25.5	0.46	0.239	456.07	0.0010	0.0829	0.9942
34	63				31	120	6	0	0.75	23	46	0.022	4105	0	4105	26.5	0.45	0.229	438.55	0.0010	0.0838	1.0057
35	62				31	120	6	0	0.75	23	46	0.022	4225	0	4225	27.5	0.43	0.221	422.23	0.0009	0.0847	1.0165
36	61				31	120	6	0	0.74	23	45	0.022	4345	0	4345	28.5	0.41	0.213	407.00	0.0009	0.0856	1.0268
37	60				31	120	6	0	0.73	22	45	0.022	4465	0	4465	29.5	0.40	0.206	392.76	0.0008	0.0864	1.0366
38	59				31	120	6	0	0.71	22	44	0.023	4585	0	4585	30.5	0.39	0.199	379.43	0.0008	0.0872	1.0459
39	58				31	120	6	0	0.70	22	44	0.023	4705	0	4705	31.5	0.37	0.192	366.94	0.0007	0.0879	1.0548
40	57				31	120	6	0	0.68	21	43	0.023	4825	0	4825	32.5	0.36	0.186	355.20	0.0007	0.0886	1.0634
41	56				31	120	6	0	0.67	21	43	0.023	4945	0	4945	33.5	0.35	0.180	344.17	0.0007	0.0893	1.0716
42	55				31	120	6	0	0.66	20	42	0.024	5065	0	5065	34.5	0.34	0.175	333.79	0.0007	0.0900	1.0795
43	54				31	120	6	0	0.65	20	42	0.024	5185	0	5185	35.5	0.33	0.170	324.00	0.0006	0.0906	1.0871
44	53				31	120	6	0	0.64	20	42	0.024	5305	0	5305	36.5	0.32	0.165	314.76	0.0006	0.0912	1.0943
45	52				31	120	6	0	0.65	20	42	0.024	5425	0	5425	37.5	0.31	0.160	306.03	0.0006	0.0918	1.1011
46	51				31	120	6	0	0.60	19	40	0.025	5545	0	5545	38.5	0.31	0.156	297.77	0.0006	0.0923	1.1080
47	50				31	120	6	0	0.60	19	40	0.025	5665	0	5665	39.5	0.30	0.152	289.95	0.0005	0.0929	1.1145
48	49				31	120	6	0	0.60	19	40	0.025	5785	0	5785	40.5	0.29	0.148	282.54	0.0005	0.0934	1.1208
49	48				31	120	6	0	0.60	19	40	0.025	5905	0	5905	41.5	0.28	0.144	275.51	0.0005	0.0939	1.1268
50	47				31	120	6	0	0.60	19	40	0.025	6025	0	6025	42.5	0.28	0.141	268.83	0.0005	0.0944	1.1325
51	46				31	120	6	0	0.60	19	40	0.025	6145	0	6145	43.5	0.27	0.137	262.47	0.0005	0.0948	1.1380
52	45				31	120	6	0	0.60	19	40	0.025	6265	0	6265	44.5	0.27	0.134	256.43	0.0004	0.0953	1.1432
53	44				31	120	6	0	0.60	19	40	0.025	6385	0	6385	45.5	0.26	0.131	250.67	0.0004	0.0957	1.1483
54	43				31	120	6	0	0.60	19	40	0.025	6505	0	6505	46.5	0.25	0.128	245.18	0.0004	0.0961	1.1531
55	42				31	120	6	0	0.60	19	40	0.025	6625	0	6625	47.5	0.25	0.126	239.94	0.0004	0.0965	1.1578
56	41				31	120	6	0	0.60	19	40	0.025	6745	0	6745	48.5	0.24	0.123	234.94	0.0004	0.0969	1.1623
57	40				31	120	6	0	0.60	19	40	0.025	6865	0	6865	49.5	0.24	0.120	230.16	0.0004	0.0972	1.1666
58	39				31	120	6	0	0.60	19	40	0.025	6985	0	6985	50.5	0.23	0.118	225.59	0.0003	0.0976	1.1708
59	38				31	120	6	0	0.60	19	40	0.025	7105	0	7105	51.5	0.23	0.116	221.21	0.0003	0.0979	1.1748

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γsat (pcf)	Material #	SPT N Iterated	Iterated γsat (pcf)	Iterated Material #	Water γw (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Depth Below Footing (ft)	B/Z	I	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)
60	37				31	120	6	0	0.60	19	40	0.025	7225	0	7225	52.5	0.22	0.114	217.02	0.0003	0.0982	1.1787
61	36				31	120	6	0	0.60	19	40	0.025	7345	0	7345	53.5	0.22	0.111	213.01	0.0003	0.0985	1.1824
62	35				31	120	6	0	0.60	19	40	0.025	7465	0	7465	54.5	0.22	0.109	209.15	0.0003	0.0988	1.1860
63	34				31	120	6	0	0.60	19	40	0.025	7585	0	7585	55.5	0.21	0.108	205.46	0.0003	0.0991	1.1895
64	33				31	120	6	0	0.60	19	40	0.025	7705	0	7705	56.5	0.21	0.106	201.91	0.0003	0.0994	1.1929
65	32				31	120	6	0	0.60	19	40	0.025	7825	0	7825	57.5	0.21	0.104	198.49	0.0003	0.0997	1.1962
66	31				31	120	6	0	0.60	19	40	0.025	7945	0	7945	58.5	0.20	0.102	195.21	0.0003	0.0999	1.1994
67	30				31	120	6	0	0.60	19	40	0.025	8065	0	8065	59.5	0.20	0.101	192.06	0.0003	0.1002	1.2025
68	29				31	120	6	0	0.60	19	40	0.025	8185	0	8185	60.5	0.20	0.099	189.02	~~0.0002~~	~~0.1005~~	~~1.2055~~
69	28				31	120	6	0	0.60	19	40	0.025	8305	0	8305	61.5	0.19	0.097	186.09	0.0002	0.1007	1.2084
70	27				31	120	6	0	0.60	19	40	0.025	8425	0	8425	62.5	0.19	0.096	183.28	0.0002	0.1009	1.2112
71	26				31	120	6	0	0.60	19	40	0.025	8545	0	8545	63.5	0.19	0.094	180.56	0.0002	0.1012	1.2139
72	25				31	120	6	0	0.60	19	40	0.025	8665	0	8665	64.5	0.18	0.093	177.94	0.0002	0.1014	1.2166
73	24				31	120	6	0	0.60	19	40	0.025	8785	0	8785	65.5	0.18	0.092	175.40	0.0002	0.1016	1.2192
74	23				31	120	6	0	0.60	19	40	0.025	8905	0	8905	66.5	0.18	0.091	172.96	0.0002	0.1018	1.2217
75	22				31	120	6	0	0.60	19	40	0.025	9025	0	9025	67.5	0.17	0.089	170.60	0.0002	0.1020	1.2242
76	21				31	120	6	0	0.60	19	40	0.025	9145	0	9145	68.5	0.17	0.088	168.32	0.0002	0.1022	1.2266
77	20				31	120	6	0	0.60	19	40	0.025	9265	0	9265	69.5	0.17	0.087	166.11	0.0002	0.1024	1.2289
78	19				31	120	6	0	0.60	19	40	0.025	9385	0	9385	70.5	0.17	0.086	163.98	0.0002	0.1026	1.2312
79	18				31	120	6	0	0.60	19	40	0.025	9505	0	9505	71.5	0.17	0.085	161.92	0.0002	0.1028	1.2334
80	17				31	120	6	0	0.60	19	40	0.025	9625	0	9625	72.5	0.16	0.084	159.92	0.0002	0.1030	1.2355
81	16				31	120	6	0	0.60	19	40	0.025	9745	0	9745	73.5	0.16	0.083	157.98	0.0002	0.1031	1.2376
82	15				31	120	6	0	0.60	19	40	0.025	9865	0	9865	74.5	0.16	0.082	156.11	0.0002	0.1033	1.2397
83	14				31	120	6	0	0.60	19	40	0.025	9985	0	9985	75.5	0.16	0.081	154.29	0.0002	0.1035	1.2417
84	13				31	120	6	0	0.60	19	40	0.025	10105	0	10105	76.5	0.15	0.080	152.53	0.0002	0.1036	1.2437
85	12				31	120	6	0	0.60	19	40	0.025	10225	0	10225	77.5	0.15	0.079	150.82	0.0002	0.1038	1.2456
86	11				31	120	6	0	0.60	19	40	0.025	10345	0	10345	78.5	0.15	0.078	149.16	0.0002	0.1040	1.2475
87	10				31	120	6	0	0.60	19	40	0.025	10465	0	10465	79.5	0.15	0.077	147.55	0.0002	0.1041	1.2493
88	9				31	120	6	0	0.60	19	40	0.025	10585	0	10585	80.5	0.15	0.076	145.98	0.0001	0.1043	1.2511
89	8				31	120	6	0	0.60	19	40	0.025	10705	0	10705	81.5	0.14	0.076	144.46	0.0001	0.1044	1.2529
90	7				31	120	6	0	0.60	19	40	0.025	10825	0	10825	82.5	0.14	0.075	142.99	0.0001	0.1045	1.2546
91	6				31	120	6	0	0.60	19	40	0.025	10945	0	10945	83.5	0.14	0.074	141.55	0.0001	0.1047	1.2563
92	5				31	120	6	0	0.60	19	40	0.025	11065	0	11065	84.5	0.14	0.073	140.16	0.0001	0.1048	1.2579
93	4				31	120	6	0	0.60	19	40	0.025	11185	0	11185	85.5	0.14	0.073	138.80	0.0001	0.1050	1.2595
94	3				31	120	6	0	0.60	19	40	0.025	11305	0	11305	86.5	0.14	0.072	137.48	0.0001	0.1051	1.2611
95	2				31	120	6	0	0.60	19	40	0.025	11425	0	11425	87.5	0.13	0.071	136.20	0.0001	0.1052	1.2627
96	1				31	120	6	0	0.60	19	40	0.025	11545	0	11545	88.5	0.13	0.071	134.95	0.0001	0.1053	1.2642
97	0				31	120	6	0	0.60	19	40	0.025	11665	0	11665	89.5	0.13	0.070	133.73	0.0001	0.1055	1.2657
98	-1				31	120	6	0	0.60	19	40	0.025	11785	0	11785	90.5	0.13	0.069	132.55	0.0001	0.1056	1.2671
99	-2				31	120	6	0	0.60	19	40	0.025	11905	0	11905	91.5	0.13	0.069	131.39	0.0001	0.1057	1.2686
100	-3				31	120	6	0	0.60	19	40	0.025	12025	0	12025	92.5	0.13	0.068	130.27	0.0001	0.1058	1.2700
101	-4				31	120	6	0	0.60	19	40	0.025	12145	0	12145	93.5	0.13	0.068	129.17	0.0001	0.1059	1.2714
102	-5				31	120	6	0	0.60	19	40	0.025	12265	0	12265	94.5	0.12	0.067	128.10	0.0001	0.1061	1.2727
103	-6				31	120	6	0	0.60	19	40	0.025	12385	0	12385	95.5	0.12	0.066	127.06	0.0001	0.1062	1.2741
104	-7				31	120	6	0	0.60	19	40	0.025	12505	0	12505	96.5	0.12	0.066	126.04	0.0001	0.1063	1.2754
105	-8				31	120	6	0	0.60	19	40	0.025	12625	0	12625	97.5	0.12	0.065	125.05	0.0001	0.1064	1.2767
106	-9				31	120	6	0	0.60	19	40	0.025	12745	0	12745	98.5	0.12	0.065	124.08	0.0001	0.1065	1.2780
107	-10				31	120	6	0	0.60	19	40	0.025	12865	0	12865	99.5	0.12	0.064	123.14	0.0001	0.1066	1.2792

81215044 - RTB
Wall 9.90L-A Sta. 10+80 (W-151-20)

76.5	Footing Elevation (ft)
2743	Footing Stress (psf)
15.9	Footing Width (ft)
100	Footing Length (ft)

200	Depth to Water (ft)

	Calculated
4.7	Settlement (in)

This is the effect of the fill to retainingt wall subgrade

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γsat (pcf)	Material #	SPT N Iterated	Iterated γsat (pcf)	Iterated Material #	Water γw (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	87.2	25	125	4	25	125	4	0	2.00	50	118	0.008				125	0	125	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	86.2				23	125	4	0	2.00	45	107	0.009				250	0	250	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
3	85.2				20	125	4	0	2.00	40	97	0.010				375	0	375	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
4	84.2				18	125	4	0	2.02	36	88	0.011				500	0	500	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
5	83.2				15	125	4	0	1.76	27	71	0.014				625	0	625	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
6	82.2	13	125	4	13	125	4	0	1.55	20	59	0.017				750	0	750	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
7	81.2				26	128	4	0	1.39	36	87	0.011				878	0	878	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
8	80.2	38	130	4	38	130	4	0	1.27	48	114	0.009				1008	0	1008	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
9	79.2				36	130	4	0	1.18	43	102	0.010				1138	0	1138	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
10	78.2				34	130	4	0	1.12	38	92	0.011				1268	0	1268	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
11	77.2	32	130	5	32	130	5	0	1.07	34	70	0.014				1398	0	1398	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
12	76.2				31	129	5	0	1.03	32	66	0.015				1527	0	1527	0.3	53.00	0.990	178%	2714.94	0.0067	0.0067	0.0802	0.08
13	75.2				30	128	5	0	1.00	30	63	0.016				1655	0	1655	1.3	12.23	0.967	160%	2651.25	0.0066	0.0132	0.1588	0.16
14	74.2				28	127	5	0	0.98	28	61	0.016				1782	0	1782	2.3	6.91	0.934	144%	2561.14	0.0064	0.0196	0.2354	0.24
15	73.2				27	126	5	0	0.96	26	58	0.017				1908	0	1908	3.3	4.82	0.896	129%	2457.75	0.0062	0.0258	0.3096	0.31
16	72.2	26	125	5	26	125	5	0	0.94	24	56	0.130	0.130	1.085	0.040	2033	0	2033	4.3	3.70	0.856	116%	2348.11	0.0434	0.0692	0.8299	0.83
17	71.2				25	125	5	0	0.92	23	54	0.130	0.130	1.085	0.040	2158	0	2158	5.3	3.00	0.815	104%	2236.73	0.0402	0.1093	1.3118	1.31
18	70.2				24	125	5	0	0.91	22	53	0.130	0.130	1.085	0.040	2283	0	2283	6.3	2.52	0.775	93%	2126.59	0.0372	0.1465	1.7579	1.76
19	69.2				24	125	5	0	0.89	21	51	0.130	0.130	1.085	0.040	2408	0	2408	7.3	2.18	0.736	84%	2019.62	0.0344	0.1809	2.1706	2.17
20	68.2				23	125	5	0	0.88	20	50	0.130	0.130	1.085	0.040	2533	0	2533	8.3	1.92	0.699	76%	1917.02	0.0318	0.2127	2.5524	2.55
21	67.2	22	125	5	22	125	5	0	0.86	19	48	0.021				2658	0	2658	9.3	1.71	0.663	68%	1819.48	0.0047	0.2174	2.6088	2.61
22	66.2				22	125	5	0	0.85	18	47	0.021				2783	0	2783	10.3	1.54	0.630	62%	1727.36	0.0044	0.2218	2.6620	2.66
23	65.2				21	125	5	0	0.84	18	46	0.022				2908	0	2908	11.3	1.41	0.598	56%	1640.73	0.0042	0.2260	2.7123	2.71
24	64.2				21	125	5	0	0.82	17	46	0.022				3033	0	3033	12.3	1.29	0.569	51%	1559.54	0.0040	0.2300	2.7597	2.76
25	63.2				20	125	5	0	0.81	17	45	0.022				3158	0	3158	13.3	1.20	0.541	47%	1483.61	0.0037	0.2337	2.8044	2.80
26	62.2	20	125	5	20	125	5	0	0.80	16	44	0.130	0.130	1.085	0.040	3283	0	3283	14.3	1.11	0.515	43%	1412.70	0.0202	0.2539	3.0469	3.05
27	61.2				22	125	5	0	0.79	17	46	0.130	0.130	1.085	0.040	3408	0	3408	15.3	1.04	0.491	40%	1346.52	0.0188	0.2727	3.2726	3.27
28	60.2				23	125	5	0	0.79	18	47	0.130	0.130	1.085	0.040	3533	0	3533	16.3	0.98	0.468	36%	1284.79	0.0175	0.2902	3.4827	3.48
29	59.2				25	125	5	0	0.78	19	49	0.130	0.130	1.085	0.040	3658	0	3658	17.3	0.92	0.447	34%	1227.20	0.0163	0.3066	3.6787	3.68
30	58.2				26	125	5	0	0.77	20	50	0.130	0.130	1.085	0.040	3783	0	3783	18.3	0.87	0.428	31%	1173.47	0.0153	0.3218	3.8618	3.86
31	57.2	28	125	4	28	125	4	0	0.77	21	61	0.016				3908	0	3908	19.3	0.82	0.410	29%	1123.31	0.0018	0.3236	3.8834	3.88
32	56.2				28	125	4	0	0.76	21	60	0.017				4033	0	4033	20.3	0.78	0.392	27%	1076.45	0.0017	0.3253	3.9039	3.90
33	55.2				28	125	4	0	0.75	21	60	0.017				4158	0	4158	21.3	0.75	0.376	25%	1032.64	0.0016	0.3269	3.9233	3.92
34	54.2				27	125	4	0	0.74	20	59	0.017				4283	0	4283	22.3	0.71	0.362	23%	991.65	0.0015	0.3285	3.9417	3.94
35	53.2				27	125	4	0	0.73	20	58	0.017				4408	0	4408	23.3	0.68	0.348	22%	953.27	0.0015	0.3299	3.9592	3.96
36	52.2	27	125	4	27	125	4	0	0.72	19	57	0.017				4533	0	4533	24.3	0.65	0.334	20%	917.29	0.0014	0.3313	3.9760	3.98
37	51.2				28	126	4	0	0.70	20	58	0.017				4659	0	4659	25.3	0.63	0.322	19%	883.53	0.0013	0.3326	3.9915	3.99
38	50.2				29	127	4	0	0.69	20	59	0.017				4786	0	4786	26.3	0.60	0.311	18%	851.82	0.0012	0.3338	4.0060	4.01
39	49.2				31	128	4	0	0.67	21	59	0.017				4914	0	4914	27.3	0.58	0.300	17%	822.00	0.0011	0.3350	4.0196	4.02
40	48.2				32	129	4	0	0.66	21	60	0.017				5043	0	5043	28.3	0.56	0.289	16%	793.94	0.0011	0.3360	4.0323	4.03
41	47.2	33	130	5	33	130	5	0	0.65	21	52	0.130	0.130	1.085	0.040	5173	0	5173	29.3	0.54	0.280	15%	767.49	0.0078	0.3438	4.1260	4.13
42	46.2				34	130	5	0	0.64	22	52	0.130	0.130	1.085	0.040	5303	0	5303	30.3	0.52	0.271	14%	742.56	0.0074	0.3512	4.2148	4.21
43	45.2				34	130	5	0	0.65	22	53	0.130	0.130	1.085	0.040	5433	0	5433	31.3	0.51	0.262	13%	719.01	0.0070	0.3583	4.2990	4.30
44	44.2				35	130	5	0	0.60	21	51	0.130	0.130	1.085	0.040	5563	0	5563	32.3	0.49	0.254	13%	696.76	0.0067	0.3649	4.3790	4.38
45	43.2				35	130	5	0	0.60	21	51	0.130	0.130	1.085	0.040	5693	0	5693	33.3	0.48	0.246	12%	675.72	0.0063	0.3712	4.4550	4.45
46	42.2	36	130	5	36	130	5	0	0.60	22	52	0.130	0.130	1.085	0.040	5823	0	5823	34.3	0.46	0.239	11%	655.79	0.0060	0.3773	4.5273	4.53
47	41.2				37	130	5	0	0.60	22	53	0.130	0.130	1.085	0.040	5953	0	5953	35.3	0.45	0.232	11%	636.90	0.0057	0.3830	4.5961	4.60
48	40.2				39	130	5	0	0.60	23	54	0.130	0.130	1.085	0.040	6083	0	6083	36.3	0.44	0.226	10%	618.99	0.0055	0.3885	4.6618	4.66
49	39.2				40	130	5	0	0.60	24	55	0.130	0.130	1.085	0.040	6213	0	6213	37.3	0.43	0.219	10%	601.98	0.0052	0.3937	4.7245	4.72
50	38.2				42	130	5	0	0.60	25	57	0.130	0.130	1.085	0.040	6343	0	6343	38.3	0.42	0.214	9%	585.81	0.0050	0.3987	4.7843	4.78

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c $1 + e_o$	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
													(cohesive soils)														
51	37.2	43	130	5	43	130	5	0	0.60	26	58	0.130	0.130	1.085	0.040	6473	0	6473	39.3	0.40	0.208	9%	570.44	0.0048	0.4035	4.8415	4.84
52	36.2				44	130	5	0	0.60	26	59	0.017				6603	0	6603	40.3	0.39	0.203	8%	555.80	0.0006	0.4041	4.8487	4.85
53	35.2				45	131	5	0	0.60	27	60	0.017				6734	0	6734	41.3	0.38	0.198	8%	541.86	0.0006	0.4046	4.8555	4.86
54	34.2				46	131	5	0	0.60	28	61	0.017				6865	0	6865	42.3	0.38	0.193	8%	528.57	0.0005	0.4052	4.8619	4.86
55	33.2				47	131	5	0	0.60	28	61	0.016				6996	0	6996	43.3	0.37	0.188	7%	515.88	0.0005	0.4057	4.8679	4.87
56	32.2				48	132	5	0	0.60	29	62	0.016				7128	0	7128	44.3	0.36	0.184	7%	503.77	0.0005	0.4061	4.8736	4.87
57	31.2				49	132	5	0	0.60	30	63	0.016				7260	0	7260	45.3	0.35	0.179	7%	492.19	0.0005	0.4066	4.8790	4.88
58	30.2				50	133	5	0	0.60	30	64	0.016				7393	0	7393	46.3	0.34	0.175	7%	481.13	0.0004	0.4070	4.8841	4.88
59	29.2				51	133	5	0	0.60	31	65	0.015				7525	0	7525	47.3	0.34	0.172	6%	470.53	0.0004	0.4074	4.8890	4.89
60	28.2				52	133	5	0	0.60	31	66	0.015				7659	0	7659	48.3	0.33	0.168	6%	460.39	0.0004	0.4078	4.8936	4.89
61	27.2				53	134	5	0	0.60	32	67	0.015				7792	0	7792	49.3	0.32	0.164	6%	450.67	0.0004	0.4082	4.8980	4.90
62	26.2				54	134	5	0	0.60	33	68	0.015				7926	0	7926	50.3	0.32	0.161	6%	441.35	0.0003	0.4085	4.9021	4.90
63	25.2				55	134	5	0	0.60	33	69	0.015				8060	0	8060	51.3	0.31	0.158	5%	432.41	0.0003	0.4088	4.9061	4.91
64	24.2				56	135	5	0	0.60	34	70	0.014				8195	0	8195	52.3	0.30	0.155	5%	423.83	0.0003	0.4092	4.9099	4.91
65	23.2				58	135	5	0	0.60	35	71	0.014				8330	0	8330	53.3	0.30	0.152	5%	415.58	0.0003	0.4095	4.9135	4.91

81215044 - RTB
Wall 9.90L-A Sta. 10+80 (W-151-20)

76.5	Footing Elevation (ft)
2743	Footing Stress (psf)
15.9	Footing Width (ft)
100	Footing Length (ft)

200	Depth to Water (ft)

This is the effect of the fill to retainingt wall subgrade

	Calculated
1.3	Settlement (in)

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c 1 + e_o (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	87.2	25	125	4	25	125	4	0	2.00	50	118	0.008				125	0	125	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	86.2				23	125	4	0	2.00	45	107	0.009				250	0	250	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
3	85.2				20	125	4	0	2.00	40	97	0.010				375	0	375	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
4	84.2				18	125	4	0	2.02	36	88	0.011				500	0	500	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
5	83.2				15	125	4	0	1.76	27	71	0.014				625	0	625	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
6	82.2	13	125	4	13	125	4	0	1.55	20	59	0.017				750	0	750	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
7	81.2				26	128	4	0	1.39	36	87	0.011				878	0	878	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
8	80.2	38	130	4	38	130	4	0	1.27	48	114	0.009				1008	0	1008	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
9	79.2				36	130	4	0	1.18	43	102	0.010				1138	0	1138	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
10	78.2				34	130	4	0	1.12	38	92	0.011				1268	0	1268	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
11	77.2	32	130	5	32	130	5	0	1.07	34	70	0.014				1398	0	1398	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
12	76.2				31	129	5	0	1.03	32	66	0.015				1527	0	1527	0.3	53.00	0.990	178%	2714.94	0.0067	0.0067	0.0802	0.08
13	75.2				30	128	5	0	1.00	30	63	0.016				1655	0	1655	1.3	12.23	0.967	160%	2651.25	0.0066	0.0132	0.1588	0.16
14	74.2				28	127	5	0	0.98	28	61	0.016				1782	0	1782	2.3	6.91	0.934	144%	2561.14	0.0064	0.0196	0.2354	0.24
15	73.2				27	126	5	0	0.96	26	58	0.017				1908	0	1908	3.3	4.82	0.896	129%	2457.75	0.0062	0.0258	0.3096	0.31
16	72.2	26	125	5	26	125	5	0	0.94	24	56	0.018	0.130	1.085	0.040	2033	0	2033	4.3	3.70	0.856	116%	2348.11	0.0060	0.0318	0.3812	0.38
17	71.2				25	125	5	0	0.92	23	54	0.018	0.130	1.085	0.040	2158	0	2158	5.3	3.00	0.815	104%	2236.73	0.0057	0.0375	0.4496	0.45
18	70.2				24	125	5	0	0.91	22	53	0.019	0.130	1.085	0.040	2283	0	2283	6.3	2.52	0.775	93%	2126.59	0.0054	0.0429	0.5148	0.51
19	69.2				24	125	5	0	0.89	21	51	0.020	0.130	1.085	0.040	2408	0	2408	7.3	2.18	0.736	84%	2019.62	0.0052	0.0481	0.5770	0.58
20	68.2				23	125	5	0	0.88	20	50	0.020	0.130	1.085	0.040	2533	0	2533	8.3	1.92	0.699	76%	1917.02	0.0049	0.0530	0.6362	0.64
21	67.2	22	125	5	22	125	5	0	0.86	19	48	0.021				2658	0	2658	9.3	1.71	0.663	68%	1819.48	0.0047	0.0577	0.6926	0.69
22	66.2				22	125	5	0	0.85	18	47	0.021				2783	0	2783	10.3	1.54	0.630	62%	1727.36	0.0044	0.0622	0.7458	0.75
23	65.2				21	125	5	0	0.84	18	46	0.022				2908	0	2908	11.3	1.41	0.598	56%	1640.73	0.0042	0.0663	0.7961	0.80
24	64.2				21	125	5	0	0.82	17	46	0.022				3033	0	3033	12.3	1.29	0.569	51%	1559.54	0.0040	0.0703	0.8435	0.84
25	63.2				20	125	5	0	0.81	17	45	0.022				3158	0	3158	13.3	1.20	0.541	47%	1483.61	0.0037	0.0740	0.8882	0.89
26	62.2	20	125	5	20	125	5	0	0.80	16	44	0.023	0.130	1.085	0.040	3283	0	3283	14.3	1.11	0.515	43%	1412.70	0.0035	0.0775	0.9305	0.93
27	61.2				22	125	5	0	0.79	17	46	0.022	0.130	1.085	0.040	3408	0	3408	15.3	1.04	0.491	40%	1346.52	0.0032	0.0807	0.9685	0.97
28	60.2				23	125	5	0	0.79	18	47	0.021	0.130	1.085	0.040	3533	0	3533	16.3	0.98	0.468	36%	1284.79	0.0029	0.0836	1.0028	1.00
29	59.2				25	125	5	0	0.78	19	49	0.021	0.130	1.085	0.040	3658	0	3658	17.3	0.92	0.447	34%	1227.20	0.0026	0.0862	1.0339	1.03
30	58.2				26	125	5	0	0.77	20	50	0.020	0.130	1.085	0.040	3783	0	3783	18.3	0.87	0.428	31%	1173.47	0.0023	0.0885	1.0620	1.06
31	57.2	28	125	4	28	125	4	0	0.77	21	61	0.016				3908	0	3908	19.3	0.82	0.410	29%	1123.31	0.0018	0.0903	1.0836	1.08
32	56.2				28	125	4	0	0.76	21	60	0.017				4033	0	4033	20.3	0.78	0.392	27%	1076.45	0.0017	0.0920	1.1040	1.10
33	55.2				28	125	4	0	0.75	21	60	0.017				4158	0	4158	21.3	0.75	0.376	25%	1032.64	0.0016	0.0936	1.1234	1.12
34	54.2				27	125	4	0	0.74	20	59	0.017				4283	0	4283	22.3	0.71	0.362	23%	991.65	0.0015	0.0952	1.1418	1.14
35	53.2				27	125	4	0	0.73	20	58	0.017				4408	0	4408	23.3	0.68	0.348	22%	953.27	0.0015	0.0966	1.1594	1.16
36	52.2	27	125	4	27	125	4	0	0.72	19	57	0.017				4533	0	4533	24.3	0.65	0.334	20%	917.29	0.0014	0.0980	1.1761	1.18
37	51.2				28	126	4	0	0.70	20	58	0.017				4659	0	4659	25.3	0.63	0.322	19%	883.53	0.0013	0.0993	1.1917	1.19
38	50.2				29	127	4	0	0.69	20	59	0.017				4786	0	4786	26.3	0.60	0.311	18%	851.82	0.0012	0.1005	1.2062	1.21
39	49.2				31	128	4	0	0.67	21	59	0.017				4914	0	4914	27.3	0.58	0.300	17%	822.00	0.0011	0.1016	1.2197	1.22
40	48.2				32	129	4	0	0.66	21	60	0.017				5043	0	5043	28.3	0.56	0.289	16%	793.94	0.0011	0.1027	1.2324	1.23
41	47.2	33	130	5	33	130	5	0	0.65	21	52	0.019	0.130	1.085	0.040	5173	0	5173	29.3	0.54	0.280	15%	767.49	0.0012	0.1039	1.2464	1.25
42	46.2				34	130	5	0	0.64	22	52	0.019	0.130	1.085	0.040	5303	0	5303	30.3	0.52	0.271	14%	742.56	0.0011	0.1050	1.2596	1.26
43	45.2				34	130	5	0	0.65	22	53	0.019	0.130	1.085	0.040	5433	0	5433	31.3	0.51	0.262	13%	719.01	0.0010	0.1060	1.2719	1.27
44	44.2				35	130	5	0	0.60	21	51	0.020	0.130	1.085	0.040	5563	0	5563	32.3	0.49	0.254	13%	696.76	0.0010	0.1070	1.2840	1.28
45	43.2				35	130	5	0	0.60	21	51	0.019	0.130	1.085	0.040	5693	0	5693	33.3	0.48	0.246	12%	675.72	0.0009	0.1079	1.2954	1.30
46	42.2	36	130	5	36	130	5	0	0.60	22	52	0.019	0.130	1.085	0.040	5823	0	5823	34.3	0.46	0.239	11%	655.79	0.0009	0.1088	1.3061	1.31
47	41.2				37	130	5	0	0.60	22	53	0.019	0.130	1.085	0.040	5953	0	5953	35.3	0.45	0.232	11%	636.90	0.0008	0.1097	1.3161	1.32
48	40.2				39	130	5	0	0.60	23	54	0.018	0.130	1.085	0.040	6083	0	6083	36.3	0.44	0.226	10%	618.99	0.0008	0.1105	1.3254	1.33
49	39.2				40	130	5	0	0.60	24	55	0.018	0.130	1.085	0.040	6213	0	6213	37.3	0.43	0.219	10%	601.98	0.0007	0.1112	1.3341	1.33
50	38.2				42	130	5	0	0.60	25	57	0.018	0.130	1.085	0.040	6343	0	6343	38.3	0.42	0.214	9%	585.81	0.0007	0.1119	1.3423	1.34

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
													(cohesive soils)														
51	37.2	43	130	5	43	130	5	0	0.60	26	58	0.017	0.130	1.085	0.040	6473	0	6473	39.3	0.40	0.208	9%	570.44	0.0006	0.1125	1.3499	1.35
52	36.2				44	130	5	0	0.60	26	59	0.017				6603	0	6603	40.3	0.39	0.203	8%	555.80	0.0006	0.1131	1.3571	1.36
53	35.2				45	131	5	0	0.60	27	60	0.017				6734	0	6734	41.3	0.38	0.198	8%	541.86	0.0006	0.1137	1.3638	1.36
54	34.2				46	131	5	0	0.60	28	61	0.017				6865	0	6865	42.3	0.38	0.193	8%	528.57	0.0005	0.1142	1.3702	1.37
55	33.2				47	131	5	0	0.60	28	61	0.016				6996	0	6996	43.3	0.37	0.188	7%	515.88	0.0005	0.1147	1.3763	1.38
56	32.2				48	132	5	0	0.60	29	62	0.016				7128	0	7128	44.3	0.36	0.184	7%	503.77	0.0005	0.1152	1.3820	1.38
57	31.2				49	132	5	0	0.60	30	63	0.016				7260	0	7260	45.3	0.35	0.179	7%	492.19	0.0005	0.1156	1.3874	1.39
58	30.2				50	133	5	0	0.60	30	64	0.016				7393	0	7393	46.3	0.34	0.175	7%	481.13	0.0004	0.1160	1.3925	1.39
59	29.2				51	133	5	0	0.60	31	65	0.015				7525	0	7525	47.3	0.34	0.172	6%	470.53	0.0004	0.1164	1.3974	1.40
60	28.2				52	133	5	0	0.60	31	66	0.015				7659	0	7659	48.3	0.33	0.168	6%	460.39	0.0004	0.1168	1.4020	1.40
61	27.2				53	134	5	0	0.60	32	67	0.015				7792	0	7792	49.3	0.32	0.164	6%	450.67	0.0004	0.1172	1.4063	1.41
62	26.2				54	134	5	0	0.60	33	68	0.015				7926	0	7926	50.3	0.32	0.161	6%	441.35	0.0003	0.1175	1.4105	1.41
63	25.2				55	134	5	0	0.60	33	69	0.015				8060	0	8060	51.3	0.31	0.158	5%	432.41	0.0003	0.1179	1.4145	1.41
64	24.2				56	135	5	0	0.60	34	70	0.014				8195	0	8195	52.3	0.30	0.155	5%	423.83	0.0003	0.1182	1.4182	1.42
65	23.2				58	135	5	0	0.60	35	71	0.014				8330	0	8330	53.3	0.30	0.152	5%	415.58	0.0003	0.1185	1.4218	1.42

PURPOSE:

To calculate minimum strap lengths of MSE wall required to provide adequate capacity demand ratio (CDR) against bearing, sliding, overturning, global stability failures and calculate settlement using LRFD Methods per the AASHTO LRFD Bridge Design Specifications, 8th edition 2017 (BDS) and the WSDOT Geotechnical Design Manual (GDM).

REFERENCES:

Wall 9.90B profile and alignment provided by Parsons on 08302021

I-405 Renton to Bellevue project conformed Request for Proposal (RFP)

Appendix G1 GBR20181214

Appendix G2 GDR20181214

Appendix G4 Reference_Info20181214

Appendix G4 ReferenceInfoBridgeSeismic20181214

Appendix G4 ReferenceInfoGeoLandslides20181214

Washington State Department of Transportation (WSDOT) Geotechnical Design Manual (GDM)

AASHTO LRFD Bridge Design Specifications, 8th edition, 2017 (BDS)

FHWA GEC No. 3 – Seismic

Project Geotechnical Soil Properties Methodology, FLJV & Wood (GSPM)

1) GENERAL INFORMATION:

Planned Wall:

The planned 9.90B wall is located to the southwest of the intersection of I-405 and Coal Creek Parkway and parallel to the existing Lake Washington Loop Trail and Coal Creek.

Retaining Wall	9.90B
Type	Mechanically Stabilized Wall
Design Plans and Cross Sections Date	8/30/2021 (Plan) and 08/31/2021 (Cross sections)
Beginning Station	I-405SB 5834+80/ Wall 1+50
End Station	I-405SB 5840+10/ Wall 6+80
Length (ft)	530
Height (ft)	4 to 30
Terracon Explorations	T-CPT-01-21, T-CPT-2B-21, T-CPT-4A-21, T-CPT-06-21, T-Well01-21
Existing Borings	GEO-35, GEO-36, GEO-37, GEO-38, R2B-77vw-17, R2B-78-17, R2B-79-17, R2B-81vw-17, KP-3-06, W-29-20, H-1-64-CC, H-2-64-CC, H-3-64-CC

Subsurface Conditions:

Understanding of subsurface conditions was developed through review of historical borings as well as through advancement of additional explorations referenced above. A standpipe piezometer was installed near the location of T-CPT-04A-21 to evaluate current groundwater conditions. The top of piezometer elevation was 65.5 feet and a groundwater elevation observed at EL= 43 feet. The piezometer elevation was surveyed using a Trimble surveying device. Boring logs are presented in the geotechnical technical memo. Cone penetrometer tests (CPTs) as used for analysis are presented in this calculations package.

Laboratory testing results, where available, were provided in the project Geotechnical Data Report.

2) SUMMARY OF GROUNDWATER CONDITIONS

Wall 9.90B is planned to be constructed parallel to the drainage of Coal Creek. Several groundwater measurements have been recorded in historic and recent soil explorations. Observed measurements suggest a decreasing groundwater elevation from south to north with the fall in grade of the creek as well as a fall with distance perpendicular to the creek alignment. The collected data suggests that the collected run-off of Coal Creek is contributing to the regional groundwater table rather than groundwater feeding or seeping into the stream channel. A summary of groundwater measurements considered for design are provided below.

Boring	Ground Surface Elevation (ft)	Observed Groundwater Depth (ft)	Assumed Groundwater Elevation (ft)
R2B-77vw-17	67.9	20.9	47
T-CPT-04A-21	64	21	43
GEO – 37	57	14	43
T-CPT-02B-21	76	36	40
T-CPT-06-21	58	16	42
GEO – 38	58	17	41
R2B-81vw-77	76.4	45.4	31

3) ENGINEERING SOIL UNITS

Subsurface soil profiles for the wall alignment as well as several cross sections were developed for analysis of the planned MSE wall. Soil parameters for design were established using correlations from SPT and CPT methodologies outlined in the project Geotechnical Soil Properties Methodology (GSPM) contract document. Developed ESU cross sections are included in this calculations package as well as recommended soil properties for design.

ESU Groupings:
ESU Group 1 – Fill materials, either new fill engineered fills or existing fills observed
ESU Group 2 – Alluvium deposits of soft to medium stiff silt and clay layers containing organic materials

ESU Group 3 – Recent deposits not containing organics such as alluvium, recessional outwash, or lacustrine deposits

ESU Group 4 – Glacially overridden deposits consisting or advanced outwash sands and gravels or glaciolacustrine silts and clays

Soil Parameter Development

Applicable boring and CPT explorations near the wall location have been reviewed in accordance with the methods explained in the GSPM. USCS soil type of GW, GP, GM, GC, SW, SP, SM, SC and ML soils with little to no plasticity have been assigned internal friction angles according to the figure below and assigned within the range according to their soil type and guidance provided in the WSDOT GDM Section 5.8.3

$N1_{60}$ from SPT (blows/ft)	φ (o)
<4	25-30
4	27-32
10	30-35
30	35-40
50	38-43

Figure 6: Correlation of SPT N values to drained friction angle of granular soils (modified after Bowles, 1977 as reported in AASHTO 2012)

Source: Table 5-1 (WSDOT 2015)

Statistical analysis for each ESU using corrected blow counts, correlated friction angles and unit weights for SPT borings are provided in this calculations package. CPT explorations have been processed using CPeT-IT to determine friction angle correlations.

New fills, that for the reinforced zone of the MSE all and general embankment fill, have been assigned soil properties as follows:

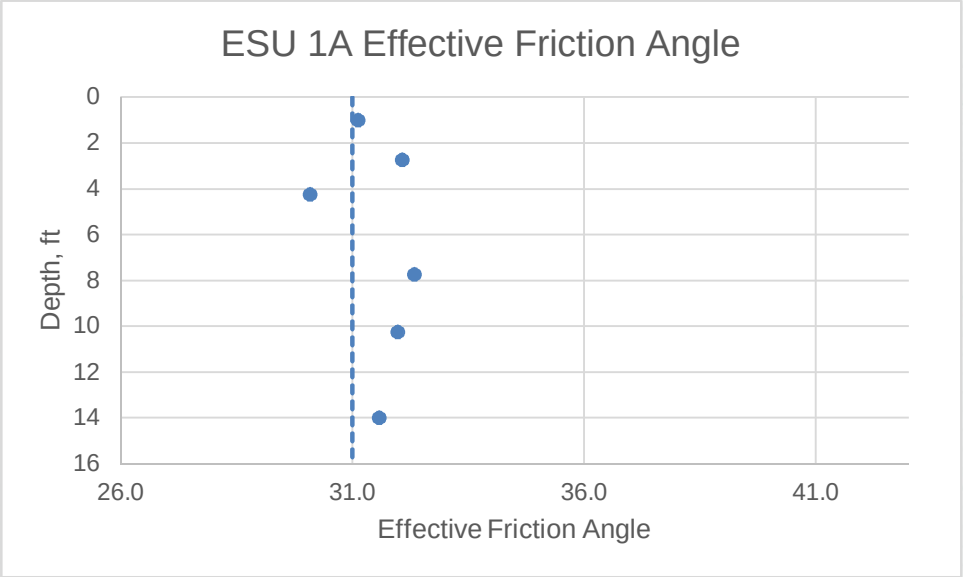
- MSE zone – Gravel backfill for walls
  Unit weight – 130 pcf
  Drained Properties – friction angle 38 degrees, cohesion 0 psf
  Undrained Properties – friction angle 38 degrees, cohesion 0 psf

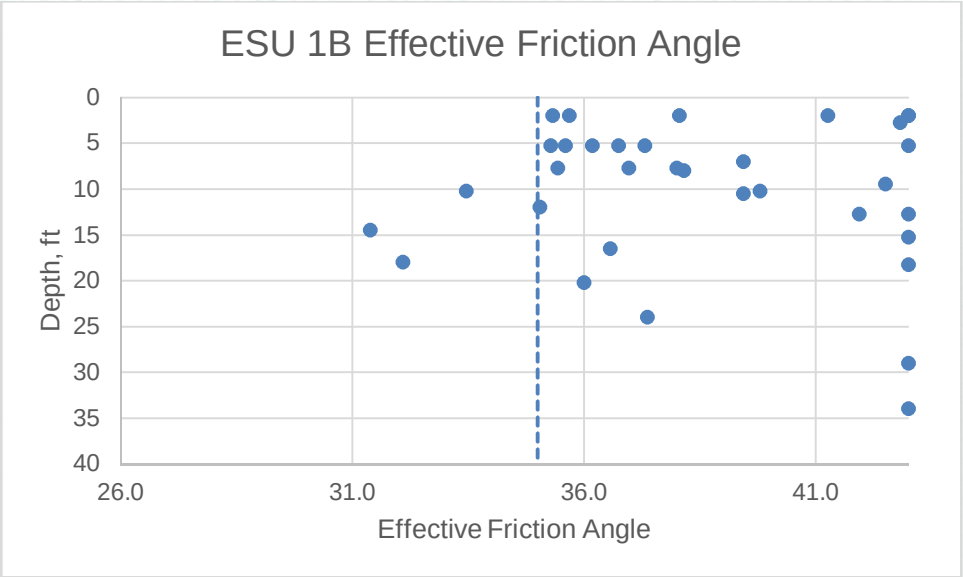
- Contractor has indicated general fill soils will consist of common borrow per WSDOT GDM Table 5-2.
  Assigned values:
  ESU 1 – Common Borrow
  Unit weight – 120 pcf
  Drained Properties – friction angle 32 degrees, cohesion 0 psf
  Undrained Properties – friction angle 32 degrees, cohesion 100 psf (variable fines content anticipated)

Material	WSDOT Standard Specification	Soil Type (USCS classification)	φ (degrees)	Cohesion (psf)	Total Unit Weight (pcf)
Common Borrow	9-03.14(3)	ML, SM, GM	30 to 34	0	115 to 130
Select Borrow	9-03.14(2)	GP, GP-GM, SP, SP-SM	34 to 38	0	120 to 135
Gravel Borrow	9-03.14(1)	GW, GW-GM, SW, SW-SM	36 to 40	0	130 to 145
Gravel Backfill for Walls	9-03.12(2)	GW, GP, SW, SP	36 to 40	0	125 to 135

Presumptive Design Property Ranges for Compacted Borrow and Other WSDOT *Standard Specification* Materials
Table 5-2

The following charts present the correlations of corrected blow count to effective friction angle for each granular soil ESU. Selected values for design are discussed below and presented on the Wall Layout ESU Figure.

