FINAL BRIDGE GEOTECHNICAL ENGINEERING REPORT

S-51 (BATTERY PARK ROAD) REPLACEMENT BRIDGE OVER BLACK MINGO CREEK

WILLIAMSBURG COUNTY, SOUTH CAROLINA

PREPARED FOR

INFRASTRUCTURE CONSULTING & ENGINEERING

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PREPARED BY

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SCDOT Project No.: P029461
F&ME Project No.: G5556.02

F&ME CONSULTANTS

February 17, 2016

Mr. Andy Gillis, P.E.
Infrastructure Consulting & Engineering, PLLC
1021 Briargate Circle
Columbia, South Carolina 29210

Re: Final Bridge Geotechnical Engineering Report
S-51 (Battery Park Rd.) Emergency Bridge Replacement over Black Mingo Creek
Williamsburg County, South Carolina
SCDOT Project ID P029461
F&ME File No. G5556.02

Dear Mr. Gillis:

Submitted herein is the final geotechnical report for the above referenced project. Included is a general project description, a summary of the performed field investigation(s), our analysis of the subsurface findings, and our conclusions and recommendations for the proposed bridge foundation system and bridge embankments.

Please notify us if there are any questions or if we may be of further assistance with the implementation of our recommendations.

Sincerely,

F&ME CONSULTANTS

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 30374 JOHN FRANCIS HAMILTON 2/17/16

SOUTH CAROLINA F&ME CONSULTANTS, INC. No. 4891 CERTIFICATE OF AUTHORIZATION

Bradley M. Fischer, E.I.T.
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John F. Hamilton, PE
Geotechnical Design Manager

Attachments

JFH/jfh:bmf

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APPENDIX

EXECUTIVE SUMMARY

A final subsurface investigation was performed for the damaged SC Route 51 (Battery Park Rd.) bridge over Black Mingo Creek in Williamsburg County, South Carolina. The bridge was damaged such that the road and bridge were closed following excessive flooding. A preliminary subsurface investigation was included with the project's Request for Proposals (RFP). The preliminary subsurface investigation was performed from November 25, 2015 to November 30, 2015 by S&ME, Inc. through the SCDOT Geotechnical On-call contract and included two (2) soil test borings and two (2) cone penetrometer tests. One boring and one CPT were generally performed near each proposed bridge end bent. The intent of the final subsurface investigation was to supplement the information provided with the preliminary subsurface investigation for compliance with the requirements of the SCDOT Geotechnical Design Manual (GDM) and the RFP.

The following is a summary of the findings and our recommendations for the bridge foundations and bridge embankments.

1. The proposed replacement bridge consists of three (3) spans (37'-6", 70'-0", & 56'-6"). The planned foundation elements for the replacement bridge are HP14x73 steel piles at End Bents 1 and 4 (EB1 and EB4) and 18 inch square, pre-stressed concrete piles at Interior Bents 2 and 3 (IB2 and IB3).
2. Approximately two (2) feet of fill is planned relative to the top of the existing embankments.
3. One (1) soil test boring was performed at each proposed bent location. In addition, one (1) cone penetrometer test (CPT) was performed at and fifty (50) feet from each proposed bridge end.
4. Axial loading conditions will govern the end bent pile design, and lateral loading conditions govern the interior bent pile design. The end bent and interior bent piles will develop the required axial resistance through end bearing on cemented soil material within the Pee Dee formation (ie. SPT blow counts in excess of 50 blows per foot). The PSC piles will require augering to advance the piles to the required minimum tip elevation for lateral stability.
5. We expect that any settlement resulting from fill placement will occur rapidly. The predicted deformations resulting from fill placement will meet the GDM performance criteria without ground improvement.
6. Some seismic soil shear strength loss (SSL) is expected at the site. The material subject to SSL occurs in the alluvial material above the Pee Dee formation at both the beginning and end of bridge embankments and does require ground improvement to meet the GDM performance limits. The anticipated ground improvement consists of driving steel sheet piles as shear resistance elements. SKZ 20 sheet piles are anticipated to be used. The sheet piles will be installed as a coupled "set" (ie. two z-shaped sections per set). The shear piles are planned to be implemented at the beginning and end of bridge embankments. The shear piles on both the right and left side slopes at the beginning of bridge will require an eight (8) foot center-to-center spacing. The shear piles at the end slopes at both the beginning and end of bridge as well as the right side slope at the end of bridge will require a ten (10) foot center-to-center spacing. Both *Slide* Version 7.009 developed by Rocscience and LPile^{v2013} developed by Ensoft were used to evaluate the shear piles.

1. INTRODUCTION

The bridge project is located on SC Route 51 (Battery Park Rd.) over Black Mingo Creek in Williamsburg County, South Carolina. A site location plan is presented in Section 1 of the Appendix.

It is our understanding that the project will include the demolition/removal of the remaining portions of the existing bridge structure and replacement with a new bridge on the existing horizontal alignment. We understand that the maximum increase in vertical grade of the replacement bridge relative to the existing grade is approximately two (2) feet.

The proposed replacement bridge consists of three (3) spans (37'-6", 70'-0", & 56'-6"). The planned foundation elements for the replacement bridge are HP14x73 steel piles at End Bents 1 and 4 (EB1 and EB4) and 18 inch square, pre-stressed concrete piles at Interior Bents 2 and 3 (IB2 and IB3).

As specified in the project's Request for Proposals (RFP), the Roadway structure Operation Classification (ROC) is II and the Bridge Operational Classification is II. The specified ROC applies to bridge embankments only. As defined in the RFP, the "bridge embankment" is the longitudinal length of embankment where mitigation is required to meet the global performance objectives of the bridge system or 50 feet, whichever is greater. As discussed in the following sections, the roadway embankments located within 50 feet of the proposed bridge ends will be referred to as the "bridge embankments".

Roadway embankments located more than 50 feet from a bridge end are considered a ROC IV embankment. For information related to the roadway sections outside of 50 feet from the bridge ends, please refer to the Final Roadway Geotechnical Engineering Report.

The final subsurface investigation was performed by F&ME in general accordance with the 2010 GDM and the RFP. The final bridge foundation and bridge embankment analyses and the development of the final design recommendations were performed in accordance with the 2010 GDM. Where the GDM does not offer design guidance, the AASHTO LRFD Specifications for Highway Bridges, 6th Ed., 2012 with the 2012 interim revisions were utilized.

2. SUBSURFACE INVESTIGATION

2.1. Preliminary Subsurface Investigation

On November 25, 2015, two (2) soil test borings (designated as STB-1 and STB-4) were performed. STB-1 was performed on the north side of the existing bridge, and STB-2 was performed at the south side of the existing bridge. The borings were advanced using a CME-45D drill rig. Rotary wash drilling techniques were utilized to maintain a stable borehole. Standard split-spoon samples (SPT-tests) were continuously obtained in the top ten (10) feet. Following the continuous sampling, SPT's were obtained at regular, five (5) foot intervals throughout the remaining depths of the soil test borings.

All borings were advanced to a depth of 100 feet below the top of the existing embankment. During standard penetration testing of the encountered soils, an automatic hammer system was used. The energy ratio of the hammer system is provided as 81%.

On November 30, 2015, two (2) cone penetrometer soundings (designated as CPT-2 and CPT-3) were performed. CPT-2 was performed in the general vicinity of STB-1, and CPT-3 was performed in the general vicinity of STB-4. The CPT equipment was advanced utilizing a truck mounted rig. The CPT's were advanced to depths were the maximum reaction force was observed and were subsequently terminated. The CPT's were extended to an approximate depth of twenty-three (23) feet below existing grade from the top of the existing embankment in each sounding.

2.2. Final Bridge Subsurface Investigation

On January 18-20, 2016, two (2) soil test borings (designated as B-3 and B-4) were performed by F&ME to supplement the preliminary field investigation for final bridge foundation design purposes. In accordance with the GDM for bridge bents supported by pile foundations, a minimum of one (1) soil test boring is required at each end bent. The borings performed during the preliminary subsurface investigation are considered sufficient for the end bent pile design, and the borings performed during the final subsurface investigation will be used for the interior bent pile design.

The soil test borings were advanced utilizing a CME 550 drill rig. Rotary wash drilling techniques were used to maintain a stable borehole. SPT tests were continuously obtained in the top ten (10) feet of each test boring. Following the continuous sampling, SPT samples were obtained at regular, five (5) foot intervals throughout the remaining depths of the borings. SPT samples were performed in general accordance with ASTM D-1586 to determine the relative densities and consistencies of the subsurface soils and to collect subsurface soil samples. During SPT testing of the encountered soils, an automatic hammer system was used. The energy ratio for the CME 550 hammer is 74%. The soil test borings were advanced to an approximate depth of seventy-five (75) feet below existing ground surface in each test boring.

From February 1-2, 2016, two (2) cone penetrometer tests (designated as CPT-5 and CPT-6) were performed at the site. CPT-5 and CPT-6 were performed approximately 50 feet away from each end bent of the proposed bridge. The CPT soundings were advanced utilizing a CME 550 drill rig. CPT measurements were generally performed on five (5) centimeter intervals. At each location, the CPT extended to a depth where the maximum reaction force from the rig was observed and was subsequently terminated. CPT refusal was encountered at an approximate depth of sixteen (16) feet below the existing ground surface at CPT-5 and an approximate depth of twenty-five (25) feet below the existing ground surface at CPT-6.

2.3. Field Investigation Summary

Northing and easting coordinates for the borings and soundings were obtained during the final subsurface investigation by F&ME personnel utilizing a Trimble R8 GPS rover on the SC VRS system. The coordinates for the boring/sounding locations were used to coordinately place each boring/sounding location on the CAD drawing (provided by ICE) for the proposed roadway alignment. Subsequently, the station and offset of each boring/sounding location relative to the proposed roadway alignment was determined.

The locations of the borings and soundings performed during the preliminary and final subsurface investigation are provided in the following table.

Soil Testing Location Table					
Test Number	Test Hole Locale	Station	Offset from CL (ft)	Elevation (ft-MSL)	Depth (ft)
STB-1	Begin Bridge End Bent/Roadway	67+50	2.0-RT	26.0	100.0
STB-4	End Bridge End Bent/Roadway	69+15	5.0-LT	26.3	100.0
B-3	Bridge Interior Bent 1/Bridge Deck	67+84	1.0-RT	26.0	75.0
B-4	Bridge Interior Bent 2/Bridge Deck	68+69	CL	26.6	75.0
CPT-2	Begin Bridge End Bent/Roadway	67+41	5.0-LT	25.8	23.4
CPT-3	End Bridge End Bent/Roadway	69+27	4.0-RT	26.4	23.6
CPT-5	Roadway	67+11	1.0-RT	25.4	16.3
CPT-6	Roadway	69+77	CL	26.3	24.9

All of the collected soil samples performed for the final subsurface investigation were examined and logged in the field by F&ME personnel, sealed in plastic bags, and transported to our laboratory for further examination and analyses. The soils were visually classified in the field based upon the Unified Soil Classification System.

We have provided an overall boring location plan in Section 2 of the Appendix displaying the locations of the borings and soundings performed during the preliminary and final subsurface investigations relative to the project's construction limits. We have provided a generalized subsurface profile in Section 3 of the Appendix. The generalized subsurface profile was generated from linear interpolation between soil testing locations and should be considered illustrative in nature.

3. LABORATORY TESTING PROGRAM

Select soil samples from the test borings were tested in our laboratory to determine representative physical and engineering soil properties. The laboratory program included moisture content, Atterberg limits, grain size distribution, hydrometer, and wash #200 tests. These tests were used to determine the strength and behavioral characteristics of the soil strata encountered as well as to verify the field classifications by the AASHTO classification system and the Unified Soil Classification System (USCS).

Electro-chemical testing was also performed. Electro-chemical testing consisted of sulfate, pH, and soil resistivity tests. The results from the electro-chemical testing will provide indications of subsurface properties that could cause possible long-term degradation of foundation elements.

The type and number of laboratory tests are summarized in the following table.

Laboratory Test Program	
Type of Test	Number of Tests
Moisture Content	9
Atterberg Limits	6
Grain Size	9
Hydrometer	1
Wash #200	9
Corrosion Series	2
Organic Impurities	1

Data sheets presenting the results of the laboratory test program are provided in Section 6 of the Appendix.

4. GENERAL SITE GEOLOGY

The site is located in the Lower Coastal Plain physiographical province of South Carolina. The Lower Coastal Plain is a gently seaward dipping surface containing six terraces, which represent sedimentary sequences formed during eustatic sea level transgression or regression and/or tectonic uplift or subsidence over geologic time. The geology underlying the bridge site is described in general terms.

The near surface geology at the site includes recent alluvial sediments, which in turn are underlain by Pleistocene age sediments. Underlying these sediments unconformably in the vicinity are sediments of the Paleocene aged Rhems Formation (where not eroded away) and then the Cretaceous aged PeeDee Formation. The sediments in the area consist of fluvial, beach, backbarrier, estuarine, and continental shelf deposits. Due to uplift and subsequent erosion, sediments from the Pliocene through the Eocene are not present in the area.

5. SUBSURFACE CONDITIONS

The below soil descriptions, strata depths, and consistencies are generalized and were interpreted by F&ME based on the subsurface conditions as encountered in the test borings/soundings. We have included the soil test boring/sounding logs in Section 4 of the Appendix for detailed descriptions of the encountered soil conditions. As with any geologic formation, the depth and thickness of the soil strata will vary across the site. Although the test borings/soundings designate strata changes at specific depths in the description of the soil stratigraphy on the soil test boring/sounding logs, transitions between soil strata are generally gradual. Therefore, the outlined subsurface profile shown on the soil test boring/sounding logs should only be considered general on-site soil conditions and should not be utilized as an absolute indicator.

5.1. Soil Stratigraphy

The tests performed during the subsurface investigations indicate three (3) main strata. The following table summarizes the encountered soils at the site.

Soil Stratification Table

Geologic Formation	Elevation of Top of Layer (ft-MSL)	Depth to Top of Layer (ft)	USCS Soil Type	SPT N-Values (bpf)	Average CPT Tip Resistance (tsf)	Comments
Fill	+26	0	SM	11	90	Existing Embankment
Pleistocene	+20	6	SC & SM	7	20	Original Ground
Pee Dee Formation	+7	19	SC, SM, SP-SM, & CL	44	80	

5.2. Groundwater Conditions

Within the performed soil test borings, the depth to groundwater was measured immediately following completion of the borings or 24-hours following completion of the borings.

The depth to the groundwater table was measured as approximately 8 to 10 feet below the top of the existing roadway elevations. For the geotechnical foundation and embankment design, we have selected a design water table relative to the measured depth in each test boring/sounding.

6. BRIDGE FOUNDATION LOADINGS

The controlling factored loads per foundation element for the Strength and Service Limit States are summarized in the following table. The loads were developed by ICE, and all load cases are provided in Section 8 of the Appendix. The point of application for the loads is at the top of pile.

Maximum Factored Loads

	Analysis For:	Limit State		F_y (kip)	F_x[2] (kip)	F_z[1] (kip)	M_z (k-ft)	M_x (k-ft)
EB1	Axial Resistance & Structural Capacity	Strength	--	146	--	--	--	--
	Lateral Stability	Strength	Max Shear	127	0	3	-2	23
			Max. Moment	133	0	3	2	29
	Lateral Displacements	Service	Max Shear	94	-1	2	-4	14
			Max. Moment	98	1	2	5	18
IB2	Axial Resistance & Structural Capacity	Strength	--	237	--	--	--	--
	Lateral Stability	Strength	Max Shear	89	0	-3	-12	-59
			Max. Moment	225	0	-2	-6	-75
	Lateral Displacements	Service	Max Shear	66	1	-2	7	-38
			Max. Moment	157	1	-1	13	-47
IB3	Axial Resistance & Structural Capacity	Strength	--	265	--	--	--	--
	Lateral Stability	Strength	Max Shear	104	0	3	-12	49
			Max. Moment	245	0	2	-6	65
	Lateral Displacements	Service	Max Shear	77	1	2	10	30
			Max. Moment	173	2	1	16	39
EB4	Axial Resistance & Structural Capacity	Strength	--	177	--	--	--	--
	Lateral Stability	Strength	Max Shear	151	0	4	-2	24
			Max. Moment	157	0	4	3	30
	Lateral Displacements	Service	Max Shear	111	-1	3	-5	15
			Max. Moment	116	1	3	6	19

[1]***z-axis oriented in longitudinal direction (parallel to roadway centerline)***
[2]***x-axis oriented in transverse direction (perpendicular to roadway centerline)***

7. CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented in this report are based upon the general soil conditions as encountered in the test borings and soundings, our analyses of the site and subsurface conditions, and our experience on similar projects. The recommendations do not reflect variations in subsurface conditions or the presence of undiscovered obstructions that could exist outside the soil testing locations or in unexplored areas of the site. If subsurface conditions are discovered during construction activities that deviate from the soils indicated on the test boring/sounding logs, F&ME should be contacted to evaluate the impact of the identified conditions on the proposed bridge foundation systems and the proposed bridge approach embankments.

7.1. Site Preparation

Based on the subsurface conditions as encountered during the field investigations, the soil subgrade below the planned bridge approach embankment areas is considered as adequate for construction of the proposed roadway embankments. Extensive undercutting or other ground modifications are not anticipated for acceptable roadway embankment performance under normal, static conditions.

Site preparation should be performed in accordance with Section 201 of the SCDOT Standard Specifications for Highway Construction, 2007 Edition, Supplemental Specifications, and/or Special Provisions. Where existing ground surface approximates final grade or where final roadway embankment fill heights will not exceed five (5) feet above existing grade, the ground surface below the embankment footprint should by stripped of any organic materials and topsoil to depths as required, and grubbing of tree root systems will be required. Stump holes and other holes resulting from obstruction removal shall be backfilled with suitable material and properly compacted. In planned roadway embankment areas where fill heights will exceed five (5) feet, stumps may be left in place as long as stumps do not extend more than 8 inches above ground line.

7.2. Bridge Embankment Static Settlements

Bridge embankment construction at both bridge end bent locations will require minimal fill placement. The maximum fill height is estimated to be approximately two (2) feet relative to the existing roadway.

Settlement is predicted to be less than one (1) inch and is expected to occur rapidly after placement of new fill. The maximum predicted settlement at the roadway centerline for the bridge and roadway embankments following final paving operations are summarized in the following tables.

Embankment Performance Limits at SLS for ROC II				
Deformation ID No.		Service Limit State Performance Limit Description	Predicted	Performance Limit
Settlement (Longitudinal)	EV-01	Maximum Vertical Settlement along the profile grade over the design life of the embankment. (inches)	0	8.00
	EV-02	Maximum Settlement Rate per year after the roadway has been paved. (inches/year)	0	0.10
	EV-03	Maximum Vertical Differential Settlement occurring longitudinally along the profile grade after the roadway has been paved. Differential ratio is shown in parenthesis for informational purposes. (inches per 50 feet of embankment longitudinally)	0	1.50 (1/400)

Bridge/Embankment Transition Performance Limits at SLS for ROC II				
Deformation ID No.		Service Limit State Performance Limit Description	Predicted	Performance Limit
Settlement (Longitudinal)	EV-05	Maximum Vertical Differential Settlement Between End Bent and End of Approach Slab (Inches). The Approach Slab Length (L_{Slab}) is measured in feet.	0	2.00"[1]

[1]***Performance Limit based on a twenty (20) foot approach slab length at EB1 & EB4***

The detailed static settlement calculations are provided in Section 9 of the Appendix.

7.3. Seismic Site Class Designation

F&ME has performed a seismic evaluation for this bridge site. The seismic evaluation was based on a Multi-channel spectral Analysis of Surface Waves (MASW) test. The MASW test was performed by F&ME from the top of the existing roadway approximately 500 feet from the southern end bent (EB4) of the proposed bridge. The results from the MASW testing were utilized to generate the subsurface shear wave velocity profile. The seismic evaluation was performed in accordance with Chapter 12 of the GDM.

The seismic site class designation is determined from the average shear wave velocity measured to a depth of 100 feet below the depth-to-motion. In accordance with section 12.4.2 of the GDM, the depth-to-motion for the bridge structure is estimated at the point-of-fixity of the bridge foundation elements. As such, the depth-to-motion for the bridge end bent foundation elements is approximately fifteen (15) feet below the top of pile, and the depth-to-motion for the bridge interior bent foundation elements is approximately forty (40) feet below the top of pile. The depth-to-motion for the bridge approach embankments is considered at the base of the existing embankment fill.

Based on the MASW test results, the average shear wave velocity below the bridge embankments' depth-to-motion is less than 1,200 ft/s. As such, the seismic evaluation indicates a seismic site classification of D for the bridge embankments. The average shear wave velocity below the bridge foundations' depth-to-motion is greater than 1,200 ft/s. As such, the seismic evaluation indicates a seismic site classification of C for the bridge end bent and interior bent piles.

The SCDOT provided the project ADRS curves for a Site Class C and a Site Class D. The following table provides the applicable spectral accelerations from the developed ADRS curves for a Site Class C and a Site Class D.

Acceleration Design Response Spectra			
	Site Class C		
	PGA	S_{DS}	S_{D1}
FEE	0.11	0.21	0.10
SEE	0.39	0.80	0.41

Acceleration Design Response Spectra			
	Site Class D		
	PGA	S_{DS}	S_{D1}
FEE	0.14	0.28	0.14
SEE	0.42	0.88	0.50

The referenced ADRS curves are provided in Section 7 of the Appendix.

7.4. Geotechnical Seismic Hazard Potential

Geotechnical seismic hazards consist of a loss in a soil's shear strength through cyclic ground motions induced by earthquakes. In sand-like soils, this phenomenon is typically referred to as soil liquefaction. Cyclic-softening is the typical terminology for fine grained soils.

Liquefaction is the loss of a soil's shear strength due to a rapid increase in pore water pressure resulting from soil particle contraction induced by seismic vibrations. Soils most susceptible to liquefaction generally consist of saturated, loose, "clean" (i.e. Plasticity Indexes less than 7), fine (10% particle size ranging from 0.07 to 0.25 mm) sands.

F&ME has performed soil shear loss (SSL) calculations in accordance with Chapter 13 of the GDM. Calculations were developed using data obtained from both SPT and CPT tests. Using data obtained from the CPT tests, calculations were developed with the CLiq v.1.7 software developed by Geologismiki. Where the calculations indicate that SSL is triggered, the Idriss & Boulanger (2008) methodology for calculating the soil's residual shear strength was utilized. Based on the calculations, some SSL is triggered for the FEE and SEE seismic events within the loose, alluvial material below the existing embankment and extending into the creek channel.

The residual soil strength parameters determined from the SSL calculations were utilized in the embankment global slope stability analyses for the FEE and SEE seismic events.

7.5. Seismic Induced Embankment Deformations

Where the calculations indicate that SSL is triggered, a subsequent deformation analysis was performed to calculate the vertical settlement from the sand-like soil's redistribution effects. Re-distribution effects of the fine-grained soil particles that are predicted to undergo SSL are negligible. Lateral displacements were also calculated from lateral spreading due to the liquefied soils. The liquefaction induced settlement was calculated in accordance with the Idriss & Boulanger (2008) methodology.

The calculated liquefaction-induced vertical settlement at the beginning of bridge embankment varies from 0.2 inches to 0.4 inches for the FEE event and 0.6 inches to 1.2 inches for the SEE event. The calculated liquefaction-induced vertical settlement at the end of bridge embankment varies from 0.7 inches to 1.6 inches for the FEE event and 1.8 inches to 3.3 inches for the SEE event. The calculated liquefaction-induced vertical settlement at the IB2 pile locations is approximately 3.5 inches for the FEE event and the SEE event. SSL is not predicted at the IB3 pile locations. The seismic settlement will induce downdrag loadings on the IB2 piles. The additional down drag loadings will not govern the IB2 foundation design.

The results from the seismic vertical deformation analyses at the bridge approach embankments are summarized in the following tables.

Embankment Settlement Performance Limits at EE I Limit State for ROC II					
Deformation ID No.		EE I Limit State Performance Limit Description	Design EQ	Predicted	Performance Limit
Settlement (Longitudinal)	EV-03	Maximum Vertical Differential Settlement occurring longitudinally along the profile grade after the roadway has been paved. Differential ratio is shown in parenthesis for informational purposes. (inches per 50 feet of embankment longitudinally)	FEE	0.9"	1.50" (1/400)
			SEE	1.5"	4.00" (1/200)

Bridge/Embankment Transition Settlement Performance Limits at EE I Limit State for ROC II					
Deformation ID No.		EE I Limit State Performance Limit Description	Design EQ	Predicted	Performance Limit
Settlement (Longitudinal)	EV-05	Maximum Vertical Differential Settlement Between End Bent and End of Approach Slab (Inches). The Approach Slab Length (L_{Slab}) is measure in feet.	FEE	0.7"	2.00"[1]
			SEE	1.8"	4.00"[1]

[1]***Performance Limit based on a twenty (20) foot approach slab length at EB1 & EB4***

The detailed seismic settlement calculations are provided in Section 10 of the Appendix.

7.6. Bridge Approach Embankment Slope Stability

F&ME has performed static and seismic global slope stability analyses of the bridge end slopes and bridge embankment side slopes. F&ME utilized the computer software program, *Slide* Version 7.009 developed by Rocscience, for the global slope stability analyses. In accordance with Chapter 17 of the GDM, a minimum of three (3) slope stability methodologies were utilized. The three (3) slope stability design methodologies used were the Bishop Method, Spencer Method, and General Limit Equilibrium Method.

The subsurface soil stratigraphy, groundwater conditions, and soil strength parameters utilized in these analyses were based on generalized conditions as indicated by the test borings and soundings performed at each respective bridge embankment location.

We have performed bridge end slope stability analyses based on the provided bridge plan and profile sheet. The plan and profile sheet shows 2H:1V end slopes armored with rip-rap at both bridge end slopes.

The seismic ground motion parameters were calculated based on the provided design response spectrums' peak ground acceleration (PGA) for a Site Class D. Specifically, the Response Spectrum lists a FEE PGA of 0.14g and a SEE PGA of 0.42g. The horizontal ground acceleration value (K_h) used in our seismic slope stability analyses was taken as the full PGA value of the respective seismic design event. The calculated residual soil strength parameters were utilized with the seismic slope stability analyses. A uniform distributed live loading of 250 pounds per square foot (psf) was applied within the planned approach slab/roadway pavement areas for the static design. Live load was neglected during the seismic design analyses.

Both bridge embankments will require ground improvement to meet the seismic performance limits. The planned ground improvement consists of driven, steel sheets piles as shear resistance elements. SKZ 20 sheet piles are anticipated to be used. The sheet piles will be installed as a coupled "set" (ie. two z-shaped sections per set). The sets will be spaced at either an eight (8) foot center-to-center spacing or a ten (10) foot center-to-center spacing. Both *Slide* Version 7.009 developed by Rocscience and LPile^{v2013} developed by Ensoft were used to evaluate the shear piles. In *Slide*, a shear resistance and a center-to-center pile spacing is entered. The program divides the shear resistance by the pile spacing to develop a uniform shear resistance between pile sets. The shear resistance input into *Slide* is determined from LPile based on depth of the critical slope stability plane along the pile and the calculated Newmark deformation.

The shear piles were evaluated for structural stability utilizing the LPile software. The calculated Newmark deformation is applied as a uniform soil movement loading along the length of pile within the critical slope stability plane. The resulting shear force from LPile is then entered into *Slide*. In addition, the calculated bending moment determined from LPile is compared to the moment capacity of the SKZ 20 pile set. The appropriate pile group modification factors are entered based on the pile spacing. The shear capacity of a single SKZ 20 pile set is approximately 300 kips, and the moment capacity of a single SKZ 20 pile set is approximately 700 kip-ft. The LPile calculated shear forces and moments are below the maximum values. The results from the LPile analyses of the shear piles are presented in Section 11C of the Appendix.

The *Slide* output yields factors of safety results while the GDM design criteria lists resistance factors. In accordance with the GDM, the factor of safety results were inverted to convert the values to resistance factor results. The following table presents the calculated geotechnical resistance factor (φ) results from the slope stability analyses.

Global Embankment Slope Stability Results Summary					
Location	Design Event	Resistance Factor (φ) Bishop Method	Spencer Method	GLE Method	Design Criteria
Begin Bridge Left Side Slope	Static	0.63	0.65	0.65	0.65[1]
	FEE	0.91	0.93	0.94	0.90[1]
	SEE	2.32[2]	1.89[2]	1.89[2]	0.90[1]
Begin Bridge Right Side Slope	Static	0.61	0.63	0.63	0.65[1]
	FEE	0.87	0.88	0.89	0.90[1]
	SEE	2.27[2]	2.00[2]	1.96[2]	0.90[1]
Begin Bridge End Slope	Static	0.78	0.79	0.79	0.65[1]
	FEE	0.95	0.96	0.97	0.90[1]
	SEE	2.22[2]	1.75[2]	1.89[2]	0.90[1]
End Bridge End Slope	Static	0.95	0.96	0.96	0.65[1]
	FEE	1.08[2]	1.08[2]	1.09[2]	0.90[1]
	SEE	1.75[2]	1.52[2]	1.54[2]	0.90[1]
End Bridge Left Side Slope	Static	0.39	0.39	0.39	0.65[1]
	FEE	0.78	0.77	0.78	0.90[1]
	SEE	1.54[2]	1.37[2]	1.43[2]	0.90[1]
End Bridge Right Side Slope	Static	0.58	0.58	0.58	0.65[1]
	FEE	0.99	0.94	0.97	0.90[1]
	SEE	1.79[2]	1.52[2]	1.56[2]	0.90[1]

[1]Design criteria based on Roadway Operational Classification (ROC) II
[2]Newmark Seismic Displacement Analysis performed in accordance with Chapter 13 of GDM

Where geotechnical resistance factors for seismic slope stability did not comply with the criteria established in the GDM, a Newmark Seismic Displacement Analysis was performed in accordance with Chapter 13 of the GDM. The following table presents the worst-case results from the Newmark seismic displacement analysis. For those locations where the slope stability resistance factors were equal or less than 1.00, a Newmark Seismic Displacement Analysis was not performed since the yield acceleration values are greater than the PGA, and the calculated displacement is zero (0). The Newmark seismic displacement calculations are presented in Section 11B of the Appendix.

Embankment Global Instability Performance Limits At EEI Limit State For ROC II					
Deformation ID No.		Extreme Event Limit State Performance Limit Description	Predicted	Design EQ	Performance Limit
Vertical Displacement	GI-01	Maximum Vertical Displacement at top of slope failure surface. (inches)	< 0.2	FEE	2.0”
			4	SEE	4.0”
	GI-02	Maximum Vertical Displacement at bottom of slope failure surface. (inches)	< 0.2	FEE	2.0”
			4	SEE	4.0”
Lateral Displacement	GI-03	Maximum Lateral Displacement at top of slope failure surface. (inches)	< 0.2	FEE	6.0”
			4	SEE	12.0”
	GI-04	Maximum Lateral Displacement at bottom of slope failure surface. (inches)	< 0.2	FEE	6.0”
			4	SEE	12.0”

The *Slide* output graphs depicting the slope geometry, soil strength parameters, soil profiles, and computer generated critical failure circles of each of the above listed slope stability analyses are presented in Section 11A of the Appendix.

7.7. Pile Corrosion and Deterioration Potential

Electro-chemical laboratory tests were performed on bulk soil samples collected at each existing bridge embankment. The results from the performed electro-chemical testing are summarized in the following table.

Results of Electro-Chemical Testing					
Bulk Sample ID	Design Bent ID	Depth (ft)	Resistivity (ohm-cm)	pH	Sulfate (mg/kg)
BS-1	EB4	0-5	7,100	7.0	BQL
BS-2	EB1	0-5	10,000	6.9	BQL

BQL = Below Quantitation Limit

Per AASHTO LRFD Bridge Design Specifications, the following soil or site conditions are considered indicative of a potential for steel and/or concrete pile deterioration or corrosion.

1. Resistivity less than 2,000 ohm-cm;
2. pH less than 5.5;
3. pH between 5.5 and 8.5 in soils with high organic content;
4. Sulfate concentrations greater than 1,000 ppm;
5. Landfills and cinder fills;
6. Soils subject to mine or industrial discharge; and,
7. Areas with a mixture of high resistivity soils and low resistivity high alkaline soils.

Based on the electro-chemical lab test results, corrosion/deterioration potential does not exist at the bridge site, and we do not recommend that steel corrosion or concrete deterioration mitigation measures be implemented.

7.8. Pile Foundation Axial Analyses

Driven pile foundations are planned at EB1 and EB4 using steel HP14x73 piles. Driven pile foundations are planned at IB2 and IB3 using 18" square, pre-stressed concrete piles. The Strength Limit State axial loading conditions govern the geotechnical pile design at the end bents. The Strength Limit State lateral loading conditions govern the geotechnical pile design at the interior bents.

Resistance factors for driven piles were determined in accordance with the GDM. The end bent and interior bent piles will develop the required bearing resistance in end bearing on cemented soil layers within the Coastal Plain. The method for controlling installation and verifying pile capacities will be based upon pile dynamic measurements (PDA) with CAPWAP analyses at end of drive conditions. Each bent line will be supported by more than four (4) piles and are, therefore, classified as redundant foundation systems. As such, the geotechnical resistance factor for axial compressive resistance of driven piles is 0.65.

The following table outlines the end bent and interior bent axial pile bearing requirements for each applicable limit state. In the Bridge Plan Notes section, we have only provided the required ultimate driving resistance for the Strength Limit State since it is controlling the pile design.

Pile Foundation Axial Loads

		EB1	IB2	IB3	EB4
Service Limit State	Factored Design Load (Tons)	52	82	93	63
	Geotechnical Resistance Factor	N/A	N/A	N/A	N/A
	Nominal Resistance (Tons)	N/A	N/A	N/A	N/A
	Estimated Scour Loss (Tons)	N/A	N/A	N/A	N/A
	Downdrag Loss (Tons)	N/A	N/A	N/A	N/A
	Required Driving Resistance (Tons)	N/A	N/A	N/A	N/A
	Anticipated Pile Tip EL (ft-MSL)	N/A	N/A	N/A	N/A
Strength Limit State	Factored Design Load (Tons)	73	118.5	132.5	89
	Geotechnical Resistance Factor	0.65	0.65	0.65	0.65
	Nominal Resistance (Tons)	188	183	204	188
	Estimated Scour Loss (Tons)	0	13	5	0
	Factored Downdrag (Tons)	0	0	0	0
	Required Driving Resistance (Tons)	113	196	209	137
	Anticipated Pile Tip EL (ft-MSL)	-5	-30.5	-32.5	-11
EEI Limit State	Factored Design Load (Tons)	52	82	93	63
	Geotechnical Resistance Factor	1.00	1.00	1.00	1.00
	Nominal Resistance (Tons)	52	82	93	63
	Liquefaction Induced Downdrag (Tons)	17	3	0	20
	Required Driving Resistance (Tons)	69	85	93	83
	Anticipated Pile Tip EL (ft-MSL)	+2	-5	-11	-1

7.9. Bridge Foundation Lateral Design Analyses

To determine the foundations' response under static lateral loading conditions, F&ME has performed lateral analyses utilizing the computer software program LPile$^{v.2013}$. We have analyzed the lateral performance of the IB2 and IB3 foundations for the scoured conditions. The soil parameters and depths used as input into the LPILE program were based on generalized conditions as shown on the test boring/sounding logs.

A very dense, cemented sand layer was observed in all tests performed at the site. F&ME provided ICE with the design soil parameters of this cemented sand layer for inclusion in the HEC-18 Erodibility Index formula. The provided soil parameters are similar to that of an intermediate geo-material (ie. soil exhibiting N-values greater than 50 bpf). Based on the Erodibility Index formula, scour is limited to the top of this cemented sand layer.

The following table lists the maximum top of pile deflections and maximum bending moments occurring below the ground line for the end bent and interior bent pile foundations. The provided deflections were determined by the geotechnical and structural engineer.

Lateral Response Summary			
Bent ID.	Design Event	Longitudinal Top of Pile Deflection (in)	Transverse Top of Pile Deflection (in)
EB1	Service	< 0.1	< 0.1
IB2	Service	0.95	0.20
IB3	Service	0.90	0.20
EB4	Service	0.1	< 0.1

The minimum pile/shaft penetration depths required to maintain lateral stability (critical depth) were performed by lateral soil-structure interaction analyses using the LPile$^{v.2013}$ computer program. The critical depth may be considered as the point where the lateral deflection of the foundation becomes and practically remains constant. The critical depths were determined for the scoured condition. The critical depths at each bent location referenced from the bottom of the cap elevations are provided in the following table.

Critical Depth[1]		
Bent No.	Depth[1,2] (ft)	Min. PSC Tip EL (ft-NAVD88)
EB1	15	+6
IB2	38	-15
IB3	39	-16
EB4	15	+6

[1]Based on maximum Strength load case
[2]Referenced from top of pile

We have included the input/output summary sheets, critical depth, deflection and bending moment graphs from our LPILE generated lateral analyses in Section 12 through 15 of the Appendix.

8. BRIDGE PLAN NOTES

Place the following notes on the bridge plans for EB1 and EB4.

Pile Bearing		
Bent I.D.	***EB1***	***EB4***
Factored Design Load	***73 Tons***	***89 Tons***
Geotechnical Resistance Factor	***0.65***	***0.65***
Nominal Resistance	***113 Tons***	***137 Tons***
Estimated Scour	***0 Tons***	***0 Tons***
Factored Downdrag	***0 Tons***	***0 Tons***
Required Driving Resistance	***113 Tons***	***137 Tons***

Method of controlling installation of piles and verifying their capacity:
Pile Installation Chart from Wave Equation without stress measurements during driving.

Reinforced pile tips with teeth are required to mitigate hard driving conditions at EB1 and EB4. Install the reinforced pile tips in accordance with the manufacturer's installation recommendations.

For End Bent 1 and End Bent 4, the required minimum pile tip elevation to achieve lateral stability and the estimated pile tip elevation to achieve the required axial capacity are provided in the following table:

Pile Tip Elevation Table		
Bent I.D.	***Minimum Pile Tip Elevation (ft-NAVD88)***	***Estimated Pile Tip Elevation (ft-NAVD88)***
EB1	***+6***	***-5***
EB4	***+6***	***-11***

The following estimated parameters were used for performing a drivability analysis for EB1 and EB4:

Estimated Pile Drivability Analysis Parameters	
Skin Quake (QS)	***0.10 in.***
Toe Quake (QT)	***0.05 in.***
Skin Damping (SD)	***0.05 sec/ft***
Toe Damping (TD)	***0.15 sec/ft***
% Skin Friction	***20%***
Distribution Shape No.	***1.0[1]***
Bearing Graph	***Proportional[2]***
Pile Penetration	***95%***
Hammer Energy Range	***40 - 75 ft-kips***

[1]Distribution Shape No. varies with depth: 0 at the ground surface and 1.0 at the pile tip elevation
[2]Bearing Graph Options – proportional, constant skin friction, and constant end bearing. Note: GRLWEAP (2010) was used to perform the wave equation analysis.

A pile hammer having a rated energy as indicated above is considered suitable for driven pile installation. However, final hammer approval is based on a wave equation analysis that accurately reflects the Contractor's proposed driving system.

The pile lengths shown on the plans are for estimation purposes only. The actual pile lengths and driving criteria shall be based on results from the Pile Driving Analyzer (PDA) and the CAPWAP analyses.

Pile Driving Analyzer (PDA) testing shall also be performed on the first production pile driven at each end bent. If a CAPWAP analysis determines that capacity has not been achieved, a restrike of one of the production piles may be required. The restrike shall be performed on the production pile exhibiting the lowest blows per foot. PDA testing shall also be performed on the restrike. Following a minimum four (4) day wait period following initial drive, pile restrikes shall commence. The hammer shall be warmed up before redriving begins by applying at least 20 blows to another pile. The maximum amount of redriving required to determine bearing shall be 6 inches or the total number of blows required will be 50, whichever occurs first. If the ultimate driving resistance has not reached the required ultimate driving resistance, the Contractor may be required to continue driving until the required ultimate driving resistance is obtained.

Each pile is to be installed in one continuous operation. Include details of any anticipated temporary driving discontinuities including anticipated time intervals in the Pile Installation Plan.

Reference the 2007 Standard Specifications for Highway Construction for Driven Pile Foundations, Section 711. Notes included in these plans are in addition to the requirements of the Standard Specifications.

Place the following notes on the bridge plans for IB2 and IB3.

Pile Bearing		
Bent I.D.	***IB2***	***IB3***
Factored Design Load	***118.5 Tons***	***132.5 Tons***
Geotechnical Resistance Factor	***0.65***	***0.65***
Nominal Resistance	***183 Tons***	***204 Tons***
Estimated Scour	***13 Tons***	***5 Tons***
Factored Downdrag	***0 Tons***	***0 Tons***
Required Driving Resistance	***196 Tons***	***209 Tons***

Method of controlling installation of piles and verifying their capacity:
Pile Installation Chart from Wave Equation without stress measurements during driving.

The estimated pile tip elevation to achieve the required axial resistance for the 18-inch pre-stressed concrete pile section for Interior Bent 2 is -28.0 ft-NAVD88. This equates to an estimated tip elevation of the W8x58 steel pile points of -30.5 ft-NAVD88. The minimum tip elevation required to obtain lateral stability for the 18-inch pre-stressed concrete pile section is -15.0 ft-NAVD88. The piles shall be fabricated and delivered to the job site with a 2.5 foot length of W8x58 pile point extending from the tip of the pre-stressed concrete pile.

The estimated pile tip elevation to achieve the required axial resistance for the 18-inch pre-stressed concrete pile section for Interior Bent 3 is -30.0 ft-NAVD88. This equates to an estimated tip elevation of the W8x58 steel pile points of -32.5 ft-NAVD88. The minimum tip elevation required to obtain lateral stability for the 18-inch pre-stressed concrete pile section is -16.0 ft-NAVD88. The piles shall be fabricated and delivered to the job site with a 2.5 foot length of W8x58 pile point extending from the tip of the pre-stressed concrete pile.

The following estimated parameters were used for performing a drivability analysis for IB2 and IB3:

Estimated Pile Drivability Analysis Parameters	
Skin Quake (QS)	***0.10 in.***
Toe Quake (QT)	***0.05 in.***
Skin Damping (SD)	***0.05 sec/ft***
Toe Damping (TD)	***0.15 sec/ft***
% Skin Friction	***20%***
Distribution Shape No.	***1.0[1]***
Bearing Graph	***Proportional[2]***
Toe No. 2 Quake	***0.05***
Toe No. 2 Damping	***0.15***
End Bearing Fraction (Toe No. 2)	***0.90***
Pile Penetration	***25%***
Hammer Energy Range	***40 - 75 ft-kips***

[1]Distribution Shape No. varies with depth: 0 at the ground surface and 1.0 at the pile tip elevation
[2]Bearing Graph Options – proportional, constant skin friction, and constant end bearing. Note: GRLWEAP (2010) was used to perform the wave equation analysis.

A pile hammer having a rated energy as indicated above is considered suitable for driven pile installation. However, final hammer approval is based on a wave equation analysis that accurately reflects the Contractor's proposed driving system.

Predrill pile locations at IB2 to a minimum elevation of -15.0 ft-NAVD88 that will result in a maximum predrilling diameter of 30 inches. Perform predrilling so spoils are minimized and large ground movements or voids below ground do not occur. After predrilling operations have occurred, drive the 18" PSC piling to the estimated pile tip elevation. Do not strike the pile over 5 blows with less than ¼ inch of movement.

Predrill pile locations at IB3 to a minimum elevation of -16.0 ft-NAVD88 that will result in a maximum predrilling diameter of 30 inches. Perform predrilling so spoils are minimized and large ground movements or voids below ground do not occur. After predrilling operations have occurred, drive the 18" PSC piling to the estimated pile tip elevation. Do not strike the pile over 5 blows with less than ¼ inch of movement.

The pile lengths shown on the plans are for estimation purposes only. The actual pile lengths and driving criteria shall be based on results from the Pile Driving Analyzer (PDA) and the CAPWAP analyses.

Pile Driving Analyzer (PDA) testing shall also be performed on the first production pile driven at each interior bent. If a CAPWAP analysis determines that capacity has not been achieved, a restrike of one of the production piles may be required. The restrike shall be performed on the production pile exhibiting the lowest blows per foot. PDA testing shall also be performed on the restrike. Following a minimum four (4) day wait period following initial drive, pile restrikes shall commence. The hammer shall be warmed up before redriving begins by applying at least 20 blows to another pile. The maximum amount of redriving required to determine bearing shall be 6 inches or the total number of blows required will be 50, whichever occurs first. If the ultimate driving resistance has not reached the required ultimate driving resistance, the Contractor may be required to continue driving until the required ultimate driving resistance is obtained.

Each pile is to be installed in one continuous operation. Include details of any anticipated temporary driving discontinuities including anticipated time intervals in the Pile Installation Plan.

Reference the 2007 Standard Specifications for Highway Construction for Driven Pile Foundations, Section 711. Notes included in these plans are in addition to the requirements of the Standard Specifications.

9. VIBRATION MONITORING

Currently, no residential structures are located in the vicinity of the bridge and roadway construction. As such, a vibration monitoring program is not recommended. In accordance with the project's Special Provisions, the Contractor is required to monitor vibrations at all structures within a 300 foot radius of the proposed bridge and roadway construction.

10. LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to the referenced bridge project. The conclusions and recommendations contained herein are based upon the provided test borings and testing result data contained within, and applicable standards in this geographic area at the time this report was prepared. No other warranty, expressed or implied, is made.

In the event that any changes in nature, design, or location of the structure and/or foundation elements are planned, the recommendations contained in this report will not be considered valid unless the changes are reviewed and verified in writing.

S-51 EMERGENCY BRIDGE REPLACEMENT OVER BLACK MINGO CREEK

FINAL BRIDGE GEOTECHNICAL ENGINEERING REPORT

APPENDIX

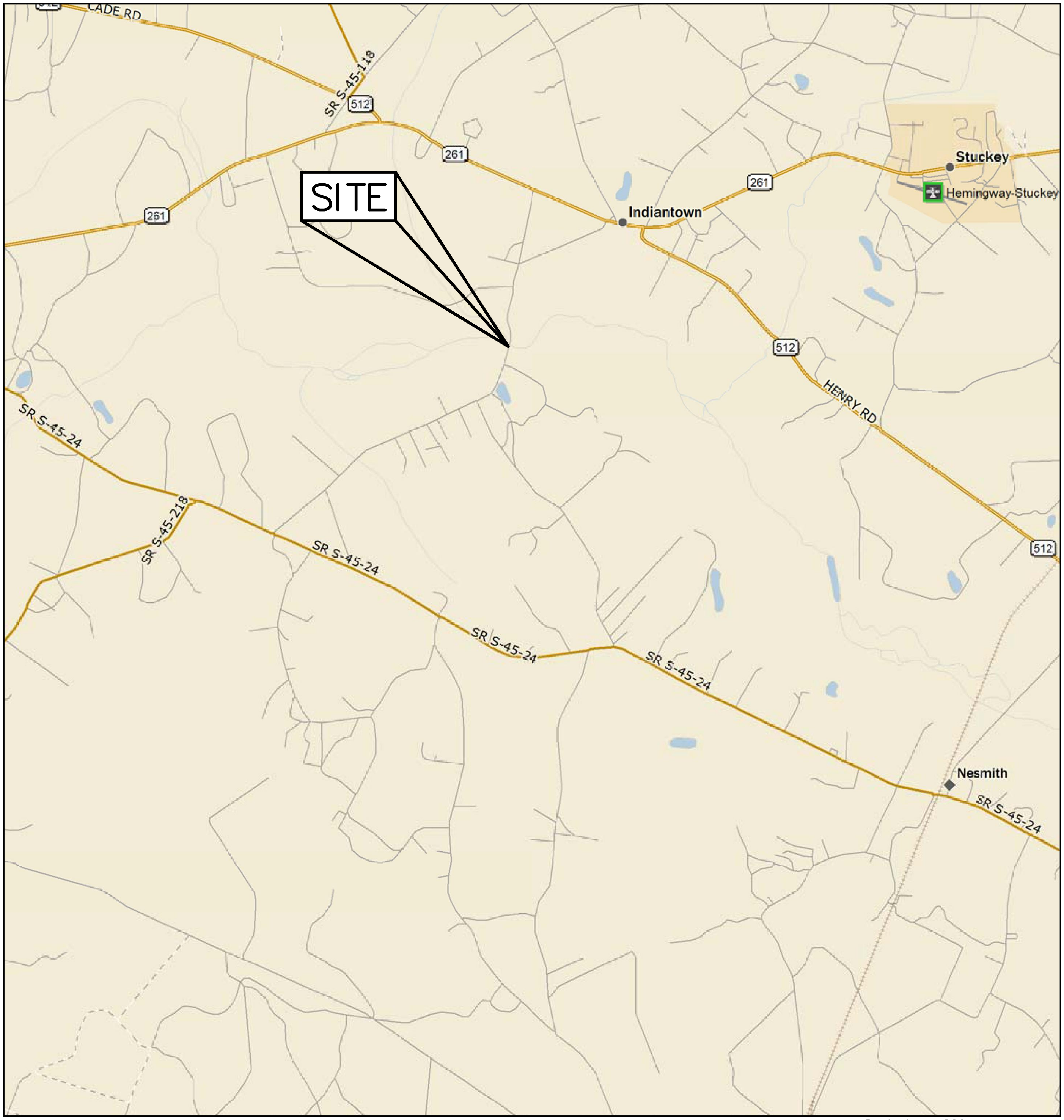
CONTENTS

APPENDIX

SECTION 1

SITE LOCATION PLAN

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	



Data use subject to license.

www.delorme.com

TN

MN (8.1°W)

Scale 1 : 75,000

1" = 1.18 mi

Data Zoom 11-4

F&ME CONSULTANTS

GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.______ DATE______
DWG. CTC DATE 12/16/2015 GROUP ___ - ____
R/W______ DATE______

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

SITE LOCATION PLAN

SCALE = AS NOTED

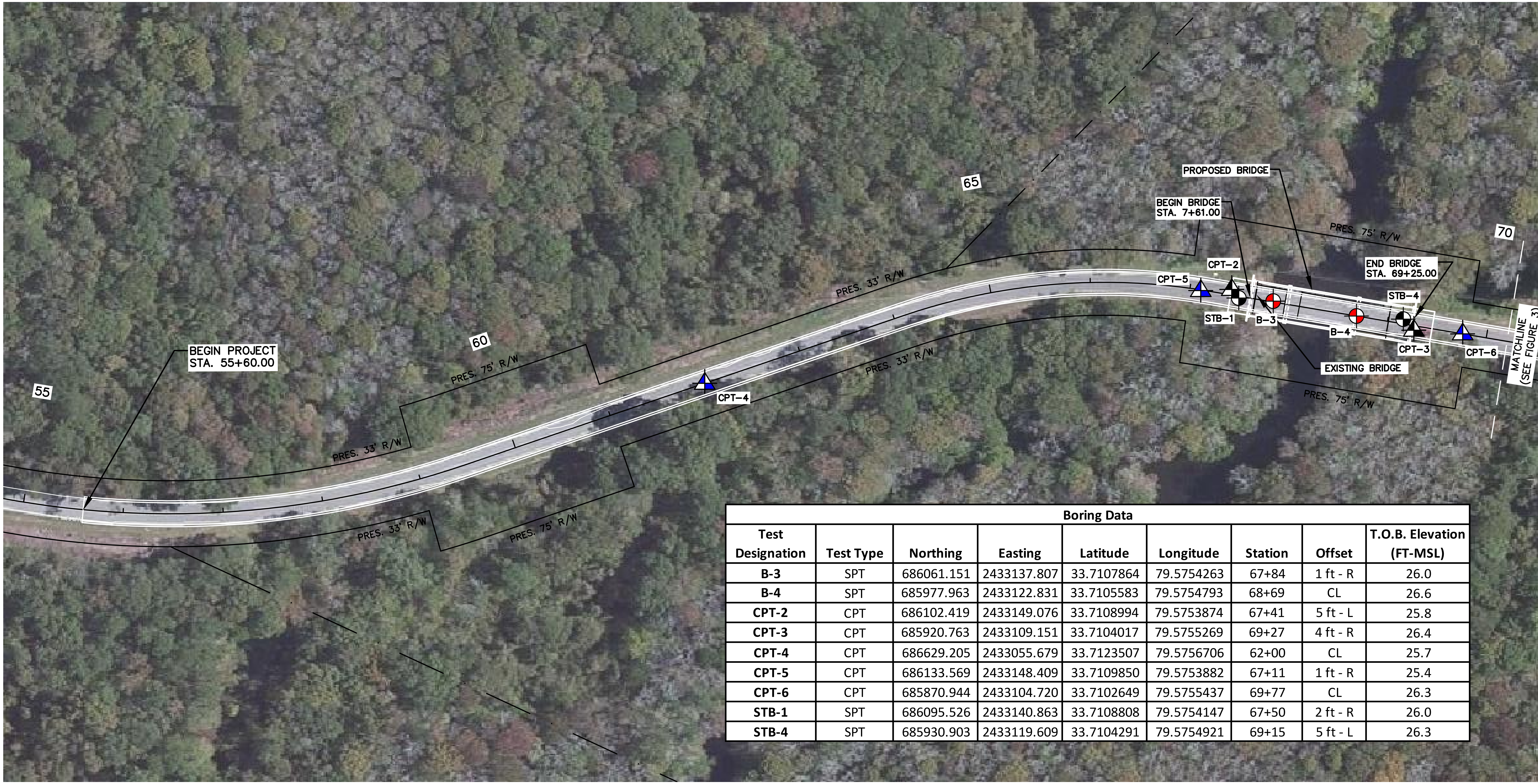
FIGURE 1

APPENDIX

SECTION 2

SOIL TESTING LOCATION PLAN

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	



Boring Data

Test Designation	Test Type	Northing	Easting	Latitude	Longitude	Station	Offset	T.O.B. Elevation (FT-MSL)
B-3	SPT	686061.151	2433137.807	33.7107864	79.5754263	67+84	1 ft - R	26.0
B-4	SPT	685977.963	2433122.831	33.7105583	79.5754793	68+69	CL	26.6
CPT-2	CPT	686102.419	2433149.076	33.7108994	79.5753874	67+41	5 ft - L	25.8
CPT-3	CPT	685920.763	2433109.151	33.7104017	79.5755269	69+27	4 ft - R	26.4
CPT-4	CPT	686629.205	2433055.679	33.7123507	79.5756706	62+00	CL	25.7
CPT-5	CPT	686133.569	2433148.409	33.7109850	79.5753882	67+11	1 ft - R	25.4
CPT-6	CPT	685870.944	2433104.720	33.7102649	79.5755437	69+77	CL	26.3
STB-1	SPT	686095.526	2433140.863	33.7108808	79.5754147	67+50	2 ft - R	26.0
STB-4	SPT	685930.903	2433119.609	33.7104291	79.5754921	69+15	5 ft - L	26.3

LEGEND:

- SOIL TEST BORING LOCATION (PERFORMED BY F&ME)
- CPT LOCATION (PERFORMED BY F&ME)
- BORING LOCATION (PREVIOUSLY PERFORMED BY OTHERS)
- CPT LOCATION (PREVIOUSLY PERFORMED BY OTHERS)

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO. ______ DATE ______
DWG. CTC DATE 2/11/2016 GROUP ___ - ____
R/W ______ DATE ______

F&ME CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

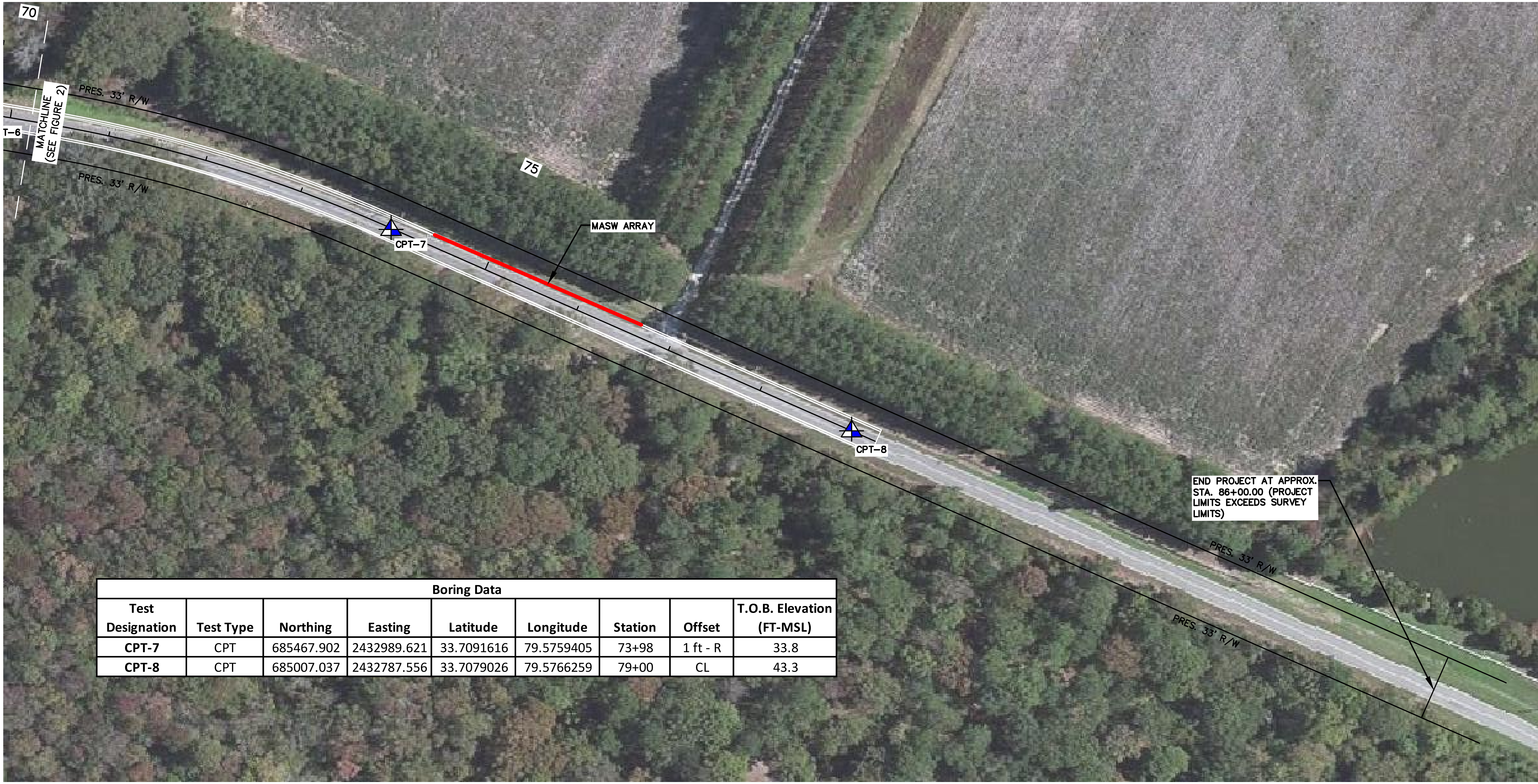
S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

PROPOSED BORING LOCATION PLAN

SCALE = NTS

FIGURE 2

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	



Boring Data								
Test Designation	Test Type	Northing	Easting	Latitude	Longitude	Station	Offset	T.O.B. Elevation (FT-MSL)
CPT-7	CPT	685467.902	2432989.621	33.7091616	79.5759405	73+98	1 ft - R	33.8
CPT-8	CPT	685007.037	2432787.556	33.7079026	79.5766259	79+00	CL	43.3

LEGEND:

CPT LOCATION (PERFORMED BY F&ME)

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.____ DATE____
DWG. CTC DATE 2/11/2016 GROUP ___ - ____
R/W____ DATE____

F&ME CONSULTANTS

GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

PROPOSED BORING LOCATION PLAN

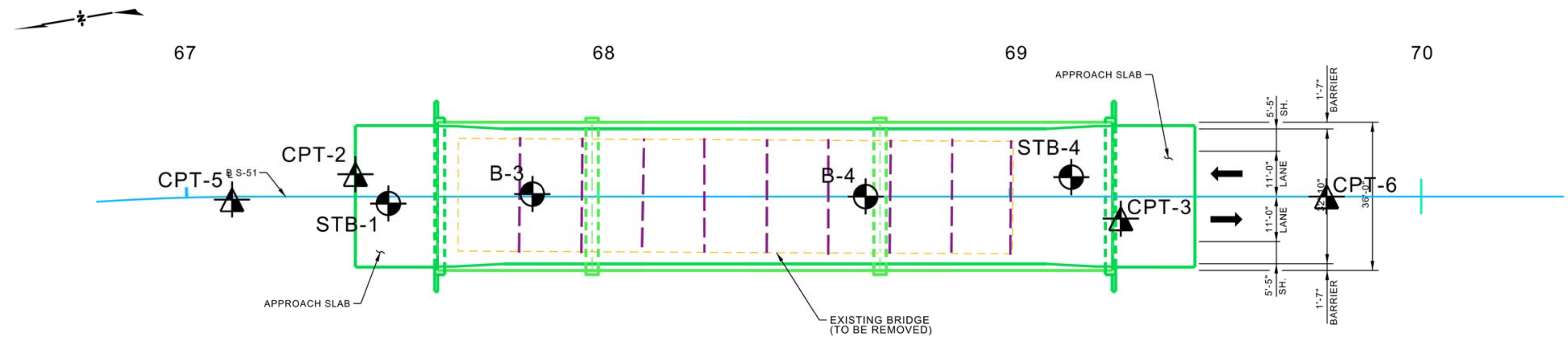
SCALE = NTS

FIGURE 3

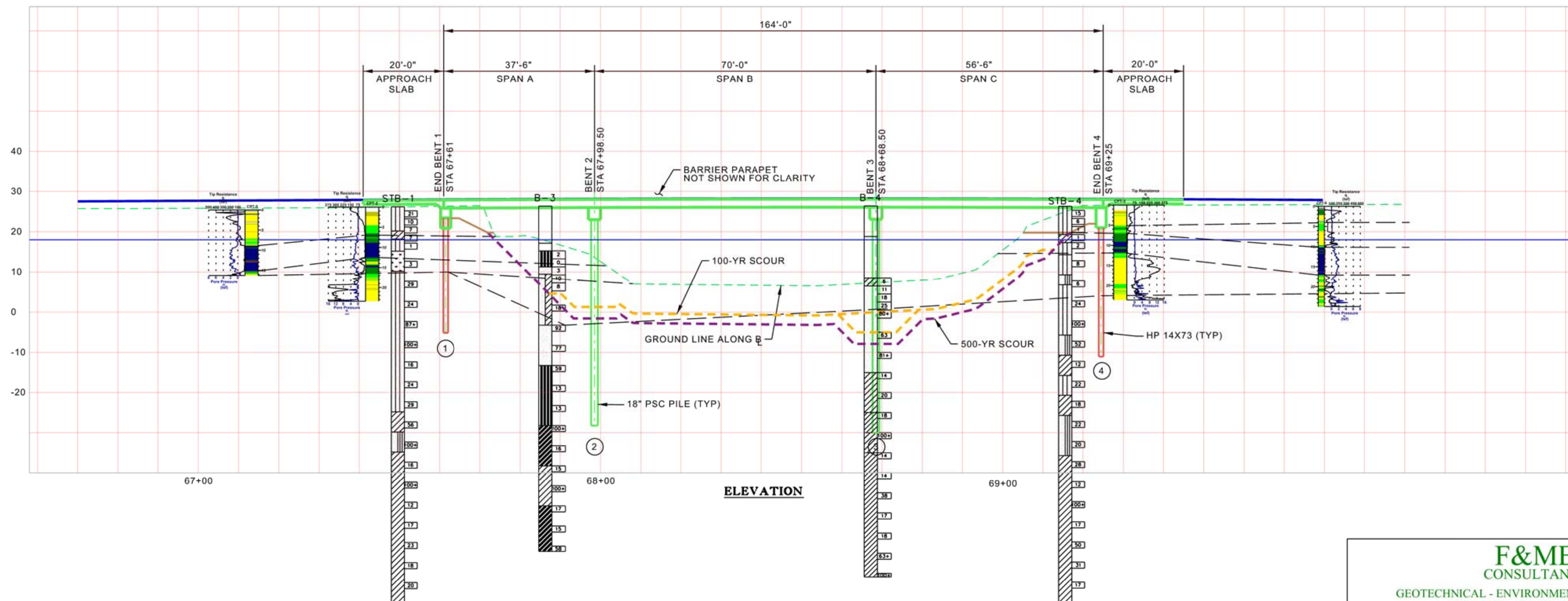
APPENDIX

SECTION 3

GENERALIZED SUBSURFACE PROFILE



PLAN



ELEVATION

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COLUMBIA, SOUTH CAROLINA

S-51 BRIDGE OVER BLACK MINGO CREEK

GENERALIZED SUBSURFACE PROFILE

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO. ______ DATE ______
DWG. JFH DATE 2.3.16
R/W ______ DATE ______
GROUP ___ - ___

HRZ SCALE = NTS
VRT SCALE = NTS

APPENDIX

SECTION 4

BORING LOGS & CPT LOGS

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-1
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek			**Route:**	S-45-51
Eng./Geo.:	D. Schoen	**Boring Location:**	67+50	**Offset:**	2'-RT
Alignment:	Mainline	**Elev.:**	26.0 ft	**Latitude:**	33.7108808
Longitude:	79.5754147	**Date Started:**	11/25/2015	**Date Completed:**	11/25/2015
Total Depth:	100 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)	**Drill Machine:**	CME 45D	**Drill Method:**	Mud Rotary
Hammer Type:	Automatic	**Energy Ratio:**	81%	**Core Size:**	N/A
Driller:	Carolina Drilling	**Groundwater: TOB**	N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	0.0	**ASPHALT** = 11 inches						
	0.9	medium dense, moist, brownish yellow, subangular, silty fine SAND (SM), 10YR 6/6, fill	1.0	SS/1	10	12	9	21
		- - - loose	3.0	SS/2	6	5	5	10
21.0		- - - LL=NP, PL=NP, PI=NP, NMC=17.5, %200=15.8	5.0	SS/3	5	3	4	7
	7.0	loose, moist, dark gray, subangular, low plasticity fines, clayey fine SAND (SC), 2.5Y 4/1, fill	7.0	SS/4	4	4	3	7
16.0	9.0	very loose, moist, very dark gray, high plasticity fines, organic laden silty SAND (SM), 10YR 3/1, trace wood fragments, LL=167, PL=86, PI=81, alluvium	9.0	SS/5	WOR	WOH	1	1
11.0	12.0	soft, wet, very dark gray, PEAT (PT), 10YR 3/1, alluvium - - - NMC=205.0, %200=6.4, OC=26.3	13.5	SS/6	1	1	2	3
6.0	17.0	medium dense, moist, dark greenish gray, subangular, weakly reactive, silty fine SAND (SM), Gley 1 3/5GY, trace moderately cemented lenses, Pee Dee Formation - - - LL=NP, PL=NP, PI=NP, NMC=15.2, %200=22.8	18.5	SS/7	14	19	10	29
1.0		- - - light yellowish brown, 2.5Y 6/4, few gravel, LL=NP, PL=NP, PI=NP, NMC=20.4, %200=13.1	23.5	SS/8	8	13	11	24

● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

167

205

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461		**County:**	Williamsburg		**Boring No.:**	STB-1
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek					**Route:**	S-45-51
Eng./Geo.:	D. Schoen	**Boring Location:**	67+50	**Offset:**	2'-RT	**Alignment:**	Mainline
Elev.:	26.0 ft	**Latitude:**	33.7108808	**Longitude:**	79.5754147	**Date Started:**	11/25/2015
Total Depth:	100 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● / PL MC LL / ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		- - - very dense, light olive brown, 2.5Y 5/3, 50> material not continuous - discrete lenses less than 6" thick		28.5	SS/9	24	37	50/4.5"	50/4.5"	
-4.0										
		- - - recovered pieces of moderately cemented sand		33.5	SS/10	50/0.5"			50/0.5"	
-9.0										
		- - - medium dense, dark greenish gray, weakly reactive, Gley 1 3/10Y		38.5	SS/11	5	6	10	16	
-14.0										
		- - - not reactive, LL=NP, PL=NP, PI=NP, NMC=32.6, %200=25.0		43.5	SS/12	7	10	14	24	
-19.0										
				48.5	SS/13	9	13	16	29	
-24.0										

LEGEND

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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461			**County:**	Williamsburg			**Boring No.:**	STB-1		
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek							**Route:**	S-45-51		
Eng./Geo.:	D. Schoen	**Boring Location:**	67+50	**Offset:**	2'-RT			**Alignment:**	Mainline		
Elev.:	26.0 ft	**Latitude:**	33.7108808	**Longitude:**	79.5754147			**Date Started:**	11/25/2015		
Total Depth:	100 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft			**Date Completed:**	11/25/2015		
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y	(N)		**Liner Used:**	Y	(N)	
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic			**Energy Ratio:**	81%		
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB**	N/A		**24HR**	N/A		

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	52.0	hard, moist, very dark gray, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee	53.5	SS/14	31	21	35	56
-29.0								
	57.0	very dense, moist, dark gray, subangular, slightly sility fine SAND (SP-SM), Gley 1 4/N, Pee Dee	58.5	SS/15	50/4.5"			50/4.5"
-34.0								
	62.0	vey stiff, moist, very dark gray, weakly reactive, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee - - - LL=39, PL=23, PI=16, NMC=27.0, %200=65.6	63.5	SS/16	7	7	9	16
-39.0								
		- - - hard, @ tip of spoon - greenish gray, slightly cemented	68.5	SS/17	50/4.25"			50/4.25"
-44.0								
		- - - stiff, dark gray, Gley 1 3/N	73.5	SS/18	5	5	7	12
-49.0								

SPT N VALUE / PL MC LL / FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-1		
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek			**Route:**	S-45-51		
Eng./Geo.:	D. Schoen	**Boring Location:**	67+50	**Offset:**	2'-RT	**Alignment:**	Mainline
Elev.:	26.0 ft	**Latitude:**	33.7108808	**Longitude:**	79.5754147	**Date Started:**	11/25/2015
Total Depth:	100 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		--- very stiff		78.5	SS/19	6	7	10	17	●
-54.0										
				83.5	SS/20	6	9	14	23	●
-59.0										
				88.5	SS/21	7	8	10	18	●
-64.0										
				93.5	SS/22	7	9	11	20	●
-69.0										
		--- hard		98.5	SS/23	50/1.5"			50/1.5"	
-74.0	100.0	**BORING TERMINATED AT 100 FEET**								

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-4		
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek	**Route:**	S-45-51				
Eng./Geo.:	D. Schoen	**Boring Location:**	69+15	**Offset:**	5'-LT	**Alignment:**	Mainline
Elev.:	26.3 ft	**Latitude:**	33.7104291	**Longitude:**	79.5754921	**Date Started:**	11/25/2015
Total Depth:	100 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**	**Liner Required:**	Y (N)	**Liner Used:**	Y (N)	
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	0.0	**ASPHALT** = 10 inches						
	0.8	medium dense, moist, light brownish yellow, subangular, silty fine SAND (SM), 2.5Y 6/4, fill	1.0	SS/1	6	8	7	15
		- - - loose, brownish yellow, 10YR 6/6	3.0	SS/2	2	3	3	6
21.3		- - - very loose, yellowish brown, 10YR 5/6	5.0	SS/3	1	1 / 12"		1
	7.0	very loose, moist, reddish yellow and strong brown, subangular, low plasticity fines, clayey SAND (SC), 7.5YR 6/6 and 7.5YR 4/6, LL=48, PL=23, PI=25, NMC=29.6, %200=33.8, fill	7.0	SS/4	WOH	WOH	1	1
16.3	9.0	very loose, moist, very dark gray, high plasticity fines, organic laden silty SAND (SM), 10 YR 3/1, trace wood fragments, LL=99, PL=47, PI=52, NMC=67.4, %200=33.1, alluvium	9.0	SS/5	WOH	1	1	2
11.3	12.0	loose, moist, dark grayish brown, subangular, silty fine SAND (SM), 10YR 4/2, alluvium	13.5	SS/6	1	2	6	8
	17.0	loose, moist, dark grayish brown, subangular, slightly silty fine SAND (SP-SM), 10YR 4/2, alluvium	18.5	SS/7	5	3	3	6
6.3	19.5	loose, moist, dark greenish gray, subangular, silty fine SAND (SM), Gley 1 3/5GY, Pee Dee Formation						
1.3		- - - medium dense, light yellowish brown, 2.5Y 6/4	23.5	SS/8	4	8	16	24

● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

Soil Test Log

Project ID:	P029461			**County:**	Williamsburg	**Boring No.:**	STB-4
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek					**Route:**	S-45-51
Eng./Geo.:	D. Schoen	**Boring Location:**	69+15	**Offset:**	5'-LT	**Alignment:**	Mainline
Elev.:	26.3 ft	**Latitude:**	33.7104291	**Longitude:**	79.5754921	**Date Started:**	11/25/2015
Total Depth:	100 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
-3.7		- - - very dense, light olive brown, 2.5Y 5/3, LL=NP, PL=NP, PI=NP, NMC=30.9, %200=13.9, @ tip of spoon - moderately cemented, 50> material not continuous - discrete lenses less than 6" thick		28.5	SS/9	10	50/4"		50/4"
-8.7	32.0	very dense, moist, light olive brown, subangular, slightly silty fine SAND (SP-SM), 2.5Y 5/3, Pee Dee		33.5	SS/10	13	18	34	52
-13.7	37.0	stiff, moist, very dark gray, weakly reactive, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee		38.5	SS/11	3	6	6	12
-18.7	42.0	medium dense, dark greenish gray, subangular, not reactive, silty SAND (SM), Gley 1 3/10Y, Pee Dee LL=NP, PL=NP, PI=NP, NMC=32.2, %200=19.5		43.5	SS/12	6	9	13	22
-23.7	47.0	very stiff, moist, very dark gray, weakly reactive, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee		48.5	SS/13	6	9	9	18

● SPT N VALUE ● PL MC LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

SC_DOT G5556.02 S-51 RBO BLACK MINGO CREEK.GPJ SCDOT DATA TEMPLATE_12_30_2014.GDT 2/12/16

LEGEND

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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-4		
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek			**Route:**	S-45-51		
Eng./Geo.:	D. Schoen	**Boring Location:**	69+15	**Offset:**	5'-LT	**Alignment:**	Mainline
Elev.:	26.3 ft	**Latitude:**	33.7104291	**Longitude:**	79.5754921	**Date Started:**	11/25/2015
Total Depth:	100 ft	**Soil Depth:**	100 ft	**Core Depth:**	0 ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	52.0	medium dense, moist, dark greenish gray, subangular, weakly reactive, silty fine SAND (SM), Gley 1 3/10Y, Pee Dee	53.5	SS/14	6	9	13	22
-28.7								
		- - - not reactive	58.5	SS/15	7	8	12	20
-33.7								
	62.0	very stiff, dark greenish gray, not reactive, low plasticity, sandy CLAY (CL), Gley 1 3/10Y, Pee Dee - - - LL=44, PL=20, PI=24, NMC=23.1, %200=66.1	63.5	SS/16	5	8	20	28
-38.7								
		- - - stiff, weakly reactive	68.5	SS/17	4	5	7	12
-43.7								
		- - - hard	73.5	SS/18	50/4"			50/4"
-48.7								

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461				**County:**	Williamsburg		**Boring No.:**	STB-4	
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek							**Route:**	S-45-51	
Eng./Geo.:	D. Schoen	**Boring Location:**	69+15		**Offset:**	5'-LT		**Alignment:**	Mainline	
Elev.:	26.3 ft	**Latitude:**	33.7104291		**Longitude:**	79.5754921		**Date Started:**	11/25/2015	
Total Depth:	100 ft	**Soil Depth:**	100 ft		**Core Depth:**	0 ft		**Date Completed:**	11/25/2015	
Bore Hole Diameter (in):	3	**Sampler Configuration**			**Liner Required:**	Y (N)		**Liner Used:**	Y (N)	
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary		**Hammer Type:**	Automatic		**Energy Ratio:**	81%	
Core Size:	N/A	**Driller:**	Carolina Drilling		**Groundwater:**	**TOB**	N/A	**24HR**	N/A	

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● / PL MC LL / ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		- - - very stiff		78.5	SS/19	6	7	10	17	
-53.7										
		- - - hard		83.5	SS/20	5	14	36	50	
-58.7										
		- - - LL=43, PL=18, PI=25, NMC=23.2, %200=55.8		88.5	SS/21	7	17	14	31	
-63.7										
		- - - very stiff		93.5	SS/22	6	8	9	17	
-68.7										
		- - - hard		98.5	SS/23	7	17	50/1"	50/1"	
-73.7	100.0	**BORING TERMINATED AT 100 FEET**								

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	B-3
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek			**Route:**	S-51
Eng./Geo.:	D. Harris	**Boring Location:**	67+84	**Offset:**	1'-RT
Alignment:	Mainline				
Elev.:	26.0 ft	**Latitude:**	33.7107864	**Longitude:**	79.5754263
Date Started:	1/18/2016	**Date Completed:**	1/18/2016		
Total Depth:	86.1 ft	**Soil Depth:**	75 ft	**Core Depth:**	0 ft
Bore Hole Diameter (in):	6	**Sampler Configuration**			
Liner Required:	Y (N)	**Liner Used:**	Y (N)		
Drill Machine:	CME 550	**Drill Method:**	HSA/RW	**Hammer Type:**	Automatic
Energy Ratio:	74%				
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	TOB 9.2 ft / 24HR N/A

● SPT N VALUE ● PL — MC — LL ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	SPT N Value plot
	0.0	Concrete Bridge Deck							
	0.8	CONCRETE (8.25")							
21.0		AIR GAP							
16.0	9.2 ▽								
	11.1	**ALLUVIUM** Very Loose to Loose, Wet, Black, Non to Low Plasticity, Organic Silty SAND (SM/A-2-4), with Traces of Wood, Munsell=2.5Y 2.5/1, NMC=250%, %#200=15.7	11.1	SS-1	WOH/12"		2	2	4th 6" = 2 Blows; 250
11.0		@SS-2 => NMC=311%, %#200=15.1	13.1	SS-2	WOH/18"			WOH	4th 6" = WOH; 311
		@SS-3 => NMC=23.9%, LL=NP, PL=NP, PI=NP, %#200=26.1	15.1	SS-3	WOH	1	2	3	4th 6" = 6 Blows
		@SS-4 => Dark Gray, Low Plasticity, Munsell=2.5Y 4/1	17.1	SS-4	8	5	5	10	4th 6" = 6 Blows
6.0		@SS-5 => NMC=16.7%, LL=NP, PL=NP, PI=NP, %#200=32.9	19.1	SS-5	4	5	3	8	4th 6" = 3 Blows
1.0		=> Medium Dense, Yellowish Brown, Munsell=10YR 5/6	24.6	SS-6	14	11	7	18	
-4.0	29.6	**PEE DEE FORMATION** Very Dense, Moist to Wet, Light Yellowish Brown, Non-Plastic, Fine SAND (SP/A-3), Munsell=2.5Y 6/3	29.6	SS-7	24	42	50/5"	92+	
-9.0			34.6	SS-8	19	27	50/5.5"	77+	
-14.0	39.6	Very Dense, Moist to Wet, Gray, Low Plasticity, Silty Fine SAND (SM/A-2-4), Munsell=2.5Y 5/1	39.6	SS-9	5	9	50/5.5"	59+	

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461			**County:**	Williamsburg			**Boring No.:**	B-3
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek							**Route:**	S-51
Eng./Geo.:	D. Harris	**Boring Location:**	67+84	**Offset:**	1'-RT			**Alignment:**	Mainline
Elev.:	26.0 ft	**Latitude:**	33.7107864	**Longitude:**	79.5754263			**Date Started:**	1/18/2016
Total Depth:	86.1 ft	**Soil Depth:**	75 ft	**Core Depth:**	0 ft			**Date Completed:**	1/18/2016
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y (N)			**Liner Used:**	Y (N)
Drill Machine:	CME 550	**Drill Method:**	HSA/RW	**Hammer Type:**	Automatic			**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	**TOB**	9.2 ft		**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	Notes
-19.0		@SS-10 => Medium Dense, NMC=32.7%, LL=NP, PL=NP, PI=NP, %#200=33.4	44.6	SS-10	6	6	7	13	
-24.0			49.6	SS-11	5	5	8	13	
-29.0	54.6	Hard to Very Stiff, Moist, Dark Gray, Low Plasticity, <u>CLAY (CL/A-6)</u>, Micaceous, Munsell=5Y 4/1	54.6	SS-12	6	50/2"		100+	>>
-34.0			59.6	SS-13	5	7	9	16	
-39.0	64.6	Medium Dense, Moist, Dark Gray, Clayey, Non-Plastic, Fine <u>SAND (SC/A-2-4)</u>, Munsell=5Y 4/1	64.6	SS-14	5	6	9	15	
		=> Very Dense, Moist, with Sandstone Lense, Munsell=5Y 4/1	68.1						Hard Drilling at 68.1 feet
-44.0			69.6	SS-15		50/1"		100+	>>
-49.0	74.6	Very Stiff, Moist, Very Dark Greenish Gray, Low Plasticity, <u>CLAY (CL)</u>, with Fine Sand, Micaceous, Munsell=10Y 3/1	74.6	SS-16	11	8	9	17	
-54.0		=> with Shell Fragments	79.6	SS-17	11	6	9	15	
-59.0		=> Hard	84.6	SS-18	6	8	50/4"	58+	
	85.9	Boring Terminated at 85.9 feet							

SPT N VALUE; PL, MC, LL; ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461			**County:**	Williamsburg	**Boring No.:**	B-4
Site Description:	S-51 (Battery Park Road) RBO Black Mingo Creek					**Route:**	S-51
Eng./Geo.:	D. Harris	**Boring Location:**	68+69	**Offset:**	CL	**Alignment:**	Mainline
Elev.:	26.6 ft	**Latitude:**	33.7105583	**Longitude:**	79.5754793	**Date Started:**	1/19/2016
Total Depth:	92.9 ft	**Soil Depth:**	75 ft	**Core Depth:**	0 ft	**Date Completed:**	1/20/2016
Bore Hole Diameter (in):	6	**Sampler Configuration**		**Liner Required:**	Y [✓ N]	**Liner Used:**	Y [✓ N]
Drill Machine:	CME 550	**Drill Method:**	HSA/RW	**Hammer Type:**	Automatic	**Energy Ratio:**	74%
Core Size:	N/A	**Driller:**	Ameridrill	**Groundwater:**	**TOB** 7.6 ft	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● / PL MC LL / ▲ FINES CONTENT (%)
	0.0	Concrete Bridge Deck							
	0.3	ASPHALT (3.5")							
	1.0	CONCRETE (9")							
		AIR VOID							
21.6									
	7.6 ▽								
16.6									
11.6									
	17.9	**ALLUVIUM** Loose, Wet, Gray, Non-Plastic, Clayey Fine to Medium SAND (SC/A-2-6), with Wood Fragments, Munsell=5Y 5/1, NMC=25.0%, %#200=34.0	17.9	SS-1	3	3	3	6	4th 6" = 3 Blows
6.6			19.9	SS-2	2	5	6	11	4th 6" = 9 Blows
			21.9	SS-3	5	8	10	18	4th 6" = 10 Blows
	23.9	@SS-2 => Medium Dense, Olive Brown, with Clay and Wood Fragments, Munsell=2.5Y 4/3, NMC=28.2%, LL=31, PL=20, PI=11, %#200=35.3	23.9	SS-4	8	11	14	25	4th 6" = 27 Blows
1.6		**PEE DEE FORMATION** Medium Dense to Very Dense, Wet, Light Olive Brown Low Plasticity, Fine SAND (SP/A-3), with Clay and Wood Fragments, Munsell=5Y 5/1	25.9	SS-5	9	30	50/5.5"	80+	
-3.4			31.4	SS-6	27	31	32	63	
-8.4		=> Gray, Munsell=2.5Y 6/1	36.4	SS-7	20	31	50/5.5"	81+	
-13.4	41.4	Medium Dense, Wet, Dark Gray, Low Plasticity, Fine Sandy SILT (ML/A-4(7)), Munsell=2.5Y 4/1, NMC=34.8%, LL=39, PL=29, PI=10, %#200=68.7	41.4	SS-8	4	6	8	14	
-18.4			46.4	SS-9	7	10	10	20	

LEGEND

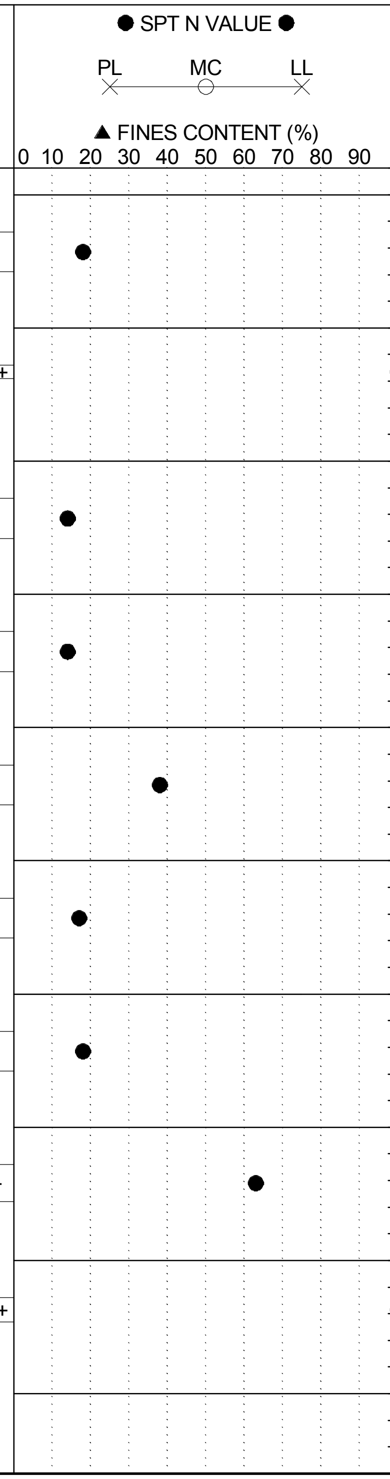
Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID: P029461			**County:** Williamsburg			**Boring No.:** B-4	
Site Description: S-51 (Battery Park Road) RBO Black Mingo Creek						**Route:** S-51	
Eng./Geo.: D. Harris	**Boring Location:** 68+69		**Offset:** CL			**Alignment:** Mainline	
Elev.: 26.6 ft	**Latitude:** 33.7105583		**Longitude:** 79.5754793			**Date Started:** 1/19/2016	
Total Depth: 92.9 ft	**Soil Depth:** 75 ft		**Core Depth:** 0 ft			**Date Completed:** 1/20/2016	
Bore Hole Diameter (in): 6	**Sampler Configuration**		**Liner Required:** Y (N)			**Liner Used:** Y (N)	
Drill Machine: CME 550	**Drill Method:** HSA/RW		**Hammer Type:** Automatic			**Energy Ratio:** 74%	
Core Size: N/A	**Driller:** Ameridrill		**Groundwater:**	**TOB** 7.6 ft		**24HR** N/A	

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
-23.4								
	51.4	Very Stiff, Wet, Dark Gray, Low Plasticity, Fine Sandy CLAY (CL/A-6), Munsell=2.5Y 4/1	51.4	SS-10	5	8	10	18
-28.4	56.4	Hard, Wet, Dark Gray, Clayey, Low Plasticity, Fine SAND (SC/A-2-6), Munsell=2.5Y 4/1	56.4	SS-11	50/5.5"			100+
-33.4	61.4	Stiff to Hard, Wet to Moist, Dark Gray, Low Plasticity, Fine Sandy CLAY (CL/A-6), Munsell=2.5Y 4/1	61.4	SS-12	4	6	8	14
-38.4			66.4	SS-13	5	6	8	14
-43.4		=> with Shell Fragments	71.4	SS-14	30	18	20	38
-48.4			76.4	SS-15	5	7	10	17
-53.4			81.4	SS-16	6	8	10	18
-58.4			86.4	SS-17	7	13	50/4.5"	63+
-63.4	92.3	Boring Terminated at 92.3 feet	91.4	SS-18	7	50/4.5"		100+
-68.4								



LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

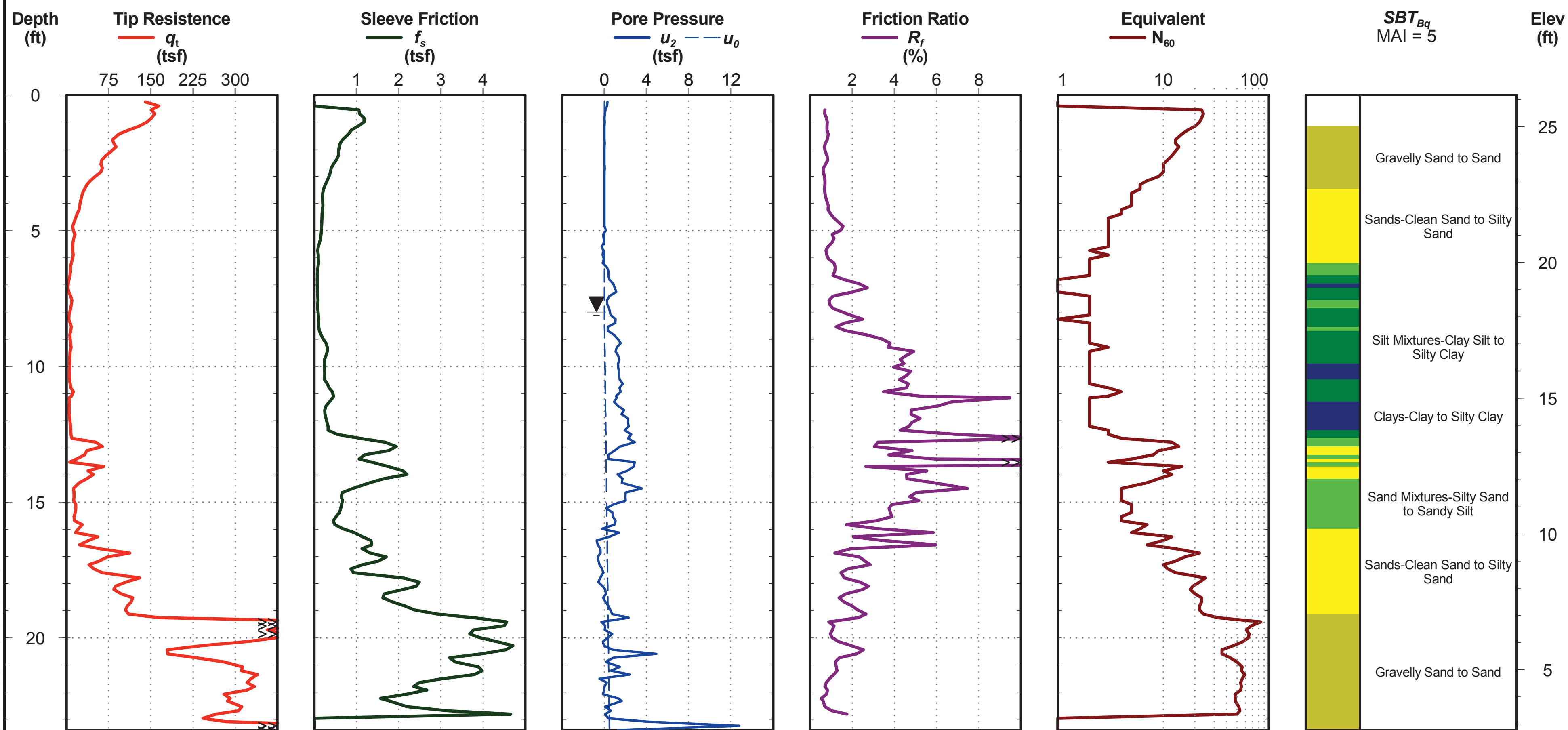
S-45-51 ERBO Black Mingo Creek
Williamsburg County, South Carolina
S&ME Project No: 1413-15-145

Cone Penetration Test — CPT-2

Date: Nov. 30, 2015
Estimated Water Depth: 8 ft
Rig/Operator: CPT Truck/A. Feix

Northing: 686102.64
Easting: 2433149.33
Elevation: 25.8 ft

Total Depth: 23.4 ft
Termination Criteria: Maximum Reaction Force
Cone Size: 1.75



CPT REPORT - STANDARD - SBT BQ 1413-15-145 CPT.GPJ S&ME.GDT 12/1/15

CPT-2

Electronic Filename: 1413-15-145_SCDOT_S-45-51 RBO Black M

S-45-51 ERBO Black Mingo Creek
Williamsburg County, South Carolina
S&ME Project No: 1413-15-145

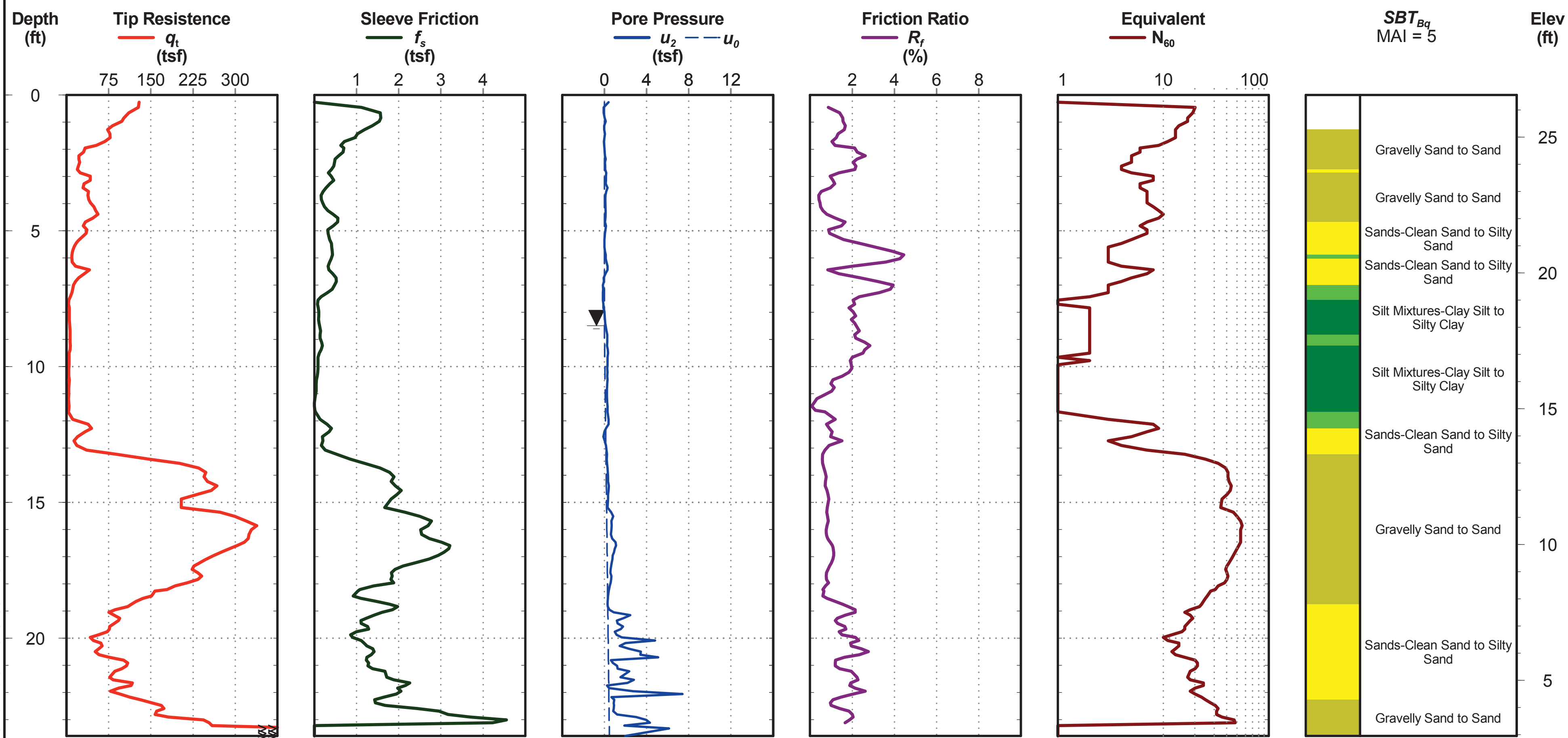
Cone Penetration Test

CPT-3

Date: Nov. 30, 2015
Estimated Water Depth: 8.5 ft
Rig/Operator: CPT Truck/A. Feix

Northing: 685920.66
Easting: 2433109.09
Elevation: 26.4 ft

Total Depth: 23.6 ft
Termination Criteria: Maximum Reaction Force
Cone Size: 1.75



CPT REPORT - STANDARD - SBT BQ 1413-15-145 CPT.GPJ S&ME.GDT 12/1/15

CPT-3

Electronic Filename: 1413-15-145_SCDOT_S-45-51 RBO Black M

F&ME CONSULTANTS

S-51 (Battery Park Rd.) RBO Black Mingo Creek
Williamsburg County, South Carolina
Project No. :G5556.02

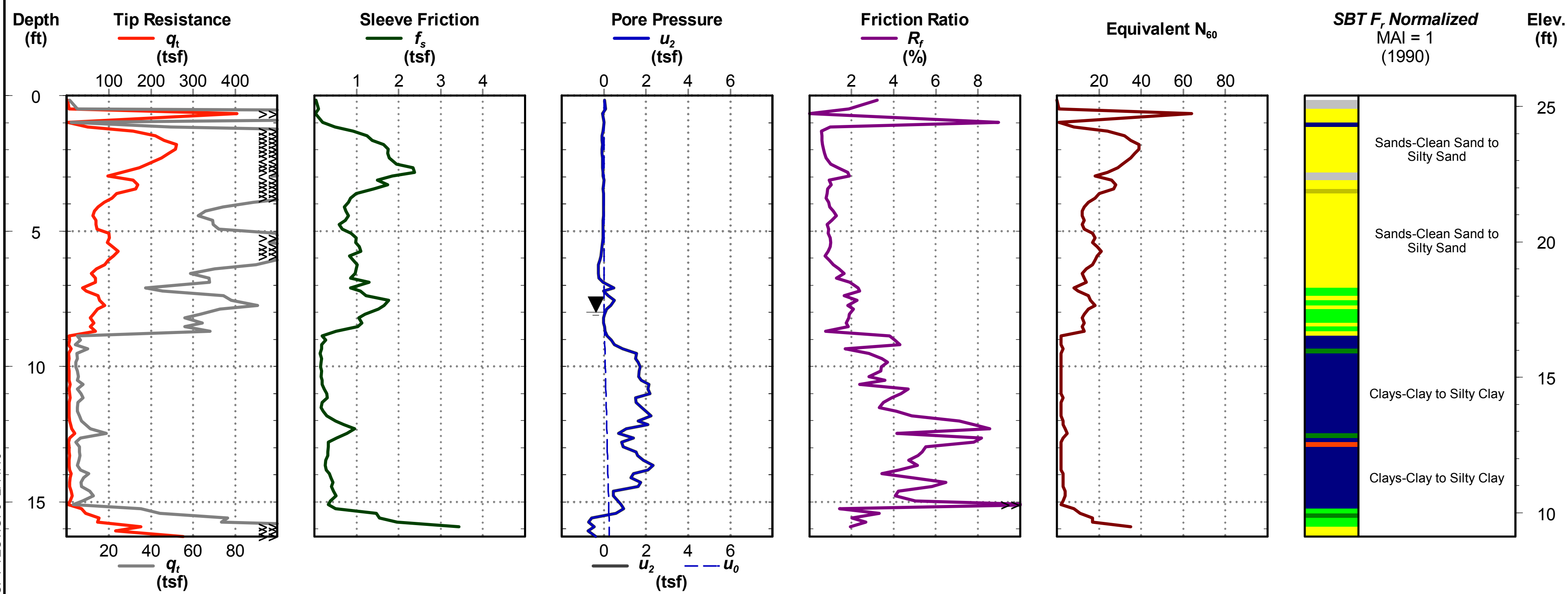
Cone Penetration Test

CPT-5

Date: Feb. 2, 2016
Estimated Water Depth: 8 ft
Rig/Operator: PJ

Station: 67+11
Offset: 1'-RT
Elevation: 25.4

Total Depth: 16.3 ft
Termination Criteria: Maximum Reaction Force
Cone Size:



CPT-5

Electronic File Name: G5556.02 S-51 over Black Mingo Creek CPT

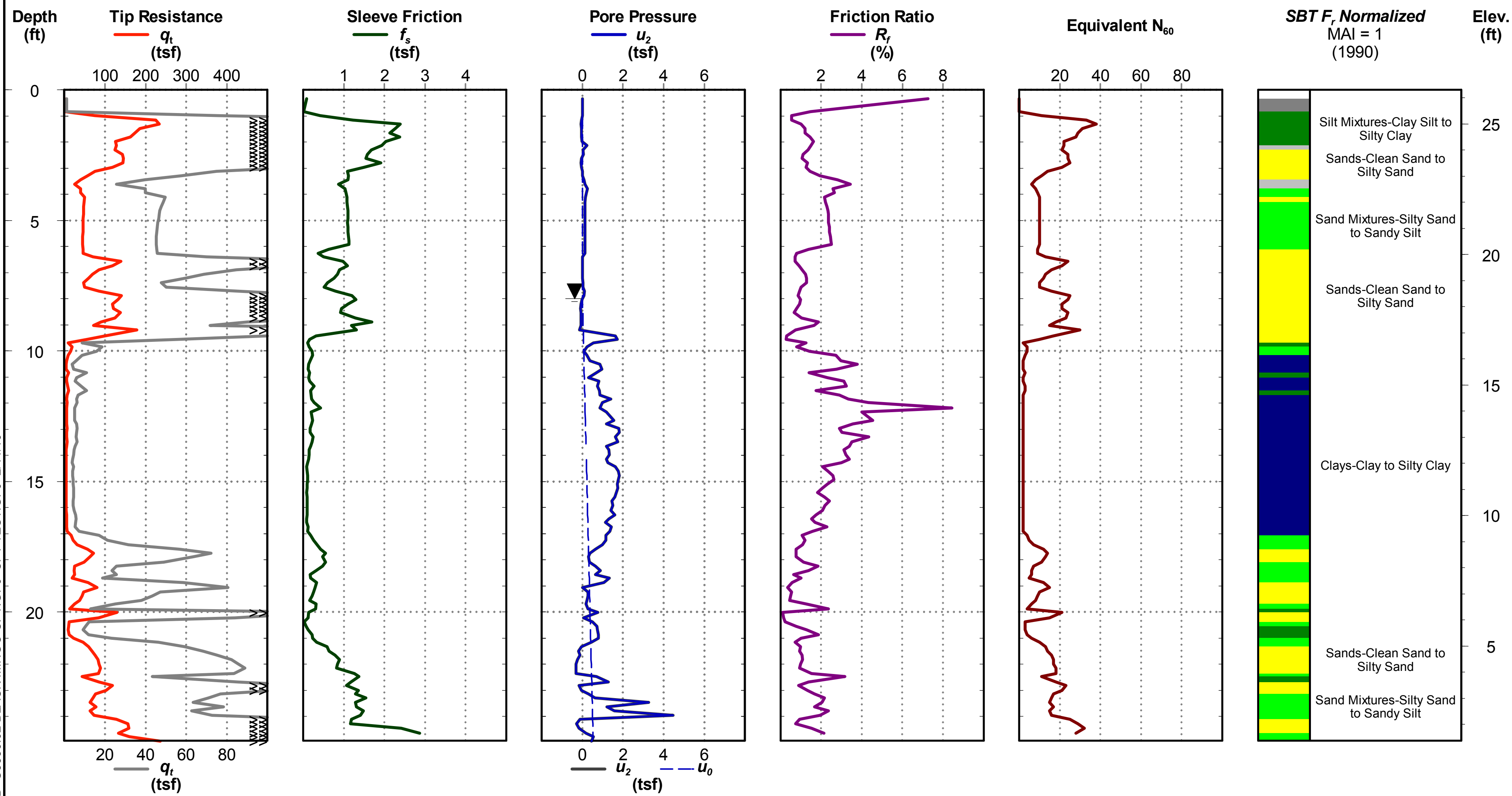
F&ME CONSULTANTS

S-51 (Battery Park Rd.) RBO Black Mingo Creek
Williamsburg County, South Carolina
Project No. :G5556.02

Cone Penetration Test

CPT-6

Date:	Feb. 1, 2016	**Station:**	69+77	**Total Depth:**	24.9 ft
Estimated Water Depth:	8 ft	**Offset:**	CL	**Termination Criteria:**	Maximum Reaction Force
Rig/Operator:	PJ	**Elevation:**	26.3	**Cone Size:**	



CPT-6

Electronic File Name: G5556.02 S-51 over Black Mingo Creek CPT

APPENDIX

SECTION 5

SOIL PARAMETER CORRELATIONS

SUBSECTION A
SPT METHOD

Project: S-51 Bridge over Black Mingo Creek - **Soil Strength Parameter Calculations**
Location : Station 67+50 (EB1)
Calc. By: JFH
Date: 1/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 7*

Top of Boring EL = 26.3 ft-MSL
Groundwater Depth = 8.0 ft

SPT-1

	Elevation	**Depth**	**SPT Test Interval**		**γ**	**γ'**	**σ'_v**	**N_{meas}**	**C_R**	**C_S**	**C_B**	**C_E**	**C_N**	**N_{60}**	**$N^*_{1,60}$**	**Correlated Effective Phi Angle, φ'**	**Correlated Effective Cohesion, c'**
	ft-MSL	*ft*	*ft*		*pcf*	*pcf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*deg*	*psf*
	26.3	1	0	2	115	115	0.12	21	0.75	1.00	1.00	1.43	1.60	30.1	36.1	43.6	2257.5
	25.3	2					0.23		0.75	1.00	1.00	1.43	1.60	30.1	36.1	43.6	2257.5
	24.3	3	2	4	115	115	0.35	10	0.75	1.00	1.00	1.43	1.60	14.3	17.2	36.3	1075.0
SM	23.3	4					0.46		0.75	1.00	1.00	1.43	1.60	14.3	17.2	36.3	1075.0
	22.3	5	4	6	115	115	0.58	7	0.85	1.00	1.00	1.43	1.60	10.0	13.6	34.5	752.5
	21.3	6					0.69		0.85	1.00	1.00	1.43	1.60	10.0	13.6	34.5	752.5
	20.3	7	6	8	115	115	0.81	7	0.85	1.00	1.00	1.43	1.58	10.0	13.4	34.4	752.5
SC	19.3	8					0.92		0.85	1.00	1.00	1.43	1.47	10.0	12.6	33.9	752.5
	18.3	9	8	10	115	52.6	0.97	1	0.85	1.00	1.00	1.43	1.43	1.4	1.7	25.2	107.5
	17.3	10					1.03		0.85	1.00	1.00	1.43	1.40	1.4	1.7	25.1	107.5
SM	16.3	11					1.08		0.95	1.00	1.00	1.43	1.36	4.3	5.6	29.3	322.5
	15.3	12					1.13		0.95	1.00	1.00	1.43	1.33	4.3	5.4	29.1	322.5
	14.3	13	10.0	15.0	115	52.6	1.18	3	0.95	1.00	1.00	1.43	1.30	4.3	5.3	29.0	322.5
	13.3	14					1.24		0.95	1.00	1.00	1.43	1.27	4.3	5.2	28.9	322.5
OH	12.3	15					1.29		0.95	1.00	1.00	1.43	1.25	4.3	5.1	28.9	322.5
	11.3	16					1.29		0.95	1.00	1.00	1.43	1.25	41.6	49.2	47.5	3117.5
	10.3	17					1.29		0.95	1.00	1.00	1.43	1.25	41.6	49.2	47.5	3117.5
	9.3	18	15.0	20.0	105	42.6	1.29	29	0.95	1.00	1.00	1.43	1.25	41.6	49.2	47.5	3117.5
	8.3	19					1.29		0.95	1.00	1.00	1.43	1.25	41.6	49.2	47.5	3117.5
	7.3	20					1.33		0.95	1.00	1.00	1.43	1.23	41.6	48.4	47.3	3117.5
	6.3	21					1.33		0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	5.3	22					1.33		0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	4.3	23	20.0	25.0	110	47.6	1.33	24	0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	3.3	24					1.33		0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	2.3	25					1.38		0.95	1.00	1.00	1.43	1.20	34.4	39.4	44.6	2580.0
	1.3	26					1.38		1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	0.3	27					1.38		1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	-0.7	28	25.0	30.0	120	57.6	1.38	100	1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	-1.7	29					1.38		1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	-2.7	30					1.44		1.00	1.00	1.00	1.43	1.18	143.3	169.2	71.0	10750.0
	-3.7	31					1.44		1.00	1.00	1.00	1.43	1.18	143.3	169.2	71.0	10750.0
	-4.7	32					1.44		1.00	1.00	1.00	1.43	1.18	143.3	169.2	71.0	10750.0
	-5.7	33	30.0	35.0	120	57.6	1.44	100	1.00	1.00	1.00	1.43	1.18	143.3	169.2	71.0	10750.0
	-6.7	34					1.44		1.00	1.00	1.00	1.43	1.18	143.3	169.2	71.0	10750.0
	-7.7	35					1.49		1.00	1.00	1.00	1.43	1.16	143.3	165.9	70.5	10750.0
	-8.7	36					1.49		1.00	1.00	1.00	1.43	1.16	22.9	26.5	40.2	1720.0
	-9.7	37					1.49		1.00	1.00	1.00	1.43	1.16	22.9	26.5	40.2	1720.0
	-10.7	38	35.0	40.0	115	52.6	1.49	16	1.00	1.00	1.00	1.43	1.16	22.9	26.5	40.2	1720.0
	-11.7	39					1.49		1.00	1.00	1.00	1.43	1.16	22.9	26.5	40.2	1720.0
	-12.7	40					1.55		1.00	1.00	1.00	1.43	1.14	22.9	26.1	40.0	1720.0
	-13.7	41					1.55		1.00	1.00	1.00	1.43	1.14	34.4	39.1	44.5	2580.0
	-14.7	42					1.55		1.00	1.00	1.00	1.43	1.14	34.4	39.1	44.5	2580.0
	-15.7	43	40.0	45.0	115	52.6	1.55	24	1.00	1.00	1.00	1.43	1.14	34.4	39.1	44.5	2580.0
	-16.7	44					1.55		1.00	1.00	1.00	1.43	1.14	34.4	39.1	44.5	2580.0
	-17.7	45					1.60		1.00	1.00	1.00	1.43	1.12	34.4	38.5	44.3	2580.0
	-18.7	46					1.60		1.00	1.00	1.00	1.43	1.12	41.6	46.5	46.8	3117.5
	-19.7	47					1.60		1.00	1.00	1.00	1.43	1.12	41.6	46.5	46.8	3117.5
	-20.7	48	45.0	50.0	115	52.6	1.60	29	1.00	1.00	1.00	1.43	1.12	41.6	46.5	46.8	3117.5
	-21.7	49					1.60		1.00	1.00	1.00	1.43	1.12	41.6	46.5	46.8	3117.5
	-22.7	50					1.65		1.00	1.00	1.00	1.43	1.10	41.6	45.7	46.5	3117.5
	-23.7	51					1.65		1.00	1.00	1.00	1.43	1.10	80.3	45.7	46.5	6020.0
	-24.7	52					1.65		1.00	1.00	1.00	1.43	1.10	80.3	45.7	46.5	6020.0
	-25.7	53	50.0	50.0	115	52.6	1.65	56	1.00	1.00	1.00	1.43	1.10	80.3	45.7	46.5	6020.0
	-26.7	54					1.65		1.00	1.00	1.00	1.43	1.10	80.3	45.7	46.5	6020.0
	-27.7	55					1.70		1.00	1.00	1.00	1.43	1.08	80.3	45.0	46.3	6020.0
	-28.7	56					1.70		1.00	1.00	1.00	1.43	1.08	143.3	45.0	46.3	10750.0
	-29.7	57					1.70		1.00	1.00	1.00	1.43	1.08	143.3	45.0	46.3	10750.0
COASTAL	-30.7	58	50.0	50.0	115	52.6	1.70	100	1.00	1.00	1.00	1.43	1.08	143.3	45.0	46.3	10750.0
PLAIN	-31.7	59					1.70		1.00	1.00	1.00	1.43	1.08	143.3	45.0	46.3	10750.0
	-32.7	60					1.76		1.00	1.00	1.00	1.43	1.07	143.3	44.4	46.1	10750.0
	-33.7	61					1.76		1.00	1.00	1.00	1.43	1.07	22.9	44.4	46.1	1720.0
	-34.7	62					1.76		1.00	1.00	1.00	1.43	1.07	22.9	44.4	46.1	1720.0
	-35.7	63	50.0	50.0	115	52.6	1.76	16	1.00	1.00	1.00	1.43	1.07	22.9	44.4	46.1	1720.0
	-36.7	64					1.76		1.00	1.00	1.00	1.43	1.07	22.9	44.4	46.1	1720.0
	-37.7	65					1.81		1.00	1.00	1.00	1.43	1.05	22.9	43.7	45.9	1720.0
	-38.7	66					1.81		1.00	1.00	1.00	1.43	1.05	143.3	43.7	45.9	10750.0
	-39.7	67					1.81		1.00	1.00	1.00	1.43	1.05	143.3	43.7	45.9	10750.0
	-40.7	68	50.0	50.0	115	52.6	1.81	100	1.00	1.00	1.00	1.43	1.05	143.3	43.7	45.9	10750.0
	-41.7	69					1.81		1.00	1.00	1.00	1.43	1.05	143.3	43.7	45.9	10750.0
	-42.7	70					1.86		1.00	1.00	1.00	1.43	1.04	143.3	43.1	45.8	10750.0
	-43.7	71					1.86		1.00	1.00	1.00	1.43	1.04	17.2	43.1	45.8	1290.0
	-44.7	72					1.86		1.00	1.00	1.00	1.43	1.04	17.2	43.1	45.8	1290.0
	-45.7	73	50.0	50.0	115	52.6	1.86	12	1.00	1.00	1.00	1.43	1.04	17.2	43.1	45.8	1290.0
	-46.7	74					1.86		1.00	1.00	1.00	1.43	1.04	17.2	43.1	45.8	1290.0
	-47.7	75					1.91		1.00	1.00	1.00	1.43	1.02	17.2	42.5	45.6	1290.0
	-48.7	76					1.91		1.00	1.00	1.00	1.43	1.02	24.4	42.5	45.6	1827.5
	-49.7	77					1.91		1.00	1.00	1.00	1.43	1.02	24.4	42.5	45.6	1827.5
	-50.7	78	50.0	50.0	115	52.6	1.91	17	1.00	1.00	1.00	1.43	1.02	24.4	42.5	45.6	1827.5
	-51.7	79					1.91		1.00	1.00	1.00	1.43	1.02	24.4	42.5	45.6	1827.5
	-52.7	80					1.97		1.00	1.00	1.00	1.43	1.01	24.4	41.9	45.4	1827.5
	-53.7	81					1.97		1.00	1.00	1.00	1.43	1.01	33.0	41.9	45.4	2472.5
	-54.7	82					1.97		1.00	1.00	1.00	1.43	1.01	33.0	41.9	45.4	2472.5
	-55.7	83	50.0	50.0	115	52.6	1.97	23	1.00	1.00	1.00	1.43	1.01	33.0	41.9	45.4	2472.5
	-56.7	84					1.97		1.00	1.00	1.00	1.43	1.01	33.0	41.9	45.4	2472.5
	-57.7	85					2.02		1.00	1.00	1.00	1.43	1.00	33.0	41.4	45.2	2472.5
	-58.7	86					2.02		1.00	1.00	1.00	1.43	1.00	25.8	41.4	45.2	1935.0
	-59.7	87					2.02		1.00	1.00	1.00	1.43	1.00	25.8	41.4	45.2	1935.0
	-60.7	88	50.0	50.0	115	52.6	2.02	18	1.00	1.00	1.00	1.43	1.00	25.8	41.4	45.2	1935.0
	-61.7	89					2.02		1.00	1.00	1.00	1.43	1.00	25.8	41.4	45.2	1935.0
	-62.7	90					2.07		1.00	1.00	1.00	1.43	0.98	25.8	40.8	45.1	1935.0
	-63.7	91					2.07		1.00	1.00	1.00	1.43	0.98	28.7	40.8	45.1	2150.0
	-64.7	92					2.07		1.00	1.00	1.00	1.43	0.98	28.7	40.8	45.1	2150.0
	-65.7	93	50.0	50.0	115	52.6	2.07	20	1.00	1.00	1.00	1.43	0.98	28.7	40.8	45.1	2150.0
	-66.7	94					2.07		1.00	1.00	1.00	1.43	0.98	28.7	40.8	45.1	2150.0
	-67.7	95					2.12		1.00	1.00	1.00	1.43	0.97	28.7	40.3	44.9	2150.0
	-68.7	96					2.12		1.00	1.00	1.00	1.43	0.97	143.3	40.3	44.9	10750.0
	-69.7	97					2.12		1.00	1.00	1.00	1.43	0.97	143.3	40.3	44.9	10750.0
	-70.7	98	50.0	50.0	115	52.6	2.12	100	1.00	1.00	1.00	1.43	0.97	143.3	40.3	44.9	10750.0
	-71.7	99					2.12		1.00	1.00	1.00	1.43	0.97	143.3	40.3	44.9	10750.0
	-72.7	100					2.18		1.00	1.00	1.00	1.43	0.96	143.3	39.8	44.8	10750.0

Project: S-51 Bridge over Black Mingo Creek - **Soil Strength Parameter Calculations**
Location : Station 69+15 (EB4)
Calc. By: JFH
Date: 1/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 7*

F&ME CONSULTANTS

Top of Boring EL = 15.2 ft-MSL
Groundwater Depth = 0.0 ft

B-3

	Elevation	Depth	SPT Test Interval		γ	γ'	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	N_{60}	$N^*_{1,60}$	Correlated Effective Phi Angle, ϕ'	Correlated Effective Cohesion, c'
	ft-MSL	*ft*	*ft*		*pcf*	*pcf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*deg*	*psf*
SM	15.2	1	0	2	115	52.6	0.05	2	0.75	1.00	1.00	1.43	1.60	2.9	3.4	27.3	215.0
	14.2	2					0.11		0.75	1.00	1.00	1.43	1.60	2.9	3.4	27.3	215.0
	13.2	3	2	4	115	52.6	0.16	0	0.75	1.00	1.00	1.43	1.60	0.0	0.0	20.0	0.0
	12.2	4					0.21		0.75	1.00	1.00	1.43	1.60	0.0	0.0	20.0	0.0
	11.2	5	4	6	115	52.6	0.26	3	0.85	1.00	1.00	1.43	1.60	4.3	5.8	29.5	322.5
	10.2	6					0.32		0.85	1.00	1.00	1.43	1.60	4.3	5.8	29.5	322.5
	9.2	7	6	8	115	52.6	0.37	10	0.85	1.00	1.00	1.43	1.60	14.3	19.5	37.3	1075.0
	8.2	8					0.42		0.85	1.00	1.00	1.43	1.60	14.3	19.5	37.3	1075.0
	7.2	9	8	10	115	52.6	0.47	8	0.85	1.00	1.00	1.43	1.60	11.5	15.6	35.5	860.0
	6.2	10					0.53		0.85	1.00	1.00	1.43	1.60	11.5	15.6	35.5	860.0
	5.2	11	10.0	15.0	115	52.6	0.58	18	0.95	1.00	1.00	1.43	1.60	25.8	39.2	44.6	1935.0
	4.2	12					0.63		0.95	1.00	1.00	1.43	1.60	25.8	39.2	44.6	1935.0
	3.2	13					0.68		0.95	1.00	1.00	1.43	1.60	25.8	39.2	44.6	1935.0
	2.2	14					0.74		0.95	1.00	1.00	1.43	1.60	25.8	39.2	44.6	1935.0
	1.2	15					0.79		0.95	1.00	1.00	1.43	1.59	25.8	39.0	44.5	1935.0
	0.2	16	15.0	20.0	105	42.6	0.79	92	0.95	1.00	1.00	1.43	1.59	131.9	199.5	75.4	9890.0
	-0.8	17					0.79		0.95	1.00	1.00	1.43	1.59	131.9	199.5	75.4	9890.0
	-1.8	18					0.79		0.95	1.00	1.00	1.43	1.59	131.9	199.5	75.4	9890.0
COASTAL PLAIN	-2.8	19					0.79		0.95	1.00	1.00	1.43	1.59	131.9	199.5	75.4	9890.0
	-3.8	20					0.83		0.95	1.00	1.00	1.43	1.55	131.9	194.3	74.7	9890.0
	-4.8	21	20.0	25.0	110	47.6	0.83	77	0.95	1.00	1.00	1.43	1.55	110.4	162.6	70.0	8277.5
	-5.8	22					0.83		0.95	1.00	1.00	1.43	1.55	110.4	162.6	70.0	8277.5
	-6.8	23					0.83		0.95	1.00	1.00	1.43	1.55	110.4	162.6	70.0	8277.5
	-7.8	24					0.83		0.95	1.00	1.00	1.43	1.55	110.4	162.6	70.0	8277.5
	-8.8	25					0.88		0.95	1.00	1.00	1.43	1.51	110.4	158.1	69.3	8277.5
	-9.8	26	25.0	30.0	110	47.6	0.88	59	1.00	1.00	1.00	1.43	1.51	84.6	127.5	64.3	6342.5
	-10.8	27					0.88		1.00	1.00	1.00	1.43	1.51	84.6	127.5	64.3	6342.5
	-11.8	28					0.88		1.00	1.00	1.00	1.43	1.51	84.6	127.5	64.3	6342.5
	-12.8	29					0.88		1.00	1.00	1.00	1.43	1.51	84.6	127.5	64.3	6342.5
	-13.8	30					0.93		1.00	1.00	1.00	1.43	1.47	84.6	124.2	63.7	6342.5
	-14.8	31	30.0	35.0	110	47.6	0.93	13	1.00	1.00	1.00	1.43	1.47	18.6	27.4	40.5	1397.5
	-15.8	32					0.93		1.00	1.00	1.00	1.43	1.47	18.6	27.4	40.5	1397.5
	-16.8	33					0.93		1.00	1.00	1.00	1.43	1.47	18.6	27.4	40.5	1397.5
	-17.8	34					0.93		1.00	1.00	1.00	1.43	1.47	18.6	27.4	40.5	1397.5
	-18.8	35					0.97		1.00	1.00	1.00	1.43	1.43	18.6	26.7	40.3	1397.5
	-19.8	36	35.0	40.0	110	47.6	0.97	13	1.00	1.00	1.00	1.43	1.43	18.6	26.7	40.3	1397.5
	-20.8	37					0.97		1.00	1.00	1.00	1.43	1.43	18.6	26.7	40.3	1397.5
	-21.8	38					0.97		1.00	1.00	1.00	1.43	1.43	18.6	26.7	40.3	1397.5
	-22.8	39					0.97		1.00	1.00	1.00	1.43	1.43	18.6	26.7	40.3	1397.5
	-23.8	40					1.02		1.00	1.00	1.00	1.43	1.40	18.6	26.1	40.0	1397.5
	-24.8	41	40.0	45.0	115	52.6	1.02	100	1.00	1.00	1.00	1.43	1.40	143.3	200.5	75.6	10750.0
	-25.8	42					1.02		1.00	1.00	1.00	1.43	1.40	143.3	200.5	75.6	10750.0
	-26.8	43					1.02		1.00	1.00	1.00	1.43	1.40	143.3	200.5	75.6	10750.0
	-27.8	44					1.02		1.00	1.00	1.00	1.43	1.40	143.3	200.5	75.6	10750.0
	-28.8	45					1.07		1.00	1.00	1.00	1.43	1.36	143.3	195.5	74.9	10750.0
	-29.8	46	45.0	50.0	115	52.6	1.07	16	1.00	1.00	1.00	1.43	1.36	22.9	31.3	42.0	1720.0
	-30.8	47					1.07		1.00	1.00	1.00	1.43	1.36	22.9	31.3	42.0	1720.0
	-31.8	48					1.07		1.00	1.00	1.00	1.43	1.36	22.9	31.3	42.0	1720.0
	-32.8	49					1.07		1.00	1.00	1.00	1.43	1.36	22.9	31.3	42.0	1720.0
	-33.8	50					1.13		1.00	1.00	1.00	1.43	1.33	22.9	30.5	41.7	1720.0
	-34.8	51	50.0	50.0	115	52.6	1.13	15	1.00	1.00	1.00	1.43	1.33	21.5	30.5	41.7	1612.5
	-35.8	52					1.13		1.00	1.00	1.00	1.43	1.33	21.5	30.5	41.7	1612.5
	-36.8	53					1.13		1.00	1.00	1.00	1.43	1.33	21.5	30.5	41.7	1612.5
	-37.8	54					1.13		1.00	1.00	1.00	1.43	1.33	21.5	30.5	41.7	1612.5
	-38.8	55					1.18		1.00	1.00	1.00	1.43	1.30	21.5	29.9	41.4	1612.5
	-39.8	56	50.0	50.0	115	52.6	1.18	100	1.00	1.00	1.00	1.43	1.30	143.3	29.9	41.4	10750.0
	-40.8	57					1.18		1.00	1.00	1.00	1.43	1.30	143.3	29.9	41.4	10750.0
	-41.8	58					1.18		1.00	1.00	1.00	1.43	1.30	143.3	29.9	41.4	10750.0
	-42.8	59					1.18		1.00	1.00	1.00	1.43	1.30	143.3	29.9	41.4	10750.0
	-43.8	60					1.23		1.00	1.00	1.00	1.43	1.27	143.3	29.2	41.2	10750.0
	-44.8	61	50.0	50.0	115	52.6	1.23	17	1.00	1.00	1.00	1.43	1.27	24.4	29.2	41.2	1827.5
	-45.8	62					1.23		1.00	1.00	1.00	1.43	1.27	24.4	29.2	41.2	1827.5
	-46.8	63					1.23		1.00	1.00	1.00	1.43	1.27	24.4	29.2	41.2	1827.5
	-47.8	64					1.23		1.00	1.00	1.00	1.43	1.27	24.4	29.2	41.2	1827.5
	-48.8	65					1.29		1.00	1.00	1.00	1.43	1.25	24.4	28.6	41.0	1827.5
	-49.8	66	50.0	50.0	115	52.6	1.29	15	1.00	1.00	1.00	1.43	1.25	21.5	28.6	41.0	1612.5
	-50.8	67					1.29		1.00	1.00	1.00	1.43	1.25	21.5	28.6	41.0	1612.5
	-51.8	68					1.29		1.00	1.00	1.00	1.43	1.25	21.5	28.6	41.0	1612.5
	-52.8	69					1.29		1.00	1.00	1.00	1.43	1.25	21.5	28.6	41.0	1612.5
	-53.8	70					1.34		1.00	1.00	1.00	1.43	1.22	21.5	28.0	40.8	1612.5
	-54.8	71	50.0	50.0	115	52.6	1.34	58	1.00	1.00	1.00	1.43	1.22	83.1	28.0	40.8	6235.0
	-55.8	72					1.34		1.00	1.00	1.00	1.43	1.22	83.1	28.0	40.8	6235.0
	-56.8	73					1.34		1.00	1.00	1.00	1.43	1.22	83.1	28.0	40.8	6235.0
	-57.8	74					1.34		1.00	1.00	1.00	1.43	1.22	83.1	28.0	40.8	6235.0
	-58.8	75					1.39		1.00	1.00	1.00	1.43	1.20	83.1	27.5	40.6	6235.0

Project: S-51 Bridge over Black Mingo Creek - **Soil Strength Parameter Calculations**
Location : Station 69+15 (EB4)
Calc. By: JFH
Date: 1/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 7*

F&ME CONSULTANTS

Top of Boring EL = 8.5 ft-MSL
Groundwater Depth = 0.0 ft

B-4

	Elevation	Depth	SPT Test Interval		γ	γ'	σ'$_v$	N_{meas}	C_R	C_S	C_B	C_E	C_N	N_{60}	$N^*_{1,60}$	Correlated Effective Phi Angle, ϕ'	Correlated Effective Cohesion, c'
	ft-MSL	*ft*	*ft*		*pcf*	*pcf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*deg*	*psf*
SC	8.5	1	0	2	115	52.6	0.05	6	0.75	1.00	1.00	1.43	1.60	8.6	10.3	32.6	645.0
	7.5	2					0.11		0.75	1.00	1.00	1.43	1.60	8.6	10.3	32.6	645.0
	6.5	3	2	4	115	52.6	0.16	11	0.75	1.00	1.00	1.43	1.60	15.8	18.9	37.1	1182.5
	5.5	4					0.21		0.75	1.00	1.00	1.43	1.60	15.8	18.9	37.1	1182.5
	4.5	5	4	6	115	52.6	0.26	18	0.85	1.00	1.00	1.43	1.60	25.8	35.1	43.2	1935.0
	3.5	6					0.32		0.85	1.00	1.00	1.43	1.60	25.8	35.1	43.2	1935.0
SP	2.5	7	6	8	115	52.6	0.37	25	0.85	1.00	1.00	1.43	1.60	35.8	48.7	47.4	2687.5
	1.5	8					0.42		0.85	1.00	1.00	1.43	1.60	35.8	48.7	47.4	2687.5
COASTAL PLAIN	0.5	9	8	10	115	52.6	0.47	80	0.85	1.00	1.00	1.43	1.60	114.7	155.9	69.0	8600.0
	-0.5	10					0.53		0.85	1.00	1.00	1.43	1.60	114.7	155.9	69.0	8600.0
	-1.5	11	10.0	15.0	115	52.6	0.58	63	0.95	1.00	1.00	1.43	1.60	90.3	137.3	66.0	6772.5
	-2.5	12					0.63		0.95	1.00	1.00	1.43	1.60	90.3	137.3	66.0	6772.5
	-3.5	13					0.68		0.95	1.00	1.00	1.43	1.60	90.3	137.3	66.0	6772.5
	-4.5	14					0.74		0.95	1.00	1.00	1.43	1.60	90.3	137.3	66.0	6772.5
	-5.5	15					0.79		0.95	1.00	1.00	1.43	1.59	90.3	136.6	65.9	6772.5
	-6.5	16	15.0	20.0	105	42.6	0.79	81	0.95	1.00	1.00	1.43	1.59	116.1	175.6	72.0	8707.5
	-7.5	17					0.79		0.95	1.00	1.00	1.43	1.59	116.1	175.6	72.0	8707.5
	-8.5	18					0.79		0.95	1.00	1.00	1.43	1.59	116.1	175.6	72.0	8707.5
	-9.5	19					0.79		0.95	1.00	1.00	1.43	1.59	116.1	175.6	72.0	8707.5
	-10.5	20					0.83		0.95	1.00	1.00	1.43	1.55	116.1	171.0	71.3	8707.5
	-11.5	21	20.0	25.0	110	47.6	0.83	14	0.95	1.00	1.00	1.43	1.55	20.1	29.6	41.3	1505.0
	-12.5	22					0.83		0.95	1.00	1.00	1.43	1.55	20.1	29.6	41.3	1505.0
	-13.5	23					0.83		0.95	1.00	1.00	1.43	1.55	20.1	29.6	41.3	1505.0
	-14.5	24					0.83		0.95	1.00	1.00	1.43	1.55	20.1	29.6	41.3	1505.0
	-15.5	25					0.88		0.95	1.00	1.00	1.43	1.51	20.1	28.8	41.0	1505.0
	-16.5	26	25.0	30.0	110	47.6	0.88	20	1.00	1.00	1.00	1.43	1.51	28.7	43.2	45.8	2150.0
	-17.5	27					0.88		1.00	1.00	1.00	1.43	1.51	28.7	43.2	45.8	2150.0
	-18.5	28					0.88		1.00	1.00	1.00	1.43	1.51	28.7	43.2	45.8	2150.0
	-19.5	29					0.88		1.00	1.00	1.00	1.43	1.51	28.7	43.2	45.8	2150.0
	-20.5	30					0.93		1.00	1.00	1.00	1.43	1.47	28.7	42.1	45.5	2150.0
	-21.5	31	30.0	35.0	110	47.6	0.93	18	1.00	1.00	1.00	1.43	1.47	25.8	37.9	44.2	1935.0
	-22.5	32					0.93		1.00	1.00	1.00	1.43	1.47	25.8	37.9	44.2	1935.0
	-23.5	33					0.93		1.00	1.00	1.00	1.43	1.47	25.8	37.9	44.2	1935.0
	-24.5	34					0.93		1.00	1.00	1.00	1.43	1.47	25.8	37.9	44.2	1935.0
	-25.5	35					0.97		1.00	1.00	1.00	1.43	1.43	25.8	37.0	43.9	1935.0
	-26.5	36	35.0	40.0	110	47.6	0.97	100	1.00	1.00	1.00	1.43	1.43	143.3	205.3	76.2	10750.0
	-27.5	37					0.97		1.00	1.00	1.00	1.43	1.43	143.3	205.3	76.2	10750.0
	-28.5	38					0.97		1.00	1.00	1.00	1.43	1.43	143.3	205.3	76.2	10750.0
	-29.5	39					0.97		1.00	1.00	1.00	1.43	1.43	143.3	205.3	76.2	10750.0
	-30.5	40					1.02		1.00	1.00	1.00	1.43	1.40	143.3	200.5	75.6	10750.0
	-31.5	41	40.0	45.0	115	52.6	1.02	14	1.00	1.00	1.00	1.43	1.40	20.1	28.1	40.8	1505.0
	-32.5	42					1.02		1.00	1.00	1.00	1.43	1.40	20.1	28.1	40.8	1505.0
	-33.5	43					1.02		1.00	1.00	1.00	1.43	1.40	20.1	28.1	40.8	1505.0
	-34.5	44					1.02		1.00	1.00	1.00	1.43	1.40	20.1	28.1	40.8	1505.0
	-35.5	45					1.07		1.00	1.00	1.00	1.43	1.36	20.1	27.4	40.5	1505.0
	-36.5	46	45.0	50.0	115	52.6	1.07	14	1.00	1.00	1.00	1.43	1.36	20.1	27.4	40.5	1505.0
	-37.5	47					1.07		1.00	1.00	1.00	1.43	1.36	20.1	27.4	40.5	1505.0
	-38.5	48					1.07		1.00	1.00	1.00	1.43	1.36	20.1	27.4	40.5	1505.0
	-39.5	49					1.07		1.00	1.00	1.00	1.43	1.36	20.1	27.4	40.5	1505.0
	-40.5	50					1.13		1.00	1.00	1.00	1.43	1.33	20.1	26.7	40.3	1505.0
	-41.5	51	50.0	50.0	115	52.6	1.13	38	1.00	1.00	1.00	1.43	1.33	54.5	26.7	40.3	4085.0
	-42.5	52					1.13		1.00	1.00	1.00	1.43	1.33	54.5	26.7	40.3	4085.0
	-43.5	53					1.13		1.00	1.00	1.00	1.43	1.33	54.5	26.7	40.3	4085.0
	-44.5	54					1.13		1.00	1.00	1.00	1.43	1.33	54.5	26.7	40.3	4085.0
	-45.5	55					1.18		1.00	1.00	1.00	1.43	1.30	54.5	26.1	40.1	4085.0
	-46.5	56	50.0	50.0	115	52.6	1.18	17	1.00	1.00	1.00	1.43	1.30	24.4	26.1	40.1	1827.5
	-47.5	57					1.18		1.00	1.00	1.00	1.43	1.30	24.4	26.1	40.1	1827.5
	-48.5	58					1.18		1.00	1.00	1.00	1.43	1.30	24.4	26.1	40.1	1827.5
	-49.5	59					1.18		1.00	1.00	1.00	1.43	1.30	24.4	26.1	40.1	1827.5
	-50.5	60					1.23		1.00	1.00	1.00	1.43	1.27	24.4	25.6	39.8	1827.5
	-51.5	61	50.0	50.0	115	52.6	1.23	18	1.00	1.00	1.00	1.43	1.27	25.8	25.6	39.8	1935.0
	-52.5	62					1.23		1.00	1.00	1.00	1.43	1.27	25.8	25.6	39.8	1935.0
	-53.5	63					1.23		1.00	1.00	1.00	1.43	1.27	25.8	25.6	39.8	1935.0
	-54.5	64					1.23		1.00	1.00	1.00	1.43	1.27	25.8	25.6	39.8	1935.0
	-55.5	65					1.29		1.00	1.00	1.00	1.43	1.25	25.8	25.0	39.6	1935.0
	-56.5	66	50.0	50.0	115	52.6	1.29	63	1.00	1.00	1.00	1.43	1.25	90.3	25.0	39.6	6772.5
	-57.5	67					1.29		1.00	1.00	1.00	1.43	1.25	90.3	25.0	39.6	6772.5
	-58.5	68					1.29		1.00	1.00	1.00	1.43	1.25	90.3	25.0	39.6	6772.5
	-59.5	69					1.29		1.00	1.00	1.00	1.43	1.25	90.3	25.0	39.6	6772.5
	-60.5	70					1.34		1.00	1.00	1.00	1.43	1.22	90.3	24.5	39.4	6772.5
	-61.5	71	50.0	50.0	115	52.6	1.34	100	1.00	1.00	1.00	1.43	1.22	143.3	24.5	39.4	10750.0
	-62.5	72					1.34		1.00	1.00	1.00	1.43	1.22	143.3	24.5	39.4	10750.0
	-63.5	73					1.34		1.00	1.00	1.00	1.43	1.22	143.3	24.5	39.4	10750.0
	-64.5	74					1.34		1.00	1.00	1.00	1.43	1.22	143.3	24.5	39.4	10750.0
	-65.5	75					1.39		1.00	1.00	1.00	1.43	1.20	143.3	24.1	39.3	10750.0

Project: S-51 Bridge over Black Mingo Creek - **Soil Strength Parameter Calculations**
Location : Station 69+15 (EB4)
Calc. By: JFH
Date: 1/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 7*

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Top of Boring EL = 26.5 ft-MSL
Groundwater Depth = 8.5 ft

SPT-4

	Elevation	Depth	SPT Test Interval		γ	γ'	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	N_{60}	$N^*_{1,60}$	Correlated Effective Phi Angle, ϕ'	Correlated Effective Cohesion, c'
	ft-MSL	*ft*	*ft*		*pcf*	*pcf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*deg*	*psf*
SM	26.5	1	0	2	115	115	0.12	15	0.75	1.00	1.00	1.43	1.60	21.5	25.8	39.9	1612.5
	25.5	2					0.23		0.75	1.00	1.00	1.43	1.60	21.5	25.8	39.9	1612.5
	24.5	3	2	4	115	115	0.35	6	0.75	1.00	1.00	1.43	1.60	8.6	10.3	32.6	645.0
	23.5	4					0.46		0.75	1.00	1.00	1.43	1.60	8.6	10.3	32.6	645.0
	22.5	5	4	6	115	115	0.58	1	0.85	1.00	1.00	1.43	1.60	1.4	1.9	25.5	107.5
	21.5	6					0.69		0.85	1.00	1.00	1.43	1.60	1.4	1.9	25.5	107.5
	20.5	7	6	8	115	115	0.81	1	0.85	1.00	1.00	1.43	1.58	1.4	1.9	25.4	107.5
SC	19.5	8					0.92		0.85	1.00	1.00	1.43	1.47	1.4	1.8	25.3	107.5
	18.5	9	8	10	115	52.6	0.97	2	0.85	1.00	1.00	1.43	1.43	2.9	3.5	27.3	215.0
SM	17.5	10					1.03		0.85	1.00	1.00	1.43	1.40	2.9	3.4	27.2	215.0
	16.5	11	10.0	15.0	115	52.6	1.08	8	0.95	1.00	1.00	1.43	1.36	11.5	14.8	35.1	860.0
	15.5	12					1.13		0.95	1.00	1.00	1.43	1.33	11.5	14.5	34.9	860.0
	14.5	13					1.18		0.95	1.00	1.00	1.43	1.30	11.5	14.2	34.8	860.0
	13.5	14					1.24		0.95	1.00	1.00	1.43	1.27	11.5	13.9	34.6	860.0
	12.5	15					1.29		0.95	1.00	1.00	1.43	1.25	11.5	13.6	34.5	860.0
	11.5	16	15.0	20.0	105	42.6	1.29	6	0.95	1.00	1.00	1.43	1.25	8.6	10.2	32.5	645.0
	10.5	17					1.29		0.95	1.00	1.00	1.43	1.25	8.6	10.2	32.5	645.0
SP-SM	9.5	18					1.29		0.95	1.00	1.00	1.43	1.25	8.6	10.2	32.5	645.0
	8.5	19					1.29		0.95	1.00	1.00	1.43	1.25	8.6	10.2	32.5	645.0
COASTAL PLAIN	7.5	20					1.33		0.95	1.00	1.00	1.43	1.23	8.6	10.0	32.4	645.0
	6.5	21	20.0	25.0	110	47.6	1.33	24	0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	5.5	22					1.33		0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	4.5	23					1.33		0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	3.5	24					1.33		0.95	1.00	1.00	1.43	1.23	34.4	40.1	44.8	2580.0
	2.5	25					1.38		0.95	1.00	1.00	1.43	1.20	34.4	39.4	44.6	2580.0
	1.5	26	25.0	30.0	110	47.6	1.38	100	1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	0.5	27					1.38		1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	-0.5	28					1.38		1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	-1.5	29					1.38		1.00	1.00	1.00	1.43	1.20	143.3	172.7	71.6	10750.0
	-2.5	30					1.43		1.00	1.00	1.00	1.43	1.18	143.3	169.7	71.1	10750.0
	-3.5	31	30.0	35.0	110	47.6	1.43	52	1.00	1.00	1.00	1.43	1.18	74.5	88.3	56.9	5590.0
	-4.5	32					1.43		1.00	1.00	1.00	1.43	1.18	74.5	88.3	56.9	5590.0
	-5.5	33					1.43		1.00	1.00	1.00	1.43	1.18	74.5	88.3	56.9	5590.0
	-6.5	34					1.43		1.00	1.00	1.00	1.43	1.18	74.5	88.3	56.9	5590.0
	-7.5	35					1.47		1.00	1.00	1.00	1.43	1.16	74.5	86.8	56.6	5590.0
	-8.5	36	35.0	40.0	110	47.6	1.47	12	1.00	1.00	1.00	1.43	1.16	17.2	20.0	37.6	1290.0
	-9.5	37					1.47		1.00	1.00	1.00	1.43	1.16	17.2	20.0	37.6	1290.0
	-10.5	38					1.47		1.00	1.00	1.00	1.43	1.16	17.2	20.0	37.6	1290.0
	-11.5	39					1.47		1.00	1.00	1.00	1.43	1.16	17.2	20.0	37.6	1290.0
	-12.5	40					1.52		1.00	1.00	1.00	1.43	1.15	17.2	19.7	37.4	1290.0
	-13.5	41	40.0	45.0	115	52.6	1.52	22	1.00	1.00	1.00	1.43	1.15	31.5	36.2	43.6	2365.0
	-14.5	42					1.52		1.00	1.00	1.00	1.43	1.15	31.5	36.2	43.6	2365.0
	-15.5	43					1.52		1.00	1.00	1.00	1.43	1.15	31.5	36.2	43.6	2365.0
	-16.5	44					1.52		1.00	1.00	1.00	1.43	1.15	31.5	36.2	43.6	2365.0
	-17.5	45					1.57		1.00	1.00	1.00	1.43	1.13	31.5	35.5	43.4	2365.0
	-18.5	46	45.0	50.0	115	52.6	1.57	18	1.00	1.00	1.00	1.43	1.13	25.8	29.1	41.2	1935.0
	-19.5	47					1.57		1.00	1.00	1.00	1.43	1.13	25.8	29.1	41.2	1935.0
	-20.5	48					1.57		1.00	1.00	1.00	1.43	1.13	25.8	29.1	41.2	1935.0
	-21.5	49					1.57		1.00	1.00	1.00	1.43	1.13	25.8	29.1	41.2	1935.0
	-22.5	50					1.63		1.00	1.00	1.00	1.43	1.11	25.8	28.6	41.0	1935.0
	-23.5	51	50.0	50.0	115	52.6	1.63	22	1.00	1.00	1.00	1.43	1.11	31.5	28.6	41.0	2365.0
	-24.5	52					1.63		1.00	1.00	1.00	1.43	1.11	31.5	28.6	41.0	2365.0
	-25.5	53					1.63		1.00	1.00	1.00	1.43	1.11	31.5	28.6	41.0	2365.0
	-26.5	54					1.63		1.00	1.00	1.00	1.43	1.11	31.5	28.6	41.0	2365.0
	-27.5	55					1.68		1.00	1.00	1.00	1.43	1.09	31.5	28.2	40.8	2365.0
	-28.5	56	50.0	50.0	115	52.6	1.68	20	1.00	1.00	1.00	1.43	1.09	28.7	28.2	40.8	2150.0
	-29.5	57					1.68		1.00	1.00	1.00	1.43	1.09	28.7	28.2	40.8	2150.0
	-30.5	58					1.68		1.00	1.00	1.00	1.43	1.09	28.7	28.2	40.8	2150.0
	-31.5	59					1.68		1.00	1.00	1.00	1.43	1.09	28.7	28.2	40.8	2150.0
	-32.5	60					1.73		1.00	1.00	1.00	1.43	1.07	28.7	27.7	40.7	2150.0
	-33.5	61	50.0	50.0	115	52.6	1.73	28	1.00	1.00	1.00	1.43	1.07	40.1	27.7	40.7	3010.0
	-34.5	62					1.73		1.00	1.00	1.00	1.43	1.07	40.1	27.7	40.7	3010.0
	-35.5	63					1.73		1.00	1.00	1.00	1.43	1.07	40.1	27.7	40.7	3010.0
	-36.5	64					1.73		1.00	1.00	1.00	1.43	1.07	40.1	27.7	40.7	3010.0
	-37.5	65					1.78		1.00	1.00	1.00	1.43	1.06	40.1	27.3	40.5	3010.0
	-38.5	66	50.0	50.0	115	52.6	1.78	12	1.00	1.00	1.00	1.43	1.06	17.2	27.3	40.5	1290.0
	-39.5	67					1.78		1.00	1.00	1.00	1.43	1.06	17.2	27.3	40.5	1290.0
	-40.5	68					1.78		1.00	1.00	1.00	1.43	1.06	17.2	27.3	40.5	1290.0
	-41.5	69					1.78		1.00	1.00	1.00	1.43	1.06	17.2	27.3	40.5	1290.0
	-42.5	70					1.84		1.00	1.00	1.00	1.43	1.04	17.2	26.9	40.4	1290.0
	-43.5	71	50.0	50.0	115	52.6	1.84	100	1.00	1.00	1.00	1.43	1.04	143.3	26.9	40.4	10750.0
	-44.5	72					1.84		1.00	1.00	1.00	1.43	1.04	143.3	26.9	40.4	10750.0
	-45.5	73					1.84		1.00	1.00	1.00	1.43	1.04	143.3	26.9	40.4	10750.0
	-46.5	74					1.84		1.00	1.00	1.00	1.43	1.04	143.3	26.9	40.4	10750.0
	-47.5	75					1.89		1.00	1.00	1.00	1.43	1.03	143.3	26.5	40.2	10750.0
	-48.5	76	50.0	50.0	115	52.6	1.89	17	1.00	1.00	1.00	1.43	1.03	24.4	26.5	40.2	1827.5
	-49.5	77					1.89		1.00	1.00	1.00	1.43	1.03	24.4	26.5	40.2	1827.5
	-50.5	78					1.89		1.00	1.00	1.00	1.43	1.03	24.4	26.5	40.2	1827.5
	-51.5	79					1.89		1.00	1.00	1.00	1.43	1.03	24.4	26.5	40.2	1827.5
	-52.5	80					1.94		1.00	1.00	1.00	1.43	1.01	24.4	26.2	40.1	1827.5
	-53.5	81	50.0	50.0	115	52.6	1.94	50	1.00	1.00	1.00	1.43	1.01	71.7	26.2	40.1	5375.0
	-54.5	82					1.94		1.00	1.00	1.00	1.43	1.01	71.7	26.2	40.1	5375.0
	-55.5	83					1.94		1.00	1.00	1.00	1.43	1.01	71.7	26.2	40.1	5375.0
	-56.5	84					1.94		1.00	1.00	1.00	1.43	1.01	71.7	26.2	40.1	5375.0
	-57.5	85					1.99		1.00	1.00	1.00	1.43	1.00	71.7	25.8	39.9	5375.0
	-58.5	86	50.0	50.0	115	52.6	1.99	31	1.00	1.00	1.00	1.43	1.00	44.4	25.8	39.9	3332.5
	-59.5	87					1.99		1.00	1.00	1.00	1.43	1.00	44.4	25.8	39.9	3332.5
	-60.5	88					1.99		1.00	1.00	1.00	1.43	1.00	44.4	25.8	39.9	3332.5
	-61.5	89					1.99		1.00	1.00	1.00	1.43	1.00	44.4	25.8	39.9	3332.5
	-62.5	90					2.05		1.00	1.00	1.00	1.43	0.99	44.4	25.5	39.8	3332.5
	-63.5	91	50.0	50.0	115	52.6	2.05	17	1.00	1.00	1.00	1.43	0.99	24.4	25.5	39.8	1827.5
	-64.5	92					2.05		1.00	1.00	1.00	1.43	0.99	24.4	25.5	39.8	1827.5
	-65.5	93					2.05		1.00	1.00	1.00	1.43	0.99	24.4	25.5	39.8	1827.5
	-66.5	94					2.05		1.00	1.00	1.00	1.43	0.99	24.4	25.5	39.8	1827.5
	-67.5	95					2.10		1.00	1.00	1.00	1.43	0.98	24.4	25.2	39.7	1827.5
	-68.5	96	50.0	50.0	115	52.6	2.10	100	1.00	1.00	1.00	1.43	0.98	143.3	25.2	39.7	10750.0
	-69.5	97					2.10		1.00	1.00	1.00	1.43	0.98	143.3	25.2	39.7	10750.0
	-70.5	98					2.10		1.00	1.00	1.00	1.43	0.98	143.3	25.2	39.7	10750.0
	-71.5	99					2.10		1.00	1.00	1.00	1.43	0.98	143.3	25.2	39.7	10750.0
	-72.5	100					2.15		1.00	1.00	1.00	1.43	0.96	143.3	24.9	39.6	10750.0

APPENDIX

SECTION 5

SOIL PARAMETER CORRELATIONS

SUBSECTION B
CPT METHOD

F&ME CONSULTANTS

In situ data											Estimations									
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
0.164	0.95732	0.12848	9	1.33E-07	0	13.35364	0	0	0	27.745	14	0.06813	5.24716	0.33	24.2419	138.45677	0	1.95777	0.68849	20
0.328	0.96684	0.03399	3	1.13E-07	0	13.31665	0	0	0	28.48156	14	0.06794	2.97644	0.33	13.75115	142.48514	0	1.61268	1.01609	20
0.656	0.96208	0.12862	3	3.35E-08	0	13.19475	0	0	0	35.19725	14	0.06732	2.00983	0.33	9.28544	157.2693	0	1.41	0.8451	20
0.82	0.98589	0.0716	6	3.07E-05	5	208.27278	61	41	166.1751	208.2728	0	0	0	0.33	0	350.8143	-0.17099	0	0	20
1.148	55.63396	0.72421	6	1.03E-04	11	409.04845	77	43	326.3684	409.0485	0	0	0	0.33	0	474.71036	-0.2197	0	0	20
1.312	84.02962	1.22595	6	1.31E-04	15	580.88644	89	44	463.4732	580.8864	0	0	0	0.33	0	554.58911	-0.25739	0	0	20
1.476	69.04117	1.43136	6	9.05E-05	17	654.3179	91	45	522.0622	654.3179	0	0	0	0.33	0	584.40442	-0.26674	0	0	20
1.64	66.78361	1.56445	6	5.61E-05	16	669.33201	88	44	534.0415	669.332	0	0	0	0.33	0	590.01465	-0.2643	0	0	20
1.804	70.48905	1.58486	6	4.75E-05	16	681.0306	85	44	543.3755	681.0306	0	0	0	0.33	0	594.90808	-0.2594	0	0	20
1.969	66.43593	1.51411	6	4.41E-05	16	662.28046	82	44	528.4153	662.2805	0	0	0	0.33	0	588.16028	-0.24799	0	0	20
2.133	58.5583	1.23882	6	7.52E-05	17	665.43082	81	44	530.9289	665.4308	0	0	0	0.33	0	591.16602	-0.2379	0	0	20
2.297	91.31666	1.07423	6	1.70E-04	19	688.36912	83	44	549.2307	688.3691	0	0	0	0.33	0	602.43207	-0.23331	0	0	20
2.461	109.4914	1.06406	6	2.77E-04	22	761.8514	87	44	607.8602	761.8514	0	0	0	0.33	0	631.40082	-0.24068	0	0	20
2.625	112.711	1.45567	6	2.34E-04	22	800.04243	87	44	638.3317	800.0424	0	0	0	0.33	0	645.1579	-0.24342	0	0	20
2.789	97.19869	1.41906	6	1.89E-04	23	856.42617	88	44	683.3188	856.4262	0	0	0	0.33	0	664.68677	-0.24902	0	0	20
2.953	118.8503	1.62865	6	2.41E-04	26	926.19765	91	45	738.9875	926.1977	0	0	0	0.33	0	688.94733	-0.25532	0	0	20
3.117	155.5808	1.79367	6	3.08E-04	29	1021.76795	95	45	815.2404	1021.768	0	0	0	0.33	0	720.34094	-0.26548	0	0	20
3.281	154.1234	1.97675	6	2.92E-04	31	1082.1722	96	45	863.4353	1082.172	0	0	0	0.33	0	739.09906	-0.26926	0	0	20
3.445	139.6779	2.12976	6	2.04E-04	30	1089.98675	94	45	869.6703	1089.987	0	0	0	0.33	0	741.09167	-0.267	0	0	20
3.609	130.7191	2.09947	6	1.66E-04	29	1072.8608	91	45	856.006	1072.861	0	0	0	0.33	0	735.87939	-0.26112	0	0	20
3.773	132.0146	1.90167	6	1.42E-04	27	1023.21915	87	44	816.3983	1023.219	0	0	0	0.33	0	720.73737	-0.25077	0	0	20
3.937	110.6821	1.68297	6	1.17E-04	25	935.21856	82	44	746.185	935.2186	0	0	0	0.33	0	692.79706	-0.23436	0	0	20
4.101	86.66819	1.33182	6	5.63E-05	20	821.4611	73	43	655.4211	821.4611	0	0	0	0.33	0	653.55103	-0.21236	0	0	20
4.265	56.38171	1.27935	5	1.61E-05	15	685.92948	62	41	547.2842	685.9295	0	0	0	0.33	0	602.30774	-0.1886	0	0	20
4.429	26.1762	1.08454	5	1.42E-05	15	684.88978	61	41	546.4546	684.8898	0	0	0	0.33	0	602.05627	-0.18602	0	0	20
4.593	82.68652	1.31923	6	3.55E-05	18	758.43842	66	42	605.137	758.4384	0	0	0	0.33	0	631.46173	-0.19185	0	0	20
4.757	106.8385	1.36011	6	8.76E-05	22	859.31881	73	43	685.6267	859.3188	0	0	0	0.33	0	668.83783	-0.2066	0	0	20
4.921	98.05122	1.35741	6	1.02E-04	23	869.58994	74	43	693.8218	869.5899	0	0	0	0.33	0	672.9278	-0.20595	0	0	20
5.085	94.15051	1.24614	6	9.00E-05	21	836.061	71	42	667.0699	836.061	0	0	0	0.33	0	661.62115	-0.19743	0	0	20
5.249	89.03053	1.08859	6	6.29E-05	22	871.09816	70	42	695.0251	871.0982	0	0	0	0.33	0	673.12274	-0.20006	0	0	20
5.413	91.52622	1.82297	6	5.40E-05	22	914.46767	71	42	729.6285	914.4677	0	0	0	0.33	0	687.52972	-0.20429	0	0	20
5.577	100.023	1.67714	6	3.00E-05	22	933.22956	69	42	744.5981	933.2296	0	0	0	0.33	0	692.87683	-0.20498	0	0	20
5.741	65.9406	1.62574	6	3.48E-05	20	866.78141	66	42	691.5809	866.7814	0	0	0	0.33	0	671.49365	-0.19158	0	0	20
5.906	79.83838	1.00284	6	4.01E-05	20	823.36452	64	41	656.9398	823.3645	0	0	0	0.33	0	657.24677	-0.1817	0	0	20
6.07	93.75044	1.13566	6	8.75E-05	22	852.33443	68	42	680.0541	852.3344	0	0	0	0.33	0	668.93091	-0.18602	0	0	20
6.234	111.8299	1.37298	6	1.07E-04	25	948.44912	72	42	756.7413	948.4491	0	0	0	0.33	0	701.26874	-0.20009	0	0	20

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In situ data										Estimations										
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
6.398	123.9321	1.61856	6	1.15E-04	27	1048.44386	76	43	836.5244	1048.444	0	0	0	0.33	0	732.90472	-0.21272	0	0	20
6.562	132.748	1.8866	6	1.21E-04	30	1128.15863	78	43	900.1266	1128.159	0	0	0	0.33	0	757.08832	-0.22148	0	0	20
6.726	143.5595	1.97512	6	1.26E-04	31	1169.69257	79	43	933.2654	1169.693	0	0	0	0.33	0	769.48169	-0.22491	0	0	20
6.89	141.6354	1.89599	6	1.41E-04	32	1214.72836	81	44	969.1982	1214.728	0	0	0	0.33	0	782.76495	-0.22905	0	0	20
7.054	157.724	2.13608	6	1.30E-04	34	1279.37992	82	44	1020.782	1279.38	0	0	0	0.33	0	800.87903	-0.23416	0	0	20
7.218	160.3816	2.56872	6	1.35E-04	34	1275.5488	82	44	1017.725	1275.549	0	0	0	0.33	0	800.12207	-0.23213	0	0	20
7.382	143.4881	1.7604	6	1.69E-04	34	1254.10872	82	44	1000.619	1254.109	0	0	0	0.33	0	794.80688	-0.22933	0	0	20
7.546	168.888	1.69122	6	2.56E-04	33	1185.36605	81	44	945.7708	1185.366	0	0	0	0.33	0	776.39935	-0.22201	0	0	20
7.71	169.188	1.62076	6	2.56E-04	33	1176.72352	81	44	938.8752	1176.724	0	0	0	0.33	0	774.1474	-0.2194	0	0	20
7.874	140.0446	1.64181	6	1.55E-04	31	1139.6907	76	43	909.3277	1139.691	0	0	0	0.33	0	762.79999	-0.21013	0	0	20
8.038	114.0351	1.68383	6	6.43E-05	28	1103.15215	70	42	880.1746	1103.152	0	0	0	0.33	0	750.80597	-0.19836	0	0	20
8.202	95.58411	1.86619	5	2.34E-05	24	1057.08215	64	41	843.4166	1057.082	0	0	0	0.33	0	735.59961	-0.18816	0	0	20
8.366	69.84131	1.8802	5	1.28E-05	22	1029.4694	60	41	821.3852	1029.469	0	0	0	0.33	0	726.46564	-0.18423	0	0	20
8.53	78.73817	1.79154	5	1.29E-05	22	1008.30861	59	41	804.5016	1008.309	0	0	0	0.33	0	720.18005	-0.17934	0	0	20
8.694	91.05947	1.58671	6	3.49E-05	24	1019.52454	63	41	813.4504	1019.525	0	0	0	0.33	0	725.44586	-0.17805	0	0	20
8.858	120.0267	1.27039	6	8.23E-05	25	987.8954	66	42	788.2144	987.8954	0	0	0	0.33	0	717.25085	-0.176	0	0	20
9.022	116.5975	0.98685	6	1.60E-04	25	931.01098	67	42	742.8279	931.011	0	0	0	0.33	0	700.60327	-0.17103	0	0	20
9.186	111.5489	0.80526	6	1.99E-04	24	866.70887	65	41	691.523	866.7089	0	0	0	0.33	0	680.2226	-0.16116	0	0	20
9.35	109.139	0.72279	6	2.30E-04	23	830.32806	64	41	662.4958	830.3281	0	0	0	0.33	0	668.53058	-0.15485	0	0	20
9.514	111.125	0.68219	6	2.62E-04	24	846.60098	65	41	675.4795	846.601	0	0	0	0.33	0	674.50629	-0.15736	0	0	20
9.678	126.0706	0.83207	6	3.04E-04	26	914.24378	68	42	729.4498	914.2438	0	0	0	0.33	0	697.27148	-0.16876	0	0	20
9.843	146.7982	1.05368	6	3.16E-04	29	1007.15025	71	42	803.5773	1007.15	0	0	0	0.33	0	726.83551	-0.18224	0	0	20
10.007	152.7993	1.23271	6	2.91E-04	30	1064.2488	72	43	849.1347	1064.249	0	0	0	0.33	0	744.23669	-0.18731	0	0	20
10.171	143.7119	1.22318	6	2.14E-04	29	1058.38784	70	42	844.4584	1058.388	0	0	0	0.33	0	742.13647	-0.18299	0	0	20
10.335	120.6792	1.13331	6	1.42E-04	27	1011.46313	66	42	807.0185	1011.463	0	0	0	0.33	0	727.35254	-0.17175	0	0	20
10.499	106.1337	1.06968	6	1.06E-04	25	947.53661	63	41	756.0133	947.5366	0	0	0	0.33	0	707.03156	-0.15855	0	0	20
10.663	102.3187	0.88255	6	7.91E-05	23	894.81284	59	41	713.9464	894.8128	0	0	0	0.33	0	689.71082	-0.14669	0	0	20
10.827	86.6539	0.86619	6	6.53E-05	21	823.30946	56	40	656.8959	823.3095	0	0	0	0.33	0	665.67474	-0.13206	0	0	20
10.991	73.55628	0.6438	6	4.16E-05	19	769.2279	52	39	613.7457	769.2279	0	0	0	0.33	0	646.29565	-0.11822	0	0	20
11.155	66.14064	0.66662	6	2.05E-05	17	753.10578	48	39	600.8823	753.1058	0	0	0	0.33	0	639.54736	-0.11178	0	0	20
11.319	55.7054	0.96857	5	6.72E-06	15	737.81564	44	38	588.6827	737.8156	0	0	0	0.33	0	632.44104	-0.11101	0	0	20
11.483	35.00639	0.89108	5	2.09E-06	13	553.95518	38	36	558.1857	699.5927	0	0	0	0.33	0	616.81525	-0.11352	0	0	20
11.647	30.14836	0.75848	5	1.14E-06	12	465.00018	35	36	522.7828	655.2211	0	0	0	0.33	0	599.27734	-0.11065	0	0	20
11.811	36.62573	0.79396	5	1.11E-06	11	451.11824	35	35	509.5135	638.5903	0	0	0	0.33	0	592.99115	-0.10578	0	0	20
11.975	32.02965	0.73928	5	1.28E-06	11	458.42847	35	35	504.9151	632.8269	0	0	0	0.33	0	591.15894	-0.10106	0	0	20
12.139	31.72484	0.64408	4	8.21E-07	10	384.09998	0	0	458.1522	574.2175	14	1.95969	2.51667	0.33	11.62702	566.98511	0	1.52273	3.10195	20

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In situ data											Estimations									
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
12.303	20.76093	0.47401	4	3.77E-07	8	293.45649	0	0	402.9222	504.9959	14	1.49723	1.94346	0.33	8.97877	536.32953	0	1.3939	2.84378	20
12.467	12.61182	0.42979	4	9.71E-08	6	197.99475	0	0	0	435.5704	14	1.01018	1.34003	0.33	6.19093	502.50421	0	1.22746	2.21555	20
12.631	11.2592	0.43669	3	3.70E-08	5	150.08014	0	0	0	393.0907	14	0.76572	1.02943	0.33	4.75594	480.32901	0	1.12161	1.8549	20
12.795	10.46858	0.34717	3	2.83E-08	5	120.01811	0	0	0	364.5211	14	0.67659	0.90503	0.33	4.18125	465.43658	0	1.07328	1.89951	20
12.959	8.88257	0.26335	3	2.70E-08	5	102.12056	0	0	0	339.9264	14	0.62563	0.8328	0.33	3.84753	452.35156	0	1.04317	2.07096	20
13.123	9.135	0.27764	3	2.16E-08	4	88.16157	0	0	0	329.8093	14	0.58269	0.77194	0.33	3.56636	446.6485	0	1.01645	2.02598	20
13.287	8.67777	0.30459	3	2.84E-08	5	101.54405	0	0	0	337.5286	14	0.62686	0.82647	0.33	3.81831	451.30048	0	1.04046	2.15239	20
13.451	10.74958	0.27401	3	2.98E-08	5	98.8552	0	0	0	330.8922	14	0.61996	0.81354	0.33	3.75854	447.82251	0	1.03486	2.26188	20
13.615	8.86829	0.22723	4	5.25E-08	5	111.23302	0	0	0	318.5123	14	0.661	0.85857	0.33	3.96659	441.89029	0	1.0541	2.90222	20
13.78	10.42095	0.16836	3	4.12E-08	4	88.80495	0	0	0	297.4081	14	0.59066	0.76708	0.33	3.54392	429.58368	0	1.01425	2.97715	20
13.944	7.81571	0.1877	3	2.18E-08	4	63.5868	0	0	0	282.6834	14	0.50055	0.64813	0.33	2.99438	420.17123	0	0.95746	2.63101	20
14.108	4.98662	0.20327	3	9.35E-09	4	44.6642	0	0	0	276.8328	14	0.42041	0.54203	0.33	2.50419	415.65506	0	0.83503	2.07925	26.42264
14.272	6.95841	0.20348	3	7.01E-09	4	39.82077	0	0	0	275.9348	14	0.39782	0.5107	0.33	2.35944	414.83646	0	0.80133	1.91818	27.39808
14.436	6.74885	0.20299	3	1.14E-08	4	50.15638	0	0	0	284.3796	14	0.44744	0.57192	0.33	2.64229	420.59912	0	0.83259	2.1544	28.38628
14.6	7.04891	0.20412	3	1.29E-08	4	52.58431	0	0	0	285.2689	14	0.45912	0.58435	0.33	2.6997	421.37741	0	0.83425	2.2465	28.96439
14.764	7.41088	0.19374	3	1.67E-08	4	58.48013	0	0	0	287.5346	14	0.48521	0.61493	0.33	2.84096	423.14951	0	0.84881	2.43051	29.49844
14.961	7.83	0.18905	3	1.80E-08	4	57.92759	0	0	0	283.0588	14	0.48413	0.61047	0.33	2.82039	420.70923	0	0.84484	2.56954	29.57648
15.092	7.0108	0.17113	3	2.14E-08	4	60.47386	0	0	0	280.9099	14	0.49548	0.62271	0.33	2.87694	419.73764	0	0.85216	2.76237	29.65973
15.256	7.9062	0.16715	3	1.72E-08	4	52.20294	0	0	0	272.1399	14	0.46129	0.57739	0.33	2.66753	414.25937	0	0.8257	2.71836	29.26958
15.42	6.41069	0.16061	3	1.67E-08	4	51.90754	0	0	0	273.139	14	0.46092	0.57458	0.33	2.65457	414.91766	0	0.81876	2.6981	29.67129
15.617	6.95365	0.17448	3	1.51E-08	4	50.97006	0	0	0	276.5243	14	0.45786	0.56798	0.33	2.62405	416.91653	0	0.80536	2.57694	30.35945
15.748	7.68712	0.18727	3	1.99E-08	4	64.42345	0	0	0	296.0995	14	0.51561	0.63749	0.33	2.94518	428.92334	0	0.84018	2.55278	31.45635
15.945	8.76827	0.23207	3	2.58E-08	4	80.75756	0	0	0	317.1818	14	0.57877	0.71191	0.33	3.28901	441.40024	0	0.88742	2.52135	31.6725
16.076	9.68748	0.25553	3	1.95E-08	4	77.27458	0	0	0	326.8522	14	0.56713	0.69518	0.33	3.21173	446.49988	0	0.89009	2.21952	30.5226
16.24	7.37754	0.26363	3	1.40E-08	4	66.89672	0	0	0	323.6212	14	0.52882	0.64542	0.33	2.98185	444.38065	0	0.868	2.04004	29.60872
16.437	7.2537	0.24294	3	1.09E-08	4	57.18126	0	0	0	313.92	14	0.49016	0.5952	0.33	2.74981	438.72812	0	0.83557	1.98304	29.47509
16.568	8.04433	0.22012	3	2.43E-08	4	76.81281	0	0	0	315.2863	14	0.56905	0.68869	0.33	3.18175	440.61121	0	0.88061	2.55633	30.96904
16.732	10.59717	0.1914	3	4.15E-08	5	99.82339	0	0	0	326.9416	14	0.65021	0.78329	0.33	3.61878	447.92276	0	0.93451	2.897	31.54585
16.929	10.69719	0.24835	4	1.20E-07	6	185.1691	0	0	0	391.7799	14	0.94474	1.11661	0.33	5.15874	483.82932	0	1.10873	3.20345	33.44429
17.06	20.4323	0.4273	4	5.06E-07	8	285.66353	0	0	371.9639	466.1948	14	1.45747	1.68556	0.33	7.78729	521.86615	0	1.32765	4.04971	20
17.257	32.35352	0.38244	5	2.15E-06	10	425.81366	31	34	426.6637	534.7518	0	0	0	0.33	0	554.63	-0.05393	0	0	20
17.388	41.02653	0.36644	5	2.78E-06	11	474.27066	33	35	453.7865	568.7458	0	0	0	0.33	0	569.3515	-0.05968	0	0	20
17.552	31.20093	0.56004	5	1.57E-06	11	432.37305	32	35	458.5195	574.6778	0	0	0	0.33	0	570.95099	-0.06681	0	0	20
17.717	23.55668	0.52513	4	3.44E-07	9	308.37689	0	0	0	539.6699	14	1.57335	1.79748	0.33	8.30435	554.08984	0	1.35717	2.99084	20
17.881	14.52646	0.46143	3	3.81E-08	6	175.07406	0	0	0	456.1381	14	0.89323	1.04119	0.33	4.81029	513.86029	0	1.12598	1.85684	20
18.045	2.66239	0.42773	3	6.39E-09	5	73.69917	0	0	0	401.5428	14	0.56924	0.66055	0.33	3.05176	485.56906	0	0.96369	1.28047	20

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In situ data						Estimations														
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
18.209	9.97325	0.41785	3	3.38E-09	5	57.42923	0	0	0	398.6876	14	0.50363	0.58179	0.33	2.68788	483.52084	0	0.92274	1.07205	20
18.373	11.76405	0.53558	3	1.42E-08	6	135.94742	0	0	0	474.4096	14	0.7767	0.89302	0.33	4.12577	521.51953	0	1.06839	1.33544	20
18.537	14.11686	0.75649	3	9.15E-08	9	270.38982	0	0	0	601.1704	14	1.37954	1.56545	0.33	7.23236	578.32861	0	1.29451	1.77673	20
18.701	35.26358	0.99069	5	1.06E-06	13	499.01193	33	35	568.0351	711.9373	0	0	0	0.33	0	624.45184	-0.09838	0	0	20
18.865	60.79204	0.65994	5	6.18E-06	16	765.01885	40	37	610.3874	765.0189	0	0	0	0.33	0	646.22821	-0.09134	0	0	20
19.029	65.25476	0.58699	5	1.30E-05	16	742.92263	42	37	592.7574	742.9226	0	0	0	0.33	0	639.58032	-0.08439	0	0	20
19.226	53.02396	0.63519	5	1.47E-05	15	686.37592	41	37	547.6404	686.3759	0	0	0	0.33	0	619.23993	-0.07248	0	0	20
19.357	50.98549	0.30124	5	9.19E-06	14	658.11487	38	36	525.0917	658.1149	0	0	0	0.33	0	607.87091	-0.06663	0	0	20
19.521	45.55593	0.53168	5	8.55E-06	13	618.97056	37	36	493.8595	618.9706	0	0	0	0.33	0	592.73132	-0.05759	0	0	20
19.685	42.55062	0.43669	5	9.18E-06	14	643.85871	38	36	513.7171	643.8587	0	0	0	0.33	0	602.60199	-0.06255	0	0	20
19.849	58.24872	0.41002	5	1.44E-05	14	650.10764	40	37	518.7029	650.1076	0	0	0	0.33	0	605.89478	-0.06296	0	0	20
20.013	59.08697	0.46591	6	2.73E-05	16	688.02284	43	38	548.9544	688.0228	0	0	0	0.33	0	621.41833	-0.07239	0	0	20
20.21	72.08458	0.48823	6	3.12E-05	18	752.0914	45	38	600.0729	752.0914	0	0	0	0.33	0	644.93945	-0.08535	0	0	20
20.341	80.63852	0.70416	6	2.44E-05	19	806.33005	46	38	643.3484	806.3301	0	0	0	0.33	0	663.50879	-0.09371	0	0	20
20.505	64.37841	0.82808	6	3.73E-05	20	850.29295	49	39	678.4252	850.293	0	0	0	0.33	0	679.15326	-0.10329	0	0	20
20.669	101.6805	0.61749	6	5.54E-05	21	856.57027	51	39	683.4337	856.5703	0	0	0	0.33	0	681.96832	-0.10716	0	0	20
20.833	100.5707	0.6182	6	5.34E-05	23	936.76734	53	39	747.4208	936.7673	0	0	0	0.33	0	708.05444	-0.11921	0	0	20
20.997	87.13971	1.30509	5	1.58E-05	23	1043.74917	50	39	832.7786	1043.749	0	0	0	0.33	0	739.68274	-0.12753	0	0	20
21.161	71.1987	1.79702	5	4.39E-06	23	1031.38356	47	38	908.3126	1138.418	0	0	0	0.33	0	766.33545	-0.14316	0	0	20
21.325	66.30734	2.01209	5	1.71E-06	22	922.27045	44	38	963.206	1207.218	0	0	0	0.33	0	785.08661	-0.15936	0	0	20
21.49	63.81164	2.52258	5	1.76E-06	24	999.77394	46	38	1039.169	1302.425	0	0	0	0.33	0	811.54883	-0.16932	0	0	20
21.654	87.89223	2.74696	5	3.75E-06	30	1327.6971	52	39	1203.417	1508.282	0	0	0	0.33	0	866.16962	-0.18281	0	0	20
21.818	136.6678	3.58486	5	7.89E-06	36	1703.25877	59	41	1358.983	1703.259	0	0	0	0.33	0	914.51959	-0.19557	0	0	20
21.982	146.9983	3.91099	5	9.89E-06	38	1809.83874	62	41	1444.02	1809.839	0	0	0	0.33	0	939.61108	-0.20313	0	0	20
22.146	127.2994	3.64728	5	7.94E-06	37	1773.31359	60	41	1414.878	1773.314	0	0	0	0.33	0	931.06891	-0.20013	0	0	20
22.31	112.9301	3.3823	5	5.95E-06	35	1628.88934	58	40	1357.947	1701.96	0	0	0	0.33	0	914.18683	-0.19478	0	0	20
22.507	110.263	4.17157	5	3.48E-06	34	1536.68995	56	40	1411.24	1768.754	0	0	0	0.33	0	929.37012	-0.20291	0	0	20

S-51 over Black Mingo Creek - Estimated Soil Parameter Correlations
CPT-3
Correlations from CPeT-IT v.1.7.6.42