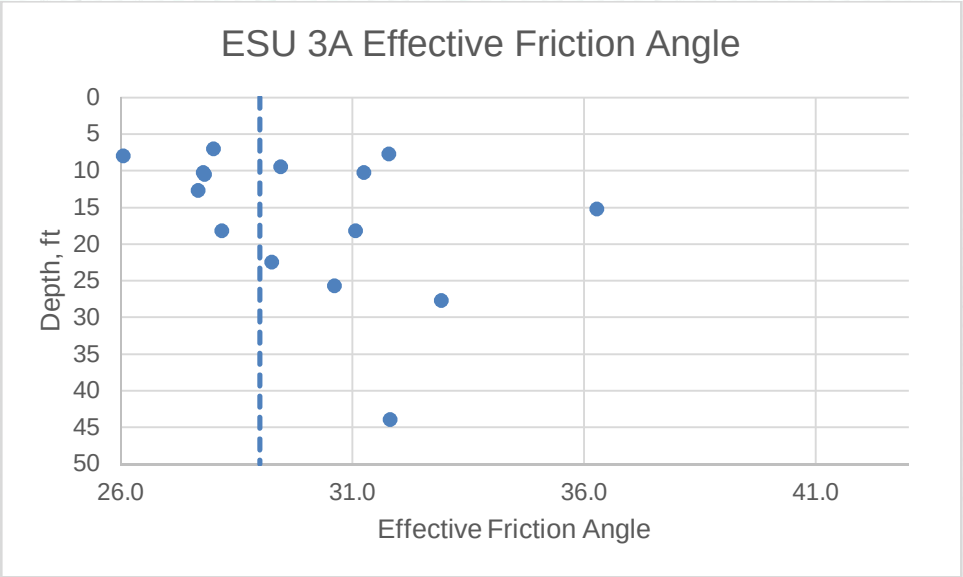




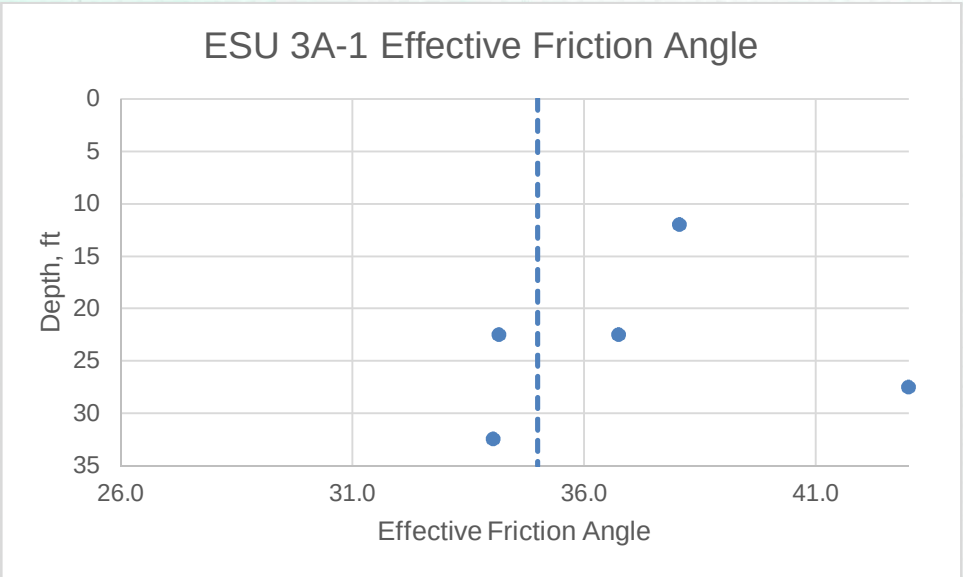
From review of available grain size analyses the typical fines content for fill soils in ESU 1A and 1B at the wall location range from 25 to 45 percent with most fines contents above 40 percent. A value of approximately 200 psf will be assigned for developed cohesion in undrained loading scenarios such as pseudostatic and post-liquefied analyses as suggested in Chapter 6.5.3 of the AASHTO BDS and Table 11-2 of FHWA GEC No 3.

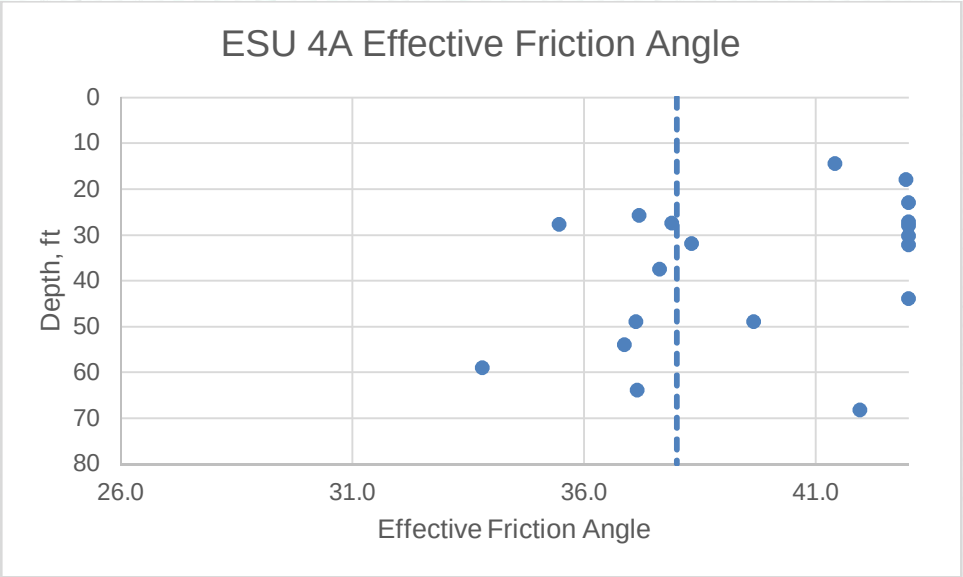
TABLE 11-2 MAXIMUM AMOUNT OF APPARENT COHESION THAT SHOULD BE ASSUMED FOR BACKFILL SOILS (NCHRP, 2008)

% (by weight) passing #200 sieve	maximum apparent cohesion
5 - 15	50 psf
15 - 25	100 psf
25-50	200 psf

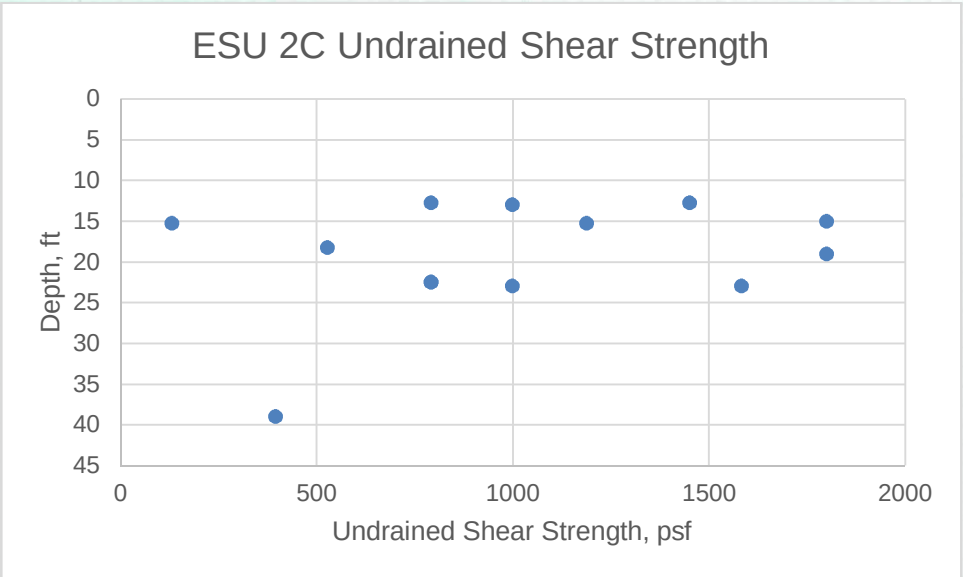


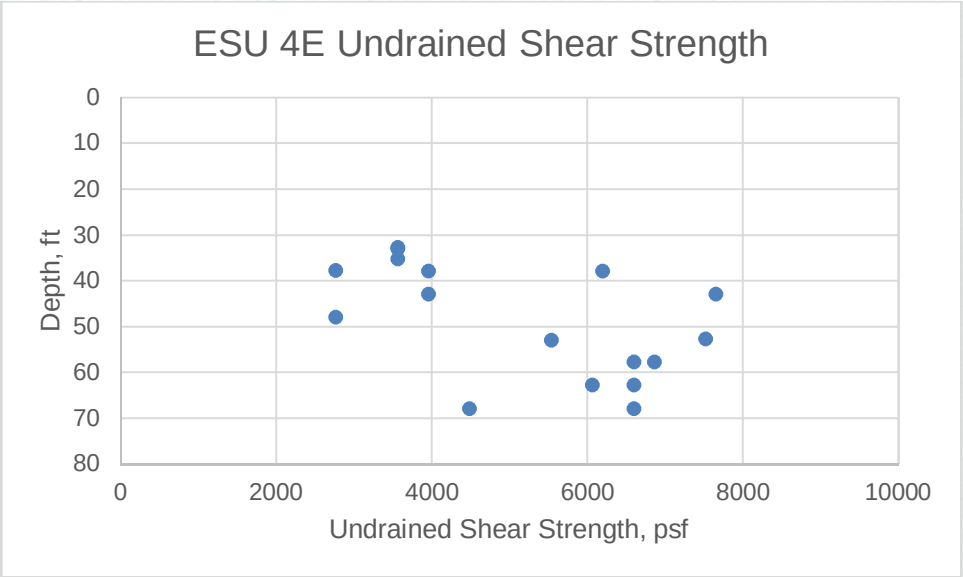
From review of available grain size analyses and Atterberg limit data, the typical fines content for soils in ESU 3A at the wall location range from 25 to 45 percent with most fines contents near 35 percent. Review of test data from the historic borings for the Coal Creek Culvert installation (H-1-64cc etc) indicate that strength test values of the silty sands at this location contain a true cohesion strength component from plasticity ranging from 100 to 375psf. A median value of approximately 200 psf will be assigned to ESU 3A in undrained loading scenarios such as pseudostatic and post-liquefied analyses (in zones above the water table where liquefaction has not occurred) as suggested in Chapter 6.5.3 of the AASHTO BDS.





Undrained shear strength – the shear strength of soil units with plasticity have been developed from blow count correlations using equation 9 of the GSPM and analysis of CPTs using an N_{kt} value of 14.





Due to the observed wide variability in undrained strength for unit 2C from existing SPT data, CPT correlations have been used where possible to reinforce or increase soil strengths. Shansep methods have been incorporated into global stability analyses to attempt to model the observed variability of the in-situ data and to model future long-term conditions due to the addition of new fills above unit 2C. The Shansep adjustments have been applied to the pseudostatic and post-liquefied condition.

For the analysis:

- A = 300 psf
- S = 0.2 as majority of failures within this zone are translational (direct shear mode)
- m = 0.8
-

The **SHANSEP** model (Stress History and Normalized Soil Engineering Properties) is used for modeling undrained shear strength of certain clay soils (Ladd and Foote, 1974). For a soil subjected to a given stress path, the following equation describes the undrained shear strength.

$$\tau = A + \sigma_v' S (OCR)^m$$

where:

τ = undrained shear strength

A = minimum undrained shear strength

σ_v' = in situ effective vertical stress

S = normally consolidated ratio of $\left(\frac{\tau}{\sigma_v'}\right)_{nc}$

OCR = over consolidation ratio

m = exponent typically between 0.75 and 1

SOIL PROPERTY ESTIMATION SHEET (FROM SPT AND LABORATORY TESTING)

Project Name:	Renton to Bellvue	Ground Elev. (ft):	69.9
Project Number:	81215044	GW Depth (ft.):	23.5
Boring No.:	GEO 35	Hammer Energy:	83
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4	2	67.9	125	250	250	18	24.9	1.70	42.3	sm		7	0	0	0					20	
2	4	6.5	5.25	64.65	125	656.25	656.25	16	22.1	1.37	30.4	sm		7	0	0	0					20	
3	6.5	9	7.75	62.15	125	968.75	968.75	14	19.4	1.24	24.1	sm		7		0						20	
4	9	11.5	10.25	59.65	120	1268.75	1268.75	11	15.2	1.15	17.6	sm		7		0						20	
5	11.5	14	12.75	57.15	130	1593.75	1593.75	38	52.6	1.08	56.7	sm		7		0						20	
6	14	16.5	15.25	54.65	130	1918.75	1918.75	36	49.8	1.02	50.6	sm		7		0						20	
7	16.5	20	18.25	51.65	135	2323.75	2323.75	48	66.4	0.95	63.2	sm		7		0						20	
8	20	25	22.5	47.4	110	2791.25	2791.25	6	8.3	0.89	7.4	ML		18		0						85	
9	25	26.5	25.75	44.15	110	3148.75	3008.35	9	12.5	0.87	10.8	ML		18		0						85	
10	26.5	29	27.75	42.15	115	3378.75	3113.55	10	13.8	0.85	11.8	GM		3		0						25	
11	29	31.5	30.25	39.65	135	3716.25	3295.05	47	65.0	0.83	54.3	SM		7		0						30	
12	31.5	34	32.75	37.15	120	4016.25	3439.05	27	37.4	0.82	30.6	CL		17		0						75	
13	34	36.5	35.25	34.65	120	4316.25	3583.05	27	37.4	0.81	30.1	CL		17		0						75	
14	36.5	39	37.75	32.15	120	4616.25	3727.05	21	29.1	0.79	23.1	CH		19		0						85	
15	39	45	42	27.9	125	5147.5	3993.1	29	40.1	0.77	30.9	SM		7		0						45	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	63.7
Project Number:	81215044	GW Depth (ft.):	17
Boring No.:	GEO 36	Hammer Energy:	83
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4	2	67.9	125	250	250	21	29.1	1.70	49.3	sm		7	0	0	0					80	37
2	4	6.5	5.25	64.65	125	656.25	656.25	30	41.5	1.37	57.0	sm		7	0	0	0					15	10
3	6.5	9	7.75	62.15	125	968.75	968.75	19	26.3	1.24	32.7	sm		7		0						67	
4	9	11.5	10.25	59.65	125	1281.25	1281.25	24	33.2	1.15	38.2	sm		7		0						80	
5	11.5	14	12.75	57.15	125	1593.75	1593.75	11	15.2	1.08	16.4	ML		18		0						80	
6	14	16.5	15.25	54.65	125	1906.25	1906.25	9	12.5	1.02	12.7	ML		18		0						20	
7	16.5	20	18.25	51.65	115	2251.25	2251.25	8	11.1	0.96	10.6	sm		7		0						45	
8	20	25	22.5	47.4	115	2740	2740	23	31.8	0.90	28.5	sm		7		0						65	
9	25	26.5	25.75	44.15	120	3130	2989.6	25	34.6	0.87	30.0	sm		7		0						15	
10	26.5	29	27.75	42.15	120	3370	3104.8	19	26.3	0.85	22.5	gm		3		0						80	
11	29	31.5	30.25	39.65	120	3670	3248.8	33	45.7	0.84	38.3	sm		7		0						73	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	57
Project Number:	81215044	GW Depth (ft.):	17
Boring No.:	GEO 37	Hammer Energy:	83
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample	Sample Depth Interval (ft)			Mid-Point	Unit Weight	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								

Number	Top	Bottom	Mid-Point	Elev. (ft)	Weight (pcf)	Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4	2	67.9	125	250	250	26	36.0	1.70	61.0	SM		7	0	0	0					30	
2	4	6.5	5.25	64.65	125	656.25	656.25	15	20.8	1.37	28.5	SM		7	0	0	0					25	
3	6.5	9	7.75	62.15	125	968.75	968.75	5	6.9	1.24	8.6	SP		6		0						9	
4	9	11.5	10.25	59.65	125	1281.25	1281.25	2	2.8	1.15	3.2	SM		7		0						20	
5	11.5	14	12.75	57.15	125	1593.75	1593.75	2	2.8	1.08	3.0	SM		7		0						30	
6	14	16.5	15.25	54.65	125	1906.25	1906.25	1	1.4	1.02	1.4	ML		18		0						85	
7	16.5	20	18.25	51.65	115	2251.25	2251.25	4	5.5	0.96	5.3	ML		18		0						85	
8	20	25	22.5	47.4	115	2740	2740	16	22.1	0.90	19.8	SM		7		0						30	
9	25	30	27.5	42.4	120	3340	3090.4	50	69.2	0.86	59.2	SM		7		0						30	
10	30	35	32.5	37.4	120	3940	3378.4	17	23.5	0.83	19.4	SM		7		0						20	
11	35	40	37.5	32.4	120	4540	3666.4	40	55.3	0.80	44.2	SP		6		0						8	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	58.6
Project Number:	81215044	GW Depth (ft.):	14.5
Boring No.:	GEO 38	Hammer Energy:	83
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4	2	67.9	125	250	250	14	19.4	1.70	32.9	SM		7	0	0	0					30	
2	4	6.5	5.25	64.65	125	656.25	656.25	14	19.4	1.37	26.6	SM		7	0	0	0					25	
3	6.5	9	7.75	62.15	125	968.75	968.75	17	23.5	1.24	29.3	SM		7		0						25	
4	9	11.5	10.25	59.65	125	1281.25	1281.25	7	9.7	1.15	11.1	SM		7		0						25	
5	11.5	14	12.75	57.15	125	1593.75	1593.75	6	8.3	1.08	8.9	ML		18	45	33	12					75	
6	14	16.5	15.25	54.65	125	1906.25	1906.25	20	27.7	1.02	28.2	SP		6		0						12	
7	16.5	20	18.25	51.65	115	2251.25	2251.25	3	4.2	0.96	4.0	SM		7		0						25	
8	20	25	22.5	47.4	115	2740	2740	6	8.3	0.90	7.4	ML		18		0						80	
9	25	30	27.5	42.4	120	3340	3090.4	41	56.7	0.86	48.6	GM		3		0						25	
10	30	34	32	37.9	120	3880	3349.6	50	69.2	0.83	57.4	GM		3		0						20	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	67.9
Project Number:	81215044	GW Depth (ft.):	21
Boring No.:	R2B-77vw-17	Hammer Energy:	88.4
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	5.5	2.75	67.15	125	343.75	343.75	21	29.1	1.59	46.2	SM		7	0	0	0					30	
2	5.5	8.5	7	62.9	125	875	875	21	29.1	1.28	37.1	SM		7	0	0	0					25	18
3	8.5	10.5	9.5	60.4	130	1200	1200	28	38.7	1.17	45.4	SM		7		0						25	
4	10.5	13.5	12	57.9	120	1500	1500	15	20.8	1.10	22.8	SM		7		0						25	
5	13.5	15.5	14.5	55.4	115	1787.5	1787.5	8	11.1	1.04	11.5	SM		7		0						25	
6	15.5	20.5	18	51.9	115	2190	2190	10	13.8	0.97	13.4	SM		7		0						12	
7	20.5	25.5	23	46.9	115	2765	2765	12	16.6	0.89	14.8	CL		17		-9	9	4				80	27
8	25.5	30.5	28	41.9	135	3440	3159.2	52	71.9	0.85	61.1	SM		7	0	0	0					30	24
9	30.5	35.5	33	36.9	125	4065	3472.2	27	37.4	0.82	30.5	ML		18		0						70	
10	35.5	40.5	38	31.9	120	4665	3760.2	30	41.5	0.79	32.8	ML		18		0						70	
11	40.5	45.5	43	26.9	125	5290	4073.2	30	41.5	0.76	31.7	ML		18		-14	14	2.5				85	21
12	45.5	50.5	48	21.9	125	5915	4386.2	21	29.1	0.74	21.5	ML		18		0						80	
13	50.5	55.5	53	16.9	125	6540	4699.2	42	58.1	0.72	41.6	ML		18		0						80	
14	55.5	60	57.75	12.15	130	7157.5	5020.3	50	69.2	0.69	48.0	CL		17		0						90	
15	60	65.5	62.75	7.15	130	7807.5	5358.3	46	63.6	0.67	42.8	CL		17		0						90	

16	65.5	70.5	68	1.9	130	8490	5713.2	34	47.0	0.65	30.6	CL		17		0						90	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	59.3
Project Number:	81215044	GW Depth (ft.):	9.5
Boring No.:	R2B-78-17	Hammer Energy:	88.4
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	5.5	2.75	67.15	115	316.25	316.25	6	8.3	1.62	13.4	SM		7		0						30	
2	5.5	8.5	7	62.9	110	783.75	783.75	2	2.8	1.32	3.6	SM		7		0						25	17
3	8.5	10.5	9.5	60.4	110	1058.75	1058.75	4	5.5	1.21	6.7	SM		7		0						25	
4	10.5	13.5	12	57.9	120	1358.75	1358.75	21	29.1	1.13	32.9	SM		7		0						25	30
5	13.5	15.5	14.5	55.4	120	1658.75	1658.75	22	30.4	1.06	32.4	GW		1		0						5	
6	15.5	20.5	18	51.9	125	2096.25	2096.25	28	38.7	0.99	38.2	GW		1		0						5	
7	20.5	25.5	23	46.9	130	2746.25	2746.25	38	52.6	0.90	47.1	GW		1		0						5	
8	25.5	29	27.25	42.65	135	3320	3086	50	69.2	0.86	59.3	GW		1		0						5	
9	29	35.5	32.25	37.65	135	3995	3449	87	120.4	0.82	98.6	SM		7	0	0	0					30	12
10	35.5	40.5	38	31.9	130	4742.5	3837.7	47	65.0	0.78	51.0	ML		18		0						70	
11	40.5	45.5	43	26.9	130	5392.5	4175.7	58	80.2	0.76	60.6	ML		18		0						80	21
12	45.5	50	47.75	22.15	135	6033.75	4520.55	50	69.2	0.73	50.4	SP		6		0						9	
13	50	55.5	52.75	17.15	130	6683.75	4858.55	57	78.9	0.70	55.6	ML		18		0						80	
14	55.5	60	57.75	12.15	130	7333.75	5196.55	52	71.9	0.68	49.1	ML		18		0						80	
15	60	65.5	62.75	7.15	130	7983.75	5534.55	50	69.2	0.66	45.7	ML		18		-12	12	3.166667				80	26
16	65.5	70.5	68	1.9	130	8666.25	5889.45	50	69.2	0.64	44.3	ML		18		0						80	
17	70.5	74	72.25	-2.35	135	9240	6198	50	69.2	0.62	43.1	SW		5		0						12	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	77
Project Number:	81215044	GW Depth (ft.):	30
Boring No.:	R2B-79-17	Hammer Energy:	88.4
Station:			
Offset:			

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	2	1	68.9	115	115	115	4	5.5	1.96	10.8	SM		7		0						30	
2	2	6.5	4.25	65.65	110	472.5	472.5	4	5.5	1.48	8.2	SM		7		0						25	
3	6.5	9.5	8	61.9	110	885	885	0	0.0	1.27	0.0	SM		7	0	0	0					25	13
4	9.5	11.5	10.5	59.4	120	1185	1185	2	2.8	1.18	3.3	SM		7		0						25	
5	11.5	14.5	13	56.9	120	1485	1485	24	33.2	1.10	36.6	SM		7		0						25	
6	14.5	16.5	15.5	54.4	125	1797.5	1797.5	30	41.5	1.04	43.1	SM		7		0						25	
7	16.5	21.5	19	50.9	130	2252.5	2252.5	60	83.0	0.96	79.8	SM		7		0						25	
8	21.5	26.5	24	45.9	135	2927.5	2896.3	27	37.4	0.88	32.8	SM		7		0						25	
9	26.5	31.5	29	40.9	135	3602.5	3259.3	9	12.5	0.84	10.4	SM		7		0						25	
10	31.5	36.5	34	35.9	130	4252.5	3597.3	6	8.3	0.81	6.7	ML		18		0						70	
11	36.5	41.5	39	30.9	130	4902.5	3935.3	25	34.6	0.78	26.8	ML		18		0						80	
12	41.5	46.5	44	25.9	135	5577.5	4298.3	50	69.2	0.75	51.6	SM		7		0						25	
13	46.5	51.5	49	20.9	130	6227.5	4636.3	27	37.4	0.72	26.9	SW		5		0						12	
14	51.5	56.5	54	15.9	130	6877.5	4974.3	30	41.5	0.70	28.9	SM		7		0						20	
15	56.5	61.5	59	10.9	130	7527.5	5312.3	20	27.7	0.68	18.7	SM		7		0						25	
16	61.5	66.5	64	5.9	130	8177.5	5650.3	33	45.7	0.65	29.9	SM		7		0						25	25
17	66.5	70	68.25	1.65	135	8751.25	5958.85	50	69.2	0.64	44.0	SM		7		0						25	

Project Name:	Renton to Bellvue	Ground Elev. (ft):	81
Project Number:	81215044	GW Depth (ft.):	20.6

Boring No.: KP-3-06
Station:
Offset:

Hammer Energy: 88.4

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4	2	67.9	115	230	230	10	13.8	1.73	23.9	SP		6		0						7	6
2	4	6.5	5.25	64.65	115	603.75	603.75	12	16.6	1.40	23.3	SP		6		0						7	
3	6.5	9.5	8	61.9	115	920	920	19	26.3	1.26	33.2	SM		7		0						25	
4	9.5	11.5	10.5	59.4	120	1220	1220	23	31.8	1.17	37.1	SM		7	14	14	0					39	12
5	11.5	14	12.75	57.15	125	1501.25	1501.25	29	40.1	1.10	44.0	SM		7		0						30	
6	14	19	16.5	53.4	120	1951.25	1951.25	20	27.7	1.01	27.9	SM		7		0						30	
7	19	21.5	20.25	49.65	120	2401.25	2401.25	20	27.7	0.94	26.0	SM		7		0						30	
8	21.5	26.5	24	45.9	125	2870	2838.8	25	34.6	0.88	30.6	SM		7		0						39	15
9	26.5	31.5	29	40.9	135	3545	3201.8	57	78.9	0.84	66.6	SM		7		0						35	
10	31.5	36.5	34	35.9	135	4220	3564.8	56	77.5	0.81	62.6	SM		7		0						35	
11	36.5	41.5	39	30.9	110	4770	3802.8	3	4.2	0.79	3.3	ML		18	37	28	9	2	1.781173			64	46
12	41.5	46.5	44	25.9	115	5345	4065.8	12	16.6	0.76	12.7	SM		7		0						25	
13	46.5	51.5	49	20.9	125	5970	4378.8	25	34.6	0.74	25.6	GW		1		0						12	
14	51.5	56.5	54	15.9	125	6595	4691.8	26	36.0	0.72	25.8	GM		3		0						20	

Project Name: Renton to Bellvue
Project Number: 81215044
Boring No.: W-29-20
Station:
Offset:

Ground Elev. (ft): 78.2
GW Depth (ft.):
Hammer Energy: 80

A	B	C	D	E	F	G	H	I	J	K	L	M	N		O	P	Q	R	S	T	U	V	W
Sample Number	Sample Depth Interval (ft)			Mid-Point Elev. (ft)	Unit Weight (pcf)	Overburden Stress (psf)		Standard Penetration Testing				Soil Classification			Laboratory Testing								
	Top	Bottom	Mid-Point			Total	Effective	N_{field}	N_{60}	C_N	$N_{1(60)}$	USCS	AASHTO	Material ID - See Note	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Liquidity Index (LI)	LN (LI)	% Gravel	% Sand	%Fines	% Water Content
1	0	4	2	67.9	110	220	220	9	12.5	1.74	21.7	SP		6		0						10	
2	4	6.5	5.25	64.65	115	593.75	593.75	11	15.2	1.41	21.4	SP		6		0						10	9
3	6.5	9	7.75	62.15	110	868.75	868.75	8	11.1	1.28	14.2	SM		7		0						15	
4	9	11.5	10.25	59.65	110	1143.75	1143.75	8	11.1	1.19	13.2	SM		7		0						23	6
5	11.5	16.5	14	55.9	110	1556.25	1556.25	8	11.1	1.09	12.0	SM		7		0						25	

EFFECTIVE STRENGTH OF COARSE AND FINE GRAINED SOILS

Boring: GEO 35

Sample Number	Sample Depth (ft)	Sample Elevation (ft)	N_{60}	$N_{1(60)}$	Material ID	Caltrans per Bowles
1	2	67.9	24.9	42.3	7.0	41.3
2	5.25	64.65	22.1	30.4	7.0	37.3
3	7.75	62.15	19.4	24.1	7.0	35.4
4	10.25	59.65	15.2	17.6	7.0	33.5
5	12.75	57.15	52.6	56.7	7.0	43.0
6	15.25	54.65	49.8	50.6	7.0	43.0
7	18.25	51.65	66.4	63.2	7.0	43.0
8	22.5	47.4	8.3	7.4	18.0	29.2
9	25.75	44.15	12.5	10.8	18.0	30.6
10	27.75	42.15	13.8	11.8	3.0	32.9
11	30.25	39.65	65.0	54.3	7.0	43.0
12	32.75	37.15	37.4	30.6	17.0	43.0
13	35.25	34.65	37.4	30.1	17.0	43.0
14	37.75	32.15	29.1	23.1	19.0	43.0
15	42	27.9	40.1	30.9	7.0	37.5

Boring: GEO 36

1	2	67.9	29.1	49.3	7.0	43.0
2	5.25	64.65	41.5	57.0	7.0	43.0
3	7.75	62.15	26.3	32.7	7.0	38.0
4	10.25	59.65	33.2	38.2	7.0	39.8
5	12.75	57.15	15.2	16.4	18.0	32.6
6	15.25	54.65	12.5	12.7	18.0	31.3
7	18.25	51.65	11.1	10.6	7.0	31.1
8	22.5	47.4	31.8	28.5	7.0	36.7
9	25.75	44.15	34.6	30.0	7.0	37.2
10	27.75	42.15	26.3	22.5	3.0	35.5
11	30.25	39.65	45.7	38.3	7.0	39.8

Boring: GEO 37

1	2	67.9	36.0	61.0	7.0	43.0
2	5.25	64.65	20.8	28.5	7.0	36.7
3	7.75	62.15	6.9	8.6	6.0	31.8
4	10.25	59.65	2.8	3.2	7.0	27.8
5	12.75	57.15	2.8	3.0	7.0	27.7
6	15.25	54.65	1.4	1.4	18.0	26.4
7	18.25	51.65	5.5	5.3	18.0	28.3
8	22.5	47.4	22.1	19.8	7.0	34.2
9	27.5	42.4	69.2	59.2	7.0	43.0

10	32.5	37.4	23.5	19.4	7.0	34.0
11	37.5	32.4	55.3	44.2	6.0	37.6

Boring: GEO 38

1	2	67.9	19.4	32.9	7.0	38.1
2	5.25	64.65	19.4	26.6	7.0	36.2
3	7.75	62.15	23.5	29.3	7.0	37.0
4	10.25	59.65	9.7	11.1	7.0	31.3
5	12.75	57.15	8.3	8.9	18.0	29.9
6	15.25	54.65	27.7	28.2	6.0	36.3
7	18.25	51.65	4.2	4.0	7.0	28.2
8	22.5	47.4	8.3	7.4	18.0	29.3
9	27.5	42.4	56.7	48.6	3.0	37.9
10	32	37.9	69.2	57.4	3.0	38.3

Boring: R2B-77vw-17

1	2.75	67.15	29.1	46.2	7.0	42.8
2	7	62.9	29.1	37.1	7.0	39.4
3	9.5	60.4	38.7	45.4	7.0	42.5
4	12	57.9	20.8	22.8	7.0	35.1
5	14.5	55.4	11.1	11.5	7.0	31.4
6	18	51.9	13.8	13.4	7.0	32.1
7	23	46.9	16.6	14.8	17.0	43.0
8	28	41.9	71.9	61.1	7.0	43.0
9	33	36.9	37.4	30.5	18.0	36.8
10	38	31.9	41.5	32.8	18.0	37.5
11	43	26.9	41.5	31.7	18.0	37.2
12	48	21.9	29.1	21.5	18.0	34.2
13	53	16.9	58.1	41.6	18.0	40.5
14	57.75	12.15	69.2	48.0	17.0	43.0
15	62.75	7.15	63.6	42.8	17.0	43.0
16	68	1.9	47.0	30.6	17.0	43.0

Boring: R2B-78-17

1	2.75	67.15	8.3	13.4	7.0	32.1
2	7	62.9	2.8	3.6	7.0	28.0
3	9.5	60.4	5.5	6.7	7.0	29.5
4	12	57.9	29.1	32.9	7.0	38.1
5	14.5	55.4	30.4	32.4	1.0	41.4
6	18	51.9	38.7	38.2	1.0	42.9
7	23	46.9	52.6	47.1	1.0	43.0
8	27.25	42.65	69.2	59.3	1.0	43.0
9	32.25	37.65	120.4	98.6	7.0	43.0
10	38	31.9	65.0	51.0	18.0	43.0
11	43	26.9	80.2	60.6	18.0	43.0
12	47.75	22.15	69.2	50.4	6.0	38.0
13	52.75	17.15	78.9	55.6	18.0	43.0

14	57.75	12.15	71.9	49.1	18.0	43.0
15	62.75	7.15	69.2	45.7	18.0	42.1
16	68	1.9	69.2	44.3	18.0	41.6
17	72.25	-2.35	69.2	43.1	5.0	38.6

Boring: R2B-79-17

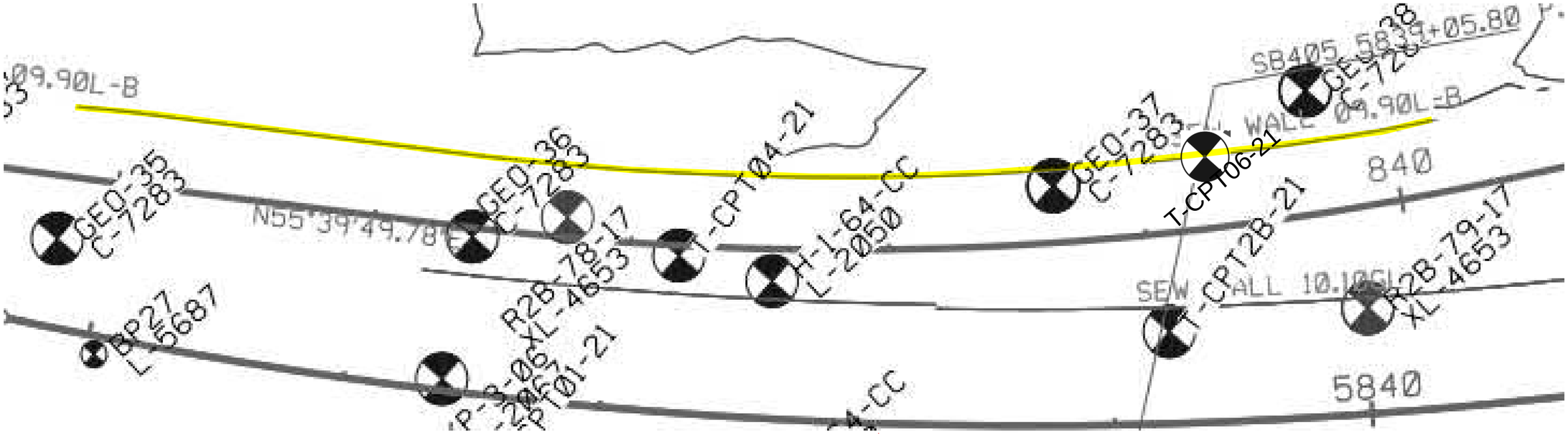
1	1	68.9	5.5	10.8	7.0	31.1
2	4.25	65.65	5.5	8.2	7.0	30.1
3	8	61.9	0.0	0.0	7.0	26.1
4	10.5	59.4	2.8	3.3	7.0	27.8
5	13	56.9	33.2	36.6	7.0	39.2
6	15.5	54.4	41.5	43.1	7.0	41.6
7	19	50.9	83.0	79.8	7.0	43.0
8	24	45.9	37.4	32.8	7.0	38.0
9	29	40.9	12.5	10.4	7.0	31.0
10	34	35.9	8.3	6.7	18.0	28.9
11	39	30.9	34.6	26.8	18.0	35.7
12	44	25.9	69.2	51.6	7.0	43.0
13	49	20.9	37.4	26.9	5.0	37.1
14	54	15.9	41.5	28.9	7.0	36.9
15	59	10.9	27.7	18.7	7.0	33.8
16	64	5.9	45.7	29.9	7.0	37.2
17	68.25	1.65	69.2	44.0	7.0	41.9

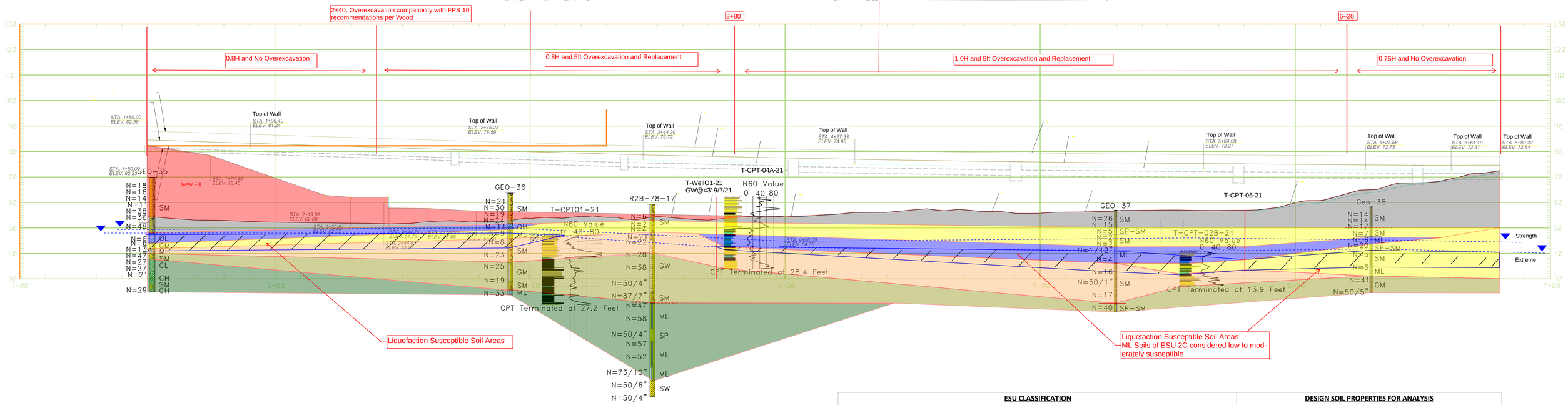
Boring: KP-3-06

1	2	67.9	13.8	23.9	6.0	35.7
2	5.25	64.65	16.6	23.3	6.0	35.6
3	8	61.9	26.3	33.2	7.0	38.2
4	10.5	59.4	31.8	37.1	7.0	39.4
5	12.75	57.15	40.1	44.0	7.0	41.9
6	16.5	53.4	27.7	27.9	7.0	36.6
7	20.25	49.65	27.7	26.0	7.0	36.0
8	24	45.9	34.6	30.6	7.0	37.4
9	29	40.9	78.9	66.6	7.0	43.0
10	34	35.9	77.5	62.6	7.0	43.0
11	39	30.9	4.2	3.3	18.0	27.3
12	44	25.9	16.6	12.7	7.0	31.8
13	49	20.9	34.6	25.6	1.0	39.7
14	54	15.9	36.0	25.8	3.0	36.0

Boring: W-29-20

1	2	67.9	12.5	21.7	6.0	35.3
2	5.25	64.65	15.2	21.4	6.0	35.3
3	7.75	62.15	11.1	14.2	7.0	32.3
4	10.25	59.65	11.1	13.2	7.0	32.0
5	14	55.9	11.1	12.0	7.0	31.6





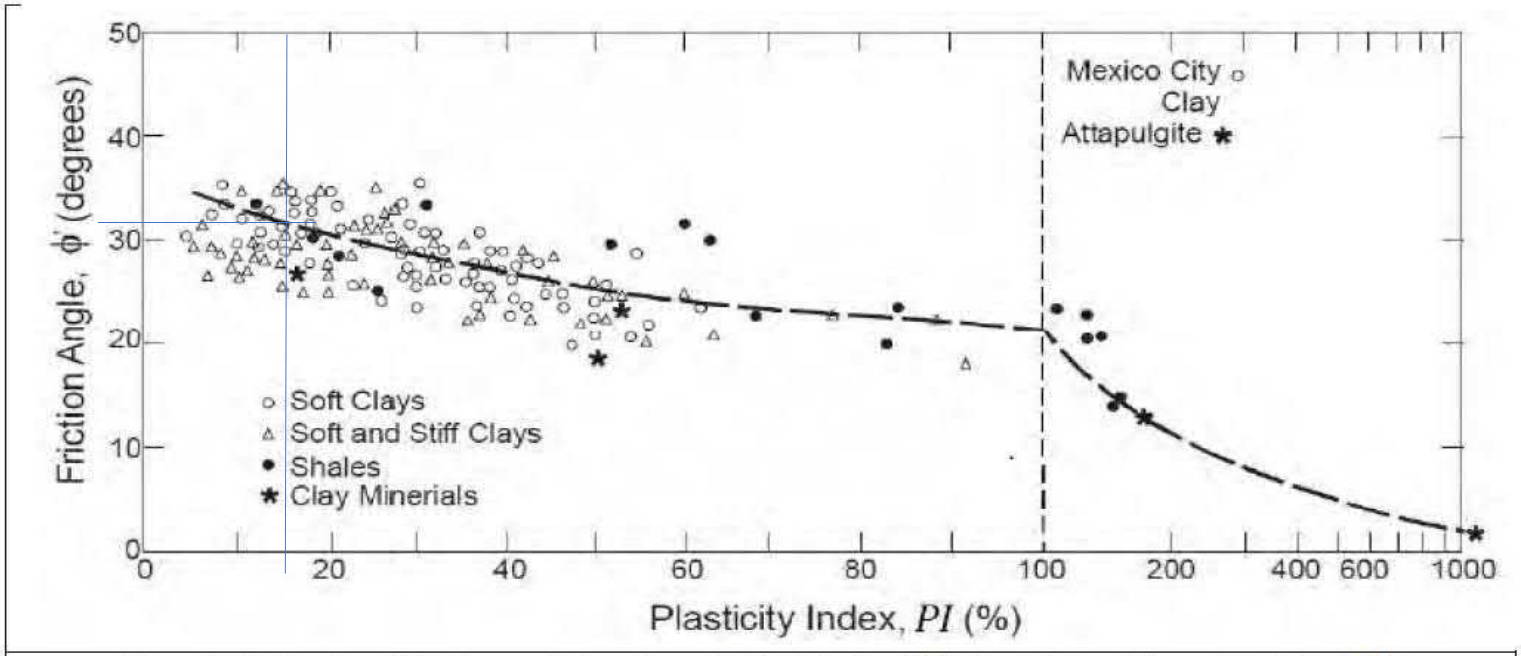
ESU CLASSIFICATION					DESIGN SOIL PROPERTIES FOR ANALYSIS					
ESU GROUP		SOIL MATERIAL				DRAINED CONDITION		UNDRAINED CONDITION		POST LIQUEFIED
COLOR	ESU #	DESCRIPTION	DENSITY/CONSISTENCY	PRIMARY CONSTITUENT	UNIT WEIGHT (pcf)	FRICTION ANGLE (deg)	Su'(psf)	FRICTION ANGLE (deg)	Su (psf)	$Su_{residual}$ (Sr/σ'_{vo})
	1	NEW FILL - COMMON BORROW	DENSE	SAND AND GRAVEL	120	32	0	32	100	NA
	1A	UNCONTROLLED FILL	LOOSE	SAND AND GRAVEL	115	31	50	31	200	NA
	1B	UNCONTROLLED FILL	MEDIUM DENSE TO DENSE	SAND AND GRAVEL	125	35	50	35	200	NA
	2C	ORGANIC SOIL	SOFT TO MEDIUM STIFF	SILT / CLAY	105	28	0	0	300 - 1000	0.2
	3A	ALLUVIUM	VERY LOOSE TO LOOSE	SAND	115	29	0	29	200	0.1
	3A-1	ALLUVIUM	MEDIUM DENSE TO DENSE	SAND	120	35	0	35	0	0.12 - 0.15
	4A	ADVANCE OUTWASH	DENSE TO VERY DENSE	SAND	130	38	0	38	0	NA
	4E	GLACIOLACUSTRINE	VERY STIFF TO HARD	SILT / CLAY	130	34	0	0	4000 - 6000	NA

Unit 2C Drained Friction Angle Correlations

SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH (ft)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)		SOIL DESCRIPTION
◆	GEO-34	20.0	34	37	12	13	Gray lean clay (CL)
■	GEO-36	12.5	26	51	10	15	Brown organic silt (OH)
▲	GEO-37	15.0	40	44	48	17	Gray silt with organics (ML)
●	GEO-38	12.5	38	45	51	12	Gray silt with organics (ML)

Average PI = 14

Selected Phi = 28



Low end value in data scatter to account of presence of organics

Figure 8: Estimates of friction angle based on plasticity index, PI (adapted from Terzaghi, et al., 1996)

Source: Figure 7-45 (Loehr et al. 2017)

4) Seismic Conditions:

Determination of As

The site adjusted seismic acceleration, As, was determined in accordance with GDM Chapter 6 as shown in the attached analysis. A site peak ground acceleration, PGA, of 0.429g and an earthquake magnitude of 7 were developed for the wall location. Based on observed soil conditions a Site Class D was assigned and the PGA adjusted per the following table:

Table 6-4 Values of Site Coefficient, F_{pga}, for Peak Ground Acceleration

Site Class	Mapped Peak Ground Acceleration Coefficient (PGA)					
	PGA ≤ 0.10	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA = 0.5	PGA ≥ 0.6
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.2	1.2	1.2	1.2	1.2
D	1.6	1.4	1.3	1.2	1.1	1.1
E	2.4	1.9	1.6	1.4	1.2	1.1
F	*	*	*	*	*	*

* Site-specific response geotechnical investigation and dynamic site response analysis should be considered.

Note: Use straight line interpolation for intermediate values of PGA.

By interpolation, Fpga = 1.17. As = 0.429g x 1.17 = **0.5g**

U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Coal Creel PKWY Over I-405 PGA with Deaggregation

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Spectral Period

Peak Ground Acceleration

Latitude

Decimal degrees

47.568

Time Horizon

Return period in years

975

Longitude

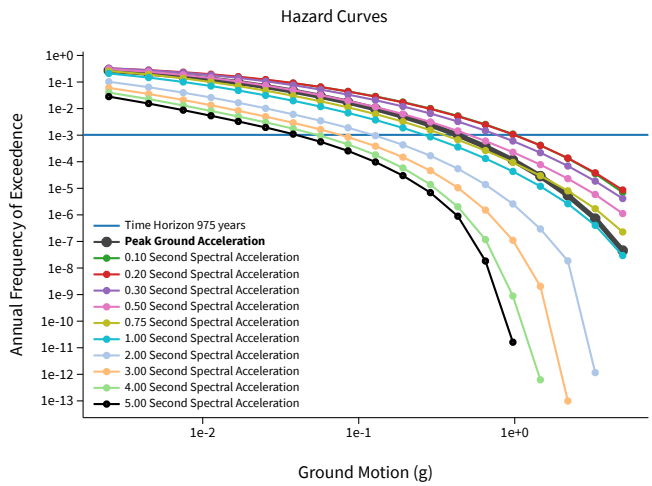
Decimal degrees, negative values for western longitudes

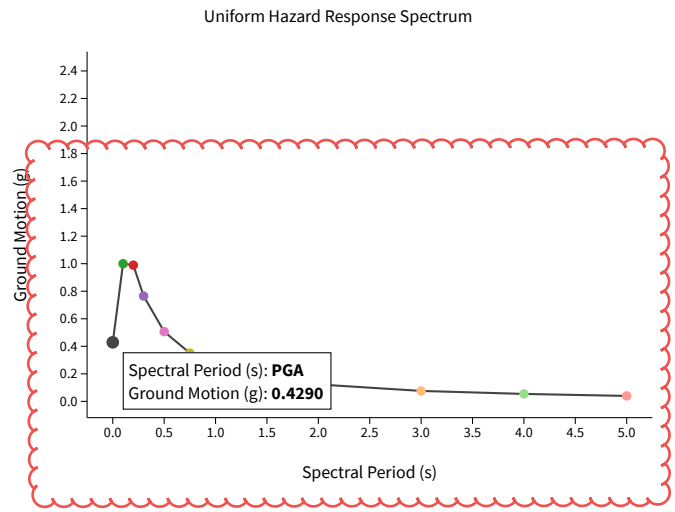
-122.18

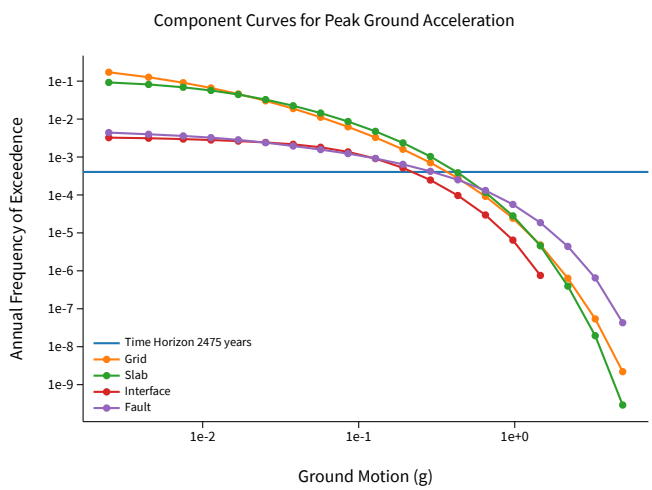
Site Class

760 m/s (B/C boundary)

Hazard Curve







$$A_S = F_{pga}\, PGA \qquad (3.10.4.2\text{-}2)$$

Table 6-4 Values of Site Coefficient, F_{pga}, for Peak Ground Acceleration

Site Class	Mapped Peak Ground Acceleration Coefficient (PGA)					
	PGA ≤ 0.10	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA = 0.5	PGA ≥ 0.6
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.2	1.2	1.2	1.2	1.2
D	1.6	1.4	1.3	1.2	1.1	1.1
E	2.4	1.9	1.6	1.4	1.2	1.1
F	*	*	*	*	*	*

* Site-specific response geotechnical investigation and dynamic site response analysis should be considered.
Note: Use straight line interpolation for intermediate values of *PGA*.

[View Raw Data]

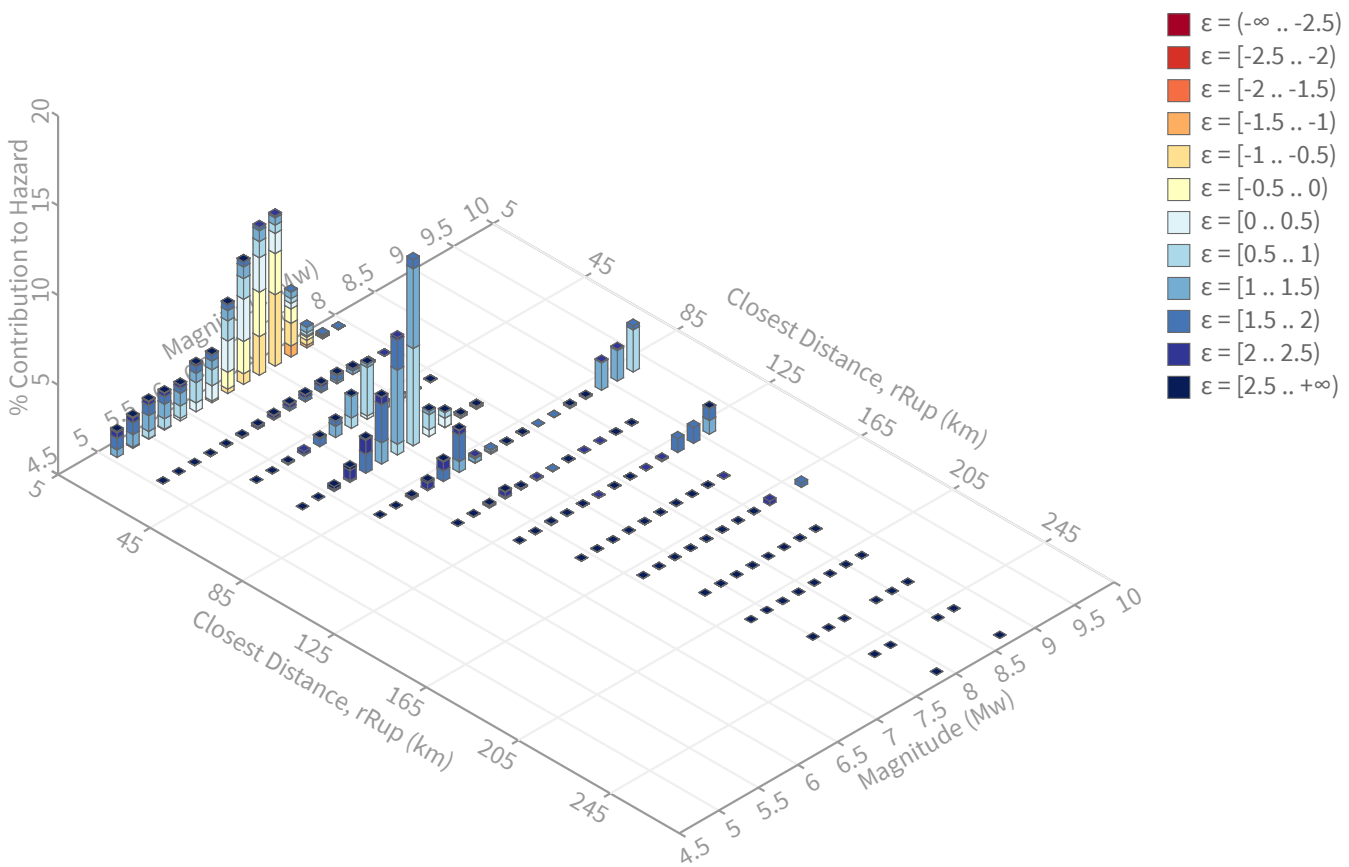
Fpga = 1.17 by interpolation

As = 1.17*0.429 = 0.5

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 975 yrs
Exceedance rate: 0.001025641 yr^{-1}
PGA ground motion: 0.42898465 g

Recovered targets

Return period: 1000.1144 yrs
Exceedance rate: 0.00099988558 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.32 %

Mean (over all sources)

m: 6.98
r: 41.81 km
ε_0: 0.88 σ

Mode (largest m-r bin)

m: 7.1
r: 66.68 km
ε_0: 1.02 σ
Contribution: 10.38 %

Mode (largest m-r-ε_0 bin)

m: 7.11
r: 63.16 km
ε_0: 0.81 σ
Contribution: 5.43 %

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 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
Seattle	Fault							22.78
Seattle - northern		2.12	6.99	-0.47	122.171°W	47.584°N	21.03	14.63
Seattle - middle		4.95	6.84	0.16	122.222°W	47.555°N	245.72	4.92
Seattle - southern		7.61	6.81	0.51	122.203°W	47.533°N	204.09	3.23
pacnwdeep.2014.in	Slab							20.25
pacnwdeep.2014.in	Slab							13.82
puget_2014.ch.in	Grid							6.07
sub0_ch_bot.in	Interface							5.78
Cascadia Megathrust - whole CSZ Characteristic		99.34	9.12	1.08	123.357°W	47.313°N	252.66	5.78
puget_2014.gr.in	Grid							5.19
WUSmap_2014_fixSm.ch.in (opt)	Grid							3.37
sub0_ch_mid.in	Interface							3.02
Cascadia Megathrust - whole CSZ Characteristic		133.84	8.93	1.63	123.916°W	47.709°N	277.51	3.02
WUSmap_2014_fixSm.gr.in (opt)	Grid							2.87
WUSmap_2014_adSm.ch.in (opt)	Grid							2.13
pacnwdeep_Mmax75.2014.in	Slab							1.98
WUSmap_2014_adSm.gr.in (opt)	Grid							1.81
puget_2014_M8.in	Grid							1.72
Geologic Model Partial Rupture	Fault							1.06
pacnwdeep_Mmax75.2014.in	Slab							1.01

U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Coal Creel PKWY with Deaggregation 0.2s (Ss)

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Spectral Period

0.20 Second Spectral Acceleration

Latitude

Decimal degrees

47.568

Time Horizon

Return period in years

975

Longitude

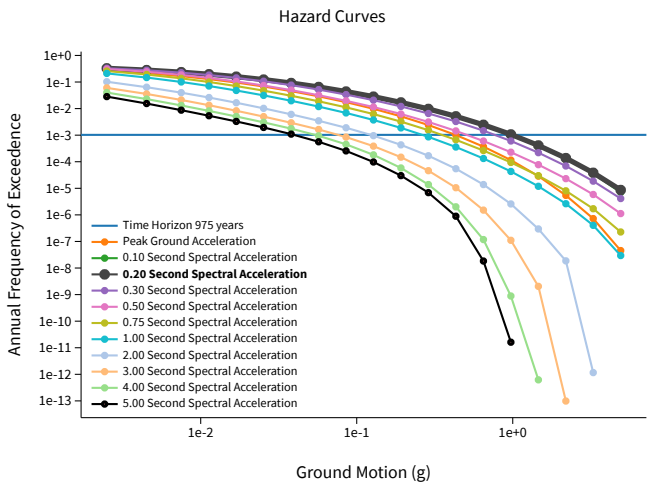
Decimal degrees, negative values for western longitudes

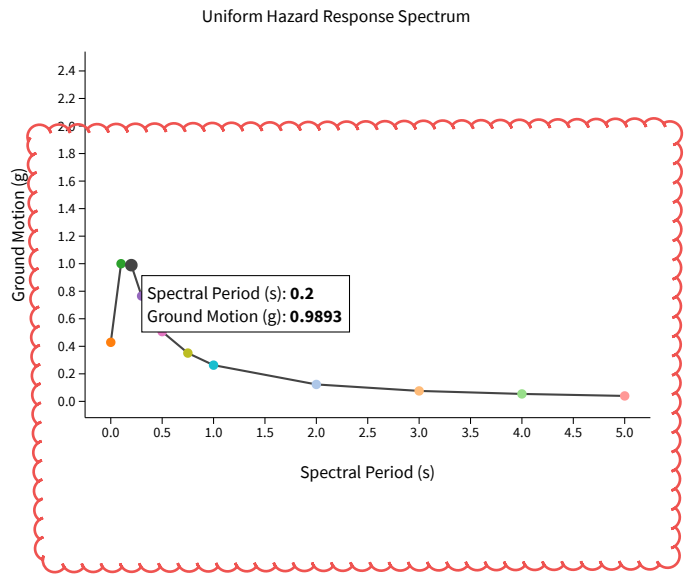
-122.18

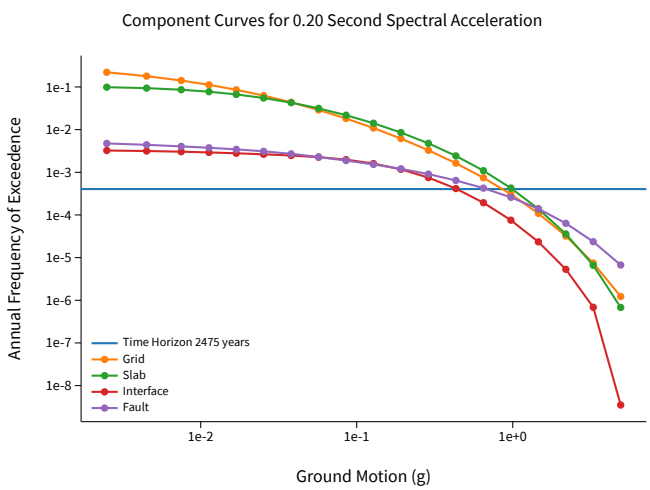
Site Class

760 m/s (B/C boundary)

Hazard Curve







View Raw Data

U.S. Geological Survey - Earthquake Hazards Program

Coal Creek PKWY over I-405 1.0s (S_1)

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Spectral Period

0.10 Second Spectral Acceleration

Latitude

Decimal degrees

47.568

Time Horizon

Return period in years

975

Longitude

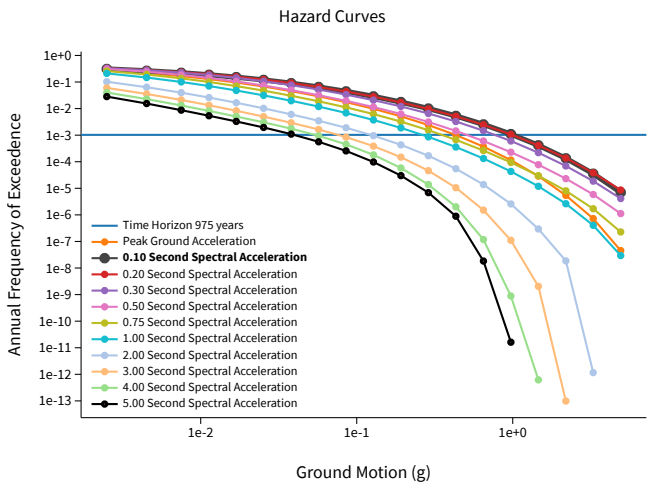
Decimal degrees, negative values for western longitudes

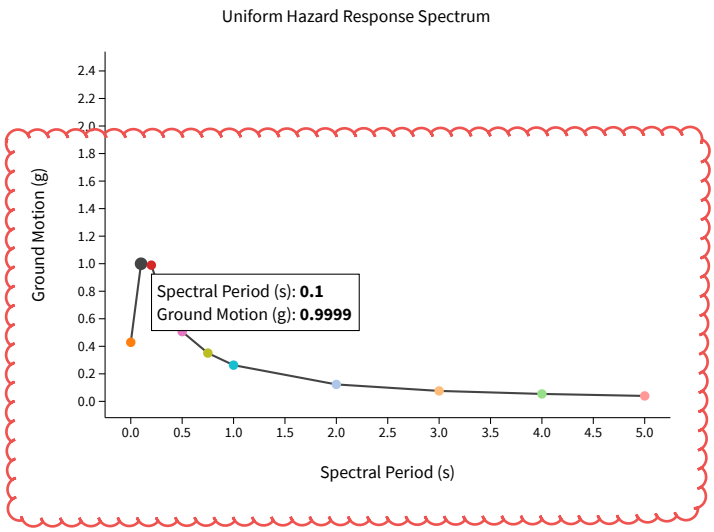
-122.18

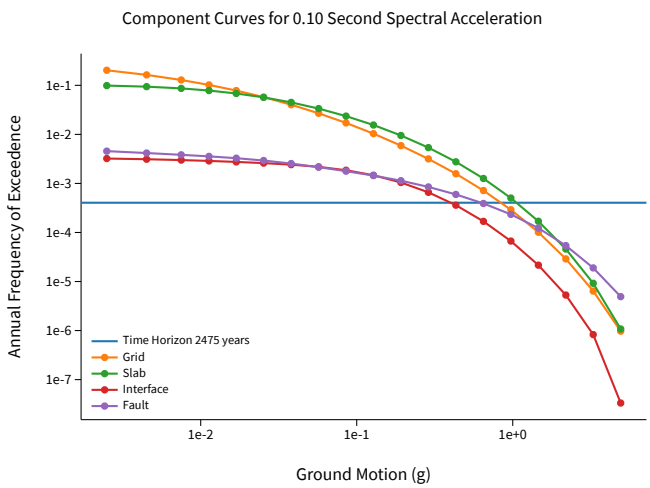
Site Class

760 m/s (B/C boundary)

Hazard Curve







View Raw Data

5) Liquefaction:

Liquefaction Triggering Analyses

SPT Correlation:
Liquefaction triggering analyses were performed using LiqSvs 2.0 software, Idriss and Boulanger criteria, and the developed As and earthquake magnitudes shown above.

CPT Correlation:
Liquefaction triggering and residual strength analyses were performed using CLiq software and in accordance with section 2.11.2 of the GSPM. Output reports from these analyses are provided.

SPT and CPT profiles included for liquefaction analysis have been assigned observed groundwater elevations near the exploration locations or within the explorations themselves. Soil profiles have been depth adjusted to account for an average future fill height of approximately 20 feet that will be present. Exploration locations where new fills are less have been adjusted accordingly for lesser thicknesses of fill placement.

Explorations Considered for Liquefaction Analyses				
Exploration	Ground Surface Elevation (ft)	Planned Top of Fill Elevation (ft)	Adjusted Profile Depth (ft)	Groundwater Elevation (ft)
T-CPT-04A-21	64	74	10	43[1]
GEO – 37	57	77	20	43[1]
T-CPT-02B-21	76	81	~5	40
T-CPT-06-21	58	75	17	42
GEO – 38	58	58	0	41
Notes: 1) Groundwater table established from T-Well01-21				

Residual Strength Determinations:

The residual strength of the liquefying soils is determined in accordance with GDM Section 6-4.2.5 and 6-2.2 which mainly reference Kramer (2007). WSDOT Geotechnical Design Manual (GDM) Section 6-2.2 contains the following table:

Liquefaction Residual Strength Models and Weights

Table 6-3 Weighting Factors for Residual Strength Estimation (Kramer, 2007)

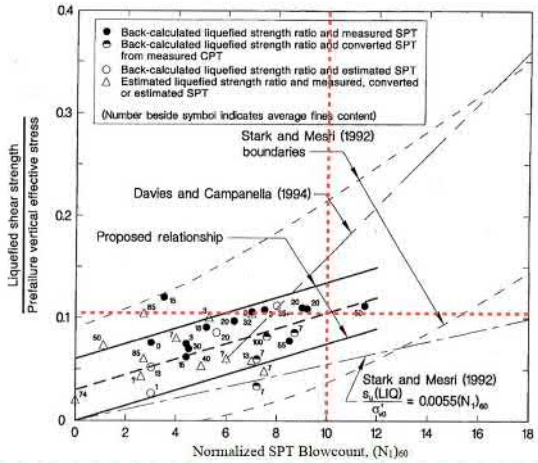
Model	Weighting Factor
Idriss	0.2
Olson-Stark	0.2
Idriss-Boulanger	0.2
Hybrid	0.4

Most of the models use the clean sand corrected blowcounts with the adjustment based on the following table from Seed and Harder (1990), the exceptions are Olson and Stark 2002, and Kramer-Wang 2007 (Hybrid).

Results of liquefaction triggering analyses for borings and CPTs indicate zones of liquefaction are predominantly indicated to occur in ESUs 3A, 3A-1, and non-plastic zones of 2C.

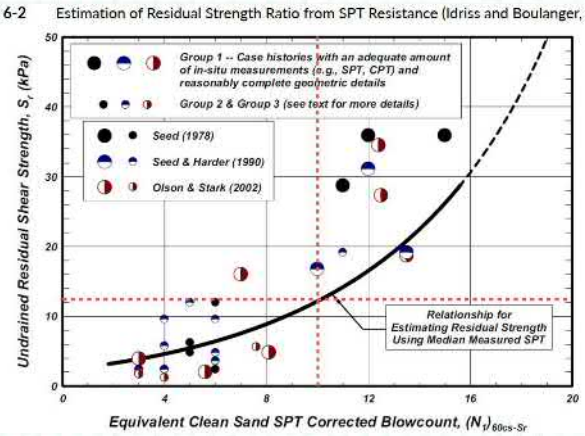
ESU 3A: From LiqSvs results of borings GEO37 and GEO38 the average $(N_1)_{60CS}$ ~ 10. From the WSDOT methods indicated above the resulting Sr/σ' is developed below.

Figure 6-1 Estimation of Residual Strength Ratio from SPT Resistance (Olson and Stark, 2002)



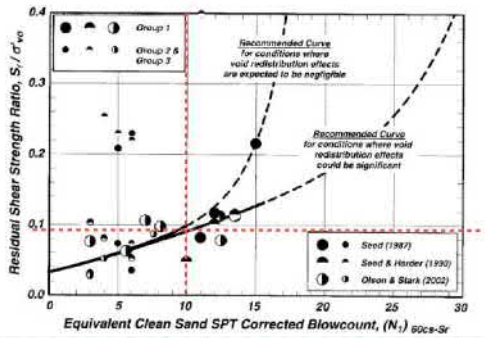
Sr/σ' = 0.105

Figure 6-2 Estimation of Residual Strength Ratio from SPT Resistance (Idriss and Boulanger, 2007)



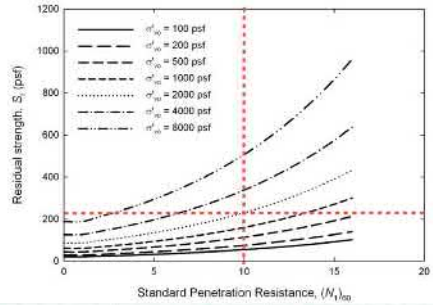
Sr = 13kpa = 270 psf.
Avg. overburden pressure = 2600 psf
Sr/ σ'= 270/2600 = 0.10

Figure 6-3 Estimation of Residual Strength Ratio from SPT Resistance (Idriss and Boulanger, 2007)



Sr/σ' = 0.095

Figure 6-4 Variation of Residual Strength Ratio with SPT Resistance and Initial Vertical Effective Stress Using Kramer-Wang Model (Kramer, 2007)



Sr = 220 psf using the 2,000 psf line
Sr/ σ'= 220/2,000 = 0.11

Weighted Sr/σ' = (0.2(0.105) + 0.2(0.10) + 0.2(0.095) + 0.4(0.11)) = 0.104

ESU 2C: For this unit, results of Cliq analysis of CPT have been interpreted for determination of Sr/σ'. From attached interpretations for T-CPT04A-21 and T-CPT06-21 the approximately Sr/σ' ~ 0.2 for post-liquefaction residual strength.

SPT BASED LIQUEFACTION ANALYSIS REPORT

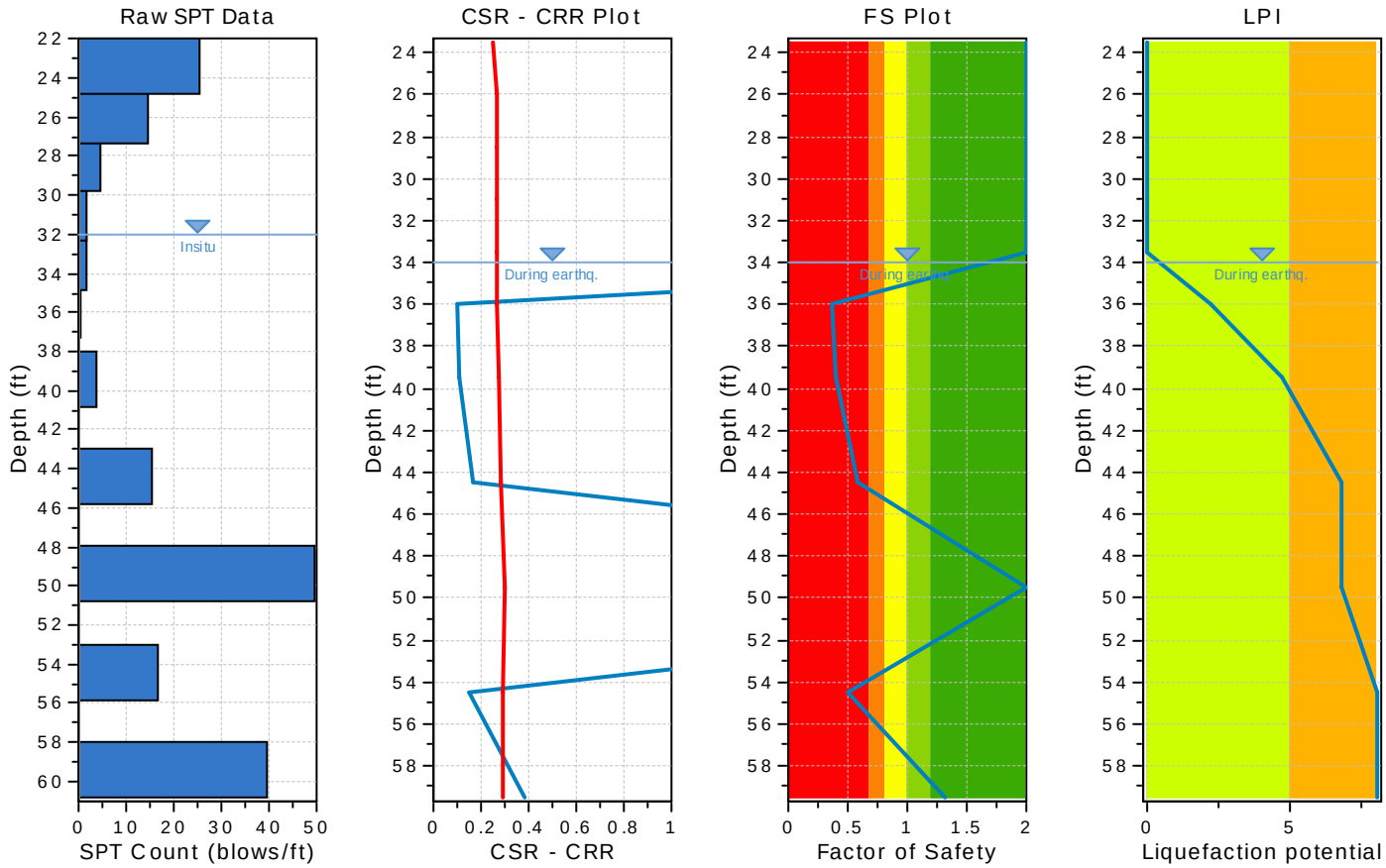
Project title : Renton to Bellevue

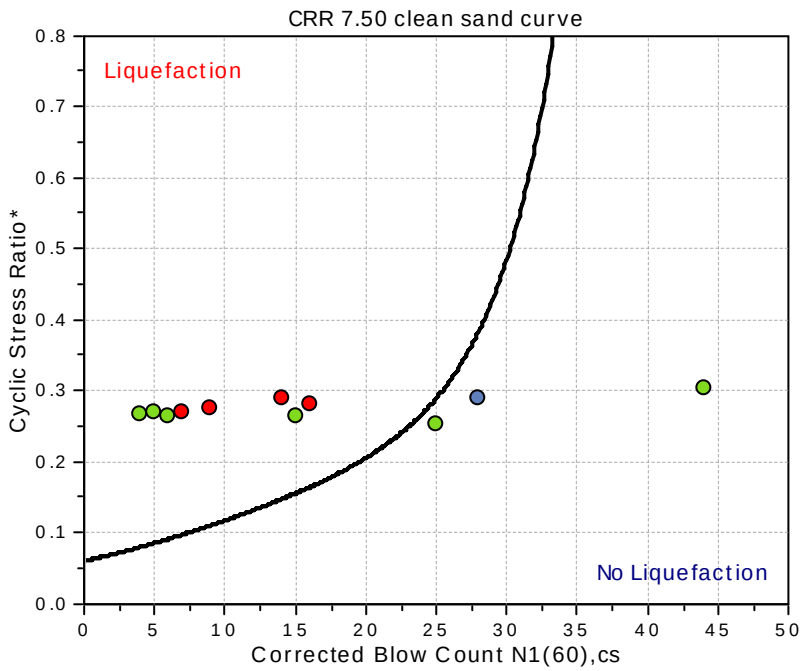
SPT Name: Geo 37

Location : Geo 37 - depth adjusted for future 20ft fill height

:: Input parameters and analysis properties ::

Analysis method:	Boulanger & Idriss, 2014	G.W.T. (in-situ):	32.00 ft
Fines correction method:	Boulanger & Idriss, 2014	G.W.T. (earthq.):	34.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	7.00
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.46 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.00		





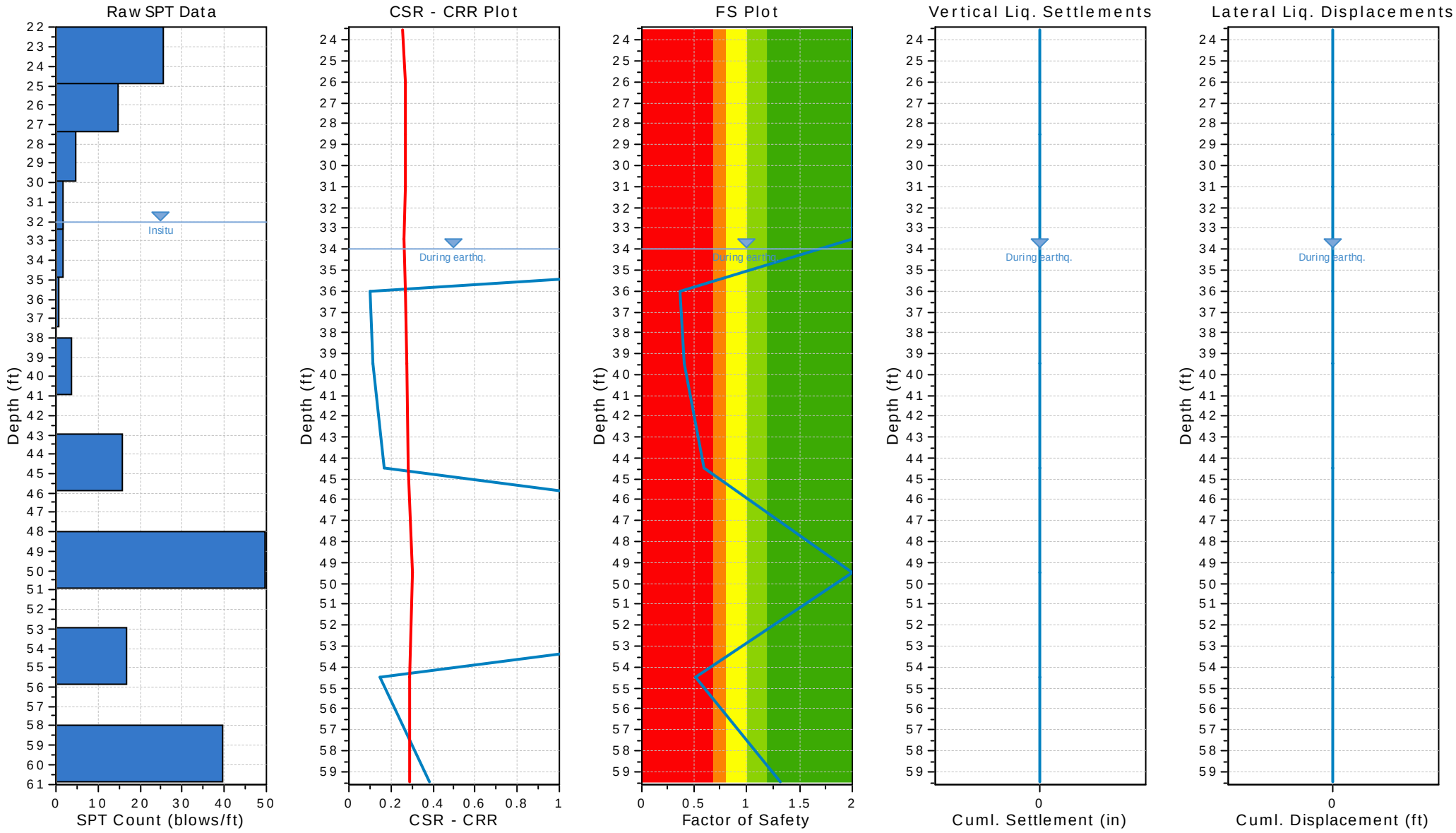
F.S. color scheme

- 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

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
23.50	26	15.00	120.00	0.00	Yes
26.00	15	15.00	120.00	0.00	Yes
28.50	5	9.00	120.00	0.00	Yes
31.00	2	15.00	120.00	0.00	Yes
33.50	2	25.00	120.00	0.00	Yes
36.00	1	80.00	120.00	0.00	Yes
39.50	4	80.00	120.00	0.00	Yes
44.50	16	30.00	120.00	0.00	Yes
49.50	50	20.00	120.00	0.00	Yes
54.50	17	15.00	120.00	0.00	Yes
59.50	40	5.00	120.00	0.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	m	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	FC (%)	$\Delta(N_1)_{60}$	$(N_1)_{60cs}$	$CRR_{7.5}$
23.50	26	120.00	1.41	0.00	1.41	0.40	0.89	1.00	1.00	0.95	1.00	22	15.00	3.26	25	4.000
26.00	15	120.00	1.56	0.00	1.56	0.49	0.83	1.00	1.00	0.95	1.00	12	15.00	3.26	15	4.000
28.50	5	120.00	1.71	0.00	1.71	0.63	0.74	1.00	1.00	0.95	1.00	4	9.00	0.72	5	4.000
31.00	2	120.00	1.86	0.00	1.86	0.64	0.70	1.00	1.00	1.00	1.00	1	15.00	3.26	4	4.000
33.50	2	120.00	2.01	0.05	1.96	0.62	0.68	1.00	1.00	1.00	1.00	1	25.00	5.07	6	4.000
36.00	1	120.00	2.16	0.12	2.04	0.62	0.66	1.00	1.00	1.00	1.00	1	80.00	5.54	7	0.098
39.50	4	120.00	2.37	0.23	2.14	0.59	0.66	1.00	1.00	1.00	1.00	3	80.00	5.54	9	0.111
44.50	16	120.00	2.67	0.39	2.28	0.49	0.69	1.00	1.00	1.00	1.00	11	30.00	5.36	16	0.165
49.50	50	120.00	2.97	0.55	2.42	0.28	0.79	1.00	1.00	1.00	1.00	40	20.00	4.48	44	4.000
54.50	17	120.00	3.27	0.70	2.57	0.51	0.64	1.00	1.00	1.00	1.00	11	15.00	3.26	14	0.148
59.50	40	120.00	3.57	0.86	2.71	0.38	0.70	1.00	1.00	1.00	1.00	28	5.00	0.00	28	0.384

(N1)60cs avg ~ 10

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
m: Stress exponent normalization factor
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
$\Delta(N_1)_{60}$ Equivalent clean sand adjustment
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF_{max}	$(N_1)_{60cs}$	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
23.50	120.00	1.41	0.00	1.41	0.91	1.00	0.273	1.72	25	1.13	0.242	0.95	0.254	2.000
26.00	120.00	1.56	0.00	1.56	0.90	1.00	0.269	1.32	15	1.06	0.255	0.96	0.266	2.000
28.50	120.00	1.71	0.00	1.71	0.89	1.00	0.265	1.12	5	1.02	0.260	0.96	0.269	2.000
31.00	120.00	1.86	0.00	1.86	0.87	1.00	0.261	1.11	4	1.02	0.256	0.96	0.267	2.000
33.50	120.00	2.01	0.00	2.01	0.86	1.00	0.257	1.13	6	1.02	0.251	0.95	0.265	2.000
36.00	120.00	2.16	0.06	2.10	0.84	1.00	0.260	1.14	7	1.02	0.254	0.94	0.269	0.365
39.50	120.00	2.37	0.17	2.20	0.83	1.00	0.266	1.17	9	1.03	0.258	0.94	0.276	0.403
44.50	120.00	2.67	0.33	2.34	0.80	1.00	0.272	1.35	16	1.06	0.256	0.91	0.282	0.585
49.50	120.00	2.97	0.48	2.49	0.77	1.00	0.275	2.20	44	1.21	0.227	0.75	0.303	2.000
54.50	120.00	3.27	0.64	2.63	0.74	1.00	0.276	1.29	14	1.05	0.263	0.90	0.291	0.508
59.50	120.00	3.57	0.80	2.77	0.72	1.00	0.276	1.88	28	1.16	0.239	0.82	0.291	1.320

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$: Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
r_d: Nonlinear shear mass factor
α: Improvement factor due to stone columns
CSR : Cyclic Stress Ratio
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$: CSR adjusted for M=7.5
K_{sigma}: Effective overburden stress factor
CSR^*: CSR fully adjusted (user FS applied)***
FS: Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
23.50	2.000	0.00	6.42	2.50	0.00
26.00	2.000	0.00	6.04	2.50	0.00
28.50	2.000	0.00	5.66	2.50	0.00
31.00	2.000	0.00	5.28	2.50	0.00
33.50	2.000	0.00	4.89	2.50	0.00
36.00	0.365	0.64	4.51	2.50	2.18
39.50	0.403	0.60	3.98	3.50	2.54
44.50	0.585	0.42	3.22	5.00	2.04
49.50	2.000	0.00	2.46	5.00	0.00
54.50	0.508	0.49	1.69	5.00	1.27
59.50	1.320	0.00	0.93	5.00	0.00

Overall potential I_L : 8.03

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} weight factor	ε_{Nc} (%)	Δh (ft)	ΔS (in)
23.50	22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} weight factor	ε_{Nc} (%)	Δh (ft)	ΔS (in)
26.00	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000
28.50	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000
31.00	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000
33.50	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000

Cumulative settlemetns: 0.000

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical & Lateral displ.acements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60cs}$	γ_{lim} (%)	F_α	FS_{liq}	γ_{max} (%)	e_v weight factor	e_v (%)	dz (ft)	S_{v-1D} (in)	LDI (ft)
36.00	7	66.51	0.95	0.365	66.51	1.00	4.52	0.00	0.000	0.00
39.50	9	52.88	0.93	0.403	52.88	1.00	3.97	0.00	0.000	0.00
44.50	16	24.69	0.71	0.585	24.69	1.00	2.74	0.00	0.000	0.00
49.50	44	0.34	-1.11	2.000	0.00	1.00	0.00	0.00	0.000	0.00
54.50	14	30.65	0.79	0.508	30.65	1.00	3.02	0.00	0.000	0.00
59.50	28	6.08	0.04	1.320	1.78	1.00	0.38	0.00	0.000	0.00

Cumulative settlements: 0.000 0.00

Abbreviations

γ_{lim}: Limiting shear strain (%)
F_α/N: Maximun shear strain factor
γ_{max}: Maximum shear strain (%)
e_v:: Post liquefaction volumetric strain (%)
S_{v-1D}: Estimated vertical settlement (in)
LDI: Estimated lateral displacement (ft)

References

- Ronald D. Andrus, Hossein Hayati, Nisha P. Mohanan, 2009. Correcting Liquefaction Resistance for Aged Sands Using Measured to Estimated Velocity Ratio, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 135, No. 6, June 1

- Boulanger, R.W. and Idriss, I. M., 2014. CPT AND SPT BASED LIQUEFACTION TRIGGERING PROCEDURES. DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA AT DAVIS

- Dipl.-Ing. Heinz J. Priebe, Vibro Replacement to Prevent Earthquake Induced Liquefaction, Proceedings of the Geotechnique-Colloquium at Darmstadt, Germany, on March 19th, 1998 (also published in Ground Engineering, September 1998), Technical paper 12-57E

- Robertson, P.K. and Cabal, K.L., 2007, Guide to Cone Penetration Testing for Geotechnical Engineering. Available at no cost at http://www.geologismiki.gr/

- 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., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833

- Zhang, G., Robertson. P.K., Brachman, R., 2002, Estimating Liquefaction Induced Ground Settlements from the CPT, Canadian Geotechnical Journal, 39: pp 1168-1180

- Zhang, G., Robertson. P.K., Brachman, R., 2004, Estimating Liquefaction Induced Lateral Displacements using the SPT and CPT, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 130, No. 8, 861-871

- Pradel, D., 1998, Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 124, No. 4, 364-368

- R. Kayen, R. E. S. Moss, E. M. Thompson, R. B. Seed, K. O. Cetin, A. Der Kiureghian, Y. Tanaka, K. Tokimatsu, 2013. Shear-Wave Velocity–Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, Journal of

SPT BASED LIQUEFACTION ANALYSIS REPORT

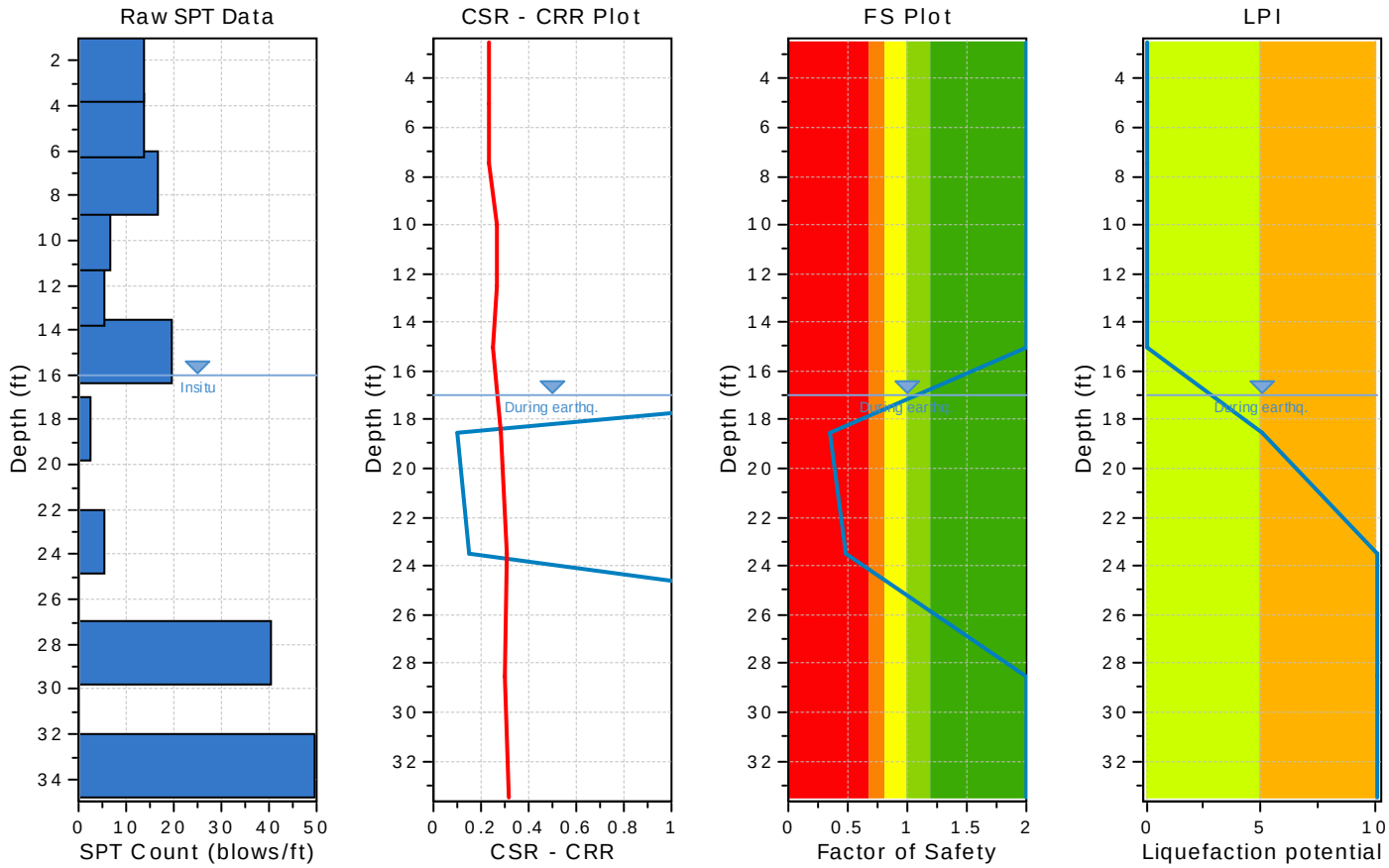
Project title : Renton to Bellevue

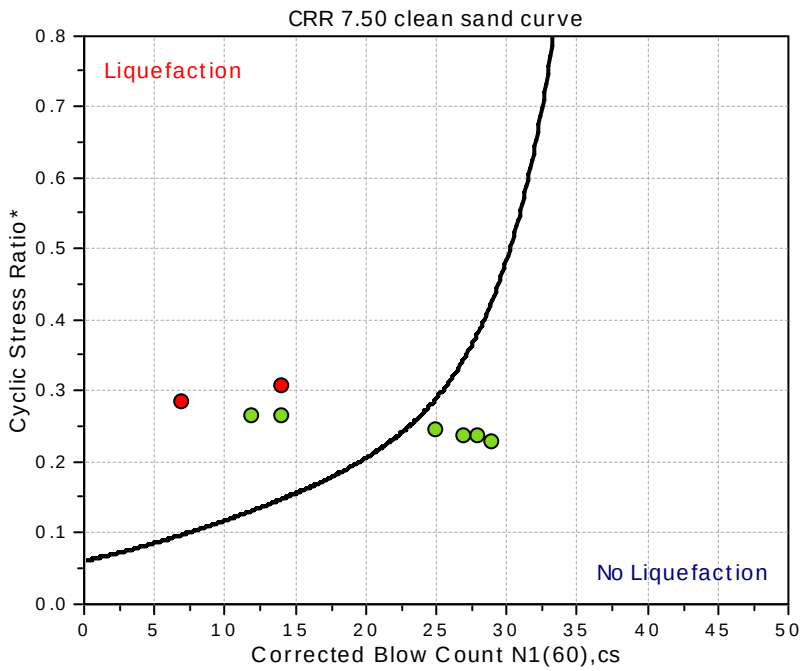
SPT Name: Geo 38

Location : Geo 38

:: Input parameters and analysis properties ::