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In situ data				Estimations																
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
0.27	129.1247	0	7	1.15E-02	19	479.27941	100	46	382.4038	479.2794	0	0	0	0.33	0	505.15436	-0.29132	0	0	20
0.455	127.9494	1.11793	6	1.12E-03	22	693.56685	100	47	553.3778	693.5669	0	0	0	0.33	0	607.67853	-0.33212	0	0	20
0.655	110.9062	1.56516	6	5.92E-04	22	722.88521	100	47	576.7701	722.8852	0	0	0	0.33	0	620.3894	-0.31881	0	0	20
0.85	102.0908	1.57826	6	3.12E-04	21	741.00315	100	46	591.2259	741.0032	0	0	0	0.33	0	628.11584	-0.30427	0	0	20
0.975	98.22885	1.53758	6	2.26E-04	20	712.53965	100	46	568.5157	712.5397	0	0	0	0.33	0	615.93408	-0.29193	0	0	20
1.135	82.02505	1.37283	6	1.71E-04	18	672.24507	96	45	536.3658	672.2451	0	0	0	0.33	0	598.26489	-0.2754	0	0	20
1.279	73.04209	1.18705	6	1.53E-04	17	628.75641	90	45	501.6674	628.7564	0	0	0	0.33	0	578.59003	-0.25809	0	0	20
1.431	77.15575	1.02533	6	1.68E-04	16	607.09371	86	44	484.3833	607.0937	0	0	0	0.33	0	568.53552	-0.2443	0	0	20
1.574	77.82718	0.96128	6	1.96E-04	16	576.94303	82	44	460.3269	576.943	0	0	0	0.33	0	554.23785	-0.22924	0	0	20
1.714	68.08859	0.71132	6	1.66E-04	14	529.98703	77	43	422.862	529.987	0	0	0	0.33	0	531.2052	-0.21195	0	0	20
1.858	52.97636	0.62506	6	8.04E-05	12	468.15353	69	42	373.5268	468.1535	0	0	0	0.33	0	499.25665	-0.1918	0	0	20
1.95	33.07859	0.69769	6	2.99E-05	10	422.23899	63	41	336.8928	422.239	0	0	0	0.33	0	474.14249	-0.18057	0	0	20
2.11	30.30823	0.67851	5	9.84E-06	8	378.83139	56	40	302.2591	378.8314	0	0	0	0.33	0	449.10999	-0.17332	0	0	20
2.239	22.08046	0.57795	5	6.92E-06	7	350.77051	52	39	279.8701	350.7705	0	0	0	0.33	0	432.15671	-0.1631	0	0	20
2.362	21.91249	0.48995	5	5.74E-06	7	312.83365	49	39	262.4621	328.9525	0	0	0	0.33	0	418.50079	-0.15234	0	0	20
2.482	23.42376	0.47849	5	5.93E-06	7	308.82832	48	39	257.6186	322.882	0	0	0	0.33	0	414.62131	-0.14418	0	0	20
2.622	21.24062	0.46311	5	5.28E-06	6	295.74331	47	38	251.9128	315.7307	0	0	0	0.33	0	410.00403	-0.13781	0	0	20
2.747	19.14169	0.40767	5	6.37E-06	6	309.66194	46	38	247.0707	309.6619	0	0	0	0.33	0	406.04449	-0.12691	0	0	20
2.869	24.34736	0.33401	5	1.77E-05	8	340.91915	49	39	272.01	340.9192	0	0	0	0.33	0	426.04495	-0.1216	0	0	20
2.995	42.14575	0.40026	6	3.62E-05	9	380.24351	53	40	303.3858	380.2435	0	0	0	0.33	0	449.94623	-0.12757	0	0	20
3.141	42.06199	0.46013	6	4.09E-05	9	396.07813	54	40	316.0198	396.0781	0	0	0	0.33	0	459.21933	-0.12878	0	0	20
3.271	31.39935	0.36855	6	3.02E-05	9	371.09514	51	39	296.0865	371.0951	0	0	0	0.33	0	444.50061	-0.11768	0	0	20
3.42	29.1329	0.27984	6	3.82E-05	8	344.45425	49	39	274.8305	344.4543	0	0	0	0.33	0	428.24814	-0.102	0	0	20
3.551	38.87148	0.20813	6	6.89E-05	8	330.80701	48	39	263.9418	330.807	0	0	0	0.33	0	419.67883	-0.0916	0	0	20
3.693	38.20006	0.15765	6	1.15E-04	9	330.48271	49	39	263.683	330.4827	0	0	0	0.33	0	419.47308	-0.08839	0	0	20
3.845	39.37539	0.16906	6	1.26E-04	9	336.44773	49	39	268.4423	336.4477	0	0	0	0.33	0	423.24176	-0.08799	0	0	20
3.97	42.90138	0.19984	6	1.34E-04	10	361.54654	51	39	288.468	361.5465	0	0	0	0.33	0	438.74463	-0.09597	0	0	20
4.119	48.61052	0.24229	6	1.33E-04	11	396.85967	53	39	316.6434	396.8597	0	0	0	0.33	0	459.67215	-0.10655	0	0	20
4.255	51.88478	0.31664	6	1.17E-04	12	443.20338	55	40	353.6197	443.2034	0	0	0	0.33	0	485.77063	-0.11972	0	0	20
4.396	56.08265	0.44525	6	7.06E-05	12	479.67665	55	40	382.7207	479.6767	0	0	0	0.33	0	505.36365	-0.12785	0	0	20
4.532	46.67955	0.56021	6	3.24E-05	11	485.48389	53	39	387.3542	485.4839	0	0	0	0.33	0	508.41357	-0.12797	0	0	20
4.682	33.33032	0.55405	5	1.41E-05	10	454.92281	48	39	362.9703	454.9228	0	0	0	0.33	0	492.15121	-0.12078	0	0	20
4.823	29.80432	0.44588	5	1.24E-05	9	420.62297	46	38	335.6034	420.623	0	0	0	0.33	0	473.23428	-0.10794	0	0	20
4.964	36.26909	0.31943	6	1.74E-05	9	402.24625	45	38	320.9412	402.2463	0	0	0	0.33	0	462.78122	-0.09619	0	0	20
5.097	34.92579	0.32457	5	1.46E-05	9	386.37606	43	38	308.2788	386.3761	0	0	0	0.33	0	453.56009	-0.08931	0	0	20
5.328	22.91986	0.36459	5	5.13E-06	7	345.79989	39	37	296.1057	371.1191	0	0	0	0.33	0	444.51498	-0.09084	0	0	20

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In situ data										Estimations										
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
5.471	17.21072	0.4078	5	1.21E-06	6	245.34302	34	35	272.9819	342.1373	0	0	0	0.33	0	426.80545	-0.10182	0	0	20
5.602	13.433	0.41396	4	4.01E-07	5	188.85484	0	0	256.4217	321.3818	14	0.96355	2.40159	0.33	11.09533	413.65701	0	1.49855	2.27756	20
5.751	10.83016	0.42204	4	1.71E-07	5	153.59685	0	0	0	305.0704	14	0.78366	2.01288	0.33	9.29953	403.02289	0	1.41074	1.81963	20
5.887	9.65483	0.43017	3	1.02E-07	4	134.78387	0	0	0	294.0009	14	0.68767	1.78454	0.33	8.24458	395.64352	0	1.35382	1.61238	20
6.029	9.4031	0.40168	3	9.69E-08	4	131.65933	0	0	0	289.7232	14	0.67173	1.71067	0.33	7.9033	392.75467	0	1.33438	1.65063	20
6.151	10.15873	0.3646	4	2.38E-07	5	161.48163	0	0	0	301.9406	14	0.82389	1.95701	0.33	9.04137	400.95023	0	1.39722	2.2218	20
6.304	16.03539	0.32393	5	2.87E-06	7	308.04751	36	36	293.0227	367.2551	0	0	0	0.33	0	442.19479	-0.08115	0	0	20
6.444	40.80245	0.34467	5	7.22E-06	9	412.19204	40	37	328.8766	412.192	0	0	0	0.33	0	468.46756	-0.08296	0	0	20
6.58	31.73529	0.43462	5	6.77E-06	9	442.91069	41	37	353.3862	442.9107	0	0	0	0.33	0	485.6102	-0.09194	0	0	20
6.732	21.57656	0.5127	5	1.63E-06	8	319.10462	36	36	336.372	421.5862	0	0	0	0.33	0	473.77585	-0.10346	0	0	20
6.868	16.28757	0.52142	4	4.09E-07	6	227.85666	0	0	308.3364	386.4483	14	1.16253	2.44266	0.33	11.28507	453.60245	0	1.50727	2.25497	20
7.004	12.25767	0.48157	4	1.74E-07	5	179.11296	0	0	0	354.4045	14	0.91384	1.97103	0.33	9.10614	434.3895	0	1.40063	1.88264	20
7.15	11.1661	0.42409	4	1.05E-07	5	147.16509	0	0	0	319.2017	14	0.75084	1.63175	0.33	7.5387	412.25156	0	1.313	1.8139	20
7.28	9.48686	0.31131	4	8.39E-08	4	121.97499	0	0	0	275.4997	14	0.62232	1.34451	0.33	6.21164	382.99255	0	1.22887	2.04223	20
7.429	6.88447	0.16049	3	5.42E-08	3	88.79323	0	0	0	219.2437	14	0.4576	0.99	0.33	4.57379	341.65933	0	1.10673	2.40887	20
7.552	4.28163	0.0867	3	2.99E-08	2	42.63502	0	0	0	168.2816	14	0.31533	0.68983	0.33	3.18702	299.32846	0	0.97809	2.88725	20
7.709	3.52599	0.0739	3	2.17E-08	2	30.4333	0	0	0	152.1256	14	0.26899	0.57723	0.33	2.66681	284.59741	0	0.92026	3.14451	20
7.844	4.9535	0.0909	3	2.51E-08	2	34.54325	0	0	0	159.1654	14	0.28908	0.60966	0.33	2.81662	291.10794	0	0.93762	3.15726	20
7.982	5.12102	0.10439	3	3.11E-08	2	41.80213	0	0	0	170.1181	14	0.32113	0.66415	0.33	3.06837	300.95737	0	0.96548	3.142	20
8.134	4.86929	0.10519	3	3.04E-08	2	42.44918	0	0	0	172.9095	14	0.32506	0.66626	0.33	3.07812	303.41644	0	0.96653	3.08281	20
8.264	5.12102	0.10042	3	3.05E-08	2	43.62582	0	0	0	175.8509	14	0.33082	0.67281	0.33	3.10837	305.98633	0	0.96977	3.04264	20
8.406	5.3732	0.11405	3	3.65E-08	3	52.84627	0	0	0	188.8553	14	0.36693	0.73481	0.33	3.39482	317.0986	0	0.99945	2.95603	20
8.683	6.38056	0.15047	3	4.11E-08	3	60.54472	0	0	0	199.8657	14	0.3968	0.77848	0.33	3.59657	326.21115	0	1.01938	2.90754	20
8.831	6.38056	0.13672	3	4.50E-08	3	66.12285	0	0	0	206.6705	14	0.41715	0.80873	0.33	3.73635	331.71796	0	1.03276	2.89826	20
8.958	6.21259	0.13597	3	4.27E-08	3	67.01823	0	0	0	210.6165	14	0.42099	0.8122	0.33	3.75235	334.86972	0	1.03427	2.78934	20
9.105	6.54853	0.17105	3	3.69E-08	3	68.55419	0	0	0	219.0163	14	0.4263	0.82047	0.33	3.79057	341.48206	0	1.03787	2.52189	20
9.232	6.63229	0.18996	3	3.33E-08	3	68.22811	0	0	0	222.9423	14	0.42601	0.81711	0.33	3.77507	344.52914	0	1.03641	2.39206	20
9.383	6.21259	0.16259	3	2.43E-08	3	53.94015	0	0	0	210.3315	14	0.37976	0.72469	0.33	3.34807	334.6431	0	0.99472	2.37349	20
9.511	4.61756	0.11784	3	1.88E-08	3	39.3328	0	0	0	188.8732	14	0.32544	0.61664	0.33	2.84886	317.11359	0	0.94128	2.59338	20
9.658	4.36539	0.0885	3	1.52E-08	2	29.86219	0	0	0	171.6891	14	0.28472	0.53512	0.33	2.47225	302.34381	0	0.89672	2.84675	20
9.787	4.53336	0.0877	3	1.61E-08	2	28.25298	0	0	0	165.8502	14	0.27792	0.51867	0.33	2.39624	297.1582	0	0.8872	3.10678	20
9.933	4.36539	0.0868	3	1.54E-08	2	27.47653	0	0	0	165.5978	14	0.27516	0.50947	0.33	2.35373	296.93198	0	0.88178	3.10668	20
10.071	4.28163	0.0859	3	1.42E-08	2	25.96192	0	0	0	163.8011	14	0.26847	0.49339	0.33	2.27944	295.31677	0	0.87216	3.12222	20
10.207	4.28163	0.0801	3	1.53E-08	2	25.26035	0	0	0	160.1675	14	0.26578	0.48491	0.33	2.24027	292.02289	0	0.86701	3.36086	20
10.351	4.28163	0.0665	3	2.25E-08	2	27.27003	0	0	0	155.7494	14	0.27721	0.5019	0.33	2.31879	287.96713	0	0.87728	4.09342	20
10.484	4.78553	0.0525	4	3.28E-08	2	28.90012	0	0	0	150.3871	14	0.28655	0.51457	0.33	2.3773	282.96643	0	0.88479	5.07811	20

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In situ data											Estimations									
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
10.629	4.70133	0.0469	4	3.38E-08	2	26.93246	0	0	0	144.9794	14	0.27782	0.4946	0.33	2.28506	277.83237	0	0.8729	5.61369	20
10.77	3.94569	0.0461	3	2.84E-08	2	23.64543	0	0	0	140.5548	14	0.26098	0.46226	0.33	2.13565	273.55994	0	0.85294	5.6542	20
10.908	4.11366	0.0427	3	2.58E-08	2	20.23496	0	0	0	132.8046	14	0.24229	0.42611	0.33	1.96862	265.91101	0	0.82951	6.21824	20
11.059	3.94569	0.02575	4	3.57E-08	2	19.24788	0	0	0	122.8286	14	0.23766	0.41321	0.33	1.90903	255.7287	0	0.82084	8.67405	20
11.184	3.77772	0.0121	1	6.70E-08	2	18.06886	0	0	0	107.593	14	0.23333	0.39509	0.33	1.82534	239.34354	0	0.80835	18.3093	20
11.331	3.94569	-0.00039	1	1.31E-07	2	19.33804	0	0	0	99.97789	14	0.24488	0.40291	0.33	1.86143	230.71812	0	0.81378	47.19709	20
11.458	4.4496	0.00354	1	1.51E-07	2	20.66754	0	0	0	101.2669	14	0.25447	0.41438	0.33	1.91446	232.2007	0	0.82163	54.3936	20
11.61	4.19787	0.0106	1	6.69E-08	2	18.09581	0	0	0	108.7905	14	0.23587	0.39142	0.33	1.80838	240.67175	0	0.80577	18.87481	20
11.67	3.19006	0.0226	4	9.36E-08	3	49.83168	0	0	0	171.0215	14	0.39405	0.64521	0.33	2.98085	301.75543	0	0.95598	6.98556	20
11.944	11.08189	0.13264	5	1.70E-06	6	236.95148	27	33	247.8003	310.5763	0	0	0	0.33	0	406.64355	-0.0167	0	0	20
12.13	38.45179	0.30039	5	6.79E-06	9	437.20714	35	36	348.8355	437.2071	0	0	0	0.33	0	482.47336	-0.04893	0	0	20
12.279	44.32889	0.40641	5	1.09E-05	11	497.30926	39	37	396.7893	497.3093	0	0	0	0.33	0	514.56824	-0.06375	0	0	20
12.403	33.07859	0.34783	5	6.27E-06	9	457.88293	36	36	365.3321	457.8829	0	0	0	0.33	0	493.74982	-0.05488	0	0	20
12.586	19.64559	0.19023	5	1.90E-06	7	296.83758	30	34	304.3388	381.438	0	0	0	0.33	0	450.65237	-0.04124	0	0	20
12.74	13.18082	0.20068	5	1.03E-06	6	228.664	26	33	261.7516	328.0621	0	0	0	0.33	0	417.93402	-0.02765	0	0	20
12.911	18.47026	0.16713	5	2.64E-06	7	304.82193	30	34	294.3754	368.9505	0	0	0	0.33	0	443.21432	-0.03049	0	0	20
13.075	35.93316	0.25558	6	2.76E-05	12	519.60063	42	37	414.575	519.6006	0	0	0	0.33	0	525.9743	-0.06542	0	0	20
13.232	88.48982	0.53007	6	1.50E-04	20	731.43097	56	40	583.5885	731.431	0	0	0	0.33	0	624.04572	-0.1249	0	0	20
13.408	146.8394	0.84994	6	4.62E-04	29	962.5802	71	42	768.0161	962.5802	0	0	0	0.33	0	715.89313	-0.17935	0	0	20
13.562	200.8235	1.18886	6	7.91E-04	36	1167.92903	81	44	931.8583	1167.929	0	0	0	0.33	0	788.5658	-0.21848	0	0	20
13.732	234.9099	1.56033	6	9.54E-04	42	1325.40437	87	44	1057.503	1325.404	0	0	0	0.33	0	840.04767	-0.24027	0	0	20
13.898	247.7553	1.78338	6	9.07E-04	45	1423.11099	90	45	1135.461	1423.111	0	0	0	0.33	0	870.46057	-0.24889	0	0	20
14.059	244.3968	1.88912	6	8.87E-04	46	1459.25156	91	45	1164.296	1459.252	0	0	0	0.33	0	881.44415	-0.25154	0	0	20
14.232	250.3577	1.81993	6	9.31E-04	47	1485.10149	92	45	1184.921	1485.101	0	0	0	0.33	0	889.21704	-0.25467	0	0	20
14.389	267.4846	1.92118	6	9.31E-04	48	1510.44799	92	45	1205.145	1510.448	0	0	0	0.33	0	896.77319	-0.25667	0	0	20
14.566	257.4101	2.05862	6	7.94E-04	47	1515.59453	91	45	1209.251	1515.595	0	0	0	0.33	0	898.29962	-0.25311	0	0	20
14.72	230.9638	1.95365	6	5.72E-04	45	1473.07962	87	44	1175.329	1473.08	0	0	0	0.33	0	885.61066	-0.24123	0	0	20
14.875	204.1816	1.81994	6	4.73E-04	42	1405.8714	84	44	1121.706	1405.871	0	0	0	0.33	0	865.17212	-0.22983	0	0	20
15.193	203.7619	1.66707	6	5.64E-04	44	1451.50946	86	44	1158.119	1451.509	0	0	0	0.33	0	879.10278	-0.2375	0	0	20
15.368	272.942	2.14376	6	7.51E-04	49	1571.44823	92	45	1253.815	1571.448	0	0	0	0.33	0	914.70227	-0.25489	0	0	20
15.519	299.2204	2.49961	6	9.26E-04	55	1739.2808	98	45	1387.724	1739.281	0	0	0	0.33	0	962.30902	-0.27378	0	0	20
15.688	319.2856	2.77381	6	1.05E-03	58	1825.93312	100	46	1456.862	1825.933	0	0	0	0.33	0	985.9892	-0.28308	0	0	20
15.856	337.9243	2.69712	6	1.17E-03	59	1843.65525	100	46	1471.002	1843.655	0	0	0	0.33	0	990.76251	-0.28664	0	0	20
16.008	328.605	2.51696	6	1.27E-03	59	1825.67717	100	46	1456.657	1825.677	0	0	0	0.33	0	985.92004	-0.28673	0	0	20
16.18	324.2392	2.54533	6	1.18E-03	59	1823.14668	100	46	1454.638	1823.147	0	0	0	0.33	0	985.23657	-0.28433	0	0	20
16.337	322.8121	2.72724	6	9.63E-04	59	1866.02145	100	46	1488.847	1866.021	0	0	0	0.33	0	996.75409	-0.28268	0	0	20

In situ data				Estimations																
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
16.467	316.0114	3.01659	6	7.32E-04	59	1917.7749	100	46	1530.14	1917.775	0	0	0	0.33	0	1010.4819	-0.27997	0	0	20
16.588	303.1661	3.21151	6	5.58E-04	59	1941.91794	98	45	1549.403	1941.918	0	0	0	0.33	0	1016.8225	-0.2752	0	0	20
16.711	289.0616	3.1889	6	4.54E-04	57	1925.35236	96	45	1536.185	1925.352	0	0	0	0.33	0	1012.4762	-0.26885	0	0	20
16.837	275.2927	3.07246	6	3.97E-04	55	1879.57269	94	45	1499.659	1879.573	0	0	0	0.33	0	1000.3668	-0.26195	0	0	20
16.957	262.3636	2.93555	6	3.62E-04	53	1816.81529	92	45	1449.587	1816.815	0	0	0	0.33	0	983.52435	-0.25466	0	0	20
17.092	248.6784	2.72005	6	3.53E-04	50	1735.25381	89	45	1384.511	1735.254	0	0	0	0.33	0	961.1944	-0.24707	0	0	20
17.226	236.505	2.38601	6	3.66E-04	48	1640.66417	87	44	1309.041	1640.664	0	0	0	0.33	0	934.6297	-0.23951	0	0	20
17.348	226.43	2.10479	6	4.07E-04	46	1551.3924	85	44	1237.813	1551.392	0	0	0	0.33	0	908.8465	-0.23369	0	0	20
17.471	223.4079	1.91029	6	4.85E-04	45	1496.12593	85	44	1193.717	1496.126	0	0	0	0.33	0	892.51141	-0.23223	0	0	20
17.593	233.3145	1.82627	6	5.79E-04	45	1478.70568	85	44	1179.818	1478.706	0	0	0	0.33	0	887.30023	-0.23437	0	0	20
17.716	240.3669	1.84559	6	6.34E-04	45	1475.29957	86	44	1177.101	1475.3	0	0	0	0.33	0	886.27771	-0.23587	0	0	20
17.839	233.3987	1.81446	6	5.53E-04	44	1471.9692	85	44	1174.444	1471.969	0	0	0	0.33	0	885.27679	-0.23202	0	0	20
17.962	214.5083	1.8795	6	4.87E-04	42	1402.01959	82	44	1118.633	1402.02	0	0	0	0.33	0	863.98608	-0.22176	0	0	20
18.081	193.0997	1.40509	6	4.60E-04	38	1295.00947	78	43	1033.252	1295.009	0	0	0	0.33	0	830.35956	-0.20874	0	0	20
18.21	178.7431	1.08244	6	4.58E-04	35	1168.7635	74	43	932.5241	1168.764	0	0	0	0.33	0	788.84747	-0.19358	0	0	20
18.265	157.1661	1.03139	6	4.30E-04	32	1087.98094	71	42	868.0699	1087.981	0	0	0	0.33	0	761.0976	-0.18168	0	0	20
18.445	151.2052	0.921	6	2.87E-04	30	1066.49955	68	42	850.9305	1066.5	0	0	0	0.33	0	753.54651	-0.16911	0	0	20
18.536	135.925	1.10229	6	1.58E-04	30	1097.22703	66	42	875.4471	1097.227	0	0	0	0.33	0	764.32483	-0.16693	0	0	20
18.649	123.4998	1.48058	6	6.88E-05	29	1162.95966	63	41	927.8933	1162.96	0	0	0	0.33	0	786.88641	-0.16646	0	0	20
18.75	115.1878	1.79028	6	3.43E-05	29	1223.45148	61	41	976.1581	1223.451	0	0	0	0.33	0	807.0921	-0.16828	0	0	20
18.841	108.9753	1.97392	5	1.84E-05	27	1222.10282	58	40	975.082	1222.103	0	0	0	0.33	0	806.64716	-0.16574	0	0	20
18.955	86.39088	1.85012	5	1.10E-05	25	1166.74177	54	40	930.911	1166.742	0	0	0	0.33	0	788.16492	-0.15904	0	0	20
19.051	74.97306	1.60576	5	9.20E-06	23	1094.37554	51	39	873.172	1094.376	0	0	0	0.33	0	763.33099	-0.15004	0	0	20
19.151	84.20819	1.41651	5	1.39E-05	23	1049.98785	52	39	837.7563	1049.988	0	0	0	0.33	0	747.69049	-0.14285	0	0	20
19.266	94.45068	1.23519	6	2.35E-05	23	1019.94796	54	40	813.7883	1019.948	0	0	0	0.33	0	736.91724	-0.13892	0	0	20
19.358	92.01581	1.10151	6	2.78E-05	23	989.8457	53	40	789.7705	989.8457	0	0	0	0.33	0	725.9613	-0.13493	0	0	20
19.459	84.54412	1.10835	6	2.03E-05	22	976.54368	52	39	779.1572	976.5437	0	0	0	0.33	0	721.06689	-0.13167	0	0	20
19.571	76.31636	1.2628	5	1.38E-05	22	980.26189	50	39	782.1239	980.2619	0	0	0	0.33	0	722.43829	-0.13156	0	0	20
19.665	75.81245	1.29141	5	1.16E-05	21	957.91023	49	39	764.2901	957.9102	0	0	0	0.33	0	714.15442	-0.12815	0	0	20
19.762	72.28646	1.00244	5	9.92E-06	19	897.13358	46	38	715.7981	897.1336	0	0	0	0.33	0	691.12769	-0.11879	0	0	20
19.876	56.58656	0.85676	5	5.91E-06	17	783.6142	42	37	654.1009	819.8065	0	0	0	0.33	0	660.6712	-0.10783	0	0	20
19.969	41.89402	0.90576	5	2.83E-06	15	669.17885	39	37	638.2067	799.8857	0	0	0	0.33	0	652.59491	-0.10995	0	0	20
20.088	47.01549	1.11005	5	2.59E-06	16	689.83276	40	37	668.4959	837.8482	0	0	0	0.33	0	667.90149	-0.11703	0	0	20
20.183	60.86819	1.17788	5	3.69E-06	18	789.07738	43	37	717.1353	898.8096	0	0	0	0.33	0	691.77295	-0.12338	0	0	20
20.291	63.21885	1.2449	5	3.93E-06	19	832.13431	44	38	747.6672	937.0762	0	0	0	0.33	0	706.34552	-0.12842	0	0	20
20.396	56.75453	1.38817	5	2.70E-06	18	784.83535	42	37	754.6549	945.8341	0	0	0	0.33	0	709.63855	-0.1328	0	0	20

S-51 over Black Mingo Creek - Estimated Soil Parameter Correlations
CPT-3
Correlations from CPeT-IT v.1.7.6.42

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	In situ data			Estimations																
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
20.497	50.45772	1.41709	5	2.21E-06	18	758.38303	42	37	756.2969	947.8922	0	0	0	0.33	0	710.41022	-0.13481	0	0	20
20.607	57.17422	1.34924	5	3.76E-06	19	847.83189	44	38	767.9508	962.4984	0	0	0	0.33	0	715.86267	-0.13147	0	0	20
20.702	75.39275	1.24716	5	1.15E-05	22	1004.48215	49	39	801.4485	1004.482	0	0	0	0.33	0	731.30884	-0.13144	0	0	20
20.812	101.4194	1.23091	6	2.70E-05	24	1048.97257	54	40	836.9462	1048.973	0	0	0	0.33	0	747.32892	-0.1385	0	0	20
20.912	108.5556	1.29067	6	4.06E-05	26	1078.03258	57	40	860.1324	1078.033	0	0	0	0.33	0	757.60992	-0.14444	0	0	20
21.018	106.2044	1.26877	6	3.58E-05	26	1091.90677	56	40	871.2022	1091.907	0	0	0	0.33	0	762.46954	-0.14513	0	0	20
21.125	98.31261	1.38201	6	2.14E-05	25	1110.52927	54	40	886.0606	1110.529	0	0	0	0.33	0	768.94403	-0.14483	0	0	20
21.222	85.38352	1.67694	5	1.10E-05	24	1123.81702	52	39	896.6625	1123.817	0	0	0	0.33	0	773.53064	-0.14586	0	0	20
21.436	76.65185	1.71822	5	6.73E-06	24	1152.07316	50	39	919.2073	1152.073	0	0	0	0.33	0	783.1947	-0.15037	0	0	20
21.531	82.10925	1.88528	5	8.90E-06	26	1236.09509	53	40	986.2461	1236.095	0	0	0	0.33	0	811.25177	-0.159	0	0	20
21.648	116.5311	2.2617	5	1.31E-05	29	1313.13642	56	40	1047.715	1313.136	0	0	0	0.33	0	836.15088	-0.16658	0	0	20
21.743	114.9361	2.1583	5	1.45E-05	29	1331.80562	57	40	1062.611	1331.806	0	0	0	0.33	0	842.07379	-0.16829	0	0	20
21.841	92.68768	1.97742	5	9.00E-06	27	1276.12379	54	40	1018.184	1276.124	0	0	0	0.33	0	824.28259	-0.1625	0	0	20
21.957	77.74342	2.05485	5	7.11E-06	26	1237.97249	52	39	987.744	1237.972	0	0	0	0.33	0	811.86761	-0.15865	0	0	20
22.058	93.69505	1.94055	5	1.09E-05	27	1233.31781	53	40	984.0302	1233.318	0	0	0	0.33	0	810.3399	-0.15647	0	0	20
22.169	112.4175	1.65146	6	2.88E-05	29	1229.5512	58	40	981.0249	1229.551	0	0	0	0.33	0	809.10156	-0.15742	0	0	20
22.264	131.4754	1.43091	6	6.83E-05	31	1227.75148	62	41	979.589	1227.751	0	0	0	0.33	0	808.50916	-0.16367	0	0	20
22.383	151.2894	1.44799	6	1.18E-04	34	1271.2372	66	42	1014.285	1271.237	0	0	0	0.33	0	822.70288	-0.17432	0	0	20
22.481	168.5001	1.67851	6	1.12E-04	37	1401.64969	69	42	1118.338	1401.65	0	0	0	0.33	0	863.87213	-0.18746	0	0	20
22.596	172.866	2.44074	6	7.15E-05	39	1548.49175	70	42	1235.499	1548.492	0	0	0	0.33	0	907.99646	-0.19648	0	0	20
22.691	160.1886	2.95602	6	4.21E-05	40	1666.13265	69	42	1329.361	1666.133	0	0	0	0.33	0	941.85602	-0.20191	0	0	20
22.811	157.334	3.16906	6	3.29E-05	42	1772.88163	70	42	1414.533	1772.882	0	0	0	0.33	0	971.55994	-0.20875	0	0	20
22.904	181.01	3.70057	6	4.43E-05	47	1962.58412	75	43	1565.892	1962.584	0	0	0	0.33	0	1022.2188	-0.22517	0	0	20
23.015	242.8855	4.554	6	6.81E-05	53	2116.66184	81	44	1688.826	2116.662	0	0	0	0.33	0	1061.5867	-0.23964	0	0	20
23.115	252.7083	4.22064	6	2.46E-04	53	1870.12824	85	44	1492.124	1870.128	0	0	0	0.33	0	997.85034	-0.23627	0	0	20
23.224	258.4175	0	7	3.39E-03	53	1487.69225	95	45	1186.989	1487.692	0	0	0	0.33	0	889.99231	-0.26608	0	0	20
23.328	452.1048	0	0	0.00E+00	0	412.8307	0	0	329.3862	412.8307	0	0	0	0.33	0	468.83035	0	0	0	20
23.502	667.7888	0	0	0.00E+00	0	535.70055	0	0	427.4207	535.7006	0	0	0	0.33	0	534.06085	0	0	0	20
23.604	714.8043	0	0	0.00E+00	0	628.25291	0	0	501.2656	628.2529	0	0	0	0.33	0	578.35828	0	0	0	20

In situ data											Estimations									
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
0.164	1.32405	0.04266	5	3.64E-06	1	36.01452	45	38	32.80679	41.11784	0	0	0	0.33	0	147.96019	-0.13803	0	0	20
0.492	5.07712	0.09477	0	0.00E+00	19	437.25227	0	0	348.8715	437.2523	0	0	0	0.33	0	482.49826	0	0	0	20
0.656	403.8832	0.02112	0	0.00E+00	19	450.46642	0	0	359.4147	450.4664	0	0	0	0.33	0	489.73477	0	0	0	20
0.984	2.15754	0.19417	7	1.62E-02	21	530.50393	93	45	423.2744	530.5039	0	0	0	0.33	0	531.46423	-0.25831	0	0	20
1.148	49.44235	0.48895	6	4.87E-04	14	459.22888	80	43	366.406	459.2289	0	0	0	0.33	0	494.47498	-0.21595	0	0	20
1.312	157.5716	0.92158	6	1.85E-03	24	719.41027	100	46	573.9976	719.4103	0	0	0	0.33	0	618.89648	-0.27981	0	0	20
1.476	210.2098	1.25731	7	3.56E-03	33	918.14856	100	47	732.5653	918.1486	0	0	0	0.33	0	699.17548	-0.31418	0	0	20
1.64	231.3946	1.37021	7	4.06E-03	38	1049.73015	100	47	837.5507	1049.73	0	0	0	0.33	0	747.59875	-0.32899	0	0	20
1.804	259.9522	1.64245	7	3.92E-03	40	1129.13954	100	47	900.9092	1129.14	0	0	0	0.33	0	775.36023	-0.33451	0	0	20
1.969	258.3376	1.75628	7	3.38E-03	41	1175.90927	100	47	938.2255	1175.909	0	0	0	0.33	0	791.25531	-0.3348	0	0	20
2.133	242.0156	1.74327	6	2.61E-03	41	1175.64826	100	47	938.0172	1175.648	0	0	0	0.33	0	791.16748	-0.32838	0	0	20
2.297	224.9839	1.77661	6	1.65E-03	38	1159.55777	100	47	925.1791	1159.558	0	0	0	0.33	0	785.73468	-0.31802	0	0	20
2.526	191.7207	1.95301	6	8.46E-04	37	1171.23026	100	47	934.4922	1171.23	0	0	0	0.33	0	789.6795	-0.30701	0	0	20
2.657	172.7649	2.34248	6	3.58E-04	33	1149.95584	100	46	917.518	1149.956	0	0	0	0.33	0	782.47467	-0.29172	0	0	20
2.822	131.1239	2.38052	6	1.66E-04	29	1070.02491	96	45	853.7433	1070.025	0	0	0	0.33	0	754.79089	-0.27616	0	0	20
2.953	97.37015	1.8524	6	1.87E-04	28	1007.68109	93	45	804.0009	1007.681	0	0	0	0.33	0	732.47241	-0.26418	0	0	20
3.117	157.8907	1.50167	6	3.21E-04	29	1001.90391	93	45	799.3914	1001.904	0	0	0	0.33	0	730.36969	-0.26009	0	0	20
3.281	168.1878	1.74497	6	6.36E-04	31	1024.89904	96	45	817.7386	1024.899	0	0	0	0.33	0	738.70367	-0.26871	0	0	20
3.445	163.9537	1.40668	6	5.72E-04	29	960.92745	92	45	766.6974	960.9275	0	0	0	0.33	0	715.27826	-0.25508	0	0	20
3.609	118.7026	0.98862	6	5.19E-04	25	846.42001	85	44	675.3351	846.42	0	0	0	0.33	0	671.30933	-0.23271	0	0	20
3.773	107.7244	0.85908	6	3.31E-04	21	740.44663	77	43	590.7819	740.4466	0	0	0	0.33	0	627.87994	-0.20446	0	0	20
3.937	88.56378	0.81607	6	2.23E-04	19	682.60881	72	42	544.6347	682.6088	0	0	0	0.33	0	602.85889	-0.18812	0	0	20
4.101	74.03256	0.71098	6	1.26E-04	17	639.41677	67	42	510.173	639.4168	0	0	0	0.33	0	583.4743	-0.17506	0	0	20
4.265	65.85963	0.75002	6	7.79E-05	16	617.11053	63	41	492.3754	617.1105	0	0	0	0.33	0	573.2066	-0.16638	0	0	20
4.429	62.46378	0.80448	6	6.68E-05	15	619.08971	62	41	493.9546	619.0897	0	0	0	0.33	0	574.12506	-0.16377	0	0	20
4.593	69.18405	0.74106	6	7.86E-05	16	612.02462	62	41	488.3175	612.0246	0	0	0	0.33	0	570.83966	-0.15941	0	0	20
4.757	69.45553	0.58464	6	1.02E-04	16	612.27366	62	41	488.5162	612.2737	0	0	0	0.33	0	570.95581	-0.15725	0	0	20
4.921	72.09411	0.66434	6	1.45E-04	18	656.87409	65	41	524.1017	656.8741	0	0	0	0.33	0	591.38568	-0.16576	0	0	20
5.085	99.31812	0.86989	6	1.62E-04	20	727.60875	68	42	580.5389	727.6088	0	0	0	0.33	0	622.41302	-0.17837	0	0	20
5.249	100.8089	0.98877	6	1.74E-04	21	781.70725	71	42	623.7026	781.7073	0	0	0	0.33	0	645.13678	-0.18659	0	0	20
5.413	96.07943	0.97796	6	1.65E-04	22	812.55717	71	42	648.3169	812.5572	0	0	0	0.33	0	657.74365	-0.18947	0	0	20
5.577	108.2436	1.07202	6	1.94E-04	23	844.53579	73	43	673.8318	844.5358	0	0	0	0.33	0	670.56171	-0.19349	0	0	20
5.741	122.2175	1.0984	6	2.46E-04	24	847.02297	73	43	675.8162	847.023	0	0	0	0.33	0	671.5484	-0.19272	0	0	20
5.906	111.3727	0.831	6	2.37E-04	23	829.81982	72	42	662.0903	829.8198	0	0	0	0.33	0	664.69379	-0.18769	0	0	20
6.07	99.13237	0.92627	6	1.65E-04	22	799.76321	68	42	638.1089	799.7632	0	0	0	0.33	0	652.54492	-0.17894	0	0	20
6.234	89.84973	1.01763	6	8.19E-05	20	782.55741	64	41	624.3809	782.5574	0	0	0	0.33	0	645.48749	-0.17071	0	0	20

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In situ data				Estimations																
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
6.398	70.22234	0.99204	6	4.03E-05	18	749.787	60	41	598.2343	749.787	0	0	0	0.33	0	631.8277	-0.16075	0	0	20
6.562	58.65356	0.96403	6	2.87E-05	17	715.37508	57	40	570.778	715.3751	0	0	0	0.33	0	617.15839	-0.15195	0	0	20
6.726	67.55994	0.85553	5	2.18E-05	17	742.55438	56	40	592.4636	742.5544	0	0	0	0.33	0	628.77295	-0.15571	0	0	20
6.89	67.71235	1.29847	5	1.44E-05	16	712.52457	53	40	568.5036	712.5246	0	0	0	0.33	0	615.92755	-0.1494	0	0	20
7.087	37.36396	0.86171	5	7.03E-06	15	707.06835	50	39	564.1503	707.0684	0	0	0	0.33	0	613.56476	-0.15137	0	0	20
7.218	45.58927	1.09136	5	8.49E-06	15	714.2672	51	39	569.894	714.2672	0	0	0	0.33	0	616.6803	-0.14923	0	0	20
7.382	74.47073	1.23235	5	1.23E-05	18	841.06791	56	40	671.0648	841.0679	0	0	0	0.33	0	669.18353	-0.1677	0	0	20
7.546	78.00471	1.76978	5	2.07E-05	21	940.91092	61	41	750.7268	940.9109	0	0	0	0.33	0	707.78925	-0.17957	0	0	20
7.743	90.42126	1.65446	5	1.72E-05	21	965.48062	61	41	770.3303	965.4806	0	0	0	0.33	0	716.97083	-0.18148	0	0	20
7.874	72.67516	1.52023	5	1.69E-05	20	908.80642	58	40	725.1115	908.8064	0	0	0	0.33	0	695.60938	-0.17133	0	0	20
8.071	63.44491	1.19822	5	1.16E-05	18	824.17804	54	40	657.5889	824.178	0	0	0	0.33	0	662.43036	-0.15724	0	0	20
8.202	56.04832	1.04941	5	1.20E-05	17	783.56312	53	39	625.1833	783.5631	0	0	0	0.33	0	645.9021	-0.14907	0	0	20
8.399	64.38317	1.12841	5	1.10E-05	16	762.98478	51	39	608.7645	762.9848	0	0	0	0.33	0	637.3642	-0.14465	0	0	20
8.53	56.04356	1.03662	6	2.00E-05	17	731.09209	52	39	583.3182	731.0921	0	0	0	0.33	0	623.90112	-0.1354	0	0	20
8.694	67.91715	0.51511	5	9.69E-06	12	568.46411	44	38	453.5618	568.4641	0	0	0	0.33	0	550.15015	-0.10166	0	0	20
8.858	4.92947	0.18848	5	3.78E-06	8	363.21242	35	35	328.7232	411.9997	0	0	0	0.33	0	468.35825	-0.06383	0	0	20
9.022	6.4869	0.26619	3	8.53E-09	3	41.66415	0	0	0	221.1721	14	0.33038	0.64342	0.33	2.9726	343.15863	0	0.95507	1.55016	20
9.186	3.90071	0.17192	3	3.17E-08	3	75.07974	0	0	0	235.4369	14	0.44585	0.85917	0.33	3.96935	354.05197	0	1.05435	2.16695	20
9.35	9.65891	0.1668	3	3.05E-08	3	60.07209	0	0	0	212.869	14	0.40039	0.76548	0.33	3.53651	336.6557	0	0.91912	2.49949	31.91002
9.514	4.3627	0.13224	3	3.73E-08	3	66.35407	0	0	0	217.445	14	0.42421	0.79806	0.33	3.68704	340.25494	0	0.91743	2.64535	33.7597
9.711	4.72943	0.17241	3	7.55E-09	3	30.56285	0	0	0	197.4065	14	0.28846	0.54057	0.33	2.49746	324.19803	0	0.74967	1.84388	32.99722
9.843	3.84832	0.15528	3	6.22E-09	3	28.74528	0	0	0	199.0393	14	0.28076	0.52237	0.33	2.41335	325.53607	0	0.73493	1.73123	33.05948
10.007	4.02931	0.14909	3	6.01E-09	3	28.15054	0	0	0	199.0669	14	0.27908	0.51465	0.33	2.37767	325.55862	0	0.72711	1.7343	33.19129
10.171	4.65323	0.16872	3	9.36E-09	3	34.94893	0	0	0	205.6081	14	0.31232	0.57092	0.33	2.63763	330.86426	0	0.76439	1.92875	33.56339
10.367	5.26763	0.15826	3	1.01E-08	3	38.41928	0	0	0	213.7678	14	0.32917	0.59548	0.33	2.75112	337.36566	0	0.78042	1.89605	33.70548
10.499	4.76277	0.18343	3	1.97E-08	3	53.83068	0	0	0	225.0833	14	0.391	0.70242	0.33	3.24518	346.17953	0	0.83825	2.19469	34.95907
10.663	7.18226	0.18208	3	1.30E-08	3	50.0671	0	0	0	234.791	14	0.3787	0.67452	0.33	3.1163	353.56595	0	0.81462	1.84038	35.26826
10.827	4.69609	0.23946	3	1.41E-08	3	59.85398	0	0	0	254.0445	14	0.41583	0.73438	0.33	3.39284	367.77701	0	0.84507	1.7147	36.01205
10.991	6.27257	0.29143	3	1.07E-08	3	60.28465	0	0	0	269.2141	14	0.41909	0.73392	0.33	3.3907	378.5983	0	0.85718	1.47549	35.13274
11.155	7.47755	0.30416	3	1.22E-08	3	60.27769	0	0	0	264.18	14	0.42082	0.73081	0.33	3.37636	375.04181	0	0.8663	1.58945	34.31286
11.319	4.91042	0.18279	3	1.06E-08	3	48.60222	0	0	0	244.3802	14	0.37944	0.65352	0.33	3.01924	360.71378	0	0.82831	1.70862	33.22022
11.516	4.63894	0.16594	3	6.02E-09	3	32.53385	0	0	0	222.4659	14	0.31198	0.53205	0.33	2.45807	344.16083	0	0.74398	1.65606	32.94271
11.647	4.58179	0.20512	3	5.45E-09	3	36.0361	0	0	0	239.153	14	0.32941	0.55814	0.33	2.57859	356.83511	0	0.74769	1.46611	34.06829
11.811	5.52482	0.28951	3	4.47E-09	3	46.92919	0	0	0	284.0543	14	0.37744	0.63436	0.33	2.93075	388.89322	0	0.80059	1.11475	34.26078
12.008	6.72027	0.50082	3	5.22E-09	4	73.05903	0	0	0	346.2568	14	0.47321	0.7877	0.33	3.63917	429.36722	0	0.89174	0.9307	35.20942
12.139	8.62062	0.70452	3	6.64E-09	5	116.1441	0	0	0	419.3148	14	0.59855	0.99002	0.33	4.57388	472.49783	0	1.02253	0.81157	34.78087

S-51 over Black Mingo Creek - Estimated Soil Parameter Correlations
CPT-5
Correlations from CPeT-IT v.1.7.6.42

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In situ data				Estimations																		
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
12.303	11.04487	0.96296	3	2.62E-08	6	171.85296	0	0	0	479.1634	14	0.8768	1.43885	0.33	6.64748	505.0932	0	1.2577	1.05388	20
12.467	18.62244	0.77853	3	2.20E-08	6	159.77516	0	0	0	459.9122	14	0.81518	1.32729	0.33	6.13206	494.84268	0	1.22346	1.05544	20
12.631	6.19637	0.52926	3	1.56E-08	5	127.15617	0	0	0	389.3387	14	0.64876	1.04813	0.33	4.84237	455.29565	0	1.12854	1.16058	20
12.795	4.12932	0.33566	3	2.54E-09	3	37.49838	0	0	0	303.1064	14	0.34545	0.55382	0.33	2.55866	401.72351	0	0.81132	0.84655	29.08807
12.959	5.8725	0.3348	3	2.79E-09	3	34.97385	0	0	0	282.9522	14	0.3349	0.53281	0.33	2.46159	388.13809	0	0.79682	0.99002	29.03948
13.156	5.75819	0.32407	3	4.11E-09	4	44.94221	0	0	0	291.4349	14	0.38137	0.60124	0.33	2.77773	393.91315	0	0.82261	1.14045	30.85613
13.287	5.96776	0.32428	3	4.20E-09	3	42.82992	0	0	0	284.2267	14	0.37342	0.58518	0.33	2.70352	389.0112	0	0.79523	1.19452	32.07797
13.451	5.37241	0.27074	3	3.51E-09	3	36.92845	0	0	0	273.6268	14	0.34804	0.54134	0.33	2.50099	381.68845	0	0.75363	1.19994	32.75613
13.648	4.56274	0.25773	3	4.10E-09	3	37.99991	0	0	0	271.0372	14	0.35464	0.54669	0.33	2.52573	379.87802	0	0.74921	1.28942	33.35727
13.812	6.18208	0.28013	3	1.05E-08	4	64.50545	0	0	0	298.9452	14	0.46375	0.70966	0.33	3.27865	398.95648	0	0.85856	1.52572	33.83017
13.944	10.07803	0.35578	3	1.46E-08	4	85.03139	0	0	0	324.2549	14	0.53402	0.81239	0.33	3.75325	415.50189	0	0.93468	1.52978	33.09644
14.108	7.74903	0.3904	3	1.13E-08	4	86.11181	0	0	0	342.9334	14	0.53936	0.81457	0.33	3.76332	427.30167	0	0.94219	1.33216	32.57778
14.272	6.50595	0.44415	3	5.15E-09	4	61.88519	0	0	0	336.5452	14	0.45889	0.68806	0.33	3.17883	423.30307	0	0.86782	1.0863	31.98434
14.436	6.68217	0.4074	3	8.26E-09	4	81.07795	0	0	0	354.9649	14	0.52713	0.78474	0.33	3.62552	434.73282	0	0.9372	1.18194	31.38706
14.6	10.8115	0.45965	3	1.96E-08	5	127.16624	0	0	0	381.6288	14	0.66252	0.97931	0.33	4.52439	450.76511	0	1.10262	1.41179	20
14.764	12.47847	0.51262	3	2.17E-08	5	131.08462	0	0	0	381.6976	14	0.67503	0.99077	0.33	4.57738	450.80576	0	1.10702	1.46787	20
14.961	7.42993	0.37974	3	6.34E-09	4	67.69626	0	0	0	344.132	14	0.48714	0.70901	0.33	3.27564	428.04776	0	0.98731	1.16634	20
15.092	2.88148	0.33559	4	1.42E-07	6	200.85334	0	0	0	412.6556	14	1.02476	1.4367	0.33	6.63756	468.7309	0	1.25706	2.48054	20
15.256	34.98734	0.49925	4	5.30E-07	10	372.2906	0	0	480.749	602.5387	14	1.89944	2.56799	0.33	11.86412	566.39862	0	1.53328	2.42315	20
15.42	44.21283	1.46975	5	3.30E-06	16	714.38696	43	38	662.5774	830.4303	0	0	0	0.33	0	664.93823	-0.13241	0	0	20
15.584	76.49967	1.54248	5	3.97E-06	20	892.26699	48	39	800.133	1002.833	0	0	0	0.33	0	730.70844	-0.15684	0	0	20
15.748	73.46578	1.96367	5	5.75E-06	22	1027.42239	51	39	861.7325	1080.038	0	0	0	0.33	0	758.31433	-0.16359	0	0	20
15.912	175.7892	3.42802	6	2.89E-05	36	1545.58222	70	42	1233.177	1545.582	0	0	0	0.33	0	907.14307	-0.2108	0	0	20

In situ data												Estimations								
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
0.328	1.18593	0.08617	3	1.53E-07	0	16.338	0	0	0	33.08257	14	0.08336	2.66811	0.33	12.32668	132.71785	0	1.55347	1.28953	20
0.82	1.19069	0.0177	6	1.79E-04	6	204.75337	58	40	163.3671	204.7534	0	0	0	0.33	0	330.17581	-0.12849	0	0	20
0.984	75.5233	0.41763	6	1.66E-03	18	530.72616	90	45	423.4517	530.7262	0	0	0	0.33	0	531.5755	-0.25028	0	0	20
1.148	224.8648	1.22567	6	2.16E-03	30	896.81785	100	47	715.5462	896.8179	0	0	0	0.33	0	691.00604	-0.32058	0	0	20
1.312	234.0189	2.39602	6	1.77E-03	37	1121.70991	100	48	894.9813	1121.71	0	0	0	0.33	0	772.80511	-0.34406	0	0	20
1.476	186.1864	2.263	6	9.26E-04	37	1161.92213	100	48	927.0655	1161.922	0	0	0	0.33	0	786.53534	-0.33837	0	0	20
1.64	174.0175	2.13068	6	5.66E-04	34	1117.92666	100	47	891.9628	1117.927	0	0	0	0.33	0	771.50079	-0.32297	0	0	20
1.804	162.8773	2.37519	6	3.74E-04	31	1064.39049	100	46	849.2477	1064.39	0	0	0	0.33	0	752.80103	-0.30658	0	0	20
1.969	125.1609	2.0379	6	2.61E-04	29	1022.39079	100	46	815.7373	1022.391	0	0	0	0.33	0	737.79919	-0.2935	0	0	20
2.133	127.99	1.93523	6	2.26E-04	26	952.66266	98	45	760.1032	952.6627	0	0	0	0.33	0	712.19562	-0.27856	0	0	20
2.297	124.437	1.67409	6	3.01E-04	27	947.0811	97	45	755.6498	947.0811	0	0	0	0.33	0	710.1062	-0.2714	0	0	20
2.461	142.9166	1.58543	6	3.92E-04	27	941.84166	96	45	751.4694	941.8417	0	0	0	0.33	0	708.13922	-0.2692	0	0	20
2.625	145.217	1.5422	6	3.99E-04	29	982.4322	97	45	783.8555	982.4322	0	0	0	0.33	0	723.23761	-0.27119	0	0	20
2.789	143.5119	1.91419	6	3.21E-04	28	964.25703	94	45	769.354	964.257	0	0	0	0.33	0	716.51636	-0.26206	0	0	20
2.953	118.8455	1.50132	6	1.89E-04	24	877.76657	87	44	700.3457	877.7666	0	0	0	0.33	0	683.62701	-0.24442	0	0	20
3.117	74.78031	1.08596	6	9.16E-05	19	744.69597	76	43	594.1723	744.696	0	0	0	0.33	0	629.67902	-0.21754	0	0	20
3.281	57.40571	1.11895	6	2.73E-05	15	633.03027	66	42	505.0774	633.0303	0	0	0	0.33	0	580.5531	-0.1945	0	0	20
3.445	39.45005	1.10608	5	8.55E-06	12	556.01077	58	40	443.6256	556.0108	0	0	0	0.33	0	544.0907	-0.18402	0	0	20
3.609	25.49513	0.87707	5	4.82E-06	10	485.62367	54	40	420.6024	527.1549	0	0	0	0.33	0	529.784	-0.18073	0	0	20
3.773	39.68343	1.02645	5	4.79E-06	11	487.51619	53	39	422.7088	529.7951	0	0	0	0.33	0	531.10901	-0.17716	0	0	20
3.937	39.85965	1.05688	5	8.63E-06	12	586.38404	56	40	467.8596	586.384	0	0	0	0.33	0	558.75421	-0.1784	0	0	20
4.101	49.69002	1.07558	5	1.02E-05	13	608.3964	57	40	485.4227	608.3964	0	0	0	0.33	0	569.14514	-0.17771	0	0	20
4.298	48.67555	1.08212	5	1.16E-05	13	627.60991	58	40	500.7526	627.6099	0	0	0	0.33	0	578.06226	-0.17634	0	0	20
4.462	47.60392	1.08966	5	1.02E-05	13	630.07524	57	40	502.7196	630.0752	0	0	0	0.33	0	579.19647	-0.17486	0	0	20
4.626	46.97047	1.09826	5	9.20E-06	13	633.10975	56	40	505.1408	633.1098	0	0	0	0.33	0	580.58954	-0.1734	0	0	20
4.757	46.69423	1.0994	5	8.57E-06	13	635.65344	55	40	507.1703	635.6534	0	0	0	0.33	0	581.7547	-0.17219	0	0	20
4.921	46.38465	1.09854	5	8.05E-06	13	638.4237	55	40	509.3806	638.4237	0	0	0	0.33	0	583.021	-0.17036	0	0	20
5.085	46.02745	1.09207	5	7.53E-06	13	641.73537	54	40	512.0229	641.7354	0	0	0	0.33	0	584.53119	-0.16879	0	0	20
5.249	45.77502	1.10174	5	7.04E-06	13	645.0597	53	40	514.6753	645.0597	0	0	0	0.33	0	586.04327	-0.16731	0	0	20
5.446	45.47496	1.10196	5	6.52E-06	13	650.55072	53	39	519.0564	650.5507	0	0	0	0.33	0	588.53229	-0.16594	0	0	20
5.61	45.31303	1.11077	5	6.09E-06	13	655.69778	52	39	523.1631	655.6978	0	0	0	0.33	0	590.8559	-0.16505	0	0	20
5.774	45.20825	1.12577	5	5.70E-06	13	628.46999	52	39	527.9196	661.6592	0	0	0	0.33	0	593.53577	-0.16438	0	0	20
5.906	45.11776	1.13374	5	7.53E-06	13	629.18717	51	39	502.011	629.1872	0	0	0	0.33	0	578.78815	-0.15156	0	0	20
6.102	45.33208	0.62147	5	1.30E-05	12	571.62425	49	39	456.0832	571.6243	0	0	0	0.33	0	551.67719	-0.12964	0	0	20
6.266	45.57975	0.36459	6	4.37E-05	13	542.92063	52	39	433.1814	542.9206	0	0	0	0.33	0	537.64783	-0.11625	0	0	20
6.398	69.92228	0.50878	6	1.69E-04	18	673.07443	62	41	537.0275	673.0744	0	0	0	0.33	0	598.63385	-0.15053	0	0	20

In situ data														Estimations						
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
6.562	138.6539	0.97775	6	2.44E-04	23	812.35791	69	42	648.1579	812.3579	0	0	0	0.33	0	657.66302	-0.17745	0	0	20
6.726	118.7502	1.08759	6	2.17E-04	24	866.76373	71	42	691.5668	866.7637	0	0	0	0.33	0	679.32886	-0.18448	0	0	20
6.89	84.55828	0.89975	6	9.50E-05	21	799.8784	64	41	638.2009	799.8784	0	0	0	0.33	0	652.59192	-0.16677	0	0	20
7.054	68.7554	0.84607	6	4.47E-05	17	716.26623	57	40	571.489	716.2662	0	0	0	0.33	0	617.54266	-0.14622	0	0	20
7.218	59.5442	0.7636	6	2.61E-05	15	651.96024	52	39	520.181	651.9602	0	0	0	0.33	0	589.16949	-0.13049	0	0	20
7.382	47.74681	0.60405	6	2.19E-05	14	600.52785	49	39	479.1446	600.5279	0	0	0	0.33	0	565.4527	-0.11701	0	0	20
7.546	49.9996	0.51177	6	3.71E-05	15	636.20406	52	39	507.6096	636.2041	0	0	0	0.33	0	582.00665	-0.12324	0	0	20
7.71	85.32033	0.80334	6	1.09E-04	21	788.98115	62	41	629.5062	788.9812	0	0	0	0.33	0	648.13135	-0.15698	0	0	20
7.874	140.0303	1.20519	6	1.78E-04	26	937.34232	70	42	747.8795	937.3423	0	0	0	0.33	0	706.44574	-0.18331	0	0	20
8.038	131.6812	1.29691	6	2.08E-04	28	994.94512	72	42	793.8392	994.9451	0	0	0	0.33	0	727.82886	-0.19156	0	0	20
8.202	117.993	1.10907	6	1.95E-04	26	955.977	70	42	762.7476	955.977	0	0	0	0.33	0	713.43341	-0.1847	0	0	20
8.366	120.541	0.939	6	2.57E-04	26	924.07138	70	42	737.291	924.0714	0	0	0	0.33	0	701.427	-0.18088	0	0	20
8.53	137.6537	0.92627	6	2.44E-04	27	948.11264	71	42	756.4729	948.1126	0	0	0	0.33	0	710.4928	-0.18356	0	0	20
8.727	124.0226	1.28283	6	1.14E-04	26	1000.43874	69	42	798.2224	1000.439	0	0	0	0.33	0	729.83545	-0.1852	0	0	20
8.891	90.03547	1.69207	6	4.34E-05	23	967.09375	63	41	771.6174	967.0938	0	0	0	0.33	0	717.56958	-0.1743	0	0	20
9.022	71.75595	1.18443	6	8.50E-05	26	1020.1456	68	42	813.946	1020.146	0	0	0	0.33	0	736.98865	-0.18471	0	0	20
9.186	178.3897	1.31184	6	2.04E-04	25	895.58933	67	42	714.566	895.5893	0	0	0	0.33	0	690.53259	-0.17155	0	0	20
9.416	99.50387	0.31433	6	3.73E-04	22	767.00194	65	41	611.9696	767.0019	0	0	0	0.33	0	639.03986	-0.1557	0	0	20
9.547	55.75303	0.15684	6	1.21E-04	12	460.09566	46	38	367.0976	460.0957	0	0	0	0.33	0	494.94141	-0.07075	0	0	20
9.678	8.5206	0.10779	5	1.41E-05	8	339.34322	34	35	270.7526	339.3432	0	0	0	0.33	0	425.05908	-0.02044	0	0	20
9.843	18.3462	0.14568	5	8.65E-07	5	191.39808	25	32	226.1688	283.4649	0	0	0	0.33	0	388.48956	-0.02626	0	0	20
10.007	15.76478	0.22332	5	5.95E-07	5	191.4918	25	33	242.0839	303.4118	0	0	0	0.33	0	401.92584	-0.04122	0	0	20
10.171	8.63491	0.2379	4	1.31E-07	4	132.02837	0	0	0	275.1477	14	0.67361	1.17047	0.33	5.40756	382.74774	0	1.17196	3.14067	20
10.367	5.60102	0.16936	3	1.75E-08	3	52.79112	0	0	0	226.8843	14	0.38586	0.69803	0.33	3.22489	347.56174	0	0.98205	2.07056	20
10.499	3.55779	0.14063	3	7.38E-09	3	29.21409	0	0	0	197.9497	14	0.28804	0.51746	0.33	2.39068	324.64383	0	0.80195	1.93862	27.74298
10.696	4.4008	0.12684	3	3.48E-08	3	59.57706	0	0	0	214.9789	14	0.41413	0.73398	0.33	3.39097	338.31998	0	0.91753	2.87813	30.29292
10.827	10.86865	0.15556	4	5.60E-08	3	75.20843	0	0	0	224.14	14	0.47054	0.81549	0.33	3.76756	345.45331	0	1.03571	3.26078	20
11.024	6.06301	0.14184	4	5.39E-08	3	78.90245	0	0	0	232.0928	14	0.48399	0.83176	0.33	3.84275	351.52853	0	1.04273	3.09326	20
11.155	5.03425	0.1626	3	2.02E-08	3	58.9113	0	0	0	238.2272	14	0.41602	0.72248	0.33	3.33787	356.14383	0	0.99369	2.14366	20
11.352	8.03004	0.26612	3	4.62E-08	4	93.37754	0	0	0	261.0617	14	0.52939	0.89993	0.33	4.15767	372.82184	0	1.0712	2.51592	20
11.516	10.75434	0.1899	3	5.35E-08	4	104.27518	0	0	0	270.3928	14	0.56296	0.94503	0.33	4.36606	379.42615	0	1.08927	2.55084	20
11.68	6.46308	0.19282	3	4.29E-08	4	86.63433	0	0	0	256.6322	14	0.51335	0.86104	0.33	3.97798	369.64539	0	0.97922	2.5665	31.80324
11.844	5.84392	0.20533	3	1.20E-08	3	52.6301	0	0	0	251.7836	14	0.40003	0.67124	0.33	3.10115	366.13681	0	0.87296	1.76824	30.64352
11.975	5.99633	0.26698	3	4.44E-09	3	42.85084	0	0	0	272.8314	14	0.36212	0.60374	0.33	2.78929	381.13327	0	0.83491	1.18269	30.01215
12.172	4.89613	0.42787	3	3.15E-09	3	35.86201	0	0	0	268.0027	14	0.33286	0.54969	0.33	2.53955	377.74548	0	0.80943	1.09614	29.0029
12.336	4.69609	0.19794	3	2.73E-09	3	29.79277	0	0	0	259.6979	14	0.30459	0.49905	0.33	2.30559	371.84674	0	0.76624	1.04741	29.47065

In situ data												Estimations								
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
12.664	4.72467	0.22915	3	4.84E-09	3	33.45149	0	0	0	241.2428	14	0.32527	0.5247	0.33	2.4241	358.39087	0	0.77641	1.49383	30.15717
12.795	5.75819	0.21308	3	7.23E-09	3	39.39942	0	0	0	244.2552	14	0.3541	0.56769	0.33	2.62271	360.62149	0	0.79055	1.67782	31.47814
12.959	5.80582	0.17824	3	1.05E-08	3	43.77407	0	0	0	241.6791	14	0.37467	0.59609	0.33	2.75392	358.71478	0	0.80344	1.93422	32.04997
13.123	5.56292	0.17817	3	8.42E-09	3	41.41816	0	0	0	245.4727	14	0.36584	0.57763	0.33	2.66863	361.51917	0	0.78475	1.78562	32.44889
13.287	5.32954	0.24593	3	7.60E-09	3	41.93425	0	0	0	252.6126	14	0.3695	0.57903	0.33	2.6751	366.73907	0	0.78767	1.6783	32.30817
13.484	6.0011	0.22318	3	6.11E-09	3	37.94876	0	0	0	251.0878	14	0.35308	0.54836	0.33	2.5334	365.63058	0	0.78237	1.60128	31.02962
13.648	5.03902	0.17917	3	5.96E-09	3	32.68878	0	0	0	234.997	14	0.32892	0.50705	0.33	2.34258	353.72101	0	0.76396	1.76273	30.09858
13.78	4.40557	0.14625	3	4.09E-09	3	24.09271	0	0	0	216.571	14	0.28322	0.43402	0.33	2.00516	339.5704	0	0.72773	1.77768	28.57089
13.976	4.18648	0.14298	3	3.06E-09	3	18.88638	0	0	0	205.2327	14	0.25186	0.3826	0.33	1.7676	330.56204	0	0.6949	1.7433	27.87773
14.14	3.75307	0.13551	3	2.70E-09	2	15.53014	0	0	0	196.3469	14	0.22921	0.34568	0.33	1.59706	323.32684	0	0.6727	1.72394	27.18245
14.272	3.49588	0.11241	3	2.98E-09	2	15.5072	0	0	0	189.0766	14	0.22971	0.34443	0.33	1.59126	317.28433	0	0.66465	1.98179	27.66451
14.436	4.17219	0.09285	3	3.24E-09	2	15.36382	0	0	0	182.5948	14	0.22947	0.34161	0.33	1.57822	311.7984	0	0.64864	2.25544	28.59535
14.6	3.65781	0.09385	3	3.88E-09	2	16.4422	0	0	0	183.9242	14	0.23823	0.35214	0.33	1.62688	312.93143	0	0.64343	2.38464	29.60995
14.764	3.78164	0.107	3	3.17E-09	2	15.64772	0	0	0	187.2231	14	0.23322	0.34231	0.33	1.58149	315.72531	0	0.63369	2.18043	29.66476
14.928	3.96263	0.11361	3	3.43E-09	3	16.70496	0	0	0	190.91	14	0.24182	0.35245	0.33	1.62833	318.81888	0	0.64358	2.2035	29.61893
15.092	4.05788	0.10203	3	4.16E-09	3	17.77323	0	0	0	190.8182	14	0.2503	0.36228	0.33	1.67375	318.74222	0	0.6536	2.37882	29.53566
15.256	4.18171	0.09371	3	5.38E-09	3	18.69254	0	0	0	187.469	14	0.25758	0.37025	0.33	1.71056	315.93262	0	0.66296	2.702	29.37489
15.42	4.31984	0.08454	3	5.53E-09	3	18.69064	0	0	0	187.1737	14	0.25845	0.36896	0.33	1.70461	315.68369	0	0.66592	2.76659	29.08975
15.584	4.14838	0.09641	3	4.63E-09	3	17.62252	0	0	0	188.2766	14	0.25182	0.35705	0.33	1.64956	316.6124	0	0.66556	2.60976	28.38308
15.748	3.9912	0.10274	3	3.75E-09	3	16.42739	0	0	0	189.5066	14	0.24395	0.34356	0.33	1.58725	317.64493	0	0.66132	2.43078	27.84133
15.912	4.05312	0.09591	3	3.98E-09	3	16.93426	0	0	0	191.0016	14	0.24852	0.34765	0.33	1.60614	318.89542	0	0.67024	2.47513	27.47575
16.109	4.41033	0.09655	3	6.29E-09	3	20.73151	0	0	0	195.3023	14	0.27608	0.38312	0.33	1.77	322.46558	0	0.69164	2.82304	28.14132
16.273	5.15332	0.09506	3	1.06E-08	3	26.1965	0	0	0	200.5935	14	0.31138	0.42924	0.33	1.98308	326.80453	0	0.72723	3.2564	28.3257
16.437	5.60579	0.08951	3	1.35E-08	3	29.28869	0	0	0	203.5005	14	0.33033	0.45237	0.33	2.08996	329.16406	0	0.7487	3.49883	28.09063
16.568	5.29144	0.093	3	1.08E-08	3	27.95077	0	0	0	207.7125	14	0.32354	0.44077	0.33	2.03634	332.55316	0	0.74633	3.15016	27.58584
16.732	4.92947	0.11945	3	1.36E-08	3	33.04525	0	0	0	217.2742	14	0.35294	0.4777	0.33	2.20696	340.12131	0	0.76843	3.19352	28.06902
16.896	6.85839	0.11248	4	9.73E-08	4	102.22257	0	0	0	270.8623	14	0.6285	0.82983	0.33	3.83379	379.75543	0	0.96751	4.48629	31.13747
17.06	16.8888	0.17995	4	4.10E-07	6	197.33553	0	0	266.886	334.4971	14	1.00681	1.28611	0.33	5.94182	422.01306	0	1.21034	5.41812	20
17.257	20.90381	0.25389	5	1.46E-06	8	311.16136	28	33	334.294	418.9818	0	0	0	0.33	0	472.31015	-0.03594	0	0	20
17.421	31.3581	0.33978	5	5.99E-06	11	495.64038	35	36	412.6608	517.2016	0	0	0	0.33	0	524.75867	-0.05098	0	0	20
17.585	56.55318	0.43484	6	1.92E-05	14	620.50802	42	37	495.0862	620.508	0	0	0	0.33	0	574.78235	-0.07304	0	0	20
17.749	72.20841	0.55052	6	3.40E-05	16	673.79405	46	38	537.6016	673.7941	0	0	0	0.33	0	598.9538	-0.08607	0	0	20
17.881	63.664	0.48468	6	2.50E-05	16	683.41507	45	38	545.278	683.4151	0	0	0	0.33	0	603.21478	-0.0864	0	0	20
18.077	48.93274	0.555	5	8.02E-06	13	623.87674	39	37	497.774	623.8767	0	0	0	0.33	0	576.34045	-0.07364	0	0	20
18.241	25.49513	0.47423	5	2.26E-06	11	441.99731	33	35	439.0484	550.2739	0	0	0	0.33	0	541.27655	-0.06557	0	0	20
18.406	23.21852	0.32563	5	1.24E-06	8	333.01081	29	34	368.6581	462.0515	0	0	0	0.33	0	495.99225	-0.04713	0	0	20

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In situ data										Estimations										
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
18.57	25.54752	0.16701	5	1.41E-06	8	301.15427	27	33	325.6025	408.0885	0	0	0	0.33	0	466.12982	-0.02697	0	0	20
18.701	18.56053	0.18919	5	7.71E-06	10	463.13938	33	35	369.5261	463.1394	0	0	0	0.33	0	496.57584	-0.02881	0	0	20
18.865	58.23443	0.33758	6	3.44E-05	13	547.81321	41	37	437.085	547.8132	0	0	0	0.33	0	540.06494	-0.05277	0	0	20
19.062	80.5004	0.29278	6	5.91E-05	15	587.87227	44	38	469.047	587.8723	0	0	0	0.33	0	559.46277	-0.06608	0	0	20
19.226	47.09907	0.26015	6	5.09E-05	14	554.00945	42	37	442.0288	554.0095	0	0	0	0.33	0	543.11066	-0.05585	0	0	20
19.39	43.30314	0.21713	6	2.02E-05	11	488.49673	37	36	389.758	488.4967	0	0	0	0.33	0	509.98868	-0.03261	0	0	20
19.554	37.93073	0.16637	5	8.23E-06	10	472.60107	33	35	377.0753	472.6011	0	0	0	0.33	0	501.62256	-0.02831	0	0	20
19.685	24.97122	0.31383	5	1.67E-06	8	337.35875	28	33	353.9153	443.5738	0	0	0	0.33	0	485.97357	-0.03231	0	0	20
19.882	12.82615	0.30252	6	4.65E-05	14	549.61783	41	37	438.5249	549.6178	0	0	0	0.33	0	540.95374	-0.052	0	0	20
20.013	129.0759	0.13004	6	2.16E-04	16	565.9489	48	39	451.555	565.9489	0	0	0	0.33	0	548.9317	-0.07134	0	0	20
20.21	83.89626	0.12862	6	3.73E-04	15	510.86747	47	38	407.607	510.8675	0	0	0	0.33	0	521.53546	-0.06507	0	0	20
20.374	11.99266	0.02837	6	2.73E-05	9	380.28768	33	35	303.421	380.2877	0	0	0	0.33	0	449.97235	0.0055	0	0	20
20.538	10.31141	0.07949	4	2.03E-07	4	101.09639	0	0	0	252.1908	14	0.66851	0.77156	0.33	3.56462	366.43277	0	1.01628	8.68479	20
20.669	9.11119	0.11845	4	8.41E-08	5	100.37952	0	0	0	293.8891	14	0.66407	0.77122	0.33	3.56303	395.5683	0	1.01612	4.62288	20
20.866	11.76881	0.22439	4	2.38E-07	6	189.40891	0	0	0	354.3177	14	0.96637	1.10212	0.33	5.09178	434.33633	0	1.14809	4.94683	20
20.997	23.03277	0.2315	5	1.99E-06	9	361.26544	29	34	367.3028	460.3528	0	0	0	0.33	0	495.07968	-0.03055	0	0	20
21.161	46.01792	0.33438	5	7.55E-06	12	582.10866	36	36	464.4484	582.1087	0	0	0	0.33	0	556.7135	-0.05294	0	0	20
21.325	59.2108	0.58742	6	1.61E-05	16	690.77602	42	37	551.1511	690.776	0	0	0	0.33	0	606.45465	-0.07561	0	0	20
21.49	68.22673	0.63747	6	1.96E-05	18	780.27236	45	38	622.5577	780.2724	0	0	0	0.33	0	644.54437	-0.09288	0	0	20
21.654	75.15181	0.78813	6	2.37E-05	19	841.58504	47	38	671.4774	841.585	0	0	0	0.33	0	669.38922	-0.10379	0	0	20
21.818	82.32454	0.89769	6	2.74E-05	21	883.75471	49	39	705.1234	883.7547	0	0	0	0.33	0	685.95496	-0.11092	0	0	20
21.982	85.62038	0.84757	6	3.35E-05	21	901.13751	50	39	718.9927	901.1375	0	0	0	0.33	0	692.66821	-0.11431	0	0	20
22.146	88.89717	0.82211	6	2.63E-05	22	946.26328	50	39	754.9973	946.2633	0	0	0	0.33	0	709.79956	-0.11952	0	0	20
22.343	83.57239	1.26904	5	8.76E-06	20	961.8888	46	38	767.4645	961.8888	0	0	0	0.33	0	715.63593	-0.12042	0	0	20
22.474	43.15549	1.37298	5	6.70E-06	21	993.62601	46	38	792.7867	993.626	0	0	0	0.33	0	727.34625	-0.12568	0	0	20
22.671	85.26318	1.1727	5	1.43E-05	22	1012.29036	49	39	807.6785	1012.29	0	0	0	0.33	0	734.14569	-0.12605	0	0	20
22.802	118.7693	1.06356	6	3.59E-05	25	1065.63668	55	40	850.242	1065.637	0	0	0	0.33	0	753.24158	-0.1364	0	0	20
22.999	102.4854	1.3599	6	2.95E-05	25	1072.86504	54	40	856.0093	1072.865	0	0	0	0.33	0	755.79193	-0.13558	0	0	20
23.13	76.89022	1.29406	5	1.09E-05	23	1076.71811	49	39	859.0836	1076.718	0	0	0	0.33	0	757.14789	-0.13359	0	0	20
23.294	70.84626	1.53999	5	5.36E-06	21	966.32633	45	38	820.7674	1028.695	0	0	0	0.33	0	740.07043	-0.12912	0	0	20
23.458	62.72097	1.28745	5	5.40E-06	21	972.422	45	38	824.8519	1033.814	0	0	0	0.33	0	741.90961	-0.12925	0	0	20
23.622	78.04757	1.31639	5	4.66E-06	21	933.85558	44	38	813.7975	1019.96	0	0	0	0.33	0	736.92145	-0.12769	0	0	20
23.786	62.42091	1.47878	5	5.28E-06	21	977.55495	45	38	832.7191	1043.675	0	0	0	0.33	0	745.43927	-0.12967	0	0	20
23.95	71.87502	1.40825	5	1.36E-05	24	1086.05565	50	39	866.5338	1086.056	0	0	0	0.33	0	760.42389	-0.13219	0	0	20
24.114	127.7185	1.19467	6	5.90E-05	28	1134.9968	58	40	905.5826	1134.997	0	0	0	0.33	0	777.36865	-0.14595	0	0	20
24.278	156.5095	1.16602	6	9.09E-05	34	1304.34699	65	41	1040.702	1304.347	0	0	0	0.33	0	833.34778	-0.17009	0	0	20

S-51 over Black Mingo Creek - Estimated Soil Parameter Correlations
CPT-6
Correlations from CPeT-IT v.1.7.6.42

F&ME CONSULTANTS

In situ data				Estimations																		
Depth (ft)	qc (tsf)	fs (tsf)	SBTn	Ksbt (ft/s)	SPT N60 (blows/ft)	Constrained Mod. (tsf)	Dr (%)	Friction angle (°)	Es (tsf)	Go (tsf)	Nkt	Su (tsf)	Su ratio	Kocr	OCR	Vs (ft/s)	State parameter	Ko	Sensitivity	Peak phi (°)
24.442	158.386	2.41458	6	7.42E-05	37	1447.6799	67	42	1155.064	1447.68	0	0	0	0.33	0	877.94232	-0.18235	0	0	20
24.639	133.5148	2.86428	5	2.37E-05	37	1598.99661	63	41	1275.795	1598.997	0	0	0	0.33	0	922.68506	-0.18696	0	0	20

APPENDIX

SECTION 6

LABORATORY TEST RESULTS

Laboratory Data Summary Sheet
S-45-51 Emergency Bridge Replacement Over Black Mingo Creek
S&ME Project No. 1413-15-145
SCDOT Project ID: P029461
2-Dec-15

BORING ID	SAMPLE NUMBER	SAMPLE TYPE	DEPTH (FT)	ELEVATION NAVD 88 (FT)	WATER CONTENT (%)	PASSING 200 SIEVE (%)	ATTERBERG LIMITS			Organic Content (%)	USCS	AASHTO
							LL	PL	PI			
STB-1	3	SS	5.0 to 6.5	21.3 to 19.8	17.5	15.8	NP	NP	NP	-	SM	A-2-4
STB-1	5	SS	9.0 to 10.5	17.3 to 15.8	-	-	167	86	81	-	SM*	nd
STB-1	6	SS	13.5 to 15.0	12.8 to 11.3	205.0	6.4	nd	nd	nd	26.3	PT	A-8
STB-1	7	SS	18.5 to 20.0	7.8 to 6.3	15.2	22.8	NP	NP	NP	-	SM	A-2-4
STB-1	8	SS	23.5 to 25.0	2.8 to 1.3	20.4	13.1	NP	NP	NP	-	SM	A-2-4
STB-1	12	SS	43.5 to 45.0	-17.3 to -18.8	32.6	25.0	NP	NP	NP	-	SM	A-2-4
STB-1	16	SS	63.5 to 65.0	-37.3 to -38.8	27.0	65.6	39	23	16	-	CL	A-6
STB-4	4	SS	7.0 to 8.5	19.5 to 18.0	29.6	33.8	48	23	25	-	SC	A-2-7
STB-4	5	SS	9.0 to 10.5	17.5 to 16.0	67.4	33.1	99	47	52	-	SM*	A-2-7
STB-4	9	SS	28.5 to 30.0	-2.0 to -3.5	30.9	13.9	NP	NP	NP	-	SM	A-2-4
STB-4	12	SS	43.5 to 45.0	-17.0 to -18.5	32.2	19.5	NP	NP	NP	-	SM	A-2-4
STB-4	16	SS	63.5 to 65.0	-37.0 to -38.5	23.1	66.1	44	20	24	-	CL	A-7-6
STB-4	21	SS	88.5 to 90.0	-62.0 to -63.5	23.3	55.8	43	18	25	-	CL	A-7-6

SS = Split Spoon
NP = Non Plastic
* = organic laden
nd = not determined (insufficient lab testing to determine)

Form No. TR-D4318-T89-90 *Client code* *Client Test #* *state #*
Revision No. 0
Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

Another code *ASTM D 4318* ☐ *AASHTO T 89* ☐ *AASHTO T 90* ☐ ***Quality Assurance***

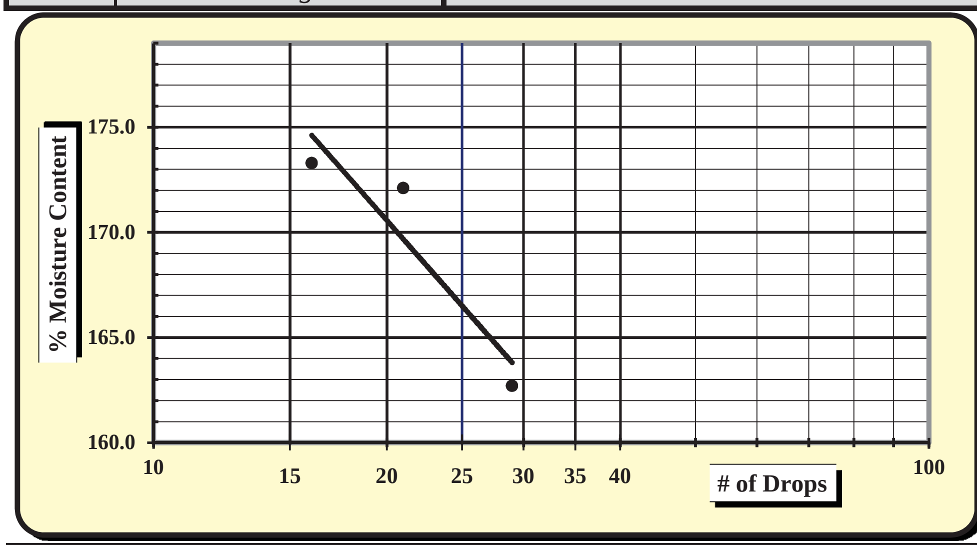
S&ME, Inc. 620 Wando Park Boulevard Mt. Pleasant, SC 29464

Project #:	**1413-15-145**	Report Date:	12-2-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s)	11-28-15
Client Name:	SCDOT		
Client Address:	955 Park Street, Room 406: Columbia, SC 29201		

Boring #: STB-1 Sample #: SS-5 Sample Date: 11-25-15
Location: n/a Offset: n/a Depth 9-10.5 FT
Sample Description: very dark gray, orgnaic laden silty SAND (SM)

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	6976	7/22/2015	Grooving tool	10473	7/28/2015
LL Apparatus	6238	7/28/2015	Grooving tool		
Oven	13796	7/28/2015	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight	21.31	20.73	14.50				21.18	22.15	
B	Wet Soil Weight + A	37.78	35.37	28.33				25.35	25.89	
C	Dry Soil Weight + A	27.58	26.11	19.56				23.41	24.17	
D	Water Weight (B-C)	10.20	9.26	8.77				1.94	1.72	
E	Dry Soil Weight (C-A)	6.27	5.38	5.06				2.23	2.02	
F	% Moisture (D/E)*100	162.7%	172.1%	173.3%				87.0%	85.1%	
N	# OF DROPS	29	21	16						
LL	LL = **F** * FACTOR									
Ave.	*Average*								**86.1%**	



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**167**
Plastic Limit	**86**
Plastic Index	**81**
Group Symbol	**MH**
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☑ Dry Preparation ☐ Air Dried ☐ *Estimate the % Retained on the #40 Sieve:* 10%

Notes / Deviations / References: Note and deviations from the test method are recorded.

Kim Gonzalez
Technician Name *Date*

Telford Wood
Technical Responsibility *Date*

Form No. TR-D4318-T89-90 | Client code | Client Test # | state #

Revision No. 0

Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

Another code | ASTM D 4318 ☐ | AASHTO T 89 ☐ | AASHTO T 90 ☐ | Quality Assurance

S&ME, Inc. 620 Wando Park Boulevard Mt. Pleasant, SC 29464

Project #:	**1413-15-145**	Report Date:	12-2-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s)	11-28-15
Client Name:	SCDOT		
Client Address:	955 Park Street, Room 406: Columbia, SC 29201		

Boring #: STB-1 | Sample #: SS-16 | Sample Date: 11-25-15

Location: n/a | Offset: n/a | Depth 63.5-65 FT

Sample Description: very dark gray, sandy CLAY (CL, A-6)

Type and Specification	S&ME ID #	Cal Date:	Type and Specification	S&ME ID #	Cal Date:
Balance (0.01 g)	6976	7/22/2015	Grooving tool	10473	7/28/2015
LL Apparatus	6238	7/28/2015	Grooving tool		
Oven	13796	7/28/2015	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight	21.17						20.97	21.11	
B	Wet Soil Weight + A	50.93						26.25	26.42	
C	Dry Soil Weight + A	42.59						25.22	25.44	
D	Water Weight (B-C)	8.34						1.03	0.98	
E	Dry Soil Weight (C-A)	21.42						4.25	4.33	
F	% Moisture (D/E)*100	38.9%						24.2%	22.6%	
N	# OF DROPS	25								
LL	LL = **F** * FACTOR									
Ave.	*Average*								**23.4%**	

One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**39**
Plastic Limit	**23**
Plastic Index	**16**
Group Symbol	**CL**
Multipoint Method	☐
One-point Method	☑

Wet Preparation ☑ | Dry Preparation ☐ | Air Dried ☐ | *Estimate the % Retained on the #40 Sieve:* 10%

Notes / Deviations / References: Note and deviations from the test method are recorded.

Kim Gonzalez | Telford Wood

Technician Name | *Date* | *Technical Responsibility* | *Date*

Form No. TR-D4318-T89-90 | Client code | Client Test # | state #

Revision No. 0

Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Another code | ASTM D 4318 ☐ | AASHTO T 89 ☐ | AASHTO T 90 ☐ | Quality Assurance

S&ME, Inc. 620 Wando Park Boulevard Mt. Pleasant, SC 29464

Project #:	**1413-15-145**	Report Date:	12-2-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s)	11-28-15
Client Name:	SCDOT		
Client Address:	955 Park Street, Room 406: Columbia, SC 29201		

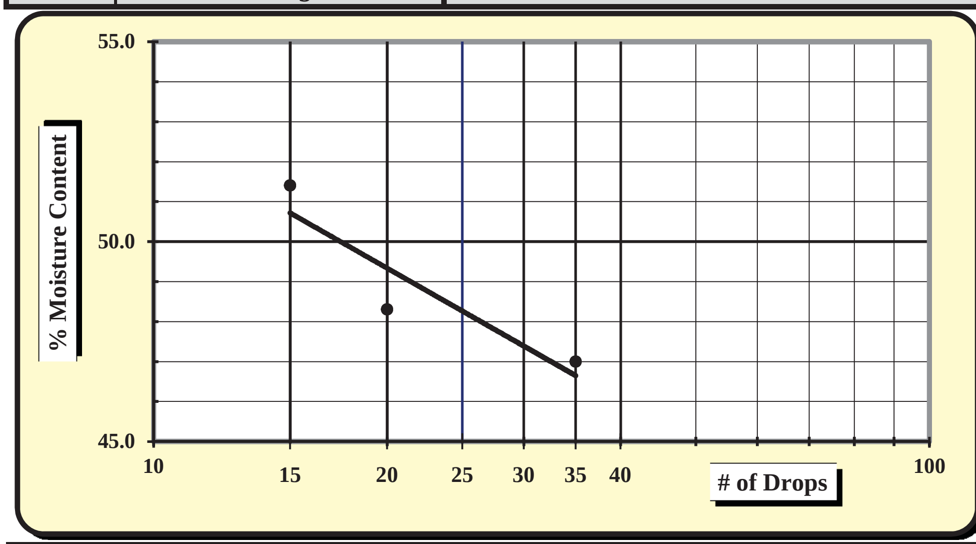
Boring #: STB-4 | Sample #: SS-4 | Sample Date: 11-25-15

Location: n/a | Offset: n/a | Depth 7-8.5 FT

Sample Description: reddish yellow and strong brown, clayey SAND (SC, A-2-7)

Type and Specification	S&ME ID #	Cal Date:	Type and Specification	S&ME ID #	Cal Date:
Balance (0.01 g)	6976	7/22/2015	Grooving tool	10473	7/28/2015
LL Apparatus	6238	7/28/2015	Grooving tool		
Oven	13796	7/28/2015	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight	21.27	21.48	21.95				14.66	14.36	
B	Wet Soil Weight + A	43.92	44.51	46.32				19.90	18.15	
C	Dry Soil Weight + A	36.68	37.01	38.05				18.93	17.42	
D	Water Weight (B-C)	7.24	7.50	8.27				0.97	0.73	
E	Dry Soil Weight (C-A)	15.41	15.53	16.10				4.27	3.06	
F	% Moisture (D/E)*100	47.0%	48.3%	51.4%				22.7%	23.9%	
N	# OF DROPS	35	20	15						
LL	LL = **F** * FACTOR									
Ave.	*Average*								**23.3%**	



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**48**
Plastic Limit	**23**
Plastic Index	**25**
Group Symbol	**CL**
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☑ | Dry Preparation ☐ | Air Dried ☐ | *Estimate the % Retained on the #40 Sieve:* 10%

Notes / Deviations / References: Note and deviations from the test method are recorded.

Kim Gonzalez | | Telford Wood |
Technician Name | *Date* | *Technical Responsibility* | *Date*

Form No. TR-D4318-T89-90 *Client code* *Client Test #* *state #*

Revision No. 0

Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

Another code *ASTM D 4318* ☐ *AASHTO T 89* ☐ *AASHTO T 90* ☐ ***Quality Assurance***

S&ME, Inc. 620 Wando Park Boulevard Mt. Pleasant, SC 29464

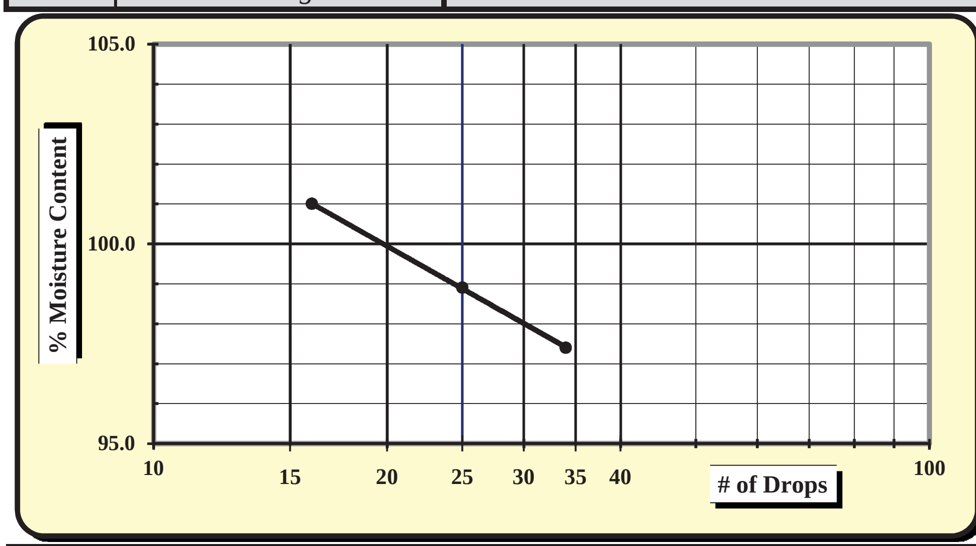
Project #:	**1413-15-145**	Report Date:	12-2-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s)	11-28-15
Client Name:	SCDOT		
Client Address:	955 Park Street, Room 406: Columbia, SC 29201		

Boring #: STB-4	Sample #: SS-5	Sample Date: 11-25-15
Location: n/a	Offset: n/a	Depth 9.5-10 FT

Sample Description: very dark gray, organic laden silty SAND (SM, A-2-7)

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	6976	7/22/2015	Grooving tool	10473	7/28/2015
LL Apparatus	6238	7/28/2015	Grooving tool		
Oven	13796	7/28/2015	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight	22.46	21.06	21.12				21.25	20.91	
B	Wet Soil Weight + A	39.37	44.85	43.81				25.63	25.19	
C	Dry Soil Weight + A	30.96	33.11	32.41				24.19	23.85	
D	Water Weight (B-C)	8.41	11.74	11.40				1.44	1.34	
E	Dry Soil Weight (C-A)	8.50	12.05	11.29				2.94	2.94	
F	% Moisture (D/E)*100	98.9%	97.4%	101.0%				49.0%	45.6%	
N	# OF DROPS	25	34	16						
LL	LL = **F** * FACTOR									
Ave.	*Average*							**47.3%**		



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**99**
Plastic Limit	**47**
Plastic Index	**52**
Group Symbol	**MH**
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☑ Dry Preparation ☐ Air Dried ☐ *Estimate the % Retained on the #40 Sieve:* 10%

Notes / Deviations / References: Note and deviations from the test method are recorded.

Kim Gonzalez
Technician Name *Date*

Telford Wood
Technical Responsibility *Date*

Form No. TR-D4318-T89-90 | Client code | Client Test # | state #

Revision No. 0

Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

Another code | ASTM D 4318 ☐ | AASHTO T 89 ☐ | AASHTO T 90 ☐ | *Quality Assurance*

S&ME, Inc. 620 Wando Park Boulevard Mt. Pleasant, SC 29464

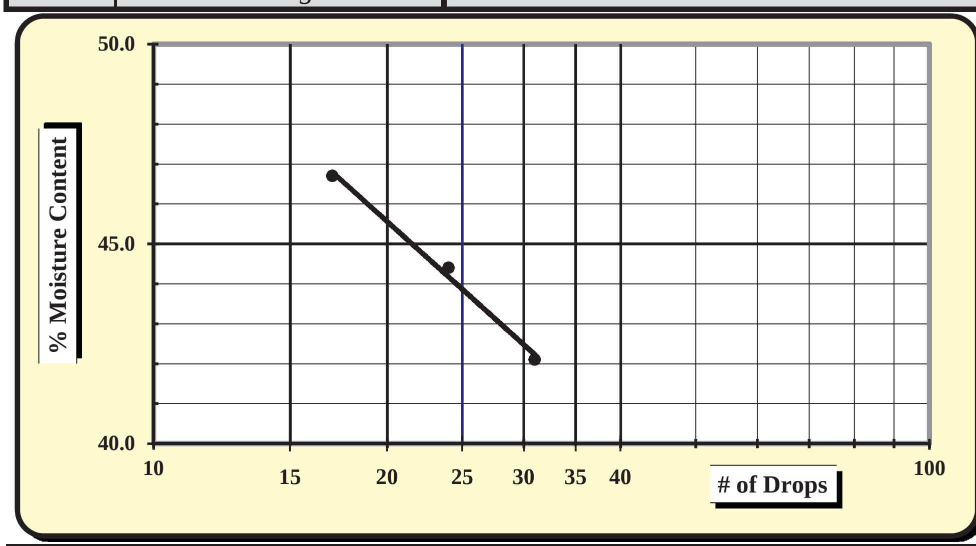
Project #:	**1413-15-145**	Report Date:	12-2-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s)	11-28-15
Client Name:	SCDOT		
Client Address:	955 Park Street, Room 406: Columbia, SC 29201		

Boring #: STB-4	Sample #: SS-16	Sample Date: 11-25-15	
Location: n/a	Offset: n/a	Depth 63.5-65 FT	

Sample Description: dark greenish gray, sandy CLAY (CL, A-7-6)

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	6976	7/22/2015	Grooving tool	10473	7/28/2015
LL Apparatus	6238	7/28/2015	Grooving tool		
Oven	13796	7/28/2015	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight	21.16	22.82	22.68				14.46	14.99	
B	Wet Soil Weight + A	42.03	46.32	44.86				17.85	16.84	
C	Dry Soil Weight + A	35.85	39.09	37.80				17.29	16.54	
D	Water Weight (B-C)	6.18	7.23	7.06				0.56	0.30	
E	Dry Soil Weight (C-A)	14.69	16.27	15.12				2.83	1.55	
F	% Moisture (D/E)*100	42.1%	44.4%	46.7%				19.8%	19.4%	
N	# OF DROPS	31	24	17						
LL	LL = **F** * FACTOR									
Ave.	*Average*								**19.6%**	



One Point Liquid Limit			
N	**Factor**	**N**	**Factor**
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**44**
Plastic Limit	**20**
Plastic Index	**24**
Group Symbol	**CL**
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☑ | Dry Preparation ☐ | Air Dried ☐ | *Estimate the % Retained on the #40 Sieve:* 10%

Notes / Deviations / References: Note and deviations from the test method are recorded.

Kim Gonzalez — *Technician Name* | *Date* | Telford Wood — *Technical Responsibility* | *Date*

Form No. TR-D4318-T89-90 | Client code | Client Test # | state #

Revision No. 0

Revision Date: 11/20/07

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Another code | ASTM D 4318 ☐ | AASHTO T 89 ☐ | AASHTO T 90 ☐ | Quality Assurance

S&ME, Inc. 620 Wando Park Boulevard Mt. Pleasant, SC 29464

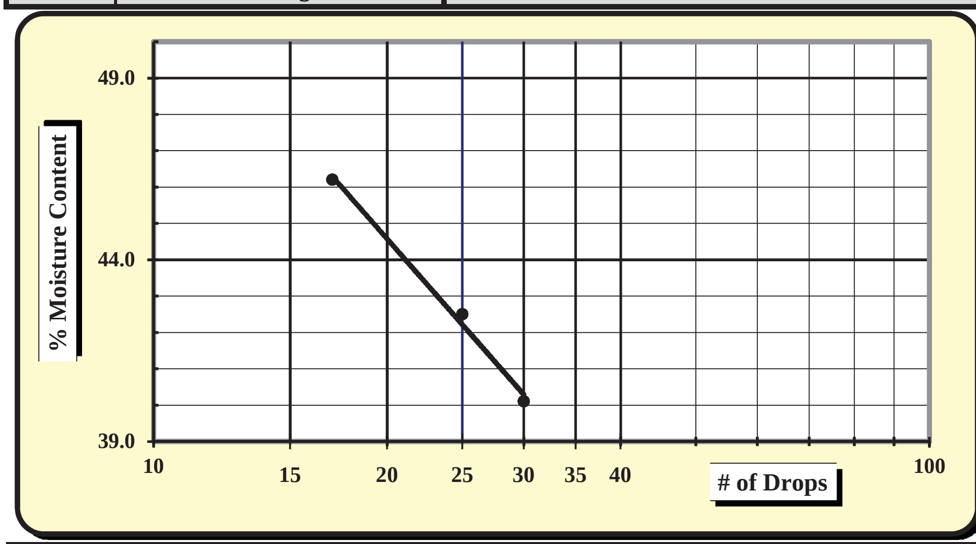
Project #:	**1413-15-145**	Report Date:	12-2-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s)	11-28-15
Client Name:	SCDOT		
Client Address:	955 Park Street, Room 406: Columbia, SC 29201		

Boring #: STB-4	Sample #: SS-21	Sample Date: 11-25-15
Location: n/a	Offset: n/a	Depth 88.5-90 FT

Sample Description: dark greenish gray, sandy CLAY (CL, A-7-6)

Type and Specification	S&ME ID #	Cal Date:	Type and Specification	S&ME ID #	Cal Date:
Balance (0.01 g)	6976	7/22/2015	Grooving tool	10473	7/28/2015
LL Apparatus	6238	7/28/2015	Grooving tool		
Oven	13796	7/28/2015	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight	21.45	21.06	21.24				22.64	21.77	
B	Wet Soil Weight + A	46.53	47.48	44.61				26.74	26.61	
C	Dry Soil Weight + A	39.35	39.60	37.23				26.11	25.85	
D	Water Weight (B-C)	7.18	7.88	7.38				0.63	0.76	
E	Dry Soil Weight (C-A)	17.90	18.54	15.99				3.47	4.08	
F	% Moisture (D/E)*100	40.1%	42.5%	46.2%				18.2%	18.6%	
N	# OF DROPS	30	25	17						
LL	LL = **F** * FACTOR									
Ave.	*Average*								**18.4%**	



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**43**
Plastic Limit	**18**
Plastic Index	**25**
Group Symbol	**CL**
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☑ | Dry Preparation ☐ | Air Dried ☐ | *Estimate the % Retained on the #40 Sieve:* 10%

Notes / Deviations / References: Note and deviations from the test method are recorded.

Kim Gonzalez | | Telford Wood |
Technician Name | *Date* | *Technical Responsibility* | *Date*

Form No: TR-D1140-3
Revision No. 0
Revision Date: 10/26/07

Material Finer than the #200 Sieve

ASTM D1140

Quality Assurance

S&ME, Inc. Branch, Branch Address

Project #:	**1413-15-145**	Report Date:	12-2-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s):	11-28-15
Client Name:	SCDOT		
Client Address:	955 Park Street, Room 406: Columbia, SC 29201		
Sample by:	D. Schoen	Sample Dates:	11-25-15
Sampling Method:	Split Spoon	Drill Rig :	CME 45D

Method; A ☐ **B** ☐ Soaked ☐ Soak Time

Sample Identification	Tare Weight	Tare Wt.+ Wet Wt	Tare Wt. + Dry Wt	Tare Wt. + Dry Wt. after Wash	Water Wt.	Percent Moisture	% Passing #200
Boring #, Sample #, Depth	grams	grams	grams	grams	grams	%	%
STB-1, SS-3, 5-6.5'	60.34	366.52	320.88	279.69	45.64	**17.5%**	**15.8%**
STB-1,SS6, 13.5-15'	60.89	255.24	124.61	120.55	130.63	**205.0%**	**6.4%**
STB-1, SS-7, 18.5-20'	60.33	392.13	348.25	282.64	43.88	**15.2%**	**22.8%**
STB-1,SS8,23.5-25'	60.62	407.04	348.25	310.43	58.79	**20.4%**	**13.1%**
STB-1,SS12,43.5-45'	60.99	401.19	317.46	253.41	83.73	**32.6%**	**25.0%**
STB-1,SS16,63.5-65'	60.29	357.29	294.11	140.73	63.18	**27.0%**	**65.6%**
STB-4,SS-4,7-8.5'	61.09	393.28	317.36	230.83	75.92	**29.6%**	**33.8%**
STB-4,SS-5,9-10.5'	61.08	356.73	237.74	179.18	118.99	**67.4%**	**33.1%**
STB-4,SS-9,28.5-30'	61.30	416.63	332.85	295.14	83.78	**30.9%**	**13.9%**
STB-4,SS-12,43.5-45'	60.04	360.49	287.34	242.97	73.15	**32.2%**	**19.5%**
STB-4,SS-16,63.5-65'	60.72	356.42	300.98	142.14	55.44	**23.1%**	**66.1%**
STB-4,SS-21,88.5-90'	62.01	364.74	307.57	170.48	57.17	**23.3%**	**55.8%**

Balance ID. ***6976*** *Calibration Date:* ***7-21-15*** *#200 Sieve* ***10482*** *Calibration Date:* ***6-24-15***

Notes / Deviations / References:

Kim Gonzalez		Nicet 2	12/2/2015
Technician Name	*Signature*	*Certification Type/No.*	*Date*
Telford Wood	Telford E Wood	Location Coordinator	12/2/2015
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D2974-1
Revision No. 0
Revision Date: 07/10/08

Moisture, Ash, and Organic Matter

ASTM D-2974

Quality Assurance

S&ME, Inc. Atlanta, 11420 Johns Creek Parkway, Duluth, GA 30097

Project #:	**1413-15-145**	Report Date:	12-1-15
Project Name:	S-45-51 EBRO Black Mingo Creek	Test Date(s):	11-28-15
Client Name:	SC DOT		
Client Address:	955 Park Street, Room 406; Columbia, SC 29201		

Boring No.	STB-1	Sample No.	SS-6	Sample Date:	11-25-15
Location:	n/a	Offset:	n/a	Depth	13.5-15'

Sample Description: very dark gray, PEAT (PT)

Equipment: Balance: 0.01 g.Readability, 500g. Minimum Capaccity

Balance: S&ME ID #: 25128 Cal. Date: 3/14/15 Due: 03/14/16

Method A: Moisture Content Determination

Required Oven Temperature:105 ± 5 °C

Oven Temperature: 105 °C		Tare #	90
t	Tare Weight (Dish plus Aluminum Foil Cover)	grams	60.74
a	Mass of ***As-Received*** Specimen + Tare Wt.	grams	186.76
b	Mass of Oven Dry Specimen + Tare Wt.	grams	107.33
w	Water Weight	(a-b)	79.43
A	Mass of As-Received Specimen	(a-t)	126.02
B	Mass of Oven Dry Specimen	(b-t)	46.59
% Moisture Content as a % of As Received or Total Mass		(w/A)*100	**63.0%**
% Moisture Content as a % of Oven-dried Mass		(w/B)*100	**170.5%**

Oven S&ME ID #: 25130 Cal. Date: 6/23/15 Due: 6/22/16

Method C (440 °C) or D (750 °C): Ash Content and Organic Matter Determination

Muffle Furnace: 440 °C		Tare #	L
t	Tare Weight (Dish plus Aluminum Foil Cover)	grams	80.42
b	Mass of Oven Dry Specimen + Tare Wt.	grams	124.03
c	Ash Weight + Tare Wt.	grams	112.58
C	Ash Weight	c-t	32.16
B	Mass of Oven Dry Specimen	(b-t)	43.61
D	***% Ash Content***	(C/B)*100	**73.7%**
	% Organic Matter	100-D	**26.3%**

Muffle Furnace: S&ME ID #: 26317 Cal. Date : 9/15/2015

Notes / Deviations / References:

Kim Gonzalez	12/1/2015		Nicet 2
Technician Name	Date	Signature	Level/Certification
Telford Wood	Telford E Wood	Location Coordinator	12/1/2015
Technical Responsibility	Signature	Position	Date

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT: S-51 RBO Black Mingo Creek **PROJECT NO.:** G5556.02

SAMPLE NUMBER: 16-0133 **DATE SAMPLE RECEIVED:** 1/27/2016

DESCRIPTION OF SOIL: VARIOUS

TESTED BY: MB **DATE OF TESTING:** 1/27/2016

DATE OF WEIGHING: 1/28/2016

BORING NO.	B-3	B-3	B-3	B-3	B-3
SAMPLE NO.	16-0133C	16-0133F	16-0133I	16-0133L	16-0133O
SAMPLE DEPTH	11.1-13.1'	13.1-15.1'	15.1-17.1'	19.1-21.1'	44.6-46.1'
WATER CONTENT, W%	249.9	311.3	23.9	16.7	32.7

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

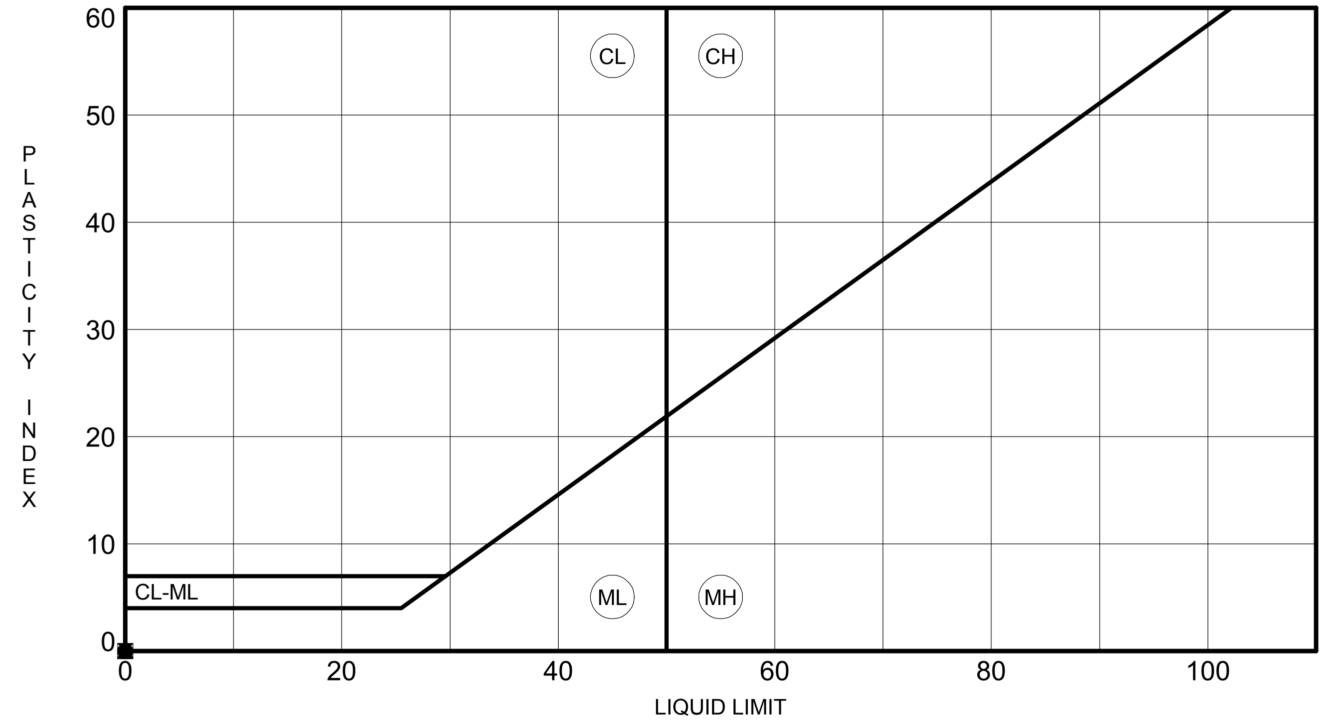
ATTERBERG LIMITS' RESULTS

SCDOT

PROJECT ID G5556.02

PROJECT NAME S-51 (Battery Park Road) RBO Black Mingo Creek

PROJECT COUNTY Williamsburg



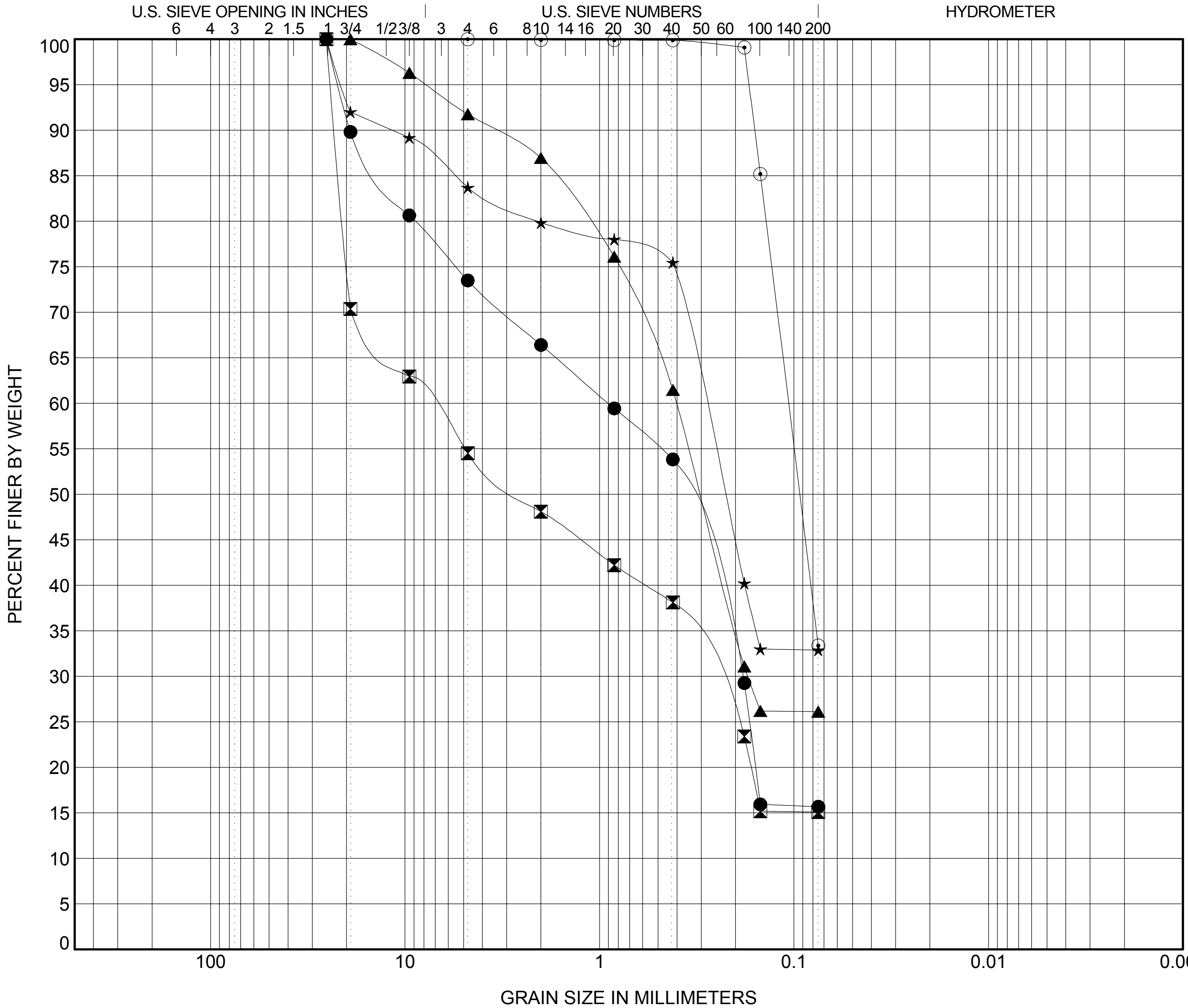
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-3**	**17.1**	**NP**	**NP**	**NP**	**26**	**Silty F/C SAND (SM) A-2-4**
⧗	**B-3**	**21.1**	**NP**	**NP**	**NP**	**33**	**Silty F/C SAND (SM) with Gravel A-2-4**
▲	**B-3**	**46.1**	**NP**	**NP**	**NP**	**33**	**Silty Fine SAND (SM) A-2-4**

GRAIN SIZE DISTRIBUTION

PROJECT ID G5556.02

PROJECT NAME S-51 (Battery Park Road) RBO Black Mingo Creek

PROJECT COUNTY Williamsburg



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-3**	**13.1**						
⧗	**B-3**	**15.1**						
▲	**B-3**	**17.1**	**Silty F/C SAND (SM) A-2-4**	**NP**	**NP**	**NP**		
★	**B-3**	**21.1**	**Silty F/C SAND (SM) with Gravel A-2-4**	**NP**	**NP**	**NP**		
⊙	**B-3**	**46.1**	**Silty Fine SAND (SM) A-2-4**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-3**	**13.1**	**25.4**	**22.083**	**0.368**		**26.5**	**57.8**	**15.7**	
⧗	**B-3**	**15.1**	**25.4**	**24.207**	**2.585**		**45.5**	**39.4**	**15.1**	
▲	**B-3**	**17.1**	**19.1**	**7.801**	**0.305**		**8.3**	**65.6**	**26.1**	
★	**B-3**	**21.1**	**25.4**	**21.249**	**0.228**		**16.3**	**50.8**	**32.9**	
⊙	**B-3**	**46.1**	**4.76**	**0.17**	**0.093**		**0.0**	**66.6**	**33.4**	

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT: S-51 RBO Black Mingo Creek **PROJECT NO.:** G5556.02

SAMPLE NUMBER: 16-0140 **DATE SAMPLE RECEIVED:** 1/27/2016

DESCRIPTION OF SOIL: VARIOUS

TESTED BY: MB **DATE OF TESTING:** 1/27/2016

DATE OF WEIGHING: 1/28/2016

BORING NO.	B-4	B-4	B-4		
SAMPLE NO.	16-0140C	16-0140F	16-0140I		
SAMPLE DEPTH	17.9-19.9'	19.9-21.9'	41.4-42.9'		
WATER CONTENT, W%	25.0	28.2	34.8		

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

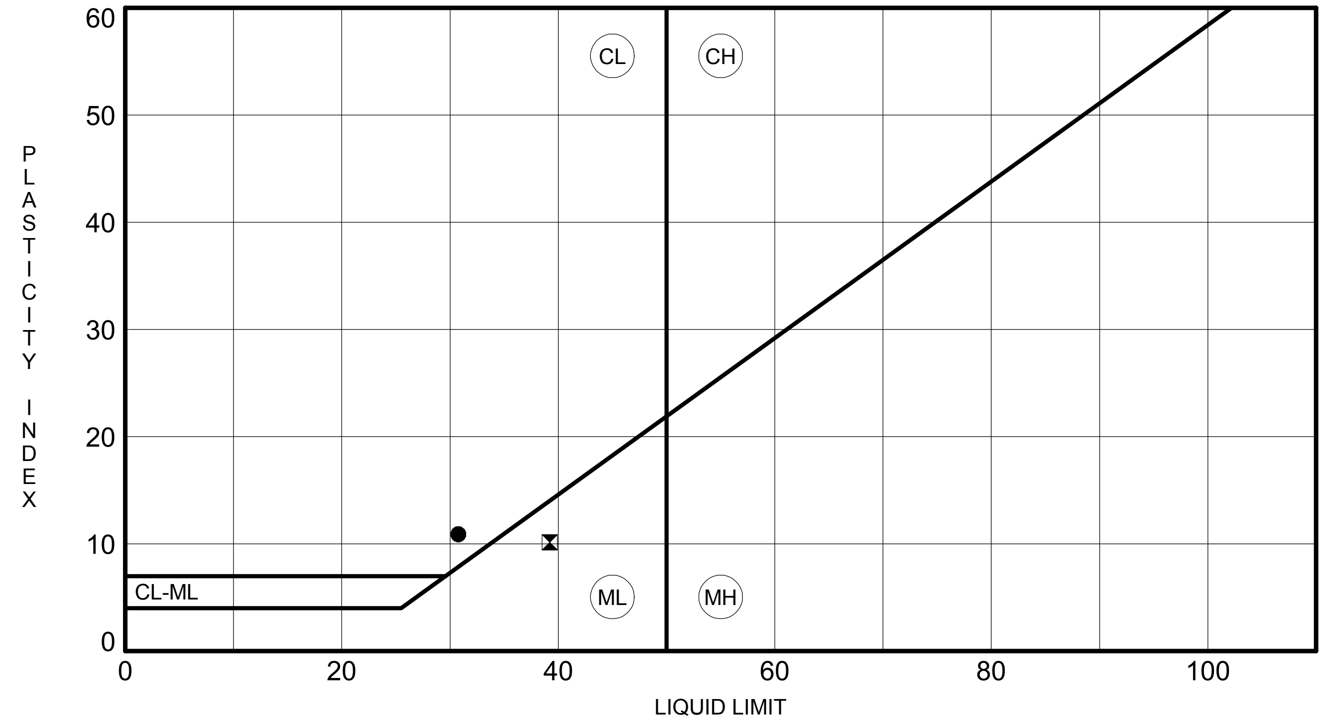
ATTERBERG LIMITS' RESULTS

SCDOT

PROJECT ID P029461

PROJECT NAME S-51 (Battery Park Road) RBO Black Mingo Creek

PROJECT COUNTY Williamsburg



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-4**	**21.9**	**31**	**20**	**11**	**35**	**Clayey F/M SAND (SC) A-2-6(0)**
⧗	**B-4**	**42.9**	**39**	**29**	**10**	**69**	**Sandy SILT (ML) A-4(7)**

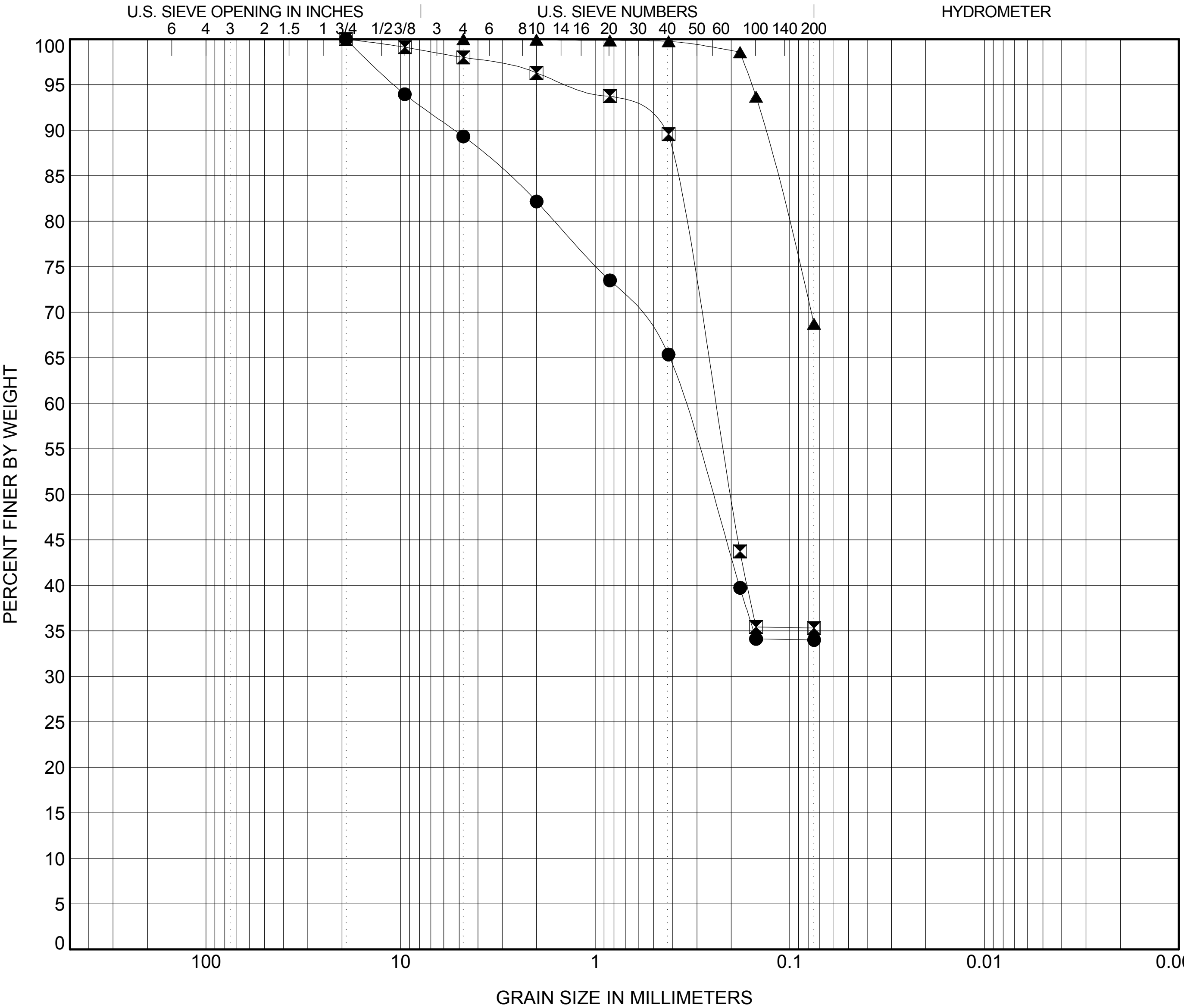
GRAIN SIZE DISTRIBUTION

SCDOT

PROJECT ID G5556.02

PROJECT NAME S-51 (Battery Park Road) RBO Black Mingo Creek

PROJECT COUNTY Williamsburg



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-4**	**19.9**						
⧗	**B-4**	**21.9**	**Clayey F/M SAND (SC) A-2-6(0)**	**31**	**20**	**11**		
▲	**B-4**	**42.9**	**Sandy SILT (ML) A-4(7)**	**39**	**29**	**10**		

	BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**19.9**	**19.1**	**10.74**	**0.253**		**10.7**	**55.3**	**34.0**	
⧗	**B-4**	**21.9**	**19.1**	**1.283**	**0.202**		**2.0**	**62.7**	**35.3**	
▲	**B-4**	**42.9**	**4.76**	**0.157**			**0.0**	**31.3**	**68.7**	

GRAIN SIZE G5556.02 S-51 RBO BLACK MINGO CREEK.GPJ GINT STD US LAB.GDT 2/1/16

F&ME/S-51 RBO BLACK MINGO CREEK/SC
SUMMARY OF SOIL DATA

Sample Identification		Sample Type	Sample Depth	Soil Classi-fication	Natural Moisture %	Atterberg Limits				Grain Size Distribution			Compaction		pH	Resistivity of Soil		Additional Tests Conducted (See Notes)
Boring Number	Sample Number					L.L.	P.L.	P.I.	L.I.	% Finer No. 4 Sieve	% Finer No. 200 Sieve	% Finer .005 mm	Maximum Dry Density (pcf)	Optimum Moisture %		Moisture Content %	Lowest Resistivity (ohm-cm)	
BS-1	16-0013A	Bag	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Sulfate (ACL)
	16-0013B	Bag	-	(SM)	16.3	-	-	-	-	-	-	-	-	-	-	19.7	7,100	-
	16-0013C	Bag	-	-	-	-	-	-	-	-	-	-	-	-	7.0	-	-	-
BS-2	16-0014A	Bag	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Sulfate (ACL)
	16-0014B	Bag	-	(SM)	11.8	-	-	-	-	-	-	-	-	-	-	92.6	10,000	-
	16-0014C	Bag	-	-	-	-	-	-	-	-	-	-	-	-	6.9	-	-	-

ABBREVIATIONS:
LIQUID LIMIT (LL)
PLASTIC LIMIT (PL)
PLASTICITY INDEX (PI)
LIQUIDITY INDEX (LI)
SPECIFIC GRAVITY (Gs)
MOISTURE (Mc)

NOTES:
T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
DS = DIRECT SHEAR TEST
O = ORGANIC CONTENT
P = pH

Determining Minimum Laboratory Soil Resistivity
AASHTO T 288

PROJECT TITLE	F&ME/S-51 RBO BLACK MINGO CREEK/SC	SAMPLE ID	BS-1 16-0013B
PROJECT NO.	1648353.02	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5556.02	SAMPLE DEPTH	-

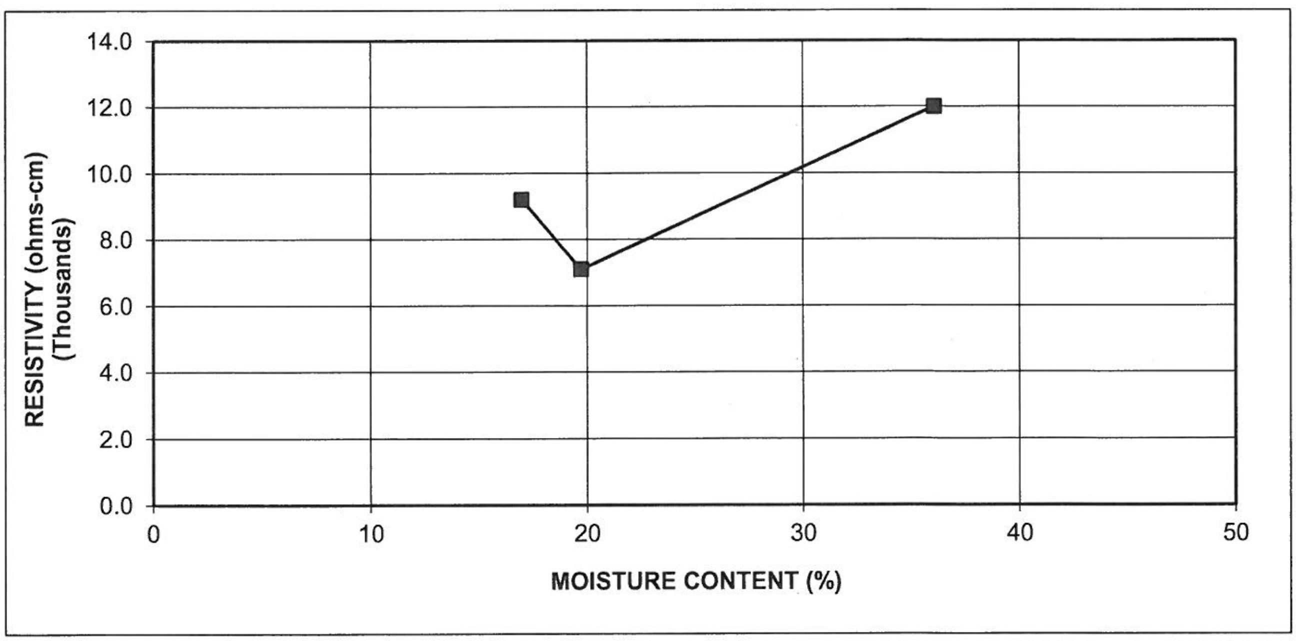
SAMPLE PREPARATION	Sieved through the #10 Sieve	Yes
TEST APPARATUS	Miller Soilbox and Nilsson 400 Soil Resistance Meter.	

Identification: Lowest resistivity

SPECIMEN (Point)	1	2	3	4
RESISTIVITY (ohms-cm)	-	9,200	7,100	12,000

MOISTURE CONTENT: As Rec'd Moisture

WET WEIGHT & TARE	235.47	238.46	260.85	512.80
DRY WEIGHT & TARE	209.68	211.37	226.31	390.31
TARE WEIGHT	51.09	51.41	51.21	50.95
WEIGHT OF MOISTURE (gm)	25.79	27.09	34.54	122.49
WEIGHT OF DRY SOIL (gm)	158.59	159.96	175.10	339.36
MOISTURE CONTENT (%)	16.26	16.94	19.73	36.09



Description: SILTY SAND; brown.

USCS: (SM)

TECH	PWM/TW
DATE	1/8/16
CHECK	DA
REVIEW	PWM
APPROVE	

Determining pH of Soil for Use in Corrosion Testing
AASHTO T 289

PROJECT TITLE	**F&ME/S-51 RBO BLACK MINGO CREEK/SC**	**SAMPLE ID**	**BS-1 16-0013C**
PROJECT NO.	**1648353.02**	**SAMPLE TYPE**	**Bag**
REMARKS	**F&ME Project No. G5556.02**	**SAMPLE DEPTH**	**-**

SAMPLE PREPARATION

Sieved through the #10 Sieve	YES
Air Dry	YES
Type of Water	DISTILLED

Trial	pH	Temperature
1	7.02	19.9
2	6.99	19.7
3	6.97	19.8
AVERAGE	6.99	19.8

Description SILTY SAND; brown.

USCS (SM)

TECH	SDM
DATE	1/13/16
CHECK	DA
REVIEW	[illegible]
APPROVE	

Determining Minimum Laboratory Soil Resistivity
AASHTO T 288

PROJECT TITLE	F&ME/S-51 RBO BLACK MINGO CREEK/SC	SAMPLE ID	BS-2 16-0014B
PROJECT NO.	1648353.02	SAMPLE TYPE	Bag
REMARKS	F&ME Project No. G5556.02	SAMPLE DEPTH	-

SAMPLE PREPARATION — Sieved through the #10 Sieve: Yes
TEST APPARATUS — Miller Soilbox and Nilsson 400 Soil Resistance Meter.

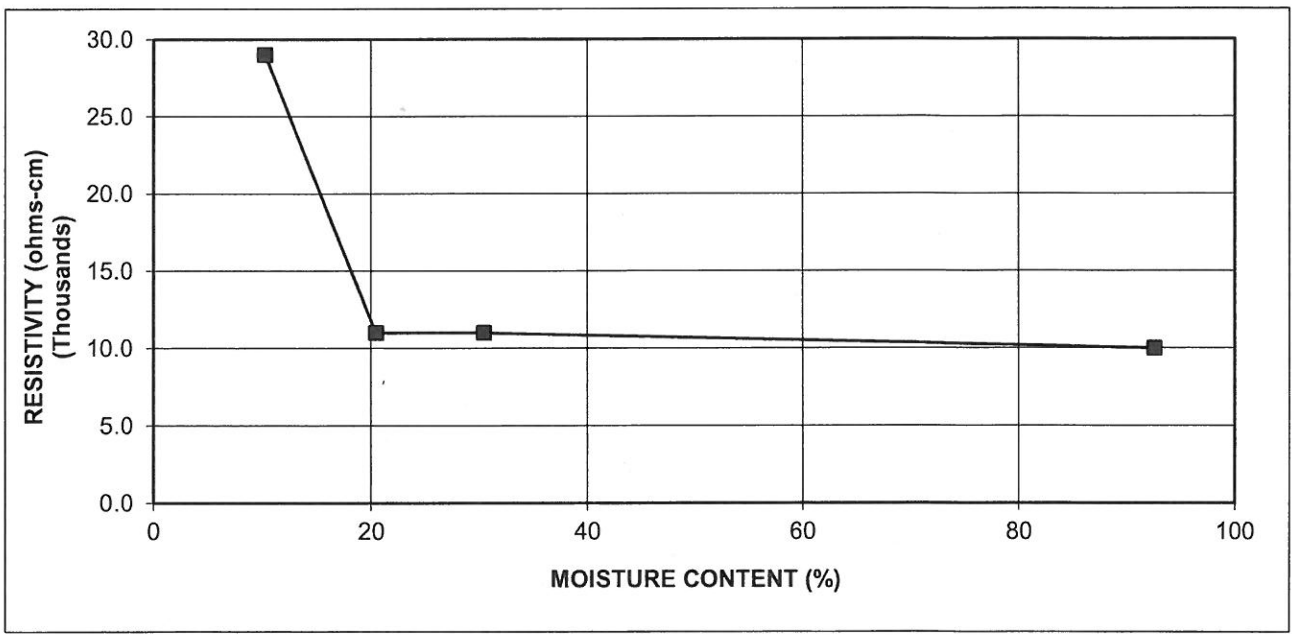
Identification:

Lowest resistivity

SPECIMEN (Point)	1	2	3	4	5
RESISTIVITY (ohms-cm)	-	29,000	11,000	11,000	10,000

MOISTURE CONTENT: As Rec'd Moisture

WET WEIGHT & TARE	266.53	186.19	211.28	493.38	410.00
DRY WEIGHT & TARE	243.73	173.67	184.20	390.51	237.90
TARE WEIGHT	50.85	51.88	51.70	51.93	51.94
WEIGHT OF MOISTURE (gm)	22.80	12.52	27.08	102.87	172.10
WEIGHT OF DRY SOIL (gm)	192.88	121.79	132.50	338.58	185.96
MOISTURE CONTENT (%)	11.82	10.28	20.44	30.38	92.55



Description: SILTY SAND; brown.

USCS: (SM)

TECH	PWM/TW
DATE	1/8/16
CHECK	DW
REVIEW	[illegible]
APPROVE	

Determining pH of Soil for Use in Corrosion Testing
AASHTO T 289

PROJECT TITLE	**F&ME/S-51 RBO BLACK MINGO CREEK/SC**	**SAMPLE ID**	**BS-2 16-0014C**
PROJECT NO.	**1648353.02**	**SAMPLE TYPE**	**Bag**
REMARKS	**F&ME Project No. G5556.02**	**SAMPLE DEPTH**	**-**

SAMPLE PREPARATION

Sieved through the #10 Sieve	YES
Air Dry	YES
Type of Water	DISTILLED

Trial	pH	Temperature
1	6.93	19.8
2	6.88	19.9
3	6.87	19.8
AVERAGE	6.89	19.8

Description SILTY SAND; brown.

USCS (SM)

TECH	SDM
DATE	1/13/16
CHECK	DA
REVIEW	[illegible]
APPROVE	

F&ME/S-51 RBO BLACK MINGO CREEK/SC
SUMMARY OF SOIL DATA

Sample Identification		Sample Type	Sample Depth	Soil Classification	Natural Moisture %	Atterberg Limits				Grain Size Distribution			Compaction		pH	Resistivity of Soil		Additional Tests Conducted (See Notes)
Boring Number	Sample Number					L.L.	P.L.	P.I.	L.I.	% Finer No. 4 Sieve	% Finer No. 200 Sieve	% Finer .005 mm	Maximum Dry Density (pcf)	Optimum Moisture %		Moisture Content %	Lowest Resistivity (ohm-cm)	
BS-1	16-0013A	Bag	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Sulfate (ACL)
	16-0013B	Bag	-	(SM)	16.3	-	-	-	-	-	-	-	-	-	-	19.7	7,100	-
	16-0013C	Bag	-	-	-	-	-	-	-	-	-	-	-	-	7.0	-	-	-
BS-2	16-0014A	Bag	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Sulfate (ACL)
	16-0014B	Bag	-	(SM)	11.8	-	-	-	-	-	-	-	-	-	-	92.6	10,000	-
	16-0014C	Bag	-	-	-	-	-	-	-	-	-	-	-	-	6.9	-	-	-

ABBREVIATIONS: LIQUID LIMIT (LL)
PLASTIC LIMIT (PL)
PLASTICITY INDEX (PI)
LIQUIDITY INDEX (LI)
SPECIFIC GRAVITY (Gs)
MOISTURE (Mc)

NOTES: T = TRIAXIAL TEST
U = UNCONFINED COMPRESSION TEST
C = CONSOLIDATION TEST
DS = DIRECT SHEAR TEST
O = ORGANIC CONTENT
P = pH

ACL

ADVANCED CHEMISTRY LABS, INC.

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Fax: (770) 409-1844
e-mail: acl@acl-labs.net

3039 Amwiler Road • Suite 100 • Atlanta, GA 30360
P.O. Box 88610 • Atlanta, GA 30356
www.acl-labs.com

Laboratory Report

ACL Project #: 68766

Client Proj #: 1648353

Prepared For:

Golder Associates, Inc.
3730 Chamblee Tucker Road
Atlanta, GA 30341-0000

Attention: Mr. Henry Mock

Report Date: 01/18/2016

This report contains 5 pages.
(including this cover page and chain of custody)

John Andros
John Andros
Lab Manager

ACCREDITED IN ACCORDANCE WITH nelac

Advanced Chemistry Labs is a woman-owned, small business concern.

ACL

ADVANCED CHEMISTRY LABS, INC.

Phone: (770) 409-1444
Fax: (770) 409-1844
e-mail: acl@acl-labs.net

3039 Amwiler Road, Suite 100, Atlanta, GA 30360
P. O. Box 88610, Atlanta, GA 30356

Explanation of Symbols and Abbreviations

Listed below are common symbols and abbreviations typically used in reporting technical data:

PQL	Practical Quantitation Limit	MDL	Method Detection Limit
BQL	Below Quantitation Limit	BDL	Below Method Detection Limit
MPN	Most Probable Number	TNTC	Too Numerous To Count
NTU	Nephelometric Turbidity Units	BTU	British Thermal Units
°C	Degrees Centigrade	°F	Degrees Fahrenheit
µmhos/cm	micromhos/cm	cfu	Colony Forming Unit
DF	Dilution Factor	meq	milliequivalents
kg	kilogram(s)	g	gram(s)
mg	milligram(s)	µg	microgram(s)
l or L	liter(s)	ml or mL	milliliter(s)
µl or µL	microliter(s)	m^3	cubic meter(s)
lb	pound(s)	ft^3	cubic foot(feet)
ft	foot(feet)	su	Standard Units
<	Less than	>	Greater than

mg/L, mg/kg	Units of concentration in milligrams per liter for liquids and milligrams per kilogram for solids. Also referred to as parts per million or "ppm" when the assumption is made that the specific gravity or density is one (1 g/mL).
µg/L, µg/kg	Units of concentration in micrograms per liter for liquids and micrograms per kilogram for solids. Also referred to as parts per billion or "ppb" when the assumption is made that the specific gravity or density is one (1 g/mL).
wt %	Units of concentration expressed on a weight/weight basis (e.g. grams per 100 grams).
Surrogate	Compound(s) added by the laboratory for quality control monitoring.
mg/kg,dw	Units of concentration in milligrams per kilogram (dry weight basis).

Data Qualifiers:

B	Analyte was also detected in the method blank
E	Estimated value - analyte was detected at concentration greater than upper calibration limit
F	Estimated value - analyte should have been tested as a field parameter
H	Estimated value - sample was analyzed beyond the accepted holding time
J	Estimated value - analyte was detected < PQL and ≥ MDL
L	The batch-specific LCS and/or LCSD was not within lab control limits for this analyte
M	The batch-specific MS and/or MSD was not within lab control limits for this analyte
R	The RPD between batch-specific sample/dup or MS/MSD was not within lab control limits for this analyte
S	The surrogate recovery was not within quality control limits
Z	Laboratory specific qualifier – refer to case narrative
*	Performed in strict accordance with the procedures and controls of the ACL quality system, but not currently in the NELAC list of certified analytes/methods

Solid samples (i.e. soil, sludge, solid waste) are reported on a wet weight basis unless otherwise noted.
Estimated uncertainty values are available upon request.

<ins>Representation and Limitation of Liability</ins> – The accuracy of all analytical results for samples begins as it is received by the laboratory. The integrity of the sample begins at the time it is placed in the possession of authorized ACL personnel. All other warranties, expressed or implied, are disclaimed. Liability is limited to the cost of the analysis.

ACL

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3039 Amwiler Road • Suite 100 • Atlanta, GA 30360
P.O. Box 88610 • Atlanta, GA 30356
www.acl-labs.com

Client: Golder Associates, Inc.
3730 Chamblee Tucker Road
Atlanta, GA 30341-0000

Client Proj #: 1648353
ACL Project #: 68766
Date Received: 01/11/2016
Date Reported: 01/18/2016

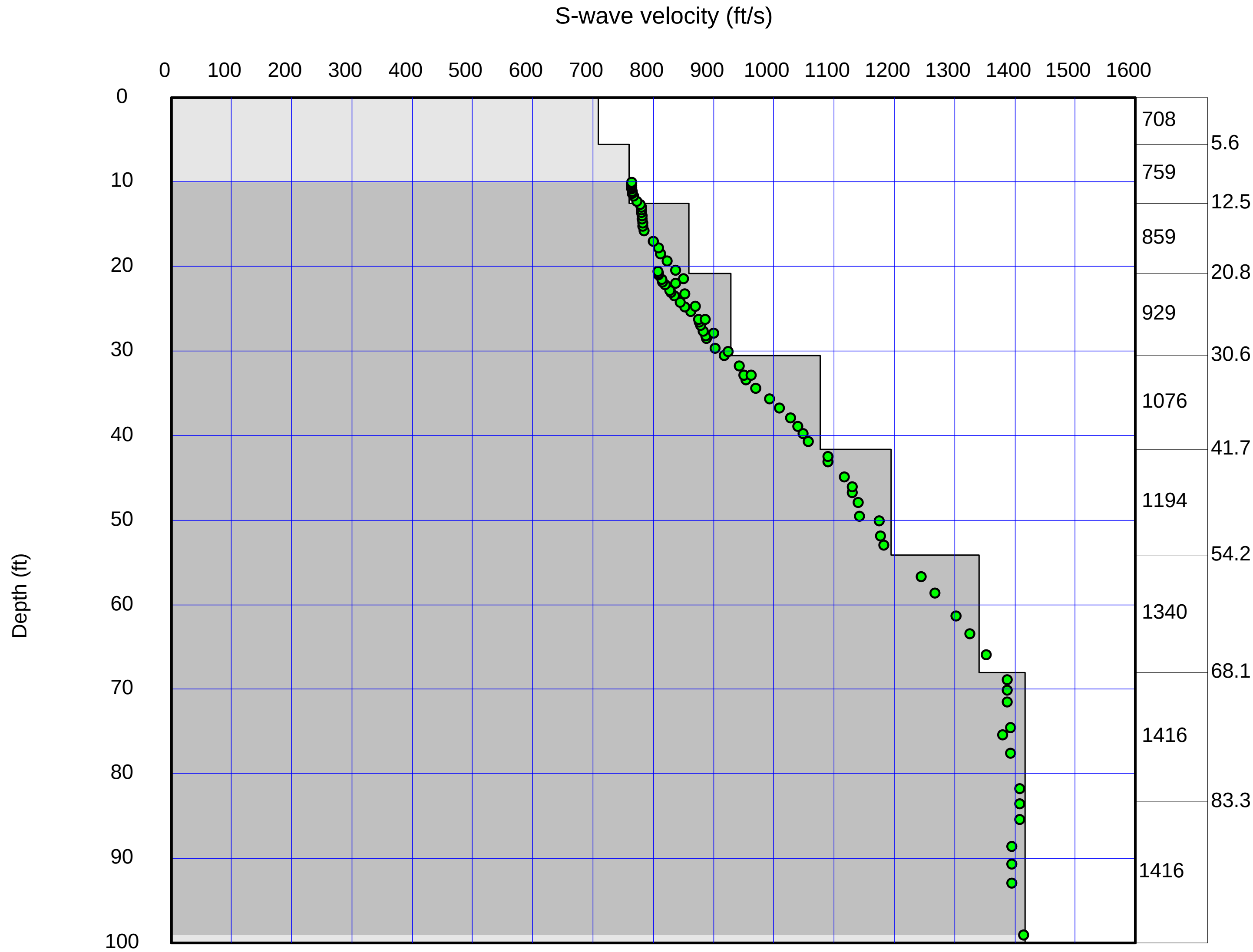
Contact: Mr. Henry Mock

Sample ID	ACL #	Analyte (Method)	Matrix	Result	PQL	Unit	Date/Time Analyzed		Analyst
BS-1, 15-2084 A	308698	Sol. Sulfate (9038)*	Soil	80	50	mg/kg	1/12/2016	9:10 AM	MM
BS-2, 15-2085 A	308699	Sol. Sulfate (9038)*	Soil	112	50	mg/kg	1/12/2016	9:10 AM	MM
BS-1, 16-0013 A	308700	Sol. Sulfate (9038)*	Soil	BQL	50	mg/kg	1/12/2016	9:10 AM	MM
BS-2, 16-0014 A	308701	Sol. Sulfate (9038)*	Soil	BQL	50	mg/kg	1/12/2016	9:10 AM	MM
BS-1, 15-2086 A	308702	Sol. Sulfate (9038)*	Soil	132	50	mg/kg	1/12/2016	9:10 AM	MM
BS-2, 15-2087 A	308703	Sol. Sulfate (9038)*	Soil	1130	500	mg/kg	1/12/2016	9:10 AM	MM
BS-1, 15-2088 A	308704	Sol. Sulfate (9038)*	Soil	96	50	mg/kg	1/12/2016	9:10 AM	MM
BS-2, 15-2089 A	308705	Sol. Sulfate (9038)*	Soil	104	50	mg/kg	1/12/2016	9:10 AM	MM

APPENDIX

SECTION 7

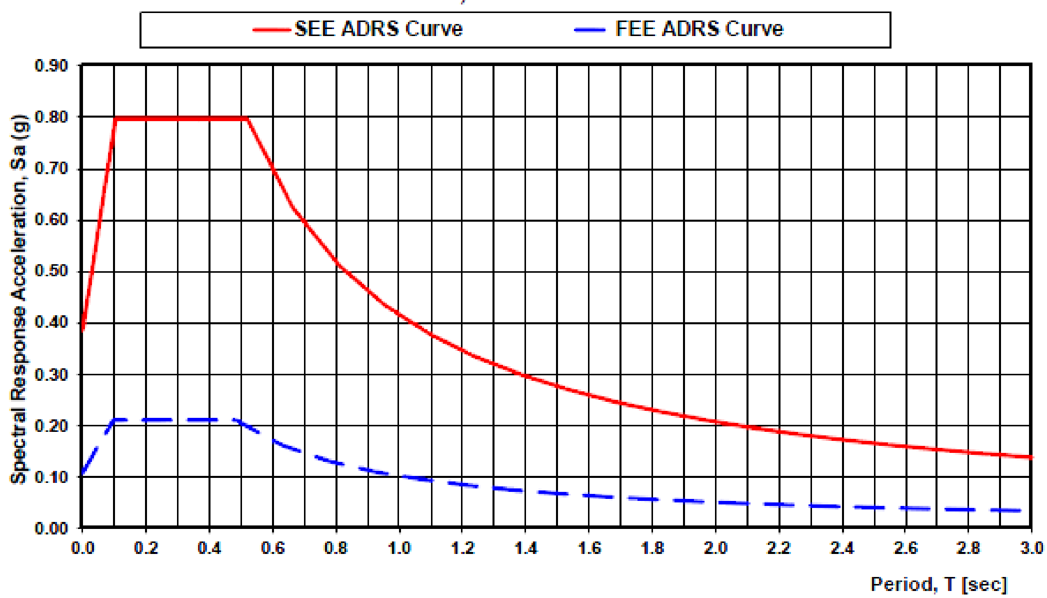
SEISMIC DESIGN DATA



S-wave velocity model (initial) : BlackMingofinal.rst

Average Vs 100ft = 1100.7 ft/sec

SC Seismic Hazard Map Three-Point ADRS Curve From Ground Surface, S-51 - Site Class C



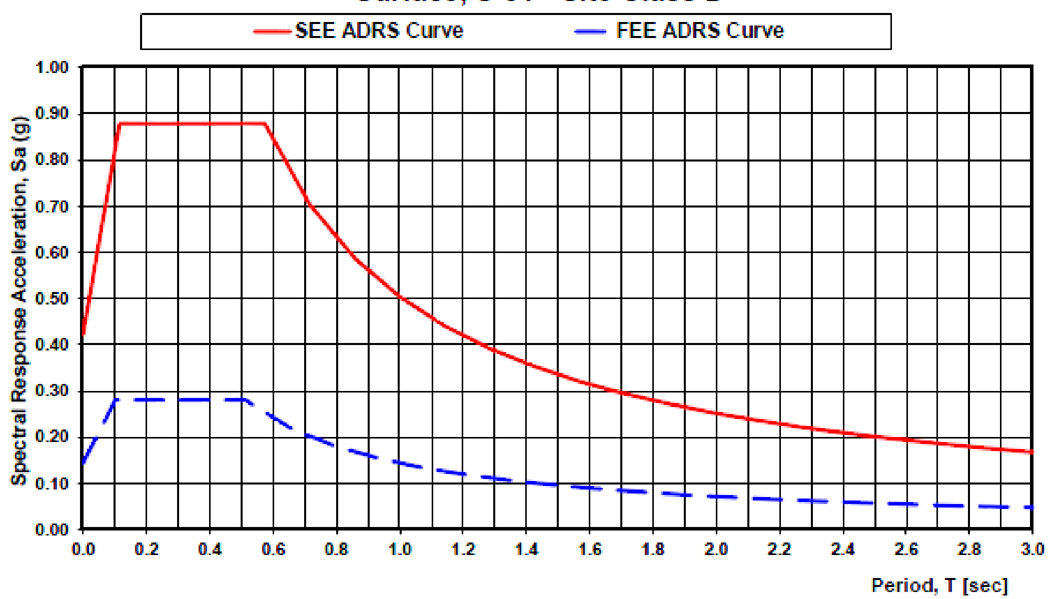
FEE ADRS Curve
Three-Point Method

	T	S_a
	0.00	0.11
	0.02	0.13
	0.03	0.14
	0.05	0.16
	0.06	0.18
	0.08	0.19
To	0.10	0.21
	0.13	0.21
	0.16	0.21
	0.19	0.21
	0.23	0.21
	0.26	0.21
	0.29	0.21
	0.32	0.21
	0.35	0.21
	0.39	0.21
	0.42	0.21
	0.45	0.21
Ts	0.48	0.21
	0.63	0.16
	0.78	0.13
	0.93	0.11
	1.08	0.09
	1.22	0.08
	1.37	0.07
	1.52	0.07
	1.67	0.06
	1.82	0.06
	1.96	0.05
	2.11	0.05
	2.26	0.05
	2.41	0.04
	2.56	0.04
	2.70	0.04
	2.85	0.04
	3.00	0.03

SEE ADRS Curve
Three-Point Method

	T	Sa
	0.00	0.39
	0.02	0.45
	0.03	0.52
	0.05	0.59
	0.07	0.66
	0.09	0.73
To	0.10	0.80
	0.14	0.80
	0.17	0.80
	0.21	0.80
	0.24	0.80
	0.28	0.80
	0.31	0.80
	0.35	0.80
	0.38	0.80
	0.42	0.80
	0.45	0.80
	0.49	0.80
Ts	0.52	0.80
	0.67	0.62
	0.81	0.51
	0.96	0.43
	1.10	0.38
	1.25	0.33
	1.40	0.30
	1.54	0.27
	1.69	0.25
	1.83	0.23
	1.98	0.21
	2.12	0.20
	2.27	0.18
	2.42	0.17
	2.56	0.16
	2.71	0.15
	2.85	0.15
	3.00	0.14

SC Seismic Hazard Map Three-Point ADRS Curve From Ground Surface, S-51 - Site Class D



FEE ADRS Curve
Three-Point Method

	T	S_a
	0.00	0.14
	0.02	0.17
	0.03	0.19
	0.05	0.21
	0.07	0.24
	0.09	0.26
To	0.10	0.28
	0.14	0.28
	0.17	0.28
	0.20	0.28
	0.24	0.28
	0.27	0.28
	0.31	0.28
	0.34	0.28
	0.38	0.28
	0.41	0.28
	0.44	0.28
	0.48	0.28
Ts	0.51	0.28
	0.66	0.22
	0.80	0.18
	0.95	0.15
	1.10	0.13
	1.24	0.12
	1.39	0.10
	1.54	0.09
	1.68	0.09
	1.83	0.08
	1.98	0.07
	2.12	0.07
	2.27	0.06
	2.41	0.06
	2.56	0.06
	2.71	0.05
	2.85	0.05
	3.00	0.05

SEE ADRS Curve
Three-Point Method

	T	Sa
	0.00	0.42
	0.02	0.50
	0.04	0.57
	0.06	0.65
	0.08	0.73
	0.10	0.80
To	0.11	0.88
	0.15	0.88
	0.19	0.88
	0.23	0.88
	0.27	0.88
	0.31	0.88
	0.34	0.88
	0.38	0.88
	0.42	0.88
	0.46	0.88
	0.50	0.88
	0.54	0.88
Ts	0.57	0.88
	0.72	0.70
	0.86	0.59
	1.00	0.50
	1.14	0.44
	1.29	0.39
	1.43	0.35
	1.57	0.32
	1.72	0.29
	1.86	0.27
	2.00	0.25
	2.14	0.24
	2.29	0.22
	2.43	0.21
	2.57	0.20
	2.71	0.19
	2.86	0.18
	3.00	0.17

APPENDIX

SECTION 8

BRIDGE FOUNDATION LOADINGS

ICE	JOB: S-51 over Black Mingo Creek				
1021 Briargate Circle	SHEET NO.	1	OF	1	
Columbia, SC 29210	CALCULATED BY:	DKY		DATE:	2/12/2016
PH:(803) 822-0333	CHECKED BY:			DATE:	

Top of Pile Reactions for End Bent 1

SERVICE REACTIONS - (7) HP14x73 Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	35.792	**1**	-65	2	18	5

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.292	-1	**-104**	2	11	-4

Max Longitudinal (global Fz)

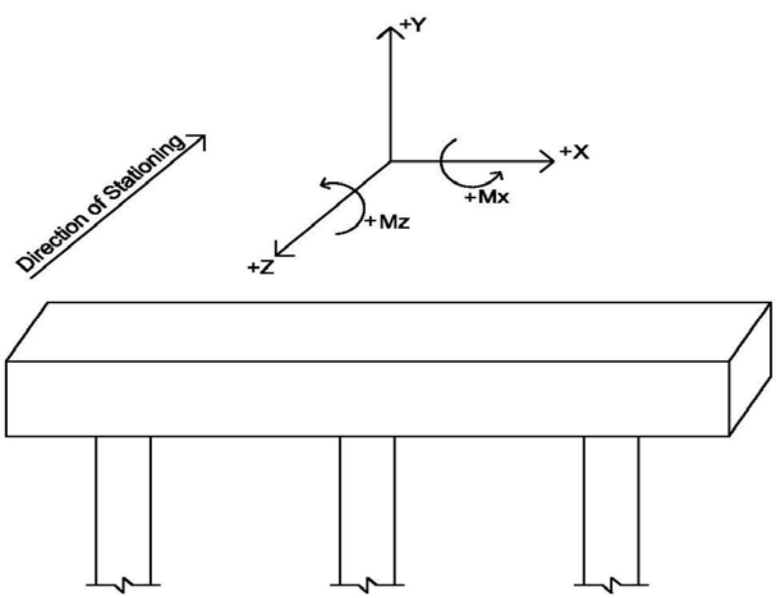
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	2.792	-1	-94	**2**	14	-4

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
7	35.792	1	-98	2	**18**	5

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
7	35.792	1	-83	2	18	**5**



ICE
1021 Briargate Circle
Columbia, SC 29210
PH:(803) 822-0333

JOB: S-51 over Black Mingo Creek
SHEET NO. 1 OF 1
CALCULATED BY: DKY DATE: 2/12/2016
CHECKED BY: DATE:

Top of Pile Reactions for End Bent 1

STRENGTH REACTIONS - (7) HP14x73 Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	35.792	**1**	-55	1	3	8

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.292	-1	**-146**	1	2	-7

Max Longitudinal (global Fz)

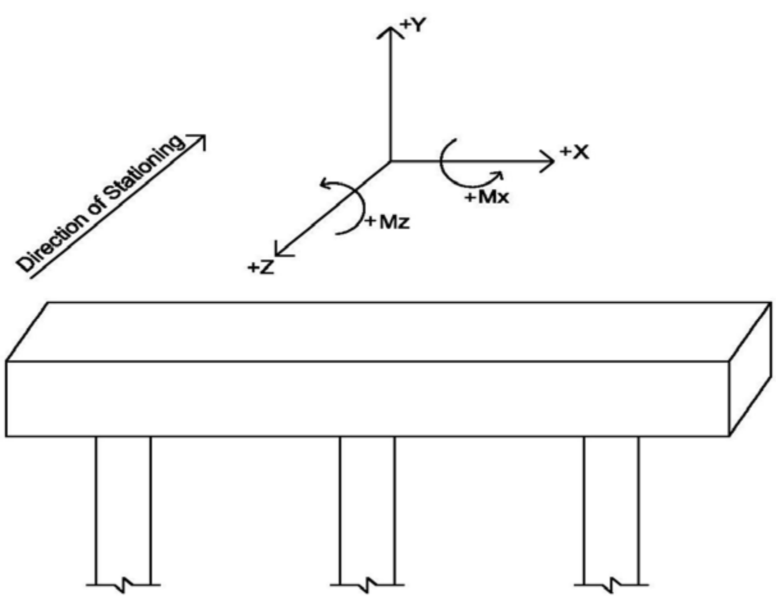
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	2.792	0	-127	**3**	23	-2

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
7	35.792	0	-133	3	**29**	2

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
7	35.792	1	-72	1	3	**8**



ICE
1021 Briargate Circle
Columbia, SC 29210
PH:(803) 822-0333

JOB: S-51 over Black Mingo Creek
SHEET NO. 1 OF 1
CALCULATED BY: DKY DATE: 2/15/2016
CHECKED BY: DATE:

Top of Pile Reactions for Interior Bent 2 (100 Yr Scour Case)

SERVICE REACTIONS - (7) 18" Square Concrete Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	36.000	**2**	-92	2	-26	20

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.500	1	**-164**	1	-28	13

Max Longitudinal (global Fz)

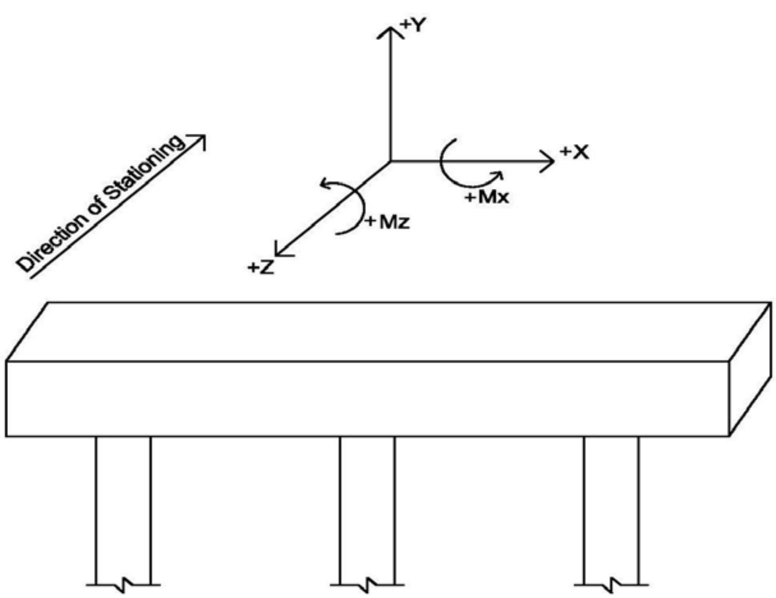
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	3.000	1	-66	**-2**	-38	7

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
4	19.500	1	-157	-1	**-47**	13

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
1	3.000	-2	-105	2	-22	**-31**



ICE
1021 Briargate Circle
Columbia, SC 29210
PH:(803) 822-0333

Top of Pile Reactions for Interior Bent 2 (100 Yr Scour Case)

STRENGTH REACTIONS - (7) 18" Square Concrete Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	36.000	**3**	-122	0	-19	34

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.500	0	**-237**	2	-42	-6

Max Longitudinal (global Fz)

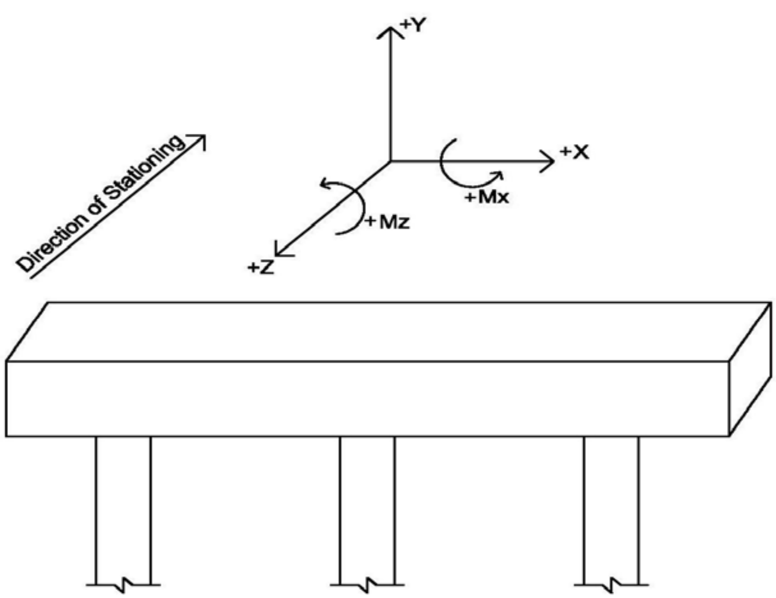
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	3.000	0	-89	**-3**	-59	-12

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
4	19.500	0	-225	-2	**-75**	-6

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
4	19.500	-3	-113	0	-16	**-45**



ICE	JOB: S-51 over Black Mingo Creek				
1021 Briargate Circle	SHEET NO.	1	OF	1	
Columbia, SC 29210	CALCULATED BY:	DKY		DATE:	2/15/2016
PH:(803) 822-0333	CHECKED BY:			DATE:	

Top of Pile Reactions for Interior Bent 3 (100 Yr Scour Case)

SERVICE REACTIONS - (7) 18" Square Concrete Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	36.000	**2**	-106	1	16	24

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.500	2	**-185**	1	18	16

Max Longitudinal (global Fz)

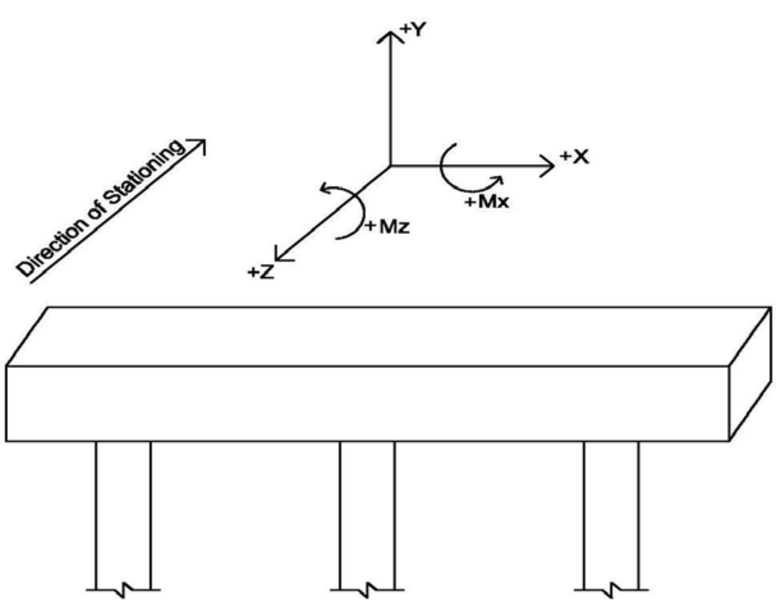
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	3.000	1	-77	**2**	30	10

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
4	19.500	2	-173	1	**39**	16

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
1	3.000	-2	-119	1	13	**-33**



ICE
1021 Briargate Circle
Columbia, SC 29210
PH:(803) 822-0333

JOB: S-51 over Black Mingo Creek
SHEET NO. 1 OF 1
CALCULATED BY: DKY DATE: 2/15/2016
CHECKED BY: DATE:

Top of Pile Reactions for Interior Bent 3 (100 Yr Scour Case)

STRENGTH REACTIONS - (7) 18" Square Concrete Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	36.000	**3**	-142	0	7	40

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.500	0	**-265**	2	29	-6

Max Longitudinal (global Fz)

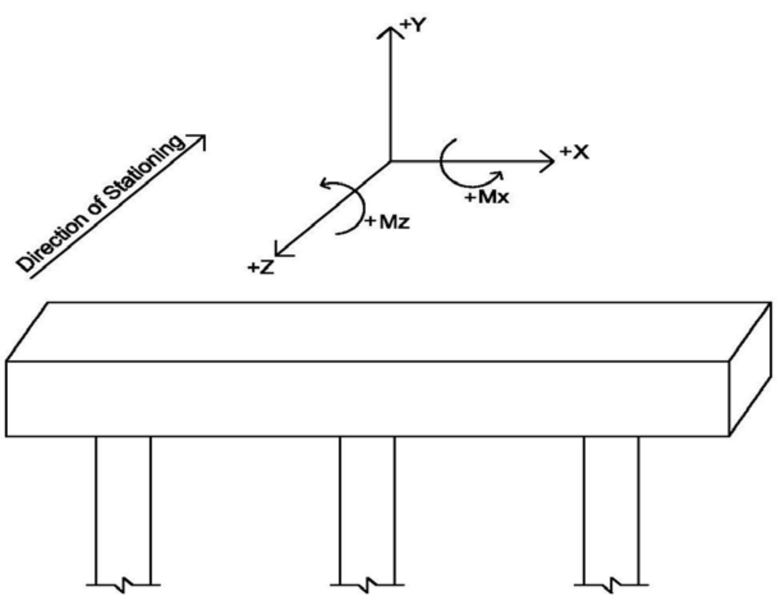
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	3.000	0	-104	**3**	49	-12

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
4	19.500	0	-245	2	**65**	-6

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
4	19.500	-3	-132	0	6	**-50**



ICE
1021 Briargate Circle
Columbia, SC 29210
PH:(803) 822-0333

JOB: S-51 over Black Mingo Creek
SHEET NO. 1 OF 1
CALCULATED BY: DKY DATE: 2/12/2016
CHECKED BY: DATE:

Top of Pile Reactions for End Bent 4

SERVICE REACTIONS - (7) HP14x73 Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	35.792	**1**	-77	3	19	6

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.292	-1	**-126**	2	12	-4

Max Longitudinal (global Fz)

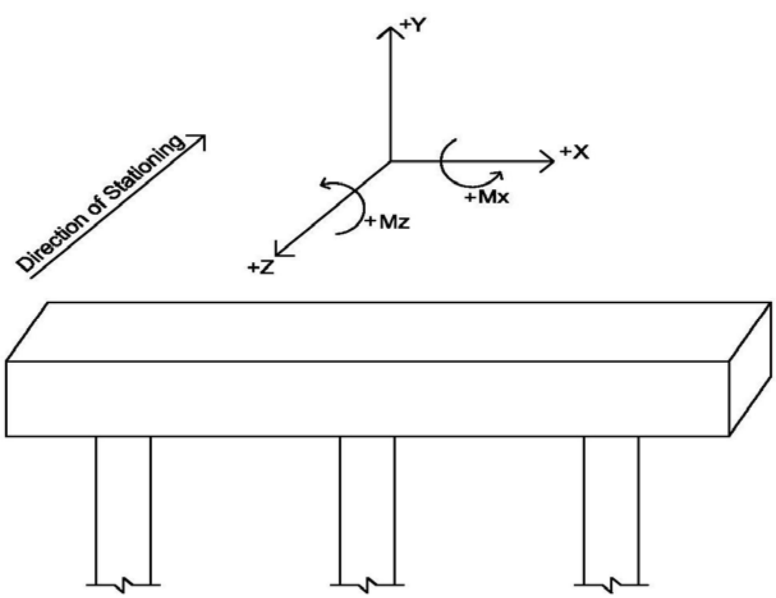
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	2.792	-1	-111	**3**	15	-5

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
7	35.792	1	-116	3	**19**	6

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
7	35.792	1	-98	3	19	**6**



Top of Pile Reactions for End Bent 4

STRENGTH REACTIONS - (7) HP14x73 Piles

Max Transverse (global Fx)

Pile Number	Distance from left end	**Fx kips**	Fy kips	Fz kips	Mx ft-k	Mz ft-k
7	35.792	**1**	-66	1	4	8

Max Axial (global Fy)

Pile Number	Distance from left end	Fx kips	**Fy kips**	Fz kips	Mx ft-k	Mz ft-k
4	19.292	-1	**-177**	1	3	-7

Max Longitudinal (global Fz)

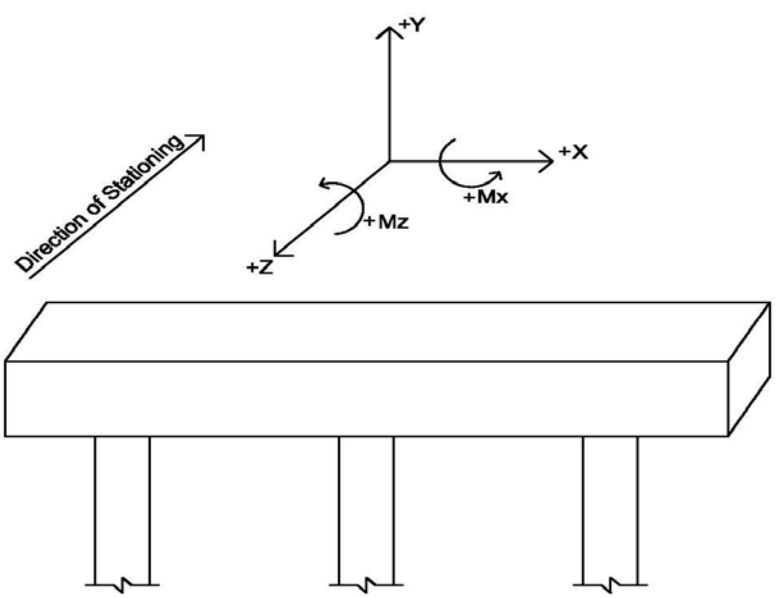
Pile Number	Distance from left end	Fx kips	Fy kips	**Fz kips**	Mx ft-k	Mz ft-k
1	2.792	0	-151	**4**	24	-2

Max Moment From Long. Load (global Mx)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	**Mx ft-k**	Mz ft-k
7	35.792	0	-157	4	**30**	3

Max Moment from Transverse load (global Mz)

Pile Number	Distance from left end	Fx kips	Fy kips	Fz kips	Mx ft-k	**Mz ft-k**
7	35.792	1	-112	1	4	**8**



APPENDIX

SECTION 9

STATIC SETTLEMENT CALCULATIONS

SUBSECTION A
SPT METHOD

F&ME CONSULTANTS

Project: S-51 over Black Mingo Creek - **Static Settlement Calculations**
Location : End of Bridge/End Bent 1
Calc. By: JFH
Date: 12/28/2015
Method: Hough Method

	@ CL	
Soil Fill Height =	1.7	ft
Stone Fill Height =	0	ft
Embankment Crest Width =	41	ft
Embankment Side Slope =	2:1	
Embankment Side Length =	10	ft
Dist. from CL to mid. pt. side slope, b_f =	25.5	ft
Pt. of Interest from mid. pt. side slope =	25.5	ft
Pt. of Interest in multiples of b_f =	1.0	ft
Soil Fill Unit Wgt. =	125.0	pcf
Stone Fill Unit Wgt. =	100.0	pcf
ΔP ' =	212.5	psf
	1.5	psi

Ex. Ground EL @ CL =	26.3	ft-MSL
Groundwater EL =	18.3	ft-MSL

Consolidation Parameters		
C_c =	N/A	dim
e_0 =	N/A	dim
H_0 =	N/A	ft
H_d =	N/A	ft
U =	N/A	
T_v =	N/A	dim
C_v =	N/A	ft^2/day

Wick Drain Parameters		
d =	N/A	in
	N/A	ft
Drain Spacing =	N/A	ft
D =	N/A	ft
F(n) =	N/A	
ch = 2cv =	N/A	ft^2/day
U_h =	N/A	
t =	N/A	days

	Depth (ft)	"K" @ CL	"K" @ Mid-Slope
0.2b =	5.1	1.00	0.25
0.4b =	10.2	1.00	0.25
0.6b =	15.3	1.00	0.25
0.8b =	20.4	0.90	0.20
1.0b =	25.5	0.80	0.20
1.2b =	30.6	0.75	0.20
1.6b =	40.8	0.60	0.20

STB-1

Embankment Settlement at Roadway Centerline

SPT Depth		TOL	BOL	H	USCS	K	γ	γ '	σ'$_{ot}$	σ'$_{ob}$	σ'$_{om}$	Δσ	σ'$_f$	N_{meas}	N_{60}	$N_{1,60}$	C'	Δ H	S_c	t
ft		ft-MSL	ft-MSL	ft	dim	dim	pcf	pcf	psf	psf	psf	psf	psf	dim	dim	dim	dim	(in)	in	days
1.0	2.5	26.3	23.8	2.5	SM	1.00	115	115	0.0	287.5	143.8	212.5	356.3	21	28.4	45	107	0.11	--	--
3.0	4.5	23.3	21.8	2.0	SM	1.00	115	115	287.5	517.5	402.5	212.5	615.0	10	13.5	22	61	0.07	--	--
5.0	6.5	21.3	19.8	2.0	SM	1.00	115	115	517.5	747.5	632.5	212.5	845.0	7	9.5	15	50	0.06	--	--
7.0	8.5	19.3	17.8	2.0	SC	1.00	115	52.6	747.5	852.7	800.1	212.5	1012.6	7	9.5	15	50	0.05	--	--
9.0	10.5	17.3	15.8	2.0	SM	1.00	105	42.6	852.7	937.9	895.3	212.5	1107.8	1	1.4	2	30	0.07	--	--
10.5	15.0	15.8	11.3	4.5	OH	1.00	105	42.6	937.9	1129.6	1033.8	212.5	1246.3	3	4.1	6	25	0.18	--	--
15.0	20.0	11.3	6.3	5.0	SM	0.90	115	52.6	1129.6	1392.6	1261.1	191.3	1452.4	29	39.2	49	115	0.03	--	--
20.0	25.0	6.3	1.3	5.0	SM	0.80	115	52.6	1392.6	1655.6	1524.1	170.0	1694.1	24	32.4	37	90	0.03	--	--
25.0	30.0	1.3	-3.7	5.0	SM	0.75	115	52.6	1655.6	1918.6	1787.1	159.4	1946.5	100	135.0	143	300	0.01	--	--
30.0	35.0	-3.7	-8.7	5.0	SM	0.70	115	52.6	1918.6	2181.6	2050.1	148.8	2198.9	100	135.0	133	300	0.01	--	--
35.0	40.0	-8.7	-13.7	5.0	SM	0.60	115	52.6	2181.6	2444.6	2313.1	127.5	2440.6	16	21.6	20	60	0.02	--	--
40.0	45.0	-13.7	-18.7	5.0	SM	0.60	115	52.6	2444.6	2707.6	2576.1	127.5	2703.6	24	32.4	29	75	0.02	--	--
45.0	50.0	-18.7	-23.7																	
50.0	55.0	-23.7	-28.7																	
55.0	60.0	-28.7	-33.7																	
60.0	65.0	-33.7	-38.7																	
65.0	70.0	-38.7	-43.7																	
70.0	75.0	-43.7	-48.7																	

Total Immediate Settlement (in) = 0.66
Total Consolidation Settlement (in) = 0.00

F&ME
CONSULTANTS

Project: S-51 over Black Mingo Creek - **Static Settlement Calculations**
Location : End of Bridge/End Bent 4
Calc. By: JFH
Date: 12/28/2015
Method: Hough Method

	@ CL	
Soil Fill Height =	1.7	ft
Stone Fill Height =	0	ft
Embankment Crest Width =	41	ft
Embankment Side Slope =	2:1	
Embankment Side Length =	10	ft
Dist. from CL to mid. pt. side slope, b_f =	25.5	ft
Pt. of Interest from mid. pt. side slope =	25.5	ft
Pt. of Interest in multiples of b_f =	1.0	ft
Soil Fill Unit Wgt. =	125.0	pcf
Stone Fill Unit Wgt. =	100.0	pcf
ΔP ' =	212.5	psf
	1.5	psi

Ex. Ground EL @ CL =	26.3	ft-MSL
Groundwater EL =	18.3	ft-MSL

Consolidation Parameters		
C_c =	N/A	dim
e_0 =	N/A	dim
H_0 =	N/A	ft
H_d =	N/A	ft
U =	N/A	
T_v =	N/A	dim
C_v =	N/A	ft^2/day

Wick Drain Parameters		
d =	N/A	in
	N/A	ft
Drain Spacing =	N/A	ft
D =	N/A	ft
F(n) =	N/A	
ch = 2cv =	N/A	ft^2/day
U_h =	N/A	
t =	N/A	days

	Depth (ft)	"K" @ CL	"K" @ Mid-Slope
0.2b =	5.1	1.00	0.25
0.4b =	10.2	1.00	0.25
0.6b =	15.3	1.00	0.25
0.8b =	20.4	0.90	0.20
1.0b =	25.5	0.80	0.20
1.2b =	30.6	0.75	0.20
1.6b =	40.8	0.60	0.20

STB-4

Embankment Settlement at Roadway Centerline

SPT Depth		**TOL**	**BOL**	**H**	**USCS**	**K**	**γ**	**γ '**	**σ'_{ot}**	**σ'_{ob}**	**σ'_{om}**	**Δσ**	**σ'_f**	**N_{meas}**	**N_{60}**	**$N_{1,60}$**	**C'**	**Δ H**	**S_c**	**t**
ft		*ft-MSL*	*ft-MSL*	*ft*	*dim*	*dim*	*pcf*	*pcf*	*psf*	*psf*	*psf*	*psf*	*psf*	*dim*	*dim*	*dim*	*dim*	(in)	*in*	*days*
1.0	2.5	26.3	23.8	2.5	SM	1.00	115	115	0.0	287.5	143.8	212.5	356.3	15	20.3	32	80	0.15	--	--
3.0	4.5	23.3	21.8	2.0	SM	1.00	110	110	287.5	507.5	397.5	212.5	610.0	6	8.1	13	47	0.09	--	--
5.0	6.5	21.3	19.8	2.0	SM	1.00	100	100	507.5	707.5	607.5	212.5	820.0	1	1.4	2	30	0.10	--	--
7.0	8.5	19.3	17.8	2.0	SC	1.00	100	37.6	707.5	782.7	745.1	212.5	957.6	1	1.4	2	30	0.09	--	--
9.0	10.5	17.3	15.8	2.0	SM	1.00	105	42.6	782.7	867.9	825.3	212.5	1037.8	2	2.7	4	34	0.07	--	--
10.5	15.0	15.8	11.3	4.5	SM	1.00	110	47.6	867.9	1082.1	975.0	212.5	1187.5	8	10.8	15	50	0.09	--	--
15.0	20.0	11.3	6.3	5.0	SP-SM	0.90	110	47.6	1082.1	1320.1	1201.1	191.3	1392.4	6	8.1	10	48	0.08	--	--
20.0	25.0	6.3	1.3	5.0	SM	0.80	115	52.6	1320.1	1583.1	1451.6	170.0	1621.6	24	32.4	38	92	0.03	--	--
25.0	30.0	1.3	-3.7	5.0	SM	0.75	115	52.6	1583.1	1846.1	1714.6	159.4	1874.0	100	135.0	146	300	0.01	--	--
30.0	35.0	-3.7	-8.7	5.0	SP-SM	0.70	115	52.6	1846.1	2109.1	1977.6	148.8	2126.4	52	70.2	71	210	0.01	--	--
35.0	40.0	-8.7	-13.7	5.0	CL	0.60	115	52.6	2109.1	2372.1	2240.6	127.5	2368.1	12	16.2	15	35	0.04	--	--
40.0	45.0	-13.7	-18.7	5.0	SM	0.60	115	52.6	2372.1	2635.1	2503.6	127.5	2631.1	22	29.7	27	70	0.02	--	--
45.0	50.0	-18.7	-23.7																	
50.0	55.0	-23.7	-28.7																	
55.0	60.0	-28.7	-33.7																	
60.0	65.0	-33.7	-38.7																	
65.0	70.0	-38.7	-43.7																	
70.0	75.0	-43.7	-48.7																	

Total Immediate Settlement (in) = 0.78
Total Consolidation Settlement (in) = 0.00

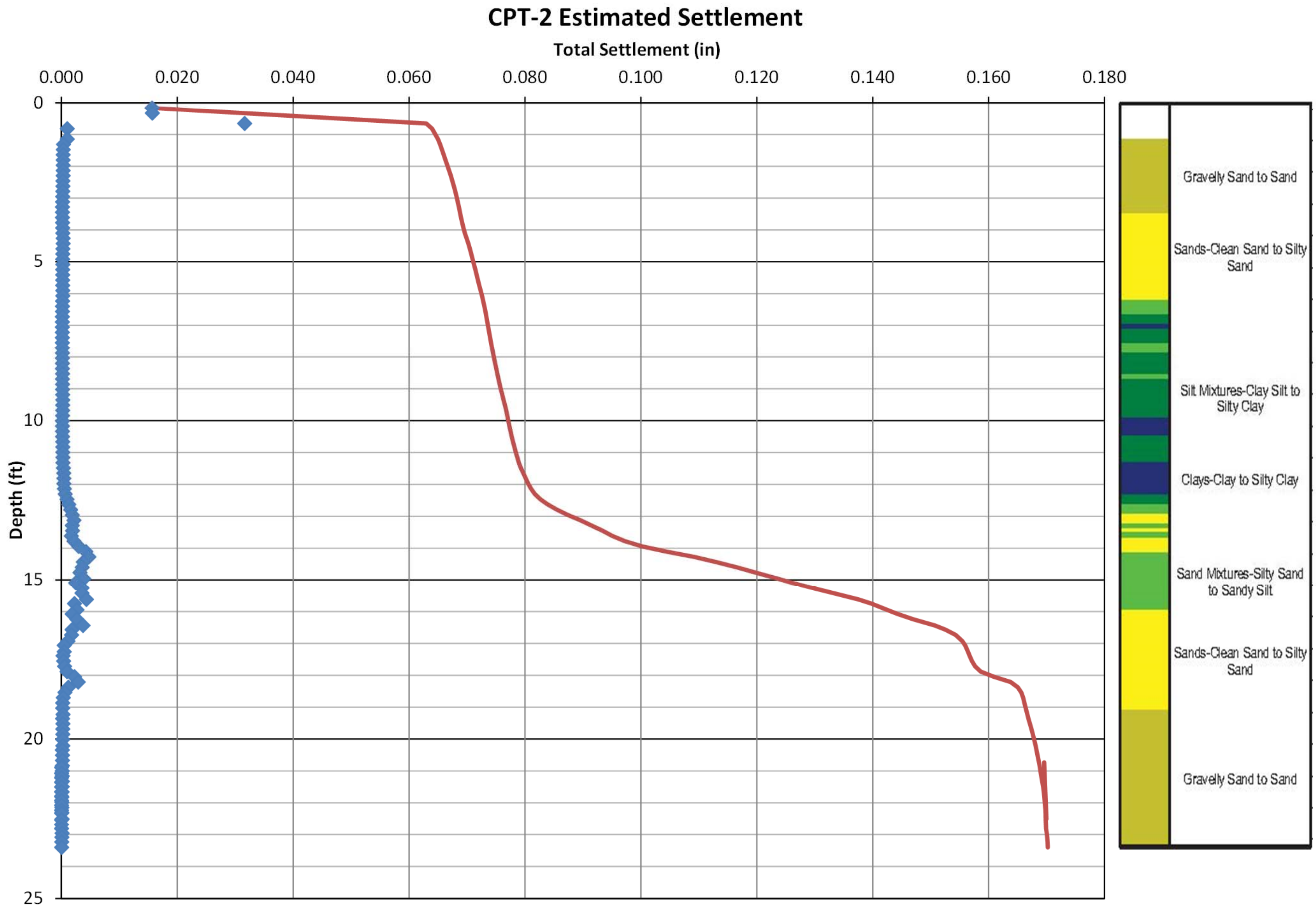
S-51 EMERGENCY BRIDGE REPLACEMENT
OVER BLACK MINGO CREEK
FINAL BRIDGE GEOTECHNICAL ENGINEERING REPORT

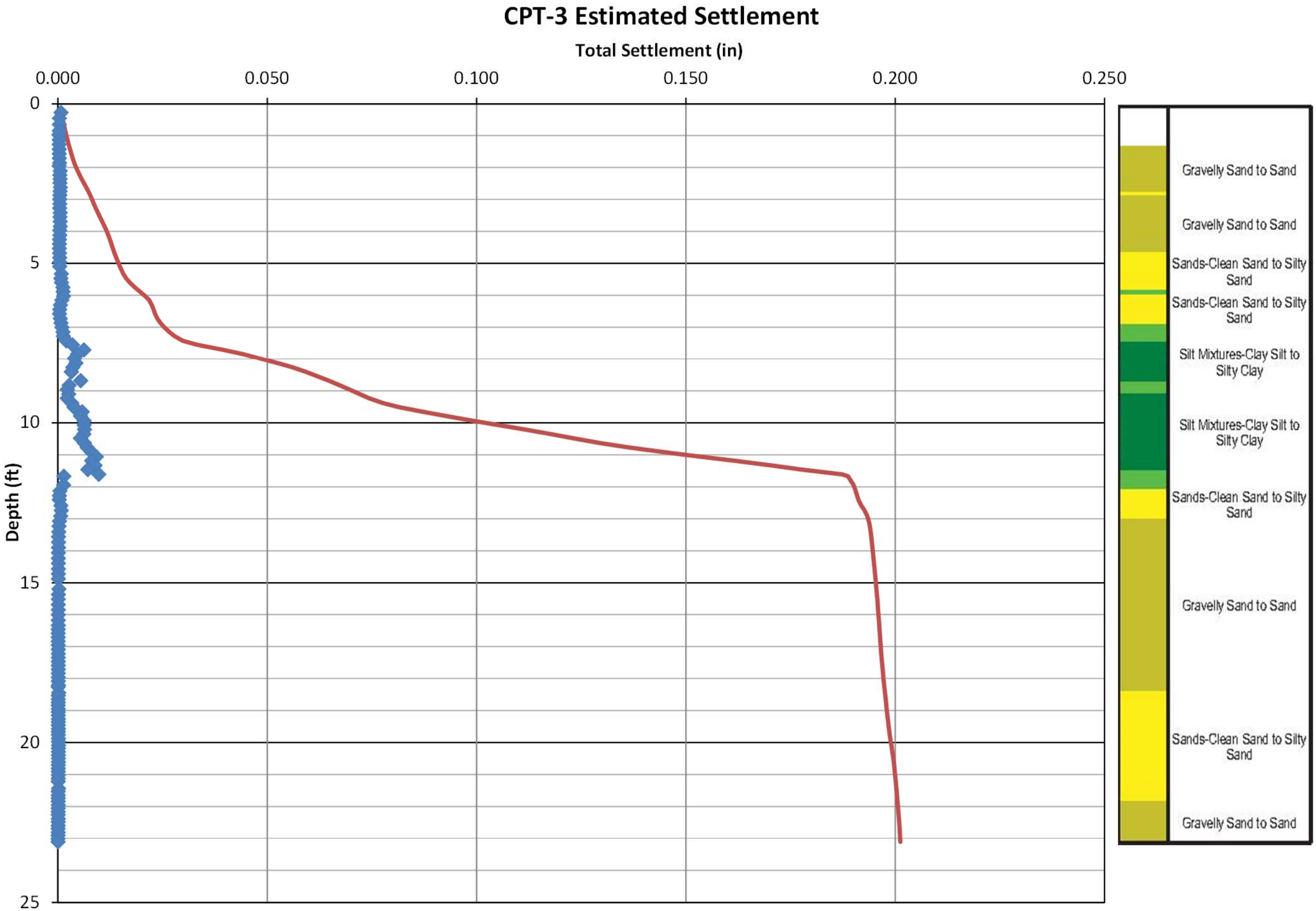
APPENDIX

SECTION 9

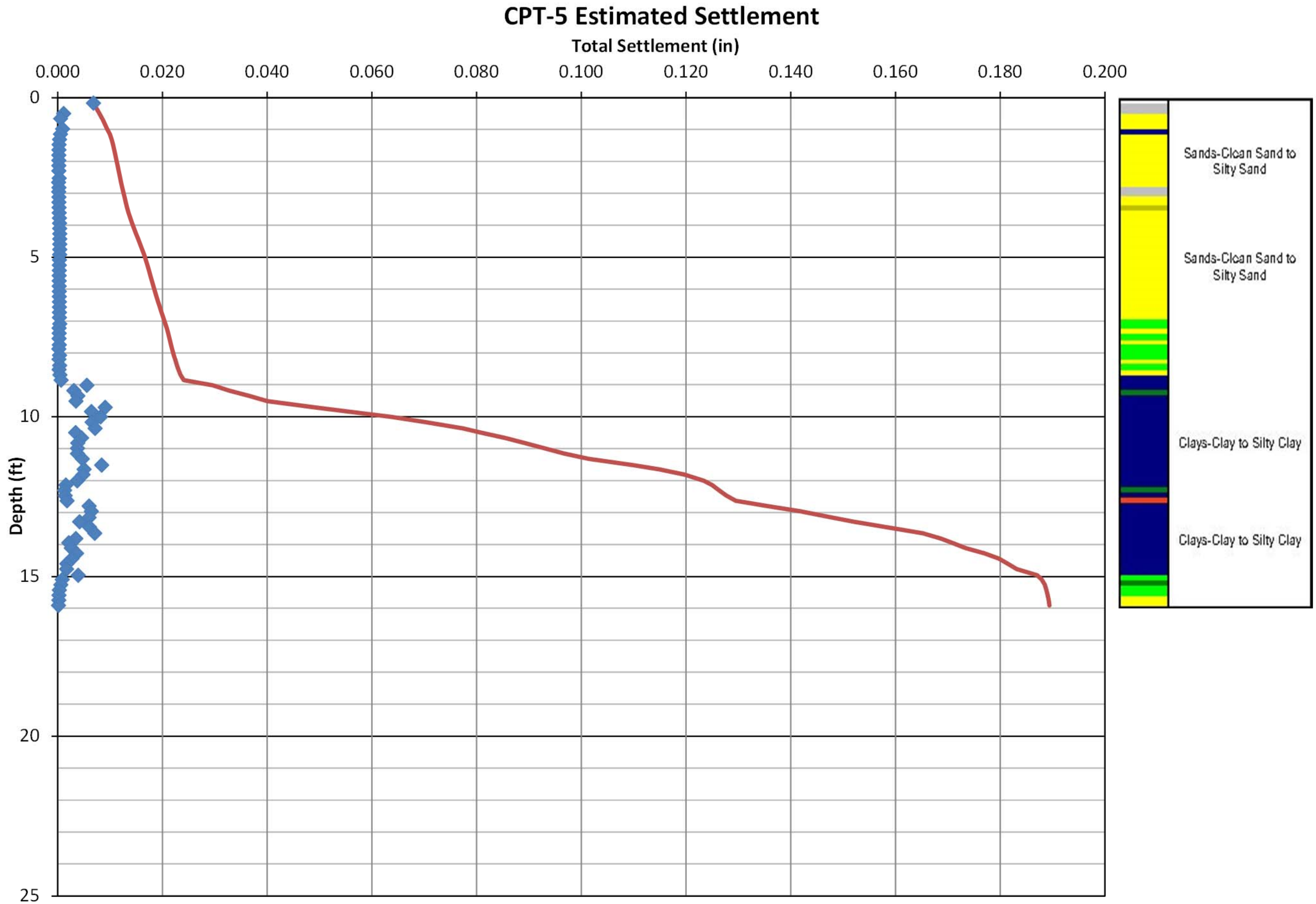
STATIC SETTLEMENT CALCULATIONS

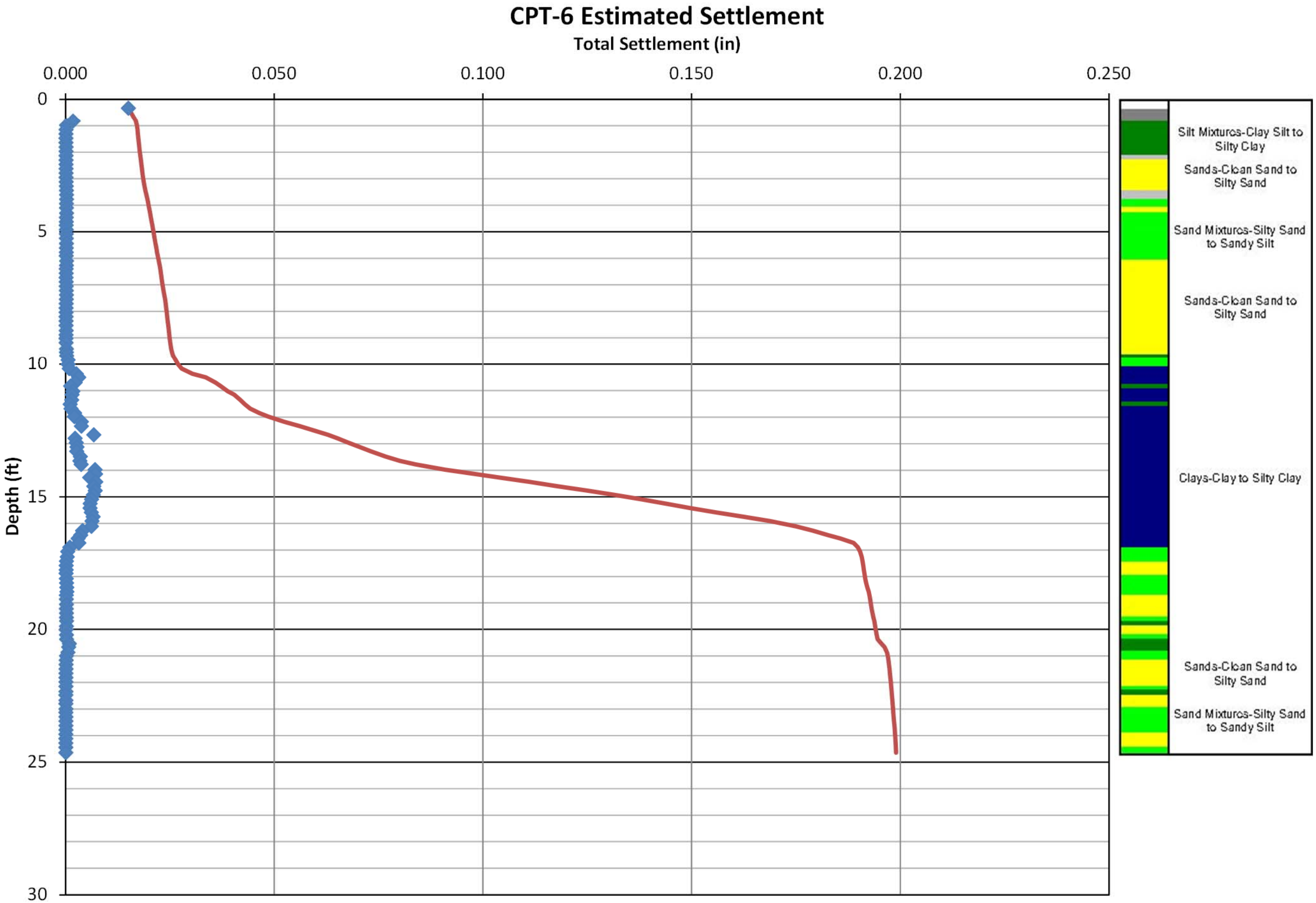
SUBSECTION B
CPT METHOD


CPT-2 Estimated Settlement
Total Settlement (in)
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
0.180
Depth (ft)
0
5
10
15
20
25
Gravelly Sand to Sand
Sands-Clean Sand to Silty Sand
Silt Mixtures-Clay Silt to Silty Clay
Clays-Clay to Silty Clay
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
Gravelly Sand to Sand


CPT-3 Estimated Settlement
Total Settlement (in)
0.000
0.050
0.100
0.150
0.200
0.250
Depth (ft)
0
5
10
15
20
25
Gravelly Sand to Sand
Gravelly Sand to Sand
Sands-Clean Sand to Silty Sand
Sands-Clean Sand to Silty Sand
Silt Mixtures-Clay Silt to Silty Clay
Silt Mixtures-Clay Silt to Silty Clay
Sands-Clean Sand to Silty Sand
Gravelly Sand to Sand
Sands-Clean Sand to Silty Sand
Gravelly Sand to Sand

F&ME CONSULTANTS




CPT-6 Estimated Settlement
Total Settlement (in)
0.000
0.050
0.100
0.150
0.200
0.250
Depth (ft)
0
5
10
15
20
25
30
Silt Mixtures-Clay Silt to Silty Clay
Sands-Clean Sand to Silty Sand
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty Clay
Sands-Clean Sand to Silty Sand
Sand Mixtures-Silty Sand to Sandy Silt

APPENDIX

SECTION 10

SOIL SHEAR LOSS CALCULATIONS

SUBSECTION A
SPT METHOD

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : End Bent 1
Calc. By: JFH
Date: 2/2/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

F&ME CONSULTANTS

Depth to Groundwater =	8.0	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	2.0	ft

Design Event =	FEE
Peak Ground Acceleration, PGA (%g) =	0.14
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.85

SPT-1

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$	α	β
ft		dim	pcf	pcf	ksf	ksf	dim	dim	dim	dim	dim	dim	dim	%	dim	dim	dim	dim	dim
0.0	2.0	SM	125	125	0.250	0.250	21	0.75	1.00	1.00	1.35	1.70	36.1	16	NP	3.6	39.7		
2.0	4.0	SM	125	125	0.500	0.500	10	0.75	1.00	1.00	1.35	1.70	17.2	16	NP	3.6	20.8		
4.0	6.0	SM	125	125	0.750	0.750	7	0.75	1.00	1.00	1.35	1.67	11.8	16	NP	3.6	15.4		
6.0	8.0	SC	115	115	0.980	0.980	7	0.85	1.00	1.00	1.35	1.45	11.7	15	NP	3.3	14.9		
8.0	10.0	SM	115	52.6	1.210	1.085	1	0.85	1.00	1.00	1.35	1.52	1.7	20	81	4.5	6.2	-0.137	0.016
13.5	15.0	PT	115	52.6	1.785	1.348	3	0.95	1.00	1.00	1.35	1.27	4.9	6	NP	0.0	4.9	-0.236	0.027
18.5	20.0	SM	115	52.6	2.360	1.611	29	0.95	1.00	1.00	1.35	1.07	39.7	23	NP	4.9	44.6	-0.348	0.039
23.5	25.0	SM	115	52.6	2.935	1.874	24	0.95	1.00	1.00	1.35	1.02	31.5	13	NP	2.5	34.0	-0.472	0.053
28.5	30.0	SM	115	52.6	3.510	2.137	24	1.00	1.00	1.00	1.35	0.98	31.7	10	NP	1.1	32.8	-0.604	0.068
33.5	35.0	SM	115	52.6	4.085	2.400	100	1.00	1.00	1.00	1.35	1.02	137.9	10	NP	1.1	139.1	-0.744	0.083

SPT Test Interval		r_d	$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	High Overburden Correction C_σ	High Overburden Correction K_α	Age Correction K_{DR}	Static Shear Stress Ratio Correction K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		dim	ksf	ksf	dim	dim	dim	dim	dim	dim	dim	dim				
0.0	2.0															
2.0	4.0															
4.0	6.0															
6.0	8.0															
8.0	10.0	0.97832	1.46	1.34	0.150	0.097	1.009	0.097	0.064	1.03	1.00	1.00	0.100	0.97	Clay-Like	Full SSL
13.5	15.0	0.96046	2.04	1.60	0.171	0.111	1.054	0.106	0.075	1.02	1.00	1.00	0.089	1.18	Sand-Like	Full SSL
18.5	20.0	0.94052	2.61	1.86	0.185	0.120	1.054	0.114	0.300	1.04	1.00	1.00	--	0.00	Sand-Like	No SSL
23.5	25.0	0.91887	3.19	2.12	0.193	0.125	1.054	0.119	0.218	1.00	1.00	1.00	359.825	0.00	Sand-Like	No SSL
28.5	30.0	0.89587	3.76	2.39	0.198	0.128	1.054	0.122	0.220	0.97	1.00	1.00	153.531	0.00	Sand-Like	No SSL
33.5	35.0	0.87189	4.34	2.65	0.200	0.130	1.054	0.123	-0.091	1.02	1.00	1.00	--	0.00	Sand-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_v	ΔS
ft		ft	dim	dim	dim	dim	in	in	%	in
0.0	2.0									
2.0	4.0									
4.0	6.0									
6.0	8.0									
8.0	10.0									
13.5	15.0	5.0	4.9	0.500	0.923	0.500	30.00	71.74	5.3%	3.17
18.5	20.0									
23.5	25.0									
28.5	30.0									
33.5	35.0									
									S =	3.17

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; $\gamma_{max} = \gamma_{lim}$ if $FS_{liq} \leq F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		dim	dim	%	deg	psf
0.0	2.0					
2.0	4.0					
4.0	6.0					
6.0	8.0					
8.0	10.0	6.2	0.068			90.4
13.5	15.0	4.9	0.059	--	3.39	
18.5	20.0					
23.5	25.0					
28.5	30.0					
33.5	35.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : End Bent 1
Calc. By: JFH
Date: 2/2/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

F&ME CONSULTANTS

Depth to Groundwater =	8.0	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	2.0	ft

Design Event =	SEE
Peak Ground Acceleration, PGA (%g) =	0.42
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.9

SPT-1

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$
ft		*dim*	*pcf*	*pcf*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*%*	*dim*	*dim*	*dim*
0.0	2.0	SM	125	125	0.250	0.250	21	0.75	1.00	1.00	1.35	1.70	36.1	16	NP	3.6	39.7
2.0	4.0	SM	125	125	0.500	0.500	10	0.75	1.00	1.00	1.35	1.70	17.2	16	NP	3.6	20.8
4.0	6.0	SM	125	125	0.750	0.750	7	0.75	1.00	1.00	1.35	1.67	11.8	16	NP	3.6	15.4
6.0	8.0	SC	115	115	0.980	0.980	7	0.85	1.00	1.00	1.35	1.45	11.7	15	NP	3.3	14.9
8.0	10.0	SM	115	52.6	1.210	1.085	1	0.85	1.00	1.00	1.35	1.52	1.7	20	81	4.5	6.2
13.5	15.0	PT	115	52.6	1.785	1.348	3	0.95	1.00	1.00	1.35	1.27	4.9	6	NP	0.0	4.9
18.5	20.0	SM	115	52.6	2.360	1.611	29	0.95	1.00	1.00	1.35	1.07	39.7	23	NP	4.9	44.6
23.5	25.0	SM	115	52.6	2.935	1.874	24	0.95	1.00	1.00	1.35	1.02	31.5	13	NP	2.5	34.0
28.5	30.0	SM	115	52.6	3.510	2.137	24	1.00	1.00	1.00	1.35	0.98	31.7	10	NP	1.1	32.8
33.5	35.0	SM	115	52.6	4.085	2.400	100	1.00	1.00	1.00	1.35	1.02	137.9	10	NP	1.1	139.1

SPT Test Interval		α	β	r_d	$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	High Overburden Correction C_σ	High Overburden Correction K_α	Age Correction K_{DR}	Static Shear Stress Ratio Correction K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		*dim*	*dim*	*dim*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*				
0.0	2.0																	
2.0	4.0																	
4.0	6.0																	
6.0	8.0																	
8.0	10.0	-0.137	0.016	0.97832	1.46	1.34	0.449	0.292	1.009	0.290	0.064	1.03	1.00	1.00	0.100	2.90	Clay-Like	Full SSL
13.5	15.0	-0.236	0.027	0.96046	2.04	1.60	0.514	0.334	1.054	0.317	0.075	1.02	1.00	1.00	0.089	3.55	Sand-Like	Full SSL
18.5	20.0	-0.348	0.039	0.94052	2.61	1.86	0.554	0.360	1.054	0.341	0.300	1.04	1.00	1.00	--	0.00	Sand-Like	No SSL
23.5	25.0	-0.472	0.053	0.91887	3.19	2.12	0.579	0.376	1.054	0.357	0.218	1.00	1.00	1.00	359.825	0.00	Sand-Like	No SSL
28.5	30.0	-0.604	0.068	0.89587	3.76	2.39	0.593	0.385	1.054	0.365	0.220	0.97	1.00	1.00	153.531	0.00	Sand-Like	No SSL
33.5	35.0	-0.744	0.083	0.87189	4.34	2.65	0.599	0.389	1.054	0.369	-0.091	1.02	1.00	1.00	--	0.00	Sand-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_v	ΔS
ft		*ft*	*dim*	*dim*	*dim*	*dim*	*in*	*in*	*%*	*in*
0.0	2.0									
2.0	4.0									
4.0	6.0									
6.0	8.0									
8.0	10.0									
13.5	15.0	5.0	4.9	0.500	0.923	0.500	30.00	71.74	5.3%	3.17
18.5	20.0									
23.5	25.0									
28.5	30.0									
33.5	35.0									
									S =	3.17

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; $\gamma_{max} = \gamma_{lim}$ if $FS_{liq} \leq F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		*dim*	*dim*	*%*	*deg*	*psf*
0.0	2.0					
2.0	4.0					
4.0	6.0					
6.0	8.0					
8.0	10.0	6.2	0.068			90.4
13.5	15.0	4.9	0.059	--	3.39	
18.5	20.0					
23.5	25.0					
28.5	30.0					
33.5	35.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : Interior Bent 2
Calc. By: JFH
Date: 2/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

Depth to Groundwater =	0.0	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	0.0	ft

Design Event =	FEE
Peak Ground Acceleration, PGA (%g) =	0.14
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.85

B-3

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$	α	β	r_d
ft		dim	pcf	pcf	ksf	ksf	dim	dim	dim	dim	dim	dim	dim	%	dim	dim	dim	dim	dim	dim
0.0	2.0	SM	115	52.6	0.230	0.105	2	0.75	1.00	1.00	1.23	1.70	3.1	16	NP	3.6	6.7	-0.009	0.002	1.00179
2.0	4.0	SM	115	52.6	0.460	0.210	0	0.75	1.00	1.00	1.23	1.70	0.0	15	NP	3.3	3.3	-0.037	0.005	0.99656
4.0	6.0	SM	115	52.6	0.690	0.316	3	0.75	1.00	1.00	1.23	1.70	4.7	26	NP	5.1	9.9	-0.068	0.008	0.9909
6.0	8.0	SM	115	52.6	0.920	0.421	10	0.85	1.00	1.00	1.23	1.70	17.8	26	NP	5.1	23.0	-0.101	0.012	0.98481
8.0	10.0	SM	115	52.6	1.150	0.526	8	0.85	1.00	1.00	1.23	1.70	14.3	32	NP	5.4	19.7	-0.137	0.016	0.97832
13.5	15.0	SM	115	52.6	1.725	0.789	18	0.95	1.00	1.00	1.23	1.41	29.6	15	NP	3.3	32.9	-0.236	0.027	0.96046
18.5	20.0	SP	125	62.6	2.350	1.102	92	0.95	1.00	1.00	1.23	0.99	107.1	10	NP	1.1	108.3	-0.348	0.039	0.94052
23.5	25.0	SP	125	62.6	2.975	1.415	77	0.95	1.00	1.00	1.23	1.02	91.7	10	NP	1.1	92.9	-0.472	0.053	0.91887

SPT Test Interval		$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	High Overburden Correction		Age Correction	Static Shear Stress Ratio Correction				
								C_σ	K_α	K_{DR}	K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		ksf	ksf	dim	dim	dim	dim	dim	dim	dim	dim				
0.0	2.0	0.23	0.11	0.307	0.199	1.054	0.189	0.070	1.10	1.00	1.00	0.111	1.70	Sand-Like	Full SSL
2.0	4.0	0.46	0.21	0.305	0.198	1.054	0.188	0.053	1.10	1.00	1.00	0.085	2.22	Sand-Like	Full SSL
4.0	6.0	0.69	0.32	0.303	0.197	1.054	0.187	0.075	1.10	1.00	1.00	0.149	1.25	Sand-Like	Full SSL
6.0	8.0	0.92	0.42	0.301	0.196	1.054	0.186	0.123	1.10	1.00	1.00	1.730	0.11	Sand-Like	No SSL
8.0	10.0	1.15	0.53	0.299	0.195	1.054	0.185	0.108	1.10	1.00	1.00	0.710	0.26	Sand-Like	No SSL
13.5	15.0	1.73	0.79	0.294	0.191	1.054	0.181	0.199	1.10	1.00	1.00	185.262	0.00	Sand-Like	No SSL
18.5	20.0	2.35	1.10	0.281	0.183	1.054	0.173	-0.134	0.91	1.00	1.00	--	0.00	Sand-Like	No SSL
23.5	25.0	2.98	1.42	0.270	0.176	1.054	0.167	-0.181	0.93	1.00	1.00	--	0.00	Sand-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_V	ΔS
ft		ft	dim	dim	dim	dim	in	in	%	in
0.0	2.0	2.0	6.7	0.500	0.947	0.500	12.00	28.70	4.6%	1.11
2.0	4.0	2.0	3.3	0.500	0.854	0.500	12.00	28.70	6.2%	1.48
4.0	6.0	2.0	9.9	0.480	0.917	0.480	11.53	27.56	3.8%	0.90
6.0	8.0									
8.0	10.0									
13.5	15.0									
18.5	20.0									
23.5	25.0									
									S =	3.49

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; γ_{max} = γ_{lim} if $FS_{liq} \le F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		dim	dim	%	deg	psf
0.0	2.0	6.7	0.071	--	4.07	
2.0	4.0	3.3	0.049	--	2.82	
4.0	6.0	9.9	0.097	--	5.57	
6.0	8.0					
8.0	10.0					
13.5	15.0					
18.5	20.0					
23.5	25.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : Interior Bent 2
Calc. By: JFH
Date: 2/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

F&ME CONSULTANTS

Depth to Groundwater =	0.0	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	0.0	ft

Design Event =	SEE
Peak Ground Acceleration, PGA (%g) =	0.42
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.9

B-3

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$
ft		*dim*	*pcf*	*pcf*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*%*	*dim*	*dim*	*dim*
0.0	2.0	SM	115	52.6	0.230	0.105	2	0.75	1.00	1.00	1.23	1.70	3.1	16	NP	3.6	6.7
2.0	4.0	SM	115	52.6	0.460	0.210	0	0.75	1.00	1.00	1.23	1.70	0.0	15	NP	3.3	3.3
4.0	6.0	SM	115	52.6	0.690	0.316	3	0.75	1.00	1.00	1.23	1.70	4.7	26	NP	5.1	9.9
6.0	8.0	SM	115	52.6	0.920	0.421	10	0.85	1.00	1.00	1.23	1.70	17.8	26	NP	5.1	23.0
8.0	10.0	SM	115	52.6	1.150	0.526	8	0.85	1.00	1.00	1.23	1.70	14.3	32	NP	5.4	19.7
13.5	15.0	SM	115	52.6	1.725	0.789	18	0.95	1.00	1.00	1.23	1.41	29.6	15	NP	3.3	32.9
18.5	20.0	SP	125	62.6	2.350	1.102	92	0.95	1.00	1.00	1.23	0.99	107.1	10	NP	1.1	108.3
23.5	25.0	SP	125	62.6	2.975	1.415	77	0.95	1.00	1.00	1.23	1.02	91.7	10	NP	1.1	92.9

SPT Test Interval		α	β	r_d	$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	High Overburden Correction C_σ	High Overburden Correction K_α	Age Correction K_{DR}	Static Shear Stress Ratio Correction K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		*dim*	*dim*	*dim*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*				
0.0	2.0	-0.009	0.002	1.00179	0.23	0.11	0.920	0.598	1.054	0.567	0.070	1.10	1.00	1.00	0.111	5.10	Sand-Like	Full SSL
2.0	4.0	-0.037	0.005	0.99656	0.46	0.21	0.915	0.595	1.054	0.564	0.053	1.10	1.00	1.00	0.085	6.67	Sand-Like	Full SSL
4.0	6.0	-0.068	0.008	0.9909	0.69	0.32	0.910	0.591	1.054	0.561	0.075	1.10	1.00	1.00	0.149	3.76	Sand-Like	Full SSL
6.0	8.0	-0.101	0.012	0.98481	0.92	0.42	0.904	0.588	1.054	0.557	0.123	1.10	1.00	1.00	1.730	0.32	Sand-Like	No SSL
8.0	10.0	-0.137	0.016	0.97832	1.15	0.53	0.898	0.584	1.054	0.554	0.108	1.10	1.00	1.00	0.710	0.78	Sand-Like	Limited SSL
13.5	15.0	-0.236	0.027	0.96046	1.73	0.79	0.882	0.573	1.054	0.544	0.199	1.10	1.00	1.00	185.262	0.00	Sand-Like	No SSL
18.5	20.0	-0.348	0.039	0.94052	2.35	1.10	0.842	0.548	1.054	0.519	-0.134	0.91	1.00	1.00	--	0.00	Sand-Like	No SSL
23.5	25.0	-0.472	0.053	0.91887	2.98	1.42	0.811	0.527	1.054	0.500	-0.181	0.93	1.00	1.00	--	0.00	Sand-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_v	ΔS
ft		*ft*	*dim*	*dim*	*dim*	*dim*	*in*	*in*	*%*	*in*
0.0	2.0	2.0	6.7	0.500	0.947	0.500	12.00	28.70	4.6%	1.11
2.0	4.0	2.0	3.3	0.500	0.854	0.500	12.00	28.70	6.2%	1.48
4.0	6.0	2.0	9.9	0.480	0.917	0.480	11.53	27.56	3.8%	0.90
6.0	8.0									
8.0	10.0									
13.5	15.0									
18.5	20.0									
23.5	25.0									
									S =	3.49

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; $\gamma_{max} = \gamma_{lim}$ if $FS_{liq} \le F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		*dim*	*dim*	*%*	*deg*	*psf*
0.0	2.0	6.7	0.071	--	4.07	
2.0	4.0	3.3	0.049	--	2.82	
4.0	6.0	9.9	0.097	--	5.57	
6.0	8.0					
8.0	10.0					
13.5	15.0					
18.5	20.0					
23.5	25.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : Interior Bent 3
Calc. By: JFH
Date: 2/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

F&ME CONSULTANTS

Depth to Groundwater =	0.0	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	0.0	ft

Design Event =	FEE
Peak Ground Acceleration, PGA (%g) =	0.14
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.85

B-4

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$	α	β
ft		dim	pcf	pcf	ksf	ksf	dim	dim	dim	dim	dim	dim	dim	%	dim	dim	dim	dim	dim
0.0	2.0	SC	115	52.6	0.230	0.105	6	0.75	1.00	1.00	1.23	1.70	9.4	34	20	5.5	14.9	-0.009	0.002
2.0	4.0	SC	115	52.6	0.460	0.210	11	0.75	1.00	1.00	1.23	1.70	17.3	35	20	5.5	22.8	-0.037	0.005
4.0	6.0	SC	115	52.6	0.690	0.316	18	0.75	1.00	1.00	1.23	1.70	28.3	35	20	5.5	33.8	-0.068	0.008
6.0	8.0	SP	115	52.6	0.920	0.421	25	0.85	1.00	1.00	1.23	1.57	41.2	20	NP	4.5	45.7	-0.101	0.012
8.0	10.0	SP	125	62.6	1.170	0.546	80	0.85	1.00	1.00	1.23	1.07	90.1	15	NP	3.3	93.3	-0.137	0.016
13.5	15.0	SP	125	62.6	1.795	0.859	63	0.95	1.00	1.00	1.23	1.09	80.1	10	NP	1.1	81.2	-0.236	0.027
18.5	20.0	SP	125	62.6	2.420	1.172	81	0.95	1.00	1.00	1.23	1.02	96.4	10	NP	1.1	97.6	-0.348	0.039
23.5	25.0	ML	115	52.6	2.995	1.435	14	0.95	1.00	1.00	1.23	1.16	19.0	69	10	5.5	24.5	-0.472	0.053

SPT Test Interval		r_d	$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	High Overburden Correction C_σ	K_α	Age Correction K_{DR}	Static Shear Stress Ratio Correction K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		dim	ksf	ksf	dim	dim	dim	dim	dim	dim	dim	dim				
0.0	2.0	1.00179	0.23	0.11	0.307	0.199	1.009	0.198	0.090	1.10	1.00	1.00	0.283	0.70	Clay-Like	No SSL
2.0	4.0	0.99656	0.46	0.21	0.305	0.198	1.009	0.197	0.121	1.10	1.00	1.00	1.641	0.12	Clay-Like	No SSL
4.0	6.0	0.9909	0.69	0.32	0.303	0.197	1.009	0.195	0.187	1.10	1.00	1.00	344.259	0.00	Clay-Like	No SSL
6.0	8.0	0.98481	0.92	0.42	0.301	0.196	1.054	0.186	0.300	1.10	1.00	1.00	--	0.00	Sand-Like	No SSL
8.0	10.0	0.97832	1.17	0.55	0.293	0.191	1.054	0.181	-0.189	0.74	1.00	1.00	--	0.00	Sand-Like	No SSL
13.5	15.0	0.96046	1.80	0.86	0.281	0.183	1.054	0.173	-0.255	0.77	1.00	1.00	--	0.00	Sand-Like	No SSL
18.5	20.0	0.94052	2.42	1.17	0.272	0.177	1.054	0.168	-0.163	0.90	1.00	1.00	--	0.00	Sand-Like	No SSL
23.5	25.0	0.91887	3.00	1.44	0.268	0.175	1.009	0.173	0.129	1.05	1.00	1.00	2.781	0.06	Clay-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_V	ΔS
ft		ft	dim	dim	dim	dim	in	in	%	in
0.0	2.0									
2.0	4.0									
4.0	6.0									
6.0	8.0									
8.0	10.0									
13.5	15.0									
18.5	20.0									
23.5	25.0									
									S =	0.00

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; $\gamma_{max} = \gamma_{lim}$ if $FS_{liq} \leq F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		dim	dim	%	deg	psf
0.0	2.0					
2.0	4.0					
4.0	6.0					
6.0	8.0					
8.0	10.0					
13.5	15.0					
18.5	20.0					
23.5	25.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : Interior Bent 3
Calc. By: JFH
Date: 2/5/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

F&ME CONSULTANTS

Depth to Groundwater =	0.0	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	0.0	ft

Design Event =	SEE
Peak Ground Acceleration, PGA (%g) =	0.42
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.9

B-4

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$	α	β	r_d
ft		*dim*	*pcf*	*pcf*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*%*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*
0.0	2.0	SC	115	52.6	0.230	0.105	6	0.75	1.00	1.00	1.23	1.70	9.4	34	20	5.5	14.9	-0.009	0.002	1.00179
2.0	4.0	SC	115	52.6	0.460	0.210	11	0.75	1.00	1.00	1.23	1.70	17.3	35	20	5.5	22.8	-0.037	0.005	0.99656
4.0	6.0	SC	115	52.6	0.690	0.316	18	0.75	1.00	1.00	1.23	1.70	28.3	35	20	5.5	33.8	-0.068	0.008	0.9909
6.0	8.0	SP	115	52.6	0.920	0.421	25	0.85	1.00	1.00	1.23	1.57	41.2	20	NP	4.5	45.7	-0.101	0.012	0.98481
8.0	10.0	SP	125	62.6	1.170	0.546	80	0.85	1.00	1.00	1.23	1.07	90.1	15	NP	3.3	93.3	-0.137	0.016	0.97832
13.5	15.0	SP	125	62.6	1.795	0.859	63	0.95	1.00	1.00	1.23	1.09	80.1	10	NP	1.1	81.2	-0.236	0.027	0.96046
18.5	20.0	SP	125	62.6	2.420	1.172	81	0.95	1.00	1.00	1.23	1.02	96.4	10	NP	1.1	97.6	-0.348	0.039	0.94052
23.5	25.0	ML	115	52.6	2.995	1.435	14	0.95	1.00	1.00	1.23	1.16	19.0	69	10	5.5	24.5	-0.472	0.053	0.91887

SPT Test Interval		$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	High Overburden Correction C_σ	High Overburden Correction K_α	Age Correction K_{DR}	Static Shear Stress Ratio Correction K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*				
0.0	2.0	0.23	0.11	0.920	0.598	1.009	0.593	0.090	1.10	1.00	1.00	0.283	2.09	Clay-Like	Full SSL
2.0	4.0	0.46	0.21	0.915	0.595	1.009	0.590	0.121	1.10	1.00	1.00	1.641	0.36	Clay-Like	No SSL
4.0	6.0	0.69	0.32	0.910	0.591	1.009	0.586	0.187	1.10	1.00	1.00	344.259	0.00	Clay-Like	No SSL
6.0	8.0	0.92	0.42	0.904	0.588	1.054	0.557	0.300	1.10	1.00	1.00	--	0.00	Sand-Like	No SSL
8.0	10.0	1.17	0.55	0.880	0.572	1.054	0.543	-0.189	0.74	1.00	1.00	--	0.00	Sand-Like	No SSL
13.5	15.0	1.80	0.86	0.843	0.548	1.054	0.520	-0.255	0.77	1.00	1.00	--	0.00	Sand-Like	No SSL
18.5	20.0	2.42	1.17	0.816	0.530	1.054	0.503	-0.163	0.90	1.00	1.00	--	0.00	Sand-Like	No SSL
23.5	25.0	3.00	1.44	0.805	0.524	1.009	0.519	0.129	1.05	1.00	1.00	2.781	0.19	Clay-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_v	ΔS
ft		*ft*	*dim*	*dim*	*dim*	*dim*	*in*	*in*	*%*	*in*
0.0	2.0									
2.0	4.0									
4.0	6.0									
6.0	8.0									
8.0	10.0									
13.5	15.0									
18.5	20.0									
23.5	25.0									
									S =	0.00

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; $\gamma_{max} = \gamma_{lim}$ if $FS_{liq} \le F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		*dim*	*dim*	*%*	*deg*	*psf*
0.0	2.0	14.9	0.213			22.4
2.0	4.0					
4.0	6.0					
6.0	8.0					
8.0	10.0					
13.5	15.0					
18.5	20.0					
23.5	25.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : End Bent 4
Calc. By: JFH
Date: 2/2/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

F&ME CONSULTANTS

Depth to Groundwater =	8.5	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	2.0	ft

Design Event =	FEE
Peak Ground Acceleration, PGA (%g) =	0.14
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.85

SPT-4

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$	α	β
ft		*dim*	*pcf*	*pcf*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*%*	*dim*	*dim*	*dim*	*dim*	*dim*
0.0	2.0	SM	125	125	0.250	0.250	15	0.75	1.00	1.00	1.35	1.70	25.8	15	NP	3.3	29.1		
2.0	4.0	SM	125	125	0.500	0.500	6	0.75	1.00	1.00	1.35	1.70	10.3	15	NP	3.3	13.6		
4.0	6.0	SM	125	125	0.750	0.750	1	0.75	1.00	1.00	1.35	1.70	1.7	15	NP	3.3	5.0		
6.0	8.0	SC	115	115	0.980	0.980	1	0.85	1.00	1.00	1.35	1.62	1.9	34	25	5.5	7.3		
8.0	10.0	SM	115	52.6	1.210	1.085	2	0.85	1.00	1.00	1.35	1.48	3.4	33	52	5.5	8.9	-0.137	0.016
13.5	15.0	SM	115	52.6	1.785	1.348	8	0.95	1.00	1.00	1.35	1.22	12.6	20	NP	4.5	17.0	-0.236	0.027
18.5	20.0	SP-SM	115	52.6	2.360	1.611	6	0.95	1.00	1.00	1.35	1.13	8.7	20	NP	4.5	13.2	-0.348	0.039
23.5	25.0	SM	115	52.6	2.935	1.874	24	0.95	1.00	1.00	1.35	1.02	31.5	18	NP	4.1	35.6	-0.472	0.053
28.5	30.0	SM	115	52.6	3.510	2.137	100	1.00	1.00	1.00	1.35	1.01	136.0	14	NP	2.9	138.9	-0.604	0.068
33.5	35.0	SP-SM	115	52.6	4.085	2.400	52	1.00	1.00	1.00	1.35	0.97	68.3	12	NP	2.1	70.4	-0.744	0.083

SPT Test Interval		r_d	$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	High Overburden Correction C_σ	High Overburden Correction K_α	Age Correction K_{DR}	Static Shear Stress Ratio Correction K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		*dim*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*				
0.0	2.0															
2.0	4.0															
4.0	6.0															
6.0	8.0															
8.0	10.0	0.97832	1.46	1.34	0.150	0.097	1.009	0.097	0.070	1.03	1.00	1.00	0.127	0.76	Clay-Like	Limited SSL
13.5	15.0	0.96046	2.04	1.60	0.171	0.111	1.054	0.106	0.101	1.03	1.00	1.00	0.380	0.28	Sand-Like	No SSL
18.5	20.0	0.94052	2.61	1.86	0.185	0.120	1.054	0.114	0.088	1.01	1.00	1.00	0.202	0.56	Sand-Like	No SSL
23.5	25.0	0.91887	3.19	2.12	0.193	0.125	1.054	0.119	0.218	1.00	1.00	1.00	1191.900	0.00	Sand-Like	No SSL
28.5	30.0	0.89587	3.76	2.39	0.198	0.128	1.054	0.122	-0.092	1.01	1.00	1.00	--	0.00	Sand-Like	No SSL
33.5	35.0	0.87189	4.34	2.65	0.200	0.130	1.054	0.123	-0.459	1.10	1.00	1.00	--	0.00	Sand-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_v	ΔS
ft		*ft*	*dim*	*dim*	*dim*	*dim*	*in*	*in*	*%*	*in*
0.0	2.0									
2.0	4.0									
4.0	6.0									
6.0	8.0									
8.0	10.0									
13.5	15.0									
18.5	20.0									
23.5	25.0									
28.5	30.0									
33.5	35.0									
									S =	0.00

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; $\gamma_{max} = \gamma_{lim}$ if $FS_{liq} \le F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		*dim*	*dim*	*%*	*deg*	*psf*
0.0	2.0					
2.0	4.0					
4.0	6.0					
6.0	8.0					
8.0	10.0					
13.5	15.0					
18.5	20.0					
23.5	25.0					
28.5	30.0					
33.5	35.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

F&ME CONSULTANTS

Project: S-51 Bridge over Black Mingo Creek - Soil Shear Loss Calculations
Location : End Bent 4
Calc. By: JFH
Date: 2/2/2016
Method: *SCDOT Geotechnical Design Manual (2010); Chapter 13; Idriss & Boulanger (2008)*

Depth to Groundwater =	8.5	ft

Soil Fill Unit Weight =	125	pcf
Soil Fill Height =	2.0	ft

Design Event =	SEE
Peak Ground Acceleration, PGA (%g) =	0.42
Earthquake Magnitude, M_w =	7.3
Max. RF defining on-set of Liquefaction =	0.9

SPT-4

SPT Test Interval		USCS Desig.	γ	γ'	σ_v	σ'_v	N_{meas}	C_R	C_S	C_B	C_E	C_N	$N^*_{1,60}$	FC	PI	$\Delta N_{1,60}$	$N^*_{1,60,CS}$
ft		*dim*	*pcf*	*pcf*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*%*	*dim*	*dim*	*dim*
0.0	2.0	SM	125	125	0.250	0.250	15	0.75	1.00	1.00	1.35	1.70	25.8	15	NP	3.3	29.1
2.0	4.0	SM	125	125	0.500	0.500	6	0.75	1.00	1.00	1.35	1.70	10.3	15	NP	3.3	13.6
4.0	6.0	SM	125	125	0.750	0.750	1	0.75	1.00	1.00	1.35	1.70	1.7	15	NP	3.3	5.0
6.0	8.0	SC	115	115	0.980	0.980	1	0.85	1.00	1.00	1.35	1.62	1.9	34	25	5.5	7.3
8.0	10.0	SM	115	52.6	1.210	1.085	2	0.85	1.00	1.00	1.35	1.48	3.4	33	52	5.5	8.9
13.5	15.0	SM	115	52.6	1.785	1.348	8	0.95	1.00	1.00	1.35	1.22	12.6	20	NP	4.5	17.0
18.5	20.0	SP-SM	115	52.6	2.360	1.611	6	0.95	1.00	1.00	1.35	1.13	8.7	20	NP	4.5	13.2
23.5	25.0	SM	115	52.6	2.935	1.874	24	0.95	1.00	1.00	1.35	1.02	31.5	18	NP	4.1	35.6
28.5	30.0	SM	115	52.6	3.510	2.137	100	1.00	1.00	1.00	1.35	1.01	136.0	14	NP	2.9	138.9
33.5	35.0	SP-SM	115	52.6	4.085	2.400	52	1.00	1.00	1.00	1.35	0.97	68.3	12	NP	2.1	70.4

SPT Test Interval											High Overburden Correction		Age Correction	Static Shear Stress Ratio Correction				
		α	β	r_d	$\sigma_{v,OB}$	$\sigma'_{v0,OB}$	CSR_{PEAK}	CSR_{eq}	MSF	$CSR_{eq,7.5}$	C_σ	K_α	K_{DR}	K_σ	$CRR^*_{eq,7.5}$	$(D/C)^*_{SL}$	EQ Hazard Desc.	SSL Potential
ft		*dim*	*dim*	*dim*	*ksf*	*ksf*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*	*dim*				
0.0	2.0																	
2.0	4.0																	
4.0	6.0																	
6.0	8.0																	
8.0	10.0	-0.137	0.016	0.97832	1.46	1.34	0.449	0.292	1.009	0.290	0.070	1.03	1.00	1.00	0.127	2.29	Clay-Like	Full SSL
13.5	15.0	-0.236	0.027	0.96046	2.04	1.60	0.514	0.334	1.054	0.317	0.101	1.03	1.00	1.00	0.380	0.83	Sand-Like	Limited SSL
18.5	20.0	-0.348	0.039	0.94052	2.61	1.86	0.554	0.360	1.054	0.341	0.088	1.01	1.00	1.00	0.202	1.69	Sand-Like	Full SSL
23.5	25.0	-0.472	0.053	0.91887	3.19	2.12	0.579	0.376	1.054	0.357	0.218	1.00	1.00	1.00	1191.900	0.00	Sand-Like	No SSL
28.5	30.0	-0.604	0.068	0.89587	3.76	2.39	0.593	0.385	1.054	0.365	-0.092	1.01	1.00	1.00	--	0.00	Sand-Like	No SSL
33.5	35.0	-0.744	0.083	0.87189	4.34	2.65	0.599	0.389	1.054	0.369	-0.459	1.10	1.00	1.00	--	0.00	Sand-Like	No SSL

Liquefaction Induced Displacements

SPT Test Interval		Layer Thickness	$N^*_{1,60,CS}$	γ_{lim}	F_α	γ_{max}	ΔLDI	LD	ε_v	ΔS
ft		*ft*	*dim*	*dim*	*dim*	*dim*	*in*	*in*	*%*	*in*
0.0	2.0									
2.0	4.0									
4.0	6.0									
6.0	8.0									
8.0	10.0									
13.5	15.0									
18.5	20.0	5.0	13.2	0.336	0.824	0.336	20.13	48.15	3.1%	1.89
23.5	25.0									
28.5	30.0									
33.5	35.0									
									S =	1.89

γ_{lim} = Limiting Shear Strain; Limiting shear strain is further limited to 50% of the computed value (Idriss & Boulanger, 2008)
γ_{max} = Maximum Shear Strain; $\gamma_{max} = \gamma_{lim}$ if $FS_{liq} \le F_\alpha$ (Idriss & Boulanger, 2008)
LDI = Lateral Displacement Index
ε_v = Volumetric Strain
S = Liquefaction Induced Vertical Displacement

Residual Soil Strength Parameters

SPT Test Interval		$N^*_{1,60,CS}$	τ_{rl} / σ'_{vo}	R_u	ϕ_{rl}	τ_{rl}
ft		*dim*	*dim*	*%*	*deg*	*psf*
0.0	2.0					
2.0	4.0					
4.0	6.0					
6.0	8.0					
8.0	10.0	8.9	0.088			117.3
13.5	15.0					
18.5	20.0	13.2	0.150	--	8.53	
23.5	25.0					
28.5	30.0					
33.5	35.0					

τ_{rl} / σ'_{vo} = Liquefaction Residual Shear Strength Ratio
R_u = Excess Pore Pressure Ratio
ϕ_{rl} = Internal Friction Angle for Cyclic Liquefaction
τ_{rl} = Liquefaction Residual Shear Strength

APPENDIX

SECTION 10

SOIL SHEAR LOSS CALCULATIONS

SUBSECTION B
CPT METHOD

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

CLiq Output
FEE Event

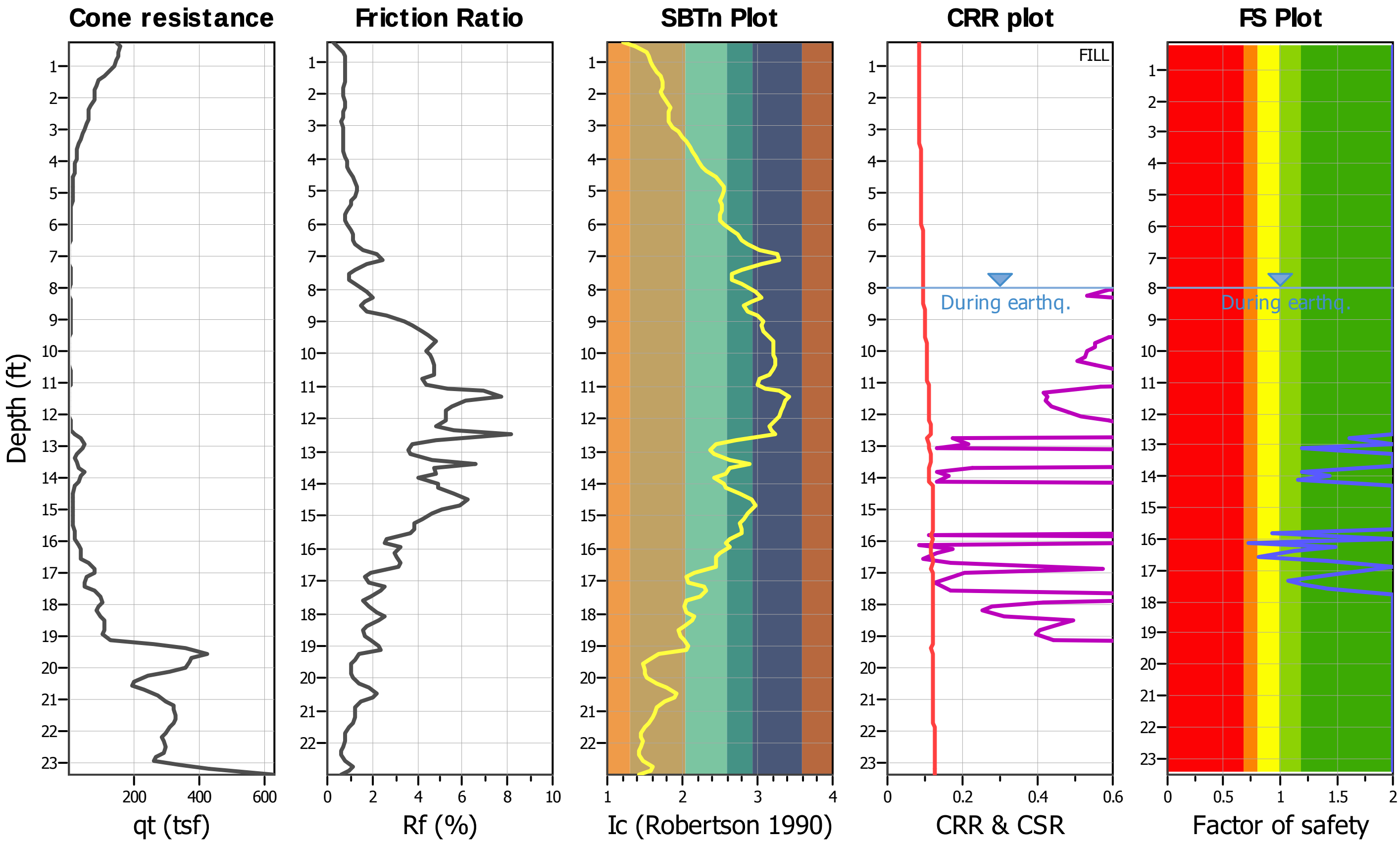
LIQUEFACTION ANALYSIS REPORT

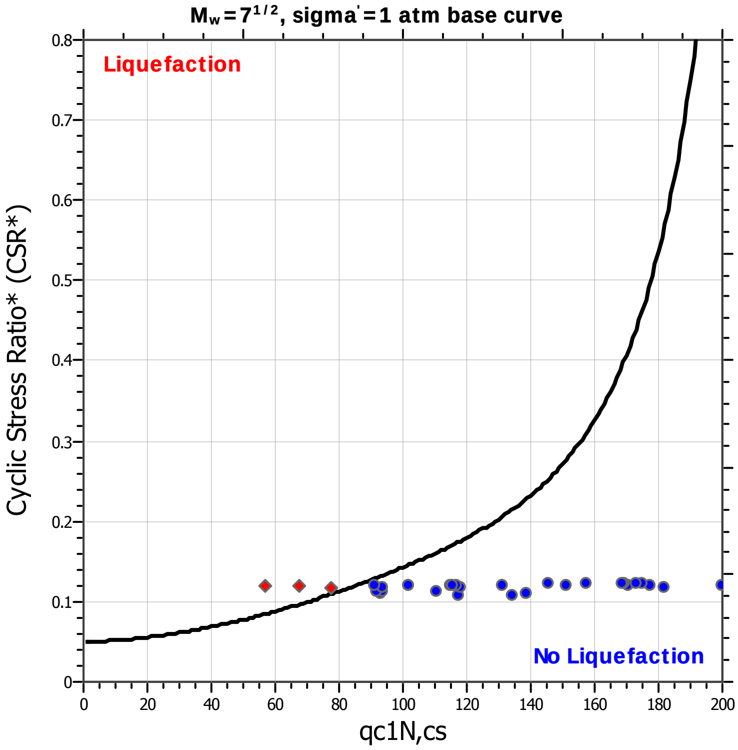
Project title : **Location :**

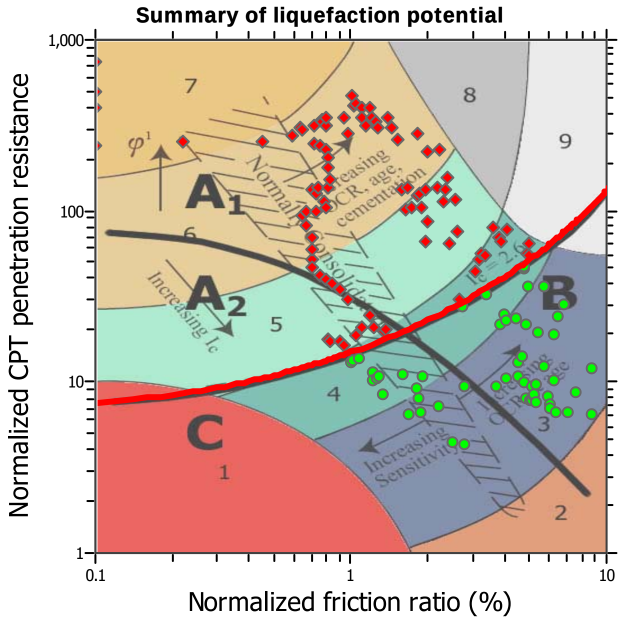
CPT file : CPT2

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.00 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.00 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.14	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

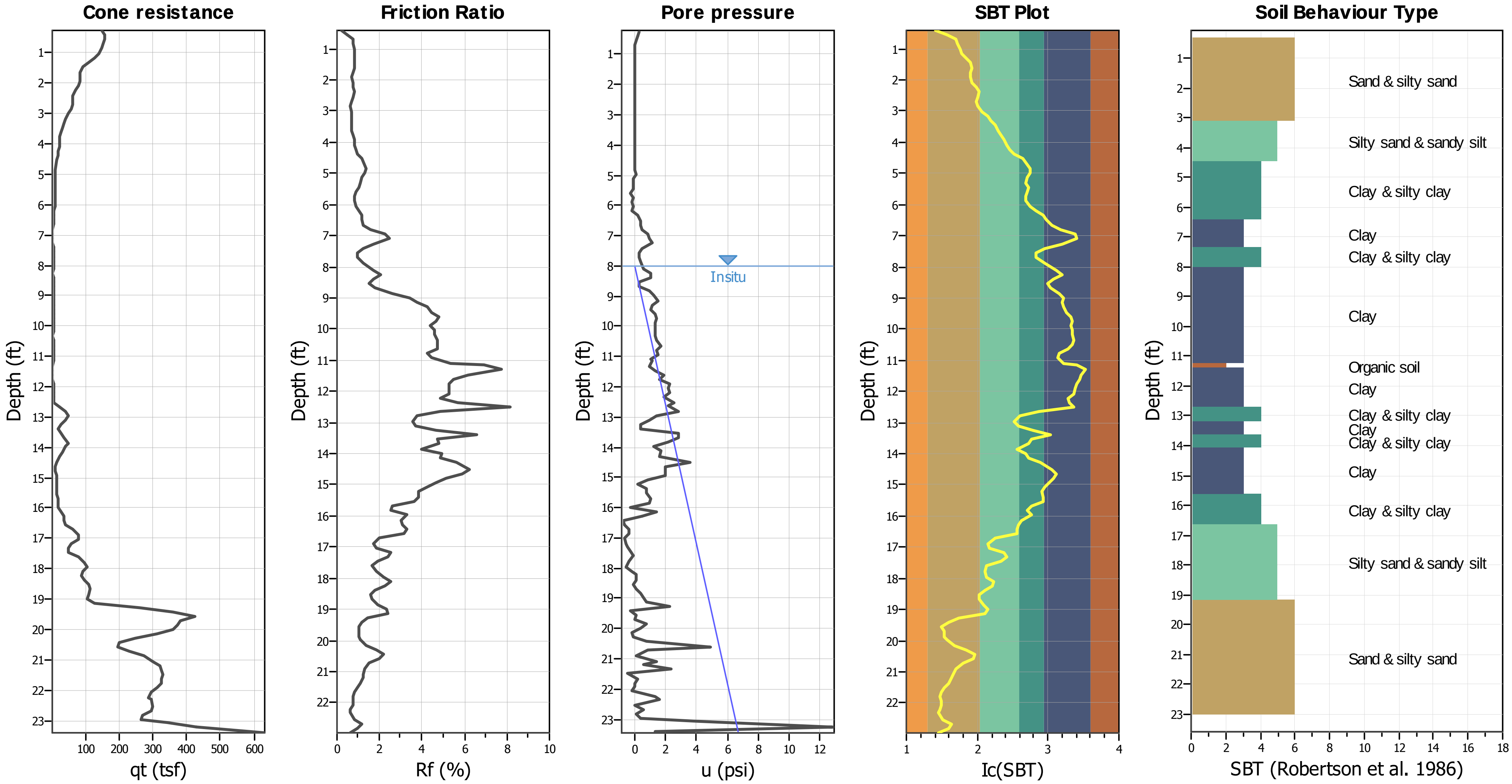






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



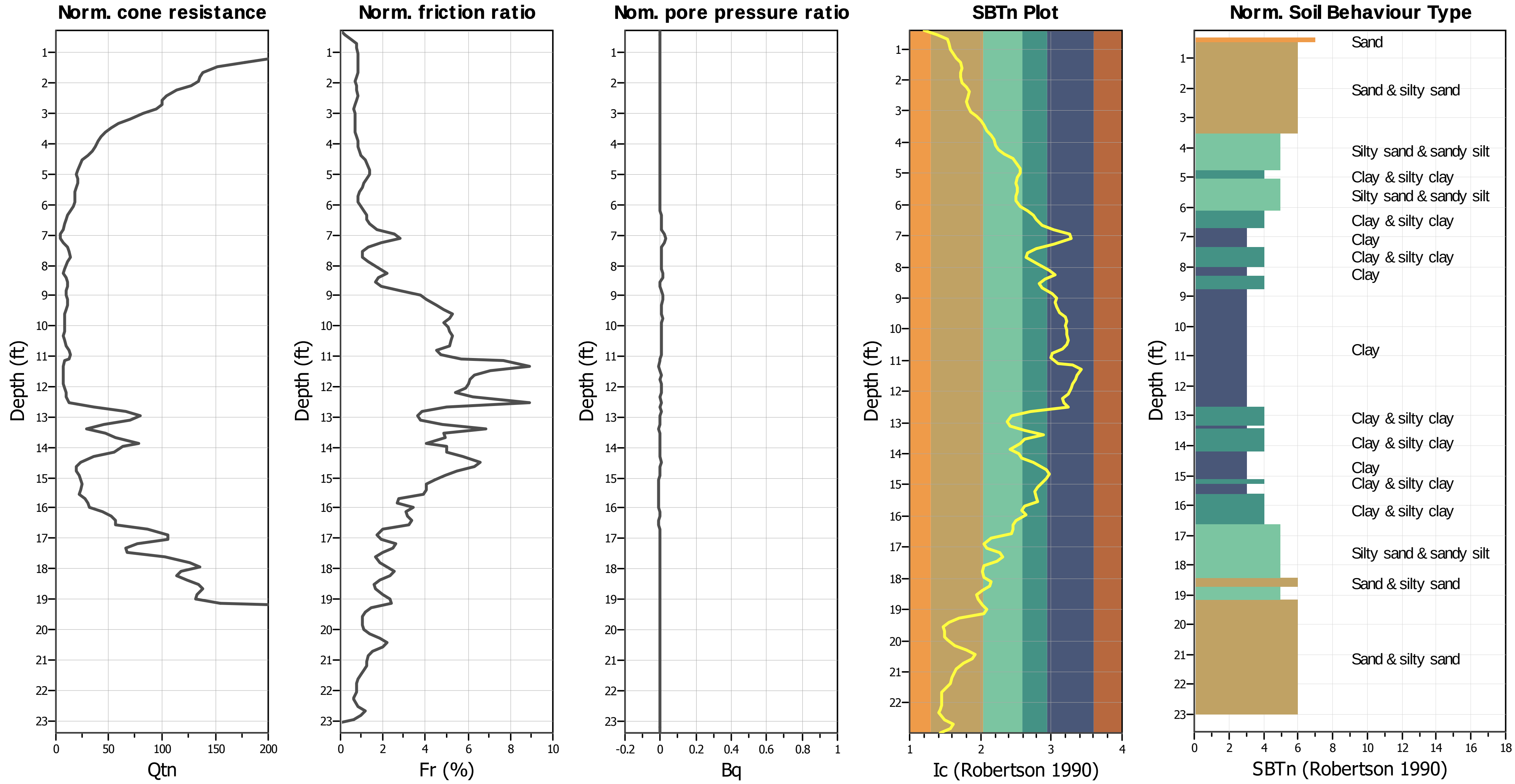
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	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)



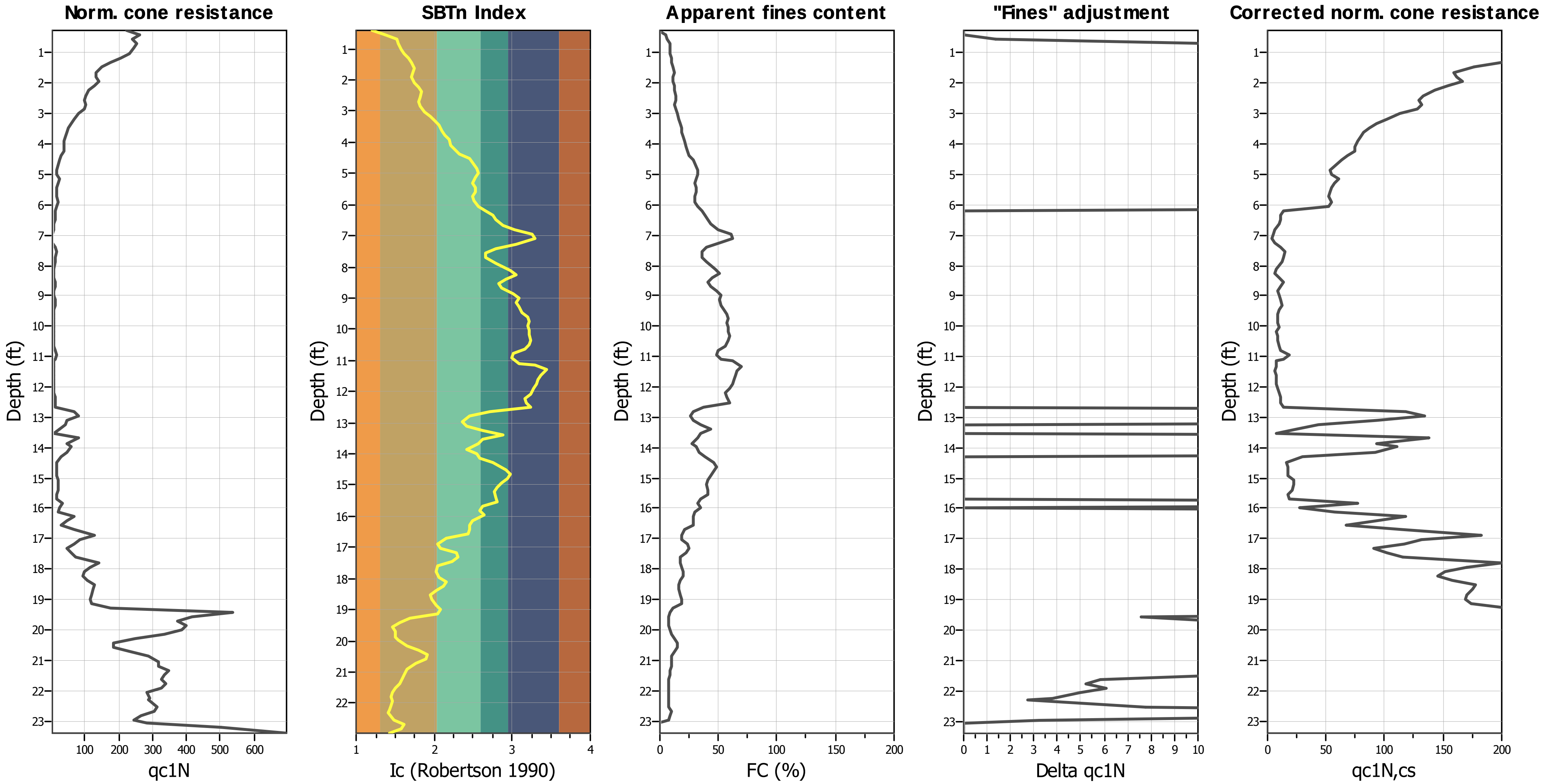
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

SBTn legend

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

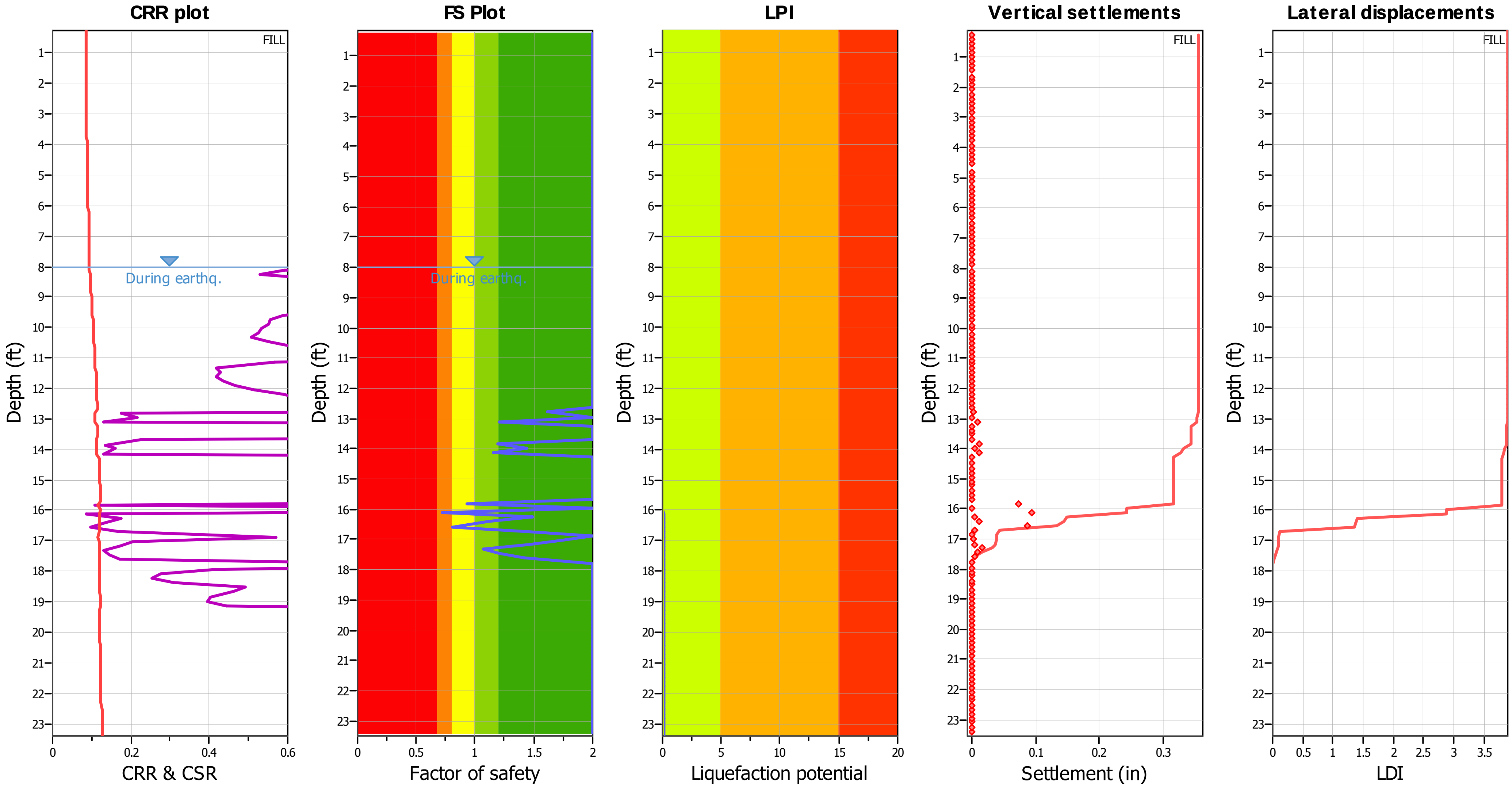
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

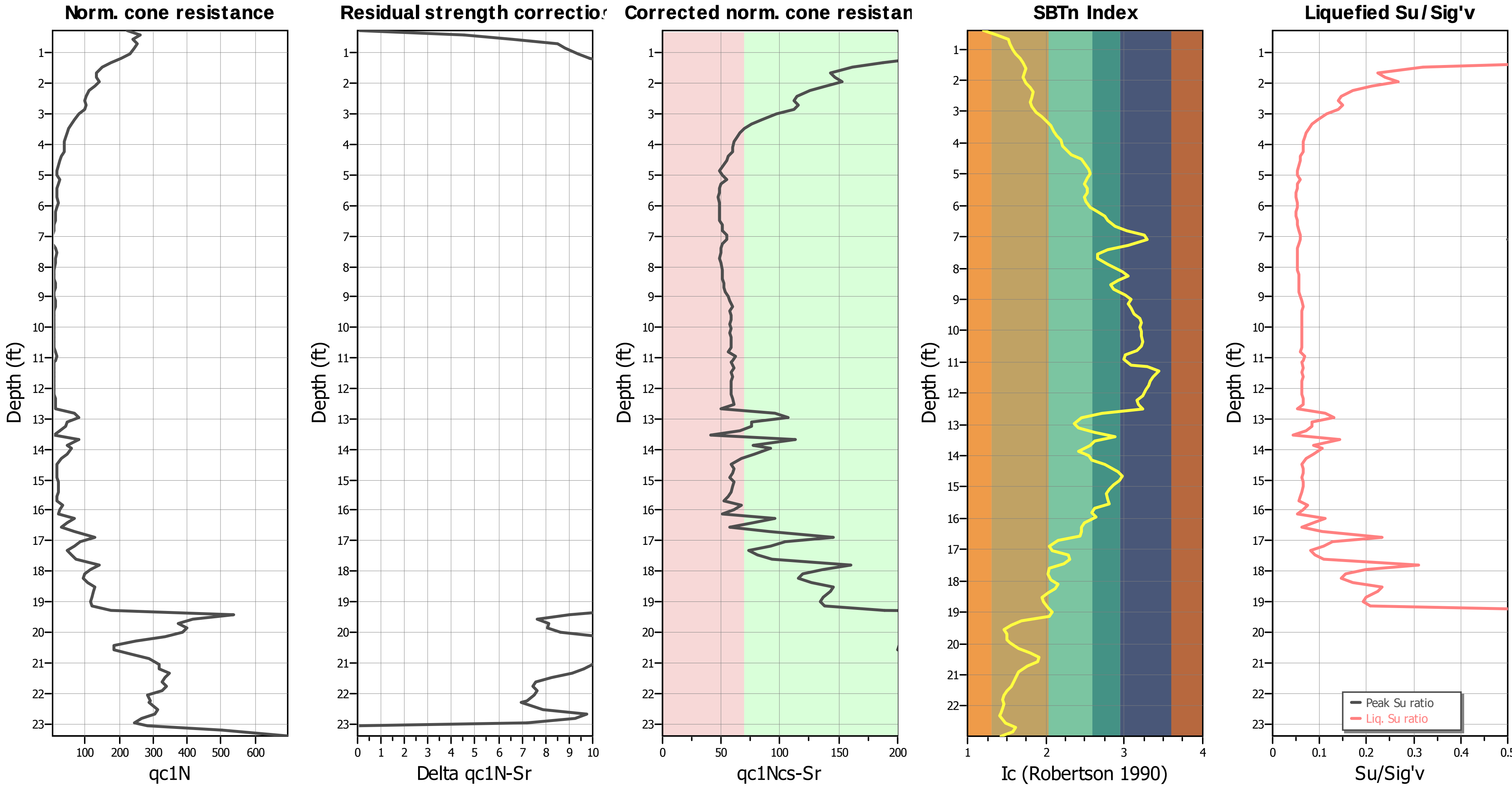
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.26	140.05	0.00	0.29	N/A	87.36
2	0.41	164.19	0.00	0.25	0.00	115.01
3	0.56	150.61	1.06	0.11	1.29	120.11
4	0.70	156.73	1.08	0.06	3.22	123.26
5	0.85	151.03	1.18	-0.01	3.54	123.48
6	1.00	143.07	1.18	0.02	4.09	123.25
7	1.15	129.24	1.04	-0.01	4.65	122.32
8	1.30	110.30	0.88	0.01	5.47	121.06
9	1.44	93.37	0.81	0.01	6.45	119.63
10	1.65	81.72	0.67	0.02	6.95	118.54
11	1.78	84.07	0.62	0.02	6.59	117.66
12	1.92	88.00	0.59	0.02	6.41	117.23
13	2.08	79.29	0.57	0.01	6.96	116.90
14	2.24	69.98	0.57	0.01	8.17	116.34
15	2.39	62.78	0.52	0.01	8.94	115.60
16	2.55	61.18	0.45	0.02	8.71	114.68
17	2.70	63.87	0.40	0.02	8.22	113.87
18	2.84	61.18	0.38	0.01	8.49	113.07
19	3.00	50.96	0.35	0.01	9.74	112.06
20	3.16	42.41	0.30	0.01	11.55	110.67
21	3.31	36.38	0.26	0.01	13.10	109.15
22	3.47	32.02	0.22	0.01	14.47	107.83
23	3.62	28.58	0.20	0.01	15.77	106.89
24	3.77	26.49	0.20	0.01	17.15	106.44
25	3.92	24.81	0.20	0.01	18.47	106.28
26	4.08	23.38	0.20	0.01	19.50	106.11
27	4.23	22.63	0.19	0.01	21.12	105.73
28	4.38	19.03	0.18	0.01	23.50	105.17
29	4.53	16.01	0.18	0.01	28.71	104.31
30	4.84	10.90	0.17	0.02	33.16	103.72
31	4.99	11.82	0.17	0.15	33.44	103.32
32	5.13	15.00	0.16	-0.11	31.53	103.08
33	5.29	12.82	0.15	-0.07	30.61	102.25
34	5.43	11.57	0.12	-0.04	31.94	100.82
35	5.59	11.06	0.09	-0.24	31.63	99.24
36	5.74	10.90	0.08	-0.12	30.46	98.57
37	5.89	11.99	0.09	-0.17	30.81	98.54
38	6.04	10.64	0.09	-0.04	33.35	98.77
39	6.19	8.55	0.10	-0.16	38.16	98.07
40	6.34	7.04	0.08	0.23	43.00	97.25
41	6.50	6.62	0.08	0.40	45.56	96.13
42	6.65	6.20	0.07	0.36	50.72	95.14
43	6.80	4.02	0.07	0.47	60.69	94.22
44	6.95	2.85	0.07	0.83	77.43	93.60
45	7.11	2.51	0.07	0.98	80.21	94.03
46	7.25	3.77	0.08	1.14	61.37	95.26
47	7.41	7.21	0.08	0.48	45.44	96.64
48	7.56	9.47	0.09	0.26	38.19	97.23

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	7.71	8.80	0.08	0.27	38.04	97.34
50	7.87	7.46	0.08	0.44	45.18	96.99
51	8.11	4.69	0.09	0.60	56.67	96.86
52	8.26	3.86	0.10	1.06	61.94	97.19
53	8.40	6.03	0.10	1.04	52.78	98.07
54	8.55	8.47	0.10	0.33	47.26	98.88
55	8.69	7.12	0.12	0.33	49.95	99.97
56	8.84	5.70	0.16	0.92	58.91	101.49
57	8.99	5.95	0.21	1.29	64.07	103.48
58	9.14	6.96	0.28	1.54	62.40	105.29
59	9.29	8.05	0.31	1.19	64.38	106.13
60	9.45	6.03	0.31	1.06	67.18	105.99
61	9.60	5.78	0.28	1.30	72.98	105.08
62	9.74	5.36	0.24	1.43	73.99	104.37
63	9.89	5.20	0.24	1.30	72.88	104.05
64	10.04	5.87	0.24	1.30	74.55	104.08
65	10.19	4.94	0.25	1.38	74.99	104.09
66	10.34	5.11	0.25	1.38	76.52	104.03
67	10.48	5.45	0.24	1.45	73.73	104.80
68	10.64	6.29	0.31	1.74	69.81	106.00
69	10.79	7.38	0.35	1.43	59.66	108.07
70	10.94	11.90	0.43	1.55	58.41	109.18
71	11.09	8.47	0.45	1.10	64.99	109.39
72	11.15	4.36	0.44	1.19	80.42	108.20
73	11.31	5.11	0.36	0.92	92.72	106.42
74	11.46	4.27	0.27	1.30	86.22	105.08
75	11.61	4.78	0.25	1.88	84.13	104.13
76	11.77	4.94	0.25	1.61	81.82	104.26
77	11.91	4.86	0.28	2.27	79.50	104.90
78	12.07	5.78	0.30	2.23	76.20	105.73
79	12.21	6.45	0.32	2.31	70.40	106.46
80	12.36	7.29	0.33	1.93	71.44	108.26
81	12.51	7.21	0.54	2.55	75.72	112.16
82	12.65	9.30	1.08	2.23	41.25	118.56
83	12.80	51.38	1.67	2.87	28.40	122.64
84	12.95	63.53	1.94	1.47	25.18	124.11
85	13.10	36.29	1.76	0.96	27.44	123.08
86	13.26	31.93	1.19	0.38	36.78	120.59
87	13.41	17.85	1.06	0.38	50.98	118.71
88	13.53	4.86	1.36	2.87	36.56	120.92
89	13.69	65.54	1.74	2.81	33.88	123.05
90	13.85	37.55	2.10	2.16	27.09	124.95
91	13.98	47.69	2.20	1.26	32.60	124.31
92	14.14	35.79	1.66	1.72	34.47	122.93
93	14.29	22.04	1.31	1.66	43.46	119.83
94	14.50	11.57	0.92	3.56	53.43	116.68
95	14.65	12.74	0.66	2.02	57.30	114.22
96	14.80	13.16	0.64	1.98	53.98	113.42

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	14.94	12.57	0.67	2.02	50.09	113.60
98	15.09	16.51	0.65	0.84	46.97	113.73
99	15.23	16.60	0.62	0.19	44.10	113.58
100	15.38	15.42	0.59	0.77	45.57	112.88
101	15.53	13.16	0.52	0.81	45.98	111.97
102	15.69	14.16	0.45	1.06	36.77	112.06
103	15.83	27.91	0.48	0.97	34.31	113.19
104	15.98	21.12	0.68	-0.24	37.07	115.23
105	16.12	16.01	0.95	1.39	30.63	118.08
106	16.28	55.74	1.14	0.46	28.65	120.08
107	16.41	39.56	1.35	-0.73	28.59	121.06
108	16.57	22.97	1.36	-0.62	28.05	121.08
109	16.72	58.42	1.13	-0.39	17.68	122.19
110	16.87	112.73	1.32	-0.36	14.40	123.38
111	17.02	72.92	1.71	-0.63	15.22	124.03
112	17.17	58.17	1.52	-0.56	21.72	122.87
113	17.31	40.15	1.14	-0.45	22.82	120.94
114	17.46	48.61	0.87	-0.22	20.27	119.69
115	17.60	63.45	0.93	-0.12	14.21	122.90
116	17.80	129.91	2.10	-0.40	13.64	125.96
117	17.95	105.69	2.49	-0.57	14.48	127.90
118	18.10	87.50	2.42	-0.17	17.24	127.52
119	18.23	84.15	2.10	0.08	16.58	126.51
120	18.39	97.56	1.65	0.15	13.56	125.77
121	18.53	117.51	1.63	-0.12	11.67	125.67
122	18.68	115.08	1.86	0.10	11.96	126.43
123	18.83	107.87	2.16	0.39	13.63	127.25
124	18.98	104.85	2.37	0.58	15.32	128.34
125	19.13	110.13	2.92	0.73	14.34	130.20
126	19.26	166.12	3.79	2.32	5.99	133.55
127	19.41	514.20	4.56	-0.29	3.69	135.27
128	19.56	398.11	4.50	0.07	2.32	135.66
129	19.71	357.21	3.78	0.04	2.85	134.88
130	19.86	385.54	3.68	0.75	2.80	134.47
131	20.00	374.56	3.92	0.36	3.31	134.73
132	20.14	322.01	4.32	-0.15	5.14	134.98
133	20.29	240.71	4.71	-0.03	8.14	134.75
134	20.44	179.28	4.54	0.80	10.85	134.03
135	20.59	178.77	3.95	4.94	10.12	133.10
136	20.73	230.66	3.20	0.84	7.27	132.70
137	20.89	280.36	3.34	0.12	5.26	133.09
138	21.07	312.46	3.89	1.47	4.75	133.84
139	21.21	310.61	3.98	0.63	4.37	134.28
140	21.35	339.19	3.79	2.40	3.81	133.76
141	21.50	327.63	3.03	-0.47	2.98	132.69
142	21.65	320.92	2.48	0.22	2.26	131.45
143	21.79	334.25	2.36	0.01	2.13	131.09
144	21.93	320.59	2.67	-0.02	2.31	130.69

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	22.08	280.02	2.19	-0.14	2.21	129.73
146	22.23	290.75	1.57	1.30	1.94	128.56
147	22.32	286.14	1.79	1.64	1.68	128.66
148	22.54	311.37	2.20	0.06	2.60	130.56
149	22.69	305.67	3.17	0.61	4.49	132.97
150	22.81	266.19	4.65	0.08	3.96	130.96
151	22.96	242.72	0.00	0.36	1.92	127.08
152	23.09	282.96	0.00	4.06	N/A	87.36
153	23.24	502.38	0.00	12.80	N/A	87.36
154	23.40	696.16	0.00	1.33	N/A	87.36

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.26	0.14	0.00	0.14	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
2	2.41	0.15	0.00	0.15	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
3	2.56	0.15	0.00	0.15	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
4	2.70	0.16	0.00	0.16	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
5	2.85	0.17	0.00	0.17	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
6	3.00	0.18	0.00	0.18	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
7	3.15	0.19	0.00	0.19	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
8	3.30	0.20	0.00	0.20	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
9	3.44	0.21	0.00	0.21	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
10	3.65	0.22	0.00	0.22	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
11	3.78	0.23	0.00	0.23	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
12	3.92	0.24	0.00	0.24	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
13	4.08	0.25	0.00	0.25	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
14	4.24	0.25	0.00	0.25	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
15	4.39	0.26	0.00	0.26	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
16	4.55	0.27	0.00	0.27	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
17	4.70	0.28	0.00	0.28	0.99	0.091	1.05	0.086	1.10	1.10	2.000	No
18	4.84	0.29	0.00	0.29	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
19	5.00	0.30	0.00	0.30	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
20	5.16	0.31	0.00	0.31	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
21	5.31	0.32	0.00	0.32	0.99	0.090	1.05	0.086	1.09	1.10	2.000	No
22	5.47	0.32	0.00	0.32	0.99	0.090	1.05	0.086	1.09	1.10	2.000	No
23	5.62	0.33	0.00	0.33	0.99	0.090	1.05	0.086	1.08	1.10	2.000	No
24	5.77	0.34	0.00	0.34	0.99	0.090	1.05	0.086	1.08	1.10	2.000	No
25	5.92	0.35	0.00	0.35	0.99	0.090	1.05	0.086	1.07	1.10	2.000	No
26	6.08	0.36	0.00	0.36	0.99	0.090	1.05	0.086	1.07	1.10	2.000	No
27	6.23	0.36	0.00	0.36	0.99	0.090	1.05	0.085	1.07	1.10	2.000	No
28	6.38	0.37	0.00	0.37	0.99	0.090	1.05	0.085	1.06	1.10	2.000	No
29	6.53	0.38	0.00	0.38	0.99	0.090	1.05	0.085	1.06	1.10	2.000	No
30	6.84	0.40	0.00	0.40	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
31	6.99	0.40	0.00	0.40	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
32	7.13	0.41	0.00	0.41	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
33	7.29	0.42	0.00	0.42	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
34	7.43	0.43	0.00	0.43	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
35	7.59	0.43	0.00	0.43	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
36	7.74	0.44	0.00	0.44	0.99	0.090	1.05	0.085	1.04	1.10	2.000	No
37	7.89	0.45	0.00	0.45	0.99	0.090	1.05	0.085	1.04	1.10	2.000	No
38	8.04	0.46	0.00	0.46	0.98	0.090	1.05	0.085	1.04	1.10	2.000	No
39	8.19	0.46	0.00	0.46	0.98	0.090	1.05	0.085	1.04	1.10	2.000	No
40	8.34	0.47	0.00	0.47	0.98	0.090	1.05	0.085	1.04	1.10	2.000	No
41	8.49	0.48	0.00	0.48	0.98	0.089	1.05	0.085	1.04	1.10	2.000	No
42	8.65	0.49	0.00	0.49	0.98	0.089	1.05	0.085	1.04	1.10	2.000	No
43	8.80	0.49	0.00	0.49	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
44	8.95	0.50	0.00	0.50	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
45	9.11	0.51	0.00	0.51	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
46	9.26	0.51	0.00	0.51	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
47	9.41	0.52	0.00	0.52	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
48	9.56	0.53	0.00	0.53	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	9.71	0.54	0.00	0.54	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
50	9.87	0.54	0.00	0.54	0.98	0.089	1.05	0.084	1.03	1.10	2.000	No
51	10.11	0.56	0.00	0.55	0.98	0.090	1.05	0.085	1.03	1.10	0.095	No
52	10.26	0.56	0.01	0.55	0.98	0.090	1.05	0.086	1.03	1.10	0.096	No
53	10.40	0.57	0.01	0.56	0.98	0.091	1.05	0.086	1.03	1.10	0.096	No
54	10.55	0.58	0.02	0.56	0.98	0.092	1.05	0.087	1.03	1.10	0.097	No
55	10.69	0.58	0.02	0.56	0.98	0.092	1.05	0.087	1.03	1.10	0.098	No
56	10.84	0.59	0.03	0.57	0.98	0.093	1.05	0.088	1.03	1.10	0.099	No
57	10.99	0.60	0.03	0.57	0.97	0.094	1.05	0.089	1.03	1.10	0.099	No
58	11.14	0.61	0.04	0.57	0.97	0.094	1.05	0.089	1.03	1.10	0.100	No
59	11.29	0.62	0.04	0.58	0.97	0.095	1.05	0.090	1.03	1.10	0.101	No
60	11.45	0.62	0.05	0.58	0.97	0.095	1.05	0.091	1.03	1.10	0.101	No
61	11.60	0.63	0.05	0.58	0.97	0.096	1.05	0.091	1.03	1.10	0.102	No
62	11.74	0.64	0.05	0.58	0.97	0.097	1.05	0.092	1.03	1.10	0.103	No
63	11.89	0.65	0.06	0.59	0.97	0.097	1.05	0.092	1.03	1.10	0.103	No
64	12.04	0.65	0.06	0.59	0.97	0.098	1.05	0.093	1.03	1.10	0.104	No
65	12.19	0.66	0.07	0.59	0.97	0.098	1.05	0.093	1.03	1.10	0.105	No
66	12.34	0.67	0.07	0.60	0.97	0.099	1.05	0.094	1.03	1.10	0.105	No
67	12.48	0.68	0.08	0.60	0.97	0.100	1.05	0.094	1.03	1.10	0.106	No
68	12.64	0.69	0.08	0.60	0.97	0.100	1.05	0.095	1.03	1.10	0.107	No
69	12.79	0.69	0.09	0.61	0.97	0.101	1.05	0.096	1.03	1.10	0.107	No
70	12.94	0.70	0.09	0.61	0.97	0.101	1.05	0.096	1.03	1.10	0.107	No
71	13.09	0.71	0.10	0.61	0.97	0.102	1.05	0.097	1.03	1.10	0.108	No
72	13.15	0.71	0.10	0.62	0.97	0.102	1.05	0.097	1.02	1.10	0.109	No
73	13.31	0.72	0.10	0.62	0.97	0.103	1.05	0.097	1.02	1.10	0.109	No
74	13.46	0.73	0.11	0.62	0.97	0.103	1.05	0.098	1.02	1.10	0.110	No
75	13.61	0.74	0.11	0.63	0.97	0.104	1.05	0.098	1.02	1.10	0.111	No
76	13.77	0.75	0.12	0.63	0.97	0.104	1.05	0.099	1.02	1.10	0.111	No
77	13.91	0.75	0.12	0.63	0.96	0.105	1.05	0.099	1.02	1.10	0.112	No
78	14.07	0.76	0.13	0.64	0.96	0.105	1.05	0.100	1.02	1.10	0.112	No
79	14.21	0.77	0.13	0.64	0.96	0.106	1.05	0.100	1.02	1.10	0.113	No
80	14.36	0.78	0.14	0.64	0.96	0.106	1.05	0.101	1.02	1.10	0.113	No
81	14.51	0.79	0.14	0.65	0.96	0.107	1.05	0.101	1.02	1.10	0.114	No
82	14.65	0.79	0.15	0.65	0.96	0.107	1.05	0.102	1.02	1.10	0.114	No
83	14.80	0.80	0.15	0.65	0.96	0.107	1.05	0.102	1.04	1.10	0.108	No
84	14.95	0.81	0.15	0.66	0.96	0.108	1.05	0.102	1.04	1.10	0.108	No
85	15.10	0.82	0.16	0.66	0.96	0.108	1.05	0.103	1.03	1.10	0.109	No
86	15.26	0.83	0.16	0.67	0.96	0.109	1.05	0.103	1.03	1.10	0.115	No
87	15.41	0.84	0.17	0.67	0.96	0.109	1.05	0.104	1.03	1.10	0.116	No
88	15.53	0.85	0.17	0.68	0.96	0.109	1.05	0.104	1.02	1.10	0.117	No
89	15.69	0.86	0.18	0.68	0.96	0.110	1.05	0.104	1.04	1.10	0.110	No
90	15.85	0.87	0.18	0.69	0.96	0.110	1.05	0.105	1.03	1.10	0.112	No
91	15.98	0.88	0.19	0.69	0.96	0.111	1.05	0.105	1.03	1.10	0.112	No
92	16.14	0.89	0.19	0.69	0.96	0.111	1.05	0.105	1.03	1.10	0.113	No
93	16.29	0.89	0.20	0.70	0.96	0.111	1.05	0.106	1.02	1.10	0.119	No
94	16.50	0.91	0.20	0.70	0.95	0.112	1.05	0.106	1.02	1.10	0.120	No
95	16.65	0.92	0.21	0.71	0.95	0.112	1.05	0.106	1.02	1.10	0.120	No
96	16.80	0.92	0.21	0.71	0.95	0.113	1.05	0.107	1.02	1.10	0.120	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
97	16.94	0.93	0.22	0.72	0.95	0.113	1.05	0.107	1.02	1.10	0.121	No
98	17.09	0.94	0.22	0.72	0.95	0.113	1.05	0.107	1.02	1.10	0.121	No
99	17.23	0.95	0.23	0.72	0.95	0.114	1.05	0.108	1.02	1.10	0.121	No
100	17.38	0.96	0.23	0.73	0.95	0.114	1.05	0.108	1.02	1.10	0.122	No
101	17.53	0.97	0.24	0.73	0.95	0.114	1.05	0.108	1.02	1.10	0.122	No
102	17.69	0.97	0.24	0.73	0.95	0.115	1.05	0.109	1.02	1.10	0.123	No
103	17.83	0.98	0.24	0.74	0.95	0.115	1.05	0.109	1.02	1.10	0.117	No
104	17.98	0.99	0.25	0.74	0.95	0.115	1.05	0.109	1.02	1.10	0.123	No
105	18.12	1.00	0.25	0.75	0.95	0.116	1.05	0.110	1.02	1.10	0.118	No
106	18.28	1.01	0.26	0.75	0.95	0.116	1.05	0.110	1.03	1.10	0.118	No
107	18.41	1.02	0.26	0.75	0.95	0.116	1.05	0.110	1.02	1.10	0.118	No
108	18.57	1.03	0.27	0.76	0.95	0.116	1.05	0.110	1.02	1.10	0.119	No
109	18.72	1.04	0.27	0.76	0.95	0.117	1.05	0.111	1.03	1.10	0.119	No
110	18.87	1.05	0.28	0.77	0.95	0.117	1.05	0.111	1.04	1.10	0.117	No
111	19.02	1.05	0.28	0.77	0.94	0.117	1.05	0.111	1.03	1.10	0.119	No
112	19.17	1.06	0.29	0.78	0.94	0.118	1.05	0.111	1.03	1.10	0.120	No
113	19.31	1.07	0.29	0.78	0.94	0.118	1.05	0.112	1.02	1.10	0.120	No
114	19.46	1.08	0.30	0.79	0.94	0.118	1.05	0.112	1.02	1.10	0.120	No
115	19.60	1.09	0.30	0.79	0.94	0.118	1.05	0.112	1.03	1.10	0.120	No
116	19.80	1.10	0.31	0.80	0.94	0.119	1.05	0.112	1.04	1.10	0.119	No
117	19.95	1.11	0.31	0.80	0.94	0.119	1.05	0.113	1.03	1.10	0.120	No
118	20.10	1.12	0.31	0.81	0.94	0.119	1.05	0.113	1.03	1.10	0.121	No
119	20.23	1.13	0.32	0.81	0.94	0.119	1.05	0.113	1.03	1.10	0.121	No
120	20.39	1.14	0.32	0.82	0.94	0.119	1.05	0.113	1.03	1.10	0.121	No
121	20.53	1.15	0.33	0.82	0.94	0.120	1.05	0.113	1.03	1.10	0.121	No
122	20.68	1.16	0.33	0.82	0.94	0.120	1.05	0.114	1.03	1.10	0.121	No
123	20.83	1.17	0.34	0.83	0.94	0.120	1.05	0.114	1.03	1.10	0.122	No
124	20.98	1.18	0.34	0.83	0.94	0.120	1.05	0.114	1.03	1.10	0.122	No
125	21.13	1.19	0.35	0.84	0.94	0.120	1.05	0.114	1.03	1.10	0.122	No
126	21.26	1.20	0.35	0.84	0.94	0.121	1.05	0.114	1.05	1.10	0.120	No
127	21.41	1.21	0.36	0.85	0.93	0.121	1.05	0.114	1.07	1.10	0.118	No
128	21.56	1.22	0.36	0.85	0.93	0.121	1.05	0.115	1.06	1.10	0.118	No
129	21.71	1.23	0.37	0.86	0.93	0.121	1.05	0.115	1.06	1.10	0.119	No
130	21.86	1.24	0.37	0.87	0.93	0.121	1.05	0.115	1.06	1.10	0.119	No
131	22.00	1.24	0.37	0.87	0.93	0.121	1.05	0.115	1.06	1.10	0.120	No
132	22.14	1.25	0.38	0.88	0.93	0.121	1.05	0.115	1.06	1.10	0.120	No
133	22.29	1.26	0.38	0.88	0.93	0.122	1.05	0.115	1.05	1.10	0.120	No
134	22.44	1.27	0.39	0.89	0.93	0.122	1.05	0.115	1.04	1.10	0.122	No
135	22.59	1.28	0.39	0.89	0.93	0.122	1.05	0.116	1.04	1.10	0.122	No
136	22.73	1.29	0.40	0.90	0.93	0.122	1.05	0.116	1.05	1.10	0.121	No
137	22.89	1.30	0.40	0.90	0.93	0.122	1.05	0.116	1.05	1.10	0.122	No
138	23.07	1.32	0.41	0.91	0.93	0.122	1.05	0.116	1.05	1.10	0.122	No
139	23.21	1.33	0.41	0.91	0.93	0.122	1.05	0.116	1.04	1.10	0.122	No
140	23.35	1.34	0.42	0.92	0.93	0.122	1.05	0.116	1.04	1.10	0.123	No
141	23.50	1.35	0.42	0.92	0.93	0.123	1.05	0.116	1.04	1.10	0.123	No
142	23.65	1.36	0.43	0.93	0.92	0.123	1.05	0.116	1.04	1.10	0.123	No
143	23.79	1.36	0.43	0.93	0.92	0.123	1.05	0.117	1.04	1.10	0.124	No
144	23.93	1.37	0.43	0.94	0.92	0.123	1.05	0.117	1.04	1.10	0.124	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
145	24.08	1.38	0.44	0.94	0.92	0.123	1.05	0.117	1.03	1.10	0.124	No
146	24.23	1.39	0.44	0.95	0.92	0.123	1.05	0.117	1.03	1.10	0.124	No
147	24.32	1.40	0.45	0.95	0.92	0.123	1.05	0.117	1.03	1.10	0.125	No
148	24.54	1.41	0.45	0.96	0.92	0.123	1.05	0.117	1.03	1.10	0.125	No
149	24.69	1.42	0.46	0.96	0.92	0.124	1.05	0.117	1.03	1.10	0.125	No
150	24.81	1.43	0.46	0.97	0.92	0.124	1.05	0.117	1.03	1.10	0.126	No
151	24.96	1.44	0.47	0.97	0.92	0.124	1.05	0.117	1.02	1.10	0.126	No
152	25.09	1.45	0.47	0.98	0.92	0.124	1.05	0.118	1.02	1.10	0.126	No
153	25.24	1.45	0.48	0.98	0.92	0.124	1.05	0.118	1.02	1.10	0.127	No
154	25.40	1.46	0.48	0.98	0.92	0.124	1.05	0.118	1.02	1.10	0.127	No

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.26	148.10	-1.00	N/A	0.30	1.70	225.01	0.00	225.01	4.000	No	No	2.00
2	2.41	159.67	4.51	1.20	0.26	1.70	263.80	0.01	263.80	4.000	No	No	2.00
3	2.56	157.18	6.48	1.38	0.28	1.70	241.98	1.34	243.32	4.000	No	No	2.00
4	2.70	152.79	8.41	1.53	0.26	1.70	251.81	10.55	262.36	4.000	No	No	2.00
5	2.85	150.28	8.72	1.55	0.26	1.70	242.65	12.57	255.22	4.000	No	No	2.00
6	3.00	141.11	9.25	1.58	0.27	1.70	229.86	16.21	246.07	4.000	No	No	2.00
7	3.15	127.54	9.77	1.62	0.30	1.70	207.64	19.22	226.86	4.000	No	No	2.00
8	3.30	110.97	10.54	1.66	0.33	1.70	177.21	23.01	200.22	4.000	No	No	2.00
9	3.44	95.13	11.42	1.72	0.36	1.70	150.01	26.72	176.73	4.000	No	No	2.00
10	3.65	86.38	11.88	1.74	0.39	1.70	131.29	27.44	158.73	4.000	No	No	2.00
11	3.78	84.60	11.55	1.72	0.39	1.70	135.06	25.87	160.94	4.000	No	No	2.00
12	3.92	83.79	11.39	1.72	0.38	1.70	141.39	25.55	166.95	4.000	No	No	2.00
13	4.08	79.09	11.88	1.74	0.40	1.70	127.39	26.99	154.38	4.000	No	No	2.00
14	4.24	70.68	12.95	1.80	0.41	1.70	112.44	30.90	143.34	4.000	No	No	2.00
15	4.39	64.65	13.62	1.84	0.43	1.70	100.86	32.30	133.16	4.000	No	No	2.00
16	4.55	62.61	13.42	1.83	0.44	1.70	98.30	30.94	129.24	4.000	No	No	2.00
17	4.70	62.08	13.00	1.80	0.43	1.70	102.61	29.61	132.22	4.000	No	No	2.00
18	4.84	58.67	13.22	1.82	0.44	1.70	98.30	30.02	128.32	4.000	No	No	2.00
19	5.00	51.52	14.30	1.87	0.47	1.70	81.87	31.73	113.61	4.000	No	No	2.00
20	5.16	43.25	15.83	1.95	0.49	1.70	68.14	34.04	102.18	4.000	No	No	2.00
21	5.31	36.93	17.10	2.01	0.51	1.70	58.44	35.08	93.53	4.000	No	No	2.00
22	5.47	32.32	18.21	2.05	0.53	1.70	51.44	35.63	87.07	4.000	No	No	2.00
23	5.62	29.03	19.24	2.10	0.54	1.70	45.92	35.93	81.84	4.000	No	No	2.00
24	5.77	26.63	20.33	2.14	0.55	1.70	42.55	36.52	79.07	4.000	No	No	2.00
25	5.92	24.89	21.35	2.18	0.55	1.70	39.86	36.95	76.81	4.000	No	No	2.00
26	6.08	23.61	22.14	2.21	0.56	1.70	37.57	37.07	74.64	4.000	No	No	2.00
27	6.23	21.68	23.36	2.26	0.56	1.70	36.36	37.77	74.13	4.000	No	No	2.00
28	6.38	19.22	25.14	2.33	0.58	1.70	30.57	37.16	67.73	4.000	No	No	2.00
29	6.53	15.31	28.92	2.45	0.59	1.70	25.72	37.25	62.97	4.000	No	No	2.00
30	6.84	12.91	32.06	2.55	0.63	1.70	17.51	35.29	52.80	4.000	No	No	2.00
31	6.99	12.57	32.25	2.56	0.62	1.70	18.99	35.83	54.82	4.000	No	No	2.00
32	7.13	13.21	30.92	2.52	0.60	1.70	24.10	37.28	61.38	4.000	No	No	2.00
33	7.29	13.13	30.27	2.50	0.62	1.70	20.60	35.94	56.54	4.000	No	No	2.00
34	7.43	11.82	31.21	2.53	0.62	1.70	18.58	35.48	54.07	4.000	No	No	2.00
35	7.59	11.17	30.99	2.52	0.63	1.70	17.78	35.16	52.94	4.000	No	No	2.00
36	7.74	11.31	30.17	2.50	0.63	1.70	17.51	34.87	52.38	4.000	No	No	2.00
37	7.89	11.17	30.42	2.50	0.62	1.70	19.26	35.52	54.78	4.000	No	No	2.00
38	8.04	10.39	32.20	2.56	0.63	1.70	17.10	35.18	52.28	4.000	No	No	2.00
39	8.19	8.74	35.49	2.66	0.65	1.70	13.74	0.00	13.74	4.000	No	Yes	2.00
40	8.34	7.41	38.74	2.75	0.66	1.70	11.31	0.00	11.31	4.000	No	Yes	2.00
41	8.49	6.63	40.43	2.79	0.66	1.70	10.64	0.00	10.64	4.000	No	Yes	2.00
42	8.65	5.62	43.79	2.88	0.66	1.70	9.96	0.00	9.96	4.000	No	Yes	2.00
43	8.80	4.37	50.09	3.03	0.68	1.70	6.46	0.00	6.46	4.000	No	Yes	2.00
44	8.95	3.14	60.27	3.26	0.69	1.70	4.58	0.00	4.58	4.000	No	Yes	2.00
45	9.11	3.06	61.91	3.29	0.70	1.70	4.04	0.00	4.04	4.000	No	Yes	2.00
46	9.26	4.51	50.51	3.04	0.69	1.70	6.06	0.00	6.06	4.000	No	Yes	2.00
47	9.41	6.83	40.36	2.79	0.65	1.70	11.58	0.00	11.58	4.000	No	Yes	2.00
48	9.56	8.50	35.52	2.66	0.64	1.70	15.22	0.00	15.22	4.000	No	Yes	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	9.71	8.58	35.41	2.65	0.64	1.70	14.14	0.00	14.14	4.000	No	Yes	2.00
50	9.87	6.99	40.18	2.79	0.65	1.70	11.98	0.00	11.98	4.000	No	Yes	2.00
51	10.11	5.35	47.57	2.97	0.68	1.70	7.54	0.00	7.54	0.592	No	Yes	2.00
52	10.26	4.87	50.87	3.05	0.68	1.70	6.19	0.00	6.19	0.531	No	Yes	2.00
53	10.40	6.13	45.11	2.91	0.66	1.70	9.70	0.00	9.70	0.676	No	Yes	2.00
54	10.55	7.22	41.54	2.82	0.64	1.70	13.60	0.00	13.60	0.800	No	Yes	2.00
55	10.69	7.10	43.29	2.87	0.66	1.70	11.45	0.00	11.45	0.781	No	Yes	2.00
56	10.84	6.27	48.98	3.01	0.67	1.70	9.16	0.00	9.16	0.677	No	Yes	2.00
57	10.99	6.22	52.19	3.08	0.66	1.70	9.56	0.00	9.56	0.666	No	Yes	2.00
58	11.14	7.00	51.15	3.06	0.66	1.70	11.18	0.00	11.18	0.750	No	Yes	2.00
59	11.29	7.03	52.38	3.08	0.65	1.70	12.93	0.00	12.93	0.747	No	Yes	2.00
60	11.45	6.64	54.09	3.12	0.66	1.70	9.70	0.00	9.70	0.696	No	Yes	2.00
61	11.60	5.75	57.60	3.20	0.67	1.70	9.29	0.00	9.29	0.590	No	Yes	2.00
62	11.74	5.47	58.21	3.21	0.67	1.70	8.62	0.00	8.62	0.554	No	Yes	2.00
63	11.89	5.50	57.55	3.20	0.67	1.70	8.35	0.00	8.35	0.552	No	Yes	2.00
64	12.04	5.36	58.55	3.22	0.67	1.70	9.43	0.00	9.43	0.533	No	Yes	2.00
65	12.19	5.33	58.81	3.23	0.67	1.70	7.94	0.00	7.94	0.525	No	Yes	2.00
66	12.34	5.19	59.72	3.24	0.67	1.70	8.21	0.00	8.21	0.506	No	Yes	2.00
67	12.48	5.64	58.06	3.21	0.67	1.70	8.75	0.00	8.75	0.550	No	Yes	2.00
68	12.64	6.39	55.69	3.16	0.66	1.69	10.04	0.00	10.04	0.626	No	Yes	2.00
69	12.79	8.54	49.45	3.02	0.65	1.67	11.65	0.00	11.65	0.851	No	Yes	2.00
70	12.94	9.27	48.67	3.00	0.62	1.62	18.24	0.00	18.24	0.920	No	Yes	2.00
71	13.09	8.26	52.75	3.09	0.65	1.65	13.16	0.00	13.16	0.807	No	Yes	2.00
72	13.15	5.99	62.03	3.29	0.68	1.69	6.95	0.00	6.95	0.567	No	Yes	2.00
73	13.31	4.60	69.19	3.43	0.67	1.67	8.07	0.00	8.07	0.416	No	Yes	2.00
74	13.46	4.74	65.44	3.36	0.68	1.67	6.76	0.00	6.76	0.428	No	Yes	2.00
75	13.61	4.69	64.22	3.34	0.68	1.66	7.50	0.00	7.50	0.419	No	Yes	2.00
76	13.77	4.89	62.86	3.31	0.68	1.65	7.72	0.00	7.72	0.436	No	Yes	2.00
77	13.91	5.23	61.49	3.28	0.68	1.65	7.56	0.00	7.56	0.466	No	Yes	2.00
78	14.07	5.73	59.54	3.24	0.67	1.63	8.90	0.00	8.90	0.514	No	Yes	2.00
79	14.21	6.54	56.05	3.17	0.66	1.62	9.85	0.00	9.85	0.591	No	Yes	2.00
80	14.36	7.02	56.68	3.18	0.66	1.60	11.03	0.00	11.03	0.633	No	Yes	2.00
81	14.51	7.97	59.25	3.23	0.66	1.59	10.86	0.00	10.86	0.722	No	Yes	2.00
82	14.65	22.67	37.58	2.71	0.64	1.57	13.82	0.00	13.82	2.157	No	Yes	2.00
83	14.80	41.44	28.71	2.45	0.46	1.38	66.89	50.84	117.72	0.175	No	No	1.62
84	14.95	50.43	26.38	2.37	0.43	1.34	80.57	53.99	134.56	0.215	No	No	2.00
85	15.10	43.93	28.02	2.43	0.51	1.42	48.55	44.46	93.01	0.131	No	No	1.20
86	15.26	28.70	34.55	2.63	0.53	1.42	42.92	0.00	42.92	2.653	No	Yes	2.00
87	15.41	18.23	43.95	2.88	0.59	1.48	24.93	0.00	24.93	1.647	No	Yes	2.00
88	15.53	29.45	34.40	2.62	0.68	1.56	7.17	0.00	7.17	2.683	No	Yes	2.00
89	15.69	36.02	32.56	2.57	0.42	1.31	81.34	57.13	138.46	0.227	No	No	2.00
90	15.85	50.29	27.77	2.42	0.51	1.39	49.15	44.54	93.69	0.133	No	No	1.19
91	15.98	40.37	31.67	2.54	0.48	1.35	60.77	49.88	110.65	0.161	No	No	1.44
92	16.14	35.20	32.97	2.58	0.52	1.38	46.59	45.38	91.97	0.130	No	No	1.15
93	16.29	23.17	39.05	2.76	0.57	1.42	29.60	0.00	29.60	2.009	No	Yes	2.00
94	16.50	15.48	45.52	2.92	0.63	1.46	15.99	0.00	15.99	1.305	No	Yes	2.00
95	16.65	12.52	47.97	2.98	0.62	1.45	17.47	0.00	17.47	1.035	No	Yes	2.00
96	16.80	12.85	45.87	2.93	0.62	1.44	17.94	0.00	17.94	1.056	No	Yes	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
97	16.94	14.10	43.38	2.87	0.63	1.44	17.12	0.00	17.12	1.158	No	Yes	2.00
98	17.09	15.24	41.35	2.82	0.60	1.42	22.10	0.00	22.10	1.248	No	Yes	2.00
99	17.23	16.18	39.47	2.77	0.60	1.41	22.14	0.00	22.14	1.321	No	Yes	2.00
100	17.38	15.07	40.44	2.79	0.61	1.41	20.57	0.00	20.57	1.217	No	Yes	2.00
101	17.53	14.26	40.71	2.80	0.62	1.42	17.62	0.00	17.62	1.140	No	Yes	2.00
102	17.69	18.42	34.55	2.63	0.62	1.41	18.85	0.00	18.85	1.483	No	Yes	2.00
103	17.83	21.07	32.86	2.58	0.55	1.35	35.67	41.64	77.31	0.109	No	No	0.93
104	17.98	21.69	34.76	2.63	0.58	1.37	27.35	0.00	27.35	1.736	No	Yes	2.00
105	18.12	30.96	30.29	2.50	0.61	1.39	20.98	36.07	57.05	0.085	No	No	0.71
106	18.28	37.11	28.88	2.45	0.46	1.27	67.12	50.99	118.12	0.176	No	No	1.49
107	18.41	39.42	28.84	2.45	0.51	1.31	48.79	44.89	93.68	0.132	No	No	1.12
108	18.57	40.31	28.45	2.44	0.58	1.35	29.22	38.26	67.48	0.097	No	No	0.81
109	18.72	64.70	20.74	2.16	0.47	1.27	69.91	44.89	114.80	0.169	No	No	1.43
110	18.87	81.35	18.15	2.05	0.35	1.19	127.07	55.01	182.08	0.571	No	No	2.00
111	19.02	81.26	18.80	2.08	0.44	1.24	85.38	45.74	131.12	0.206	No	No	1.73
112	19.17	57.07	23.81	2.28	0.46	1.25	68.77	48.17	116.95	0.173	No	No	1.45
113	19.31	48.97	24.64	2.31	0.52	1.28	48.60	42.55	91.15	0.129	No	No	1.07
114	19.46	50.73	22.72	2.24	0.49	1.26	57.98	43.80	101.77	0.145	No	No	1.21
115	19.60	80.65	17.99	2.05	0.47	1.24	74.45	41.11	115.56	0.170	No	No	1.42
116	19.80	99.68	17.54	2.03	0.33	1.16	142.67	57.05	199.71	1.123	No	No	2.00
117	19.95	107.70	18.21	2.05	0.37	1.18	117.92	52.84	170.76	0.415	No	No	2.00
118	20.10	92.44	20.39	2.15	0.40	1.19	98.74	52.55	151.29	0.277	No	No	2.00
119	20.23	89.74	19.88	2.13	0.41	1.20	95.10	50.57	145.67	0.253	No	No	2.00
120	20.39	99.74	17.47	2.02	0.39	1.18	108.98	48.45	157.43	0.310	No	No	2.00
121	20.53	110.05	15.92	1.95	0.36	1.16	129.29	47.90	177.19	0.493	No	No	2.00
122	20.68	113.49	16.17	1.96	0.36	1.16	126.49	48.23	174.71	0.460	No	No	2.00
123	20.83	109.27	17.53	2.02	0.37	1.16	118.62	51.02	169.65	0.404	No	No	2.00
124	20.98	107.63	18.88	2.08	0.37	1.16	115.07	53.83	168.90	0.397	No	No	2.00
125	21.13	127.05	18.11	2.05	0.37	1.16	120.22	53.13	173.35	0.444	No	No	2.00
126	21.26	263.50	11.01	1.69	0.32	1.13	177.89	26.70	204.59	1.420	No	No	2.00
127	21.41	359.49	8.86	1.56	0.26	1.11	537.09	25.88	562.97	4.000	No	No	2.00
128	21.56	423.17	7.53	1.46	0.26	1.10	415.01	7.56	422.56	4.000	No	No	2.00
129	21.71	380.29	8.05	1.50	0.26	1.10	371.63	10.98	382.61	4.000	No	No	2.00
130	21.86	372.45	7.99	1.50	0.26	1.10	400.32	11.13	411.45	4.000	No	No	2.00
131	22.00	360.71	8.50	1.53	0.26	1.10	388.26	15.71	403.97	4.000	No	No	2.00
132	22.14	312.43	10.23	1.65	0.26	1.09	333.18	32.95	366.13	4.000	No	No	2.00
133	22.29	247.34	12.92	1.80	0.26	1.09	248.58	51.81	300.38	4.000	No	No	2.00
134	22.44	199.62	15.24	1.92	0.28	1.10	185.57	56.78	242.35	4.000	No	No	2.00
135	22.59	196.27	14.62	1.89	0.28	1.09	184.99	53.12	238.11	4.000	No	No	2.00
136	22.73	229.96	12.16	1.76	0.26	1.09	236.91	43.29	280.20	4.000	No	No	2.00
137	22.89	274.50	10.35	1.65	0.26	1.08	287.41	30.54	317.96	4.000	No	No	2.00
138	23.07	301.15	9.87	1.62	0.26	1.08	319.61	27.69	347.31	4.000	No	No	2.00
139	23.21	320.78	9.51	1.60	0.26	1.08	317.20	23.54	340.74	4.000	No	No	2.00
140	23.35	325.82	8.98	1.57	0.26	1.08	345.79	19.24	365.03	4.000	No	No	2.00
141	23.50	329.26	8.17	1.51	0.26	1.08	333.42	11.04	344.46	4.000	No	No	2.00
142	23.65	327.60	7.47	1.46	0.26	1.07	326.04	5.85	331.89	4.000	No	No	2.00
143	23.79	325.25	7.33	1.45	0.26	1.07	339.05	5.25	344.30	4.000	No	No	2.00
144	23.93	311.62	7.51	1.46	0.26	1.07	324.70	6.10	330.80	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
145	24.08	297.13	7.41	1.45	0.26	1.07	283.15	4.97	288.12	4.000	No	No	2.00
146	24.23	285.65	7.14	1.43	0.26	1.07	293.52	3.78	297.29	4.000	No	No	2.00
147	24.32	296.10	6.88	1.41	0.26	1.07	288.59	2.70	291.29	4.000	No	No	2.00
148	24.54	301.07	7.80	1.48	0.26	1.06	313.31	7.77	321.08	4.000	No	No	2.00
149	24.69	294.41	9.63	1.61	0.26	1.06	307.06	24.15	331.21	4.000	No	No	2.00
150	24.81	271.53	9.12	1.58	0.26	1.06	267.04	16.98	284.02	4.000	No	No	2.00
151	24.96	263.98	7.12	1.43	0.27	1.06	243.59	3.22	246.80	4.000	No	No	2.00
152	25.09	342.77	-1.00	N/A	0.26	1.06	283.29	0.00	283.29	4.000	No	No	2.00
153	25.24	429.38	-1.00	N/A	0.26	1.06	502.69	0.00	502.69	4.000	No	No	2.00
154	25.40	631.64	-1.00	N/A	0.26	1.06	696.14	0.00	696.14	4.000	No	No	2.00

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.26	2.00	0.00	9.66	0.15	0.00	2.41	2.00	0.00	9.63	0.15	0.00
2.56	2.00	0.00	9.61	0.15	0.00	2.70	2.00	0.00	9.59	0.14	0.00
2.85	2.00	0.00	9.57	0.15	0.00	3.00	2.00	0.00	9.54	0.15	0.00
3.15	2.00	0.00	9.52	0.15	0.00	3.30	2.00	0.00	9.50	0.15	0.00
3.44	2.00	0.00	9.48	0.14	0.00	3.65	2.00	0.00	9.44	0.21	0.00
3.78	2.00	0.00	9.42	0.14	0.00	3.92	2.00	0.00	9.40	0.13	0.00
4.08	2.00	0.00	9.38	0.16	0.00	4.24	2.00	0.00	9.35	0.16	0.00
4.39	2.00	0.00	9.33	0.15	0.00	4.55	2.00	0.00	9.31	0.15	0.00
4.70	2.00	0.00	9.28	0.15	0.00	4.84	2.00	0.00	9.26	0.14	0.00
5.00	2.00	0.00	9.24	0.17	0.00	5.16	2.00	0.00	9.21	0.16	0.00
5.31	2.00	0.00	9.19	0.15	0.00	5.47	2.00	0.00	9.17	0.16	0.00
5.62	2.00	0.00	9.14	0.15	0.00	5.77	2.00	0.00	9.12	0.15	0.00
5.92	2.00	0.00	9.10	0.15	0.00	6.08	2.00	0.00	9.07	0.15	0.00
6.23	2.00	0.00	9.05	0.15	0.00	6.38	2.00	0.00	9.03	0.15	0.00
6.53	2.00	0.00	9.00	0.15	0.00	6.84	2.00	0.00	8.96	0.31	0.00
6.99	2.00	0.00	8.93	0.15	0.00	7.13	2.00	0.00	8.91	0.14	0.00
7.29	2.00	0.00	8.89	0.15	0.00	7.43	2.00	0.00	8.87	0.14	0.00
7.59	2.00	0.00	8.84	0.16	0.00	7.74	2.00	0.00	8.82	0.15	0.00
7.89	2.00	0.00	8.80	0.15	0.00	8.04	2.00	0.00	8.77	0.15	0.00
8.19	2.00	0.00	8.75	0.15	0.00	8.34	2.00	0.00	8.73	0.15	0.00
8.49	2.00	0.00	8.71	0.15	0.00	8.65	2.00	0.00	8.68	0.15	0.00
8.80	2.00	0.00	8.66	0.15	0.00	8.95	2.00	0.00	8.64	0.15	0.00
9.11	2.00	0.00	8.61	0.15	0.00	9.26	2.00	0.00	8.59	0.15	0.00
9.41	2.00	0.00	8.57	0.16	0.00	9.56	2.00	0.00	8.54	0.15	0.00
9.71	2.00	0.00	8.52	0.15	0.00	9.87	2.00	0.00	8.50	0.15	0.00
10.11	2.00	0.00	8.46	0.24	0.00	10.26	2.00	0.00	8.44	0.15	0.00
10.40	2.00	0.00	8.42	0.14	0.00	10.55	2.00	0.00	8.39	0.15	0.00
10.69	2.00	0.00	8.37	0.14	0.00	10.84	2.00	0.00	8.35	0.15	0.00
10.99	2.00	0.00	8.32	0.15	0.00	11.14	2.00	0.00	8.30	0.15	0.00
11.29	2.00	0.00	8.28	0.15	0.00	11.45	2.00	0.00	8.26	0.15	0.00
11.60	2.00	0.00	8.23	0.15	0.00	11.74	2.00	0.00	8.21	0.15	0.00
11.89	2.00	0.00	8.19	0.15	0.00	12.04	2.00	0.00	8.17	0.14	0.00
12.19	2.00	0.00	8.14	0.15	0.00	12.34	2.00	0.00	8.12	0.15	0.00
12.48	2.00	0.00	8.10	0.15	0.00	12.64	2.00	0.00	8.07	0.16	0.00
12.79	2.00	0.00	8.05	0.15	0.00	12.94	2.00	0.00	8.03	0.15	0.00
13.09	2.00	0.00	8.00	0.15	0.00	13.15	2.00	0.00	8.00	0.06	0.00
13.31	2.00	0.00	7.97	0.16	0.00	13.46	2.00	0.00	7.95	0.15	0.00
13.61	2.00	0.00	7.93	0.15	0.00	13.77	2.00	0.00	7.90	0.15	0.00
13.91	2.00	0.00	7.88	0.15	0.00	14.07	2.00	0.00	7.86	0.15	0.00
14.21	2.00	0.00	7.83	0.15	0.00	14.36	2.00	0.00	7.81	0.14	0.00
14.51	2.00	0.00	7.79	0.15	0.00	14.65	2.00	0.00	7.77	0.14	0.00
14.80	1.62	0.00	7.74	0.15	0.00	14.95	2.00	0.00	7.72	0.15	0.00
15.10	1.20	0.00	7.70	0.15	0.00	15.26	2.00	0.00	7.68	0.15	0.00
15.41	2.00	0.00	7.65	0.15	0.00	15.53	2.00	0.00	7.63	0.12	0.00
15.69	2.00	0.00	7.61	0.16	0.00	15.85	1.19	0.00	7.58	0.16	0.00
15.98	1.44	0.00	7.56	0.14	0.00	16.14	1.15	0.00	7.54	0.15	0.00
16.29	2.00	0.00	7.52	0.15	0.00	16.50	2.00	0.00	7.49	0.21	0.00
16.65	2.00	0.00	7.46	0.15	0.00	16.80	2.00	0.00	7.44	0.15	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
16.94	2.00	0.00	7.42	0.14	0.00	17.09	2.00	0.00	7.40	0.15	0.00
17.23	2.00	0.00	7.37	0.14	0.00	17.38	2.00	0.00	7.35	0.16	0.00
17.53	2.00	0.00	7.33	0.15	0.00	17.69	2.00	0.00	7.30	0.15	0.00
17.83	0.93	0.07	7.28	0.15	0.02	17.98	2.00	0.00	7.26	0.15	0.00
18.12	0.71	0.29	7.24	0.14	0.09	18.28	1.49	0.00	7.21	0.15	0.00
18.41	1.12	0.00	7.19	0.14	0.00	18.57	0.81	0.19	7.17	0.16	0.06
18.72	1.43	0.00	7.15	0.15	0.00	18.87	2.00	0.00	7.12	0.15	0.00
19.02	1.73	0.00	7.10	0.15	0.00	19.17	1.45	0.00	7.08	0.15	0.00
19.31	1.07	0.00	7.06	0.13	0.00	19.46	1.21	0.00	7.03	0.15	0.00
19.60	1.42	0.00	7.01	0.14	0.00	19.80	2.00	0.00	6.98	0.19	0.00
19.95	2.00	0.00	6.96	0.15	0.00	20.10	2.00	0.00	6.94	0.15	0.00
20.23	2.00	0.00	6.92	0.13	0.00	20.39	2.00	0.00	6.89	0.16	0.00
20.53	2.00	0.00	6.87	0.14	0.00	20.68	2.00	0.00	6.85	0.15	0.00
20.83	2.00	0.00	6.83	0.15	0.00	20.98	2.00	0.00	6.80	0.15	0.00
21.13	2.00	0.00	6.78	0.15	0.00	21.26	2.00	0.00	6.76	0.13	0.00
21.41	2.00	0.00	6.74	0.15	0.00	21.56	2.00	0.00	6.71	0.15	0.00
21.71	2.00	0.00	6.69	0.15	0.00	21.86	2.00	0.00	6.67	0.15	0.00
22.00	2.00	0.00	6.65	0.13	0.00	22.14	2.00	0.00	6.63	0.14	0.00
22.29	2.00	0.00	6.60	0.15	0.00	22.44	2.00	0.00	6.58	0.15	0.00
22.59	2.00	0.00	6.56	0.15	0.00	22.73	2.00	0.00	6.54	0.14	0.00
22.89	2.00	0.00	6.51	0.16	0.00	23.07	2.00	0.00	6.48	0.18	0.00
23.21	2.00	0.00	6.46	0.14	0.00	23.35	2.00	0.00	6.44	0.14	0.00
23.50	2.00	0.00	6.42	0.15	0.00	23.65	2.00	0.00	6.40	0.15	0.00
23.79	2.00	0.00	6.37	0.14	0.00	23.93	2.00	0.00	6.35	0.14	0.00
24.08	2.00	0.00	6.33	0.15	0.00	24.23	2.00	0.00	6.31	0.15	0.00
24.32	2.00	0.00	6.29	0.09	0.00	24.54	2.00	0.00	6.26	0.21	0.00
24.69	2.00	0.00	6.24	0.15	0.00	24.81	2.00	0.00	6.22	0.13	0.00
24.96	2.00	0.00	6.20	0.15	0.00	25.09	2.00	0.00	6.18	0.13	0.00
25.24	2.00	0.00	6.15	0.15	0.00	25.40	2.00	0.00	6.13	0.17	0.00

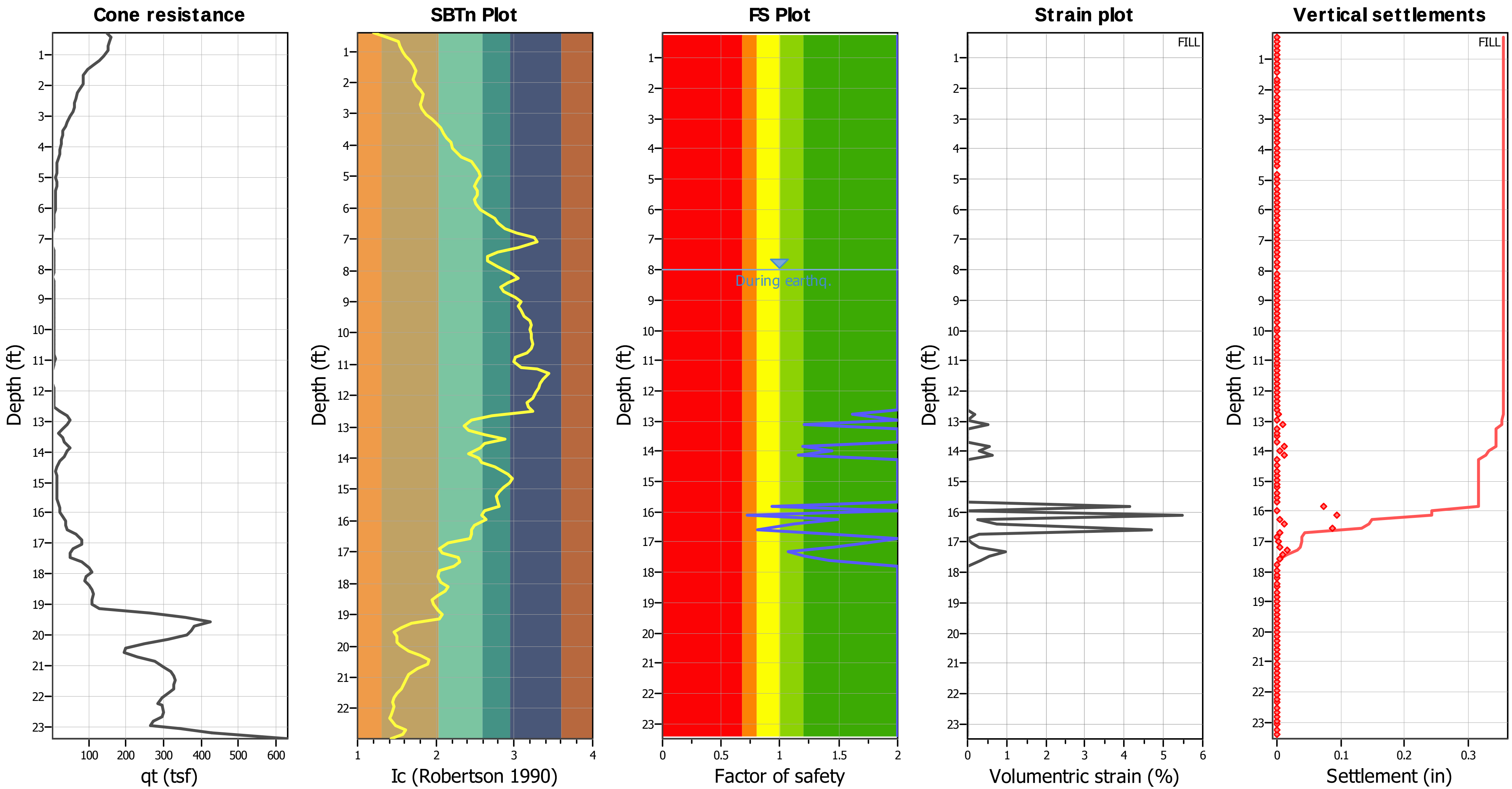
Overall liquefaction potential: 0.18

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.11	7.54	2.00	0.00	1.00	0.00	10.26	6.19	2.00	0.00	1.00	0.00
10.40	9.70	2.00	0.00	1.00	0.00	10.55	13.60	2.00	0.00	1.00	0.00
10.69	11.45	2.00	0.00	1.00	0.00	10.84	9.16	2.00	0.00	1.00	0.00
10.99	9.56	2.00	0.00	1.00	0.00	11.14	11.18	2.00	0.00	1.00	0.00
11.29	12.93	2.00	0.00	1.00	0.00	11.45	9.70	2.00	0.00	1.00	0.00
11.60	9.29	2.00	0.00	1.00	0.00	11.74	8.62	2.00	0.00	1.00	0.00
11.89	8.35	2.00	0.00	1.00	0.00	12.04	9.43	2.00	0.00	1.00	0.00
12.19	7.94	2.00	0.00	1.00	0.00	12.34	8.21	2.00	0.00	1.00	0.00
12.48	8.75	2.00	0.00	1.00	0.00	12.64	10.04	2.00	0.00	1.00	0.00
12.79	11.65	2.00	0.00	1.00	0.00	12.94	18.24	2.00	0.00	1.00	0.00
13.09	13.16	2.00	0.00	1.00	0.00	13.15	6.95	2.00	0.00	1.00	0.00
13.31	8.07	2.00	0.00	1.00	0.00	13.46	6.76	2.00	0.00	1.00	0.00
13.61	7.50	2.00	0.00	1.00	0.00	13.77	7.72	2.00	0.00	1.00	0.00
13.91	7.56	2.00	0.00	1.00	0.00	14.07	8.90	2.00	0.00	1.00	0.00
14.21	9.85	2.00	0.00	1.00	0.00	14.36	11.03	2.00	0.00	1.00	0.00
14.51	10.86	2.00	0.00	1.00	0.00	14.65	13.82	2.00	0.00	1.00	0.00
14.80	117.72	1.62	0.17	1.00	0.00	14.95	134.56	2.00	0.00	1.00	0.00
15.10	93.01	1.20	0.53	1.00	0.01	15.26	42.92	2.00	0.00	1.00	0.00
15.41	24.93	2.00	0.00	1.00	0.00	15.53	7.17	2.00	0.00	1.00	0.00
15.69	138.46	2.00	0.00	1.00	0.00	15.85	93.69	1.19	0.56	1.00	0.01
15.98	110.65	1.44	0.29	1.00	0.00	16.14	91.97	1.15	0.63	1.00	0.01
16.29	29.60	2.00	0.00	1.00	0.00	16.50	15.99	2.00	0.00	1.00	0.00
16.65	17.47	2.00	0.00	1.00	0.00	16.80	17.94	2.00	0.00	1.00	0.00
16.94	17.12	2.00	0.00	1.00	0.00	17.09	22.10	2.00	0.00	1.00	0.00
17.23	22.14	2.00	0.00	1.00	0.00	17.38	20.57	2.00	0.00	1.00	0.00
17.53	17.62	2.00	0.00	1.00	0.00	17.69	18.85	2.00	0.00	1.00	0.00
17.83	77.31	0.93	4.14	1.00	0.07	17.98	27.35	2.00	0.00	1.00	0.00
18.12	57.05	0.71	5.47	1.00	0.09	18.28	118.12	1.49	0.26	1.00	0.00
18.41	93.68	1.12	0.76	1.00	0.01	18.57	67.48	0.81	4.71	1.00	0.09
18.72	114.80	1.43	0.31	1.00	0.01	18.87	182.08	2.00	0.00	1.00	0.00
19.02	131.12	1.73	0.12	1.00	0.00	19.17	116.95	1.45	0.29	1.00	0.01
19.31	91.15	1.07	0.97	1.00	0.02	19.46	101.77	1.21	0.56	1.00	0.01
19.60	115.56	1.42	0.32	1.00	0.01	19.80	199.71	2.00	0.00	1.00	0.00
19.95	170.76	2.00	0.00	1.00	0.00	20.10	151.29	2.00	0.00	1.00	0.00
20.23	145.67	2.00	0.00	1.00	0.00	20.39	157.43	2.00	0.00	1.00	0.00
20.53	177.19	2.00	0.00	1.00	0.00	20.68	174.71	2.00	0.00	1.00	0.00
20.83	169.65	2.00	0.00	1.00	0.00	20.98	168.90	2.00	0.00	1.00	0.00
21.13	173.35	2.00	0.00	1.00	0.00	21.26	204.59	2.00	0.00	1.00	0.00
21.41	562.97	2.00	0.00	1.00	0.00	21.56	422.56	2.00	0.00	1.00	0.00
21.71	382.61	2.00	0.00	1.00	0.00	21.86	411.45	2.00	0.00	1.00	0.00
22.00	403.97	2.00	0.00	1.00	0.00	22.14	366.13	2.00	0.00	1.00	0.00
22.29	300.38	2.00	0.00	1.00	0.00	22.44	242.35	2.00	0.00	1.00	0.00
22.59	238.11	2.00	0.00	1.00	0.00	22.73	280.20	2.00	0.00	1.00	0.00
22.89	317.96	2.00	0.00	1.00	0.00	23.07	347.31	2.00	0.00	1.00	0.00
23.21	340.74	2.00	0.00	1.00	0.00	23.35	365.03	2.00	0.00	1.00	0.00
23.50	344.46	2.00	0.00	1.00	0.00	23.65	331.89	2.00	0.00	1.00	0.00
23.79	344.30	2.00	0.00	1.00	0.00	23.93	330.80	2.00	0.00	1.00	0.00
24.08	288.12	2.00	0.00	1.00	0.00	24.23	297.29	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

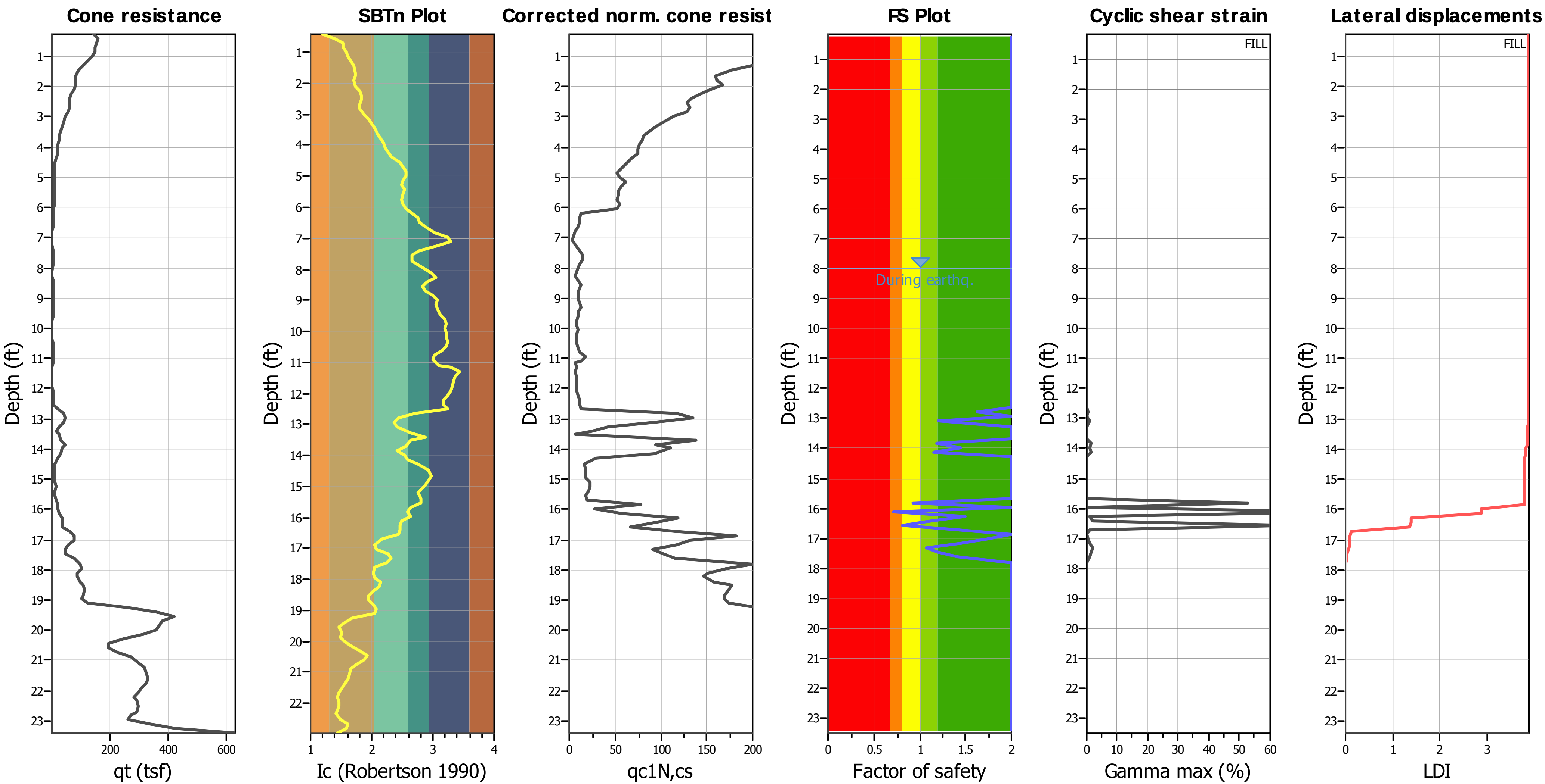
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
24.32	291.29	2.00	0.00	1.00	0.00	24.54	321.08	2.00	0.00	1.00	0.00
24.69	331.21	2.00	0.00	1.00	0.00	24.81	284.02	2.00	0.00	1.00	0.00
24.96	246.80	2.00	0.00	1.00	0.00	25.09	283.29	2.00	0.00	1.00	0.00
25.24	502.69	2.00	0.00	1.00	0.00	25.40	696.14	2.00	0.00	1.00	0.00

Total estimated settlement: 0.36

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.11	7.54	0.00	2.00	0.00	0.00	0.00
10.26	6.19	0.00	2.00	0.00	0.00	0.00
10.40	9.70	0.00	2.00	0.00	0.00	0.00
10.55	13.60	0.00	2.00	0.00	0.00	0.00
10.69	11.45	0.00	2.00	0.00	0.00	0.00
10.84	9.16	0.00	2.00	0.00	0.00	0.00
10.99	9.56	0.00	2.00	0.00	0.00	0.00
11.14	11.18	0.00	2.00	0.00	0.00	0.00
11.29	12.93	0.00	2.00	0.00	0.00	0.00
11.45	9.70	0.00	2.00	0.00	0.00	0.00
11.60	9.29	0.00	2.00	0.00	0.00	0.00
11.74	8.62	0.00	2.00	0.00	0.00	0.00
11.89	8.35	0.00	2.00	0.00	0.00	0.00
12.04	9.43	0.00	2.00	0.00	0.00	0.00
12.19	7.94	0.00	2.00	0.00	0.00	0.00
12.34	8.21	0.00	2.00	0.00	0.00	0.00
12.48	8.75	0.00	2.00	0.00	0.00	0.00
12.64	10.04	0.00	2.00	0.00	0.00	0.00
12.79	11.65	0.00	2.00	0.00	0.00	0.00
12.94	18.24	0.00	2.00	0.00	0.00	0.00
13.09	13.16	0.00	2.00	0.00	0.00	0.00
13.15	6.95	0.00	2.00	0.00	0.00	0.00
13.31	8.07	0.00	2.00	0.00	0.00	0.00
13.46	6.76	0.00	2.00	0.00	0.00	0.00
13.61	7.50	0.00	2.00	0.00	0.00	0.00
13.77	7.72	0.00	2.00	0.00	0.00	0.00
13.91	7.56	0.00	2.00	0.00	0.00	0.00
14.07	8.90	0.00	2.00	0.00	0.00	0.00
14.21	9.85	0.00	2.00	0.00	0.00	0.00
14.36	11.03	0.00	2.00	0.00	0.00	0.00
14.51	10.86	0.00	2.00	0.00	0.00	0.00
14.65	13.82	0.00	2.00	0.00	0.00	0.00
14.80	117.72	0.21	1.62	0.63	0.00	0.01
14.95	134.56	0.14	2.00	0.44	0.00	0.00
15.10	93.01	0.37	1.20	0.85	0.01	0.02
15.26	42.92	0.00	2.00	0.00	0.00	0.00
15.41	24.93	0.00	2.00	0.00	0.00	0.00
15.53	7.17	0.00	2.00	0.00	0.00	0.00
15.69	138.46	0.12	2.00	0.39	0.00	0.00
15.85	93.69	0.36	1.19	0.84	0.01	0.02
15.98	110.65	0.24	1.44	0.70	0.01	0.01
16.14	91.97	0.37	1.15	0.85	0.01	0.03
16.29	29.60	0.00	2.00	0.00	0.00	0.00
16.50	15.99	0.00	2.00	0.00	0.00	0.00
16.65	17.47	0.00	2.00	0.00	0.00	0.00
16.80	17.94	0.00	2.00	0.00	0.00	0.00
16.94	17.12	0.00	2.00	0.00	0.00	0.00
17.09	22.10	0.00	2.00	0.00	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
17.23	22.14	0.00	2.00	0.00	0.00	0.00
17.38	20.57	0.00	2.00	0.00	0.00	0.00
17.53	17.62	0.00	2.00	0.00	0.00	0.00
17.69	18.85	0.00	2.00	0.00	0.00	0.00
17.83	77.31	0.53	0.93	0.93	0.53	0.93
17.98	27.35	0.00	2.00	0.00	0.00	0.00
18.12	57.05	0.86	0.71	0.94	0.86	1.47
18.28	118.12	0.20	1.49	0.62	0.01	0.01
18.41	93.68	0.36	1.12	0.84	0.02	0.03
18.57	67.48	0.66	0.81	0.94	0.66	1.24
18.72	114.80	0.22	1.43	0.66	0.01	0.02
18.87	182.08	0.04	2.00	-0.19	0.00	0.00
19.02	131.12	0.15	1.73	0.48	0.00	0.01
19.17	116.95	0.21	1.45	0.64	0.01	0.02
19.31	91.15	0.38	1.07	0.86	0.02	0.03
19.46	101.77	0.30	1.21	0.78	0.01	0.03
19.60	115.56	0.22	1.42	0.65	0.01	0.02
19.80	199.71	0.02	2.00	-0.45	0.00	0.00
19.95	170.76	0.05	2.00	-0.03	0.00	0.00
20.10	151.29	0.09	2.00	0.23	0.00	0.00
20.23	145.67	0.10	2.00	0.30	0.00	0.00
20.39	157.43	0.08	2.00	0.15	0.00	0.00
20.53	177.19	0.04	2.00	-0.12	0.00	0.00
20.68	174.71	0.05	2.00	-0.09	0.00	0.00
20.83	169.65	0.06	2.00	-0.02	0.00	0.00
20.98	168.90	0.06	2.00	-0.01	0.00	0.00
21.13	173.35	0.05	2.00	-0.07	0.00	0.00
21.26	204.59	0.02	2.00	-0.52	0.00	0.00
21.41	562.97	0.00	2.00	-6.19	0.00	0.00
21.56	422.56	0.00	2.00	-3.97	0.00	0.00
21.71	382.61	0.00	2.00	-3.33	0.00	0.00
21.86	411.45	0.00	2.00	-3.79	0.00	0.00
22.00	403.97	0.00	2.00	-3.67	0.00	0.00
22.14	366.13	0.00	2.00	-3.06	0.00	0.00
22.29	300.38	0.00	2.00	-2.01	0.00	0.00
22.44	242.35	0.00	2.00	-1.09	0.00	0.00
22.59	238.11	0.00	2.00	-1.03	0.00	0.00
22.73	280.20	0.00	2.00	-1.69	0.00	0.00
22.89	317.96	0.00	2.00	-2.29	0.00	0.00
23.07	347.31	0.00	2.00	-2.76	0.00	0.00
23.21	340.74	0.00	2.00	-2.66	0.00	0.00
23.35	365.03	0.00	2.00	-3.05	0.00	0.00
23.50	344.46	0.00	2.00	-2.72	0.00	0.00
23.65	331.89	0.00	2.00	-2.51	0.00	0.00
23.79	344.30	0.00	2.00	-2.71	0.00	0.00
23.93	330.80	0.00	2.00	-2.50	0.00	0.00
24.08	288.12	0.00	2.00	-1.81	0.00	0.00
24.23	297.29	0.00	2.00	-1.96	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
24.32	291.29	0.00	2.00	-1.87	0.00	0.00
24.54	321.08	0.00	2.00	-2.34	0.00	0.00
24.69	331.21	0.00	2.00	-2.50	0.00	0.00
24.81	284.02	0.00	2.00	-1.75	0.00	0.00
24.96	246.80	0.00	2.00	-1.16	0.00	0.00
25.09	283.29	0.00	2.00	-1.74	0.00	0.00
25.24	502.69	0.00	2.00	-5.24	0.00	0.00
25.40	696.14	0.00	2.00	-8.24	0.00	0.00

Total estimated displacement: 3.90

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.26	148.10	237.93	1.00	237.93	-1.00	0.96	0.96
2.41	159.67	256.50	1.00	256.50	1.20	0.97	0.97
2.56	157.18	252.49	1.00	252.49	1.38	0.97	0.97
2.70	152.79	245.42	1.00	245.42	1.53	0.96	0.96
2.85	150.28	241.37	1.00	241.37	1.55	0.96	0.96
3.00	141.11	226.63	1.00	226.63	1.58	0.95	0.95
3.15	127.54	204.80	1.00	204.80	1.62	0.93	0.93
3.30	110.97	178.17	1.01	180.62	1.66	0.63	0.91
3.44	95.13	152.71	1.05	160.26	1.72	0.32	0.89
3.65	86.38	138.64	1.07	147.92	1.74	0.22	0.87
3.78	84.60	135.75	1.05	143.16	1.72	0.24	0.87
3.92	83.79	134.44	1.05	140.94	1.72	0.27	0.87
4.08	79.09	126.88	1.07	135.42	1.74	0.21	0.86
4.24	70.68	113.35	1.11	125.63	1.80	0.17	0.85
4.39	64.65	103.64	1.14	117.66	1.84	0.15	0.83
4.55	62.61	100.35	1.13	113.10	1.83	0.14	0.83
4.70	62.08	99.49	1.11	110.44	1.80	0.15	0.83
4.84	58.67	94.00	1.12	105.20	1.82	0.14	0.82
5.00	51.52	82.49	1.16	96.01	1.87	0.11	0.80
5.16	43.25	69.19	1.24	85.54	1.95	0.10	0.78
5.31	36.93	59.03	1.31	77.17	2.01	0.08	0.76
5.47	32.32	51.61	1.38	71.14	2.05	0.08	0.74
5.62	29.03	46.31	1.45	67.26	2.10	0.07	0.72
5.77	26.63	42.43	1.54	65.30	2.14	0.07	0.71
5.92	24.89	39.64	1.63	64.57	2.18	0.07	0.70
6.08	23.61	37.56	1.70	64.01	2.21	0.06	0.70
6.23	21.68	34.45	1.83	63.07	2.26	0.06	0.69
6.38	19.22	30.49	2.03	62.03	2.33	0.06	0.67
6.53	15.31	24.19	2.55	61.69	2.45	0.06	0.64
6.84	12.91	20.30	3.06	62.06	2.55	0.05	0.62
6.99	12.57	19.75	3.09	61.04	2.56	0.05	0.62
7.13	13.21	20.77	2.86	59.51	2.52	0.06	0.63
7.29	13.13	20.62	2.76	56.92	2.50	0.05	0.63
7.43	11.82	18.50	2.91	53.90	2.53	0.05	0.61
7.59	11.17	17.46	2.88	50.23	2.52	0.05	0.61
7.74	11.31	17.67	2.74	48.47	2.50	0.05	0.61
7.89	11.17	17.43	2.78	48.52	2.50	0.05	0.61
8.04	10.39	16.16	3.08	49.79	2.56	0.05	0.60
8.19	8.74	13.51	3.69	49.80	2.66	0.05	1.77
8.34	7.41	11.34	4.35	49.35	2.75	0.05	1.46
8.49	6.63	10.08	4.72	47.58	2.79	0.05	1.27
8.65	5.62	8.45	5.50	46.49	2.88	0.05	1.04
8.80	4.37	6.42	7.11	45.69	3.03	0.05	0.78
8.95	3.14	4.44	10.05	44.65	3.26	0.06	0.53
9.11	3.06	4.30	10.56	45.42	3.29	0.06	0.50
9.26	4.51	6.62	7.23	47.84	3.04	0.05	0.76
9.41	6.83	10.33	4.70	48.59	2.79	0.05	1.16
9.56	8.50	13.00	3.69	48.01	2.66	0.05	1.43

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
9.71	8.58	13.13	3.67	48.19	2.65	0.05	1.42
9.87	6.99	10.56	4.66	49.25	2.79	0.05	1.12
10.11	5.35	7.90	6.45	50.91	2.97	0.05	0.82
10.26	4.87	7.13	7.32	52.19	3.05	0.05	0.74
10.40	6.13	9.13	5.82	53.18	2.91	0.05	0.94
10.55	7.22	10.87	4.97	54.03	2.82	0.06	1.11
10.69	7.10	10.68	5.38	57.43	2.87	0.06	1.08
10.84	6.27	9.32	6.81	63.54	3.01	0.06	0.94
10.99	6.22	9.23	7.68	70.94	3.08	0.06	0.92
11.14	7.00	10.48	7.40	77.52	3.06	0.06	1.04
11.29	7.03	10.51	7.74	81.30	3.08	0.06	1.04
11.45	6.64	9.86	8.22	81.10	3.12	0.06	0.97
11.60	5.75	8.42	9.25	77.82	3.20	0.06	0.82
11.74	5.47	7.96	9.43	75.02	3.21	0.06	0.77
11.89	5.50	7.99	9.23	73.75	3.20	0.06	0.77
12.04	5.36	7.75	9.53	73.89	3.22	0.06	0.74
12.19	5.33	7.70	9.61	73.95	3.23	0.06	0.73
12.34	5.19	7.46	9.88	73.75	3.24	0.06	0.70
12.48	5.64	8.17	9.38	76.64	3.21	0.06	0.76
12.64	6.39	9.37	8.68	81.34	3.16	0.06	0.87
12.79	8.54	12.81	6.94	88.90	3.02	0.06	1.18
12.94	9.27	13.96	6.73	93.99	3.00	0.07	1.28
13.09	8.26	12.33	7.84	96.70	3.09	0.06	1.12
13.15	5.99	8.68	10.60	92.03	3.29	0.06	0.79
13.31	4.60	6.43	12.90	82.93	3.43	0.07	0.58
13.46	4.74	6.65	11.67	77.58	3.36	0.06	0.59
13.61	4.69	6.55	11.28	73.89	3.34	0.06	0.58
13.77	4.89	6.86	10.86	74.43	3.31	0.06	0.61
13.91	5.23	7.39	10.43	77.02	3.28	0.06	0.65
14.07	5.73	8.19	9.83	80.44	3.24	0.06	0.71
14.21	6.54	9.47	8.79	83.24	3.17	0.06	0.82
14.36	7.02	10.23	8.97	91.75	3.18	0.06	0.88
14.51	7.97	11.74	9.74	114.33	3.23	0.07	1.00
14.65	22.67	35.34	4.11	145.13	2.71	0.05	3.00
14.80	41.44	65.48	2.52	164.89	2.45	0.11	0.77
14.95	50.43	79.91	2.19	175.17	2.37	0.13	0.80
15.10	43.93	69.46	2.42	167.92	2.43	0.09	0.78
15.26	28.70	44.98	3.51	157.75	2.63	0.09	3.68
15.41	18.23	28.14	5.54	155.91	2.88	0.07	2.29
15.53	29.45	46.15	3.48	160.56	2.62	0.04	3.73
15.69	36.02	56.70	3.14	178.23	2.57	0.14	0.75
15.85	50.29	77.74	2.38	185.14	2.42	0.09	0.79
15.98	40.37	63.65	2.99	190.36	2.54	0.11	0.77
16.14	35.20	55.33	3.22	177.93	2.58	0.09	0.75
16.29	23.17	35.98	4.42	158.94	2.76	0.07	2.79
16.50	15.48	23.62	5.92	139.93	2.92	0.06	1.81
16.65	12.52	18.85	6.55	123.45	2.98	0.07	1.44
16.80	12.85	19.37	6.01	116.42	2.93	0.06	1.47

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
16.94	14.10	21.36	5.40	115.40	2.87	0.06	1.61
17.09	15.24	23.18	4.93	114.22	2.82	0.07	1.73
17.23	16.18	24.68	4.51	111.26	2.77	0.06	1.84
17.38	15.07	22.87	4.72	108.01	2.79	0.06	1.69
17.53	14.26	21.50	4.78	102.82	2.80	0.06	1.58
17.69	18.42	27.01	3.51	94.70	2.63	0.06	2.06
17.83	21.07	30.58	3.20	97.77	2.58	0.07	0.67
17.98	21.69	31.69	3.55	112.38	2.63	0.07	2.41
18.12	30.96	44.29	2.76	122.34	2.50	0.05	0.72
18.28	37.11	52.54	2.54	133.70	2.45	0.11	0.74
18.41	39.42	55.57	2.54	141.03	2.45	0.09	0.75
18.57	40.31	56.37	2.48	139.85	2.44	0.06	0.75
18.72	64.70	86.00	1.57	135.38	2.16	0.11	0.81
18.87	81.35	105.69	1.37	145.25	2.05	0.23	0.84
19.02	81.26	105.65	1.42	150.03	2.08	0.13	0.84
19.17	57.07	76.20	1.88	143.29	2.28	0.11	0.79
19.31	48.97	65.27	1.98	128.91	2.31	0.08	0.77
19.46	50.73	66.47	1.76	117.19	2.24	0.09	0.77
19.60	80.65	102.37	1.36	139.61	2.05	0.11	0.83
19.80	99.68	125.61	1.33	167.62	2.03	0.31	0.86
19.95	107.70	135.84	1.38	187.27	2.05	0.20	0.87
20.10	92.44	117.67	1.54	181.75	2.15	0.15	0.85
20.23	89.74	113.31	1.50	170.22	2.13	0.15	0.84
20.39	99.74	123.35	1.33	164.05	2.02	0.17	0.86
20.53	110.05	134.12	1.24	166.50	1.95	0.23	0.87
20.68	113.49	138.00	1.25	173.10	1.96	0.22	0.87
20.83	109.27	133.52	1.33	178.09	2.02	0.20	0.87
20.98	107.63	132.08	1.43	188.31	2.08	0.19	0.87
21.13	127.05	154.63	1.37	212.05	2.05	0.21	0.89
21.26	263.50	304.27	1.03	314.38	1.69	0.66	1.00
21.41	359.49	405.93	1.00	405.93	1.56	1.05	1.05
21.56	423.17	470.02	1.00	470.02	1.46	1.07	1.07
21.71	380.29	423.15	1.00	423.15	1.50	1.05	1.05
21.86	372.45	412.78	1.00	412.78	1.50	1.05	1.05
22.00	360.71	400.48	1.00	400.48	1.53	1.04	1.04
22.14	312.43	350.79	1.00	351.03	1.65	1.02	1.02
22.29	247.34	281.91	1.11	312.12	1.80	0.98	0.98
22.44	199.62	229.72	1.21	277.25	1.92	0.95	0.95
22.59	196.27	224.06	1.18	263.96	1.89	0.95	0.95
22.73	229.96	257.70	1.08	277.72	1.76	0.97	0.97
22.89	274.50	302.88	1.01	304.56	1.65	1.00	1.00
23.07	301.15	329.88	1.00	329.88	1.62	1.01	1.01
23.21	320.78	349.45	1.00	349.45	1.60	1.02	1.02
23.35	325.82	352.50	1.00	352.50	1.57	1.02	1.02
23.50	329.26	352.99	1.00	352.99	1.51	1.02	1.02
23.65	327.60	348.29	1.00	348.29	1.46	1.02	1.02
23.79	325.25	344.53	1.00	344.53	1.45	1.02	1.02
23.93	311.62	329.66	1.00	329.66	1.46	1.01	1.01

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
24.08	297.13	313.18	1.00	313.18	1.45	1.00	1.00
24.23	285.65	299.62	1.00	299.62	1.43	0.99	0.99
24.32	296.10	309.55	1.00	309.55	1.41	1.00	1.00
24.54	301.07	315.61	1.00	315.61	1.48	1.00	1.00
24.69	294.41	311.12	1.00	311.12	1.61	1.00	1.00
24.81	271.53	285.29	1.00	285.29	1.58	0.99	0.99
24.96	263.98	273.25	1.00	273.25	1.43	0.98	0.98
25.09	342.77	401.49	1.00	401.49	-1.00	1.04	1.04
25.24	429.38	502.23	1.00	502.23	-1.00	1.08	1.08
25.40	631.64	737.71	1.00	737.71	-1.00	1.16	1.16

Abbreviations

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

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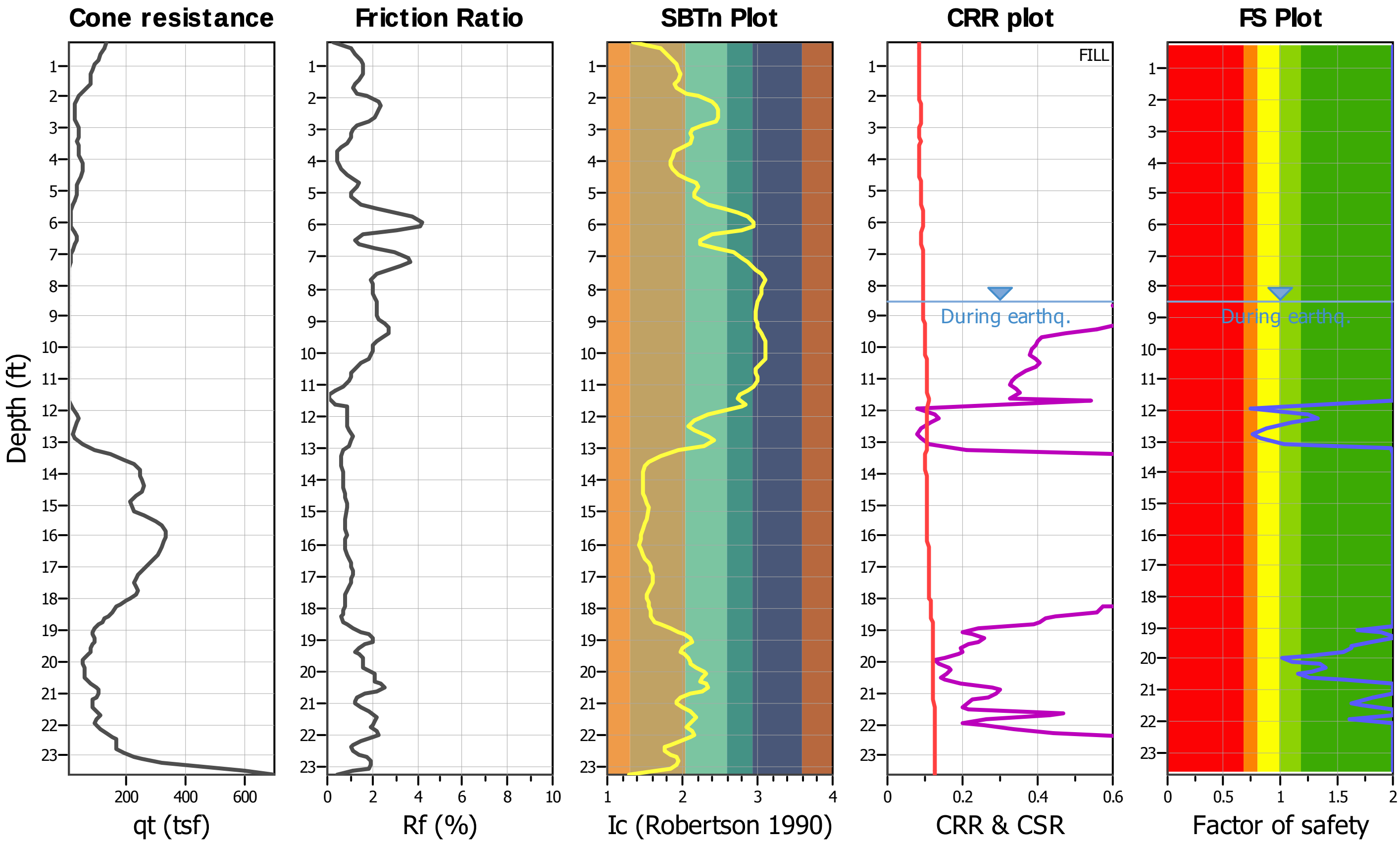
LIQUEFACTION ANALYSIS REPORT

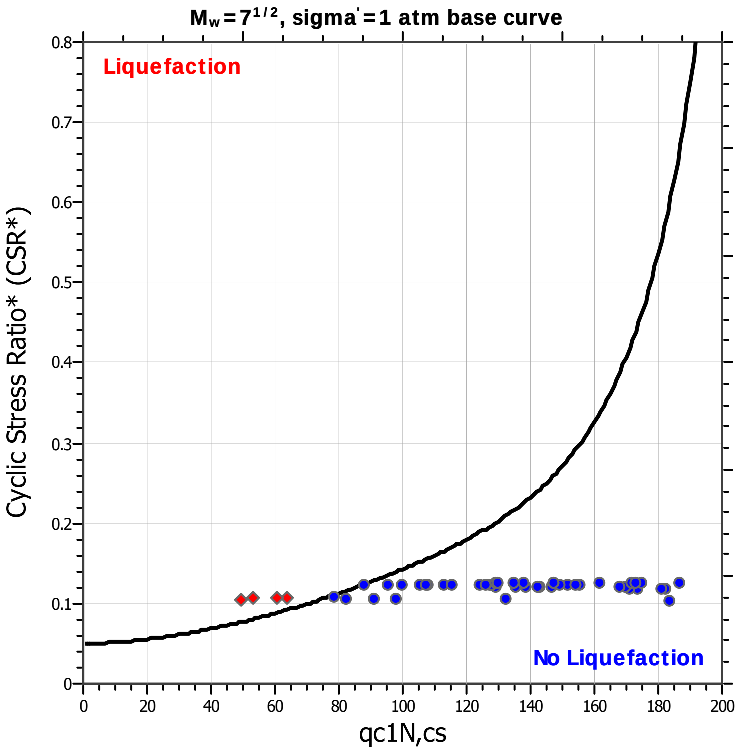
Project title : **Location :**

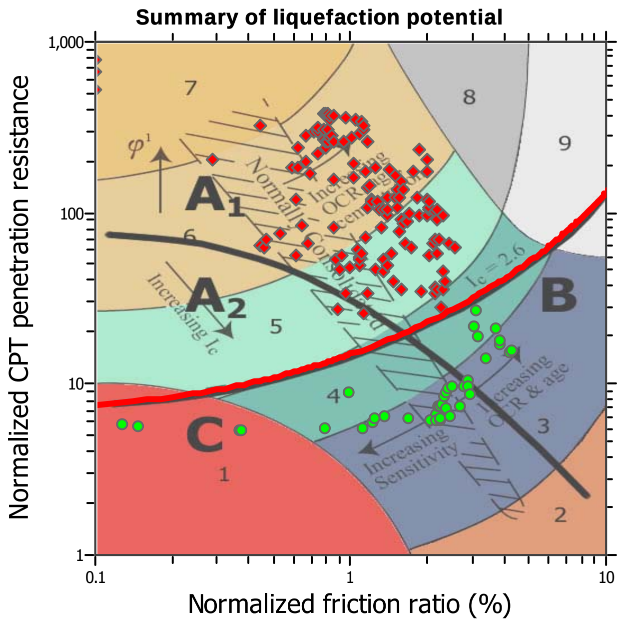
CPT file : CPT3

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.50 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.50 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.14	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