Analysis method:	Boulanger & Idriss, 2014	G.W.T. (in-situ):	16.00 ft
Fines correction method:	Boulanger & Idriss, 2014	G.W.T. (earthq.):	17.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	7.00
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.46 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.40		





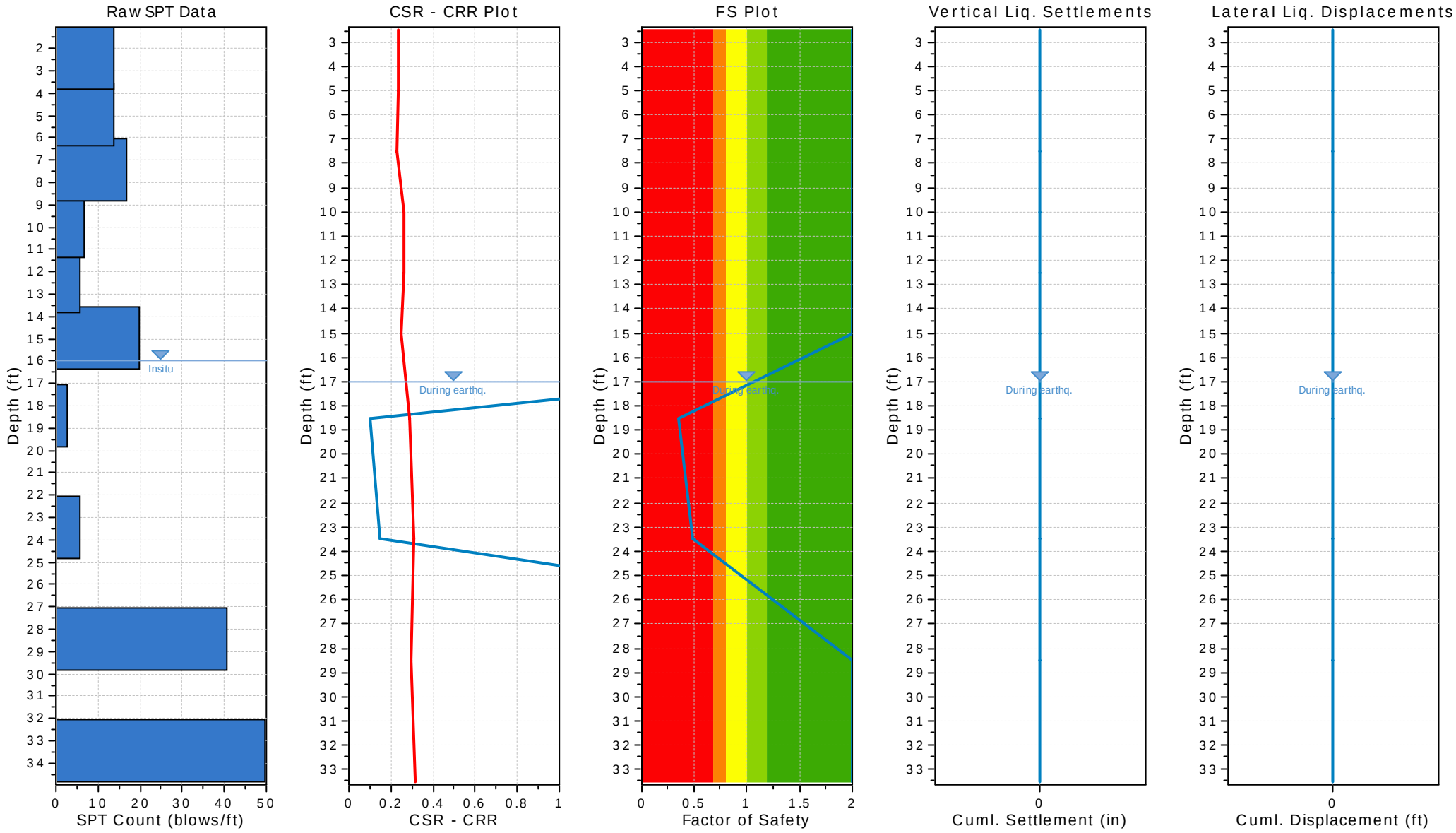
F.S. color scheme

- 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

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.50	14	15.00	120.00	0.00	Yes
5.00	14	15.00	120.00	0.00	Yes
7.50	17	15.00	120.00	0.00	Yes
10.00	7	10.00	120.00	0.00	Yes
12.50	6	65.00	120.00	0.00	Yes
15.00	20	8.00	120.00	0.00	Yes
18.50	3	15.00	120.00	0.00	Yes
23.50	6	55.00	120.00	0.00	Yes
28.50	41	15.00	120.00	0.00	Yes
33.50	50	15.00	120.00	0.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	m	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	FC (%)	$\Delta(N_1)_{60}$	$(N_1)_{60cs}$	$CRR_{7.5}$
2.50	14	120.00	0.15	0.00	0.15	0.36	1.70	1.40	1.00	0.75	1.00	25	15.00	3.26	28	4.000
5.00	14	120.00	0.30	0.00	0.30	0.37	1.60	1.40	1.00	0.75	1.00	24	15.00	3.26	27	4.000
7.50	17	120.00	0.45	0.00	0.45	0.36	1.36	1.40	1.00	0.80	1.00	26	15.00	3.26	29	4.000
10.00	7	120.00	0.60	0.00	0.60	0.51	1.34	1.40	1.00	0.85	1.00	11	10.00	1.15	12	4.000
12.50	6	120.00	0.75	0.00	0.75	0.49	1.18	1.40	1.00	0.85	1.00	8	65.00	5.59	14	4.000
15.00	20	120.00	0.90	0.00	0.90	0.39	1.07	1.40	1.00	0.85	1.00	25	8.00	0.37	25	4.000
18.50	3	120.00	1.11	0.08	1.03	0.58	1.01	1.40	1.00	0.95	1.00	4	15.00	3.26	7	0.098
23.50	6	120.00	1.41	0.23	1.18	0.51	0.95	1.40	1.00	0.95	1.00	8	55.00	5.61	14	0.148
28.50	41	120.00	1.71	0.39	1.32	0.26	0.94	1.40	1.00	0.95	1.00	51	15.00	3.26	54	4.000
33.50	50	120.00	2.01	0.55	1.46	0.26	0.92	1.40	1.00	1.00	1.00	64	15.00	3.26	67	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
m: Stress exponent normalization factor
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
$\Delta(N_1)_{60}$ Equivalent clean sand adjustment
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cyclic resistance ratio for M=7.5

(N1)60cs avg ~ 10

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF_{max}	$(N_1)_{60cs}$	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.50	120.00	0.15	0.00	0.15	1.00	1.00	0.299	1.88	28	1.16	0.259	1.10	0.235	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF_{max}	$(N_1)_{60cs}$	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
5.00	120.00	0.30	0.00	0.30	0.99	1.00	0.297	1.82	27	1.15	0.259	1.10	0.235	2.000
7.50	120.00	0.45	0.00	0.45	0.98	1.00	0.294	1.94	29	1.17	0.252	1.10	0.229	2.000
10.00	120.00	0.60	0.00	0.60	0.97	1.00	0.291	1.24	12	1.04	0.280	1.06	0.265	2.000
12.50	120.00	0.75	0.00	0.75	0.96	1.00	0.288	1.29	14	1.05	0.274	1.04	0.264	2.000
15.00	120.00	0.90	0.00	0.90	0.95	1.00	0.285	1.72	25	1.13	0.253	1.03	0.246	2.000
18.50	120.00	1.11	0.05	1.06	0.94	1.00	0.292	1.14	7	1.02	0.285	1.00	0.286	0.344
23.50	120.00	1.41	0.20	1.21	0.91	1.00	0.319	1.29	14	1.05	0.303	0.99	0.307	0.481
28.50	120.00	1.71	0.36	1.35	0.89	1.00	0.335	2.20	54	1.21	0.277	0.93	0.298	2.000
33.50	120.00	2.01	0.51	1.50	0.86	1.00	0.345	2.20	67	1.21	0.285	0.90	0.317	2.000

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$: Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
r_d: Nonlinear shear mass factor
α: Improvement factor due to stone columns
CSR : Cyclic Stress Ratio
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$: CSR adjusted for M=7.5
K_{sigma}: Effective overburden stress factor
CSR^*: CSR fully adjusted (user FS applied)***
FS: Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.50	2.000	0.00	9.62	2.50	0.00
5.00	2.000	0.00	9.24	2.50	0.00
7.50	2.000	0.00	8.86	2.50	0.00
10.00	2.000	0.00	8.48	2.50	0.00
12.50	2.000	0.00	8.10	2.50	0.00
15.00	2.000	0.00	7.71	2.50	0.00
18.50	0.344	0.66	7.18	3.50	5.03
23.50	0.481	0.52	6.42	5.00	5.08
28.50	2.000	0.00	5.66	5.00	0.00
33.50	2.000	0.00	4.89	5.00	0.00

Overall potential I_L : 10.10

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} weight factor	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.50	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000
5.00	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000
7.50	26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000
10.00	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} weight factor	ε_{Nc} (%)	Δh (ft)	ΔS (in)
12.50	8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000
15.00	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.000

Cumulative settlemetns: 0.000

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical & Lateral displ.acements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60cs}$	γ_{lim} (%)	F_α	FS_{liq}	γ_{max} (%)	e_v weight factor	e_v (%)	dz (ft)	S_{v-1D} (in)	LDI (ft)
18.50	7	66.51	0.95	0.344	66.51	1.00	4.52	0.00	0.000	0.00
23.50	14	30.65	0.79	0.481	30.65	1.00	3.02	0.00	0.000	0.00
28.50	54	0.00	-1.92	2.000	0.00	1.00	0.00	0.00	0.000	0.00
33.50	67	0.00	-3.03	2.000	0.00	1.00	0.00	0.00	0.000	0.00

Cumulative settlements: 0.000 0.00

Abbreviations

γ_{lim}: Limiting shear strain (%)
F_α/N: Maximun shear strain factor
γ_{max}: Maximum shear strain (%)
e_v:: Post liquefaction volumetric strain (%)
S_{v-1D}: Estimated vertical settlement (in)
LDI: Estimated lateral displacement (ft)

References

- Ronald D. Andrus, Hossein Hayati, Nisha P. Mohanan, 2009. Correcting Liquefaction Resistance for Aged Sands Using Measured to Estimated Velocity Ratio, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 135, No. 6, June 1

- Boulanger, R.W. and Idriss, I. M., 2014. CPT AND SPT BASED LIQUEFACTION TRIGGERING PROCEDURES. DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA AT DAVIS

- Dipl.-Ing. Heinz J. Priebe, Vibro Replacement to Prevent Earthquake Induced Liquefaction, Proceedings of the Geotechnique-Colloquium at Darmstadt, Germany, on March 19th, 1998 (also published in Ground Engineering, September 1998), Technical paper 12-57E

- Robertson, P.K. and Cabal, K.L., 2007, Guide to Cone Penetration Testing for Geotechnical Engineering. Available at no cost at http://www.geologismiki.gr/

- 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., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833

- Zhang, G., Robertson. P.K., Brachman, R., 2002, Estimating Liquefaction Induced Ground Settlements from the CPT, Canadian Geotechnical Journal, 39: pp 1168-1180

- Zhang, G., Robertson. P.K., Brachman, R., 2004, Estimating Liquefaction Induced Lateral Displacements using the SPT and CPT, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 130, No. 8, 861-871

- Pradel, D., 1998, Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 124, No. 4, 364-368

- R. Kayen, R. E. S. Moss, E. M. Thompson, R. B. Seed, K. O. Cetin, A. Der Kiureghian, Y. Tanaka, K. Tokimatsu, 2013. Shear-Wave Velocity–Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, Journal of

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http://www.geologismiki.gr

LIQUEFACTION ANALYSIS REPORT

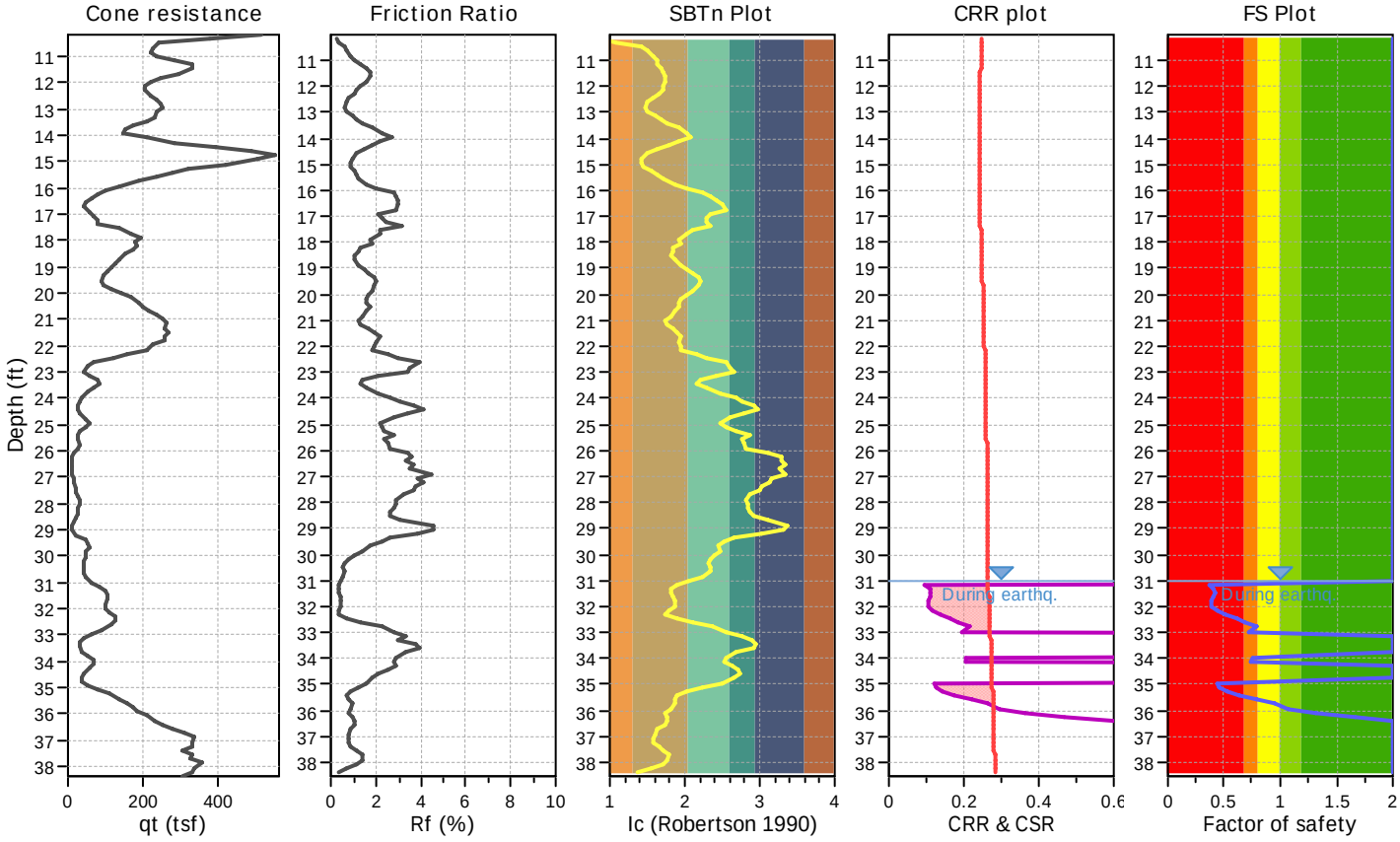
Project title : Renton to Bellevue

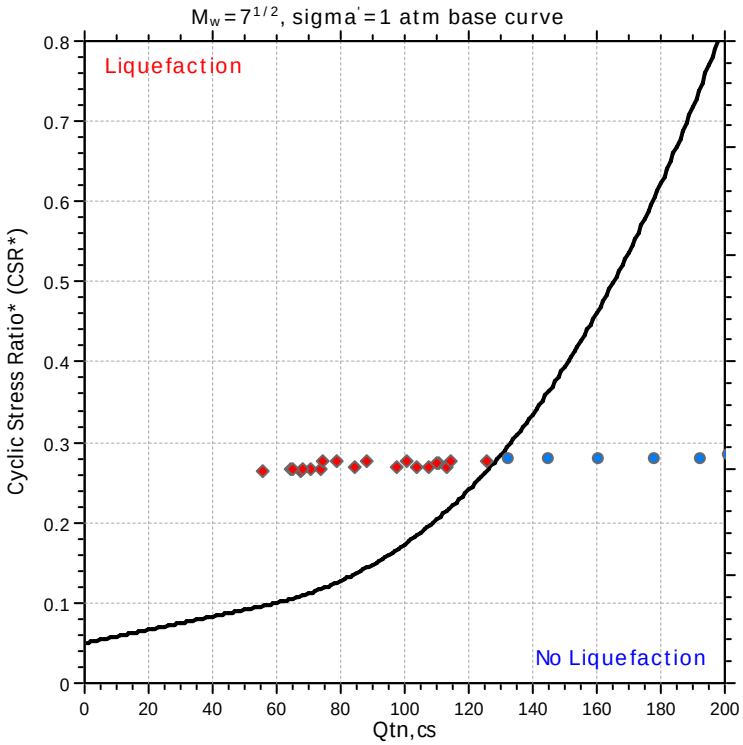
Location : T-CPT-04A-21

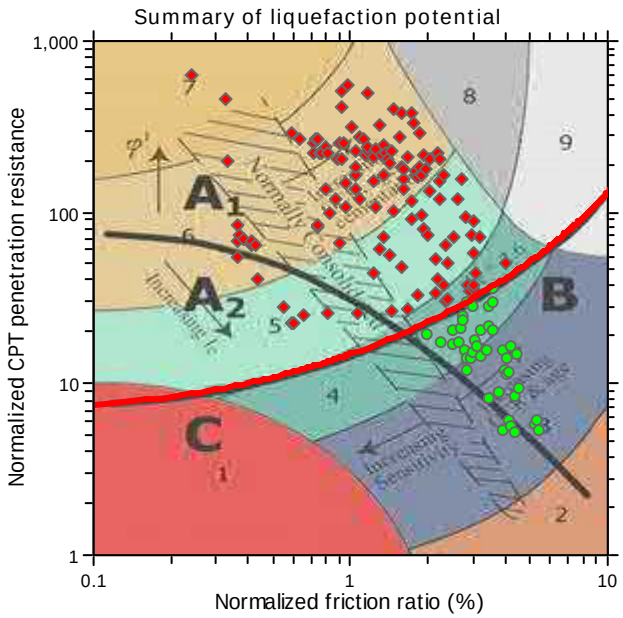
CPT file : Sheet1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	31.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	31.00 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:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.46	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

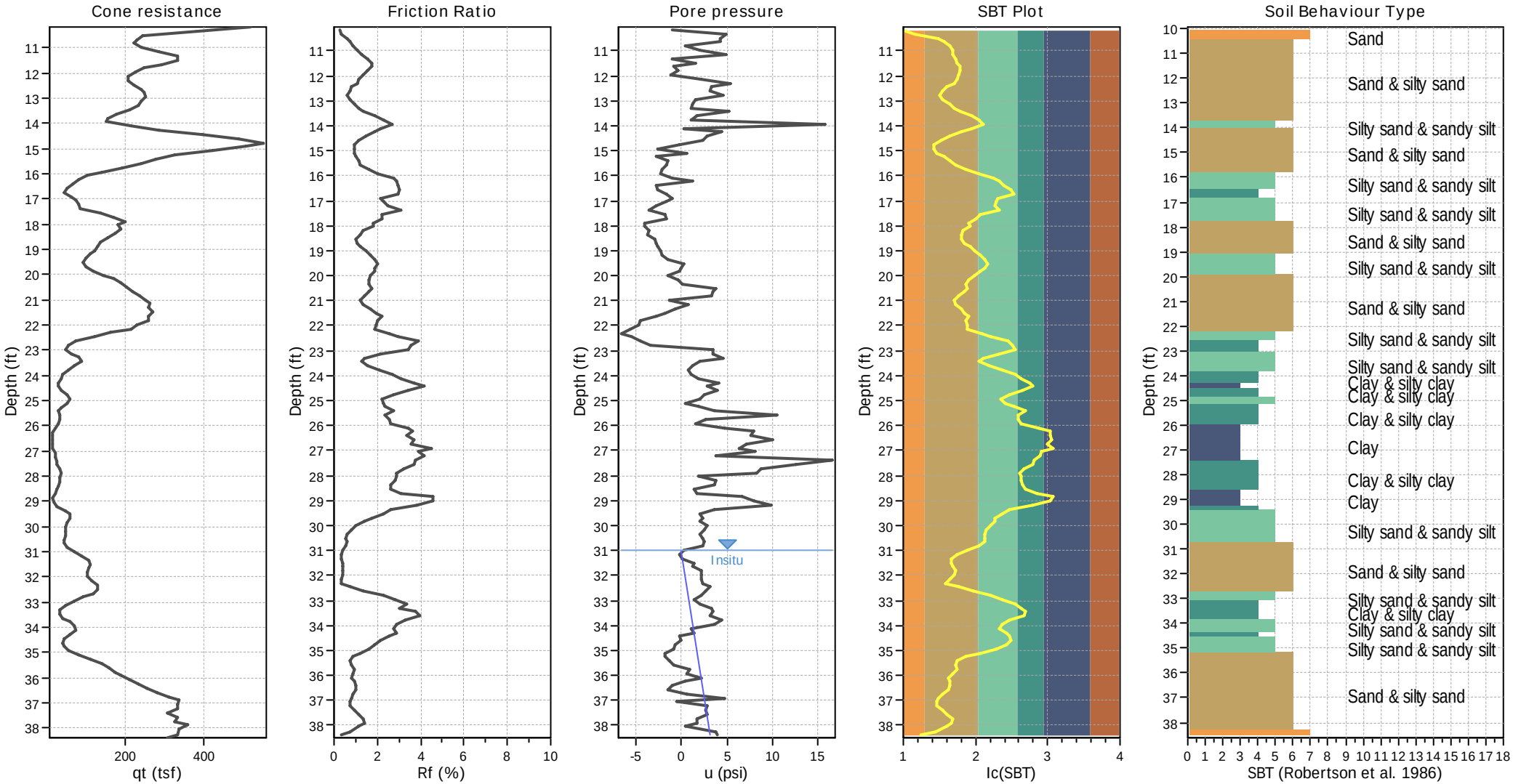






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



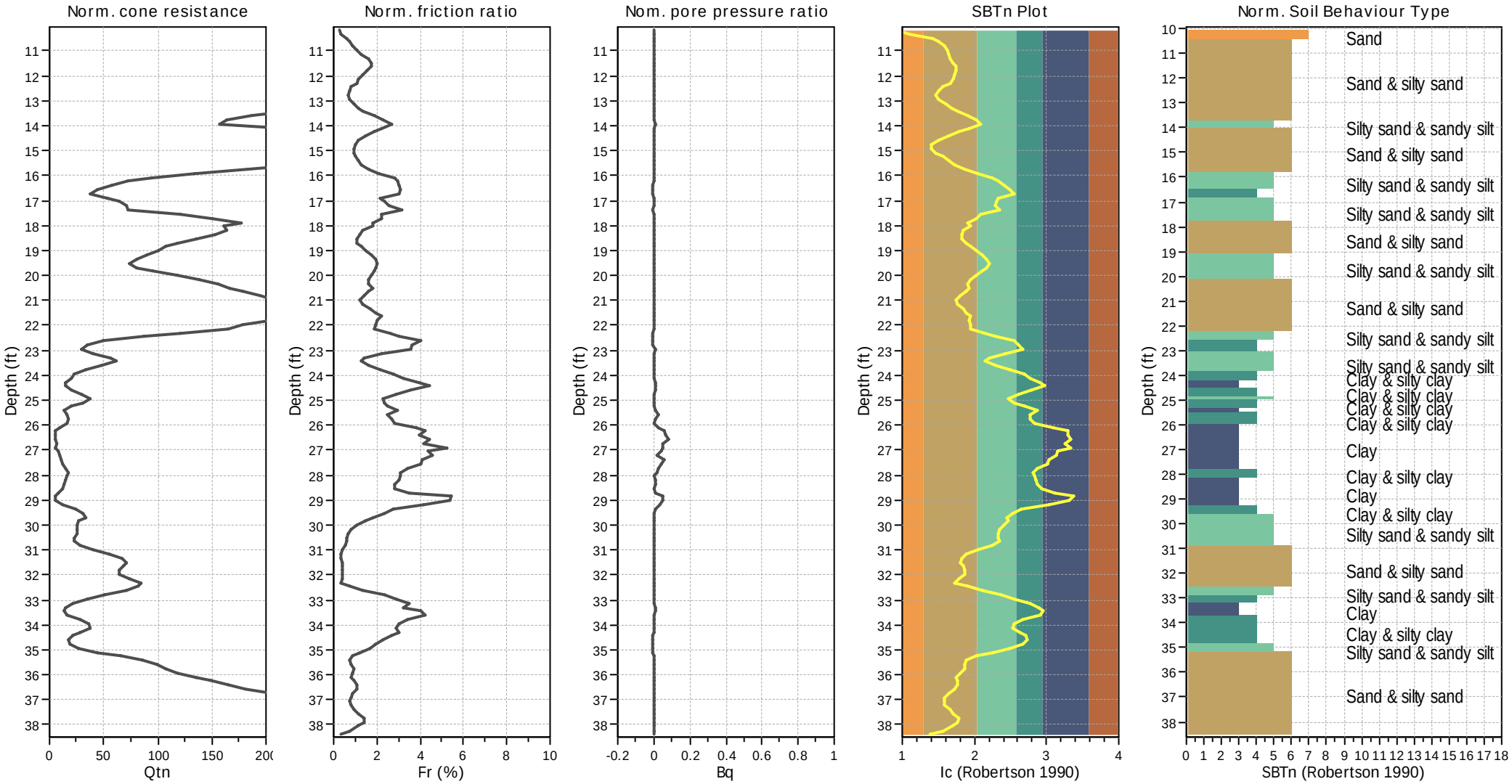
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	31.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	31.00 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)



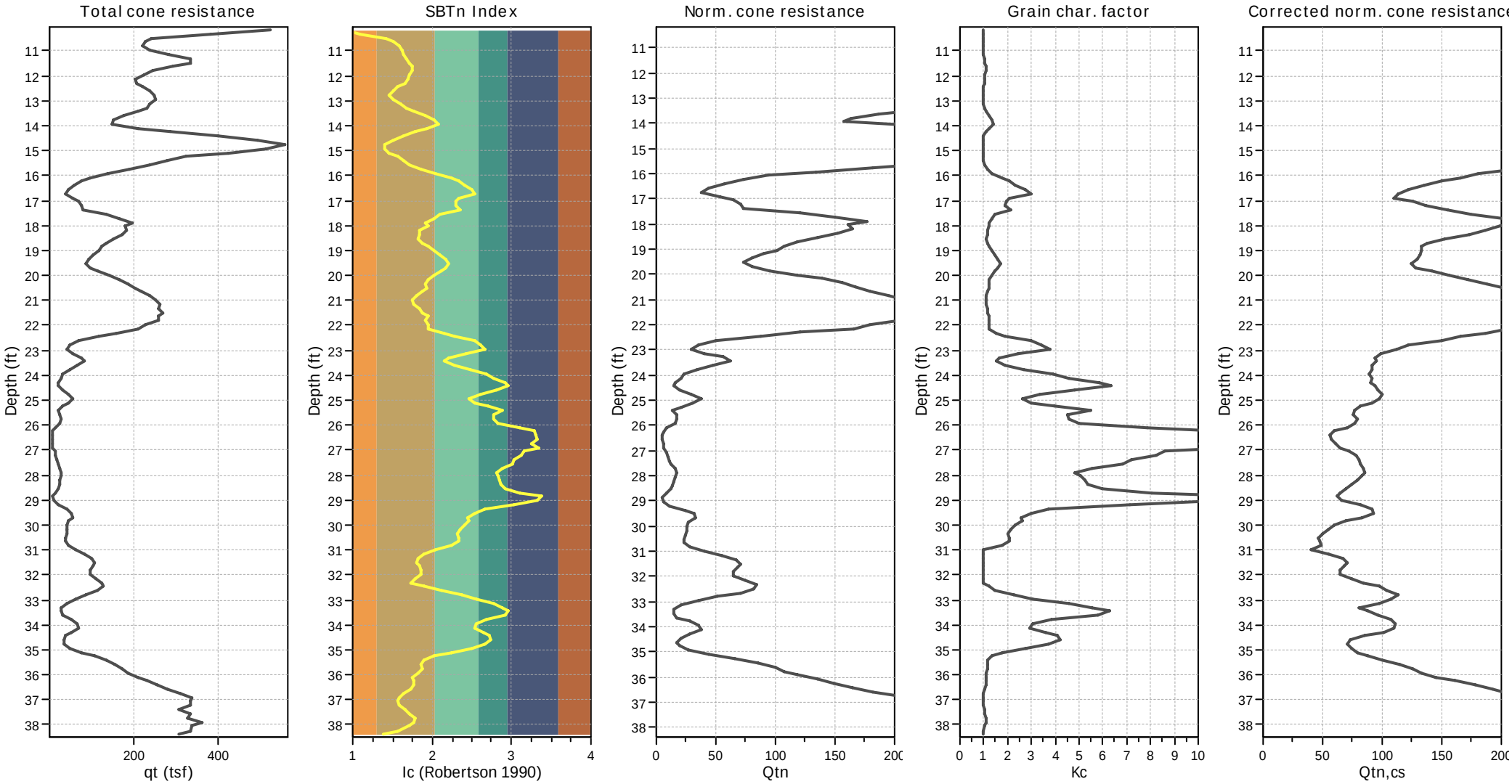
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	31.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	31.00 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

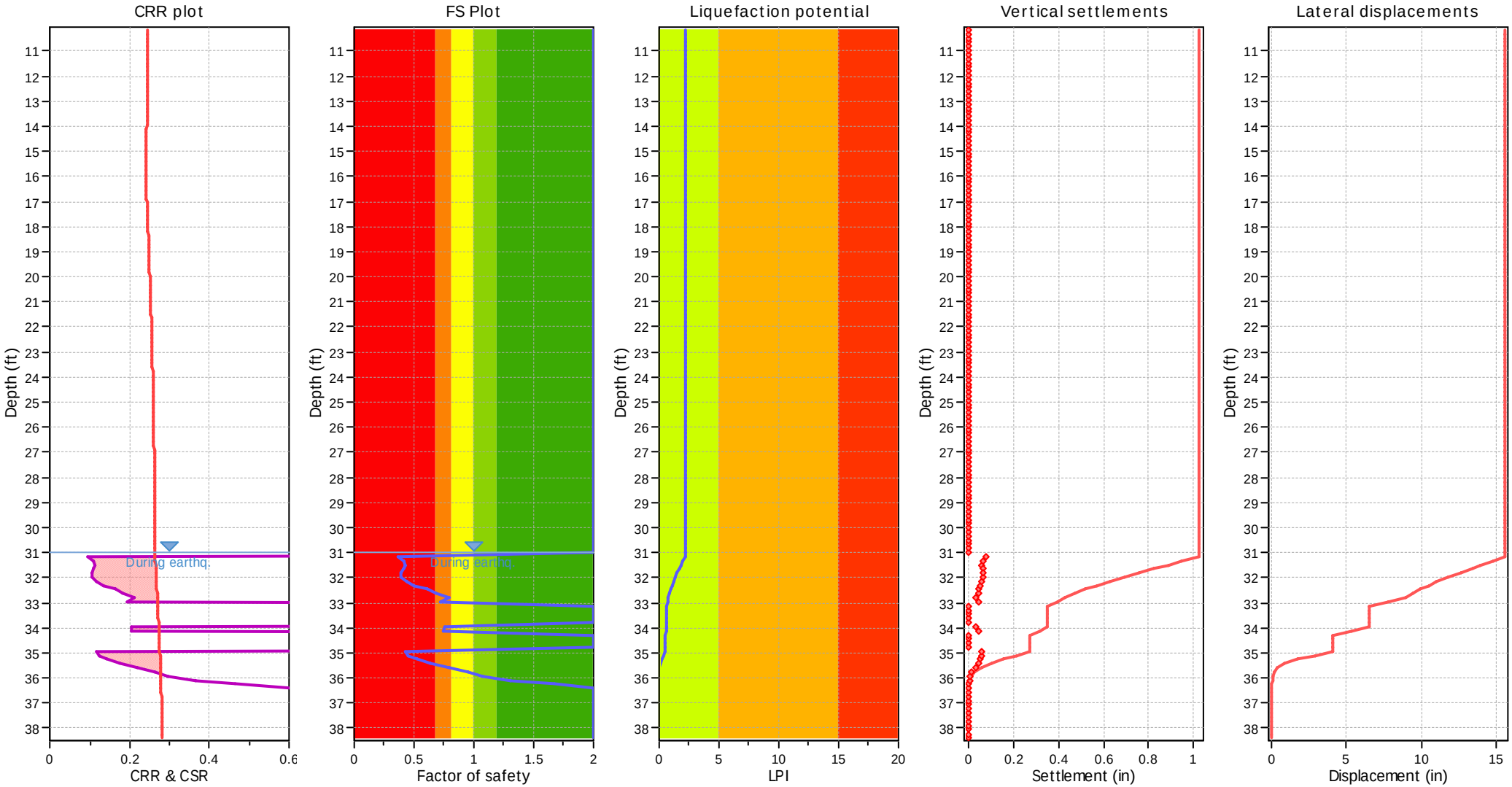
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	31.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	31.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	31.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	31.00 ft	Fill height:	N/A	Limit depth:	N/A

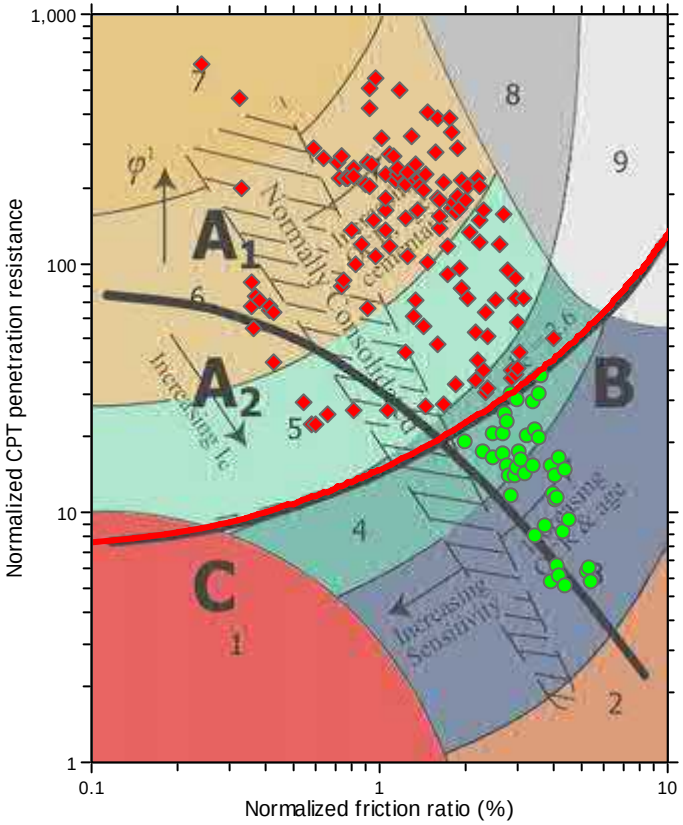
F.S. color scheme

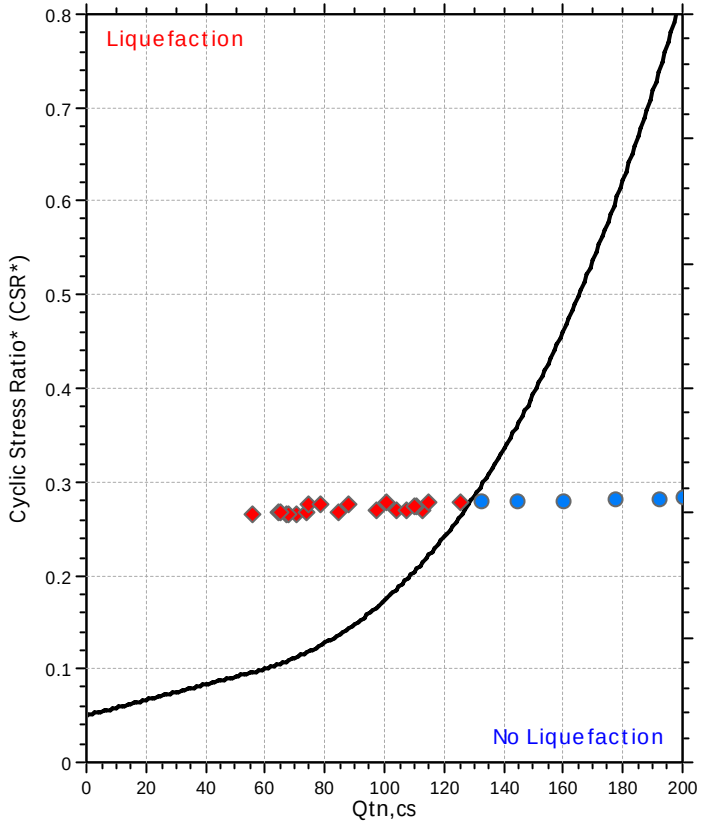
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

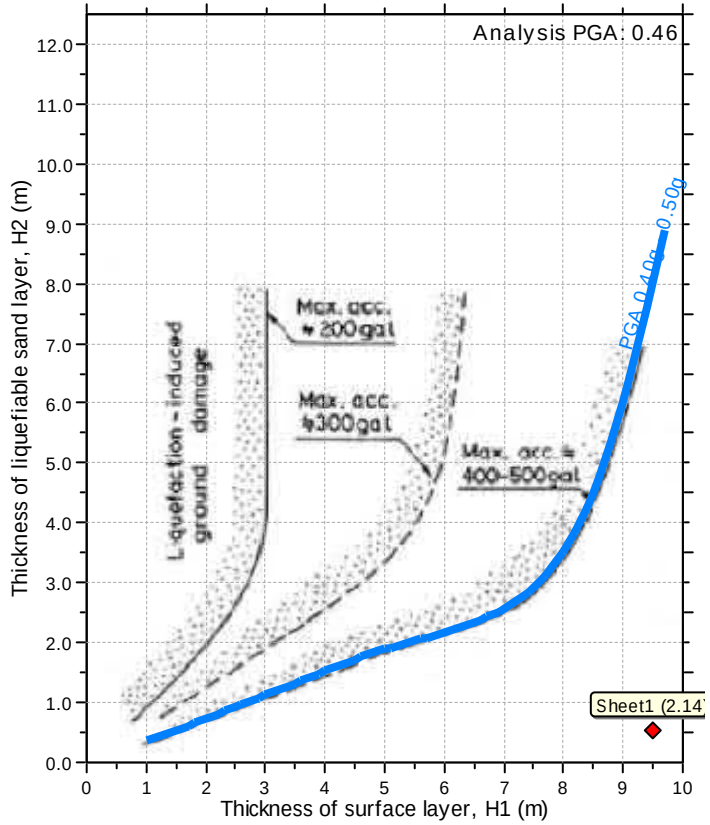
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



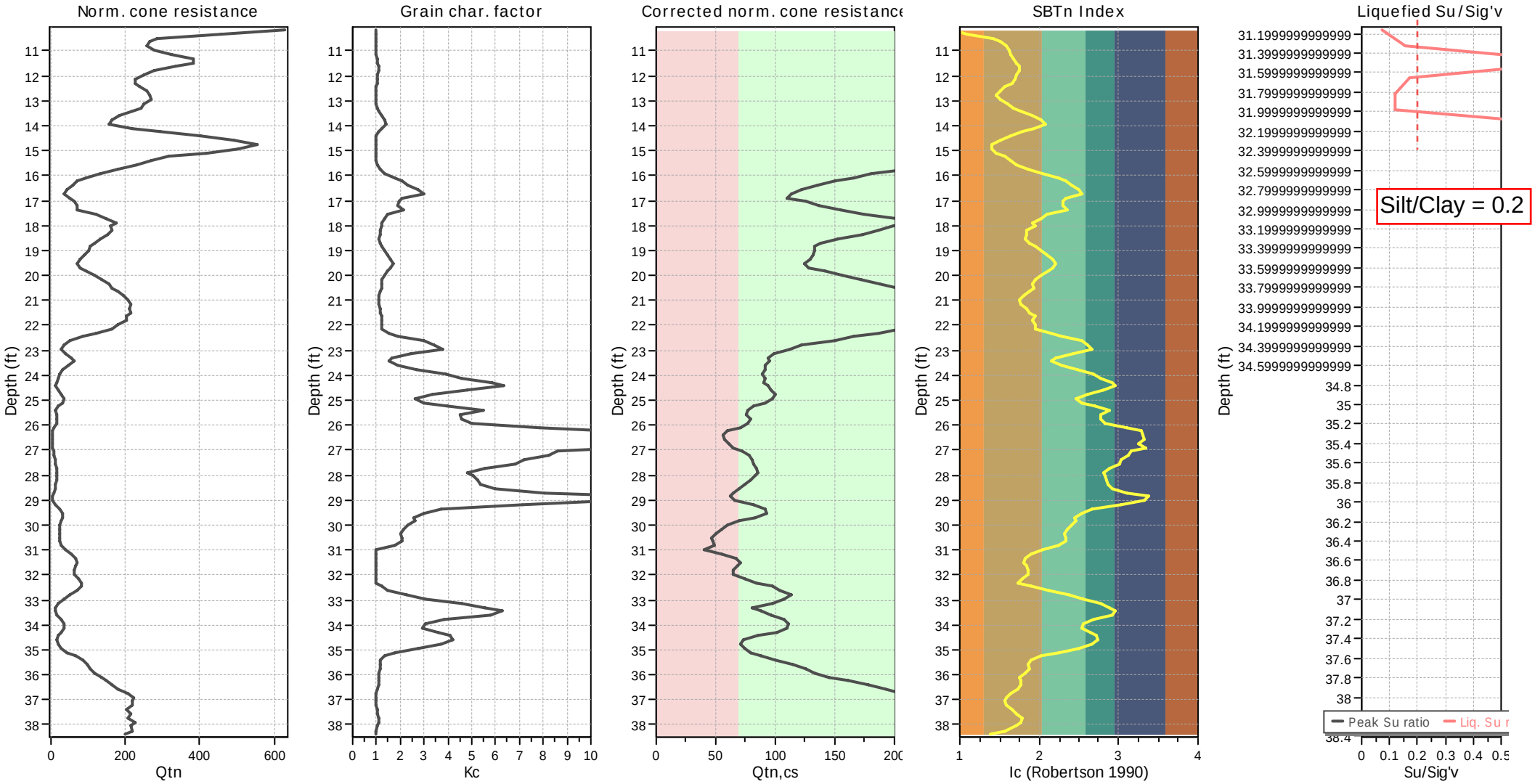




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	31.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	31.00 ft	Fill height:	N/A	Limit depth:	N/A

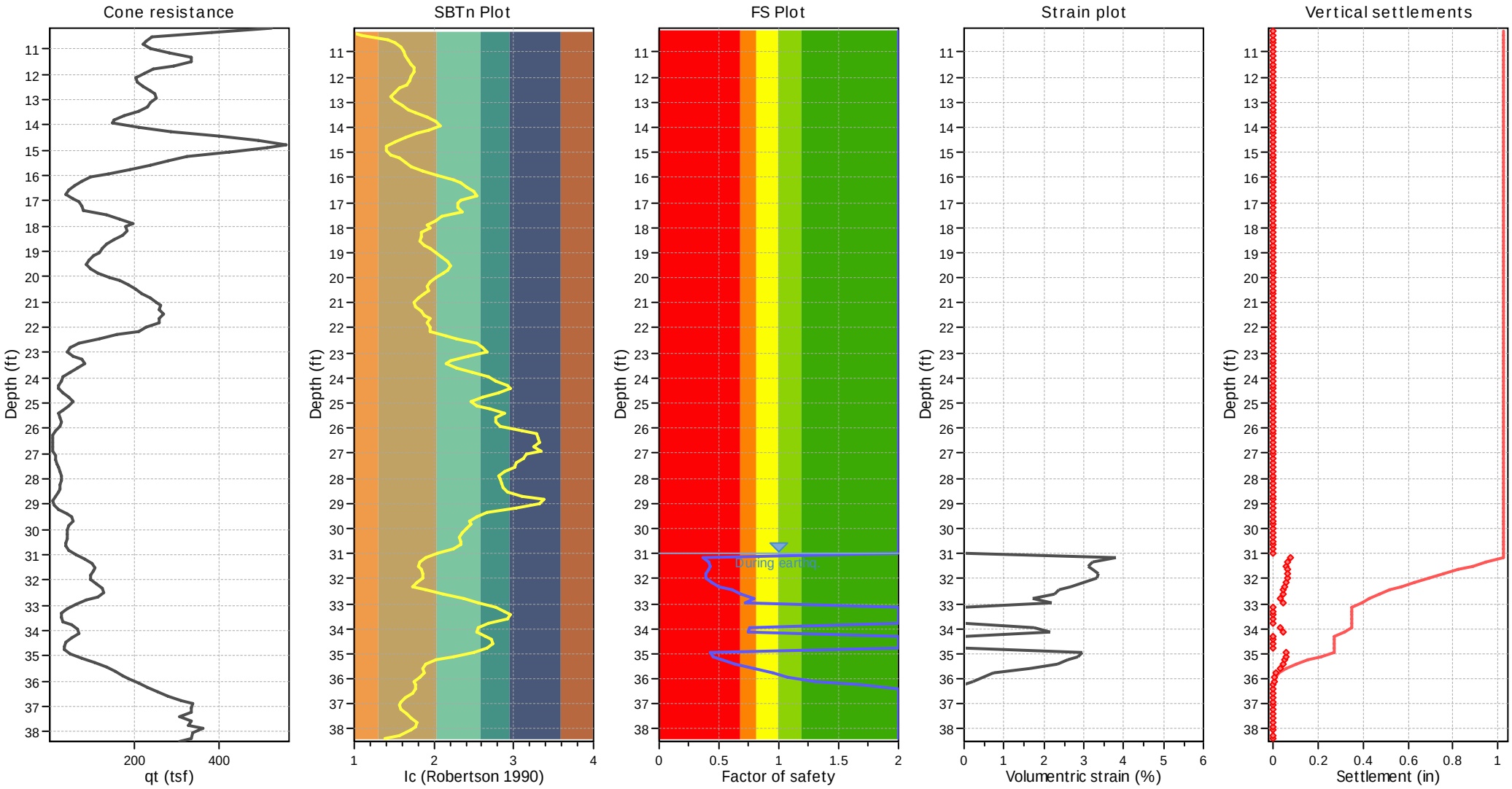
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	31.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	31.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
31.16	55.44	0.36	3.79	1.00	0.07	31.33	67.38	0.41	3.23	1.00	0.06
31.49	70.68	0.42	3.11	1.00	0.06	31.65	68.00	0.41	3.21	1.00	0.06
31.82	64.26	0.39	3.36	1.00	0.07	31.98	64.80	0.39	3.34	1.00	0.07
32.15	73.78	0.44	3.00	1.00	0.06	32.31	84.27	0.51	2.69	1.00	0.05
32.47	97.19	0.62	2.39	1.00	0.05	32.64	104.01	0.69	2.26	1.00	0.04
32.80	112.87	0.79	1.70	1.00	0.03	32.97	107.41	0.72	2.20	1.00	0.04
33.13	97.30	2.00	0.00	1.00	0.00	33.29	80.18	2.00	0.00	1.00	0.00
33.46	87.89	2.00	0.00	1.00	0.00	33.62	95.90	2.00	0.00	1.00	0.00
33.79	107.65	2.00	0.00	1.00	0.00	33.95	110.58	0.75	1.75	1.00	0.03
34.11	109.83	0.74	2.16	1.00	0.04	34.28	101.09	2.00	0.00	1.00	0.00
34.44	84.96	2.00	0.00	1.00	0.00	34.61	73.66	2.00	0.00	1.00	0.00
34.77	71.32	2.00	0.00	1.00	0.00	34.93	74.60	0.43	2.97	1.00	0.06
35.10	78.70	0.45	2.84	1.00	0.06	35.26	88.07	0.52	2.59	1.00	0.05
35.43	100.44	0.63	2.33	1.00	0.05	35.59	114.65	0.79	1.66	1.00	0.03
35.76	125.71	0.95	0.71	1.00	0.01	35.92	132.63	1.07	0.46	1.00	0.01
36.08	145.09	1.31	0.22	1.00	0.00	36.25	160.69	1.67	0.00	1.00	0.00
36.41	177.98	2.00	0.00	1.00	0.00	36.58	192.58	2.00	0.00	1.00	0.00
36.74	206.26	2.00	0.00	1.00	0.00	36.90	223.99	2.00	0.00	1.00	0.00
37.07	220.24	2.00	0.00	1.00	0.00	37.23	219.87	2.00	0.00	1.00	0.00
37.40	204.38	2.00	0.00	1.00	0.00	37.56	224.83	2.00	0.00	1.00	0.00
37.72	225.86	2.00	0.00	1.00	0.00	37.89	248.58	2.00	0.00	1.00	0.00
38.05	226.84	2.00	0.00	1.00	0.00	38.25	219.34	2.00	0.00	1.00	0.00
38.38	200.99	2.00	0.00	1.00	0.00						

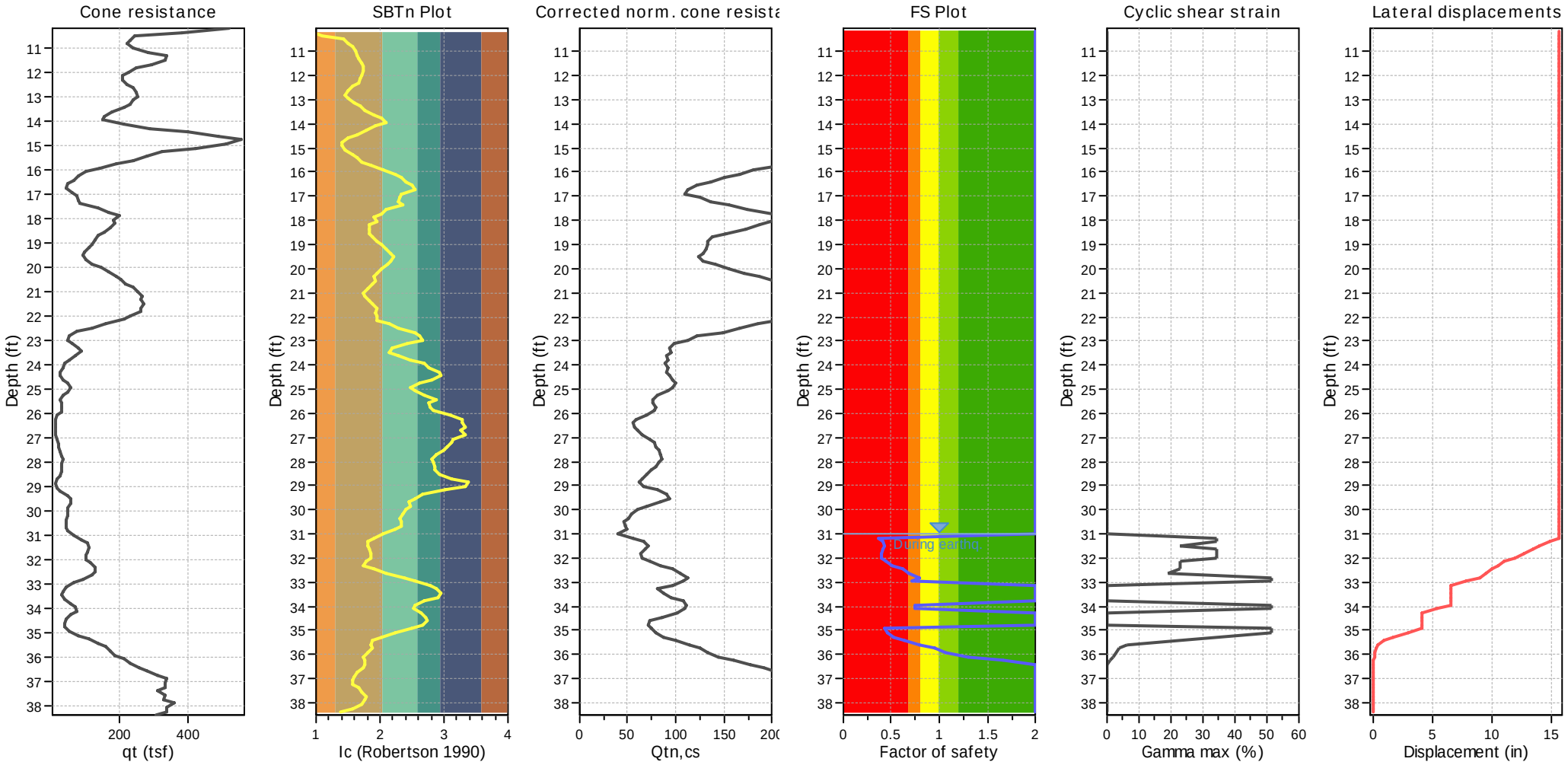
Total estimated settlement: 1.02

Abbreviations

$Q_{tn,cs}$:	Equivalent clean sand normalized cone resistance
FS:	Factor of safety against liquefaction
e_v (%):	Post-liquefaction volumentric strain
DF:	e_v depth weighting factor
Settlement:	Calculated settlement

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

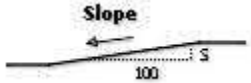


Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

Surface condition



:: Lateral displacement index calculation ::

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
31.16	86.47	55.44	0.36	55.44	0.36	47.53	34.10	0.81
31.33	102.93	67.38	0.35	67.38	0.41	53.97	34.10	0.81
31.49	107.81	70.68	0.37	70.68	0.42	55.54	22.70	0.54
31.65	104.67	68.00	0.41	68.00	0.41	54.27	34.10	0.81
31.82	99.83	64.26	0.42	64.26	0.39	52.41	34.10	0.81
31.98	100.53	64.80	0.40	64.80	0.39	52.68	34.10	0.81
32.15	112.44	73.78	0.36	73.78	0.44	56.96	22.70	0.54
32.31	126.63	84.27	0.36	84.27	0.51	61.35	22.70	0.54
32.47	128.05	81.69	0.73	97.19	0.62	60.33	22.70	0.54
32.64	117.09	70.86	1.32	104.01	0.69	55.63	19.00	0.45
32.80	90.11	50.71	2.31	112.87	0.79	44.59	51.20	1.21
32.97	65.62	34.99	2.80	107.41	0.72	32.34	51.20	1.21
33.13	42.92	21.27	3.33	97.30	2.00	15.91	0.00	0.00
33.29	30.55	14.40	3.01	80.18	2.00	3.03	0.00	0.00
33.46	30.33	14.02	3.77	87.89	2.00	2.16	0.00	0.00
33.62	35.07	16.49	3.96	95.90	2.00	7.51	0.00	0.00
33.79	54.95	27.91	3.31	107.65	2.00	24.88	0.00	0.00
33.95	68.29	35.97	2.90	110.58	0.75	33.25	51.20	1.21
34.11	71.00	37.62	2.77	109.83	0.74	34.73	51.20	1.21
34.28	55.39	28.22	2.91	101.09	2.00	25.24	0.00	0.00
34.44	42.27	20.85	2.55	84.96	2.00	15.25	0.00	0.00
34.61	35.96	17.44	2.14	73.66	2.00	9.35	0.00	0.00
34.77	38.65	19.11	1.87	71.32	2.00	12.38	0.00	0.00
34.93	51.81	27.07	1.61	74.60	0.43	23.87	51.20	1.21
35.10	78.03	44.00	1.19	78.70	0.45	39.90	51.20	1.21
35.26	109.68	65.82	0.89	88.07	0.52	53.19	34.10	0.81
35.43	136.83	85.32	0.73	100.44	0.63	61.76	22.70	0.54
35.59	158.24	99.46	0.81	114.65	0.79	66.82	6.24	0.15
35.76	172.36	107.88	0.95	125.71	0.95	69.50	3.68	0.09
35.92	186.82	118.67	0.86	132.63	1.07	72.65	2.65	0.06
36.08	210.03	135.84	0.79	145.09	1.31	77.11	1.84	0.04
36.25	230.89	148.45	0.94	160.69	1.67	80.04	1.11	0.03
36.41	256.28	164.88	1.03	177.98	2.00	83.51	0.00	0.00
36.58	280.57	181.78	1.04	192.58	2.00	86.73	0.00	0.00
36.74	311.72	206.64	0.88	206.26	2.00	90.96	0.00	0.00
36.90	337.86	223.99	0.81	223.99	2.00	93.62	0.00	0.00
37.07	332.70	220.24	0.75	220.24	2.00	93.06	0.00	0.00
37.23	332.58	219.87	0.77	219.87	2.00	93.00	0.00	0.00
37.40	308.40	202.42	0.91	204.38	2.00	90.28	0.00	0.00
37.56	332.97	215.50	1.13	224.83	2.00	92.34	0.00	0.00
37.72	325.63	206.06	1.37	225.86	2.00	90.86	0.00	0.00
37.89	361.00	229.31	1.42	248.58	2.00	94.39	0.00	0.00
38.05	337.63	217.65	1.13	226.84	2.00	92.67	0.00	0.00
38.25	334.65	219.34	0.72	219.34	2.00	92.92	0.00	0.00
38.38	307.14	200.99	0.33	200.99	2.00	90.04	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)

Total estimated displacement: 15.59

Abbreviations

q_t:	Total cone resistance
Q_{tn}:	Adjusted cone resistance to an effective overburden stress of 1 atm
R_f:	Friction ration
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
FS:	Calculated factor of safety against liquefaction
D_r:	Calculated relative density
$Gamma_{max}$:	Calculated maximum cyclic shear strain
Lat. disp.:	Lateral displacement

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LIQUEFACTION ANALYSIS REPORT

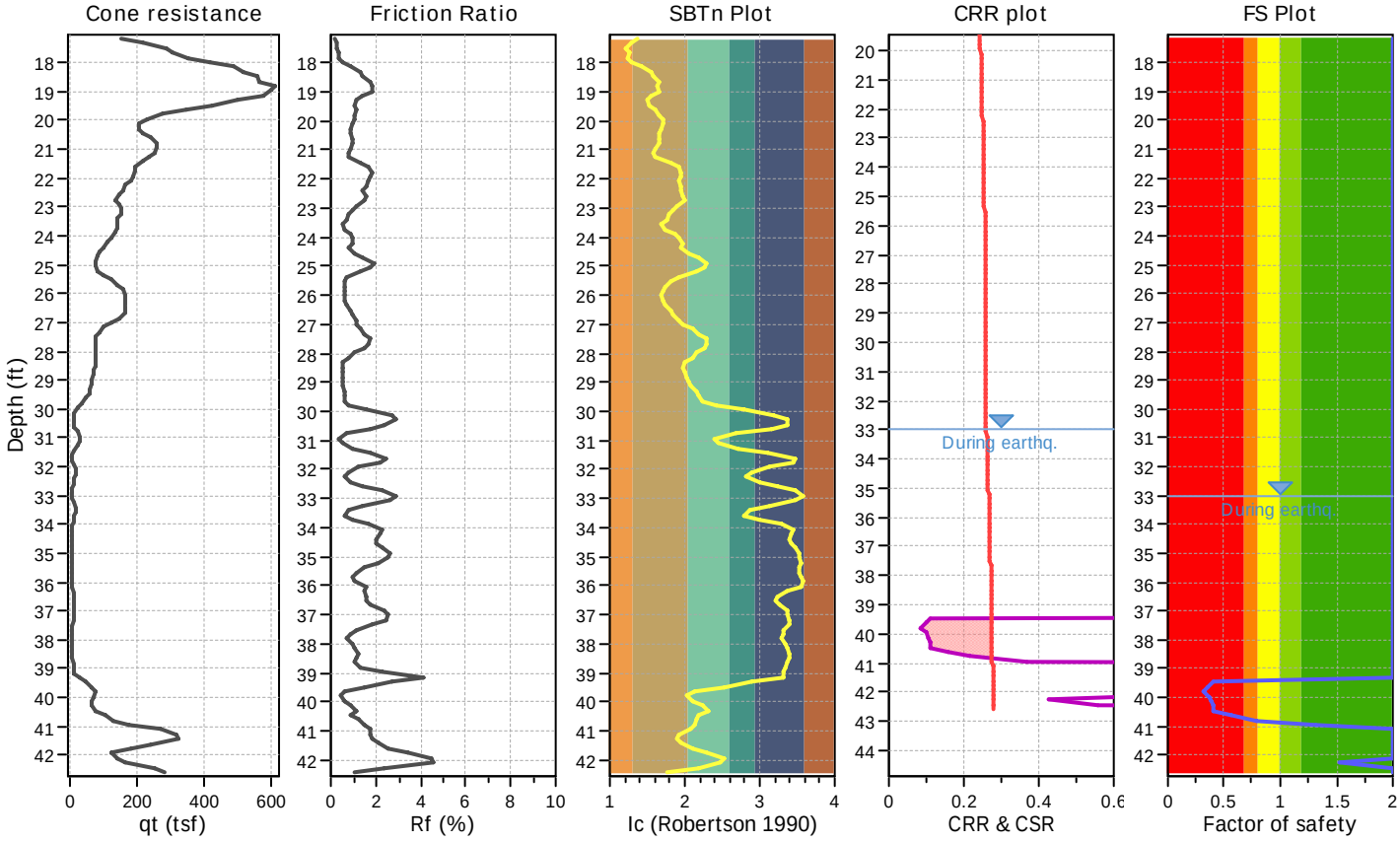
Project title : Renton to Bellevue

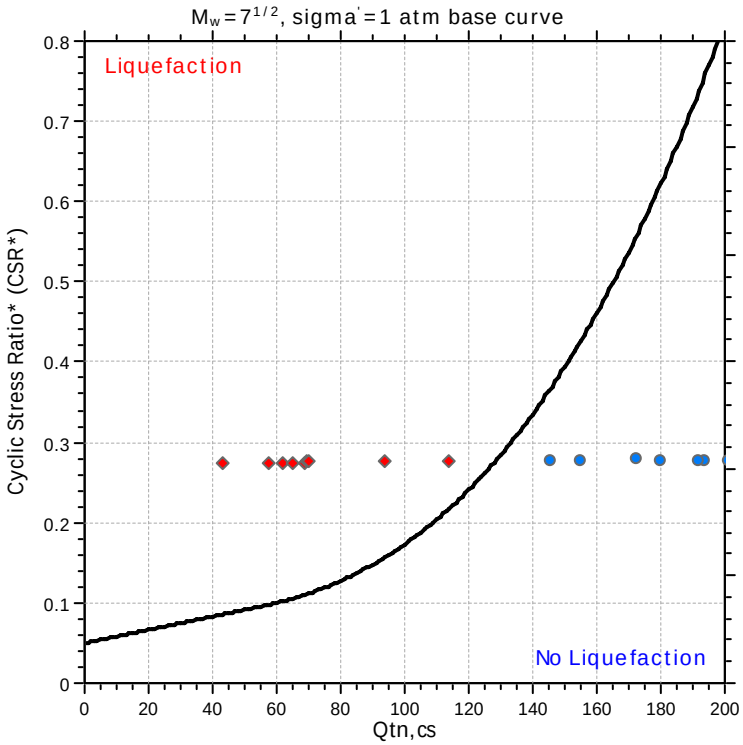
Location : T-CPT06-21 depth adjusted 17 feet

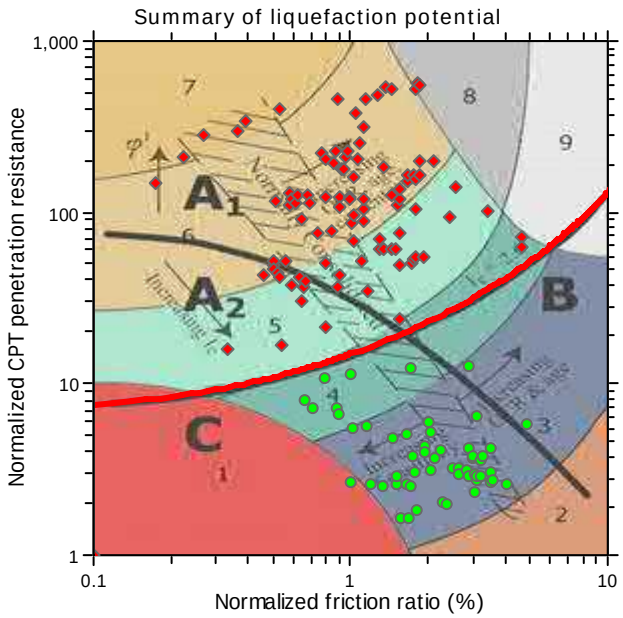
CPT file : CPT-06

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	33.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	33.00 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:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.46	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

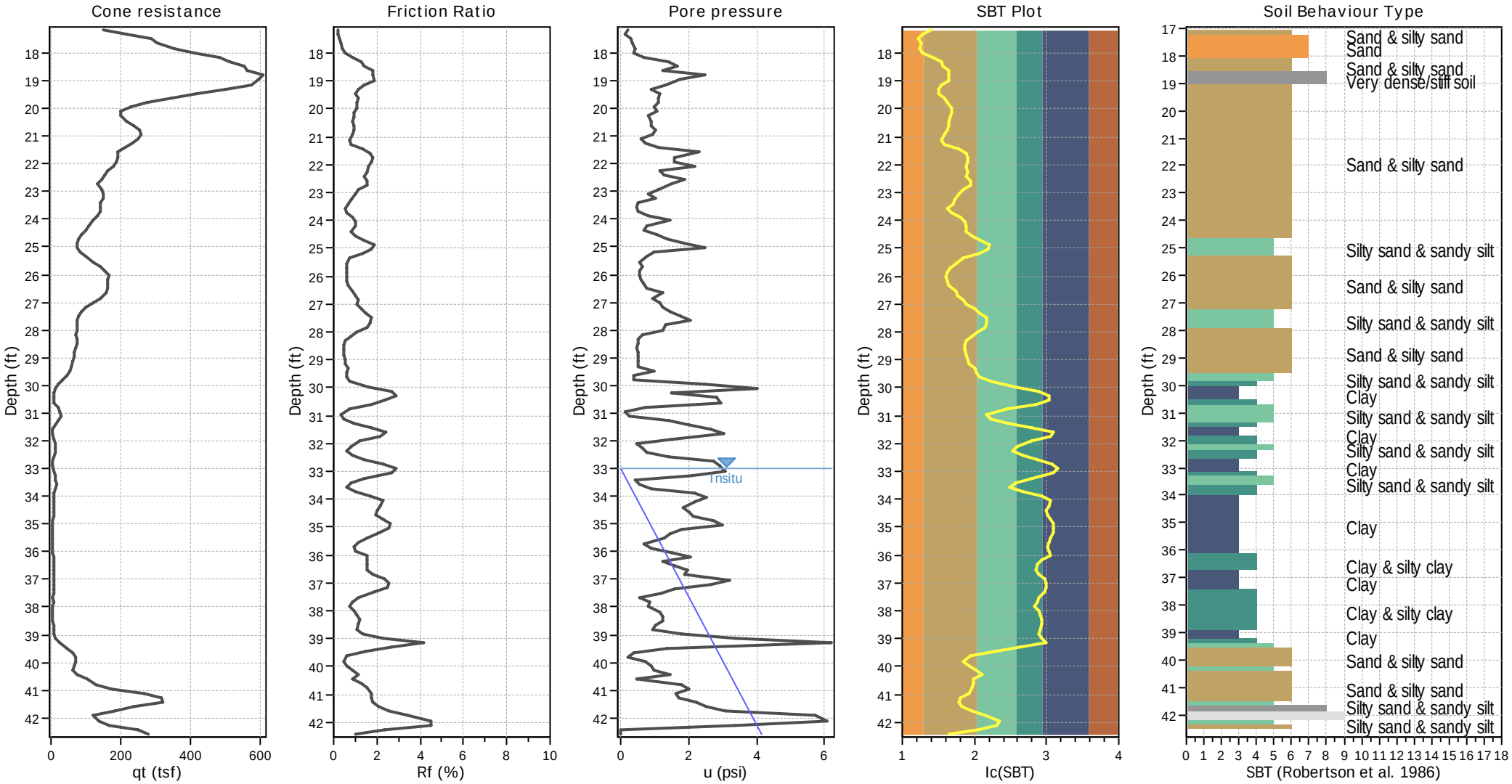






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



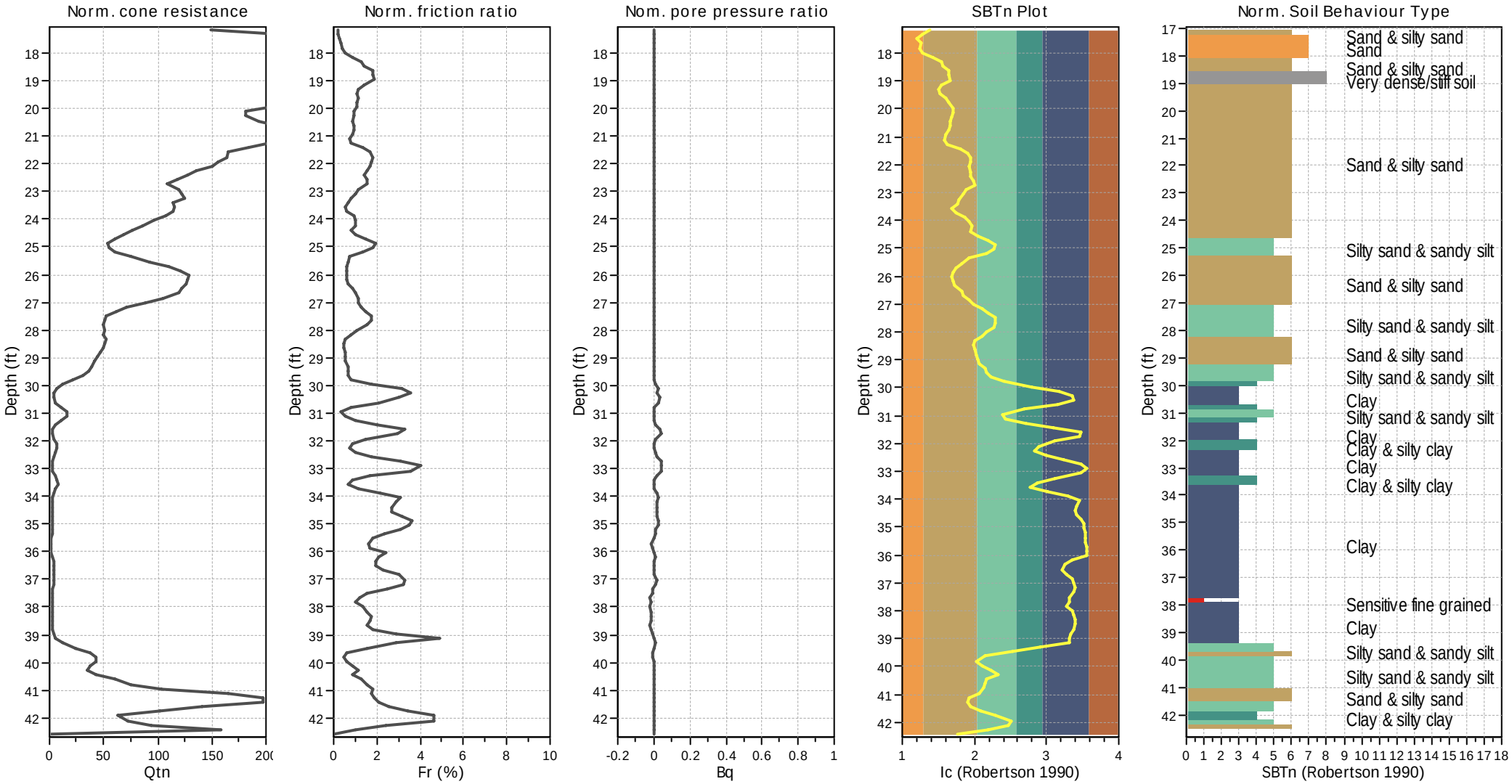
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	33.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	33.00 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)



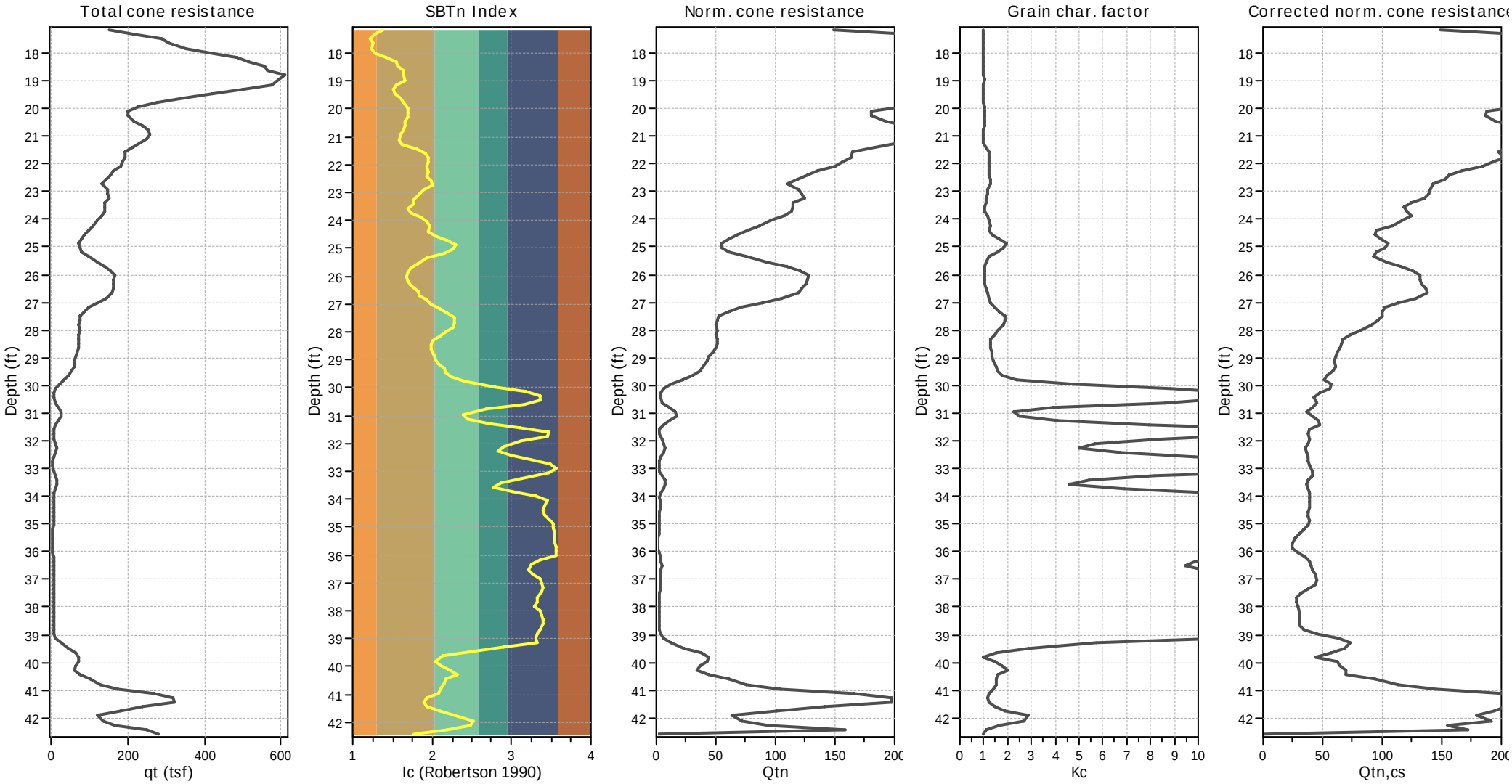
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	33.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	33.00 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

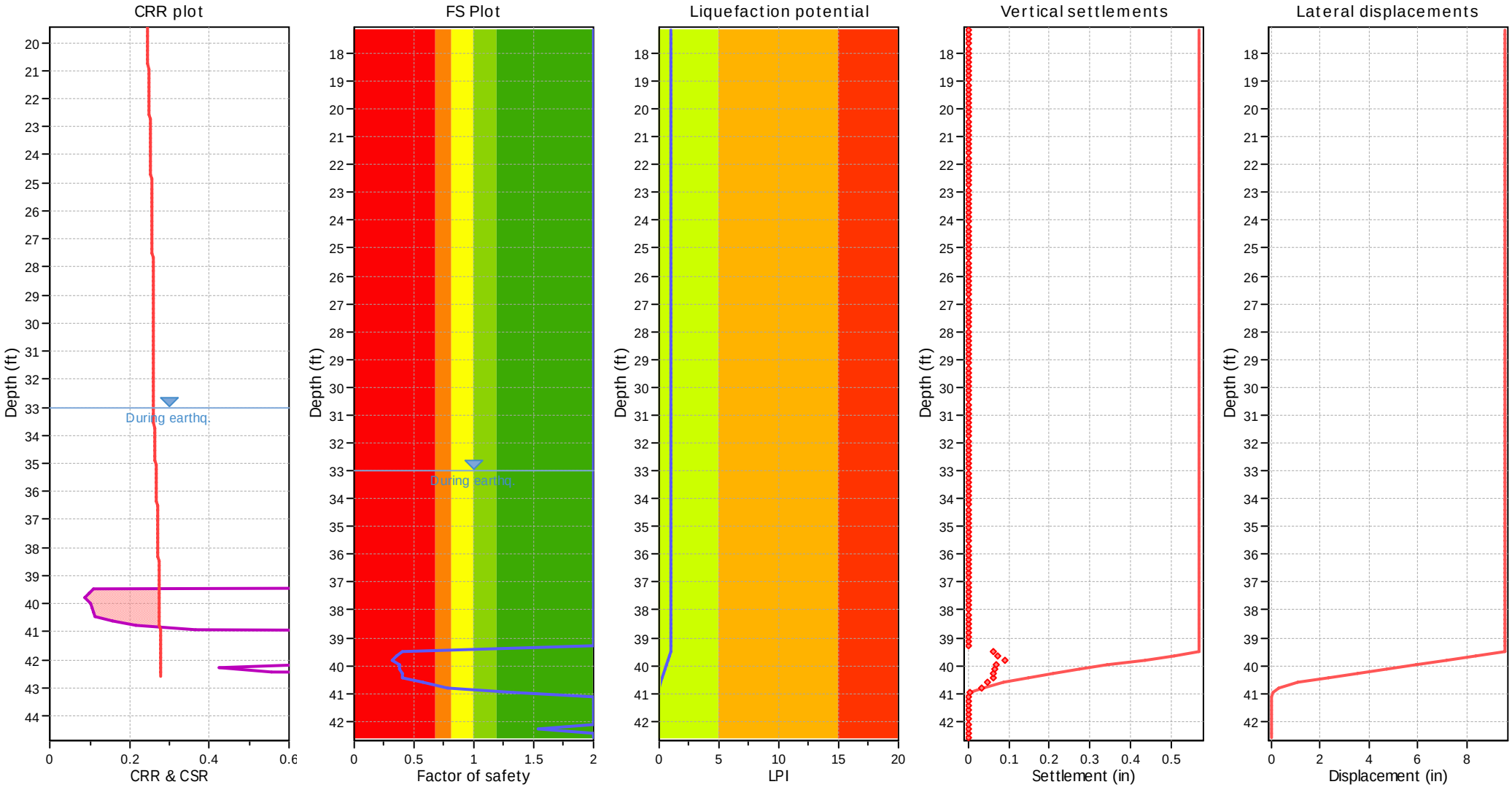
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	33.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	33.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	33.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	33.00 ft	Fill height:	N/A	Limit depth:	N/A

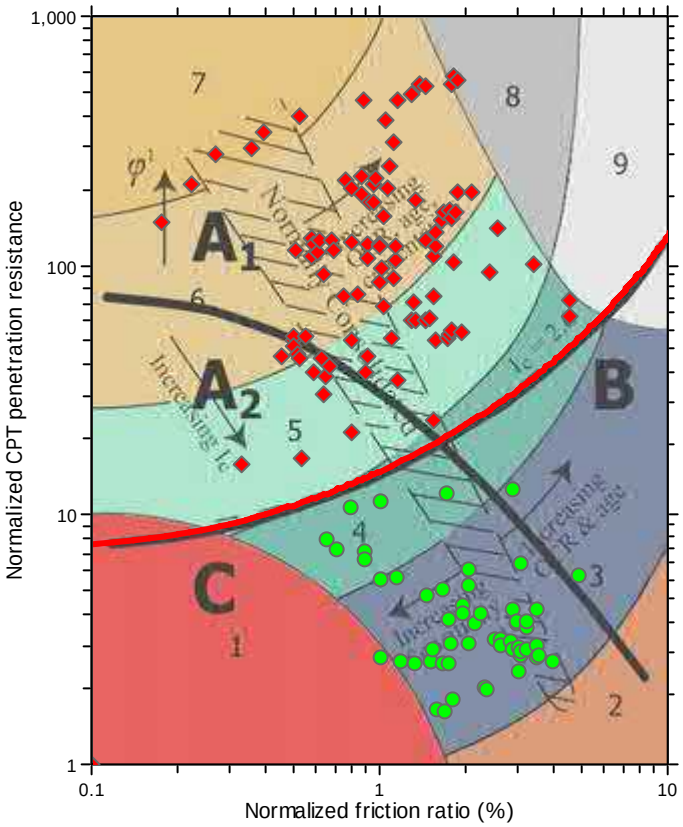
F.S. color scheme

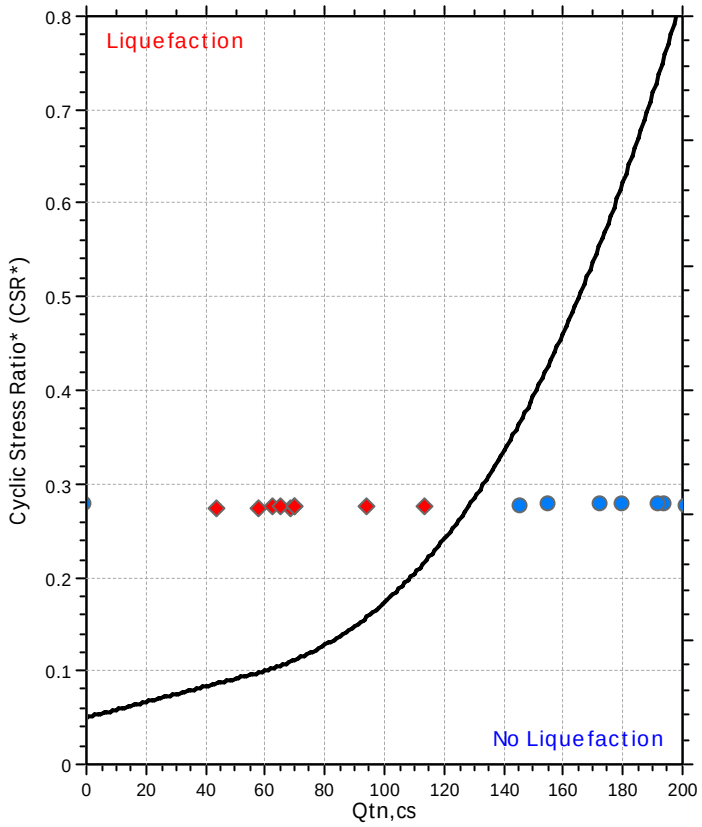
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

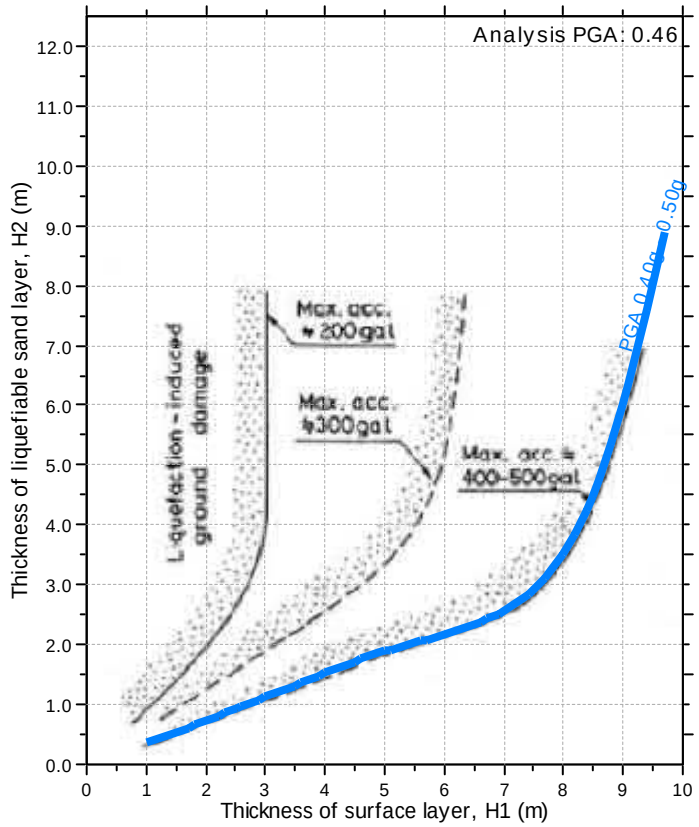
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



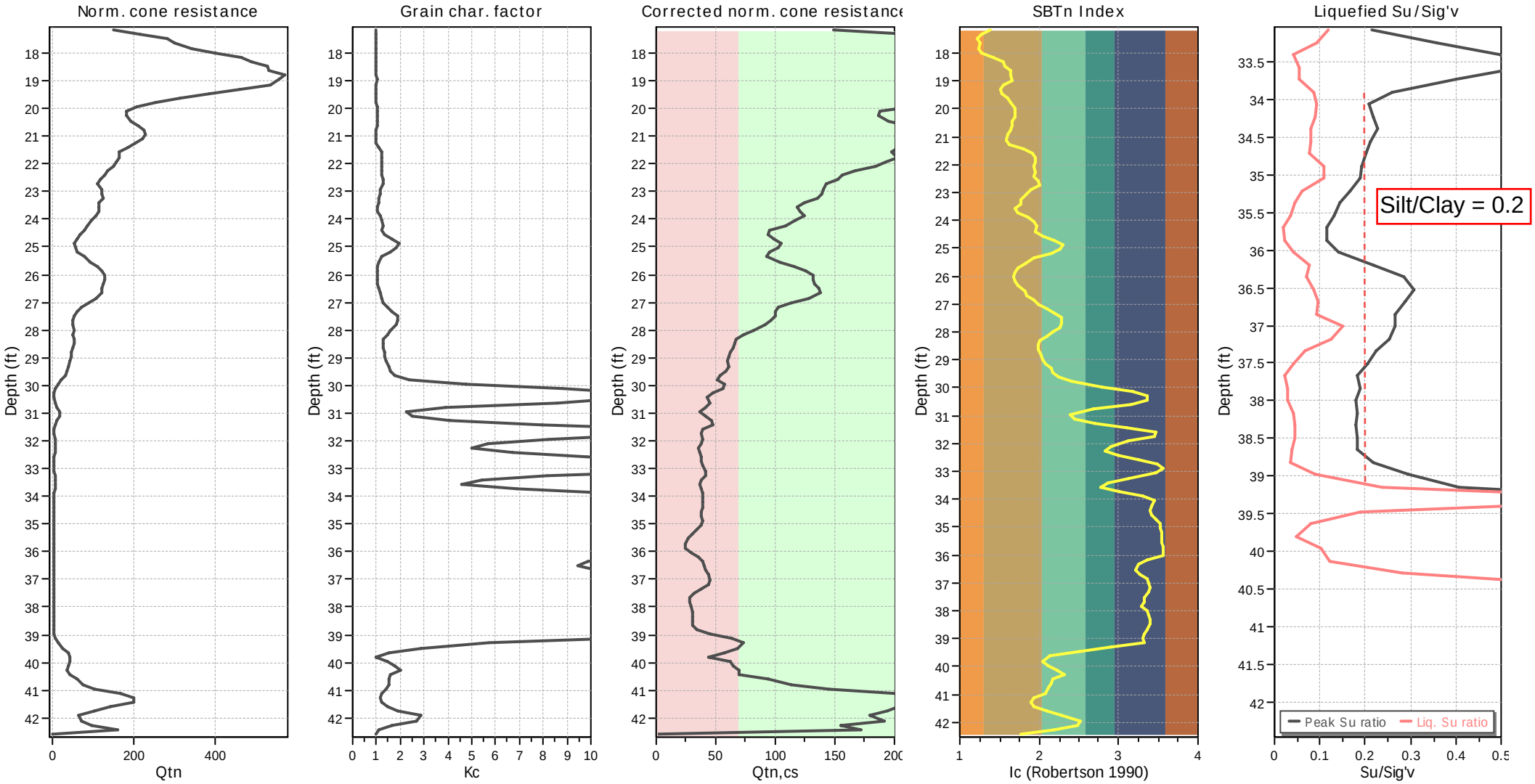




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	33.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	33.00 ft	Fill height:	N/A	Limit depth:	N/A