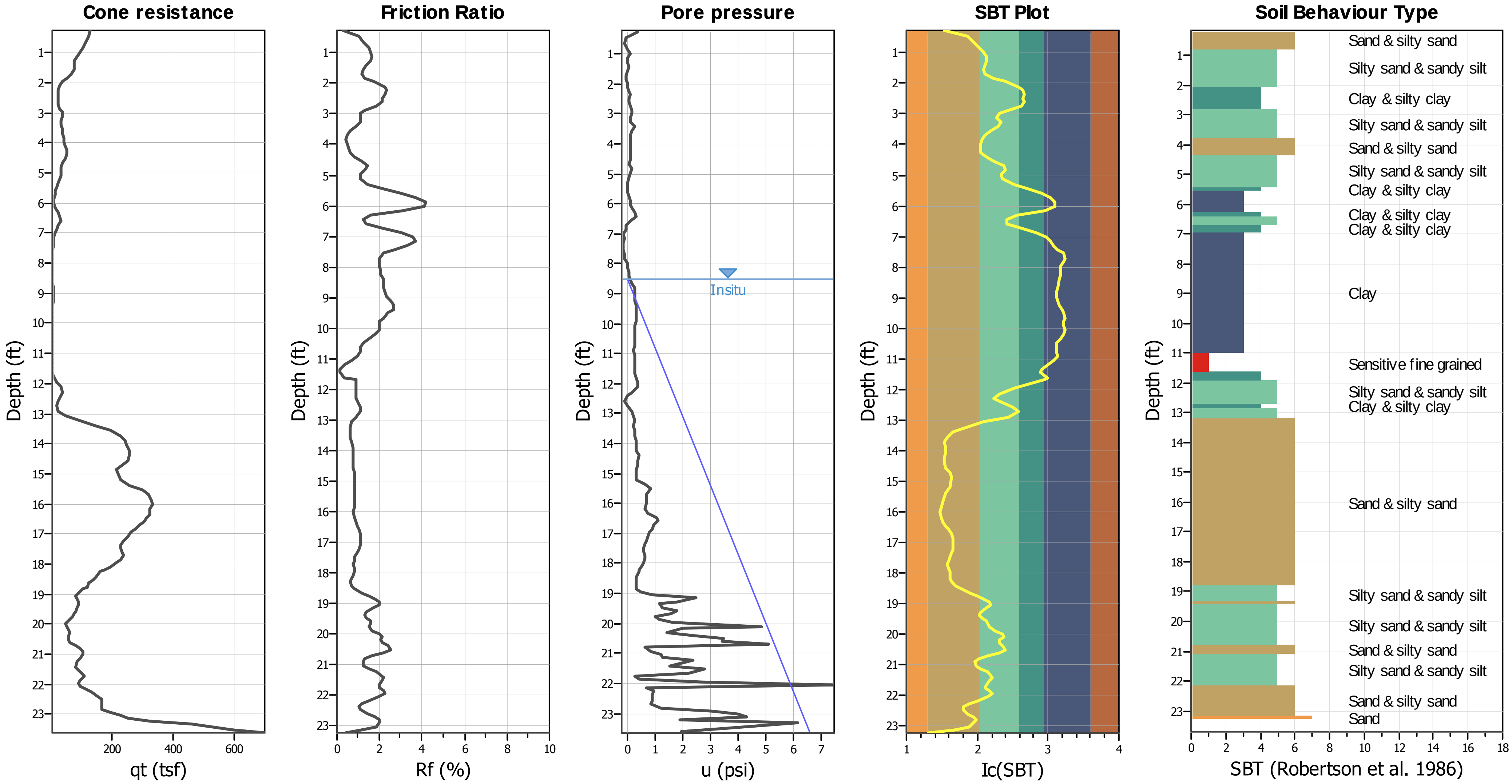






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



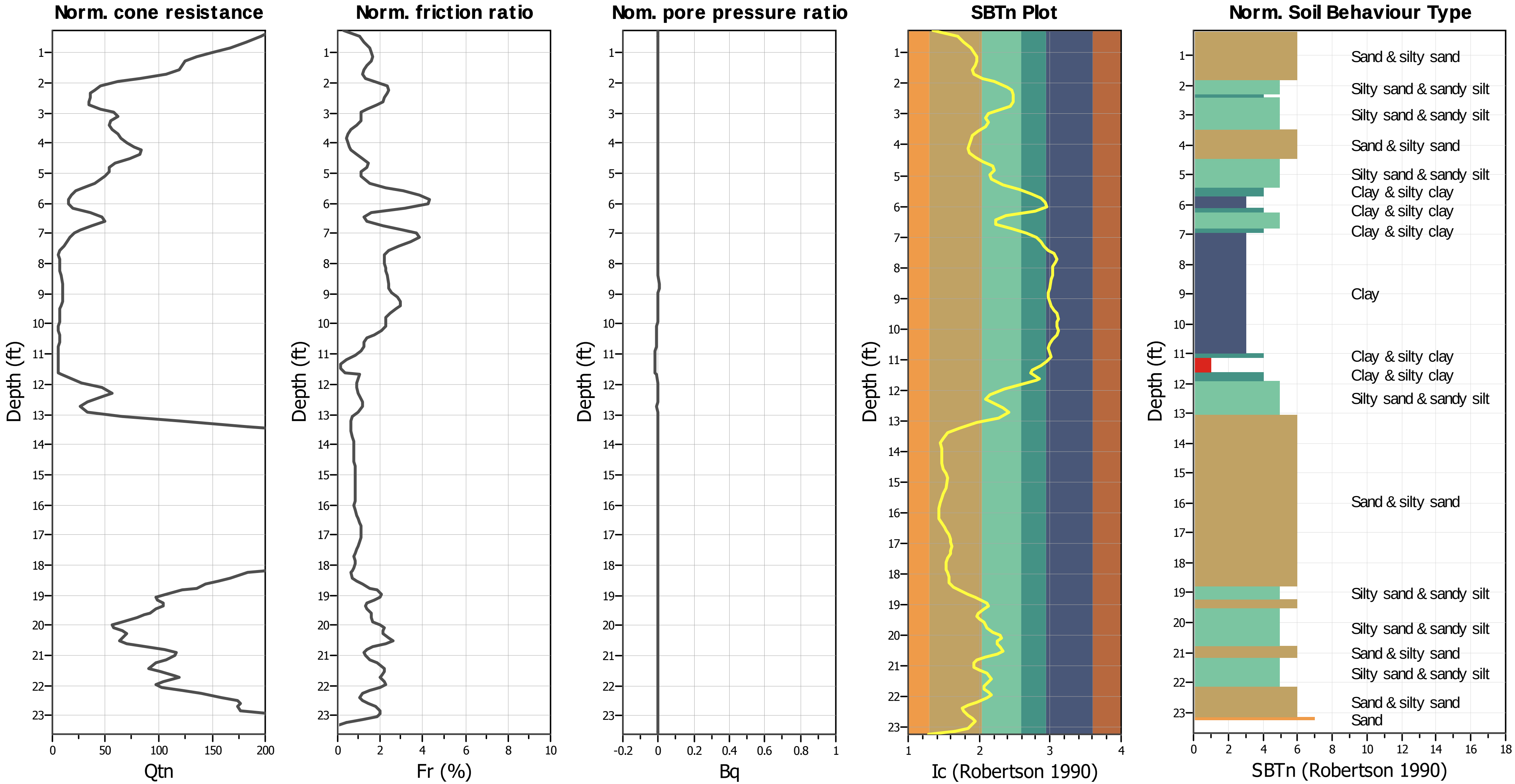
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	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)



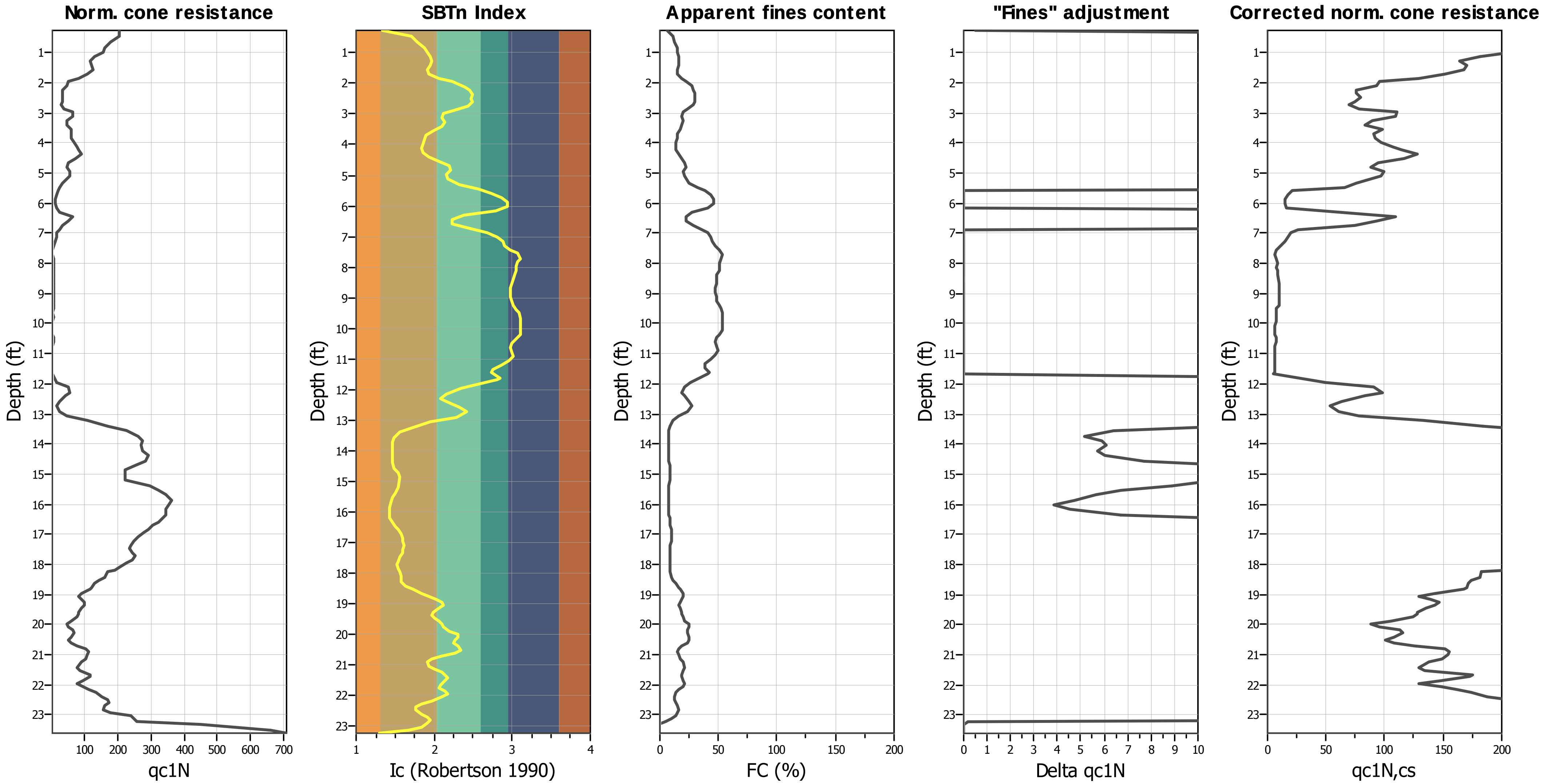
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

SBTn legend

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

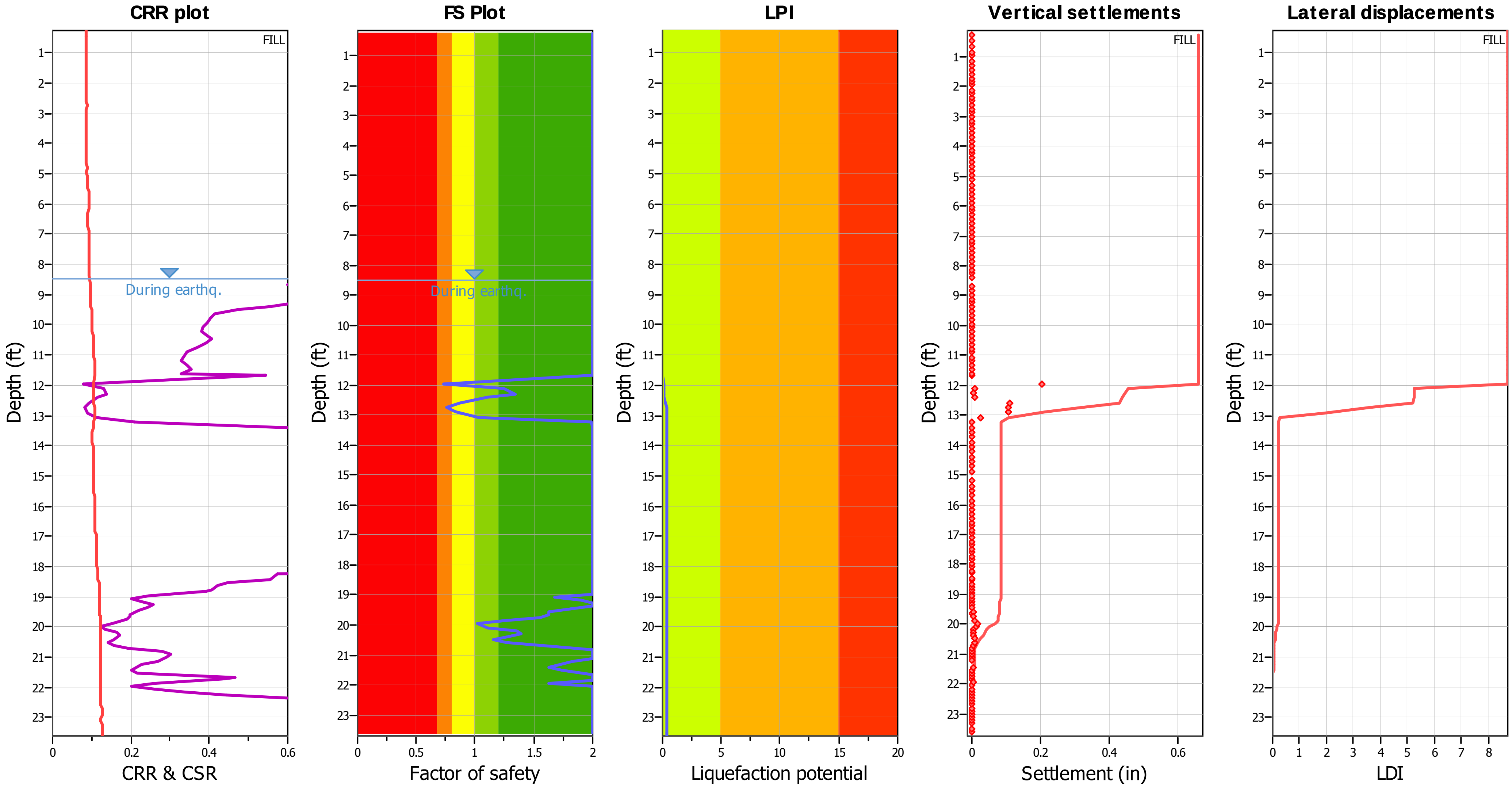
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

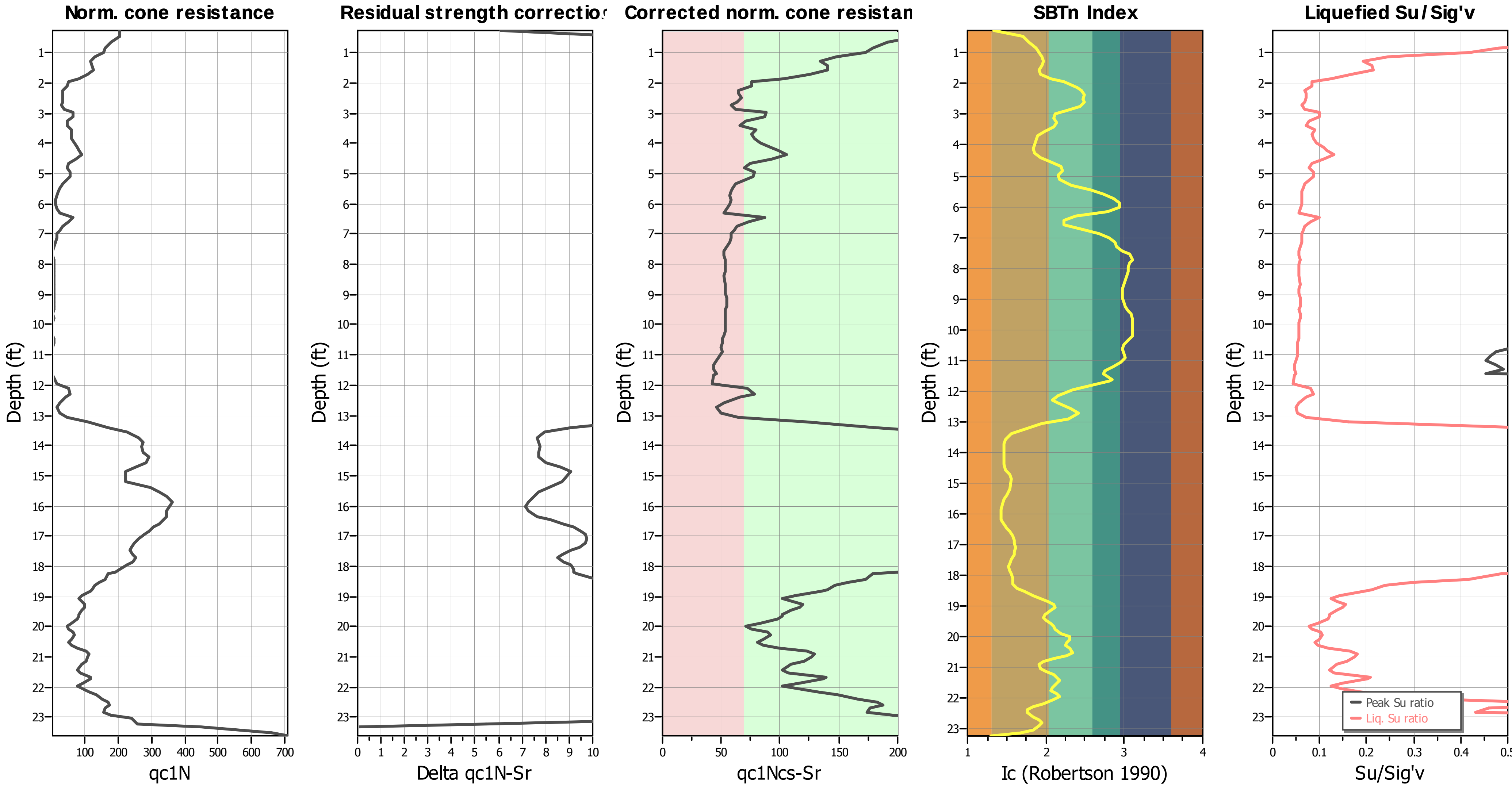
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.27	129.12	0.00	0.39	0.84	114.90
2	0.46	127.95	1.12	-0.06	6.24	123.73
3	0.66	110.91	1.57	-0.08	7.86	124.38
4	0.85	102.09	1.58	0.02	9.77	124.85
5	0.97	98.23	1.54	0.12	10.88	124.30
6	1.14	82.03	1.37	-0.01	11.83	123.37
7	1.28	73.04	1.19	-0.01	12.13	122.18
8	1.43	77.16	1.03	0.05	11.46	121.25
9	1.57	77.83	0.96	0.00	10.58	120.00
10	1.71	68.09	0.71	-0.03	11.16	118.55
11	1.86	52.98	0.63	-0.03	14.43	117.04
12	1.95	33.08	0.70	0.00	19.71	116.23
13	2.11	30.31	0.68	0.03	26.59	115.30
14	2.24	22.08	0.58	0.05	28.88	114.14
15	2.36	21.91	0.49	0.13	30.01	113.01
16	2.48	23.42	0.48	0.06	29.43	112.42
17	2.62	21.24	0.46	0.07	29.88	111.88
18	2.75	19.14	0.41	0.09	28.19	111.09
19	2.87	24.35	0.33	0.18	20.98	111.38
20	3.00	42.15	0.40	0.16	16.55	112.29
21	3.14	42.06	0.46	0.14	15.61	112.65
22	3.27	31.40	0.37	0.13	17.04	111.60
23	3.42	29.13	0.28	0.29	15.67	109.64
24	3.55	38.87	0.21	0.17	12.70	107.73
25	3.69	38.20	0.16	0.10	5.00	106.58
26	3.85	39.38	0.17	0.10	5.00	106.55
27	3.97	42.90	0.20	0.09	5.00	107.84
28	4.12	48.61	0.24	0.10	9.16	109.64
29	4.25	51.88	0.32	0.12	9.43	111.91
30	4.40	56.08	0.45	0.10	11.27	113.89
31	4.53	46.68	0.56	0.11	14.56	114.79
32	4.68	33.33	0.55	0.05	18.65	114.27
33	4.82	29.80	0.45	0.16	19.20	112.80
34	4.96	36.27	0.32	0.11	17.26	111.44
35	5.10	34.93	0.32	0.05	18.02	110.70
36	5.33	22.92	0.36	0.01	23.69	110.76
37	5.47	17.21	0.41	0.00	33.45	110.51
38	5.60	13.43	0.41	0.01	42.21	110.24
39	5.75	10.83	0.42	0.05	49.77	109.88
40	5.89	9.65	0.43	0.13	54.62	109.50
41	6.03	9.40	0.40	0.12	54.75	109.10
42	6.15	10.16	0.36	0.19	45.65	108.90
43	6.30	16.04	0.32	0.29	25.88	110.05
44	6.44	40.80	0.34	0.30	20.08	111.21
45	6.58	31.74	0.43	0.11	20.22	112.51
46	6.73	21.58	0.51	-0.06	28.82	112.71
47	6.87	16.29	0.52	-0.05	38.95	112.14
48	7.00	12.26	0.48	-0.14	46.06	111.13

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	7.15	11.17	0.42	-0.11	50.55	109.51
50	7.28	9.49	0.31	-0.14	52.54	106.84
51	7.43	6.88	0.16	-0.15	56.72	102.68
52	7.55	4.28	0.09	-0.14	62.93	97.79
53	7.71	3.53	0.07	-0.10	65.75	95.66
54	7.84	4.95	0.09	-0.08	63.86	96.32
55	7.98	5.12	0.10	0.00	61.28	97.35
56	8.13	4.87	0.11	0.03	61.32	97.61
57	8.26	5.12	0.10	0.05	61.10	97.87
58	8.41	5.37	0.11	0.07	59.02	99.07
59	8.68	6.38	0.15	0.19	57.44	99.94
60	8.83	6.38	0.14	0.27	56.36	100.44
61	8.96	6.21	0.14	0.28	56.76	100.81
62	9.11	6.55	0.17	0.27	58.04	101.67
63	9.23	6.63	0.19	0.26	58.94	102.05
64	9.38	6.21	0.16	0.33	61.95	101.01
65	9.51	4.62	0.12	0.35	64.47	98.90
66	9.66	4.37	0.09	0.31	66.49	96.95
67	9.79	4.53	0.09	0.31	65.68	96.09
68	9.93	4.37	0.09	0.30	65.91	96.00
69	10.07	4.28	0.09	0.28	66.47	95.74
70	10.21	4.28	0.08	0.29	65.54	95.11
71	10.35	4.28	0.07	0.28	61.43	94.07
72	10.48	4.79	0.05	0.29	57.57	92.81
73	10.63	4.70	0.05	0.27	57.03	91.79
74	10.77	3.95	0.05	0.26	58.51	91.15
75	10.91	4.11	0.04	0.24	59.22	89.76
76	11.06	3.95	0.03	0.25	55.84	87.36
77	11.18	3.78	0.01	0.26	49.58	87.36
78	11.33	3.95	0.00	0.28	43.35	87.36
79	11.46	4.45	0.00	0.29	42.01	87.36
80	11.61	4.20	0.01	0.29	49.06	87.36
81	11.67	3.19	0.02	0.29	46.00	93.52
82	11.94	11.08	0.13	0.40	24.37	103.47
83	12.13	38.45	0.30	0.39	17.49	109.35
84	12.28	44.33	0.41	0.15	15.45	111.53
85	12.40	33.08	0.35	0.01	17.82	110.29
86	12.59	19.65	0.19	-0.10	23.69	107.55
87	12.74	13.18	0.20	0.02	27.05	104.89
88	12.91	18.47	0.17	0.15	21.94	106.37
89	13.07	35.93	0.26	0.21	11.78	111.30
90	13.23	88.49	0.53	0.26	6.47	116.82
91	13.41	146.84	0.85	0.23	3.75	121.28
92	13.56	200.82	1.19	0.26	2.65	124.45
93	13.73	234.91	1.56	0.29	2.31	126.53
94	13.90	247.76	1.78	0.32	2.41	127.73
95	14.06	244.40	1.89	0.35	2.46	128.14
96	14.23	250.36	1.82	0.34	2.37	128.38

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	14.39	267.48	1.92	0.43	2.37	128.64
98	14.57	257.41	2.06	0.40	2.69	128.75
99	14.72	230.96	1.95	0.36	3.36	128.41
100	14.88	204.18	1.82	0.34	3.76	127.70
101	15.19	203.76	1.67	0.31	3.39	128.11
102	15.37	272.94	2.14	0.64	2.81	129.26
103	15.52	299.22	2.50	0.83	2.41	130.78
104	15.69	319.29	2.77	0.68	2.19	131.48
105	15.86	337.92	2.70	0.70	1.98	131.57
106	16.01	328.60	2.52	0.67	1.84	131.37
107	16.18	324.24	2.55	0.62	1.98	131.36
108	16.34	322.81	2.73	0.74	2.36	131.78
109	16.47	316.01	3.02	1.06	2.90	132.30
110	16.59	303.17	3.21	1.10	3.46	132.58
111	16.71	289.06	3.19	0.97	3.92	132.51
112	16.84	275.29	3.07	0.92	4.22	132.17
113	16.96	262.36	2.94	0.79	4.43	131.67
114	17.09	248.68	2.72	0.76	4.50	130.94
115	17.23	236.50	2.39	0.70	4.41	130.03
116	17.35	226.43	2.10	0.64	4.16	129.07
117	17.47	223.41	1.91	0.59	3.77	128.39
118	17.59	233.31	1.83	0.58	3.39	128.10
119	17.72	240.37	1.85	0.66	3.19	128.01
120	17.84	233.40	1.81	0.63	3.49	128.02
121	17.96	214.51	1.88	0.58	3.76	127.24
122	18.08	193.10	1.41	0.53	3.88	125.89
123	18.21	178.74	1.08	0.43	3.89	124.05
124	18.27	157.17	1.03	0.42	4.03	122.77
125	18.45	151.21	0.92	0.34	4.97	122.59
126	18.54	135.93	1.10	0.33	6.52	123.41
127	18.65	123.50	1.48	0.32	8.99	124.80
128	18.75	115.19	1.79	0.31	11.35	125.95
129	18.84	108.98	1.97	0.32	13.71	126.17
130	18.95	86.39	1.85	0.47	15.84	125.59
131	19.05	74.97	1.61	0.88	16.63	124.56
132	19.15	84.21	1.42	2.46	14.87	123.66
133	19.27	94.45	1.24	1.79	12.78	122.89
134	19.36	92.02	1.10	1.18	12.14	122.27
135	19.46	84.54	1.11	1.25	13.33	122.16
136	19.57	76.32	1.26	1.78	14.91	122.39
137	19.66	75.81	1.29	1.56	15.63	122.04
138	19.76	72.29	1.00	0.98	16.29	120.93
139	19.88	56.59	0.86	1.15	18.64	119.53
140	19.97	41.89	0.91	1.64	22.42	119.42
141	20.09	47.02	1.11	4.81	22.91	120.27
142	20.18	60.87	1.18	1.98	21.05	121.33
143	20.29	63.22	1.24	1.44	20.68	122.02
144	20.40	56.75	1.39	2.34	22.65	122.32

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	20.50	50.46	1.42	3.45	23.79	122.42
146	20.61	57.17	1.35	3.41	21.04	122.43
147	20.70	75.39	1.25	5.09	15.75	122.68
148	20.81	101.42	1.23	0.62	12.29	123.05
149	20.91	108.56	1.29	0.83	10.78	123.34
150	21.02	106.20	1.27	1.20	11.23	123.60
151	21.13	98.31	1.38	1.26	13.17	124.10
152	21.22	85.38	1.68	2.37	15.91	124.56
153	21.44	76.65	1.72	1.52	18.13	125.14
154	21.53	82.11	1.89	2.79	16.86	126.20
155	21.65	116.53	2.26	2.18	15.17	127.05
156	21.74	114.94	2.16	0.26	14.74	127.23
157	21.84	92.69	1.98	0.44	16.78	126.68
158	21.96	77.74	2.05	2.70	17.94	126.23
159	22.06	93.70	1.94	7.40	16.05	126.00
160	22.17	112.42	1.65	0.66	12.11	125.56
161	22.26	131.48	1.43	0.93	9.07	125.19
162	22.38	151.29	1.45	0.90	7.40	125.56
163	22.48	168.50	1.68	0.91	7.56	127.24
164	22.60	172.87	2.44	0.88	8.95	129.03
165	22.69	160.19	2.96	0.84	10.72	130.38
166	22.81	157.33	3.17	1.21	11.62	131.42
167	22.90	181.01	3.70	3.02	10.59	132.90
168	23.02	242.89	4.55	3.99	9.17	133.92
169	23.11	252.71	4.22	4.32	5.47	131.60
170	23.22	258.42	0.00	1.89	0.31	126.85
171	23.33	452.10	0.00	6.14	N/A	87.36
172	23.50	667.79	0.00	3.42	N/A	87.36
173	23.60	714.80	0.00	1.96	N/A	87.36

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.27	0.14	0.00	0.14	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
2	2.46	0.15	0.00	0.15	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
3	2.65	0.16	0.00	0.16	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
4	2.85	0.18	0.00	0.18	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
5	2.98	0.18	0.00	0.18	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
6	3.13	0.19	0.00	0.19	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
7	3.28	0.20	0.00	0.20	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
8	3.43	0.21	0.00	0.21	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
9	3.57	0.22	0.00	0.22	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
10	3.71	0.23	0.00	0.23	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
11	3.86	0.24	0.00	0.24	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
12	3.95	0.24	0.00	0.24	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
13	4.11	0.25	0.00	0.25	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
14	4.24	0.26	0.00	0.26	1.00	0.091	1.05	0.086	1.09	1.10	2.000	No
15	4.36	0.27	0.00	0.27	1.00	0.091	1.05	0.086	1.09	1.10	2.000	No
16	4.48	0.27	0.00	0.27	1.00	0.091	1.05	0.086	1.09	1.10	2.000	No
17	4.62	0.28	0.00	0.28	0.99	0.091	1.05	0.086	1.08	1.10	2.000	No
18	4.75	0.29	0.00	0.29	0.99	0.090	1.05	0.086	1.08	1.10	2.000	No
19	4.87	0.29	0.00	0.29	0.99	0.090	1.05	0.086	1.08	1.10	2.000	No
20	5.00	0.30	0.00	0.30	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
21	5.14	0.31	0.00	0.31	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
22	5.27	0.32	0.00	0.32	0.99	0.090	1.05	0.086	1.09	1.10	2.000	No
23	5.42	0.33	0.00	0.33	0.99	0.090	1.05	0.086	1.08	1.10	2.000	No
24	5.55	0.33	0.00	0.33	0.99	0.090	1.05	0.086	1.09	1.10	2.000	No
25	5.69	0.34	0.00	0.34	0.99	0.090	1.05	0.086	1.09	1.10	2.000	No
26	5.84	0.35	0.00	0.35	0.99	0.090	1.05	0.086	1.09	1.10	2.000	No
27	5.97	0.35	0.00	0.35	0.99	0.090	1.05	0.086	1.09	1.10	2.000	No
28	6.12	0.36	0.00	0.36	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
29	6.25	0.37	0.00	0.37	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
30	6.40	0.38	0.00	0.38	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
31	6.53	0.39	0.00	0.39	0.99	0.090	1.05	0.085	1.09	1.10	2.000	No
32	6.68	0.40	0.00	0.40	0.99	0.090	1.05	0.085	1.07	1.10	2.000	No
33	6.82	0.40	0.00	0.40	0.99	0.090	1.05	0.085	1.07	1.10	2.000	No
34	6.96	0.41	0.00	0.41	0.99	0.090	1.05	0.085	1.07	1.10	2.000	No
35	7.10	0.42	0.00	0.42	0.99	0.090	1.05	0.085	1.07	1.10	2.000	No
36	7.33	0.43	0.00	0.43	0.99	0.090	1.05	0.085	1.06	1.10	2.000	No
37	7.47	0.44	0.00	0.44	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
38	7.60	0.45	0.00	0.45	0.99	0.090	1.05	0.085	1.05	1.10	2.000	No
39	7.75	0.45	0.00	0.45	0.99	0.090	1.05	0.085	1.04	1.10	2.000	No
40	7.89	0.46	0.00	0.46	0.99	0.090	1.05	0.085	1.04	1.10	2.000	No
41	8.03	0.47	0.00	0.47	0.98	0.090	1.05	0.085	1.04	1.10	2.000	No
42	8.15	0.48	0.00	0.48	0.98	0.090	1.05	0.085	1.04	1.10	2.000	No
43	8.30	0.48	0.00	0.48	0.98	0.090	1.05	0.085	1.04	1.10	2.000	No
44	8.44	0.49	0.00	0.49	0.98	0.089	1.05	0.085	1.06	1.10	2.000	No
45	8.58	0.50	0.00	0.50	0.98	0.089	1.05	0.085	1.05	1.10	2.000	No
46	8.73	0.51	0.00	0.51	0.98	0.089	1.05	0.085	1.05	1.10	2.000	No
47	8.87	0.52	0.00	0.52	0.98	0.089	1.05	0.085	1.04	1.10	2.000	No
48	9.00	0.52	0.00	0.52	0.98	0.089	1.05	0.085	1.04	1.10	2.000	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	9.15	0.53	0.00	0.53	0.98	0.089	1.05	0.085	1.04	1.10	2.000	No
50	9.28	0.54	0.00	0.54	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
51	9.43	0.55	0.00	0.55	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
52	9.55	0.55	0.00	0.55	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
53	9.71	0.56	0.00	0.56	0.98	0.089	1.05	0.085	1.03	1.10	2.000	No
54	9.84	0.57	0.00	0.57	0.98	0.089	1.05	0.084	1.03	1.10	2.000	No
55	9.98	0.57	0.00	0.57	0.98	0.089	1.05	0.084	1.03	1.10	2.000	No
56	10.13	0.58	0.00	0.58	0.98	0.089	1.05	0.084	1.03	1.10	2.000	No
57	10.26	0.59	0.00	0.59	0.98	0.089	1.05	0.084	1.03	1.10	2.000	No
58	10.41	0.59	0.00	0.59	0.98	0.089	1.05	0.084	1.03	1.10	2.000	No
59	10.68	0.61	0.01	0.60	0.98	0.090	1.05	0.085	1.03	1.10	0.095	No
60	10.83	0.62	0.01	0.60	0.98	0.090	1.05	0.086	1.03	1.10	0.096	No
61	10.96	0.62	0.01	0.61	0.98	0.091	1.05	0.086	1.03	1.10	0.097	No
62	11.11	0.63	0.02	0.61	0.97	0.091	1.05	0.087	1.03	1.10	0.097	No
63	11.23	0.64	0.02	0.61	0.97	0.092	1.05	0.087	1.02	1.10	0.098	No
64	11.38	0.64	0.03	0.62	0.97	0.093	1.05	0.088	1.02	1.10	0.099	No
65	11.51	0.65	0.03	0.62	0.97	0.093	1.05	0.088	1.02	1.10	0.099	No
66	11.66	0.66	0.04	0.62	0.97	0.094	1.05	0.089	1.02	1.10	0.100	No
67	11.79	0.66	0.04	0.62	0.97	0.094	1.05	0.089	1.02	1.10	0.100	No
68	11.93	0.67	0.04	0.63	0.97	0.095	1.05	0.090	1.02	1.10	0.101	No
69	12.07	0.68	0.05	0.63	0.97	0.095	1.05	0.090	1.02	1.10	0.102	No
70	12.21	0.68	0.05	0.63	0.97	0.096	1.05	0.091	1.02	1.10	0.102	No
71	12.35	0.69	0.06	0.63	0.97	0.096	1.05	0.091	1.02	1.10	0.103	No
72	12.48	0.70	0.06	0.63	0.97	0.097	1.05	0.092	1.02	1.10	0.103	No
73	12.63	0.70	0.07	0.64	0.97	0.097	1.05	0.092	1.02	1.10	0.104	No
74	12.77	0.71	0.07	0.64	0.97	0.098	1.05	0.093	1.02	1.10	0.105	No
75	12.91	0.72	0.08	0.64	0.97	0.098	1.05	0.093	1.02	1.10	0.105	No
76	13.06	0.72	0.08	0.64	0.97	0.099	1.05	0.094	1.02	1.10	0.106	No
77	13.18	0.73	0.08	0.64	0.97	0.099	1.05	0.094	1.02	1.10	0.106	No
78	13.33	0.73	0.09	0.65	0.97	0.100	1.05	0.095	1.02	1.10	0.107	No
79	13.46	0.74	0.09	0.65	0.97	0.100	1.05	0.095	1.02	1.10	0.107	No
80	13.61	0.75	0.10	0.65	0.97	0.101	1.05	0.096	1.02	1.10	0.108	No
81	13.67	0.75	0.10	0.65	0.97	0.101	1.05	0.096	1.02	1.10	0.108	No
82	13.94	0.76	0.11	0.66	0.96	0.102	1.05	0.097	1.02	1.10	0.104	No
83	14.13	0.77	0.11	0.66	0.96	0.103	1.05	0.097	1.03	1.10	0.104	No
84	14.28	0.78	0.12	0.66	0.96	0.103	1.05	0.098	1.04	1.10	0.104	No
85	14.40	0.79	0.12	0.67	0.96	0.104	1.05	0.098	1.03	1.10	0.105	No
86	14.59	0.80	0.13	0.67	0.96	0.104	1.05	0.099	1.03	1.10	0.106	No
87	14.74	0.81	0.13	0.67	0.96	0.105	1.05	0.099	1.02	1.10	0.107	No
88	14.91	0.82	0.14	0.68	0.96	0.105	1.05	0.100	1.03	1.10	0.107	No
89	15.07	0.82	0.14	0.68	0.96	0.106	1.05	0.100	1.03	1.10	0.107	No
90	15.23	0.83	0.15	0.69	0.96	0.106	1.05	0.101	1.05	1.10	0.105	No
91	15.41	0.84	0.15	0.69	0.96	0.107	1.05	0.101	1.08	1.10	0.103	No
92	15.56	0.85	0.16	0.70	0.96	0.107	1.05	0.101	1.10	1.10	0.101	No
93	15.73	0.86	0.16	0.70	0.96	0.107	1.05	0.102	1.10	1.10	0.102	No
94	15.90	0.88	0.17	0.71	0.96	0.108	1.05	0.102	1.10	1.10	0.102	No
95	16.06	0.89	0.17	0.71	0.96	0.108	1.05	0.103	1.10	1.10	0.103	No
96	16.23	0.90	0.18	0.72	0.96	0.109	1.05	0.103	1.10	1.10	0.103	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
97	16.39	0.91	0.18	0.72	0.96	0.109	1.05	0.103	1.10	1.10	0.103	No
98	16.57	0.92	0.19	0.73	0.95	0.109	1.05	0.104	1.10	1.10	0.104	No
99	16.72	0.93	0.19	0.73	0.95	0.110	1.05	0.104	1.10	1.10	0.104	No
100	16.88	0.94	0.20	0.74	0.95	0.110	1.05	0.104	1.10	1.10	0.104	No
101	17.19	0.96	0.21	0.75	0.95	0.111	1.05	0.105	1.10	1.10	0.105	No
102	17.37	0.97	0.21	0.76	0.95	0.111	1.05	0.105	1.10	1.10	0.105	No
103	17.52	0.98	0.22	0.76	0.95	0.111	1.05	0.106	1.10	1.10	0.106	No
104	17.69	0.99	0.22	0.77	0.95	0.112	1.05	0.106	1.10	1.10	0.106	No
105	17.86	1.00	0.23	0.77	0.95	0.112	1.05	0.106	1.09	1.10	0.107	No
106	18.01	1.01	0.23	0.78	0.95	0.112	1.05	0.107	1.09	1.10	0.107	No
107	18.18	1.02	0.24	0.78	0.95	0.113	1.05	0.107	1.09	1.10	0.108	No
108	18.34	1.03	0.24	0.79	0.95	0.113	1.05	0.107	1.09	1.10	0.108	No
109	18.47	1.04	0.25	0.79	0.95	0.113	1.05	0.107	1.09	1.10	0.109	No
110	18.59	1.05	0.25	0.80	0.95	0.113	1.05	0.108	1.08	1.10	0.109	No
111	18.71	1.06	0.26	0.80	0.95	0.114	1.05	0.108	1.08	1.10	0.109	No
112	18.84	1.07	0.26	0.81	0.95	0.114	1.05	0.108	1.08	1.10	0.110	No
113	18.96	1.07	0.26	0.81	0.94	0.114	1.05	0.108	1.08	1.10	0.110	No
114	19.09	1.08	0.27	0.81	0.94	0.114	1.05	0.108	1.08	1.10	0.110	No
115	19.23	1.09	0.27	0.82	0.94	0.114	1.05	0.109	1.08	1.10	0.111	No
116	19.35	1.10	0.28	0.82	0.94	0.115	1.05	0.109	1.08	1.10	0.111	No
117	19.47	1.11	0.28	0.83	0.94	0.115	1.05	0.109	1.07	1.10	0.112	No
118	19.59	1.12	0.28	0.83	0.94	0.115	1.05	0.109	1.07	1.10	0.112	No
119	19.72	1.12	0.29	0.84	0.94	0.115	1.05	0.109	1.07	1.10	0.112	No
120	19.84	1.13	0.29	0.84	0.94	0.115	1.05	0.109	1.07	1.10	0.113	No
121	19.96	1.14	0.30	0.84	0.94	0.116	1.05	0.110	1.07	1.10	0.113	No
122	20.08	1.15	0.30	0.85	0.94	0.116	1.05	0.110	1.06	1.10	0.114	No
123	20.21	1.15	0.30	0.85	0.94	0.116	1.05	0.110	1.05	1.10	0.115	No
124	20.27	1.16	0.30	0.85	0.94	0.116	1.05	0.110	1.04	1.10	0.116	No
125	20.45	1.17	0.31	0.86	0.94	0.116	1.05	0.110	1.04	1.10	0.117	No
126	20.54	1.17	0.31	0.86	0.94	0.116	1.05	0.110	1.03	1.10	0.118	No
127	20.65	1.18	0.32	0.86	0.94	0.117	1.05	0.111	1.03	1.10	0.118	No
128	20.75	1.19	0.32	0.87	0.94	0.117	1.05	0.111	1.03	1.10	0.119	No
129	20.84	1.19	0.32	0.87	0.94	0.117	1.05	0.111	1.02	1.10	0.119	No
130	20.95	1.20	0.33	0.87	0.94	0.117	1.05	0.111	1.02	1.10	0.120	No
131	21.05	1.21	0.33	0.88	0.94	0.117	1.05	0.111	1.02	1.10	0.120	No
132	21.15	1.21	0.33	0.88	0.94	0.117	1.05	0.111	1.02	1.10	0.120	No
133	21.27	1.22	0.34	0.88	0.94	0.117	1.05	0.111	1.02	1.10	0.120	No
134	21.36	1.23	0.34	0.89	0.93	0.118	1.05	0.112	1.02	1.10	0.120	No
135	21.46	1.23	0.34	0.89	0.93	0.118	1.05	0.112	1.02	1.10	0.121	No
136	21.57	1.24	0.35	0.89	0.93	0.118	1.05	0.112	1.02	1.10	0.121	No
137	21.66	1.24	0.35	0.90	0.93	0.118	1.05	0.112	1.02	1.10	0.121	No
138	21.76	1.25	0.35	0.90	0.93	0.118	1.05	0.112	1.01	1.10	0.121	No
139	21.88	1.26	0.35	0.90	0.93	0.118	1.05	0.112	1.01	1.10	0.122	No
140	21.97	1.26	0.36	0.90	0.93	0.118	1.05	0.112	1.01	1.10	0.122	No
141	22.09	1.27	0.36	0.91	0.93	0.119	1.05	0.112	1.01	1.10	0.122	No
142	22.18	1.28	0.36	0.91	0.93	0.119	1.05	0.113	1.01	1.10	0.122	No
143	22.29	1.28	0.37	0.91	0.93	0.119	1.05	0.113	1.01	1.10	0.122	No
144	22.40	1.29	0.37	0.92	0.93	0.119	1.05	0.113	1.01	1.10	0.123	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
145	22.50	1.29	0.37	0.92	0.93	0.119	1.05	0.113	1.01	1.10	0.123	No
146	22.61	1.30	0.38	0.92	0.93	0.119	1.05	0.113	1.01	1.10	0.123	No
147	22.70	1.31	0.38	0.93	0.93	0.119	1.05	0.113	1.01	1.10	0.123	No
148	22.81	1.31	0.38	0.93	0.93	0.119	1.05	0.113	1.01	1.10	0.123	No
149	22.91	1.32	0.39	0.93	0.93	0.120	1.05	0.113	1.01	1.10	0.123	No
150	23.02	1.33	0.39	0.94	0.93	0.120	1.05	0.113	1.01	1.10	0.123	No
151	23.13	1.33	0.39	0.94	0.93	0.120	1.05	0.114	1.01	1.10	0.123	No
152	23.22	1.34	0.40	0.94	0.93	0.120	1.05	0.114	1.01	1.10	0.124	No
153	23.44	1.35	0.40	0.95	0.93	0.120	1.05	0.114	1.01	1.10	0.124	No
154	23.53	1.36	0.41	0.95	0.93	0.120	1.05	0.114	1.01	1.10	0.124	No
155	23.65	1.37	0.41	0.96	0.92	0.120	1.05	0.114	1.01	1.10	0.124	No
156	23.74	1.37	0.41	0.96	0.92	0.120	1.05	0.114	1.01	1.10	0.124	No
157	23.84	1.38	0.42	0.96	0.92	0.120	1.05	0.114	1.01	1.10	0.124	No
158	23.96	1.39	0.42	0.97	0.92	0.121	1.05	0.114	1.01	1.10	0.125	No
159	24.06	1.39	0.42	0.97	0.92	0.121	1.05	0.114	1.01	1.10	0.125	No
160	24.17	1.40	0.43	0.97	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
161	24.26	1.40	0.43	0.98	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
162	24.38	1.41	0.43	0.98	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
163	24.48	1.42	0.44	0.98	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
164	24.60	1.43	0.44	0.99	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
165	24.69	1.43	0.44	0.99	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
166	24.81	1.44	0.45	0.99	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
167	24.90	1.45	0.45	1.00	0.92	0.121	1.05	0.115	1.01	1.10	0.125	No
168	25.02	1.45	0.45	1.00	0.92	0.121	1.05	0.115	1.02	1.10	0.125	No
169	25.11	1.46	0.46	1.00	0.92	0.122	1.05	0.115	1.02	1.10	0.125	No
170	25.22	1.47	0.46	1.01	0.92	0.122	1.05	0.115	1.01	1.10	0.125	No
171	25.33	1.47	0.46	1.01	0.92	0.122	1.05	0.115	1.01	1.10	0.125	No
172	25.50	1.48	0.47	1.01	0.92	0.122	1.05	0.116	1.01	1.10	0.126	No
173	25.60	1.48	0.47	1.01	0.92	0.122	1.05	0.116	1.01	1.10	0.126	No

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.27	128.74	6.00	1.34	0.32	1.70	207.46	0.51	207.97	4.000	No	No	2.00
2	2.46	122.27	11.23	1.71	0.28	1.70	205.57	31.41	236.98	4.000	No	No	2.00
3	2.65	113.65	12.68	1.79	0.31	1.70	178.19	39.21	217.40	4.000	No	No	2.00
4	2.85	103.74	14.33	1.87	0.31	1.70	164.02	47.39	211.41	4.000	No	No	2.00
5	2.98	94.12	15.27	1.92	0.32	1.70	157.82	51.14	208.95	4.000	No	No	2.00
6	3.13	84.43	16.06	1.96	0.36	1.70	131.78	49.00	180.78	4.000	No	No	2.00
7	3.28	77.41	16.31	1.97	0.38	1.70	117.35	46.66	164.01	4.000	No	No	2.00
8	3.43	76.01	15.75	1.94	0.37	1.70	123.96	46.02	169.98	4.000	No	No	2.00
9	3.57	74.36	15.01	1.91	0.37	1.70	125.04	43.17	168.21	4.000	No	No	2.00
10	3.71	66.30	15.50	1.93	0.40	1.70	109.39	41.90	151.30	4.000	No	No	2.00
11	3.86	51.38	18.17	2.05	0.44	1.70	85.11	44.25	129.37	4.000	No	No	2.00
12	3.95	38.79	22.30	2.22	0.51	1.70	53.15	41.90	95.05	4.000	No	No	2.00
13	4.11	28.49	27.40	2.40	0.51	1.70	48.69	44.22	92.91	4.000	No	No	2.00
14	4.24	24.77	29.04	2.46	0.56	1.70	35.48	40.54	76.01	4.000	No	No	2.00
15	4.36	22.47	29.85	2.48	0.56	1.70	35.21	40.71	75.92	4.000	No	No	2.00
16	4.48	22.19	29.44	2.47	0.55	1.70	37.63	41.39	79.03	4.000	No	No	2.00
17	4.62	21.27	29.75	2.48	0.56	1.70	34.13	40.32	74.45	4.000	No	No	2.00
18	4.75	21.58	28.55	2.44	0.57	1.70	30.75	38.80	69.55	4.000	No	No	2.00
19	4.87	28.55	23.26	2.26	0.55	1.70	39.12	38.53	77.65	4.000	No	No	2.00
20	5.00	36.19	19.86	2.12	0.48	1.70	67.71	42.90	110.61	4.000	No	No	2.00
21	5.14	38.54	19.12	2.09	0.48	1.70	67.58	41.58	109.15	4.000	No	No	2.00
22	5.27	34.20	20.24	2.14	0.52	1.70	50.45	38.63	89.08	4.000	No	No	2.00
23	5.42	33.14	19.16	2.10	0.54	1.70	46.81	36.04	82.85	4.000	No	No	2.00
24	5.55	35.40	16.77	1.99	0.50	1.70	62.45	35.27	97.72	4.000	No	No	2.00
25	5.69	38.82	14.78	1.90	0.52	1.70	61.37	29.44	90.82	4.000	No	No	2.00
26	5.84	40.16	14.32	1.87	0.52	1.70	63.26	28.28	91.55	4.000	No	No	2.00
27	5.97	43.63	13.96	1.85	0.50	1.70	68.93	28.05	96.97	4.000	No	No	2.00
28	6.12	47.80	13.81	1.85	0.48	1.70	78.10	29.12	107.22	4.000	No	No	2.00
29	6.25	52.19	14.04	1.86	0.47	1.70	83.36	31.00	114.36	4.000	No	No	2.00
30	6.40	51.55	15.59	1.94	0.44	1.70	90.10	38.09	128.19	4.000	No	No	2.00
31	6.53	45.37	18.28	2.06	0.46	1.70	75.00	41.88	116.88	4.000	No	No	2.00
32	6.68	36.61	21.49	2.19	0.51	1.70	53.55	41.12	94.67	4.000	No	No	2.00
33	6.82	33.14	21.91	2.21	0.53	1.70	47.88	39.92	87.80	4.000	No	No	2.00
34	6.96	33.67	20.41	2.15	0.50	1.70	58.27	41.09	99.36	4.000	No	No	2.00
35	7.10	31.37	21.00	2.17	0.50	1.70	56.11	41.27	97.39	4.000	No	No	2.00
36	7.33	25.02	25.28	2.33	0.56	1.70	36.82	39.24	76.06	4.000	No	No	2.00
37	7.47	17.85	32.26	2.56	0.58	1.70	27.65	38.78	66.43	4.000	No	No	2.00
38	7.60	13.82	38.22	2.73	0.61	1.70	21.58	0.00	21.58	4.000	No	Yes	2.00
39	7.75	11.31	43.18	2.86	0.63	1.70	17.40	0.00	17.40	4.000	No	Yes	2.00
40	7.89	9.96	46.28	2.94	0.63	1.70	15.51	0.00	15.51	4.000	No	Yes	2.00
41	8.03	9.74	46.36	2.94	0.64	1.70	15.11	0.00	15.11	4.000	No	Yes	2.00
42	8.15	11.87	40.49	2.79	0.63	1.70	16.32	0.00	16.32	4.000	No	Yes	2.00
43	8.30	22.34	26.88	2.39	0.60	1.70	25.76	36.50	62.26	4.000	No	No	2.00
44	8.44	29.53	22.58	2.23	0.48	1.66	63.99	45.47	109.46	4.000	No	No	2.00
45	8.58	31.37	22.69	2.24	0.51	1.70	50.99	41.64	92.63	4.000	No	No	2.00
46	8.73	23.20	29.00	2.46	0.56	1.70	34.67	40.26	74.92	4.000	No	No	2.00
47	8.87	16.71	36.03	2.67	0.59	1.70	26.17	0.00	26.17	4.000	No	Yes	2.00
48	9.00	13.24	40.76	2.80	0.61	1.70	19.69	0.00	19.69	4.000	No	Yes	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	9.15	10.97	43.68	2.88	0.62	1.70	17.94	0.00	17.94	4.000	No	Yes	2.00
50	9.28	9.18	44.95	2.91	0.64	1.70	15.24	0.00	15.24	4.000	No	Yes	2.00
51	9.43	6.88	47.61	2.97	0.66	1.70	11.06	0.00	11.06	4.000	No	Yes	2.00
52	9.55	4.90	51.48	3.06	0.68	1.70	6.88	0.00	6.88	4.000	No	Yes	2.00
53	9.71	4.25	53.22	3.10	0.69	1.70	5.67	0.00	5.67	4.000	No	Yes	2.00
54	9.84	4.53	52.06	3.08	0.67	1.70	7.96	0.00	7.96	4.000	No	Yes	2.00
55	9.98	4.98	50.46	3.04	0.67	1.70	8.23	0.00	8.23	4.000	No	Yes	2.00
56	10.13	5.04	50.49	3.04	0.67	1.70	7.82	0.00	7.82	4.000	No	Yes	2.00
57	10.26	5.12	50.35	3.04	0.67	1.70	8.23	0.00	8.23	4.000	No	Yes	2.00
58	10.41	5.63	49.05	3.01	0.67	1.70	8.63	0.00	8.63	4.000	No	Yes	2.00
59	10.68	6.05	48.06	2.98	0.66	1.69	10.21	0.00	10.21	0.600	No	Yes	2.00
60	10.83	6.33	47.38	2.97	0.66	1.69	10.17	0.00	10.17	0.626	No	Yes	2.00
61	10.96	6.38	47.63	2.97	0.66	1.68	9.88	0.00	9.88	0.628	No	Yes	2.00
62	11.11	6.47	48.44	2.99	0.66	1.67	10.36	0.00	10.36	0.632	No	Yes	2.00
63	11.23	6.47	49.00	3.01	0.66	1.67	10.45	0.00	10.45	0.628	No	Yes	2.00
64	11.38	5.83	50.88	3.05	0.66	1.67	9.78	0.00	9.78	0.556	No	Yes	2.00
65	11.51	5.07	52.43	3.09	0.68	1.68	7.32	0.00	7.32	0.474	No	Yes	2.00
66	11.66	4.51	53.67	3.11	0.68	1.68	6.91	0.00	6.91	0.413	No	Yes	2.00
67	11.79	4.43	53.17	3.10	0.68	1.67	7.15	0.00	7.15	0.402	No	Yes	2.00
68	11.93	4.40	53.32	3.11	0.68	1.66	6.87	0.00	6.87	0.396	No	Yes	2.00
69	12.07	4.31	53.66	3.11	0.68	1.66	6.72	0.00	6.72	0.385	No	Yes	2.00
70	12.21	4.29	53.09	3.10	0.68	1.66	6.70	0.00	6.70	0.380	No	Yes	2.00
71	12.35	4.45	50.56	3.04	0.68	1.65	6.68	0.00	6.68	0.395	No	Yes	2.00
72	12.48	4.59	48.14	2.99	0.68	1.64	7.42	0.00	7.42	0.406	No	Yes	2.00
73	12.63	4.48	47.80	2.98	0.68	1.64	7.28	0.00	7.28	0.393	No	Yes	2.00
74	12.77	4.26	48.73	3.00	0.68	1.64	6.12	0.00	6.12	0.368	No	Yes	2.00
75	12.91	4.01	49.18	3.01	0.68	1.64	6.36	0.00	6.36	0.341	No	Yes	2.00
76	13.06	3.95	47.05	2.96	0.68	1.63	6.09	0.00	6.09	0.334	No	Yes	2.00
77	13.18	3.89	43.05	2.86	0.69	1.63	5.83	0.00	5.83	0.326	No	Yes	2.00
78	13.33	4.06	38.98	2.75	0.69	1.63	6.07	0.00	6.07	0.341	No	Yes	2.00
79	13.46	4.20	38.08	2.73	0.68	1.62	6.81	0.00	6.81	0.354	No	Yes	2.00
80	13.61	3.95	42.72	2.85	0.68	1.62	6.42	0.00	6.42	0.327	No	Yes	2.00
81	13.67	6.16	40.72	2.80	0.69	1.63	4.90	0.00	4.90	0.543	No	Yes	2.00
82	13.94	17.58	25.78	2.35	0.64	1.56	16.31	32.94	49.25	0.077	No	No	0.74
83	14.13	31.29	20.59	2.15	0.52	1.42	51.75	39.48	91.23	0.129	No	No	1.24
84	14.28	38.62	18.99	2.09	0.50	1.41	58.86	39.01	97.87	0.139	No	No	1.34
85	14.40	32.35	20.84	2.16	0.54	1.43	44.86	37.82	82.68	0.116	No	No	1.11
86	14.59	21.97	25.29	2.33	0.59	1.48	27.48	36.26	63.74	0.092	No	No	0.87
87	14.74	17.10	27.73	2.42	0.63	1.51	18.79	34.56	53.35	0.081	No	No	0.76
88	14.91	22.53	23.98	2.28	0.60	1.48	25.80	34.94	60.74	0.089	No	No	0.83
89	15.07	47.63	16.02	1.96	0.55	1.42	48.34	30.15	78.50	0.111	No	No	1.03
90	15.23	90.42	11.45	1.72	0.43	1.32	110.11	22.35	132.46	0.210	No	No	1.99
91	15.41	145.39	8.92	1.56	0.35	1.25	172.83	11.16	184.00	0.608	No	No	2.00
92	15.56	194.19	7.86	1.49	0.29	1.19	226.61	6.38	232.99	4.000	No	No	2.00
93	15.73	227.83	7.51	1.46	0.26	1.17	260.65	5.15	265.80	4.000	No	No	2.00
94	15.90	242.36	7.61	1.47	0.26	1.17	274.22	5.91	280.14	4.000	No	No	2.00
95	16.06	247.51	7.66	1.47	0.26	1.17	269.86	6.10	275.96	4.000	No	No	2.00
96	16.23	254.09	7.57	1.47	0.26	1.17	275.74	5.71	281.45	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
97	16.39	258.42	7.58	1.47	0.26	1.16	293.92	6.02	299.94	4.000	No	No	2.00
98	16.57	251.96	7.89	1.49	0.26	1.16	282.12	7.71	289.83	4.000	No	No	2.00
99	16.72	230.86	8.54	1.54	0.26	1.16	252.58	11.56	264.14	4.000	No	No	2.00
100	16.88	212.97	8.93	1.56	0.28	1.17	224.90	13.49	238.39	4.000	No	No	2.00
101	17.19	226.97	8.58	1.54	0.29	1.16	223.88	10.82	234.70	4.000	No	No	2.00
102	17.37	258.65	8.01	1.50	0.26	1.15	295.78	8.85	304.63	4.000	No	No	2.00
103	17.52	297.16	7.62	1.47	0.26	1.14	323.56	6.73	330.29	4.000	No	No	2.00
104	17.69	318.82	7.39	1.45	0.26	1.14	344.42	5.67	350.09	4.000	No	No	2.00
105	17.86	328.61	7.18	1.44	0.26	1.14	363.66	4.72	368.38	4.000	No	No	2.00
106	18.01	330.27	7.04	1.43	0.26	1.14	352.88	3.87	356.75	4.000	No	No	2.00
107	18.18	325.23	7.18	1.44	0.26	1.13	347.36	4.53	351.89	4.000	No	No	2.00
108	18.34	321.03	7.56	1.47	0.26	1.13	345.08	6.71	351.79	4.000	No	No	2.00
109	18.47	314.01	8.09	1.50	0.26	1.13	337.20	10.49	347.70	4.000	No	No	2.00
110	18.59	302.76	8.65	1.54	0.26	1.13	322.96	14.94	337.89	4.000	No	No	2.00
111	18.71	289.19	9.08	1.57	0.26	1.13	307.41	18.53	325.94	4.000	No	No	2.00
112	18.84	275.59	9.37	1.59	0.26	1.12	292.27	20.67	312.94	4.000	No	No	2.00
113	18.96	262.12	9.57	1.60	0.26	1.12	278.09	21.83	299.92	4.000	No	No	2.00
114	19.09	249.19	9.63	1.61	0.26	1.12	263.12	21.50	284.62	4.000	No	No	2.00
115	19.23	237.21	9.55	1.60	0.26	1.12	249.81	19.93	269.74	4.000	No	No	2.00
116	19.35	228.79	9.31	1.59	0.26	1.12	238.80	17.21	256.01	4.000	No	No	2.00
117	19.47	227.73	8.94	1.56	0.27	1.12	235.75	13.98	249.74	4.000	No	No	2.00
118	19.59	232.37	8.57	1.54	0.26	1.11	245.31	11.52	256.84	4.000	No	No	2.00
119	19.72	235.70	8.39	1.52	0.26	1.11	252.35	10.39	262.74	4.000	No	No	2.00
120	19.84	229.43	8.67	1.54	0.26	1.11	244.67	12.24	256.90	4.000	No	No	2.00
121	19.96	213.68	8.93	1.56	0.28	1.11	225.95	13.50	239.45	4.000	No	No	2.00
122	20.08	195.46	9.05	1.57	0.31	1.12	205.07	13.44	218.51	3.195	No	No	2.00
123	20.21	176.34	9.05	1.57	0.32	1.13	190.86	12.83	203.69	1.358	No	No	2.00
124	20.27	162.38	9.18	1.58	0.35	1.14	169.55	12.70	182.25	0.574	No	No	2.00
125	20.45	148.10	10.07	1.64	0.36	1.14	162.78	18.41	181.20	0.556	No	No	2.00
126	20.54	136.88	11.49	1.72	0.37	1.14	146.73	26.78	173.51	0.446	No	No	2.00
127	20.65	124.88	13.66	1.84	0.37	1.14	133.24	38.09	171.33	0.421	No	No	2.00
128	20.75	115.89	15.66	1.94	0.37	1.14	124.17	45.71	169.88	0.406	No	No	2.00
129	20.84	103.52	17.59	2.03	0.37	1.14	117.40	50.91	168.31	0.391	No	No	2.00
130	20.95	90.12	19.30	2.10	0.41	1.15	94.21	49.15	143.36	0.244	No	No	2.00
131	21.05	81.88	19.92	2.13	0.44	1.16	82.31	47.07	129.37	0.201	No	No	1.68
132	21.15	84.57	18.52	2.07	0.42	1.15	91.77	46.80	138.58	0.228	No	No	1.90
133	21.27	90.25	16.84	1.99	0.41	1.15	102.24	44.91	147.15	0.259	No	No	2.00
134	21.36	90.36	16.31	1.97	0.42	1.15	99.72	42.64	142.36	0.241	No	No	2.00
135	21.46	84.31	17.28	2.01	0.43	1.15	91.83	43.69	135.52	0.218	No	No	1.81
136	21.57	78.91	18.56	2.07	0.44	1.15	83.11	44.60	127.70	0.197	No	No	1.63
137	21.66	74.83	19.13	2.09	0.44	1.15	82.41	45.60	128.02	0.198	No	No	1.63
138	21.76	68.25	19.65	2.12	0.45	1.15	78.62	45.57	124.19	0.189	No	No	1.56
139	21.88	56.94	21.48	2.19	0.49	1.16	62.13	43.63	105.77	0.152	No	No	1.25
140	21.97	48.54	24.34	2.30	0.53	1.17	46.49	41.66	88.15	0.124	No	No	1.02
141	22.09	49.97	24.70	2.31	0.51	1.17	51.79	43.60	95.39	0.135	No	No	1.10
142	22.18	57.07	23.31	2.26	0.47	1.15	66.17	46.89	113.06	0.166	No	No	1.35
143	22.29	60.31	23.03	2.25	0.47	1.15	68.48	47.31	115.80	0.171	No	No	1.40
144	22.40	56.85	24.51	2.30	0.48	1.15	61.64	46.55	108.19	0.157	No	No	1.28

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
145	22.50	54.84	25.35	2.33	0.50	1.15	54.97	45.07	100.04	0.143	No	No	1.16
146	22.61	61.07	23.31	2.26	0.48	1.15	61.89	45.57	107.46	0.155	No	No	1.26
147	22.70	78.04	19.23	2.10	0.45	1.13	80.64	45.33	125.97	0.193	No	No	1.57
148	22.81	95.15	16.43	1.98	0.40	1.12	106.97	44.71	151.68	0.279	No	No	2.00
149	22.91	105.41	15.18	1.92	0.39	1.11	114.12	41.64	155.76	0.300	No	No	2.00
150	23.02	104.37	15.56	1.93	0.40	1.11	111.55	42.58	154.12	0.292	No	No	2.00
151	23.13	96.66	17.16	2.01	0.40	1.11	103.30	46.14	149.43	0.269	No	No	2.00
152	23.22	86.81	19.35	2.10	0.42	1.12	90.02	48.11	138.13	0.226	No	No	1.83
153	23.44	81.41	21.09	2.17	0.44	1.12	80.85	48.56	129.41	0.201	No	No	1.62
154	23.53	91.80	20.10	2.13	0.43	1.11	86.26	48.49	134.75	0.216	No	No	1.74
155	23.65	104.55	18.77	2.08	0.36	1.09	120.28	54.93	175.21	0.467	No	No	2.00
156	23.74	108.07	18.42	2.06	0.37	1.09	118.60	53.58	172.18	0.430	No	No	2.00
157	23.84	95.14	20.04	2.13	0.41	1.10	96.37	51.22	147.59	0.261	No	No	2.00
158	23.96	88.09	20.94	2.17	0.44	1.11	81.27	48.46	129.73	0.202	No	No	1.62
159	24.06	94.67	19.46	2.11	0.41	1.10	97.10	50.29	147.39	0.260	No	No	2.00
160	24.17	112.57	16.29	1.97	0.38	1.09	115.71	46.22	161.92	0.339	No	No	2.00
161	24.26	131.74	13.73	1.84	0.37	1.08	134.63	38.70	173.34	0.444	No	No	2.00
162	24.38	150.43	12.28	1.77	0.35	1.08	154.02	33.00	187.02	0.674	No	No	2.00
163	24.48	164.23	12.41	1.77	0.32	1.07	170.36	36.22	206.58	1.574	No	No	2.00
164	24.60	167.20	13.62	1.84	0.31	1.06	173.96	44.93	218.89	3.277	No	No	2.00
165	24.69	163.48	15.13	1.91	0.31	1.07	161.30	51.17	212.47	2.188	No	No	2.00
166	24.81	166.20	15.88	1.95	0.31	1.06	158.19	54.13	212.33	2.169	No	No	2.00
167	24.90	193.78	15.02	1.91	0.29	1.06	180.78	54.58	235.36	4.000	No	No	2.00
168	25.02	225.59	13.81	1.85	0.26	1.05	241.29	58.05	299.34	4.000	No	No	2.00
169	25.11	251.39	10.53	1.66	0.26	1.05	250.79	29.37	280.16	4.000	No	No	2.00
170	25.22	321.14	5.44	1.29	0.26	1.05	256.18	0.16	256.34	4.000	No	No	2.00
171	25.33	459.49	-1.00	N/A	0.26	1.05	448.02	0.00	448.02	4.000	No	No	2.00
172	25.50	595.96	-1.00	N/A	0.26	1.05	661.33	0.00	661.33	4.000	No	No	2.00
173	25.60	699.17	-1.00	N/A	0.26	1.05	707.62	0.00	707.62	4.000	No	No	2.00

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.27	2.00	0.00	9.65	0.18	0.00	2.46	2.00	0.00	9.63	0.18	0.00
2.65	2.00	0.00	9.60	0.20	0.00	2.85	2.00	0.00	9.57	0.20	0.00
2.98	2.00	0.00	9.55	0.13	0.00	3.13	2.00	0.00	9.52	0.16	0.00
3.28	2.00	0.00	9.50	0.14	0.00	3.43	2.00	0.00	9.48	0.15	0.00
3.57	2.00	0.00	9.46	0.14	0.00	3.71	2.00	0.00	9.43	0.14	0.00
3.86	2.00	0.00	9.41	0.14	0.00	3.95	2.00	0.00	9.40	0.09	0.00
4.11	2.00	0.00	9.37	0.16	0.00	4.24	2.00	0.00	9.35	0.13	0.00
4.36	2.00	0.00	9.34	0.12	0.00	4.48	2.00	0.00	9.32	0.12	0.00
4.62	2.00	0.00	9.30	0.14	0.00	4.75	2.00	0.00	9.28	0.13	0.00
4.87	2.00	0.00	9.26	0.12	0.00	5.00	2.00	0.00	9.24	0.13	0.00
5.14	2.00	0.00	9.22	0.15	0.00	5.27	2.00	0.00	9.20	0.13	0.00
5.42	2.00	0.00	9.17	0.15	0.00	5.55	2.00	0.00	9.15	0.13	0.00
5.69	2.00	0.00	9.13	0.14	0.00	5.84	2.00	0.00	9.11	0.15	0.00
5.97	2.00	0.00	9.09	0.13	0.00	6.12	2.00	0.00	9.07	0.15	0.00
6.25	2.00	0.00	9.05	0.14	0.00	6.40	2.00	0.00	9.03	0.14	0.00
6.53	2.00	0.00	9.00	0.14	0.00	6.68	2.00	0.00	8.98	0.15	0.00
6.82	2.00	0.00	8.96	0.14	0.00	6.96	2.00	0.00	8.94	0.14	0.00
7.10	2.00	0.00	8.92	0.13	0.00	7.33	2.00	0.00	8.88	0.23	0.00
7.47	2.00	0.00	8.86	0.14	0.00	7.60	2.00	0.00	8.84	0.13	0.00
7.75	2.00	0.00	8.82	0.15	0.00	7.89	2.00	0.00	8.80	0.14	0.00
8.03	2.00	0.00	8.78	0.14	0.00	8.15	2.00	0.00	8.76	0.12	0.00
8.30	2.00	0.00	8.73	0.15	0.00	8.44	2.00	0.00	8.71	0.14	0.00
8.58	2.00	0.00	8.69	0.14	0.00	8.73	2.00	0.00	8.67	0.15	0.00
8.87	2.00	0.00	8.65	0.14	0.00	9.00	2.00	0.00	8.63	0.14	0.00
9.15	2.00	0.00	8.61	0.15	0.00	9.28	2.00	0.00	8.59	0.13	0.00
9.43	2.00	0.00	8.56	0.15	0.00	9.55	2.00	0.00	8.54	0.12	0.00
9.71	2.00	0.00	8.52	0.16	0.00	9.84	2.00	0.00	8.50	0.14	0.00
9.98	2.00	0.00	8.48	0.14	0.00	10.13	2.00	0.00	8.46	0.15	0.00
10.26	2.00	0.00	8.44	0.13	0.00	10.41	2.00	0.00	8.41	0.14	0.00
10.68	2.00	0.00	8.37	0.28	0.00	10.83	2.00	0.00	8.35	0.15	0.00
10.96	2.00	0.00	8.33	0.13	0.00	11.11	2.00	0.00	8.31	0.15	0.00
11.23	2.00	0.00	8.29	0.13	0.00	11.38	2.00	0.00	8.27	0.15	0.00
11.51	2.00	0.00	8.25	0.13	0.00	11.66	2.00	0.00	8.22	0.15	0.00
11.79	2.00	0.00	8.20	0.13	0.00	11.93	2.00	0.00	8.18	0.15	0.00
12.07	2.00	0.00	8.16	0.14	0.00	12.21	2.00	0.00	8.14	0.14	0.00
12.35	2.00	0.00	8.12	0.14	0.00	12.48	2.00	0.00	8.10	0.13	0.00
12.63	2.00	0.00	8.08	0.14	0.00	12.77	2.00	0.00	8.05	0.14	0.00
12.91	2.00	0.00	8.03	0.14	0.00	13.06	2.00	0.00	8.01	0.15	0.00
13.18	2.00	0.00	7.99	0.13	0.00	13.33	2.00	0.00	7.97	0.15	0.00
13.46	2.00	0.00	7.95	0.13	0.00	13.61	2.00	0.00	7.93	0.15	0.00
13.67	2.00	0.00	7.92	0.06	0.00	13.94	0.74	0.26	7.87	0.27	0.17
14.13	1.24	0.00	7.85	0.19	0.00	14.28	1.34	0.00	7.82	0.15	0.00
14.40	1.11	0.00	7.80	0.12	0.00	14.59	0.87	0.13	7.78	0.18	0.06
14.74	0.76	0.24	7.75	0.15	0.09	14.91	0.83	0.17	7.73	0.17	0.07
15.07	1.03	0.00	7.70	0.16	0.00	15.23	1.99	0.00	7.68	0.16	0.00
15.41	2.00	0.00	7.65	0.18	0.00	15.56	2.00	0.00	7.63	0.15	0.00
15.73	2.00	0.00	7.60	0.17	0.00	15.90	2.00	0.00	7.58	0.17	0.00
16.06	2.00	0.00	7.55	0.16	0.00	16.23	2.00	0.00	7.53	0.17	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
16.39	2.00	0.00	7.50	0.16	0.00	16.57	2.00	0.00	7.48	0.18	0.00
16.72	2.00	0.00	7.45	0.15	0.00	16.88	2.00	0.00	7.43	0.16	0.00
17.19	2.00	0.00	7.38	0.32	0.00	17.37	2.00	0.00	7.35	0.18	0.00
17.52	2.00	0.00	7.33	0.15	0.00	17.69	2.00	0.00	7.30	0.17	0.00
17.86	2.00	0.00	7.28	0.17	0.00	18.01	2.00	0.00	7.26	0.15	0.00
18.18	2.00	0.00	7.23	0.17	0.00	18.34	2.00	0.00	7.21	0.16	0.00
18.47	2.00	0.00	7.19	0.13	0.00	18.59	2.00	0.00	7.17	0.12	0.00
18.71	2.00	0.00	7.15	0.12	0.00	18.84	2.00	0.00	7.13	0.13	0.00
18.96	2.00	0.00	7.11	0.12	0.00	19.09	2.00	0.00	7.09	0.13	0.00
19.23	2.00	0.00	7.07	0.13	0.00	19.35	2.00	0.00	7.05	0.12	0.00
19.47	2.00	0.00	7.03	0.12	0.00	19.59	2.00	0.00	7.01	0.12	0.00
19.72	2.00	0.00	7.00	0.12	0.00	19.84	2.00	0.00	6.98	0.12	0.00
19.96	2.00	0.00	6.96	0.12	0.00	20.08	2.00	0.00	6.94	0.12	0.00
20.21	2.00	0.00	6.92	0.13	0.00	20.27	2.00	0.00	6.91	0.05	0.00
20.45	2.00	0.00	6.88	0.18	0.00	20.54	2.00	0.00	6.87	0.09	0.00
20.65	2.00	0.00	6.85	0.11	0.00	20.75	2.00	0.00	6.84	0.10	0.00
20.84	2.00	0.00	6.82	0.09	0.00	20.95	2.00	0.00	6.81	0.11	0.00
21.05	1.68	0.00	6.79	0.10	0.00	21.15	1.90	0.00	6.78	0.10	0.00
21.27	2.00	0.00	6.76	0.11	0.00	21.36	2.00	0.00	6.75	0.09	0.00
21.46	1.81	0.00	6.73	0.10	0.00	21.57	1.63	0.00	6.71	0.11	0.00
21.66	1.63	0.00	6.70	0.09	0.00	21.76	1.56	0.00	6.68	0.10	0.00
21.88	1.25	0.00	6.67	0.11	0.00	21.97	1.02	0.00	6.65	0.09	0.00
22.09	1.10	0.00	6.63	0.12	0.00	22.18	1.35	0.00	6.62	0.09	0.00
22.29	1.40	0.00	6.60	0.11	0.00	22.40	1.28	0.00	6.59	0.10	0.00
22.50	1.16	0.00	6.57	0.10	0.00	22.61	1.26	0.00	6.55	0.11	0.00
22.70	1.57	0.00	6.54	0.10	0.00	22.81	2.00	0.00	6.52	0.11	0.00
22.91	2.00	0.00	6.51	0.10	0.00	23.02	2.00	0.00	6.49	0.11	0.00
23.13	2.00	0.00	6.48	0.11	0.00	23.22	1.83	0.00	6.46	0.10	0.00
23.44	1.62	0.00	6.43	0.21	0.00	23.53	1.74	0.00	6.41	0.09	0.00
23.65	2.00	0.00	6.40	0.12	0.00	23.74	2.00	0.00	6.38	0.09	0.00
23.84	2.00	0.00	6.37	0.10	0.00	23.96	1.62	0.00	6.35	0.12	0.00
24.06	2.00	0.00	6.33	0.10	0.00	24.17	2.00	0.00	6.32	0.11	0.00
24.26	2.00	0.00	6.30	0.09	0.00	24.38	2.00	0.00	6.28	0.12	0.00
24.48	2.00	0.00	6.27	0.10	0.00	24.60	2.00	0.00	6.25	0.11	0.00
24.69	2.00	0.00	6.24	0.09	0.00	24.81	2.00	0.00	6.22	0.12	0.00
24.90	2.00	0.00	6.20	0.09	0.00	25.02	2.00	0.00	6.19	0.11	0.00
25.11	2.00	0.00	6.17	0.10	0.00	25.22	2.00	0.00	6.16	0.11	0.00
25.33	2.00	0.00	6.14	0.10	0.00	25.50	2.00	0.00	6.11	0.17	0.00
25.60	2.00	0.00	6.10	0.10	0.00						

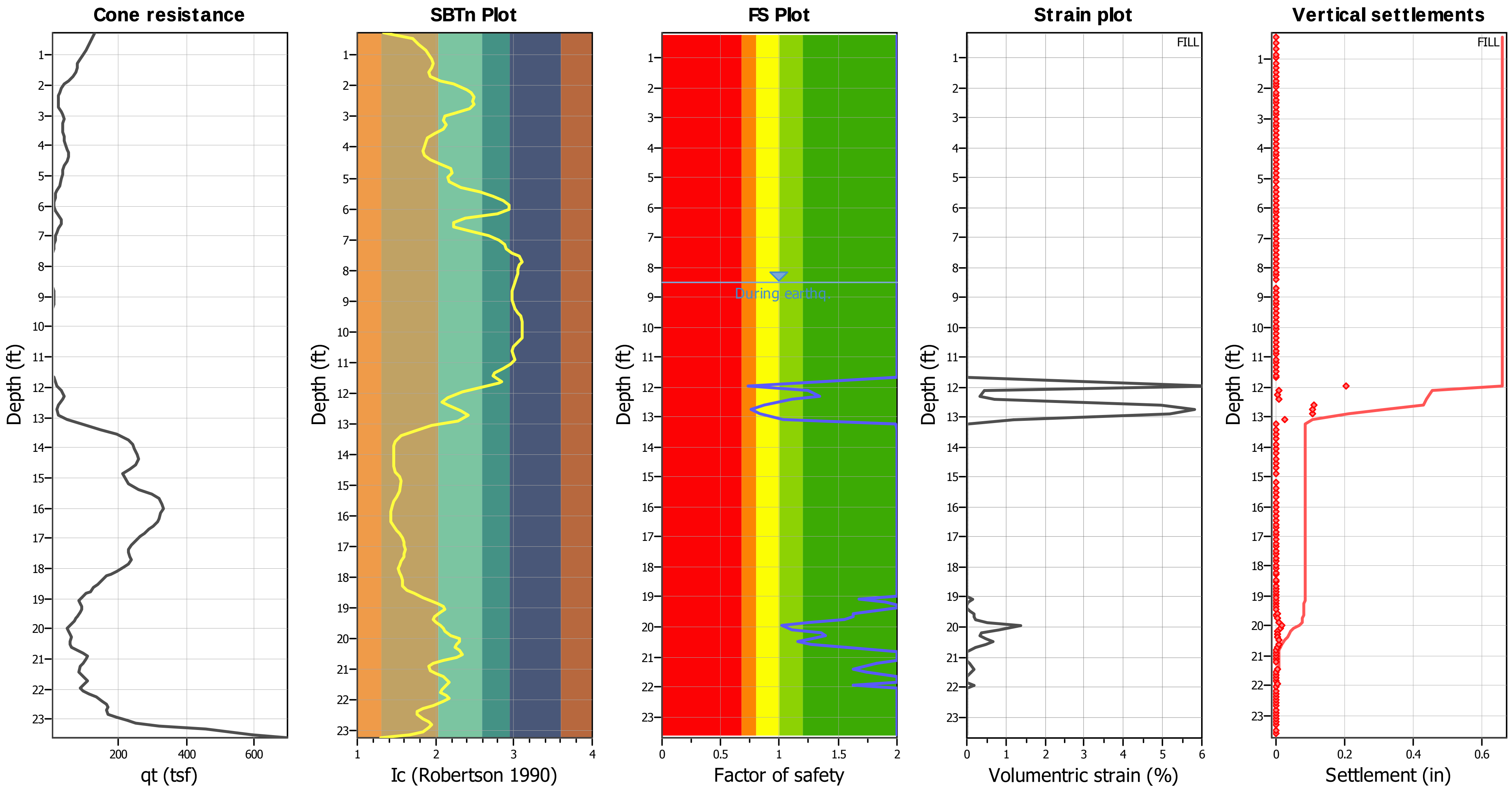
Overall liquefaction potential: 0.39

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.68	10.21	2.00	0.00	1.00	0.00	10.83	10.17	2.00	0.00	1.00	0.00
10.96	9.88	2.00	0.00	1.00	0.00	11.11	10.36	2.00	0.00	1.00	0.00
11.23	10.45	2.00	0.00	1.00	0.00	11.38	9.78	2.00	0.00	1.00	0.00
11.51	7.32	2.00	0.00	1.00	0.00	11.66	6.91	2.00	0.00	1.00	0.00
11.79	7.15	2.00	0.00	1.00	0.00	11.93	6.87	2.00	0.00	1.00	0.00
12.07	6.72	2.00	0.00	1.00	0.00	12.21	6.70	2.00	0.00	1.00	0.00
12.35	6.68	2.00	0.00	1.00	0.00	12.48	7.42	2.00	0.00	1.00	0.00
12.63	7.28	2.00	0.00	1.00	0.00	12.77	6.12	2.00	0.00	1.00	0.00
12.91	6.36	2.00	0.00	1.00	0.00	13.06	6.09	2.00	0.00	1.00	0.00
13.18	5.83	2.00	0.00	1.00	0.00	13.33	6.07	2.00	0.00	1.00	0.00
13.46	6.81	2.00	0.00	1.00	0.00	13.61	6.42	2.00	0.00	1.00	0.00
13.67	4.90	2.00	0.00	1.00	0.00	13.94	49.25	0.74	6.22	1.00	0.20
14.13	91.23	1.24	0.43	1.00	0.01	14.28	97.87	1.34	0.34	1.00	0.01
14.40	82.68	1.11	0.70	1.00	0.01	14.59	63.74	0.87	4.96	1.00	0.11
14.74	53.35	0.76	5.80	1.00	0.11	14.91	60.74	0.83	5.18	1.00	0.11
15.07	78.50	1.03	1.20	1.00	0.02	15.23	132.46	1.99	0.00	1.00	0.00
15.41	184.00	2.00	0.00	1.00	0.00	15.56	232.99	2.00	0.00	1.00	0.00
15.73	265.80	2.00	0.00	1.00	0.00	15.90	280.14	2.00	0.00	1.00	0.00
16.06	275.96	2.00	0.00	1.00	0.00	16.23	281.45	2.00	0.00	1.00	0.00
16.39	299.94	2.00	0.00	1.00	0.00	16.57	289.83	2.00	0.00	1.00	0.00
16.72	264.14	2.00	0.00	1.00	0.00	16.88	238.39	2.00	0.00	1.00	0.00
17.19	234.70	2.00	0.00	1.00	0.00	17.37	304.63	2.00	0.00	1.00	0.00
17.52	330.29	2.00	0.00	1.00	0.00	17.69	350.09	2.00	0.00	1.00	0.00
17.86	368.38	2.00	0.00	1.00	0.00	18.01	356.75	2.00	0.00	1.00	0.00
18.18	351.89	2.00	0.00	1.00	0.00	18.34	351.79	2.00	0.00	1.00	0.00
18.47	347.70	2.00	0.00	1.00	0.00	18.59	337.89	2.00	0.00	1.00	0.00
18.71	325.94	2.00	0.00	1.00	0.00	18.84	312.94	2.00	0.00	1.00	0.00
18.96	299.92	2.00	0.00	1.00	0.00	19.09	284.62	2.00	0.00	1.00	0.00
19.23	269.74	2.00	0.00	1.00	0.00	19.35	256.01	2.00	0.00	1.00	0.00
19.47	249.74	2.00	0.00	1.00	0.00	19.59	256.84	2.00	0.00	1.00	0.00
19.72	262.74	2.00	0.00	1.00	0.00	19.84	256.90	2.00	0.00	1.00	0.00
19.96	239.45	2.00	0.00	1.00	0.00	20.08	218.51	2.00	0.00	1.00	0.00
20.21	203.69	2.00	0.00	1.00	0.00	20.27	182.25	2.00	0.00	1.00	0.00
20.45	181.20	2.00	0.00	1.00	0.00	20.54	173.51	2.00	0.00	1.00	0.00
20.65	171.33	2.00	0.00	1.00	0.00	20.75	169.88	2.00	0.00	1.00	0.00
20.84	168.31	2.00	0.00	1.00	0.00	20.95	143.36	2.00	0.00	1.00	0.00
21.05	129.37	1.68	0.15	1.00	0.00	21.15	138.58	1.90	0.04	1.00	0.00
21.27	147.15	2.00	0.00	1.00	0.00	21.36	142.36	2.00	0.00	1.00	0.00
21.46	135.52	1.81	0.08	1.00	0.00	21.57	127.70	1.63	0.17	1.00	0.00
21.66	128.02	1.63	0.17	1.00	0.00	21.76	124.19	1.56	0.22	1.00	0.00
21.88	105.77	1.25	0.50	1.00	0.01	21.97	88.15	1.02	1.39	1.00	0.02
22.09	95.39	1.10	0.82	1.00	0.01	22.18	113.06	1.35	0.38	1.00	0.00
22.29	115.80	1.40	0.34	1.00	0.00	22.40	108.19	1.28	0.47	1.00	0.01
22.50	100.04	1.16	0.67	1.00	0.01	22.61	107.46	1.26	0.49	1.00	0.01
22.70	125.97	1.57	0.21	1.00	0.00	22.81	151.68	2.00	0.00	1.00	0.00
22.91	155.76	2.00	0.00	1.00	0.00	23.02	154.12	2.00	0.00	1.00	0.00
23.13	149.43	2.00	0.00	1.00	0.00	23.22	138.13	1.83	0.07	1.00	0.00
23.44	129.41	1.62	0.18	1.00	0.00	23.53	134.75	1.74	0.11	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

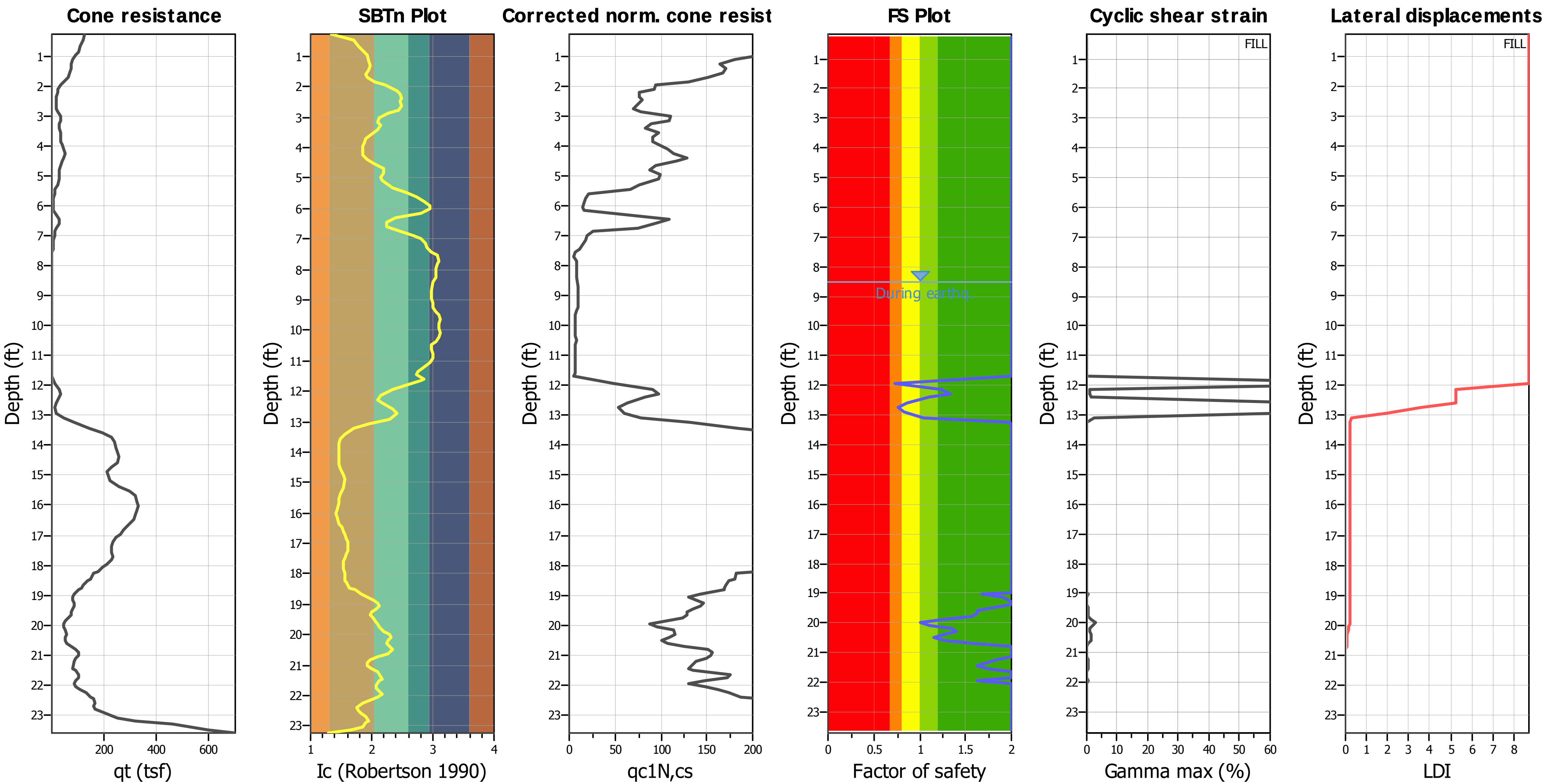
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
23.65	175.21	2.00	0.00	1.00	0.00	23.74	172.18	2.00	0.00	1.00	0.00
23.84	147.59	2.00	0.00	1.00	0.00	23.96	129.73	1.62	0.18	1.00	0.00
24.06	147.39	2.00	0.00	1.00	0.00	24.17	161.92	2.00	0.00	1.00	0.00
24.26	173.34	2.00	0.00	1.00	0.00	24.38	187.02	2.00	0.00	1.00	0.00
24.48	206.58	2.00	0.00	1.00	0.00	24.60	218.89	2.00	0.00	1.00	0.00
24.69	212.47	2.00	0.00	1.00	0.00	24.81	212.33	2.00	0.00	1.00	0.00
24.90	235.36	2.00	0.00	1.00	0.00	25.02	299.34	2.00	0.00	1.00	0.00
25.11	280.16	2.00	0.00	1.00	0.00	25.22	256.34	2.00	0.00	1.00	0.00
25.33	448.02	2.00	0.00	1.00	0.00	25.50	661.33	2.00	0.00	1.00	0.00
25.60	707.62	2.00	0.00	1.00	0.00						

Total estimated settlement: 0.66

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.68	10.21	0.00	2.00	0.00	0.00	0.00
10.83	10.17	0.00	2.00	0.00	0.00	0.00
10.96	9.88	0.00	2.00	0.00	0.00	0.00
11.11	10.36	0.00	2.00	0.00	0.00	0.00
11.23	10.45	0.00	2.00	0.00	0.00	0.00
11.38	9.78	0.00	2.00	0.00	0.00	0.00
11.51	7.32	0.00	2.00	0.00	0.00	0.00
11.66	6.91	0.00	2.00	0.00	0.00	0.00
11.79	7.15	0.00	2.00	0.00	0.00	0.00
11.93	6.87	0.00	2.00	0.00	0.00	0.00
12.07	6.72	0.00	2.00	0.00	0.00	0.00
12.21	6.70	0.00	2.00	0.00	0.00	0.00
12.35	6.68	0.00	2.00	0.00	0.00	0.00
12.48	7.42	0.00	2.00	0.00	0.00	0.00
12.63	7.28	0.00	2.00	0.00	0.00	0.00
12.77	6.12	0.00	2.00	0.00	0.00	0.00
12.91	6.36	0.00	2.00	0.00	0.00	0.00
13.06	6.09	0.00	2.00	0.00	0.00	0.00
13.18	5.83	0.00	2.00	0.00	0.00	0.00
13.33	6.07	0.00	2.00	0.00	0.00	0.00
13.46	6.81	0.00	2.00	0.00	0.00	0.00
13.61	6.42	0.00	2.00	0.00	0.00	0.00
13.67	4.90	0.00	2.00	0.00	0.00	0.00
13.94	49.25	1.05	0.74	0.94	1.05	3.44
14.13	91.23	0.38	1.24	0.86	0.01	0.02
14.28	97.87	0.33	1.34	0.81	0.01	0.01
14.40	82.68	0.46	1.11	0.91	0.01	0.02
14.59	63.74	0.73	0.87	0.94	0.73	1.60
14.74	53.35	0.94	0.76	0.94	0.94	1.74
14.91	60.74	0.78	0.83	0.94	0.78	1.61
15.07	78.50	0.51	1.03	0.92	0.02	0.05
15.23	132.46	0.14	1.99	0.46	0.00	0.00
15.41	184.00	0.04	2.00	-0.22	0.00	0.00
15.56	232.99	0.01	2.00	-0.95	0.00	0.00
15.73	265.80	0.00	2.00	-1.46	0.00	0.00
15.90	280.14	0.00	2.00	-1.69	0.00	0.00
16.06	275.96	0.00	2.00	-1.62	0.00	0.00
16.23	281.45	0.00	2.00	-1.71	0.00	0.00
16.39	299.94	0.00	2.00	-2.00	0.00	0.00
16.57	289.83	0.00	2.00	-1.84	0.00	0.00
16.72	264.14	0.00	2.00	-1.44	0.00	0.00
16.88	238.39	0.00	2.00	-1.03	0.00	0.00
17.19	234.70	0.01	2.00	-0.98	0.00	0.00
17.37	304.63	0.00	2.00	-2.08	0.00	0.00
17.52	330.29	0.00	2.00	-2.49	0.00	0.00
17.69	350.09	0.00	2.00	-2.81	0.00	0.00
17.86	368.38	0.00	2.00	-3.10	0.00	0.00
18.01	356.75	0.00	2.00	-2.91	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
18.18	351.89	0.00	2.00	-2.83	0.00	0.00
18.34	351.79	0.00	2.00	-2.83	0.00	0.00
18.47	347.70	0.00	2.00	-2.77	0.00	0.00
18.59	337.89	0.00	2.00	-2.61	0.00	0.00
18.71	325.94	0.00	2.00	-2.42	0.00	0.00
18.84	312.94	0.00	2.00	-2.21	0.00	0.00
18.96	299.92	0.00	2.00	-2.00	0.00	0.00
19.09	284.62	0.00	2.00	-1.76	0.00	0.00
19.23	269.74	0.00	2.00	-1.52	0.00	0.00
19.35	256.01	0.00	2.00	-1.31	0.00	0.00
19.47	249.74	0.00	2.00	-1.21	0.00	0.00
19.59	256.84	0.00	2.00	-1.32	0.00	0.00
19.72	262.74	0.00	2.00	-1.41	0.00	0.00
19.84	256.90	0.00	2.00	-1.32	0.00	0.00
19.96	239.45	0.00	2.00	-1.05	0.00	0.00
20.08	218.51	0.01	2.00	-0.73	0.00	0.00
20.21	203.69	0.02	2.00	-0.51	0.00	0.00
20.27	182.25	0.04	2.00	-0.19	0.00	0.00
20.45	181.20	0.04	2.00	-0.18	0.00	0.00
20.54	173.51	0.05	2.00	-0.07	0.00	0.00
20.65	171.33	0.05	2.00	-0.04	0.00	0.00
20.75	169.88	0.05	2.00	-0.02	0.00	0.00
20.84	168.31	0.06	2.00	0.00	0.00	0.00
20.95	143.36	0.11	2.00	0.33	0.00	0.00
21.05	129.37	0.16	1.68	0.50	0.00	0.01
21.15	138.58	0.12	1.90	0.39	0.00	0.00
21.27	147.15	0.10	2.00	0.28	0.00	0.00
21.36	142.36	0.11	2.00	0.34	0.00	0.00
21.46	135.52	0.13	1.81	0.43	0.00	0.00
21.57	127.70	0.16	1.63	0.52	0.01	0.01
21.66	128.02	0.16	1.63	0.52	0.01	0.01
21.76	124.19	0.18	1.56	0.56	0.01	0.01
21.88	105.77	0.27	1.25	0.74	0.01	0.02
21.97	88.15	0.41	1.02	0.88	0.03	0.03
22.09	95.39	0.35	1.10	0.83	0.02	0.03
22.18	113.06	0.23	1.35	0.68	0.01	0.01
22.29	115.80	0.21	1.40	0.65	0.01	0.01
22.40	108.19	0.26	1.28	0.72	0.01	0.02
22.50	100.04	0.31	1.16	0.79	0.02	0.02
22.61	107.46	0.26	1.26	0.73	0.01	0.02
22.70	125.97	0.17	1.57	0.54	0.01	0.01
22.81	151.68	0.09	2.00	0.23	0.00	0.00
22.91	155.76	0.08	2.00	0.17	0.00	0.00
23.02	154.12	0.08	2.00	0.19	0.00	0.00
23.13	149.43	0.09	2.00	0.25	0.00	0.00
23.22	138.13	0.13	1.83	0.40	0.00	0.00
23.44	129.41	0.16	1.62	0.50	0.01	0.02
23.53	134.75	0.14	1.74	0.44	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
23.65	175.21	0.05	2.00	-0.09	0.00	0.00
23.74	172.18	0.05	2.00	-0.05	0.00	0.00
23.84	147.59	0.10	2.00	0.28	0.00	0.00
23.96	129.73	0.15	1.62	0.50	0.01	0.01
24.06	147.39	0.10	2.00	0.28	0.00	0.00
24.17	161.92	0.07	2.00	0.09	0.00	0.00
24.26	173.34	0.05	2.00	-0.07	0.00	0.00
24.38	187.02	0.03	2.00	-0.26	0.00	0.00
24.48	206.58	0.02	2.00	-0.55	0.00	0.00
24.60	218.89	0.01	2.00	-0.73	0.00	0.00
24.69	212.47	0.01	2.00	-0.64	0.00	0.00
24.81	212.33	0.01	2.00	-0.64	0.00	0.00
24.90	235.36	0.01	2.00	-0.99	0.00	0.00
25.02	299.34	0.00	2.00	-1.99	0.00	0.00
25.11	280.16	0.00	2.00	-1.69	0.00	0.00
25.22	256.34	0.00	2.00	-1.31	0.00	0.00
25.33	448.02	0.00	2.00	-4.38	0.00	0.00
25.50	661.33	0.00	2.00	-7.71	0.00	0.00
25.60	707.62	0.00	2.00	-8.41	0.00	0.00

Total estimated displacement: 8.72

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.27	128.74	206.81	1.00	206.81	1.34	0.93	0.93
2.46	122.27	196.40	1.04	204.67	1.71	0.93	0.93
2.65	113.65	182.53	1.10	200.36	1.79	0.70	0.92
2.85	103.74	166.59	1.17	194.11	1.87	0.48	0.90
2.98	94.12	151.11	1.21	182.61	1.92	0.42	0.89
3.13	84.43	135.54	1.25	169.23	1.96	0.24	0.87
3.28	77.41	124.24	1.26	156.78	1.97	0.19	0.86
3.43	76.01	121.98	1.23	150.31	1.94	0.21	0.86
3.57	74.36	119.31	1.20	142.72	1.91	0.21	0.85
3.71	66.30	106.35	1.22	129.73	1.93	0.17	0.84
3.86	51.38	82.37	1.38	113.32	2.05	0.12	0.80
3.95	38.79	62.13	1.72	106.88	2.22	0.08	0.76
4.11	28.49	45.57	2.33	106.18	2.40	0.08	0.72
4.24	24.77	39.58	2.57	101.66	2.46	0.07	0.70
4.36	22.47	35.88	2.69	96.63	2.48	0.07	0.69
4.48	22.19	35.42	2.63	93.10	2.47	0.07	0.69
4.62	21.27	33.92	2.68	90.85	2.48	0.07	0.69
4.75	21.58	34.41	2.50	85.86	2.44	0.06	0.69
4.87	28.55	45.59	1.82	82.95	2.26	0.07	0.72
5.00	36.19	57.86	1.50	86.82	2.12	0.10	0.75
5.14	38.54	61.62	1.44	88.91	2.09	0.10	0.76
5.27	34.20	54.64	1.53	83.69	2.14	0.08	0.75
5.42	33.14	52.92	1.45	76.54	2.10	0.07	0.74
5.55	35.40	56.55	1.29	72.84	1.99	0.09	0.75
5.69	38.82	62.02	1.00	62.02	1.90	0.09	0.76
5.84	40.16	64.16	1.00	64.16	1.87	0.09	0.77
5.97	43.63	69.73	1.00	69.73	1.85	0.09	0.78
6.12	47.80	76.42	1.14	87.33	1.85	0.11	0.79
6.25	52.19	83.46	1.15	96.21	1.86	0.12	0.80
6.40	51.55	82.42	1.22	100.91	1.94	0.13	0.80
6.53	45.37	72.47	1.38	100.23	2.06	0.11	0.78
6.68	36.61	58.38	1.64	95.87	2.19	0.08	0.75
6.82	33.14	52.79	1.68	88.79	2.21	0.08	0.74
6.96	33.67	53.63	1.55	82.93	2.15	0.09	0.74
7.10	31.37	49.93	1.60	79.78	2.17	0.09	0.73
7.33	25.02	39.70	2.05	81.49	2.33	0.07	0.71
7.47	17.85	28.18	3.09	87.14	2.56	0.06	0.66
7.60	13.82	21.70	4.24	91.97	2.73	0.06	3.00
7.75	11.31	17.64	5.35	94.42	2.86	0.06	2.38
7.89	9.96	15.47	6.11	94.58	2.94	0.06	2.04
8.03	9.74	15.10	6.14	92.63	2.94	0.06	1.95
8.15	11.87	18.50	4.73	87.61	2.79	0.06	2.34
8.30	22.34	35.31	2.26	79.78	2.39	0.06	0.69
8.44	29.53	46.85	1.75	81.93	2.23	0.10	0.73
8.58	31.37	49.80	1.76	87.64	2.24	0.08	0.73
8.73	23.20	36.66	2.56	93.95	2.46	0.07	0.70
8.87	16.71	26.21	3.79	99.40	2.67	0.07	2.98
9.00	13.24	20.62	4.79	98.88	2.80	0.06	2.30

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
9.15	10.97	16.97	5.47	92.88	2.88	0.06	1.85
9.28	9.18	14.08	5.78	81.42	2.91	0.06	1.51
9.43	6.88	10.38	6.45	67.00	2.97	0.06	1.10
9.55	4.90	7.18	7.49	53.77	3.06	0.06	0.75
9.71	4.25	6.13	7.97	48.91	3.10	0.06	0.63
9.84	4.53	6.57	7.65	50.28	3.08	0.06	0.66
9.98	4.98	7.28	7.21	52.52	3.04	0.06	0.72
10.13	5.04	7.36	7.22	53.13	3.04	0.06	0.72
10.26	5.12	7.49	7.18	53.76	3.04	0.06	0.72
10.41	5.63	8.29	6.83	56.61	3.01	0.06	0.79
10.68	6.05	8.94	6.57	58.75	2.98	0.06	0.83
10.83	6.33	9.38	6.39	59.98	2.97	0.06	0.87
10.96	6.38	9.46	6.46	61.11	2.97	0.06	0.87
11.11	6.47	9.58	6.67	63.92	2.99	0.06	0.88
11.23	6.47	9.57	6.82	65.27	3.01	0.06	0.87
11.38	5.83	8.53	7.32	62.44	3.05	0.06	0.77
11.51	5.07	7.30	7.75	56.62	3.09	0.06	0.66
11.66	4.51	6.39	8.10	51.78	3.11	0.06	0.57
11.79	4.43	6.25	7.96	49.73	3.10	0.06	0.56
11.93	4.40	6.19	8.00	49.53	3.11	0.06	0.55
12.07	4.31	6.04	8.10	48.95	3.11	0.06	0.53
12.21	4.29	5.99	7.94	47.54	3.10	0.06	0.53
12.35	4.45	6.25	7.24	45.21	3.04	0.06	0.55
12.48	4.59	6.46	6.59	42.61	2.99	0.05	0.56
12.63	4.48	6.27	6.50	40.80	2.98	0.05	0.55
12.77	4.26	5.90	6.75	39.82	3.00	0.05	0.51
12.91	4.01	5.49	6.87	37.67	3.01	0.05	0.47
13.06	3.95	5.39	6.31	34.00	2.96	0.05	0.46
13.18	3.89	5.29	5.32	28.15	2.86	0.05	0.45
13.33	4.06	5.55	4.40	24.42	2.75	0.05	0.47
13.46	4.20	5.76	4.21	24.27	2.73	0.05	0.49
13.61	3.95	5.35	5.24	28.05	2.85	0.05	0.45
13.67	6.16	8.90	4.79	42.58	2.80	0.05	0.75
13.94	17.58	27.22	2.12	57.57	2.35	0.04	0.66
14.13	31.29	46.59	1.56	72.75	2.15	0.08	0.73
14.28	38.62	56.46	1.43	80.95	2.09	0.09	0.75
14.40	32.35	47.91	1.58	75.87	2.16	0.07	0.73
14.59	21.97	33.40	2.05	68.56	2.33	0.06	0.68
14.74	17.10	26.18	2.38	62.22	2.42	0.05	0.65
14.91	22.53	33.54	1.90	63.68	2.28	0.05	0.68
15.07	47.63	66.12	1.25	82.40	1.96	0.07	0.77
15.23	90.42	118.79	1.05	124.79	1.72	0.16	0.85
15.41	145.39	183.65	1.00	183.65	1.56	0.53	0.92
15.56	194.19	240.40	1.00	240.40	1.49	0.96	0.96
15.73	227.83	279.39	1.00	279.39	1.46	0.98	0.98
15.90	242.36	296.62	1.00	296.62	1.47	0.99	0.99
16.06	247.51	302.01	1.00	302.01	1.47	1.00	1.00
16.23	254.09	308.34	1.00	308.34	1.47	1.00	1.00

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
16.39	258.42	312.47	1.00	312.47	1.47	1.00	1.00
16.57	251.96	304.85	1.00	304.85	1.49	1.00	1.00
16.72	230.86	280.96	1.00	280.96	1.54	0.98	0.98
16.88	212.97	259.58	1.00	259.58	1.56	0.97	0.97
17.19	226.97	273.20	1.00	273.20	1.54	0.98	0.98
17.37	258.65	307.73	1.00	307.73	1.50	1.00	1.00
17.52	297.16	350.46	1.00	350.46	1.47	1.02	1.02
17.69	318.82	373.42	1.00	373.42	1.45	1.03	1.03
17.86	328.61	382.32	1.00	382.32	1.44	1.04	1.04
18.01	330.27	382.15	1.00	382.15	1.43	1.04	1.04
18.18	325.23	375.66	1.00	375.66	1.44	1.03	1.03
18.34	321.03	371.42	1.00	371.42	1.47	1.03	1.03
18.47	314.01	364.70	1.00	364.70	1.50	1.03	1.03
18.59	302.76	352.96	1.00	352.96	1.54	1.02	1.02
18.71	289.19	337.79	1.00	337.79	1.57	1.01	1.01
18.84	275.59	321.90	1.00	321.90	1.59	1.01	1.01
18.96	262.12	305.88	1.00	305.88	1.60	1.00	1.00
19.09	249.19	289.97	1.00	289.97	1.61	0.99	0.99
19.23	237.21	274.86	1.00	274.86	1.60	0.98	0.98
19.35	228.79	263.67	1.00	263.67	1.59	0.97	0.97
19.47	227.73	260.69	1.00	260.69	1.56	0.97	0.97
19.59	232.37	264.30	1.00	264.30	1.54	0.97	0.97
19.72	235.70	266.88	1.00	266.88	1.52	0.98	0.98
19.84	229.43	259.84	1.00	259.84	1.54	0.97	0.97
19.96	213.68	241.93	1.00	241.93	1.56	0.96	0.96
20.08	195.46	220.90	1.00	220.90	1.57	0.95	0.95
20.21	176.34	198.68	1.00	198.68	1.57	0.93	0.93
20.27	162.38	182.88	1.00	182.88	1.58	0.49	0.92
20.45	148.10	167.43	1.00	167.43	1.64	0.42	0.90
20.54	136.88	156.18	1.05	164.30	1.72	0.30	0.89
20.65	124.88	144.33	1.14	164.06	1.84	0.24	0.88
20.75	115.89	135.31	1.23	166.13	1.94	0.21	0.87
20.84	103.52	121.88	1.34	163.03	2.03	0.20	0.86
20.95	90.12	106.62	1.46	155.33	2.10	0.14	0.84
21.05	81.88	96.80	1.51	145.71	2.13	0.12	0.82
21.15	84.57	99.00	1.40	138.60	2.07	0.14	0.83
21.27	90.25	104.42	1.29	134.90	1.99	0.15	0.83
21.36	90.36	103.98	1.26	131.23	1.97	0.15	0.83
21.46	84.31	97.23	1.32	128.20	2.01	0.14	0.82
21.57	78.91	91.27	1.40	127.99	2.07	0.12	0.81
21.66	74.83	86.51	1.44	124.91	2.09	0.12	0.81
21.76	68.25	78.80	1.48	116.94	2.12	0.12	0.79
21.88	56.94	65.90	1.64	108.16	2.19	0.10	0.77
21.97	48.54	56.54	1.94	109.68	2.30	0.08	0.75
22.09	49.97	58.14	1.98	115.26	2.31	0.09	0.75
22.18	57.07	66.03	1.83	120.53	2.26	0.10	0.77
22.29	60.31	69.55	1.80	124.87	2.25	0.11	0.78
22.40	56.85	65.67	1.96	128.71	2.30	0.10	0.77

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
22.50	54.84	63.32	2.06	130.54	2.33	0.09	0.77
22.61	61.07	69.88	1.82	127.52	2.26	0.10	0.78
22.70	78.04	87.92	1.45	127.61	2.10	0.12	0.81
22.81	95.15	105.82	1.27	134.28	1.98	0.16	0.84
22.91	105.41	116.37	1.20	140.15	1.92	0.18	0.85
23.02	104.37	115.14	1.22	140.77	1.93	0.17	0.85
23.13	96.66	107.05	1.31	140.33	2.01	0.16	0.84
23.22	86.81	96.67	1.46	141.19	2.10	0.14	0.82
23.44	81.41	90.67	1.61	145.54	2.17	0.12	0.81
23.53	91.80	101.75	1.52	154.66	2.13	0.13	0.83
23.65	104.55	115.12	1.42	163.18	2.08	0.21	0.85
23.74	108.07	118.58	1.39	165.19	2.06	0.20	0.85
23.84	95.14	104.59	1.52	158.45	2.13	0.15	0.83
23.96	88.09	96.75	1.59	154.05	2.17	0.12	0.82
24.06	94.67	103.25	1.47	151.73	2.11	0.15	0.83
24.17	112.57	121.24	1.26	152.87	1.97	0.19	0.85
24.26	131.74	140.33	1.14	159.92	1.84	0.25	0.88
24.38	150.43	159.01	1.08	172.09	1.77	0.36	0.89
24.48	164.23	173.46	1.09	188.65	1.77	0.55	0.91
24.60	167.20	177.07	1.14	201.02	1.84	0.63	0.91
24.69	163.48	173.72	1.20	208.78	1.91	0.46	0.91
24.81	166.20	176.59	1.24	218.84	1.95	0.43	0.91
24.90	193.78	205.01	1.20	245.31	1.91	0.83	0.93
25.02	225.59	237.19	1.14	271.13	1.85	0.96	0.96
25.11	251.39	260.47	1.01	264.00	1.66	0.97	0.97
25.22	321.14	323.96	1.00	323.96	1.29	1.01	1.01
25.33	459.49	518.17	1.00	518.17	-1.00	1.09	1.09
25.50	595.96	670.85	1.00	670.85	-1.00	1.14	1.14
25.60	699.17	786.17	1.00	786.17	-1.00	1.17	1.17

Abbreviations

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

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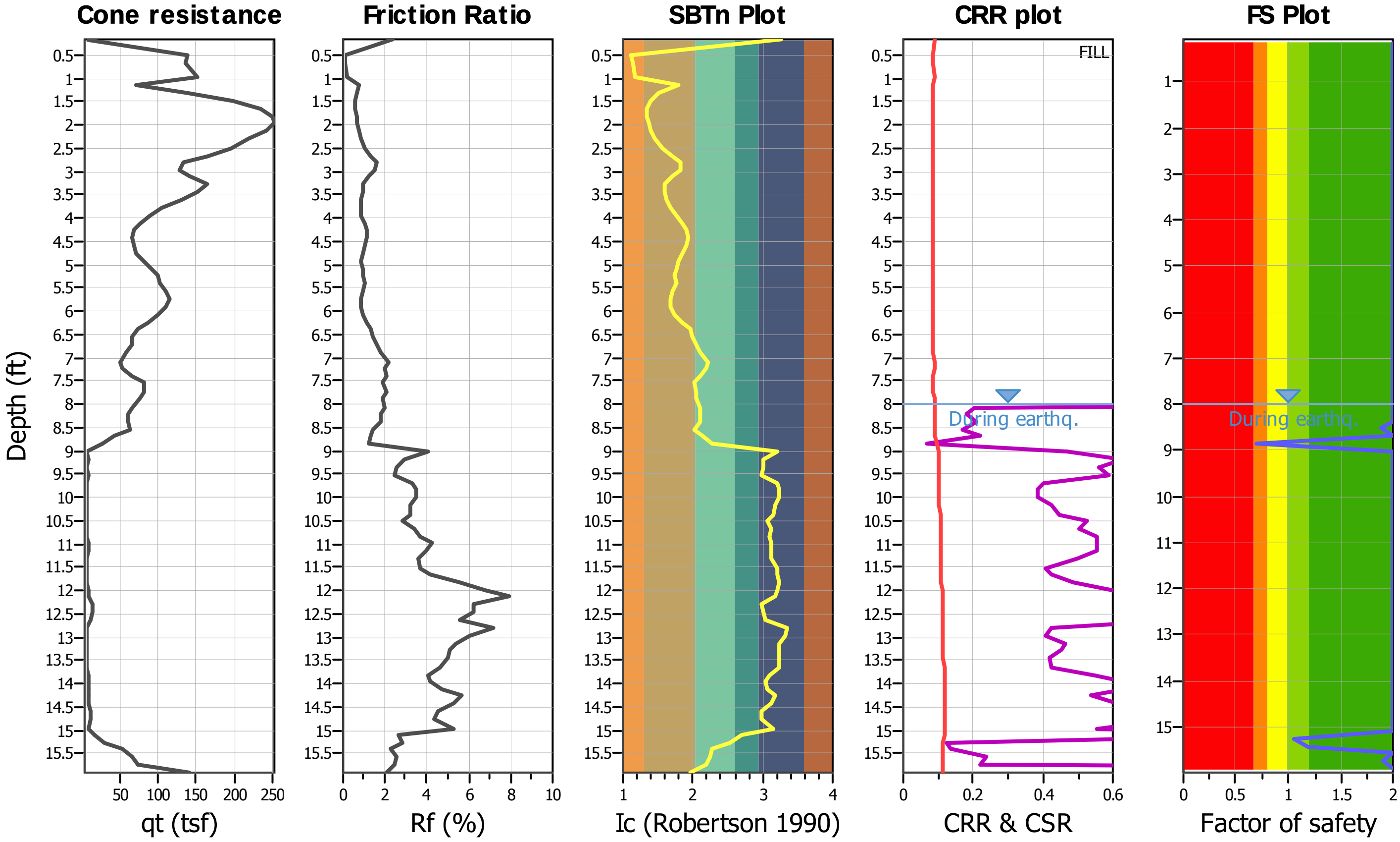
LIQUEFACTION ANALYSIS REPORT

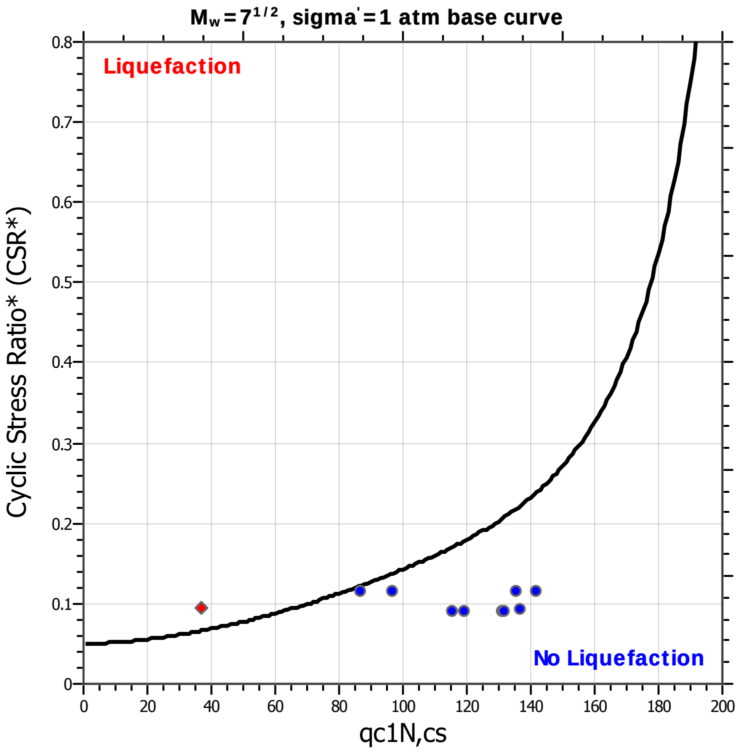
Project title : **Location :**

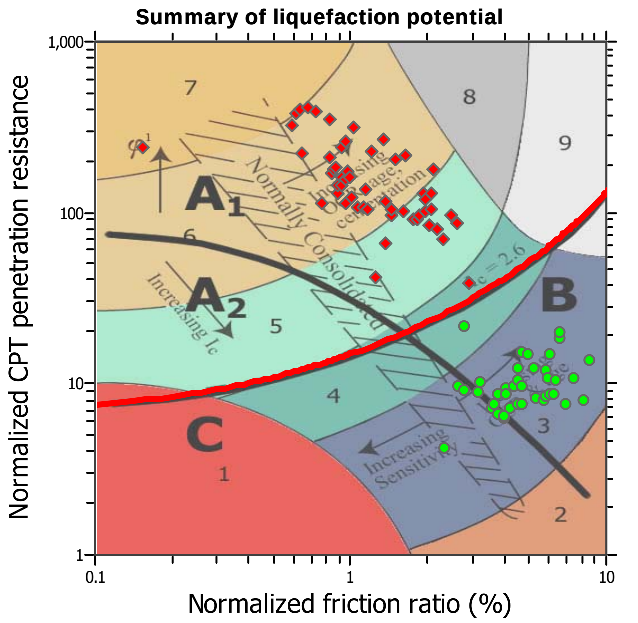
CPT file : CPT-5

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.00 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.00 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.14	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

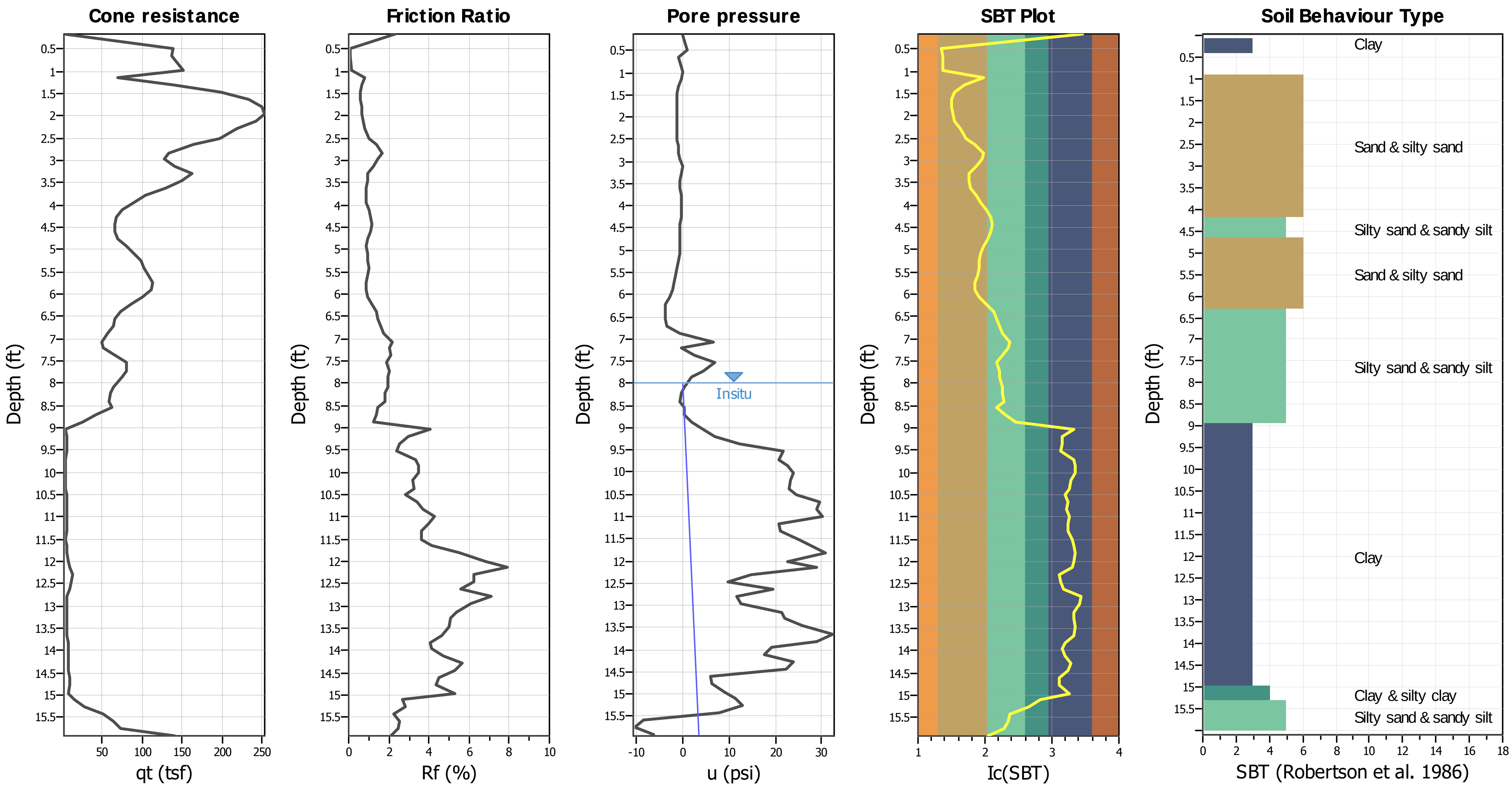






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



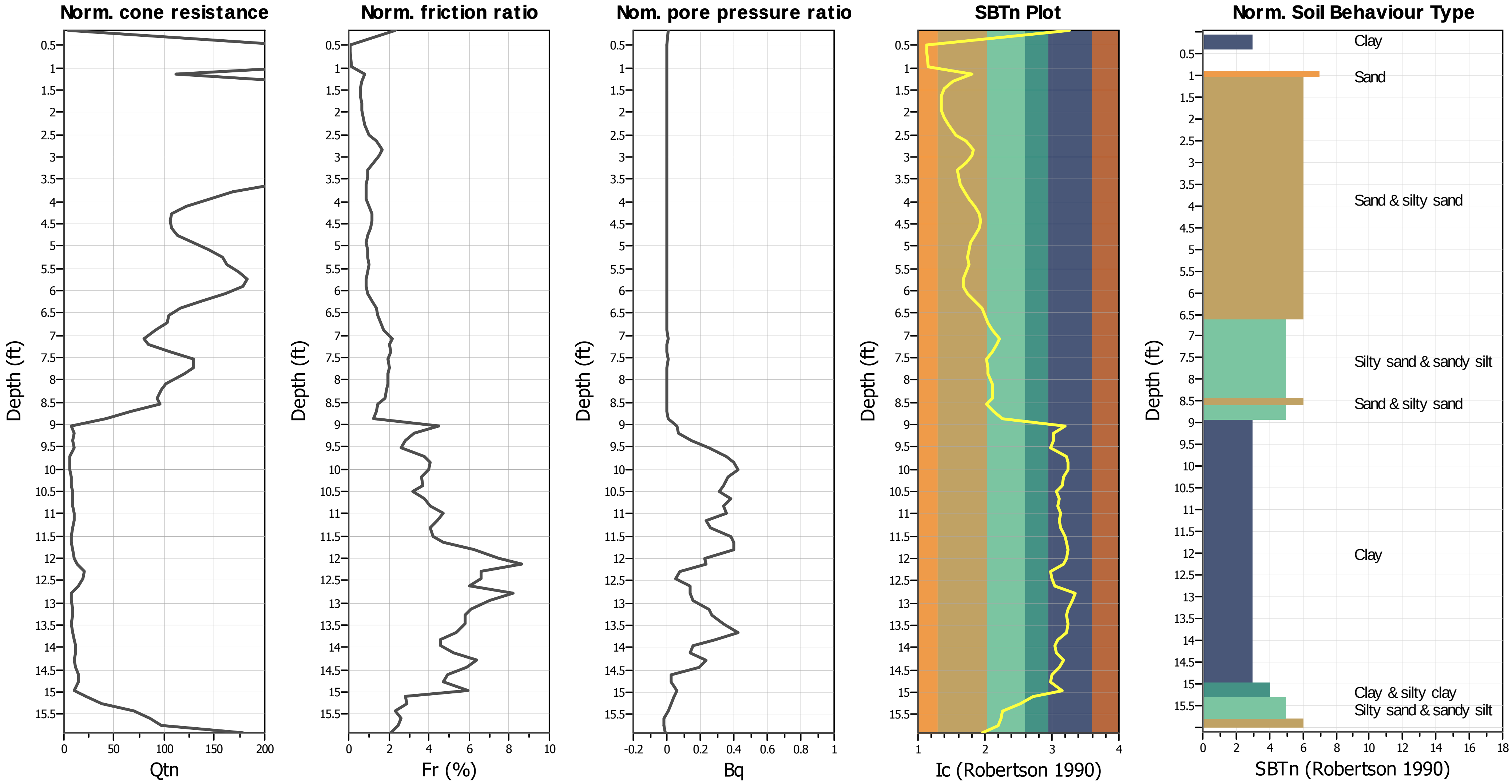
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	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)



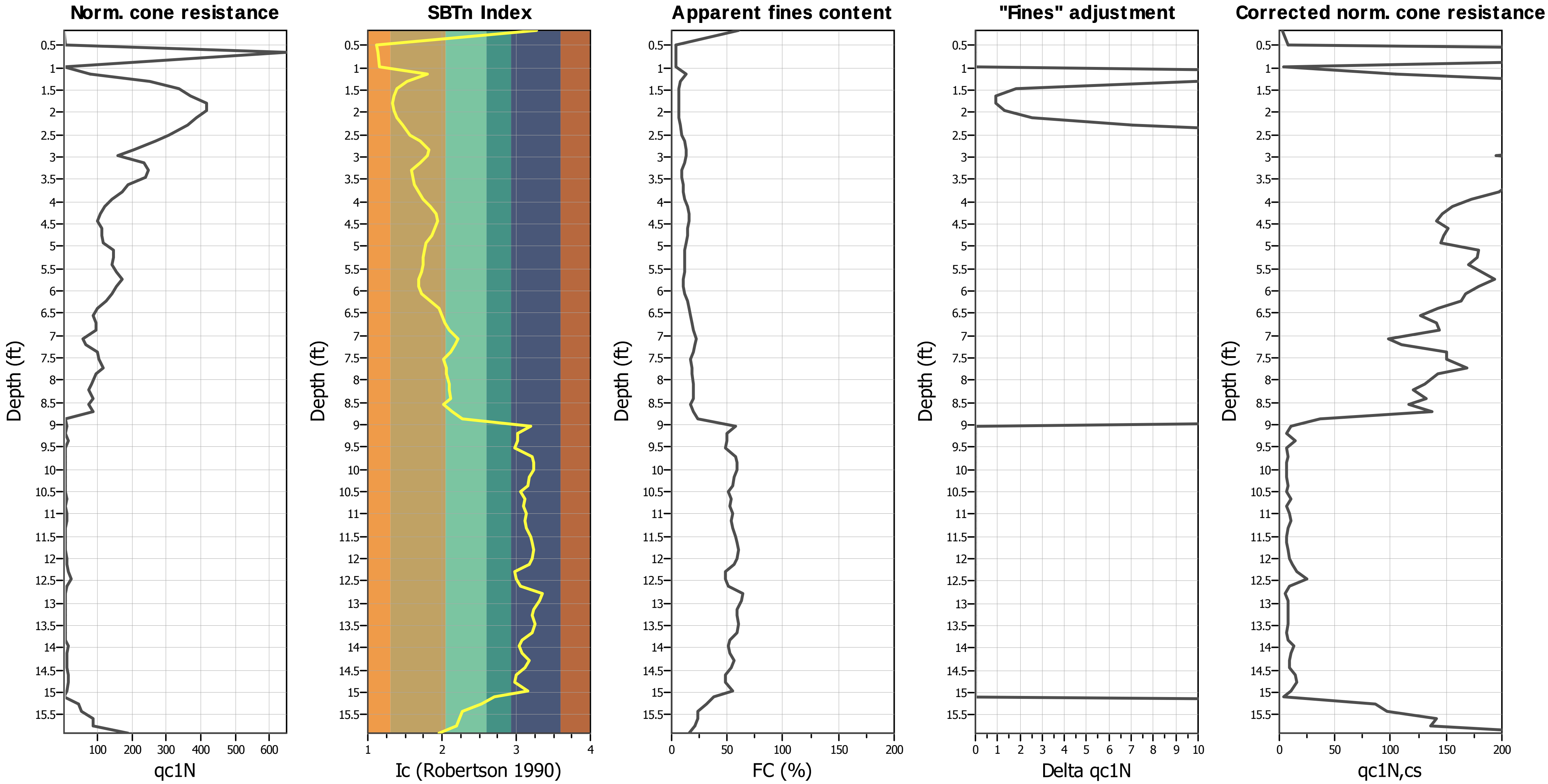
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

SBTn legend

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

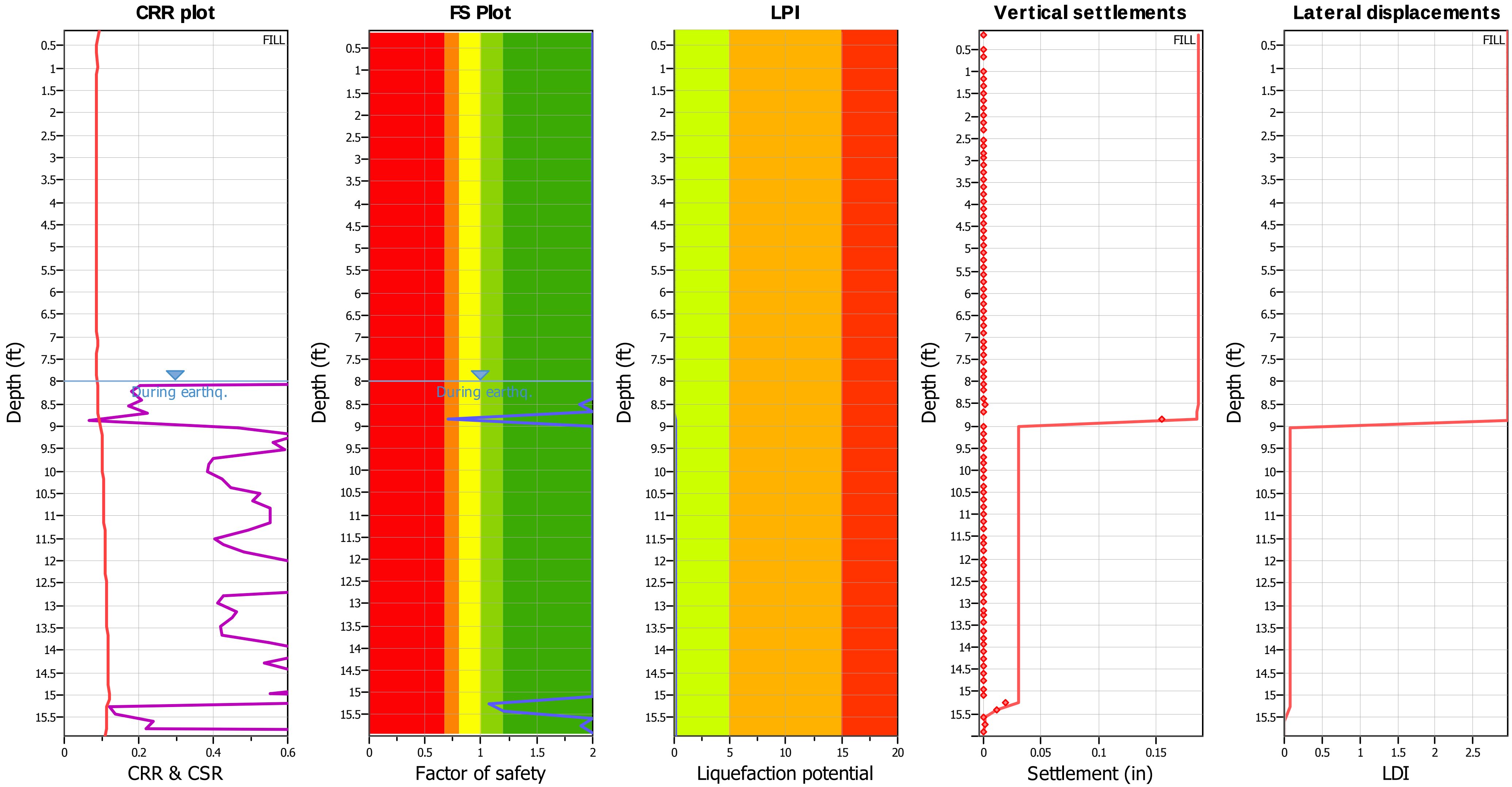
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

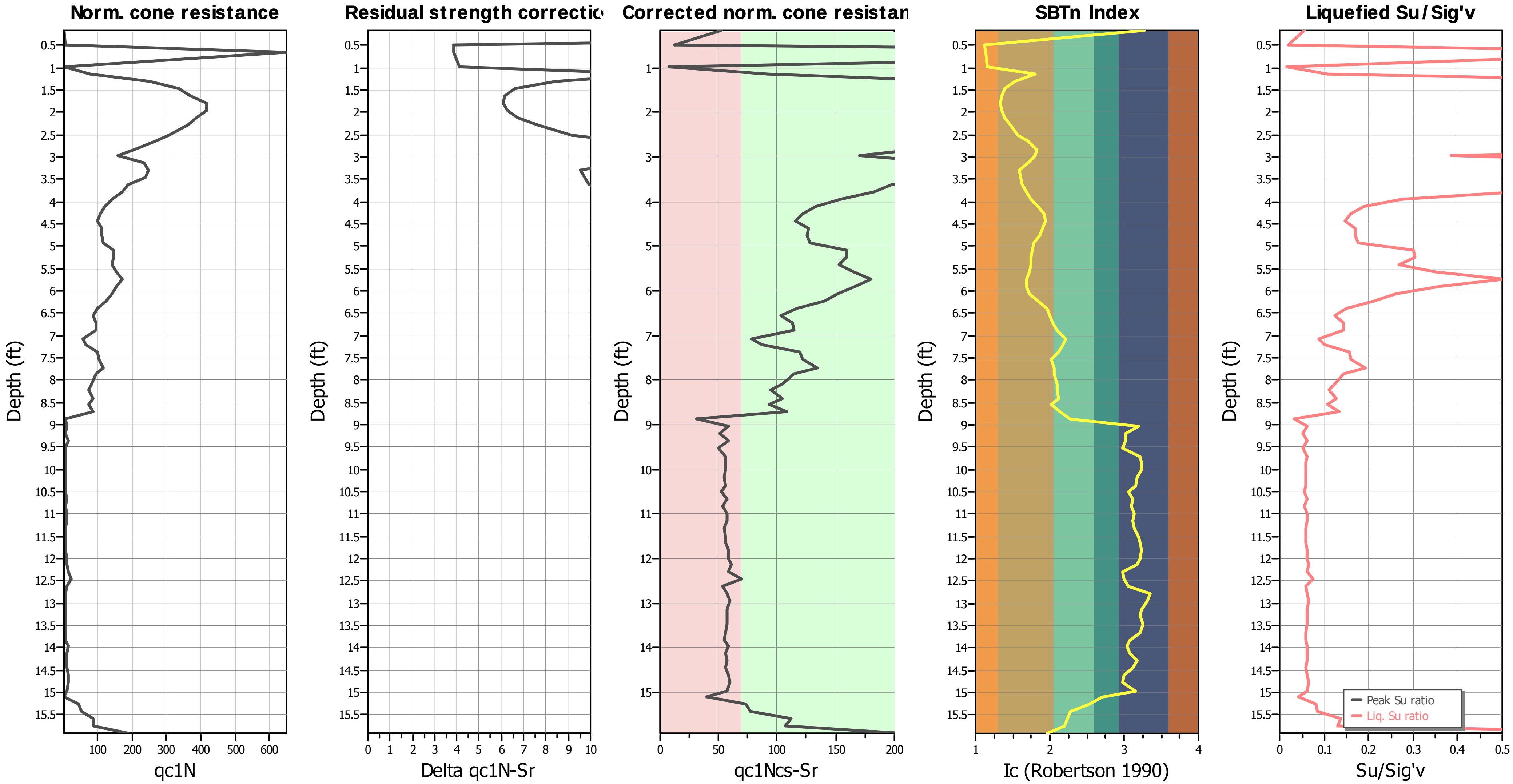
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.16	1.32	0.04	0.21	78.20	92.00
2	0.49	5.08	0.09	1.10	0.00	102.85
3	0.66	403.88	0.02	-0.93	0.00	105.67
4	0.98	2.16	0.19	0.11	0.00	111.92
5	1.15	49.44	0.49	-0.17	8.13	116.05
6	1.31	157.57	0.92	-0.80	3.12	121.45
7	1.48	210.21	1.26	-1.17	1.33	124.42
8	1.64	231.39	1.37	-1.23	0.89	126.16
9	1.80	259.95	1.64	-1.14	0.84	127.13
10	1.97	258.34	1.76	-1.26	1.03	127.71
11	2.13	242.02	1.74	-1.21	1.47	127.79
12	2.30	224.98	1.78	-1.13	2.37	127.82
13	2.53	191.72	1.95	-1.01	3.88	128.31
14	2.66	172.76	2.34	-0.94	6.27	128.58
15	2.82	131.12	2.38	-0.73	8.81	127.95
16	2.95	97.37	1.85	-0.51	8.31	126.86
17	3.12	157.89	1.50	0.11	6.38	126.23
18	3.28	168.19	1.74	-0.16	4.26	125.91
19	3.44	163.95	1.41	-0.56	4.49	124.85
20	3.61	118.70	0.99	-0.37	4.71	122.74
21	3.77	107.72	0.86	-0.34	5.98	120.75
22	3.94	88.56	0.82	-0.31	7.18	119.57
23	4.10	74.03	0.71	-0.26	9.11	118.82
24	4.26	65.86	0.75	-0.24	10.83	118.49
25	4.43	62.46	0.80	-0.39	11.30	118.53
26	4.59	69.18	0.74	-0.56	10.50	118.02
27	4.76	69.46	0.58	-0.57	9.37	117.64
28	4.92	72.09	0.66	-0.55	7.96	118.42
29	5.08	99.32	0.87	-0.60	7.43	120.00
30	5.25	100.81	0.99	-0.72	7.08	121.06
31	5.41	96.08	0.98	-1.00	7.13	121.64
32	5.58	108.24	1.07	-1.44	6.52	122.06
33	5.74	122.22	1.10	-1.71	5.72	121.82
34	5.91	111.37	0.83	-2.12	5.76	121.39
35	6.07	99.13	0.93	-2.79	6.79	120.93
36	6.23	89.85	1.02	-3.77	9.07	120.99
37	6.40	70.22	0.99	-3.65	11.68	120.67
38	6.56	58.65	0.96	-3.57	12.99	119.99
39	6.73	67.56	0.86	-3.38	14.07	120.72
40	6.89	67.71	1.30	-0.51	15.87	120.19
41	7.09	37.36	0.86	6.57	19.30	120.41
42	7.22	45.59	1.09	-0.18	18.19	120.37
43	7.38	74.47	1.23	2.63	16.16	122.77
44	7.55	78.00	1.77	7.00	13.69	124.21
45	7.74	90.42	1.65	4.56	14.37	124.63
46	7.87	72.68	1.52	1.89	14.38	123.58
47	8.07	63.44	1.20	0.38	15.98	122.08
48	8.20	56.05	1.05	-0.31	15.84	121.17

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	8.40	64.38	1.13	-0.37	16.20	120.71
50	8.53	56.04	1.04	0.45	13.70	119.54
51	8.69	67.92	0.52	0.58	16.76	115.46
52	8.86	4.93	0.19	2.01	21.43	110.00
53	9.02	6.49	0.27	4.64	73.30	102.82
54	9.19	3.90	0.17	6.89	59.40	103.23
55	9.35	9.66	0.17	12.44	59.63	101.16
56	9.51	4.36	0.13	21.62	57.30	101.30
57	9.71	4.73	0.17	20.86	73.61	100.29
58	9.84	3.85	0.16	22.50	75.58	100.50
59	10.01	4.03	0.15	23.98	75.69	100.43
60	10.17	4.65	0.17	23.31	70.52	100.72
61	10.37	5.27	0.16	22.98	69.40	101.35
62	10.50	4.76	0.18	24.66	62.32	101.91
63	10.66	7.18	0.18	29.67	66.25	102.90
64	10.83	4.70	0.24	28.87	65.16	104.31
65	10.99	6.27	0.29	30.17	67.81	105.49
66	11.15	7.48	0.30	20.73	66.27	104.99
67	11.32	4.91	0.18	21.10	67.53	103.48
68	11.52	4.64	0.17	25.00	73.33	101.87
69	11.65	4.58	0.21	27.54	74.24	103.27
70	11.81	5.52	0.29	30.93	76.26	106.57
71	12.01	6.72	0.50	22.61	74.26	110.04
72	12.14	8.62	0.70	28.88	71.44	113.29
73	12.30	11.04	0.96	14.80	57.28	115.04
74	12.47	18.62	0.78	9.71	58.79	114.33
75	12.63	6.20	0.53	19.57	61.94	111.45
76	12.79	4.13	0.34	11.71	84.93	107.77
77	12.96	5.87	0.33	12.54	82.14	106.34
78	13.16	5.76	0.32	21.29	75.43	106.53
79	13.29	5.97	0.32	22.07	75.00	106.00
80	13.45	5.37	0.27	25.74	76.79	105.31
81	13.65	4.56	0.26	32.35	74.75	104.96
82	13.81	6.18	0.28	28.89	64.50	106.27
83	13.94	10.08	0.36	19.29	61.07	107.59
84	14.11	7.75	0.39	17.68	63.46	108.70
85	14.27	6.51	0.44	24.04	71.58	108.66
86	14.44	6.68	0.41	22.47	66.49	109.36
87	14.60	10.81	0.46	6.12	57.89	110.24
88	14.76	12.48	0.51	6.22	56.89	110.14
89	14.96	7.43	0.38	9.09	69.17	108.72
90	15.09	2.88	0.34	11.30	41.08	110.30
91	15.26	34.99	0.50	12.82	31.91	116.43
92	15.42	44.21	1.47	7.94	21.40	121.06
93	15.58	76.50	1.54	-8.29	20.50	124.14
94	15.75	73.47	1.96	-10.21	18.72	125.17
95	15.91	175.79	3.43	-6.27	12.01	130.24

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.16	0.13	0.00	0.13	1.00	0.091	1.05	0.086	1.08	1.10	2.000	No
2	2.49	0.15	0.00	0.15	1.00	0.091	1.05	0.086	1.09	1.10	2.000	No
3	2.66	0.16	0.00	0.16	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
4	2.98	0.18	0.00	0.18	1.00	0.091	1.05	0.086	1.07	1.10	2.000	No
5	3.15	0.19	0.00	0.19	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
6	3.31	0.20	0.00	0.20	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
7	3.48	0.21	0.00	0.21	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
8	3.64	0.22	0.00	0.22	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
9	3.80	0.23	0.00	0.23	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
10	3.97	0.24	0.00	0.24	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
11	4.13	0.25	0.00	0.25	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
12	4.30	0.26	0.00	0.26	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
13	4.53	0.27	0.00	0.27	1.00	0.091	1.05	0.086	1.10	1.10	2.000	No
14	4.66	0.28	0.00	0.28	0.99	0.091	1.05	0.086	1.10	1.10	2.000	No
15	4.82	0.29	0.00	0.29	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
16	4.95	0.30	0.00	0.30	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
17	5.12	0.31	0.00	0.31	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
18	5.28	0.32	0.00	0.32	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
19	5.45	0.33	0.00	0.33	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
20	5.61	0.34	0.00	0.34	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
21	5.77	0.35	0.00	0.35	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
22	5.94	0.36	0.00	0.36	0.99	0.090	1.05	0.086	1.10	1.10	2.000	No
23	6.10	0.37	0.00	0.37	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
24	6.26	0.38	0.00	0.38	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
25	6.43	0.39	0.00	0.39	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
26	6.59	0.40	0.00	0.40	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
27	6.76	0.41	0.00	0.41	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
28	6.92	0.42	0.00	0.42	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
29	7.08	0.43	0.00	0.43	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
30	7.25	0.44	0.00	0.44	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
31	7.41	0.45	0.00	0.45	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
32	7.58	0.46	0.00	0.46	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
33	7.74	0.47	0.00	0.47	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
34	7.91	0.48	0.00	0.48	0.99	0.090	1.05	0.085	1.10	1.10	2.000	No
35	8.07	0.49	0.00	0.49	0.98	0.090	1.05	0.085	1.10	1.10	2.000	No
36	8.23	0.50	0.00	0.50	0.98	0.090	1.05	0.085	1.10	1.10	2.000	No
37	8.40	0.51	0.00	0.51	0.98	0.090	1.05	0.085	1.08	1.10	2.000	No
38	8.56	0.52	0.00	0.52	0.98	0.089	1.05	0.085	1.07	1.10	2.000	No
39	8.73	0.53	0.00	0.53	0.98	0.089	1.05	0.085	1.07	1.10	2.000	No
40	8.89	0.54	0.00	0.54	0.98	0.089	1.05	0.085	1.07	1.10	2.000	No
41	9.09	0.55	0.00	0.55	0.98	0.089	1.05	0.085	1.05	1.10	2.000	No
42	9.22	0.56	0.00	0.56	0.98	0.089	1.05	0.085	1.05	1.10	2.000	No
43	9.38	0.57	0.00	0.57	0.98	0.089	1.05	0.085	1.07	1.10	2.000	No
44	9.55	0.58	0.00	0.58	0.98	0.089	1.05	0.085	1.07	1.10	2.000	No
45	9.74	0.59	0.00	0.59	0.98	0.089	1.05	0.085	1.07	1.10	2.000	No
46	9.87	0.60	0.00	0.60	0.98	0.089	1.05	0.084	1.06	1.10	2.000	No
47	10.07	0.61	0.00	0.61	0.98	0.089	1.05	0.085	1.05	1.10	0.089	No
48	10.20	0.62	0.01	0.61	0.98	0.090	1.05	0.085	1.05	1.10	0.089	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	10.40	0.63	0.01	0.62	0.98	0.091	1.05	0.086	1.05	1.10	0.090	No
50	10.53	0.64	0.02	0.62	0.98	0.091	1.05	0.087	1.05	1.10	0.091	No
51	10.69	0.65	0.02	0.63	0.98	0.092	1.05	0.087	1.05	1.10	0.091	No
52	10.86	0.66	0.03	0.63	0.98	0.093	1.05	0.088	1.02	1.10	0.094	No
53	11.02	0.67	0.03	0.63	0.97	0.093	1.05	0.088	1.02	1.10	0.099	No
54	11.19	0.67	0.04	0.64	0.97	0.094	1.05	0.089	1.02	1.10	0.100	No
55	11.35	0.68	0.04	0.64	0.97	0.094	1.05	0.090	1.02	1.10	0.101	No
56	11.51	0.69	0.05	0.64	0.97	0.095	1.05	0.090	1.02	1.10	0.102	No
57	11.71	0.70	0.05	0.65	0.97	0.096	1.05	0.091	1.02	1.10	0.102	No
58	11.84	0.71	0.06	0.65	0.97	0.096	1.05	0.091	1.02	1.10	0.103	No
59	12.01	0.72	0.06	0.65	0.97	0.097	1.05	0.092	1.02	1.10	0.104	No
60	12.17	0.72	0.07	0.66	0.97	0.097	1.05	0.092	1.02	1.10	0.104	No
61	12.37	0.73	0.07	0.66	0.97	0.098	1.05	0.093	1.02	1.10	0.105	No
62	12.50	0.74	0.08	0.66	0.97	0.099	1.05	0.094	1.02	1.10	0.105	No
63	12.66	0.75	0.08	0.67	0.97	0.099	1.05	0.094	1.02	1.10	0.106	No
64	12.83	0.76	0.09	0.67	0.97	0.100	1.05	0.095	1.02	1.10	0.107	No
65	12.99	0.77	0.09	0.67	0.97	0.100	1.05	0.095	1.02	1.10	0.107	No
66	13.15	0.77	0.10	0.68	0.97	0.101	1.05	0.096	1.02	1.10	0.108	No
67	13.32	0.78	0.10	0.68	0.97	0.101	1.05	0.096	1.02	1.10	0.109	No
68	13.52	0.79	0.11	0.68	0.97	0.102	1.05	0.097	1.02	1.10	0.109	No
69	13.65	0.80	0.11	0.69	0.97	0.102	1.05	0.097	1.02	1.10	0.110	No
70	13.81	0.81	0.12	0.69	0.96	0.103	1.05	0.098	1.02	1.10	0.110	No
71	14.01	0.82	0.13	0.69	0.96	0.104	1.05	0.098	1.02	1.10	0.111	No
72	14.14	0.83	0.13	0.70	0.96	0.104	1.05	0.099	1.02	1.10	0.111	No
73	14.30	0.84	0.13	0.70	0.96	0.104	1.05	0.099	1.02	1.10	0.112	No
74	14.47	0.85	0.14	0.71	0.96	0.105	1.05	0.099	1.02	1.10	0.112	No
75	14.63	0.85	0.14	0.71	0.96	0.105	1.05	0.100	1.02	1.10	0.113	No
76	14.79	0.86	0.15	0.71	0.96	0.106	1.05	0.100	1.02	1.10	0.114	No
77	14.96	0.87	0.15	0.72	0.96	0.106	1.05	0.101	1.02	1.10	0.114	No
78	15.16	0.88	0.16	0.72	0.96	0.107	1.05	0.101	1.02	1.10	0.115	No
79	15.29	0.89	0.16	0.72	0.96	0.107	1.05	0.102	1.02	1.10	0.115	No
80	15.45	0.90	0.17	0.73	0.96	0.108	1.05	0.102	1.02	1.10	0.116	No
81	15.65	0.91	0.18	0.73	0.96	0.108	1.05	0.103	1.02	1.10	0.116	No
82	15.81	0.92	0.18	0.74	0.96	0.109	1.05	0.103	1.02	1.10	0.117	No
83	15.94	0.92	0.19	0.74	0.96	0.109	1.05	0.103	1.02	1.10	0.117	No
84	16.11	0.93	0.19	0.74	0.96	0.109	1.05	0.104	1.02	1.10	0.117	No
85	16.27	0.94	0.20	0.75	0.96	0.110	1.05	0.104	1.02	1.10	0.118	No
86	16.44	0.95	0.20	0.75	0.95	0.110	1.05	0.104	1.02	1.10	0.118	No
87	16.60	0.96	0.21	0.75	0.95	0.111	1.05	0.105	1.02	1.10	0.119	No
88	16.76	0.97	0.21	0.76	0.95	0.111	1.05	0.105	1.02	1.10	0.119	No
89	16.96	0.98	0.22	0.76	0.95	0.111	1.05	0.106	1.01	1.10	0.120	No
90	17.09	0.99	0.22	0.77	0.95	0.112	1.05	0.106	1.01	1.10	0.120	No
91	17.26	1.00	0.23	0.77	0.95	0.112	1.05	0.106	1.02	1.10	0.114	No
92	17.42	1.01	0.23	0.78	0.95	0.112	1.05	0.107	1.02	1.10	0.115	No
93	17.58	1.02	0.24	0.78	0.95	0.113	1.05	0.107	1.03	1.10	0.114	No
94	17.75	1.03	0.24	0.79	0.95	0.113	1.05	0.107	1.03	1.10	0.115	No
95	17.91	1.04	0.25	0.79	0.95	0.113	1.05	0.107	1.07	1.10	0.111	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.16	2.58	60.72	3.27	0.71	1.70	2.13	0.00	2.13	4.000	No	Yes	2.00
2	2.49	138.02	3.82	1.13	0.78	1.70	8.16	0.00	8.16	4.000	No	No	2.00
3	2.66	137.04	3.86	1.13	0.26	1.70	648.90	0.00	648.90	4.000	No	No	2.00
4	2.98	151.82	4.10	1.16	0.78	1.70	3.47	0.00	3.47	4.000	No	No	2.00
5	3.15	69.72	12.91	1.80	0.49	1.70	79.44	25.62	105.05	4.000	No	No	2.00
6	3.31	139.06	8.31	1.52	0.26	1.70	253.16	9.90	263.06	4.000	No	No	2.00
7	3.48	199.71	6.51	1.38	0.26	1.70	337.73	1.83	339.56	4.000	No	No	2.00
8	3.64	233.84	6.06	1.35	0.26	1.70	371.77	0.90	372.66	4.000	No	No	2.00
9	3.80	249.88	6.01	1.34	0.26	1.70	417.65	0.89	418.54	4.000	No	No	2.00
10	3.97	253.42	6.20	1.36	0.26	1.70	415.06	1.28	416.34	4.000	No	No	2.00
11	4.13	241.76	6.66	1.40	0.26	1.70	388.83	2.54	391.37	4.000	No	No	2.00
12	4.30	219.56	7.58	1.47	0.26	1.70	361.47	7.09	368.56	4.000	No	No	2.00
13	4.53	196.48	9.04	1.57	0.26	1.68	304.52	17.98	322.50	4.000	No	No	2.00
14	4.66	165.19	11.26	1.71	0.26	1.66	270.43	38.68	309.11	4.000	No	No	2.00
15	4.82	133.74	13.51	1.83	0.27	1.64	203.09	49.12	252.21	4.000	No	No	2.00
16	4.95	128.79	13.07	1.81	0.34	1.70	156.44	38.51	194.95	4.000	No	No	2.00
17	5.12	141.15	11.36	1.71	0.26	1.58	236.23	35.88	272.10	4.000	No	No	2.00
18	5.28	163.34	9.41	1.59	0.26	1.56	248.07	18.59	266.66	4.000	No	No	2.00
19	5.45	150.28	9.62	1.61	0.26	1.54	238.59	19.90	258.49	4.000	No	No	2.00
20	5.61	130.12	9.83	1.62	0.32	1.67	187.74	18.36	206.10	4.000	No	No	2.00
21	5.77	104.99	11.00	1.69	0.34	1.68	170.90	25.95	196.85	4.000	No	No	2.00
22	5.94	90.10	12.08	1.75	0.37	1.70	142.29	30.15	172.44	4.000	No	No	2.00
23	6.10	76.15	13.76	1.84	0.40	1.70	118.94	36.11	155.06	4.000	No	No	2.00
24	6.26	67.45	15.23	1.92	0.41	1.70	105.81	40.08	145.89	4.000	No	No	2.00
25	6.43	65.83	15.62	1.94	0.42	1.70	100.36	40.40	140.75	4.000	No	No	2.00
26	6.59	67.03	14.95	1.90	0.40	1.70	111.15	40.05	151.21	4.000	No	No	2.00
27	6.76	70.24	13.99	1.86	0.41	1.70	111.59	35.91	147.50	4.000	No	No	2.00
28	6.92	80.28	12.76	1.79	0.41	1.69	115.29	30.35	145.64	4.000	No	No	2.00
29	7.08	90.73	12.30	1.77	0.36	1.56	146.46	32.14	178.60	4.000	No	No	2.00
30	7.25	98.72	11.99	1.75	0.36	1.55	147.23	30.22	177.45	4.000	No	No	2.00
31	7.41	101.70	12.04	1.75	0.37	1.55	140.58	29.64	170.22	4.000	No	No	2.00
32	7.58	108.83	11.49	1.72	0.36	1.51	154.13	27.68	181.80	4.000	No	No	2.00
33	7.74	113.92	10.77	1.68	0.34	1.46	169.20	24.02	193.23	4.000	No	No	2.00
34	7.91	110.88	10.80	1.68	0.36	1.48	156.02	23.00	179.02	4.000	No	No	2.00
35	8.07	100.08	11.73	1.74	0.37	1.49	139.59	27.57	167.16	4.000	No	No	2.00
36	8.23	86.35	13.73	1.84	0.38	1.48	126.10	37.20	163.29	4.000	No	No	2.00
37	8.40	72.86	15.93	1.95	0.41	1.52	101.04	41.66	142.71	4.000	No	No	2.00
38	8.56	65.43	17.01	2.00	0.44	1.55	85.85	41.48	127.33	4.000	No	No	2.00
39	8.73	64.61	17.89	2.04	0.42	1.49	95.41	46.19	141.60	4.000	No	No	2.00
40	8.89	57.56	19.32	2.10	0.41	1.47	94.37	49.24	143.61	4.000	No	No	2.00
41	9.09	50.25	21.99	2.21	0.50	1.58	55.83	42.37	98.20	4.000	No	No	2.00
42	9.22	52.52	21.13	2.18	0.48	1.53	65.97	44.30	110.27	4.000	No	No	2.00
43	9.38	66.07	19.55	2.11	0.40	1.42	99.77	51.20	150.98	4.000	No	No	2.00
44	9.55	81.03	17.57	2.03	0.40	1.40	103.56	47.40	150.97	4.000	No	No	2.00
45	9.74	80.43	18.12	2.05	0.37	1.36	116.13	52.12	168.25	4.000	No	No	2.00
46	9.87	75.55	18.14	2.05	0.41	1.40	95.86	46.94	142.80	4.000	No	No	2.00
47	10.07	64.07	19.41	2.11	0.44	1.41	84.35	46.68	131.03	0.206	No	No	2.00
48	10.20	61.29	19.30	2.10	0.46	1.43	75.58	44.08	119.65	0.179	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	10.40	58.82	19.58	2.11	0.43	1.39	84.77	47.13	131.90	0.208	No	No	2.00
50	10.53	62.78	17.58	2.03	0.47	1.42	75.33	40.38	115.71	0.171	No	No	1.88
51	10.69	42.98	20.02	2.13	0.42	1.37	88.18	48.89	137.07	0.223	No	No	2.00
52	10.86	26.48	23.60	2.27	0.69	1.67	7.77	29.11	36.88	0.066	No	No	0.70
53	11.02	5.17	57.80	3.20	0.66	1.63	9.96	0.00	9.96	0.468	No	Yes	2.00
54	11.19	6.80	49.29	3.01	0.69	1.64	6.06	0.00	6.06	0.628	No	Yes	2.00
55	11.35	6.17	49.44	3.02	0.64	1.58	14.46	0.00	14.46	0.561	No	Yes	2.00
56	11.51	6.51	47.97	2.98	0.68	1.63	6.71	0.00	6.71	0.590	No	Yes	2.00
57	11.71	4.63	57.99	3.21	0.68	1.62	7.22	0.00	7.22	0.399	No	Yes	2.00
58	11.84	4.53	59.16	3.23	0.69	1.62	5.89	0.00	5.89	0.387	No	Yes	2.00
59	12.01	4.51	59.23	3.23	0.68	1.61	6.13	0.00	6.13	0.382	No	Yes	2.00
60	12.17	4.99	56.12	3.17	0.68	1.60	7.03	0.00	7.03	0.425	No	Yes	2.00
61	12.37	5.24	55.45	3.15	0.67	1.58	7.89	0.00	7.89	0.445	No	Yes	2.00
62	12.50	6.11	51.10	3.06	0.68	1.58	7.13	0.00	7.13	0.526	No	Yes	2.00
63	12.66	5.95	53.52	3.11	0.66	1.56	10.57	0.00	10.57	0.507	No	Yes	2.00
64	12.83	6.48	52.86	3.10	0.68	1.57	6.98	0.00	6.98	0.553	No	Yes	2.00
65	12.99	6.53	54.48	3.13	0.67	1.55	9.20	0.00	9.20	0.554	No	Yes	2.00
66	13.15	6.57	53.53	3.11	0.66	1.54	10.86	0.00	10.86	0.552	No	Yes	2.00
67	13.32	6.00	54.31	3.13	0.68	1.55	7.20	0.00	7.20	0.495	No	Yes	2.00
68	13.52	5.06	57.82	3.20	0.68	1.55	6.78	0.00	6.78	0.405	No	Yes	2.00
69	13.65	5.32	58.36	3.22	0.68	1.54	6.68	0.00	6.68	0.426	No	Yes	2.00
70	13.81	6.00	59.57	3.24	0.67	1.53	7.98	0.00	7.98	0.484	No	Yes	2.00
71	14.01	7.35	58.37	3.22	0.66	1.51	9.59	0.00	9.59	0.602	No	Yes	2.00
72	14.14	9.11	56.68	3.18	0.65	1.49	12.15	0.00	12.15	0.756	No	Yes	2.00
73	14.30	13.02	47.96	2.98	0.63	1.47	15.34	0.00	15.34	1.098	No	Yes	2.00
74	14.47	12.17	48.91	3.00	0.59	1.42	25.08	0.00	25.08	1.013	No	Yes	2.00
75	14.63	9.85	50.87	3.05	0.67	1.49	8.71	0.00	8.71	0.801	No	Yes	2.00
76	14.79	5.61	64.68	3.35	0.69	1.50	5.84	0.00	5.84	0.426	No	Yes	2.00
77	14.96	5.47	63.05	3.31	0.67	1.48	8.20	0.00	8.20	0.410	No	Yes	2.00
78	15.16	6.13	59.07	3.23	0.67	1.47	8.01	0.00	8.01	0.463	No	Yes	2.00
79	15.29	6.03	58.82	3.23	0.67	1.47	8.26	0.00	8.26	0.452	No	Yes	2.00
80	15.45	5.69	59.89	3.25	0.68	1.46	7.43	0.00	7.43	0.419	No	Yes	2.00
81	15.65	5.79	58.67	3.22	0.68	1.46	6.30	0.00	6.30	0.424	No	Yes	2.00
82	15.81	7.33	52.45	3.09	0.67	1.45	8.45	0.00	8.45	0.550	No	Yes	2.00
83	15.94	8.32	50.33	3.04	0.64	1.42	13.52	0.00	13.52	0.630	No	Yes	2.00
84	16.11	8.40	51.81	3.07	0.66	1.43	10.45	0.00	10.45	0.632	No	Yes	2.00
85	16.27	7.29	56.76	3.18	0.67	1.43	8.78	0.00	8.78	0.535	No	Yes	2.00
86	16.44	8.25	53.67	3.11	0.67	1.42	8.97	0.00	8.97	0.611	No	Yes	2.00
87	16.60	10.16	48.34	2.99	0.64	1.39	14.25	0.00	14.25	0.762	No	Yes	2.00
88	16.76	10.34	47.71	2.98	0.63	1.38	16.30	0.00	16.30	0.772	No	Yes	2.00
89	16.96	7.72	55.31	3.15	0.66	1.40	9.83	0.00	9.83	0.554	No	Yes	2.00
90	17.09	15.26	37.46	2.71	0.70	1.42	3.87	0.00	3.87	1.155	No	Yes	2.00
91	17.26	27.51	31.19	2.53	0.53	1.30	42.96	43.71	86.67	0.122	No	No	1.07
92	17.42	51.96	23.57	2.27	0.51	1.28	53.47	43.22	96.68	0.137	No	No	1.20
93	17.58	64.68	22.89	2.24	0.42	1.22	88.35	53.22	141.57	0.238	No	No	2.00
94	17.75	74.34	21.54	2.19	0.43	1.22	84.99	50.44	135.43	0.218	No	No	1.90
95	17.91	141.57	16.21	1.96	0.27	1.13	188.12	62.38	250.49	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.16	2.00	0.00	9.67	0.33	0.00	2.49	2.00	0.00	9.62	0.33	0.00
2.66	2.00	0.00	9.60	0.16	0.00	2.98	2.00	0.00	9.55	0.33	0.00
3.15	2.00	0.00	9.52	0.16	0.00	3.31	2.00	0.00	9.50	0.16	0.00
3.48	2.00	0.00	9.47	0.16	0.00	3.64	2.00	0.00	9.45	0.16	0.00
3.80	2.00	0.00	9.42	0.16	0.00	3.97	2.00	0.00	9.40	0.17	0.00
4.13	2.00	0.00	9.37	0.16	0.00	4.30	2.00	0.00	9.35	0.16	0.00
4.53	2.00	0.00	9.31	0.23	0.00	4.66	2.00	0.00	9.29	0.13	0.00
4.82	2.00	0.00	9.27	0.17	0.00	4.95	2.00	0.00	9.25	0.13	0.00
5.12	2.00	0.00	9.22	0.16	0.00	5.28	2.00	0.00	9.20	0.16	0.00
5.45	2.00	0.00	9.17	0.16	0.00	5.61	2.00	0.00	9.15	0.16	0.00
5.77	2.00	0.00	9.12	0.16	0.00	5.94	2.00	0.00	9.10	0.16	0.00
6.10	2.00	0.00	9.07	0.16	0.00	6.26	2.00	0.00	9.05	0.16	0.00
6.43	2.00	0.00	9.02	0.16	0.00	6.59	2.00	0.00	9.00	0.16	0.00
6.76	2.00	0.00	8.97	0.16	0.00	6.92	2.00	0.00	8.95	0.16	0.00
7.08	2.00	0.00	8.92	0.16	0.00	7.25	2.00	0.00	8.90	0.16	0.00
7.41	2.00	0.00	8.87	0.16	0.00	7.58	2.00	0.00	8.85	0.16	0.00
7.74	2.00	0.00	8.82	0.16	0.00	7.91	2.00	0.00	8.80	0.17	0.00
8.07	2.00	0.00	8.77	0.16	0.00	8.23	2.00	0.00	8.75	0.16	0.00
8.40	2.00	0.00	8.72	0.16	0.00	8.56	2.00	0.00	8.70	0.16	0.00
8.73	2.00	0.00	8.67	0.16	0.00	8.89	2.00	0.00	8.65	0.16	0.00
9.09	2.00	0.00	8.62	0.20	0.00	9.22	2.00	0.00	8.60	0.13	0.00
9.38	2.00	0.00	8.57	0.16	0.00	9.55	2.00	0.00	8.55	0.16	0.00
9.74	2.00	0.00	8.52	0.20	0.00	9.87	2.00	0.00	8.50	0.13	0.00
10.07	2.00	0.00	8.47	0.20	0.00	10.20	2.00	0.00	8.45	0.13	0.00
10.40	2.00	0.00	8.42	0.20	0.00	10.53	1.88	0.00	8.40	0.13	0.00
10.69	2.00	0.00	8.37	0.16	0.00	10.86	0.70	0.30	8.35	0.16	0.12
11.02	2.00	0.00	8.32	0.16	0.00	11.19	2.00	0.00	8.30	0.16	0.00
11.35	2.00	0.00	8.27	0.16	0.00	11.51	2.00	0.00	8.25	0.16	0.00
11.71	2.00	0.00	8.22	0.20	0.00	11.84	2.00	0.00	8.20	0.13	0.00
12.01	2.00	0.00	8.17	0.16	0.00	12.17	2.00	0.00	8.15	0.16	0.00
12.37	2.00	0.00	8.12	0.20	0.00	12.50	2.00	0.00	8.10	0.13	0.00
12.66	2.00	0.00	8.07	0.16	0.00	12.83	2.00	0.00	8.05	0.16	0.00
12.99	2.00	0.00	8.02	0.16	0.00	13.15	2.00	0.00	8.00	0.16	0.00
13.32	2.00	0.00	7.97	0.16	0.00	13.52	2.00	0.00	7.94	0.20	0.00
13.65	2.00	0.00	7.92	0.13	0.00	13.81	2.00	0.00	7.90	0.16	0.00
14.01	2.00	0.00	7.87	0.20	0.00	14.14	2.00	0.00	7.85	0.13	0.00
14.30	2.00	0.00	7.82	0.16	0.00	14.47	2.00	0.00	7.80	0.16	0.00
14.63	2.00	0.00	7.77	0.16	0.00	14.79	2.00	0.00	7.75	0.16	0.00
14.96	2.00	0.00	7.72	0.16	0.00	15.16	2.00	0.00	7.69	0.20	0.00
15.29	2.00	0.00	7.67	0.13	0.00	15.45	2.00	0.00	7.65	0.16	0.00
15.65	2.00	0.00	7.62	0.20	0.00	15.81	2.00	0.00	7.59	0.16	0.00
15.94	2.00	0.00	7.57	0.13	0.00	16.11	2.00	0.00	7.55	0.16	0.00
16.27	2.00	0.00	7.52	0.16	0.00	16.44	2.00	0.00	7.50	0.16	0.00
16.60	2.00	0.00	7.47	0.16	0.00	16.76	2.00	0.00	7.45	0.16	0.00
16.96	2.00	0.00	7.42	0.20	0.00	17.09	2.00	0.00	7.40	0.13	0.00
17.26	1.07	0.00	7.37	0.16	0.00	17.42	1.20	0.00	7.35	0.16	0.00
17.58	2.00	0.00	7.32	0.16	0.00	17.75	1.90	0.00	7.30	0.16	0.00
17.91	2.00	0.00	7.27	0.16	0.00						

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI

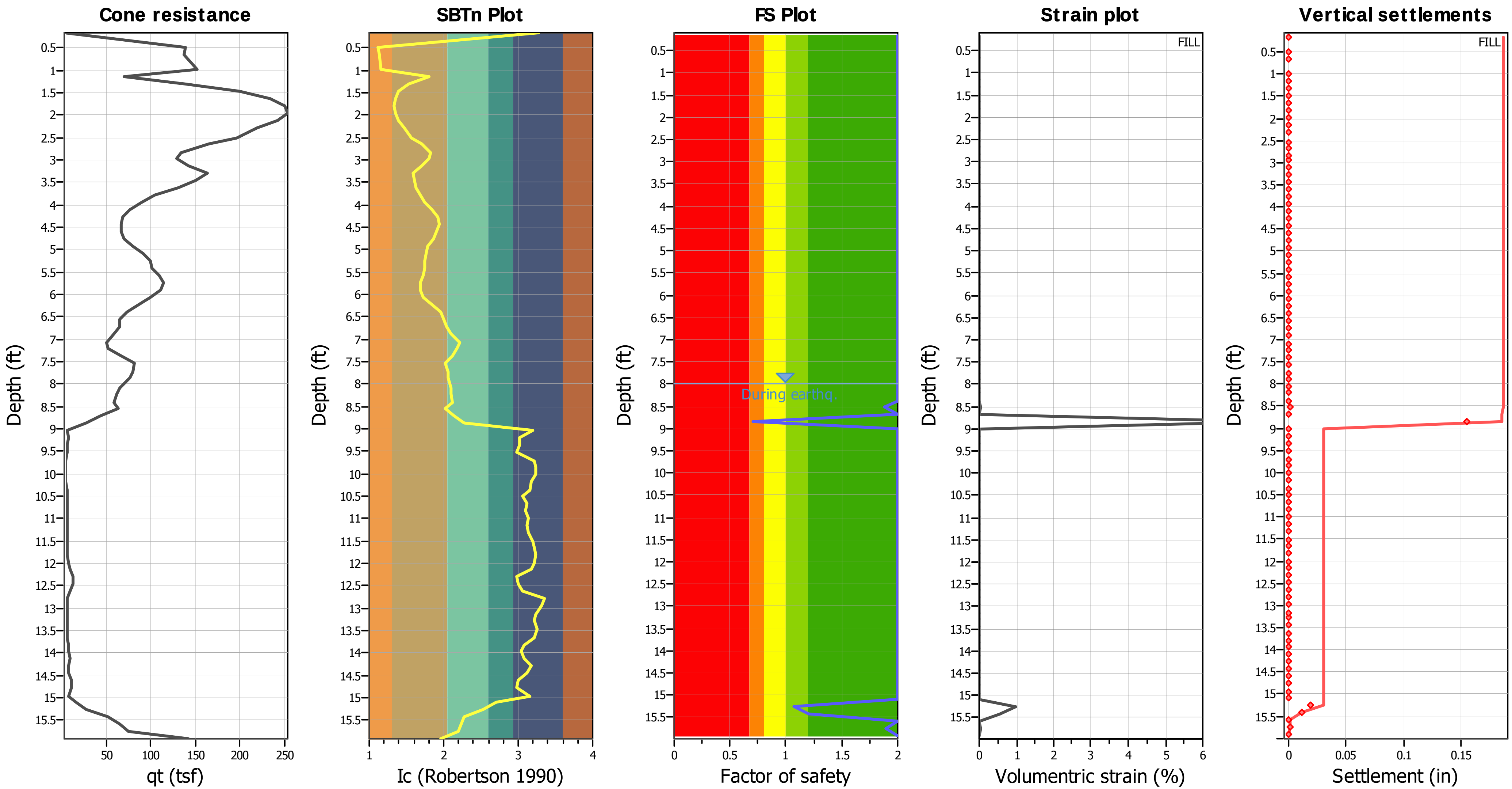
Overall liquefaction potential: 0.12

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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 ::