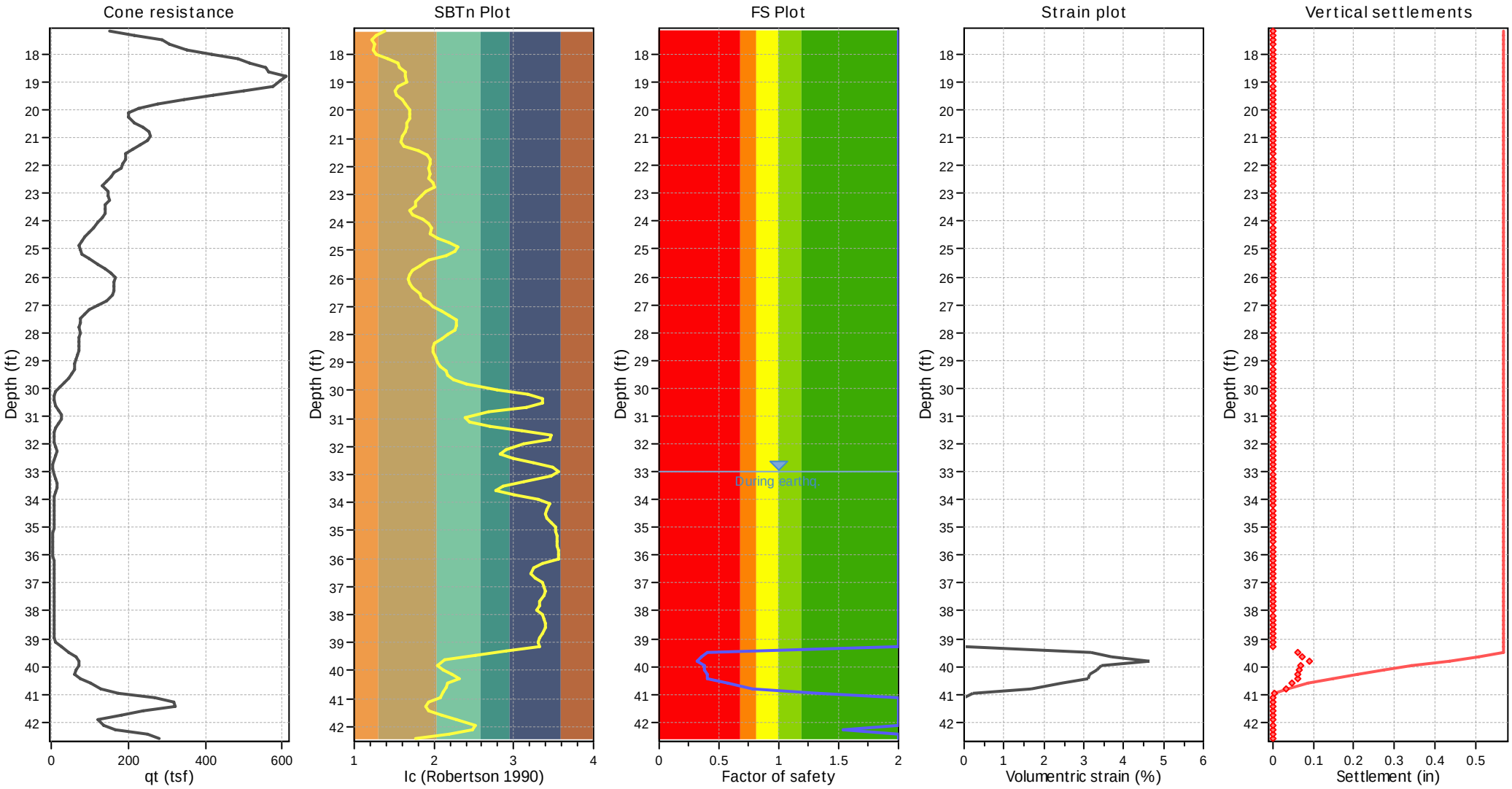
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	33.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.46	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	33.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
33.08	40.94	2.00	0.00	1.00	0.00	33.24	41.21	2.00	0.00	1.00	0.00
33.40	38.34	2.00	0.00	1.00	0.00	33.57	36.15	2.00	0.00	1.00	0.00
33.73	38.39	2.00	0.00	1.00	0.00	33.90	38.76	2.00	0.00	1.00	0.00
34.06	38.83	2.00	0.00	1.00	0.00	34.22	39.01	2.00	0.00	1.00	0.00
34.39	38.73	2.00	0.00	1.00	0.00	34.55	37.55	2.00	0.00	1.00	0.00
34.72	38.29	2.00	0.00	1.00	0.00	34.88	39.07	2.00	0.00	1.00	0.00
35.05	38.30	2.00	0.00	1.00	0.00	35.21	34.62	2.00	0.00	1.00	0.00
35.37	30.05	2.00	0.00	1.00	0.00	35.54	26.81	2.00	0.00	1.00	0.00
35.70	24.61	2.00	0.00	1.00	0.00	35.87	24.96	2.00	0.00	1.00	0.00
36.03	29.83	2.00	0.00	1.00	0.00	36.19	35.42	2.00	0.00	1.00	0.00
36.36	39.36	2.00	0.00	1.00	0.00	36.52	40.60	2.00	0.00	1.00	0.00
36.69	41.31	2.00	0.00	1.00	0.00	36.85	43.42	2.00	0.00	1.00	0.00
37.01	44.63	2.00	0.00	1.00	0.00	37.18	43.31	2.00	0.00	1.00	0.00
37.34	37.96	2.00	0.00	1.00	0.00	37.51	31.86	2.00	0.00	1.00	0.00
37.67	28.54	2.00	0.00	1.00	0.00	37.83	27.78	2.00	0.00	1.00	0.00
38.00	28.92	2.00	0.00	1.00	0.00	38.16	30.13	2.00	0.00	1.00	0.00
38.33	30.96	2.00	0.00	1.00	0.00	38.49	30.77	2.00	0.00	1.00	0.00
38.65	30.18	2.00	0.00	1.00	0.00	38.82	34.00	2.00	0.00	1.00	0.00
38.98	45.23	2.00	0.00	1.00	0.00	39.15	62.92	2.00	0.00	1.00	0.00
39.31	72.88	2.00	0.00	1.00	0.00	39.47	68.59	0.40	3.18	1.00	0.06
39.64	57.52	0.36	3.68	1.00	0.07	39.80	43.30	0.31	4.64	1.00	0.09
39.97	62.12	0.37	3.45	1.00	0.07	40.13	64.87	0.38	3.33	1.00	0.07
40.29	69.53	0.40	3.15	1.00	0.06	40.46	70.12	0.41	3.13	1.00	0.06
40.62	93.82	0.57	2.46	1.00	0.05	40.79	113.56	0.78	1.69	1.00	0.03
40.95	145.41	1.32	0.22	1.00	0.00	41.11	201.15	2.00	0.00	1.00	0.00
41.28	233.94	2.00	0.00	1.00	0.00	41.44	242.45	2.00	0.00	1.00	0.00
41.61	204.23	2.00	0.00	1.00	0.00	41.77	193.74	2.00	0.00	1.00	0.00
41.93	179.85	2.00	0.00	1.00	0.00	42.10	191.92	2.00	0.00	1.00	0.00
42.26	154.96	1.53	0.00	1.00	0.00	42.43	172.33	2.00	0.00	1.00	0.00
42.59	-1.00	2.00	0.00	1.00	0.00						

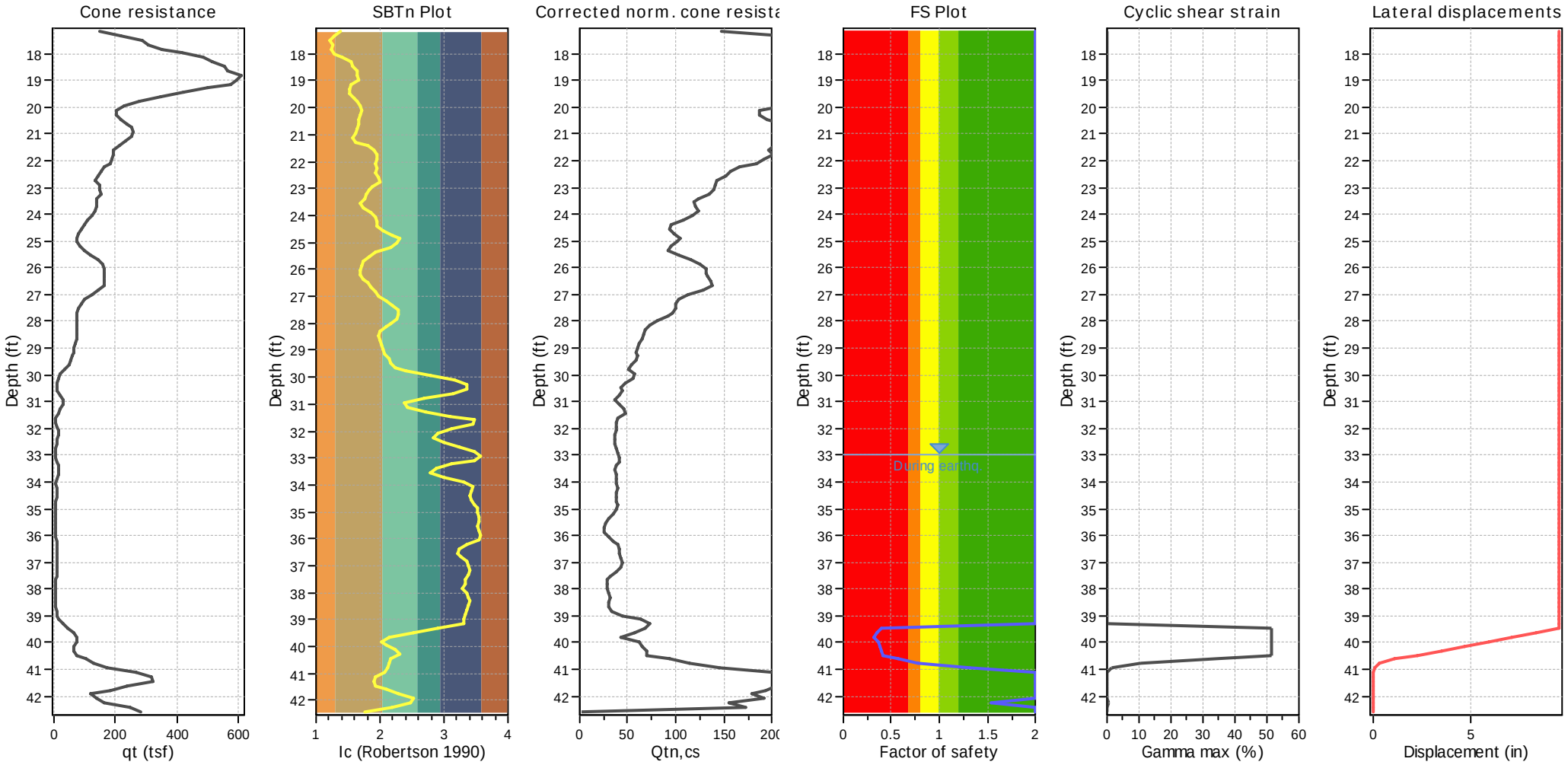
Total estimated settlement: 0.57

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

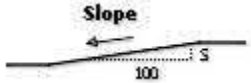


Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

Surface condition



:: Lateral displacement index calculation ::

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
33.08	7.68	2.99	2.66	40.94	2.00	0.00	0.00	0.00
33.24	11.63	5.03	1.39	41.21	2.00	0.00	0.00	0.00
33.40	15.36	7.08	0.78	38.34	2.00	0.00	0.00	0.00
33.57	16.57	7.87	0.59	36.15	2.00	0.00	0.00	0.00
33.73	12.78	5.59	0.99	38.39	2.00	0.00	0.00	0.00
33.90	8.98	3.62	1.68	38.76	2.00	0.00	0.00	0.00
34.06	7.65	2.92	2.28	38.83	2.00	0.00	0.00	0.00
34.22	7.95	3.07	2.16	39.01	2.00	0.00	0.00	0.00
34.39	8.16	3.17	2.01	38.73	2.00	0.00	0.00	0.00
34.55	7.79	2.96	1.98	37.55	2.00	0.00	0.00	0.00
34.72	7.51	2.81	2.29	38.29	2.00	0.00	0.00	0.00
34.88	7.31	2.70	2.62	39.07	2.00	0.00	0.00	0.00
35.05	7.21	2.64	2.52	38.30	2.00	0.00	0.00	0.00
35.21	6.61	2.33	2.13	34.62	2.00	0.00	0.00	0.00
35.37	6.05	2.04	1.53	30.05	2.00	0.00	0.00	0.00
35.54	5.64	1.82	1.16	26.81	2.00	0.00	0.00	0.00
35.70	5.28	1.63	0.96	24.61	2.00	0.00	0.00	0.00
35.87	5.28	1.63	1.03	24.96	2.00	0.00	0.00	0.00
36.03	5.98	1.98	1.56	29.83	2.00	0.00	0.00	0.00
36.19	8.13	3.05	1.53	35.42	2.00	0.00	0.00	0.00
36.36	9.98	3.98	1.56	39.36	2.00	0.00	0.00	0.00
36.52	10.64	4.30	1.57	40.60	2.00	0.00	0.00	0.00
36.69	10.14	4.03	1.79	41.31	2.00	0.00	0.00	0.00
36.85	9.55	3.73	2.34	43.42	2.00	0.00	0.00	0.00
37.01	9.58	3.73	2.55	44.63	2.00	0.00	0.00	0.00
37.18	9.20	3.53	2.49	43.31	2.00	0.00	0.00	0.00
37.34	8.44	3.14	1.87	37.96	2.00	0.00	0.00	0.00
37.51	7.92	2.88	1.12	31.86	2.00	0.00	0.00	0.00
37.67	7.34	2.58	0.85	28.54	2.00	0.00	0.00	0.00
37.83	7.51	2.66	0.72	27.78	2.00	0.00	0.00	0.00
38.00	7.22	2.50	0.93	28.92	2.00	0.00	0.00	0.00
38.16	7.33	2.55	1.07	30.13	2.00	0.00	0.00	0.00
38.33	7.27	2.51	1.21	30.96	2.00	0.00	0.00	0.00
38.49	7.33	2.54	1.17	30.77	2.00	0.00	0.00	0.00
38.65	7.39	2.56	1.07	30.18	2.00	0.00	0.00	0.00
38.82	8.38	3.04	1.32	34.00	2.00	0.00	0.00	0.00
38.98	10.66	4.15	2.30	45.23	2.00	0.00	0.00	0.00
39.15	13.88	5.71	4.13	62.92	2.00	0.00	0.00	0.00
39.31	27.81	12.66	2.68	72.88	2.00	0.00	0.00	0.00
39.47	45.92	23.76	1.46	68.59	0.40	19.57	51.20	1.21
39.64	65.05	37.57	0.57	57.52	0.36	34.69	51.20	1.21
39.80	72.83	43.30	0.44	43.30	0.31	39.37	51.20	1.21
39.97	72.66	42.34	0.61	62.12	0.37	38.63	51.20	1.21
40.13	65.92	37.02	0.86	64.87	0.38	34.20	51.20	1.21
40.29	63.16	34.58	1.12	69.53	0.40	31.95	51.20	1.21
40.46	76.25	43.50	0.88	70.12	0.41	39.53	51.20	1.21
40.62	104.49	60.43	1.26	93.82	0.57	50.37	34.10	0.81
40.79	129.64	75.65	1.51	113.56	0.78	57.79	10.55	0.25

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	q_t (tsf)	Q_{tn}	R_f (%)	$Q_{tn,cs}$	FS	D_r	$Gamma_{max}$ (%)	Lat. disp. (in)
40.95	174.31	103.40	1.77	145.41	1.32	68.10	1.42	0.03
41.11	268.06	165.64	1.74	201.15	2.00	83.66	0.00	0.00
41.28	317.10	197.40	1.84	233.94	2.00	89.45	0.00	0.00
41.44	321.70	197.79	2.08	242.45	2.00	89.51	0.00	0.00
41.61	240.28	141.05	2.53	204.23	2.00	78.35	0.00	0.00
41.77	183.30	101.83	3.39	193.74	2.00	67.60	0.00	0.00
41.93	121.42	62.84	4.51	179.85	2.00	51.67	0.00	0.00
42.10	137.73	72.03	4.52	191.92	2.00	56.17	0.00	0.00
42.26	166.14	93.85	2.38	154.96	1.53	64.91	0.54	0.01
42.43	250.19	158.91	1.02	172.33	2.00	82.29	0.00	0.00
42.59	282.41	N/A	0.00	-1.00	2.00	0.00	0.00	0.00

Total estimated displacement: 9.56

Abbreviations

q_t:	Total cone resistance
Q_{tn}:	Adjusted cone resistance to an effective overburden stress of 1 atm
R_f:	Friction ration
$Q_{tn,cs}$:	Adjusted and corrected cone resistance due to fines
FS:	Calculated factor of safety against liquefaction
D_r:	Calculated relative density
$Gamma_{max}$:	Calculated maximum cyclic shear strain
Lat. disp.:	Lateral displacement

6) Global Stability:

Global & Compound Stability:

The software Slide2 by Rocscience. was used for these analyses. Minimum factor of safety is 1.3 (resistance factor of 0.75) in the static case and 1.1 in the seismic (pseudo-static) case per Chapter 15 of the WSDOT GDM and Appendix G updates and Section 11.6.2.3 of the AASHTO BDS. A minimum factor of safety in the post-liquefied condition where liquefiable soils are present is also 1.1.

We assumed the following:

- Live Load traffic surcharge was taken to be 250 psf for static conditions
- Live Load traffic surcharge was taken to be 125 psf for post-liquefied conditions
- No Live Load applied during pseudostatic conditions, decoupled analysis
- MSE reinforced zone was modeled with readily available geogrid reinforcement using default parameters of the Slide2 software
- For pseudostatic analysis the maximum allowable lateral displacement of the wall mass was assumed to be 8 inches per GDM Appendix 15-E-3 and to include wave scattering effects. The k_h for pseudostatic stability analysis was determined by:

$$k_h = 0.74 A_s \left(\frac{A_s}{d}\right)^{0.25} \qquad (15\text{-}E\text{-}18)$$

where,

k_h	=	horizontal seismic acceleration coefficient (dim)
A_s	=	earthquake ground acceleration coefficient as specified in Equation 3.10.4.2-2 in AASHTO (2020)
d	=	lateral wall displacement (in.)

k_h = 0.74 * 0.5g (0.5/8)^0.25 = **0.185g**

Results are summarized below. Slide2 output prints are attached.

If the factor of safety (F.S.) of these analyses do not meet WSDOT minimum requirements, improvements such as lengthening of MSE reinforcements, overexcavation and replacement, or ground improvement were investigated.

SHANSEP methodology was used in plastic silt and clay soil models for the undrained pseudostatic case.

Residual stress ratios for liquefied zones of ESUs 2C, 3A, and 3A-1 were applied to model strengths in the post-liquefied case as determine above in the liquefaction section.

SUMMARY OF RESULTS:

Wall Designation	**9.90B**			
Station Evaluated	2+70	3+70	5+20	6+20
Wall Height Evaluated, H_T [1] (ft.)	27	27	22.5	15
Embedment (ft.)	4[2]	4[2]	2	2
Global Static FOS	1.9	1.9	1.5	1.5
Global Seismic FOS	1.4	1.2	1.1	1.1
Global Post-Liquefied	1.6	1.5	1.2	1.1
Reinforcement to Height Ratio	$0.7H_T$	$0.8H_T$	$1.0H_T$	$0.7H_T$
Comments	None	5 ft OX and replace	5ft OX and replace	None

1) Total wall height, H_T = exposed height + embedment
2) Embedment increased for scour considerations

Overexcavation and replacement recommended in some areas with use of Quarry Spalls or similar high friction angle material or geosynthetic reinforcement.

External Stability:

AASHTO typically requires a minimum reinforcement length of 70 percent of the total wall height (HT), or a minimum length of 8 feet, whichever is greater. The commercial software MSEW 3.0 or MSEW Plus, both developed by Adama Engineering, Inc. was used to evaluate the minimum length of reinforcement required for the external stability for the following modes of failure:

- Bearing
- Sliding
- Overturning

Recommended lengths of reinforcement for the wall from MSEW analyses are provided below. Final geotechnical design recommendations are provided for the minimum required length of reinforcement when all analyses have been considered and the controlling case and length of reinforcement have been identified.

Terracon

PROJECT: I-405 Renton to Bellevue – MSE Wall 9.90B WSDOT C9242 Page ____ of ____

JOB NO. 81215044 Date 10/13/2021 Comp. By RWS CHECKED BY: pjp

Height (feet)	Design Staion	Condition	Foundation Soils γ (pcf)	Foundation Soils φ	Foundation Soils c (psf)	Reinforced Zone γ (pcf)	Reinforced Zone φ	Retained Zone γ (pcf)	Retained Zone φ	Strap Length (feet)	MSEW L/H ratio
27.5	ML 2+70/ Wall Sta. 5836+00	Static	115	31	0	130	38	120	32	19.25	0.70
		Pseudostatic	115	26	50	130	38	120	32	22	0.80
		Post Liquefied	115	22	220	130	38	120	32	22	0.80
27	ML 3+70/ Wall Sta. 5837+00	Static	127	38	0	130	38	120	32	21.6	0.80
		Pseudostatic	127	35	0	130	38	120	32	21.6	0.80
		Post Liquefied	127	35	0	130	38	120	32	21.6	0.80
22.5	ML 5+20/ Wall Sta. 5838+50	Static	117	33	0	130	38	120	32	22.5	1.00
		Pseudostatic	117	27	150	130	38	120	32	22.5	1.00
		Post Liquefied	117	25	150	130	38	120	32	22.5	1.00
15	ML 6+20 / Wall Sta. 5839+50	Static	117	31	0	130	38	120	32	11.25	0.75
		Pseudostatic	117	31	130	130	38	120	32	11.25	0.75
		Post Liquefied	117	31	130	130	38	120	32	11.25	0.75

MSE RETAINING WALL DESIGN DATA

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	RETAINED SOIL			FOUNDATION SOIL					GROUND IMPROVEMENT DEPTH (FT)	MINIMUM EARTH REINFORCEMENT RATIO OR LENGTH (FT)	MINIIMUM WALL EMBEDMENT (FT)
				FRICTION ANGLE (DEG)	COHESION (PSF)	UNIT WEIGHT (PCF)	TOTAL (UNDRAINED)		EFFECTIVE (DRAINED)		UNIT WEIGHT (PCF)			
							FRICTION ANGLE (DEG)	COHESION (PSF)	FRICTION ANGLE (DEG)	COHESION (PSF)				
9.90B	1+50.00	2+40	27.5	32	50	120	26	50	32	0	115	None	0.8H or 8 feet, whichever is greater	4
	2+40	3+80	27	32	50	120	35	0	38	0	127	5 feet overexcavation	0.8H	4
	3+80	6+20	22.5	32	50	120	27	150	33	0	117	5 feet overexcavation	1.0H	2
	6+20	6+80.22	15	32	50	120	31	130	31	0	117	None	0.75H or 8 feet, whichever is greater	2

REV.	DATE	BY	DESCRIPTION

SHEET-TITLE

PROJECT
CLIENT
FACILITY NAME

CITY/COUNTY STATE

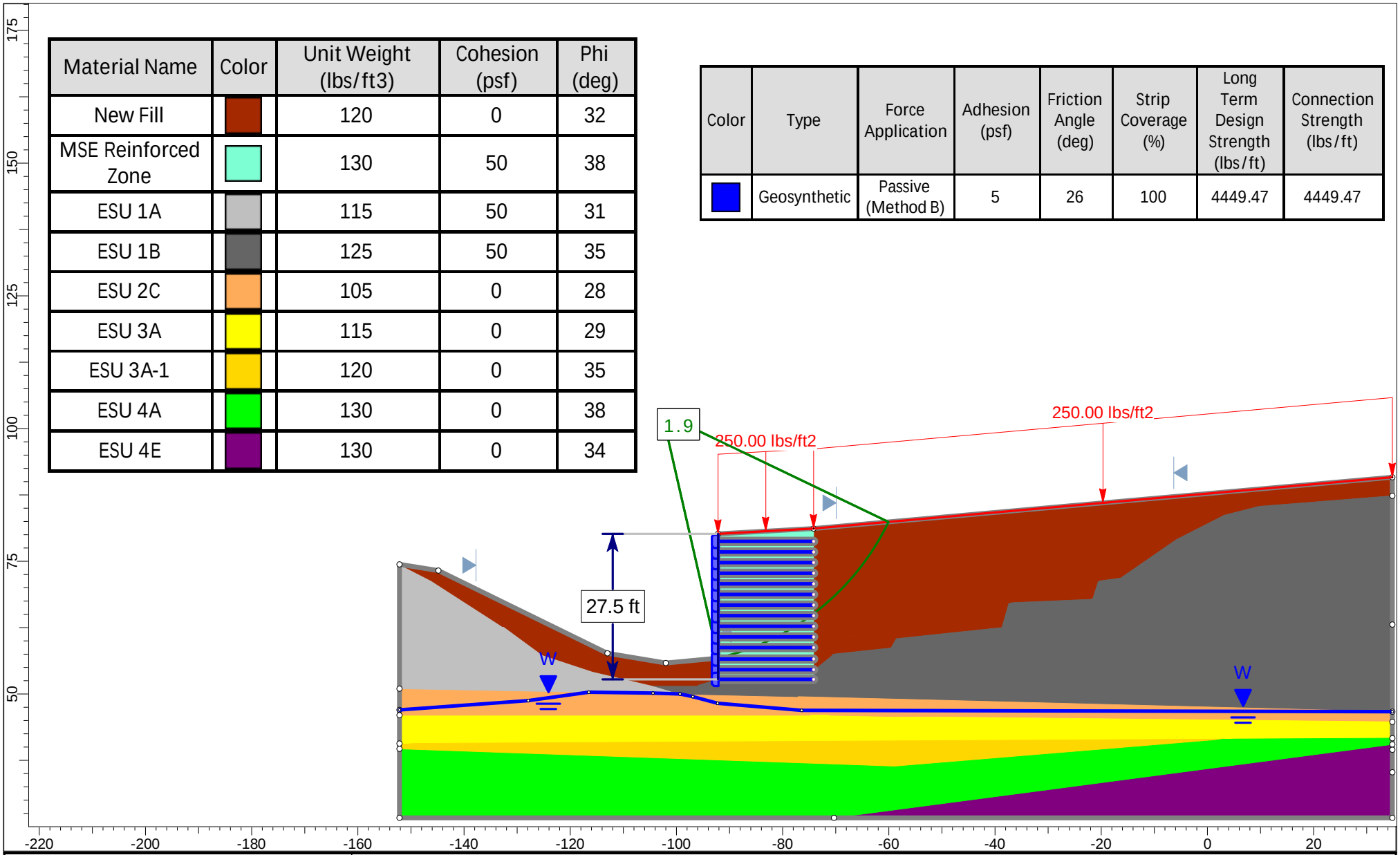
Terracon
Consulting Engineers and Scientists

FIG/DRAWING

DESIGNED BY:	XXX
DRAWN BY:	XXX
APPVD. BY:	XXX
SCALE:	AS SHOWN
DATE:	XX-XX-XX
JOB NO.	XXXXXXXX
CAD FILE	SHEET NAME
SHEET NO.:	XX OF XX

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Fill		120	0	32
MSE Reinforced Zone		130	50	38
ESU 1A		115	50	31
ESU 1B		125	50	35
ESU 2C		105	0	28
ESU 3A		115	0	29
ESU 3A-1		120	0	35
ESU 4A		130	0	38
ESU 4E		130	0	34

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



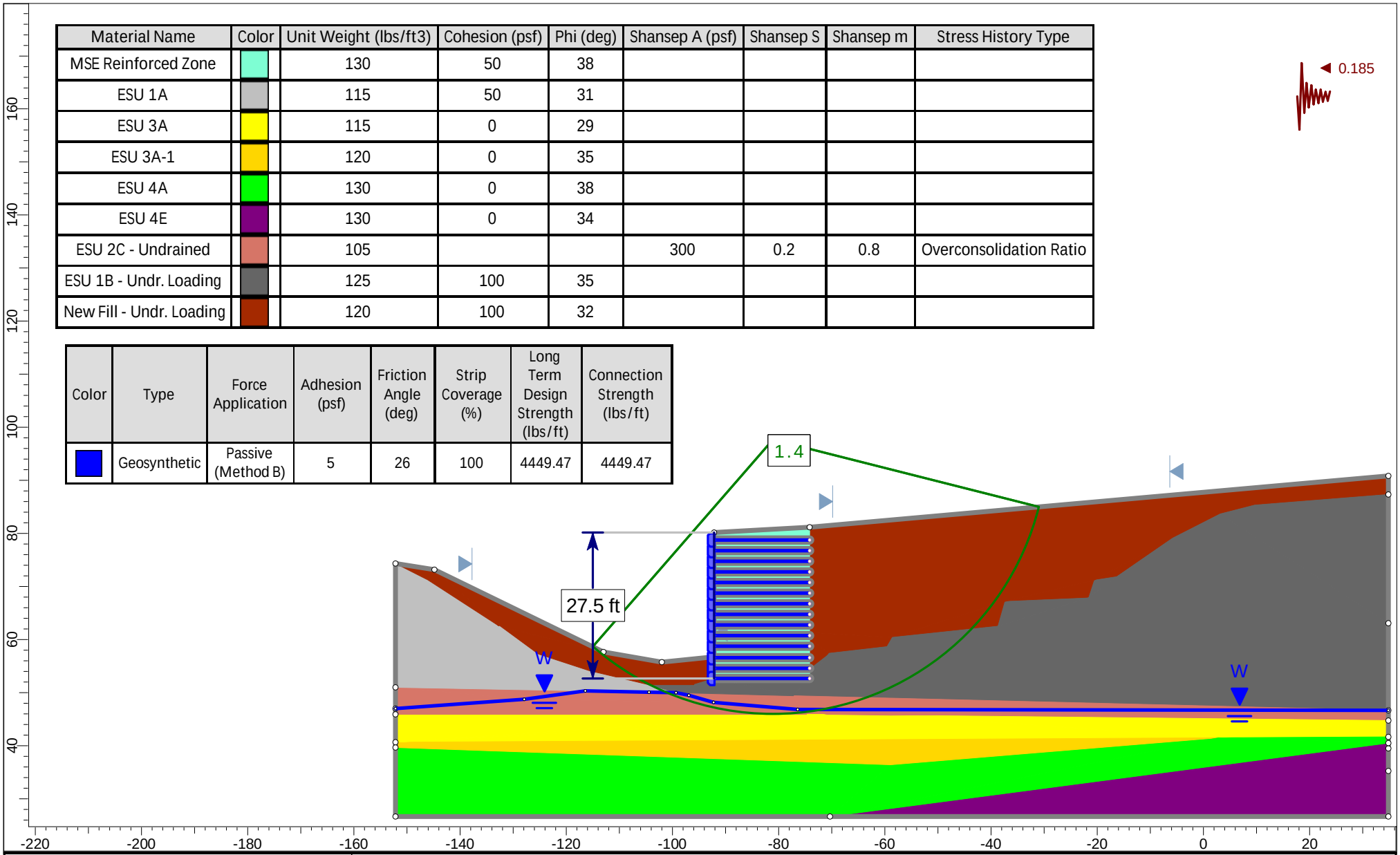
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5826+00./ ML 2+70)		
Group Name	Sta. 5836+00_ML 2+70 w/ MSE wall	Scenario Name	1.1 Static - Long Term
Drawn By	RWS	Scale	1:300
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5836 at 2+70.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	50	38				
ESU 1A		115	50	31				
ESU 3A		115	0	29				
ESU 3A-1		120	0	35				
ESU 4A		130	0	38				
ESU 4E		130	0	34				
ESU 2C - Undrained		105			300	0.2	0.8	Overconsolidation Ratio
ESU 1B - Undr. Loading		125	100	35				
New Fill - Undr. Loading		120	100	32				

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



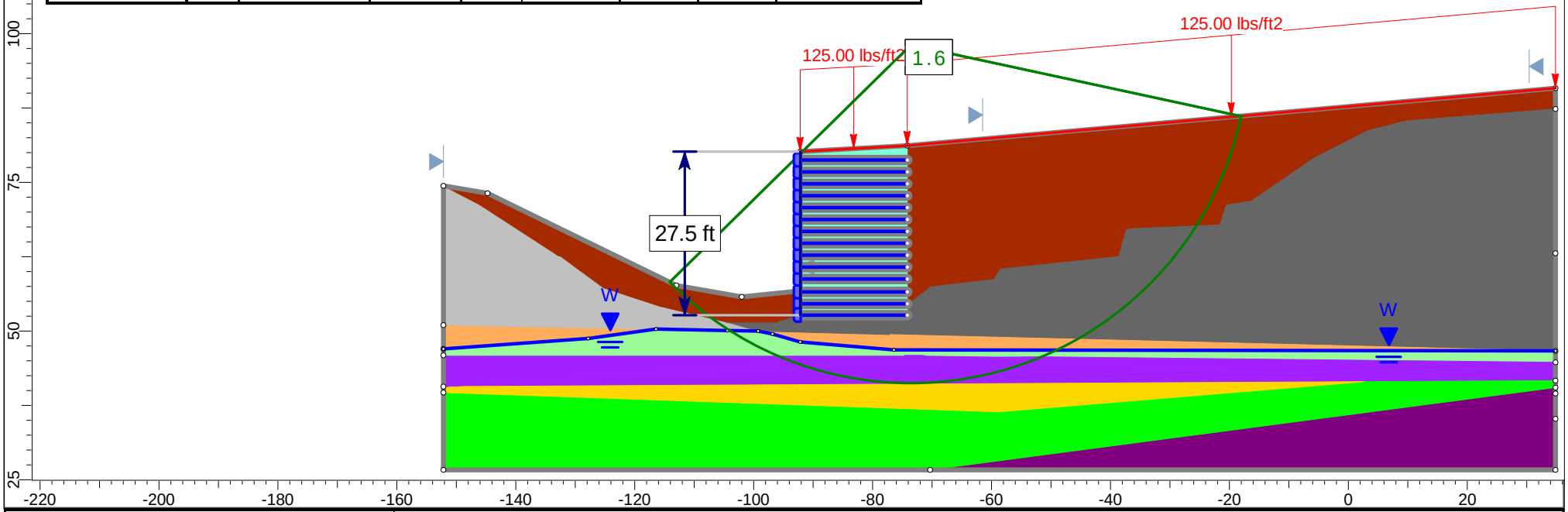
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5826+00./ ML 2+70)		
Group Name	Sta. 5836+00_ML 2+70 w/ MSE wall	Scenario Name	1.2 Pseudostatic
Drawn By	RWS	Scale	1:300
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5836 at 2+70.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	50	38				
ESU 1A		115	50	31				
ESU 1B		125	50	35				
ESU 2C		105	0	28				
ESU 3A-1		120	0	35				
ESU 4A		130	0	38				
ESU 4E		130	0	34				
ESU 3A - Residual		115			175	0.08	0.8	Overconsolidation Ratio
ESU 2C - Residual		120			300	0.2	0.8	Overconsolidation Ratio
New Fill - Undr. Loading		120	100	32				

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



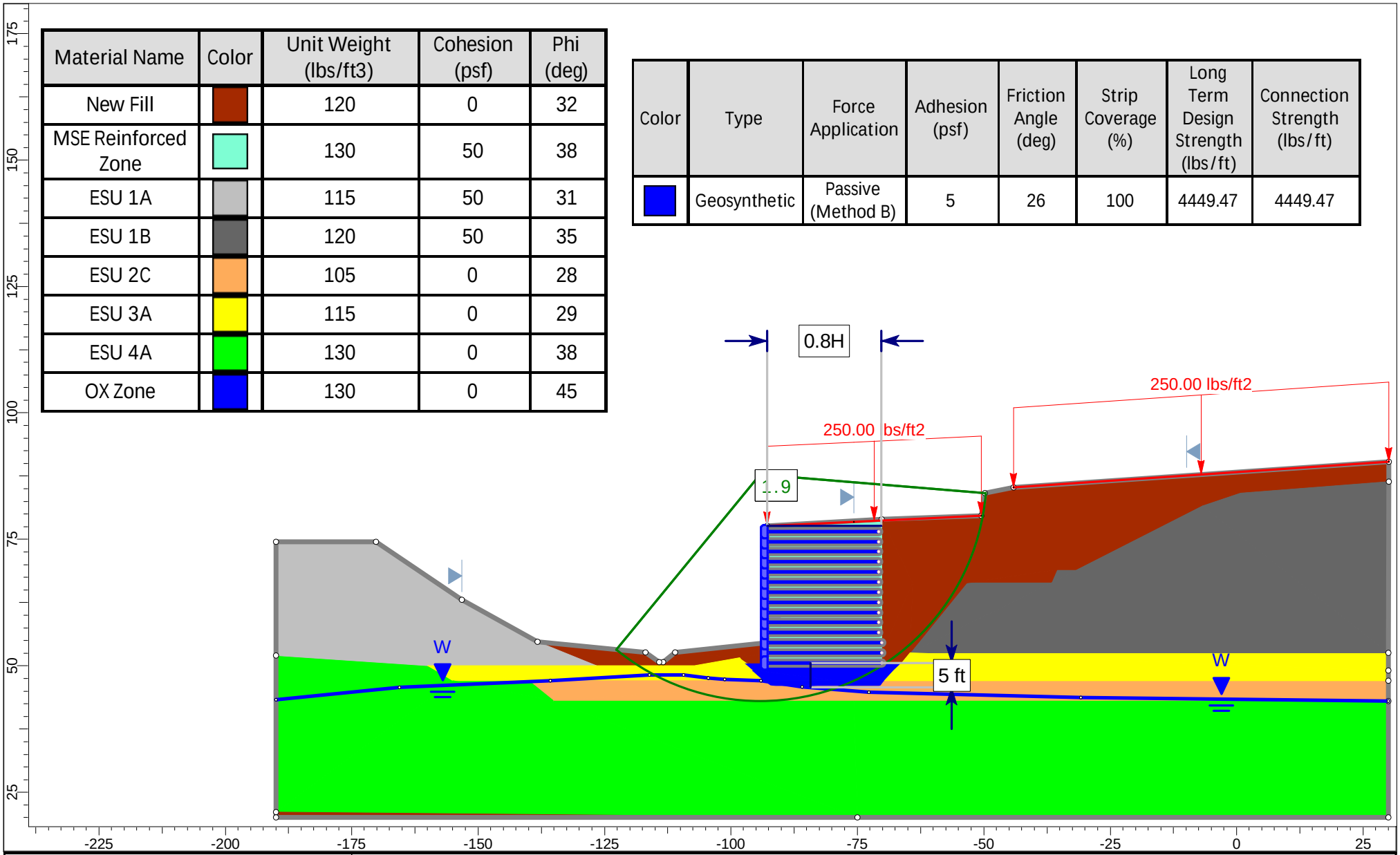
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5826+00./ ML 2+70)		
Group Name	Sta. 5836+00_ML 2+70 w/ MSE wall	Scenario Name	1.3 Post Liquefied
Drawn By	RWS	Scale	1:300
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5836 at 2+70.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Fill		120	0	32
MSE Reinforced Zone		130	50	38
ESU 1A		115	50	31
ESU 1B		120	50	35
ESU 2C		105	0	28
ESU 3A		115	0	29
ESU 4A		130	0	38
OX Zone		130	0	45

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



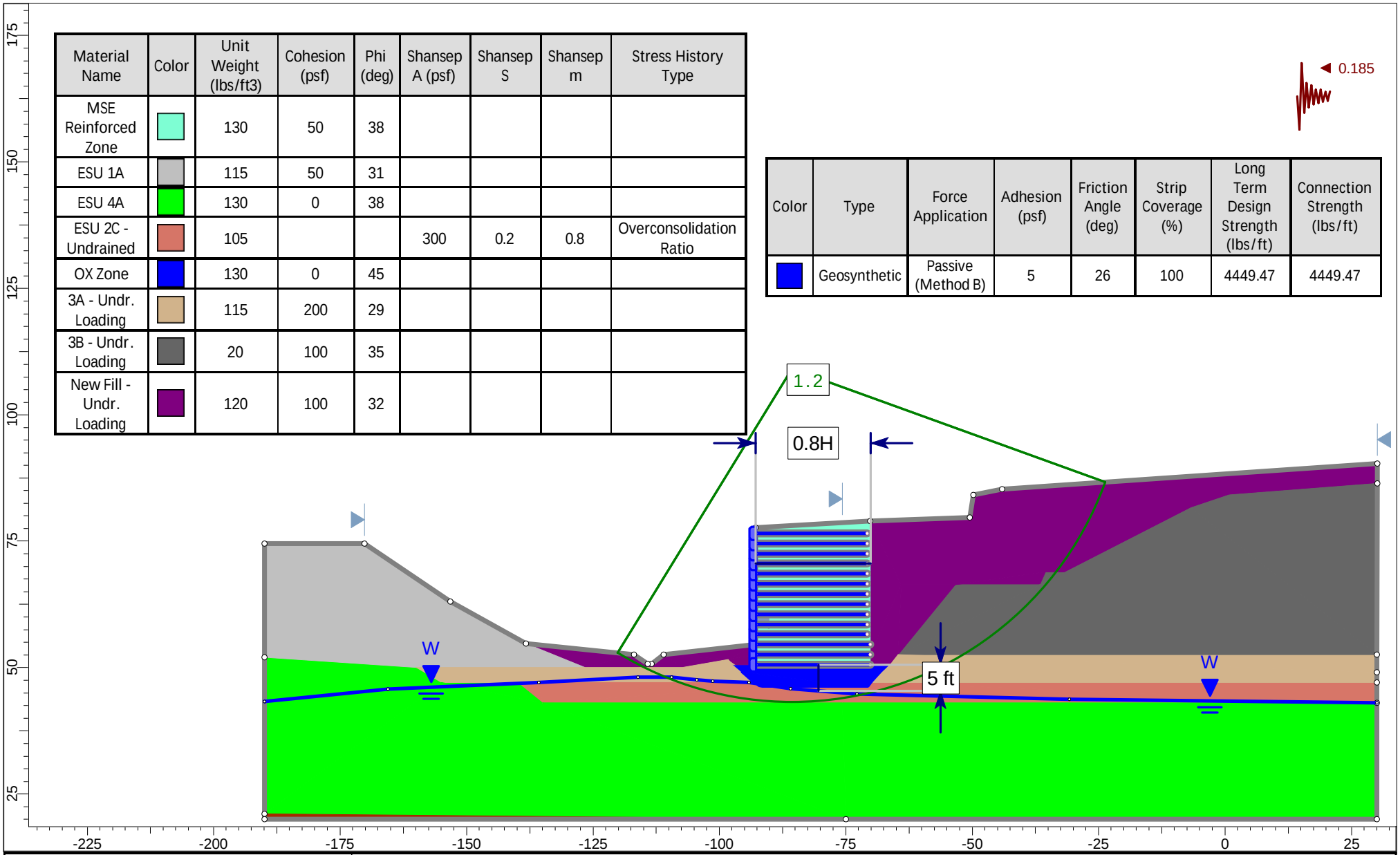
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5837+00./ ML 3+70)
Group Name	Sta. 5827+00_ML 3+70 w/ MSE wall (Overex)
Scenario Name	1.1 Static
Drawn By	RWS
Scale	1:315
Analysis Method	Spencer
Date	9/7/21
File Name	Wall 9.90B Sta 5837 at 3+70 with OX.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	50	38				
ESU 1A		115	50	31				
ESU 4A		130	0	38				
ESU 2C - Undrained		105			300	0.2	0.8	Overconsolidation Ratio
OX Zone		130	0	45				
3A - Undr. Loading		115	200	29				
3B - Undr. Loading		20	100	35				
New Fill - Undr. Loading		120	100	32				

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



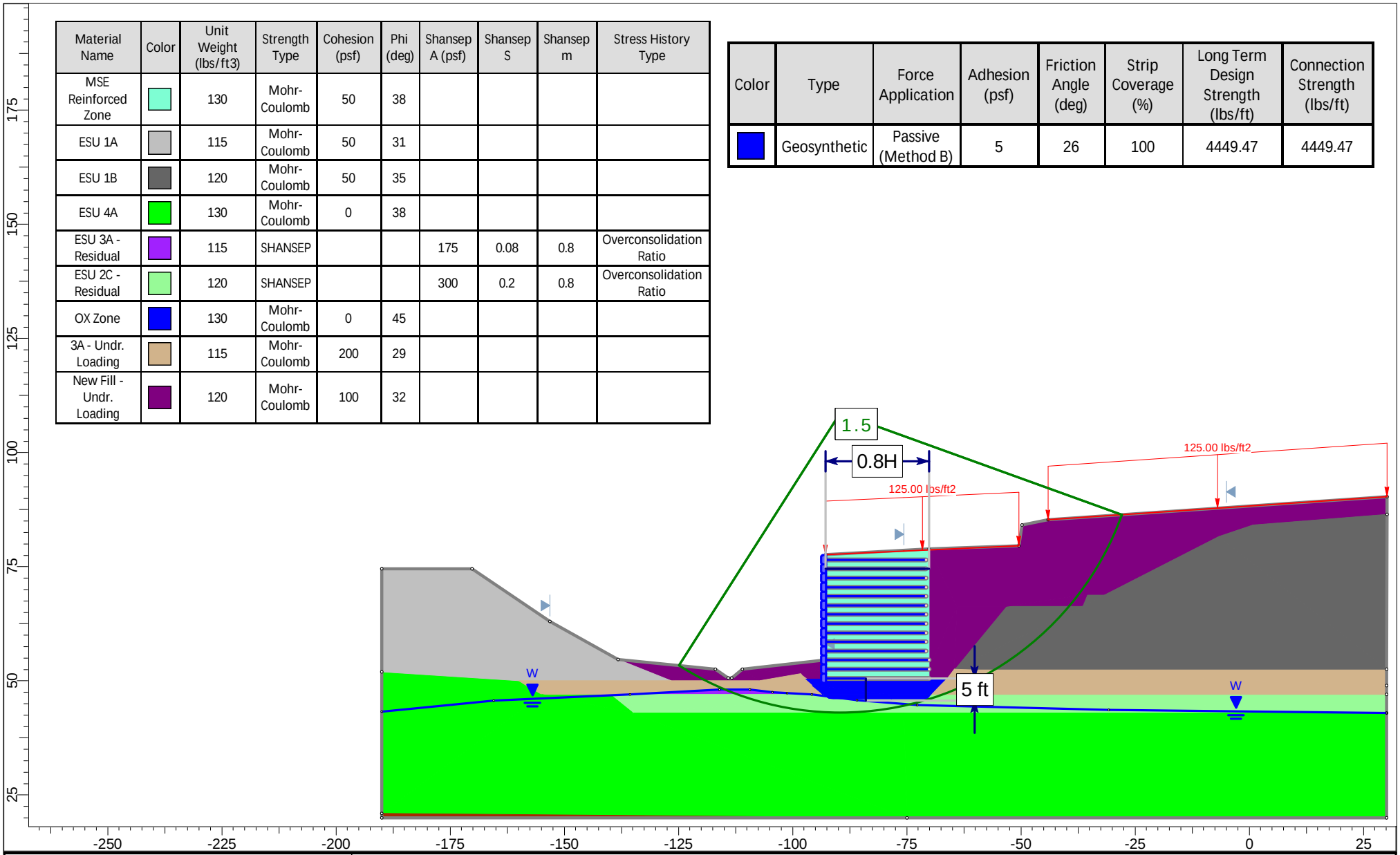
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5837+00./ ML 3+70)		
Group Name	Sta. 5827+00_ML 3+70 w/ MSE wall (Overex)	Scenario Name	1.2 Pseudostatic
Drawn By	RWS	Scale	1:315
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5837 at 3+70 with OX.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	Mohr-Coulomb	50	38				
ESU 1A		115	Mohr-Coulomb	50	31				
ESU 1B		120	Mohr-Coulomb	50	35				
ESU 4A		130	Mohr-Coulomb	0	38				
ESU 3A - Residual		115	SHANSEP			175	0.08	0.8	Overconsolidation Ratio
ESU 2C - Residual		120	SHANSEP			300	0.2	0.8	Overconsolidation Ratio
OX Zone		130	Mohr-Coulomb	0	45				
3A - Undr. Loading		115	Mohr-Coulomb	200	29				
New Fill - Undr. Loading		120	Mohr-Coulomb	100	32				

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



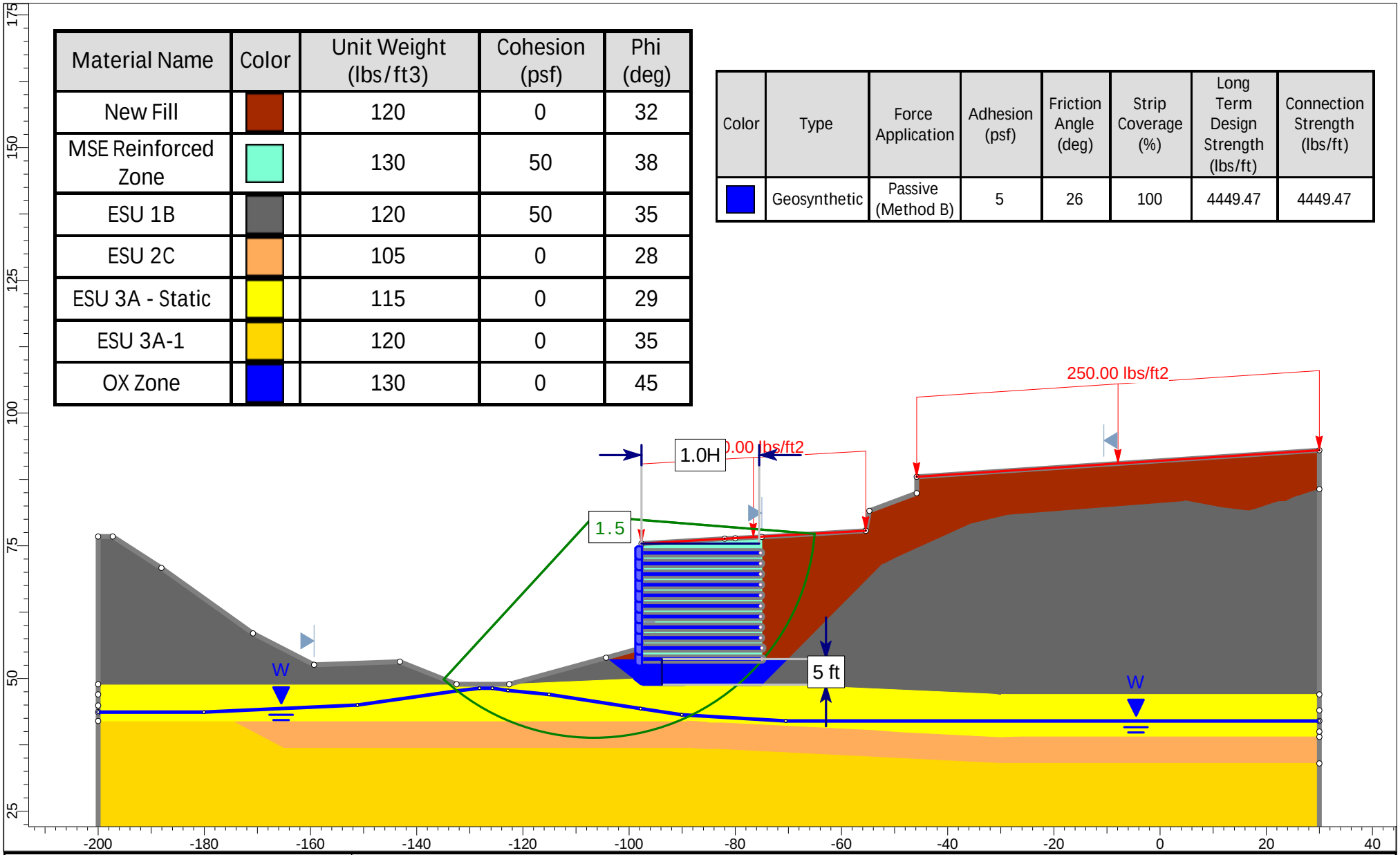
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5837+00./ ML 3+70)		
Group Name	Sta. 5827+00_ML 3+70 w/ MSE wall (Overex)	Scenario Name	1.3 Post Liquefied
Drawn By	RWS	Scale	1:349
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5837 at 3+70 with OX.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Fill		120	0	32
MSE Reinforced Zone		130	50	38
ESU 1B		120	50	35
ESU 2C		105	0	28
ESU 3A - Static		115	0	29
ESU 3A-1		120	0	35
OX Zone		130	0	45

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



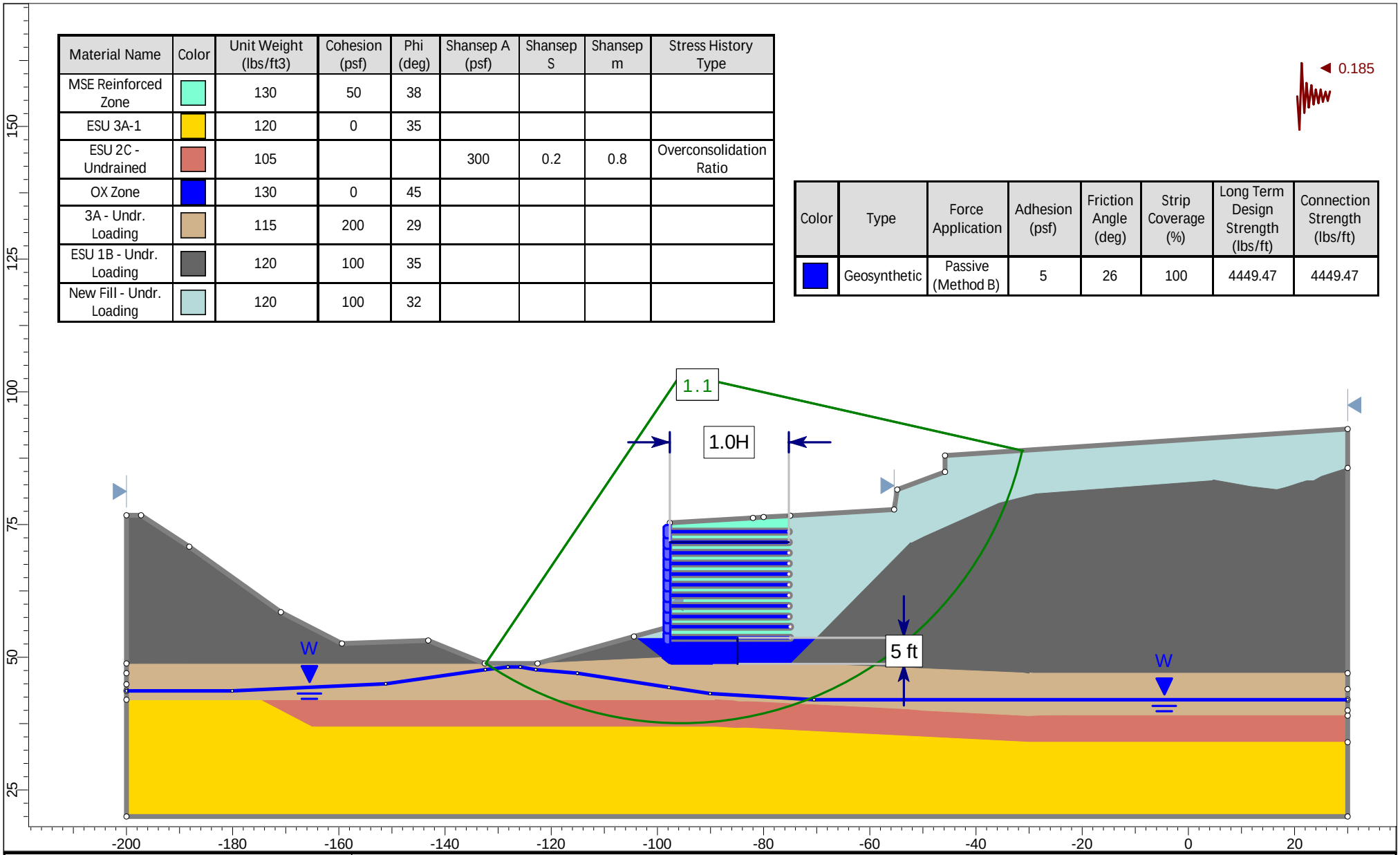
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5838+50./ ML 5+20)		
Group Name	Sta. 5828+50_ML 5+20 w/ MSE wall (Overex)	Scenario Name	1.1 Static
Drawn By	RWS	Scale	1:300
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5838+50 at 5+20 with OX.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	50	38				
ESU 3A-1		120	0	35				
ESU 2C - Undrained		105			300	0.2	0.8	Overconsolidation Ratio
OX Zone		130	0	45				
3A - Undr. Loading		115	200	29				
ESU 1B - Undr. Loading		120	100	35				
New Fill - Undr. Loading		120	100	32				

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



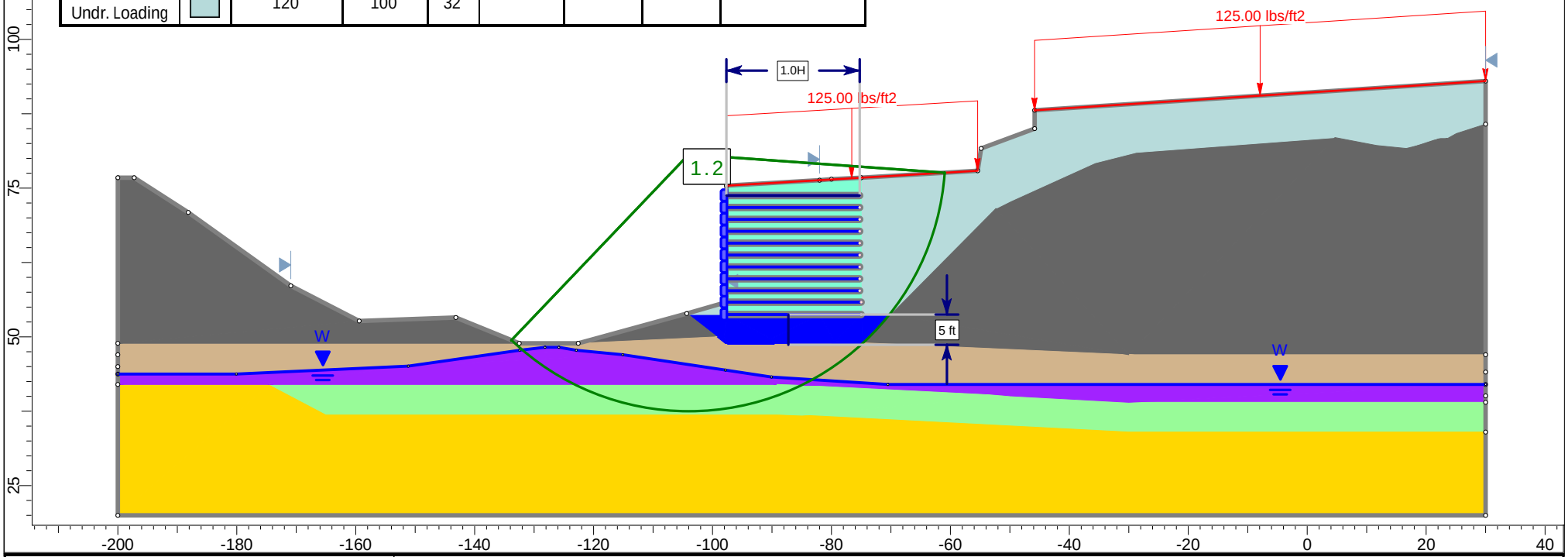
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5838+50./ ML 5+20)		
Group Name	Sta. 5828+50_ML 5+20 w/ MSE wall (Overex)	Scenario Name	1.2 Pseudostatic
Drawn By	RWS	Scale	1:300
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5838+50 at 5+20 with OX.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	50	38				
ESU 3A-1		120	0	35				
ESU 3A - Residual		115			175	0.08	0.8	Overconsolidation Ratio
ESU 2C - Residual		120			300	0.2	0.8	Overconsolidation Ratio
OX Zone		130	0	45				
3A - Undr. Loading		115	200	29				
ESU 1B - Undr. Loading		120	100	35				
New Fill - Undr. Loading		120	100	32				

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



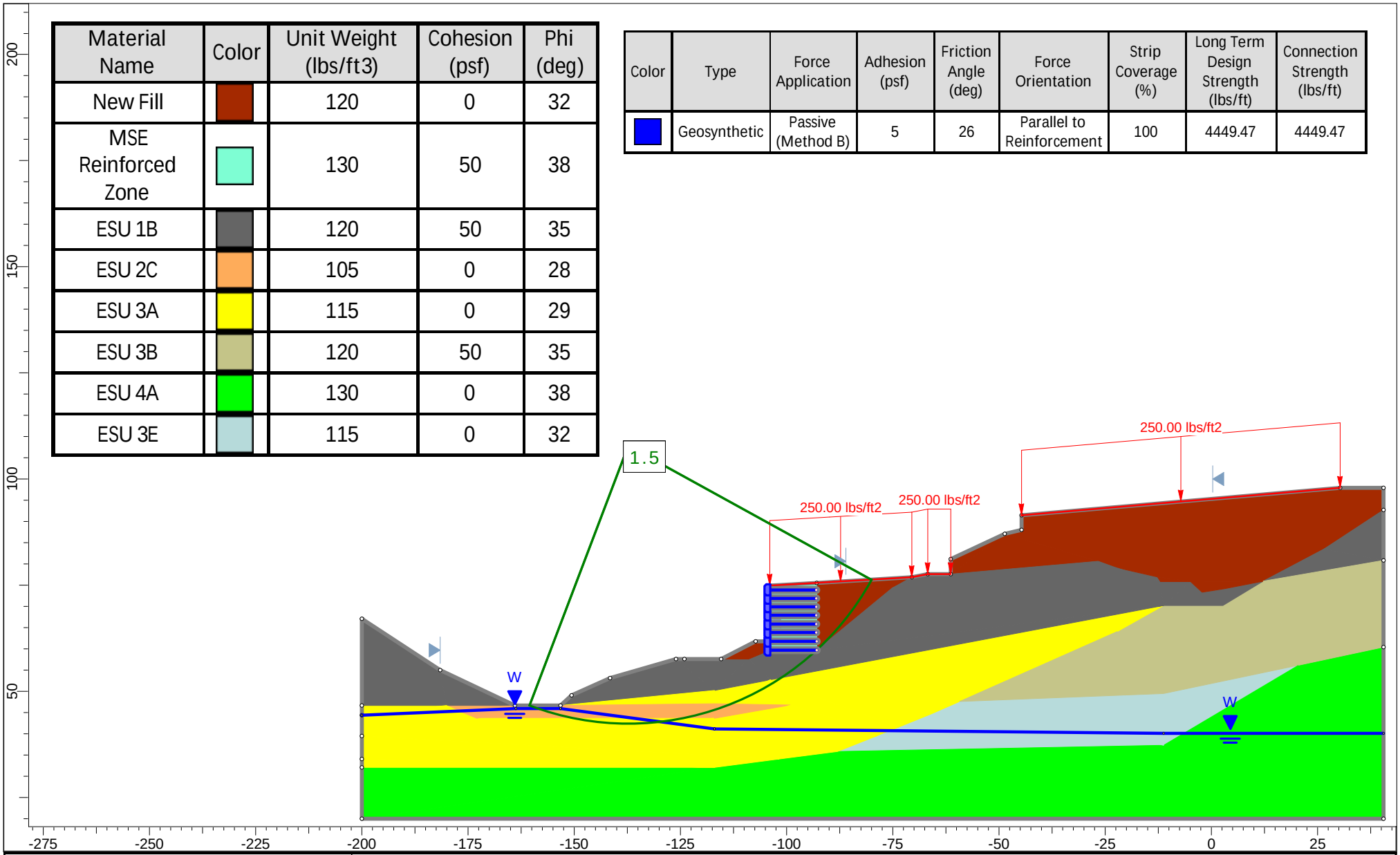
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5838+50./ ML 5+20)		
Group Name	Sta. 5828+50_ML 5+20 w/ MSE wall (Overex)	Scenario Name	1.3 Post Liquefied
Drawn By	RWS	Scale	1:300
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5838+50 at 5+20 with OX.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
New Fill		120	0	32
MSE Reinforced Zone		130	50	38
ESU 1B		120	50	35
ESU 2C		105	0	28
ESU 3A		115	0	29
ESU 3B		120	50	35
ESU 4A		130	0	38
ESU 3E		115	0	32

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Force Orientation	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	Parallel to Reinforcement	100	4449.47	4449.47

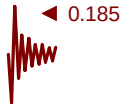


Terracon

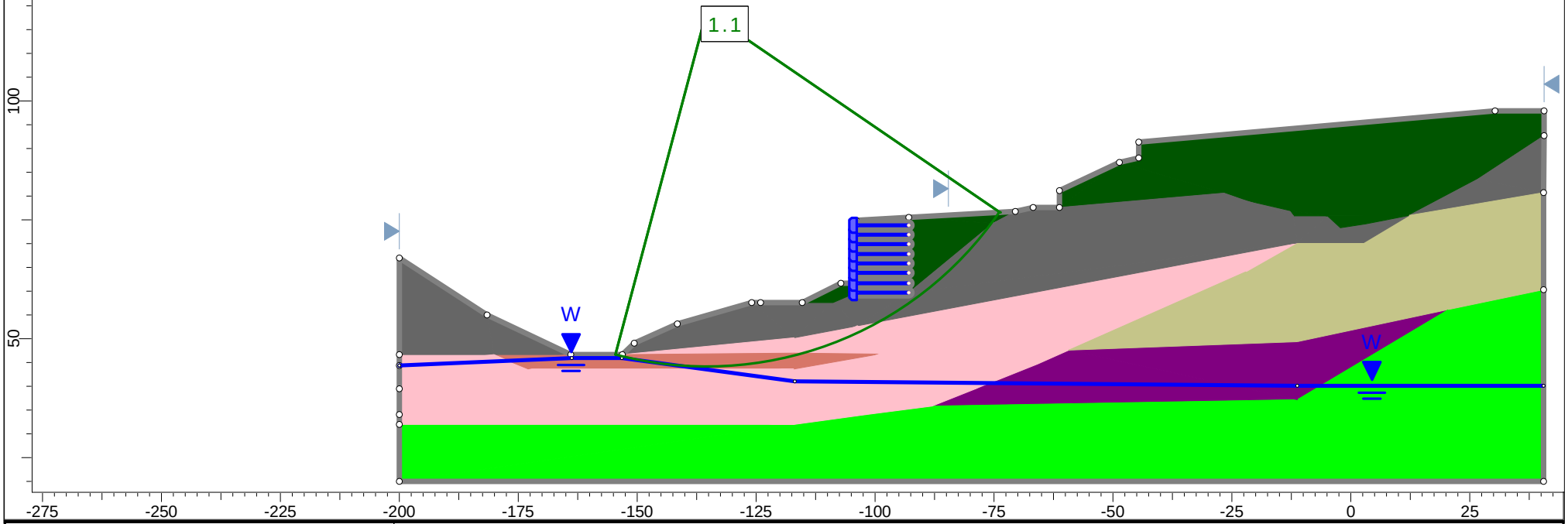
SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5839+50./ ML 6+20)		
Group Name	Sta. 5829+50_ML 6+20 w/ MSE wall	Scenario Name	1.1 Static
Drawn By	RWS	Scale	1:375
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5839+50 at 6+20.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	50	38				
ESU 1B		120	50	35				
ESU 3B		120	50	35				
ESU 4A		130	0	38				
ESU 2C - Undrained		105			300	0.2	0.8	Overconsolidation Ratio
ESU 3E - Undrained		115	1200	0				
ESU 1B - Undr. Loading		120	100	35				
ESU 3A - Undr. Loading		115	200	29				
New Fill - Undr. Loading		120	100	32				



Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



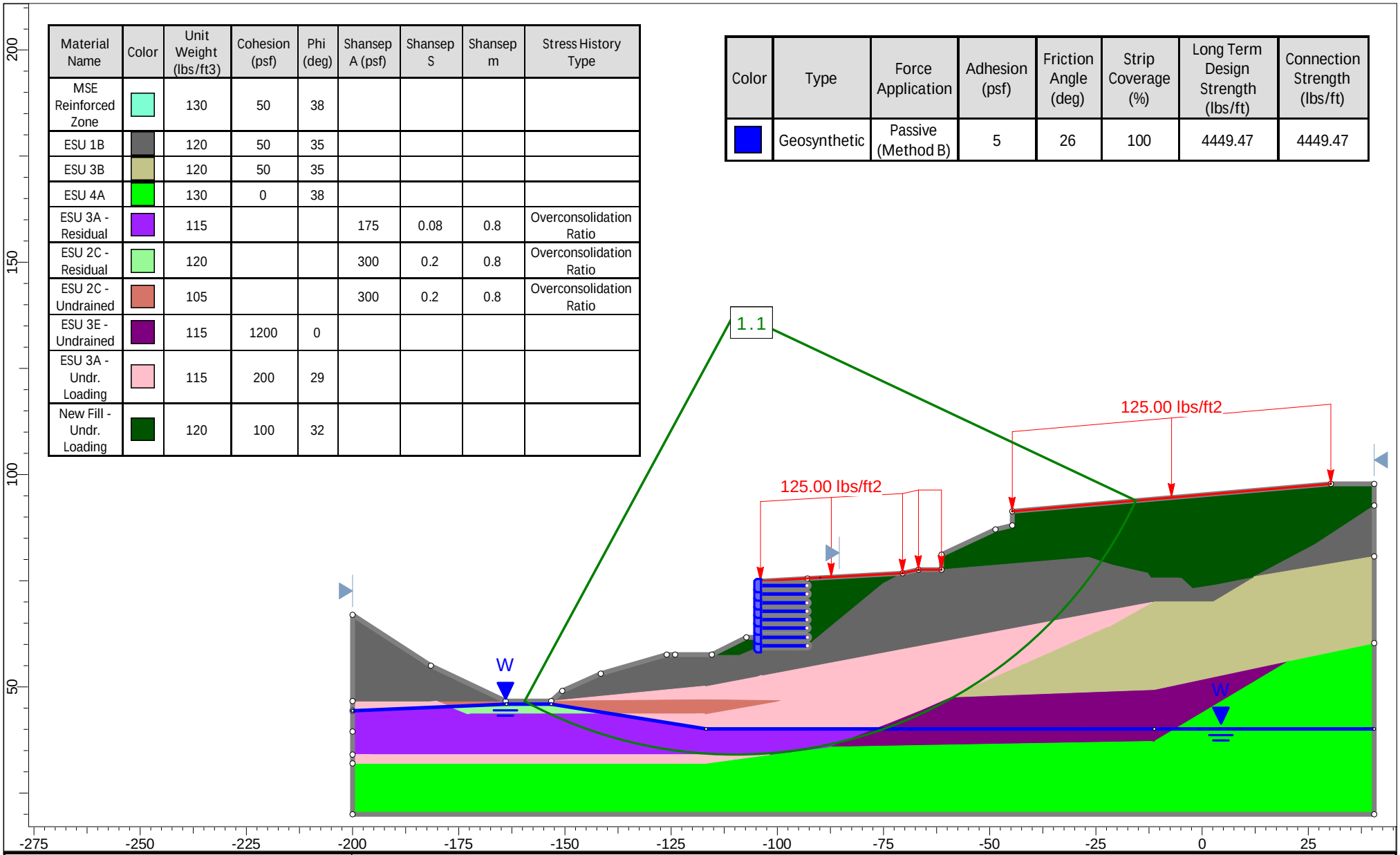
Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5839+50./ ML 6+20)		
Group Name	Sta. 5829+50_ML 6+20 w/ MSE wall	Scenario Name	1.2 Pseudostatic
Drawn By	RWS	Scale	1:375
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5839+50 at 6+20.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)	Shansep A (psf)	Shansep S	Shansep m	Stress History Type
MSE Reinforced Zone		130	50	38				
ESU 1B		120	50	35				
ESU 3B		120	50	35				
ESU 4A		130	0	38				
ESU 3A - Residual		115			175	0.08	0.8	Overconsolidation Ratio
ESU 2C - Residual		120			300	0.2	0.8	Overconsolidation Ratio
ESU 2C - Undrained		105			300	0.2	0.8	Overconsolidation Ratio
ESU 3E - Undrained		115	1200	0				
ESU 3A - Undr. Loading		115	200	29				
New Fill - Undr. Loading		120	100	32				

Color	Type	Force Application	Adhesion (psf)	Friction Angle (deg)	Strip Coverage (%)	Long Term Design Strength (lbs/ft)	Connection Strength (lbs/ft)
	Geosynthetic	Passive (Method B)	5	26	100	4449.47	4449.47



Terracon

SLIDEINTERPRET 9.018

Project	RENTON TO BELLEVUE, WALL 9.90LB (WALL STA. 5839+50./ ML 6+20)		
Group Name	Sta. 5829+50_ML 6+20 w/ MSE wall	Scenario Name	1.3 Post Liquefied
Drawn By	RWS	Scale	1:375
Analysis Method	Spencer		
Date	9/7/21	File Name	Wall 9.90B Sta 5839+50 at 6+20.slmd

7) Settlement Analyses:

We chose 4 representative sections of the wall and estimated settlements of wall at those stations. We used Hough method to estimate settlement of wall footings on cohesionless soils. If the foundation soil has both cohesive soil as well as cohesionless soil, total settlement will be settlement estimated using consolidation theory for fine grained soil and settlement estimated using Hough method for the coarse-grained soil.

We reviewed all the previously submitted report sent to us by FLATIRON. Test data provided in those reports and our previous experience we used the consolidation properties compiled below. Details of settlement analysis and the summary of results are provided in next pages.

Wall	ESU Unit	USCS Soil Type	e_0	$C_c/1+e_0$	C_r
2+70	2C	OH	0.849	0.15	0.03
5+20	2C	ML	1.085	0.13	0.04
6+20	2C	ML	1.085	0.13	0.04

Consolidation Parameters are collected from following Reference Documents:

1. WOOD (2021), Geotechnical Engineering Report: Fish Passage 10.0, Project # PS19-20316-0, Kirkland, Washington
2. WSDOT (2018), I-405 Renton to Bellevue Widening and Express Toll Lanes Project, XL-4653/XL-5467, I-405, MP 0.0-14.6, Olympia, Washington

Wall 9.90L(B) shows groundwater table is at the 2C layers everywhere within the wall footprint. We estimated consolidated settlement within the 2C layers and the time rate of consolidation of this layer as well.

SETTLEMENT RESULT SUMMARY

RETAINING WALL	BEGIN STATION	END STATION	MAXIMUM HEIGHT, H (FT)	GROUND IMPROVEMENT DEPTH (FT)	MINIMUM EARTH REINFORCEMENT RATIO OR LENGTH (FT)	BORING LOG USED FOR HOUGH ANALYSIS	ESTIMATED SETTLEMENT (IN)
9.90B	1+50.00	2+40	27.5	None	0.8H or 8 feet, whichever is greater	GEO 36	2 to 4 inches
	2+40	3+80	27	5 ft overexcavation	0.8H or 8 feet, whichever is greater	R2B-78-17	2 to 4 inches
	3+80	6+20	22.5	5 ft overexcavation	1.0H or 8 feet, whichever is greater	GEO 37	2 to 5 inches
	6+20	6+80.22	15	None	0.75H or 8 feet, whichever is greater	GEO 38	1 to 2 inches

NOTE:

1. Settlement is calculated up to a depth below the bottom of wall where stress increase due to wall foundation load is less than 10% of the existing overburden stress.

REV.	DATE	BY	DESCRIPTION

WALL 9.90 L(A)

81215044: I-405 RENTON TO BELELVUE
PARSONS TRANSPORATION GROUP

OCT 2021

WA

Terracon
Consulting Engineers and Scientists

FIG/DRAWING

DESIGNED BY:	XXX
DRAWN BY:	XXX
APPVD. BY:	XXX
SCALE:	AS SHOWN
DATE:	XX-XX-XX
JOB NO.	XXXXXXXX
CAD FILE	SHEET NAME
SHEET NO.:	XX OF XX

5.2.2 Consolidation Coefficients

Consolidation parameters of compressible soil layers for performing geotechnical settlement analysis are presented in Table 8.

Table 8: Design Consolidation Parameters

ESU	USCS Soil Type	OCR	P'c (psf)	eo	Consolidation Indices				Coefficient of Consolidation	
					Cc/(1+eo)	Cr/(1+eo)	Cα/(1+eo)	Cαr/(1+eo)	Cv (ft^2/day)	Cvr (ft^2/day)
2C	ML	1.5	NA	0.849	0.15	0.03	0.005	0.0009	0.2	1.0
3E	CL/ML	NA	8,000	0.641	0.12	0.024	0.004	0.0007	0.3	2.0

Abbreviation(s)

Cα = secondary compression index
Cαr = secondary recompression index
Cc = compression index
Cr = recompression index
Cv = coefficient of consolidation (virgin compression)
Cvr = coefficient of consolidation (reloading)
eo = Initial in-situ void ratio
ESU = Engineering Stratigraphic Unit
ft^2/day = square feet per day
NA = not applicable
OCR = overconsolidation ratio
P'c = preconsolidation pressure
psf = pounds per square foot
USCS = Unified Soil Classification System

The consolidation indices were determined based on the correlations provided in the Geotechnical Soil Properties Methodology report (Wood 2020b). The preconsolidation pressure and/or overconsolidation ratio were determined using the Stress History and Normalized Soil Engineering Property, or SHANSEP, method, per Ladd and Foott (1974), assuming a constant normally consolidated shear strength ratio of 0.22.

5.3 Soil Parameters for Standard WSDOT Materials

Table 9 presents design soil properties to be used for typical WSDOT specified backfill. The selected values for the design friction angle are the midpoint of the typical range of values outlined in Table 5-2 of the GDM and not near or above the upper value of the range, as suggested in Section 5.12 of the Project GDM. The moist unit weight selected for design is within the range suggested in Table 5-2 of the GDM.

Table 9: WSDOT Specified Backfill Engineering Soil Parameters

Material	WSDOT Standard Specification	Soil Type (USCS classification)	Soil Friction Angle (degrees)[1]	Cohesion (psf)	Moist Unit Weight (pcf)
Common Borrow	9-03.14(3)	ML, SM, GM	32	0	120
Select Borrow	9-03.14(2)	GP, GP-GM, SP, SP-SM	36	0	125
Gravel Borrow	9-03-14(1)	GW, GW-GM, SW, SW-SM	38	0	130
Gravel Backfill for Walls	9-03.12(2)	GW, GP, SW, SP	38	0	130

Source: Project GDM Table 5-2 - Presumptive Design Property Ranges for Compacted Borrow and WSDOT Standard Specifications (WSDOT 2018c).

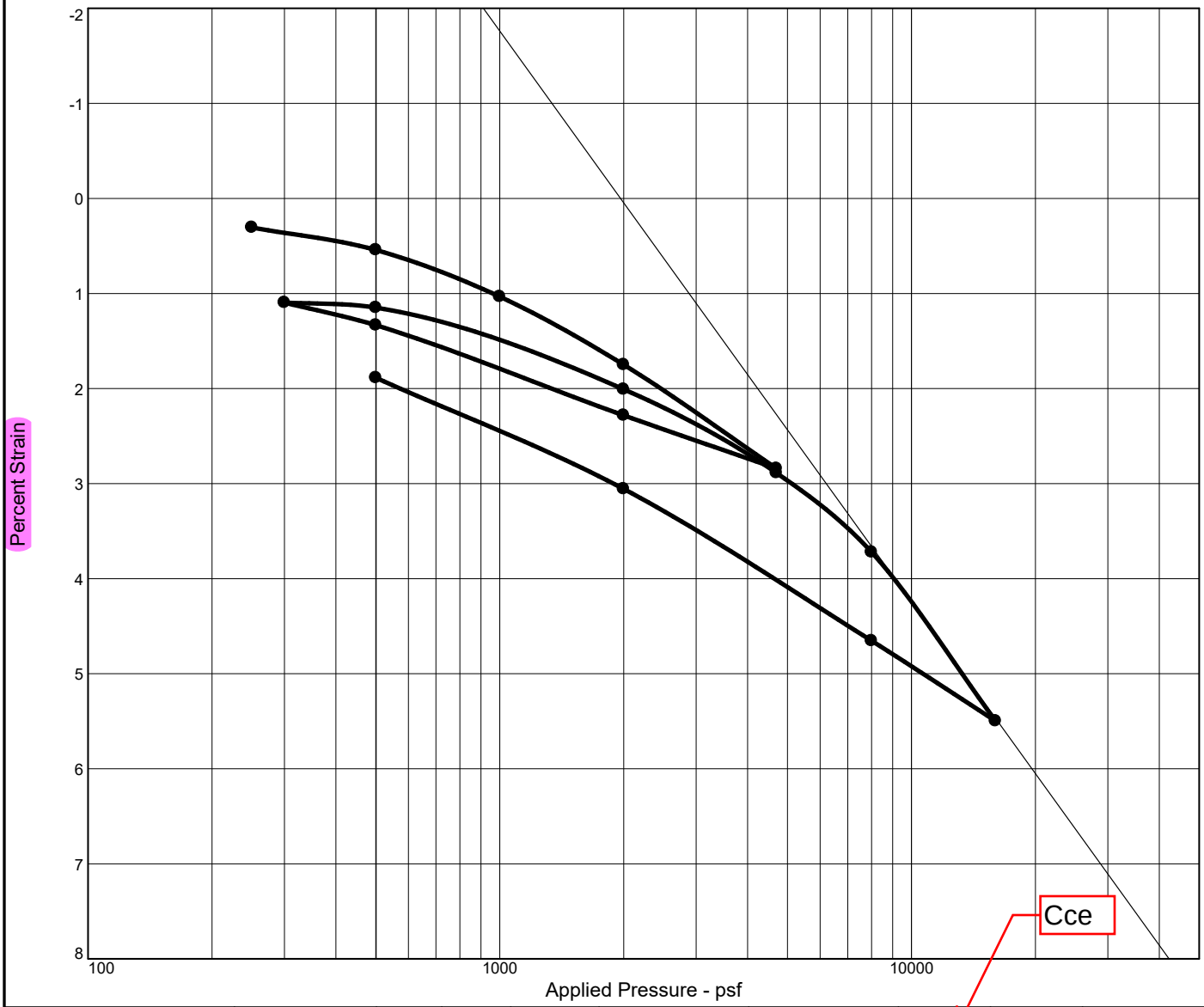
Abbreviation(s)

pcf = pounds per cubic foot
psf = pounds per square foot
USCS = Unified Soil Classification System
WSDOT = Washington State Department of Transportation

6.0 Geotechnical Analyses and Recommendations

The following sections describe results of geotechnical engineering analyses and recommendations for the Fish Passage 10.0 culvert, wing walls, and CABS embankment. The recommendations are based on our interpretation of the subsurface conditions as shown in the ESU profiles, and elevation and/or geometry of the culvert as shown on Sheets 2 to 4 in

CONSOLIDATION TEST REPORT



Natural Saturation	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_r	Initial Void Ratio
101.8 %	40.0 %	82.6	67	41	2.76	980	2858	0.13	0.04	1.085

MATERIAL DESCRIPTION	USCS	AASHTO
CH - FAT CLAY	CH	T-216

Project No. XL-4653 **Client:** Jason Qiu

Project: I-405 Renton to Bellevue

Source of Sample: R2B-69-17 **Depth:** 8.0 **Sample Number:** PS-4

Remarks:

WSDOT

Figure

Tested By: DDH **Checked By:** GW

81215044 - RTB
Wall 9.90L-B Sta. 2+70 (GEO- 36)

52.5	Footing Elevation (ft)
3510	Footing Stress (psf)
23	Footing Width (ft)
100	Footing Length (ft)

4.5	Depth to Water (ft)

This is the effect of the fill to retaining wall subgrade

	Calculated
6.08	Settlement (in)

1. Per GDM Section 8.11.2.3.1 settlement estimated by Hough method can be reduced by 1.5 factor.
2.Approximately **4.0** inch of settlement is expected.
3. Settlement is calculated up to a depth below the bottom of wall where stress increase due to wall foundation load is less than than 10% of the existing overburden stress.
4. **"2C Layer"** has sand like behavior, and will consolidate. Used WOODS provided Consol data.

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	63.7	21	120	4	21	120	4	0	2.00	42	101	0.010				120	0	120	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	62.7				23	120	4	0	2.00	47	110	0.009				240	0	240	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
3	61.7				26	120	4	0	2.00	51	120	0.008				360	0	360	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
4	60.7				28	120	4	0	2.00	56	130	0.008				480	0	480	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
5	59.7	30	120	4	30	120	4	62.4	1.94	58	137	0.007				600	62	538	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
6	58.7				26	120	4	62.4	1.82	48	113	0.009				720	125	595	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
7	57.7				23	120	4	62.4	1.71	39	94	0.011				840	187	653	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
8	56.7	19	120	4	19	120	4	62.4	1.61	31	78	0.013				960	250	710	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
9	55.7				21	120	4	62.4	1.53	32	80	0.013				1080	312	768	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
10	54.7				22	120	4	62.4	1.45	32	81	0.012				1200	374	826	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
11	53.7	24	120	4	24	120	4	62.4	1.39	33	83	0.012				1320	437	883	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
12	52.7				18	113	4	62.4	1.34	23	64	0.016				1433	499	933	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
13	51.7	11	105	6	11	105	6	62.4	1.30	14	34	0.150	0.150	0.849	0.030	1538	562	976	0.8	28.75	0.985	225%	3458.36	0.0986	0.0986	1.1833	1.18
14	50.7				10	105	6	62.4	1.26	13	32	0.150	0.150	0.849	0.030	1643	624	1019	1.8	12.78	0.968	207%	3398.25	0.0956	0.1942	2.3302	2.33
15	49.7				10	105	6	62.4	1.23	12	31	0.150	0.150	0.849	0.030	1748	686	1061	2.8	8.21	0.946	190%	3321.90	0.0924	0.2866	3.4390	3.44
16	48.7	9	105	6	9	105	6	62.4	1.20	11	30	0.034				1853	749	1104	3.8	6.05	0.922	175%	3235.38	0.0201	0.3067	3.6806	3.68
17	47.7				9	108	6	62.4	1.18	10	29	0.035				1960	811	1149	4.8	4.79	0.895	160%	3142.47	0.0199	0.3266	3.9188	3.92
18	46.7				9	110	6	62.4	1.15	10	28	0.036				2070	874	1196	5.8	3.97	0.868	147%	3045.87	0.0195	0.3461	4.1531	4.15
19	45.7				8	113	6	62.4	1.12	9	28	0.036				2183	936	1247	6.8	3.38	0.840	135%	2947.57	0.0191	0.3652	4.3828	4.38
20	44.7	8	115	3	8	115	3	62.4	1.10	9	46	0.022				2298	998	1299	7.8	2.95	0.812	124%	2849.07	0.0110	0.3762	4.5146	4.51
21	43.7				12	116	3	62.4	1.08	13	54	0.019				2414	1061	1353	8.8	2.61	0.784	114%	2751.47	0.0090	0.3852	4.6221	4.62
22	42.7				16	118	3	62.4	1.06	16	62	0.016				2531	1123	1408	9.8	2.35	0.757	105%	2655.62	0.0075	0.3927	4.7119	4.71
23	41.7				19	119	3	62.4	1.05	20	69	0.014				2650	1186	1464	10.8	2.13	0.730	97%	2562.12	0.0064	0.3990	4.7881	4.79
24	40.7	23	120	3	23	120	3	62.4	1.03	24	77	0.013				2770	1248	1522	11.8	1.95	0.704	89%	2471.40	0.0055	0.4045	4.8536	4.85
25	39.7				23	120	3	62.4	1.02	24	77	0.013				2890	1310	1580	12.8	1.80	0.679	82%	2383.73	0.0052	0.4097	4.9158	4.92
26	38.7				24	120	3	62.4	1.00	24	77	0.013				3010	1373	1637	13.8	1.67	0.655	76%	2299.32	0.0049	0.4146	4.9750	4.98
27	37.7				24	120	3	62.4	0.99	24	78	0.013				3130	1435	1695	14.8	1.55	0.632	71%	2218.24	0.0047	0.4193	5.0313	5.03
28	36.7				25	120	3	62.4	0.98	24	78	0.013				3250	1498	1752	15.8	1.46	0.610	66%	2140.52	0.0045	0.4237	5.0847	5.08
29	35.7	25	120	2	25	120	2	62.4	0.97	24	87	0.012				3370	1560	1810	16.8	1.37	0.589	61%	2066.16	0.0038	0.4275	5.1303	5.13
30	34.7				24	120	2	62.4	0.96	23	83	0.012				3490	1622	1868	17.8	1.29	0.568	57%	1995.10	0.0038	0.4313	5.1761	5.18
31	33.7				22	120	2	62.4	0.96	21	79	0.013				3610	1685	1925	18.8	1.22	0.549	53%	1927.25	0.0038	0.4352	5.2219	5.22
32	32.7				21	120	2	62.4	0.95	19	75	0.013				3730	1747	1983	19.8	1.16	0.531	50%	1862.53	0.0038	0.4390	5.2679	5.27
33	31.7	19	120	3	19	120	3	62.4	0.94	18	64	0.016				3850	1810	2040	20.8	1.11	0.513	47%	1800.80	0.0043	0.4433	5.3191	5.32
34	30.7				22	120	3	62.4	0.93	20	70	0.014				3970	1872	2098	21.8	1.06	0.496	44%	1741.96	0.0038	0.4470	5.3643	5.36
35	29.7				25	120	3	62.4	0.92	23	75	0.013				4090	1934	2156	22.8	1.01	0.480	41%	1685.88	0.0034	0.4504	5.4046	5.40
36	28.7				27	120	3	62.4	0.92	25	80	0.012				4210	1997	2213	23.8	0.97	0.465	39%	1632.43	0.0030	0.4534	5.4406	5.44
37	27.7				30	120	3	62.4	0.91	27	85	0.012				4330	2059	2271	24.8	0.93	0.451	37%	1581.49	0.0027	0.4561	5.4729	5.47
38	26.7	33	120	5	33	120	5	62.4	0.90	30	64	0.016				4450	2122	2328	25.8	0.89	0.437	34%	1532.93	0.0035	0.4595	5.5143	5.51
39	25.7				34	120	5	62.4	0.90	30	65	0.015				4570	2184	2386	26.8	0.86	0.424	33%	1486.64	0.0033	0.4628	5.5534	5.55
40	24.7				35	121	5	62.4	0.89	31	66	0.015				4691	2246	2445	27.8	0.83	0.411	31%	1442.49	0.0031	0.4659	5.5902	5.59
41	23.7				36	121	5	62.4	0.88	32	66	0.015				4813	2309	2504	28.8	0.80	0.399	29%	1400.37	0.0029	0.4688	5.6250	5.63
42	22.7				37	122	5	62.4	0.87	32	67	0.015				4934	2371	2563	29.8	0.77	0.388	28%	1360.18	0.0027	0.4715	5.6579	5.66
43	21.7				38	122	5	62.4	0.87	33	68	0.015				5057	2434	2623	30.8	0.75	0.377	26%	1321.81	0.0026	0.4741	5.6891	5.69
44	20.7				39	123	5	62.4	0.86	34	69	0.014				5179	2496	2683	31.8	0.72	0.366	25%	1285.17	0.0025	0.4765	5.7186	5.72
45	19.7				40	123	5	62.4	0.85	34	70	0.014				5302	2558	2744	32.8	0.70	0.356	24%	1250.16	0.0023	0.4789	5.7465	5.75
46	18.7				41	123	5	62.4	0.85	35	71	0.014				5426	2621	2805	33.8	0.68	0.347	22%	1216.69	0.0022	0.4811	5.7730	5.77
47	17.7				42	124	5	62.4	0.84	35	72	0.014				5550	2683	2866	34.8	0.66	0.338	21%	1184.68	0.0021	0.4832	5.7981	5.80
48	16.7				43	124	5	62.4	0.83	36	73	0.014				5674	2746	2928	35.8	0.64	0.329	20%	1154.06	0.0020	0.4852	5.8219	5.82
49	15.7				44	125	5	62.4	0.83	36	73	0.014				5799	2808	2991	36.8	0.63	0.320	19%	1124.75	0.0019	0.4870	5.8446	5.84
50	14.7				45	125	5	62.4	0.82	37	74	0.013				5924	2870	3054	37.8	0.61	0.312	19%	1096.67	0.0018	0.4888	5.8661	5.87

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
51	13.7				46	126	5	62.4	0.82	37	75	0.013				6050	2933	3117	38.8	0.59	0.305	18%	1069.77	0.0017	0.4905	5.8865	5.89
52	12.7				47	126	5	62.4	0.81	38	76	0.013				6176	2995	3180	39.8	0.58	0.297	17%	1043.98	0.0016	0.4922	5.9060	5.91
53	11.7				48	127	5	62.4	0.81	39	77	0.013				6302	3058	3245	40.8	0.56	0.290	16%	1019.25	0.0015	0.4937	5.9245	5.92
54	10.7				49	127	5	62.4	0.80	39	78	0.013				6429	3120	3309	41.8	0.55	0.284	15%	995.51	0.0015	0.4952	5.9422	5.94
55	9.7				50	127	5	62.4	0.80	40	79	0.013				6557	3182	3374	42.8	0.54	0.277	15%	972.73	0.0014	0.4966	5.9589	5.96
56	8.7				51	128	5	62.4	0.79	40	80	0.013				6684	3245	3440	43.8	0.53	0.271	14%	950.84	0.0013	0.4979	5.9749	5.97
57	7.7				52	128	5	62.4	0.79	41	80	0.012				6813	3307	3505	44.8	0.51	0.265	14%	929.80	0.0013	0.4992	5.9902	5.99
58	6.7				53	129	5	62.4	0.78	41	81	0.012				6941	3370	3572	45.8	0.50	0.259	13%	909.58	0.0012	0.5004	6.0047	6.00
59	5.7				54	129	5	62.4	0.78	42	82	0.012				7070	3432	3638	46.8	0.49	0.254	13%	890.13	0.0012	0.5016	6.0186	6.02
60	4.7				55	130	5	62.4	0.78	42	83	0.012				7200	3494	3706	47.8	0.48	0.248	12%	871.41	0.0011	0.5027	6.0319	6.03
61	3.7				56	130	5	62.4	0.77	43	84	0.012				7330	3557	3773	48.8	0.47	0.243	12%	853.38	0.0011	0.5037	6.0445	6.04
62	2.7				57	130	5	62.4	0.77	44	85	0.012				7460	3619	3841	49.8	0.46	0.238	11%	836.02	0.0010	0.5047	6.0566	6.06
63	1.7				58	131	5	62.4	0.77	44	86	0.012				7591	3682	3910	50.8	0.45	0.233	11%	819.29	0.0010	0.5057	6.0682	6.07
64	0.7				59	131	5	62.4	0.76	45	87	0.012				7723	3744	3979	51.8	0.44	0.229	10%	803.16	0.0009	0.5066	6.0792	6.08
65	-0.3				60	132	5	62.4	0.76	45	87	0.011				7854	3806	4048	52.8	0.44	0.224	10%	787.61	0.0009	0.5075	6.0898	6.09

81215044 - RTB
Wall 9.90L-B Sta. 3+70 (R2B-78-17)

59.3	Footing Elevation (ft)
3510	Footing Stress (psf)
22	Footing Width (ft)
100	Footing Length (ft)

4	Depth to Water (ft)

This is the effect of the fill to retaining wall subgrade

	Calculated
3.9	Settlement (in)

1. Per GDM Section 8.11.2.3.1 settlement estimated by Hough method can be reduced by 1.5 factor.
2.Approximately 2.60 inch of settlement is expected.
3. Settlement is calculated up to a depth below the bottom of wall where stress increase due to wall foundation load is less than than 10% of the existing overburden stress.
4. **"2C Layer"** is not present at this boring log.