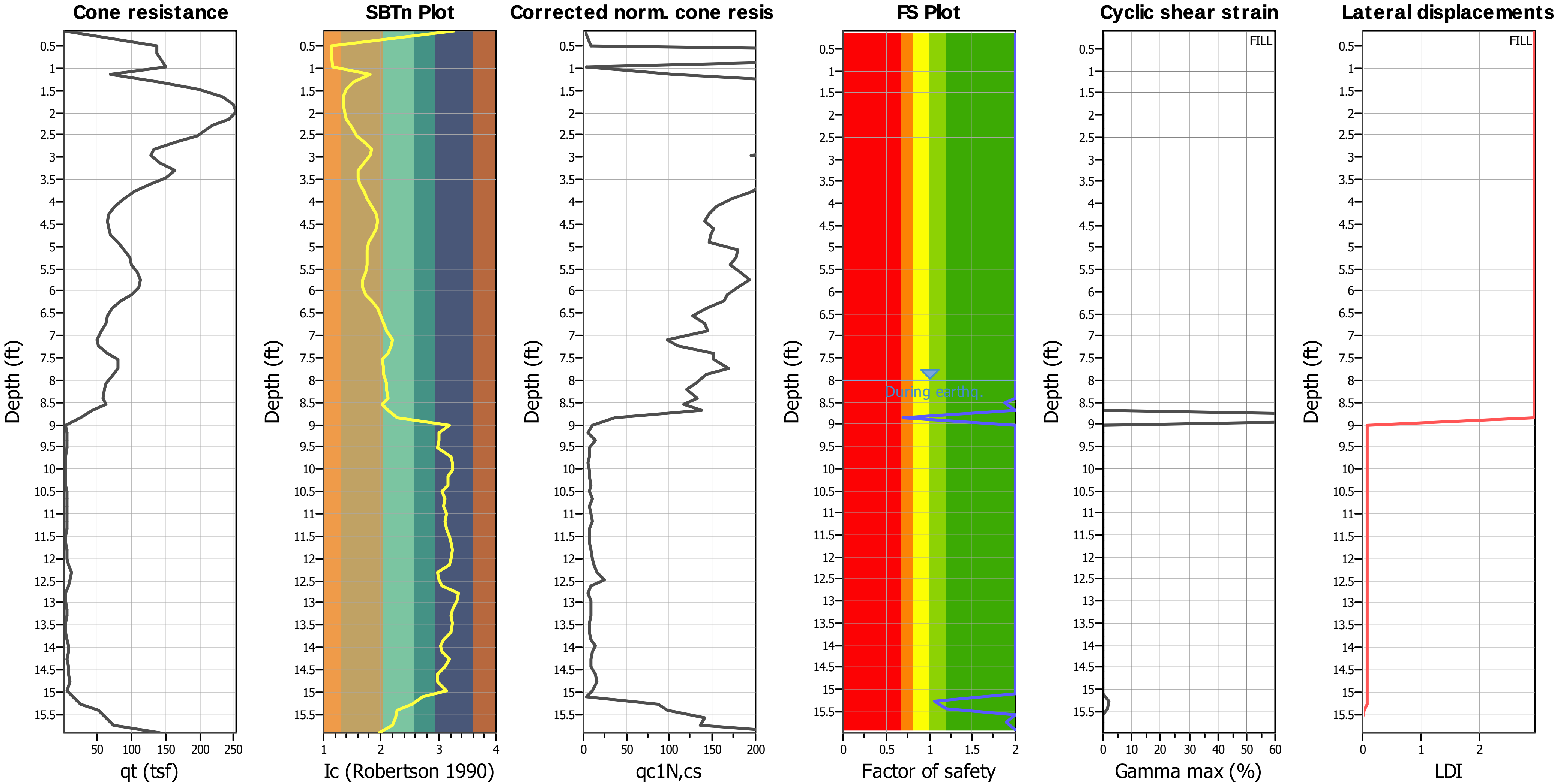
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.07	131.03	2.00	0.00	1.00	0.00	10.20	119.65	2.00	0.00	1.00	0.00
10.40	131.90	2.00	0.00	1.00	0.00	10.53	115.71	1.88	0.04	1.00	0.00
10.69	137.07	2.00	0.00	1.00	0.00	10.86	36.88	0.70	7.87	1.00	0.15
11.02	9.96	2.00	0.00	1.00	0.00	11.19	6.06	2.00	0.00	1.00	0.00
11.35	14.46	2.00	0.00	1.00	0.00	11.51	6.71	2.00	0.00	1.00	0.00
11.71	7.22	2.00	0.00	1.00	0.00	11.84	5.89	2.00	0.00	1.00	0.00
12.01	6.13	2.00	0.00	1.00	0.00	12.17	7.03	2.00	0.00	1.00	0.00
12.37	7.89	2.00	0.00	1.00	0.00	12.50	7.13	2.00	0.00	1.00	0.00
12.66	10.57	2.00	0.00	1.00	0.00	12.83	6.98	2.00	0.00	1.00	0.00
12.99	9.20	2.00	0.00	1.00	0.00	13.15	10.86	2.00	0.00	1.00	0.00
13.32	7.20	2.00	0.00	1.00	0.00	13.52	6.78	2.00	0.00	1.00	0.00
13.65	6.68	2.00	0.00	1.00	0.00	13.81	7.98	2.00	0.00	1.00	0.00
14.01	9.59	2.00	0.00	1.00	0.00	14.14	12.15	2.00	0.00	1.00	0.00
14.30	15.34	2.00	0.00	1.00	0.00	14.47	25.08	2.00	0.00	1.00	0.00
14.63	8.71	2.00	0.00	1.00	0.00	14.79	5.84	2.00	0.00	1.00	0.00
14.96	8.20	2.00	0.00	1.00	0.00	15.16	8.01	2.00	0.00	1.00	0.00
15.29	8.26	2.00	0.00	1.00	0.00	15.45	7.43	2.00	0.00	1.00	0.00
15.65	6.30	2.00	0.00	1.00	0.00	15.81	8.45	2.00	0.00	1.00	0.00
15.94	13.52	2.00	0.00	1.00	0.00	16.11	10.45	2.00	0.00	1.00	0.00
16.27	8.78	2.00	0.00	1.00	0.00	16.44	8.97	2.00	0.00	1.00	0.00
16.60	14.25	2.00	0.00	1.00	0.00	16.76	16.30	2.00	0.00	1.00	0.00
16.96	9.83	2.00	0.00	1.00	0.00	17.09	3.87	2.00	0.00	1.00	0.00
17.26	86.67	1.07	0.96	1.00	0.02	17.42	96.68	1.20	0.56	1.00	0.01
17.58	141.57	2.00	0.00	1.00	0.00	17.75	135.43	1.90	0.04	1.00	0.00
17.91	250.49	2.00	0.00	1.00	0.00						

Total estimated settlement: 0.19

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.07	131.03	0.15	2.00	0.48	0.00	0.00
10.20	119.65	0.20	2.00	0.61	0.00	0.00
10.40	131.90	0.15	2.00	0.47	0.00	0.00
10.53	115.71	0.22	1.88	0.65	0.00	0.00
10.69	137.07	0.13	2.00	0.41	0.00	0.00
10.86	36.88	1.47	0.70	0.94	1.47	2.89
11.02	9.96	0.00	2.00	0.00	0.00	0.00
11.19	6.06	0.00	2.00	0.00	0.00	0.00
11.35	14.46	0.00	2.00	0.00	0.00	0.00
11.51	6.71	0.00	2.00	0.00	0.00	0.00
11.71	7.22	0.00	2.00	0.00	0.00	0.00
11.84	5.89	0.00	2.00	0.00	0.00	0.00
12.01	6.13	0.00	2.00	0.00	0.00	0.00
12.17	7.03	0.00	2.00	0.00	0.00	0.00
12.37	7.89	0.00	2.00	0.00	0.00	0.00
12.50	7.13	0.00	2.00	0.00	0.00	0.00
12.66	10.57	0.00	2.00	0.00	0.00	0.00
12.83	6.98	0.00	2.00	0.00	0.00	0.00
12.99	9.20	0.00	2.00	0.00	0.00	0.00
13.15	10.86	0.00	2.00	0.00	0.00	0.00
13.32	7.20	0.00	2.00	0.00	0.00	0.00
13.52	6.78	0.00	2.00	0.00	0.00	0.00
13.65	6.68	0.00	2.00	0.00	0.00	0.00
13.81	7.98	0.00	2.00	0.00	0.00	0.00
14.01	9.59	0.00	2.00	0.00	0.00	0.00
14.14	12.15	0.00	2.00	0.00	0.00	0.00
14.30	15.34	0.00	2.00	0.00	0.00	0.00
14.47	25.08	0.00	2.00	0.00	0.00	0.00
14.63	8.71	0.00	2.00	0.00	0.00	0.00
14.79	5.84	0.00	2.00	0.00	0.00	0.00
14.96	8.20	0.00	2.00	0.00	0.00	0.00
15.16	8.01	0.00	2.00	0.00	0.00	0.00
15.29	8.26	0.00	2.00	0.00	0.00	0.00
15.45	7.43	0.00	2.00	0.00	0.00	0.00
15.65	6.30	0.00	2.00	0.00	0.00	0.00
15.81	8.45	0.00	2.00	0.00	0.00	0.00
15.94	13.52	0.00	2.00	0.00	0.00	0.00
16.11	10.45	0.00	2.00	0.00	0.00	0.00
16.27	8.78	0.00	2.00	0.00	0.00	0.00
16.44	8.97	0.00	2.00	0.00	0.00	0.00
16.60	14.25	0.00	2.00	0.00	0.00	0.00
16.76	16.30	0.00	2.00	0.00	0.00	0.00
16.96	9.83	0.00	2.00	0.00	0.00	0.00
17.09	3.87	0.00	2.00	0.00	0.00	0.00
17.26	86.67	0.42	1.07	0.89	0.02	0.04
17.42	96.68	0.34	1.20	0.82	0.01	0.03
17.58	141.57	0.12	2.00	0.35	0.00	0.00
17.75	135.43	0.13	1.90	0.43	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
17.91	250.49	0.00	2.00	-1.22	0.00	0.00

Total estimated displacement: 2.96

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.16	2.58	4.14	10.19	42.16	3.27	0.06	24.38
2.49	138.02	221.71	1.00	221.71	1.13	0.02	0.95
2.66	137.04	220.12	1.00	220.12	1.13	0.94	0.94
2.98	151.82	243.84	1.00	243.84	1.16	0.02	0.96
3.15	69.72	111.92	1.11	123.88	1.80	0.11	0.84
3.31	139.06	223.31	1.00	223.31	1.52	0.95	0.95
3.48	199.71	320.73	1.00	320.73	1.38	1.01	1.01
3.64	233.84	375.54	1.00	375.54	1.35	1.03	1.03
3.80	249.88	401.30	1.00	401.30	1.34	1.04	1.04
3.97	253.42	406.97	1.00	406.97	1.36	1.05	1.05
4.13	241.76	388.23	1.00	388.23	1.40	1.04	1.04
4.30	219.56	352.54	1.00	352.54	1.47	1.02	1.02
4.53	196.48	315.43	1.00	315.43	1.57	1.00	1.00
4.66	165.19	265.15	1.04	276.62	1.71	0.97	0.97
4.82	133.74	214.61	1.13	242.62	1.83	0.94	0.94
4.95	128.79	206.64	1.11	230.00	1.81	0.38	0.93
5.12	141.15	226.47	1.05	237.13	1.71	0.95	0.95
5.28	163.34	262.12	1.00	262.12	1.59	0.97	0.97
5.45	150.28	241.11	1.00	241.11	1.61	0.96	0.96
5.61	130.12	208.71	1.00	208.71	1.62	0.88	0.94
5.77	104.99	168.32	1.03	173.87	1.69	0.53	0.90
5.94	90.10	144.38	1.07	155.19	1.75	0.28	0.88
6.10	76.15	121.95	1.14	139.13	1.84	0.19	0.86
6.26	67.45	107.95	1.21	130.23	1.92	0.16	0.84
6.43	65.83	105.34	1.23	129.11	1.94	0.15	0.83
6.59	67.03	107.25	1.19	127.96	1.90	0.17	0.84
6.76	70.24	112.39	1.15	129.30	1.86	0.17	0.84
6.92	80.28	128.51	1.10	141.49	1.79	0.18	0.86
7.08	90.73	145.28	1.08	157.40	1.77	0.30	0.88
7.25	98.72	158.11	1.07	169.41	1.75	0.30	0.89
7.41	101.70	162.87	1.07	174.78	1.75	0.27	0.90
7.58	108.83	174.31	1.05	183.41	1.72	0.35	0.91
7.74	113.92	182.47	1.02	186.75	1.68	0.50	0.92
7.91	110.88	177.57	1.02	181.95	1.68	0.36	0.91
8.07	100.08	160.20	1.06	170.07	1.74	0.26	0.90
8.23	86.35	138.14	1.14	157.40	1.84	0.21	0.87
8.40	72.86	116.44	1.24	144.60	1.95	0.15	0.85
8.56	65.43	104.49	1.30	136.04	2.00	0.12	0.83
8.73	64.61	103.15	1.36	139.95	2.04	0.14	0.83
8.89	57.56	91.81	1.46	133.90	2.10	0.14	0.82
9.09	50.25	80.05	1.69	135.24	2.21	0.09	0.80
9.22	52.52	83.68	1.61	134.65	2.18	0.10	0.80
9.38	66.07	105.43	1.48	155.65	2.11	0.16	0.83
9.55	81.03	129.46	1.34	173.04	2.03	0.16	0.86
9.74	80.43	128.48	1.37	176.33	2.05	0.19	0.86
9.87	75.55	120.02	1.37	164.83	2.05	0.14	0.85
10.07	64.07	101.95	1.46	149.36	2.11	0.13	0.83
10.20	61.29	96.86	1.46	141.08	2.10	0.11	0.82

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.40	58.82	92.52	1.48	136.79	2.11	0.13	0.82
10.53	62.78	95.93	1.34	128.28	2.03	0.11	0.82
10.69	42.98	66.98	1.51	101.37	2.13	0.13	0.77
10.86	26.48	41.69	1.86	77.38	2.27	0.03	0.71
11.02	5.17	7.44	9.30	69.21	3.20	0.06	0.65
11.19	6.80	10.04	6.90	69.23	3.01	0.05	0.87
11.35	6.17	9.02	6.93	62.54	3.02	0.06	0.78
11.51	6.51	9.56	6.55	62.59	2.98	0.05	0.82
11.71	4.63	6.51	9.36	60.91	3.21	0.06	0.55
11.84	4.53	6.34	9.71	61.55	3.23	0.06	0.54
12.01	4.51	6.30	9.74	61.34	3.23	0.06	0.53
12.17	4.99	7.05	8.81	62.11	3.17	0.06	0.59
12.37	5.24	7.43	8.61	64.01	3.15	0.06	0.62
12.50	6.11	8.83	7.39	65.19	3.06	0.06	0.73
12.66	5.95	8.55	8.06	68.92	3.11	0.06	0.70
12.83	6.48	9.39	7.87	73.91	3.10	0.06	0.77
12.99	6.53	9.46	8.33	78.86	3.13	0.06	0.77
13.15	6.57	9.51	8.06	76.64	3.11	0.06	0.77
13.32	6.00	8.58	8.28	71.04	3.13	0.06	0.69
13.52	5.06	7.06	9.31	65.75	3.20	0.06	0.56
13.65	5.32	7.46	9.47	70.64	3.22	0.06	0.59
13.81	6.00	8.54	9.84	84.01	3.24	0.06	0.67
14.01	7.35	10.69	9.48	101.34	3.22	0.06	0.84
14.14	9.11	13.51	8.97	121.26	3.18	0.07	1.05
14.30	13.02	19.77	6.55	129.43	2.98	0.06	1.52
14.47	12.17	18.39	6.79	124.95	3.00	0.08	1.41
14.63	9.85	14.65	7.32	107.25	3.05	0.06	1.11
14.79	5.61	7.83	11.43	89.49	3.35	0.06	0.59
14.96	5.47	7.59	10.92	82.86	3.31	0.06	0.57
15.16	6.13	8.64	9.69	83.69	3.23	0.06	0.64
15.29	6.03	8.46	9.61	81.31	3.23	0.06	0.63
15.45	5.69	7.89	9.93	78.41	3.25	0.06	0.58
15.65	5.79	8.04	9.56	76.94	3.22	0.06	0.59
15.81	7.33	10.50	7.76	81.46	3.09	0.06	0.76
15.94	8.32	12.08	7.18	86.69	3.04	0.06	0.88
16.11	8.40	12.20	7.58	92.51	3.07	0.06	0.88
16.27	7.29	10.40	9.00	93.52	3.18	0.06	0.74
16.44	8.25	11.88	8.10	96.23	3.11	0.06	0.85
16.60	10.16	14.82	6.65	98.46	2.99	0.06	1.06
16.76	10.34	15.00	6.48	97.25	2.98	0.06	1.07
16.96	7.72	10.77	8.57	92.33	3.15	0.06	0.77
17.09	15.26	21.52	4.08	87.83	2.71	0.04	1.60
17.26	27.51	38.21	2.91	111.15	2.53	0.08	0.70
17.42	51.96	69.40	1.85	128.65	2.27	0.09	0.78
17.58	64.68	85.78	1.78	152.76	2.24	0.14	0.81
17.75	74.34	97.29	1.65	160.24	2.19	0.13	0.82
17.91	141.57	177.98	1.26	223.61	1.96	0.91	0.91

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$

Abbreviations

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

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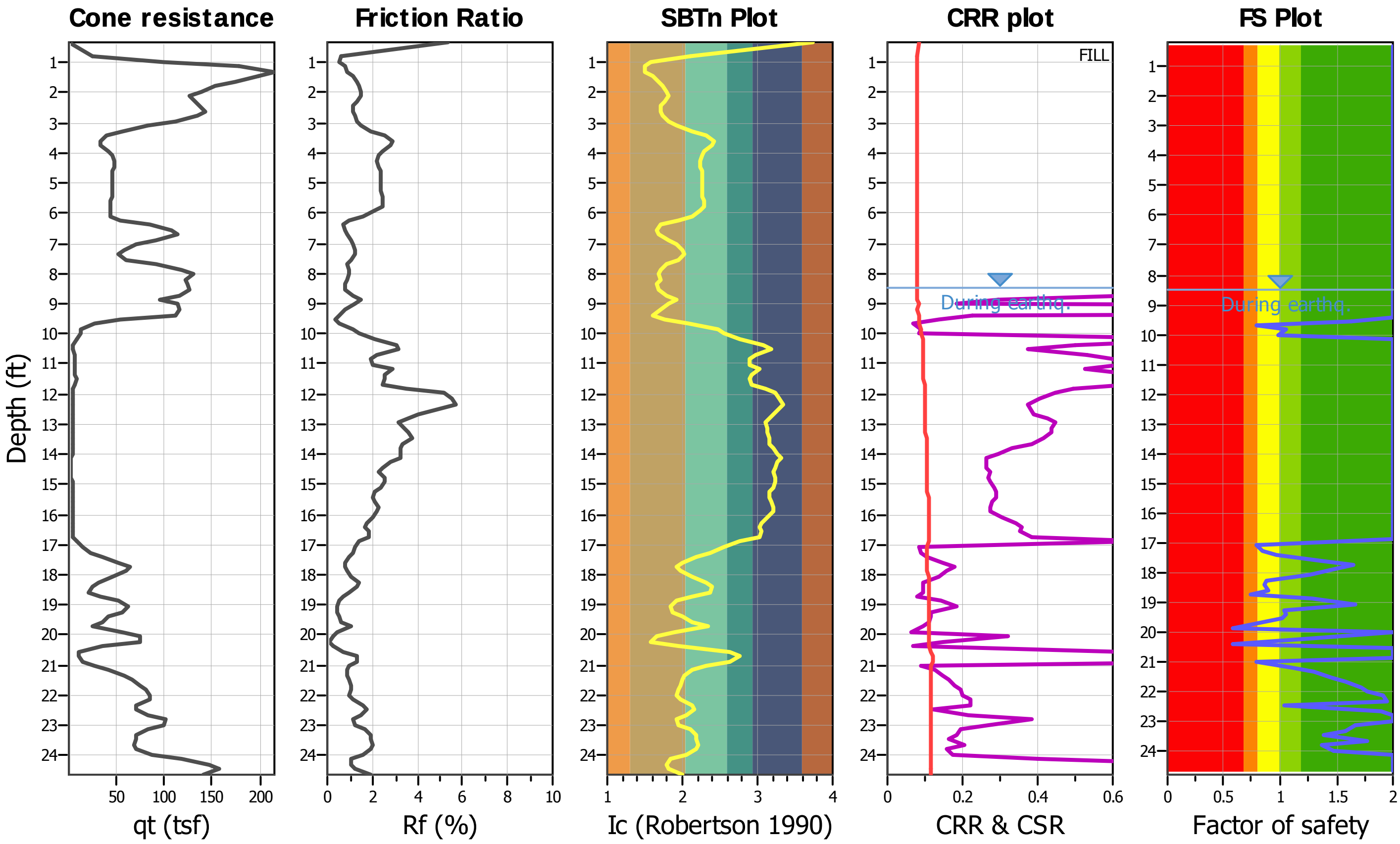
LIQUEFACTION ANALYSIS REPORT

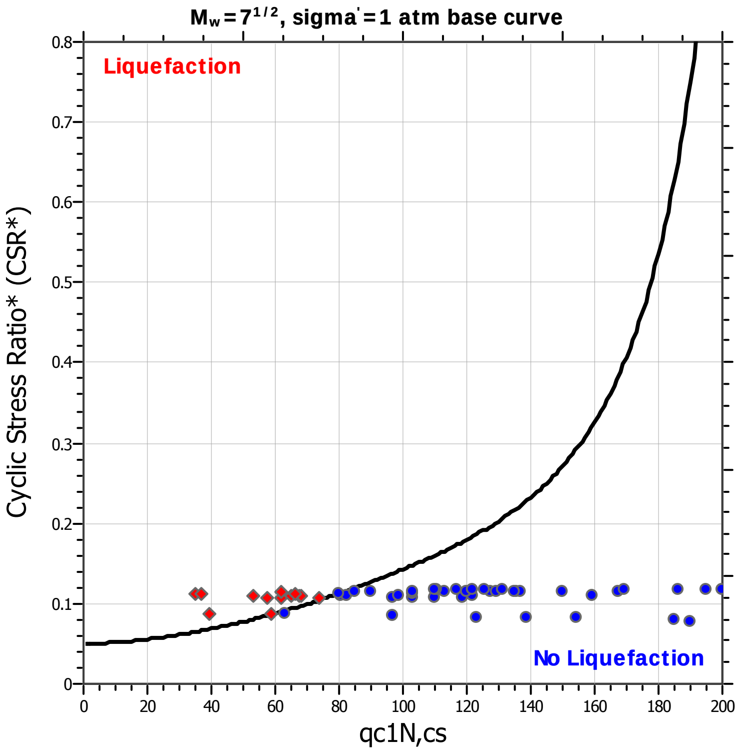
Project title : **Location :**

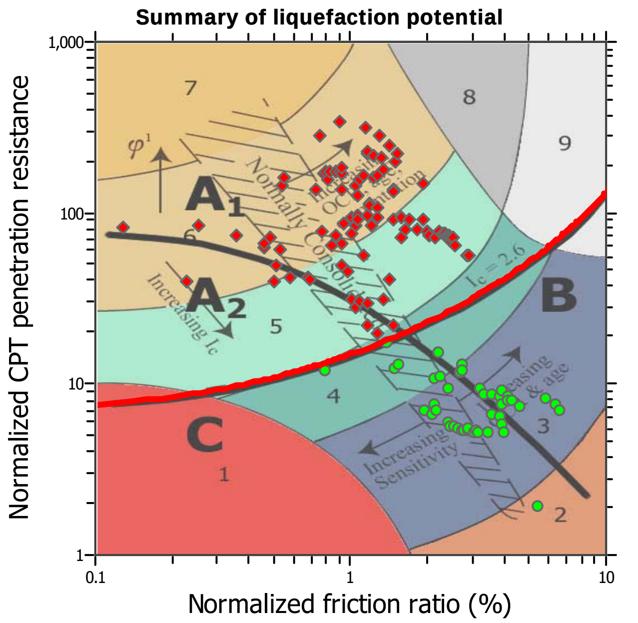
CPT file : CPT-6

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.50 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.50 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.14	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

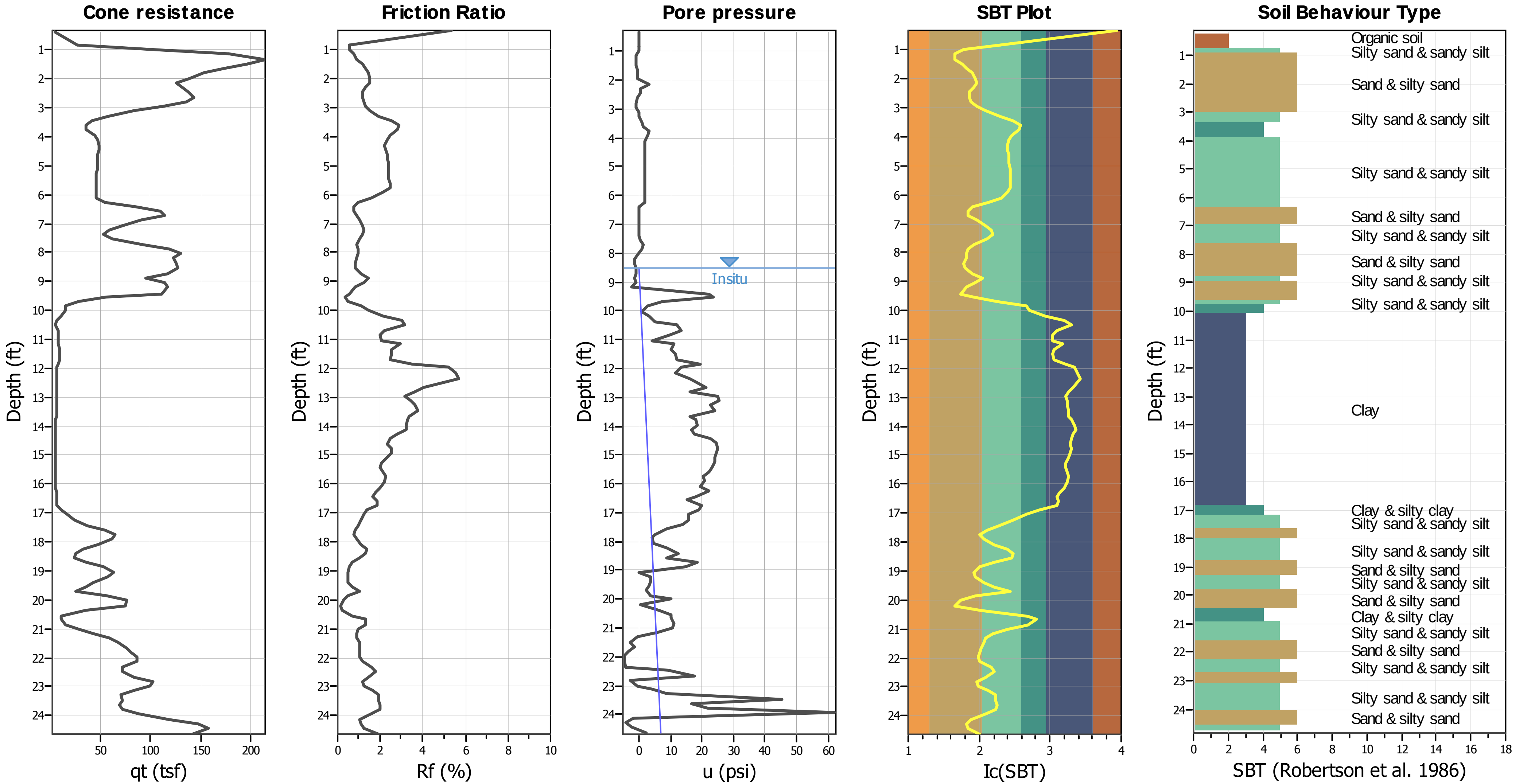






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



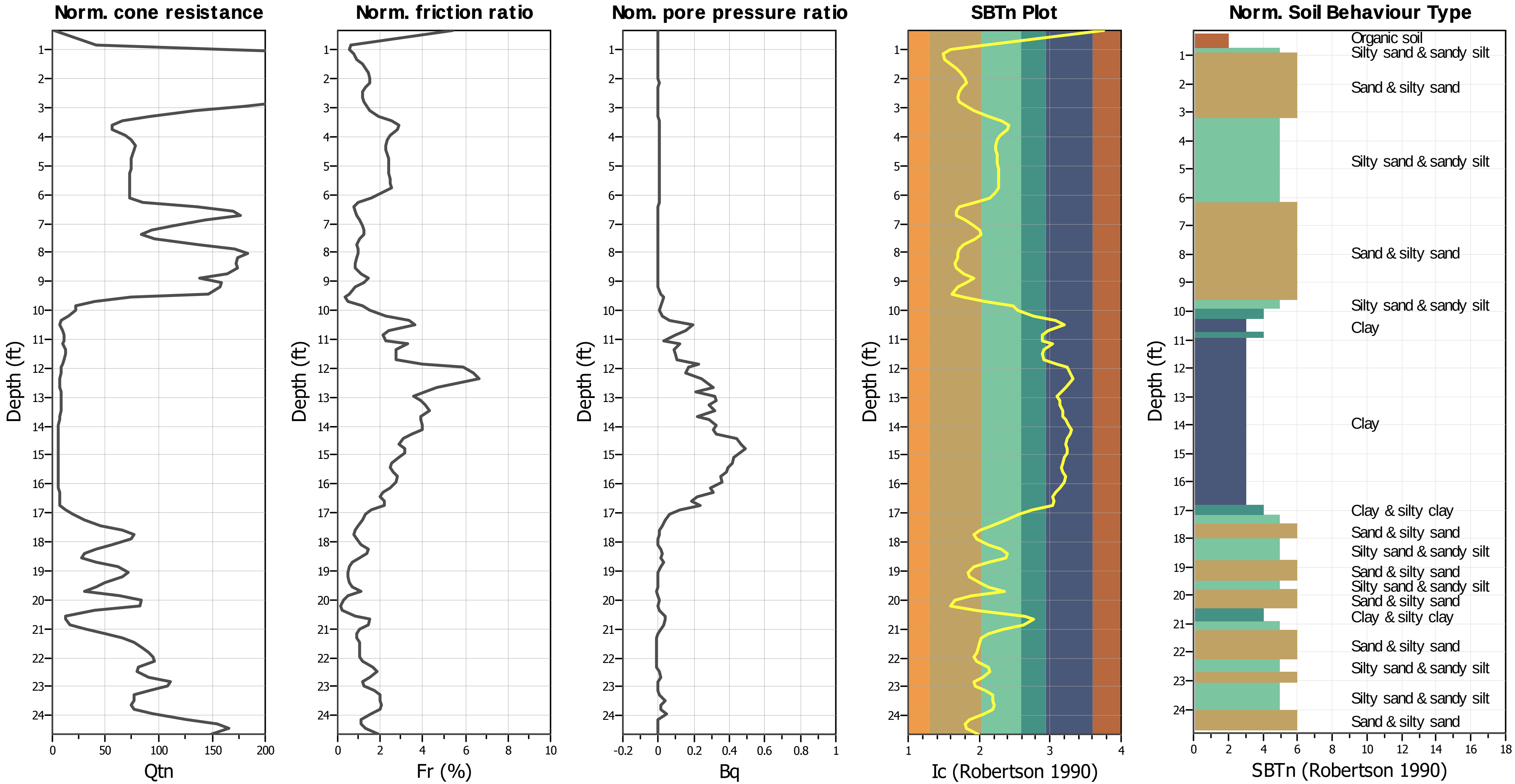
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	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)



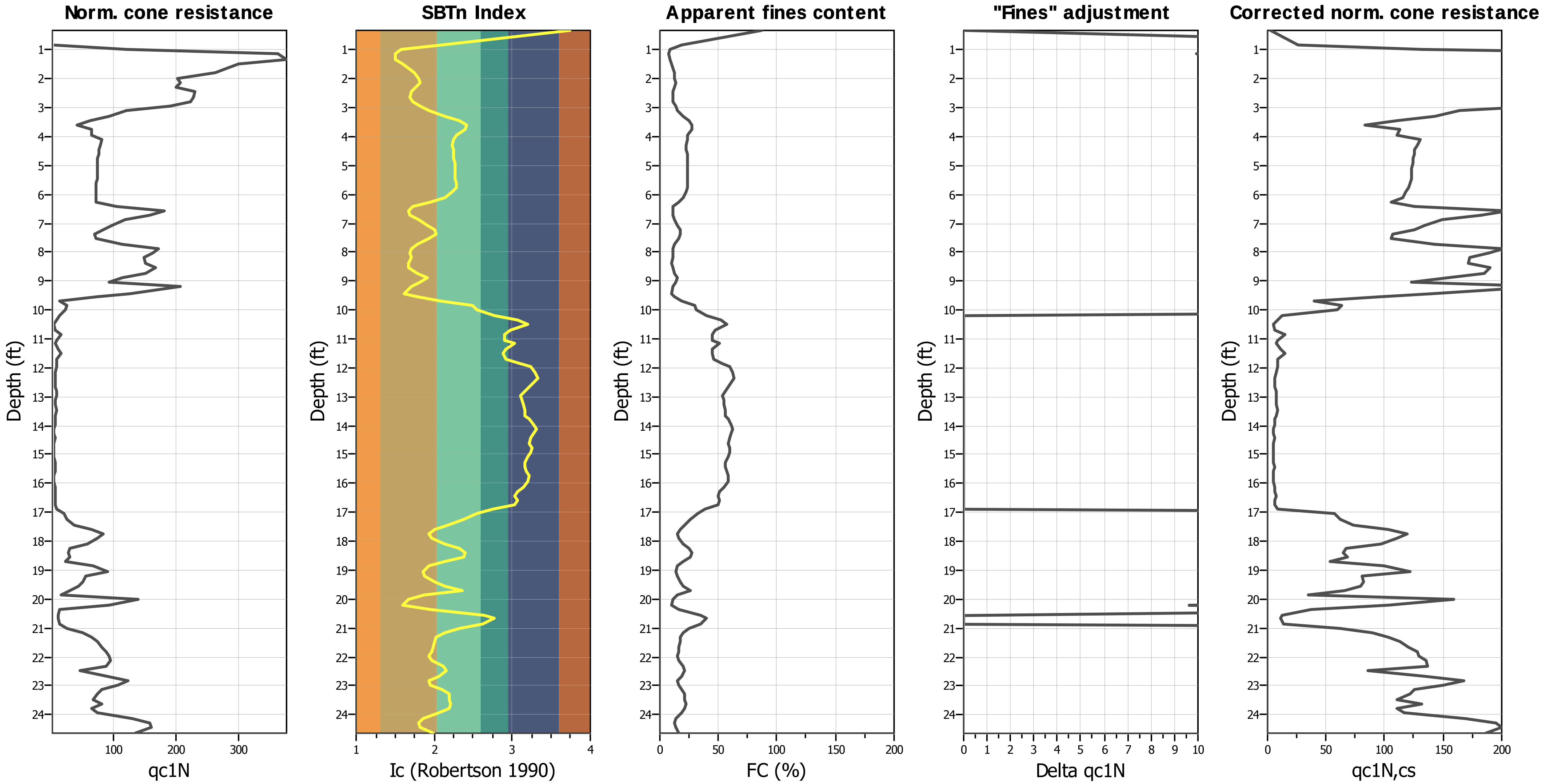
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

SBTn legend

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

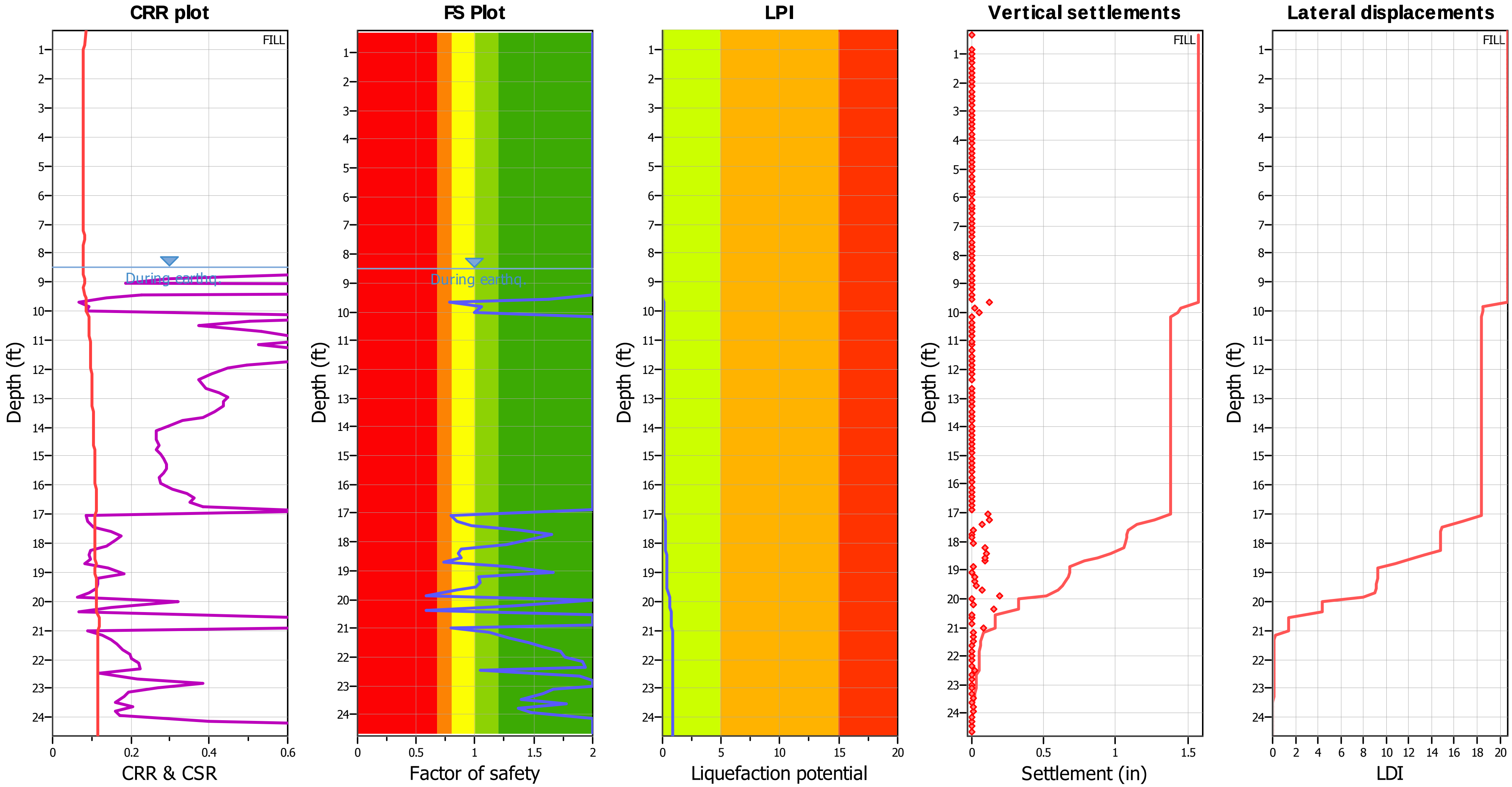
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

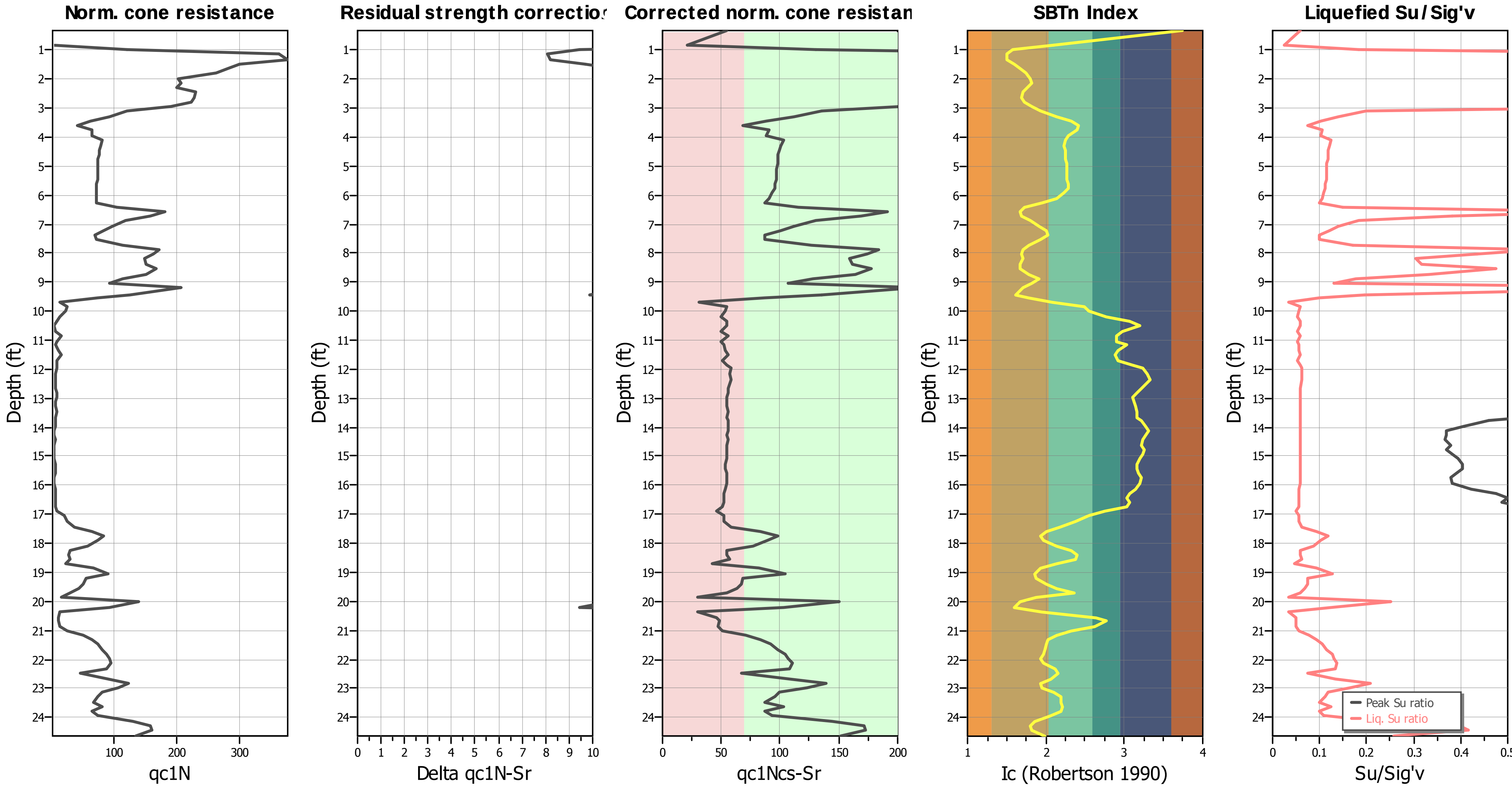
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.14	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.33	1.19	0.09	-0.05	100.00	90.50
2	0.82	1.19	0.02	-0.05	15.70	104.38
3	0.98	75.52	0.42	-0.09	4.14	117.19
4	1.15	224.86	1.23	-0.71	2.76	125.09
5	1.31	234.02	2.40	-0.87	2.89	128.30
6	1.48	186.19	2.26	-0.78	4.41	129.15
7	1.64	174.02	2.13	-0.50	5.74	128.81
8	1.80	162.88	2.38	-0.58	6.96	128.26
9	1.97	125.16	2.04	-0.40	8.07	127.79
10	2.13	127.99	1.94	3.21	8.50	126.69
11	2.30	124.44	1.67	0.54	7.32	126.19
12	2.46	142.92	1.59	0.58	6.30	125.72
13	2.63	145.22	1.54	-0.48	6.08	126.19
14	2.79	143.51	1.91	-0.84	6.65	125.93
15	2.95	118.85	1.50	-0.69	8.40	124.76
16	3.12	74.78	1.09	-0.08	11.19	122.62
17	3.28	57.41	1.12	0.11	16.79	120.86
18	3.44	39.45	1.11	1.06	23.29	119.56
19	3.61	25.50	0.88	1.62	26.73	118.96
20	3.77	39.68	1.03	3.43	26.43	118.85
21	3.94	39.86	1.06	2.85	22.24	119.83
22	4.10	49.69	1.08	1.98	20.94	120.12
23	4.30	48.68	1.08	1.84	19.88	120.33
24	4.46	47.60	1.09	1.81	20.37	120.33
25	4.63	46.97	1.10	1.81	20.73	120.34
26	4.76	46.69	1.10	1.81	20.95	120.34
27	4.92	46.38	1.10	1.82	21.08	120.31
28	5.08	46.03	1.09	1.83	21.24	120.29
29	5.25	45.78	1.10	1.85	21.40	120.29
30	5.45	45.47	1.10	1.85	21.59	120.31
31	5.61	45.31	1.11	1.86	21.77	120.36
32	5.77	45.21	1.13	1.86	21.94	120.42
33	5.91	45.12	1.13	1.85	20.24	119.27
34	6.10	45.33	0.62	1.85	17.19	117.03
35	6.27	45.58	0.36	1.86	11.51	114.89
36	6.40	69.92	0.51	0.19	6.54	117.57
37	6.56	138.65	0.98	0.05	5.55	120.60
38	6.73	118.75	1.09	0.14	5.85	121.74
39	6.89	84.56	0.90	0.09	8.20	120.85
40	7.05	68.76	0.85	0.08	10.83	119.36
41	7.22	59.54	0.76	0.14	12.92	117.98
42	7.38	47.75	0.60	0.24	13.56	116.51
43	7.55	50.00	0.51	0.54	11.31	117.03
44	7.71	85.32	0.80	1.52	7.77	120.02
45	7.87	140.03	1.21	1.16	6.38	122.64
46	8.04	131.68	1.30	-0.30	5.97	123.50
47	8.20	117.99	1.11	-1.09	6.18	122.81
48	8.37	120.54	0.94	-1.29	5.48	121.99

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	8.53	137.65	0.93	-1.06	5.64	122.45
50	8.73	124.02	1.28	-0.98	7.76	123.81
51	8.89	90.04	1.69	-1.10	10.91	123.78
52	9.02	71.76	1.18	-1.03	8.66	124.25
53	9.19	178.39	1.31	-2.12	6.11	121.40
54	9.42	99.50	0.31	22.45	4.58	117.96
55	9.55	55.75	0.16	23.83	5.00	108.00
56	9.68	8.52	0.11	7.55	15.27	103.82
57	9.84	18.35	0.15	3.01	30.06	103.30
58	10.01	15.76	0.22	1.06	32.57	105.06
59	10.17	8.63	0.24	3.07	44.53	104.49
60	10.37	5.60	0.17	5.28	63.71	102.21
61	10.50	3.56	0.14	11.96	72.67	99.93
62	10.70	4.40	0.13	13.46	56.51	100.48
63	10.83	10.87	0.16	9.72	51.66	100.79
64	11.02	6.06	0.14	4.14	51.78	101.45
65	11.15	5.03	0.16	11.19	61.17	102.69
66	11.35	8.03	0.27	10.26	52.88	103.82
67	11.52	10.75	0.19	11.50	51.29	104.31
68	11.68	6.46	0.19	11.94	53.24	103.39
69	11.84	5.84	0.21	19.44	65.53	103.74
70	11.97	6.00	0.27	13.48	76.14	105.75
71	12.17	4.90	0.43	11.81	80.10	105.51
72	12.34	4.70	0.20	16.30	83.63	105.02
73	12.66	4.72	0.23	21.40	74.17	103.05
74	12.79	5.76	0.21	16.41	69.60	103.00
75	12.96	5.81	0.18	24.96	65.49	102.50
76	13.12	5.56	0.18	25.25	67.55	102.86
77	13.29	5.33	0.25	22.48	68.45	103.41
78	13.48	6.00	0.22	24.14	70.52	103.33
79	13.65	5.04	0.18	16.24	70.55	101.97
80	13.78	4.41	0.15	18.23	74.53	100.51
81	13.98	4.19	0.14	18.53	78.38	99.56
82	14.14	3.75	0.14	16.54	81.47	98.78
83	14.27	3.50	0.11	17.43	78.76	97.78
84	14.44	4.17	0.09	22.63	76.47	96.83
85	14.60	3.66	0.09	24.50	74.49	96.78
86	14.76	3.78	0.11	25.20	76.83	97.24
87	14.93	3.96	0.11	24.65	75.70	97.51
88	15.09	4.06	0.10	23.86	73.44	97.27
89	15.26	4.18	0.09	24.23	70.53	96.61
90	15.42	4.32	0.08	23.14	70.13	96.47
91	15.58	4.15	0.10	22.19	71.94	96.66
92	15.75	3.99	0.10	20.16	74.18	96.90
93	15.91	4.05	0.10	20.79	73.43	96.94
94	16.11	4.41	0.10	19.39	68.40	96.96
95	16.27	5.15	0.10	22.33	63.03	97.04
96	16.44	5.61	0.09	17.97	60.52	97.06

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	16.57	5.29	0.09	15.54	62.73	97.64
98	16.73	4.93	0.12	19.73	60.41	98.36
99	16.90	6.86	0.11	18.80	43.41	101.31
100	17.06	16.89	0.18	15.94	33.11	104.43
101	17.26	20.90	0.25	15.88	25.39	108.03
102	17.42	31.36	0.34	13.75	18.22	111.21
103	17.59	56.55	0.43	8.76	13.30	114.00
104	17.75	72.21	0.55	5.26	11.19	115.20
105	17.88	63.66	0.48	4.16	12.31	115.68
106	18.08	48.93	0.55	4.74	16.92	114.61
107	18.24	25.50	0.47	8.93	23.07	112.96
108	18.41	23.22	0.33	12.39	26.32	109.83
109	18.57	25.55	0.17	8.97	25.53	107.04
110	18.70	18.56	0.19	18.51	17.01	108.18
111	18.86	58.23	0.34	14.84	11.09	110.44
112	19.06	80.50	0.29	-0.06	5.00	111.45
113	19.23	47.10	0.26	3.79	5.00	110.18
114	19.39	43.30	0.22	3.93	13.02	108.17
115	19.55	37.93	0.17	3.14	16.69	108.30
116	19.68	24.97	0.31	2.34	24.55	108.32
117	19.88	12.83	0.30	3.75	5.00	109.90
118	20.01	129.08	0.13	10.44	5.00	108.55
119	20.21	83.90	0.13	0.60	4.19	103.63
120	20.37	11.99	0.03	6.74	5.00	100.39
121	20.54	10.31	0.08	10.01	37.45	97.12
122	20.67	9.11	0.12	10.10	44.13	101.67
123	20.87	11.77	0.22	10.98	36.47	104.75
124	21.00	23.03	0.23	10.79	23.50	108.56
125	21.16	46.02	0.33	6.17	17.02	112.44
126	21.32	59.21	0.59	-0.49	13.88	115.38
127	21.49	68.23	0.64	-2.63	13.12	117.63
128	21.65	75.15	0.79	-1.54	12.42	118.94
129	21.82	82.32	0.90	-3.21	11.89	119.75
130	21.98	85.62	0.85	-4.54	11.18	119.98
131	22.15	88.90	0.82	-4.55	12.07	120.98
132	22.34	83.57	1.27	-4.30	16.49	121.75
133	22.47	43.16	1.37	9.42	17.69	122.42
134	22.67	85.26	1.17	17.73	14.43	122.39
135	22.80	118.77	1.06	-2.48	10.98	122.88
136	23.00	102.49	1.36	-0.53	11.68	123.06
137	23.13	76.89	1.29	4.19	15.61	123.51
138	23.29	70.85	1.54	8.63	18.75	122.97
139	23.46	62.72	1.29	45.30	18.72	123.03
140	23.62	78.05	1.32	16.59	19.43	122.82
141	23.79	62.42	1.48	21.88	18.84	123.14
142	23.95	71.88	1.41	61.96	14.67	123.44
143	24.11	127.72	1.19	-1.74	9.33	123.60
144	24.28	156.51	1.17	-4.21	8.01	125.85

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	24.44	158.39	2.41	-2.21	8.65	127.68
146	24.64	133.51	2.86	2.27	12.60	129.66

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.33	0.14	0.00	0.14	1.00	0.091	1.05	0.086	1.07	1.00	2.000	No
2	2.82	0.17	0.00	0.17	1.00	0.091	1.05	0.086	1.07	1.00	2.000	No
3	2.98	0.18	0.00	0.18	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
4	3.15	0.19	0.00	0.19	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
5	3.31	0.20	0.00	0.20	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
6	3.48	0.21	0.00	0.21	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
7	3.64	0.22	0.00	0.22	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
8	3.80	0.23	0.00	0.23	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
9	3.97	0.24	0.00	0.24	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
10	4.13	0.25	0.00	0.25	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
11	4.30	0.26	0.00	0.26	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
12	4.46	0.27	0.00	0.27	1.00	0.091	1.05	0.086	1.10	1.00	2.000	No
13	4.63	0.28	0.00	0.28	0.99	0.091	1.05	0.086	1.10	1.00	2.000	No
14	4.79	0.29	0.00	0.29	0.99	0.090	1.05	0.086	1.10	1.00	2.000	No
15	4.95	0.30	0.00	0.30	0.99	0.090	1.05	0.086	1.10	1.00	2.000	No
16	5.12	0.31	0.00	0.31	0.99	0.090	1.05	0.086	1.10	1.00	2.000	No
17	5.28	0.32	0.00	0.32	0.99	0.090	1.05	0.086	1.10	1.00	2.000	No
18	5.45	0.33	0.00	0.33	0.99	0.090	1.05	0.086	1.09	1.00	2.000	No
19	5.61	0.34	0.00	0.34	0.99	0.090	1.05	0.086	1.07	1.00	2.000	No
20	5.77	0.35	0.00	0.35	0.99	0.090	1.05	0.086	1.09	1.00	2.000	No
21	5.94	0.36	0.00	0.36	0.99	0.090	1.05	0.086	1.09	1.00	2.000	No
22	6.10	0.37	0.00	0.37	0.99	0.090	1.05	0.085	1.10	1.00	2.000	No
23	6.30	0.38	0.00	0.38	0.99	0.090	1.05	0.085	1.09	1.00	2.000	No
24	6.46	0.39	0.00	0.39	0.99	0.090	1.05	0.085	1.09	1.00	2.000	No
25	6.63	0.40	0.00	0.40	0.99	0.090	1.05	0.085	1.09	1.00	2.000	No
26	6.76	0.41	0.00	0.41	0.99	0.090	1.05	0.085	1.08	1.00	2.000	No
27	6.92	0.42	0.00	0.42	0.99	0.090	1.05	0.085	1.08	1.00	2.000	No
28	7.08	0.43	0.00	0.43	0.99	0.090	1.05	0.085	1.08	1.00	2.000	No
29	7.25	0.44	0.00	0.44	0.99	0.090	1.05	0.085	1.08	1.00	2.000	No
30	7.45	0.45	0.00	0.45	0.99	0.090	1.05	0.085	1.07	1.00	2.000	No
31	7.61	0.46	0.00	0.46	0.99	0.090	1.05	0.085	1.07	1.00	2.000	No
32	7.77	0.47	0.00	0.47	0.99	0.090	1.05	0.085	1.07	1.00	2.000	No
33	7.91	0.48	0.00	0.48	0.99	0.090	1.05	0.085	1.07	1.00	2.000	No
34	8.10	0.49	0.00	0.49	0.98	0.090	1.05	0.085	1.07	1.00	2.000	No
35	8.27	0.50	0.00	0.50	0.98	0.090	1.05	0.085	1.06	1.00	2.000	No
36	8.40	0.51	0.00	0.51	0.98	0.090	1.05	0.085	1.08	1.00	2.000	No
37	8.56	0.52	0.00	0.52	0.98	0.089	1.05	0.085	1.10	1.00	2.000	No
38	8.73	0.53	0.00	0.53	0.98	0.089	1.05	0.085	1.10	1.00	2.000	No
39	8.89	0.54	0.00	0.54	0.98	0.089	1.05	0.085	1.08	1.00	2.000	No
40	9.05	0.55	0.00	0.55	0.98	0.089	1.05	0.085	1.07	1.00	2.000	No
41	9.22	0.56	0.00	0.56	0.98	0.089	1.05	0.085	1.06	1.00	2.000	No
42	9.38	0.56	0.00	0.56	0.98	0.089	1.05	0.085	1.05	1.00	2.000	No
43	9.55	0.57	0.00	0.57	0.98	0.089	1.05	0.085	1.05	1.00	2.000	No
44	9.71	0.58	0.00	0.58	0.98	0.089	1.05	0.085	1.07	1.00	2.000	No
45	9.87	0.59	0.00	0.59	0.98	0.089	1.05	0.084	1.10	1.00	2.000	No
46	10.04	0.60	0.00	0.60	0.98	0.089	1.05	0.084	1.10	1.00	2.000	No
47	10.20	0.61	0.00	0.61	0.98	0.089	1.05	0.084	1.09	1.00	2.000	No
48	10.37	0.62	0.00	0.62	0.98	0.089	1.05	0.084	1.08	1.00	2.000	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	10.53	0.63	0.00	0.63	0.98	0.089	1.05	0.084	1.10	1.00	0.077	No
50	10.73	0.65	0.01	0.64	0.98	0.090	1.05	0.085	1.08	1.00	0.079	No
51	10.89	0.66	0.01	0.64	0.98	0.090	1.05	0.086	1.06	1.00	0.081	No
52	11.02	0.67	0.02	0.65	0.97	0.091	1.05	0.086	1.05	1.00	0.082	No
53	11.19	0.68	0.02	0.65	0.97	0.092	1.05	0.087	1.10	1.00	0.079	No
54	11.42	0.69	0.03	0.66	0.97	0.092	1.05	0.088	1.06	1.00	0.083	No
55	11.55	0.70	0.03	0.66	0.97	0.093	1.05	0.088	1.04	1.00	0.085	No
56	11.68	0.70	0.04	0.67	0.97	0.093	1.05	0.089	1.02	1.00	0.087	No
57	11.84	0.71	0.04	0.67	0.97	0.094	1.05	0.089	1.03	1.00	0.087	No
58	12.01	0.72	0.05	0.67	0.97	0.095	1.05	0.090	1.02	1.00	0.088	No
59	12.17	0.73	0.05	0.68	0.97	0.095	1.05	0.090	1.02	1.00	0.092	No
60	12.37	0.74	0.06	0.68	0.97	0.096	1.05	0.091	1.02	1.00	0.093	No
61	12.50	0.74	0.06	0.68	0.97	0.096	1.05	0.091	1.02	1.00	0.094	No
62	12.70	0.75	0.07	0.69	0.97	0.097	1.05	0.092	1.02	1.00	0.094	No
63	12.83	0.76	0.07	0.69	0.97	0.097	1.05	0.092	1.02	1.00	0.095	No
64	13.02	0.77	0.08	0.69	0.97	0.098	1.05	0.093	1.02	1.00	0.095	No
65	13.15	0.78	0.08	0.70	0.97	0.099	1.05	0.093	1.02	1.00	0.096	No
66	13.35	0.79	0.09	0.70	0.97	0.099	1.05	0.094	1.02	1.00	0.096	No
67	13.52	0.80	0.09	0.70	0.97	0.100	1.05	0.095	1.02	1.00	0.097	No
68	13.68	0.81	0.10	0.71	0.97	0.100	1.05	0.095	1.02	1.00	0.098	No
69	13.84	0.81	0.10	0.71	0.96	0.101	1.05	0.096	1.02	1.00	0.098	No
70	13.97	0.82	0.11	0.71	0.96	0.101	1.05	0.096	1.02	1.00	0.099	No
71	14.17	0.83	0.11	0.72	0.96	0.102	1.05	0.096	1.02	1.00	0.099	No
72	14.34	0.84	0.12	0.72	0.96	0.102	1.05	0.097	1.02	1.00	0.100	No
73	14.66	0.86	0.13	0.73	0.96	0.103	1.05	0.098	1.02	1.00	0.101	No
74	14.79	0.86	0.13	0.73	0.96	0.104	1.05	0.098	1.02	1.00	0.101	No
75	14.96	0.87	0.14	0.73	0.96	0.104	1.05	0.099	1.02	1.00	0.102	No
76	15.12	0.88	0.14	0.74	0.96	0.104	1.05	0.099	1.02	1.00	0.102	No
77	15.29	0.89	0.15	0.74	0.96	0.105	1.05	0.100	1.02	1.00	0.102	No
78	15.48	0.90	0.16	0.74	0.96	0.105	1.05	0.100	1.02	1.00	0.103	No
79	15.65	0.91	0.16	0.75	0.96	0.106	1.05	0.100	1.01	1.00	0.103	No
80	15.78	0.91	0.16	0.75	0.96	0.106	1.05	0.101	1.01	1.00	0.104	No
81	15.98	0.92	0.17	0.75	0.96	0.107	1.05	0.101	1.01	1.00	0.104	No
82	16.14	0.93	0.18	0.76	0.96	0.107	1.05	0.102	1.01	1.00	0.105	No
83	16.27	0.94	0.18	0.76	0.96	0.108	1.05	0.102	1.01	1.00	0.105	No
84	16.44	0.95	0.19	0.76	0.95	0.108	1.05	0.102	1.01	1.00	0.106	No
85	16.60	0.95	0.19	0.76	0.95	0.108	1.05	0.103	1.01	1.00	0.106	No
86	16.76	0.96	0.20	0.77	0.95	0.109	1.05	0.103	1.01	1.00	0.107	No
87	16.93	0.97	0.20	0.77	0.95	0.109	1.05	0.104	1.01	1.00	0.107	No
88	17.09	0.98	0.21	0.77	0.95	0.110	1.05	0.104	1.01	1.00	0.107	No
89	17.26	0.99	0.21	0.78	0.95	0.110	1.05	0.104	1.01	1.00	0.108	No
90	17.42	0.99	0.22	0.78	0.95	0.111	1.05	0.105	1.01	1.00	0.108	No
91	17.58	1.00	0.22	0.78	0.95	0.111	1.05	0.105	1.01	1.00	0.109	No
92	17.75	1.01	0.23	0.78	0.95	0.111	1.05	0.106	1.01	1.00	0.109	No
93	17.91	1.02	0.23	0.79	0.95	0.112	1.05	0.106	1.01	1.00	0.109	No
94	18.11	1.03	0.24	0.79	0.95	0.112	1.05	0.106	1.01	1.00	0.110	No
95	18.27	1.04	0.24	0.79	0.95	0.113	1.05	0.107	1.01	1.00	0.110	No
96	18.44	1.04	0.25	0.80	0.95	0.113	1.05	0.107	1.01	1.00	0.111	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
97	18.57	1.05	0.25	0.80	0.95	0.113	1.05	0.107	1.01	1.00	0.111	No
98	18.73	1.06	0.26	0.80	0.95	0.114	1.05	0.108	1.01	1.00	0.111	No
99	18.90	1.07	0.26	0.80	0.95	0.114	1.05	0.108	1.01	1.00	0.112	No
100	19.06	1.07	0.27	0.81	0.94	0.114	1.05	0.108	1.01	1.00	0.107	No
101	19.26	1.09	0.27	0.81	0.94	0.115	1.05	0.109	1.01	1.00	0.107	No
102	19.42	1.09	0.28	0.82	0.94	0.115	1.05	0.109	1.02	1.00	0.107	No
103	19.59	1.10	0.28	0.82	0.94	0.115	1.05	0.109	1.02	1.00	0.107	No
104	19.75	1.11	0.29	0.82	0.94	0.116	1.05	0.110	1.02	1.00	0.107	No
105	19.88	1.12	0.29	0.83	0.94	0.116	1.05	0.110	1.02	1.00	0.108	No
106	20.08	1.13	0.30	0.83	0.94	0.116	1.05	0.110	1.02	1.00	0.108	No
107	20.24	1.14	0.30	0.84	0.94	0.117	1.05	0.111	1.01	1.00	0.109	No
108	20.41	1.15	0.31	0.84	0.94	0.117	1.05	0.111	1.01	1.00	0.109	No
109	20.57	1.16	0.31	0.84	0.94	0.117	1.05	0.111	1.01	1.00	0.110	No
110	20.70	1.17	0.32	0.85	0.94	0.117	1.05	0.111	1.01	1.00	0.110	No
111	20.86	1.18	0.32	0.85	0.94	0.118	1.05	0.112	1.02	1.00	0.110	No
112	21.06	1.19	0.33	0.86	0.94	0.118	1.05	0.112	1.02	1.00	0.110	No
113	21.23	1.20	0.33	0.86	0.94	0.118	1.05	0.112	1.02	1.00	0.110	No
114	21.39	1.20	0.34	0.86	0.93	0.118	1.05	0.112	1.01	1.00	0.111	No
115	21.55	1.21	0.34	0.87	0.93	0.119	1.05	0.113	1.01	1.00	0.111	No
116	21.68	1.22	0.35	0.87	0.93	0.119	1.05	0.113	1.01	1.00	0.112	No
117	21.88	1.23	0.36	0.88	0.93	0.119	1.05	0.113	1.01	1.00	0.112	No
118	22.01	1.24	0.36	0.88	0.93	0.119	1.05	0.113	1.03	1.00	0.110	No
119	22.21	1.25	0.37	0.88	0.93	0.120	1.05	0.114	1.02	1.00	0.112	No
120	22.37	1.26	0.37	0.89	0.93	0.120	1.05	0.114	1.01	1.00	0.113	No
121	22.54	1.26	0.38	0.89	0.93	0.120	1.05	0.114	1.01	1.00	0.118	No
122	22.67	1.27	0.38	0.89	0.93	0.121	1.05	0.114	1.01	1.00	0.119	No
123	22.87	1.28	0.39	0.90	0.93	0.121	1.05	0.115	1.01	1.00	0.119	No
124	23.00	1.29	0.39	0.90	0.93	0.121	1.05	0.115	1.01	1.00	0.114	No
125	23.16	1.30	0.40	0.90	0.93	0.121	1.05	0.115	1.01	1.00	0.114	No
126	23.32	1.31	0.40	0.91	0.93	0.121	1.05	0.115	1.01	1.00	0.114	No
127	23.49	1.32	0.41	0.91	0.93	0.122	1.05	0.115	1.01	1.00	0.114	No
128	23.65	1.33	0.41	0.92	0.92	0.122	1.05	0.116	1.01	1.00	0.114	No
129	23.82	1.34	0.42	0.92	0.92	0.122	1.05	0.116	1.01	1.00	0.114	No
130	23.98	1.35	0.42	0.93	0.92	0.122	1.05	0.116	1.01	1.00	0.114	No
131	24.15	1.36	0.43	0.93	0.92	0.122	1.05	0.116	1.01	1.00	0.115	No
132	24.34	1.37	0.43	0.94	0.92	0.123	1.05	0.116	1.01	1.00	0.115	No
133	24.47	1.38	0.44	0.94	0.92	0.123	1.05	0.116	1.01	1.00	0.115	No
134	24.67	1.39	0.44	0.95	0.92	0.123	1.05	0.117	1.01	1.00	0.115	No
135	24.80	1.40	0.45	0.95	0.92	0.123	1.05	0.117	1.01	1.00	0.115	No
136	25.00	1.41	0.45	0.96	0.92	0.123	1.05	0.117	1.01	1.00	0.116	No
137	25.13	1.42	0.46	0.96	0.92	0.123	1.05	0.117	1.01	1.00	0.116	No
138	25.29	1.43	0.46	0.97	0.92	0.123	1.05	0.117	1.01	1.00	0.116	No
139	25.46	1.44	0.47	0.97	0.92	0.124	1.05	0.117	1.01	1.00	0.116	No
140	25.62	1.45	0.47	0.97	0.92	0.124	1.05	0.117	1.01	1.00	0.116	No
141	25.79	1.46	0.48	0.98	0.92	0.124	1.05	0.117	1.01	1.00	0.117	No
142	25.95	1.47	0.48	0.98	0.91	0.124	1.05	0.118	1.01	1.00	0.117	No
143	26.11	1.48	0.49	0.99	0.91	0.124	1.05	0.118	1.01	1.00	0.117	No
144	26.28	1.49	0.49	1.00	0.91	0.124	1.05	0.118	1.01	1.00	0.117	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
145	26.44	1.50	0.50	1.00	0.91	0.124	1.05	0.118	1.01	1.00	0.117	No
146	26.64	1.51	0.50	1.01	0.91	0.124	1.05	0.118	1.01	1.00	0.117	No

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.33	1.19	86.70	3.74	0.71	1.70	1.91	0.00	1.91	4.000	No	Yes	2.00
2	2.82	25.97	19.18	2.10	0.75	1.70	1.91	23.92	25.83	4.000	No	No	2.00
3	2.98	100.52	9.29	1.59	0.43	1.70	121.34	10.90	132.24	4.000	No	No	2.00
4	3.15	178.13	7.96	1.49	0.26	1.70	361.28	9.97	371.24	4.000	No	No	2.00
5	3.31	215.01	8.09	1.50	0.26	1.70	375.98	11.39	387.37	4.000	No	No	2.00
6	3.48	198.06	9.55	1.60	0.26	1.70	299.13	22.86	321.99	4.000	No	No	2.00
7	3.64	174.35	10.78	1.68	0.26	1.70	279.58	34.55	314.13	4.000	No	No	2.00
8	3.80	154.01	11.88	1.74	0.26	1.70	261.69	43.95	305.63	4.000	No	No	2.00
9	3.97	138.69	12.86	1.80	0.27	1.70	201.09	43.99	245.08	4.000	No	No	2.00
10	4.13	125.88	13.23	1.82	0.26	1.70	205.63	47.53	253.17	4.000	No	No	2.00
11	4.30	131.80	12.20	1.76	0.28	1.70	199.93	38.71	238.64	4.000	No	No	2.00
12	4.46	137.53	11.29	1.71	0.26	1.69	228.61	34.40	263.01	4.000	No	No	2.00
13	4.63	143.88	11.09	1.70	0.26	1.66	228.07	32.53	260.60	4.000	No	No	2.00
14	4.79	135.85	11.60	1.73	0.26	1.63	221.58	36.42	258.00	4.000	No	No	2.00
15	4.95	112.37	13.15	1.81	0.29	1.68	189.15	44.25	233.40	4.000	No	No	2.00
16	5.12	83.67	15.53	1.93	0.38	1.70	120.15	44.31	164.45	4.000	No	No	2.00
17	5.28	57.22	20.04	2.13	0.42	1.70	92.23	50.07	142.30	4.000	No	No	2.00
18	5.45	40.80	24.99	2.32	0.47	1.70	63.38	47.47	110.86	4.000	No	No	2.00
19	5.61	34.91	27.51	2.41	0.54	1.70	40.96	41.74	82.70	4.000	No	No	2.00
20	5.77	35.05	27.29	2.40	0.47	1.70	63.76	49.09	112.85	4.000	No	No	2.00
21	5.94	43.12	24.21	2.29	0.47	1.70	64.04	47.05	111.09	4.000	No	No	2.00
22	6.10	46.11	23.23	2.26	0.44	1.70	79.83	51.00	130.84	4.000	No	No	2.00
23	6.30	48.68	22.43	2.23	0.44	1.70	78.20	49.59	127.79	4.000	No	No	2.00
24	6.46	47.78	22.79	2.24	0.45	1.70	76.48	49.49	125.98	4.000	No	No	2.00
25	6.63	47.12	23.07	2.25	0.45	1.70	75.46	49.49	124.95	4.000	No	No	2.00
26	6.76	46.71	23.24	2.26	0.45	1.70	75.02	49.53	124.55	4.000	No	No	2.00
27	6.92	46.40	23.34	2.26	0.45	1.70	74.52	49.48	124.01	4.000	No	No	2.00
28	7.08	46.09	23.46	2.26	0.45	1.70	73.95	49.43	123.38	4.000	No	No	2.00
29	7.25	45.79	23.58	2.27	0.45	1.70	73.54	49.43	122.97	4.000	No	No	2.00
30	7.45	45.55	23.72	2.27	0.45	1.70	73.06	49.41	122.47	4.000	No	No	2.00
31	7.61	45.36	23.85	2.28	0.45	1.69	72.22	49.28	121.51	4.000	No	No	2.00
32	7.77	45.24	23.98	2.28	0.46	1.67	71.32	49.12	120.43	4.000	No	No	2.00
33	7.91	45.25	22.70	2.24	0.46	1.66	70.77	47.65	118.41	4.000	No	No	2.00
34	8.10	45.37	20.36	2.14	0.47	1.65	70.58	44.50	115.08	4.000	No	No	2.00
35	8.27	53.63	15.79	1.95	0.49	1.66	71.43	34.66	106.09	4.000	No	No	2.00
36	8.40	84.73	11.51	1.72	0.44	1.57	104.04	21.99	126.03	4.000	No	No	2.00
37	8.56	109.11	10.61	1.67	0.32	1.38	180.93	23.87	204.80	4.000	No	No	2.00
38	8.73	113.99	10.89	1.69	0.35	1.41	158.32	23.84	182.16	4.000	No	No	2.00
39	8.89	90.69	12.98	1.80	0.40	1.47	117.10	31.78	148.88	4.000	No	No	2.00
40	9.05	70.95	15.23	1.92	0.43	1.49	96.51	38.14	134.64	4.000	No	No	2.00
41	9.22	58.68	16.95	2.00	0.45	1.49	84.11	40.91	125.02	4.000	No	No	2.00
42	9.38	52.43	17.47	2.02	0.48	1.53	68.92	38.52	107.43	4.000	No	No	2.00
43	9.55	61.03	15.63	1.94	0.49	1.52	71.62	34.21	105.84	4.000	No	No	2.00
44	9.71	91.80	12.60	1.78	0.41	1.41	113.90	29.26	143.16	4.000	No	No	2.00
45	9.87	119.02	11.37	1.71	0.33	1.30	172.47	28.84	201.30	4.000	No	No	2.00
46	10.04	129.90	11.00	1.69	0.34	1.31	163.35	25.13	188.48	4.000	No	No	2.00
47	10.20	123.39	11.18	1.70	0.37	1.33	147.92	24.84	172.76	4.000	No	No	2.00
48	10.37	125.38	10.54	1.67	0.37	1.32	150.30	20.71	171.01	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	10.53	127.39	10.69	1.67	0.34	1.28	167.05	23.26	190.31	0.759	No	No	2.00
50	10.73	117.22	12.59	1.78	0.35	1.29	150.69	34.58	185.26	0.634	No	No	2.00
51	10.89	95.26	15.29	1.92	0.40	1.32	112.71	41.77	154.48	0.293	No	No	2.00
52	11.02	113.37	13.38	1.83	0.45	1.37	93.18	29.89	123.07	0.186	No	No	2.00
53	11.19	116.64	11.12	1.70	0.28	1.22	205.30	30.41	235.71	4.000	No	No	2.00
54	11.42	111.43	9.71	1.61	0.42	1.33	125.36	13.51	138.87	0.229	No	No	2.00
55	11.55	54.85	12.43	1.77	0.51	1.41	74.18	22.73	96.91	0.138	No	No	1.62
56	11.68	27.70	18.84	2.08	0.68	1.58	12.73	26.44	39.16	0.068	No	No	0.78
57	11.84	14.27	29.88	2.49	0.59	1.48	25.72	37.55	63.27	0.092	No	No	1.05
58	12.01	14.28	31.65	2.54	0.61	1.49	22.22	36.81	59.02	0.087	No	No	0.99
59	12.17	10.05	39.75	2.77	0.65	1.53	12.47	0.00	12.47	0.881	No	Yes	2.00
60	12.37	6.03	51.97	3.08	0.67	1.54	8.17	0.00	8.17	0.502	No	Yes	2.00
61	12.50	4.67	57.42	3.20	0.69	1.56	5.23	0.00	5.23	0.373	No	Yes	2.00
62	12.70	6.44	47.47	2.97	0.68	1.54	6.41	0.00	6.41	0.533	No	Yes	2.00
63	12.83	7.24	44.39	2.89	0.63	1.49	15.32	0.00	15.32	0.603	No	Yes	2.00
64	13.02	7.44	44.46	2.90	0.67	1.52	8.70	0.00	8.70	0.616	No	Yes	2.00
65	13.15	6.50	50.39	3.04	0.68	1.52	7.23	0.00	7.23	0.527	No	Yes	2.00
66	13.35	8.10	45.17	2.91	0.66	1.49	11.33	0.00	11.33	0.666	No	Yes	2.00
67	13.52	8.58	44.16	2.89	0.64	1.47	14.94	0.00	14.94	0.704	No	Yes	2.00
68	13.68	7.89	45.40	2.92	0.67	1.49	9.11	0.00	9.11	0.638	No	Yes	2.00
69	13.84	6.32	53.09	3.10	0.67	1.49	8.23	0.00	8.23	0.495	No	Yes	2.00
70	13.97	5.79	59.50	3.24	0.67	1.48	8.41	0.00	8.41	0.446	No	Yes	2.00
71	14.17	5.40	61.85	3.29	0.68	1.49	6.87	0.00	6.87	0.408	No	Yes	2.00
72	14.34	5.01	63.92	3.33	0.68	1.48	6.57	0.00	6.57	0.371	No	Yes	2.00
73	14.66	5.32	58.32	3.21	0.68	1.47	6.56	0.00	6.56	0.392	No	Yes	2.00
74	14.79	5.73	55.57	3.16	0.67	1.46	7.94	0.00	7.94	0.425	No	Yes	2.00
75	14.96	6.03	53.06	3.10	0.67	1.45	7.97	0.00	7.97	0.447	No	Yes	2.00
76	15.12	5.92	54.32	3.13	0.68	1.45	7.62	0.00	7.62	0.434	No	Yes	2.00
77	15.29	5.98	54.87	3.14	0.68	1.45	7.28	0.00	7.28	0.436	No	Yes	2.00
78	15.48	5.76	56.12	3.17	0.67	1.44	8.14	0.00	8.14	0.414	No	Yes	2.00
79	15.65	5.43	56.14	3.17	0.68	1.44	6.84	0.00	6.84	0.384	No	Yes	2.00
80	15.78	4.80	58.54	3.22	0.69	1.44	5.98	0.00	5.98	0.330	No	Yes	2.00
81	15.98	4.37	60.83	3.27	0.69	1.43	5.67	0.00	5.67	0.293	No	Yes	2.00
82	16.14	4.06	62.65	3.30	0.69	1.43	5.07	0.00	5.07	0.266	No	Yes	2.00
83	16.27	4.08	61.06	3.27	0.69	1.43	4.72	0.00	4.72	0.265	No	Yes	2.00
84	16.44	4.09	59.70	3.24	0.69	1.42	5.60	0.00	5.60	0.264	No	Yes	2.00
85	16.60	4.22	58.51	3.22	0.69	1.42	4.90	0.00	4.90	0.273	No	Yes	2.00
86	16.76	4.16	59.91	3.25	0.69	1.41	5.05	0.00	5.05	0.266	No	Yes	2.00
87	16.93	4.29	59.24	3.23	0.69	1.41	5.27	0.00	5.27	0.275	No	Yes	2.00
88	17.09	4.42	57.88	3.21	0.69	1.40	5.38	0.00	5.38	0.283	No	Yes	2.00
89	17.26	4.53	56.13	3.17	0.69	1.40	5.53	0.00	5.53	0.290	No	Yes	2.00
90	17.42	4.55	55.89	3.16	0.69	1.39	5.69	0.00	5.69	0.290	No	Yes	2.00
91	17.58	4.47	56.98	3.19	0.69	1.39	5.45	0.00	5.45	0.282	No	Yes	2.00
92	17.75	4.37	58.32	3.22	0.69	1.39	5.23	0.00	5.23	0.272	No	Yes	2.00
93	17.91	4.44	57.88	3.21	0.69	1.38	5.30	0.00	5.30	0.276	No	Yes	2.00
94	18.11	4.84	54.84	3.14	0.69	1.38	5.74	0.00	5.74	0.304	No	Yes	2.00
95	18.27	5.34	51.54	3.07	0.68	1.37	6.67	0.00	6.67	0.341	No	Yes	2.00
96	18.44	5.62	49.99	3.03	0.68	1.36	7.22	0.00	7.22	0.360	No	Yes	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
97	18.57	5.53	51.36	3.06	0.68	1.36	6.81	0.00	6.81	0.352	No	Yes	2.00
98	18.73	5.95	49.92	3.03	0.68	1.36	6.33	0.00	6.33	0.382	No	Yes	2.00
99	18.90	9.82	39.02	2.75	0.67	1.35	8.73	0.00	8.73	0.672	No	Yes	2.00
100	19.06	15.13	32.03	2.55	0.61	1.31	20.88	36.43	57.31	0.085	No	No	0.79
101	19.26	23.27	26.53	2.37	0.60	1.29	25.58	36.28	61.86	0.090	No	No	0.84
102	19.42	36.46	21.16	2.18	0.56	1.27	37.67	36.10	73.77	0.104	No	No	0.97
103	19.59	53.51	17.26	2.01	0.49	1.23	65.69	37.23	102.92	0.147	No	No	1.37
104	19.75	64.23	15.52	1.93	0.46	1.21	82.53	36.22	118.76	0.177	No	No	1.65
105	19.88	61.67	16.45	1.98	0.48	1.22	73.12	36.93	110.05	0.160	No	No	1.49
106	20.08	46.12	20.15	2.14	0.51	1.23	56.65	40.25	96.91	0.138	No	No	1.27
107	20.24	32.67	24.82	2.31	0.58	1.26	30.33	36.90	67.23	0.096	No	No	0.88
108	20.41	24.90	27.21	2.40	0.59	1.26	27.61	37.24	64.85	0.093	No	No	0.85
109	20.57	22.63	26.63	2.38	0.58	1.25	30.18	37.82	68.00	0.097	No	No	0.89
110	20.70	34.32	20.22	2.14	0.63	1.27	22.28	30.66	52.94	0.080	No	No	0.73
111	20.86	52.59	15.44	1.93	0.50	1.21	66.42	32.53	98.94	0.141	No	No	1.28
112	21.06	62.03	13.91	1.85	0.45	1.18	89.95	31.63	121.58	0.183	No	No	1.67
113	21.23	57.00	14.31	1.87	0.54	1.22	54.25	26.56	80.80	0.114	No	No	1.03
114	21.39	42.83	17.03	2.00	0.54	1.21	49.66	32.82	82.48	0.116	No	No	1.05
115	21.55	35.45	19.97	2.13	0.55	1.21	43.49	36.31	79.79	0.112	No	No	1.01
116	21.68	25.29	25.92	2.35	0.59	1.23	28.95	37.07	66.02	0.095	No	No	0.85
117	21.88	55.70	14.55	1.88	0.70	1.27	15.41	19.77	35.18	0.065	No	No	0.58
118	22.01	75.34	10.58	1.67	0.39	1.14	139.20	19.97	159.17	0.321	No	No	2.00
119	22.21	75.07	9.34	1.59	0.49	1.18	93.40	9.65	103.05	0.148	No	No	1.32
120	22.37	35.48	16.03	1.96	0.69	1.26	14.24	22.55	36.79	0.066	No	No	0.59
121	22.54	10.60	35.01	2.64	0.65	1.24	12.06	0.00	12.06	0.637	No	Yes	2.00
122	22.67	10.55	39.49	2.77	0.66	1.24	10.65	0.00	10.65	0.631	No	Yes	2.00
123	22.87	14.79	34.34	2.62	0.65	1.23	13.65	0.00	13.65	0.910	No	Yes	2.00
124	23.00	27.07	25.14	2.33	0.60	1.21	26.25	35.79	62.04	0.090	No	No	0.79
125	23.16	42.83	20.22	2.14	0.52	1.17	51.07	38.79	89.85	0.127	No	No	1.11
126	23.32	57.83	17.73	2.03	0.49	1.16	64.92	38.10	103.02	0.148	No	No	1.30
127	23.49	67.51	17.12	2.01	0.47	1.15	74.13	38.94	113.08	0.166	No	No	1.45
128	23.65	75.20	16.55	1.98	0.46	1.14	81.10	39.06	120.16	0.180	No	No	1.58
129	23.82	80.99	16.11	1.96	0.44	1.13	88.25	39.38	127.63	0.197	No	No	1.73
130	23.98	85.55	15.52	1.93	0.44	1.13	91.45	38.12	129.57	0.202	No	No	1.77
131	24.15	85.97	16.26	1.97	0.43	1.12	94.42	41.25	135.67	0.219	No	No	1.91
132	24.34	71.88	19.81	2.12	0.43	1.12	88.43	48.58	137.01	0.223	No	No	1.94
133	24.47	70.77	20.75	2.16	0.53	1.15	46.87	38.28	85.15	0.120	No	No	1.04
134	24.67	82.51	18.18	2.05	0.43	1.11	89.83	45.48	135.31	0.218	No	No	1.89
135	24.80	102.24	15.35	1.92	0.38	1.10	123.25	44.22	167.48	0.384	No	No	2.00
136	25.00	99.39	15.93	1.95	0.40	1.10	106.78	42.94	149.72	0.270	No	No	2.00
137	25.13	83.47	19.11	2.09	0.45	1.11	80.75	45.13	125.88	0.193	No	No	1.66
138	25.29	70.43	21.57	2.19	0.45	1.11	74.34	47.34	121.68	0.183	No	No	1.58
139	25.46	70.88	21.54	2.19	0.48	1.11	65.96	44.84	110.80	0.161	No	No	1.39
140	25.62	68.13	22.09	2.21	0.44	1.10	81.15	50.04	131.19	0.206	No	No	1.77
141	25.79	71.26	21.64	2.20	0.48	1.11	65.30	44.76	110.06	0.160	No	No	1.37
142	25.95	87.73	18.37	2.06	0.46	1.10	74.77	42.01	116.78	0.173	No	No	1.48
143	26.11	118.97	13.96	1.85	0.37	1.08	130.14	39.10	169.24	0.400	No	No	2.00
144	26.28	147.50	12.81	1.79	0.34	1.07	157.98	37.08	195.06	0.917	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
145	26.44	157.72	13.37	1.82	0.33	1.06	159.33	40.81	200.15	1.146	No	No	2.00
146	26.64	141.82	16.69	1.99	0.35	1.07	134.43	52.03	186.46	0.661	No	No	2.00

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.33	2.00	0.00	9.65	0.49	0.00	2.82	2.00	0.00	9.57	0.49	0.00
2.98	2.00	0.00	9.55	0.16	0.00	3.15	2.00	0.00	9.52	0.16	0.00
3.31	2.00	0.00	9.50	0.16	0.00	3.48	2.00	0.00	9.47	0.16	0.00
3.64	2.00	0.00	9.45	0.16	0.00	3.80	2.00	0.00	9.42	0.16	0.00
3.97	2.00	0.00	9.40	0.17	0.00	4.13	2.00	0.00	9.37	0.16	0.00
4.30	2.00	0.00	9.35	0.16	0.00	4.46	2.00	0.00	9.32	0.16	0.00
4.63	2.00	0.00	9.30	0.16	0.00	4.79	2.00	0.00	9.27	0.16	0.00
4.95	2.00	0.00	9.25	0.16	0.00	5.12	2.00	0.00	9.22	0.16	0.00
5.28	2.00	0.00	9.20	0.16	0.00	5.45	2.00	0.00	9.17	0.16	0.00
5.61	2.00	0.00	9.15	0.16	0.00	5.77	2.00	0.00	9.12	0.16	0.00
5.94	2.00	0.00	9.10	0.16	0.00	6.10	2.00	0.00	9.07	0.16	0.00
6.30	2.00	0.00	9.04	0.20	0.00	6.46	2.00	0.00	9.02	0.16	0.00
6.63	2.00	0.00	8.99	0.16	0.00	6.76	2.00	0.00	8.97	0.13	0.00
6.92	2.00	0.00	8.95	0.16	0.00	7.08	2.00	0.00	8.92	0.16	0.00
7.25	2.00	0.00	8.90	0.16	0.00	7.45	2.00	0.00	8.87	0.20	0.00
7.61	2.00	0.00	8.84	0.16	0.00	7.77	2.00	0.00	8.82	0.16	0.00
7.91	2.00	0.00	8.80	0.13	0.00	8.10	2.00	0.00	8.77	0.20	0.00
8.27	2.00	0.00	8.74	0.16	0.00	8.40	2.00	0.00	8.72	0.13	0.00
8.56	2.00	0.00	8.70	0.16	0.00	8.73	2.00	0.00	8.67	0.16	0.00
8.89	2.00	0.00	8.65	0.16	0.00	9.05	2.00	0.00	8.62	0.16	0.00
9.22	2.00	0.00	8.60	0.16	0.00	9.38	2.00	0.00	8.57	0.16	0.00
9.55	2.00	0.00	8.55	0.16	0.00	9.71	2.00	0.00	8.52	0.16	0.00
9.87	2.00	0.00	8.50	0.16	0.00	10.04	2.00	0.00	8.47	0.16	0.00
10.20	2.00	0.00	8.45	0.16	0.00	10.37	2.00	0.00	8.42	0.16	0.00
10.53	2.00	0.00	8.40	0.16	0.00	10.73	2.00	0.00	8.37	0.20	0.00
10.89	2.00	0.00	8.34	0.16	0.00	11.02	2.00	0.00	8.32	0.13	0.00
11.19	2.00	0.00	8.30	0.16	0.00	11.42	2.00	0.00	8.26	0.23	0.00
11.55	1.62	0.00	8.24	0.13	0.00	11.68	0.78	0.22	8.22	0.13	0.07
11.84	1.05	0.00	8.20	0.16	0.00	12.01	0.99	0.01	8.17	0.16	0.00
12.17	2.00	0.00	8.15	0.16	0.00	12.37	2.00	0.00	8.12	0.20	0.00
12.50	2.00	0.00	8.10	0.13	0.00	12.70	2.00	0.00	8.07	0.20	0.00
12.83	2.00	0.00	8.05	0.13	0.00	13.02	2.00	0.00	8.02	0.20	0.00
13.15	2.00	0.00	8.00	0.13	0.00	13.35	2.00	0.00	7.97	0.20	0.00
13.52	2.00	0.00	7.94	0.16	0.00	13.68	2.00	0.00	7.92	0.16	0.00
13.84	2.00	0.00	7.89	0.16	0.00	13.97	2.00	0.00	7.87	0.13	0.00
14.17	2.00	0.00	7.84	0.20	0.00	14.34	2.00	0.00	7.82	0.16	0.00
14.66	2.00	0.00	7.77	0.33	0.00	14.79	2.00	0.00	7.75	0.13	0.00
14.96	2.00	0.00	7.72	0.16	0.00	15.12	2.00	0.00	7.70	0.16	0.00
15.29	2.00	0.00	7.67	0.16	0.00	15.48	2.00	0.00	7.64	0.20	0.00
15.65	2.00	0.00	7.62	0.16	0.00	15.78	2.00	0.00	7.60	0.13	0.00
15.98	2.00	0.00	7.57	0.20	0.00	16.14	2.00	0.00	7.54	0.16	0.00
16.27	2.00	0.00	7.52	0.13	0.00	16.44	2.00	0.00	7.50	0.16	0.00
16.60	2.00	0.00	7.47	0.16	0.00	16.76	2.00	0.00	7.45	0.16	0.00
16.93	2.00	0.00	7.42	0.16	0.00	17.09	2.00	0.00	7.40	0.16	0.00
17.26	2.00	0.00	7.37	0.16	0.00	17.42	2.00	0.00	7.35	0.16	0.00
17.58	2.00	0.00	7.32	0.16	0.00	17.75	2.00	0.00	7.30	0.16	0.00
17.91	2.00	0.00	7.27	0.16	0.00	18.11	2.00	0.00	7.24	0.20	0.00
18.27	2.00	0.00	7.22	0.16	0.00	18.44	2.00	0.00	7.19	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
18.57	2.00	0.00	7.17	0.13	0.00	18.73	2.00	0.00	7.15	0.16	0.00
18.90	2.00	0.00	7.12	0.16	0.00	19.06	0.79	0.21	7.10	0.16	0.07
19.26	0.84	0.16	7.07	0.20	0.07	19.42	0.97	0.03	7.04	0.16	0.01
19.59	1.37	0.00	7.02	0.16	0.00	19.75	1.65	0.00	6.99	0.16	0.00
19.88	1.49	0.00	6.97	0.13	0.00	20.08	1.27	0.00	6.94	0.20	0.00
20.24	0.88	0.12	6.92	0.16	0.04	20.41	0.85	0.15	6.89	0.16	0.05
20.57	0.89	0.11	6.87	0.16	0.04	20.70	0.73	0.27	6.85	0.13	0.07
20.86	1.28	0.00	6.82	0.16	0.00	21.06	1.67	0.00	6.79	0.20	0.00
21.23	1.03	0.00	6.77	0.16	0.00	21.39	1.05	0.00	6.74	0.16	0.00
21.55	1.01	0.00	6.72	0.16	0.00	21.68	0.85	0.15	6.70	0.13	0.04
21.88	0.58	0.42	6.67	0.20	0.17	22.01	2.00	0.00	6.65	0.13	0.00
22.21	1.32	0.00	6.62	0.20	0.00	22.37	0.59	0.41	6.59	0.16	0.14
22.54	2.00	0.00	6.57	0.16	0.00	22.67	2.00	0.00	6.55	0.13	0.00
22.87	2.00	0.00	6.52	0.20	0.00	23.00	0.79	0.21	6.50	0.13	0.05
23.16	1.11	0.00	6.47	0.16	0.00	23.32	1.30	0.00	6.45	0.16	0.00
23.49	1.45	0.00	6.42	0.16	0.00	23.65	1.58	0.00	6.40	0.16	0.00
23.82	1.73	0.00	6.37	0.16	0.00	23.98	1.77	0.00	6.35	0.16	0.00
24.15	1.91	0.00	6.32	0.16	0.00	24.34	1.94	0.00	6.29	0.20	0.00
24.47	1.04	0.00	6.27	0.13	0.00	24.67	1.89	0.00	6.24	0.20	0.00
24.80	2.00	0.00	6.22	0.13	0.00	25.00	2.00	0.00	6.19	0.20	0.00
25.13	1.66	0.00	6.17	0.13	0.00	25.29	1.58	0.00	6.15	0.16	0.00
25.46	1.39	0.00	6.12	0.16	0.00	25.62	1.77	0.00	6.10	0.16	0.00
25.79	1.37	0.00	6.07	0.16	0.00	25.95	1.48	0.00	6.05	0.16	0.00
26.11	2.00	0.00	6.02	0.16	0.00	26.28	2.00	0.00	6.00	0.16	0.00
26.44	2.00	0.00	5.97	0.16	0.00	26.64	2.00	0.00	5.94	0.20	0.00

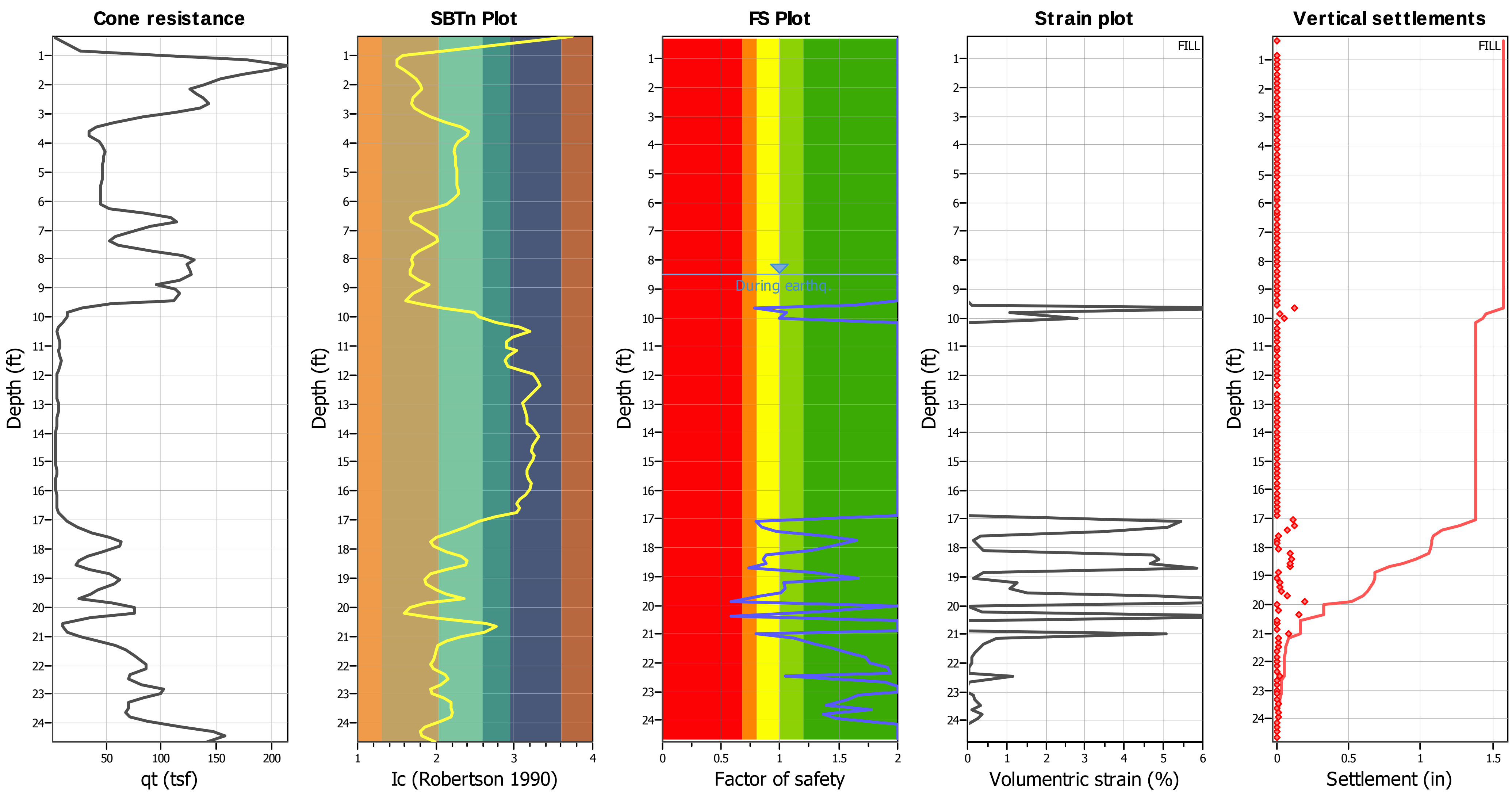
Overall liquefaction potential: 0.83

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.53	190.31	2.00	0.00	1.00	0.00	10.73	185.26	2.00	0.00	1.00	0.00
10.89	154.48	2.00	0.00	1.00	0.00	11.02	123.07	2.00	0.00	1.00	0.00
11.19	235.71	2.00	0.00	1.00	0.00	11.42	138.87	2.00	0.00	1.00	0.00
11.55	96.91	1.62	0.12	1.00	0.00	11.68	39.16	0.78	7.50	1.00	0.12
11.84	63.27	1.05	1.07	1.00	0.02	12.01	59.02	0.99	2.78	1.00	0.05
12.17	12.47	2.00	0.00	1.00	0.00	12.37	8.17	2.00	0.00	1.00	0.00
12.50	5.23	2.00	0.00	1.00	0.00	12.70	6.41	2.00	0.00	1.00	0.00
12.83	15.32	2.00	0.00	1.00	0.00	13.02	8.70	2.00	0.00	1.00	0.00
13.15	7.23	2.00	0.00	1.00	0.00	13.35	11.33	2.00	0.00	1.00	0.00
13.52	14.94	2.00	0.00	1.00	0.00	13.68	9.11	2.00	0.00	1.00	0.00
13.84	8.23	2.00	0.00	1.00	0.00	13.97	8.41	2.00	0.00	1.00	0.00
14.17	6.87	2.00	0.00	1.00	0.00	14.34	6.57	2.00	0.00	1.00	0.00
14.66	6.56	2.00	0.00	1.00	0.00	14.79	7.94	2.00	0.00	1.00	0.00
14.96	7.97	2.00	0.00	1.00	0.00	15.12	7.62	2.00	0.00	1.00	0.00
15.29	7.28	2.00	0.00	1.00	0.00	15.48	8.14	2.00	0.00	1.00	0.00
15.65	6.84	2.00	0.00	1.00	0.00	15.78	5.98	2.00	0.00	1.00	0.00
15.98	5.67	2.00	0.00	1.00	0.00	16.14	5.07	2.00	0.00	1.00	0.00
16.27	4.72	2.00	0.00	1.00	0.00	16.44	5.60	2.00	0.00	1.00	0.00
16.60	4.90	2.00	0.00	1.00	0.00	16.76	5.05	2.00	0.00	1.00	0.00
16.93	5.27	2.00	0.00	1.00	0.00	17.09	5.38	2.00	0.00	1.00	0.00
17.26	5.53	2.00	0.00	1.00	0.00	17.42	5.69	2.00	0.00	1.00	0.00
17.58	5.45	2.00	0.00	1.00	0.00	17.75	5.23	2.00	0.00	1.00	0.00
17.91	5.30	2.00	0.00	1.00	0.00	18.11	5.74	2.00	0.00	1.00	0.00
18.27	6.67	2.00	0.00	1.00	0.00	18.44	7.22	2.00	0.00	1.00	0.00
18.57	6.81	2.00	0.00	1.00	0.00	18.73	6.33	2.00	0.00	1.00	0.00
18.90	8.73	2.00	0.00	1.00	0.00	19.06	57.31	0.79	5.45	1.00	0.11
19.26	61.86	0.84	5.09	1.00	0.12	19.42	73.77	0.97	3.48	1.00	0.07
19.59	102.92	1.37	0.33	1.00	0.01	19.75	118.76	1.65	0.15	1.00	0.00
19.88	110.05	1.49	0.25	1.00	0.00	20.08	96.91	1.27	0.43	1.00	0.01
20.24	67.23	0.88	4.72	1.00	0.09	20.41	64.85	0.85	4.88	1.00	0.10
20.57	68.00	0.89	4.67	1.00	0.09	20.70	52.94	0.73	5.84	1.00	0.09
20.86	98.94	1.28	0.42	1.00	0.01	21.06	121.58	1.67	0.14	1.00	0.00
21.23	80.80	1.03	1.25	1.00	0.02	21.39	82.48	1.05	1.08	1.00	0.02
21.55	79.79	1.01	1.54	1.00	0.03	21.68	66.02	0.85	4.80	1.00	0.08
21.88	35.18	0.58	8.16	1.00	0.19	22.01	159.17	2.00	0.00	1.00	0.00
22.21	103.05	1.32	0.39	1.00	0.01	22.37	36.79	0.59	7.88	1.00	0.16
22.54	12.06	2.00	0.00	1.00	0.00	22.67	10.65	2.00	0.00	1.00	0.00
22.87	13.65	2.00	0.00	1.00	0.00	23.00	62.04	0.79	5.08	1.00	0.08
23.16	89.85	1.11	0.75	1.00	0.01	23.32	103.02	1.30	0.42	1.00	0.01
23.49	113.08	1.45	0.28	1.00	0.01	23.65	120.16	1.58	0.20	1.00	0.00
23.82	127.63	1.73	0.12	1.00	0.00	23.98	129.57	1.77	0.10	1.00	0.00
24.15	135.67	1.91	0.04	1.00	0.00	24.34	137.01	1.94	0.02	1.00	0.00
24.47	85.15	1.04	1.17	1.00	0.02	24.67	135.31	1.89	0.04	1.00	0.00
24.80	167.48	2.00	0.00	1.00	0.00	25.00	149.72	2.00	0.00	1.00	0.00
25.13	125.88	1.66	0.15	1.00	0.00	25.29	121.68	1.58	0.20	1.00	0.00
25.46	110.80	1.39	0.34	1.00	0.01	25.62	131.19	1.77	0.10	1.00	0.00
25.79	110.06	1.37	0.36	1.00	0.01	25.95	116.78	1.48	0.27	1.00	0.01
26.11	169.24	2.00	0.00	1.00	0.00	26.28	195.06	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

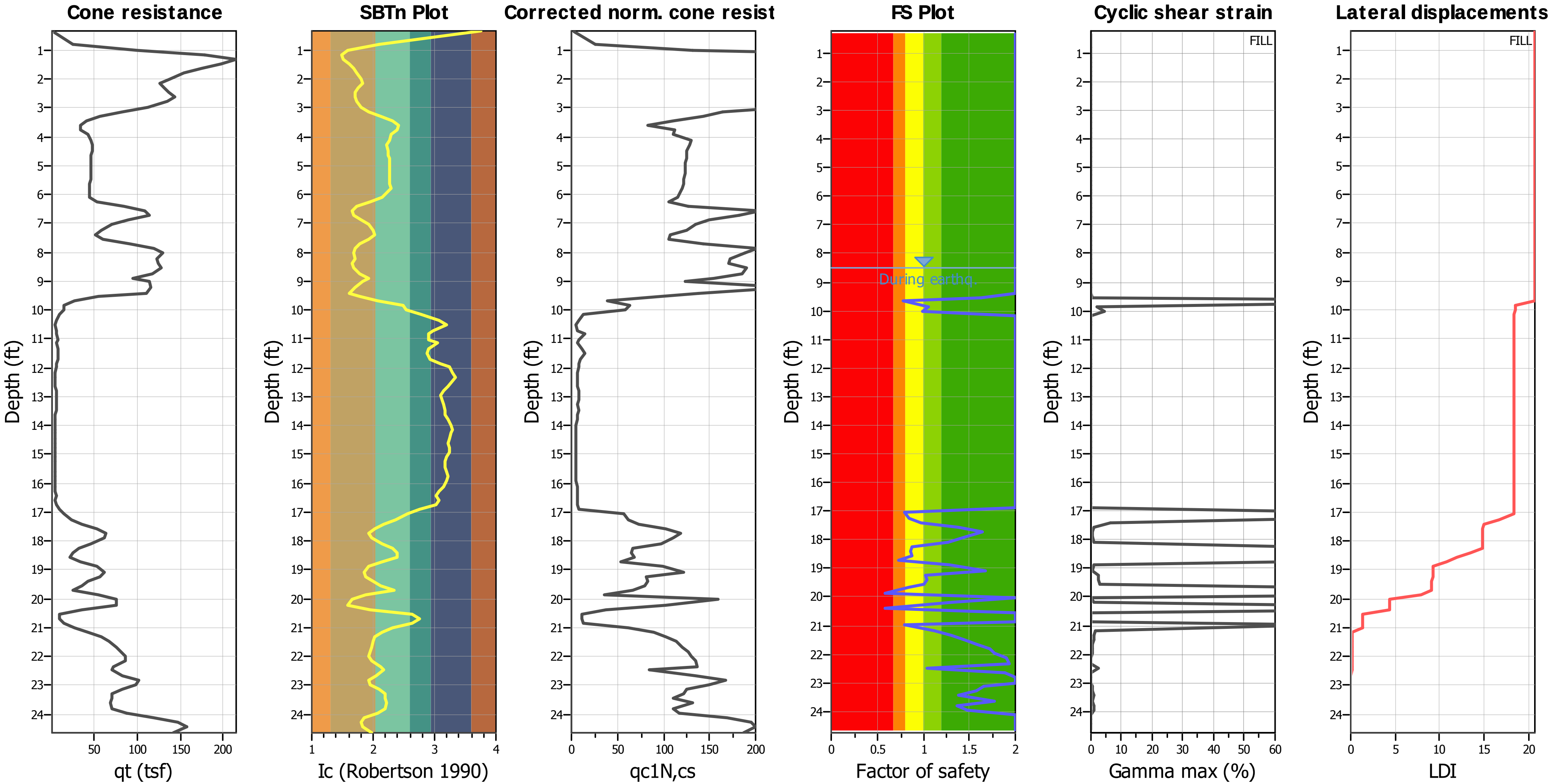
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
26.44	200.15	2.00	0.00	1.00	0.00	26.64	186.46	2.00	0.00	1.00	0.00

Total estimated settlement: 1.57

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.53	190.31	0.03	2.00	-0.31	0.00	0.00
10.73	185.26	0.03	2.00	-0.24	0.00	0.00
10.89	154.48	0.08	2.00	0.19	0.00	0.00
11.02	123.07	0.18	2.00	0.57	0.00	0.00
11.19	235.71	0.01	2.00	-0.99	0.00	0.00
11.42	138.87	0.12	2.00	0.39	0.00	0.00
11.55	96.91	0.33	1.62	0.82	0.00	0.00
11.68	39.16	1.37	0.78	0.94	1.37	2.16
11.84	63.27	0.74	1.05	0.94	0.02	0.03
12.01	59.02	0.82	0.99	0.94	0.04	0.08
12.17	12.47	0.00	2.00	0.00	0.00	0.00
12.37	8.17	0.00	2.00	0.00	0.00	0.00
12.50	5.23	0.00	2.00	0.00	0.00	0.00
12.70	6.41	0.00	2.00	0.00	0.00	0.00
12.83	15.32	0.00	2.00	0.00	0.00	0.00
13.02	8.70	0.00	2.00	0.00	0.00	0.00
13.15	7.23	0.00	2.00	0.00	0.00	0.00
13.35	11.33	0.00	2.00	0.00	0.00	0.00
13.52	14.94	0.00	2.00	0.00	0.00	0.00
13.68	9.11	0.00	2.00	0.00	0.00	0.00
13.84	8.23	0.00	2.00	0.00	0.00	0.00
13.97	8.41	0.00	2.00	0.00	0.00	0.00
14.17	6.87	0.00	2.00	0.00	0.00	0.00
14.34	6.57	0.00	2.00	0.00	0.00	0.00
14.66	6.56	0.00	2.00	0.00	0.00	0.00
14.79	7.94	0.00	2.00	0.00	0.00	0.00
14.96	7.97	0.00	2.00	0.00	0.00	0.00
15.12	7.62	0.00	2.00	0.00	0.00	0.00
15.29	7.28	0.00	2.00	0.00	0.00	0.00
15.48	8.14	0.00	2.00	0.00	0.00	0.00
15.65	6.84	0.00	2.00	0.00	0.00	0.00
15.78	5.98	0.00	2.00	0.00	0.00	0.00
15.98	5.67	0.00	2.00	0.00	0.00	0.00
16.14	5.07	0.00	2.00	0.00	0.00	0.00
16.27	4.72	0.00	2.00	0.00	0.00	0.00
16.44	5.60	0.00	2.00	0.00	0.00	0.00
16.60	4.90	0.00	2.00	0.00	0.00	0.00
16.76	5.05	0.00	2.00	0.00	0.00	0.00
16.93	5.27	0.00	2.00	0.00	0.00	0.00
17.09	5.38	0.00	2.00	0.00	0.00	0.00
17.26	5.53	0.00	2.00	0.00	0.00	0.00
17.42	5.69	0.00	2.00	0.00	0.00	0.00
17.58	5.45	0.00	2.00	0.00	0.00	0.00
17.75	5.23	0.00	2.00	0.00	0.00	0.00
17.91	5.30	0.00	2.00	0.00	0.00	0.00
18.11	5.74	0.00	2.00	0.00	0.00	0.00
18.27	6.67	0.00	2.00	0.00	0.00	0.00
18.44	7.22	0.00	2.00	0.00	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
18.57	6.81	0.00	2.00	0.00	0.00	0.00
18.73	6.33	0.00	2.00	0.00	0.00	0.00
18.90	8.73	0.00	2.00	0.00	0.00	0.00
19.06	57.31	0.85	0.79	0.94	0.85	1.68
19.26	61.86	0.76	0.84	0.94	0.76	1.80
19.42	73.77	0.57	0.97	0.94	0.06	0.13
19.59	102.92	0.29	1.37	0.77	0.01	0.02
19.75	118.76	0.20	1.65	0.62	0.00	0.01
19.88	110.05	0.25	1.49	0.70	0.01	0.01
20.08	96.91	0.33	1.27	0.82	0.01	0.02
20.24	67.23	0.67	0.88	0.94	0.67	1.32
20.41	64.85	0.71	0.85	0.94	0.71	1.40
20.57	68.00	0.66	0.89	0.94	0.66	1.29
20.70	52.94	0.95	0.73	0.94	0.95	1.50
20.86	98.94	0.32	1.28	0.80	0.01	0.02
21.06	121.58	0.19	1.67	0.59	0.00	0.01
21.23	80.80	0.49	1.03	0.91	0.03	0.05
21.39	82.48	0.47	1.05	0.91	0.02	0.04
21.55	79.79	0.50	1.01	0.92	0.03	0.06
21.68	66.02	0.69	0.85	0.94	0.69	1.08
21.88	35.18	1.54	0.58	0.94	1.54	3.64
22.01	159.17	0.07	2.00	0.13	0.00	0.00
22.21	103.05	0.29	1.32	0.77	0.01	0.02
22.37	36.79	1.47	0.59	0.94	1.47	2.89
22.54	12.06	0.00	2.00	0.00	0.00	0.00
22.67	10.65	0.00	2.00	0.00	0.00	0.00
22.87	13.65	0.00	2.00	0.00	0.00	0.00
23.00	62.04	0.76	0.79	0.94	0.76	1.19
23.16	89.85	0.39	1.11	0.87	0.02	0.03
23.32	103.02	0.29	1.30	0.77	0.01	0.02
23.49	113.08	0.23	1.45	0.67	0.01	0.02
23.65	120.16	0.19	1.58	0.60	0.01	0.01
23.82	127.63	0.16	1.73	0.52	0.00	0.01
23.98	129.57	0.15	1.77	0.50	0.00	0.01
24.15	135.67	0.13	1.91	0.43	0.00	0.00
24.34	137.01	0.13	1.94	0.41	0.00	0.00
24.47	85.15	0.44	1.04	0.89	0.02	0.04
24.67	135.31	0.13	1.89	0.43	0.00	0.00
24.80	167.48	0.06	2.00	0.01	0.00	0.00
25.00	149.72	0.09	2.00	0.25	0.00	0.00
25.13	125.88	0.17	1.66	0.54	0.00	0.01
25.29	121.68	0.19	1.58	0.59	0.01	0.01
25.46	110.80	0.24	1.39	0.70	0.01	0.02
25.62	131.19	0.15	1.77	0.48	0.00	0.01
25.79	110.06	0.25	1.37	0.70	0.01	0.02
25.95	116.78	0.21	1.48	0.64	0.01	0.02
26.11	169.24	0.06	2.00	-0.01	0.00	0.00
26.28	195.06	0.03	2.00	-0.38	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
26.44	200.15	0.02	2.00	-0.45	0.00	0.00
26.64	186.46	0.03	2.00	-0.25	0.00	0.00

Total estimated displacement: 20.69

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.33	1.19	1.88	19.01	35.79	3.74	0.06	5.64
2.82	25.97	41.66	1.45	60.32	2.10	0.03	0.71
2.98	100.52	161.42	1.00	161.42	1.59	0.18	0.90
3.15	178.13	286.09	1.00	286.09	1.49	0.99	0.99
3.31	215.01	345.33	1.00	345.33	1.50	1.02	1.02
3.48	198.06	318.09	1.00	318.09	1.60	1.00	1.00
3.64	174.35	279.97	1.02	286.69	1.68	0.98	0.98
3.80	154.01	247.28	1.07	263.92	1.74	0.96	0.96
3.97	138.69	222.64	1.10	245.96	1.80	0.95	0.95
4.13	125.88	202.04	1.12	226.19	1.82	0.93	0.93
4.30	131.80	211.54	1.08	228.36	1.76	0.94	0.94
4.46	137.53	220.72	1.04	230.52	1.71	0.95	0.95
4.63	143.88	230.91	1.04	239.34	1.70	0.95	0.95
4.79	135.85	217.99	1.06	230.32	1.73	0.94	0.94
4.95	112.37	180.26	1.12	201.19	1.81	0.91	0.91
5.12	83.67	134.14	1.22	163.80	1.93	0.20	0.87
5.28	57.22	91.61	1.52	138.83	2.13	0.14	0.82
5.45	40.80	65.22	2.02	131.52	2.32	0.10	0.77
5.61	34.91	55.74	2.34	130.70	2.41	0.07	0.75
5.77	35.05	55.95	2.31	129.51	2.40	0.11	0.75
5.94	43.12	68.90	1.92	132.61	2.29	0.10	0.78
6.10	46.11	73.69	1.82	133.87	2.26	0.12	0.79
6.30	48.68	77.81	1.73	134.87	2.23	0.12	0.79
6.46	47.78	76.33	1.77	135.16	2.24	0.12	0.79
6.63	47.12	75.26	1.80	135.42	2.25	0.12	0.79
6.76	46.71	74.59	1.82	135.55	2.26	0.12	0.79
6.92	46.40	74.07	1.83	135.40	2.26	0.12	0.79
7.08	46.09	73.56	1.84	135.42	2.26	0.12	0.79
7.25	45.79	73.06	1.85	135.47	2.27	0.11	0.78
7.45	45.55	72.66	1.87	135.84	2.27	0.11	0.78
7.61	45.36	72.34	1.88	136.32	2.28	0.11	0.78
7.77	45.24	72.13	1.90	136.96	2.28	0.11	0.78
7.91	45.25	72.13	1.76	126.99	2.24	0.11	0.78
8.10	45.37	72.31	1.54	111.47	2.14	0.11	0.78
8.27	53.63	85.56	1.23	105.62	1.95	0.10	0.81
8.40	84.73	135.52	1.05	142.67	1.72	0.15	0.87
8.56	109.11	169.83	1.02	172.67	1.67	0.72	0.90
8.73	113.99	176.37	1.03	181.34	1.69	0.38	0.91
8.89	90.69	144.45	1.11	160.25	1.80	0.18	0.88
9.05	70.95	113.32	1.21	136.70	1.92	0.14	0.84
9.22	58.68	93.59	1.30	121.54	2.00	0.12	0.82
9.38	52.43	83.54	1.33	111.11	2.02	0.10	0.80
9.55	61.03	96.47	1.23	118.30	1.94	0.10	0.82
9.71	91.80	136.83	1.09	149.78	1.78	0.17	0.87
9.87	119.02	171.67	1.05	179.79	1.71	0.56	0.91
10.04	129.90	184.18	1.03	190.20	1.69	0.43	0.92
10.20	123.39	173.65	1.04	180.59	1.70	0.30	0.91
10.37	125.38	172.76	1.01	175.20	1.67	0.32	0.91

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.53	127.39	174.42	1.02	177.96	1.67	0.47	0.91
10.73	117.22	164.32	1.09	179.83	1.78	0.33	0.90
10.89	95.26	137.75	1.21	166.60	1.92	0.18	0.87
11.02	113.37	159.18	1.13	179.14	1.83	0.13	0.89
11.19	116.64	157.63	1.04	163.56	1.70	0.89	0.89
11.42	111.43	146.31	1.00	146.31	1.61	0.20	0.88
11.55	54.85	74.46	1.00	74.46	1.77	0.10	0.79
11.68	27.70	40.16	1.42	57.13	2.08	0.03	0.71
11.84	14.27	21.98	2.70	59.31	2.49	0.06	0.63
12.01	14.28	21.99	2.99	65.67	2.54	0.06	0.63
12.17	10.05	15.17	4.57	69.33	2.77	0.05	1.22
12.37	6.03	8.70	7.62	66.33	3.08	0.06	0.70
12.50	4.67	6.50	9.19	59.77	3.20	0.06	0.52
12.70	6.44	9.34	6.42	59.97	2.97	0.05	0.74
12.83	7.24	10.61	5.64	59.91	2.89	0.06	0.84
13.02	7.44	10.92	5.66	61.84	2.90	0.05	0.86
13.15	6.50	9.39	7.19	67.55	3.04	0.06	0.73
13.35	8.10	11.94	5.84	69.72	2.91	0.06	0.92
13.52	8.58	12.70	5.59	70.98	2.89	0.06	0.98
13.68	7.89	11.59	5.89	68.31	2.92	0.05	0.89
13.84	6.32	9.04	7.94	71.76	3.10	0.06	0.69
13.97	5.79	8.19	9.82	80.39	3.24	0.06	0.62
14.17	5.40	7.53	10.54	79.41	3.29	0.06	0.57
14.34	5.01	6.90	11.19	77.23	3.33	0.06	0.52
14.66	5.32	7.37	9.46	69.72	3.21	0.06	0.54
14.79	5.73	8.02	8.65	69.35	3.16	0.06	0.59
14.96	6.03	8.49	7.93	67.28	3.10	0.06	0.62
15.12	5.92	8.29	8.29	68.69	3.13	0.06	0.60
15.29	5.98	8.37	8.44	70.71	3.14	0.06	0.61
15.48	5.76	8.01	8.81	70.54	3.17	0.06	0.58
15.65	5.43	7.47	8.81	65.81	3.17	0.06	0.53
15.78	4.80	6.42	9.52	61.17	3.22	0.06	0.46
15.98	4.37	5.69	10.22	58.16	3.27	0.06	0.41
16.14	4.06	5.16	10.79	55.71	3.30	0.06	0.37
16.27	4.08	5.16	10.29	53.08	3.27	0.06	0.37
16.44	4.09	5.13	9.88	50.68	3.24	0.06	0.37
16.60	4.22	5.30	9.52	50.48	3.22	0.06	0.38
16.76	4.16	5.17	9.94	51.44	3.25	0.06	0.37
16.93	4.29	5.34	9.74	52.00	3.23	0.06	0.38
17.09	4.42	5.50	9.33	51.35	3.21	0.06	0.39
17.26	4.53	5.64	8.81	49.68	3.17	0.06	0.40
17.42	4.55	5.64	8.74	49.27	3.16	0.06	0.40
17.58	4.47	5.47	9.06	49.61	3.19	0.06	0.39
17.75	4.37	5.29	9.46	50.02	3.22	0.06	0.38
17.91	4.44	5.36	9.33	50.03	3.21	0.06	0.38
18.11	4.84	5.92	8.43	49.94	3.14	0.06	0.42
18.27	5.34	6.64	7.51	49.83	3.07	0.06	0.47
18.44	5.62	7.01	7.08	49.64	3.03	0.06	0.50

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.57	5.53	6.85	7.45	51.03	3.06	0.06	0.49
18.73	5.95	7.43	7.06	52.47	3.03	0.05	0.53
18.90	9.82	12.69	4.41	55.95	2.75	0.05	0.93
19.06	15.13	19.50	3.05	59.49	2.55	0.06	0.62
19.26	23.27	29.62	2.21	65.53	2.37	0.06	0.67
19.42	36.46	45.42	1.61	73.20	2.18	0.06	0.72
19.59	53.51	65.22	1.32	85.90	2.01	0.09	0.77
19.75	64.23	77.22	1.22	94.28	1.93	0.12	0.79
19.88	61.67	74.37	1.27	94.43	1.98	0.10	0.79
20.08	46.12	56.41	1.52	85.98	2.14	0.09	0.75
20.24	32.67	40.50	2.00	80.87	2.31	0.06	0.71
20.41	24.90	30.80	2.30	70.95	2.40	0.06	0.67
20.57	22.63	27.67	2.23	61.58	2.38	0.06	0.66
20.70	34.32	41.05	1.53	62.79	2.14	0.05	0.71
20.86	52.59	61.46	1.22	74.79	1.93	0.09	0.76
21.06	62.03	71.64	1.00	71.64	1.85	0.13	0.78
21.23	57.00	65.71	1.00	65.71	1.87	0.08	0.77
21.39	42.83	49.77	1.30	64.87	2.00	0.07	0.73
21.55	35.45	41.53	1.51	62.68	2.13	0.07	0.71
21.68	25.29	30.05	2.13	64.06	2.35	0.06	0.67
21.88	55.70	63.47	1.00	63.47	1.88	0.03	0.77
22.01	75.34	83.70	1.00	83.70	1.67	0.25	0.80
22.21	75.07	82.34	1.00	82.34	1.59	0.12	0.80
22.37	35.48	39.98	1.00	39.98	1.96	0.03	0.71
22.54	10.60	11.96	3.59	43.00	2.64	0.05	0.88
22.67	10.55	12.03	4.51	54.30	2.77	0.05	0.88
22.87	14.79	17.06	3.47	59.18	2.62	0.05	1.26
23.00	27.07	31.19	2.04	63.48	2.33	0.05	0.68
23.16	42.83	48.87	1.53	74.79	2.14	0.08	0.73
23.32	57.83	65.40	1.35	88.06	2.03	0.09	0.77
23.49	67.51	76.03	1.31	99.49	2.01	0.11	0.79
23.65	75.20	84.28	1.28	107.47	1.98	0.12	0.80
23.82	80.99	90.32	1.25	113.01	1.96	0.13	0.81
23.98	85.55	94.85	1.22	115.77	1.93	0.13	0.82
24.15	85.97	95.29	1.26	119.99	1.97	0.14	0.82
24.34	71.88	80.33	1.50	120.23	2.12	0.13	0.80
24.47	70.77	79.11	1.58	124.61	2.16	0.07	0.79
24.67	82.51	91.03	1.38	125.27	2.05	0.13	0.81
24.80	102.24	111.39	1.21	135.02	1.92	0.21	0.84
25.00	99.39	108.03	1.24	134.16	1.95	0.16	0.84
25.13	83.47	91.38	1.44	131.85	2.09	0.12	0.81
25.29	70.43	77.24	1.65	127.39	2.19	0.11	0.79
25.46	70.88	77.39	1.65	127.48	2.19	0.10	0.79
25.62	68.13	74.15	1.70	125.99	2.21	0.12	0.79
25.79	71.26	77.17	1.66	127.79	2.20	0.10	0.79
25.95	87.73	93.94	1.39	130.50	2.06	0.11	0.82
26.11	118.97	125.38	1.15	144.08	1.85	0.23	0.86
26.28	147.50	154.55	1.10	170.45	1.79	0.40	0.89

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

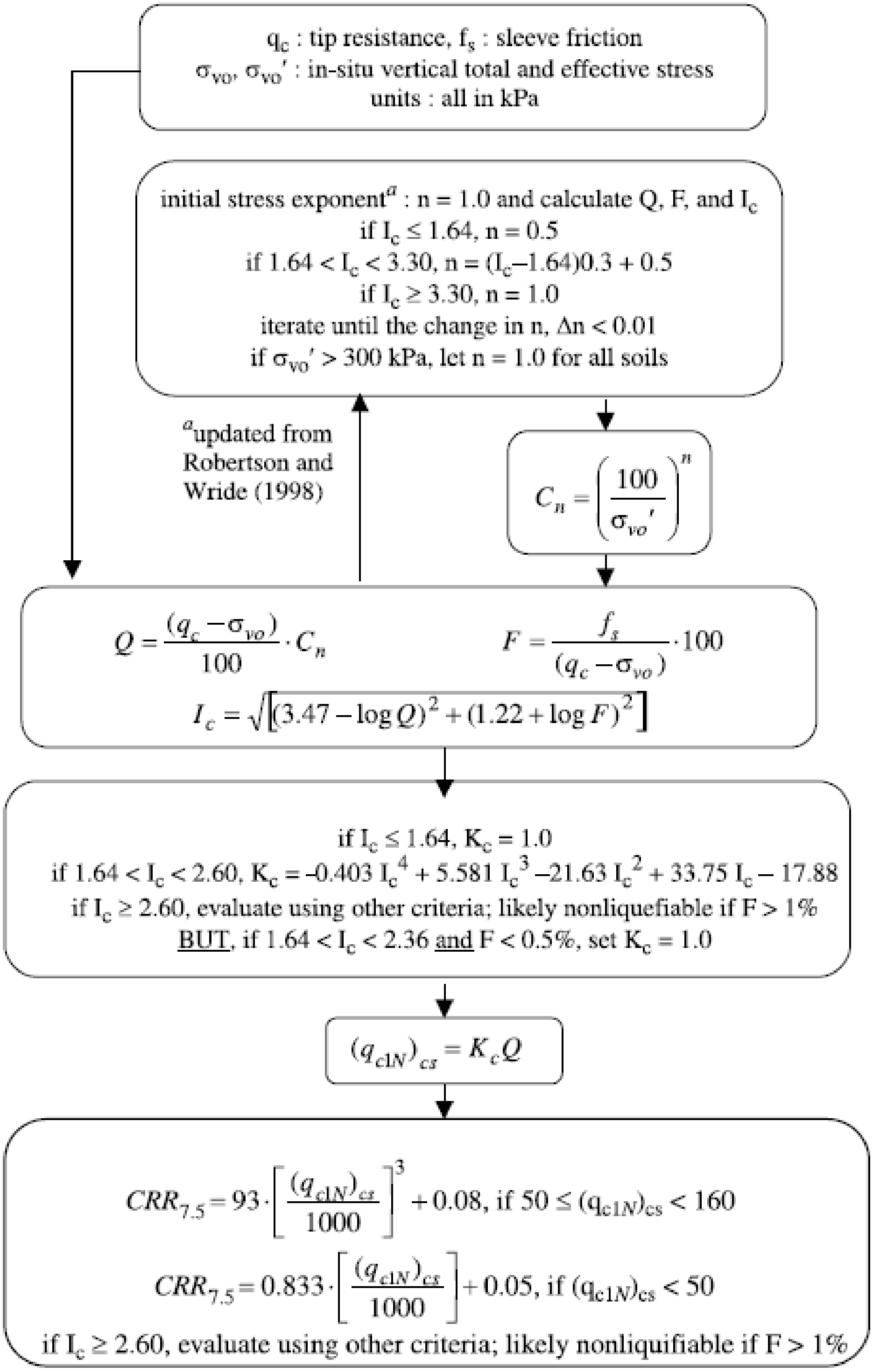
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
26.44	157.72	165.12	1.12	185.72	1.82	0.42	0.90
26.64	141.82	149.34	1.28	191.64	1.99	0.26	0.89

Abbreviations

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

Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

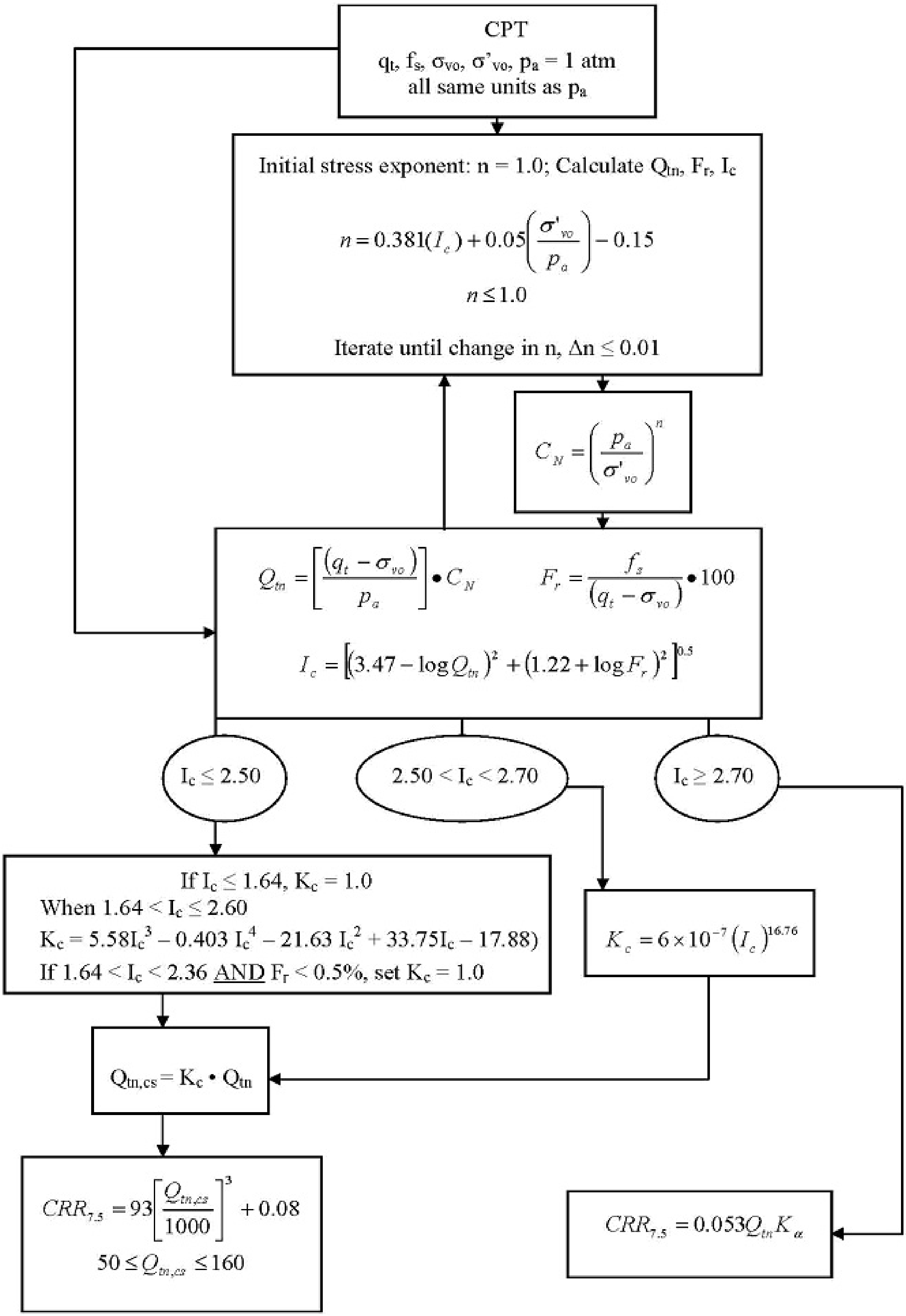
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

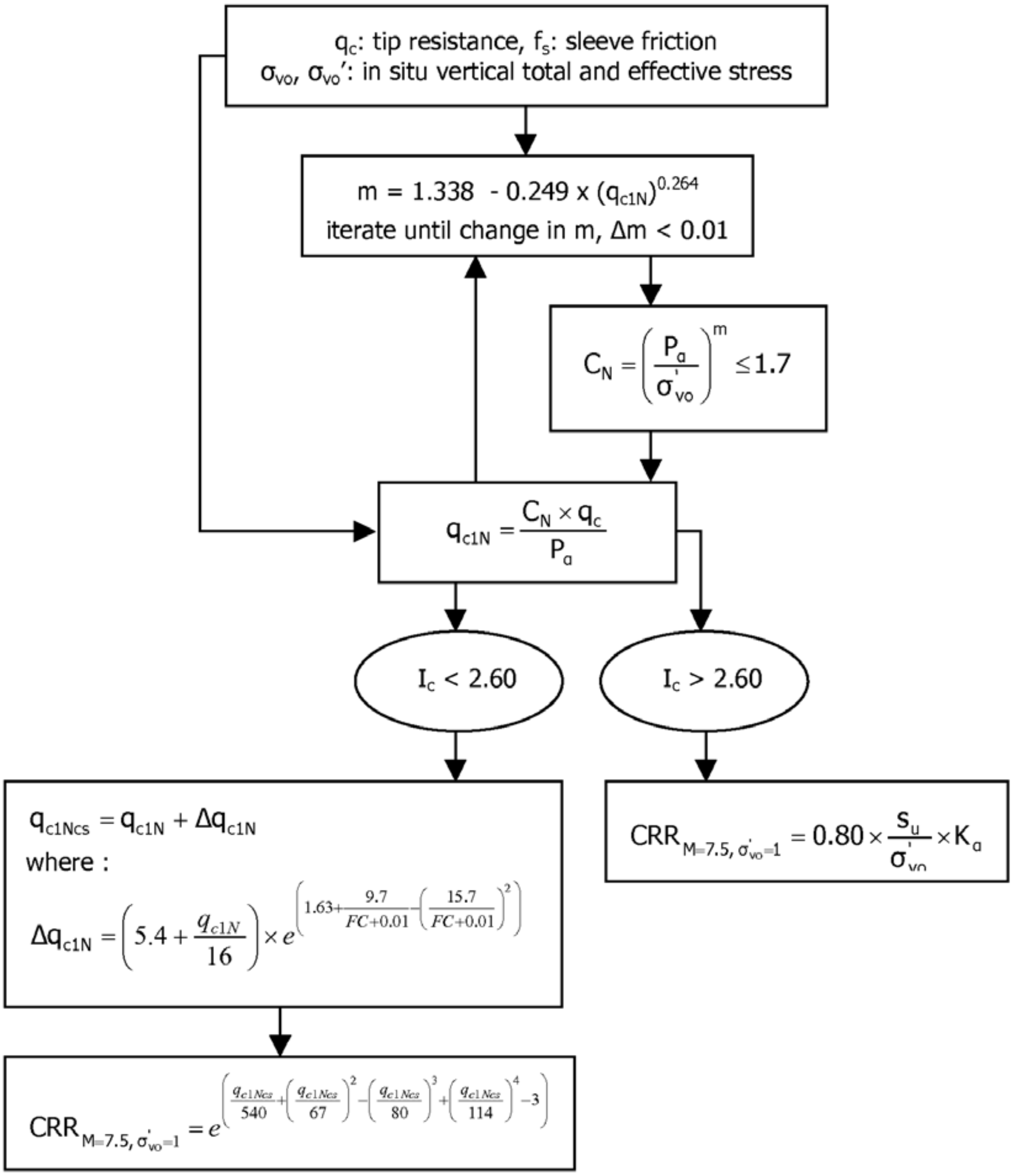
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)

CPT

q_t, f_s, I_c

↓

$I_c < I_c$ cut-off

↓

Initial estimate using raw tip measurements, friction ratio. Calculate $q_{t,1}$. Repeat until an acceptable convergence tolerance is achieved.

$$c = f_1 \cdot \left(\frac{R_f}{f_3}\right)^{f_2}$$

↓

$$C_q = \left(\frac{P_a}{\sigma'_v}\right)^c$$

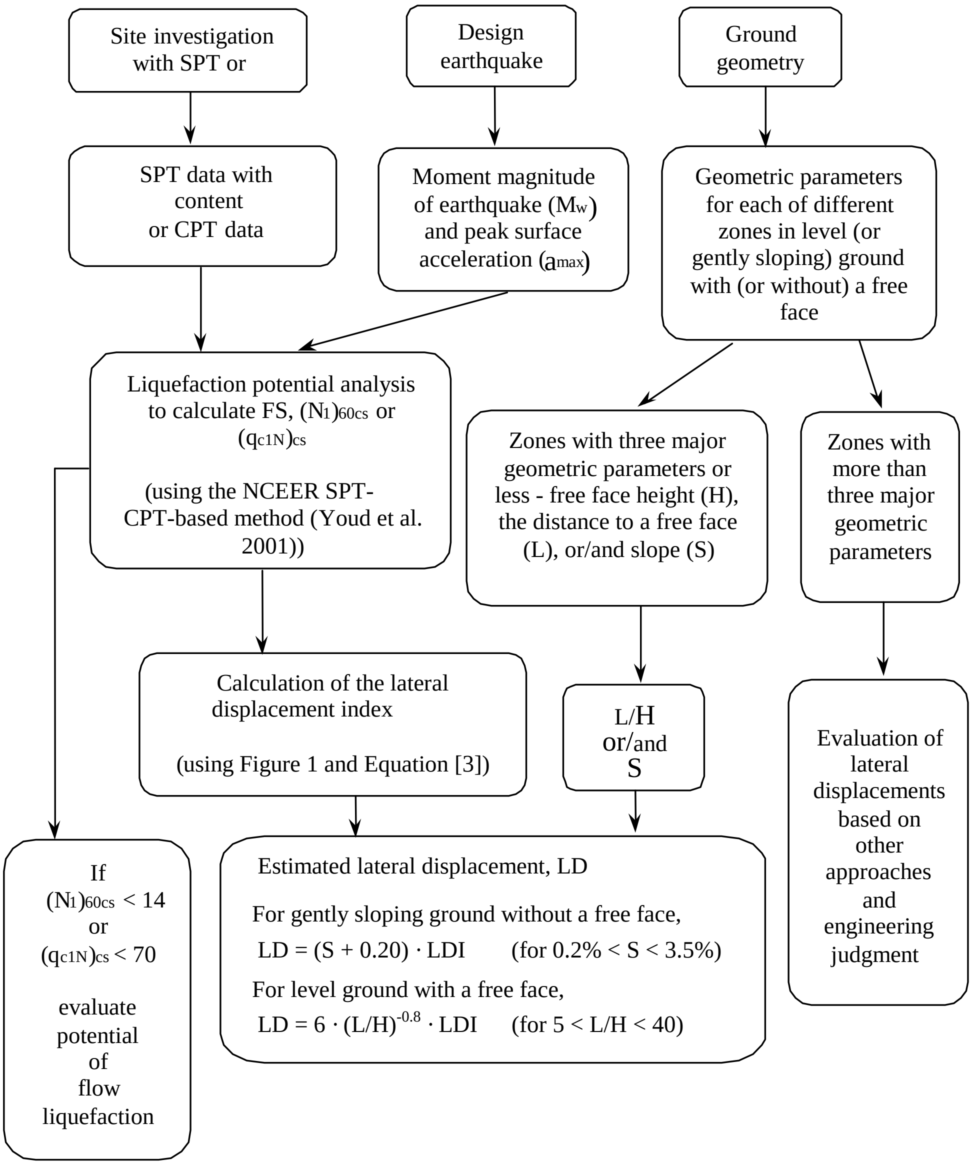
↓

$$q_{t,1} = C_q \cdot q_t$$

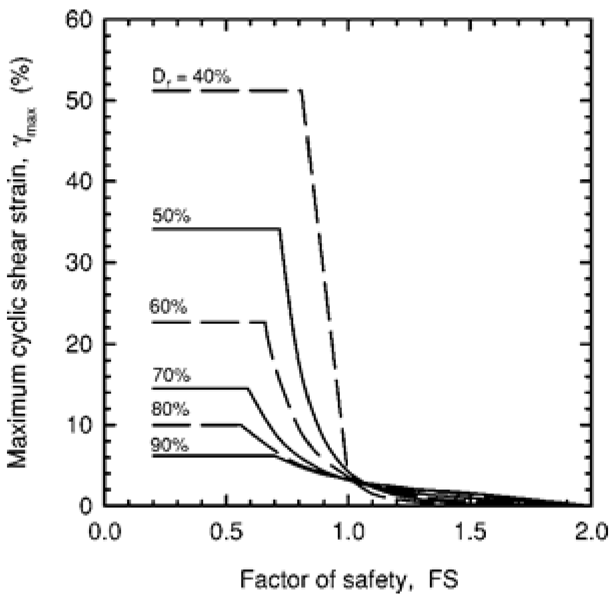
↓

$$CRR = \exp\left[\frac{q_{t,1}^{1.045} + q_{t,1} \cdot (0.110 \cdot R_f) + (0.001 \cdot R_f) + c \cdot (1 + 0.850 \cdot R_f) - 0.848 \cdot \ln(M_w) - 0.002 \cdot \ln(\sigma'_v) - 20.923 + 1.632 \cdot \Phi^{-1}(P_L)}{7.177}\right]$$

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] **Figure 1**

$$\mathrm{LDI} = \int_0^{Z_{max}} \gamma_{max}\, dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{\alpha_{max}}{g} \cdot \sigma_{v0} \cdot r_d$$

↓

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

↓

Estimate shear strain amplitude, γ (based on Pradel (1998))

$$\gamma = \left[\frac{1 + \alpha \cdot e^{bR}}{1 + \alpha}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0}\ \text{(Note } \tau_{av} \text{ and } G_0 \text{ same units)}$$

$$\alpha = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

↓

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60,cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

↓

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

↓

Seismic settlement, s

$$s = 2 \cdot \int_0^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, “Estimation of seismic compression in dry soils using the CPT” FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

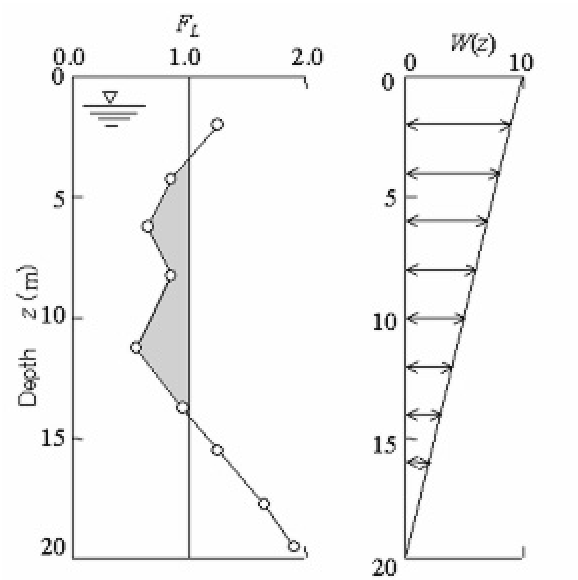
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\textbf{LPI} = \int_{0}^{20} (10 - 0{,}5_z) \times F_L \times d_z$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

References

- Lunne, T., Robertson, P.K., and Powell, J.J.M 1997. Cone penetration testing in geotechnical practice, E & FN Spon Routledge, 352 p, ISBN 0-7514-0393-8.

- Boulanger, R.W. and Idriss, I. M., 2007. Evaluation of Cyclic Softening in Silts and Clays. ASCE Journal of Geotechnical and Geoenvironmental Engineering June, Vol. 133, No. 6 pp 641-652

- 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/

- Robertson, P.K. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27 (1), 151-8.

- Robertson, P.K. and Wride, C.E., 1998. Cyclic Liquefaction and its Evaluation based on the CPT Canadian Geotechnical Journal, 1998, Vol. 35, August.

- 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

- Iwasaki, T., 1986, Soil liquefaction studies in Japan: state-of-the-art, Soil Dynamics and Earthquake Engineering, Vol. 5, No. 1, 2-70

- Papathanassiou G., 2008, LPI-based approach for calibrating the severity of liquefaction-induced failures and for assessing the probability of liquefaction surface evidence, Eng. Geol. 96:94–104

- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355

- P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering - from case history to practice, IS-Tokyo, June 2009

- Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, *Symposium in honor of professor I. M. Idriss,* SAN diego, CA

- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006

TABLE OF CONTENTS

CLiq Output
SEE Event

F&ME Consultants, Inc.
3112 Devine Street
Columbia, SC
(803) 254-4540

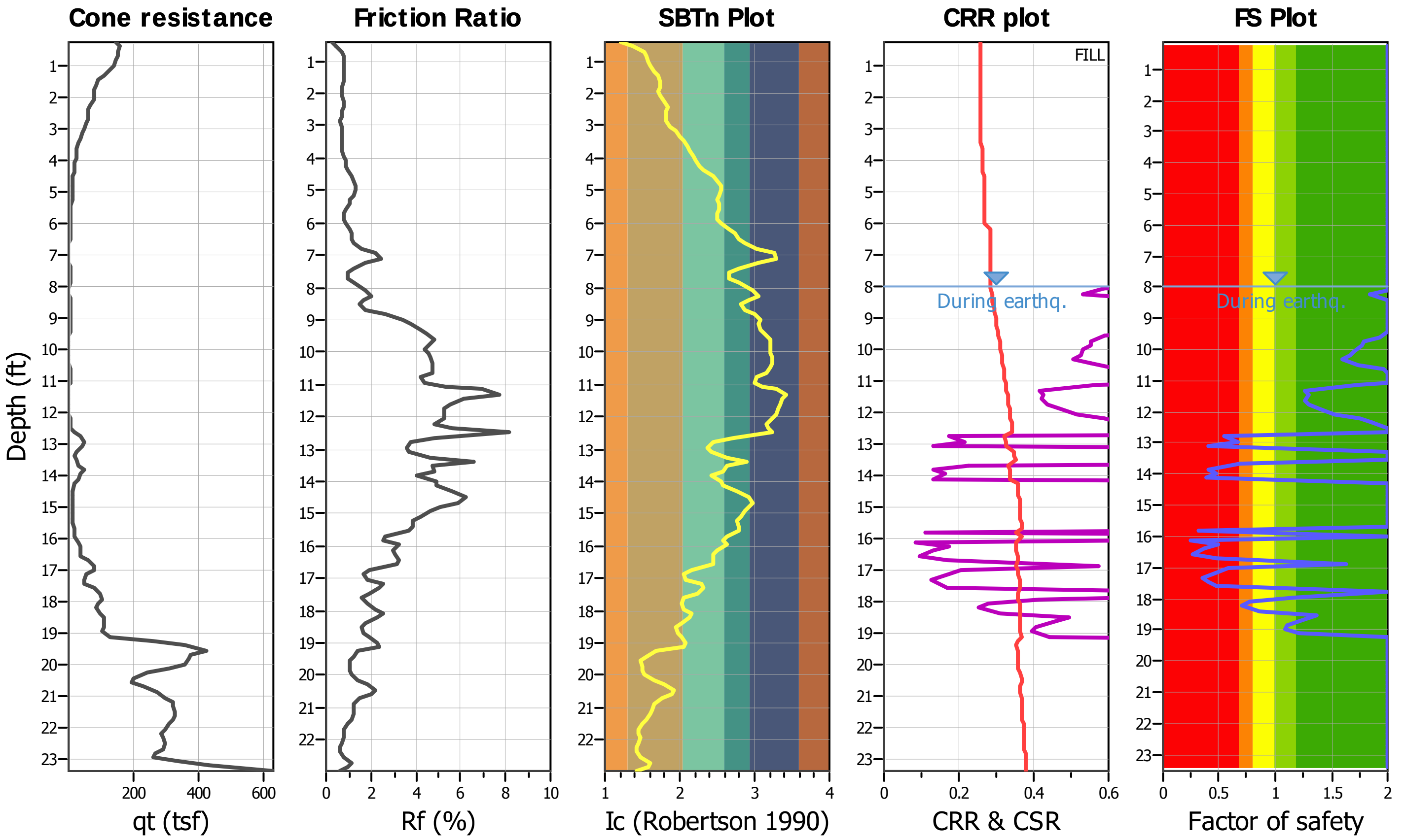
LIQUEFACTION ANALYSIS REPORT

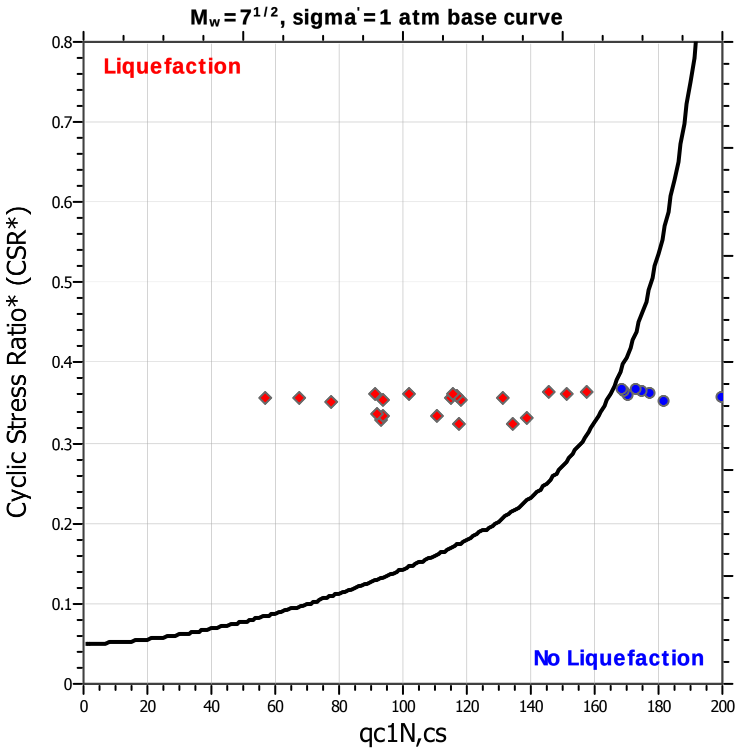
Project title : **Location :**

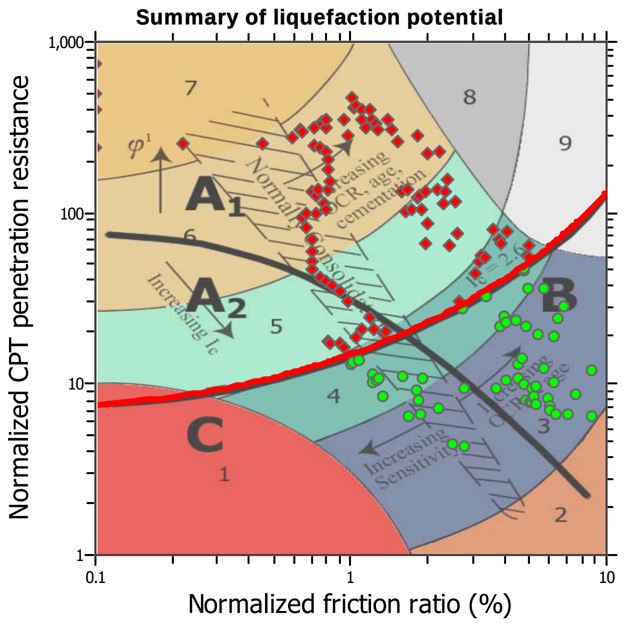
CPT file : CPT2

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.00 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.00 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

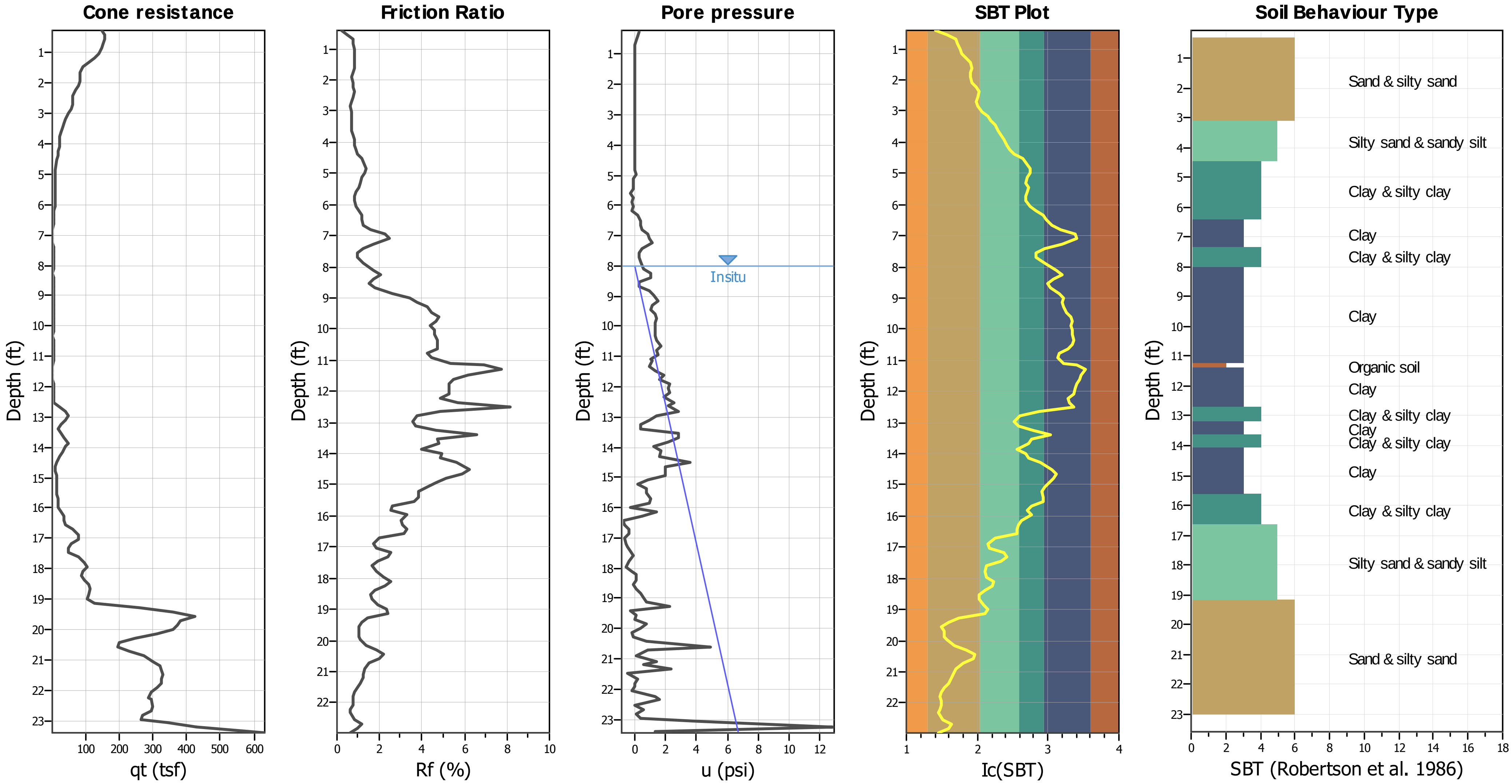






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



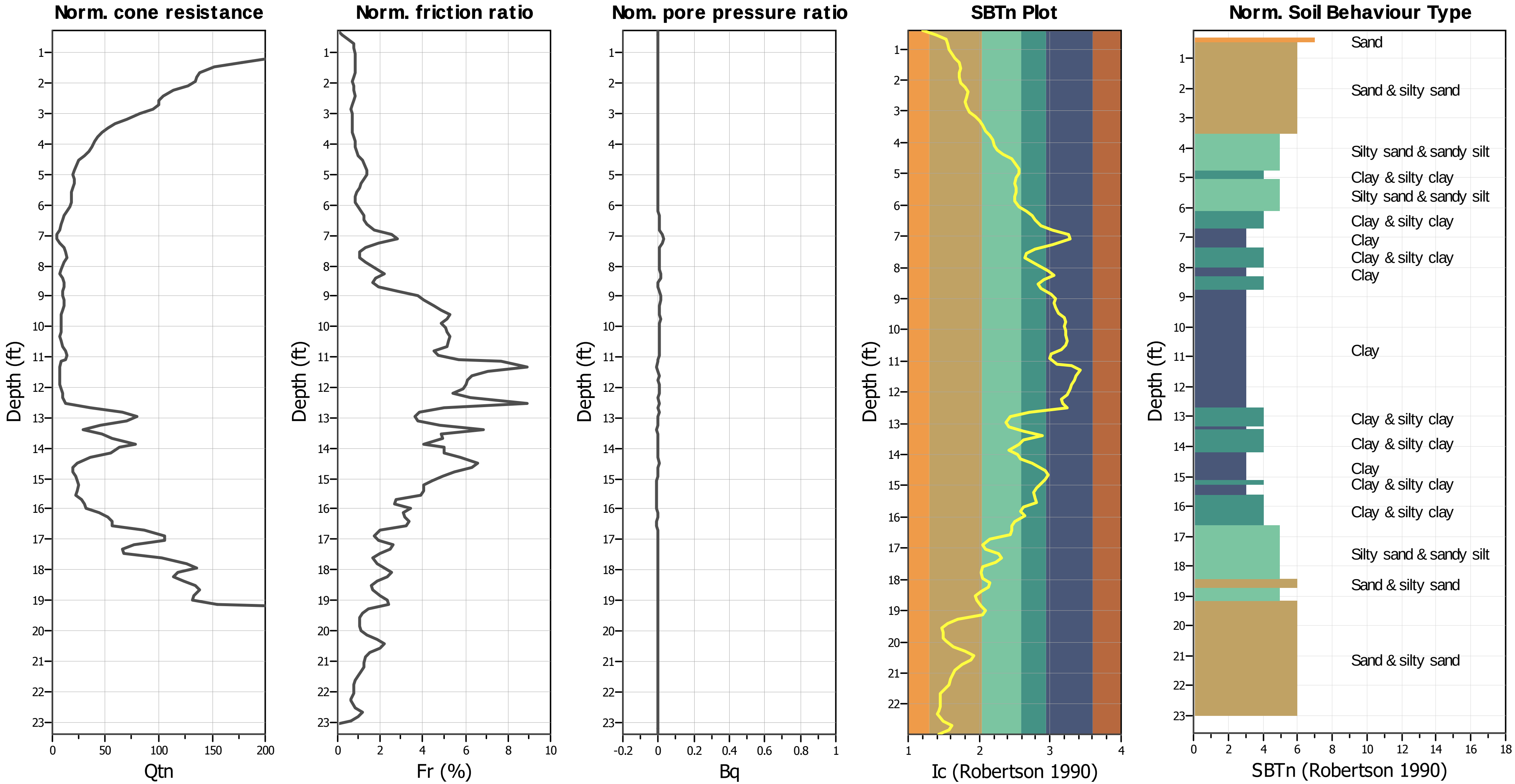
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	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)



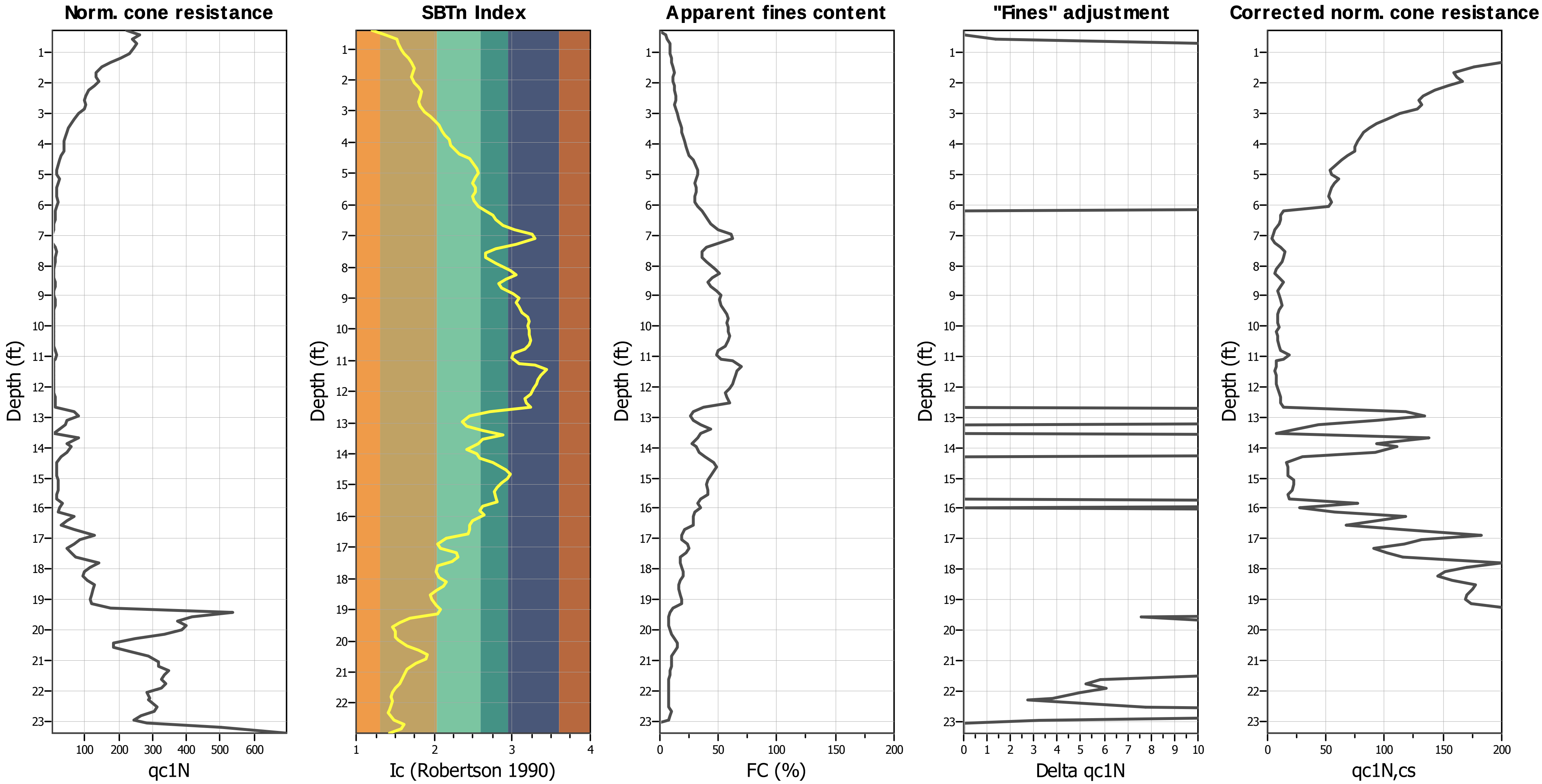
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	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

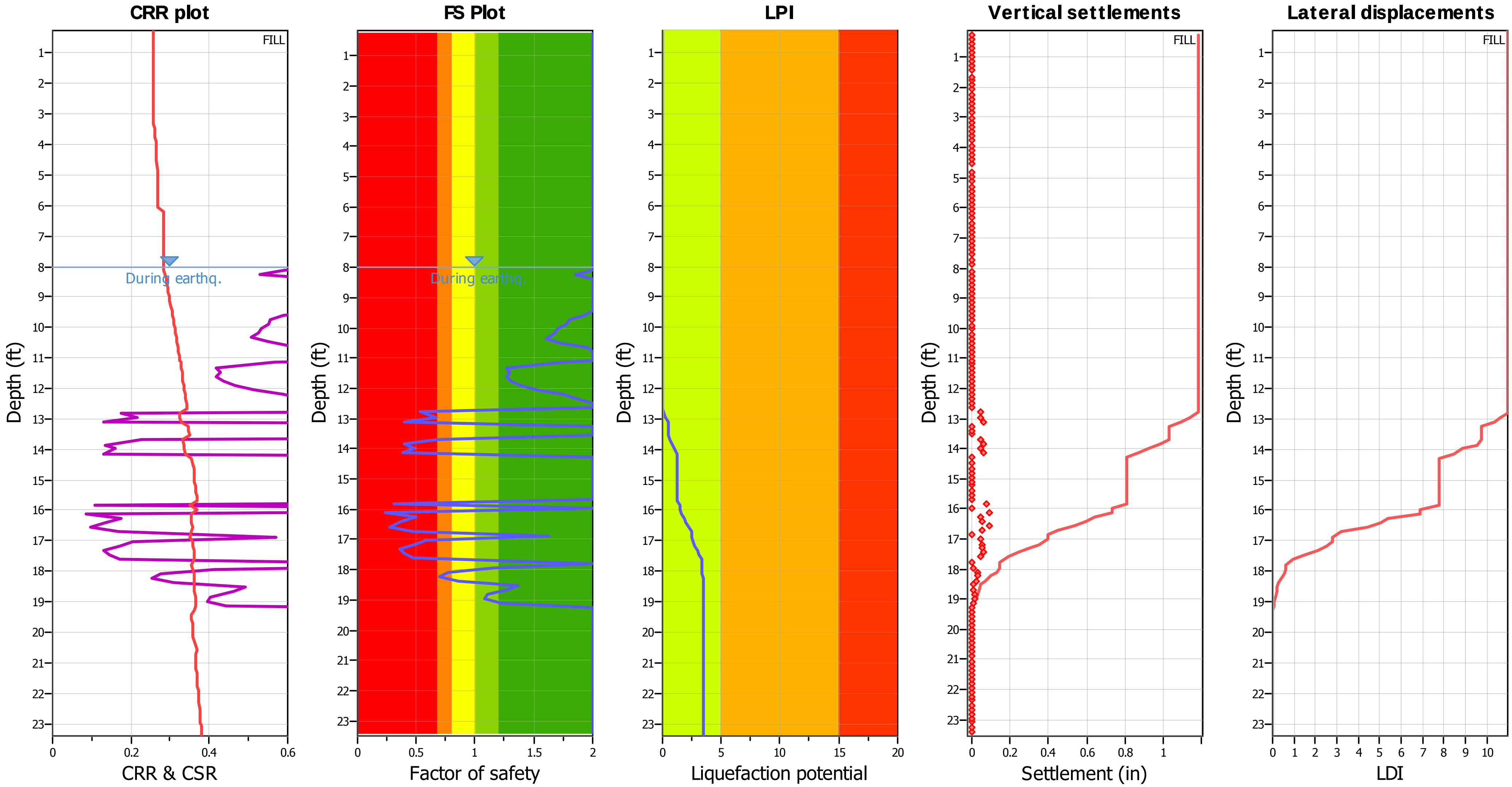
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

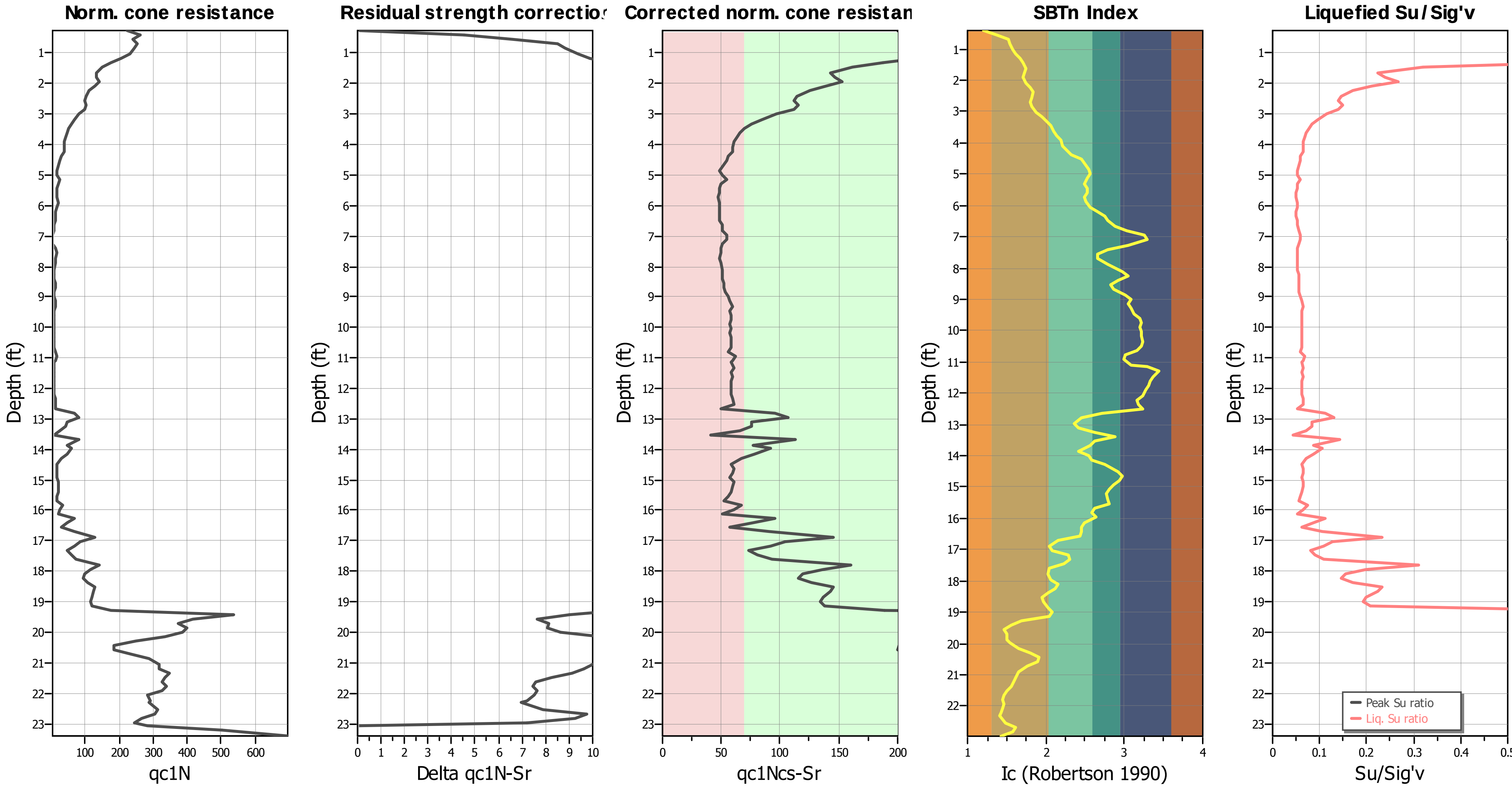
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.26	140.05	0.00	0.29	N/A	87.36
2	0.41	164.19	0.00	0.25	0.00	115.01
3	0.56	150.61	1.06	0.11	1.29	120.11
4	0.70	156.73	1.08	0.06	3.22	123.26
5	0.85	151.03	1.18	-0.01	3.54	123.48
6	1.00	143.07	1.18	0.02	4.09	123.25
7	1.15	129.24	1.04	-0.01	4.65	122.32
8	1.30	110.30	0.88	0.01	5.47	121.06
9	1.44	93.37	0.81	0.01	6.45	119.63
10	1.65	81.72	0.67	0.02	6.95	118.54
11	1.78	84.07	0.62	0.02	6.59	117.66
12	1.92	88.00	0.59	0.02	6.41	117.23
13	2.08	79.29	0.57	0.01	6.96	116.90
14	2.24	69.98	0.57	0.01	8.17	116.34
15	2.39	62.78	0.52	0.01	8.94	115.60
16	2.55	61.18	0.45	0.02	8.71	114.68
17	2.70	63.87	0.40	0.02	8.22	113.87
18	2.84	61.18	0.38	0.01	8.49	113.07
19	3.00	50.96	0.35	0.01	9.74	112.06
20	3.16	42.41	0.30	0.01	11.55	110.67
21	3.31	36.38	0.26	0.01	13.10	109.15
22	3.47	32.02	0.22	0.01	14.47	107.83
23	3.62	28.58	0.20	0.01	15.77	106.89
24	3.77	26.49	0.20	0.01	17.15	106.44
25	3.92	24.81	0.20	0.01	18.47	106.28
26	4.08	23.38	0.20	0.01	19.50	106.11
27	4.23	22.63	0.19	0.01	21.12	105.73
28	4.38	19.03	0.18	0.01	23.50	105.17
29	4.53	16.01	0.18	0.01	28.71	104.31
30	4.84	10.90	0.17	0.02	33.16	103.72
31	4.99	11.82	0.17	0.15	33.44	103.32
32	5.13	15.00	0.16	-0.11	31.53	103.08
33	5.29	12.82	0.15	-0.07	30.61	102.25
34	5.43	11.57	0.12	-0.04	31.94	100.82
35	5.59	11.06	0.09	-0.24	31.63	99.24
36	5.74	10.90	0.08	-0.12	30.46	98.57
37	5.89	11.99	0.09	-0.17	30.81	98.54
38	6.04	10.64	0.09	-0.04	33.35	98.77
39	6.19	8.55	0.10	-0.16	38.16	98.07
40	6.34	7.04	0.08	0.23	43.00	97.25
41	6.50	6.62	0.08	0.40	45.56	96.13
42	6.65	6.20	0.07	0.36	50.72	95.14
43	6.80	4.02	0.07	0.47	60.69	94.22
44	6.95	2.85	0.07	0.83	77.43	93.60
45	7.11	2.51	0.07	0.98	80.21	94.03
46	7.25	3.77	0.08	1.14	61.37	95.26
47	7.41	7.21	0.08	0.48	45.44	96.64
48	7.56	9.47	0.09	0.26	38.19	97.23

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	7.71	8.80	0.08	0.27	38.04	97.34
50	7.87	7.46	0.08	0.44	45.18	96.99
51	8.11	4.69	0.09	0.60	56.67	96.86
52	8.26	3.86	0.10	1.06	61.94	97.19
53	8.40	6.03	0.10	1.04	52.78	98.07
54	8.55	8.47	0.10	0.33	47.26	98.88
55	8.69	7.12	0.12	0.33	49.95	99.97
56	8.84	5.70	0.16	0.92	58.91	101.49
57	8.99	5.95	0.21	1.29	64.07	103.48
58	9.14	6.96	0.28	1.54	62.40	105.29
59	9.29	8.05	0.31	1.19	64.38	106.13
60	9.45	6.03	0.31	1.06	67.18	105.99
61	9.60	5.78	0.28	1.30	72.98	105.08
62	9.74	5.36	0.24	1.43	73.99	104.37
63	9.89	5.20	0.24	1.30	72.88	104.05
64	10.04	5.87	0.24	1.30	74.55	104.08
65	10.19	4.94	0.25	1.38	74.99	104.09
66	10.34	5.11	0.25	1.38	76.52	104.03
67	10.48	5.45	0.24	1.45	73.73	104.80
68	10.64	6.29	0.31	1.74	69.81	106.00
69	10.79	7.38	0.35	1.43	59.66	108.07
70	10.94	11.90	0.43	1.55	58.41	109.18
71	11.09	8.47	0.45	1.10	64.99	109.39
72	11.15	4.36	0.44	1.19	80.42	108.20
73	11.31	5.11	0.36	0.92	92.72	106.42
74	11.46	4.27	0.27	1.30	86.22	105.08
75	11.61	4.78	0.25	1.88	84.13	104.13
76	11.77	4.94	0.25	1.61	81.82	104.26
77	11.91	4.86	0.28	2.27	79.50	104.90
78	12.07	5.78	0.30	2.23	76.20	105.73
79	12.21	6.45	0.32	2.31	70.40	106.46
80	12.36	7.29	0.33	1.93	71.44	108.26
81	12.51	7.21	0.54	2.55	75.72	112.16
82	12.65	9.30	1.08	2.23	41.25	118.56
83	12.80	51.38	1.67	2.87	28.40	122.64
84	12.95	63.53	1.94	1.47	25.18	124.11
85	13.10	36.29	1.76	0.96	27.44	123.08
86	13.26	31.93	1.19	0.38	36.78	120.59
87	13.41	17.85	1.06	0.38	50.98	118.71
88	13.53	4.86	1.36	2.87	36.56	120.92
89	13.69	65.54	1.74	2.81	33.88	123.05
90	13.85	37.55	2.10	2.16	27.09	124.95
91	13.98	47.69	2.20	1.26	32.60	124.31
92	14.14	35.79	1.66	1.72	34.47	122.93
93	14.29	22.04	1.31	1.66	43.46	119.83
94	14.50	11.57	0.92	3.56	53.43	116.68
95	14.65	12.74	0.66	2.02	57.30	114.22
96	14.80	13.16	0.64	1.98	53.98	113.42