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	59.3	6	120	4	6	120	4	0	2.00	12	45	0.022				120	0	120	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	58.3				5	118	4	0	2.00	11	43	0.023				238	0	238	1	22.00	0.982	1451%	3445.61	0.0277	0.0277	0.3323	0.33
3	57.3				5	115	4	0	2.00	9	41	0.024				353	0	353	2	11.00	0.962	958%	3377.38	0.0250	0.0527	0.6329	0.63
4	56.3				4	113	4	62.4	2.00	8	39	0.026				465	62	403	3	7.33	0.938	708%	3293.72	0.0248	0.0775	0.9303	0.93
5	55.3				3	110	4	62.4	2.00	7	37	0.027				575	125	450	4	5.50	0.912	557%	3200.49	0.0247	0.1022	1.2265	1.23
6	54.3				3	108	4	62.4	2.00	5	35	0.029				683	187	495	5	4.40	0.884	454%	3101.52	0.0247	0.1269	1.5231	1.52
7	53.3	2	105	4	2	105	4	62.4	1.94	4	33	0.031				788	250	538	6	3.67	0.855	381%	2999.52	0.0250	0.1519	1.8233	1.82
8	52.3				3	105	4	62.4	1.85	5	34	0.029				893	312	581	7	3.14	0.825	325%	2896.48	0.0227	0.1747	2.0959	2.10
9	51.3				3	105	4	62.4	1.76	6	36	0.028				998	374	623	8	2.75	0.796	280%	2793.89	0.0207	0.1954	2.3447	2.34
10	50.3	4	105	4	4	105	4	62.4	1.69	7	37	0.027				1103	437	666	9	2.44	0.767	244%	2692.84	0.0190	0.2144	2.5730	2.57
11	49.3				10	110	4	62.4	1.61	16	51	0.020				1213	499	713	10	2.20	0.739	214%	2594.13	0.0131	0.2275	2.7301	2.73
12	48.3				15	115	4	62.4	1.53	23	65	0.015				1328	562	766	11	2.00	0.712	188%	2498.30	0.0098	0.2373	2.8472	2.85
13	47.3	21	120	4	21	120	4	62.4	1.46	31	78	0.013				1448	624	824	12	1.83	0.685	166%	2405.75	0.0076	0.2449	2.9388	2.94
14	46.3				21	120	4	62.4	1.39	30	76	0.013				1568	686	881	13	1.69	0.660	148%	2316.69	0.0074	0.2523	3.0273	3.03
15	45.3				22	120	4	62.4	1.33	29	74	0.013				1688	749	939	14	1.57	0.636	132%	2231.27	0.0071	0.2594	3.1125	3.11
16	44.3	22	120	2	22	120	2	62.4	1.28	28	97	0.010				1808	811	996	15	1.47	0.612	119%	2149.53	0.0051	0.2645	3.1743	3.17
17	43.3				24	120	2	62.4	1.24	29	99	0.010				1928	874	1054	16	1.38	0.590	107%	2071.46	0.0048	0.2693	3.2313	3.23
18	42.3				25	120	2	62.4	1.20	30	102	0.010				2048	936	1112	17	1.29	0.569	98%	1997.00	0.0044	0.2737	3.2840	3.28
19	41.3				27	120	2	62.4	1.16	31	104	0.010				2168	998	1169	18	1.22	0.549	89%	1926.05	0.0041	0.2777	3.3327	3.33
20	40.3	28	120	2	28	120	2	62.4	1.13	32	107	0.009				2288	1061	1227	19	1.16	0.529	81%	1858.51	0.0038	0.2815	3.3777	3.38
21	39.3				30	122	2	62.4	1.11	33	111	0.009				2410	1123	1286	20	1.10	0.511	74%	1794.24	0.0034	0.2849	3.4187	3.42
22	38.3				32	124	2	62.4	1.08	35	115	0.009				2534	1186	1348	21	1.05	0.494	68%	1733.12	0.0031	0.2880	3.4561	3.46
23	37.3				34	126	2	62.4	1.06	36	120	0.008				2660	1248	1412	22	1.00	0.477	63%	1674.98	0.0028	0.2909	3.4903	3.49
24	36.3				36	128	2	62.4	1.04	37	124	0.008				2788	1310	1477	23	0.96	0.461	58%	1619.70	0.0026	0.2934	3.5214	3.52
25	35.3	38	130	2	38	130	2	62.4	1.02	39	128	0.008				2918	1373	1545	24	0.92	0.446	54%	1567.13	0.0024	0.2958	3.5498	3.55
26	34.3				50	130	2	62.4	1.01	51	172	0.006				3048	1435	1612	25	0.88	0.432	50%	1517.12	0.0017	0.2975	3.5699	3.57
27	33.3				63	130	2	62.4	1.00	63	226	0.004				3178	1498	1680	26	0.85	0.419	46%	1469.54	0.0012	0.2987	3.5843	3.58
28	32.3				75	130	2	62.4	0.98	74	293	0.003				3308	1560	1748	27	0.81	0.406	43%	1424.25	0.0009	0.2996	3.5949	3.59
29	31.3				88	130	2	62.4	0.97	85	375	0.003				3438	1622	1815	28	0.79	0.393	40%	1381.14	0.0007	0.3002	3.6028	3.60
30	30.3	100	130	2	100	130	2	62.4	0.96	96	474	0.002				3568	1685	1883	29	0.76	0.382	38%	1340.08	0.0005	0.3007	3.6087	3.61
31	29.3				100	130	2	62.4	0.95	95	464	0.002				3698	1747	1950	30	0.73	0.371	35%	1300.95	0.0005	0.3012	3.6144	3.61
32	28.3				100	130	2	62.4	0.94	94	456	0.002				3828	1810	2018	31	0.71	0.360	33%	1263.66	0.0005	0.3017	3.6200	3.62
33	27.3				100	130	2	62.4	0.93	93	447	0.002				3958	1872	2086	32	0.69	0.350	31%	1228.08	0.0004	0.3021	3.6254	3.63
34	26.3				100	130	2	62.4	0.93	93	439	0.002				4088	1934	2153	33	0.67	0.340	29%	1194.14	0.0004	0.3026	3.6306	3.63
35	25.3	100	130	3	100	130	3	62.4	0.92	92	331	0.003				4218	1997	2221	34	0.65	0.331	28%	1161.73	0.0006	0.3031	3.6373	3.64
36	24.3				89	130	3	62.4	0.91	81	271	0.004				4348	2059	2288	35	0.63	0.322	26%	1130.77	0.0006	0.3037	3.6450	3.64
37	23.3				79	130	3	62.4	0.90	71	221	0.005				4478	2122	2356	36	0.61	0.314	25%	1101.18	0.0008	0.3045	3.6540	3.65
38	22.3				68	130	3	62.4	0.89	61	181	0.006				4608	2184	2424	37	0.59	0.306	23%	1072.89	0.0009	0.3054	3.6646	3.66
39	21.3				58	130	3	62.4	0.88	51	147	0.007				4738	2246	2491	38	0.58	0.298	22%	1045.82	0.0010	0.3064	3.6770	3.68
40	20.3	47	130	5	47	130	5	62.4	0.88	41	81	0.012				4868	2309	2559	39	0.56	0.291	21%	1019.91	0.0018	0.3082	3.6986	3.70
41	19.3				49	130	5	62.4	0.87	43	83	0.012				4998	2371	2626	40	0.55	0.284	20%	995.09	0.0017	0.3099	3.7187	3.72
42	18.3				51	130	5	62.4	0.86	44	86	0.012				5128	2434	2694	41	0.54	0.277	19%	971.31	0.0016	0.3114	3.7374	3.74
43	17.3				54	130	5	62.4	0.85	46	88	0.011				5258	2496	2762	42	0.52	0.270	18%	948.50	0.0015	0.3129	3.7548	3.75
44	16.3				56	130	5	62.4	0.84	47	91	0.011				5388	2558	2829	43	0.51	0.264	17%	926.63	0.0014	0.3143	3.7711	3.77
45	15.3	58	130	5	58	130	5	62.4	0.84	49	93	0.011				5518	2621	2897	44	0.50	0.258	16%	905.63	0.0013	0.3155	3.7863	3.79
46	14.3				66	130	5	62.4	0.83	55	104	0.010				5648	2683	2964	45	0.49	0.252	16%	885.47	0.0011	0.3166	3.7994	3.80
47	13.3				75	130	5	62.4	0.82	62	115	0.009				5778	2746	3032	46	0.48	0.247	15%	866.09	0.0009	0.3176	3.8108	3.81
48	12.3				83	130	5	62.4	0.82	68	127	0.008				5908	2808	3100	47	0.47	0.241	14%	847.47	0.0008	0.3184	3.8207	3.82
49	11.3				92	130	5	62.4	0.81	74	138	0.007				6038	2870	3167	48	0.46	0.236	14%	829.56	0.0007	0.3191	3.8295	3.83
50	10.3	100	130	4	100	130	4	62.4	0.81	81	194	0.005				6168	2933	3235	49	0.45	0.231	13%	812.33	0.0005	0.3196	3.8355	3.84

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
51	9.3				91	130	4	62.4	0.80	73	174	0.006				6298	2995	3302	50	0.44	0.227	13%	795.74	0.0005	0.3202	3.8419	3.84
52	8.3				83	130	4	62.4	0.80	66	156	0.006				6428	3058	3370	51	0.43	0.222	12%	779.76	0.0006	0.3207	3.8489	3.85
53	7.3				74	130	4	62.4	0.79	59	138	0.007				6558	3120	3438	52	0.42	0.218	12%	764.37	0.0006	0.3214	3.8565	3.86
54	6.3				66	130	4	62.4	0.79	52	122	0.008				6688	3182	3505	53	0.42	0.214	11%	749.53	0.0007	0.3221	3.8648	3.86
55	5.3	57	130	5	57	130	5	62.4	0.78	45	87	0.012				6818	3245	3573	54	0.41	0.209	11%	735.21	0.0009	0.3230	3.8760	3.88
56	4.3				56	130	5	62.4	0.78	44	85	0.012				6948	3307	3640	55	0.40	0.206	10%	721.40	0.0009	0.3239	3.8871	3.89
57	3.3				55	130	5	62.4	0.78	43	83	0.012				7078	3370	3708	56	0.39	0.202	10%	708.07	0.0009	0.3248	3.8980	3.90
58	2.3				54	130	5	62.4	0.77	42	82	0.012				7208	3432	3776	57	0.39	0.198	10%	695.20	0.0009	0.3257	3.9088	3.91
59	1.3				53	130	5	62.4	0.77	41	80	0.012				7338	3494	3843	58	0.38	0.195	9%	682.76	0.0009	0.3266	3.9194	3.92
60	0.3	52	130	5	52	130	5	62.4	0.77	40	79	0.013				7468	3557	3911	59	0.37	0.191	9%	670.75	0.0009	0.3275	3.9298	3.93
61	-0.7				62	130	5	62.4	0.76	47	90	0.011				7598	3619	3978	60	0.37	0.188	9%	659.13	0.0007	0.3282	3.9387	3.94
62	-1.7				71	130	5	62.4	0.76	54	102	0.010				7728	3682	4046	61	0.36	0.185	8%	647.89	0.0006	0.3289	3.9463	3.95
63	-2.7				81	130	5	62.4	0.75	61	114	0.009				7858	3744	4114	62	0.35	0.181	8%	637.01	0.0005	0.3294	3.9529	3.95
64	-3.7				90	130	5	62.4	0.75	68	126	0.008				7988	3806	4181	63	0.35	0.178	8%	626.48	0.0005	0.3299	3.9586	3.96
65	-4.7	100	130	4	100	130	4	62.4	0.74	74	177	0.006				8118	3869	4249	64	0.34	0.176	8%	616.29	0.0003	0.3302	3.9626	3.96

81215044 - RTB
Wall 9.90L-B Sta. 5+20 (GEO-37)

53.5	Footing Elevation (ft)
2925	Footing Stress (psf)
23	Footing Width (ft)
100	Footing Length (ft)

9	Depth to Water (ft)

This is the effect of the fill to retaininght wall subgrade

	Calculated
7.6	Settlement (in)

1. Per GDM Section 8.11.2.3.1 settlement estimated by Hough method can be reduced by 1.5 factor.
2.Approximately **5** inch of settlement is expected.
3. Settlement is calculated up to a depth below the bottom of wall where stress increase due to wall foundation load is less than than 10% of the existing overburden stress.
4. **"2C Layer"** has PI = 48, clay like behavior, and will consolidate.I used RFP provided consol data.

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	53.5	50	130	1	50	130	1	0	2.00	100	991	0.001				130	0	130	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	52.5				40	127	1	0	2.00	81	605	0.002				257	0	257	1	23.00	0.982	1118%	2873.40	0.0018	0.0018	0.0215	0.02
3	51.5				31	124	1	0	2.00	62	348	0.003				381	0	381	2	11.50	0.964	740%	2820.03	0.0027	0.0045	0.0534	0.05
4	50.5				21	121	1	0	2.02	43	191	0.005				502	0	502	3	7.67	0.942	549%	2754.39	0.0043	0.0087	0.1044	0.10
5	49.5				12	118	1	0	1.77	21	89	0.011				620	0	620	4	5.75	0.917	432%	2681.01	0.0082	0.0169	0.2024	0.20
6	48.5	2	115	4	2	115	4	0	1.58	3	32	0.032				735	0	735	5	4.60	0.890	354%	2602.81	0.0208	0.0376	0.4516	0.45
7	47.5				2	115	4	0	1.43	3	31	0.032				850	0	850	6	3.83	0.862	297%	2521.91	0.0192	0.0568	0.6818	0.68
8	46.5	2	115	4	2	115	4	0	1.31	3	31	0.032				965	0	965	7	3.29	0.834	253%	2439.87	0.0177	0.0746	0.8946	0.89
9	45.5				2	115	4	62.4	1.26	3	31	0.033				1080	62	1018	8	2.88	0.806	218%	2357.87	0.0169	0.0915	1.0979	1.10
10	44.5				2	115	4	62.4	1.23	2	31	0.033				1195	125	1070	9	2.56	0.778	191%	2276.79	0.0162	0.1077	1.2919	1.29
11	43.5	2	115	4	2	115	4	62.4	1.19	2	31	0.033				1310	187	1123	10	2.30	0.751	168%	2197.27	0.0154	0.1231	1.4769	1.48
12	42.5				2	110	4	62.4	1.16	2	30	0.034				1420	250	1170	11	2.09	0.725	149%	2119.79	0.0152	0.1382	1.6588	1.66
13	41.5	1	105	5	1	105	5	62.4	1.14	1	25	0.130	0.130	1.085	0.040	1525	312	1213	12	1.92	0.699	134%	2044.68	0.0558	0.1940	2.3281	2.33
14	40.5				2	105	5	62.4	1.12	2	26	0.130	0.130	1.085	0.040	1630	374	1256	13	1.77	0.674	121%	1972.16	0.0533	0.2473	2.9678	2.97
15	39.5				3	105	5	62.4	1.10	3	27	0.130	0.130	1.085	0.040	1735	437	1298	14	1.64	0.650	110%	1902.36	0.0509	0.2983	3.5791	3.58
16	38.5				3	105	5	62.4	1.09	4	28	0.130	0.130	1.085	0.040	1840	499	1341	15	1.53	0.627	100%	1835.35	0.0487	0.3469	4.1634	4.16
17	37.5	4	105	5	4	105	5	62.4	1.07	4	29	0.130	0.130	1.085	0.040	1945	562	1383	16	1.44	0.606	91%	1771.15	0.0465	0.3935	4.7219	4.72
18	36.5				6	108	5	62.4	1.06	7	32	0.130	0.130	1.085	0.040	2053	624	1429	17	1.35	0.585	83%	1709.74	0.0444	0.4379	5.2549	5.25
19	35.5				9	111	5	62.4	1.04	9	35	0.130	0.130	1.085	0.040	2164	686	1478	18	1.28	0.564	76%	1651.06	0.0424	0.4803	5.7632	5.76
20	34.5				11	114	5	62.4	1.03	12	38	0.130	0.130	1.085	0.040	2278	749	1529	19	1.21	0.545	70%	1595.05	0.0403	0.5206	6.2472	6.25
21	33.5				14	117	5	62.4	1.01	14	41	0.130	0.130	1.085	0.040	2395	811	1584	20	1.15	0.527	64%	1541.62	0.0384	0.5590	6.7078	6.71
22	32.5	16	120	4	16	120	4	62.4	1.00	16	52	0.019				2515	874	1641	21	1.10	0.510	59%	1490.67	0.0054	0.5644	6.7729	6.77
23	31.5				16	120	4	62.4	0.99	16	52	0.019				2635	936	1699	22	1.05	0.493	55%	1442.11	0.0052	0.5696	6.8350	6.84
24	30.5				16	120	4	62.4	0.98	16	51	0.019				2755	998	1757	23	1.00	0.477	51%	1395.82	0.0049	0.5745	6.8943	6.89
25	29.5				16	120	4	62.4	0.97	16	51	0.019				2875	1061	1814	24	0.96	0.462	47%	1351.71	0.0047	0.5792	6.9508	6.95
26	28.5				16	120	4	62.4	0.96	16	51	0.019				2995	1123	1872	25	0.92	0.448	44%	1309.66	0.0045	0.5837	7.0047	7.00
27	27.5				17	120	4	62.4	0.95	16	51	0.020				3115	1186	1929	26	0.88	0.434	41%	1269.58	0.0043	0.5880	7.0561	7.06
28	26.5				17	120	4	62.4	0.95	16	51	0.020				3235	1248	1987	27	0.85	0.421	38%	1231.37	0.0041	0.5921	7.1052	7.11
29	25.5				17	120	4	62.4	0.94	16	51	0.020				3355	1310	2045	28	0.82	0.409	36%	1194.92	0.0039	0.5960	7.1522	7.15
30	24.5				17	120	4	62.4	0.93	16	51	0.020				3475	1373	2102	29	0.79	0.397	33%	1160.15	0.0037	0.5998	7.1971	7.20
31	23.5				17	120	4	62.4	0.92	16	51	0.020				3595	1435	2160	30	0.77	0.385	31%	1126.97	0.0036	0.6033	7.2400	7.24
32	22.5	17	120	4	17	120	4	62.4	0.92	16	51	0.020				3715	1498	2217	31	0.74	0.374	29%	1095.29	0.0034	0.6068	7.2810	7.28
33	21.5				23	120	4	62.4	0.91	21	60	0.017				3835	1560	2275	32	0.72	0.364	28%	1065.03	0.0028	0.6096	7.3146	7.31
34	20.5				29	120	4	62.4	0.90	26	69	0.015				3955	1622	2333	33	0.70	0.354	26%	1036.12	0.0023	0.6119	7.3425	7.34
35	19.5				34	120	4	62.4	0.90	31	78	0.013				4075	1685	2390	34	0.68	0.345	25%	1008.48	0.0020	0.6138	7.3661	7.37
36	18.5	40	120	4	40	120	4	62.4	0.89	36	87	0.011				4195	1747	2448	35	0.66	0.336	23%	982.04	0.0017	0.6155	7.3862	7.39
37	17.5				41	120	4	62.4	0.88	36	88	0.011				4315	1810	2506	36	0.64	0.327	22%	956.75	0.0016	0.6171	7.4053	7.41
38	16.5				42	121	4	62.4	0.87	36	89	0.011				4436	1872	2564	37	0.62	0.319	21%	932.53	0.0015	0.6186	7.4234	7.42
39	15.5				43	121	4	62.4	0.87	37	90	0.011				4558	1934	2623	38	0.61	0.311	20%	909.33	0.0014	0.6201	7.4406	7.44
40	14.5				43	122	4	62.4	0.86	37	91	0.011				4679	1997	2682	39	0.59	0.303	19%	887.11	0.0014	0.6214	7.4570	7.46
41	13.5				44	122	4	62.4	0.85	38	92	0.011				4801	2059	2742	40	0.58	0.296	18%	865.79	0.0013	0.6227	7.4725	7.47
42	12.5				45	123	4	62.4	0.85	38	93	0.011				4924	2122	2802	41	0.56	0.289	17%	845.35	0.0012	0.6239	7.4873	7.49
43	11.5				46	123	4	62.4	0.84	39	94	0.011				5047	2184	2863	42	0.55	0.282	16%	825.73	0.0012	0.6251	7.5014	7.50
44	10.5				47	123	4	62.4	0.83	39	95	0.011				5170	2246	2924	43	0.53	0.276	16%	806.90	0.0011	0.6262	7.5149	7.51
45	9.5				48	124	4	62.4	0.83	40	95	0.010				5294	2309	2985	44	0.52	0.270	15%	788.80	0.0011	0.6273	7.5277	7.53
46	8.5				49	124	4	62.4	0.82	40	96	0.010				5418	2371	3047	45	0.51	0.264	14%	771.41	0.0010	0.6283	7.5399	7.54
47	7.5				49	125	4	62.4	0.82	40	97	0.010				5543	2434	3109	46	0.50	0.258	14%	754.69	0.0010	0.6293	7.5515	7.55
48	6.5				50	125	4	62.4	0.81	41	98	0.010				5668	2496	3172	47	0.49	0.253	13%	738.61	0.0009	0.6302	7.5626	7.56
49	5.5				51	125	4	62.4	0.81	41	99	0.010				5793	2558	3235	48	0.48	0.247	12%	723.12	0.0009	0.6311	7.5733	7.57
50	4.5				52	126	4	62.4	0.80	42	100	0.010				5919	2621	3299	49	0.47	0.242	12%	708.22	0.0008	0.6320	7.5834	7.58

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
51	3.5				53	126	4	62.4	0.80	42	101	0.010				6046	2683	3363	50	0.46	0.237	11%	693.86	0.0008	0.6328	7.5931	7.59
52	2.5				54	127	4	62.4	0.79	43	102	0.010				6172	2746	3427	51	0.45	0.232	11%	680.02	0.0008	0.6335	7.6024	7.60
53	1.5				55	127	4	62.4	0.79	43	103	0.010				6300	2808	3492	52	0.44	0.228	11%	666.67	0.0007	0.6343	7.6112	7.61
54	0.5				55	128	4	62.4	0.78	44	104	0.010				6427	2870	3557	53	0.43	0.224	10%	653.80	0.0007	0.6350	7.6197	7.62
55	-0.5				56	128	4	62.4	0.78	44	105	0.010				6555	2933	3622	54	0.43	0.219	10%	641.38	0.0007	0.6357	7.6278	7.63
56	-1.5				57	128	4	62.4	0.78	44	106	0.009				6684	2995	3689	55	0.42	0.215	9%	629.39	0.0006	0.6363	7.6356	7.64
57	-2.5				58	129	4	62.4	0.77	45	107	0.009				6813	3058	3755	56	0.41	0.211	9%	617.81	0.0006	0.6369	7.6430	7.64
58	-3.5				59	129	4	62.4	0.77	45	108	0.009				6942	3120	3822	57	0.40	0.207	9%	606.62	0.0006	0.6375	7.6501	7.65
59	-4.5				60	130	4	62.4	0.77	46	109	0.009				7072	3182	3889	58	0.40	0.204	8%	595.81	0.0006	0.6381	7.6570	7.66
60	-5.5				61	130	4	62.4	0.76	46	110	0.009				7202	3245	3957	59	0.39	0.200	8%	585.35	0.0005	0.6386	7.6635	7.66
61	-6.5				61	131	4	62.4	0.76	47	111	0.009				7332	3307	4025	60	0.38	0.197	8%	575.24	0.0005	0.6392	7.6698	7.67
62	-7.5				62	131	4	62.4	0.75	47	111	0.009				7463	3370	4094	61	0.38	0.193	8%	565.45	0.0005	0.6397	7.6759	7.68
63	-8.5				63	131	4	62.4	0.75	47	112	0.009				7595	3432	4163	62	0.37	0.190	7%	555.97	0.0005	0.6401	7.6817	7.68
64	-9.5				64	132	4	62.4	0.75	48	113	0.009				7727	3494	4232	63	0.37	0.187	7%	546.80	0.0005	0.6406	7.6873	7.69
65	-10.5				65	132	4	62.4	0.74	48	113	0.009				7859	3557	4302	64	0.36	0.184	7%	537.91	0.0005	0.6411	7.6927	7.69

81215044 - RTB
Wall 9.90L-B Sta. 6+20 (GEO 38)

58.5	Footing Elevation (ft)
1950	Footing Stress (psf)
11.5	Footing Width (ft)
100	Footing Length (ft)

18	Depth to Water (ft)

This is the effect of the fill to retainingt wall subgrade

	Calculated
2.4	Settlement (in)

1. Per GDM Section 8.11.2.3.1 settlement estimated by Hough method can be reduced by 1.5 factor.
2.Approximately **1.6** inch of settlement is expected.
3. Settlement is calculated up to a depth below the bottom of wall where stress increase due to wall foundation load is less than than 10% of the existing overburden stress.
4. **"2C Layer"** has PI = 51, clay like behavior, and will consolidate. I used RFP provided consol data.

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c $1 + e_o$ (cohesive soils)	e_o	C_r	Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
1	58.6	14	115	4	14	115	4	0	2.00	28	73	0.014				115	0	115	N/A	N/A	0.000	0%	0.00	0.0000	0.0000	0.0000	0.00
2	57.6				14	115	4	0	2.00	28	73	0.014				230	0	230	0.9	12.78	0.968	821%	1887.92	0.0132	0.0132	0.1590	0.16
3	56.6	14	115	4	14	115	4	0	2.00	28	73	0.014				345	0	345	1.9	6.05	0.922	521%	1797.43	0.0109	0.0241	0.2897	0.29
4	55.6				14	115	4	0	2.00	28	73	0.014				460	0	460	2.9	3.97	0.868	368%	1692.15	0.0092	0.0334	0.4002	0.40
5	54.6				14	115	4	0	1.86	26	69	0.014				575	0	575	3.9	2.95	0.812	275%	1582.82	0.0083	0.0417	0.5000	0.50
6	53.6	14	115	4	14	115	4	0	1.65	23	64	0.016				690	0	690	4.9	2.35	0.757	214%	1475.35	0.0078	0.0495	0.5935	0.59
7	52.6				16	115	4	0	1.48	23	64	0.016				805	0	805	5.9	1.95	0.704	171%	1373.00	0.0068	0.0563	0.6751	0.68
8	51.6	17	115	4	17	115	4	0	1.35	23	64	0.016				920	0	920	6.9	1.67	0.655	139%	1277.40	0.0059	0.0622	0.7464	0.75
9	50.6				14	112	4	0	1.25	17	54	0.019				1032	0	1032	7.9	1.46	0.610	115%	1189.18	0.0062	0.0684	0.8211	0.82
10	49.6				10	108	4	0	1.18	12	45	0.022				1140	0	1140	8.9	1.29	0.568	97%	1108.39	0.0065	0.0749	0.8990	0.90
11	48.6	7	105	5	7	105	5	0	1.13	8	33	0.030				1245	0	1245	9.9	1.16	0.531	83%	1034.74	0.0079	0.0828	0.9937	0.99
12	47.6				7	105	5	0	1.08	7	32	0.031				1350	0	1350	10.9	1.06	0.496	72%	967.76	0.0073	0.0901	1.0811	1.08
13	46.6	6	105	5	6	105	5	0	1.05	6	31	0.130	0.130	1.085	0.040	1455	0	1455	11.9	0.97	0.465	62%	906.91	0.0274	0.1174	1.4094	1.41
14	45.6				11	108	5	0	1.02	11	37	0.130	0.130	1.085	0.040	1563	0	1563	12.9	0.89	0.437	54%	851.63	0.0246	0.1420	1.7040	1.70
15	44.6				15	112	5	0	1.00	15	43	0.130	0.130	1.085	0.040	1675	0	1675	13.9	0.83	0.411	48%	801.38	0.0221	0.1641	1.9689	1.97
16	43.6	20	115	4	20	115	4	0	0.98	20	58	0.017				1790	0	1790	14.9	0.77	0.388	42%	755.66	0.0027	0.1667	2.0008	2.00
17	42.6				16	115	4	0	0.96	15	50	0.020				1905	0	1905	15.9	0.72	0.366	37%	713.98	0.0028	0.1695	2.0339	2.03
18	41.6				12	115	4	62.4	0.95	11	43	0.023				2020	62	1958	16.9	0.68	0.347	33%	675.94	0.0030	0.1725	2.0695	2.07
19	40.6				7	115	4	62.4	0.94	7	37	0.027				2135	125	2010	17.9	0.64	0.329	30%	641.14	0.0032	0.1757	2.1083	2.11
20	39.6	3	115	4	3	115	4	62.4	0.94	3	31	0.032				2250	187	2063	18.9	0.61	0.312	27%	609.26	0.0036	0.1793	2.1516	2.15
21	38.6				4	115	4	62.4	0.93	3	32	0.031				2365	250	2115	19.9	0.58	0.297	25%	579.99	0.0033	0.1826	2.1912	2.19
22	37.6				4	115	4	62.4	0.92	4	33	0.031				2480	312	2168	20.9	0.55	0.284	22%	553.06	0.0030	0.1856	2.2274	2.23
23	36.6				5	115	4	62.4	0.92	4	33	0.030				2595	374	2221	21.9	0.53	0.271	20%	528.24	0.0028	0.1884	2.2607	2.26
24	35.6				5	115	4	62.4	0.91	5	34	0.029				2710	437	2273	22.9	0.50	0.259	19%	505.32	0.0025	0.1909	2.2912	2.29
25	34.6	6	115	4	6	115	4	62.4	0.90	5	35	0.029				2825	499	2326	23.9	0.48	0.248	17%	484.12	0.0023	0.1933	2.3194	2.32
26	33.6				13	118	4	62.4	0.90	12	45	0.022				2943	562	2381	24.9	0.46	0.238	16%	464.46	0.0017	0.1950	2.3402	2.34
27	32.6				20	121	4	62.4	0.89	18	55	0.018				3064	624	2440	25.9	0.44	0.229	15%	446.20	0.0013	0.1964	2.3563	2.36
28	31.6				27	124	4	62.4	0.88	24	65	0.015				3188	686	2502	26.9	0.43	0.220	13%	429.22	0.0011	0.1974	2.3689	2.37
29	30.6				34	127	4	62.4	0.87	30	76	0.013				3315	749	2566	27.9	0.41	0.212	12%	413.40	0.0009	0.1983	2.3792	2.38
30	29.6	41	130	2	41	130	2	62.4	0.87	36	118	0.008				3445	811	2634	28.9	0.40	0.204	12%	398.63	0.0005	0.1988	2.3854	2.39
31	28.6				61	130	2	62.4	0.86	52	177	0.006				3575	874	2701	29.9	0.38	0.197	11%	384.82	0.0003	0.1991	2.3893	2.39
32	27.6				80	130	2	62.4	0.85	68	259	0.004				3705	936	2769	30.9	0.37	0.191	10%	371.90	0.0002	0.1993	2.3919	2.39
33	26.6	100	130	2	100	130	2	62.4	0.84	84	369	0.003				3835	998	2837	31.9	0.36	0.185	9%	359.78	0.0001	0.1995	2.3935	2.39
34	25.6				100	130	2	62.4	0.84	84	364	0.003				3965	1061	2904	32.9	0.35	0.179	9%	348.40	0.0001	0.1996	2.3952	2.40
35	24.6				100	131	2	62.4	0.83	83	359	0.003				4096	1123	2973	33.9	0.34	0.173	8%	337.70	0.0001	0.1997	2.3967	2.40
36	23.6				100	131	2	62.4	0.82	82	354	0.003				4227	1186	3041	34.9	0.33	0.168	8%	327.62	0.0001	0.1999	2.3982	2.40
37	22.6				100	131	2	62.4	0.82	82	349	0.003				4358	1248	3110	35.9	0.32	0.163	7%	318.13	0.0001	0.2000	2.3997	2.40
38	21.6				100	131	2	62.4	0.81	81	344	0.003				4489	1310	3179	36.9	0.31	0.159	7%	309.17	0.0001	0.2001	2.4011	2.40
39	20.6				100	132	2	62.4	0.81	81	340	0.003				4621	1373	3248	37.9	0.30	0.154	7%	300.70	0.0001	0.2002	2.4024	2.40
40	19.6				100	132	2	62.4	0.80	80	337	0.003				4753	1435	3317	38.9	0.30	0.150	6%	292.68	0.0001	0.2003	2.4038	2.40
41	18.6				100	132	2	62.4	0.80	80	333	0.003				4885	1498	3387	39.9	0.29	0.146	6%	285.10	0.0001	0.2004	2.4050	2.41
42	17.6				100	132	2	62.4	0.79	79	330	0.003				5017	1560	3457	40.9	0.28	0.143	6%	277.90	0.0001	0.2005	2.4062	2.41
43	16.6				100	133	2	62.4	0.79	79	327	0.003				5150	1622	3527	41.9	0.27	0.139	5%	271.08	0.0001	0.2006	2.4074	2.41
44	15.6				100	133	2	62.4	0.78	78	324	0.003				5283	1685	3598	42.9	0.27	0.136	5%	264.59	0.0001	0.2007	2.4086	2.41
45	14.6				100	133	2	62.4	0.78	78	321	0.003				5416	1747	3669	43.9	0.26	0.133	5%	258.42	0.0001	0.2008	2.4097	2.41
46	13.6				100	134	2	62.4	0.77	78	319	0.003				5550	1810	3740	44.9	0.26	0.130	5%	252.55	0.0001	0.2009	2.4107	2.41
47	12.6				100	134	2	62.4	0.77	77	316	0.003				5683	1872	3811	45.9	0.25	0.127	4%	246.96	0.0001	0.2010	2.4118	2.41
48	11.6				100	134	2	62.4	0.77	77	313	0.003				5817	1934	3883	46.9	0.25	0.124	4%	241.63	0.0001	0.2011	2.4128	2.41
49	10.6				100	134	2	62.4	0.76	76	311	0.003				5952	1997	3955	47.9	0.24	0.121	4%	236.54	0.0001	0.2011	2.4138	2.41
50	9.6				100	135	2	62.4	0.76	76	308	0.003				6086	2059	4027	48.9	0.24	0.119	4%	231.68	0.0001	0.2012	2.4147	2.41

Depth (ft)	ELEV. (ft)	SPT N Field	Soil γ_{sat} (pcf)	Material #	SPT N Iterated	Iterated γ_{sat} (pcf)	Iterated Material #	Water γ_w (pcf)	N'/N FHWA HI-88-009	SPT N' Corrected	Hough C'	Hough 1/C'	C_c / $1 + e_o$ (cohesive soils)	e_o	C_r	Depth Total Stress (psf)	Pore Pressure (psf)	Effective Stress (psf)	Below Footing (ft)	B/Z	I	Δσ/ Total Stress	Stress Change (psf)	Incr. Settlement (ft)	Cumm. Settlement (ft)	Cumm. Settlement (in)	Rounded Settlement (in)
51	8.6				100	135	2	62.4	0.75	76	305	0.003				6221	2122	4100	49.9	0.23	0.116	4%	227.04	0.0001	0.2013	2.4156	2.42
52	7.6				100	135	2	62.4	0.75	75	302	0.003				6356	2184	4172	50.9	0.23	0.114	4%	222.60	0.0001	0.2014	2.4165	2.42
53	6.6				100	135	2	62.4	0.74	75	298	0.003				6492	2246	4245	51.9	0.22	0.112	3%	218.35	0.0001	0.2014	2.4174	2.42
54	5.6				100	136	2	62.4	0.74	74	294	0.003				6627	2309	4319	52.9	0.22	0.110	3%	214.27	0.0001	0.2015	2.4183	2.42
55	4.6				100	136	2	62.4	0.73	73	290	0.003				6763	2371	4392	53.9	0.21	0.108	3%	210.37	0.0001	0.2016	2.4191	2.42
56	3.6				100	136	2	62.4	0.73	73	286	0.003				6900	2434	4466	54.9	0.21	0.106	3%	206.62	0.0001	0.2017	2.4199	2.42
57	2.6				100	136	2	62.4	0.72	72	281	0.004				7036	2496	4540	55.9	0.21	0.104	3%	203.03	0.0001	0.2017	2.4207	2.42
58	1.6				100	137	2	62.4	0.71	71	276	0.004				7173	2558	4614	56.9	0.20	0.102	3%	199.58	0.0001	0.2018	2.4215	2.42
59	0.6				100	137	2	62.4	0.70	70	271	0.004				7310	2621	4689	57.9	0.20	0.101	3%	196.26	0.0001	0.2019	2.4223	2.42
60	-0.4				100	137	2	62.4	0.69	69	265	0.004				7447	2683	4764	58.9	0.20	0.099	3%	193.07	0.0001	0.2019	2.4231	2.42
61	-1.4				100	138	2	62.4	0.68	68	260	0.004				7585	2746	4839	59.9	0.19	0.097	3%	190.00	0.0001	0.2020	2.4239	2.42
62	-2.4				100	138	2	62.4	0.67	68	254	0.004				7723	2808	4915	60.9	0.19	0.096	2%	187.05	0.0001	0.2021	2.4246	2.42
63	-3.4				100	138	2	62.4	0.66	67	249	0.004				7861	2870	4990	61.9	0.19	0.094	2%	184.20	0.0001	0.2021	2.4254	2.43
64	-4.4				100	138	2	62.4	0.66	66	245	0.004				7999	2933	5066	62.9	0.18	0.093	2%	181.46	0.0001	0.2022	2.4261	2.43
65	-5.4				100	139	2	62.4	0.65	65	242	0.004				8138	2995	5143	63.9	0.18	0.092	2%	178.81	0.0001	0.2022	2.4269	2.43

Date(s) Drilled	10/30/07	Logged By	SRR	Checked By	KGO
Drilling Contractor	Geologic Drill	Drilling Method	Hollow-stem Auger	Sampling Methods	SPT
Auger Data	3¼-inch OD	Hammer Data	140 lb hammer/30 in drop rope and cathead	Drilling Equipment	Deep Rock XL Rig
Total Depth (ft)	40	Surface Elevation (ft)	57.0	Groundwater Elevation (ft)	Not Encountered
Vertical Datum	NAVD 88	Datum/ System	WSDOT Project Coordinates	Easting(x): Northing(y):	1635801.6 538047.2

Elevation feet	Depth feet	SAMPLES Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							AC	2 inches asphalt concrete pavement			
								CR	2 inches crushed rock base course			
								SM	Brown silty fine to medium sand with gravel (medium dense, moist) (fill)			
55			6	26	1			SM	Gray silty fine sand with occasional gravel (medium dense, moist)	6		
	5		18	15	2							
50			18	5	3			SP-SM	Gray fine to medium sand with silt (loose, moist)	14		%F = 9
	10		18	2	4			SM	Gray silty fine to medium sand with occasional gravel (very loose, wet) (alluvium)			Oxidation staining
									Layer of sandy silt			
45			18	2	5							
	15		18	1/12"	6			ML	Gray silt with organics (very stiff, moist)	40		Oxidation staining AL
40												
			18	4	7				Grades to soft			
	20											
								SM	Brown silty fine to coarse sand with gravel (medium dense, wet)			
35												
			18	16	8							
25												
30												
			18	50/1"	9							Pounding on rock Heave
	30											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING GEO-37

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-38
Sheet 1 of 2

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Elevation feet	Depth feet	SAMPLES Interval Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	30										
25											
		6	17	10							
	35										Heave
20							SP-SM	Gray fine to medium sand with silt (dense, moist) (advance outwash)			
		12	40	11							
	40										
15											
	45										
10											
	50										
5											
	55										
0											
	60										
-5											
	65										
-10											

V6_GTBORING P:\0\0180197\01\FINALS\018019701.GPJ GEIV6_1.GDT 6/9/08

LOG OF BORING GEO-37 (continued)

GEOENGINEERS

Project: WSDOT/I-405 Design Build Project
Project Location: Bellevue, Washington
Project Number: 0180-197-01

Figure A-38
Sheet 2 of 2