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	14.94	12.57	0.67	2.02	50.09	113.60
98	15.09	16.51	0.65	0.84	46.97	113.73
99	15.23	16.60	0.62	0.19	44.10	113.58
100	15.38	15.42	0.59	0.77	45.57	112.88
101	15.53	13.16	0.52	0.81	45.98	111.97
102	15.69	14.16	0.45	1.06	36.77	112.06
103	15.83	27.91	0.48	0.97	34.31	113.19
104	15.98	21.12	0.68	-0.24	37.07	115.23
105	16.12	16.01	0.95	1.39	30.63	118.08
106	16.28	55.74	1.14	0.46	28.65	120.08
107	16.41	39.56	1.35	-0.73	28.59	121.06
108	16.57	22.97	1.36	-0.62	28.05	121.08
109	16.72	58.42	1.13	-0.39	17.68	122.19
110	16.87	112.73	1.32	-0.36	14.40	123.38
111	17.02	72.92	1.71	-0.63	15.22	124.03
112	17.17	58.17	1.52	-0.56	21.72	122.87
113	17.31	40.15	1.14	-0.45	22.82	120.94
114	17.46	48.61	0.87	-0.22	20.27	119.69
115	17.60	63.45	0.93	-0.12	14.21	122.90
116	17.80	129.91	2.10	-0.40	13.64	125.96
117	17.95	105.69	2.49	-0.57	14.48	127.90
118	18.10	87.50	2.42	-0.17	17.24	127.52
119	18.23	84.15	2.10	0.08	16.58	126.51
120	18.39	97.56	1.65	0.15	13.56	125.77
121	18.53	117.51	1.63	-0.12	11.67	125.67
122	18.68	115.08	1.86	0.10	11.96	126.43
123	18.83	107.87	2.16	0.39	13.63	127.25
124	18.98	104.85	2.37	0.58	15.32	128.34
125	19.13	110.13	2.92	0.73	14.34	130.20
126	19.26	166.12	3.79	2.32	5.99	133.55
127	19.41	514.20	4.56	-0.29	3.69	135.27
128	19.56	398.11	4.50	0.07	2.32	135.66
129	19.71	357.21	3.78	0.04	2.85	134.88
130	19.86	385.54	3.68	0.75	2.80	134.47
131	20.00	374.56	3.92	0.36	3.31	134.73
132	20.14	322.01	4.32	-0.15	5.14	134.98
133	20.29	240.71	4.71	-0.03	8.14	134.75
134	20.44	179.28	4.54	0.80	10.85	134.03
135	20.59	178.77	3.95	4.94	10.12	133.10
136	20.73	230.66	3.20	0.84	7.27	132.70
137	20.89	280.36	3.34	0.12	5.26	133.09
138	21.07	312.46	3.89	1.47	4.75	133.84
139	21.21	310.61	3.98	0.63	4.37	134.28
140	21.35	339.19	3.79	2.40	3.81	133.76
141	21.50	327.63	3.03	-0.47	2.98	132.69
142	21.65	320.92	2.48	0.22	2.26	131.45
143	21.79	334.25	2.36	0.01	2.13	131.09
144	21.93	320.59	2.67	-0.02	2.31	130.69

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	22.08	280.02	2.19	-0.14	2.21	129.73
146	22.23	290.75	1.57	1.30	1.94	128.56
147	22.32	286.14	1.79	1.64	1.68	128.66
148	22.54	311.37	2.20	0.06	2.60	130.56
149	22.69	305.67	3.17	0.61	4.49	132.97
150	22.81	266.19	4.65	0.08	3.96	130.96
151	22.96	242.72	0.00	0.36	1.92	127.08
152	23.09	282.96	0.00	4.06	N/A	87.36
153	23.24	502.38	0.00	12.80	N/A	87.36
154	23.40	696.16	0.00	1.33	N/A	87.36

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.26	0.14	0.00	0.14	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
2	2.41	0.15	0.00	0.15	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
3	2.56	0.15	0.00	0.15	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
4	2.70	0.16	0.00	0.16	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
5	2.85	0.17	0.00	0.17	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
6	3.00	0.18	0.00	0.18	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
7	3.15	0.19	0.00	0.19	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
8	3.30	0.20	0.00	0.20	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
9	3.44	0.21	0.00	0.21	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
10	3.65	0.22	0.00	0.22	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
11	3.78	0.23	0.00	0.23	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
12	3.92	0.24	0.00	0.24	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
13	4.08	0.25	0.00	0.25	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
14	4.24	0.25	0.00	0.25	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
15	4.39	0.26	0.00	0.26	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
16	4.55	0.27	0.00	0.27	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
17	4.70	0.28	0.00	0.28	0.99	0.272	1.05	0.258	1.10	1.10	2.000	No
18	4.84	0.29	0.00	0.29	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
19	5.00	0.30	0.00	0.30	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
20	5.16	0.31	0.00	0.31	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
21	5.31	0.32	0.00	0.32	0.99	0.271	1.05	0.257	1.09	1.10	2.000	No
22	5.47	0.32	0.00	0.32	0.99	0.271	1.05	0.257	1.09	1.10	2.000	No
23	5.62	0.33	0.00	0.33	0.99	0.271	1.05	0.257	1.08	1.10	2.000	No
24	5.77	0.34	0.00	0.34	0.99	0.271	1.05	0.257	1.08	1.10	2.000	No
25	5.92	0.35	0.00	0.35	0.99	0.271	1.05	0.257	1.07	1.10	2.000	No
26	6.08	0.36	0.00	0.36	0.99	0.270	1.05	0.257	1.07	1.10	2.000	No
27	6.23	0.36	0.00	0.36	0.99	0.270	1.05	0.256	1.07	1.10	2.000	No
28	6.38	0.37	0.00	0.37	0.99	0.270	1.05	0.256	1.06	1.10	2.000	No
29	6.53	0.38	0.00	0.38	0.99	0.270	1.05	0.256	1.06	1.10	2.000	No
30	6.84	0.40	0.00	0.40	0.99	0.270	1.05	0.256	1.05	1.10	2.000	No
31	6.99	0.40	0.00	0.40	0.99	0.270	1.05	0.256	1.05	1.10	2.000	No
32	7.13	0.41	0.00	0.41	0.99	0.270	1.05	0.256	1.05	1.10	2.000	No
33	7.29	0.42	0.00	0.42	0.99	0.269	1.05	0.256	1.05	1.10	2.000	No
34	7.43	0.43	0.00	0.43	0.99	0.269	1.05	0.255	1.05	1.10	2.000	No
35	7.59	0.43	0.00	0.43	0.99	0.269	1.05	0.255	1.05	1.10	2.000	No
36	7.74	0.44	0.00	0.44	0.99	0.269	1.05	0.255	1.04	1.10	2.000	No
37	7.89	0.45	0.00	0.45	0.99	0.269	1.05	0.255	1.04	1.10	2.000	No
38	8.04	0.46	0.00	0.46	0.98	0.269	1.05	0.255	1.04	1.10	2.000	No
39	8.19	0.46	0.00	0.46	0.98	0.269	1.05	0.255	1.04	1.10	2.000	No
40	8.34	0.47	0.00	0.47	0.98	0.269	1.05	0.255	1.04	1.10	2.000	No
41	8.49	0.48	0.00	0.48	0.98	0.268	1.05	0.255	1.04	1.10	2.000	No
42	8.65	0.49	0.00	0.49	0.98	0.268	1.05	0.254	1.04	1.10	2.000	No
43	8.80	0.49	0.00	0.49	0.98	0.268	1.05	0.254	1.03	1.10	2.000	No
44	8.95	0.50	0.00	0.50	0.98	0.268	1.05	0.254	1.03	1.10	2.000	No
45	9.11	0.51	0.00	0.51	0.98	0.268	1.05	0.254	1.03	1.10	2.000	No
46	9.26	0.51	0.00	0.51	0.98	0.268	1.05	0.254	1.03	1.10	2.000	No
47	9.41	0.52	0.00	0.52	0.98	0.268	1.05	0.254	1.03	1.10	2.000	No
48	9.56	0.53	0.00	0.53	0.98	0.267	1.05	0.254	1.03	1.10	2.000	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	9.71	0.54	0.00	0.54	0.98	0.267	1.05	0.254	1.03	1.10	2.000	No
50	9.87	0.54	0.00	0.54	0.98	0.267	1.05	0.253	1.03	1.10	2.000	No
51	10.11	0.56	0.00	0.55	0.98	0.269	1.05	0.255	1.03	1.10	0.285	No
52	10.26	0.56	0.01	0.55	0.98	0.271	1.05	0.257	1.03	1.10	0.287	No
53	10.40	0.57	0.01	0.56	0.98	0.273	1.05	0.259	1.03	1.10	0.289	No
54	10.55	0.58	0.02	0.56	0.98	0.275	1.05	0.261	1.03	1.10	0.291	No
55	10.69	0.58	0.02	0.56	0.98	0.277	1.05	0.262	1.03	1.10	0.293	No
56	10.84	0.59	0.03	0.57	0.98	0.279	1.05	0.264	1.03	1.10	0.296	No
57	10.99	0.60	0.03	0.57	0.97	0.281	1.05	0.266	1.03	1.10	0.298	No
58	11.14	0.61	0.04	0.57	0.97	0.283	1.05	0.268	1.03	1.10	0.300	No
59	11.29	0.62	0.04	0.58	0.97	0.285	1.05	0.270	1.03	1.10	0.302	No
60	11.45	0.62	0.05	0.58	0.97	0.286	1.05	0.272	1.03	1.10	0.304	No
61	11.60	0.63	0.05	0.58	0.97	0.288	1.05	0.273	1.03	1.10	0.306	No
62	11.74	0.64	0.05	0.58	0.97	0.290	1.05	0.275	1.03	1.10	0.308	No
63	11.89	0.65	0.06	0.59	0.97	0.292	1.05	0.277	1.03	1.10	0.310	No
64	12.04	0.65	0.06	0.59	0.97	0.294	1.05	0.279	1.03	1.10	0.312	No
65	12.19	0.66	0.07	0.59	0.97	0.295	1.05	0.280	1.03	1.10	0.314	No
66	12.34	0.67	0.07	0.60	0.97	0.297	1.05	0.282	1.03	1.10	0.316	No
67	12.48	0.68	0.08	0.60	0.97	0.299	1.05	0.283	1.03	1.10	0.318	No
68	12.64	0.69	0.08	0.60	0.97	0.301	1.05	0.285	1.03	1.10	0.320	No
69	12.79	0.69	0.09	0.61	0.97	0.302	1.05	0.287	1.03	1.10	0.321	No
70	12.94	0.70	0.09	0.61	0.97	0.304	1.05	0.288	1.03	1.10	0.322	No
71	13.09	0.71	0.10	0.61	0.97	0.306	1.05	0.290	1.03	1.10	0.325	No
72	13.15	0.71	0.10	0.62	0.97	0.306	1.05	0.290	1.02	1.10	0.327	No
73	13.31	0.72	0.10	0.62	0.97	0.308	1.05	0.292	1.02	1.10	0.328	No
74	13.46	0.73	0.11	0.62	0.97	0.310	1.05	0.294	1.02	1.10	0.330	No
75	13.61	0.74	0.11	0.63	0.97	0.311	1.05	0.295	1.02	1.10	0.332	No
76	13.77	0.75	0.12	0.63	0.97	0.313	1.05	0.297	1.02	1.10	0.334	No
77	13.91	0.75	0.12	0.63	0.96	0.314	1.05	0.298	1.02	1.10	0.335	No
78	14.07	0.76	0.13	0.64	0.96	0.316	1.05	0.299	1.02	1.10	0.337	No
79	14.21	0.77	0.13	0.64	0.96	0.317	1.05	0.301	1.02	1.10	0.338	No
80	14.36	0.78	0.14	0.64	0.96	0.319	1.05	0.302	1.02	1.10	0.340	No
81	14.51	0.79	0.14	0.65	0.96	0.320	1.05	0.303	1.02	1.10	0.341	No
82	14.65	0.79	0.15	0.65	0.96	0.321	1.05	0.305	1.02	1.10	0.342	No
83	14.80	0.80	0.15	0.65	0.96	0.322	1.05	0.306	1.04	1.10	0.324	No
84	14.95	0.81	0.15	0.66	0.96	0.324	1.05	0.307	1.04	1.10	0.324	No
85	15.10	0.82	0.16	0.66	0.96	0.325	1.05	0.308	1.03	1.10	0.328	No
86	15.26	0.83	0.16	0.67	0.96	0.326	1.05	0.309	1.03	1.10	0.345	No
87	15.41	0.84	0.17	0.67	0.96	0.328	1.05	0.311	1.03	1.10	0.348	No
88	15.53	0.85	0.17	0.68	0.96	0.328	1.05	0.312	1.02	1.10	0.352	No
89	15.69	0.86	0.18	0.68	0.96	0.330	1.05	0.313	1.04	1.10	0.331	No
90	15.85	0.87	0.18	0.69	0.96	0.331	1.05	0.314	1.03	1.10	0.335	No
91	15.98	0.88	0.19	0.69	0.96	0.332	1.05	0.315	1.03	1.10	0.335	No
92	16.14	0.89	0.19	0.69	0.96	0.333	1.05	0.316	1.03	1.10	0.338	No
93	16.29	0.89	0.20	0.70	0.96	0.334	1.05	0.317	1.02	1.10	0.356	No
94	16.50	0.91	0.20	0.70	0.95	0.336	1.05	0.318	1.02	1.10	0.359	No
95	16.65	0.92	0.21	0.71	0.95	0.337	1.05	0.319	1.02	1.10	0.360	No
96	16.80	0.92	0.21	0.71	0.95	0.338	1.05	0.320	1.02	1.10	0.361	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR*	Belongs to transition
97	16.94	0.93	0.22	0.72	0.95	0.339	1.05	0.321	1.02	1.10	0.362	No
98	17.09	0.94	0.22	0.72	0.95	0.340	1.05	0.322	1.02	1.10	0.363	No
99	17.23	0.95	0.23	0.72	0.95	0.341	1.05	0.323	1.02	1.10	0.364	No
100	17.38	0.96	0.23	0.73	0.95	0.342	1.05	0.324	1.02	1.10	0.366	No
101	17.53	0.97	0.24	0.73	0.95	0.343	1.05	0.325	1.02	1.10	0.367	No
102	17.69	0.97	0.24	0.73	0.95	0.344	1.05	0.326	1.02	1.10	0.368	No
103	17.83	0.98	0.24	0.74	0.95	0.345	1.05	0.327	1.02	1.10	0.352	No
104	17.98	0.99	0.25	0.74	0.95	0.346	1.05	0.328	1.02	1.10	0.370	No
105	18.12	1.00	0.25	0.75	0.95	0.347	1.05	0.329	1.02	1.10	0.355	No
106	18.28	1.01	0.26	0.75	0.95	0.348	1.05	0.330	1.03	1.10	0.353	No
107	18.41	1.02	0.26	0.75	0.95	0.349	1.05	0.331	1.02	1.10	0.355	No
108	18.57	1.03	0.27	0.76	0.95	0.349	1.05	0.331	1.02	1.10	0.358	No
109	18.72	1.04	0.27	0.76	0.95	0.350	1.05	0.332	1.03	1.10	0.356	No
110	18.87	1.05	0.28	0.77	0.95	0.351	1.05	0.333	1.04	1.10	0.351	No
111	19.02	1.05	0.28	0.77	0.94	0.352	1.05	0.334	1.03	1.10	0.356	No
112	19.17	1.06	0.29	0.78	0.94	0.353	1.05	0.334	1.03	1.10	0.359	No
113	19.31	1.07	0.29	0.78	0.94	0.353	1.05	0.335	1.02	1.10	0.361	No
114	19.46	1.08	0.30	0.79	0.94	0.354	1.05	0.336	1.02	1.10	0.361	No
115	19.60	1.09	0.30	0.79	0.94	0.355	1.05	0.336	1.03	1.10	0.361	No
116	19.80	1.10	0.31	0.80	0.94	0.356	1.05	0.337	1.04	1.10	0.356	No
117	19.95	1.11	0.31	0.80	0.94	0.356	1.05	0.338	1.03	1.10	0.359	No
118	20.10	1.12	0.31	0.81	0.94	0.357	1.05	0.339	1.03	1.10	0.362	No
119	20.23	1.13	0.32	0.81	0.94	0.358	1.05	0.339	1.03	1.10	0.363	No
120	20.39	1.14	0.32	0.82	0.94	0.358	1.05	0.340	1.03	1.10	0.363	No
121	20.53	1.15	0.33	0.82	0.94	0.359	1.05	0.340	1.03	1.10	0.362	No
122	20.68	1.16	0.33	0.82	0.94	0.359	1.05	0.341	1.03	1.10	0.363	No
123	20.83	1.17	0.34	0.83	0.94	0.360	1.05	0.341	1.03	1.10	0.365	No
124	20.98	1.18	0.34	0.83	0.94	0.361	1.05	0.342	1.03	1.10	0.366	No
125	21.13	1.19	0.35	0.84	0.94	0.361	1.05	0.343	1.03	1.10	0.366	No
126	21.26	1.20	0.35	0.84	0.94	0.362	1.05	0.343	1.05	1.10	0.360	No
127	21.41	1.21	0.36	0.85	0.93	0.362	1.05	0.343	1.07	1.10	0.354	No
128	21.56	1.22	0.36	0.85	0.93	0.363	1.05	0.344	1.06	1.10	0.355	No
129	21.71	1.23	0.37	0.86	0.93	0.363	1.05	0.344	1.06	1.10	0.357	No
130	21.86	1.24	0.37	0.87	0.93	0.363	1.05	0.345	1.06	1.10	0.358	No
131	22.00	1.24	0.37	0.87	0.93	0.364	1.05	0.345	1.06	1.10	0.359	No
132	22.14	1.25	0.38	0.88	0.93	0.364	1.05	0.345	1.06	1.10	0.360	No
133	22.29	1.26	0.38	0.88	0.93	0.365	1.05	0.346	1.05	1.10	0.361	No
134	22.44	1.27	0.39	0.89	0.93	0.365	1.05	0.346	1.04	1.10	0.366	No
135	22.59	1.28	0.39	0.89	0.93	0.366	1.05	0.347	1.04	1.10	0.367	No
136	22.73	1.29	0.40	0.90	0.93	0.366	1.05	0.347	1.05	1.10	0.364	No
137	22.89	1.30	0.40	0.90	0.93	0.366	1.05	0.347	1.05	1.10	0.365	No
138	23.07	1.32	0.41	0.91	0.93	0.367	1.05	0.348	1.05	1.10	0.366	No
139	23.21	1.33	0.41	0.91	0.93	0.367	1.05	0.348	1.04	1.10	0.367	No
140	23.35	1.34	0.42	0.92	0.93	0.367	1.05	0.349	1.04	1.10	0.368	No
141	23.50	1.35	0.42	0.92	0.93	0.368	1.05	0.349	1.04	1.10	0.369	No
142	23.65	1.36	0.43	0.93	0.92	0.368	1.05	0.349	1.04	1.10	0.370	No
143	23.79	1.36	0.43	0.93	0.92	0.369	1.05	0.350	1.04	1.10	0.371	No
144	23.93	1.37	0.43	0.94	0.92	0.369	1.05	0.350	1.04	1.10	0.371	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
145	24.08	1.38	0.44	0.94	0.92	0.369	1.05	0.350	1.03	1.10	0.372	No
146	24.23	1.39	0.44	0.95	0.92	0.370	1.05	0.351	1.03	1.10	0.373	No
147	24.32	1.40	0.45	0.95	0.92	0.370	1.05	0.351	1.03	1.10	0.374	No
148	24.54	1.41	0.45	0.96	0.92	0.370	1.05	0.351	1.03	1.10	0.375	No
149	24.69	1.42	0.46	0.96	0.92	0.371	1.05	0.351	1.03	1.10	0.376	No
150	24.81	1.43	0.46	0.97	0.92	0.371	1.05	0.352	1.03	1.10	0.377	No
151	24.96	1.44	0.47	0.97	0.92	0.371	1.05	0.352	1.02	1.10	0.378	No
152	25.09	1.45	0.47	0.98	0.92	0.372	1.05	0.353	1.02	1.10	0.379	No
153	25.24	1.45	0.48	0.98	0.92	0.372	1.05	0.353	1.02	1.10	0.380	No
154	25.40	1.46	0.48	0.98	0.92	0.373	1.05	0.354	1.02	1.10	0.381	No

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.26	148.10	-1.00	N/A	0.30	1.70	225.01	0.00	225.01	4.000	No	No	2.00
2	2.41	159.67	4.51	1.20	0.26	1.70	263.80	0.01	263.80	4.000	No	No	2.00
3	2.56	157.18	6.48	1.38	0.28	1.70	241.98	1.34	243.32	4.000	No	No	2.00
4	2.70	152.79	8.41	1.53	0.26	1.70	251.81	10.55	262.36	4.000	No	No	2.00
5	2.85	150.28	8.72	1.55	0.26	1.70	242.65	12.57	255.22	4.000	No	No	2.00
6	3.00	141.11	9.25	1.58	0.27	1.70	229.86	16.21	246.07	4.000	No	No	2.00
7	3.15	127.54	9.77	1.62	0.30	1.70	207.64	19.22	226.86	4.000	No	No	2.00
8	3.30	110.97	10.54	1.66	0.33	1.70	177.21	23.01	200.22	4.000	No	No	2.00
9	3.44	95.13	11.42	1.72	0.36	1.70	150.01	26.72	176.73	4.000	No	No	2.00
10	3.65	86.38	11.88	1.74	0.39	1.70	131.29	27.44	158.73	4.000	No	No	2.00
11	3.78	84.60	11.55	1.72	0.39	1.70	135.06	25.87	160.94	4.000	No	No	2.00
12	3.92	83.79	11.39	1.72	0.38	1.70	141.39	25.55	166.95	4.000	No	No	2.00
13	4.08	79.09	11.88	1.74	0.40	1.70	127.39	26.99	154.38	4.000	No	No	2.00
14	4.24	70.68	12.95	1.80	0.41	1.70	112.44	30.90	143.34	4.000	No	No	2.00
15	4.39	64.65	13.62	1.84	0.43	1.70	100.86	32.30	133.16	4.000	No	No	2.00
16	4.55	62.61	13.42	1.83	0.44	1.70	98.30	30.94	129.24	4.000	No	No	2.00
17	4.70	62.08	13.00	1.80	0.43	1.70	102.61	29.61	132.22	4.000	No	No	2.00
18	4.84	58.67	13.22	1.82	0.44	1.70	98.30	30.02	128.32	4.000	No	No	2.00
19	5.00	51.52	14.30	1.87	0.47	1.70	81.87	31.73	113.61	4.000	No	No	2.00
20	5.16	43.25	15.83	1.95	0.49	1.70	68.14	34.04	102.18	4.000	No	No	2.00
21	5.31	36.93	17.10	2.01	0.51	1.70	58.44	35.08	93.53	4.000	No	No	2.00
22	5.47	32.32	18.21	2.05	0.53	1.70	51.44	35.63	87.07	4.000	No	No	2.00
23	5.62	29.03	19.24	2.10	0.54	1.70	45.92	35.93	81.84	4.000	No	No	2.00
24	5.77	26.63	20.33	2.14	0.55	1.70	42.55	36.52	79.07	4.000	No	No	2.00
25	5.92	24.89	21.35	2.18	0.55	1.70	39.86	36.95	76.81	4.000	No	No	2.00
26	6.08	23.61	22.14	2.21	0.56	1.70	37.57	37.07	74.64	4.000	No	No	2.00
27	6.23	21.68	23.36	2.26	0.56	1.70	36.36	37.77	74.13	4.000	No	No	2.00
28	6.38	19.22	25.14	2.33	0.58	1.70	30.57	37.16	67.73	4.000	No	No	2.00
29	6.53	15.31	28.92	2.45	0.59	1.70	25.72	37.25	62.97	4.000	No	No	2.00
30	6.84	12.91	32.06	2.55	0.63	1.70	17.51	35.29	52.80	4.000	No	No	2.00
31	6.99	12.57	32.25	2.56	0.62	1.70	18.99	35.83	54.82	4.000	No	No	2.00
32	7.13	13.21	30.92	2.52	0.60	1.70	24.10	37.28	61.38	4.000	No	No	2.00
33	7.29	13.13	30.27	2.50	0.62	1.70	20.60	35.94	56.54	4.000	No	No	2.00
34	7.43	11.82	31.21	2.53	0.62	1.70	18.58	35.48	54.07	4.000	No	No	2.00
35	7.59	11.17	30.99	2.52	0.63	1.70	17.78	35.16	52.94	4.000	No	No	2.00
36	7.74	11.31	30.17	2.50	0.63	1.70	17.51	34.87	52.38	4.000	No	No	2.00
37	7.89	11.17	30.42	2.50	0.62	1.70	19.26	35.52	54.78	4.000	No	No	2.00
38	8.04	10.39	32.20	2.56	0.63	1.70	17.10	35.18	52.28	4.000	No	No	2.00
39	8.19	8.74	35.49	2.66	0.65	1.70	13.74	0.00	13.74	4.000	No	Yes	2.00
40	8.34	7.41	38.74	2.75	0.66	1.70	11.31	0.00	11.31	4.000	No	Yes	2.00
41	8.49	6.63	40.43	2.79	0.66	1.70	10.64	0.00	10.64	4.000	No	Yes	2.00
42	8.65	5.62	43.79	2.88	0.66	1.70	9.96	0.00	9.96	4.000	No	Yes	2.00
43	8.80	4.37	50.09	3.03	0.68	1.70	6.46	0.00	6.46	4.000	No	Yes	2.00
44	8.95	3.14	60.27	3.26	0.69	1.70	4.58	0.00	4.58	4.000	No	Yes	2.00
45	9.11	3.06	61.91	3.29	0.70	1.70	4.04	0.00	4.04	4.000	No	Yes	2.00
46	9.26	4.51	50.51	3.04	0.69	1.70	6.06	0.00	6.06	4.000	No	Yes	2.00
47	9.41	6.83	40.36	2.79	0.65	1.70	11.58	0.00	11.58	4.000	No	Yes	2.00
48	9.56	8.50	35.52	2.66	0.64	1.70	15.22	0.00	15.22	4.000	No	Yes	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	9.71	8.58	35.41	2.65	0.64	1.70	14.14	0.00	14.14	4.000	No	Yes	2.00
50	9.87	6.99	40.18	2.79	0.65	1.70	11.98	0.00	11.98	4.000	No	Yes	2.00
51	10.11	5.35	47.57	2.97	0.68	1.70	7.54	0.00	7.54	0.592	No	Yes	2.00
52	10.26	4.87	50.87	3.05	0.68	1.70	6.19	0.00	6.19	0.531	No	Yes	1.85
53	10.40	6.13	45.11	2.91	0.66	1.70	9.70	0.00	9.70	0.676	No	Yes	2.00
54	10.55	7.22	41.54	2.82	0.64	1.70	13.60	0.00	13.60	0.800	No	Yes	2.00
55	10.69	7.10	43.29	2.87	0.66	1.70	11.45	0.00	11.45	0.781	No	Yes	2.00
56	10.84	6.27	48.98	3.01	0.67	1.70	9.16	0.00	9.16	0.677	No	Yes	2.00
57	10.99	6.22	52.19	3.08	0.66	1.70	9.56	0.00	9.56	0.666	No	Yes	2.00
58	11.14	7.00	51.15	3.06	0.66	1.70	11.18	0.00	11.18	0.750	No	Yes	2.00
59	11.29	7.03	52.38	3.08	0.65	1.70	12.93	0.00	12.93	0.747	No	Yes	2.00
60	11.45	6.64	54.09	3.12	0.66	1.70	9.70	0.00	9.70	0.696	No	Yes	2.00
61	11.60	5.75	57.60	3.20	0.67	1.70	9.29	0.00	9.29	0.590	No	Yes	1.93
62	11.74	5.47	58.21	3.21	0.67	1.70	8.62	0.00	8.62	0.554	No	Yes	1.80
63	11.89	5.50	57.55	3.20	0.67	1.70	8.35	0.00	8.35	0.552	No	Yes	1.78
64	12.04	5.36	58.55	3.22	0.67	1.70	9.43	0.00	9.43	0.533	No	Yes	1.71
65	12.19	5.33	58.81	3.23	0.67	1.70	7.94	0.00	7.94	0.525	No	Yes	1.67
66	12.34	5.19	59.72	3.24	0.67	1.70	8.21	0.00	8.21	0.506	No	Yes	1.60
67	12.48	5.64	58.06	3.21	0.67	1.70	8.75	0.00	8.75	0.550	No	Yes	1.73
68	12.64	6.39	55.69	3.16	0.66	1.69	10.04	0.00	10.04	0.626	No	Yes	1.96
69	12.79	8.54	49.45	3.02	0.65	1.67	11.65	0.00	11.65	0.851	No	Yes	2.00
70	12.94	9.27	48.67	3.00	0.62	1.62	18.24	0.00	18.24	0.920	No	Yes	2.00
71	13.09	8.26	52.75	3.09	0.65	1.65	13.16	0.00	13.16	0.807	No	Yes	2.00
72	13.15	5.99	62.03	3.29	0.68	1.69	6.95	0.00	6.95	0.567	No	Yes	1.74
73	13.31	4.60	69.19	3.43	0.67	1.67	8.07	0.00	8.07	0.416	No	Yes	1.27
74	13.46	4.74	65.44	3.36	0.68	1.67	6.76	0.00	6.76	0.428	No	Yes	1.30
75	13.61	4.69	64.22	3.34	0.68	1.66	7.50	0.00	7.50	0.419	No	Yes	1.26
76	13.77	4.89	62.86	3.31	0.68	1.65	7.72	0.00	7.72	0.436	No	Yes	1.31
77	13.91	5.23	61.49	3.28	0.68	1.65	7.56	0.00	7.56	0.466	No	Yes	1.39
78	14.07	5.73	59.54	3.24	0.67	1.63	8.90	0.00	8.90	0.514	No	Yes	1.53
79	14.21	6.54	56.05	3.17	0.66	1.62	9.85	0.00	9.85	0.591	No	Yes	1.75
80	14.36	7.02	56.68	3.18	0.66	1.60	11.03	0.00	11.03	0.633	No	Yes	1.87
81	14.51	7.97	59.25	3.23	0.66	1.59	10.86	0.00	10.86	0.722	No	Yes	2.00
82	14.65	22.67	37.58	2.71	0.64	1.57	13.82	0.00	13.82	2.157	No	Yes	2.00
83	14.80	41.44	28.71	2.45	0.46	1.38	66.89	50.84	117.72	0.175	No	No	0.54
84	14.95	50.43	26.38	2.37	0.43	1.34	80.57	53.99	134.56	0.215	No	No	0.67
85	15.10	43.93	28.02	2.43	0.51	1.42	48.55	44.46	93.01	0.131	No	No	0.40
86	15.26	28.70	34.55	2.63	0.53	1.42	42.92	0.00	42.92	2.653	No	Yes	2.00
87	15.41	18.23	43.95	2.88	0.59	1.48	24.93	0.00	24.93	1.647	No	Yes	2.00
88	15.53	29.45	34.40	2.62	0.68	1.56	7.17	0.00	7.17	2.683	No	Yes	2.00
89	15.69	36.02	32.56	2.57	0.42	1.31	81.34	57.13	138.46	0.227	No	No	0.69
90	15.85	50.29	27.77	2.42	0.51	1.39	49.15	44.54	93.69	0.133	No	No	0.40
91	15.98	40.37	31.67	2.54	0.48	1.35	60.77	49.88	110.65	0.161	No	No	0.48
92	16.14	35.20	32.97	2.58	0.52	1.38	46.59	45.38	91.97	0.130	No	No	0.38
93	16.29	23.17	39.05	2.76	0.57	1.42	29.60	0.00	29.60	2.009	No	Yes	2.00
94	16.50	15.48	45.52	2.92	0.63	1.46	15.99	0.00	15.99	1.305	No	Yes	2.00
95	16.65	12.52	47.97	2.98	0.62	1.45	17.47	0.00	17.47	1.035	No	Yes	2.00
96	16.80	12.85	45.87	2.93	0.62	1.44	17.94	0.00	17.94	1.056	No	Yes	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
97	16.94	14.10	43.38	2.87	0.63	1.44	17.12	0.00	17.12	1.158	No	Yes	2.00
98	17.09	15.24	41.35	2.82	0.60	1.42	22.10	0.00	22.10	1.248	No	Yes	2.00
99	17.23	16.18	39.47	2.77	0.60	1.41	22.14	0.00	22.14	1.321	No	Yes	2.00
100	17.38	15.07	40.44	2.79	0.61	1.41	20.57	0.00	20.57	1.217	No	Yes	2.00
101	17.53	14.26	40.71	2.80	0.62	1.42	17.62	0.00	17.62	1.140	No	Yes	2.00
102	17.69	18.42	34.55	2.63	0.62	1.41	18.85	0.00	18.85	1.483	No	Yes	2.00
103	17.83	21.07	32.86	2.58	0.55	1.35	35.67	41.64	77.31	0.109	No	No	0.31
104	17.98	21.69	34.76	2.63	0.58	1.37	27.35	0.00	27.35	1.736	No	Yes	2.00
105	18.12	30.96	30.29	2.50	0.61	1.39	20.98	36.07	57.05	0.085	No	No	0.24
106	18.28	37.11	28.88	2.45	0.46	1.27	67.12	50.99	118.12	0.176	No	No	0.50
107	18.41	39.42	28.84	2.45	0.51	1.31	48.79	44.89	93.68	0.132	No	No	0.37
108	18.57	40.31	28.45	2.44	0.58	1.35	29.22	38.26	67.48	0.097	No	No	0.27
109	18.72	64.70	20.74	2.16	0.47	1.27	69.91	44.89	114.80	0.169	No	No	0.48
110	18.87	81.35	18.15	2.05	0.35	1.19	127.07	55.01	182.08	0.571	No	No	1.63
111	19.02	81.26	18.80	2.08	0.44	1.24	85.38	45.74	131.12	0.206	No	No	0.58
112	19.17	57.07	23.81	2.28	0.46	1.25	68.77	48.17	116.95	0.173	No	No	0.48
113	19.31	48.97	24.64	2.31	0.52	1.28	48.60	42.55	91.15	0.129	No	No	0.36
114	19.46	50.73	22.72	2.24	0.49	1.26	57.98	43.80	101.77	0.145	No	No	0.40
115	19.60	80.65	17.99	2.05	0.47	1.24	74.45	41.11	115.56	0.170	No	No	0.47
116	19.80	99.68	17.54	2.03	0.33	1.16	142.67	57.05	199.71	1.123	No	No	2.00
117	19.95	107.70	18.21	2.05	0.37	1.18	117.92	52.84	170.76	0.415	No	No	1.16
118	20.10	92.44	20.39	2.15	0.40	1.19	98.74	52.55	151.29	0.277	No	No	0.77
119	20.23	89.74	19.88	2.13	0.41	1.20	95.10	50.57	145.67	0.253	No	No	0.70
120	20.39	99.74	17.47	2.02	0.39	1.18	108.98	48.45	157.43	0.310	No	No	0.85
121	20.53	110.05	15.92	1.95	0.36	1.16	129.29	47.90	177.19	0.493	No	No	1.36
122	20.68	113.49	16.17	1.96	0.36	1.16	126.49	48.23	174.71	0.460	No	No	1.27
123	20.83	109.27	17.53	2.02	0.37	1.16	118.62	51.02	169.65	0.404	No	No	1.11
124	20.98	107.63	18.88	2.08	0.37	1.16	115.07	53.83	168.90	0.397	No	No	1.08
125	21.13	127.05	18.11	2.05	0.37	1.16	120.22	53.13	173.35	0.444	No	No	1.21
126	21.26	263.50	11.01	1.69	0.32	1.13	177.89	26.70	204.59	1.420	No	No	2.00
127	21.41	359.49	8.86	1.56	0.26	1.11	537.09	25.88	562.97	4.000	No	No	2.00
128	21.56	423.17	7.53	1.46	0.26	1.10	415.01	7.56	422.56	4.000	No	No	2.00
129	21.71	380.29	8.05	1.50	0.26	1.10	371.63	10.98	382.61	4.000	No	No	2.00
130	21.86	372.45	7.99	1.50	0.26	1.10	400.32	11.13	411.45	4.000	No	No	2.00
131	22.00	360.71	8.50	1.53	0.26	1.10	388.26	15.71	403.97	4.000	No	No	2.00
132	22.14	312.43	10.23	1.65	0.26	1.09	333.18	32.95	366.13	4.000	No	No	2.00
133	22.29	247.34	12.92	1.80	0.26	1.09	248.58	51.81	300.38	4.000	No	No	2.00
134	22.44	199.62	15.24	1.92	0.28	1.10	185.57	56.78	242.35	4.000	No	No	2.00
135	22.59	196.27	14.62	1.89	0.28	1.09	184.99	53.12	238.11	4.000	No	No	2.00
136	22.73	229.96	12.16	1.76	0.26	1.09	236.91	43.29	280.20	4.000	No	No	2.00
137	22.89	274.50	10.35	1.65	0.26	1.08	287.41	30.54	317.96	4.000	No	No	2.00
138	23.07	301.15	9.87	1.62	0.26	1.08	319.61	27.69	347.31	4.000	No	No	2.00
139	23.21	320.78	9.51	1.60	0.26	1.08	317.20	23.54	340.74	4.000	No	No	2.00
140	23.35	325.82	8.98	1.57	0.26	1.08	345.79	19.24	365.03	4.000	No	No	2.00
141	23.50	329.26	8.17	1.51	0.26	1.08	333.42	11.04	344.46	4.000	No	No	2.00
142	23.65	327.60	7.47	1.46	0.26	1.07	326.04	5.85	331.89	4.000	No	No	2.00
143	23.79	325.25	7.33	1.45	0.26	1.07	339.05	5.25	344.30	4.000	No	No	2.00
144	23.93	311.62	7.51	1.46	0.26	1.07	324.70	6.10	330.80	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
145	24.08	297.13	7.41	1.45	0.26	1.07	283.15	4.97	288.12	4.000	No	No	2.00
146	24.23	285.65	7.14	1.43	0.26	1.07	293.52	3.78	297.29	4.000	No	No	2.00
147	24.32	296.10	6.88	1.41	0.26	1.07	288.59	2.70	291.29	4.000	No	No	2.00
148	24.54	301.07	7.80	1.48	0.26	1.06	313.31	7.77	321.08	4.000	No	No	2.00
149	24.69	294.41	9.63	1.61	0.26	1.06	307.06	24.15	331.21	4.000	No	No	2.00
150	24.81	271.53	9.12	1.58	0.26	1.06	267.04	16.98	284.02	4.000	No	No	2.00
151	24.96	263.98	7.12	1.43	0.27	1.06	243.59	3.22	246.80	4.000	No	No	2.00
152	25.09	342.77	-1.00	N/A	0.26	1.06	283.29	0.00	283.29	4.000	No	No	2.00
153	25.24	429.38	-1.00	N/A	0.26	1.06	502.69	0.00	502.69	4.000	No	No	2.00
154	25.40	631.64	-1.00	N/A	0.26	1.06	696.14	0.00	696.14	4.000	No	No	2.00

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.26	2.00	0.00	9.66	0.15	0.00	2.41	2.00	0.00	9.63	0.15	0.00
2.56	2.00	0.00	9.61	0.15	0.00	2.70	2.00	0.00	9.59	0.14	0.00
2.85	2.00	0.00	9.57	0.15	0.00	3.00	2.00	0.00	9.54	0.15	0.00
3.15	2.00	0.00	9.52	0.15	0.00	3.30	2.00	0.00	9.50	0.15	0.00
3.44	2.00	0.00	9.48	0.14	0.00	3.65	2.00	0.00	9.44	0.21	0.00
3.78	2.00	0.00	9.42	0.14	0.00	3.92	2.00	0.00	9.40	0.13	0.00
4.08	2.00	0.00	9.38	0.16	0.00	4.24	2.00	0.00	9.35	0.16	0.00
4.39	2.00	0.00	9.33	0.15	0.00	4.55	2.00	0.00	9.31	0.15	0.00
4.70	2.00	0.00	9.28	0.15	0.00	4.84	2.00	0.00	9.26	0.14	0.00
5.00	2.00	0.00	9.24	0.17	0.00	5.16	2.00	0.00	9.21	0.16	0.00
5.31	2.00	0.00	9.19	0.15	0.00	5.47	2.00	0.00	9.17	0.16	0.00
5.62	2.00	0.00	9.14	0.15	0.00	5.77	2.00	0.00	9.12	0.15	0.00
5.92	2.00	0.00	9.10	0.15	0.00	6.08	2.00	0.00	9.07	0.15	0.00
6.23	2.00	0.00	9.05	0.15	0.00	6.38	2.00	0.00	9.03	0.15	0.00
6.53	2.00	0.00	9.00	0.15	0.00	6.84	2.00	0.00	8.96	0.31	0.00
6.99	2.00	0.00	8.93	0.15	0.00	7.13	2.00	0.00	8.91	0.14	0.00
7.29	2.00	0.00	8.89	0.15	0.00	7.43	2.00	0.00	8.87	0.14	0.00
7.59	2.00	0.00	8.84	0.16	0.00	7.74	2.00	0.00	8.82	0.15	0.00
7.89	2.00	0.00	8.80	0.15	0.00	8.04	2.00	0.00	8.77	0.15	0.00
8.19	2.00	0.00	8.75	0.15	0.00	8.34	2.00	0.00	8.73	0.15	0.00
8.49	2.00	0.00	8.71	0.15	0.00	8.65	2.00	0.00	8.68	0.15	0.00
8.80	2.00	0.00	8.66	0.15	0.00	8.95	2.00	0.00	8.64	0.15	0.00
9.11	2.00	0.00	8.61	0.15	0.00	9.26	2.00	0.00	8.59	0.15	0.00
9.41	2.00	0.00	8.57	0.16	0.00	9.56	2.00	0.00	8.54	0.15	0.00
9.71	2.00	0.00	8.52	0.15	0.00	9.87	2.00	0.00	8.50	0.15	0.00
10.11	2.00	0.00	8.46	0.24	0.00	10.26	1.85	0.00	8.44	0.15	0.00
10.40	2.00	0.00	8.42	0.14	0.00	10.55	2.00	0.00	8.39	0.15	0.00
10.69	2.00	0.00	8.37	0.14	0.00	10.84	2.00	0.00	8.35	0.15	0.00
10.99	2.00	0.00	8.32	0.15	0.00	11.14	2.00	0.00	8.30	0.15	0.00
11.29	2.00	0.00	8.28	0.15	0.00	11.45	2.00	0.00	8.26	0.15	0.00
11.60	1.93	0.00	8.23	0.15	0.00	11.74	1.80	0.00	8.21	0.15	0.00
11.89	1.78	0.00	8.19	0.15	0.00	12.04	1.71	0.00	8.17	0.14	0.00
12.19	1.67	0.00	8.14	0.15	0.00	12.34	1.60	0.00	8.12	0.15	0.00
12.48	1.73	0.00	8.10	0.15	0.00	12.64	1.96	0.00	8.07	0.16	0.00
12.79	2.00	0.00	8.05	0.15	0.00	12.94	2.00	0.00	8.03	0.15	0.00
13.09	2.00	0.00	8.00	0.15	0.00	13.15	1.74	0.00	8.00	0.06	0.00
13.31	1.27	0.00	7.97	0.16	0.00	13.46	1.30	0.00	7.95	0.15	0.00
13.61	1.26	0.00	7.93	0.15	0.00	13.77	1.31	0.00	7.90	0.15	0.00
13.91	1.39	0.00	7.88	0.15	0.00	14.07	1.53	0.00	7.86	0.15	0.00
14.21	1.75	0.00	7.83	0.15	0.00	14.36	1.87	0.00	7.81	0.14	0.00
14.51	2.00	0.00	7.79	0.15	0.00	14.65	2.00	0.00	7.77	0.14	0.00
14.80	0.54	0.46	7.74	0.15	0.16	14.95	0.67	0.33	7.72	0.15	0.12
15.10	0.40	0.60	7.70	0.15	0.21	15.26	2.00	0.00	7.68	0.15	0.00
15.41	2.00	0.00	7.65	0.15	0.00	15.53	2.00	0.00	7.63	0.12	0.00
15.69	0.69	0.31	7.61	0.16	0.12	15.85	0.40	0.60	7.58	0.16	0.22
15.98	0.48	0.52	7.56	0.14	0.16	16.14	0.38	0.62	7.54	0.15	0.22
16.29	2.00	0.00	7.52	0.15	0.00	16.50	2.00	0.00	7.49	0.21	0.00
16.65	2.00	0.00	7.46	0.15	0.00	16.80	2.00	0.00	7.44	0.15	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
16.94	2.00	0.00	7.42	0.14	0.00	17.09	2.00	0.00	7.40	0.15	0.00
17.23	2.00	0.00	7.37	0.14	0.00	17.38	2.00	0.00	7.35	0.16	0.00
17.53	2.00	0.00	7.33	0.15	0.00	17.69	2.00	0.00	7.30	0.15	0.00
17.83	0.31	0.69	7.28	0.15	0.23	17.98	2.00	0.00	7.26	0.15	0.00
18.12	0.24	0.76	7.24	0.14	0.24	18.28	0.50	0.50	7.21	0.15	0.17
18.41	0.37	0.63	7.19	0.14	0.19	18.57	0.27	0.73	7.17	0.16	0.25
18.72	0.48	0.52	7.15	0.15	0.17	18.87	1.63	0.00	7.12	0.15	0.00
19.02	0.58	0.42	7.10	0.15	0.13	19.17	0.48	0.52	7.08	0.15	0.17
19.31	0.36	0.64	7.06	0.13	0.18	19.46	0.40	0.60	7.03	0.15	0.19
19.60	0.47	0.53	7.01	0.14	0.16	19.80	2.00	0.00	6.98	0.19	0.00
19.95	1.16	0.00	6.96	0.15	0.00	20.10	0.77	0.23	6.94	0.15	0.07
20.23	0.70	0.30	6.92	0.13	0.08	20.39	0.85	0.15	6.89	0.16	0.05
20.53	1.36	0.00	6.87	0.14	0.00	20.68	1.27	0.00	6.85	0.15	0.00
20.83	1.11	0.00	6.83	0.15	0.00	20.98	1.08	0.00	6.80	0.15	0.00
21.13	1.21	0.00	6.78	0.15	0.00	21.26	2.00	0.00	6.76	0.13	0.00
21.41	2.00	0.00	6.74	0.15	0.00	21.56	2.00	0.00	6.71	0.15	0.00
21.71	2.00	0.00	6.69	0.15	0.00	21.86	2.00	0.00	6.67	0.15	0.00
22.00	2.00	0.00	6.65	0.13	0.00	22.14	2.00	0.00	6.63	0.14	0.00
22.29	2.00	0.00	6.60	0.15	0.00	22.44	2.00	0.00	6.58	0.15	0.00
22.59	2.00	0.00	6.56	0.15	0.00	22.73	2.00	0.00	6.54	0.14	0.00
22.89	2.00	0.00	6.51	0.16	0.00	23.07	2.00	0.00	6.48	0.18	0.00
23.21	2.00	0.00	6.46	0.14	0.00	23.35	2.00	0.00	6.44	0.14	0.00
23.50	2.00	0.00	6.42	0.15	0.00	23.65	2.00	0.00	6.40	0.15	0.00
23.79	2.00	0.00	6.37	0.14	0.00	23.93	2.00	0.00	6.35	0.14	0.00
24.08	2.00	0.00	6.33	0.15	0.00	24.23	2.00	0.00	6.31	0.15	0.00
24.32	2.00	0.00	6.29	0.09	0.00	24.54	2.00	0.00	6.26	0.21	0.00
24.69	2.00	0.00	6.24	0.15	0.00	24.81	2.00	0.00	6.22	0.13	0.00
24.96	2.00	0.00	6.20	0.15	0.00	25.09	2.00	0.00	6.18	0.13	0.00
25.24	2.00	0.00	6.15	0.15	0.00	25.40	2.00	0.00	6.13	0.17	0.00

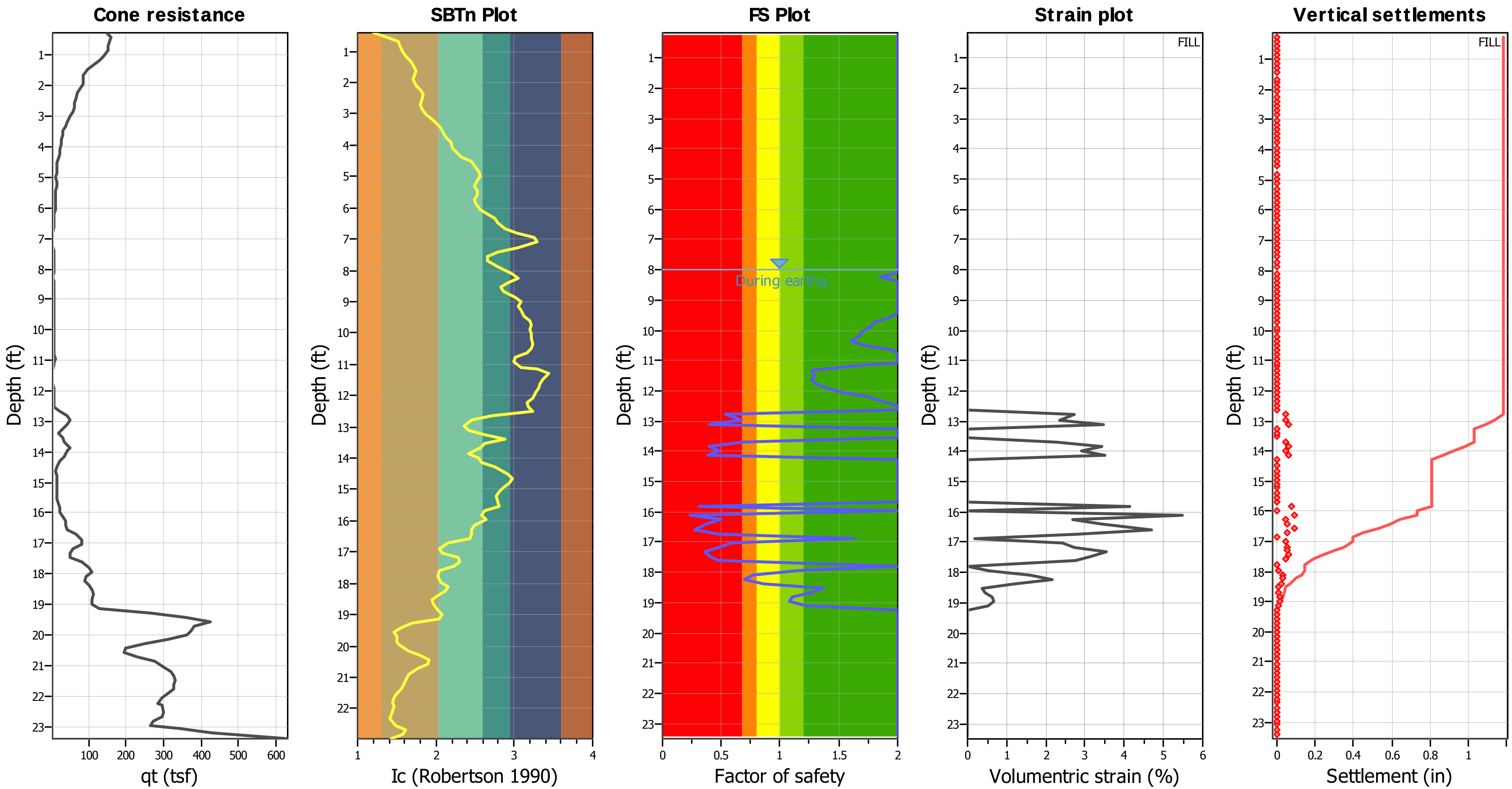
Overall liquefaction potential: 3.50

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.11	7.54	2.00	0.00	1.00	0.00	10.26	6.19	1.85	0.00	1.00	0.00
10.40	9.70	2.00	0.00	1.00	0.00	10.55	13.60	2.00	0.00	1.00	0.00
10.69	11.45	2.00	0.00	1.00	0.00	10.84	9.16	2.00	0.00	1.00	0.00
10.99	9.56	2.00	0.00	1.00	0.00	11.14	11.18	2.00	0.00	1.00	0.00
11.29	12.93	2.00	0.00	1.00	0.00	11.45	9.70	2.00	0.00	1.00	0.00
11.60	9.29	1.93	0.00	1.00	0.00	11.74	8.62	1.80	0.00	1.00	0.00
11.89	8.35	1.78	0.00	1.00	0.00	12.04	9.43	1.71	0.00	1.00	0.00
12.19	7.94	1.67	0.00	1.00	0.00	12.34	8.21	1.60	0.00	1.00	0.00
12.48	8.75	1.73	0.00	1.00	0.00	12.64	10.04	1.96	0.00	1.00	0.00
12.79	11.65	2.00	0.00	1.00	0.00	12.94	18.24	2.00	0.00	1.00	0.00
13.09	13.16	2.00	0.00	1.00	0.00	13.15	6.95	1.74	0.00	1.00	0.00
13.31	8.07	1.27	0.00	1.00	0.00	13.46	6.76	1.30	0.00	1.00	0.00
13.61	7.50	1.26	0.00	1.00	0.00	13.77	7.72	1.31	0.00	1.00	0.00
13.91	7.56	1.39	0.00	1.00	0.00	14.07	8.90	1.53	0.00	1.00	0.00
14.21	9.85	1.75	0.00	1.00	0.00	14.36	11.03	1.87	0.00	1.00	0.00
14.51	10.86	2.00	0.00	1.00	0.00	14.65	13.82	2.00	0.00	1.00	0.00
14.80	117.72	0.54	2.71	1.00	0.05	14.95	134.56	0.67	2.34	1.00	0.04
15.10	93.01	0.40	3.46	1.00	0.06	15.26	42.92	2.00	0.00	1.00	0.00
15.41	24.93	2.00	0.00	1.00	0.00	15.53	7.17	2.00	0.00	1.00	0.00
15.69	138.46	0.69	2.27	1.00	0.04	15.85	93.69	0.40	3.43	1.00	0.06
15.98	110.65	0.48	2.89	1.00	0.05	16.14	91.97	0.38	3.50	1.00	0.06
16.29	29.60	2.00	0.00	1.00	0.00	16.50	15.99	2.00	0.00	1.00	0.00
16.65	17.47	2.00	0.00	1.00	0.00	16.80	17.94	2.00	0.00	1.00	0.00
16.94	17.12	2.00	0.00	1.00	0.00	17.09	22.10	2.00	0.00	1.00	0.00
17.23	22.14	2.00	0.00	1.00	0.00	17.38	20.57	2.00	0.00	1.00	0.00
17.53	17.62	2.00	0.00	1.00	0.00	17.69	18.85	2.00	0.00	1.00	0.00
17.83	77.31	0.31	4.14	1.00	0.07	17.98	27.35	2.00	0.00	1.00	0.00
18.12	57.05	0.24	5.47	1.00	0.09	18.28	118.12	0.50	2.70	1.00	0.05
18.41	93.68	0.37	3.43	1.00	0.06	18.57	67.48	0.27	4.71	1.00	0.09
18.72	114.80	0.48	2.78	1.00	0.05	18.87	182.08	1.63	0.18	1.00	0.00
19.02	131.12	0.58	2.41	1.00	0.04	19.17	116.95	0.48	2.73	1.00	0.05
19.31	91.15	0.36	3.53	1.00	0.06	19.46	101.77	0.40	3.16	1.00	0.06
19.60	115.56	0.47	2.76	1.00	0.05	19.80	199.71	2.00	0.00	1.00	0.00
19.95	170.76	1.16	0.57	1.00	0.01	20.10	151.29	0.77	1.59	1.00	0.03
20.23	145.67	0.70	2.15	1.00	0.03	20.39	157.43	0.85	1.19	1.00	0.02
20.53	177.19	1.36	0.36	1.00	0.01	20.68	174.71	1.27	0.45	1.00	0.01
20.83	169.65	1.11	0.64	1.00	0.01	20.98	168.90	1.08	0.67	1.00	0.01
21.13	173.35	1.21	0.50	1.00	0.01	21.26	204.59	2.00	0.00	1.00	0.00
21.41	562.97	2.00	0.00	1.00	0.00	21.56	422.56	2.00	0.00	1.00	0.00
21.71	382.61	2.00	0.00	1.00	0.00	21.86	411.45	2.00	0.00	1.00	0.00
22.00	403.97	2.00	0.00	1.00	0.00	22.14	366.13	2.00	0.00	1.00	0.00
22.29	300.38	2.00	0.00	1.00	0.00	22.44	242.35	2.00	0.00	1.00	0.00
22.59	238.11	2.00	0.00	1.00	0.00	22.73	280.20	2.00	0.00	1.00	0.00
22.89	317.96	2.00	0.00	1.00	0.00	23.07	347.31	2.00	0.00	1.00	0.00
23.21	340.74	2.00	0.00	1.00	0.00	23.35	365.03	2.00	0.00	1.00	0.00
23.50	344.46	2.00	0.00	1.00	0.00	23.65	331.89	2.00	0.00	1.00	0.00
23.79	344.30	2.00	0.00	1.00	0.00	23.93	330.80	2.00	0.00	1.00	0.00
24.08	288.12	2.00	0.00	1.00	0.00	24.23	297.29	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

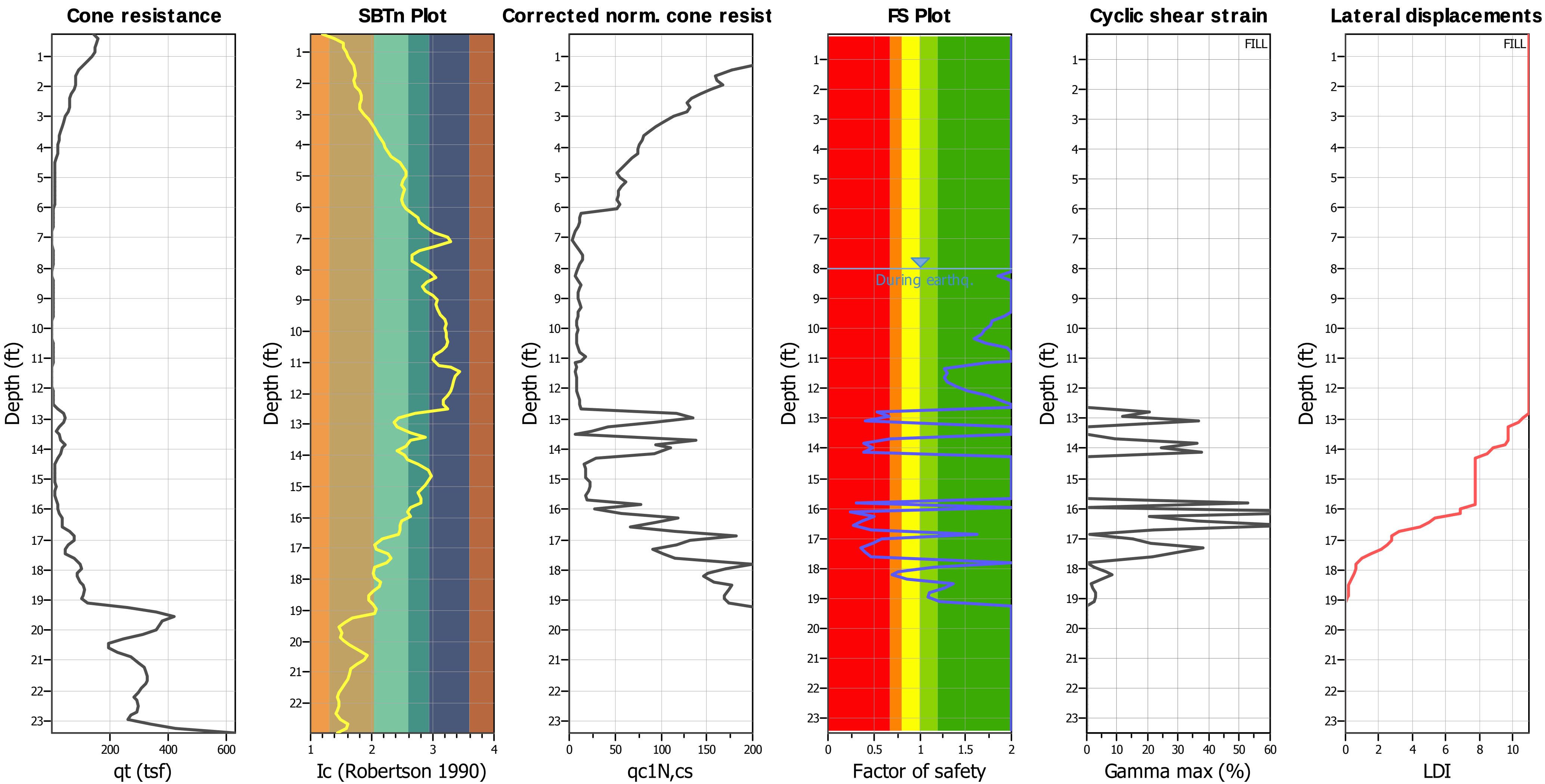
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
24.32	291.29	2.00	0.00	1.00	0.00	24.54	321.08	2.00	0.00	1.00	0.00
24.69	331.21	2.00	0.00	1.00	0.00	24.81	284.02	2.00	0.00	1.00	0.00
24.96	246.80	2.00	0.00	1.00	0.00	25.09	283.29	2.00	0.00	1.00	0.00
25.24	502.69	2.00	0.00	1.00	0.00	25.40	696.14	2.00	0.00	1.00	0.00

Total estimated settlement: 1.18

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.11	7.54	0.00	2.00	0.00	0.00	0.00
10.26	6.19	0.00	1.85	0.00	0.00	0.00
10.40	9.70	0.00	2.00	0.00	0.00	0.00
10.55	13.60	0.00	2.00	0.00	0.00	0.00
10.69	11.45	0.00	2.00	0.00	0.00	0.00
10.84	9.16	0.00	2.00	0.00	0.00	0.00
10.99	9.56	0.00	2.00	0.00	0.00	0.00
11.14	11.18	0.00	2.00	0.00	0.00	0.00
11.29	12.93	0.00	2.00	0.00	0.00	0.00
11.45	9.70	0.00	2.00	0.00	0.00	0.00
11.60	9.29	0.00	1.93	0.00	0.00	0.00
11.74	8.62	0.00	1.80	0.00	0.00	0.00
11.89	8.35	0.00	1.78	0.00	0.00	0.00
12.04	9.43	0.00	1.71	0.00	0.00	0.00
12.19	7.94	0.00	1.67	0.00	0.00	0.00
12.34	8.21	0.00	1.60	0.00	0.00	0.00
12.48	8.75	0.00	1.73	0.00	0.00	0.00
12.64	10.04	0.00	1.96	0.00	0.00	0.00
12.79	11.65	0.00	2.00	0.00	0.00	0.00
12.94	18.24	0.00	2.00	0.00	0.00	0.00
13.09	13.16	0.00	2.00	0.00	0.00	0.00
13.15	6.95	0.00	1.74	0.00	0.00	0.00
13.31	8.07	0.00	1.27	0.00	0.00	0.00
13.46	6.76	0.00	1.30	0.00	0.00	0.00
13.61	7.50	0.00	1.26	0.00	0.00	0.00
13.77	7.72	0.00	1.31	0.00	0.00	0.00
13.91	7.56	0.00	1.39	0.00	0.00	0.00
14.07	8.90	0.00	1.53	0.00	0.00	0.00
14.21	9.85	0.00	1.75	0.00	0.00	0.00
14.36	11.03	0.00	1.87	0.00	0.00	0.00
14.51	10.86	0.00	2.00	0.00	0.00	0.00
14.65	13.82	0.00	2.00	0.00	0.00	0.00
14.80	117.72	0.21	0.54	0.63	0.21	0.37
14.95	134.56	0.14	0.67	0.44	0.12	0.21
15.10	93.01	0.37	0.40	0.85	0.37	0.67
15.26	42.92	0.00	2.00	0.00	0.00	0.00
15.41	24.93	0.00	2.00	0.00	0.00	0.00
15.53	7.17	0.00	2.00	0.00	0.00	0.00
15.69	138.46	0.12	0.69	0.39	0.09	0.18
15.85	93.69	0.36	0.40	0.84	0.36	0.67
15.98	110.65	0.24	0.48	0.70	0.24	0.39
16.14	91.97	0.37	0.38	0.85	0.37	0.69
16.29	29.60	0.00	2.00	0.00	0.00	0.00
16.50	15.99	0.00	2.00	0.00	0.00	0.00
16.65	17.47	0.00	2.00	0.00	0.00	0.00
16.80	17.94	0.00	2.00	0.00	0.00	0.00
16.94	17.12	0.00	2.00	0.00	0.00	0.00
17.09	22.10	0.00	2.00	0.00	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
17.23	22.14	0.00	2.00	0.00	0.00	0.00
17.38	20.57	0.00	2.00	0.00	0.00	0.00
17.53	17.62	0.00	2.00	0.00	0.00	0.00
17.69	18.85	0.00	2.00	0.00	0.00	0.00
17.83	77.31	0.53	0.31	0.93	0.53	0.93
17.98	27.35	0.00	2.00	0.00	0.00	0.00
18.12	57.05	0.86	0.24	0.94	0.86	1.47
18.28	118.12	0.20	0.50	0.62	0.20	0.37
18.41	93.68	0.36	0.37	0.84	0.36	0.59
18.57	67.48	0.66	0.27	0.94	0.66	1.24
18.72	114.80	0.22	0.48	0.66	0.22	0.40
18.87	182.08	0.04	1.63	-0.19	0.01	0.02
19.02	131.12	0.15	0.58	0.48	0.15	0.26
19.17	116.95	0.21	0.48	0.64	0.21	0.38
19.31	91.15	0.38	0.36	0.86	0.38	0.61
19.46	101.77	0.30	0.40	0.78	0.30	0.54
19.60	115.56	0.22	0.47	0.65	0.22	0.37
19.80	199.71	0.02	2.00	-0.45	0.00	0.00
19.95	170.76	0.05	1.16	-0.03	0.03	0.05
20.10	151.29	0.09	0.77	0.23	0.06	0.11
20.23	145.67	0.10	0.70	0.30	0.08	0.12
20.39	157.43	0.08	0.85	0.15	0.05	0.09
20.53	177.19	0.04	1.36	-0.12	0.02	0.03
20.68	174.71	0.05	1.27	-0.09	0.02	0.04
20.83	169.65	0.06	1.11	-0.02	0.03	0.05
20.98	168.90	0.06	1.08	-0.01	0.03	0.05
21.13	173.35	0.05	1.21	-0.07	0.02	0.04
21.26	204.59	0.02	2.00	-0.52	0.00	0.00
21.41	562.97	0.00	2.00	-6.19	0.00	0.00
21.56	422.56	0.00	2.00	-3.97	0.00	0.00
21.71	382.61	0.00	2.00	-3.33	0.00	0.00
21.86	411.45	0.00	2.00	-3.79	0.00	0.00
22.00	403.97	0.00	2.00	-3.67	0.00	0.00
22.14	366.13	0.00	2.00	-3.06	0.00	0.00
22.29	300.38	0.00	2.00	-2.01	0.00	0.00
22.44	242.35	0.00	2.00	-1.09	0.00	0.00
22.59	238.11	0.00	2.00	-1.03	0.00	0.00
22.73	280.20	0.00	2.00	-1.69	0.00	0.00
22.89	317.96	0.00	2.00	-2.29	0.00	0.00
23.07	347.31	0.00	2.00	-2.76	0.00	0.00
23.21	340.74	0.00	2.00	-2.66	0.00	0.00
23.35	365.03	0.00	2.00	-3.05	0.00	0.00
23.50	344.46	0.00	2.00	-2.72	0.00	0.00
23.65	331.89	0.00	2.00	-2.51	0.00	0.00
23.79	344.30	0.00	2.00	-2.71	0.00	0.00
23.93	330.80	0.00	2.00	-2.50	0.00	0.00
24.08	288.12	0.00	2.00	-1.81	0.00	0.00
24.23	297.29	0.00	2.00	-1.96	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
24.32	291.29	0.00	2.00	-1.87	0.00	0.00
24.54	321.08	0.00	2.00	-2.34	0.00	0.00
24.69	331.21	0.00	2.00	-2.50	0.00	0.00
24.81	284.02	0.00	2.00	-1.75	0.00	0.00
24.96	246.80	0.00	2.00	-1.16	0.00	0.00
25.09	283.29	0.00	2.00	-1.74	0.00	0.00
25.24	502.69	0.00	2.00	-5.24	0.00	0.00
25.40	696.14	0.00	2.00	-8.24	0.00	0.00

Total estimated displacement: 10.96

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.26	148.10	237.93	1.00	237.93	-1.00	0.96	0.96
2.41	159.67	256.50	1.00	256.50	1.20	0.97	0.97
2.56	157.18	252.49	1.00	252.49	1.38	0.97	0.97
2.70	152.79	245.42	1.00	245.42	1.53	0.96	0.96
2.85	150.28	241.37	1.00	241.37	1.55	0.96	0.96
3.00	141.11	226.63	1.00	226.63	1.58	0.95	0.95
3.15	127.54	204.80	1.00	204.80	1.62	0.93	0.93
3.30	110.97	178.17	1.01	180.62	1.66	0.63	0.91
3.44	95.13	152.71	1.05	160.26	1.72	0.32	0.89
3.65	86.38	138.64	1.07	147.92	1.74	0.22	0.87
3.78	84.60	135.75	1.05	143.16	1.72	0.24	0.87
3.92	83.79	134.44	1.05	140.94	1.72	0.27	0.87
4.08	79.09	126.88	1.07	135.42	1.74	0.21	0.86
4.24	70.68	113.35	1.11	125.63	1.80	0.17	0.85
4.39	64.65	103.64	1.14	117.66	1.84	0.15	0.83
4.55	62.61	100.35	1.13	113.10	1.83	0.14	0.83
4.70	62.08	99.49	1.11	110.44	1.80	0.15	0.83
4.84	58.67	94.00	1.12	105.20	1.82	0.14	0.82
5.00	51.52	82.49	1.16	96.01	1.87	0.11	0.80
5.16	43.25	69.19	1.24	85.54	1.95	0.10	0.78
5.31	36.93	59.03	1.31	77.17	2.01	0.08	0.76
5.47	32.32	51.61	1.38	71.14	2.05	0.08	0.74
5.62	29.03	46.31	1.45	67.26	2.10	0.07	0.72
5.77	26.63	42.43	1.54	65.30	2.14	0.07	0.71
5.92	24.89	39.64	1.63	64.57	2.18	0.07	0.70
6.08	23.61	37.56	1.70	64.01	2.21	0.06	0.70
6.23	21.68	34.45	1.83	63.07	2.26	0.06	0.69
6.38	19.22	30.49	2.03	62.03	2.33	0.06	0.67
6.53	15.31	24.19	2.55	61.69	2.45	0.06	0.64
6.84	12.91	20.30	3.06	62.06	2.55	0.05	0.62
6.99	12.57	19.75	3.09	61.04	2.56	0.05	0.62
7.13	13.21	20.77	2.86	59.51	2.52	0.06	0.63
7.29	13.13	20.62	2.76	56.92	2.50	0.05	0.63
7.43	11.82	18.50	2.91	53.90	2.53	0.05	0.61
7.59	11.17	17.46	2.88	50.23	2.52	0.05	0.61
7.74	11.31	17.67	2.74	48.47	2.50	0.05	0.61
7.89	11.17	17.43	2.78	48.52	2.50	0.05	0.61
8.04	10.39	16.16	3.08	49.79	2.56	0.05	0.60
8.19	8.74	13.51	3.69	49.80	2.66	0.05	1.77
8.34	7.41	11.34	4.35	49.35	2.75	0.05	1.46
8.49	6.63	10.08	4.72	47.58	2.79	0.05	1.27
8.65	5.62	8.45	5.50	46.49	2.88	0.05	1.04
8.80	4.37	6.42	7.11	45.69	3.03	0.05	0.78
8.95	3.14	4.44	10.05	44.65	3.26	0.06	0.53
9.11	3.06	4.30	10.56	45.42	3.29	0.06	0.50
9.26	4.51	6.62	7.23	47.84	3.04	0.05	0.76
9.41	6.83	10.33	4.70	48.59	2.79	0.05	1.16
9.56	8.50	13.00	3.69	48.01	2.66	0.05	1.43

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
9.71	8.58	13.13	3.67	48.19	2.65	0.05	1.42
9.87	6.99	10.56	4.66	49.25	2.79	0.05	1.12
10.11	5.35	7.90	6.45	50.91	2.97	0.05	0.82
10.26	4.87	7.13	7.32	52.19	3.05	0.05	0.74
10.40	6.13	9.13	5.82	53.18	2.91	0.05	0.94
10.55	7.22	10.87	4.97	54.03	2.82	0.06	1.11
10.69	7.10	10.68	5.38	57.43	2.87	0.06	1.08
10.84	6.27	9.32	6.81	63.54	3.01	0.06	0.94
10.99	6.22	9.23	7.68	70.94	3.08	0.06	0.92
11.14	7.00	10.48	7.40	77.52	3.06	0.06	1.04
11.29	7.03	10.51	7.74	81.30	3.08	0.06	1.04
11.45	6.64	9.86	8.22	81.10	3.12	0.06	0.97
11.60	5.75	8.42	9.25	77.82	3.20	0.06	0.82
11.74	5.47	7.96	9.43	75.02	3.21	0.06	0.77
11.89	5.50	7.99	9.23	73.75	3.20	0.06	0.77
12.04	5.36	7.75	9.53	73.89	3.22	0.06	0.74
12.19	5.33	7.70	9.61	73.95	3.23	0.06	0.73
12.34	5.19	7.46	9.88	73.75	3.24	0.06	0.70
12.48	5.64	8.17	9.38	76.64	3.21	0.06	0.76
12.64	6.39	9.37	8.68	81.34	3.16	0.06	0.87
12.79	8.54	12.81	6.94	88.90	3.02	0.06	1.18
12.94	9.27	13.96	6.73	93.99	3.00	0.07	1.28
13.09	8.26	12.33	7.84	96.70	3.09	0.06	1.12
13.15	5.99	8.68	10.60	92.03	3.29	0.06	0.79
13.31	4.60	6.43	12.90	82.93	3.43	0.07	0.58
13.46	4.74	6.65	11.67	77.58	3.36	0.06	0.59
13.61	4.69	6.55	11.28	73.89	3.34	0.06	0.58
13.77	4.89	6.86	10.86	74.43	3.31	0.06	0.61
13.91	5.23	7.39	10.43	77.02	3.28	0.06	0.65
14.07	5.73	8.19	9.83	80.44	3.24	0.06	0.71
14.21	6.54	9.47	8.79	83.24	3.17	0.06	0.82
14.36	7.02	10.23	8.97	91.75	3.18	0.06	0.88
14.51	7.97	11.74	9.74	114.33	3.23	0.07	1.00
14.65	22.67	35.34	4.11	145.13	2.71	0.05	3.00
14.80	41.44	65.48	2.52	164.89	2.45	0.11	0.77
14.95	50.43	79.91	2.19	175.17	2.37	0.13	0.80
15.10	43.93	69.46	2.42	167.92	2.43	0.09	0.78
15.26	28.70	44.98	3.51	157.75	2.63	0.09	3.68
15.41	18.23	28.14	5.54	155.91	2.88	0.07	2.29
15.53	29.45	46.15	3.48	160.56	2.62	0.04	3.73
15.69	36.02	56.70	3.14	178.23	2.57	0.14	0.75
15.85	50.29	77.74	2.38	185.14	2.42	0.09	0.79
15.98	40.37	63.65	2.99	190.36	2.54	0.11	0.77
16.14	35.20	55.33	3.22	177.93	2.58	0.09	0.75
16.29	23.17	35.98	4.42	158.94	2.76	0.07	2.79
16.50	15.48	23.62	5.92	139.93	2.92	0.06	1.81
16.65	12.52	18.85	6.55	123.45	2.98	0.07	1.44
16.80	12.85	19.37	6.01	116.42	2.93	0.06	1.47

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
16.94	14.10	21.36	5.40	115.40	2.87	0.06	1.61
17.09	15.24	23.18	4.93	114.22	2.82	0.07	1.73
17.23	16.18	24.68	4.51	111.26	2.77	0.06	1.84
17.38	15.07	22.87	4.72	108.01	2.79	0.06	1.69
17.53	14.26	21.50	4.78	102.82	2.80	0.06	1.58
17.69	18.42	27.01	3.51	94.70	2.63	0.06	2.06
17.83	21.07	30.58	3.20	97.77	2.58	0.07	0.67
17.98	21.69	31.69	3.55	112.38	2.63	0.07	2.41
18.12	30.96	44.29	2.76	122.34	2.50	0.05	0.72
18.28	37.11	52.54	2.54	133.70	2.45	0.11	0.74
18.41	39.42	55.57	2.54	141.03	2.45	0.09	0.75
18.57	40.31	56.37	2.48	139.85	2.44	0.06	0.75
18.72	64.70	86.00	1.57	135.38	2.16	0.11	0.81
18.87	81.35	105.69	1.37	145.25	2.05	0.23	0.84
19.02	81.26	105.65	1.42	150.03	2.08	0.13	0.84
19.17	57.07	76.20	1.88	143.29	2.28	0.11	0.79
19.31	48.97	65.27	1.98	128.91	2.31	0.08	0.77
19.46	50.73	66.47	1.76	117.19	2.24	0.09	0.77
19.60	80.65	102.37	1.36	139.61	2.05	0.11	0.83
19.80	99.68	125.61	1.33	167.62	2.03	0.31	0.86
19.95	107.70	135.84	1.38	187.27	2.05	0.20	0.87
20.10	92.44	117.67	1.54	181.75	2.15	0.15	0.85
20.23	89.74	113.31	1.50	170.22	2.13	0.15	0.84
20.39	99.74	123.35	1.33	164.05	2.02	0.17	0.86
20.53	110.05	134.12	1.24	166.50	1.95	0.23	0.87
20.68	113.49	138.00	1.25	173.10	1.96	0.22	0.87
20.83	109.27	133.52	1.33	178.09	2.02	0.20	0.87
20.98	107.63	132.08	1.43	188.31	2.08	0.19	0.87
21.13	127.05	154.63	1.37	212.05	2.05	0.21	0.89
21.26	263.50	304.27	1.03	314.38	1.69	0.66	1.00
21.41	359.49	405.93	1.00	405.93	1.56	1.05	1.05
21.56	423.17	470.02	1.00	470.02	1.46	1.07	1.07
21.71	380.29	423.15	1.00	423.15	1.50	1.05	1.05
21.86	372.45	412.78	1.00	412.78	1.50	1.05	1.05
22.00	360.71	400.48	1.00	400.48	1.53	1.04	1.04
22.14	312.43	350.79	1.00	351.03	1.65	1.02	1.02
22.29	247.34	281.91	1.11	312.12	1.80	0.98	0.98
22.44	199.62	229.72	1.21	277.25	1.92	0.95	0.95
22.59	196.27	224.06	1.18	263.96	1.89	0.95	0.95
22.73	229.96	257.70	1.08	277.72	1.76	0.97	0.97
22.89	274.50	302.88	1.01	304.56	1.65	1.00	1.00
23.07	301.15	329.88	1.00	329.88	1.62	1.01	1.01
23.21	320.78	349.45	1.00	349.45	1.60	1.02	1.02
23.35	325.82	352.50	1.00	352.50	1.57	1.02	1.02
23.50	329.26	352.99	1.00	352.99	1.51	1.02	1.02
23.65	327.60	348.29	1.00	348.29	1.46	1.02	1.02
23.79	325.25	344.53	1.00	344.53	1.45	1.02	1.02
23.93	311.62	329.66	1.00	329.66	1.46	1.01	1.01

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
24.08	297.13	313.18	1.00	313.18	1.45	1.00	1.00
24.23	285.65	299.62	1.00	299.62	1.43	0.99	0.99
24.32	296.10	309.55	1.00	309.55	1.41	1.00	1.00
24.54	301.07	315.61	1.00	315.61	1.48	1.00	1.00
24.69	294.41	311.12	1.00	311.12	1.61	1.00	1.00
24.81	271.53	285.29	1.00	285.29	1.58	0.99	0.99
24.96	263.98	273.25	1.00	273.25	1.43	0.98	0.98
25.09	342.77	401.49	1.00	401.49	-1.00	1.04	1.04
25.24	429.38	502.23	1.00	502.23	-1.00	1.08	1.08
25.40	631.64	737.71	1.00	737.71	-1.00	1.16	1.16

Abbreviations

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

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Columbia, SC
(803) 254-4540

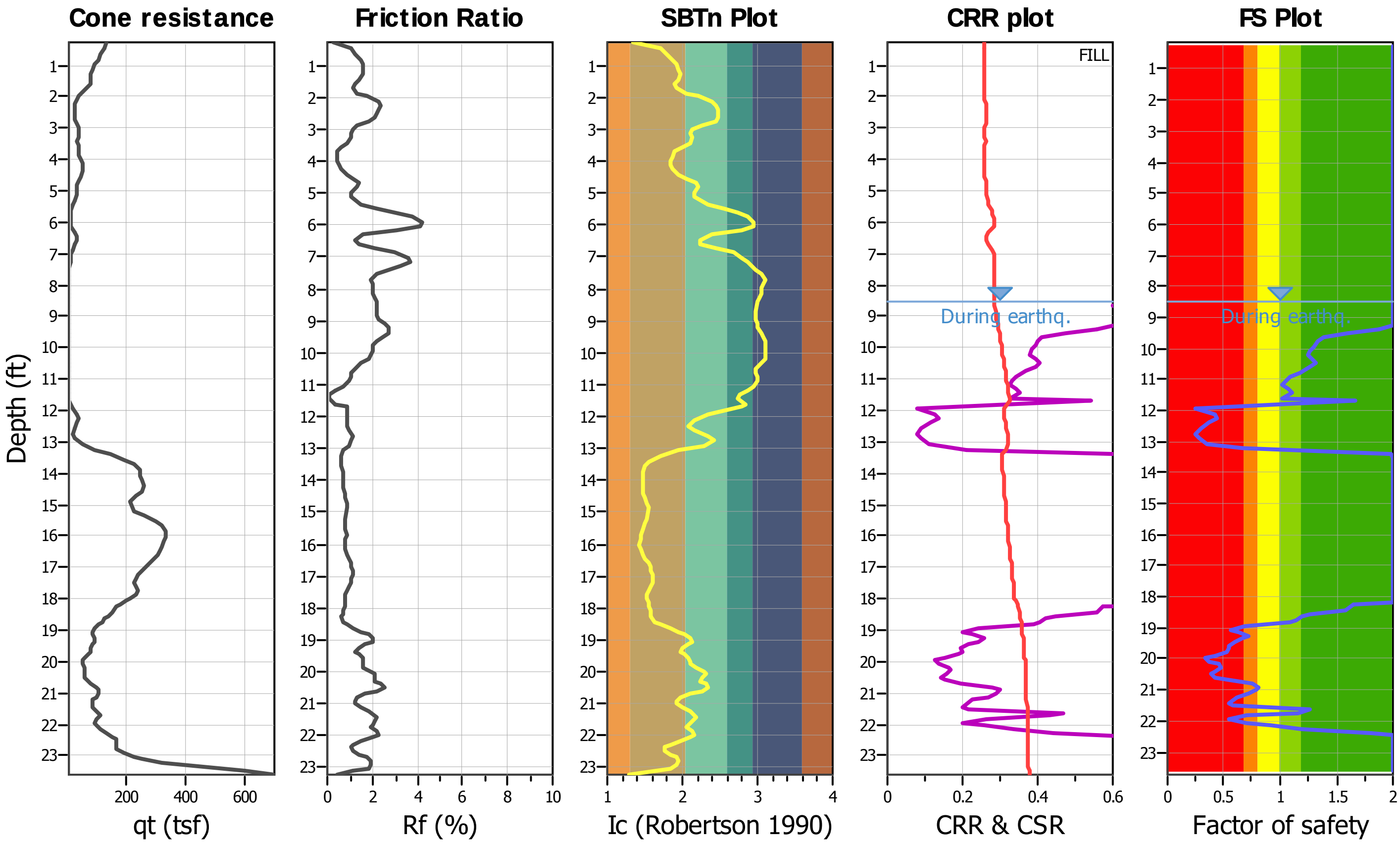
LIQUEFACTION ANALYSIS REPORT

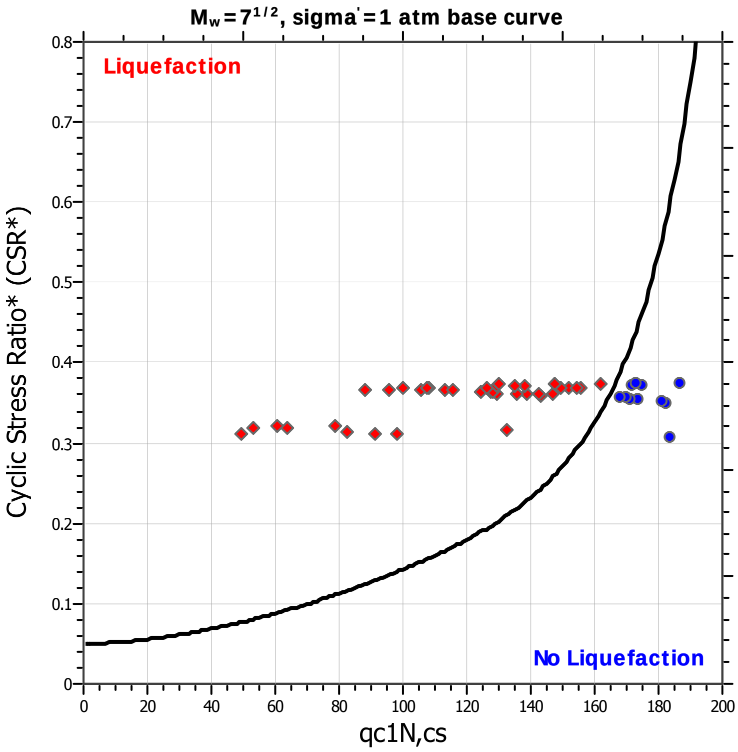
Project title : **Location :**

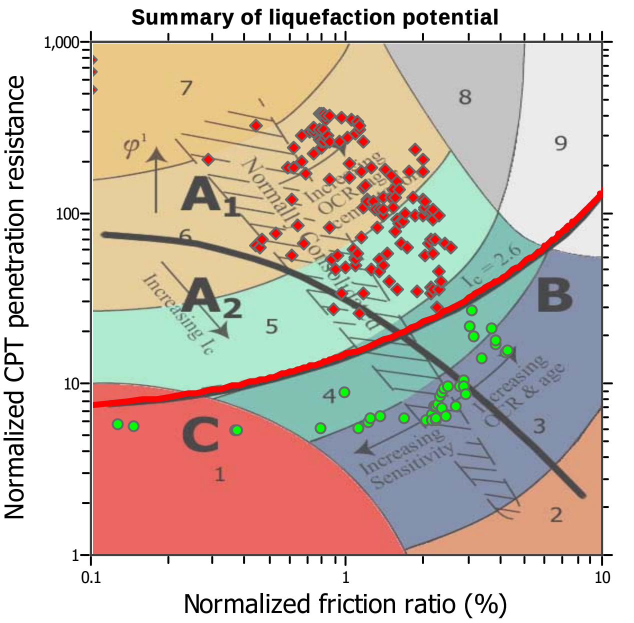
CPT file : CPT3

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.50 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.50 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

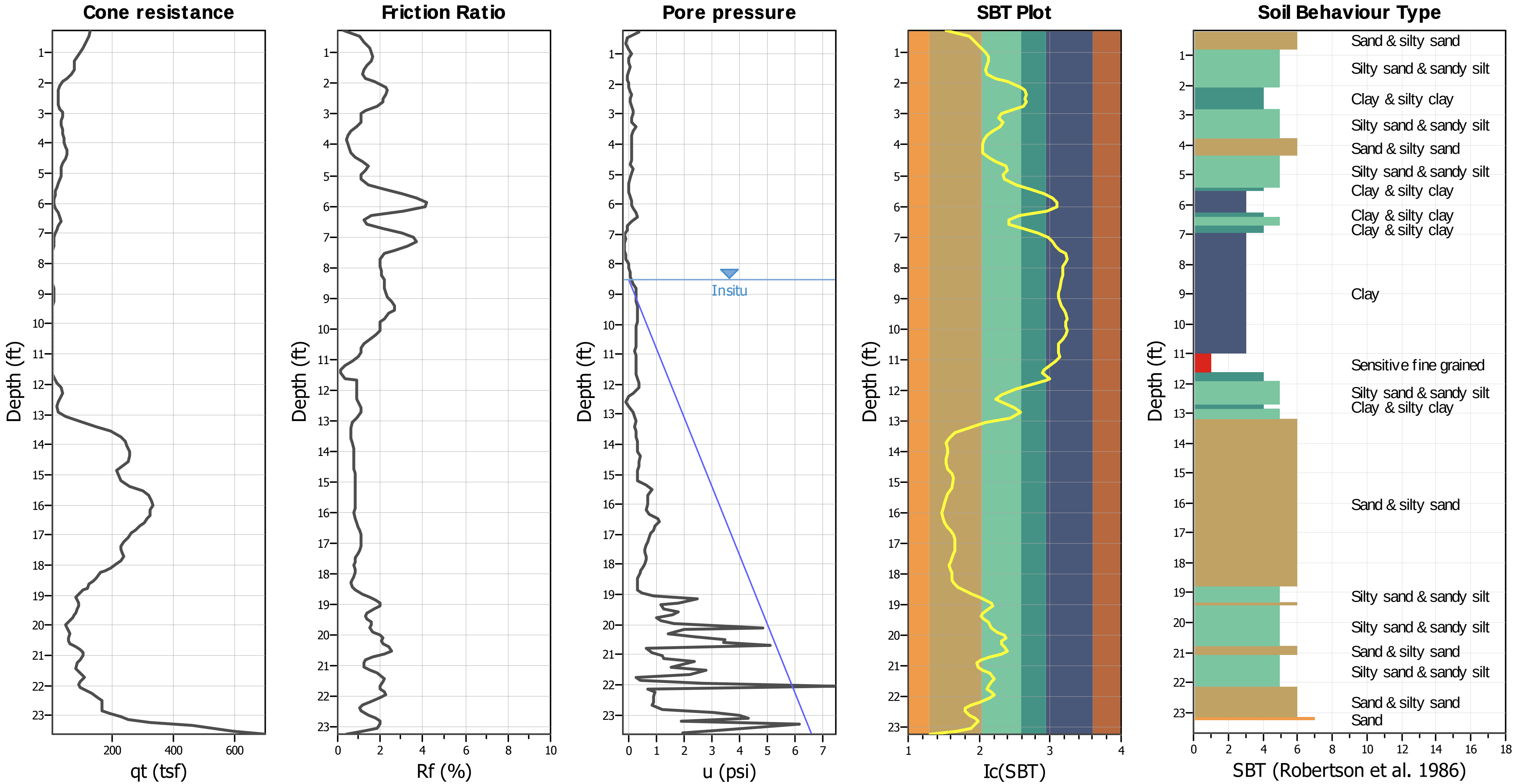






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



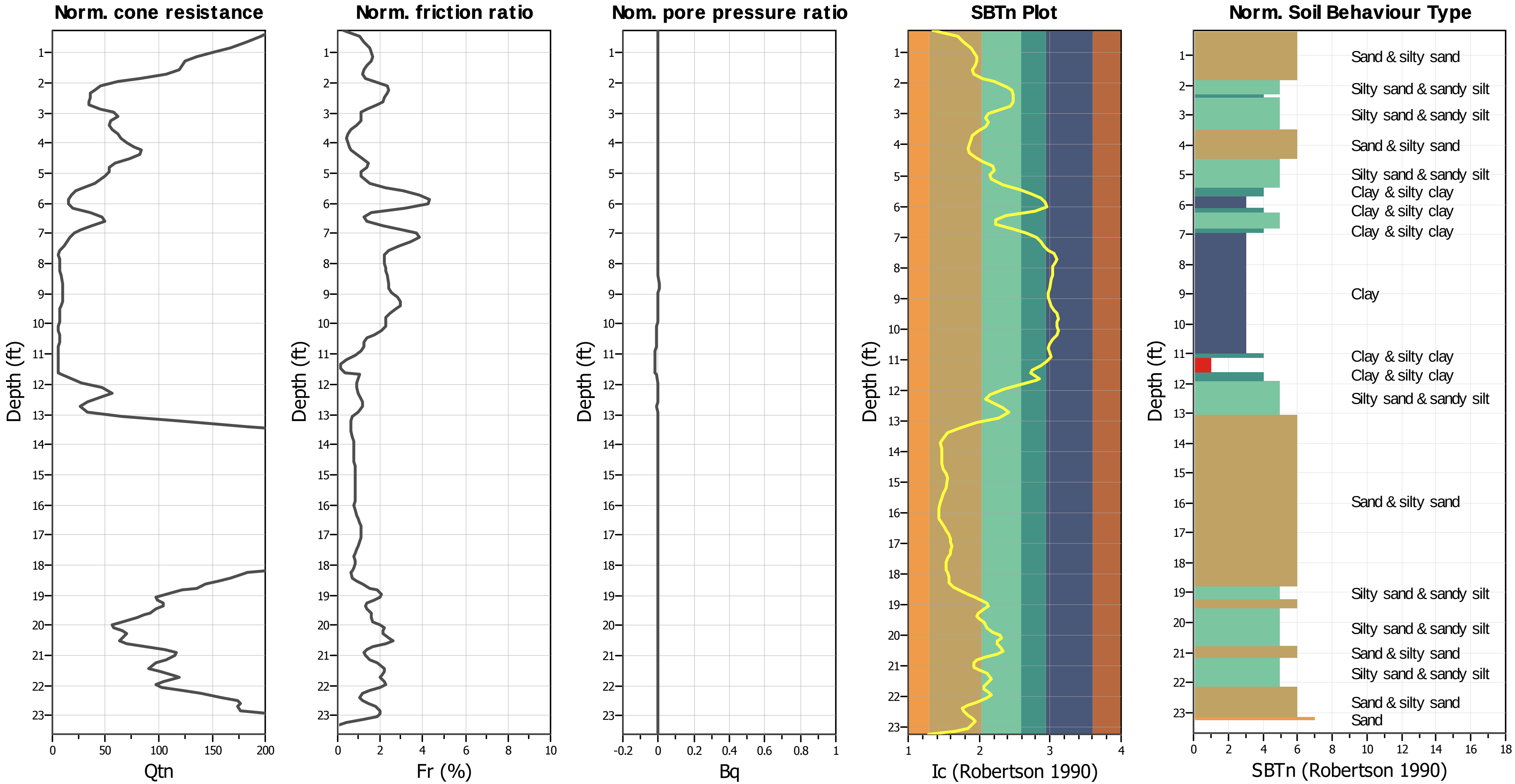
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	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)



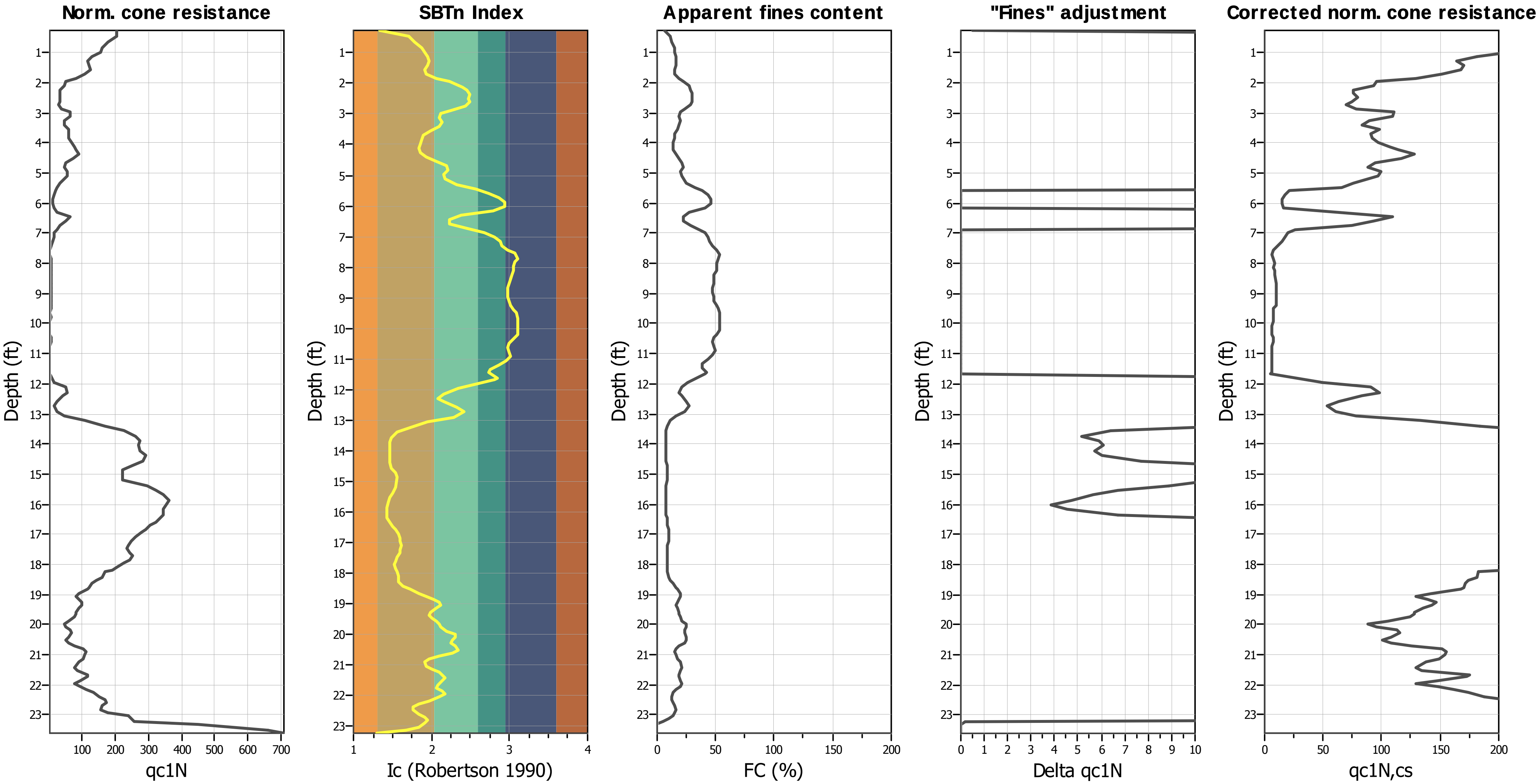
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft³
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

SBTn legend

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

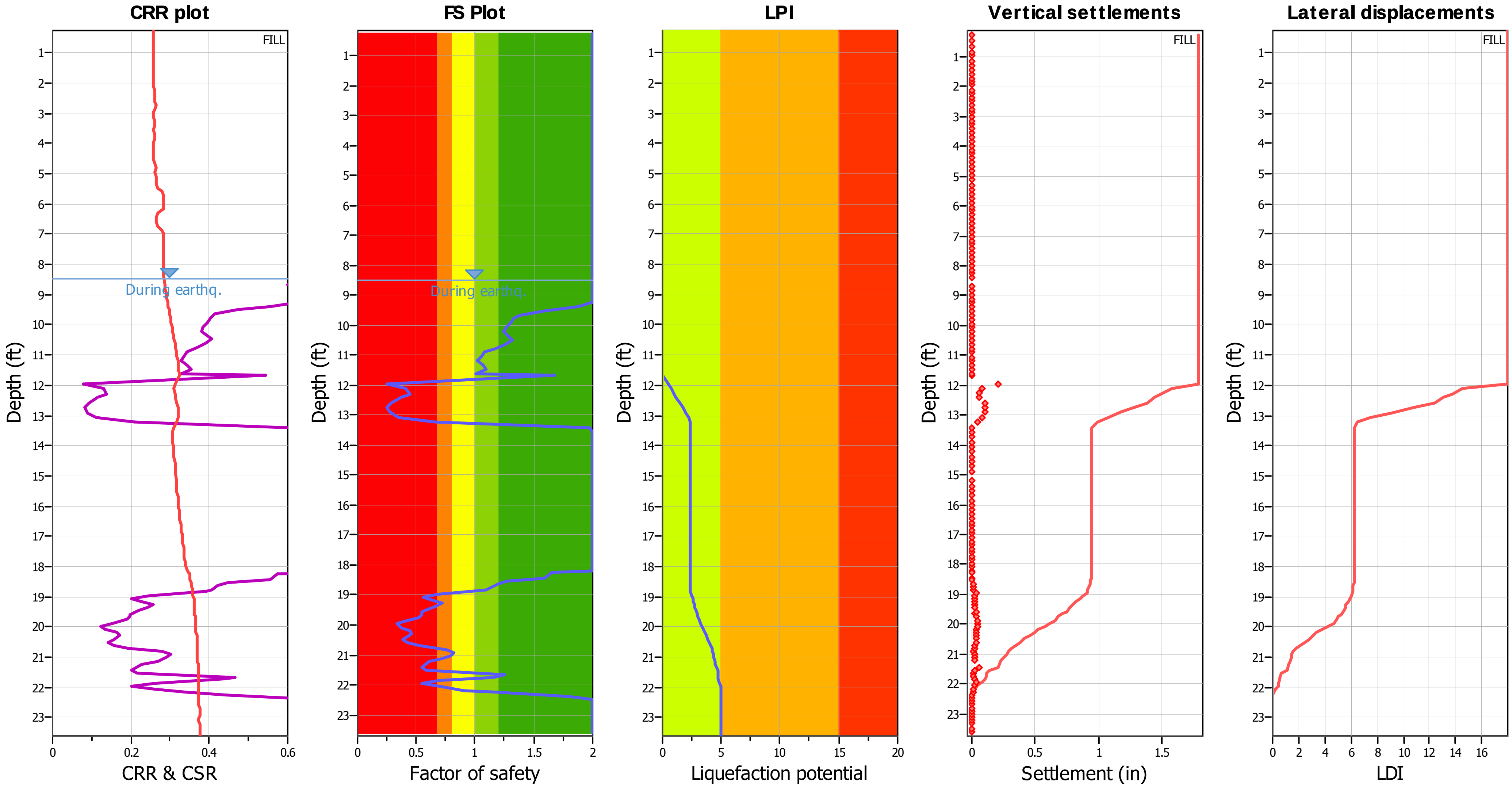
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

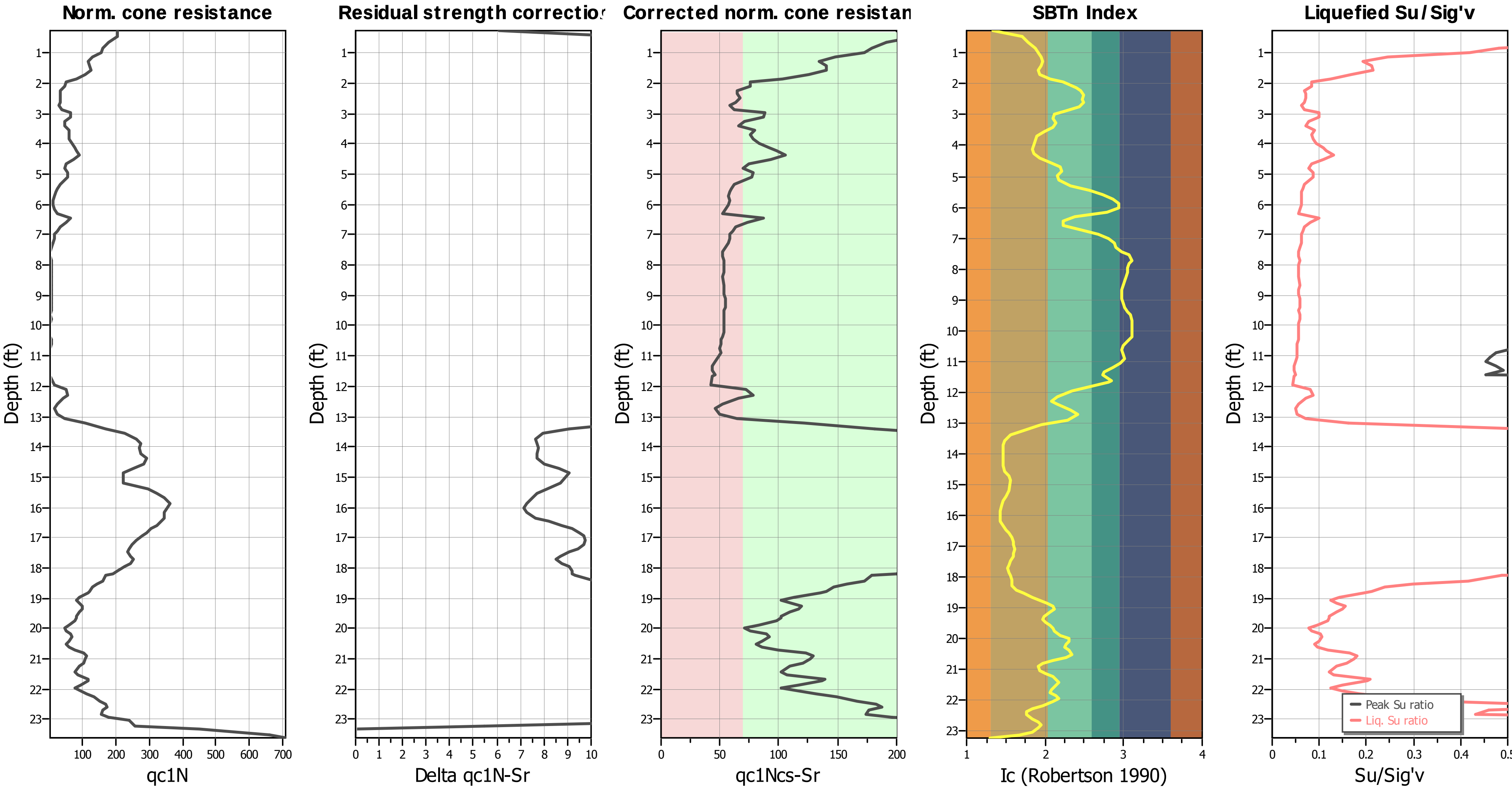
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.27	129.12	0.00	0.39	0.84	114.90
2	0.46	127.95	1.12	-0.06	6.24	123.73
3	0.66	110.91	1.57	-0.08	7.86	124.38
4	0.85	102.09	1.58	0.02	9.77	124.85
5	0.97	98.23	1.54	0.12	10.88	124.30
6	1.14	82.03	1.37	-0.01	11.83	123.37
7	1.28	73.04	1.19	-0.01	12.13	122.18
8	1.43	77.16	1.03	0.05	11.46	121.25
9	1.57	77.83	0.96	0.00	10.58	120.00
10	1.71	68.09	0.71	-0.03	11.16	118.55
11	1.86	52.98	0.63	-0.03	14.43	117.04
12	1.95	33.08	0.70	0.00	19.71	116.23
13	2.11	30.31	0.68	0.03	26.59	115.30
14	2.24	22.08	0.58	0.05	28.88	114.14
15	2.36	21.91	0.49	0.13	30.01	113.01
16	2.48	23.42	0.48	0.06	29.43	112.42
17	2.62	21.24	0.46	0.07	29.88	111.88
18	2.75	19.14	0.41	0.09	28.19	111.09
19	2.87	24.35	0.33	0.18	20.98	111.38
20	3.00	42.15	0.40	0.16	16.55	112.29
21	3.14	42.06	0.46	0.14	15.61	112.65
22	3.27	31.40	0.37	0.13	17.04	111.60
23	3.42	29.13	0.28	0.29	15.67	109.64
24	3.55	38.87	0.21	0.17	12.70	107.73
25	3.69	38.20	0.16	0.10	5.00	106.58
26	3.85	39.38	0.17	0.10	5.00	106.55
27	3.97	42.90	0.20	0.09	5.00	107.84
28	4.12	48.61	0.24	0.10	9.16	109.64
29	4.25	51.88	0.32	0.12	9.43	111.91
30	4.40	56.08	0.45	0.10	11.27	113.89
31	4.53	46.68	0.56	0.11	14.56	114.79
32	4.68	33.33	0.55	0.05	18.65	114.27
33	4.82	29.80	0.45	0.16	19.20	112.80
34	4.96	36.27	0.32	0.11	17.26	111.44
35	5.10	34.93	0.32	0.05	18.02	110.70
36	5.33	22.92	0.36	0.01	23.69	110.76
37	5.47	17.21	0.41	0.00	33.45	110.51
38	5.60	13.43	0.41	0.01	42.21	110.24
39	5.75	10.83	0.42	0.05	49.77	109.88
40	5.89	9.65	0.43	0.13	54.62	109.50
41	6.03	9.40	0.40	0.12	54.75	109.10
42	6.15	10.16	0.36	0.19	45.65	108.90
43	6.30	16.04	0.32	0.29	25.88	110.05
44	6.44	40.80	0.34	0.30	20.08	111.21
45	6.58	31.74	0.43	0.11	20.22	112.51
46	6.73	21.58	0.51	-0.06	28.82	112.71
47	6.87	16.29	0.52	-0.05	38.95	112.14
48	7.00	12.26	0.48	-0.14	46.06	111.13

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	7.15	11.17	0.42	-0.11	50.55	109.51
50	7.28	9.49	0.31	-0.14	52.54	106.84
51	7.43	6.88	0.16	-0.15	56.72	102.68
52	7.55	4.28	0.09	-0.14	62.93	97.79
53	7.71	3.53	0.07	-0.10	65.75	95.66
54	7.84	4.95	0.09	-0.08	63.86	96.32
55	7.98	5.12	0.10	0.00	61.28	97.35
56	8.13	4.87	0.11	0.03	61.32	97.61
57	8.26	5.12	0.10	0.05	61.10	97.87
58	8.41	5.37	0.11	0.07	59.02	99.07
59	8.68	6.38	0.15	0.19	57.44	99.94
60	8.83	6.38	0.14	0.27	56.36	100.44
61	8.96	6.21	0.14	0.28	56.76	100.81
62	9.11	6.55	0.17	0.27	58.04	101.67
63	9.23	6.63	0.19	0.26	58.94	102.05
64	9.38	6.21	0.16	0.33	61.95	101.01
65	9.51	4.62	0.12	0.35	64.47	98.90
66	9.66	4.37	0.09	0.31	66.49	96.95
67	9.79	4.53	0.09	0.31	65.68	96.09
68	9.93	4.37	0.09	0.30	65.91	96.00
69	10.07	4.28	0.09	0.28	66.47	95.74
70	10.21	4.28	0.08	0.29	65.54	95.11
71	10.35	4.28	0.07	0.28	61.43	94.07
72	10.48	4.79	0.05	0.29	57.57	92.81
73	10.63	4.70	0.05	0.27	57.03	91.79
74	10.77	3.95	0.05	0.26	58.51	91.15
75	10.91	4.11	0.04	0.24	59.22	89.76
76	11.06	3.95	0.03	0.25	55.84	87.36
77	11.18	3.78	0.01	0.26	49.58	87.36
78	11.33	3.95	0.00	0.28	43.35	87.36
79	11.46	4.45	0.00	0.29	42.01	87.36
80	11.61	4.20	0.01	0.29	49.06	87.36
81	11.67	3.19	0.02	0.29	46.00	93.52
82	11.94	11.08	0.13	0.40	24.37	103.47
83	12.13	38.45	0.30	0.39	17.49	109.35
84	12.28	44.33	0.41	0.15	15.45	111.53
85	12.40	33.08	0.35	0.01	17.82	110.29
86	12.59	19.65	0.19	-0.10	23.69	107.55
87	12.74	13.18	0.20	0.02	27.05	104.89
88	12.91	18.47	0.17	0.15	21.94	106.37
89	13.07	35.93	0.26	0.21	11.78	111.30
90	13.23	88.49	0.53	0.26	6.47	116.82
91	13.41	146.84	0.85	0.23	3.75	121.28
92	13.56	200.82	1.19	0.26	2.65	124.45
93	13.73	234.91	1.56	0.29	2.31	126.53
94	13.90	247.76	1.78	0.32	2.41	127.73
95	14.06	244.40	1.89	0.35	2.46	128.14
96	14.23	250.36	1.82	0.34	2.37	128.38

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	14.39	267.48	1.92	0.43	2.37	128.64
98	14.57	257.41	2.06	0.40	2.69	128.75
99	14.72	230.96	1.95	0.36	3.36	128.41
100	14.88	204.18	1.82	0.34	3.76	127.70
101	15.19	203.76	1.67	0.31	3.39	128.11
102	15.37	272.94	2.14	0.64	2.81	129.26
103	15.52	299.22	2.50	0.83	2.41	130.78
104	15.69	319.29	2.77	0.68	2.19	131.48
105	15.86	337.92	2.70	0.70	1.98	131.57
106	16.01	328.60	2.52	0.67	1.84	131.37
107	16.18	324.24	2.55	0.62	1.98	131.36
108	16.34	322.81	2.73	0.74	2.36	131.78
109	16.47	316.01	3.02	1.06	2.90	132.30
110	16.59	303.17	3.21	1.10	3.46	132.58
111	16.71	289.06	3.19	0.97	3.92	132.51
112	16.84	275.29	3.07	0.92	4.22	132.17
113	16.96	262.36	2.94	0.79	4.43	131.67
114	17.09	248.68	2.72	0.76	4.50	130.94
115	17.23	236.50	2.39	0.70	4.41	130.03
116	17.35	226.43	2.10	0.64	4.16	129.07
117	17.47	223.41	1.91	0.59	3.77	128.39
118	17.59	233.31	1.83	0.58	3.39	128.10
119	17.72	240.37	1.85	0.66	3.19	128.01
120	17.84	233.40	1.81	0.63	3.49	128.02
121	17.96	214.51	1.88	0.58	3.76	127.24
122	18.08	193.10	1.41	0.53	3.88	125.89
123	18.21	178.74	1.08	0.43	3.89	124.05
124	18.27	157.17	1.03	0.42	4.03	122.77
125	18.45	151.21	0.92	0.34	4.97	122.59
126	18.54	135.93	1.10	0.33	6.52	123.41
127	18.65	123.50	1.48	0.32	8.99	124.80
128	18.75	115.19	1.79	0.31	11.35	125.95
129	18.84	108.98	1.97	0.32	13.71	126.17
130	18.95	86.39	1.85	0.47	15.84	125.59
131	19.05	74.97	1.61	0.88	16.63	124.56
132	19.15	84.21	1.42	2.46	14.87	123.66
133	19.27	94.45	1.24	1.79	12.78	122.89
134	19.36	92.02	1.10	1.18	12.14	122.27
135	19.46	84.54	1.11	1.25	13.33	122.16
136	19.57	76.32	1.26	1.78	14.91	122.39
137	19.66	75.81	1.29	1.56	15.63	122.04
138	19.76	72.29	1.00	0.98	16.29	120.93
139	19.88	56.59	0.86	1.15	18.64	119.53
140	19.97	41.89	0.91	1.64	22.42	119.42
141	20.09	47.02	1.11	4.81	22.91	120.27
142	20.18	60.87	1.18	1.98	21.05	121.33
143	20.29	63.22	1.24	1.44	20.68	122.02
144	20.40	56.75	1.39	2.34	22.65	122.32

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	20.50	50.46	1.42	3.45	23.79	122.42
146	20.61	57.17	1.35	3.41	21.04	122.43
147	20.70	75.39	1.25	5.09	15.75	122.68
148	20.81	101.42	1.23	0.62	12.29	123.05
149	20.91	108.56	1.29	0.83	10.78	123.34
150	21.02	106.20	1.27	1.20	11.23	123.60
151	21.13	98.31	1.38	1.26	13.17	124.10
152	21.22	85.38	1.68	2.37	15.91	124.56
153	21.44	76.65	1.72	1.52	18.13	125.14
154	21.53	82.11	1.89	2.79	16.86	126.20
155	21.65	116.53	2.26	2.18	15.17	127.05
156	21.74	114.94	2.16	0.26	14.74	127.23
157	21.84	92.69	1.98	0.44	16.78	126.68
158	21.96	77.74	2.05	2.70	17.94	126.23
159	22.06	93.70	1.94	7.40	16.05	126.00
160	22.17	112.42	1.65	0.66	12.11	125.56
161	22.26	131.48	1.43	0.93	9.07	125.19
162	22.38	151.29	1.45	0.90	7.40	125.56
163	22.48	168.50	1.68	0.91	7.56	127.24
164	22.60	172.87	2.44	0.88	8.95	129.03
165	22.69	160.19	2.96	0.84	10.72	130.38
166	22.81	157.33	3.17	1.21	11.62	131.42
167	22.90	181.01	3.70	3.02	10.59	132.90
168	23.02	242.89	4.55	3.99	9.17	133.92
169	23.11	252.71	4.22	4.32	5.47	131.60
170	23.22	258.42	0.00	1.89	0.31	126.85
171	23.33	452.10	0.00	6.14	N/A	87.36
172	23.50	667.79	0.00	3.42	N/A	87.36
173	23.60	714.80	0.00	1.96	N/A	87.36

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.27	0.14	0.00	0.14	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
2	2.46	0.15	0.00	0.15	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
3	2.65	0.16	0.00	0.16	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
4	2.85	0.18	0.00	0.18	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
5	2.98	0.18	0.00	0.18	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
6	3.13	0.19	0.00	0.19	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
7	3.28	0.20	0.00	0.20	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
8	3.43	0.21	0.00	0.21	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
9	3.57	0.22	0.00	0.22	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
10	3.71	0.23	0.00	0.23	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
11	3.86	0.24	0.00	0.24	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
12	3.95	0.24	0.00	0.24	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
13	4.11	0.25	0.00	0.25	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
14	4.24	0.26	0.00	0.26	1.00	0.272	1.05	0.258	1.09	1.10	2.000	No
15	4.36	0.27	0.00	0.27	1.00	0.272	1.05	0.258	1.09	1.10	2.000	No
16	4.48	0.27	0.00	0.27	1.00	0.272	1.05	0.258	1.09	1.10	2.000	No
17	4.62	0.28	0.00	0.28	0.99	0.272	1.05	0.258	1.08	1.10	2.000	No
18	4.75	0.29	0.00	0.29	0.99	0.271	1.05	0.257	1.08	1.10	2.000	No
19	4.87	0.29	0.00	0.29	0.99	0.271	1.05	0.257	1.08	1.10	2.000	No
20	5.00	0.30	0.00	0.30	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
21	5.14	0.31	0.00	0.31	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
22	5.27	0.32	0.00	0.32	0.99	0.271	1.05	0.257	1.09	1.10	2.000	No
23	5.42	0.33	0.00	0.33	0.99	0.271	1.05	0.257	1.08	1.10	2.000	No
24	5.55	0.33	0.00	0.33	0.99	0.271	1.05	0.257	1.09	1.10	2.000	No
25	5.69	0.34	0.00	0.34	0.99	0.271	1.05	0.257	1.09	1.10	2.000	No
26	5.84	0.35	0.00	0.35	0.99	0.271	1.05	0.257	1.09	1.10	2.000	No
27	5.97	0.35	0.00	0.35	0.99	0.271	1.05	0.257	1.09	1.10	2.000	No
28	6.12	0.36	0.00	0.36	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
29	6.25	0.37	0.00	0.37	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
30	6.40	0.38	0.00	0.38	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
31	6.53	0.39	0.00	0.39	0.99	0.270	1.05	0.256	1.09	1.10	2.000	No
32	6.68	0.40	0.00	0.40	0.99	0.270	1.05	0.256	1.07	1.10	2.000	No
33	6.82	0.40	0.00	0.40	0.99	0.270	1.05	0.256	1.07	1.10	2.000	No
34	6.96	0.41	0.00	0.41	0.99	0.270	1.05	0.256	1.07	1.10	2.000	No
35	7.10	0.42	0.00	0.42	0.99	0.270	1.05	0.256	1.07	1.10	2.000	No
36	7.33	0.43	0.00	0.43	0.99	0.269	1.05	0.256	1.06	1.10	2.000	No
37	7.47	0.44	0.00	0.44	0.99	0.269	1.05	0.255	1.05	1.10	2.000	No
38	7.60	0.45	0.00	0.45	0.99	0.269	1.05	0.255	1.05	1.10	2.000	No
39	7.75	0.45	0.00	0.45	0.99	0.269	1.05	0.255	1.04	1.10	2.000	No
40	7.89	0.46	0.00	0.46	0.99	0.269	1.05	0.255	1.04	1.10	2.000	No
41	8.03	0.47	0.00	0.47	0.98	0.269	1.05	0.255	1.04	1.10	2.000	No
42	8.15	0.48	0.00	0.48	0.98	0.269	1.05	0.255	1.04	1.10	2.000	No
43	8.30	0.48	0.00	0.48	0.98	0.269	1.05	0.255	1.04	1.10	2.000	No
44	8.44	0.49	0.00	0.49	0.98	0.268	1.05	0.255	1.06	1.10	2.000	No
45	8.58	0.50	0.00	0.50	0.98	0.268	1.05	0.255	1.05	1.10	2.000	No
46	8.73	0.51	0.00	0.51	0.98	0.268	1.05	0.254	1.05	1.10	2.000	No
47	8.87	0.52	0.00	0.52	0.98	0.268	1.05	0.254	1.04	1.10	2.000	No
48	9.00	0.52	0.00	0.52	0.98	0.268	1.05	0.254	1.04	1.10	2.000	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	9.15	0.53	0.00	0.53	0.98	0.268	1.05	0.254	1.04	1.10	2.000	No
50	9.28	0.54	0.00	0.54	0.98	0.268	1.05	0.254	1.03	1.10	2.000	No
51	9.43	0.55	0.00	0.55	0.98	0.268	1.05	0.254	1.03	1.10	2.000	No
52	9.55	0.55	0.00	0.55	0.98	0.267	1.05	0.254	1.03	1.10	2.000	No
53	9.71	0.56	0.00	0.56	0.98	0.267	1.05	0.254	1.03	1.10	2.000	No
54	9.84	0.57	0.00	0.57	0.98	0.267	1.05	0.253	1.03	1.10	2.000	No
55	9.98	0.57	0.00	0.57	0.98	0.267	1.05	0.253	1.03	1.10	2.000	No
56	10.13	0.58	0.00	0.58	0.98	0.267	1.05	0.253	1.03	1.10	2.000	No
57	10.26	0.59	0.00	0.59	0.98	0.267	1.05	0.253	1.03	1.10	2.000	No
58	10.41	0.59	0.00	0.59	0.98	0.267	1.05	0.253	1.03	1.10	2.000	No
59	10.68	0.61	0.01	0.60	0.98	0.269	1.05	0.255	1.03	1.10	0.286	No
60	10.83	0.62	0.01	0.60	0.98	0.271	1.05	0.257	1.03	1.10	0.288	No
61	10.96	0.62	0.01	0.61	0.98	0.272	1.05	0.258	1.03	1.10	0.290	No
62	11.11	0.63	0.02	0.61	0.97	0.274	1.05	0.260	1.03	1.10	0.292	No
63	11.23	0.64	0.02	0.61	0.97	0.276	1.05	0.262	1.02	1.10	0.294	No
64	11.38	0.64	0.03	0.62	0.97	0.278	1.05	0.263	1.02	1.10	0.296	No
65	11.51	0.65	0.03	0.62	0.97	0.279	1.05	0.265	1.02	1.10	0.298	No
66	11.66	0.66	0.04	0.62	0.97	0.281	1.05	0.266	1.02	1.10	0.300	No
67	11.79	0.66	0.04	0.62	0.97	0.283	1.05	0.268	1.02	1.10	0.301	No
68	11.93	0.67	0.04	0.63	0.97	0.284	1.05	0.270	1.02	1.10	0.303	No
69	12.07	0.68	0.05	0.63	0.97	0.286	1.05	0.271	1.02	1.10	0.305	No
70	12.21	0.68	0.05	0.63	0.97	0.287	1.05	0.273	1.02	1.10	0.307	No
71	12.35	0.69	0.06	0.63	0.97	0.289	1.05	0.274	1.02	1.10	0.309	No
72	12.48	0.70	0.06	0.63	0.97	0.291	1.05	0.276	1.02	1.10	0.310	No
73	12.63	0.70	0.07	0.64	0.97	0.292	1.05	0.277	1.02	1.10	0.312	No
74	12.77	0.71	0.07	0.64	0.97	0.294	1.05	0.279	1.02	1.10	0.314	No
75	12.91	0.72	0.08	0.64	0.97	0.295	1.05	0.280	1.02	1.10	0.315	No
76	13.06	0.72	0.08	0.64	0.97	0.297	1.05	0.282	1.02	1.10	0.317	No
77	13.18	0.73	0.08	0.64	0.97	0.298	1.05	0.283	1.02	1.10	0.319	No
78	13.33	0.73	0.09	0.65	0.97	0.300	1.05	0.285	1.02	1.10	0.321	No
79	13.46	0.74	0.09	0.65	0.97	0.301	1.05	0.286	1.02	1.10	0.322	No
80	13.61	0.75	0.10	0.65	0.97	0.303	1.05	0.287	1.02	1.10	0.324	No
81	13.67	0.75	0.10	0.65	0.97	0.304	1.05	0.288	1.02	1.10	0.325	No
82	13.94	0.76	0.11	0.66	0.96	0.306	1.05	0.291	1.02	1.10	0.312	No
83	14.13	0.77	0.11	0.66	0.96	0.308	1.05	0.292	1.03	1.10	0.311	No
84	14.28	0.78	0.12	0.66	0.96	0.310	1.05	0.294	1.04	1.10	0.312	No
85	14.40	0.79	0.12	0.67	0.96	0.311	1.05	0.295	1.03	1.10	0.314	No
86	14.59	0.80	0.13	0.67	0.96	0.313	1.05	0.296	1.03	1.10	0.318	No
87	14.74	0.81	0.13	0.67	0.96	0.314	1.05	0.298	1.02	1.10	0.320	No
88	14.91	0.82	0.14	0.68	0.96	0.316	1.05	0.299	1.03	1.10	0.321	No
89	15.07	0.82	0.14	0.68	0.96	0.317	1.05	0.301	1.03	1.10	0.321	No
90	15.23	0.83	0.15	0.69	0.96	0.318	1.05	0.302	1.05	1.10	0.316	No
91	15.41	0.84	0.15	0.69	0.96	0.320	1.05	0.303	1.08	1.10	0.308	No
92	15.56	0.85	0.16	0.70	0.96	0.321	1.05	0.304	1.10	1.10	0.304	No
93	15.73	0.86	0.16	0.70	0.96	0.322	1.05	0.306	1.10	1.10	0.306	No
94	15.90	0.88	0.17	0.71	0.96	0.324	1.05	0.307	1.10	1.10	0.307	No
95	16.06	0.89	0.17	0.71	0.96	0.325	1.05	0.308	1.10	1.10	0.308	No
96	16.23	0.90	0.18	0.72	0.96	0.326	1.05	0.309	1.10	1.10	0.309	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR*	Belongs to transition
97	16.39	0.91	0.18	0.72	0.96	0.327	1.05	0.310	1.10	1.10	0.310	No
98	16.57	0.92	0.19	0.73	0.95	0.328	1.05	0.311	1.10	1.10	0.311	No
99	16.72	0.93	0.19	0.73	0.95	0.329	1.05	0.312	1.10	1.10	0.312	No
100	16.88	0.94	0.20	0.74	0.95	0.330	1.05	0.313	1.10	1.10	0.313	No
101	17.19	0.96	0.21	0.75	0.95	0.332	1.05	0.315	1.10	1.10	0.315	No
102	17.37	0.97	0.21	0.76	0.95	0.333	1.05	0.316	1.10	1.10	0.316	No
103	17.52	0.98	0.22	0.76	0.95	0.334	1.05	0.317	1.10	1.10	0.317	No
104	17.69	0.99	0.22	0.77	0.95	0.335	1.05	0.318	1.10	1.10	0.319	No
105	17.86	1.00	0.23	0.77	0.95	0.336	1.05	0.319	1.09	1.10	0.320	No
106	18.01	1.01	0.23	0.78	0.95	0.337	1.05	0.320	1.09	1.10	0.322	No
107	18.18	1.02	0.24	0.78	0.95	0.338	1.05	0.321	1.09	1.10	0.323	No
108	18.34	1.03	0.24	0.79	0.95	0.339	1.05	0.321	1.09	1.10	0.325	No
109	18.47	1.04	0.25	0.79	0.95	0.340	1.05	0.322	1.09	1.10	0.326	No
110	18.59	1.05	0.25	0.80	0.95	0.340	1.05	0.323	1.08	1.10	0.327	No
111	18.71	1.06	0.26	0.80	0.95	0.341	1.05	0.323	1.08	1.10	0.328	No
112	18.84	1.07	0.26	0.81	0.95	0.341	1.05	0.324	1.08	1.10	0.329	No
113	18.96	1.07	0.26	0.81	0.94	0.342	1.05	0.324	1.08	1.10	0.330	No
114	19.09	1.08	0.27	0.81	0.94	0.343	1.05	0.325	1.08	1.10	0.331	No
115	19.23	1.09	0.27	0.82	0.94	0.343	1.05	0.326	1.08	1.10	0.333	No
116	19.35	1.10	0.28	0.82	0.94	0.344	1.05	0.326	1.08	1.10	0.334	No
117	19.47	1.11	0.28	0.83	0.94	0.344	1.05	0.327	1.07	1.10	0.335	No
118	19.59	1.12	0.28	0.83	0.94	0.345	1.05	0.327	1.07	1.10	0.336	No
119	19.72	1.12	0.29	0.84	0.94	0.346	1.05	0.328	1.07	1.10	0.337	No
120	19.84	1.13	0.29	0.84	0.94	0.346	1.05	0.328	1.07	1.10	0.338	No
121	19.96	1.14	0.30	0.84	0.94	0.347	1.05	0.329	1.07	1.10	0.339	No
122	20.08	1.15	0.30	0.85	0.94	0.347	1.05	0.329	1.06	1.10	0.341	No
123	20.21	1.15	0.30	0.85	0.94	0.348	1.05	0.330	1.05	1.10	0.345	No
124	20.27	1.16	0.30	0.85	0.94	0.348	1.05	0.330	1.04	1.10	0.349	No
125	20.45	1.17	0.31	0.86	0.94	0.349	1.05	0.331	1.04	1.10	0.351	No
126	20.54	1.17	0.31	0.86	0.94	0.349	1.05	0.331	1.03	1.10	0.353	No
127	20.65	1.18	0.32	0.86	0.94	0.350	1.05	0.332	1.03	1.10	0.355	No
128	20.75	1.19	0.32	0.87	0.94	0.350	1.05	0.332	1.03	1.10	0.356	No
129	20.84	1.19	0.32	0.87	0.94	0.351	1.05	0.332	1.02	1.10	0.357	No
130	20.95	1.20	0.33	0.87	0.94	0.351	1.05	0.333	1.02	1.10	0.359	No
131	21.05	1.21	0.33	0.88	0.94	0.351	1.05	0.333	1.02	1.10	0.360	No
132	21.15	1.21	0.33	0.88	0.94	0.352	1.05	0.334	1.02	1.10	0.360	No
133	21.27	1.22	0.34	0.88	0.94	0.352	1.05	0.334	1.02	1.10	0.361	No
134	21.36	1.23	0.34	0.89	0.93	0.353	1.05	0.335	1.02	1.10	0.361	No
135	21.46	1.23	0.34	0.89	0.93	0.353	1.05	0.335	1.02	1.10	0.362	No
136	21.57	1.24	0.35	0.89	0.93	0.354	1.05	0.335	1.02	1.10	0.363	No
137	21.66	1.24	0.35	0.90	0.93	0.354	1.05	0.336	1.02	1.10	0.364	No
138	21.76	1.25	0.35	0.90	0.93	0.354	1.05	0.336	1.01	1.10	0.364	No
139	21.88	1.26	0.35	0.90	0.93	0.355	1.05	0.336	1.01	1.10	0.366	No
140	21.97	1.26	0.36	0.90	0.93	0.355	1.05	0.337	1.01	1.10	0.367	No
141	22.09	1.27	0.36	0.91	0.93	0.356	1.05	0.337	1.01	1.10	0.367	No
142	22.18	1.28	0.36	0.91	0.93	0.356	1.05	0.338	1.01	1.10	0.367	No
143	22.29	1.28	0.37	0.91	0.93	0.356	1.05	0.338	1.01	1.10	0.367	No
144	22.40	1.29	0.37	0.92	0.93	0.357	1.05	0.338	1.01	1.10	0.368	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
145	22.50	1.29	0.37	0.92	0.93	0.357	1.05	0.339	1.01	1.10	0.369	No
146	22.61	1.30	0.38	0.92	0.93	0.358	1.05	0.339	1.01	1.10	0.369	No
147	22.70	1.31	0.38	0.93	0.93	0.358	1.05	0.339	1.01	1.10	0.369	No
148	22.81	1.31	0.38	0.93	0.93	0.358	1.05	0.340	1.01	1.10	0.368	No
149	22.91	1.32	0.39	0.93	0.93	0.359	1.05	0.340	1.01	1.10	0.369	No
150	23.02	1.33	0.39	0.94	0.93	0.359	1.05	0.340	1.01	1.10	0.369	No
151	23.13	1.33	0.39	0.94	0.93	0.359	1.05	0.341	1.01	1.10	0.370	No
152	23.22	1.34	0.40	0.94	0.93	0.360	1.05	0.341	1.01	1.10	0.371	No
153	23.44	1.35	0.40	0.95	0.93	0.360	1.05	0.342	1.01	1.10	0.372	No
154	23.53	1.36	0.41	0.95	0.93	0.361	1.05	0.342	1.01	1.10	0.372	No
155	23.65	1.37	0.41	0.96	0.92	0.361	1.05	0.342	1.01	1.10	0.372	No
156	23.74	1.37	0.41	0.96	0.92	0.361	1.05	0.342	1.01	1.10	0.372	No
157	23.84	1.38	0.42	0.96	0.92	0.361	1.05	0.343	1.01	1.10	0.373	No
158	23.96	1.39	0.42	0.97	0.92	0.362	1.05	0.343	1.01	1.10	0.374	No
159	24.06	1.39	0.42	0.97	0.92	0.362	1.05	0.343	1.01	1.10	0.374	No
160	24.17	1.40	0.43	0.97	0.92	0.362	1.05	0.344	1.01	1.10	0.374	No
161	24.26	1.40	0.43	0.98	0.92	0.363	1.05	0.344	1.01	1.10	0.374	No
162	24.38	1.41	0.43	0.98	0.92	0.363	1.05	0.344	1.01	1.10	0.374	No
163	24.48	1.42	0.44	0.98	0.92	0.363	1.05	0.344	1.01	1.10	0.374	No
164	24.60	1.43	0.44	0.99	0.92	0.363	1.05	0.345	1.01	1.10	0.374	No
165	24.69	1.43	0.44	0.99	0.92	0.364	1.05	0.345	1.01	1.10	0.375	No
166	24.81	1.44	0.45	0.99	0.92	0.364	1.05	0.345	1.01	1.10	0.376	No
167	24.90	1.45	0.45	1.00	0.92	0.364	1.05	0.345	1.01	1.10	0.375	No
168	25.02	1.45	0.45	1.00	0.92	0.364	1.05	0.346	1.02	1.10	0.374	No
169	25.11	1.46	0.46	1.00	0.92	0.365	1.05	0.346	1.02	1.10	0.374	No
170	25.22	1.47	0.46	1.01	0.92	0.365	1.05	0.346	1.01	1.10	0.375	No
171	25.33	1.47	0.46	1.01	0.92	0.365	1.05	0.346	1.01	1.10	0.376	No
172	25.50	1.48	0.47	1.01	0.92	0.366	1.05	0.347	1.01	1.10	0.377	No
173	25.60	1.48	0.47	1.01	0.92	0.367	1.05	0.348	1.01	1.10	0.377	No

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.27	128.74	6.00	1.34	0.32	1.70	207.46	0.51	207.97	4.000	No	No	2.00
2	2.46	122.27	11.23	1.71	0.28	1.70	205.57	31.41	236.98	4.000	No	No	2.00
3	2.65	113.65	12.68	1.79	0.31	1.70	178.19	39.21	217.40	4.000	No	No	2.00
4	2.85	103.74	14.33	1.87	0.31	1.70	164.02	47.39	211.41	4.000	No	No	2.00
5	2.98	94.12	15.27	1.92	0.32	1.70	157.82	51.14	208.95	4.000	No	No	2.00
6	3.13	84.43	16.06	1.96	0.36	1.70	131.78	49.00	180.78	4.000	No	No	2.00
7	3.28	77.41	16.31	1.97	0.38	1.70	117.35	46.66	164.01	4.000	No	No	2.00
8	3.43	76.01	15.75	1.94	0.37	1.70	123.96	46.02	169.98	4.000	No	No	2.00
9	3.57	74.36	15.01	1.91	0.37	1.70	125.04	43.17	168.21	4.000	No	No	2.00
10	3.71	66.30	15.50	1.93	0.40	1.70	109.39	41.90	151.30	4.000	No	No	2.00
11	3.86	51.38	18.17	2.05	0.44	1.70	85.11	44.25	129.37	4.000	No	No	2.00
12	3.95	38.79	22.30	2.22	0.51	1.70	53.15	41.90	95.05	4.000	No	No	2.00
13	4.11	28.49	27.40	2.40	0.51	1.70	48.69	44.22	92.91	4.000	No	No	2.00
14	4.24	24.77	29.04	2.46	0.56	1.70	35.48	40.54	76.01	4.000	No	No	2.00
15	4.36	22.47	29.85	2.48	0.56	1.70	35.21	40.71	75.92	4.000	No	No	2.00
16	4.48	22.19	29.44	2.47	0.55	1.70	37.63	41.39	79.03	4.000	No	No	2.00
17	4.62	21.27	29.75	2.48	0.56	1.70	34.13	40.32	74.45	4.000	No	No	2.00
18	4.75	21.58	28.55	2.44	0.57	1.70	30.75	38.80	69.55	4.000	No	No	2.00
19	4.87	28.55	23.26	2.26	0.55	1.70	39.12	38.53	77.65	4.000	No	No	2.00
20	5.00	36.19	19.86	2.12	0.48	1.70	67.71	42.90	110.61	4.000	No	No	2.00
21	5.14	38.54	19.12	2.09	0.48	1.70	67.58	41.58	109.15	4.000	No	No	2.00
22	5.27	34.20	20.24	2.14	0.52	1.70	50.45	38.63	89.08	4.000	No	No	2.00
23	5.42	33.14	19.16	2.10	0.54	1.70	46.81	36.04	82.85	4.000	No	No	2.00
24	5.55	35.40	16.77	1.99	0.50	1.70	62.45	35.27	97.72	4.000	No	No	2.00
25	5.69	38.82	14.78	1.90	0.52	1.70	61.37	29.44	90.82	4.000	No	No	2.00
26	5.84	40.16	14.32	1.87	0.52	1.70	63.26	28.28	91.55	4.000	No	No	2.00
27	5.97	43.63	13.96	1.85	0.50	1.70	68.93	28.05	96.97	4.000	No	No	2.00
28	6.12	47.80	13.81	1.85	0.48	1.70	78.10	29.12	107.22	4.000	No	No	2.00
29	6.25	52.19	14.04	1.86	0.47	1.70	83.36	31.00	114.36	4.000	No	No	2.00
30	6.40	51.55	15.59	1.94	0.44	1.70	90.10	38.09	128.19	4.000	No	No	2.00
31	6.53	45.37	18.28	2.06	0.46	1.70	75.00	41.88	116.88	4.000	No	No	2.00
32	6.68	36.61	21.49	2.19	0.51	1.70	53.55	41.12	94.67	4.000	No	No	2.00
33	6.82	33.14	21.91	2.21	0.53	1.70	47.88	39.92	87.80	4.000	No	No	2.00
34	6.96	33.67	20.41	2.15	0.50	1.70	58.27	41.09	99.36	4.000	No	No	2.00
35	7.10	31.37	21.00	2.17	0.50	1.70	56.11	41.27	97.39	4.000	No	No	2.00
36	7.33	25.02	25.28	2.33	0.56	1.70	36.82	39.24	76.06	4.000	No	No	2.00
37	7.47	17.85	32.26	2.56	0.58	1.70	27.65	38.78	66.43	4.000	No	No	2.00
38	7.60	13.82	38.22	2.73	0.61	1.70	21.58	0.00	21.58	4.000	No	Yes	2.00
39	7.75	11.31	43.18	2.86	0.63	1.70	17.40	0.00	17.40	4.000	No	Yes	2.00
40	7.89	9.96	46.28	2.94	0.63	1.70	15.51	0.00	15.51	4.000	No	Yes	2.00
41	8.03	9.74	46.36	2.94	0.64	1.70	15.11	0.00	15.11	4.000	No	Yes	2.00
42	8.15	11.87	40.49	2.79	0.63	1.70	16.32	0.00	16.32	4.000	No	Yes	2.00
43	8.30	22.34	26.88	2.39	0.60	1.70	25.76	36.50	62.26	4.000	No	No	2.00
44	8.44	29.53	22.58	2.23	0.48	1.66	63.99	45.47	109.46	4.000	No	No	2.00
45	8.58	31.37	22.69	2.24	0.51	1.70	50.99	41.64	92.63	4.000	No	No	2.00
46	8.73	23.20	29.00	2.46	0.56	1.70	34.67	40.26	74.92	4.000	No	No	2.00
47	8.87	16.71	36.03	2.67	0.59	1.70	26.17	0.00	26.17	4.000	No	Yes	2.00
48	9.00	13.24	40.76	2.80	0.61	1.70	19.69	0.00	19.69	4.000	No	Yes	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	9.15	10.97	43.68	2.88	0.62	1.70	17.94	0.00	17.94	4.000	No	Yes	2.00
50	9.28	9.18	44.95	2.91	0.64	1.70	15.24	0.00	15.24	4.000	No	Yes	2.00
51	9.43	6.88	47.61	2.97	0.66	1.70	11.06	0.00	11.06	4.000	No	Yes	2.00
52	9.55	4.90	51.48	3.06	0.68	1.70	6.88	0.00	6.88	4.000	No	Yes	2.00
53	9.71	4.25	53.22	3.10	0.69	1.70	5.67	0.00	5.67	4.000	No	Yes	2.00
54	9.84	4.53	52.06	3.08	0.67	1.70	7.96	0.00	7.96	4.000	No	Yes	2.00
55	9.98	4.98	50.46	3.04	0.67	1.70	8.23	0.00	8.23	4.000	No	Yes	2.00
56	10.13	5.04	50.49	3.04	0.67	1.70	7.82	0.00	7.82	4.000	No	Yes	2.00
57	10.26	5.12	50.35	3.04	0.67	1.70	8.23	0.00	8.23	4.000	No	Yes	2.00
58	10.41	5.63	49.05	3.01	0.67	1.70	8.63	0.00	8.63	4.000	No	Yes	2.00
59	10.68	6.05	48.06	2.98	0.66	1.69	10.21	0.00	10.21	0.600	No	Yes	2.00
60	10.83	6.33	47.38	2.97	0.66	1.69	10.17	0.00	10.17	0.626	No	Yes	2.00
61	10.96	6.38	47.63	2.97	0.66	1.68	9.88	0.00	9.88	0.628	No	Yes	2.00
62	11.11	6.47	48.44	2.99	0.66	1.67	10.36	0.00	10.36	0.632	No	Yes	2.00
63	11.23	6.47	49.00	3.01	0.66	1.67	10.45	0.00	10.45	0.628	No	Yes	2.00
64	11.38	5.83	50.88	3.05	0.66	1.67	9.78	0.00	9.78	0.556	No	Yes	1.88
65	11.51	5.07	52.43	3.09	0.68	1.68	7.32	0.00	7.32	0.474	No	Yes	1.59
66	11.66	4.51	53.67	3.11	0.68	1.68	6.91	0.00	6.91	0.413	No	Yes	1.38
67	11.79	4.43	53.17	3.10	0.68	1.67	7.15	0.00	7.15	0.402	No	Yes	1.33
68	11.93	4.40	53.32	3.11	0.68	1.66	6.87	0.00	6.87	0.396	No	Yes	1.31
69	12.07	4.31	53.66	3.11	0.68	1.66	6.72	0.00	6.72	0.385	No	Yes	1.26
70	12.21	4.29	53.09	3.10	0.68	1.66	6.70	0.00	6.70	0.380	No	Yes	1.24
71	12.35	4.45	50.56	3.04	0.68	1.65	6.68	0.00	6.68	0.395	No	Yes	1.28
72	12.48	4.59	48.14	2.99	0.68	1.64	7.42	0.00	7.42	0.406	No	Yes	1.31
73	12.63	4.48	47.80	2.98	0.68	1.64	7.28	0.00	7.28	0.393	No	Yes	1.26
74	12.77	4.26	48.73	3.00	0.68	1.64	6.12	0.00	6.12	0.368	No	Yes	1.17
75	12.91	4.01	49.18	3.01	0.68	1.64	6.36	0.00	6.36	0.341	No	Yes	1.08
76	13.06	3.95	47.05	2.96	0.68	1.63	6.09	0.00	6.09	0.334	No	Yes	1.05
77	13.18	3.89	43.05	2.86	0.69	1.63	5.83	0.00	5.83	0.326	No	Yes	1.02
78	13.33	4.06	38.98	2.75	0.69	1.63	6.07	0.00	6.07	0.341	No	Yes	1.06
79	13.46	4.20	38.08	2.73	0.68	1.62	6.81	0.00	6.81	0.354	No	Yes	1.10
80	13.61	3.95	42.72	2.85	0.68	1.62	6.42	0.00	6.42	0.327	No	Yes	1.01
81	13.67	6.16	40.72	2.80	0.69	1.63	4.90	0.00	4.90	0.543	No	Yes	1.67
82	13.94	17.58	25.78	2.35	0.64	1.56	16.31	32.94	49.25	0.077	No	No	0.25
83	14.13	31.29	20.59	2.15	0.52	1.42	51.75	39.48	91.23	0.129	No	No	0.41
84	14.28	38.62	18.99	2.09	0.50	1.41	58.86	39.01	97.87	0.139	No	No	0.45
85	14.40	32.35	20.84	2.16	0.54	1.43	44.86	37.82	82.68	0.116	No	No	0.37
86	14.59	21.97	25.29	2.33	0.59	1.48	27.48	36.26	63.74	0.092	No	No	0.29
87	14.74	17.10	27.73	2.42	0.63	1.51	18.79	34.56	53.35	0.081	No	No	0.25
88	14.91	22.53	23.98	2.28	0.60	1.48	25.80	34.94	60.74	0.089	No	No	0.28
89	15.07	47.63	16.02	1.96	0.55	1.42	48.34	30.15	78.50	0.111	No	No	0.34
90	15.23	90.42	11.45	1.72	0.43	1.32	110.11	22.35	132.46	0.210	No	No	0.66
91	15.41	145.39	8.92	1.56	0.35	1.25	172.83	11.16	184.00	0.608	No	No	1.98
92	15.56	194.19	7.86	1.49	0.29	1.19	226.61	6.38	232.99	4.000	No	No	2.00
93	15.73	227.83	7.51	1.46	0.26	1.17	260.65	5.15	265.80	4.000	No	No	2.00
94	15.90	242.36	7.61	1.47	0.26	1.17	274.22	5.91	280.14	4.000	No	No	2.00
95	16.06	247.51	7.66	1.47	0.26	1.17	269.86	6.10	275.96	4.000	No	No	2.00
96	16.23	254.09	7.57	1.47	0.26	1.17	275.74	5.71	281.45	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
97	16.39	258.42	7.58	1.47	0.26	1.16	293.92	6.02	299.94	4.000	No	No	2.00
98	16.57	251.96	7.89	1.49	0.26	1.16	282.12	7.71	289.83	4.000	No	No	2.00
99	16.72	230.86	8.54	1.54	0.26	1.16	252.58	11.56	264.14	4.000	No	No	2.00
100	16.88	212.97	8.93	1.56	0.28	1.17	224.90	13.49	238.39	4.000	No	No	2.00
101	17.19	226.97	8.58	1.54	0.29	1.16	223.88	10.82	234.70	4.000	No	No	2.00
102	17.37	258.65	8.01	1.50	0.26	1.15	295.78	8.85	304.63	4.000	No	No	2.00
103	17.52	297.16	7.62	1.47	0.26	1.14	323.56	6.73	330.29	4.000	No	No	2.00
104	17.69	318.82	7.39	1.45	0.26	1.14	344.42	5.67	350.09	4.000	No	No	2.00
105	17.86	328.61	7.18	1.44	0.26	1.14	363.66	4.72	368.38	4.000	No	No	2.00
106	18.01	330.27	7.04	1.43	0.26	1.14	352.88	3.87	356.75	4.000	No	No	2.00
107	18.18	325.23	7.18	1.44	0.26	1.13	347.36	4.53	351.89	4.000	No	No	2.00
108	18.34	321.03	7.56	1.47	0.26	1.13	345.08	6.71	351.79	4.000	No	No	2.00
109	18.47	314.01	8.09	1.50	0.26	1.13	337.20	10.49	347.70	4.000	No	No	2.00
110	18.59	302.76	8.65	1.54	0.26	1.13	322.96	14.94	337.89	4.000	No	No	2.00
111	18.71	289.19	9.08	1.57	0.26	1.13	307.41	18.53	325.94	4.000	No	No	2.00
112	18.84	275.59	9.37	1.59	0.26	1.12	292.27	20.67	312.94	4.000	No	No	2.00
113	18.96	262.12	9.57	1.60	0.26	1.12	278.09	21.83	299.92	4.000	No	No	2.00
114	19.09	249.19	9.63	1.61	0.26	1.12	263.12	21.50	284.62	4.000	No	No	2.00
115	19.23	237.21	9.55	1.60	0.26	1.12	249.81	19.93	269.74	4.000	No	No	2.00
116	19.35	228.79	9.31	1.59	0.26	1.12	238.80	17.21	256.01	4.000	No	No	2.00
117	19.47	227.73	8.94	1.56	0.27	1.12	235.75	13.98	249.74	4.000	No	No	2.00
118	19.59	232.37	8.57	1.54	0.26	1.11	245.31	11.52	256.84	4.000	No	No	2.00
119	19.72	235.70	8.39	1.52	0.26	1.11	252.35	10.39	262.74	4.000	No	No	2.00
120	19.84	229.43	8.67	1.54	0.26	1.11	244.67	12.24	256.90	4.000	No	No	2.00
121	19.96	213.68	8.93	1.56	0.28	1.11	225.95	13.50	239.45	4.000	No	No	2.00
122	20.08	195.46	9.05	1.57	0.31	1.12	205.07	13.44	218.51	3.195	No	No	2.00
123	20.21	176.34	9.05	1.57	0.32	1.13	190.86	12.83	203.69	1.358	No	No	2.00
124	20.27	162.38	9.18	1.58	0.35	1.14	169.55	12.70	182.25	0.574	No	No	1.65
125	20.45	148.10	10.07	1.64	0.36	1.14	162.78	18.41	181.20	0.556	No	No	1.58
126	20.54	136.88	11.49	1.72	0.37	1.14	146.73	26.78	173.51	0.446	No	No	1.26
127	20.65	124.88	13.66	1.84	0.37	1.14	133.24	38.09	171.33	0.421	No	No	1.19
128	20.75	115.89	15.66	1.94	0.37	1.14	124.17	45.71	169.88	0.406	No	No	1.14
129	20.84	103.52	17.59	2.03	0.37	1.14	117.40	50.91	168.31	0.391	No	No	1.09
130	20.95	90.12	19.30	2.10	0.41	1.15	94.21	49.15	143.36	0.244	No	No	0.68
131	21.05	81.88	19.92	2.13	0.44	1.16	82.31	47.07	129.37	0.201	No	No	0.56
132	21.15	84.57	18.52	2.07	0.42	1.15	91.77	46.80	138.58	0.228	No	No	0.63
133	21.27	90.25	16.84	1.99	0.41	1.15	102.24	44.91	147.15	0.259	No	No	0.72
134	21.36	90.36	16.31	1.97	0.42	1.15	99.72	42.64	142.36	0.241	No	No	0.67
135	21.46	84.31	17.28	2.01	0.43	1.15	91.83	43.69	135.52	0.218	No	No	0.60
136	21.57	78.91	18.56	2.07	0.44	1.15	83.11	44.60	127.70	0.197	No	No	0.54
137	21.66	74.83	19.13	2.09	0.44	1.15	82.41	45.60	128.02	0.198	No	No	0.54
138	21.76	68.25	19.65	2.12	0.45	1.15	78.62	45.57	124.19	0.189	No	No	0.52
139	21.88	56.94	21.48	2.19	0.49	1.16	62.13	43.63	105.77	0.152	No	No	0.42
140	21.97	48.54	24.34	2.30	0.53	1.17	46.49	41.66	88.15	0.124	No	No	0.34
141	22.09	49.97	24.70	2.31	0.51	1.17	51.79	43.60	95.39	0.135	No	No	0.37
142	22.18	57.07	23.31	2.26	0.47	1.15	66.17	46.89	113.06	0.166	No	No	0.45
143	22.29	60.31	23.03	2.25	0.47	1.15	68.48	47.31	115.80	0.171	No	No	0.47
144	22.40	56.85	24.51	2.30	0.48	1.15	61.64	46.55	108.19	0.157	No	No	0.43

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
145	22.50	54.84	25.35	2.33	0.50	1.15	54.97	45.07	100.04	0.143	No	No	0.39
146	22.61	61.07	23.31	2.26	0.48	1.15	61.89	45.57	107.46	0.155	No	No	0.42
147	22.70	78.04	19.23	2.10	0.45	1.13	80.64	45.33	125.97	0.193	No	No	0.52
148	22.81	95.15	16.43	1.98	0.40	1.12	106.97	44.71	151.68	0.279	No	No	0.76
149	22.91	105.41	15.18	1.92	0.39	1.11	114.12	41.64	155.76	0.300	No	No	0.81
150	23.02	104.37	15.56	1.93	0.40	1.11	111.55	42.58	154.12	0.292	No	No	0.79
151	23.13	96.66	17.16	2.01	0.40	1.11	103.30	46.14	149.43	0.269	No	No	0.73
152	23.22	86.81	19.35	2.10	0.42	1.12	90.02	48.11	138.13	0.226	No	No	0.61
153	23.44	81.41	21.09	2.17	0.44	1.12	80.85	48.56	129.41	0.201	No	No	0.54
154	23.53	91.80	20.10	2.13	0.43	1.11	86.26	48.49	134.75	0.216	No	No	0.58
155	23.65	104.55	18.77	2.08	0.36	1.09	120.28	54.93	175.21	0.467	No	No	1.25
156	23.74	108.07	18.42	2.06	0.37	1.09	118.60	53.58	172.18	0.430	No	No	1.16
157	23.84	95.14	20.04	2.13	0.41	1.10	96.37	51.22	147.59	0.261	No	No	0.70
158	23.96	88.09	20.94	2.17	0.44	1.11	81.27	48.46	129.73	0.202	No	No	0.54
159	24.06	94.67	19.46	2.11	0.41	1.10	97.10	50.29	147.39	0.260	No	No	0.69
160	24.17	112.57	16.29	1.97	0.38	1.09	115.71	46.22	161.92	0.339	No	No	0.91
161	24.26	131.74	13.73	1.84	0.37	1.08	134.63	38.70	173.34	0.444	No	No	1.19
162	24.38	150.43	12.28	1.77	0.35	1.08	154.02	33.00	187.02	0.674	No	No	1.80
163	24.48	164.23	12.41	1.77	0.32	1.07	170.36	36.22	206.58	1.574	No	No	2.00
164	24.60	167.20	13.62	1.84	0.31	1.06	173.96	44.93	218.89	3.277	No	No	2.00
165	24.69	163.48	15.13	1.91	0.31	1.07	161.30	51.17	212.47	2.188	No	No	2.00
166	24.81	166.20	15.88	1.95	0.31	1.06	158.19	54.13	212.33	2.169	No	No	2.00
167	24.90	193.78	15.02	1.91	0.29	1.06	180.78	54.58	235.36	4.000	No	No	2.00
168	25.02	225.59	13.81	1.85	0.26	1.05	241.29	58.05	299.34	4.000	No	No	2.00
169	25.11	251.39	10.53	1.66	0.26	1.05	250.79	29.37	280.16	4.000	No	No	2.00
170	25.22	321.14	5.44	1.29	0.26	1.05	256.18	0.16	256.34	4.000	No	No	2.00
171	25.33	459.49	-1.00	N/A	0.26	1.05	448.02	0.00	448.02	4.000	No	No	2.00
172	25.50	595.96	-1.00	N/A	0.26	1.05	661.33	0.00	661.33	4.000	No	No	2.00
173	25.60	699.17	-1.00	N/A	0.26	1.05	707.62	0.00	707.62	4.000	No	No	2.00

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.27	2.00	0.00	9.65	0.18	0.00	2.46	2.00	0.00	9.63	0.18	0.00
2.65	2.00	0.00	9.60	0.20	0.00	2.85	2.00	0.00	9.57	0.20	0.00
2.98	2.00	0.00	9.55	0.13	0.00	3.13	2.00	0.00	9.52	0.16	0.00
3.28	2.00	0.00	9.50	0.14	0.00	3.43	2.00	0.00	9.48	0.15	0.00
3.57	2.00	0.00	9.46	0.14	0.00	3.71	2.00	0.00	9.43	0.14	0.00
3.86	2.00	0.00	9.41	0.14	0.00	3.95	2.00	0.00	9.40	0.09	0.00
4.11	2.00	0.00	9.37	0.16	0.00	4.24	2.00	0.00	9.35	0.13	0.00
4.36	2.00	0.00	9.34	0.12	0.00	4.48	2.00	0.00	9.32	0.12	0.00
4.62	2.00	0.00	9.30	0.14	0.00	4.75	2.00	0.00	9.28	0.13	0.00
4.87	2.00	0.00	9.26	0.12	0.00	5.00	2.00	0.00	9.24	0.13	0.00
5.14	2.00	0.00	9.22	0.15	0.00	5.27	2.00	0.00	9.20	0.13	0.00
5.42	2.00	0.00	9.17	0.15	0.00	5.55	2.00	0.00	9.15	0.13	0.00
5.69	2.00	0.00	9.13	0.14	0.00	5.84	2.00	0.00	9.11	0.15	0.00
5.97	2.00	0.00	9.09	0.13	0.00	6.12	2.00	0.00	9.07	0.15	0.00
6.25	2.00	0.00	9.05	0.14	0.00	6.40	2.00	0.00	9.03	0.14	0.00
6.53	2.00	0.00	9.00	0.14	0.00	6.68	2.00	0.00	8.98	0.15	0.00
6.82	2.00	0.00	8.96	0.14	0.00	6.96	2.00	0.00	8.94	0.14	0.00
7.10	2.00	0.00	8.92	0.13	0.00	7.33	2.00	0.00	8.88	0.23	0.00
7.47	2.00	0.00	8.86	0.14	0.00	7.60	2.00	0.00	8.84	0.13	0.00
7.75	2.00	0.00	8.82	0.15	0.00	7.89	2.00	0.00	8.80	0.14	0.00
8.03	2.00	0.00	8.78	0.14	0.00	8.15	2.00	0.00	8.76	0.12	0.00
8.30	2.00	0.00	8.73	0.15	0.00	8.44	2.00	0.00	8.71	0.14	0.00
8.58	2.00	0.00	8.69	0.14	0.00	8.73	2.00	0.00	8.67	0.15	0.00
8.87	2.00	0.00	8.65	0.14	0.00	9.00	2.00	0.00	8.63	0.14	0.00
9.15	2.00	0.00	8.61	0.15	0.00	9.28	2.00	0.00	8.59	0.13	0.00
9.43	2.00	0.00	8.56	0.15	0.00	9.55	2.00	0.00	8.54	0.12	0.00
9.71	2.00	0.00	8.52	0.16	0.00	9.84	2.00	0.00	8.50	0.14	0.00
9.98	2.00	0.00	8.48	0.14	0.00	10.13	2.00	0.00	8.46	0.15	0.00
10.26	2.00	0.00	8.44	0.13	0.00	10.41	2.00	0.00	8.41	0.14	0.00
10.68	2.00	0.00	8.37	0.28	0.00	10.83	2.00	0.00	8.35	0.15	0.00
10.96	2.00	0.00	8.33	0.13	0.00	11.11	2.00	0.00	8.31	0.15	0.00
11.23	2.00	0.00	8.29	0.13	0.00	11.38	1.88	0.00	8.27	0.15	0.00
11.51	1.59	0.00	8.25	0.13	0.00	11.66	1.38	0.00	8.22	0.15	0.00
11.79	1.33	0.00	8.20	0.13	0.00	11.93	1.31	0.00	8.18	0.15	0.00
12.07	1.26	0.00	8.16	0.14	0.00	12.21	1.24	0.00	8.14	0.14	0.00
12.35	1.28	0.00	8.12	0.14	0.00	12.48	1.31	0.00	8.10	0.13	0.00
12.63	1.26	0.00	8.08	0.14	0.00	12.77	1.17	0.00	8.05	0.14	0.00
12.91	1.08	0.00	8.03	0.14	0.00	13.06	1.05	0.00	8.01	0.15	0.00
13.18	1.02	0.00	7.99	0.13	0.00	13.33	1.06	0.00	7.97	0.15	0.00
13.46	1.10	0.00	7.95	0.13	0.00	13.61	1.01	0.00	7.93	0.15	0.00
13.67	1.67	0.00	7.92	0.06	0.00	13.94	0.25	0.75	7.87	0.27	0.50
14.13	0.41	0.59	7.85	0.19	0.26	14.28	0.45	0.55	7.82	0.15	0.20
14.40	0.37	0.63	7.80	0.12	0.19	14.59	0.29	0.71	7.78	0.18	0.31
14.74	0.25	0.75	7.75	0.15	0.27	14.91	0.28	0.72	7.73	0.17	0.29
15.07	0.34	0.66	7.70	0.16	0.25	15.23	0.66	0.34	7.68	0.16	0.12
15.41	1.98	0.00	7.65	0.18	0.00	15.56	2.00	0.00	7.63	0.15	0.00
15.73	2.00	0.00	7.60	0.17	0.00	15.90	2.00	0.00	7.58	0.17	0.00
16.06	2.00	0.00	7.55	0.16	0.00	16.23	2.00	0.00	7.53	0.17	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
16.39	2.00	0.00	7.50	0.16	0.00	16.57	2.00	0.00	7.48	0.18	0.00
16.72	2.00	0.00	7.45	0.15	0.00	16.88	2.00	0.00	7.43	0.16	0.00
17.19	2.00	0.00	7.38	0.32	0.00	17.37	2.00	0.00	7.35	0.18	0.00
17.52	2.00	0.00	7.33	0.15	0.00	17.69	2.00	0.00	7.30	0.17	0.00
17.86	2.00	0.00	7.28	0.17	0.00	18.01	2.00	0.00	7.26	0.15	0.00
18.18	2.00	0.00	7.23	0.17	0.00	18.34	2.00	0.00	7.21	0.16	0.00
18.47	2.00	0.00	7.19	0.13	0.00	18.59	2.00	0.00	7.17	0.12	0.00
18.71	2.00	0.00	7.15	0.12	0.00	18.84	2.00	0.00	7.13	0.13	0.00
18.96	2.00	0.00	7.11	0.12	0.00	19.09	2.00	0.00	7.09	0.13	0.00
19.23	2.00	0.00	7.07	0.13	0.00	19.35	2.00	0.00	7.05	0.12	0.00
19.47	2.00	0.00	7.03	0.12	0.00	19.59	2.00	0.00	7.01	0.12	0.00
19.72	2.00	0.00	7.00	0.12	0.00	19.84	2.00	0.00	6.98	0.12	0.00
19.96	2.00	0.00	6.96	0.12	0.00	20.08	2.00	0.00	6.94	0.12	0.00
20.21	2.00	0.00	6.92	0.13	0.00	20.27	1.65	0.00	6.91	0.05	0.00
20.45	1.58	0.00	6.88	0.18	0.00	20.54	1.26	0.00	6.87	0.09	0.00
20.65	1.19	0.00	6.85	0.11	0.00	20.75	1.14	0.00	6.84	0.10	0.00
20.84	1.09	0.00	6.82	0.09	0.00	20.95	0.68	0.32	6.81	0.11	0.08
21.05	0.56	0.44	6.79	0.10	0.09	21.15	0.63	0.37	6.78	0.10	0.08
21.27	0.72	0.28	6.76	0.11	0.07	21.36	0.67	0.33	6.75	0.09	0.06
21.46	0.60	0.40	6.73	0.10	0.08	21.57	0.54	0.46	6.71	0.11	0.10
21.66	0.54	0.46	6.70	0.09	0.09	21.76	0.52	0.48	6.68	0.10	0.10
21.88	0.42	0.58	6.67	0.11	0.14	21.97	0.34	0.66	6.65	0.09	0.12
22.09	0.37	0.63	6.63	0.12	0.15	22.18	0.45	0.55	6.62	0.09	0.11
22.29	0.47	0.53	6.60	0.11	0.12	22.40	0.43	0.57	6.59	0.10	0.12
22.50	0.39	0.61	6.57	0.10	0.12	22.61	0.42	0.58	6.55	0.11	0.13
22.70	0.52	0.48	6.54	0.10	0.09	22.81	0.76	0.24	6.52	0.11	0.05
22.91	0.81	0.19	6.51	0.10	0.04	23.02	0.79	0.21	6.49	0.11	0.04
23.13	0.73	0.27	6.48	0.11	0.06	23.22	0.61	0.39	6.46	0.10	0.07
23.44	0.54	0.46	6.43	0.21	0.19	23.53	0.58	0.42	6.41	0.09	0.08
23.65	1.25	0.00	6.40	0.12	0.00	23.74	1.16	0.00	6.38	0.09	0.00
23.84	0.70	0.30	6.37	0.10	0.06	23.96	0.54	0.46	6.35	0.12	0.10
24.06	0.69	0.31	6.33	0.10	0.06	24.17	0.91	0.09	6.32	0.11	0.02
24.26	1.19	0.00	6.30	0.09	0.00	24.38	1.80	0.00	6.28	0.12	0.00
24.48	2.00	0.00	6.27	0.10	0.00	24.60	2.00	0.00	6.25	0.11	0.00
24.69	2.00	0.00	6.24	0.09	0.00	24.81	2.00	0.00	6.22	0.12	0.00
24.90	2.00	0.00	6.20	0.09	0.00	25.02	2.00	0.00	6.19	0.11	0.00
25.11	2.00	0.00	6.17	0.10	0.00	25.22	2.00	0.00	6.16	0.11	0.00
25.33	2.00	0.00	6.14	0.10	0.00	25.50	2.00	0.00	6.11	0.17	0.00
25.60	2.00	0.00	6.10	0.10	0.00						

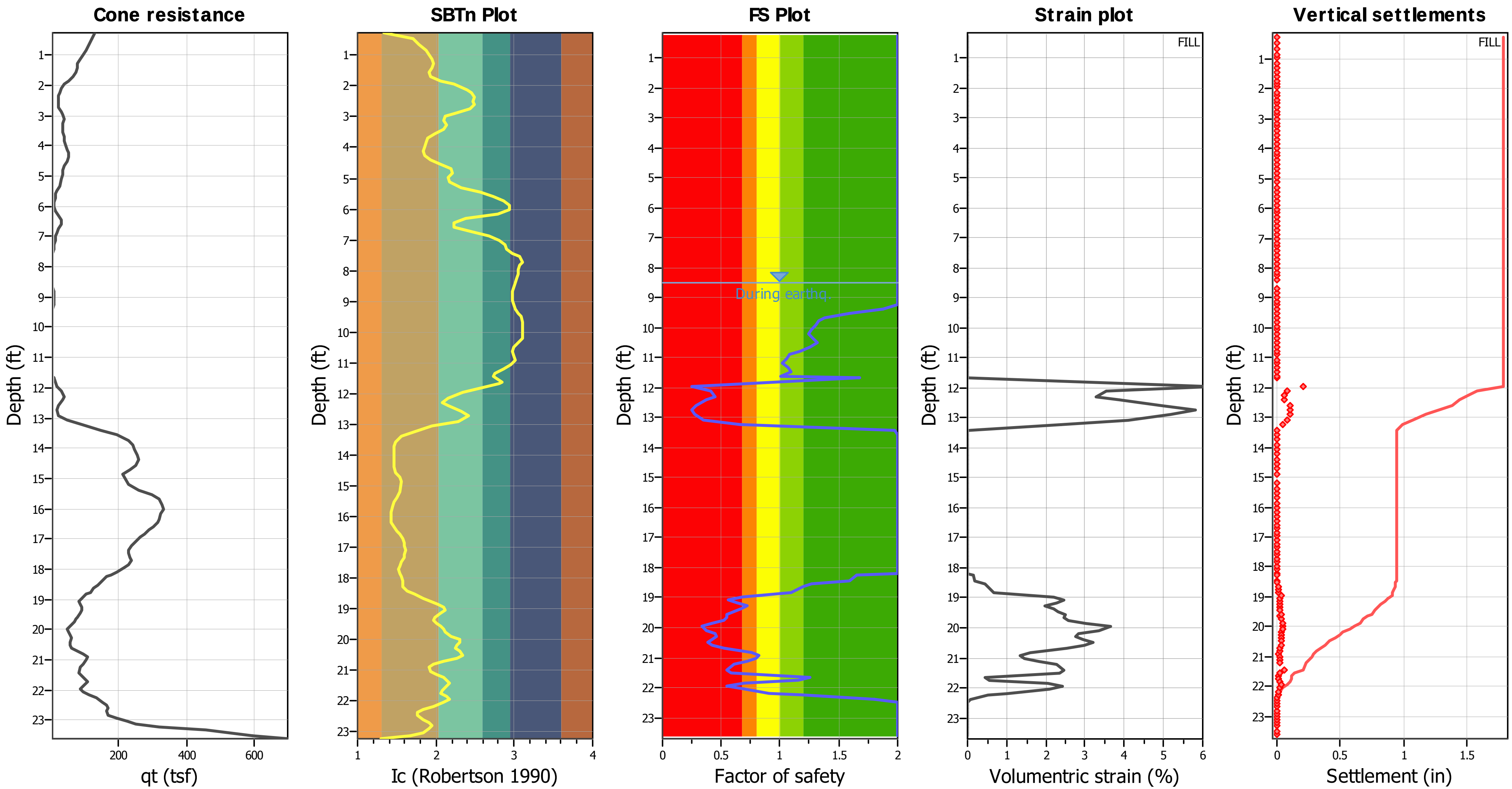
Overall liquefaction potential: 5.00

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.68	10.21	2.00	0.00	1.00	0.00	10.83	10.17	2.00	0.00	1.00	0.00
10.96	9.88	2.00	0.00	1.00	0.00	11.11	10.36	2.00	0.00	1.00	0.00
11.23	10.45	2.00	0.00	1.00	0.00	11.38	9.78	1.88	0.00	1.00	0.00
11.51	7.32	1.59	0.00	1.00	0.00	11.66	6.91	1.38	0.00	1.00	0.00
11.79	7.15	1.33	0.00	1.00	0.00	11.93	6.87	1.31	0.00	1.00	0.00
12.07	6.72	1.26	0.00	1.00	0.00	12.21	6.70	1.24	0.00	1.00	0.00
12.35	6.68	1.28	0.00	1.00	0.00	12.48	7.42	1.31	0.00	1.00	0.00
12.63	7.28	1.26	0.00	1.00	0.00	12.77	6.12	1.17	0.00	1.00	0.00
12.91	6.36	1.08	0.00	1.00	0.00	13.06	6.09	1.05	0.00	1.00	0.00
13.18	5.83	1.02	0.00	1.00	0.00	13.33	6.07	1.06	0.00	1.00	0.00
13.46	6.81	1.10	0.00	1.00	0.00	13.61	6.42	1.01	0.00	1.00	0.00
13.67	4.90	1.67	0.00	1.00	0.00	13.94	49.25	0.25	6.22	1.00	0.20
14.13	91.23	0.41	3.52	1.00	0.08	14.28	97.87	0.45	3.28	1.00	0.06
14.40	82.68	0.37	3.88	1.00	0.06	14.59	63.74	0.29	4.96	1.00	0.11
14.74	53.35	0.25	5.80	1.00	0.11	14.91	60.74	0.28	5.18	1.00	0.11
15.07	78.50	0.34	4.08	1.00	0.08	15.23	132.46	0.66	2.38	1.00	0.04
15.41	184.00	1.98	0.01	1.00	0.00	15.56	232.99	2.00	0.00	1.00	0.00
15.73	265.80	2.00	0.00	1.00	0.00	15.90	280.14	2.00	0.00	1.00	0.00
16.06	275.96	2.00	0.00	1.00	0.00	16.23	281.45	2.00	0.00	1.00	0.00
16.39	299.94	2.00	0.00	1.00	0.00	16.57	289.83	2.00	0.00	1.00	0.00
16.72	264.14	2.00	0.00	1.00	0.00	16.88	238.39	2.00	0.00	1.00	0.00
17.19	234.70	2.00	0.00	1.00	0.00	17.37	304.63	2.00	0.00	1.00	0.00
17.52	330.29	2.00	0.00	1.00	0.00	17.69	350.09	2.00	0.00	1.00	0.00
17.86	368.38	2.00	0.00	1.00	0.00	18.01	356.75	2.00	0.00	1.00	0.00
18.18	351.89	2.00	0.00	1.00	0.00	18.34	351.79	2.00	0.00	1.00	0.00
18.47	347.70	2.00	0.00	1.00	0.00	18.59	337.89	2.00	0.00	1.00	0.00
18.71	325.94	2.00	0.00	1.00	0.00	18.84	312.94	2.00	0.00	1.00	0.00
18.96	299.92	2.00	0.00	1.00	0.00	19.09	284.62	2.00	0.00	1.00	0.00
19.23	269.74	2.00	0.00	1.00	0.00	19.35	256.01	2.00	0.00	1.00	0.00
19.47	249.74	2.00	0.00	1.00	0.00	19.59	256.84	2.00	0.00	1.00	0.00
19.72	262.74	2.00	0.00	1.00	0.00	19.84	256.90	2.00	0.00	1.00	0.00
19.96	239.45	2.00	0.00	1.00	0.00	20.08	218.51	2.00	0.00	1.00	0.00
20.21	203.69	2.00	0.00	1.00	0.00	20.27	182.25	1.65	0.17	1.00	0.00
20.45	181.20	1.58	0.20	1.00	0.00	20.54	173.51	1.26	0.45	1.00	0.00
20.65	171.33	1.19	0.54	1.00	0.01	20.75	169.88	1.14	0.59	1.00	0.01
20.84	168.31	1.09	0.66	1.00	0.01	20.95	143.36	0.68	2.18	1.00	0.03
21.05	129.37	0.56	2.45	1.00	0.03	21.15	138.58	0.63	2.27	1.00	0.03
21.27	147.15	0.72	1.96	1.00	0.03	21.36	142.36	0.67	2.20	1.00	0.02
21.46	135.52	0.60	2.33	1.00	0.03	21.57	127.70	0.54	2.48	1.00	0.03
21.66	128.02	0.54	2.48	1.00	0.03	21.76	124.19	0.52	2.56	1.00	0.03
21.88	105.77	0.42	3.03	1.00	0.04	21.97	88.15	0.34	3.65	1.00	0.04
22.09	95.39	0.37	3.37	1.00	0.05	22.18	113.06	0.45	2.83	1.00	0.03
22.29	115.80	0.47	2.76	1.00	0.04	22.40	108.19	0.43	2.96	1.00	0.04
22.50	100.04	0.39	3.21	1.00	0.04	22.61	107.46	0.42	2.98	1.00	0.04
22.70	125.97	0.52	2.52	1.00	0.03	22.81	151.68	0.76	1.62	1.00	0.02
22.91	155.76	0.81	1.33	1.00	0.02	23.02	154.12	0.79	1.44	1.00	0.02
23.13	149.43	0.73	1.84	1.00	0.02	23.22	138.13	0.61	2.28	1.00	0.03
23.44	129.41	0.54	2.45	1.00	0.06	23.53	134.75	0.58	2.34	1.00	0.03

:: Post-earthquake settlement due to soil liquefaction :: (continued)

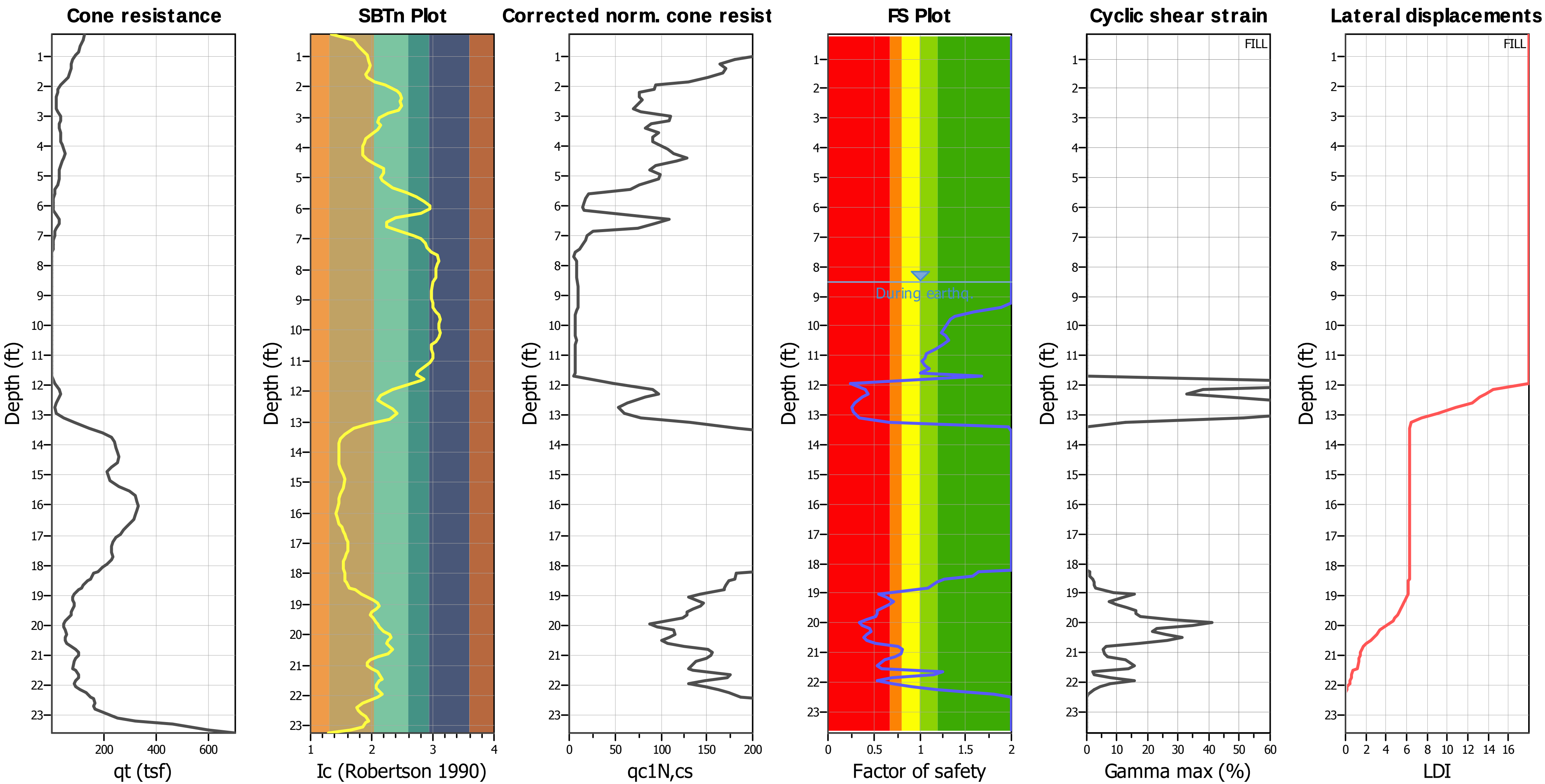
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
23.65	175.21	1.25	0.46	1.00	0.01	23.74	172.18	1.16	0.57	1.00	0.01
23.84	147.59	0.70	2.07	1.00	0.02	23.96	129.73	0.54	2.44	1.00	0.03
24.06	147.39	0.69	2.10	1.00	0.03	24.17	161.92	0.91	1.01	1.00	0.01
24.26	173.34	1.19	0.53	1.00	0.01	24.38	187.02	1.80	0.08	1.00	0.00
24.48	206.58	2.00	0.00	1.00	0.00	24.60	218.89	2.00	0.00	1.00	0.00
24.69	212.47	2.00	0.00	1.00	0.00	24.81	212.33	2.00	0.00	1.00	0.00
24.90	235.36	2.00	0.00	1.00	0.00	25.02	299.34	2.00	0.00	1.00	0.00
25.11	280.16	2.00	0.00	1.00	0.00	25.22	256.34	2.00	0.00	1.00	0.00
25.33	448.02	2.00	0.00	1.00	0.00	25.50	661.33	2.00	0.00	1.00	0.00
25.60	707.62	2.00	0.00	1.00	0.00						

Total estimated settlement: 1.79

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.68	10.21	0.00	2.00	0.00	0.00	0.00
10.83	10.17	0.00	2.00	0.00	0.00	0.00
10.96	9.88	0.00	2.00	0.00	0.00	0.00
11.11	10.36	0.00	2.00	0.00	0.00	0.00
11.23	10.45	0.00	2.00	0.00	0.00	0.00
11.38	9.78	0.00	1.88	0.00	0.00	0.00
11.51	7.32	0.00	1.59	0.00	0.00	0.00
11.66	6.91	0.00	1.38	0.00	0.00	0.00
11.79	7.15	0.00	1.33	0.00	0.00	0.00
11.93	6.87	0.00	1.31	0.00	0.00	0.00
12.07	6.72	0.00	1.26	0.00	0.00	0.00
12.21	6.70	0.00	1.24	0.00	0.00	0.00
12.35	6.68	0.00	1.28	0.00	0.00	0.00
12.48	7.42	0.00	1.31	0.00	0.00	0.00
12.63	7.28	0.00	1.26	0.00	0.00	0.00
12.77	6.12	0.00	1.17	0.00	0.00	0.00
12.91	6.36	0.00	1.08	0.00	0.00	0.00
13.06	6.09	0.00	1.05	0.00	0.00	0.00
13.18	5.83	0.00	1.02	0.00	0.00	0.00
13.33	6.07	0.00	1.06	0.00	0.00	0.00
13.46	6.81	0.00	1.10	0.00	0.00	0.00
13.61	6.42	0.00	1.01	0.00	0.00	0.00
13.67	4.90	0.00	1.67	0.00	0.00	0.00
13.94	49.25	1.05	0.25	0.94	1.05	3.44
14.13	91.23	0.38	0.41	0.86	0.38	0.85
14.28	97.87	0.33	0.45	0.81	0.33	0.58
14.40	82.68	0.46	0.37	0.91	0.46	0.69
14.59	63.74	0.73	0.29	0.94	0.73	1.60
14.74	53.35	0.94	0.25	0.94	0.94	1.74
14.91	60.74	0.78	0.28	0.94	0.78	1.61
15.07	78.50	0.51	0.34	0.92	0.51	1.01
15.23	132.46	0.14	0.66	0.46	0.13	0.24
15.41	184.00	0.04	1.98	-0.22	0.00	0.00
15.56	232.99	0.01	2.00	-0.95	0.00	0.00
15.73	265.80	0.00	2.00	-1.46	0.00	0.00
15.90	280.14	0.00	2.00	-1.69	0.00	0.00
16.06	275.96	0.00	2.00	-1.62	0.00	0.00
16.23	281.45	0.00	2.00	-1.71	0.00	0.00
16.39	299.94	0.00	2.00	-2.00	0.00	0.00
16.57	289.83	0.00	2.00	-1.84	0.00	0.00
16.72	264.14	0.00	2.00	-1.44	0.00	0.00
16.88	238.39	0.00	2.00	-1.03	0.00	0.00
17.19	234.70	0.01	2.00	-0.98	0.00	0.00
17.37	304.63	0.00	2.00	-2.08	0.00	0.00
17.52	330.29	0.00	2.00	-2.49	0.00	0.00
17.69	350.09	0.00	2.00	-2.81	0.00	0.00
17.86	368.38	0.00	2.00	-3.10	0.00	0.00
18.01	356.75	0.00	2.00	-2.91	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
18.18	351.89	0.00	2.00	-2.83	0.00	0.00
18.34	351.79	0.00	2.00	-2.83	0.00	0.00
18.47	347.70	0.00	2.00	-2.77	0.00	0.00
18.59	337.89	0.00	2.00	-2.61	0.00	0.00
18.71	325.94	0.00	2.00	-2.42	0.00	0.00
18.84	312.94	0.00	2.00	-2.21	0.00	0.00
18.96	299.92	0.00	2.00	-2.00	0.00	0.00
19.09	284.62	0.00	2.00	-1.76	0.00	0.00
19.23	269.74	0.00	2.00	-1.52	0.00	0.00
19.35	256.01	0.00	2.00	-1.31	0.00	0.00
19.47	249.74	0.00	2.00	-1.21	0.00	0.00
19.59	256.84	0.00	2.00	-1.32	0.00	0.00
19.72	262.74	0.00	2.00	-1.41	0.00	0.00
19.84	256.90	0.00	2.00	-1.32	0.00	0.00
19.96	239.45	0.00	2.00	-1.05	0.00	0.00
20.08	218.51	0.01	2.00	-0.73	0.00	0.00
20.21	203.69	0.02	2.00	-0.51	0.00	0.00
20.27	182.25	0.04	1.65	-0.19	0.01	0.01
20.45	181.20	0.04	1.58	-0.18	0.01	0.02
20.54	173.51	0.05	1.26	-0.07	0.02	0.02
20.65	171.33	0.05	1.19	-0.04	0.02	0.03
20.75	169.88	0.05	1.14	-0.02	0.03	0.03
20.84	168.31	0.06	1.09	0.00	0.03	0.03
20.95	143.36	0.11	0.68	0.33	0.09	0.12
21.05	129.37	0.16	0.56	0.50	0.16	0.18
21.15	138.58	0.12	0.63	0.39	0.12	0.15
21.27	147.15	0.10	0.72	0.28	0.07	0.10
21.36	142.36	0.11	0.67	0.34	0.10	0.11
21.46	135.52	0.13	0.60	0.43	0.13	0.16
21.57	127.70	0.16	0.54	0.52	0.16	0.22
21.66	128.02	0.16	0.54	0.52	0.16	0.18
21.76	124.19	0.18	0.52	0.56	0.18	0.20
21.88	105.77	0.27	0.42	0.74	0.27	0.37
21.97	88.15	0.41	0.34	0.88	0.41	0.46
22.09	95.39	0.35	0.37	0.83	0.35	0.49
22.18	113.06	0.23	0.45	0.68	0.23	0.26
22.29	115.80	0.21	0.47	0.65	0.21	0.28
22.40	108.19	0.26	0.43	0.72	0.26	0.32
22.50	100.04	0.31	0.39	0.79	0.31	0.38
22.61	107.46	0.26	0.42	0.73	0.26	0.34
22.70	125.97	0.17	0.52	0.54	0.17	0.19
22.81	151.68	0.09	0.76	0.23	0.06	0.08
22.91	155.76	0.08	0.81	0.17	0.05	0.06
23.02	154.12	0.08	0.79	0.19	0.06	0.07
23.13	149.43	0.09	0.73	0.25	0.07	0.09
23.22	138.13	0.13	0.61	0.40	0.13	0.15
23.44	129.41	0.16	0.54	0.50	0.16	0.40
23.53	134.75	0.14	0.58	0.44	0.14	0.16

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
23.65	175.21	0.05	1.25	-0.09	0.02	0.03
23.74	172.18	0.05	1.16	-0.05	0.03	0.03
23.84	147.59	0.10	0.70	0.28	0.08	0.09
23.96	129.73	0.15	0.54	0.50	0.15	0.21
24.06	147.39	0.10	0.69	0.28	0.08	0.10
24.17	161.92	0.07	0.91	0.09	0.04	0.06
24.26	173.34	0.05	1.19	-0.07	0.02	0.03
24.38	187.02	0.03	1.80	-0.26	0.00	0.01
24.48	206.58	0.02	2.00	-0.55	0.00	0.00
24.60	218.89	0.01	2.00	-0.73	0.00	0.00
24.69	212.47	0.01	2.00	-0.64	0.00	0.00
24.81	212.33	0.01	2.00	-0.64	0.00	0.00
24.90	235.36	0.01	2.00	-0.99	0.00	0.00
25.02	299.34	0.00	2.00	-1.99	0.00	0.00
25.11	280.16	0.00	2.00	-1.69	0.00	0.00
25.22	256.34	0.00	2.00	-1.31	0.00	0.00
25.33	448.02	0.00	2.00	-4.38	0.00	0.00
25.50	661.33	0.00	2.00	-7.71	0.00	0.00
25.60	707.62	0.00	2.00	-8.41	0.00	0.00

Total estimated displacement: 17.98

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.27	128.74	206.81	1.00	206.81	1.34	0.93	0.93
2.46	122.27	196.40	1.04	204.67	1.71	0.93	0.93
2.65	113.65	182.53	1.10	200.36	1.79	0.70	0.92
2.85	103.74	166.59	1.17	194.11	1.87	0.48	0.90
2.98	94.12	151.11	1.21	182.61	1.92	0.42	0.89
3.13	84.43	135.54	1.25	169.23	1.96	0.24	0.87
3.28	77.41	124.24	1.26	156.78	1.97	0.19	0.86
3.43	76.01	121.98	1.23	150.31	1.94	0.21	0.86
3.57	74.36	119.31	1.20	142.72	1.91	0.21	0.85
3.71	66.30	106.35	1.22	129.73	1.93	0.17	0.84
3.86	51.38	82.37	1.38	113.32	2.05	0.12	0.80
3.95	38.79	62.13	1.72	106.88	2.22	0.08	0.76
4.11	28.49	45.57	2.33	106.18	2.40	0.08	0.72
4.24	24.77	39.58	2.57	101.66	2.46	0.07	0.70
4.36	22.47	35.88	2.69	96.63	2.48	0.07	0.69
4.48	22.19	35.42	2.63	93.10	2.47	0.07	0.69
4.62	21.27	33.92	2.68	90.85	2.48	0.07	0.69
4.75	21.58	34.41	2.50	85.86	2.44	0.06	0.69
4.87	28.55	45.59	1.82	82.95	2.26	0.07	0.72
5.00	36.19	57.86	1.50	86.82	2.12	0.10	0.75
5.14	38.54	61.62	1.44	88.91	2.09	0.10	0.76
5.27	34.20	54.64	1.53	83.69	2.14	0.08	0.75
5.42	33.14	52.92	1.45	76.54	2.10	0.07	0.74
5.55	35.40	56.55	1.29	72.84	1.99	0.09	0.75
5.69	38.82	62.02	1.00	62.02	1.90	0.09	0.76
5.84	40.16	64.16	1.00	64.16	1.87	0.09	0.77
5.97	43.63	69.73	1.00	69.73	1.85	0.09	0.78
6.12	47.80	76.42	1.14	87.33	1.85	0.11	0.79
6.25	52.19	83.46	1.15	96.21	1.86	0.12	0.80
6.40	51.55	82.42	1.22	100.91	1.94	0.13	0.80
6.53	45.37	72.47	1.38	100.23	2.06	0.11	0.78
6.68	36.61	58.38	1.64	95.87	2.19	0.08	0.75
6.82	33.14	52.79	1.68	88.79	2.21	0.08	0.74
6.96	33.67	53.63	1.55	82.93	2.15	0.09	0.74
7.10	31.37	49.93	1.60	79.78	2.17	0.09	0.73
7.33	25.02	39.70	2.05	81.49	2.33	0.07	0.71
7.47	17.85	28.18	3.09	87.14	2.56	0.06	0.66
7.60	13.82	21.70	4.24	91.97	2.73	0.06	3.00
7.75	11.31	17.64	5.35	94.42	2.86	0.06	2.38
7.89	9.96	15.47	6.11	94.58	2.94	0.06	2.04
8.03	9.74	15.10	6.14	92.63	2.94	0.06	1.95
8.15	11.87	18.50	4.73	87.61	2.79	0.06	2.34
8.30	22.34	35.31	2.26	79.78	2.39	0.06	0.69
8.44	29.53	46.85	1.75	81.93	2.23	0.10	0.73
8.58	31.37	49.80	1.76	87.64	2.24	0.08	0.73
8.73	23.20	36.66	2.56	93.95	2.46	0.07	0.70
8.87	16.71	26.21	3.79	99.40	2.67	0.07	2.98
9.00	13.24	20.62	4.79	98.88	2.80	0.06	2.30

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
9.15	10.97	16.97	5.47	92.88	2.88	0.06	1.85
9.28	9.18	14.08	5.78	81.42	2.91	0.06	1.51
9.43	6.88	10.38	6.45	67.00	2.97	0.06	1.10
9.55	4.90	7.18	7.49	53.77	3.06	0.06	0.75
9.71	4.25	6.13	7.97	48.91	3.10	0.06	0.63
9.84	4.53	6.57	7.65	50.28	3.08	0.06	0.66
9.98	4.98	7.28	7.21	52.52	3.04	0.06	0.72
10.13	5.04	7.36	7.22	53.13	3.04	0.06	0.72
10.26	5.12	7.49	7.18	53.76	3.04	0.06	0.72
10.41	5.63	8.29	6.83	56.61	3.01	0.06	0.79
10.68	6.05	8.94	6.57	58.75	2.98	0.06	0.83
10.83	6.33	9.38	6.39	59.98	2.97	0.06	0.87
10.96	6.38	9.46	6.46	61.11	2.97	0.06	0.87
11.11	6.47	9.58	6.67	63.92	2.99	0.06	0.88
11.23	6.47	9.57	6.82	65.27	3.01	0.06	0.87
11.38	5.83	8.53	7.32	62.44	3.05	0.06	0.77
11.51	5.07	7.30	7.75	56.62	3.09	0.06	0.66
11.66	4.51	6.39	8.10	51.78	3.11	0.06	0.57
11.79	4.43	6.25	7.96	49.73	3.10	0.06	0.56
11.93	4.40	6.19	8.00	49.53	3.11	0.06	0.55
12.07	4.31	6.04	8.10	48.95	3.11	0.06	0.53
12.21	4.29	5.99	7.94	47.54	3.10	0.06	0.53
12.35	4.45	6.25	7.24	45.21	3.04	0.06	0.55
12.48	4.59	6.46	6.59	42.61	2.99	0.05	0.56
12.63	4.48	6.27	6.50	40.80	2.98	0.05	0.55
12.77	4.26	5.90	6.75	39.82	3.00	0.05	0.51
12.91	4.01	5.49	6.87	37.67	3.01	0.05	0.47
13.06	3.95	5.39	6.31	34.00	2.96	0.05	0.46
13.18	3.89	5.29	5.32	28.15	2.86	0.05	0.45
13.33	4.06	5.55	4.40	24.42	2.75	0.05	0.47
13.46	4.20	5.76	4.21	24.27	2.73	0.05	0.49
13.61	3.95	5.35	5.24	28.05	2.85	0.05	0.45
13.67	6.16	8.90	4.79	42.58	2.80	0.05	0.75
13.94	17.58	27.22	2.12	57.57	2.35	0.04	0.66
14.13	31.29	46.59	1.56	72.75	2.15	0.08	0.73
14.28	38.62	56.46	1.43	80.95	2.09	0.09	0.75
14.40	32.35	47.91	1.58	75.87	2.16	0.07	0.73
14.59	21.97	33.40	2.05	68.56	2.33	0.06	0.68
14.74	17.10	26.18	2.38	62.22	2.42	0.05	0.65
14.91	22.53	33.54	1.90	63.68	2.28	0.05	0.68
15.07	47.63	66.12	1.25	82.40	1.96	0.07	0.77
15.23	90.42	118.79	1.05	124.79	1.72	0.16	0.85
15.41	145.39	183.65	1.00	183.65	1.56	0.53	0.92
15.56	194.19	240.40	1.00	240.40	1.49	0.96	0.96
15.73	227.83	279.39	1.00	279.39	1.46	0.98	0.98
15.90	242.36	296.62	1.00	296.62	1.47	0.99	0.99
16.06	247.51	302.01	1.00	302.01	1.47	1.00	1.00
16.23	254.09	308.34	1.00	308.34	1.47	1.00	1.00

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
16.39	258.42	312.47	1.00	312.47	1.47	1.00	1.00
16.57	251.96	304.85	1.00	304.85	1.49	1.00	1.00
16.72	230.86	280.96	1.00	280.96	1.54	0.98	0.98
16.88	212.97	259.58	1.00	259.58	1.56	0.97	0.97
17.19	226.97	273.20	1.00	273.20	1.54	0.98	0.98
17.37	258.65	307.73	1.00	307.73	1.50	1.00	1.00
17.52	297.16	350.46	1.00	350.46	1.47	1.02	1.02
17.69	318.82	373.42	1.00	373.42	1.45	1.03	1.03
17.86	328.61	382.32	1.00	382.32	1.44	1.04	1.04
18.01	330.27	382.15	1.00	382.15	1.43	1.04	1.04
18.18	325.23	375.66	1.00	375.66	1.44	1.03	1.03
18.34	321.03	371.42	1.00	371.42	1.47	1.03	1.03
18.47	314.01	364.70	1.00	364.70	1.50	1.03	1.03
18.59	302.76	352.96	1.00	352.96	1.54	1.02	1.02
18.71	289.19	337.79	1.00	337.79	1.57	1.01	1.01
18.84	275.59	321.90	1.00	321.90	1.59	1.01	1.01
18.96	262.12	305.88	1.00	305.88	1.60	1.00	1.00
19.09	249.19	289.97	1.00	289.97	1.61	0.99	0.99
19.23	237.21	274.86	1.00	274.86	1.60	0.98	0.98
19.35	228.79	263.67	1.00	263.67	1.59	0.97	0.97
19.47	227.73	260.69	1.00	260.69	1.56	0.97	0.97
19.59	232.37	264.30	1.00	264.30	1.54	0.97	0.97
19.72	235.70	266.88	1.00	266.88	1.52	0.98	0.98
19.84	229.43	259.84	1.00	259.84	1.54	0.97	0.97
19.96	213.68	241.93	1.00	241.93	1.56	0.96	0.96
20.08	195.46	220.90	1.00	220.90	1.57	0.95	0.95
20.21	176.34	198.68	1.00	198.68	1.57	0.93	0.93
20.27	162.38	182.88	1.00	182.88	1.58	0.49	0.92
20.45	148.10	167.43	1.00	167.43	1.64	0.42	0.90
20.54	136.88	156.18	1.05	164.30	1.72	0.30	0.89
20.65	124.88	144.33	1.14	164.06	1.84	0.24	0.88
20.75	115.89	135.31	1.23	166.13	1.94	0.21	0.87
20.84	103.52	121.88	1.34	163.03	2.03	0.20	0.86
20.95	90.12	106.62	1.46	155.33	2.10	0.14	0.84
21.05	81.88	96.80	1.51	145.71	2.13	0.12	0.82
21.15	84.57	99.00	1.40	138.60	2.07	0.14	0.83
21.27	90.25	104.42	1.29	134.90	1.99	0.15	0.83
21.36	90.36	103.98	1.26	131.23	1.97	0.15	0.83
21.46	84.31	97.23	1.32	128.20	2.01	0.14	0.82
21.57	78.91	91.27	1.40	127.99	2.07	0.12	0.81
21.66	74.83	86.51	1.44	124.91	2.09	0.12	0.81
21.76	68.25	78.80	1.48	116.94	2.12	0.12	0.79
21.88	56.94	65.90	1.64	108.16	2.19	0.10	0.77
21.97	48.54	56.54	1.94	109.68	2.30	0.08	0.75
22.09	49.97	58.14	1.98	115.26	2.31	0.09	0.75
22.18	57.07	66.03	1.83	120.53	2.26	0.10	0.77
22.29	60.31	69.55	1.80	124.87	2.25	0.11	0.78
22.40	56.85	65.67	1.96	128.71	2.30	0.10	0.77

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
22.50	54.84	63.32	2.06	130.54	2.33	0.09	0.77
22.61	61.07	69.88	1.82	127.52	2.26	0.10	0.78
22.70	78.04	87.92	1.45	127.61	2.10	0.12	0.81
22.81	95.15	105.82	1.27	134.28	1.98	0.16	0.84
22.91	105.41	116.37	1.20	140.15	1.92	0.18	0.85
23.02	104.37	115.14	1.22	140.77	1.93	0.17	0.85
23.13	96.66	107.05	1.31	140.33	2.01	0.16	0.84
23.22	86.81	96.67	1.46	141.19	2.10	0.14	0.82
23.44	81.41	90.67	1.61	145.54	2.17	0.12	0.81
23.53	91.80	101.75	1.52	154.66	2.13	0.13	0.83
23.65	104.55	115.12	1.42	163.18	2.08	0.21	0.85
23.74	108.07	118.58	1.39	165.19	2.06	0.20	0.85
23.84	95.14	104.59	1.52	158.45	2.13	0.15	0.83
23.96	88.09	96.75	1.59	154.05	2.17	0.12	0.82
24.06	94.67	103.25	1.47	151.73	2.11	0.15	0.83
24.17	112.57	121.24	1.26	152.87	1.97	0.19	0.85
24.26	131.74	140.33	1.14	159.92	1.84	0.25	0.88
24.38	150.43	159.01	1.08	172.09	1.77	0.36	0.89
24.48	164.23	173.46	1.09	188.65	1.77	0.55	0.91
24.60	167.20	177.07	1.14	201.02	1.84	0.63	0.91
24.69	163.48	173.72	1.20	208.78	1.91	0.46	0.91
24.81	166.20	176.59	1.24	218.84	1.95	0.43	0.91
24.90	193.78	205.01	1.20	245.31	1.91	0.83	0.93
25.02	225.59	237.19	1.14	271.13	1.85	0.96	0.96
25.11	251.39	260.47	1.01	264.00	1.66	0.97	0.97
25.22	321.14	323.96	1.00	323.96	1.29	1.01	1.01
25.33	459.49	518.17	1.00	518.17	-1.00	1.09	1.09
25.50	595.96	670.85	1.00	670.85	-1.00	1.14	1.14
25.60	699.17	786.17	1.00	786.17	-1.00	1.17	1.17

Abbreviations

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

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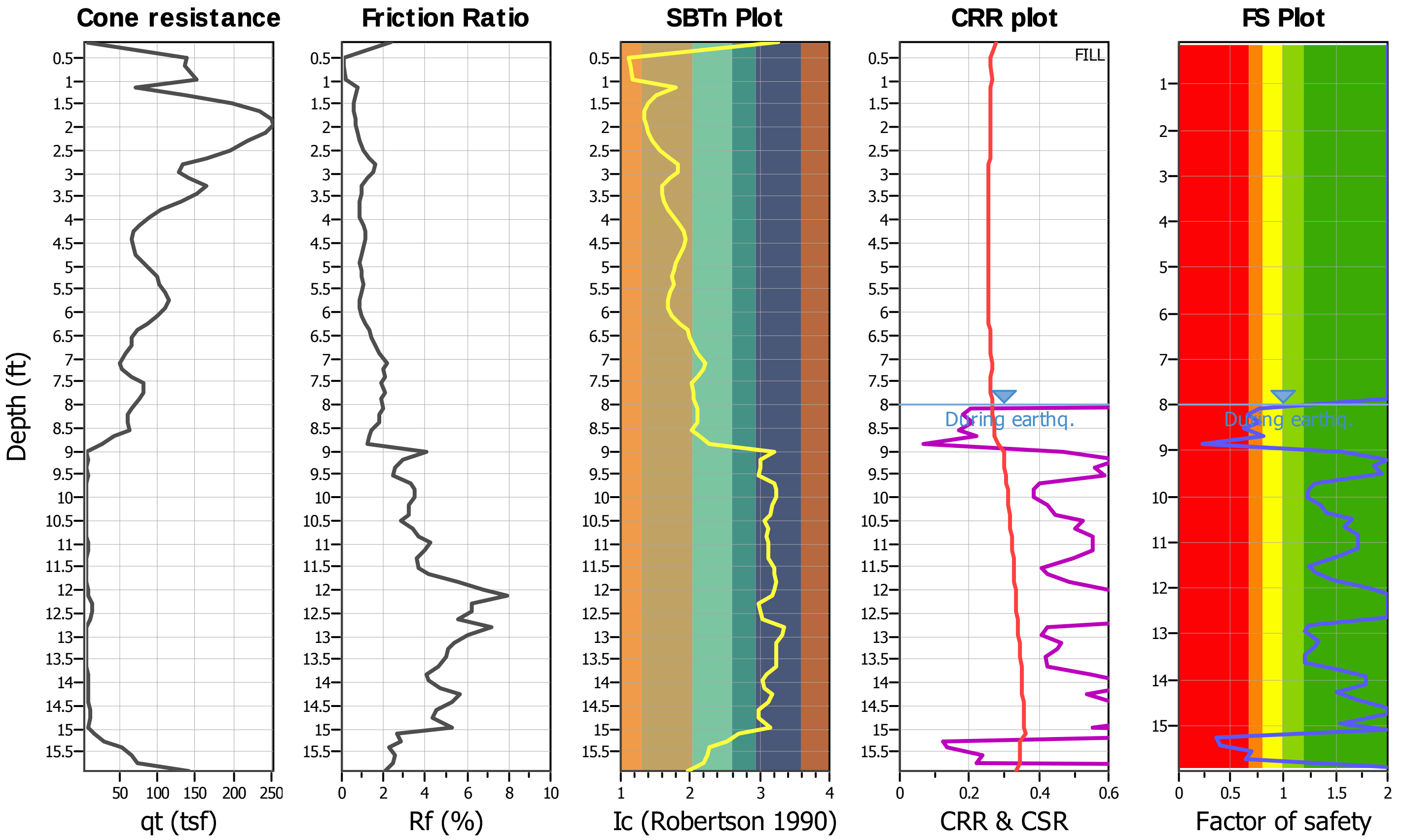
LIQUEFACTION ANALYSIS REPORT

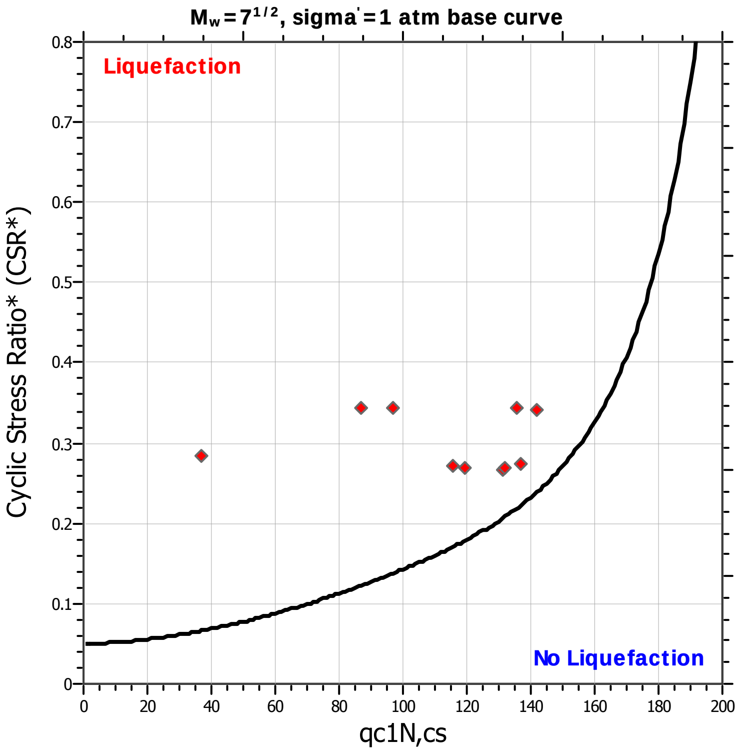
Project title : **Location :**

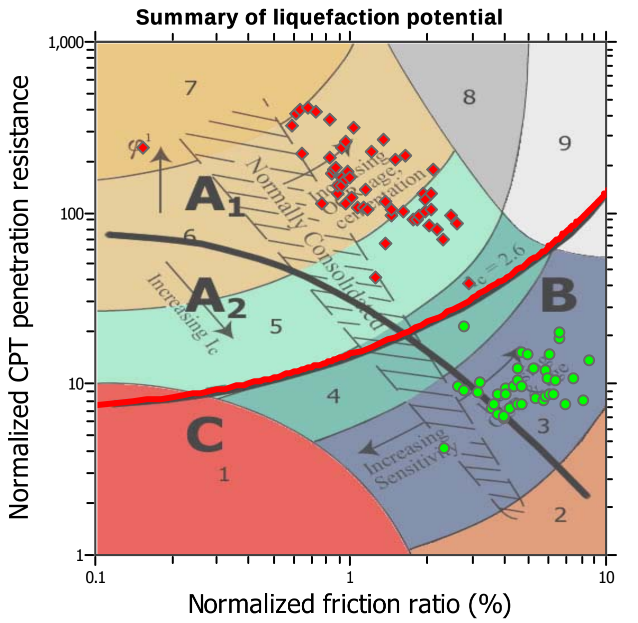
CPT file : CPT-5

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.00 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.00 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

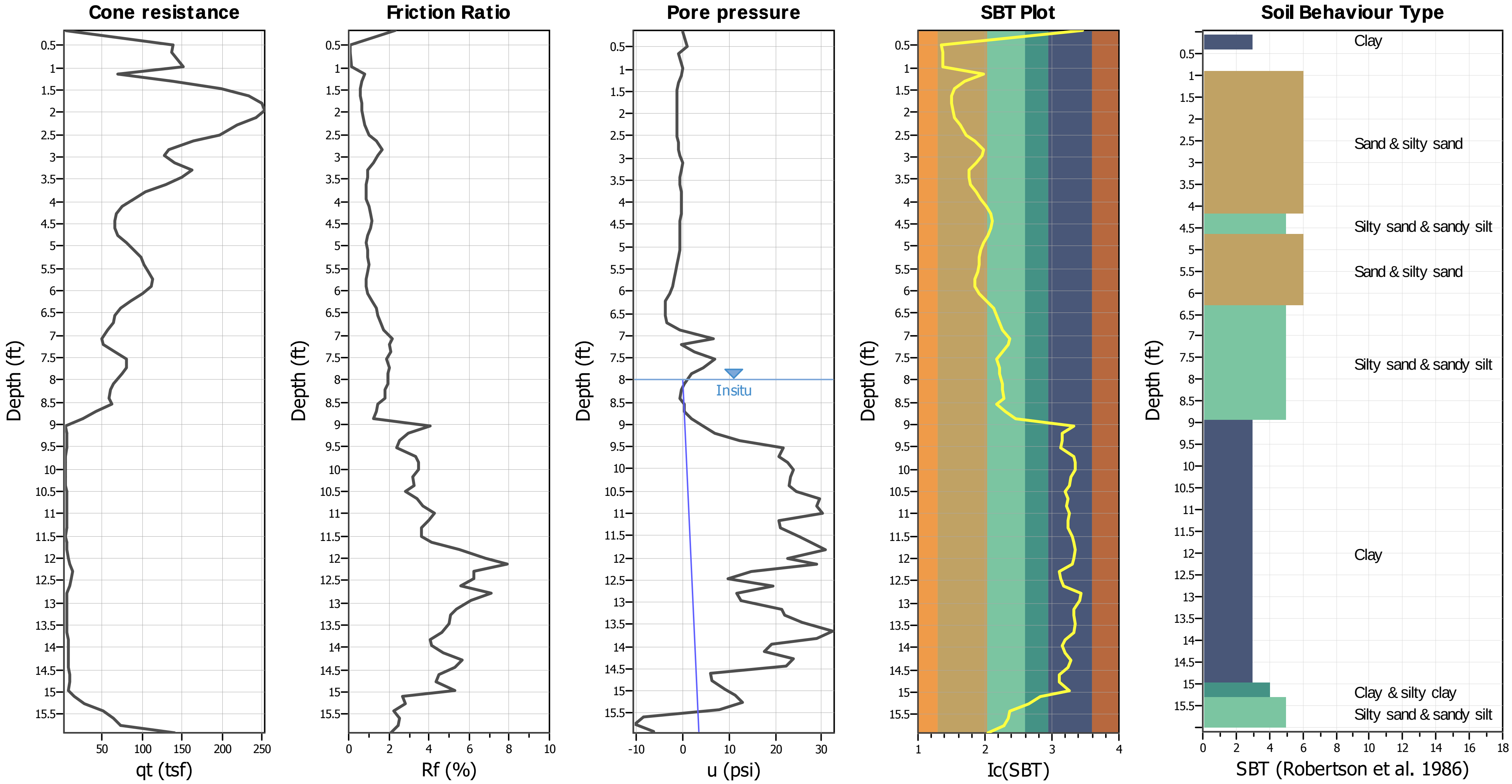






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



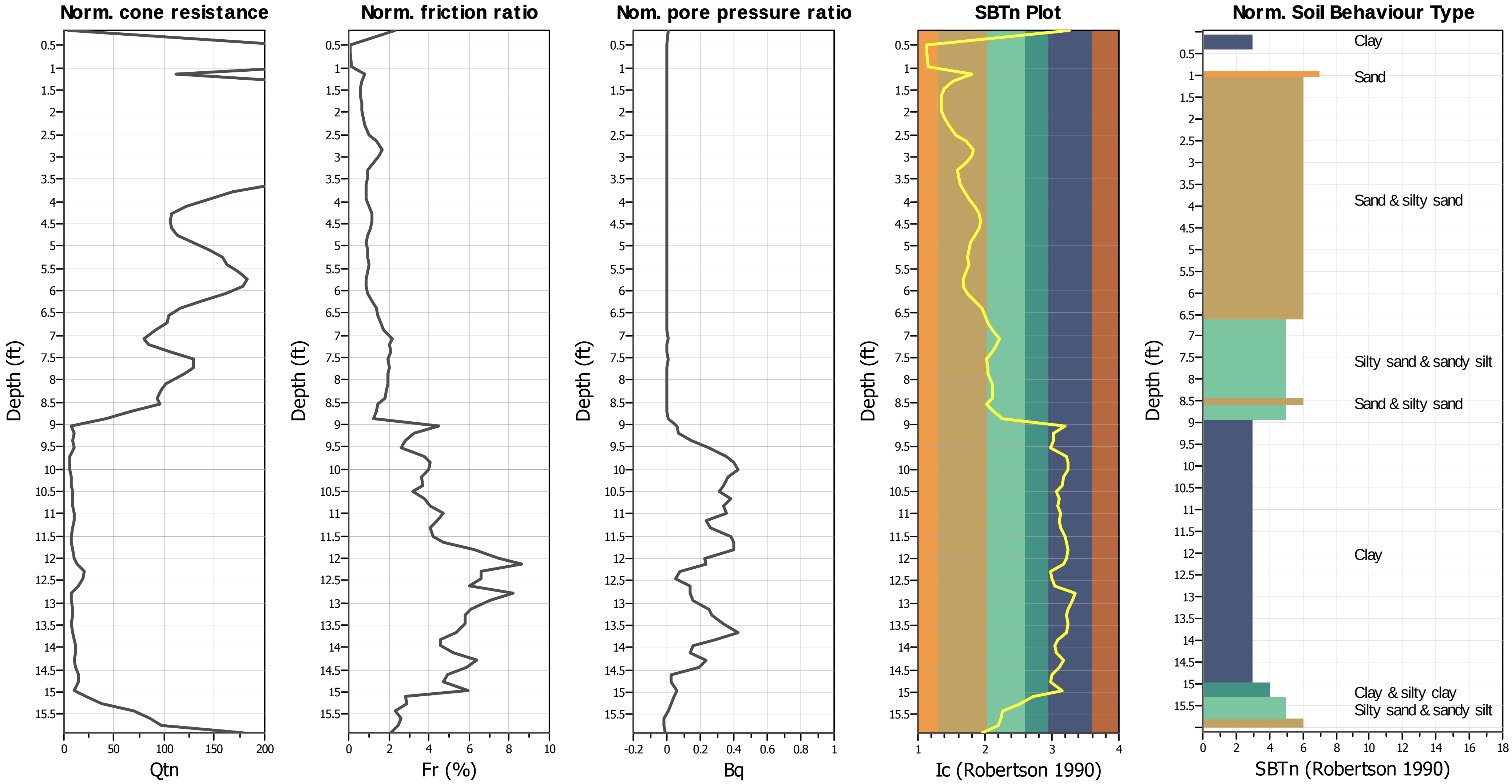
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	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)



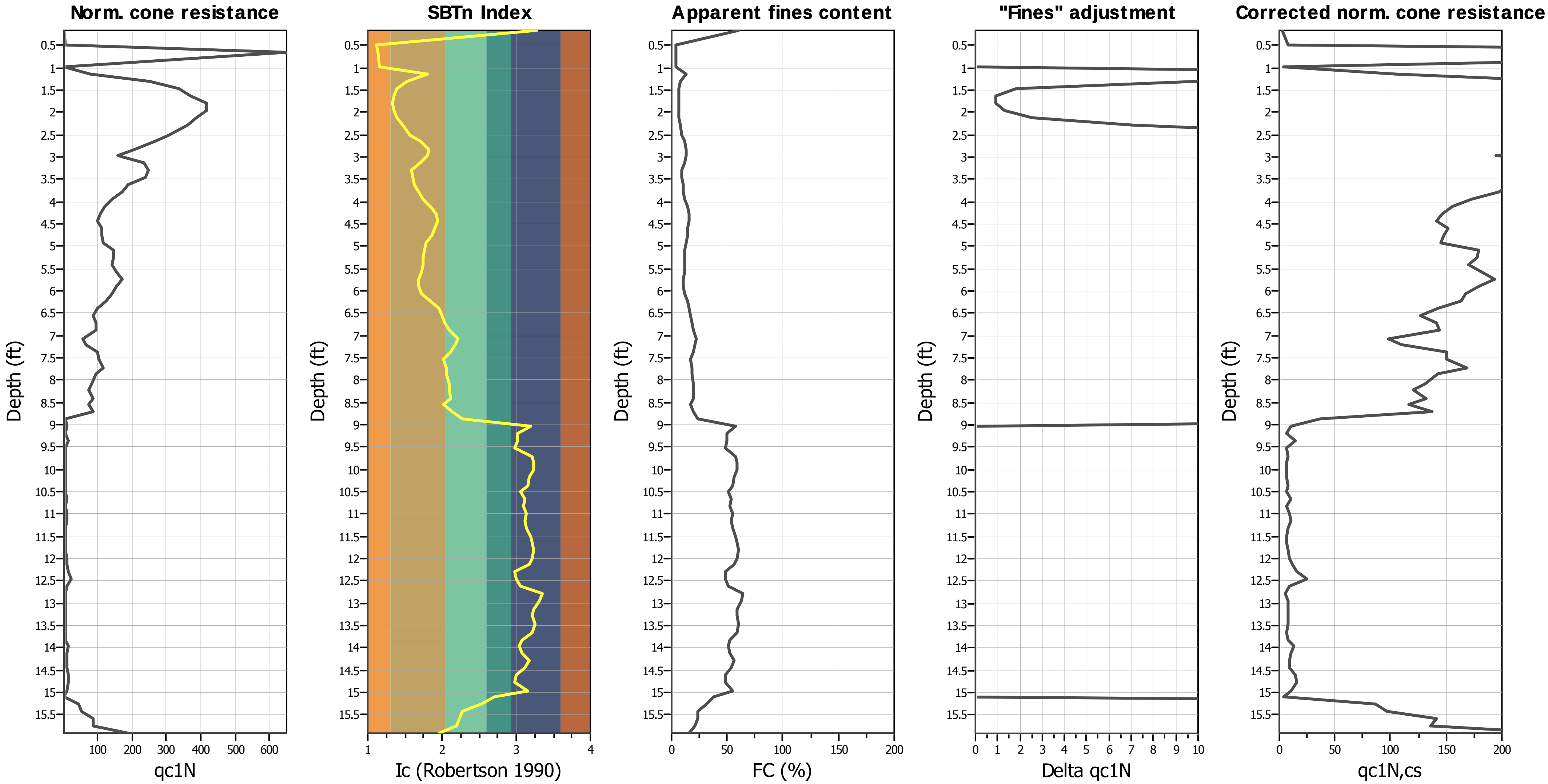
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	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

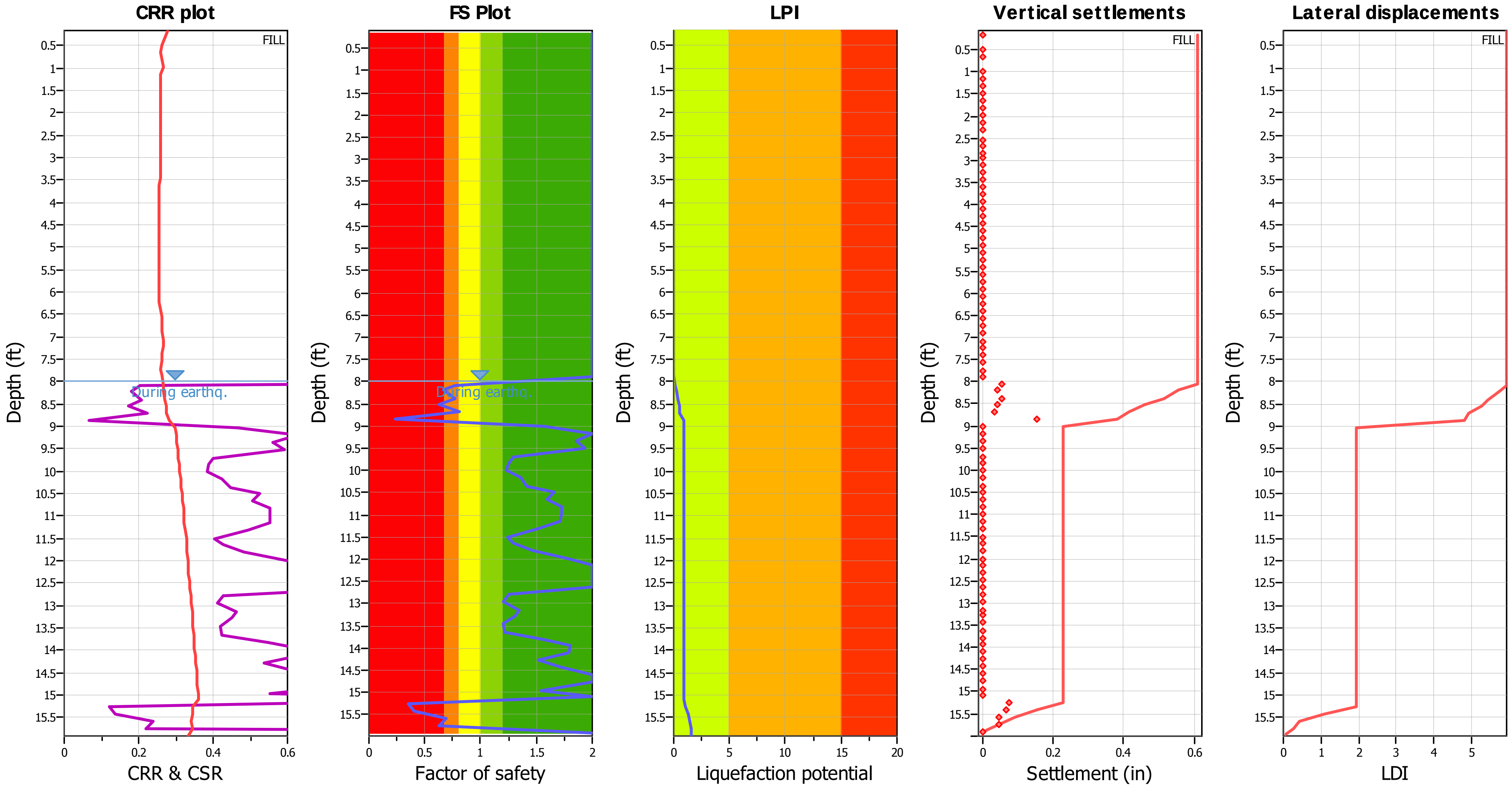
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

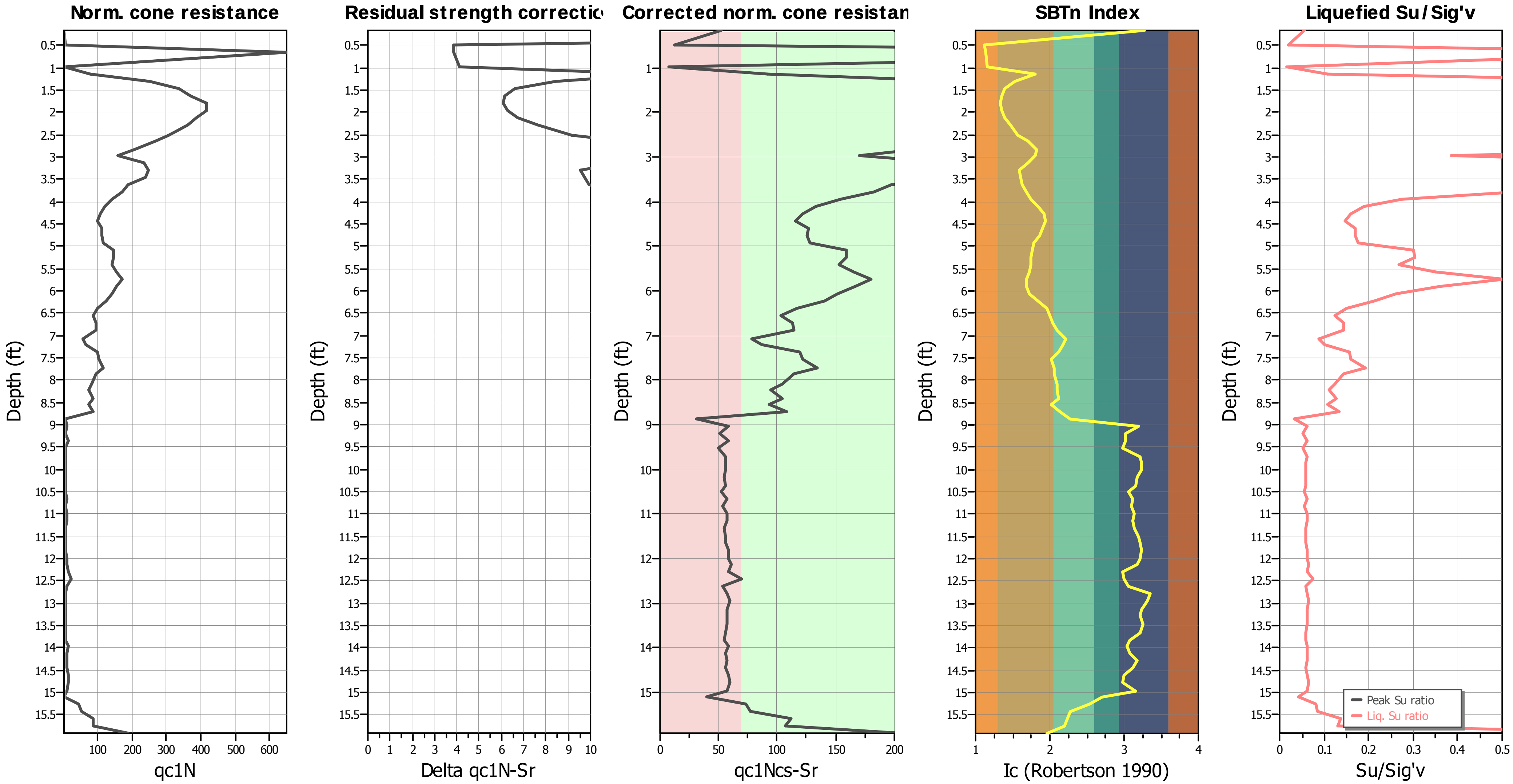
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.00 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.16	1.32	0.04	0.21	78.20	92.00
2	0.49	5.08	0.09	1.10	0.00	102.85
3	0.66	403.88	0.02	-0.93	0.00	105.67
4	0.98	2.16	0.19	0.11	0.00	111.92
5	1.15	49.44	0.49	-0.17	8.13	116.05
6	1.31	157.57	0.92	-0.80	3.12	121.45
7	1.48	210.21	1.26	-1.17	1.33	124.42
8	1.64	231.39	1.37	-1.23	0.89	126.16
9	1.80	259.95	1.64	-1.14	0.84	127.13
10	1.97	258.34	1.76	-1.26	1.03	127.71
11	2.13	242.02	1.74	-1.21	1.47	127.79
12	2.30	224.98	1.78	-1.13	2.37	127.82
13	2.53	191.72	1.95	-1.01	3.88	128.31
14	2.66	172.76	2.34	-0.94	6.27	128.58
15	2.82	131.12	2.38	-0.73	8.81	127.95
16	2.95	97.37	1.85	-0.51	8.31	126.86
17	3.12	157.89	1.50	0.11	6.38	126.23
18	3.28	168.19	1.74	-0.16	4.26	125.91
19	3.44	163.95	1.41	-0.56	4.49	124.85
20	3.61	118.70	0.99	-0.37	4.71	122.74
21	3.77	107.72	0.86	-0.34	5.98	120.75
22	3.94	88.56	0.82	-0.31	7.18	119.57
23	4.10	74.03	0.71	-0.26	9.11	118.82
24	4.26	65.86	0.75	-0.24	10.83	118.49
25	4.43	62.46	0.80	-0.39	11.30	118.53
26	4.59	69.18	0.74	-0.56	10.50	118.02
27	4.76	69.46	0.58	-0.57	9.37	117.64
28	4.92	72.09	0.66	-0.55	7.96	118.42
29	5.08	99.32	0.87	-0.60	7.43	120.00
30	5.25	100.81	0.99	-0.72	7.08	121.06
31	5.41	96.08	0.98	-1.00	7.13	121.64
32	5.58	108.24	1.07	-1.44	6.52	122.06
33	5.74	122.22	1.10	-1.71	5.72	121.82
34	5.91	111.37	0.83	-2.12	5.76	121.39
35	6.07	99.13	0.93	-2.79	6.79	120.93
36	6.23	89.85	1.02	-3.77	9.07	120.99
37	6.40	70.22	0.99	-3.65	11.68	120.67
38	6.56	58.65	0.96	-3.57	12.99	119.99
39	6.73	67.56	0.86	-3.38	14.07	120.72
40	6.89	67.71	1.30	-0.51	15.87	120.19
41	7.09	37.36	0.86	6.57	19.30	120.41
42	7.22	45.59	1.09	-0.18	18.19	120.37
43	7.38	74.47	1.23	2.63	16.16	122.77
44	7.55	78.00	1.77	7.00	13.69	124.21
45	7.74	90.42	1.65	4.56	14.37	124.63
46	7.87	72.68	1.52	1.89	14.38	123.58
47	8.07	63.44	1.20	0.38	15.98	122.08
48	8.20	56.05	1.05	-0.31	15.84	121.17

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	8.40	64.38	1.13	-0.37	16.20	120.71
50	8.53	56.04	1.04	0.45	13.70	119.54
51	8.69	67.92	0.52	0.58	16.76	115.46
52	8.86	4.93	0.19	2.01	21.43	110.00
53	9.02	6.49	0.27	4.64	73.30	102.82
54	9.19	3.90	0.17	6.89	59.40	103.23
55	9.35	9.66	0.17	12.44	59.63	101.16
56	9.51	4.36	0.13	21.62	57.30	101.30
57	9.71	4.73	0.17	20.86	73.61	100.29
58	9.84	3.85	0.16	22.50	75.58	100.50
59	10.01	4.03	0.15	23.98	75.69	100.43
60	10.17	4.65	0.17	23.31	70.52	100.72
61	10.37	5.27	0.16	22.98	69.40	101.35
62	10.50	4.76	0.18	24.66	62.32	101.91
63	10.66	7.18	0.18	29.67	66.25	102.90
64	10.83	4.70	0.24	28.87	65.16	104.31
65	10.99	6.27	0.29	30.17	67.81	105.49
66	11.15	7.48	0.30	20.73	66.27	104.99
67	11.32	4.91	0.18	21.10	67.53	103.48
68	11.52	4.64	0.17	25.00	73.33	101.87
69	11.65	4.58	0.21	27.54	74.24	103.27
70	11.81	5.52	0.29	30.93	76.26	106.57
71	12.01	6.72	0.50	22.61	74.26	110.04
72	12.14	8.62	0.70	28.88	71.44	113.29
73	12.30	11.04	0.96	14.80	57.28	115.04
74	12.47	18.62	0.78	9.71	58.79	114.33
75	12.63	6.20	0.53	19.57	61.94	111.45
76	12.79	4.13	0.34	11.71	84.93	107.77
77	12.96	5.87	0.33	12.54	82.14	106.34
78	13.16	5.76	0.32	21.29	75.43	106.53
79	13.29	5.97	0.32	22.07	75.00	106.00
80	13.45	5.37	0.27	25.74	76.79	105.31
81	13.65	4.56	0.26	32.35	74.75	104.96
82	13.81	6.18	0.28	28.89	64.50	106.27
83	13.94	10.08	0.36	19.29	61.07	107.59
84	14.11	7.75	0.39	17.68	63.46	108.70
85	14.27	6.51	0.44	24.04	71.58	108.66
86	14.44	6.68	0.41	22.47	66.49	109.36
87	14.60	10.81	0.46	6.12	57.89	110.24
88	14.76	12.48	0.51	6.22	56.89	110.14
89	14.96	7.43	0.38	9.09	69.17	108.72
90	15.09	2.88	0.34	11.30	41.08	110.30
91	15.26	34.99	0.50	12.82	31.91	116.43
92	15.42	44.21	1.47	7.94	21.40	121.06
93	15.58	76.50	1.54	-8.29	20.50	124.14
94	15.75	73.47	1.96	-10.21	18.72	125.17
95	15.91	175.79	3.43	-6.27	12.01	130.24

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.16	0.13	0.00	0.13	1.00	0.273	1.05	0.259	1.08	1.10	2.000	No
2	2.49	0.15	0.00	0.15	1.00	0.273	1.05	0.259	1.09	1.10	2.000	No
3	2.66	0.16	0.00	0.16	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
4	2.98	0.18	0.00	0.18	1.00	0.273	1.05	0.259	1.07	1.10	2.000	No
5	3.15	0.19	0.00	0.19	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
6	3.31	0.20	0.00	0.20	1.00	0.273	1.05	0.259	1.10	1.10	2.000	No
7	3.48	0.21	0.00	0.21	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
8	3.64	0.22	0.00	0.22	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
9	3.80	0.23	0.00	0.23	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
10	3.97	0.24	0.00	0.24	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
11	4.13	0.25	0.00	0.25	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
12	4.30	0.26	0.00	0.26	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
13	4.53	0.27	0.00	0.27	1.00	0.272	1.05	0.258	1.10	1.10	2.000	No
14	4.66	0.28	0.00	0.28	0.99	0.272	1.05	0.258	1.10	1.10	2.000	No
15	4.82	0.29	0.00	0.29	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
16	4.95	0.30	0.00	0.30	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
17	5.12	0.31	0.00	0.31	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
18	5.28	0.32	0.00	0.32	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
19	5.45	0.33	0.00	0.33	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
20	5.61	0.34	0.00	0.34	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
21	5.77	0.35	0.00	0.35	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
22	5.94	0.36	0.00	0.36	0.99	0.271	1.05	0.257	1.10	1.10	2.000	No
23	6.10	0.37	0.00	0.37	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
24	6.26	0.38	0.00	0.38	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
25	6.43	0.39	0.00	0.39	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
26	6.59	0.40	0.00	0.40	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
27	6.76	0.41	0.00	0.41	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
28	6.92	0.42	0.00	0.42	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
29	7.08	0.43	0.00	0.43	0.99	0.270	1.05	0.256	1.10	1.10	2.000	No
30	7.25	0.44	0.00	0.44	0.99	0.269	1.05	0.256	1.10	1.10	2.000	No
31	7.41	0.45	0.00	0.45	0.99	0.269	1.05	0.255	1.10	1.10	2.000	No
32	7.58	0.46	0.00	0.46	0.99	0.269	1.05	0.255	1.10	1.10	2.000	No
33	7.74	0.47	0.00	0.47	0.99	0.269	1.05	0.255	1.10	1.10	2.000	No
34	7.91	0.48	0.00	0.48	0.99	0.269	1.05	0.255	1.10	1.10	2.000	No
35	8.07	0.49	0.00	0.49	0.98	0.269	1.05	0.255	1.10	1.10	2.000	No
36	8.23	0.50	0.00	0.50	0.98	0.269	1.05	0.255	1.10	1.10	2.000	No
37	8.40	0.51	0.00	0.51	0.98	0.269	1.05	0.255	1.08	1.10	2.000	No
38	8.56	0.52	0.00	0.52	0.98	0.268	1.05	0.255	1.07	1.10	2.000	No
39	8.73	0.53	0.00	0.53	0.98	0.268	1.05	0.254	1.07	1.10	2.000	No
40	8.89	0.54	0.00	0.54	0.98	0.268	1.05	0.254	1.07	1.10	2.000	No
41	9.09	0.55	0.00	0.55	0.98	0.268	1.05	0.254	1.05	1.10	2.000	No
42	9.22	0.56	0.00	0.56	0.98	0.268	1.05	0.254	1.05	1.10	2.000	No
43	9.38	0.57	0.00	0.57	0.98	0.268	1.05	0.254	1.07	1.10	2.000	No
44	9.55	0.58	0.00	0.58	0.98	0.267	1.05	0.254	1.07	1.10	2.000	No
45	9.74	0.59	0.00	0.59	0.98	0.267	1.05	0.254	1.07	1.10	2.000	No
46	9.87	0.60	0.00	0.60	0.98	0.267	1.05	0.253	1.06	1.10	2.000	No
47	10.07	0.61	0.00	0.61	0.98	0.268	1.05	0.254	1.05	1.10	0.266	No
48	10.20	0.62	0.01	0.61	0.98	0.270	1.05	0.256	1.05	1.10	0.268	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	10.40	0.63	0.01	0.62	0.98	0.272	1.05	0.258	1.05	1.10	0.270	No
50	10.53	0.64	0.02	0.62	0.98	0.274	1.05	0.260	1.05	1.10	0.273	No
51	10.69	0.65	0.02	0.63	0.98	0.276	1.05	0.261	1.05	1.10	0.274	No
52	10.86	0.66	0.03	0.63	0.98	0.278	1.05	0.263	1.02	1.10	0.283	No
53	11.02	0.67	0.03	0.63	0.97	0.280	1.05	0.265	1.02	1.10	0.298	No
54	11.19	0.67	0.04	0.64	0.97	0.281	1.05	0.267	1.02	1.10	0.301	No
55	11.35	0.68	0.04	0.64	0.97	0.283	1.05	0.269	1.02	1.10	0.302	No
56	11.51	0.69	0.05	0.64	0.97	0.285	1.05	0.270	1.02	1.10	0.305	No
57	11.71	0.70	0.05	0.65	0.97	0.287	1.05	0.273	1.02	1.10	0.307	No
58	11.84	0.71	0.06	0.65	0.97	0.289	1.05	0.274	1.02	1.10	0.309	No
59	12.01	0.72	0.06	0.65	0.97	0.291	1.05	0.276	1.02	1.10	0.311	No
60	12.17	0.72	0.07	0.66	0.97	0.292	1.05	0.277	1.02	1.10	0.313	No
61	12.37	0.73	0.07	0.66	0.97	0.295	1.05	0.279	1.02	1.10	0.315	No
62	12.50	0.74	0.08	0.66	0.97	0.296	1.05	0.281	1.02	1.10	0.316	No
63	12.66	0.75	0.08	0.67	0.97	0.298	1.05	0.282	1.02	1.10	0.318	No
64	12.83	0.76	0.09	0.67	0.97	0.299	1.05	0.284	1.02	1.10	0.320	No
65	12.99	0.77	0.09	0.67	0.97	0.301	1.05	0.285	1.02	1.10	0.322	No
66	13.15	0.77	0.10	0.68	0.97	0.303	1.05	0.287	1.02	1.10	0.323	No
67	13.32	0.78	0.10	0.68	0.97	0.304	1.05	0.288	1.02	1.10	0.326	No
68	13.52	0.79	0.11	0.68	0.97	0.306	1.05	0.290	1.02	1.10	0.328	No
69	13.65	0.80	0.11	0.69	0.97	0.307	1.05	0.291	1.02	1.10	0.329	No
70	13.81	0.81	0.12	0.69	0.96	0.309	1.05	0.293	1.02	1.10	0.331	No
71	14.01	0.82	0.13	0.69	0.96	0.311	1.05	0.295	1.02	1.10	0.333	No
72	14.14	0.83	0.13	0.70	0.96	0.312	1.05	0.296	1.02	1.10	0.334	No
73	14.30	0.84	0.13	0.70	0.96	0.313	1.05	0.297	1.02	1.10	0.335	No
74	14.47	0.85	0.14	0.71	0.96	0.315	1.05	0.298	1.02	1.10	0.336	No
75	14.63	0.85	0.14	0.71	0.96	0.316	1.05	0.300	1.02	1.10	0.339	No
76	14.79	0.86	0.15	0.71	0.96	0.317	1.05	0.301	1.02	1.10	0.341	No
77	14.96	0.87	0.15	0.72	0.96	0.319	1.05	0.302	1.02	1.10	0.342	No
78	15.16	0.88	0.16	0.72	0.96	0.320	1.05	0.304	1.02	1.10	0.344	No
79	15.29	0.89	0.16	0.72	0.96	0.322	1.05	0.305	1.02	1.10	0.345	No
80	15.45	0.90	0.17	0.73	0.96	0.323	1.05	0.306	1.02	1.10	0.347	No
81	15.65	0.91	0.18	0.73	0.96	0.324	1.05	0.308	1.02	1.10	0.349	No
82	15.81	0.92	0.18	0.74	0.96	0.326	1.05	0.309	1.02	1.10	0.350	No
83	15.94	0.92	0.19	0.74	0.96	0.327	1.05	0.310	1.02	1.10	0.350	No
84	16.11	0.93	0.19	0.74	0.96	0.328	1.05	0.311	1.02	1.10	0.352	No
85	16.27	0.94	0.20	0.75	0.96	0.329	1.05	0.312	1.02	1.10	0.354	No
86	16.44	0.95	0.20	0.75	0.95	0.330	1.05	0.313	1.02	1.10	0.355	No
87	16.60	0.96	0.21	0.75	0.95	0.332	1.05	0.315	1.02	1.10	0.356	No
88	16.76	0.97	0.21	0.76	0.95	0.333	1.05	0.316	1.02	1.10	0.357	No
89	16.96	0.98	0.22	0.76	0.95	0.334	1.05	0.317	1.01	1.10	0.359	No
90	17.09	0.99	0.22	0.77	0.95	0.335	1.05	0.318	1.01	1.10	0.361	No
91	17.26	1.00	0.23	0.77	0.95	0.336	1.05	0.319	1.02	1.10	0.343	No
92	17.42	1.01	0.23	0.78	0.95	0.337	1.05	0.320	1.02	1.10	0.344	No
93	17.58	1.02	0.24	0.78	0.95	0.338	1.05	0.321	1.03	1.10	0.343	No
94	17.75	1.03	0.24	0.79	0.95	0.339	1.05	0.322	1.03	1.10	0.344	No
95	17.91	1.04	0.25	0.79	0.95	0.340	1.05	0.322	1.07	1.10	0.332	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.16	2.58	60.72	3.27	0.71	1.70	2.13	0.00	2.13	4.000	No	Yes	2.00
2	2.49	138.02	3.82	1.13	0.78	1.70	8.16	0.00	8.16	4.000	No	No	2.00
3	2.66	137.04	3.86	1.13	0.26	1.70	648.90	0.00	648.90	4.000	No	No	2.00
4	2.98	151.82	4.10	1.16	0.78	1.70	3.47	0.00	3.47	4.000	No	No	2.00
5	3.15	69.72	12.91	1.80	0.49	1.70	79.44	25.62	105.05	4.000	No	No	2.00
6	3.31	139.06	8.31	1.52	0.26	1.70	253.16	9.90	263.06	4.000	No	No	2.00
7	3.48	199.71	6.51	1.38	0.26	1.70	337.73	1.83	339.56	4.000	No	No	2.00
8	3.64	233.84	6.06	1.35	0.26	1.70	371.77	0.90	372.66	4.000	No	No	2.00
9	3.80	249.88	6.01	1.34	0.26	1.70	417.65	0.89	418.54	4.000	No	No	2.00
10	3.97	253.42	6.20	1.36	0.26	1.70	415.06	1.28	416.34	4.000	No	No	2.00
11	4.13	241.76	6.66	1.40	0.26	1.70	388.83	2.54	391.37	4.000	No	No	2.00
12	4.30	219.56	7.58	1.47	0.26	1.70	361.47	7.09	368.56	4.000	No	No	2.00
13	4.53	196.48	9.04	1.57	0.26	1.68	304.52	17.98	322.50	4.000	No	No	2.00
14	4.66	165.19	11.26	1.71	0.26	1.66	270.43	38.68	309.11	4.000	No	No	2.00
15	4.82	133.74	13.51	1.83	0.27	1.64	203.09	49.12	252.21	4.000	No	No	2.00
16	4.95	128.79	13.07	1.81	0.34	1.70	156.44	38.51	194.95	4.000	No	No	2.00
17	5.12	141.15	11.36	1.71	0.26	1.58	236.23	35.88	272.10	4.000	No	No	2.00
18	5.28	163.34	9.41	1.59	0.26	1.56	248.07	18.59	266.66	4.000	No	No	2.00
19	5.45	150.28	9.62	1.61	0.26	1.54	238.59	19.90	258.49	4.000	No	No	2.00
20	5.61	130.12	9.83	1.62	0.32	1.67	187.74	18.36	206.10	4.000	No	No	2.00
21	5.77	104.99	11.00	1.69	0.34	1.68	170.90	25.95	196.85	4.000	No	No	2.00
22	5.94	90.10	12.08	1.75	0.37	1.70	142.29	30.15	172.44	4.000	No	No	2.00
23	6.10	76.15	13.76	1.84	0.40	1.70	118.94	36.11	155.06	4.000	No	No	2.00
24	6.26	67.45	15.23	1.92	0.41	1.70	105.81	40.08	145.89	4.000	No	No	2.00
25	6.43	65.83	15.62	1.94	0.42	1.70	100.36	40.40	140.75	4.000	No	No	2.00
26	6.59	67.03	14.95	1.90	0.40	1.70	111.15	40.05	151.21	4.000	No	No	2.00
27	6.76	70.24	13.99	1.86	0.41	1.70	111.59	35.91	147.50	4.000	No	No	2.00
28	6.92	80.28	12.76	1.79	0.41	1.69	115.29	30.35	145.64	4.000	No	No	2.00
29	7.08	90.73	12.30	1.77	0.36	1.56	146.46	32.14	178.60	4.000	No	No	2.00
30	7.25	98.72	11.99	1.75	0.36	1.55	147.23	30.22	177.45	4.000	No	No	2.00
31	7.41	101.70	12.04	1.75	0.37	1.55	140.58	29.64	170.22	4.000	No	No	2.00
32	7.58	108.83	11.49	1.72	0.36	1.51	154.13	27.68	181.80	4.000	No	No	2.00
33	7.74	113.92	10.77	1.68	0.34	1.46	169.20	24.02	193.23	4.000	No	No	2.00
34	7.91	110.88	10.80	1.68	0.36	1.48	156.02	23.00	179.02	4.000	No	No	2.00
35	8.07	100.08	11.73	1.74	0.37	1.49	139.59	27.57	167.16	4.000	No	No	2.00
36	8.23	86.35	13.73	1.84	0.38	1.48	126.10	37.20	163.29	4.000	No	No	2.00
37	8.40	72.86	15.93	1.95	0.41	1.52	101.04	41.66	142.71	4.000	No	No	2.00
38	8.56	65.43	17.01	2.00	0.44	1.55	85.85	41.48	127.33	4.000	No	No	2.00
39	8.73	64.61	17.89	2.04	0.42	1.49	95.41	46.19	141.60	4.000	No	No	2.00
40	8.89	57.56	19.32	2.10	0.41	1.47	94.37	49.24	143.61	4.000	No	No	2.00
41	9.09	50.25	21.99	2.21	0.50	1.58	55.83	42.37	98.20	4.000	No	No	2.00
42	9.22	52.52	21.13	2.18	0.48	1.53	65.97	44.30	110.27	4.000	No	No	2.00
43	9.38	66.07	19.55	2.11	0.40	1.42	99.77	51.20	150.98	4.000	No	No	2.00
44	9.55	81.03	17.57	2.03	0.40	1.40	103.56	47.40	150.97	4.000	No	No	2.00
45	9.74	80.43	18.12	2.05	0.37	1.36	116.13	52.12	168.25	4.000	No	No	2.00
46	9.87	75.55	18.14	2.05	0.41	1.40	95.86	46.94	142.80	4.000	No	No	2.00
47	10.07	64.07	19.41	2.11	0.44	1.41	84.35	46.68	131.03	0.206	No	No	0.77
48	10.20	61.29	19.30	2.10	0.46	1.43	75.58	44.08	119.65	0.179	No	No	0.67

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	10.40	58.82	19.58	2.11	0.43	1.39	84.77	47.13	131.90	0.208	No	No	0.77
50	10.53	62.78	17.58	2.03	0.47	1.42	75.33	40.38	115.71	0.171	No	No	0.63
51	10.69	42.98	20.02	2.13	0.42	1.37	88.18	48.89	137.07	0.223	No	No	0.81
52	10.86	26.48	23.60	2.27	0.69	1.67	7.77	29.11	36.88	0.066	No	No	0.23
53	11.02	5.17	57.80	3.20	0.66	1.63	9.96	0.00	9.96	0.468	No	Yes	1.57
54	11.19	6.80	49.29	3.01	0.69	1.64	6.06	0.00	6.06	0.628	No	Yes	2.00
55	11.35	6.17	49.44	3.02	0.64	1.58	14.46	0.00	14.46	0.561	No	Yes	1.86
56	11.51	6.51	47.97	2.98	0.68	1.63	6.71	0.00	6.71	0.590	No	Yes	1.94
57	11.71	4.63	57.99	3.21	0.68	1.62	7.22	0.00	7.22	0.399	No	Yes	1.30
58	11.84	4.53	59.16	3.23	0.69	1.62	5.89	0.00	5.89	0.387	No	Yes	1.25
59	12.01	4.51	59.23	3.23	0.68	1.61	6.13	0.00	6.13	0.382	No	Yes	1.23
60	12.17	4.99	56.12	3.17	0.68	1.60	7.03	0.00	7.03	0.425	No	Yes	1.36
61	12.37	5.24	55.45	3.15	0.67	1.58	7.89	0.00	7.89	0.445	No	Yes	1.41
62	12.50	6.11	51.10	3.06	0.68	1.58	7.13	0.00	7.13	0.526	No	Yes	1.66
63	12.66	5.95	53.52	3.11	0.66	1.56	10.57	0.00	10.57	0.507	No	Yes	1.59
64	12.83	6.48	52.86	3.10	0.68	1.57	6.98	0.00	6.98	0.553	No	Yes	1.73
65	12.99	6.53	54.48	3.13	0.67	1.55	9.20	0.00	9.20	0.554	No	Yes	1.72
66	13.15	6.57	53.53	3.11	0.66	1.54	10.86	0.00	10.86	0.552	No	Yes	1.71
67	13.32	6.00	54.31	3.13	0.68	1.55	7.20	0.00	7.20	0.495	No	Yes	1.52
68	13.52	5.06	57.82	3.20	0.68	1.55	6.78	0.00	6.78	0.405	No	Yes	1.24
69	13.65	5.32	58.36	3.22	0.68	1.54	6.68	0.00	6.68	0.426	No	Yes	1.29
70	13.81	6.00	59.57	3.24	0.67	1.53	7.98	0.00	7.98	0.484	No	Yes	1.46
71	14.01	7.35	58.37	3.22	0.66	1.51	9.59	0.00	9.59	0.602	No	Yes	1.81
72	14.14	9.11	56.68	3.18	0.65	1.49	12.15	0.00	12.15	0.756	No	Yes	2.00
73	14.30	13.02	47.96	2.98	0.63	1.47	15.34	0.00	15.34	1.098	No	Yes	2.00
74	14.47	12.17	48.91	3.00	0.59	1.42	25.08	0.00	25.08	1.013	No	Yes	2.00
75	14.63	9.85	50.87	3.05	0.67	1.49	8.71	0.00	8.71	0.801	No	Yes	2.00
76	14.79	5.61	64.68	3.35	0.69	1.50	5.84	0.00	5.84	0.426	No	Yes	1.25
77	14.96	5.47	63.05	3.31	0.67	1.48	8.20	0.00	8.20	0.410	No	Yes	1.20
78	15.16	6.13	59.07	3.23	0.67	1.47	8.01	0.00	8.01	0.463	No	Yes	1.35
79	15.29	6.03	58.82	3.23	0.67	1.47	8.26	0.00	8.26	0.452	No	Yes	1.31
80	15.45	5.69	59.89	3.25	0.68	1.46	7.43	0.00	7.43	0.419	No	Yes	1.21
81	15.65	5.79	58.67	3.22	0.68	1.46	6.30	0.00	6.30	0.424	No	Yes	1.22
82	15.81	7.33	52.45	3.09	0.67	1.45	8.45	0.00	8.45	0.550	No	Yes	1.57
83	15.94	8.32	50.33	3.04	0.64	1.42	13.52	0.00	13.52	0.630	No	Yes	1.80
84	16.11	8.40	51.81	3.07	0.66	1.43	10.45	0.00	10.45	0.632	No	Yes	1.80
85	16.27	7.29	56.76	3.18	0.67	1.43	8.78	0.00	8.78	0.535	No	Yes	1.51
86	16.44	8.25	53.67	3.11	0.67	1.42	8.97	0.00	8.97	0.611	No	Yes	1.72
87	16.60	10.16	48.34	2.99	0.64	1.39	14.25	0.00	14.25	0.762	No	Yes	2.00
88	16.76	10.34	47.71	2.98	0.63	1.38	16.30	0.00	16.30	0.772	No	Yes	2.00
89	16.96	7.72	55.31	3.15	0.66	1.40	9.83	0.00	9.83	0.554	No	Yes	1.54
90	17.09	15.26	37.46	2.71	0.70	1.42	3.87	0.00	3.87	1.155	No	Yes	2.00
91	17.26	27.51	31.19	2.53	0.53	1.30	42.96	43.71	86.67	0.122	No	No	0.36
92	17.42	51.96	23.57	2.27	0.51	1.28	53.47	43.22	96.68	0.137	No	No	0.40
93	17.58	64.68	22.89	2.24	0.42	1.22	88.35	53.22	141.57	0.238	No	No	0.69
94	17.75	74.34	21.54	2.19	0.43	1.22	84.99	50.44	135.43	0.218	No	No	0.63
95	17.91	141.57	16.21	1.96	0.27	1.13	188.12	62.38	250.49	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.16	2.00	0.00	9.67	0.33	0.00	2.49	2.00	0.00	9.62	0.33	0.00
2.66	2.00	0.00	9.60	0.16	0.00	2.98	2.00	0.00	9.55	0.33	0.00
3.15	2.00	0.00	9.52	0.16	0.00	3.31	2.00	0.00	9.50	0.16	0.00
3.48	2.00	0.00	9.47	0.16	0.00	3.64	2.00	0.00	9.45	0.16	0.00
3.80	2.00	0.00	9.42	0.16	0.00	3.97	2.00	0.00	9.40	0.17	0.00
4.13	2.00	0.00	9.37	0.16	0.00	4.30	2.00	0.00	9.35	0.16	0.00
4.53	2.00	0.00	9.31	0.23	0.00	4.66	2.00	0.00	9.29	0.13	0.00
4.82	2.00	0.00	9.27	0.17	0.00	4.95	2.00	0.00	9.25	0.13	0.00
5.12	2.00	0.00	9.22	0.16	0.00	5.28	2.00	0.00	9.20	0.16	0.00
5.45	2.00	0.00	9.17	0.16	0.00	5.61	2.00	0.00	9.15	0.16	0.00
5.77	2.00	0.00	9.12	0.16	0.00	5.94	2.00	0.00	9.10	0.16	0.00
6.10	2.00	0.00	9.07	0.16	0.00	6.26	2.00	0.00	9.05	0.16	0.00
6.43	2.00	0.00	9.02	0.16	0.00	6.59	2.00	0.00	9.00	0.16	0.00
6.76	2.00	0.00	8.97	0.16	0.00	6.92	2.00	0.00	8.95	0.16	0.00
7.08	2.00	0.00	8.92	0.16	0.00	7.25	2.00	0.00	8.90	0.16	0.00
7.41	2.00	0.00	8.87	0.16	0.00	7.58	2.00	0.00	8.85	0.16	0.00
7.74	2.00	0.00	8.82	0.16	0.00	7.91	2.00	0.00	8.80	0.17	0.00
8.07	2.00	0.00	8.77	0.16	0.00	8.23	2.00	0.00	8.75	0.16	0.00
8.40	2.00	0.00	8.72	0.16	0.00	8.56	2.00	0.00	8.70	0.16	0.00
8.73	2.00	0.00	8.67	0.16	0.00	8.89	2.00	0.00	8.65	0.16	0.00
9.09	2.00	0.00	8.62	0.20	0.00	9.22	2.00	0.00	8.60	0.13	0.00
9.38	2.00	0.00	8.57	0.16	0.00	9.55	2.00	0.00	8.55	0.16	0.00
9.74	2.00	0.00	8.52	0.20	0.00	9.87	2.00	0.00	8.50	0.13	0.00
10.07	0.77	0.23	8.47	0.20	0.11	10.20	0.67	0.33	8.45	0.13	0.11
10.40	0.77	0.23	8.42	0.20	0.12	10.53	0.63	0.37	8.40	0.13	0.13
10.69	0.81	0.19	8.37	0.16	0.08	10.86	0.23	0.77	8.35	0.16	0.32
11.02	1.57	0.00	8.32	0.16	0.00	11.19	2.00	0.00	8.30	0.16	0.00
11.35	1.86	0.00	8.27	0.16	0.00	11.51	1.94	0.00	8.25	0.16	0.00
11.71	1.30	0.00	8.22	0.20	0.00	11.84	1.25	0.00	8.20	0.13	0.00
12.01	1.23	0.00	8.17	0.16	0.00	12.17	1.36	0.00	8.15	0.16	0.00
12.37	1.41	0.00	8.12	0.20	0.00	12.50	1.66	0.00	8.10	0.13	0.00
12.66	1.59	0.00	8.07	0.16	0.00	12.83	1.73	0.00	8.05	0.16	0.00
12.99	1.72	0.00	8.02	0.16	0.00	13.15	1.71	0.00	8.00	0.16	0.00
13.32	1.52	0.00	7.97	0.16	0.00	13.52	1.24	0.00	7.94	0.20	0.00
13.65	1.29	0.00	7.92	0.13	0.00	13.81	1.46	0.00	7.90	0.16	0.00
14.01	1.81	0.00	7.87	0.20	0.00	14.14	2.00	0.00	7.85	0.13	0.00
14.30	2.00	0.00	7.82	0.16	0.00	14.47	2.00	0.00	7.80	0.16	0.00
14.63	2.00	0.00	7.77	0.16	0.00	14.79	1.25	0.00	7.75	0.16	0.00
14.96	1.20	0.00	7.72	0.16	0.00	15.16	1.35	0.00	7.69	0.20	0.00
15.29	1.31	0.00	7.67	0.13	0.00	15.45	1.21	0.00	7.65	0.16	0.00
15.65	1.22	0.00	7.62	0.20	0.00	15.81	1.57	0.00	7.59	0.16	0.00
15.94	1.80	0.00	7.57	0.13	0.00	16.11	1.80	0.00	7.55	0.16	0.00
16.27	1.51	0.00	7.52	0.16	0.00	16.44	1.72	0.00	7.50	0.16	0.00
16.60	2.00	0.00	7.47	0.16	0.00	16.76	2.00	0.00	7.45	0.16	0.00
16.96	1.54	0.00	7.42	0.20	0.00	17.09	2.00	0.00	7.40	0.13	0.00
17.26	0.36	0.64	7.37	0.16	0.24	17.42	0.40	0.60	7.35	0.16	0.22
17.58	0.69	0.31	7.32	0.16	0.11	17.75	0.63	0.37	7.30	0.16	0.13
17.91	2.00	0.00	7.27	0.16	0.00						

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI

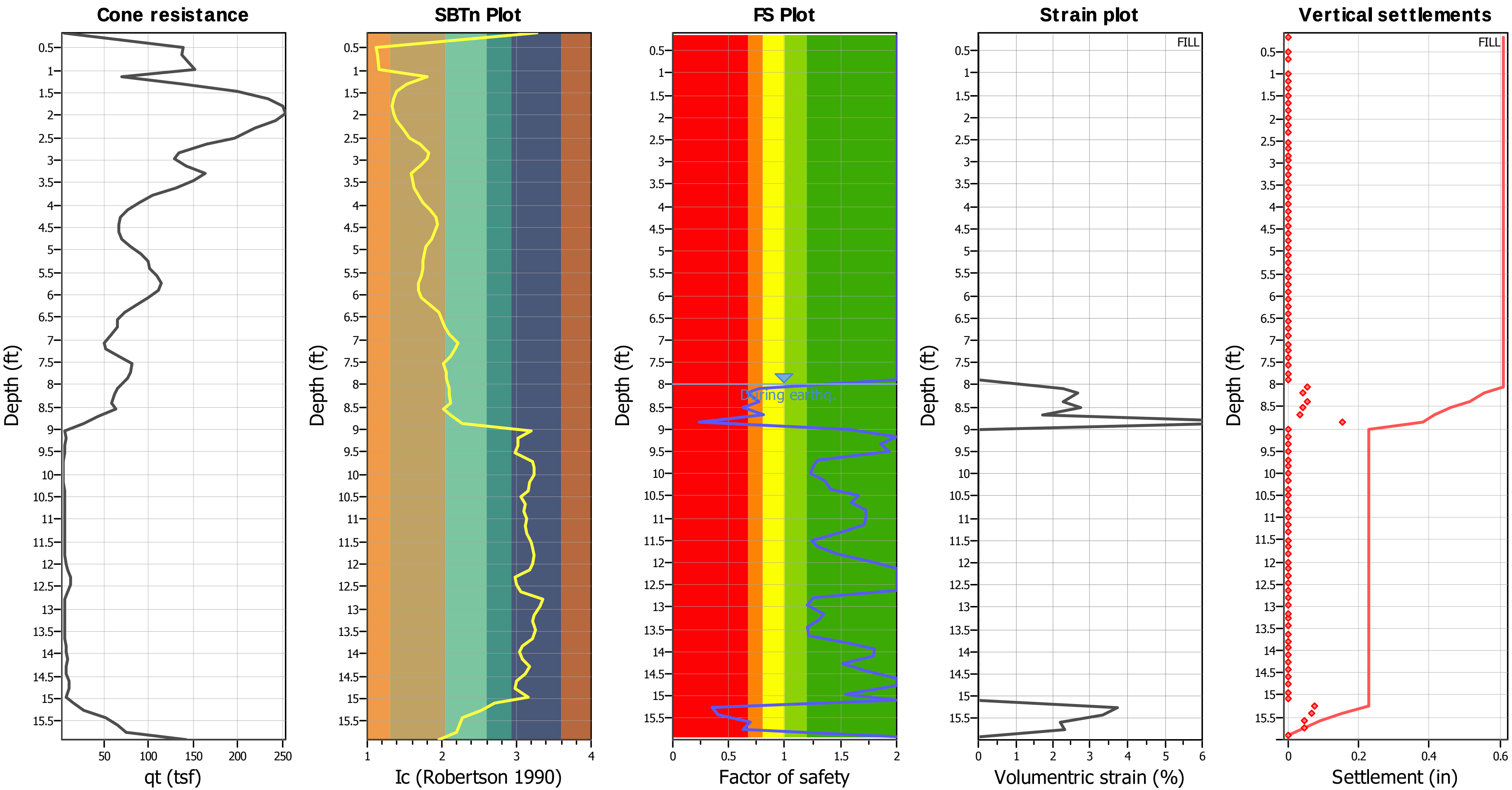
Overall liquefaction potential: 1.57

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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 ::

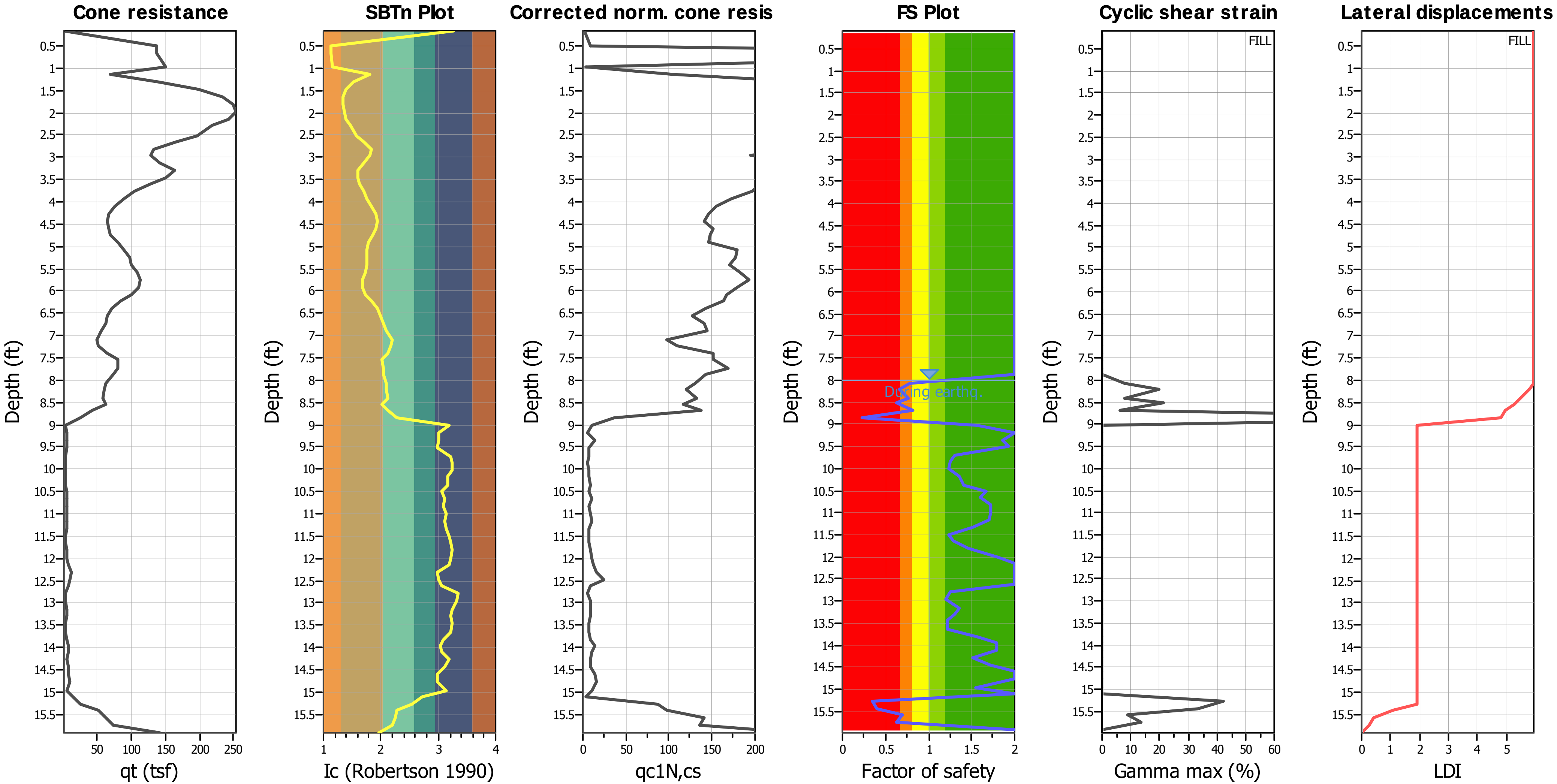
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.07	131.03	0.77	2.29	1.00	0.05	10.20	119.65	0.67	2.66	1.00	0.04
10.40	131.90	0.77	2.28	1.00	0.05	10.53	115.71	0.63	2.76	1.00	0.04
10.69	137.07	0.81	1.73	1.00	0.03	10.86	36.88	0.23	7.87	1.00	0.15
11.02	9.96	1.57	0.00	1.00	0.00	11.19	6.06	2.00	0.00	1.00	0.00
11.35	14.46	1.86	0.00	1.00	0.00	11.51	6.71	1.94	0.00	1.00	0.00
11.71	7.22	1.30	0.00	1.00	0.00	11.84	5.89	1.25	0.00	1.00	0.00
12.01	6.13	1.23	0.00	1.00	0.00	12.17	7.03	1.36	0.00	1.00	0.00
12.37	7.89	1.41	0.00	1.00	0.00	12.50	7.13	1.66	0.00	1.00	0.00
12.66	10.57	1.59	0.00	1.00	0.00	12.83	6.98	1.73	0.00	1.00	0.00
12.99	9.20	1.72	0.00	1.00	0.00	13.15	10.86	1.71	0.00	1.00	0.00
13.32	7.20	1.52	0.00	1.00	0.00	13.52	6.78	1.24	0.00	1.00	0.00
13.65	6.68	1.29	0.00	1.00	0.00	13.81	7.98	1.46	0.00	1.00	0.00
14.01	9.59	1.81	0.00	1.00	0.00	14.14	12.15	2.00	0.00	1.00	0.00
14.30	15.34	2.00	0.00	1.00	0.00	14.47	25.08	2.00	0.00	1.00	0.00
14.63	8.71	2.00	0.00	1.00	0.00	14.79	5.84	1.25	0.00	1.00	0.00
14.96	8.20	1.20	0.00	1.00	0.00	15.16	8.01	1.35	0.00	1.00	0.00
15.29	8.26	1.31	0.00	1.00	0.00	15.45	7.43	1.21	0.00	1.00	0.00
15.65	6.30	1.22	0.00	1.00	0.00	15.81	8.45	1.57	0.00	1.00	0.00
15.94	13.52	1.80	0.00	1.00	0.00	16.11	10.45	1.80	0.00	1.00	0.00
16.27	8.78	1.51	0.00	1.00	0.00	16.44	8.97	1.72	0.00	1.00	0.00
16.60	14.25	2.00	0.00	1.00	0.00	16.76	16.30	2.00	0.00	1.00	0.00
16.96	9.83	1.54	0.00	1.00	0.00	17.09	3.87	2.00	0.00	1.00	0.00
17.26	86.67	0.36	3.71	1.00	0.07	17.42	96.68	0.40	3.33	1.00	0.07
17.58	141.57	0.69	2.22	1.00	0.04	17.75	135.43	0.63	2.33	1.00	0.05
17.91	250.49	2.00	0.00	1.00	0.00						

Total estimated settlement: 0.61

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.07	131.03	0.15	0.77	0.48	0.08	0.18
10.20	119.65	0.20	0.67	0.61	0.20	0.31
10.40	131.90	0.15	0.77	0.47	0.08	0.18
10.53	115.71	0.22	0.63	0.65	0.22	0.34
10.69	137.07	0.13	0.81	0.41	0.06	0.12
10.86	36.88	1.47	0.23	0.94	1.47	2.89
11.02	9.96	0.00	1.57	0.00	0.00	0.00
11.19	6.06	0.00	2.00	0.00	0.00	0.00
11.35	14.46	0.00	1.86	0.00	0.00	0.00
11.51	6.71	0.00	1.94	0.00	0.00	0.00
11.71	7.22	0.00	1.30	0.00	0.00	0.00
11.84	5.89	0.00	1.25	0.00	0.00	0.00
12.01	6.13	0.00	1.23	0.00	0.00	0.00
12.17	7.03	0.00	1.36	0.00	0.00	0.00
12.37	7.89	0.00	1.41	0.00	0.00	0.00
12.50	7.13	0.00	1.66	0.00	0.00	0.00
12.66	10.57	0.00	1.59	0.00	0.00	0.00
12.83	6.98	0.00	1.73	0.00	0.00	0.00
12.99	9.20	0.00	1.72	0.00	0.00	0.00
13.15	10.86	0.00	1.71	0.00	0.00	0.00
13.32	7.20	0.00	1.52	0.00	0.00	0.00
13.52	6.78	0.00	1.24	0.00	0.00	0.00
13.65	6.68	0.00	1.29	0.00	0.00	0.00
13.81	7.98	0.00	1.46	0.00	0.00	0.00
14.01	9.59	0.00	1.81	0.00	0.00	0.00
14.14	12.15	0.00	2.00	0.00	0.00	0.00
14.30	15.34	0.00	2.00	0.00	0.00	0.00
14.47	25.08	0.00	2.00	0.00	0.00	0.00
14.63	8.71	0.00	2.00	0.00	0.00	0.00
14.79	5.84	0.00	1.25	0.00	0.00	0.00
14.96	8.20	0.00	1.20	0.00	0.00	0.00
15.16	8.01	0.00	1.35	0.00	0.00	0.00
15.29	8.26	0.00	1.31	0.00	0.00	0.00
15.45	7.43	0.00	1.21	0.00	0.00	0.00
15.65	6.30	0.00	1.22	0.00	0.00	0.00
15.81	8.45	0.00	1.57	0.00	0.00	0.00
15.94	13.52	0.00	1.80	0.00	0.00	0.00
16.11	10.45	0.00	1.80	0.00	0.00	0.00
16.27	8.78	0.00	1.51	0.00	0.00	0.00
16.44	8.97	0.00	1.72	0.00	0.00	0.00
16.60	14.25	0.00	2.00	0.00	0.00	0.00
16.76	16.30	0.00	2.00	0.00	0.00	0.00
16.96	9.83	0.00	1.54	0.00	0.00	0.00
17.09	3.87	0.00	2.00	0.00	0.00	0.00
17.26	86.67	0.42	0.36	0.89	0.42	0.83
17.42	96.68	0.34	0.40	0.82	0.34	0.66
17.58	141.57	0.12	0.69	0.35	0.09	0.17
17.75	135.43	0.13	0.63	0.43	0.13	0.26

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
17.91	250.49	0.00	2.00	-1.22	0.00	0.00

Total estimated displacement: 5.94

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.16	2.58	4.14	10.19	42.16	3.27	0.06	24.38
2.49	138.02	221.71	1.00	221.71	1.13	0.02	0.95
2.66	137.04	220.12	1.00	220.12	1.13	0.94	0.94
2.98	151.82	243.84	1.00	243.84	1.16	0.02	0.96
3.15	69.72	111.92	1.11	123.88	1.80	0.11	0.84
3.31	139.06	223.31	1.00	223.31	1.52	0.95	0.95
3.48	199.71	320.73	1.00	320.73	1.38	1.01	1.01
3.64	233.84	375.54	1.00	375.54	1.35	1.03	1.03
3.80	249.88	401.30	1.00	401.30	1.34	1.04	1.04
3.97	253.42	406.97	1.00	406.97	1.36	1.05	1.05
4.13	241.76	388.23	1.00	388.23	1.40	1.04	1.04
4.30	219.56	352.54	1.00	352.54	1.47	1.02	1.02
4.53	196.48	315.43	1.00	315.43	1.57	1.00	1.00
4.66	165.19	265.15	1.04	276.62	1.71	0.97	0.97
4.82	133.74	214.61	1.13	242.62	1.83	0.94	0.94
4.95	128.79	206.64	1.11	230.00	1.81	0.38	0.93
5.12	141.15	226.47	1.05	237.13	1.71	0.95	0.95
5.28	163.34	262.12	1.00	262.12	1.59	0.97	0.97
5.45	150.28	241.11	1.00	241.11	1.61	0.96	0.96
5.61	130.12	208.71	1.00	208.71	1.62	0.88	0.94
5.77	104.99	168.32	1.03	173.87	1.69	0.53	0.90
5.94	90.10	144.38	1.07	155.19	1.75	0.28	0.88
6.10	76.15	121.95	1.14	139.13	1.84	0.19	0.86
6.26	67.45	107.95	1.21	130.23	1.92	0.16	0.84
6.43	65.83	105.34	1.23	129.11	1.94	0.15	0.83
6.59	67.03	107.25	1.19	127.96	1.90	0.17	0.84
6.76	70.24	112.39	1.15	129.30	1.86	0.17	0.84
6.92	80.28	128.51	1.10	141.49	1.79	0.18	0.86
7.08	90.73	145.28	1.08	157.40	1.77	0.30	0.88
7.25	98.72	158.11	1.07	169.41	1.75	0.30	0.89
7.41	101.70	162.87	1.07	174.78	1.75	0.27	0.90
7.58	108.83	174.31	1.05	183.41	1.72	0.35	0.91
7.74	113.92	182.47	1.02	186.75	1.68	0.50	0.92
7.91	110.88	177.57	1.02	181.95	1.68	0.36	0.91
8.07	100.08	160.20	1.06	170.07	1.74	0.26	0.90
8.23	86.35	138.14	1.14	157.40	1.84	0.21	0.87
8.40	72.86	116.44	1.24	144.60	1.95	0.15	0.85
8.56	65.43	104.49	1.30	136.04	2.00	0.12	0.83
8.73	64.61	103.15	1.36	139.95	2.04	0.14	0.83
8.89	57.56	91.81	1.46	133.90	2.10	0.14	0.82
9.09	50.25	80.05	1.69	135.24	2.21	0.09	0.80
9.22	52.52	83.68	1.61	134.65	2.18	0.10	0.80
9.38	66.07	105.43	1.48	155.65	2.11	0.16	0.83
9.55	81.03	129.46	1.34	173.04	2.03	0.16	0.86
9.74	80.43	128.48	1.37	176.33	2.05	0.19	0.86
9.87	75.55	120.02	1.37	164.83	2.05	0.14	0.85
10.07	64.07	101.95	1.46	149.36	2.11	0.13	0.83
10.20	61.29	96.86	1.46	141.08	2.10	0.11	0.82

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.40	58.82	92.52	1.48	136.79	2.11	0.13	0.82
10.53	62.78	95.93	1.34	128.28	2.03	0.11	0.82
10.69	42.98	66.98	1.51	101.37	2.13	0.13	0.77
10.86	26.48	41.69	1.86	77.38	2.27	0.03	0.71
11.02	5.17	7.44	9.30	69.21	3.20	0.06	0.65
11.19	6.80	10.04	6.90	69.23	3.01	0.05	0.87
11.35	6.17	9.02	6.93	62.54	3.02	0.06	0.78
11.51	6.51	9.56	6.55	62.59	2.98	0.05	0.82
11.71	4.63	6.51	9.36	60.91	3.21	0.06	0.55
11.84	4.53	6.34	9.71	61.55	3.23	0.06	0.54
12.01	4.51	6.30	9.74	61.34	3.23	0.06	0.53
12.17	4.99	7.05	8.81	62.11	3.17	0.06	0.59
12.37	5.24	7.43	8.61	64.01	3.15	0.06	0.62
12.50	6.11	8.83	7.39	65.19	3.06	0.06	0.73
12.66	5.95	8.55	8.06	68.92	3.11	0.06	0.70
12.83	6.48	9.39	7.87	73.91	3.10	0.06	0.77
12.99	6.53	9.46	8.33	78.86	3.13	0.06	0.77
13.15	6.57	9.51	8.06	76.64	3.11	0.06	0.77
13.32	6.00	8.58	8.28	71.04	3.13	0.06	0.69
13.52	5.06	7.06	9.31	65.75	3.20	0.06	0.56
13.65	5.32	7.46	9.47	70.64	3.22	0.06	0.59
13.81	6.00	8.54	9.84	84.01	3.24	0.06	0.67
14.01	7.35	10.69	9.48	101.34	3.22	0.06	0.84
14.14	9.11	13.51	8.97	121.26	3.18	0.07	1.05
14.30	13.02	19.77	6.55	129.43	2.98	0.06	1.52
14.47	12.17	18.39	6.79	124.95	3.00	0.08	1.41
14.63	9.85	14.65	7.32	107.25	3.05	0.06	1.11
14.79	5.61	7.83	11.43	89.49	3.35	0.06	0.59
14.96	5.47	7.59	10.92	82.86	3.31	0.06	0.57
15.16	6.13	8.64	9.69	83.69	3.23	0.06	0.64
15.29	6.03	8.46	9.61	81.31	3.23	0.06	0.63
15.45	5.69	7.89	9.93	78.41	3.25	0.06	0.58
15.65	5.79	8.04	9.56	76.94	3.22	0.06	0.59
15.81	7.33	10.50	7.76	81.46	3.09	0.06	0.76
15.94	8.32	12.08	7.18	86.69	3.04	0.06	0.88
16.11	8.40	12.20	7.58	92.51	3.07	0.06	0.88
16.27	7.29	10.40	9.00	93.52	3.18	0.06	0.74
16.44	8.25	11.88	8.10	96.23	3.11	0.06	0.85
16.60	10.16	14.82	6.65	98.46	2.99	0.06	1.06
16.76	10.34	15.00	6.48	97.25	2.98	0.06	1.07
16.96	7.72	10.77	8.57	92.33	3.15	0.06	0.77
17.09	15.26	21.52	4.08	87.83	2.71	0.04	1.60
17.26	27.51	38.21	2.91	111.15	2.53	0.08	0.70
17.42	51.96	69.40	1.85	128.65	2.27	0.09	0.78
17.58	64.68	85.78	1.78	152.76	2.24	0.14	0.81
17.75	74.34	97.29	1.65	160.24	2.19	0.13	0.82
17.91	141.57	177.98	1.26	223.61	1.96	0.91	0.91

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$

Abbreviations

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

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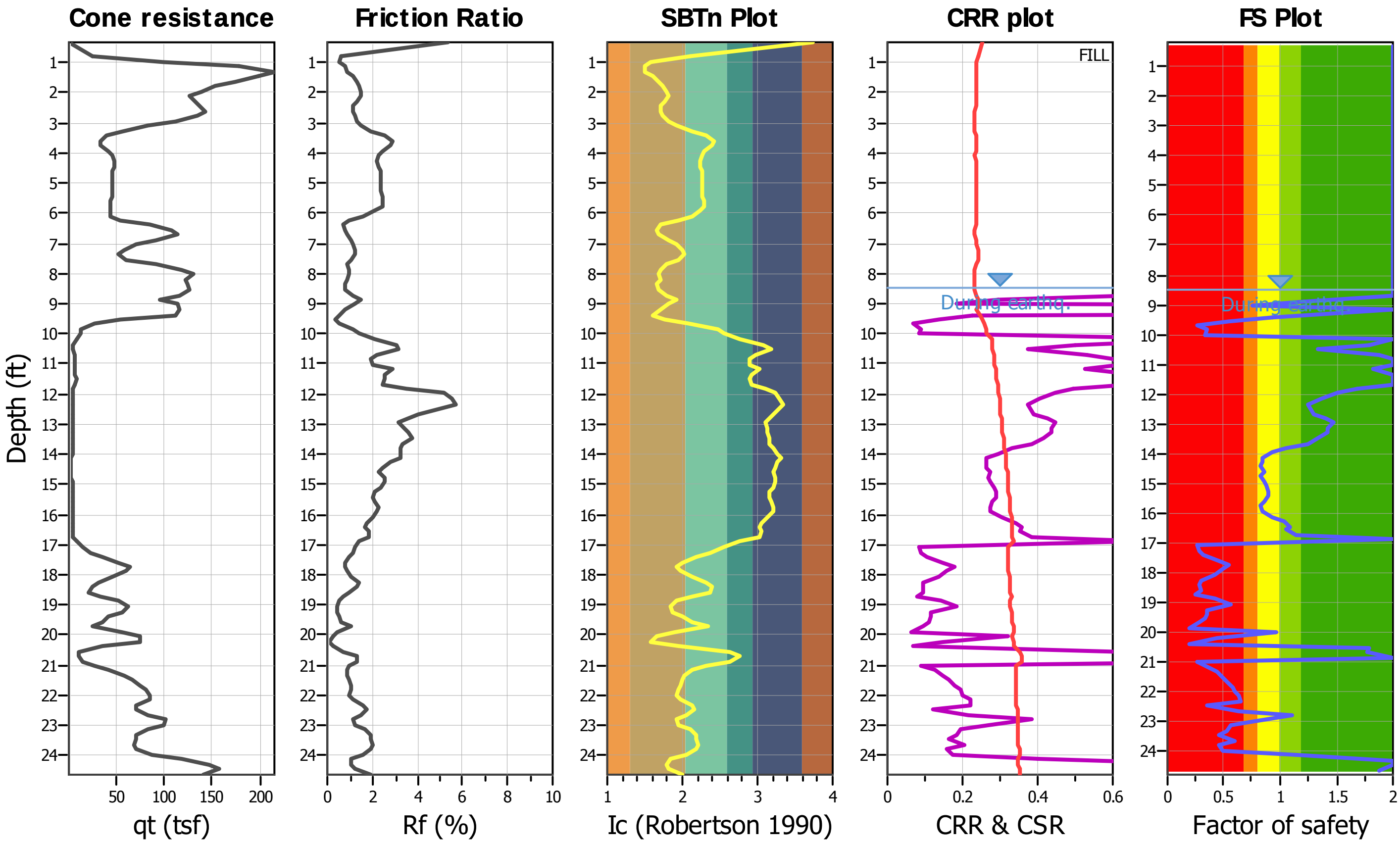
LIQUEFACTION ANALYSIS REPORT

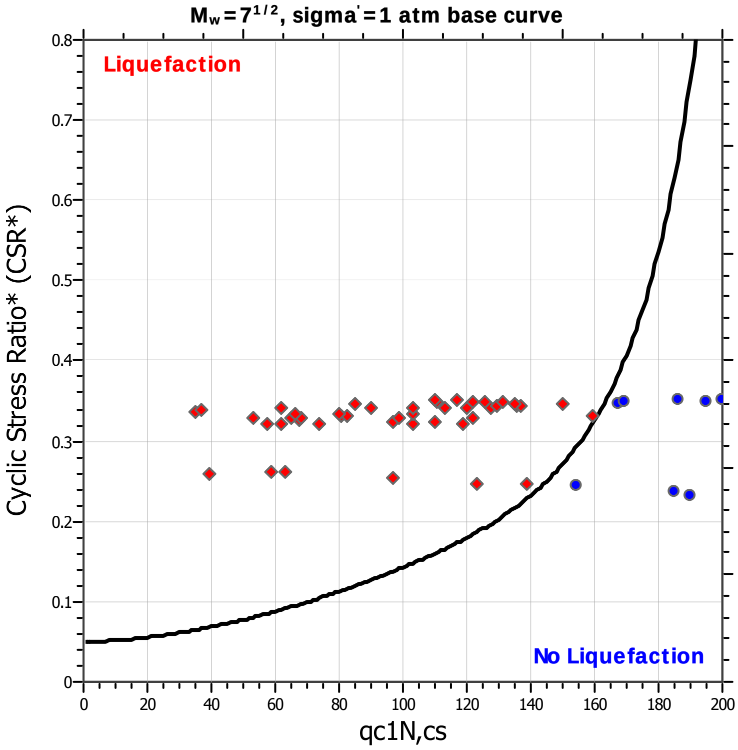
Project title : **Location :**

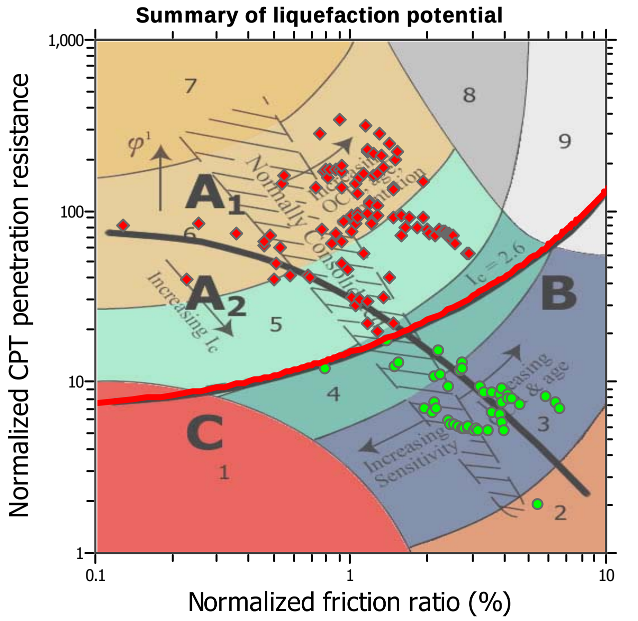
CPT file : CPT-6

Input parameters and analysis data

Analysis method:	I&B (2008)	G.W.T. (in-situ):	8.50 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	I&B (2008)	G.W.T. (earthq.):	10.50 ft	Fill height:	2.00 ft	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	125.00 lb/ft^3	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

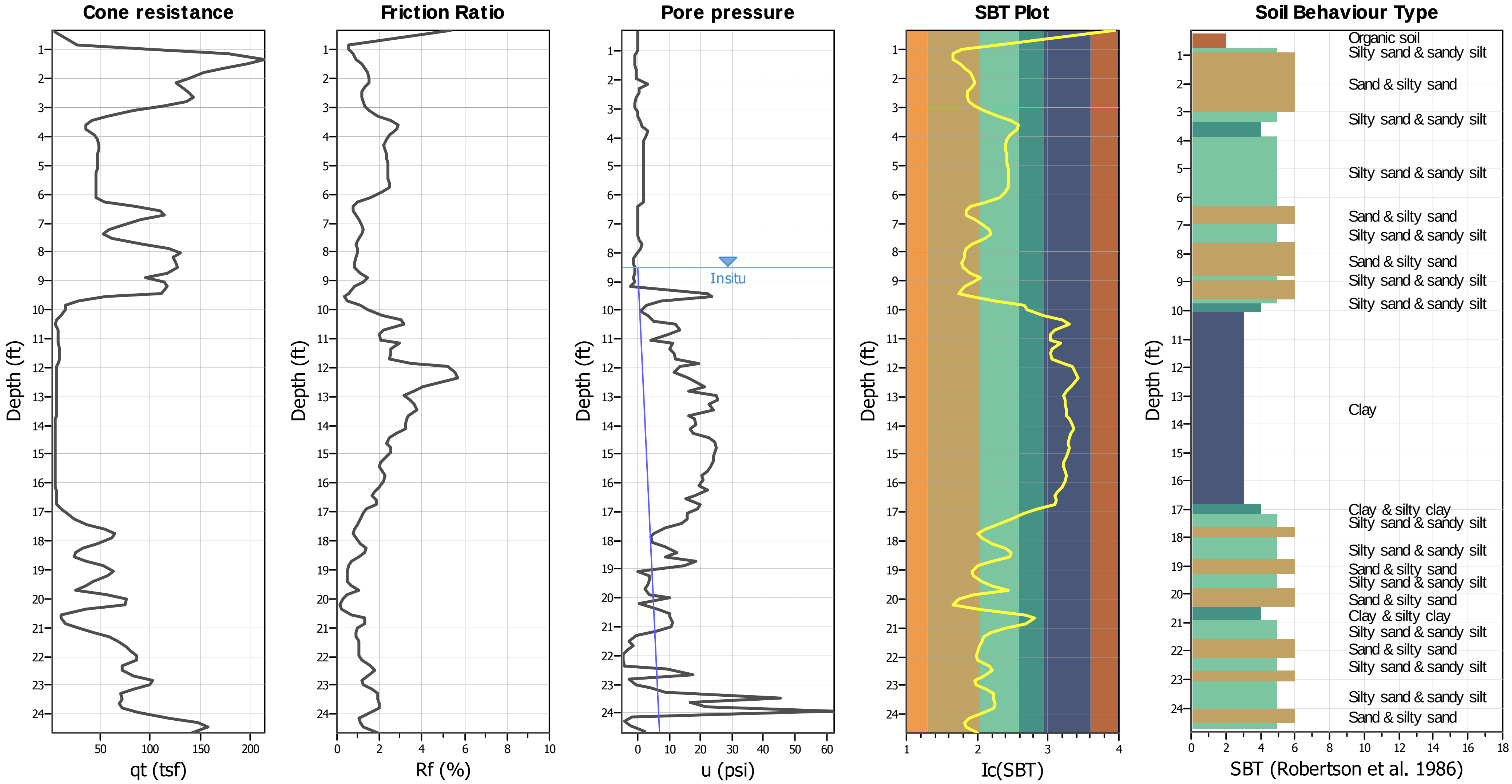






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



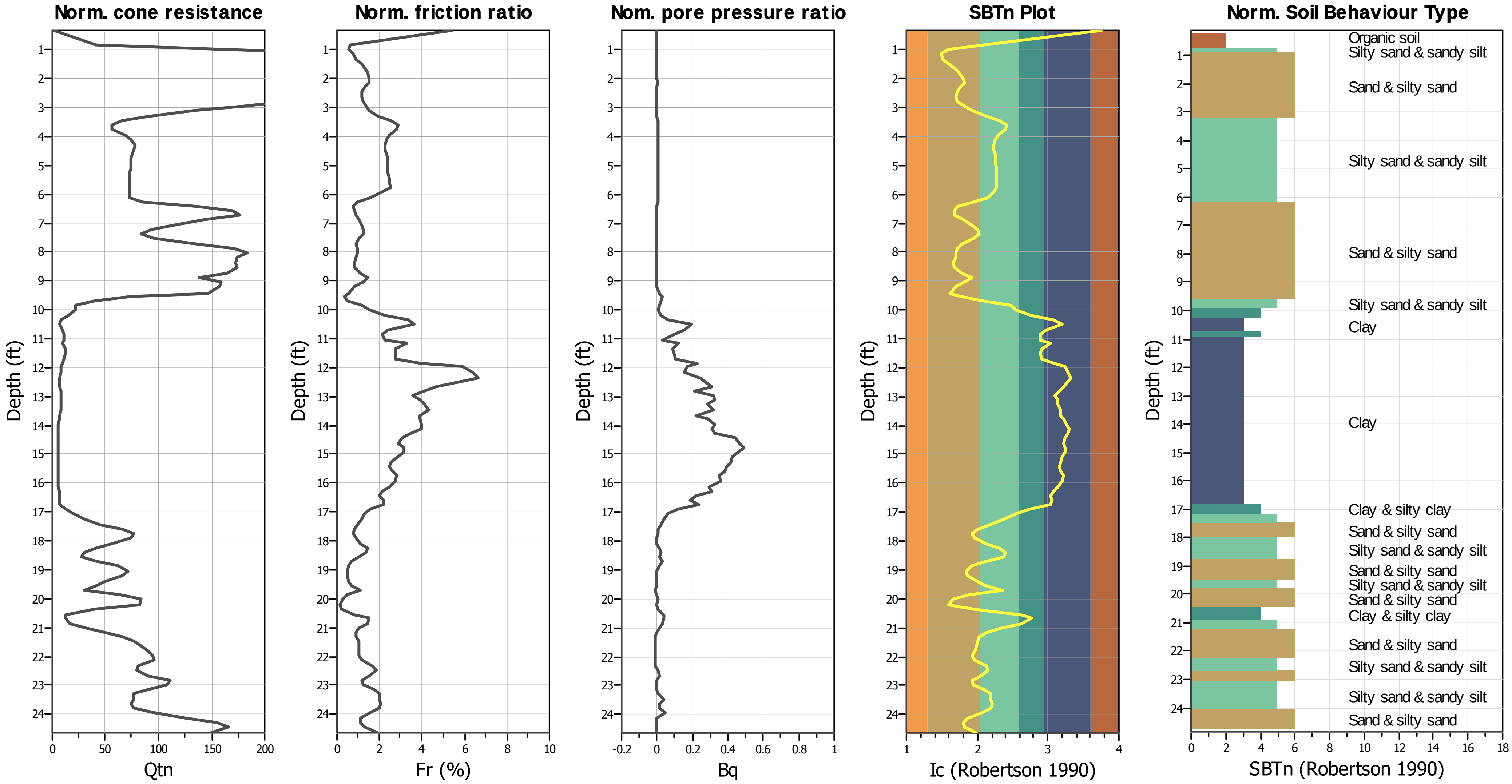
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	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)



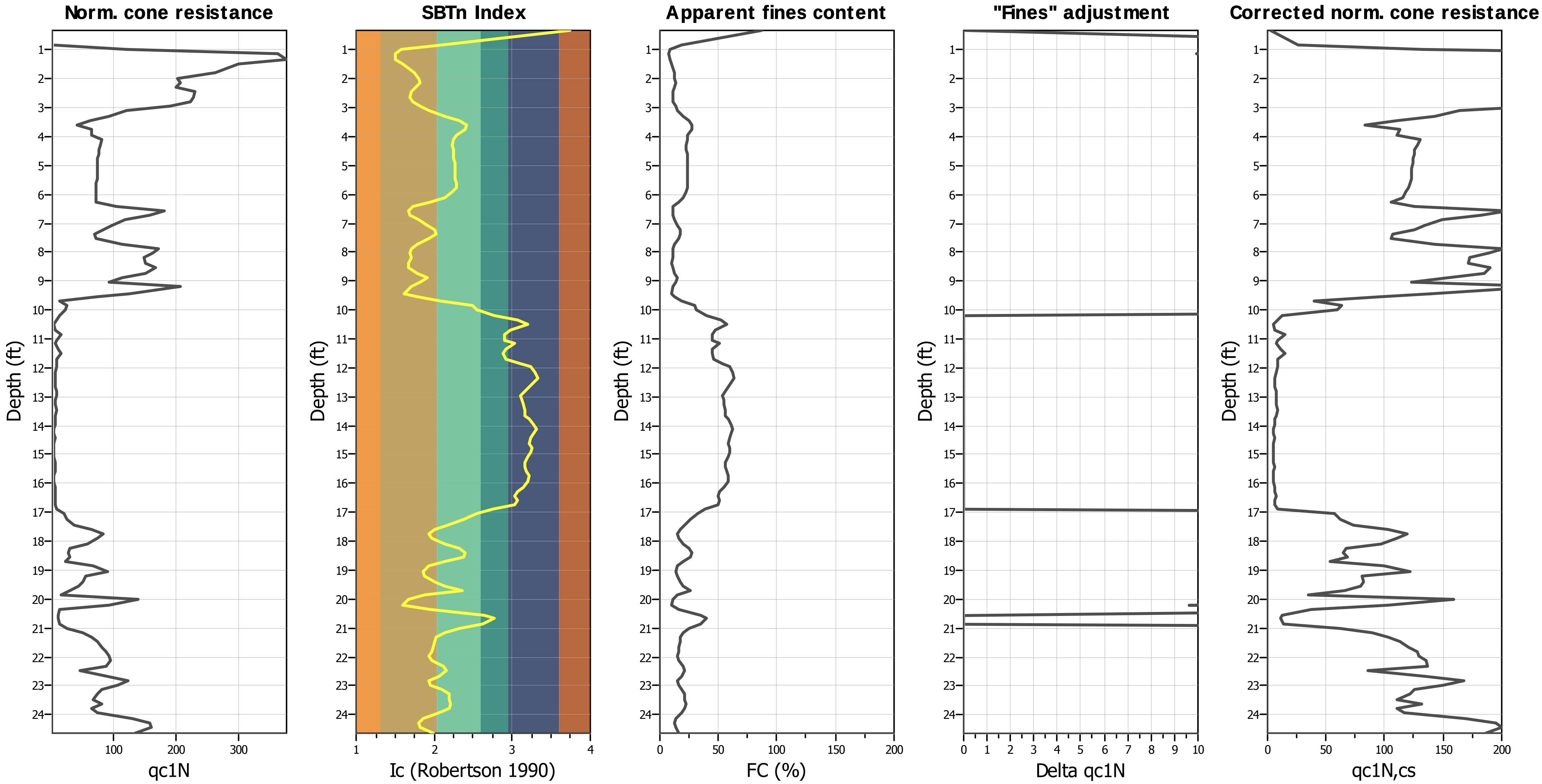
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

SBTn legend

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

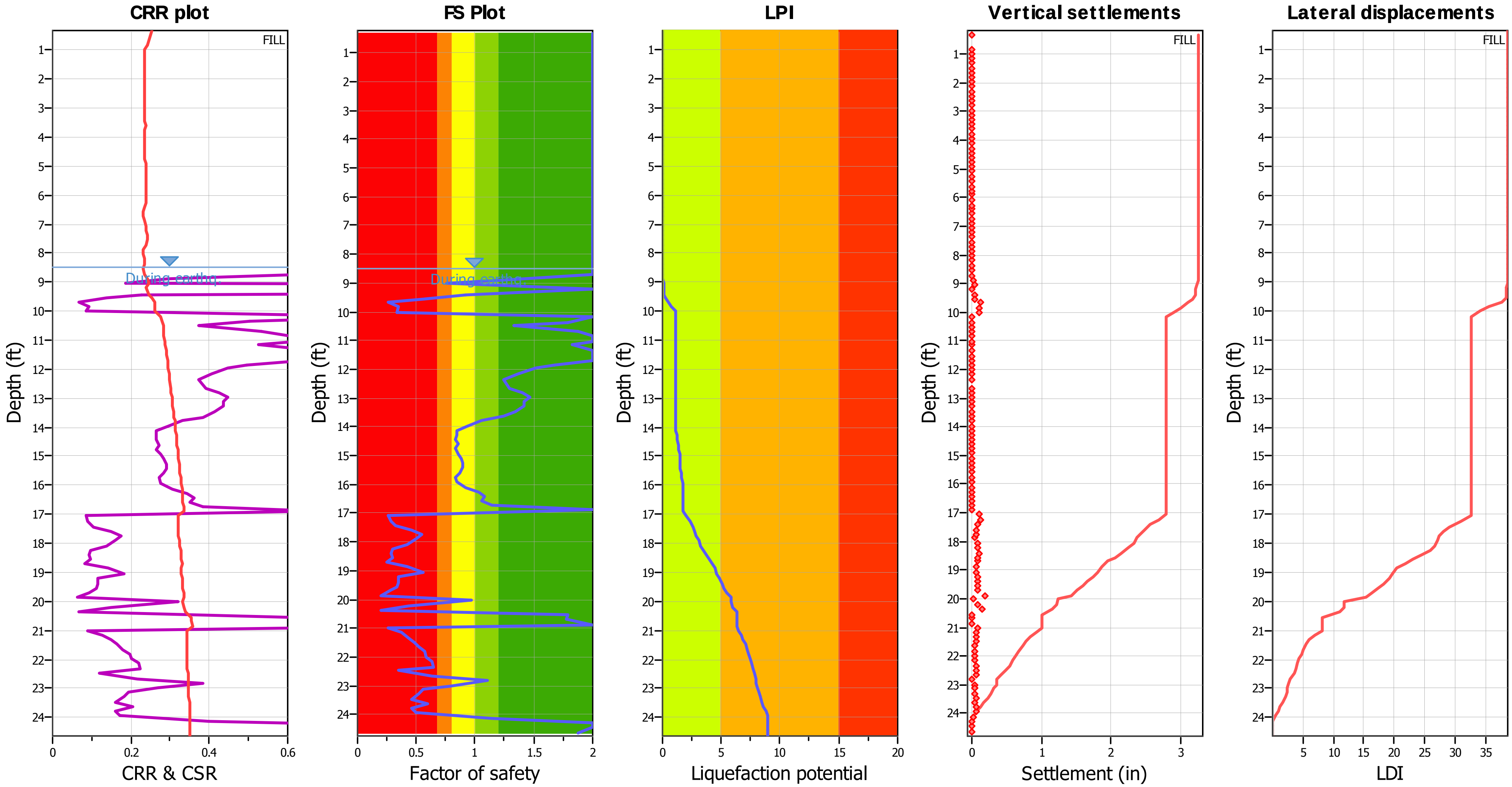
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

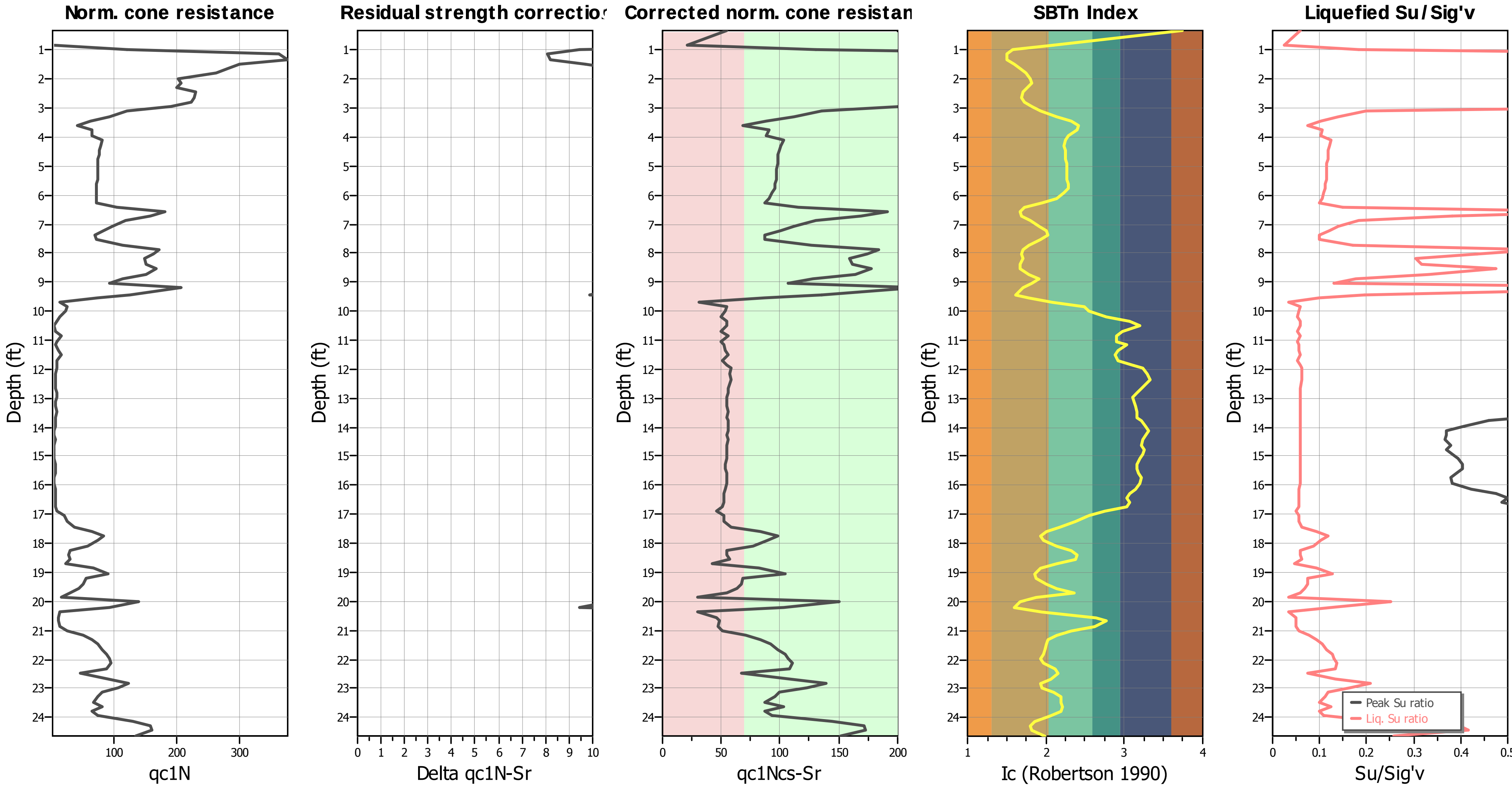
F.S. color scheme

- 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

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



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	10.50 ft	Fill weight:	125.00 lb/ft^3
Fines correction method:	I&B (2008)	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:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.42	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.50 ft	Fill height:	2.00 ft	Limit depth:	N/A

:: Field input data ::

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
1	0.33	1.19	0.09	-0.05	100.00	90.50
2	0.82	1.19	0.02	-0.05	15.70	104.38
3	0.98	75.52	0.42	-0.09	4.14	117.19
4	1.15	224.86	1.23	-0.71	2.76	125.09
5	1.31	234.02	2.40	-0.87	2.89	128.30
6	1.48	186.19	2.26	-0.78	4.41	129.15
7	1.64	174.02	2.13	-0.50	5.74	128.81
8	1.80	162.88	2.38	-0.58	6.96	128.26
9	1.97	125.16	2.04	-0.40	8.07	127.79
10	2.13	127.99	1.94	3.21	8.50	126.69
11	2.30	124.44	1.67	0.54	7.32	126.19
12	2.46	142.92	1.59	0.58	6.30	125.72
13	2.63	145.22	1.54	-0.48	6.08	126.19
14	2.79	143.51	1.91	-0.84	6.65	125.93
15	2.95	118.85	1.50	-0.69	8.40	124.76
16	3.12	74.78	1.09	-0.08	11.19	122.62
17	3.28	57.41	1.12	0.11	16.79	120.86
18	3.44	39.45	1.11	1.06	23.29	119.56
19	3.61	25.50	0.88	1.62	26.73	118.96
20	3.77	39.68	1.03	3.43	26.43	118.85
21	3.94	39.86	1.06	2.85	22.24	119.83
22	4.10	49.69	1.08	1.98	20.94	120.12
23	4.30	48.68	1.08	1.84	19.88	120.33
24	4.46	47.60	1.09	1.81	20.37	120.33
25	4.63	46.97	1.10	1.81	20.73	120.34
26	4.76	46.69	1.10	1.81	20.95	120.34
27	4.92	46.38	1.10	1.82	21.08	120.31
28	5.08	46.03	1.09	1.83	21.24	120.29
29	5.25	45.78	1.10	1.85	21.40	120.29
30	5.45	45.47	1.10	1.85	21.59	120.31
31	5.61	45.31	1.11	1.86	21.77	120.36
32	5.77	45.21	1.13	1.86	21.94	120.42
33	5.91	45.12	1.13	1.85	20.24	119.27
34	6.10	45.33	0.62	1.85	17.19	117.03
35	6.27	45.58	0.36	1.86	11.51	114.89
36	6.40	69.92	0.51	0.19	6.54	117.57
37	6.56	138.65	0.98	0.05	5.55	120.60
38	6.73	118.75	1.09	0.14	5.85	121.74
39	6.89	84.56	0.90	0.09	8.20	120.85
40	7.05	68.76	0.85	0.08	10.83	119.36
41	7.22	59.54	0.76	0.14	12.92	117.98
42	7.38	47.75	0.60	0.24	13.56	116.51
43	7.55	50.00	0.51	0.54	11.31	117.03
44	7.71	85.32	0.80	1.52	7.77	120.02
45	7.87	140.03	1.21	1.16	6.38	122.64
46	8.04	131.68	1.30	-0.30	5.97	123.50
47	8.20	117.99	1.11	-1.09	6.18	122.81
48	8.37	120.54	0.94	-1.29	5.48	121.99

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
49	8.53	137.65	0.93	-1.06	5.64	122.45
50	8.73	124.02	1.28	-0.98	7.76	123.81
51	8.89	90.04	1.69	-1.10	10.91	123.78
52	9.02	71.76	1.18	-1.03	8.66	124.25
53	9.19	178.39	1.31	-2.12	6.11	121.40
54	9.42	99.50	0.31	22.45	4.58	117.96
55	9.55	55.75	0.16	23.83	5.00	108.00
56	9.68	8.52	0.11	7.55	15.27	103.82
57	9.84	18.35	0.15	3.01	30.06	103.30
58	10.01	15.76	0.22	1.06	32.57	105.06
59	10.17	8.63	0.24	3.07	44.53	104.49
60	10.37	5.60	0.17	5.28	63.71	102.21
61	10.50	3.56	0.14	11.96	72.67	99.93
62	10.70	4.40	0.13	13.46	56.51	100.48
63	10.83	10.87	0.16	9.72	51.66	100.79
64	11.02	6.06	0.14	4.14	51.78	101.45
65	11.15	5.03	0.16	11.19	61.17	102.69
66	11.35	8.03	0.27	10.26	52.88	103.82
67	11.52	10.75	0.19	11.50	51.29	104.31
68	11.68	6.46	0.19	11.94	53.24	103.39
69	11.84	5.84	0.21	19.44	65.53	103.74
70	11.97	6.00	0.27	13.48	76.14	105.75
71	12.17	4.90	0.43	11.81	80.10	105.51
72	12.34	4.70	0.20	16.30	83.63	105.02
73	12.66	4.72	0.23	21.40	74.17	103.05
74	12.79	5.76	0.21	16.41	69.60	103.00
75	12.96	5.81	0.18	24.96	65.49	102.50
76	13.12	5.56	0.18	25.25	67.55	102.86
77	13.29	5.33	0.25	22.48	68.45	103.41
78	13.48	6.00	0.22	24.14	70.52	103.33
79	13.65	5.04	0.18	16.24	70.55	101.97
80	13.78	4.41	0.15	18.23	74.53	100.51
81	13.98	4.19	0.14	18.53	78.38	99.56
82	14.14	3.75	0.14	16.54	81.47	98.78
83	14.27	3.50	0.11	17.43	78.76	97.78
84	14.44	4.17	0.09	22.63	76.47	96.83
85	14.60	3.66	0.09	24.50	74.49	96.78
86	14.76	3.78	0.11	25.20	76.83	97.24
87	14.93	3.96	0.11	24.65	75.70	97.51
88	15.09	4.06	0.10	23.86	73.44	97.27
89	15.26	4.18	0.09	24.23	70.53	96.61
90	15.42	4.32	0.08	23.14	70.13	96.47
91	15.58	4.15	0.10	22.19	71.94	96.66
92	15.75	3.99	0.10	20.16	74.18	96.90
93	15.91	4.05	0.10	20.79	73.43	96.94
94	16.11	4.41	0.10	19.39	68.40	96.96
95	16.27	5.15	0.10	22.33	63.03	97.04
96	16.44	5.61	0.09	17.97	60.52	97.06

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
97	16.57	5.29	0.09	15.54	62.73	97.64
98	16.73	4.93	0.12	19.73	60.41	98.36
99	16.90	6.86	0.11	18.80	43.41	101.31
100	17.06	16.89	0.18	15.94	33.11	104.43
101	17.26	20.90	0.25	15.88	25.39	108.03
102	17.42	31.36	0.34	13.75	18.22	111.21
103	17.59	56.55	0.43	8.76	13.30	114.00
104	17.75	72.21	0.55	5.26	11.19	115.20
105	17.88	63.66	0.48	4.16	12.31	115.68
106	18.08	48.93	0.55	4.74	16.92	114.61
107	18.24	25.50	0.47	8.93	23.07	112.96
108	18.41	23.22	0.33	12.39	26.32	109.83
109	18.57	25.55	0.17	8.97	25.53	107.04
110	18.70	18.56	0.19	18.51	17.01	108.18
111	18.86	58.23	0.34	14.84	11.09	110.44
112	19.06	80.50	0.29	-0.06	5.00	111.45
113	19.23	47.10	0.26	3.79	5.00	110.18
114	19.39	43.30	0.22	3.93	13.02	108.17
115	19.55	37.93	0.17	3.14	16.69	108.30
116	19.68	24.97	0.31	2.34	24.55	108.32
117	19.88	12.83	0.30	3.75	5.00	109.90
118	20.01	129.08	0.13	10.44	5.00	108.55
119	20.21	83.90	0.13	0.60	4.19	103.63
120	20.37	11.99	0.03	6.74	5.00	100.39
121	20.54	10.31	0.08	10.01	37.45	97.12
122	20.67	9.11	0.12	10.10	44.13	101.67
123	20.87	11.77	0.22	10.98	36.47	104.75
124	21.00	23.03	0.23	10.79	23.50	108.56
125	21.16	46.02	0.33	6.17	17.02	112.44
126	21.32	59.21	0.59	-0.49	13.88	115.38
127	21.49	68.23	0.64	-2.63	13.12	117.63
128	21.65	75.15	0.79	-1.54	12.42	118.94
129	21.82	82.32	0.90	-3.21	11.89	119.75
130	21.98	85.62	0.85	-4.54	11.18	119.98
131	22.15	88.90	0.82	-4.55	12.07	120.98
132	22.34	83.57	1.27	-4.30	16.49	121.75
133	22.47	43.16	1.37	9.42	17.69	122.42
134	22.67	85.26	1.17	17.73	14.43	122.39
135	22.80	118.77	1.06	-2.48	10.98	122.88
136	23.00	102.49	1.36	-0.53	11.68	123.06
137	23.13	76.89	1.29	4.19	15.61	123.51
138	23.29	70.85	1.54	8.63	18.75	122.97
139	23.46	62.72	1.29	45.30	18.72	123.03
140	23.62	78.05	1.32	16.59	19.43	122.82
141	23.79	62.42	1.48	21.88	18.84	123.14
142	23.95	71.88	1.41	61.96	14.67	123.44
143	24.11	127.72	1.19	-1.74	9.33	123.60
144	24.28	156.51	1.17	-4.21	8.01	125.85

:: Field input data :: (continued)

Point ID	Depth (ft)	q_c (tsf)	f_s (tsf)	u (tsf)	Fines content (%)	Unit weight (pcf)
145	24.44	158.39	2.41	-2.21	8.65	127.68
146	24.64	133.51	2.86	2.27	12.60	129.66

Abbreviations

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

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data ::

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
1	2.33	0.14	0.00	0.14	1.00	0.273	1.05	0.259	1.07	1.00	2.000	No
2	2.82	0.17	0.00	0.17	1.00	0.273	1.05	0.259	1.07	1.00	2.000	No
3	2.98	0.18	0.00	0.18	1.00	0.273	1.05	0.259	1.10	1.00	2.000	No
4	3.15	0.19	0.00	0.19	1.00	0.273	1.05	0.259	1.10	1.00	2.000	No
5	3.31	0.20	0.00	0.20	1.00	0.273	1.05	0.259	1.10	1.00	2.000	No
6	3.48	0.21	0.00	0.21	1.00	0.272	1.05	0.258	1.10	1.00	2.000	No
7	3.64	0.22	0.00	0.22	1.00	0.272	1.05	0.258	1.10	1.00	2.000	No
8	3.80	0.23	0.00	0.23	1.00	0.272	1.05	0.258	1.10	1.00	2.000	No
9	3.97	0.24	0.00	0.24	1.00	0.272	1.05	0.258	1.10	1.00	2.000	No
10	4.13	0.25	0.00	0.25	1.00	0.272	1.05	0.258	1.10	1.00	2.000	No
11	4.30	0.26	0.00	0.26	1.00	0.272	1.05	0.258	1.10	1.00	2.000	No
12	4.46	0.27	0.00	0.27	1.00	0.272	1.05	0.258	1.10	1.00	2.000	No
13	4.63	0.28	0.00	0.28	0.99	0.272	1.05	0.258	1.10	1.00	2.000	No
14	4.79	0.29	0.00	0.29	0.99	0.271	1.05	0.257	1.10	1.00	2.000	No
15	4.95	0.30	0.00	0.30	0.99	0.271	1.05	0.257	1.10	1.00	2.000	No
16	5.12	0.31	0.00	0.31	0.99	0.271	1.05	0.257	1.10	1.00	2.000	No
17	5.28	0.32	0.00	0.32	0.99	0.271	1.05	0.257	1.10	1.00	2.000	No
18	5.45	0.33	0.00	0.33	0.99	0.271	1.05	0.257	1.09	1.00	2.000	No
19	5.61	0.34	0.00	0.34	0.99	0.271	1.05	0.257	1.07	1.00	2.000	No
20	5.77	0.35	0.00	0.35	0.99	0.271	1.05	0.257	1.09	1.00	2.000	No
21	5.94	0.36	0.00	0.36	0.99	0.271	1.05	0.257	1.09	1.00	2.000	No
22	6.10	0.37	0.00	0.37	0.99	0.270	1.05	0.256	1.10	1.00	2.000	No
23	6.30	0.38	0.00	0.38	0.99	0.270	1.05	0.256	1.09	1.00	2.000	No
24	6.46	0.39	0.00	0.39	0.99	0.270	1.05	0.256	1.09	1.00	2.000	No
25	6.63	0.40	0.00	0.40	0.99	0.270	1.05	0.256	1.09	1.00	2.000	No
26	6.76	0.41	0.00	0.41	0.99	0.270	1.05	0.256	1.08	1.00	2.000	No
27	6.92	0.42	0.00	0.42	0.99	0.270	1.05	0.256	1.08	1.00	2.000	No
28	7.08	0.43	0.00	0.43	0.99	0.270	1.05	0.256	1.08	1.00	2.000	No
29	7.25	0.44	0.00	0.44	0.99	0.269	1.05	0.256	1.08	1.00	2.000	No
30	7.45	0.45	0.00	0.45	0.99	0.269	1.05	0.255	1.07	1.00	2.000	No
31	7.61	0.46	0.00	0.46	0.99	0.269	1.05	0.255	1.07	1.00	2.000	No
32	7.77	0.47	0.00	0.47	0.99	0.269	1.05	0.255	1.07	1.00	2.000	No
33	7.91	0.48	0.00	0.48	0.99	0.269	1.05	0.255	1.07	1.00	2.000	No
34	8.10	0.49	0.00	0.49	0.98	0.269	1.05	0.255	1.07	1.00	2.000	No
35	8.27	0.50	0.00	0.50	0.98	0.269	1.05	0.255	1.06	1.00	2.000	No
36	8.40	0.51	0.00	0.51	0.98	0.269	1.05	0.255	1.08	1.00	2.000	No
37	8.56	0.52	0.00	0.52	0.98	0.268	1.05	0.255	1.10	1.00	2.000	No
38	8.73	0.53	0.00	0.53	0.98	0.268	1.05	0.254	1.10	1.00	2.000	No
39	8.89	0.54	0.00	0.54	0.98	0.268	1.05	0.254	1.08	1.00	2.000	No
40	9.05	0.55	0.00	0.55	0.98	0.268	1.05	0.254	1.07	1.00	2.000	No
41	9.22	0.56	0.00	0.56	0.98	0.268	1.05	0.254	1.06	1.00	2.000	No
42	9.38	0.56	0.00	0.56	0.98	0.268	1.05	0.254	1.05	1.00	2.000	No
43	9.55	0.57	0.00	0.57	0.98	0.267	1.05	0.254	1.05	1.00	2.000	No
44	9.71	0.58	0.00	0.58	0.98	0.267	1.05	0.254	1.07	1.00	2.000	No
45	9.87	0.59	0.00	0.59	0.98	0.267	1.05	0.253	1.10	1.00	2.000	No
46	10.04	0.60	0.00	0.60	0.98	0.267	1.05	0.253	1.10	1.00	2.000	No
47	10.20	0.61	0.00	0.61	0.98	0.267	1.05	0.253	1.09	1.00	2.000	No
48	10.37	0.62	0.00	0.62	0.98	0.267	1.05	0.253	1.08	1.00	2.000	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
49	10.53	0.63	0.00	0.63	0.98	0.267	1.05	0.253	1.10	1.00	0.231	No
50	10.73	0.65	0.01	0.64	0.98	0.269	1.05	0.255	1.08	1.00	0.236	No
51	10.89	0.66	0.01	0.64	0.98	0.271	1.05	0.257	1.06	1.00	0.243	No
52	11.02	0.67	0.02	0.65	0.97	0.273	1.05	0.259	1.05	1.00	0.247	No
53	11.19	0.68	0.02	0.65	0.97	0.275	1.05	0.261	1.10	1.00	0.237	No
54	11.42	0.69	0.03	0.66	0.97	0.277	1.05	0.263	1.06	1.00	0.248	No
55	11.55	0.70	0.03	0.66	0.97	0.279	1.05	0.264	1.04	1.00	0.254	No
56	11.68	0.70	0.04	0.67	0.97	0.280	1.05	0.266	1.02	1.00	0.260	No
57	11.84	0.71	0.04	0.67	0.97	0.282	1.05	0.267	1.03	1.00	0.261	No
58	12.01	0.72	0.05	0.67	0.97	0.284	1.05	0.269	1.02	1.00	0.263	No
59	12.17	0.73	0.05	0.68	0.97	0.285	1.05	0.271	1.02	1.00	0.277	No
60	12.37	0.74	0.06	0.68	0.97	0.288	1.05	0.273	1.02	1.00	0.280	No
61	12.50	0.74	0.06	0.68	0.97	0.289	1.05	0.274	1.02	1.00	0.281	No
62	12.70	0.75	0.07	0.69	0.97	0.291	1.05	0.276	1.02	1.00	0.283	No
63	12.83	0.76	0.07	0.69	0.97	0.292	1.05	0.277	1.02	1.00	0.284	No
64	13.02	0.77	0.08	0.69	0.97	0.294	1.05	0.279	1.02	1.00	0.286	No
65	13.15	0.78	0.08	0.70	0.97	0.296	1.05	0.280	1.02	1.00	0.288	No
66	13.35	0.79	0.09	0.70	0.97	0.297	1.05	0.282	1.02	1.00	0.289	No
67	13.52	0.80	0.09	0.70	0.97	0.299	1.05	0.284	1.02	1.00	0.291	No
68	13.68	0.81	0.10	0.71	0.97	0.301	1.05	0.285	1.02	1.00	0.293	No
69	13.84	0.81	0.10	0.71	0.96	0.302	1.05	0.287	1.02	1.00	0.294	No
70	13.97	0.82	0.11	0.71	0.96	0.303	1.05	0.288	1.02	1.00	0.296	No
71	14.17	0.83	0.11	0.72	0.96	0.305	1.05	0.289	1.02	1.00	0.298	No
72	14.34	0.84	0.12	0.72	0.96	0.307	1.05	0.291	1.02	1.00	0.299	No
73	14.66	0.86	0.13	0.73	0.96	0.309	1.05	0.294	1.02	1.00	0.302	No
74	14.79	0.86	0.13	0.73	0.96	0.311	1.05	0.295	1.02	1.00	0.303	No
75	14.96	0.87	0.14	0.73	0.96	0.312	1.05	0.296	1.02	1.00	0.305	No
76	15.12	0.88	0.14	0.74	0.96	0.313	1.05	0.297	1.02	1.00	0.306	No
77	15.29	0.89	0.15	0.74	0.96	0.315	1.05	0.299	1.02	1.00	0.307	No
78	15.48	0.90	0.16	0.74	0.96	0.316	1.05	0.300	1.02	1.00	0.309	No
79	15.65	0.91	0.16	0.75	0.96	0.318	1.05	0.301	1.01	1.00	0.310	No
80	15.78	0.91	0.16	0.75	0.96	0.319	1.05	0.302	1.01	1.00	0.312	No
81	15.98	0.92	0.17	0.75	0.96	0.320	1.05	0.304	1.01	1.00	0.313	No
82	16.14	0.93	0.18	0.76	0.96	0.322	1.05	0.305	1.01	1.00	0.315	No
83	16.27	0.94	0.18	0.76	0.96	0.323	1.05	0.306	1.01	1.00	0.316	No
84	16.44	0.95	0.19	0.76	0.95	0.324	1.05	0.307	1.01	1.00	0.317	No
85	16.60	0.95	0.19	0.76	0.95	0.325	1.05	0.309	1.01	1.00	0.318	No
86	16.76	0.96	0.20	0.77	0.95	0.327	1.05	0.310	1.01	1.00	0.320	No
87	16.93	0.97	0.20	0.77	0.95	0.328	1.05	0.311	1.01	1.00	0.321	No
88	17.09	0.98	0.21	0.77	0.95	0.329	1.05	0.312	1.01	1.00	0.322	No
89	17.26	0.99	0.21	0.78	0.95	0.330	1.05	0.313	1.01	1.00	0.324	No
90	17.42	0.99	0.22	0.78	0.95	0.332	1.05	0.315	1.01	1.00	0.325	No
91	17.58	1.00	0.22	0.78	0.95	0.333	1.05	0.316	1.01	1.00	0.326	No
92	17.75	1.01	0.23	0.78	0.95	0.334	1.05	0.317	1.01	1.00	0.327	No
93	17.91	1.02	0.23	0.79	0.95	0.335	1.05	0.318	1.01	1.00	0.328	No
94	18.11	1.03	0.24	0.79	0.95	0.337	1.05	0.319	1.01	1.00	0.330	No
95	18.27	1.04	0.24	0.79	0.95	0.338	1.05	0.320	1.01	1.00	0.331	No
96	18.44	1.04	0.25	0.80	0.95	0.339	1.05	0.322	1.01	1.00	0.332	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
97	18.57	1.05	0.25	0.80	0.95	0.340	1.05	0.322	1.01	1.00	0.333	No
98	18.73	1.06	0.26	0.80	0.95	0.341	1.05	0.323	1.01	1.00	0.334	No
99	18.90	1.07	0.26	0.80	0.95	0.342	1.05	0.324	1.01	1.00	0.335	No
100	19.06	1.07	0.27	0.81	0.94	0.343	1.05	0.325	1.01	1.00	0.321	No
101	19.26	1.09	0.27	0.81	0.94	0.344	1.05	0.327	1.01	1.00	0.322	No
102	19.42	1.09	0.28	0.82	0.94	0.345	1.05	0.327	1.02	1.00	0.322	No
103	19.59	1.10	0.28	0.82	0.94	0.346	1.05	0.328	1.02	1.00	0.322	No
104	19.75	1.11	0.29	0.82	0.94	0.347	1.05	0.329	1.02	1.00	0.322	No
105	19.88	1.12	0.29	0.83	0.94	0.348	1.05	0.330	1.02	1.00	0.323	No
106	20.08	1.13	0.30	0.83	0.94	0.349	1.05	0.331	1.02	1.00	0.325	No
107	20.24	1.14	0.30	0.84	0.94	0.350	1.05	0.332	1.01	1.00	0.327	No
108	20.41	1.15	0.31	0.84	0.94	0.350	1.05	0.332	1.01	1.00	0.328	No
109	20.57	1.16	0.31	0.84	0.94	0.351	1.05	0.333	1.01	1.00	0.329	No
110	20.70	1.17	0.32	0.85	0.94	0.352	1.05	0.334	1.01	1.00	0.330	No
111	20.86	1.18	0.32	0.85	0.94	0.353	1.05	0.335	1.02	1.00	0.329	No
112	21.06	1.19	0.33	0.86	0.94	0.354	1.05	0.336	1.02	1.00	0.329	No
113	21.23	1.20	0.33	0.86	0.94	0.355	1.05	0.336	1.02	1.00	0.331	No
114	21.39	1.20	0.34	0.86	0.93	0.355	1.05	0.337	1.01	1.00	0.332	No
115	21.55	1.21	0.34	0.87	0.93	0.356	1.05	0.338	1.01	1.00	0.333	No
116	21.68	1.22	0.35	0.87	0.93	0.357	1.05	0.338	1.01	1.00	0.335	No
117	21.88	1.23	0.36	0.88	0.93	0.358	1.05	0.339	1.01	1.00	0.336	No
118	22.01	1.24	0.36	0.88	0.93	0.358	1.05	0.340	1.03	1.00	0.331	No
119	22.21	1.25	0.37	0.88	0.93	0.359	1.05	0.341	1.02	1.00	0.335	No
120	22.37	1.26	0.37	0.89	0.93	0.360	1.05	0.342	1.01	1.00	0.339	No
121	22.54	1.26	0.38	0.89	0.93	0.361	1.05	0.342	1.01	1.00	0.355	No
122	22.67	1.27	0.38	0.89	0.93	0.362	1.05	0.343	1.01	1.00	0.356	No
123	22.87	1.28	0.39	0.90	0.93	0.363	1.05	0.344	1.01	1.00	0.357	No
124	23.00	1.29	0.39	0.90	0.93	0.363	1.05	0.344	1.01	1.00	0.341	No
125	23.16	1.30	0.40	0.90	0.93	0.364	1.05	0.345	1.01	1.00	0.341	No
126	23.32	1.31	0.40	0.91	0.93	0.364	1.05	0.346	1.01	1.00	0.341	No
127	23.49	1.32	0.41	0.91	0.93	0.365	1.05	0.346	1.01	1.00	0.342	No
128	23.65	1.33	0.41	0.92	0.92	0.366	1.05	0.347	1.01	1.00	0.342	No
129	23.82	1.34	0.42	0.92	0.92	0.366	1.05	0.347	1.01	1.00	0.343	No
130	23.98	1.35	0.42	0.93	0.92	0.367	1.05	0.348	1.01	1.00	0.343	No
131	24.15	1.36	0.43	0.93	0.92	0.367	1.05	0.348	1.01	1.00	0.344	No
132	24.34	1.37	0.43	0.94	0.92	0.368	1.05	0.349	1.01	1.00	0.345	No
133	24.47	1.38	0.44	0.94	0.92	0.368	1.05	0.349	1.01	1.00	0.346	No
134	24.67	1.39	0.44	0.95	0.92	0.369	1.05	0.350	1.01	1.00	0.346	No
135	24.80	1.40	0.45	0.95	0.92	0.369	1.05	0.350	1.01	1.00	0.345	No
136	25.00	1.41	0.45	0.96	0.92	0.370	1.05	0.350	1.01	1.00	0.347	No
137	25.13	1.42	0.46	0.96	0.92	0.370	1.05	0.351	1.01	1.00	0.348	No
138	25.29	1.43	0.46	0.97	0.92	0.370	1.05	0.351	1.01	1.00	0.348	No
139	25.46	1.44	0.47	0.97	0.92	0.371	1.05	0.352	1.01	1.00	0.349	No
140	25.62	1.45	0.47	0.97	0.92	0.371	1.05	0.352	1.01	1.00	0.349	No
141	25.79	1.46	0.48	0.98	0.92	0.372	1.05	0.352	1.01	1.00	0.350	No
142	25.95	1.47	0.48	0.98	0.91	0.372	1.05	0.353	1.01	1.00	0.351	No
143	26.11	1.48	0.49	0.99	0.91	0.372	1.05	0.353	1.01	1.00	0.350	No
144	26.28	1.49	0.49	1.00	0.91	0.373	1.05	0.353	1.01	1.00	0.350	No

:: Cyclic Stress Ratio fully adjusted (CSR*) calculation data :: (continued)

Point ID	Depth (ft)	σ_v (tsf)	u_0 (tsf)	σ_v' (tsf)	r_d	CSR	MSF	CSR_{eq}	K_σ	User FS	CSR^*	Belongs to transition
145	26.44	1.50	0.50	1.00	0.91	0.373	1.05	0.354	1.01	1.00	0.350	No
146	26.64	1.51	0.50	1.01	0.91	0.373	1.05	0.354	1.01	1.00	0.352	No

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
σ_v: Total overburden pressure at test point (tsf)
u_0: Water pressure at test point (tsf)
σ_v': Effective overburden pressure based on GWT during earthquake (tsf)
r_d: Nonlinear shear mass factor
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq}: CSR adjusted for M=7.5
K_σ: Effective overburden stress factor
CSR^*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) calculation data ::

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
1	2.33	1.19	86.70	3.74	0.71	1.70	1.91	0.00	1.91	4.000	No	Yes	2.00
2	2.82	25.97	19.18	2.10	0.75	1.70	1.91	23.92	25.83	4.000	No	No	2.00
3	2.98	100.52	9.29	1.59	0.43	1.70	121.34	10.90	132.24	4.000	No	No	2.00
4	3.15	178.13	7.96	1.49	0.26	1.70	361.28	9.97	371.24	4.000	No	No	2.00
5	3.31	215.01	8.09	1.50	0.26	1.70	375.98	11.39	387.37	4.000	No	No	2.00
6	3.48	198.06	9.55	1.60	0.26	1.70	299.13	22.86	321.99	4.000	No	No	2.00
7	3.64	174.35	10.78	1.68	0.26	1.70	279.58	34.55	314.13	4.000	No	No	2.00
8	3.80	154.01	11.88	1.74	0.26	1.70	261.69	43.95	305.63	4.000	No	No	2.00
9	3.97	138.69	12.86	1.80	0.27	1.70	201.09	43.99	245.08	4.000	No	No	2.00
10	4.13	125.88	13.23	1.82	0.26	1.70	205.63	47.53	253.17	4.000	No	No	2.00
11	4.30	131.80	12.20	1.76	0.28	1.70	199.93	38.71	238.64	4.000	No	No	2.00
12	4.46	137.53	11.29	1.71	0.26	1.69	228.61	34.40	263.01	4.000	No	No	2.00
13	4.63	143.88	11.09	1.70	0.26	1.66	228.07	32.53	260.60	4.000	No	No	2.00
14	4.79	135.85	11.60	1.73	0.26	1.63	221.58	36.42	258.00	4.000	No	No	2.00
15	4.95	112.37	13.15	1.81	0.29	1.68	189.15	44.25	233.40	4.000	No	No	2.00
16	5.12	83.67	15.53	1.93	0.38	1.70	120.15	44.31	164.45	4.000	No	No	2.00
17	5.28	57.22	20.04	2.13	0.42	1.70	92.23	50.07	142.30	4.000	No	No	2.00
18	5.45	40.80	24.99	2.32	0.47	1.70	63.38	47.47	110.86	4.000	No	No	2.00
19	5.61	34.91	27.51	2.41	0.54	1.70	40.96	41.74	82.70	4.000	No	No	2.00
20	5.77	35.05	27.29	2.40	0.47	1.70	63.76	49.09	112.85	4.000	No	No	2.00
21	5.94	43.12	24.21	2.29	0.47	1.70	64.04	47.05	111.09	4.000	No	No	2.00
22	6.10	46.11	23.23	2.26	0.44	1.70	79.83	51.00	130.84	4.000	No	No	2.00
23	6.30	48.68	22.43	2.23	0.44	1.70	78.20	49.59	127.79	4.000	No	No	2.00
24	6.46	47.78	22.79	2.24	0.45	1.70	76.48	49.49	125.98	4.000	No	No	2.00
25	6.63	47.12	23.07	2.25	0.45	1.70	75.46	49.49	124.95	4.000	No	No	2.00
26	6.76	46.71	23.24	2.26	0.45	1.70	75.02	49.53	124.55	4.000	No	No	2.00
27	6.92	46.40	23.34	2.26	0.45	1.70	74.52	49.48	124.01	4.000	No	No	2.00
28	7.08	46.09	23.46	2.26	0.45	1.70	73.95	49.43	123.38	4.000	No	No	2.00
29	7.25	45.79	23.58	2.27	0.45	1.70	73.54	49.43	122.97	4.000	No	No	2.00
30	7.45	45.55	23.72	2.27	0.45	1.70	73.06	49.41	122.47	4.000	No	No	2.00
31	7.61	45.36	23.85	2.28	0.45	1.69	72.22	49.28	121.51	4.000	No	No	2.00
32	7.77	45.24	23.98	2.28	0.46	1.67	71.32	49.12	120.43	4.000	No	No	2.00
33	7.91	45.25	22.70	2.24	0.46	1.66	70.77	47.65	118.41	4.000	No	No	2.00
34	8.10	45.37	20.36	2.14	0.47	1.65	70.58	44.50	115.08	4.000	No	No	2.00
35	8.27	53.63	15.79	1.95	0.49	1.66	71.43	34.66	106.09	4.000	No	No	2.00
36	8.40	84.73	11.51	1.72	0.44	1.57	104.04	21.99	126.03	4.000	No	No	2.00
37	8.56	109.11	10.61	1.67	0.32	1.38	180.93	23.87	204.80	4.000	No	No	2.00
38	8.73	113.99	10.89	1.69	0.35	1.41	158.32	23.84	182.16	4.000	No	No	2.00
39	8.89	90.69	12.98	1.80	0.40	1.47	117.10	31.78	148.88	4.000	No	No	2.00
40	9.05	70.95	15.23	1.92	0.43	1.49	96.51	38.14	134.64	4.000	No	No	2.00
41	9.22	58.68	16.95	2.00	0.45	1.49	84.11	40.91	125.02	4.000	No	No	2.00
42	9.38	52.43	17.47	2.02	0.48	1.53	68.92	38.52	107.43	4.000	No	No	2.00
43	9.55	61.03	15.63	1.94	0.49	1.52	71.62	34.21	105.84	4.000	No	No	2.00
44	9.71	91.80	12.60	1.78	0.41	1.41	113.90	29.26	143.16	4.000	No	No	2.00
45	9.87	119.02	11.37	1.71	0.33	1.30	172.47	28.84	201.30	4.000	No	No	2.00
46	10.04	129.90	11.00	1.69	0.34	1.31	163.35	25.13	188.48	4.000	No	No	2.00
47	10.20	123.39	11.18	1.70	0.37	1.33	147.92	24.84	172.76	4.000	No	No	2.00
48	10.37	125.38	10.54	1.67	0.37	1.32	150.30	20.71	171.01	4.000	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
49	10.53	127.39	10.69	1.67	0.34	1.28	167.05	23.26	190.31	0.759	No	No	2.00
50	10.73	117.22	12.59	1.78	0.35	1.29	150.69	34.58	185.26	0.634	No	No	2.00
51	10.89	95.26	15.29	1.92	0.40	1.32	112.71	41.77	154.48	0.293	No	No	1.21
52	11.02	113.37	13.38	1.83	0.45	1.37	93.18	29.89	123.07	0.186	No	No	0.76
53	11.19	116.64	11.12	1.70	0.28	1.22	205.30	30.41	235.71	4.000	No	No	2.00
54	11.42	111.43	9.71	1.61	0.42	1.33	125.36	13.51	138.87	0.229	No	No	0.92
55	11.55	54.85	12.43	1.77	0.51	1.41	74.18	22.73	96.91	0.138	No	No	0.54
56	11.68	27.70	18.84	2.08	0.68	1.58	12.73	26.44	39.16	0.068	No	No	0.26
57	11.84	14.27	29.88	2.49	0.59	1.48	25.72	37.55	63.27	0.092	No	No	0.35
58	12.01	14.28	31.65	2.54	0.61	1.49	22.22	36.81	59.02	0.087	No	No	0.33
59	12.17	10.05	39.75	2.77	0.65	1.53	12.47	0.00	12.47	0.881	No	Yes	2.00
60	12.37	6.03	51.97	3.08	0.67	1.54	8.17	0.00	8.17	0.502	No	Yes	1.79
61	12.50	4.67	57.42	3.20	0.69	1.56	5.23	0.00	5.23	0.373	No	Yes	1.33
62	12.70	6.44	47.47	2.97	0.68	1.54	6.41	0.00	6.41	0.533	No	Yes	1.88
63	12.83	7.24	44.39	2.89	0.63	1.49	15.32	0.00	15.32	0.603	No	Yes	2.00
64	13.02	7.44	44.46	2.90	0.67	1.52	8.70	0.00	8.70	0.616	No	Yes	2.00
65	13.15	6.50	50.39	3.04	0.68	1.52	7.23	0.00	7.23	0.527	No	Yes	1.83
66	13.35	8.10	45.17	2.91	0.66	1.49	11.33	0.00	11.33	0.666	No	Yes	2.00
67	13.52	8.58	44.16	2.89	0.64	1.47	14.94	0.00	14.94	0.704	No	Yes	2.00
68	13.68	7.89	45.40	2.92	0.67	1.49	9.11	0.00	9.11	0.638	No	Yes	2.00
69	13.84	6.32	53.09	3.10	0.67	1.49	8.23	0.00	8.23	0.495	No	Yes	1.68
70	13.97	5.79	59.50	3.24	0.67	1.48	8.41	0.00	8.41	0.446	No	Yes	1.51
71	14.17	5.40	61.85	3.29	0.68	1.49	6.87	0.00	6.87	0.408	No	Yes	1.37
72	14.34	5.01	63.92	3.33	0.68	1.48	6.57	0.00	6.57	0.371	No	Yes	1.24
73	14.66	5.32	58.32	3.21	0.68	1.47	6.56	0.00	6.56	0.392	No	Yes	1.30
74	14.79	5.73	55.57	3.16	0.67	1.46	7.94	0.00	7.94	0.425	No	Yes	1.40
75	14.96	6.03	53.06	3.10	0.67	1.45	7.97	0.00	7.97	0.447	No	Yes	1.47
76	15.12	5.92	54.32	3.13	0.68	1.45	7.62	0.00	7.62	0.434	No	Yes	1.42
77	15.29	5.98	54.87	3.14	0.68	1.45	7.28	0.00	7.28	0.436	No	Yes	1.42
78	15.48	5.76	56.12	3.17	0.67	1.44	8.14	0.00	8.14	0.414	No	Yes	1.34
79	15.65	5.43	56.14	3.17	0.68	1.44	6.84	0.00	6.84	0.384	No	Yes	1.24
80	15.78	4.80	58.54	3.22	0.69	1.44	5.98	0.00	5.98	0.330	No	Yes	1.06
81	15.98	4.37	60.83	3.27	0.69	1.43	5.67	0.00	5.67	0.293	No	Yes	0.93
82	16.14	4.06	62.65	3.30	0.69	1.43	5.07	0.00	5.07	0.266	No	Yes	0.84
83	16.27	4.08	61.06	3.27	0.69	1.43	4.72	0.00	4.72	0.265	No	Yes	0.84
84	16.44	4.09	59.70	3.24	0.69	1.42	5.60	0.00	5.60	0.264	No	Yes	0.83
85	16.60	4.22	58.51	3.22	0.69	1.42	4.90	0.00	4.90	0.273	No	Yes	0.86
86	16.76	4.16	59.91	3.25	0.69	1.41	5.05	0.00	5.05	0.266	No	Yes	0.83
87	16.93	4.29	59.24	3.23	0.69	1.41	5.27	0.00	5.27	0.275	No	Yes	0.86
88	17.09	4.42	57.88	3.21	0.69	1.40	5.38	0.00	5.38	0.283	No	Yes	0.88
89	17.26	4.53	56.13	3.17	0.69	1.40	5.53	0.00	5.53	0.290	No	Yes	0.90
90	17.42	4.55	55.89	3.16	0.69	1.39	5.69	0.00	5.69	0.290	No	Yes	0.89
91	17.58	4.47	56.98	3.19	0.69	1.39	5.45	0.00	5.45	0.282	No	Yes	0.86
92	17.75	4.37	58.32	3.22	0.69	1.39	5.23	0.00	5.23	0.272	No	Yes	0.83
93	17.91	4.44	57.88	3.21	0.69	1.38	5.30	0.00	5.30	0.276	No	Yes	0.84
94	18.11	4.84	54.84	3.14	0.69	1.38	5.74	0.00	5.74	0.304	No	Yes	0.92
95	18.27	5.34	51.54	3.07	0.68	1.37	6.67	0.00	6.67	0.341	No	Yes	1.03
96	18.44	5.62	49.99	3.03	0.68	1.36	7.22	0.00	7.22	0.360	No	Yes	1.09

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
97	18.57	5.53	51.36	3.06	0.68	1.36	6.81	0.00	6.81	0.352	No	Yes	1.06
98	18.73	5.95	49.92	3.03	0.68	1.36	6.33	0.00	6.33	0.382	No	Yes	1.14
99	18.90	9.82	39.02	2.75	0.67	1.35	8.73	0.00	8.73	0.672	No	Yes	2.00
100	19.06	15.13	32.03	2.55	0.61	1.31	20.88	36.43	57.31	0.085	No	No	0.26
101	19.26	23.27	26.53	2.37	0.60	1.29	25.58	36.28	61.86	0.090	No	No	0.28
102	19.42	36.46	21.16	2.18	0.56	1.27	37.67	36.10	73.77	0.104	No	No	0.32
103	19.59	53.51	17.26	2.01	0.49	1.23	65.69	37.23	102.92	0.147	No	No	0.46
104	19.75	64.23	15.52	1.93	0.46	1.21	82.53	36.22	118.76	0.177	No	No	0.55
105	19.88	61.67	16.45	1.98	0.48	1.22	73.12	36.93	110.05	0.160	No	No	0.50
106	20.08	46.12	20.15	2.14	0.51	1.23	56.65	40.25	96.91	0.138	No	No	0.42
107	20.24	32.67	24.82	2.31	0.58	1.26	30.33	36.90	67.23	0.096	No	No	0.29
108	20.41	24.90	27.21	2.40	0.59	1.26	27.61	37.24	64.85	0.093	No	No	0.28
109	20.57	22.63	26.63	2.38	0.58	1.25	30.18	37.82	68.00	0.097	No	No	0.30
110	20.70	34.32	20.22	2.14	0.63	1.27	22.28	30.66	52.94	0.080	No	No	0.24
111	20.86	52.59	15.44	1.93	0.50	1.21	66.42	32.53	98.94	0.141	No	No	0.43
112	21.06	62.03	13.91	1.85	0.45	1.18	89.95	31.63	121.58	0.183	No	No	0.56
113	21.23	57.00	14.31	1.87	0.54	1.22	54.25	26.56	80.80	0.114	No	No	0.34
114	21.39	42.83	17.03	2.00	0.54	1.21	49.66	32.82	82.48	0.116	No	No	0.35
115	21.55	35.45	19.97	2.13	0.55	1.21	43.49	36.31	79.79	0.112	No	No	0.34
116	21.68	25.29	25.92	2.35	0.59	1.23	28.95	37.07	66.02	0.095	No	No	0.28
117	21.88	55.70	14.55	1.88	0.70	1.27	15.41	19.77	35.18	0.065	No	No	0.19
118	22.01	75.34	10.58	1.67	0.39	1.14	139.20	19.97	159.17	0.321	No	No	0.97
119	22.21	75.07	9.34	1.59	0.49	1.18	93.40	9.65	103.05	0.148	No	No	0.44
120	22.37	35.48	16.03	1.96	0.69	1.26	14.24	22.55	36.79	0.066	No	No	0.20
121	22.54	10.60	35.01	2.64	0.65	1.24	12.06	0.00	12.06	0.637	No	Yes	1.79
122	22.67	10.55	39.49	2.77	0.66	1.24	10.65	0.00	10.65	0.631	No	Yes	1.77
123	22.87	14.79	34.34	2.62	0.65	1.23	13.65	0.00	13.65	0.910	No	Yes	2.00
124	23.00	27.07	25.14	2.33	0.60	1.21	26.25	35.79	62.04	0.090	No	No	0.26
125	23.16	42.83	20.22	2.14	0.52	1.17	51.07	38.79	89.85	0.127	No	No	0.37
126	23.32	57.83	17.73	2.03	0.49	1.16	64.92	38.10	103.02	0.148	No	No	0.43
127	23.49	67.51	17.12	2.01	0.47	1.15	74.13	38.94	113.08	0.166	No	No	0.48
128	23.65	75.20	16.55	1.98	0.46	1.14	81.10	39.06	120.16	0.180	No	No	0.53
129	23.82	80.99	16.11	1.96	0.44	1.13	88.25	39.38	127.63	0.197	No	No	0.58
130	23.98	85.55	15.52	1.93	0.44	1.13	91.45	38.12	129.57	0.202	No	No	0.59
131	24.15	85.97	16.26	1.97	0.43	1.12	94.42	41.25	135.67	0.219	No	No	0.64
132	24.34	71.88	19.81	2.12	0.43	1.12	88.43	48.58	137.01	0.223	No	No	0.65
133	24.47	70.77	20.75	2.16	0.53	1.15	46.87	38.28	85.15	0.120	No	No	0.35
134	24.67	82.51	18.18	2.05	0.43	1.11	89.83	45.48	135.31	0.218	No	No	0.63
135	24.80	102.24	15.35	1.92	0.38	1.10	123.25	44.22	167.48	0.384	No	No	1.11
136	25.00	99.39	15.93	1.95	0.40	1.10	106.78	42.94	149.72	0.270	No	No	0.78
137	25.13	83.47	19.11	2.09	0.45	1.11	80.75	45.13	125.88	0.193	No	No	0.55
138	25.29	70.43	21.57	2.19	0.45	1.11	74.34	47.34	121.68	0.183	No	No	0.53
139	25.46	70.88	21.54	2.19	0.48	1.11	65.96	44.84	110.80	0.161	No	No	0.46
140	25.62	68.13	22.09	2.21	0.44	1.10	81.15	50.04	131.19	0.206	No	No	0.59
141	25.79	71.26	21.64	2.20	0.48	1.11	65.30	44.76	110.06	0.160	No	No	0.46
142	25.95	87.73	18.37	2.06	0.46	1.10	74.77	42.01	116.78	0.173	No	No	0.49
143	26.11	118.97	13.96	1.85	0.37	1.08	130.14	39.10	169.24	0.400	No	No	1.14
144	26.28	147.50	12.81	1.79	0.34	1.07	157.98	37.08	195.06	0.917	No	No	2.00

:: Cyclic Resistance Ratio (CRR) calculation data :: (continued)

Point ID	Depth (ft)	q_t (tsf)	FC (%)	Ic	m	C_N	q_{c1N}	Δq_{c1N}	$q_{c1N,cs}$	$CRR_{7.5}$	Belongs to trans. layer	Clay-like behaviour	FS
145	26.44	157.72	13.37	1.82	0.33	1.06	159.33	40.81	200.15	1.146	No	No	2.00
146	26.64	141.82	16.69	1.99	0.35	1.07	134.43	52.03	186.46	0.661	No	No	1.88

Abbreviations

Depth: Depth from free surface, at which CPT was performed (ft)
q_t: Total cone resistance
FC: Fines content (%)
I_c: Soil behavior type index
m: Stress exponent
C_N: Overburden correction factor
q_{c1N}: Normalized and adjusted cone resistance
Δq_{c1N}: Cone resistance correction factor due to fines
$q_{c1N,cs}$: Normalized and adjusted cone resistance
$CRR_{7.5}$: Cyclic resistance ratio for M_w=7.5
FS: Factor of safety against soil liquefaction

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
2.33	2.00	0.00	9.65	0.49	0.00	2.82	2.00	0.00	9.57	0.49	0.00
2.98	2.00	0.00	9.55	0.16	0.00	3.15	2.00	0.00	9.52	0.16	0.00
3.31	2.00	0.00	9.50	0.16	0.00	3.48	2.00	0.00	9.47	0.16	0.00
3.64	2.00	0.00	9.45	0.16	0.00	3.80	2.00	0.00	9.42	0.16	0.00
3.97	2.00	0.00	9.40	0.17	0.00	4.13	2.00	0.00	9.37	0.16	0.00
4.30	2.00	0.00	9.35	0.16	0.00	4.46	2.00	0.00	9.32	0.16	0.00
4.63	2.00	0.00	9.30	0.16	0.00	4.79	2.00	0.00	9.27	0.16	0.00
4.95	2.00	0.00	9.25	0.16	0.00	5.12	2.00	0.00	9.22	0.16	0.00
5.28	2.00	0.00	9.20	0.16	0.00	5.45	2.00	0.00	9.17	0.16	0.00
5.61	2.00	0.00	9.15	0.16	0.00	5.77	2.00	0.00	9.12	0.16	0.00
5.94	2.00	0.00	9.10	0.16	0.00	6.10	2.00	0.00	9.07	0.16	0.00
6.30	2.00	0.00	9.04	0.20	0.00	6.46	2.00	0.00	9.02	0.16	0.00
6.63	2.00	0.00	8.99	0.16	0.00	6.76	2.00	0.00	8.97	0.13	0.00
6.92	2.00	0.00	8.95	0.16	0.00	7.08	2.00	0.00	8.92	0.16	0.00
7.25	2.00	0.00	8.90	0.16	0.00	7.45	2.00	0.00	8.87	0.20	0.00
7.61	2.00	0.00	8.84	0.16	0.00	7.77	2.00	0.00	8.82	0.16	0.00
7.91	2.00	0.00	8.80	0.13	0.00	8.10	2.00	0.00	8.77	0.20	0.00
8.27	2.00	0.00	8.74	0.16	0.00	8.40	2.00	0.00	8.72	0.13	0.00
8.56	2.00	0.00	8.70	0.16	0.00	8.73	2.00	0.00	8.67	0.16	0.00
8.89	2.00	0.00	8.65	0.16	0.00	9.05	2.00	0.00	8.62	0.16	0.00
9.22	2.00	0.00	8.60	0.16	0.00	9.38	2.00	0.00	8.57	0.16	0.00
9.55	2.00	0.00	8.55	0.16	0.00	9.71	2.00	0.00	8.52	0.16	0.00
9.87	2.00	0.00	8.50	0.16	0.00	10.04	2.00	0.00	8.47	0.16	0.00
10.20	2.00	0.00	8.45	0.16	0.00	10.37	2.00	0.00	8.42	0.16	0.00
10.53	2.00	0.00	8.40	0.16	0.00	10.73	2.00	0.00	8.37	0.20	0.00
10.89	1.21	0.00	8.34	0.16	0.00	11.02	0.76	0.24	8.32	0.13	0.08
11.19	2.00	0.00	8.30	0.16	0.00	11.42	0.92	0.08	8.26	0.23	0.04
11.55	0.54	0.46	8.24	0.13	0.15	11.68	0.26	0.74	8.22	0.13	0.24
11.84	0.35	0.65	8.20	0.16	0.27	12.01	0.33	0.67	8.17	0.16	0.27
12.17	2.00	0.00	8.15	0.16	0.00	12.37	1.79	0.00	8.12	0.20	0.00
12.50	1.33	0.00	8.10	0.13	0.00	12.70	1.88	0.00	8.07	0.20	0.00
12.83	2.00	0.00	8.05	0.13	0.00	13.02	2.00	0.00	8.02	0.20	0.00
13.15	1.83	0.00	8.00	0.13	0.00	13.35	2.00	0.00	7.97	0.20	0.00
13.52	2.00	0.00	7.94	0.16	0.00	13.68	2.00	0.00	7.92	0.16	0.00
13.84	1.68	0.00	7.89	0.16	0.00	13.97	1.51	0.00	7.87	0.13	0.00
14.17	1.37	0.00	7.84	0.20	0.00	14.34	1.24	0.00	7.82	0.16	0.00
14.66	1.30	0.00	7.77	0.33	0.00	14.79	1.40	0.00	7.75	0.13	0.00
14.96	1.47	0.00	7.72	0.16	0.00	15.12	1.42	0.00	7.70	0.16	0.00
15.29	1.42	0.00	7.67	0.16	0.00	15.48	1.34	0.00	7.64	0.20	0.00
15.65	1.24	0.00	7.62	0.16	0.00	15.78	1.06	0.00	7.60	0.13	0.00
15.98	0.93	0.07	7.57	0.20	0.03	16.14	0.84	0.16	7.54	0.16	0.06
16.27	0.84	0.16	7.52	0.13	0.05	16.44	0.83	0.17	7.50	0.16	0.06
16.60	0.86	0.14	7.47	0.16	0.05	16.76	0.83	0.17	7.45	0.16	0.06
16.93	0.86	0.14	7.42	0.16	0.05	17.09	0.88	0.12	7.40	0.16	0.04
17.26	0.90	0.10	7.37	0.16	0.04	17.42	0.89	0.11	7.35	0.16	0.04
17.58	0.86	0.14	7.32	0.16	0.05	17.75	0.83	0.17	7.30	0.16	0.06
17.91	0.84	0.16	7.27	0.16	0.06	18.11	0.92	0.08	7.24	0.20	0.03
18.27	1.03	0.00	7.22	0.16	0.00	18.44	1.09	0.00	7.19	0.16	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
18.57	1.06	0.00	7.17	0.13	0.00	18.73	1.14	0.00	7.15	0.16	0.00
18.90	2.00	0.00	7.12	0.16	0.00	19.06	0.26	0.74	7.10	0.16	0.26
19.26	0.28	0.72	7.07	0.20	0.31	19.42	0.32	0.68	7.04	0.16	0.24
19.59	0.46	0.54	7.02	0.16	0.19	19.75	0.55	0.45	6.99	0.16	0.16
19.88	0.50	0.50	6.97	0.13	0.14	20.08	0.42	0.58	6.94	0.20	0.24
20.24	0.29	0.71	6.92	0.16	0.24	20.41	0.28	0.72	6.89	0.16	0.25
20.57	0.30	0.70	6.87	0.16	0.24	20.70	0.24	0.76	6.85	0.13	0.21
20.86	0.43	0.57	6.82	0.16	0.19	21.06	0.56	0.44	6.79	0.20	0.18
21.23	0.34	0.66	6.77	0.16	0.22	21.39	0.35	0.65	6.74	0.16	0.22
21.55	0.34	0.66	6.72	0.16	0.22	21.68	0.28	0.72	6.70	0.13	0.19
21.88	0.19	0.81	6.67	0.20	0.32	22.01	0.97	0.03	6.65	0.13	0.01
22.21	0.44	0.56	6.62	0.20	0.22	22.37	0.20	0.80	6.59	0.16	0.27
22.54	1.79	0.00	6.57	0.16	0.00	22.67	1.77	0.00	6.55	0.13	0.00
22.87	2.00	0.00	6.52	0.20	0.00	23.00	0.26	0.74	6.50	0.13	0.19
23.16	0.37	0.63	6.47	0.16	0.20	23.32	0.43	0.57	6.45	0.16	0.18
23.49	0.48	0.52	6.42	0.16	0.17	23.65	0.53	0.47	6.40	0.16	0.15
23.82	0.58	0.42	6.37	0.16	0.14	23.98	0.59	0.41	6.35	0.16	0.13
24.15	0.64	0.36	6.32	0.16	0.11	24.34	0.65	0.35	6.29	0.20	0.13
24.47	0.35	0.65	6.27	0.13	0.16	24.67	0.63	0.37	6.24	0.20	0.14
24.80	1.11	0.00	6.22	0.13	0.00	25.00	0.78	0.22	6.19	0.20	0.08
25.13	0.55	0.45	6.17	0.13	0.11	25.29	0.53	0.47	6.15	0.16	0.15
25.46	0.46	0.54	6.12	0.16	0.16	25.62	0.59	0.41	6.10	0.16	0.12
25.79	0.46	0.54	6.07	0.16	0.16	25.95	0.49	0.51	6.05	0.16	0.15
26.11	1.14	0.00	6.02	0.16	0.00	26.28	2.00	0.00	6.00	0.16	0.00
26.44	2.00	0.00	5.97	0.16	0.00	26.64	1.88	0.00	5.94	0.20	0.00

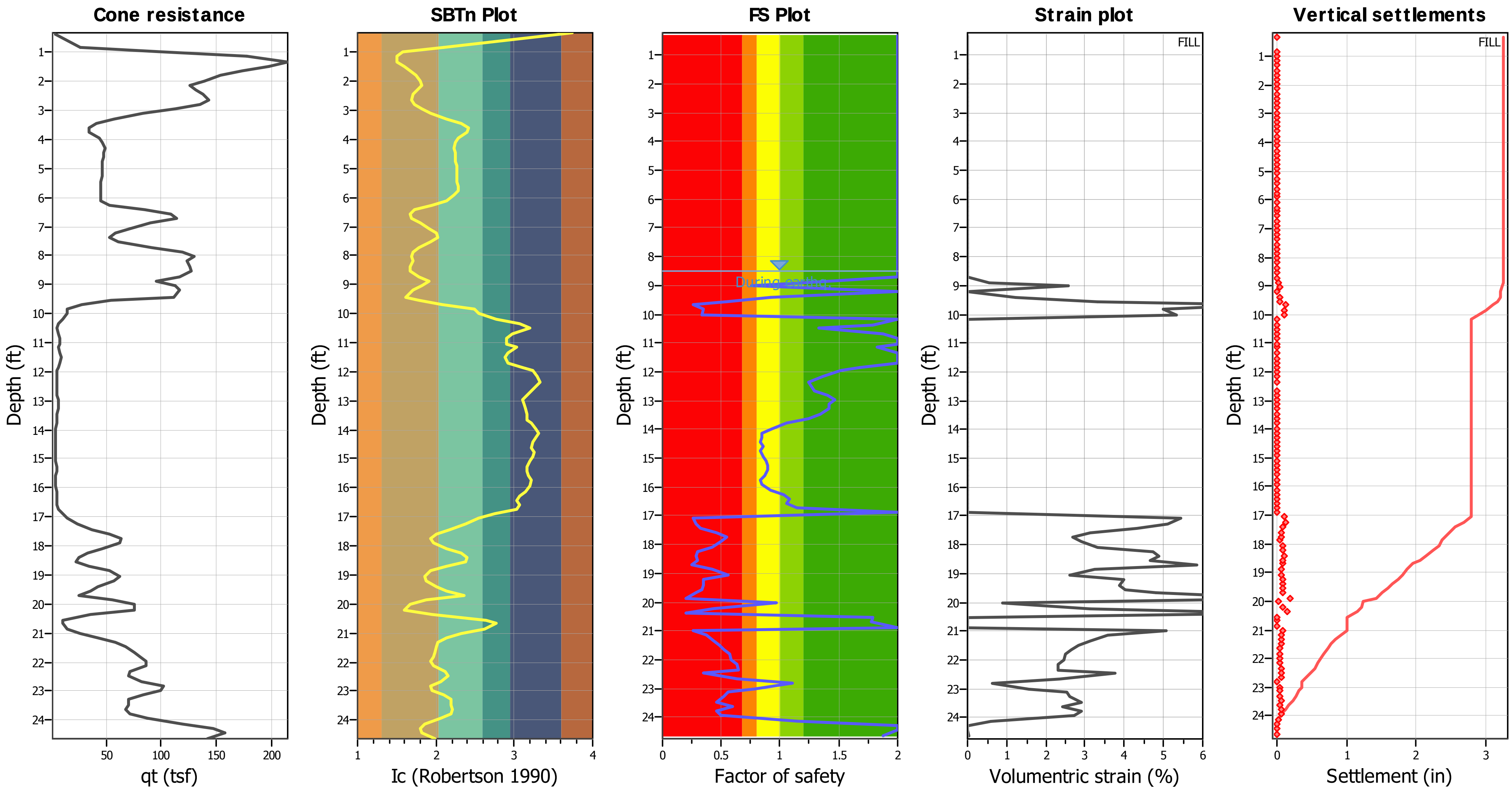
Overall liquefaction potential: 8.93

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
10.53	190.31	2.00	0.00	1.00	0.00	10.73	185.26	2.00	0.00	1.00	0.00
10.89	154.48	1.21	0.55	1.00	0.01	11.02	123.07	0.76	2.58	1.00	0.04
11.19	235.71	2.00	0.00	1.00	0.00	11.42	138.87	0.92	1.22	1.00	0.03
11.55	96.91	0.54	3.32	1.00	0.05	11.68	39.16	0.26	7.50	1.00	0.12
11.84	63.27	0.35	4.99	1.00	0.10	12.01	59.02	0.33	5.31	1.00	0.10
12.17	12.47	2.00	0.00	1.00	0.00	12.37	8.17	1.79	0.00	1.00	0.00
12.50	5.23	1.33	0.00	1.00	0.00	12.70	6.41	1.88	0.00	1.00	0.00
12.83	15.32	2.00	0.00	1.00	0.00	13.02	8.70	2.00	0.00	1.00	0.00
13.15	7.23	1.83	0.00	1.00	0.00	13.35	11.33	2.00	0.00	1.00	0.00
13.52	14.94	2.00	0.00	1.00	0.00	13.68	9.11	2.00	0.00	1.00	0.00
13.84	8.23	1.68	0.00	1.00	0.00	13.97	8.41	1.51	0.00	1.00	0.00
14.17	6.87	1.37	0.00	1.00	0.00	14.34	6.57	1.24	0.00	1.00	0.00
14.66	6.56	1.30	0.00	1.00	0.00	14.79	7.94	1.40	0.00	1.00	0.00
14.96	7.97	1.47	0.00	1.00	0.00	15.12	7.62	1.42	0.00	1.00	0.00
15.29	7.28	1.42	0.00	1.00	0.00	15.48	8.14	1.34	0.00	1.00	0.00
15.65	6.84	1.24	0.00	1.00	0.00	15.78	5.98	1.06	0.00	1.00	0.00
15.98	5.67	0.93	0.00	1.00	0.00	16.14	5.07	0.84	0.00	1.00	0.00
16.27	4.72	0.84	0.00	1.00	0.00	16.44	5.60	0.83	0.00	1.00	0.00
16.60	4.90	0.86	0.00	1.00	0.00	16.76	5.05	0.83	0.00	1.00	0.00
16.93	5.27	0.86	0.00	1.00	0.00	17.09	5.38	0.88	0.00	1.00	0.00
17.26	5.53	0.90	0.00	1.00	0.00	17.42	5.69	0.89	0.00	1.00	0.00
17.58	5.45	0.86	0.00	1.00	0.00	17.75	5.23	0.83	0.00	1.00	0.00
17.91	5.30	0.84	0.00	1.00	0.00	18.11	5.74	0.92	0.00	1.00	0.00
18.27	6.67	1.03	0.00	1.00	0.00	18.44	7.22	1.09	0.00	1.00	0.00
18.57	6.81	1.06	0.00	1.00	0.00	18.73	6.33	1.14	0.00	1.00	0.00
18.90	8.73	2.00	0.00	1.00	0.00	19.06	57.31	0.26	5.45	1.00	0.11
19.26	61.86	0.28	5.09	1.00	0.12	19.42	73.77	0.32	4.33	1.00	0.09
19.59	102.92	0.46	3.12	1.00	0.06	19.75	118.76	0.55	2.68	1.00	0.05
19.88	110.05	0.50	2.91	1.00	0.05	20.08	96.91	0.42	3.32	1.00	0.08
20.24	67.23	0.29	4.72	1.00	0.09	20.41	64.85	0.28	4.88	1.00	0.10
20.57	68.00	0.30	4.67	1.00	0.09	20.70	52.94	0.24	5.84	1.00	0.09
20.86	98.94	0.43	3.25	1.00	0.06	21.06	121.58	0.56	2.62	1.00	0.06
21.23	80.80	0.34	3.97	1.00	0.08	21.39	82.48	0.35	3.89	1.00	0.08
21.55	79.79	0.34	4.02	1.00	0.08	21.68	66.02	0.28	4.80	1.00	0.08
21.88	35.18	0.19	8.16	1.00	0.19	22.01	159.17	0.97	0.91	1.00	0.01
22.21	103.05	0.44	3.12	1.00	0.07	22.37	36.79	0.20	7.88	1.00	0.16
22.54	12.06	1.79	0.00	1.00	0.00	22.67	10.65	1.77	0.00	1.00	0.00
22.87	13.65	2.00	0.00	1.00	0.00	23.00	62.04	0.26	5.08	1.00	0.08
23.16	89.85	0.37	3.58	1.00	0.07	23.32	103.02	0.43	3.12	1.00	0.06
23.49	113.08	0.48	2.83	1.00	0.06	23.65	120.16	0.53	2.65	1.00	0.05
23.82	127.63	0.58	2.48	1.00	0.05	23.98	129.57	0.59	2.44	1.00	0.05
24.15	135.67	0.64	2.32	1.00	0.05	24.34	137.01	0.65	2.30	1.00	0.05
24.47	85.15	0.35	3.77	1.00	0.06	24.67	135.31	0.63	2.33	1.00	0.06
24.80	167.48	1.11	0.64	1.00	0.01	25.00	149.72	0.78	1.57	1.00	0.04
25.13	125.88	0.55	2.52	1.00	0.04	25.29	121.68	0.53	2.62	1.00	0.05
25.46	110.80	0.46	2.89	1.00	0.06	25.62	131.19	0.59	2.41	1.00	0.05
25.79	110.06	0.46	2.91	1.00	0.06	25.95	116.78	0.49	2.73	1.00	0.05
26.11	169.24	1.14	0.59	1.00	0.01	26.28	195.06	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

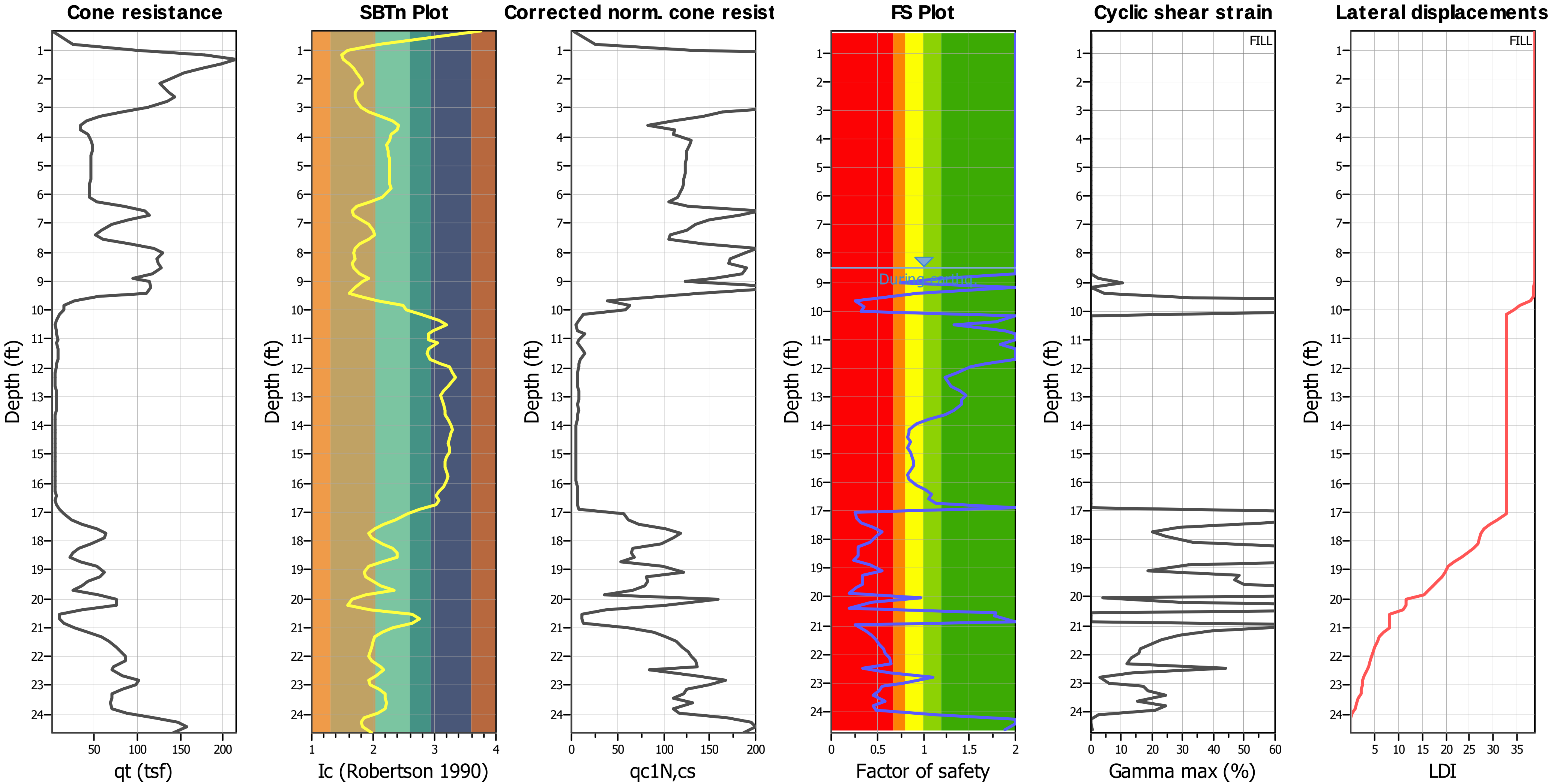
Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
26.44	200.15	2.00	0.00	1.00	0.00	26.64	186.46	1.88	0.05	1.00	0.00

Total estimated settlement: 3.25

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



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$q_{c1N,cs}$: Equivalent clean sand normalized CPT total cone resistance

F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

:: Lateral displacement index calculation ::

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
10.53	190.31	0.03	2.00	-0.31	0.00	0.00
10.73	185.26	0.03	2.00	-0.24	0.00	0.00
10.89	154.48	0.08	1.21	0.19	0.02	0.04
11.02	123.07	0.18	0.76	0.57	0.10	0.16
11.19	235.71	0.01	2.00	-0.99	0.00	0.00
11.42	138.87	0.12	0.92	0.39	0.04	0.12
11.55	96.91	0.33	0.54	0.82	0.33	0.52
11.68	39.16	1.37	0.26	0.94	1.37	2.16
11.84	63.27	0.74	0.35	0.94	0.74	1.46
12.01	59.02	0.82	0.33	0.94	0.82	1.61
12.17	12.47	0.00	2.00	0.00	0.00	0.00
12.37	8.17	0.00	1.79	0.00	0.00	0.00
12.50	5.23	0.00	1.33	0.00	0.00	0.00
12.70	6.41	0.00	1.88	0.00	0.00	0.00
12.83	15.32	0.00	2.00	0.00	0.00	0.00
13.02	8.70	0.00	2.00	0.00	0.00	0.00
13.15	7.23	0.00	1.83	0.00	0.00	0.00
13.35	11.33	0.00	2.00	0.00	0.00	0.00
13.52	14.94	0.00	2.00	0.00	0.00	0.00
13.68	9.11	0.00	2.00	0.00	0.00	0.00
13.84	8.23	0.00	1.68	0.00	0.00	0.00
13.97	8.41	0.00	1.51	0.00	0.00	0.00
14.17	6.87	0.00	1.37	0.00	0.00	0.00
14.34	6.57	0.00	1.24	0.00	0.00	0.00
14.66	6.56	0.00	1.30	0.00	0.00	0.00
14.79	7.94	0.00	1.40	0.00	0.00	0.00
14.96	7.97	0.00	1.47	0.00	0.00	0.00
15.12	7.62	0.00	1.42	0.00	0.00	0.00
15.29	7.28	0.00	1.42	0.00	0.00	0.00
15.48	8.14	0.00	1.34	0.00	0.00	0.00
15.65	6.84	0.00	1.24	0.00	0.00	0.00
15.78	5.98	0.00	1.06	0.00	0.00	0.00
15.98	5.67	0.00	0.93	0.00	0.00	0.00
16.14	5.07	0.00	0.84	0.00	0.00	0.00
16.27	4.72	0.00	0.84	0.00	0.00	0.00
16.44	5.60	0.00	0.83	0.00	0.00	0.00
16.60	4.90	0.00	0.86	0.00	0.00	0.00
16.76	5.05	0.00	0.83	0.00	0.00	0.00
16.93	5.27	0.00	0.86	0.00	0.00	0.00
17.09	5.38	0.00	0.88	0.00	0.00	0.00
17.26	5.53	0.00	0.90	0.00	0.00	0.00
17.42	5.69	0.00	0.89	0.00	0.00	0.00
17.58	5.45	0.00	0.86	0.00	0.00	0.00
17.75	5.23	0.00	0.83	0.00	0.00	0.00
17.91	5.30	0.00	0.84	0.00	0.00	0.00
18.11	5.74	0.00	0.92	0.00	0.00	0.00
18.27	6.67	0.00	1.03	0.00	0.00	0.00
18.44	7.22	0.00	1.09	0.00	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
18.57	6.81	0.00	1.06	0.00	0.00	0.00
18.73	6.33	0.00	1.14	0.00	0.00	0.00
18.90	8.73	0.00	2.00	0.00	0.00	0.00
19.06	57.31	0.85	0.26	0.94	0.85	1.68
19.26	61.86	0.76	0.28	0.94	0.76	1.80
19.42	73.77	0.57	0.32	0.94	0.57	1.13
19.59	102.92	0.29	0.46	0.77	0.29	0.57
19.75	118.76	0.20	0.55	0.62	0.20	0.39
19.88	110.05	0.25	0.50	0.70	0.25	0.39
20.08	96.91	0.33	0.42	0.82	0.33	0.78
20.24	67.23	0.67	0.29	0.94	0.67	1.32
20.41	64.85	0.71	0.28	0.94	0.71	1.40
20.57	68.00	0.66	0.30	0.94	0.66	1.29
20.70	52.94	0.95	0.24	0.94	0.95	1.50
20.86	98.94	0.32	0.43	0.80	0.32	0.63
21.06	121.58	0.19	0.56	0.59	0.19	0.44
21.23	80.80	0.49	0.34	0.91	0.49	0.95
21.39	82.48	0.47	0.35	0.91	0.47	0.92
21.55	79.79	0.50	0.34	0.92	0.50	0.98
21.68	66.02	0.69	0.28	0.94	0.69	1.08
21.88	35.18	1.54	0.19	0.94	1.54	3.64
22.01	159.17	0.07	0.97	0.13	0.04	0.06
22.21	103.05	0.29	0.44	0.77	0.29	0.68
22.37	36.79	1.47	0.20	0.94	1.47	2.89
22.54	12.06	0.00	1.79	0.00	0.00	0.00
22.67	10.65	0.00	1.77	0.00	0.00	0.00
22.87	13.65	0.00	2.00	0.00	0.00	0.00
23.00	62.04	0.76	0.26	0.94	0.76	1.19
23.16	89.85	0.39	0.37	0.87	0.39	0.77
23.32	103.02	0.29	0.43	0.77	0.29	0.57
23.49	113.08	0.23	0.48	0.67	0.23	0.45
23.65	120.16	0.19	0.53	0.60	0.19	0.38
23.82	127.63	0.16	0.58	0.52	0.16	0.32
23.98	129.57	0.15	0.59	0.50	0.15	0.30
24.15	135.67	0.13	0.64	0.43	0.13	0.26
24.34	137.01	0.13	0.65	0.41	0.12	0.28
24.47	85.15	0.44	0.35	0.89	0.44	0.69
24.67	135.31	0.13	0.63	0.43	0.13	0.32
24.80	167.48	0.06	1.11	0.01	0.03	0.04
25.00	149.72	0.09	0.78	0.25	0.06	0.14
25.13	125.88	0.17	0.55	0.54	0.17	0.27
25.29	121.68	0.19	0.53	0.59	0.19	0.37
25.46	110.80	0.24	0.46	0.70	0.24	0.48
25.62	131.19	0.15	0.59	0.48	0.15	0.29
25.79	110.06	0.25	0.46	0.70	0.25	0.48
25.95	116.78	0.21	0.49	0.64	0.21	0.41
26.11	169.24	0.06	1.14	-0.01	0.03	0.05
26.28	195.06	0.03	2.00	-0.38	0.00	0.00

:: Estimation of post-earthquake lateral Displacements :: (continued)

Depth (ft)	$q_{c1N,cs}$	$Gamma_{lim}$ (%)	FS	Fa	$Gamma_{max}$ (%)	LDI
26.44	200.15	0.02	2.00	-0.45	0.00	0.00
26.64	186.46	0.03	1.88	-0.25	0.00	0.01

Total estimated displacement: 38.68

Abbreviations

Depth: Depth of test point
$q_{c1N,cs}$: Adjusted and corrected cone resistance due to fines
$Gamma_{lim}$: Limiting shear strain
FS: Calculated factor of safety against liquefaction
Fa:
$Gamma_{max}$: Maximum cyclic shear strain
Lat. disp.: Lateral displacement

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
2.33	1.19	1.88	19.01	35.79	3.74	0.06	5.64
2.82	25.97	41.66	1.45	60.32	2.10	0.03	0.71
2.98	100.52	161.42	1.00	161.42	1.59	0.18	0.90
3.15	178.13	286.09	1.00	286.09	1.49	0.99	0.99
3.31	215.01	345.33	1.00	345.33	1.50	1.02	1.02
3.48	198.06	318.09	1.00	318.09	1.60	1.00	1.00
3.64	174.35	279.97	1.02	286.69	1.68	0.98	0.98
3.80	154.01	247.28	1.07	263.92	1.74	0.96	0.96
3.97	138.69	222.64	1.10	245.96	1.80	0.95	0.95
4.13	125.88	202.04	1.12	226.19	1.82	0.93	0.93
4.30	131.80	211.54	1.08	228.36	1.76	0.94	0.94
4.46	137.53	220.72	1.04	230.52	1.71	0.95	0.95
4.63	143.88	230.91	1.04	239.34	1.70	0.95	0.95
4.79	135.85	217.99	1.06	230.32	1.73	0.94	0.94
4.95	112.37	180.26	1.12	201.19	1.81	0.91	0.91
5.12	83.67	134.14	1.22	163.80	1.93	0.20	0.87
5.28	57.22	91.61	1.52	138.83	2.13	0.14	0.82
5.45	40.80	65.22	2.02	131.52	2.32	0.10	0.77
5.61	34.91	55.74	2.34	130.70	2.41	0.07	0.75
5.77	35.05	55.95	2.31	129.51	2.40	0.11	0.75
5.94	43.12	68.90	1.92	132.61	2.29	0.10	0.78
6.10	46.11	73.69	1.82	133.87	2.26	0.12	0.79
6.30	48.68	77.81	1.73	134.87	2.23	0.12	0.79
6.46	47.78	76.33	1.77	135.16	2.24	0.12	0.79
6.63	47.12	75.26	1.80	135.42	2.25	0.12	0.79
6.76	46.71	74.59	1.82	135.55	2.26	0.12	0.79
6.92	46.40	74.07	1.83	135.40	2.26	0.12	0.79
7.08	46.09	73.56	1.84	135.42	2.26	0.12	0.79
7.25	45.79	73.06	1.85	135.47	2.27	0.11	0.78
7.45	45.55	72.66	1.87	135.84	2.27	0.11	0.78
7.61	45.36	72.34	1.88	136.32	2.28	0.11	0.78
7.77	45.24	72.13	1.90	136.96	2.28	0.11	0.78
7.91	45.25	72.13	1.76	126.99	2.24	0.11	0.78
8.10	45.37	72.31	1.54	111.47	2.14	0.11	0.78
8.27	53.63	85.56	1.23	105.62	1.95	0.10	0.81
8.40	84.73	135.52	1.05	142.67	1.72	0.15	0.87
8.56	109.11	169.83	1.02	172.67	1.67	0.72	0.90
8.73	113.99	176.37	1.03	181.34	1.69	0.38	0.91
8.89	90.69	144.45	1.11	160.25	1.80	0.18	0.88
9.05	70.95	113.32	1.21	136.70	1.92	0.14	0.84
9.22	58.68	93.59	1.30	121.54	2.00	0.12	0.82
9.38	52.43	83.54	1.33	111.11	2.02	0.10	0.80
9.55	61.03	96.47	1.23	118.30	1.94	0.10	0.82
9.71	91.80	136.83	1.09	149.78	1.78	0.17	0.87
9.87	119.02	171.67	1.05	179.79	1.71	0.56	0.91
10.04	129.90	184.18	1.03	190.20	1.69	0.43	0.92
10.20	123.39	173.65	1.04	180.59	1.70	0.30	0.91
10.37	125.38	172.76	1.01	175.20	1.67	0.32	0.91

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
10.53	127.39	174.42	1.02	177.96	1.67	0.47	0.91
10.73	117.22	164.32	1.09	179.83	1.78	0.33	0.90
10.89	95.26	137.75	1.21	166.60	1.92	0.18	0.87
11.02	113.37	159.18	1.13	179.14	1.83	0.13	0.89
11.19	116.64	157.63	1.04	163.56	1.70	0.89	0.89
11.42	111.43	146.31	1.00	146.31	1.61	0.20	0.88
11.55	54.85	74.46	1.00	74.46	1.77	0.10	0.79
11.68	27.70	40.16	1.42	57.13	2.08	0.03	0.71
11.84	14.27	21.98	2.70	59.31	2.49	0.06	0.63
12.01	14.28	21.99	2.99	65.67	2.54	0.06	0.63
12.17	10.05	15.17	4.57	69.33	2.77	0.05	1.22
12.37	6.03	8.70	7.62	66.33	3.08	0.06	0.70
12.50	4.67	6.50	9.19	59.77	3.20	0.06	0.52
12.70	6.44	9.34	6.42	59.97	2.97	0.05	0.74
12.83	7.24	10.61	5.64	59.91	2.89	0.06	0.84
13.02	7.44	10.92	5.66	61.84	2.90	0.05	0.86
13.15	6.50	9.39	7.19	67.55	3.04	0.06	0.73
13.35	8.10	11.94	5.84	69.72	2.91	0.06	0.92
13.52	8.58	12.70	5.59	70.98	2.89	0.06	0.98
13.68	7.89	11.59	5.89	68.31	2.92	0.05	0.89
13.84	6.32	9.04	7.94	71.76	3.10	0.06	0.69
13.97	5.79	8.19	9.82	80.39	3.24	0.06	0.62
14.17	5.40	7.53	10.54	79.41	3.29	0.06	0.57
14.34	5.01	6.90	11.19	77.23	3.33	0.06	0.52
14.66	5.32	7.37	9.46	69.72	3.21	0.06	0.54
14.79	5.73	8.02	8.65	69.35	3.16	0.06	0.59
14.96	6.03	8.49	7.93	67.28	3.10	0.06	0.62
15.12	5.92	8.29	8.29	68.69	3.13	0.06	0.60
15.29	5.98	8.37	8.44	70.71	3.14	0.06	0.61
15.48	5.76	8.01	8.81	70.54	3.17	0.06	0.58
15.65	5.43	7.47	8.81	65.81	3.17	0.06	0.53
15.78	4.80	6.42	9.52	61.17	3.22	0.06	0.46
15.98	4.37	5.69	10.22	58.16	3.27	0.06	0.41
16.14	4.06	5.16	10.79	55.71	3.30	0.06	0.37
16.27	4.08	5.16	10.29	53.08	3.27	0.06	0.37
16.44	4.09	5.13	9.88	50.68	3.24	0.06	0.37
16.60	4.22	5.30	9.52	50.48	3.22	0.06	0.38
16.76	4.16	5.17	9.94	51.44	3.25	0.06	0.37
16.93	4.29	5.34	9.74	52.00	3.23	0.06	0.38
17.09	4.42	5.50	9.33	51.35	3.21	0.06	0.39
17.26	4.53	5.64	8.81	49.68	3.17	0.06	0.40
17.42	4.55	5.64	8.74	49.27	3.16	0.06	0.40
17.58	4.47	5.47	9.06	49.61	3.19	0.06	0.39
17.75	4.37	5.29	9.46	50.02	3.22	0.06	0.38
17.91	4.44	5.36	9.33	50.03	3.21	0.06	0.38
18.11	4.84	5.92	8.43	49.94	3.14	0.06	0.42
18.27	5.34	6.64	7.51	49.83	3.07	0.06	0.47
18.44	5.62	7.01	7.08	49.64	3.03	0.06	0.50

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

Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
18.57	5.53	6.85	7.45	51.03	3.06	0.06	0.49
18.73	5.95	7.43	7.06	52.47	3.03	0.05	0.53
18.90	9.82	12.69	4.41	55.95	2.75	0.05	0.93
19.06	15.13	19.50	3.05	59.49	2.55	0.06	0.62
19.26	23.27	29.62	2.21	65.53	2.37	0.06	0.67
19.42	36.46	45.42	1.61	73.20	2.18	0.06	0.72
19.59	53.51	65.22	1.32	85.90	2.01	0.09	0.77
19.75	64.23	77.22	1.22	94.28	1.93	0.12	0.79
19.88	61.67	74.37	1.27	94.43	1.98	0.10	0.79
20.08	46.12	56.41	1.52	85.98	2.14	0.09	0.75
20.24	32.67	40.50	2.00	80.87	2.31	0.06	0.71
20.41	24.90	30.80	2.30	70.95	2.40	0.06	0.67
20.57	22.63	27.67	2.23	61.58	2.38	0.06	0.66
20.70	34.32	41.05	1.53	62.79	2.14	0.05	0.71
20.86	52.59	61.46	1.22	74.79	1.93	0.09	0.76
21.06	62.03	71.64	1.00	71.64	1.85	0.13	0.78
21.23	57.00	65.71	1.00	65.71	1.87	0.08	0.77
21.39	42.83	49.77	1.30	64.87	2.00	0.07	0.73
21.55	35.45	41.53	1.51	62.68	2.13	0.07	0.71
21.68	25.29	30.05	2.13	64.06	2.35	0.06	0.67
21.88	55.70	63.47	1.00	63.47	1.88	0.03	0.77
22.01	75.34	83.70	1.00	83.70	1.67	0.25	0.80
22.21	75.07	82.34	1.00	82.34	1.59	0.12	0.80
22.37	35.48	39.98	1.00	39.98	1.96	0.03	0.71
22.54	10.60	11.96	3.59	43.00	2.64	0.05	0.88
22.67	10.55	12.03	4.51	54.30	2.77	0.05	0.88
22.87	14.79	17.06	3.47	59.18	2.62	0.05	1.26
23.00	27.07	31.19	2.04	63.48	2.33	0.05	0.68
23.16	42.83	48.87	1.53	74.79	2.14	0.08	0.73
23.32	57.83	65.40	1.35	88.06	2.03	0.09	0.77
23.49	67.51	76.03	1.31	99.49	2.01	0.11	0.79
23.65	75.20	84.28	1.28	107.47	1.98	0.12	0.80
23.82	80.99	90.32	1.25	113.01	1.96	0.13	0.81
23.98	85.55	94.85	1.22	115.77	1.93	0.13	0.82
24.15	85.97	95.29	1.26	119.99	1.97	0.14	0.82
24.34	71.88	80.33	1.50	120.23	2.12	0.13	0.80
24.47	70.77	79.11	1.58	124.61	2.16	0.07	0.79
24.67	82.51	91.03	1.38	125.27	2.05	0.13	0.81
24.80	102.24	111.39	1.21	135.02	1.92	0.21	0.84
25.00	99.39	108.03	1.24	134.16	1.95	0.16	0.84
25.13	83.47	91.38	1.44	131.85	2.09	0.12	0.81
25.29	70.43	77.24	1.65	127.39	2.19	0.11	0.79
25.46	70.88	77.39	1.65	127.48	2.19	0.10	0.79
25.62	68.13	74.15	1.70	125.99	2.21	0.12	0.79
25.79	71.26	77.17	1.66	127.79	2.20	0.10	0.79
25.95	87.73	93.94	1.39	130.50	2.06	0.11	0.82
26.11	118.97	125.38	1.15	144.08	1.85	0.23	0.86
26.28	147.50	154.55	1.10	170.45	1.79	0.40	0.89

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

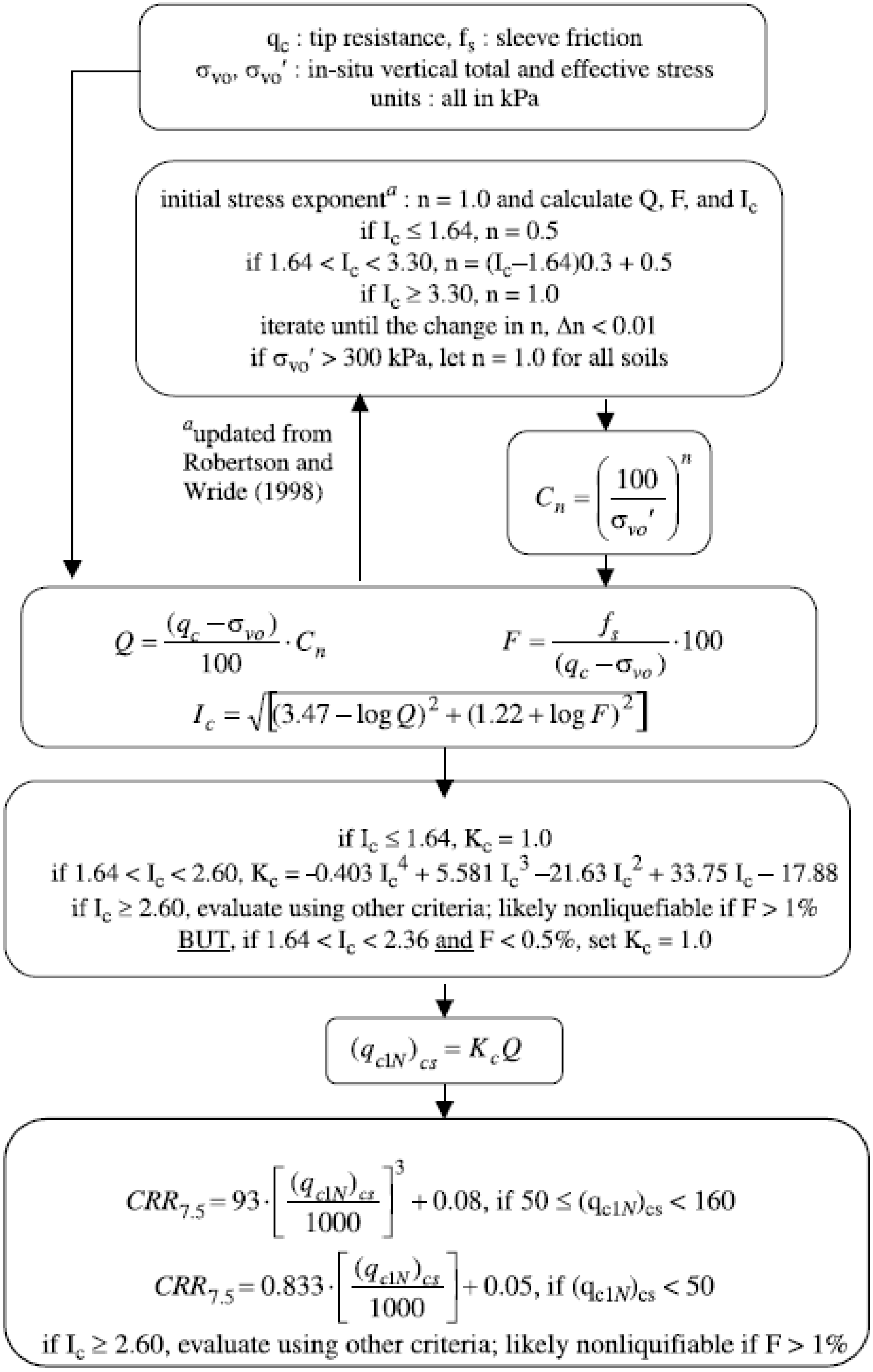
Depth (ft)	q_t (tsf)	Q_{tn}	K_c	$Q_{tn,cs}$	I_c	$S_{u(liq)}/\sigma'_v$	$S_{u(peak)}/\sigma'_v$
26.44	157.72	165.12	1.12	185.72	1.82	0.42	0.90
26.64	141.82	149.34	1.28	191.64	1.99	0.26	0.89

Abbreviations

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

Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

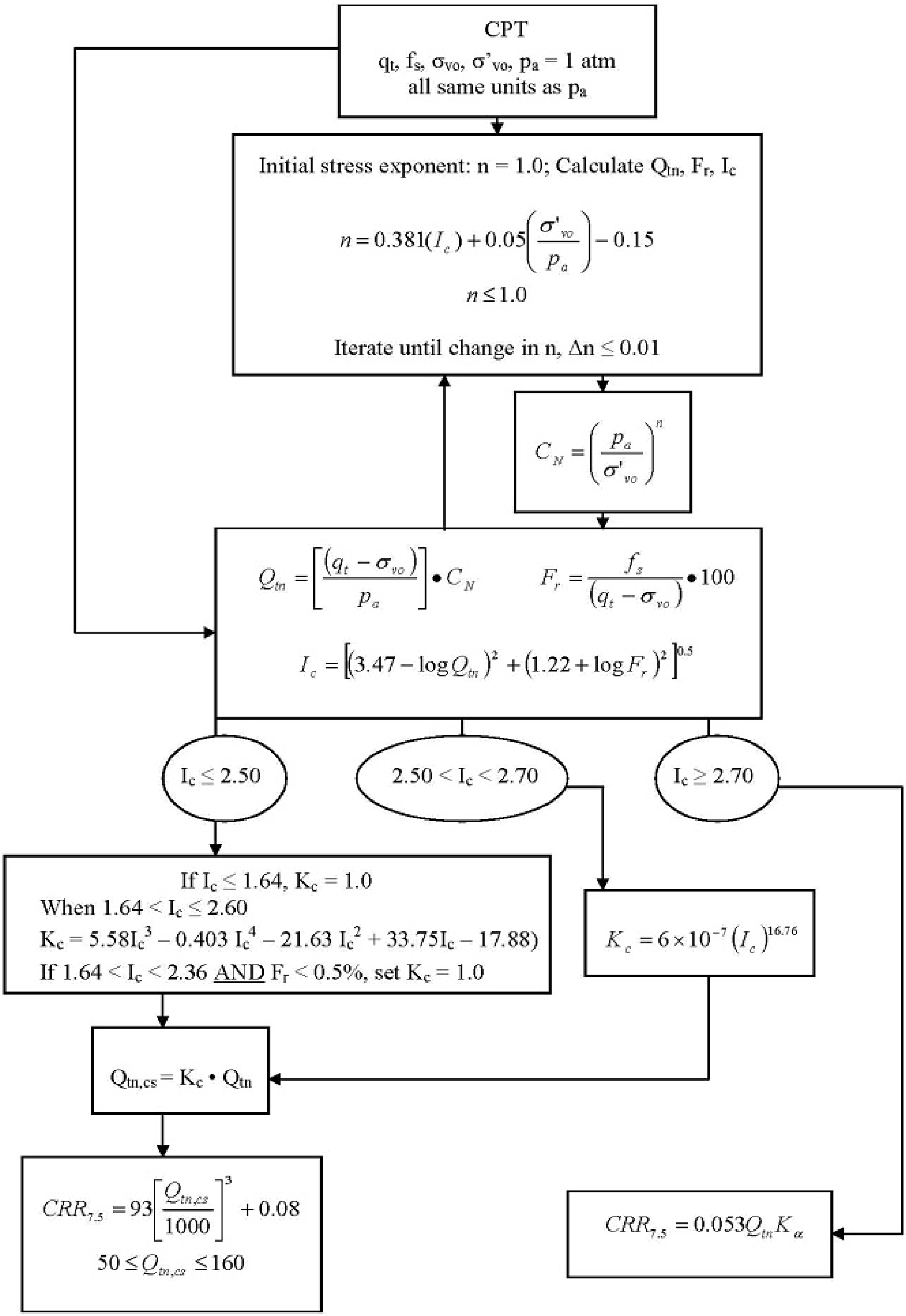
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

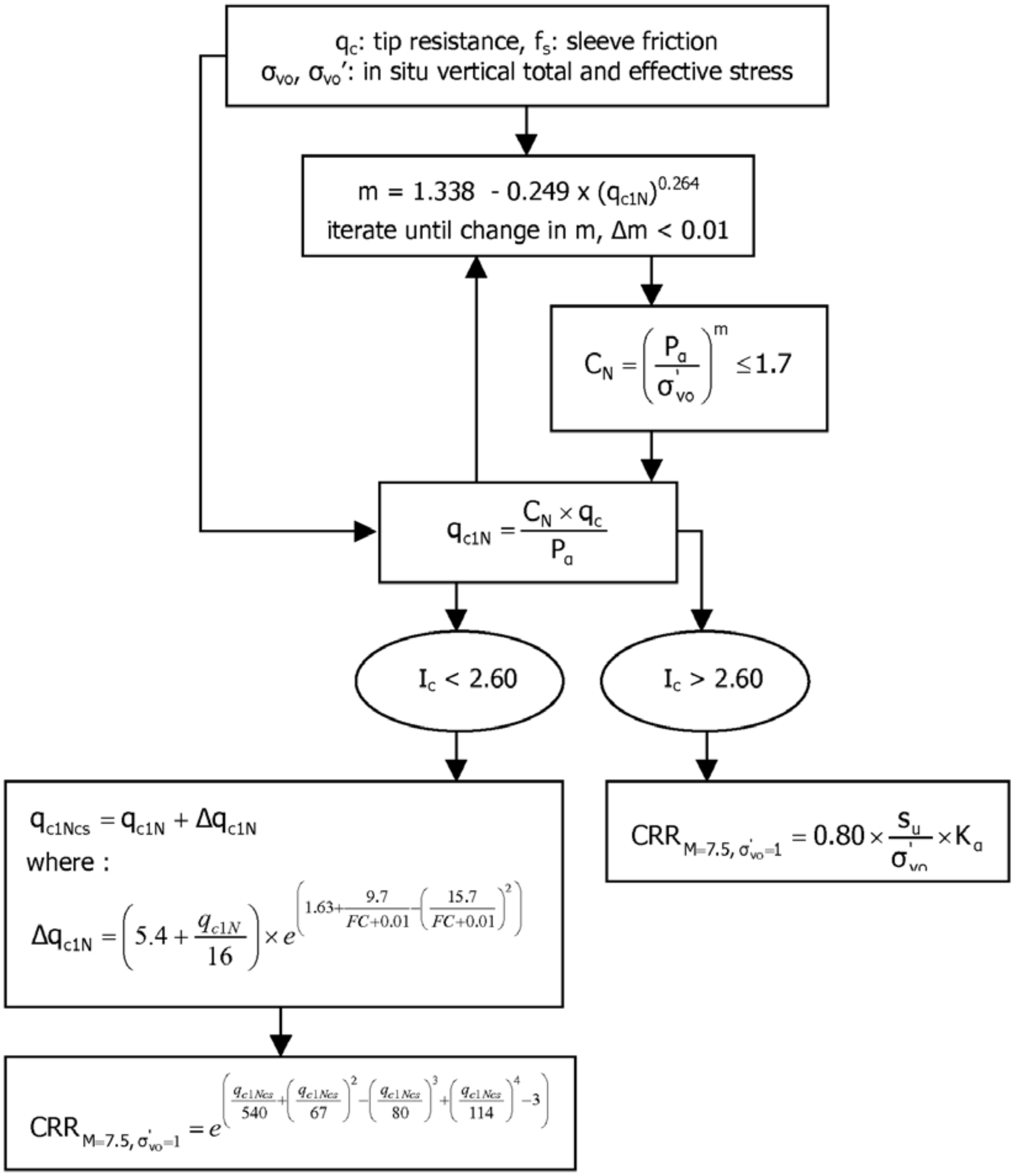
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:

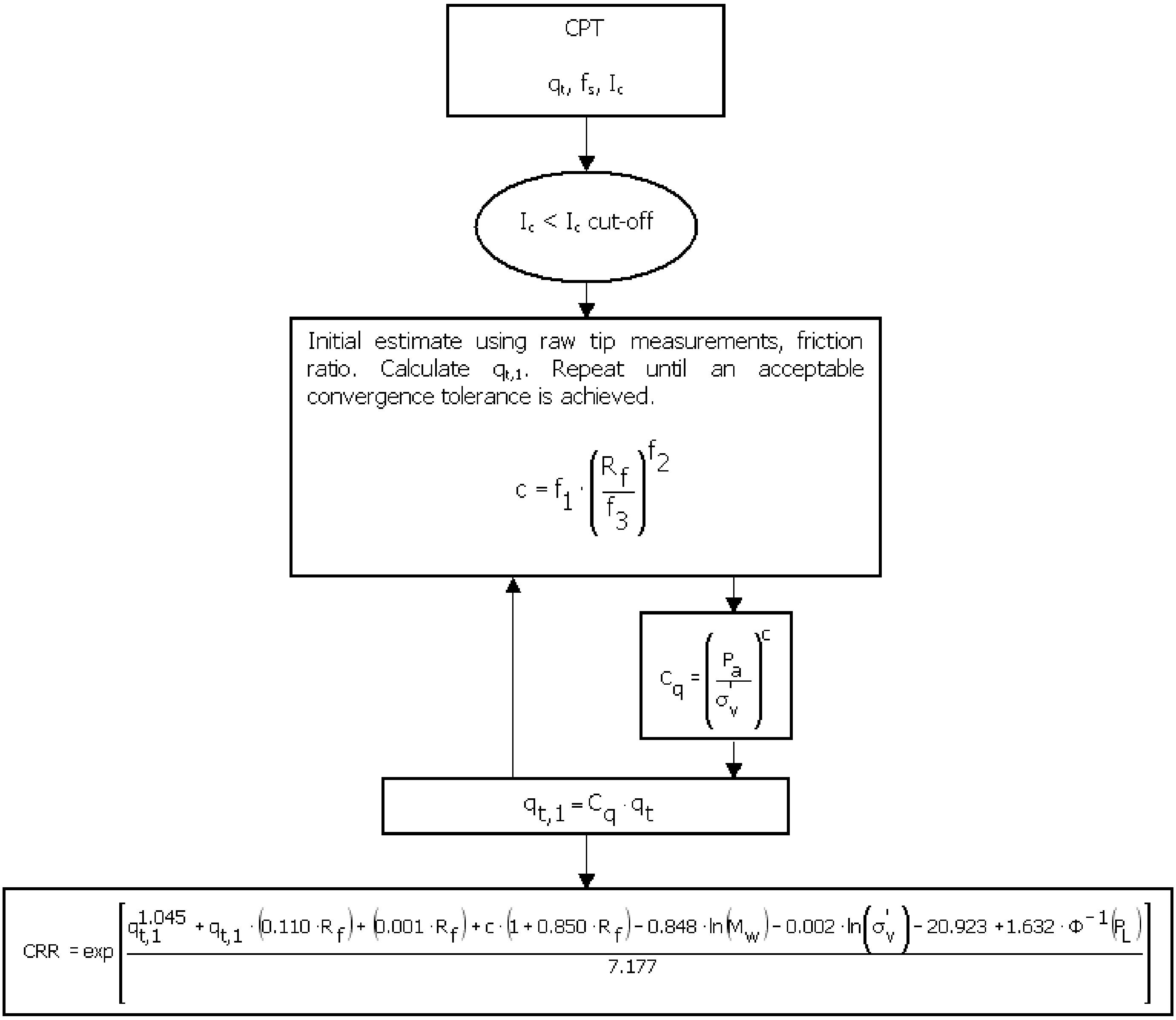


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

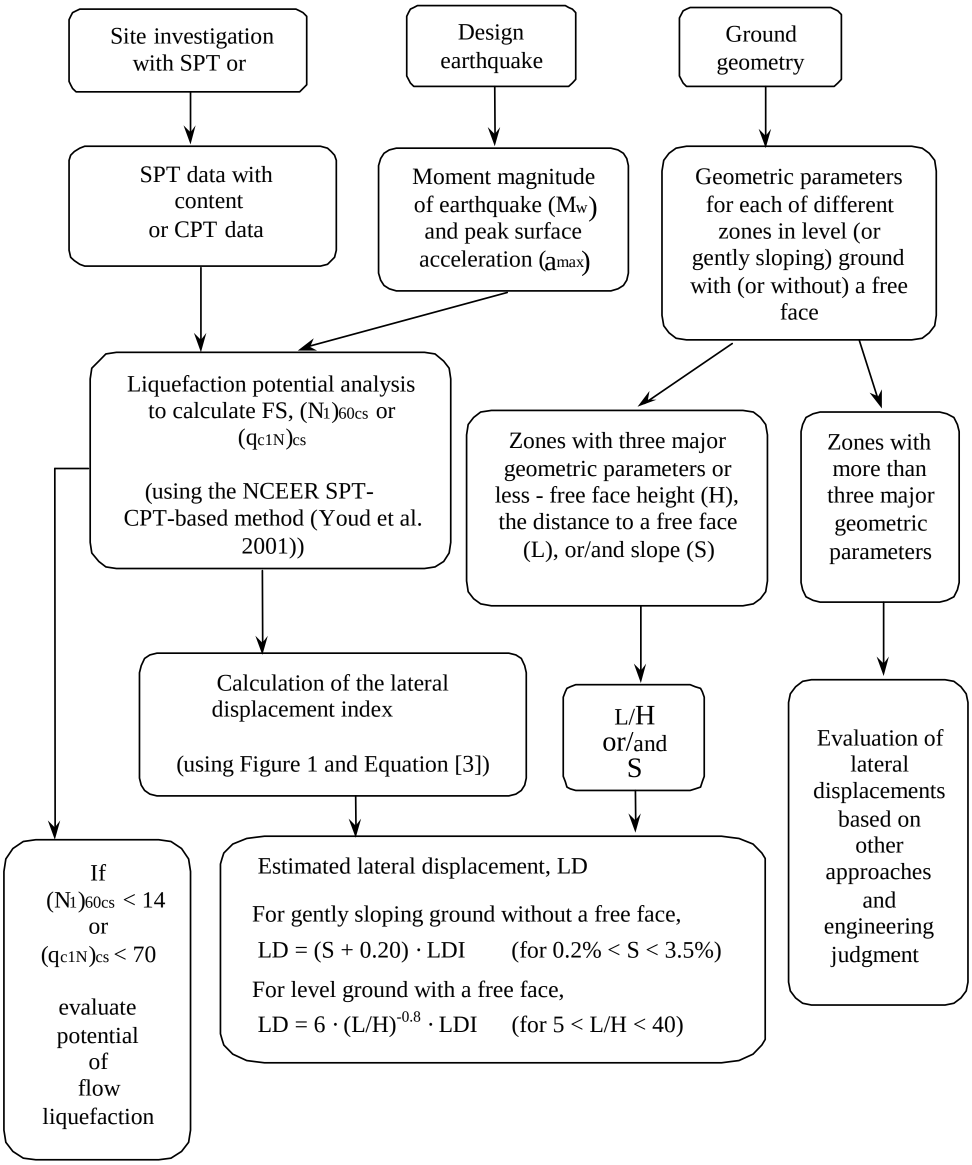
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



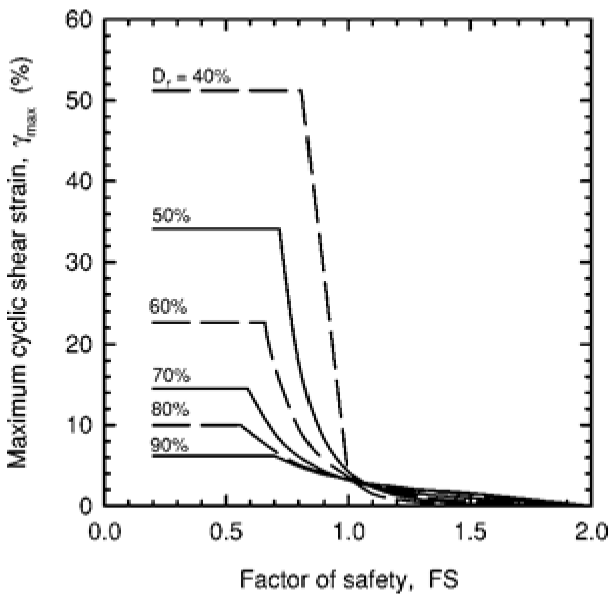
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] **Figure 1**

$$LDI = \int_0^{Z_{max}} \gamma_{max} \, dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{a_{max}}{g} \cdot \sigma_{v0} \cdot r_d$$

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

Estimate shear strain amplitude, γ (based on Pradel (1998))

$$\gamma = \left[\frac{1 + \alpha \cdot e^{bR}}{1 + \alpha}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0} \text{ (Note } \tau_{av} \text{ and } G_0 \text{ same units)}$$

$$\alpha = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60,cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

Seismic settlement, s

$$s = 2 \cdot \int_0^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

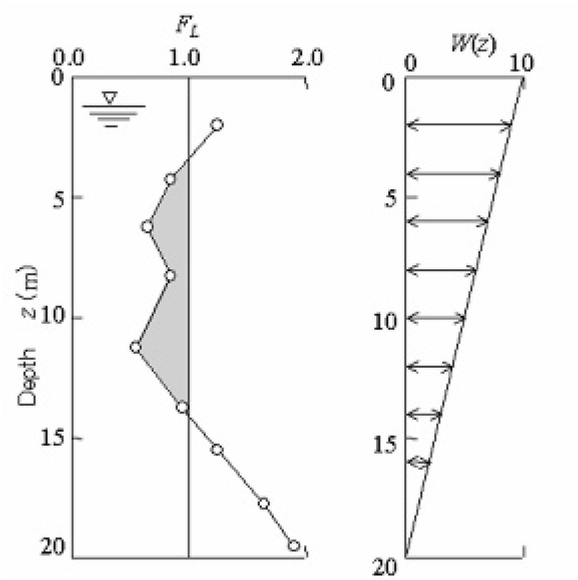
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\mathbf{LPI} = \int_0^{20} (10 - 0{,}5_z) \times F_L \times d_z$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

References

- Lunne, T., Robertson, P.K., and Powell, J.J.M 1997. Cone penetration testing in geotechnical practice, E & FN Spon Routledge, 352 p, ISBN 0-7514-0393-8.

- Boulanger, R.W. and Idriss, I. M., 2007. Evaluation of Cyclic Softening in Silts and Clays. ASCE Journal of Geotechnical and Geoenvironmental Engineering June, Vol. 133, No. 6 pp 641-652

- 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/

- Robertson, P.K. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27 (1), 151-8.

- Robertson, P.K. and Wride, C.E., 1998. Cyclic Liquefaction and its Evaluation based on the CPT Canadian Geotechnical Journal, 1998, Vol. 35, August.

- 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

- Iwasaki, T., 1986, Soil liquefaction studies in Japan: state-of-the-art, Soil Dynamics and Earthquake Engineering, Vol. 5, No. 1, 2-70

- Papathanassiou G., 2008, LPI-based approach for calibrating the severity of liquefaction-induced failures and for assessing the probability of liquefaction surface evidence, Eng. Geol. 96:94–104

- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355

- P.K. Robertson, 2009. “Performance based earthquake design using the CPT”, Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering - from case history to practice, IS-Tokyo, June 2009
- Robertson, P.K. and Lisheng, S., 2010, “Estimation of seismic compression in dry soils using the CPT” FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, *Symposium in honor of professor I. M. Idriss,* SAN diego, CA

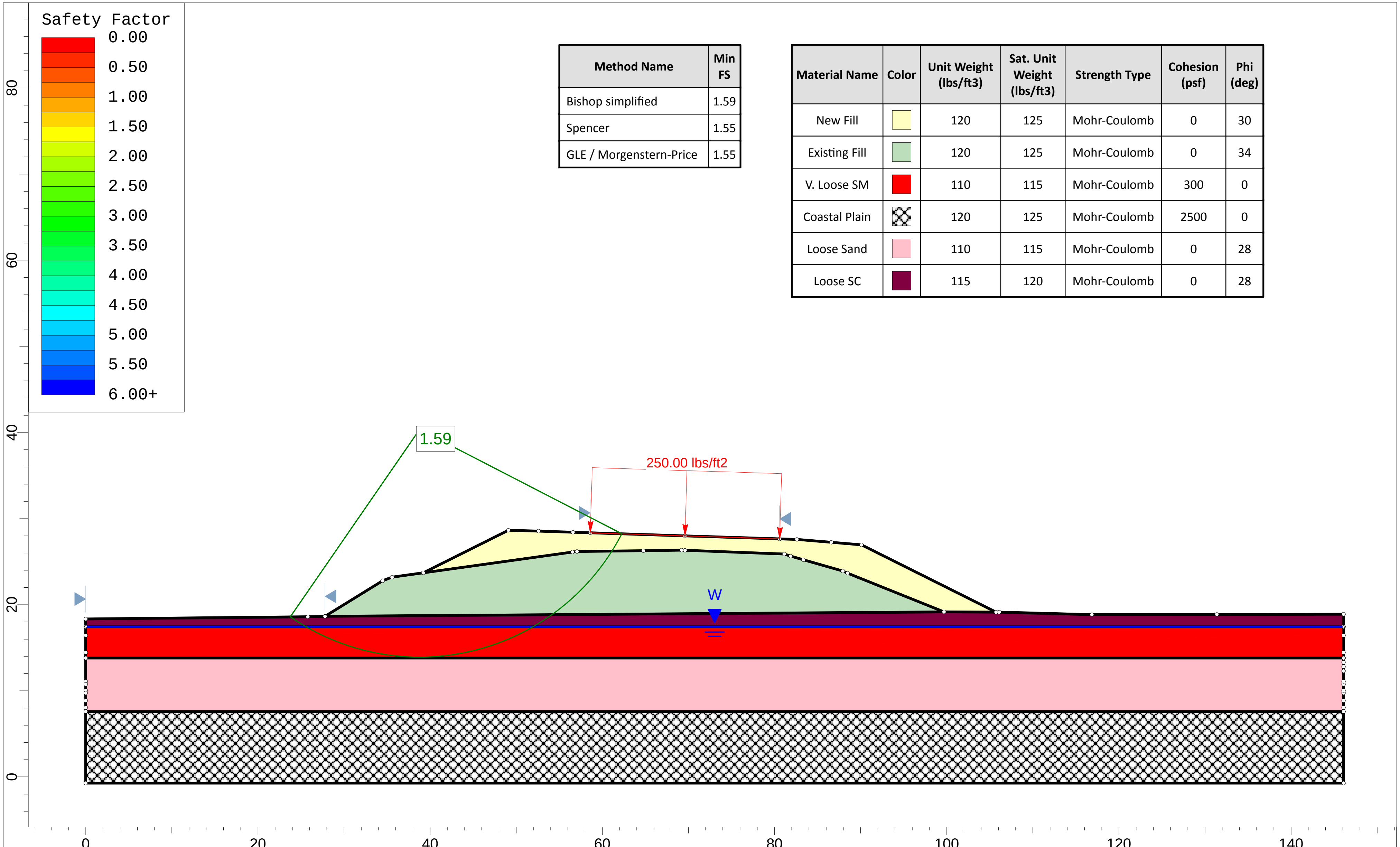
- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006

APPENDIX

SECTION 11

EMBANKMENT SLOPE STABILITY ANALYSES

SUBSECTION A
SLIDE RESULTS



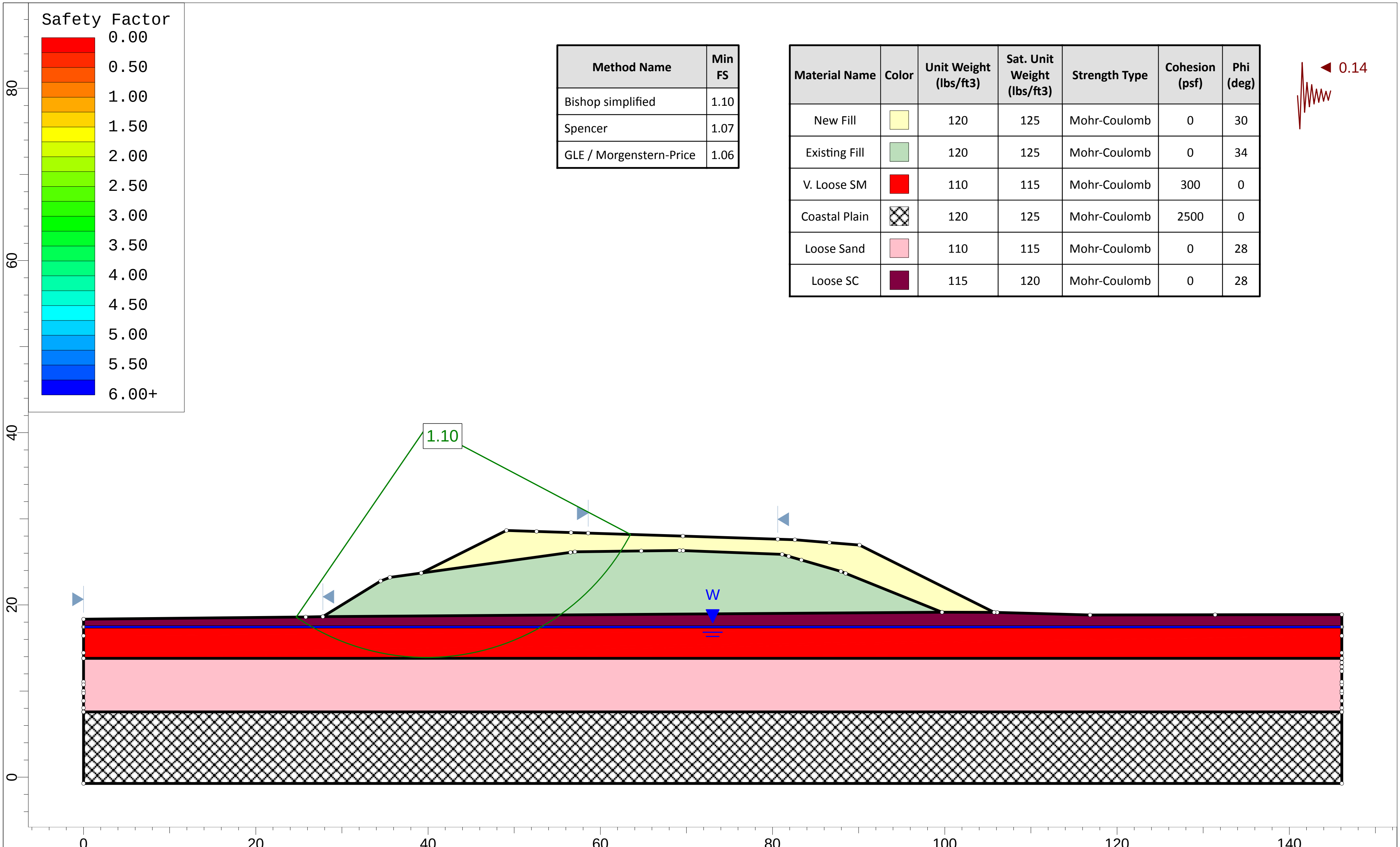
Method Name	Min FS
Bishop simplified	1.59
Spencer	1.55
GLE / Morgenstern-Price	1.55

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek		
Analysis Description	Begin Bridge_LT Side Slope_Static		
Drawn By JFH	*Scale* 1:185	*Company*	F&ME, Inc.
Date	02/03/2016, 2:00 PM	*File Name*	Begin Bridge_LT Side Slope_Static.slim



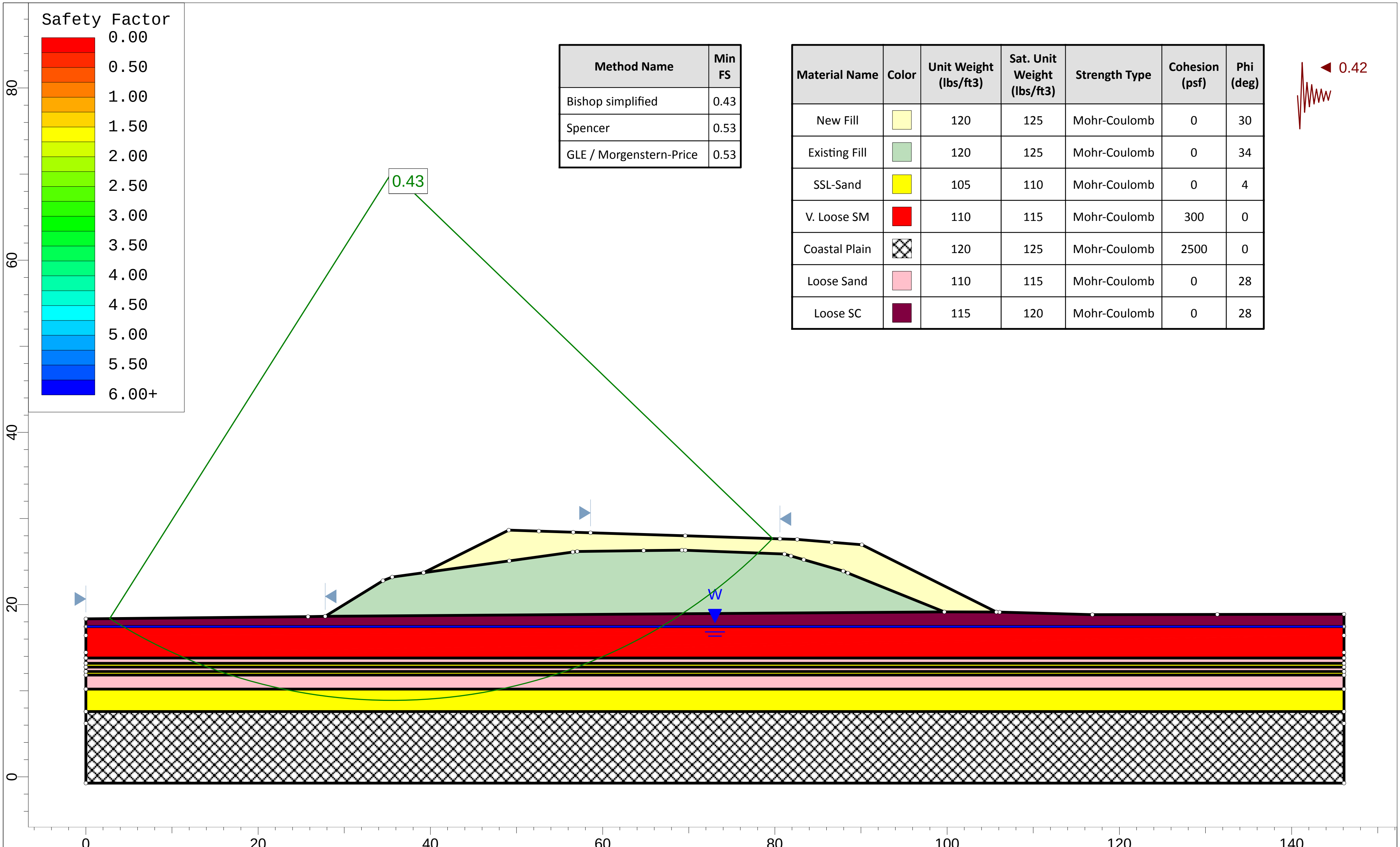
Method Name	Min FS
Bishop simplified	1.10
Spencer	1.07
GLE / Morgenstern-Price	1.06

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek		
Analysis Description	Begin Bridge_LT Side Slope_FEE		
Drawn By JFH	*Scale* 1:185	*Company*	F&ME, Inc.
Date	02/03/2016, 3:00 PM	*File Name*	Begin Bridge_LT Side Slope_FEE.slim



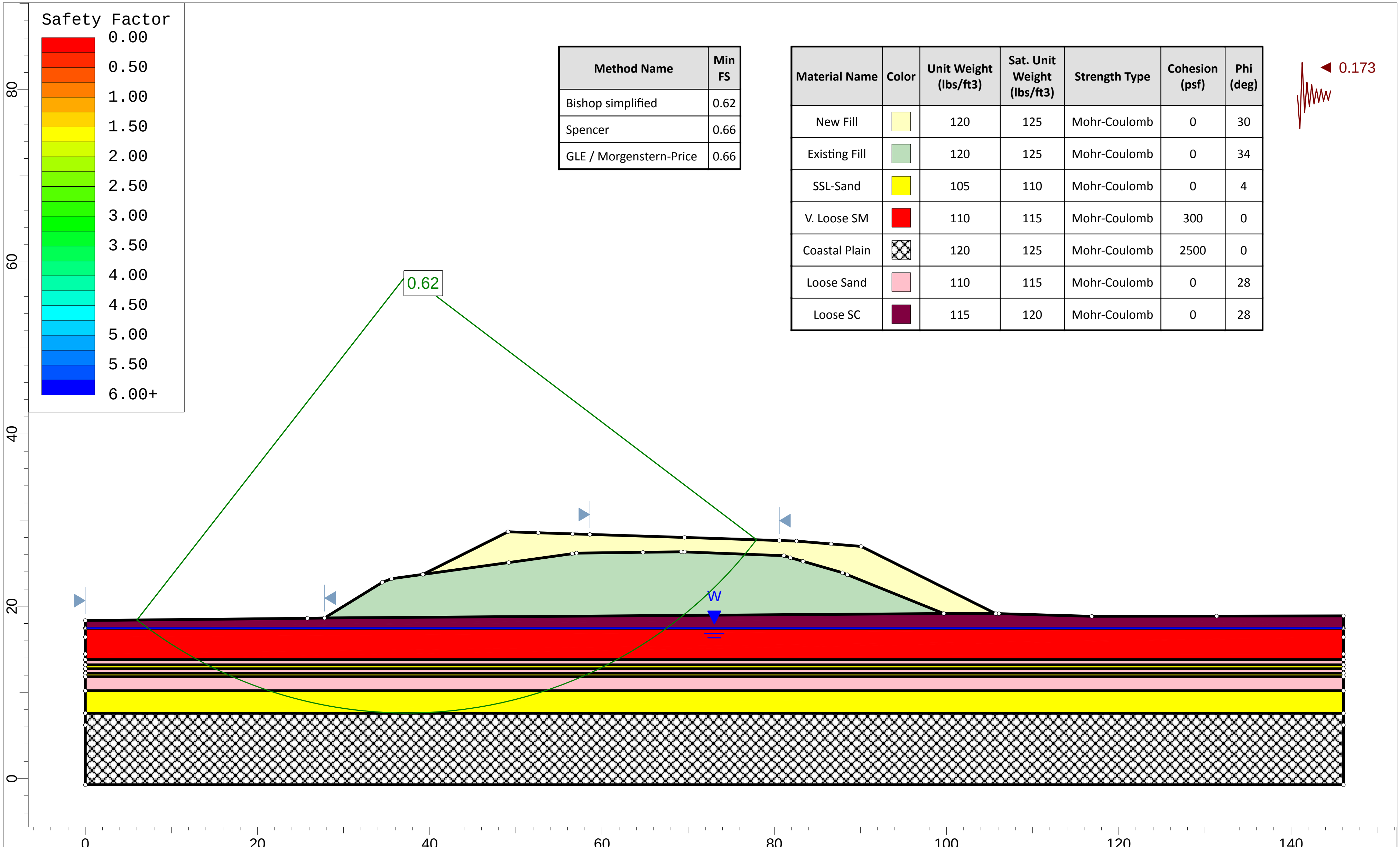
Method Name	Min FS
Bishop simplified	0.43
Spencer	0.53
GLE / Morgenstern-Price	0.53

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_LT Side Slope_SEE
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:00 PM
File Name	Begin Bridge_LT Side Slope_SEE.slim



Method Name	Min FS
Bishop simplified	0.62
Spencer	0.66
GLE / Morgenstern-Price	0.66

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project S-51 Emergency Bridge Replacement over Black Mingo Creek

Analysis Description Begin Bridge_LT Side Slope_SEE Newmark

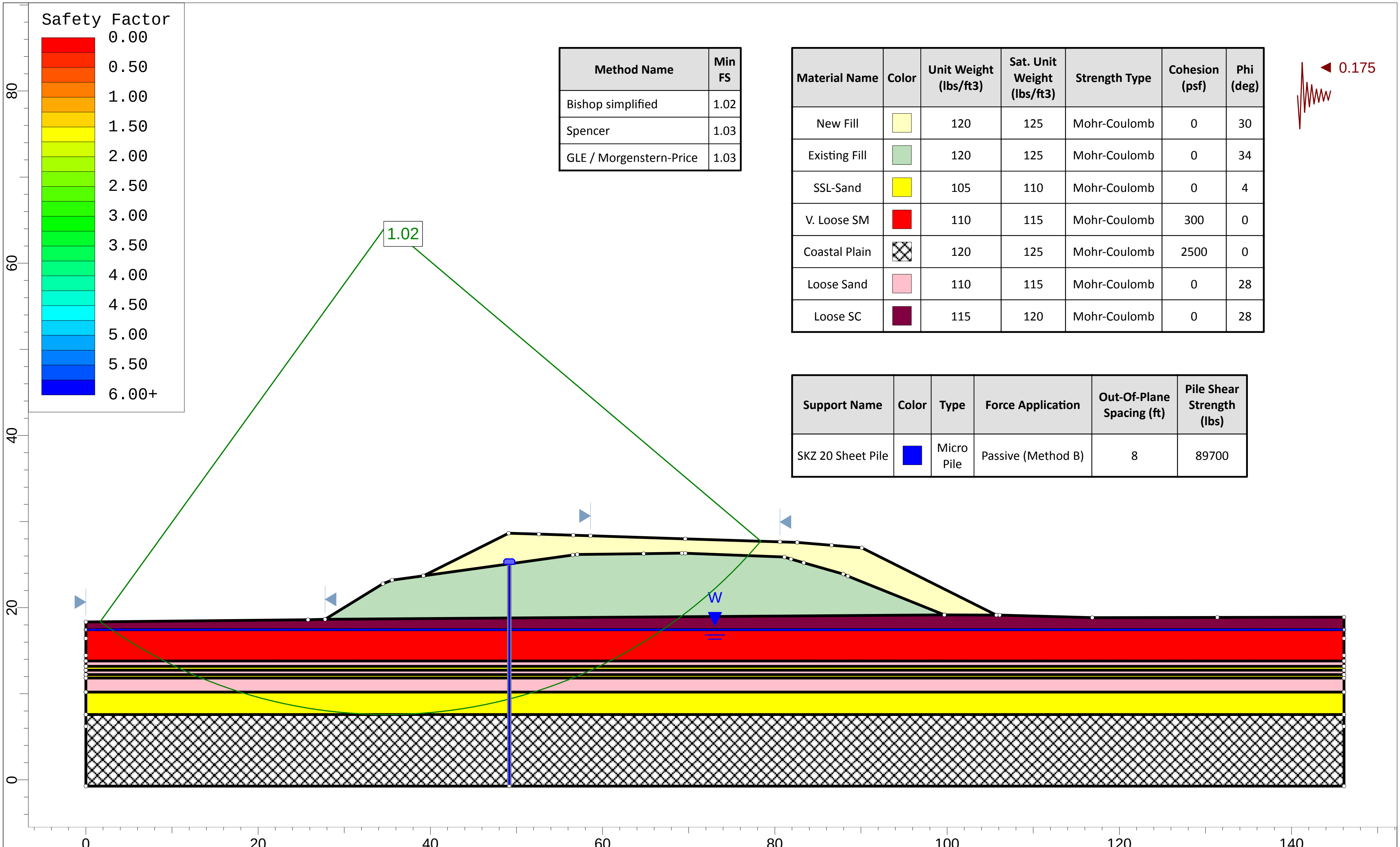
Drawn By JFH

Scale 1:185

Company F&ME, Inc.

Date 02/03/2016, 1:00 PM

File Name Begin Bridge_LT Side Slope_SEE Newmark.slim



Method Name	Min FS
Bishop simplified	1.02
Spencer	1.03
GLE / Morgenstern-Price	1.03

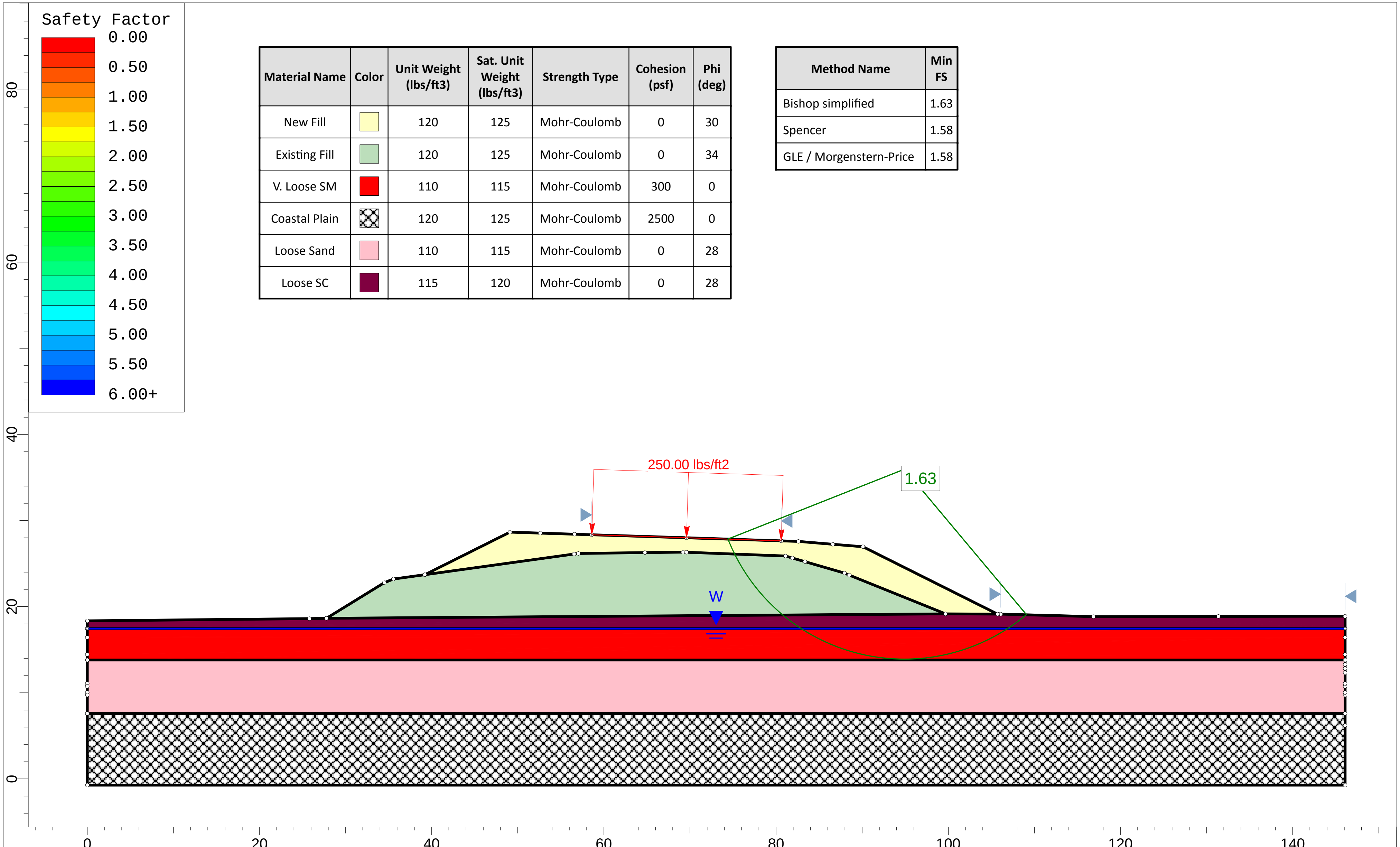
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)
SKZ 20 Sheet Pile		Micro Pile	Passive (Method B)	8	89700

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek		
Analysis Description	Begin Bridge_LT Side Slope_SEE Newmark_Pin Pile		
Drawn By JFH	*Scale* 1:185	*Company*	F&ME, Inc.
Date 02/03/2016, 1:00 PM		*File Name*	Begin Bridge_LT Side Slope_SEE Newmark_Pin Pile.slim



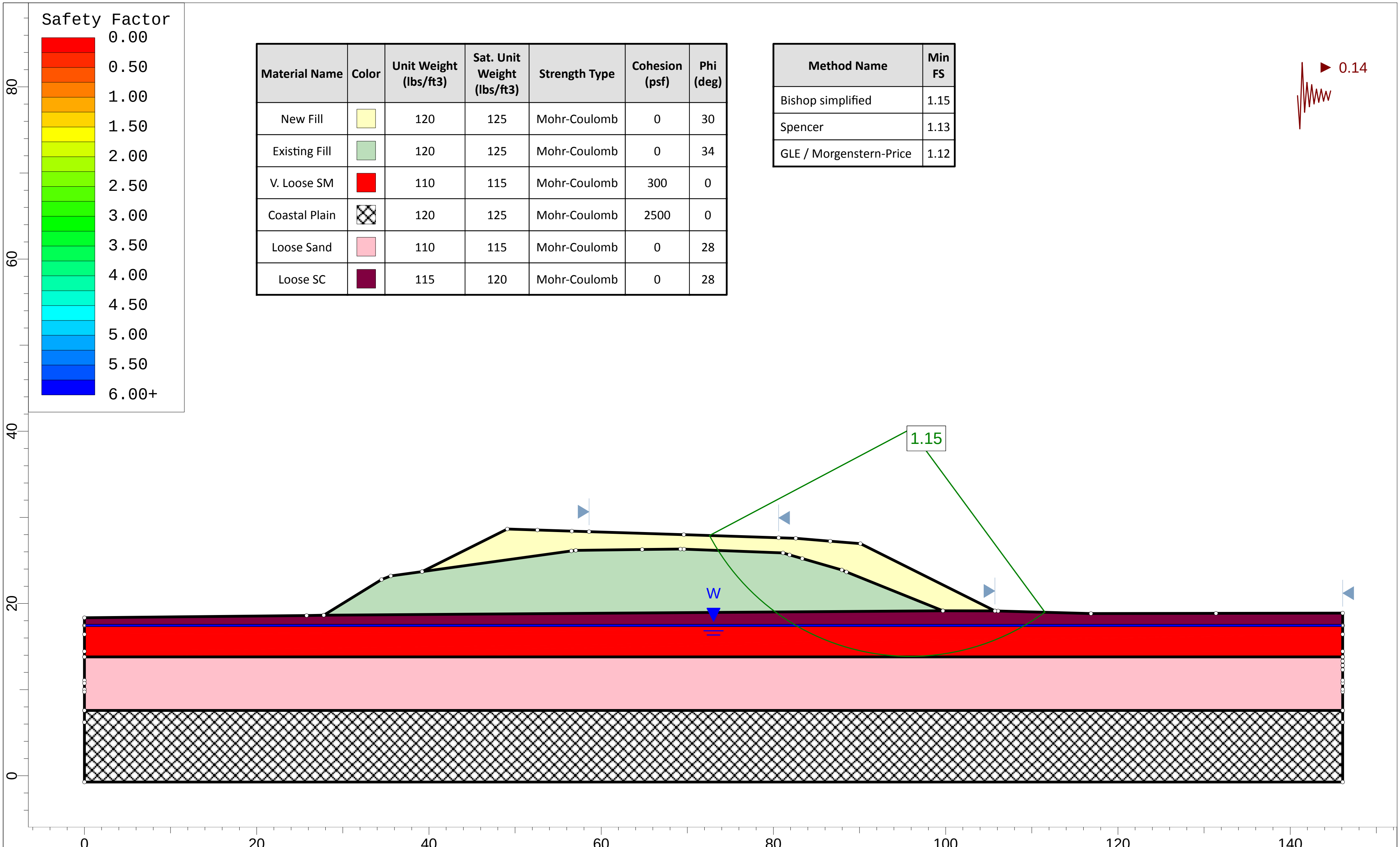
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	1.63
Spencer	1.58
GLE / Morgenstern-Price	1.58

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek		
Analysis Description	Begin Bridge_RT Side Slope_Static		
Drawn By JFH	*Scale* 1:185	*Company* F&ME, Inc.	
Date 02/03/2016, 2:00 PM		*File Name* Begin Bridge_RT Side Slope_Static.slim	



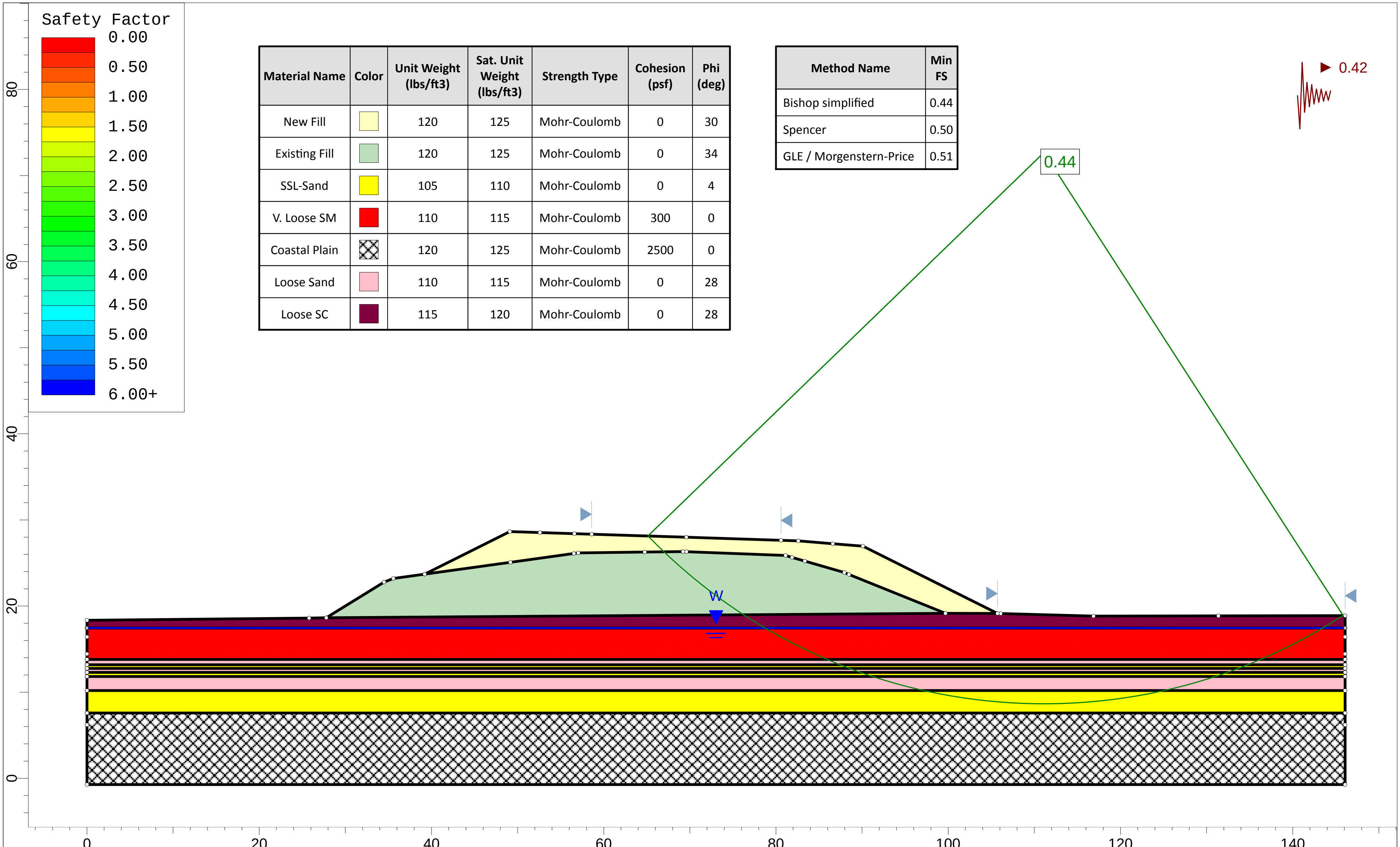
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	1.15
Spencer	1.13
GLE / Morgenstern-Price	1.12

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_RT Side Slope_FEE
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:15 PM
File Name	Begin Bridge_RT Side Slope_FEE.slim



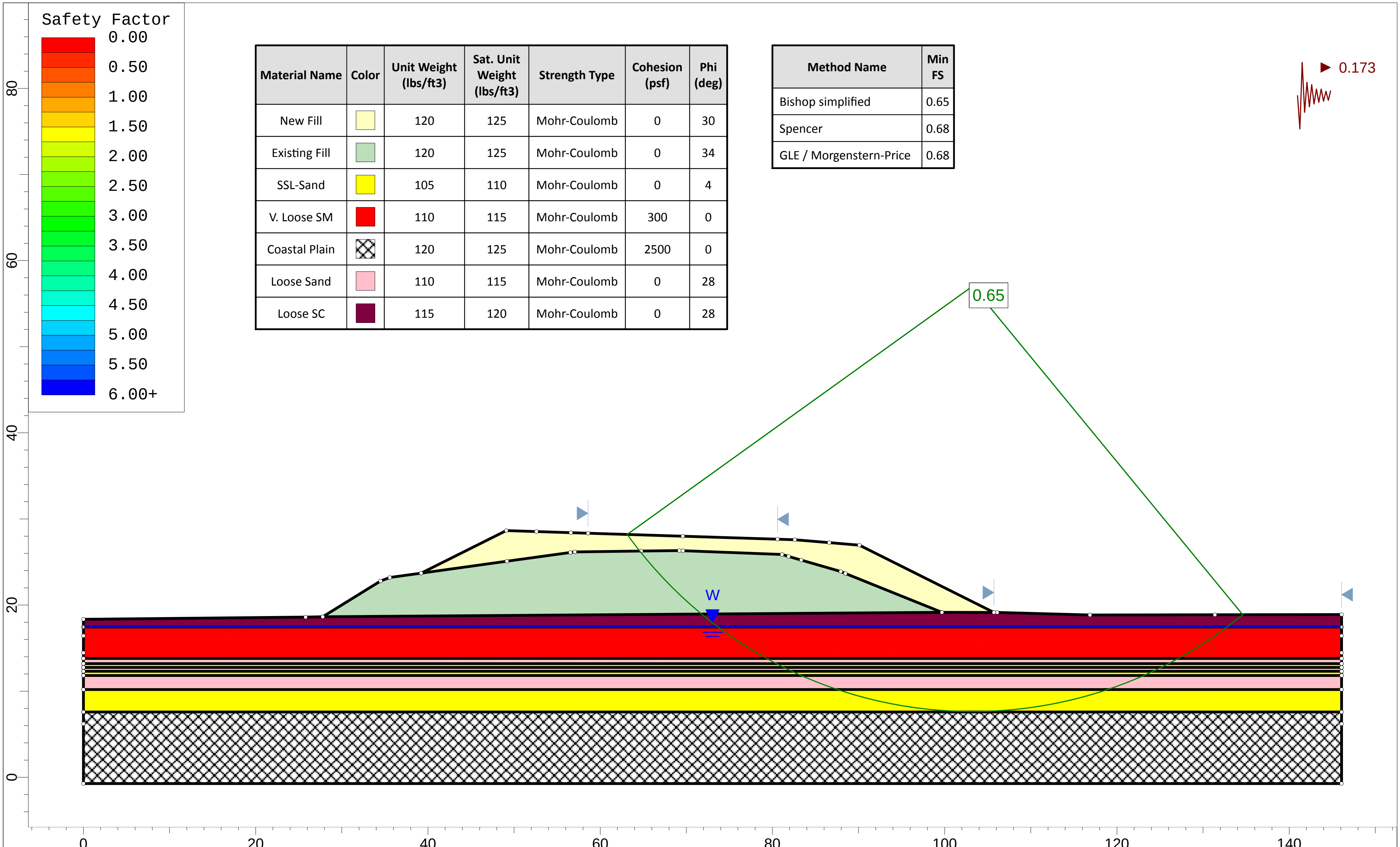
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	0.44
Spencer	0.50
GLE / Morgenstern-Price	0.51

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_RT Side Slope_SEE
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:00 PM
File Name	Begin Bridge_RT Side Slope_SEE.slim



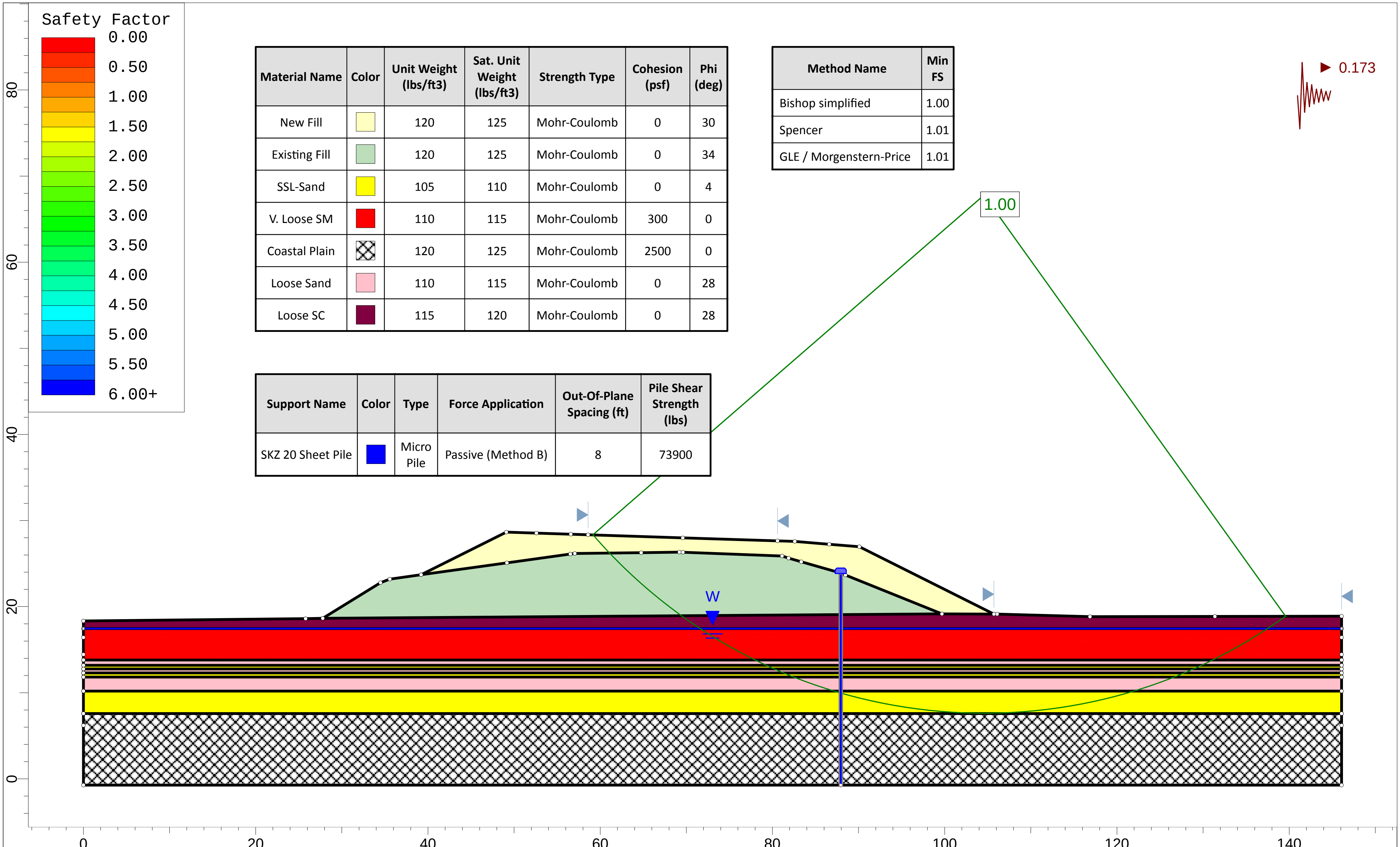
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	0.65
Spencer	0.68
GLE / Morgenstern-Price	0.68

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_RT Side Slope_SEE Newmark
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:00 PM
File Name	Begin Bridge_RT Side Slope_SEE Newmark.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

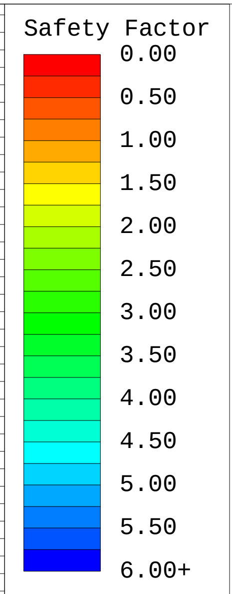
Method Name	Min FS
Bishop simplified	1.00
Spencer	1.01
GLE / Morgenstern-Price	1.01

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)
SKZ 20 Sheet Pile		Micro Pile	Passive (Method B)	8	73900

F&ME CONSULTANTS

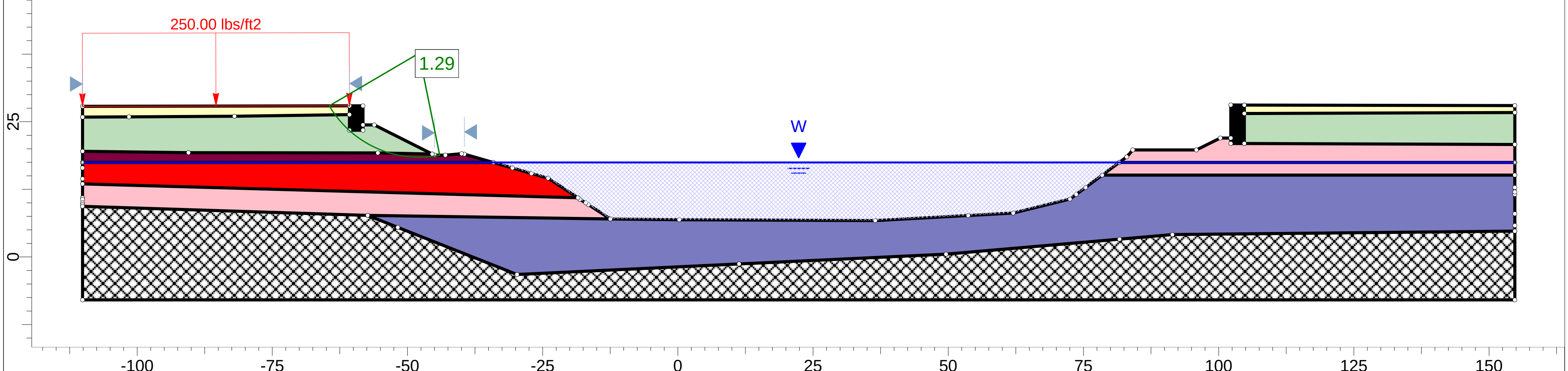
SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_RT Side Slope_SEE Newmark_Pin Pile
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:00 PM
File Name	Begin Bridge_RT Side Slope_SEE Newmark_Pin Pile.slim



Method Name	Min FS
Bishop simplified	1.29
Spencer	1.27
GLE / Morgenstern-Price	1.27

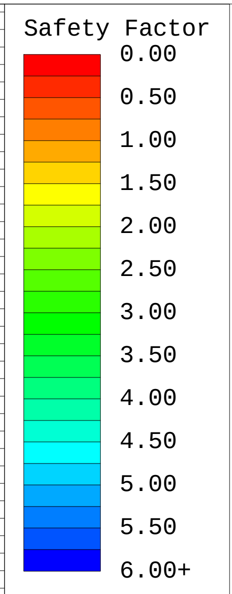
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28



F&ME CONSULTANTS

SLIDEINTERPRET 7.009

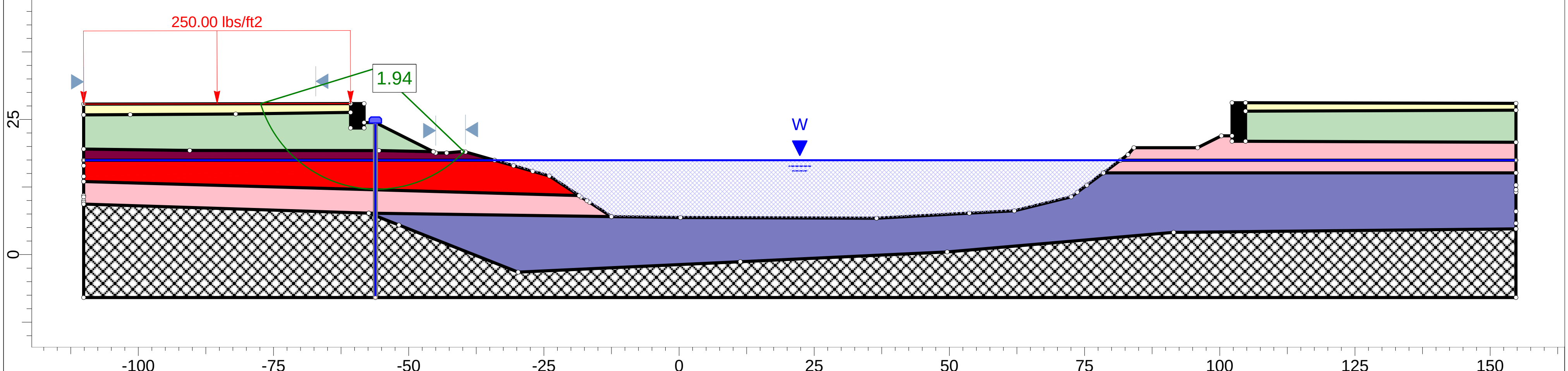
Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_End Slope_Static
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	Begin Bridge_End Slope_Static.slim



Method Name	Min FS
Bishop simplified	1.94
Spencer	1.88
GLE / Morgenstern-Price	1.90

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

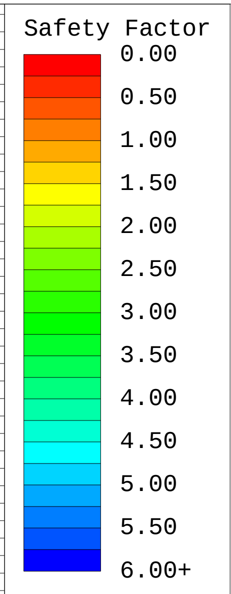
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)
SKZ 20 Sheet Pile		Micro Pile	Passive (Method B)	10	63300



F&ME CONSULTANTS

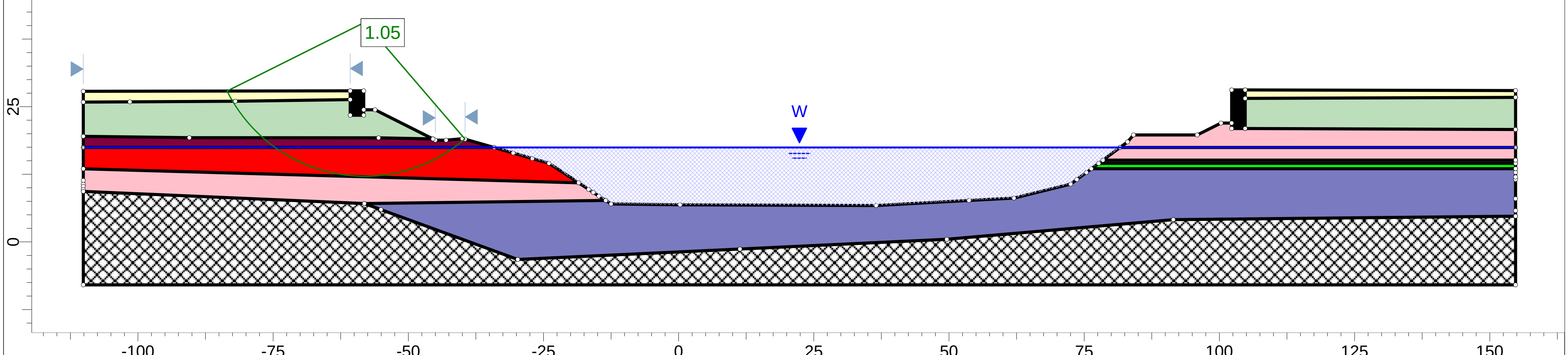
SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_End Slope_Static_Pin Pile
Drawn By JFH	*Scale* 1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	Begin Bridge_End Slope_Static_Pin Pile.slim



Method Name	Min FS
Bishop simplified	1.05
Spencer	1.04
GLE / Morgenstern-Price	1.03

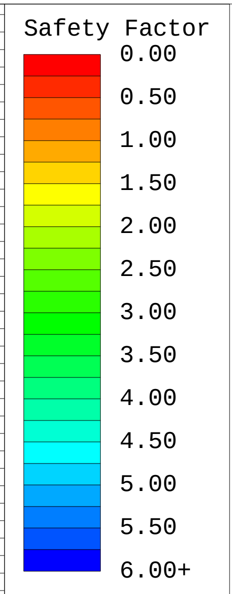
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28



F&ME CONSULTANTS

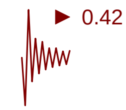
SLIDEINTERPRET 7.009

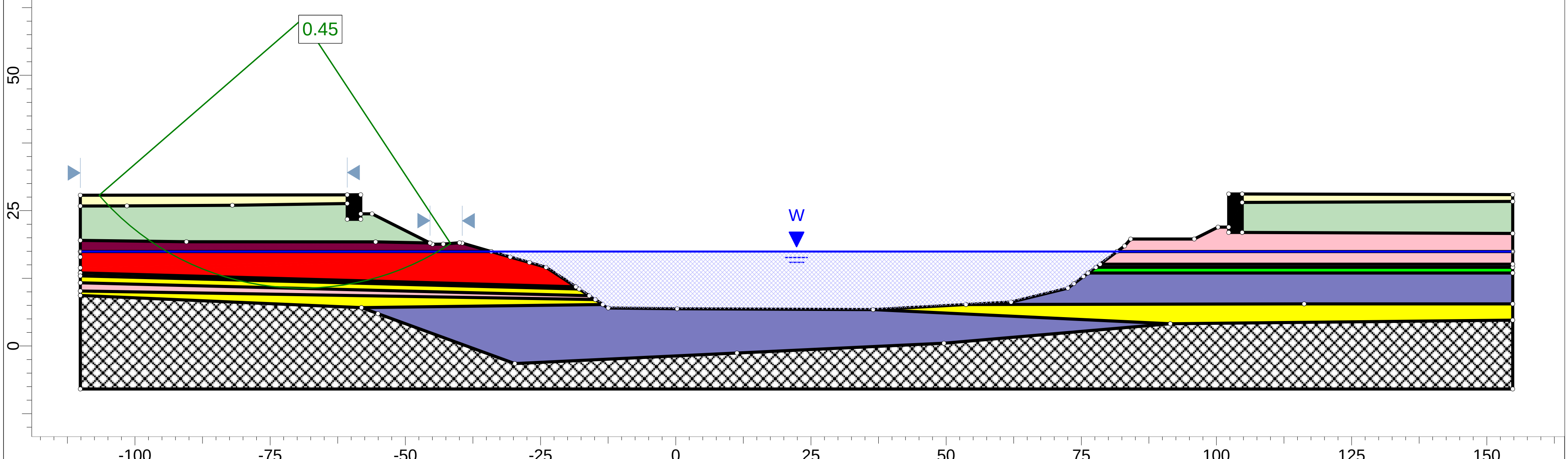
Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_End Slope_FEE
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	Begin Bridge_End Slope_FEE.slim



Method Name	Min FS
Bishop simplified	0.45
Spencer	0.57
GLE / Morgenstern-Price	0.53

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		110	115	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28

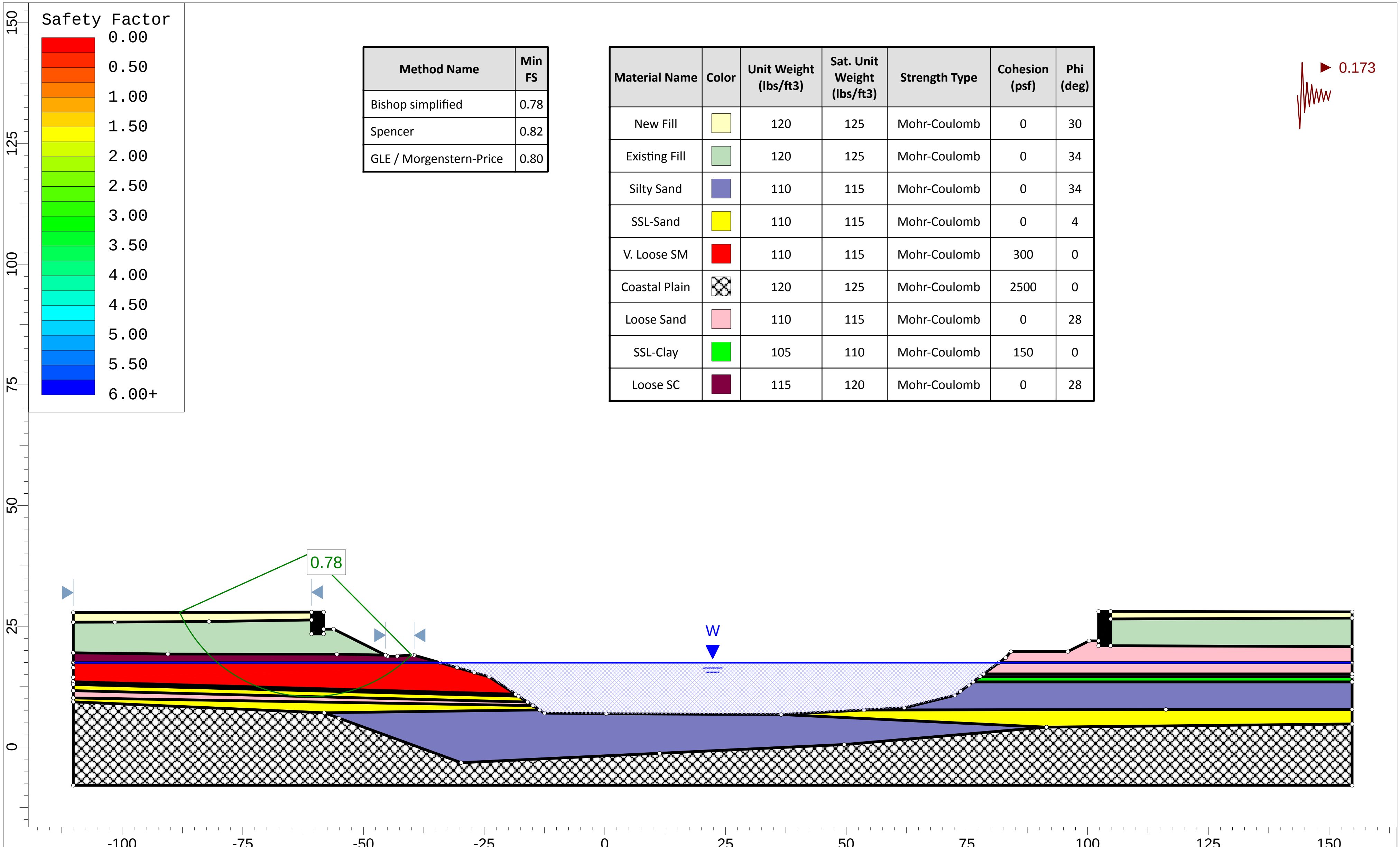




F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_End Slope_SEE
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	Begin Bridge_End Slope_SEE.slim



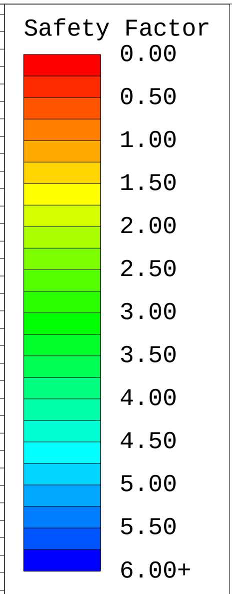
Method Name	Min FS
Bishop simplified	0.78
Spencer	0.82
GLE / Morgenstern-Price	0.80

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		110	115	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28

F&ME CONSULTANTS

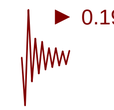
SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	Begin Bridge_End Slope_SEE Newmark
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	Begin Bridge_End Slope_SEE Newmark.slim

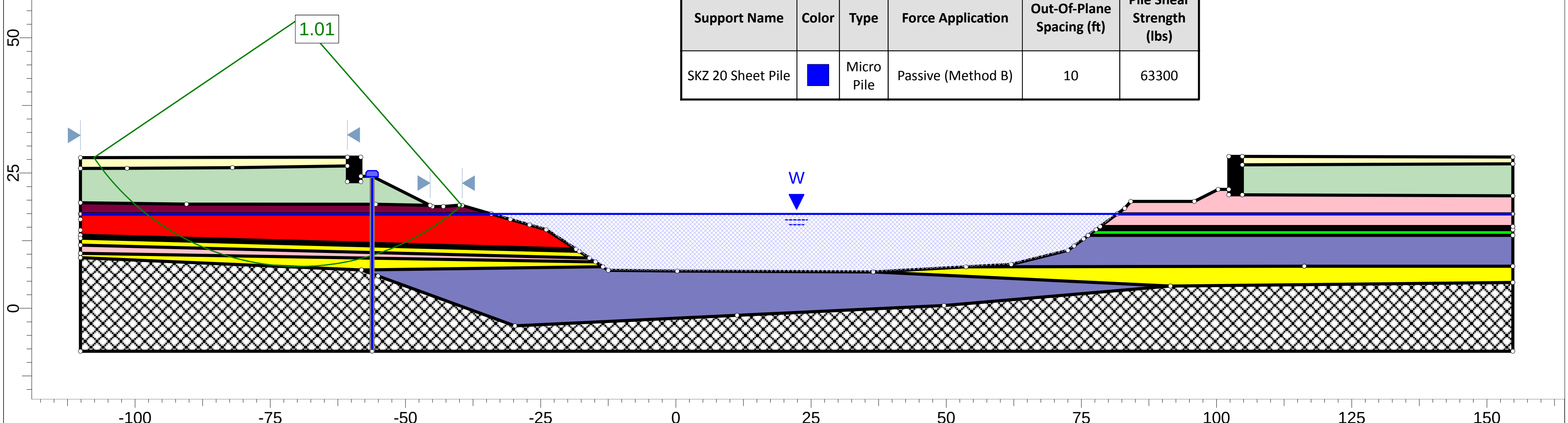


Method Name	Min FS
Bishop simplified	1.01
Spencer	1.05
GLE / Morgenstern-Price	1.05

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		110	115	Mohr-Coulomb	0	4
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28



Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)
SKZ 20 Sheet Pile		Micro Pile	Passive (Method B)	10	63300

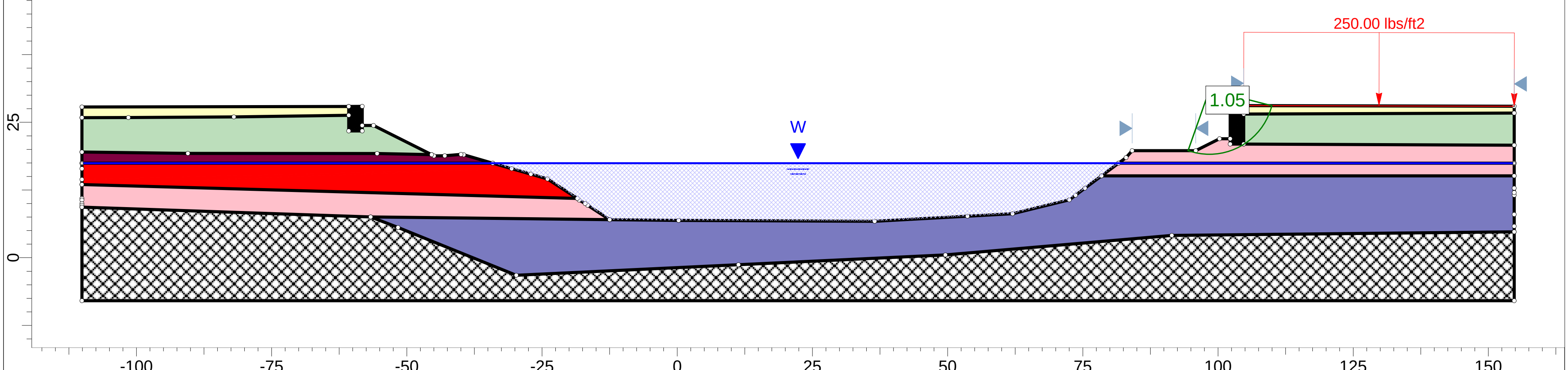


F&ME CONSULTANTS	*Project*	S-51 Emergency Bridge Replacement over Black Mingo Creek	
	Analysis Description	Begin Bridge_End Slope_SEE Newmark_Pin Pile	
	Drawn By JFH	*Scale* 1:330	*Company* F&ME, Inc.
SLIDEINTERPRET 7.009	*Date* 02/03/2016, 3:25 PM		*File Name* Begin Bridge_End Slope_SEE Newmark_Pin Pile.slim

Safety Factor
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00+

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

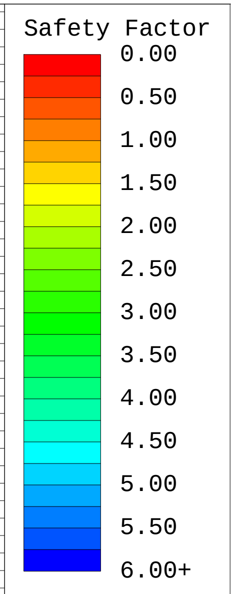
Method Name	Min FS
Bishop simplified	1.05
Spencer	1.04
GLE / Morgenstern-Price	1.04



F&ME CONSULTANTS

SLIDEINTERPRET 7.009

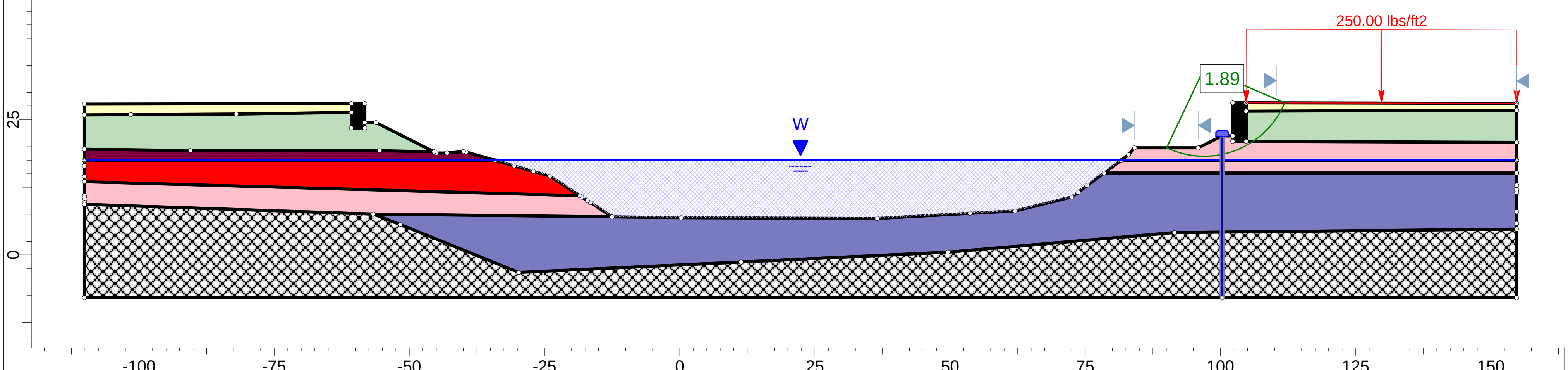
Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_End Slope_Static
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:55 PM
File Name	End Bridge_End Slope_Static.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	1.89
Spencer	1.85
GLE / Morgenstern-Price	1.85

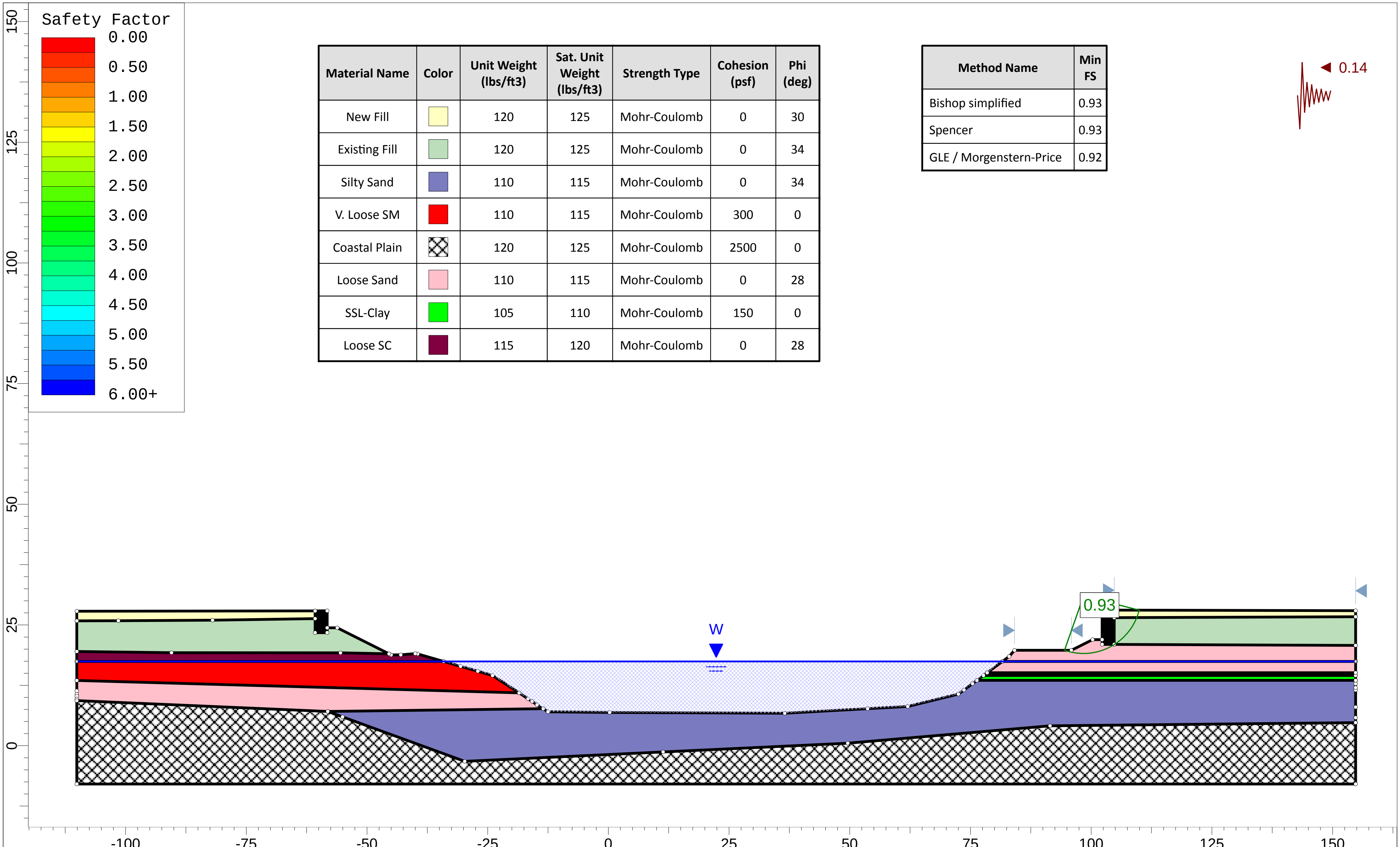
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)
SKZ 20 Sheet Pile		Micro Pile	Passive (Method B)	10	30700



F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek		
Analysis Description	End Bridge_End Slope_Static_Pin Pile		
Drawn By JFH	*Scale* 1:330	*Company*	F&ME, Inc.
Date	02/03/2016, 3:55 PM	*File Name*	End Bridge_End Slope_Static_Pin Pile.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	0.93
Spencer	0.93
GLE / Morgenstern-Price	0.92

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

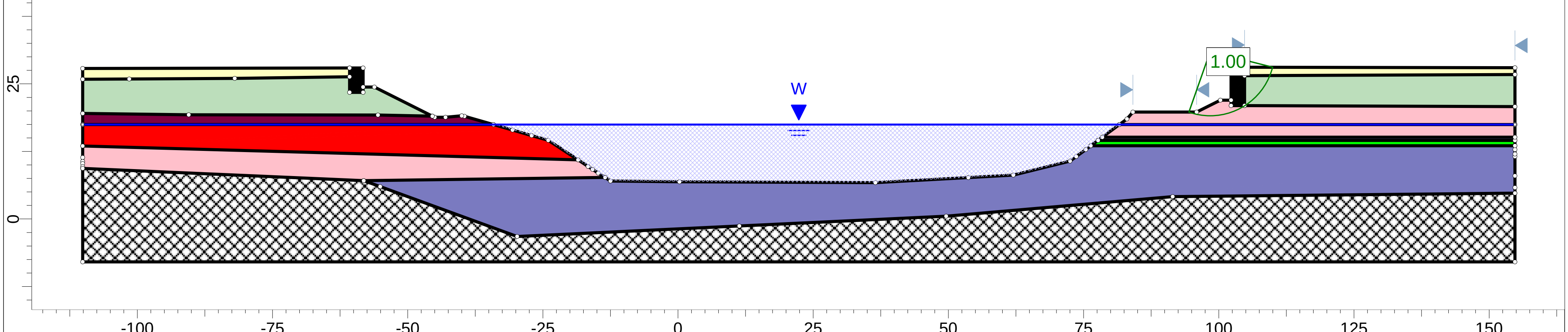
Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_End Slope_FEE
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	End Bridge_End Slope_FEE.slim

Safety Factor
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00+

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	1.00
Spencer	1.00
GLE / Morgenstern-Price	1.00

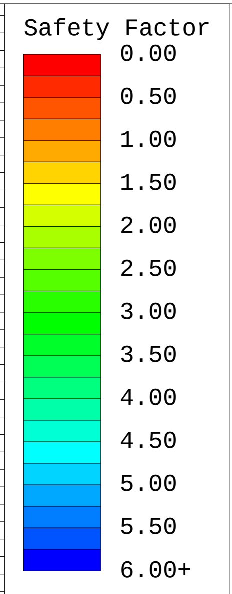
0.09



F&ME CONSULTANTS

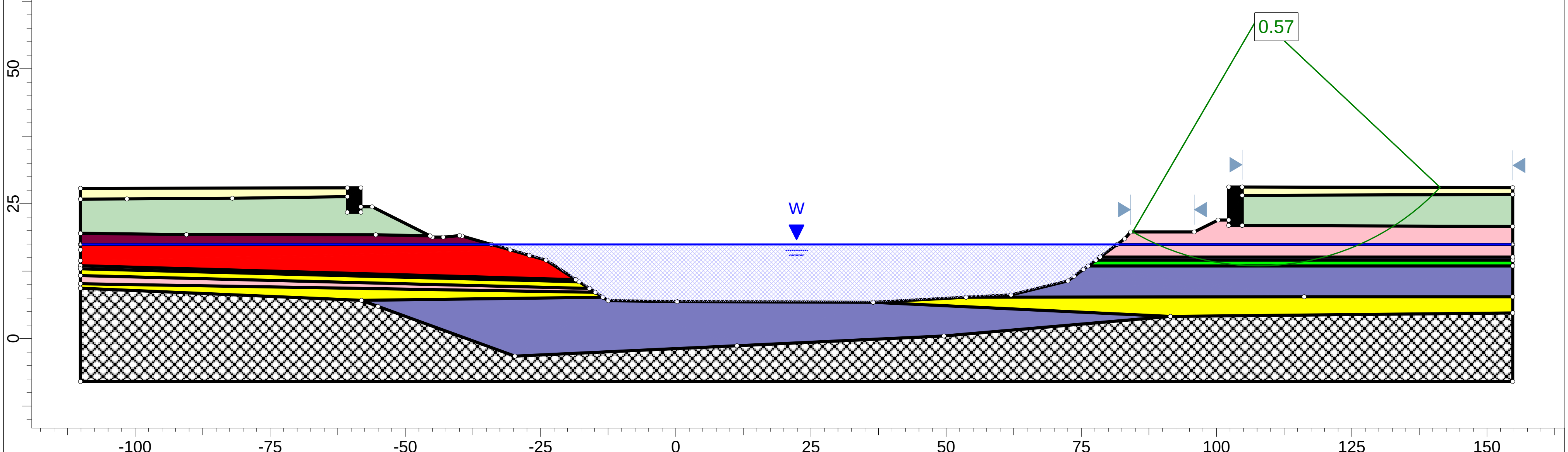
SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_End Slope_FEE Newmark
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	End Bridge_End Slope_FEE Newmark.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		110	115	Mohr-Coulomb	0	9
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28

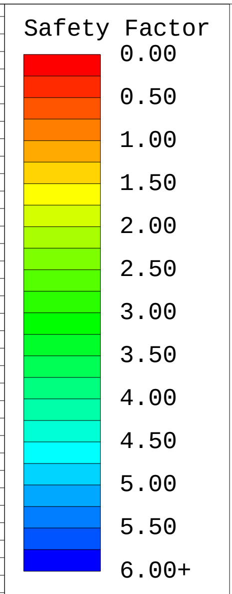
Method Name	Min FS
Bishop simplified	0.57
Spencer	0.66
GLE / Morgenstern-Price	0.65



F&ME CONSULTANTS

SLIDEINTERPRET 7.009

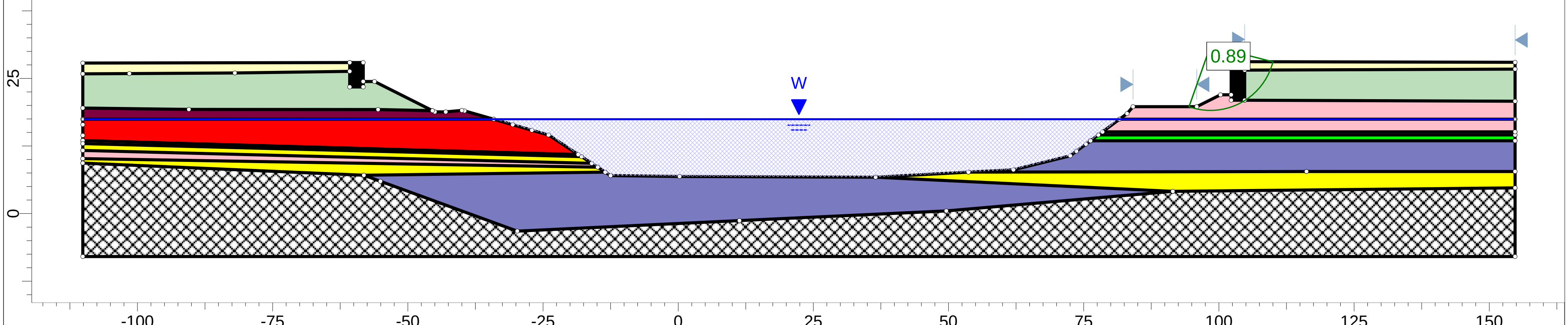
Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_End Slope_SEE
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	End Bridge_End Slope_SEE.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		110	115	Mohr-Coulomb	0	9
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	0.89
Spencer	0.88
GLE / Morgenstern-Price	0.88

0.173



F&ME CONSULTANTS

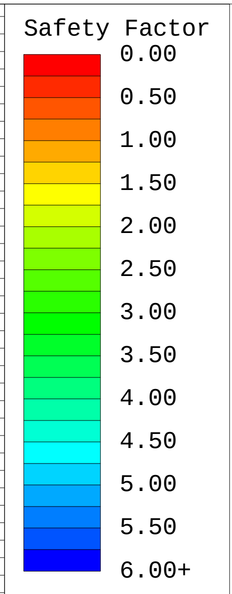
SLIDEINTERPRET 7.009

Project: S-51 Emergency Bridge Replacement over Black Mingo Creek

Analysis Description: End Bridge_End Slope_SEE Newmark

Drawn By: JFH | *Scale*: 1:330 | *Company*: F&ME, Inc.

Date: 02/03/2016, 3:25 PM | *File Name*: End Bridge_End Slope_SEE Newmark.slim

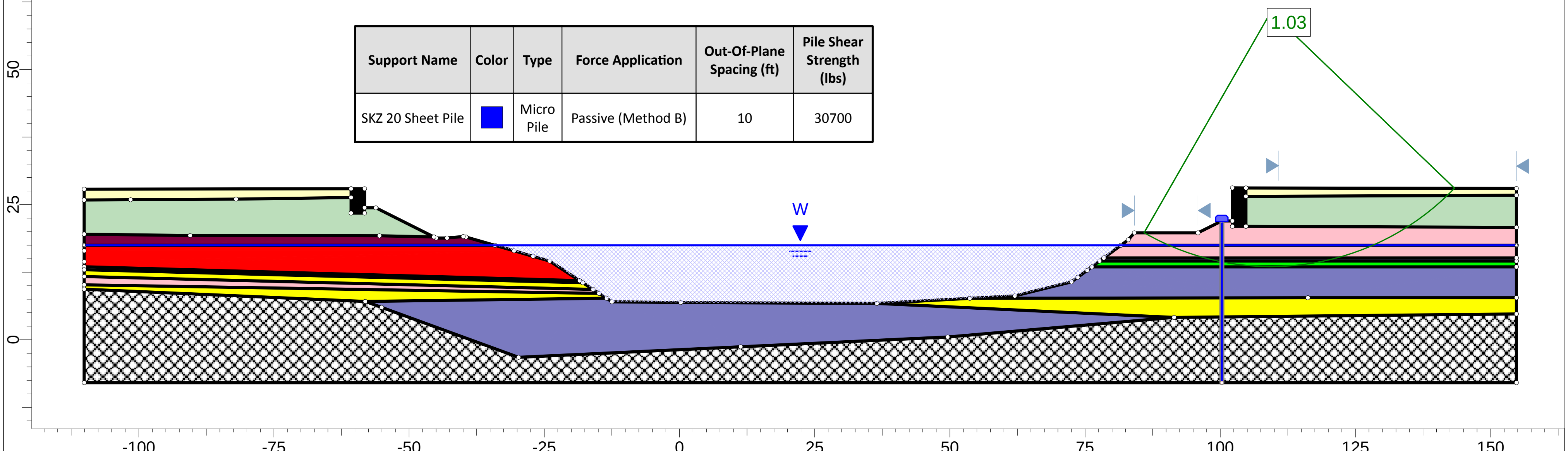


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		110	115	Mohr-Coulomb	0	9
V. Loose SM		110	115	Mohr-Coulomb	300	0
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0
Loose SC		115	120	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	1.03
Spencer	1.07
GLE / Morgenstern-Price	1.05

0.24

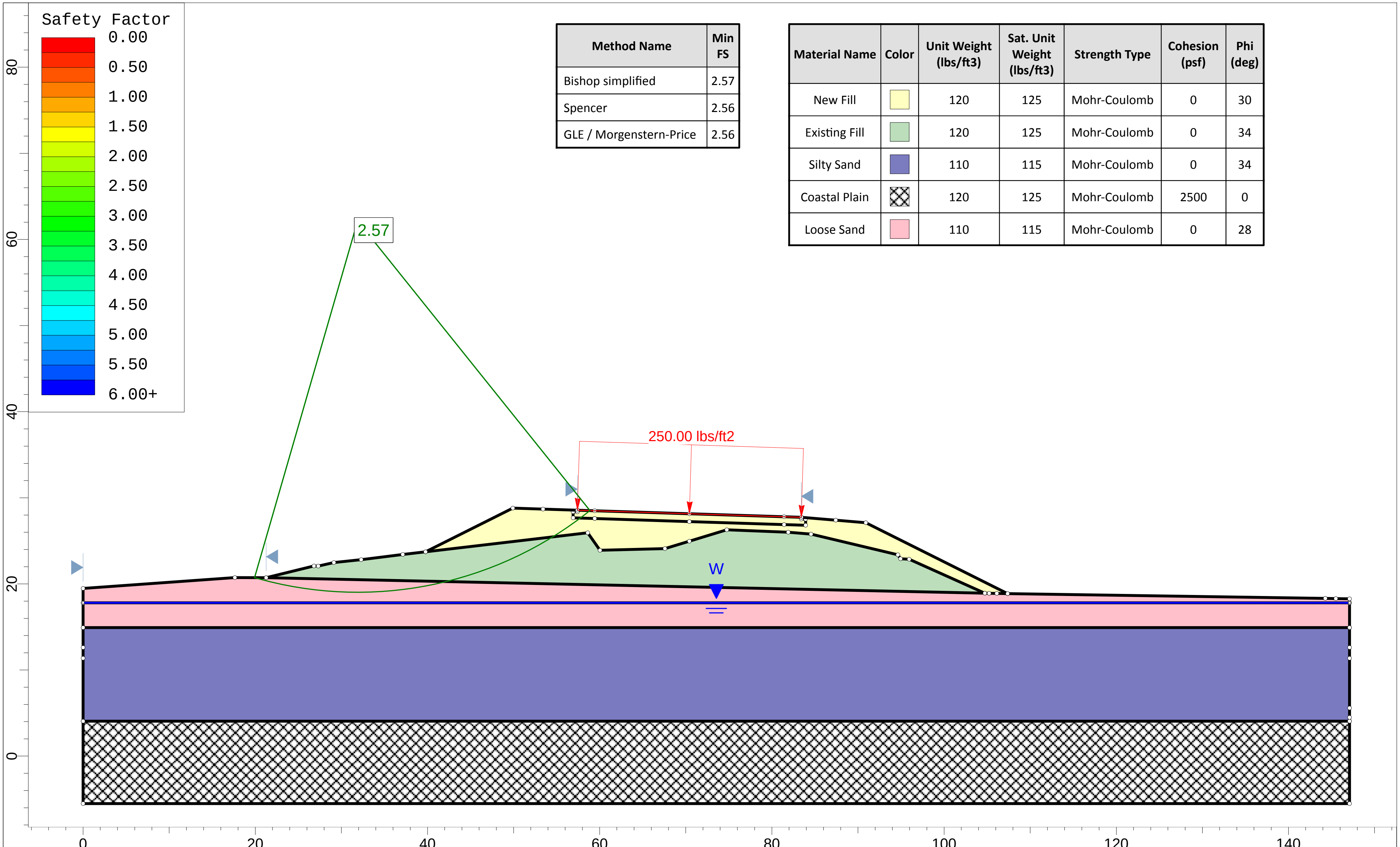
Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)
SKZ 20 Sheet Pile		Micro Pile	Passive (Method B)	10	30700



F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_End Slope_SEE Newmark_Pin Pile
Drawn By	JFH
Scale	1:330
Company	F&ME, Inc.
Date	02/03/2016, 3:25 PM
File Name	End Bridge_End Slope_SEE Newmark_Pin Pile.slim



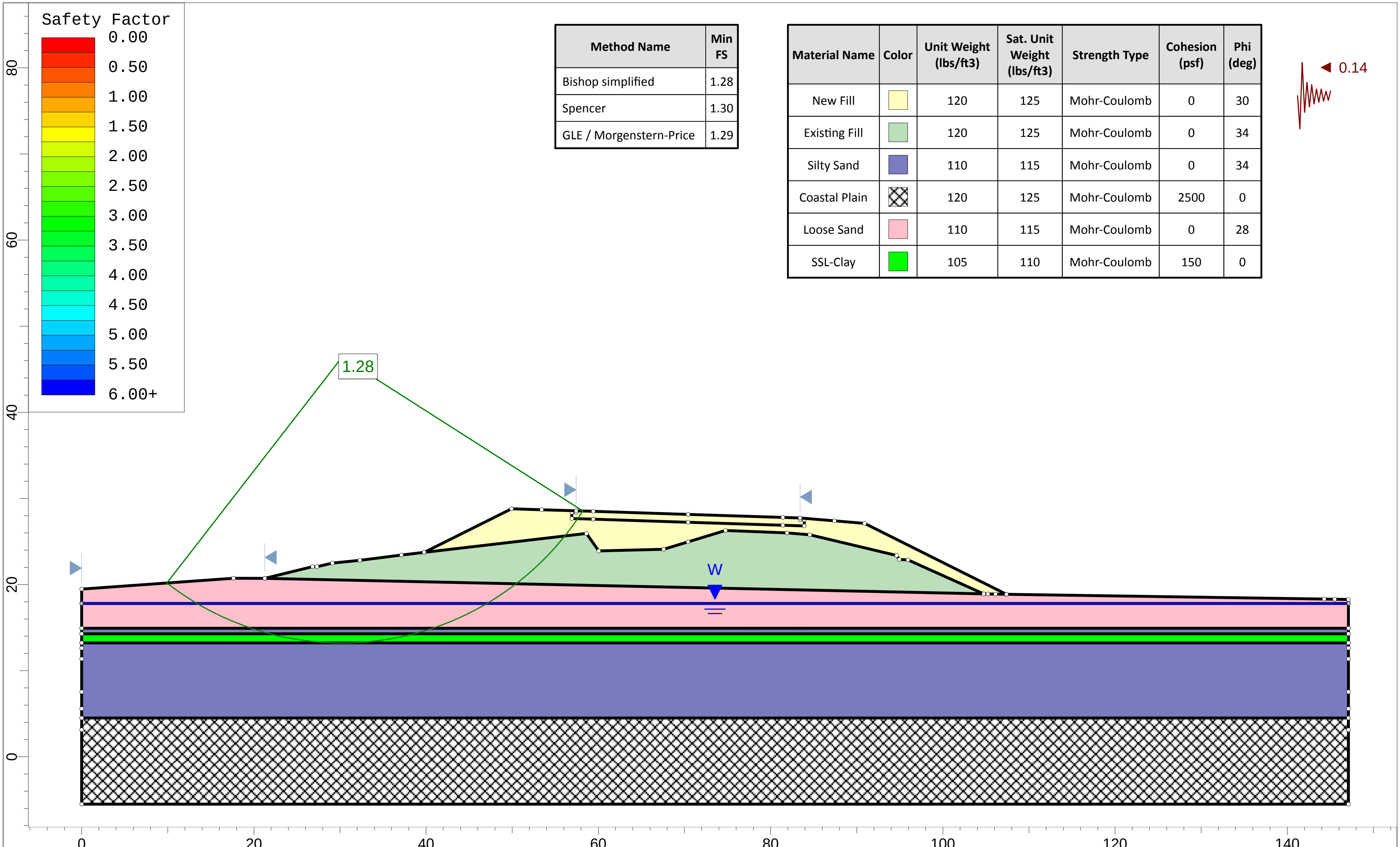
Method Name	Min FS
Bishop simplified	2.57
Spencer	2.56
GLE / Morgenstern-Price	2.56

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_LT Side Slope_Static
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:45 PM
File Name	End Bridge_LT Side Slope_Static.slim



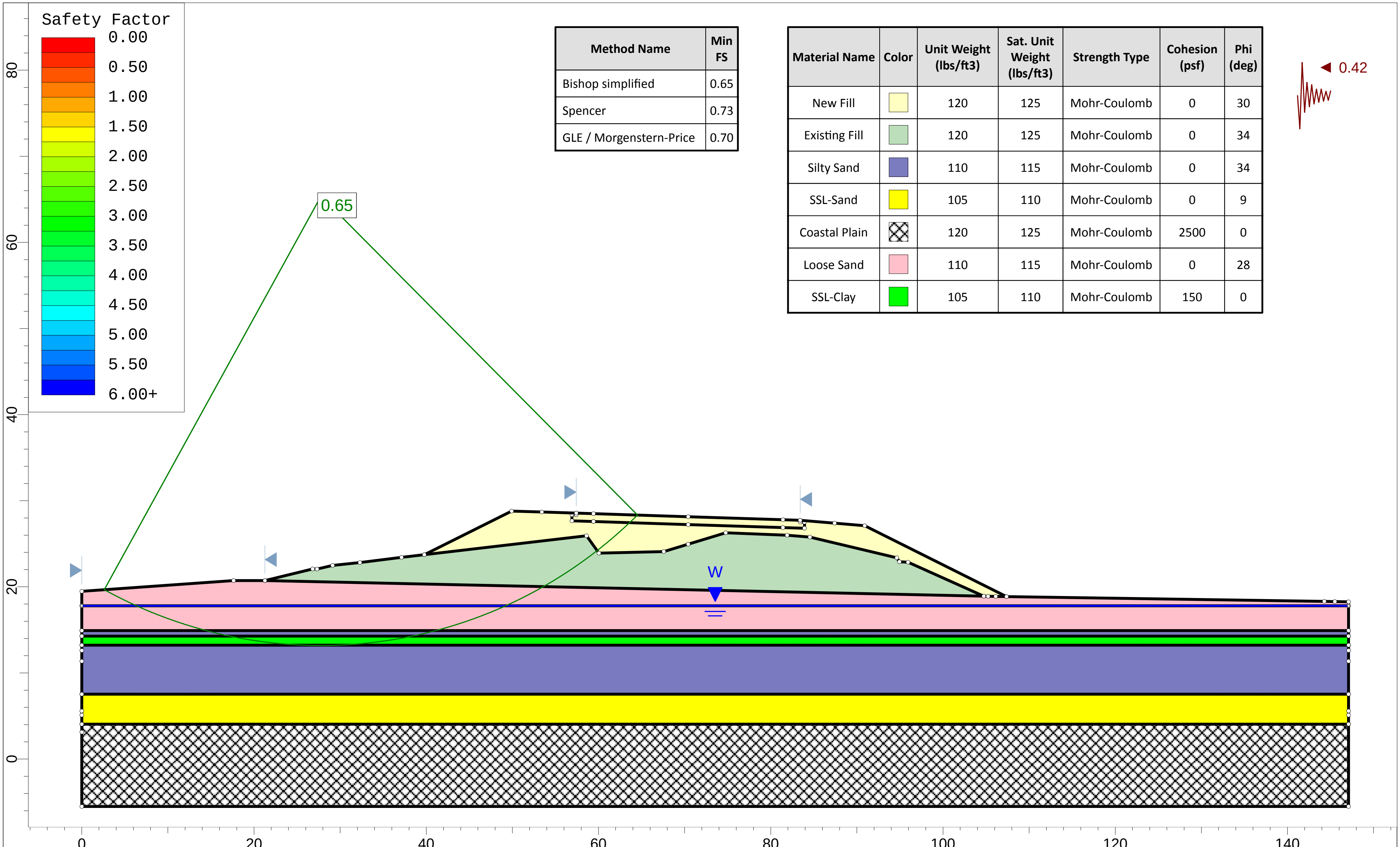
Method Name	Min FS
Bishop simplified	1.28
Spencer	1.30
GLE / Morgenstern-Price	1.29

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0

F&ME CONSULTANTS

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek		
Analysis Description	End Bridge_LT Side Slope_FEE		
Drawn By JFH	*Scale* 1:185	*Company*	F&ME, Inc.
Date	02/03/2016, 1:45 PM	*File Name*	End Bridge_LT Side Slope_FEE.slim

SLIDEINTERPRET 7.009



Method Name	Min FS
Bishop simplified	0.65
Spencer	0.73
GLE / Morgenstern-Price	0.70

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	9
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project S-51 Emergency Bridge Replacement over Black Mingo Creek

Analysis Description End Bridge_LT Side Slope_SEE

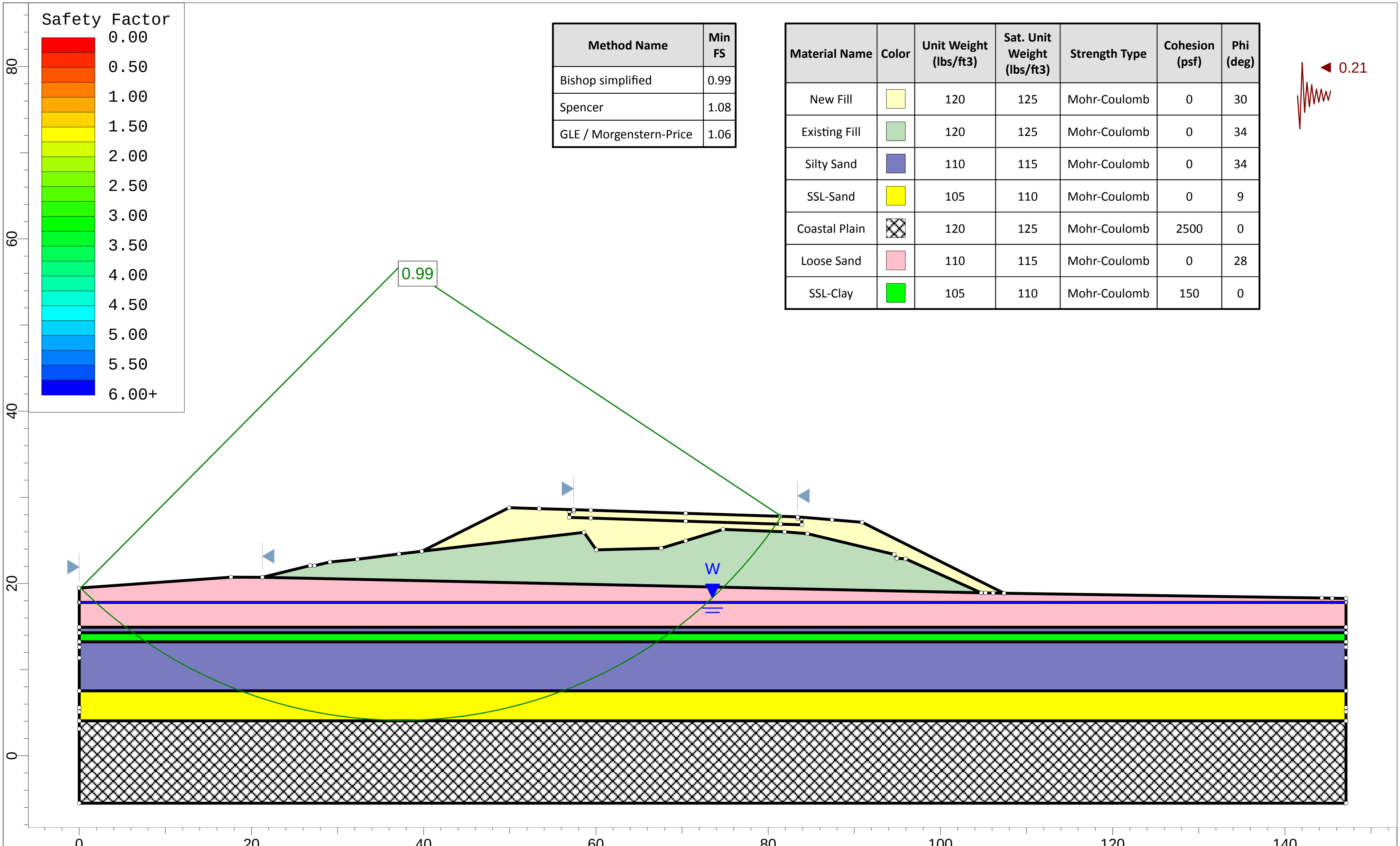
Drawn By JFH

Scale 1:185

Company F&ME, Inc.

Date 02/03/2016, 1:45 PM

File Name End Bridge_LT Side Slope_SEE.slim



Method Name	Min FS
Bishop simplified	0.99
Spencer	1.08
GLE / Morgenstern-Price	1.06

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	9
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0

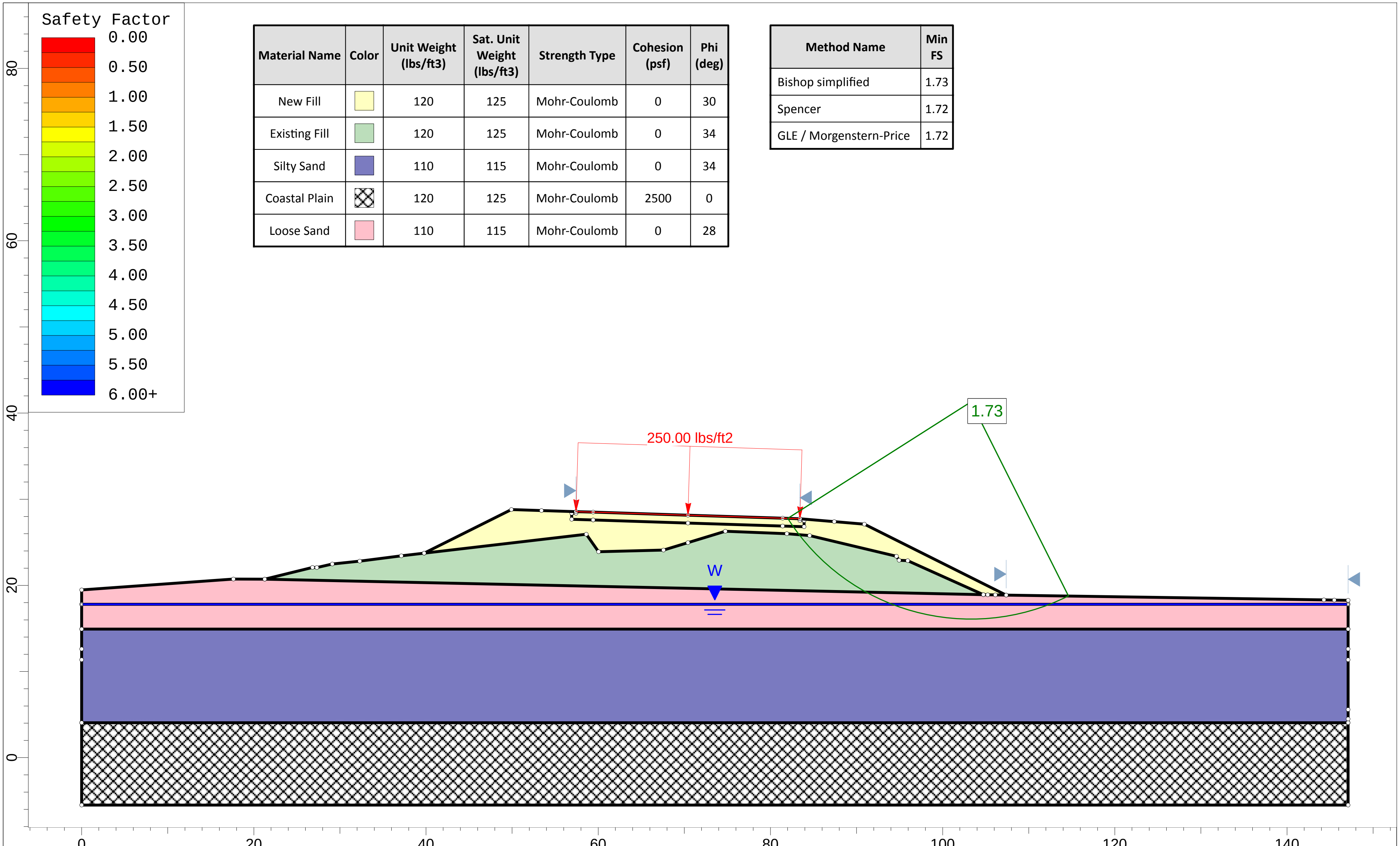
F&ME CONSULTANTS

SLIDEINTERPRET 7.009

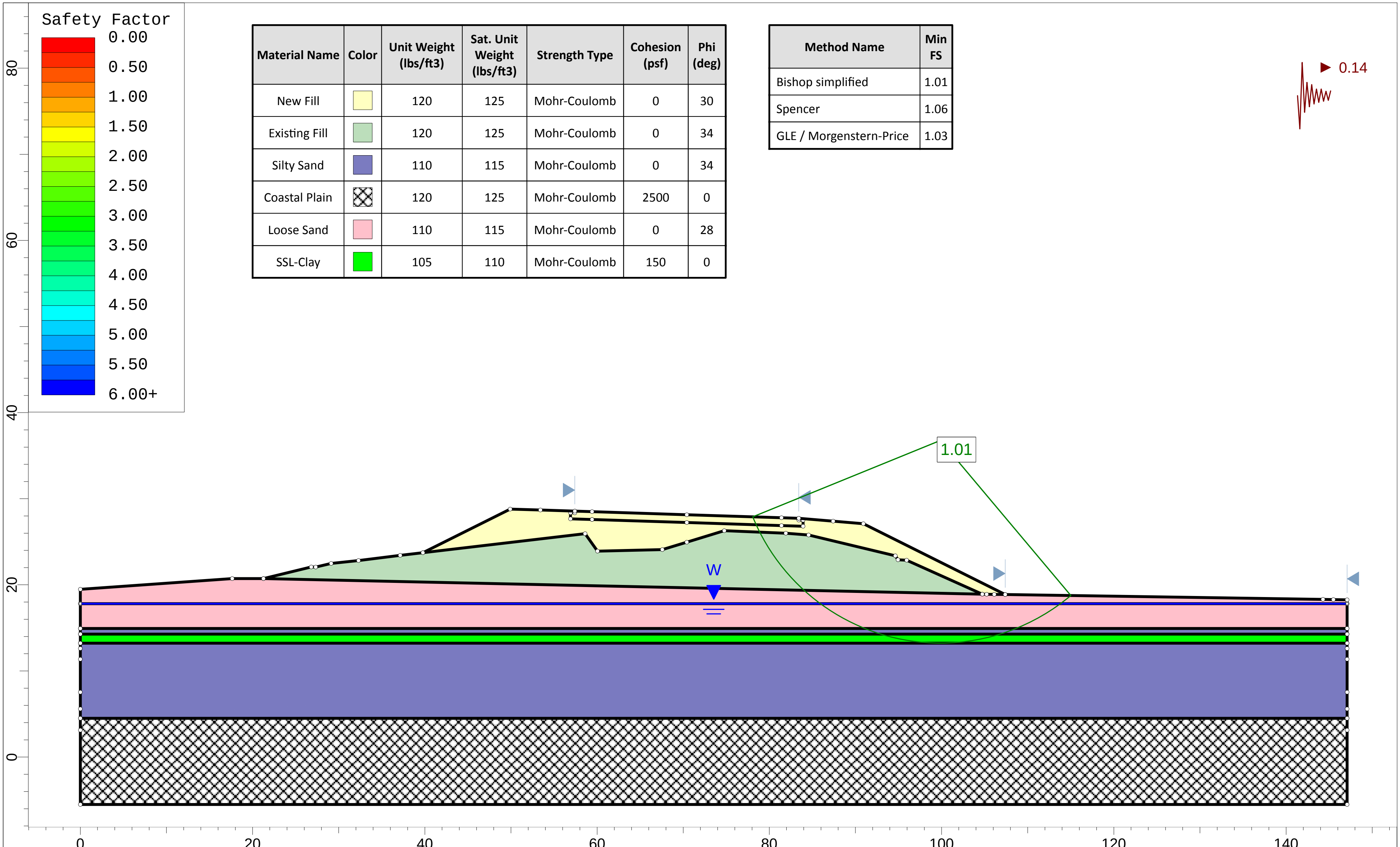
Project	S-51 Emergency Bridge Replacement over Black Mingo Creek		
Analysis Description	End Bridge_LT Side Slope_SEE Newmark		
Drawn By JFH	*Scale* 1:185	*Company*	F&ME, Inc.
Date	02/03/2016, 1:45 PM	*File Name*	End Bridge_LT Side Slope_SEE Newmark.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28

Method Name	Min FS
Bishop simplified	1.73
Spencer	1.72
GLE / Morgenstern-Price	1.72



F&ME CONSULTANTS	*Project*	S-51 Emergency Bridge Replacement over Black Mingo Creek	
	Analysis Description	End Bridge_RT Side Slope_Static	
	Drawn By JFH	*Scale* 1:185	*Company* F&ME, Inc.
SLIDEINTERPRET 7.009	*Date* 02/03/2016, 1:45 PM		*File Name* End Bridge_RT Side Slope_Static.slim



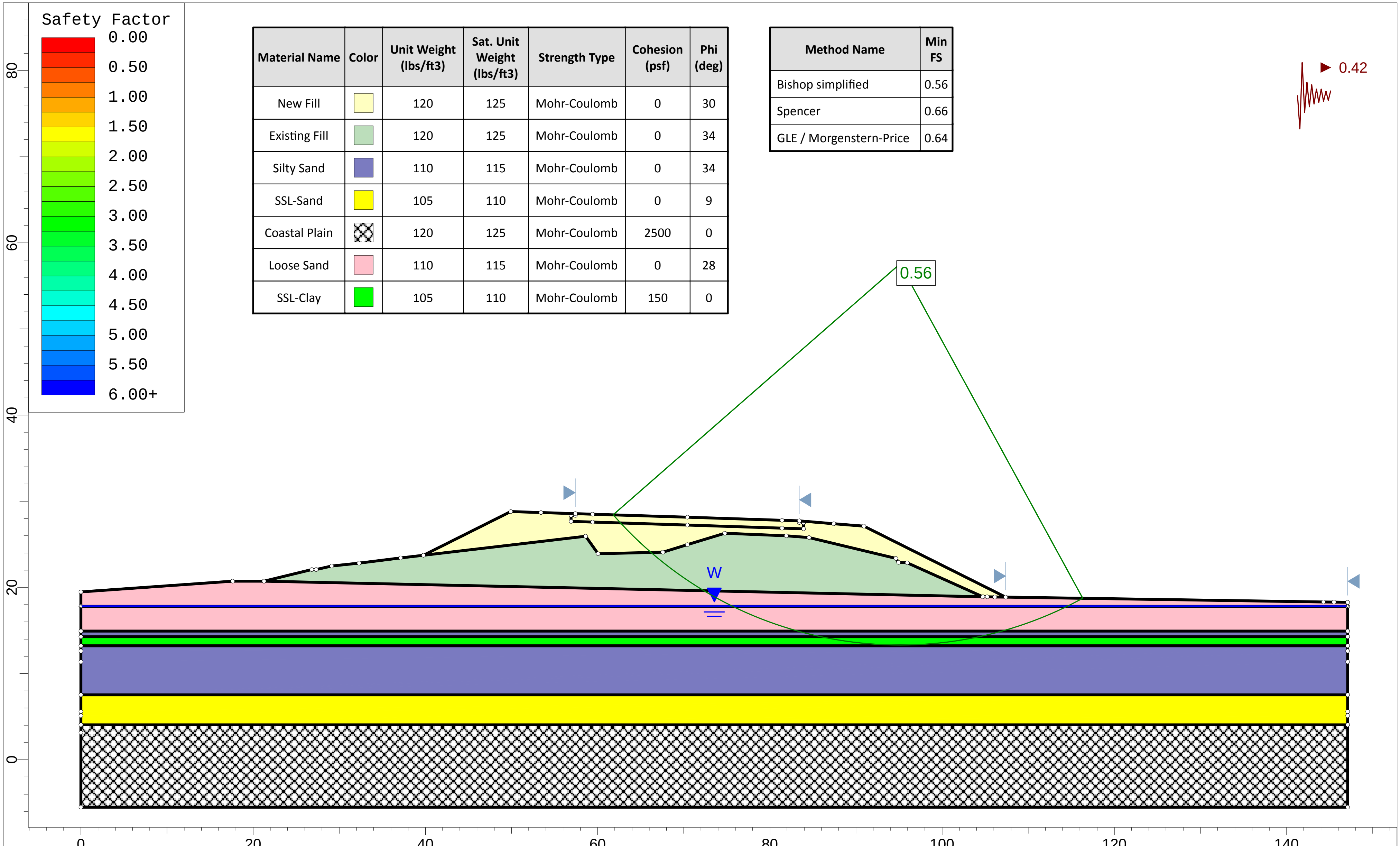
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0

Method Name	Min FS
Bishop simplified	1.01
Spencer	1.06
GLE / Morgenstern-Price	1.03

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_RT Side Slope_FEE
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:45 PM
File Name	End Bridge_RT Side Slope_FEE.slim



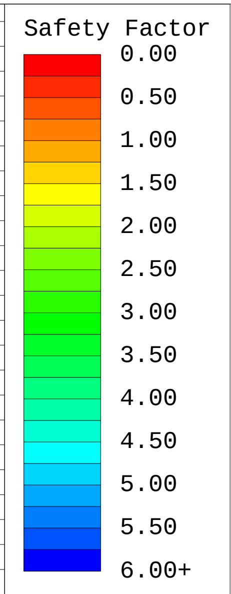
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	9
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0

Method Name	Min FS
Bishop simplified	0.56
Spencer	0.66
GLE / Morgenstern-Price	0.64

F&ME CONSULTANTS

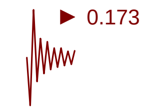
SLIDEINTERPRET 7.009

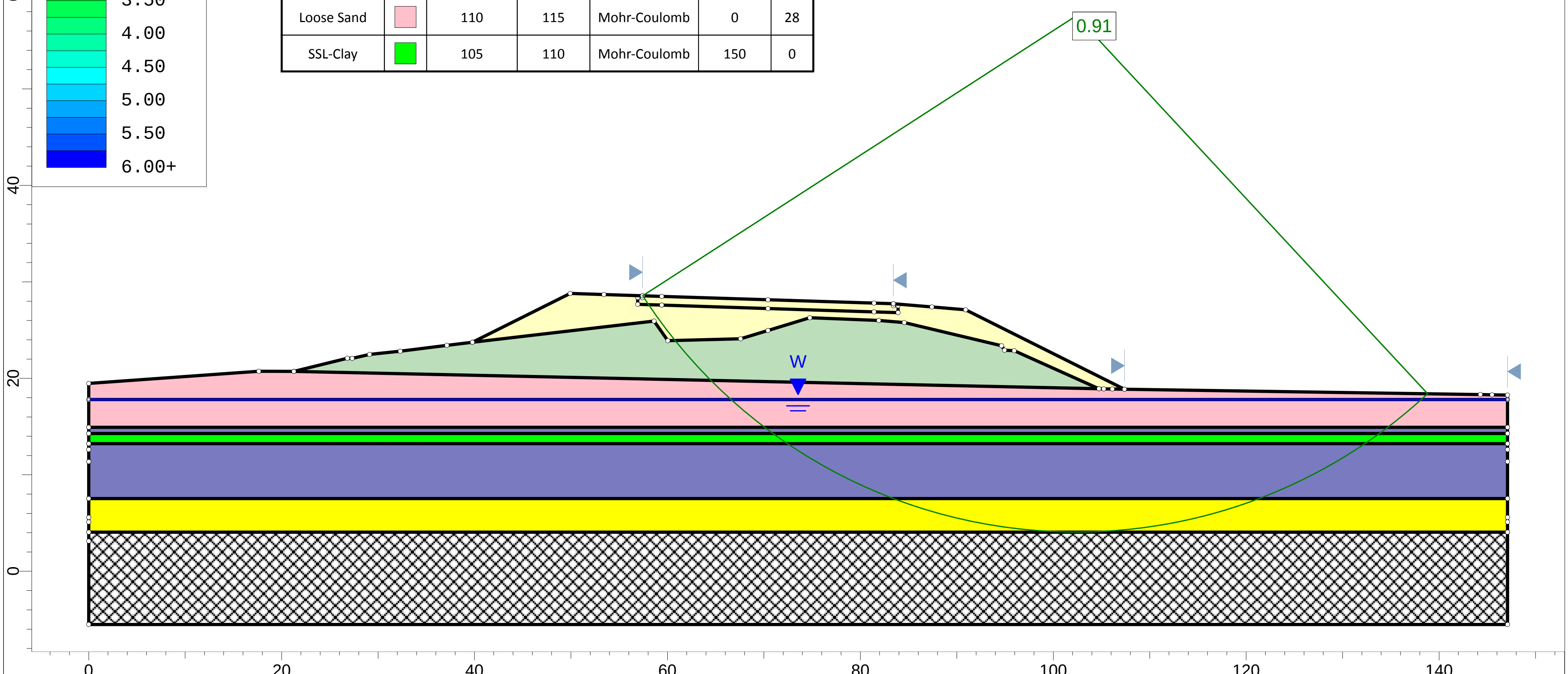
Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_RT Side Slope_SEE
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:45 PM
File Name	End Bridge_RT Side Slope_SEE.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	9
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0

Method Name	Min FS
Bishop simplified	0.91
Spencer	0.97
GLE / Morgenstern-Price	0.95

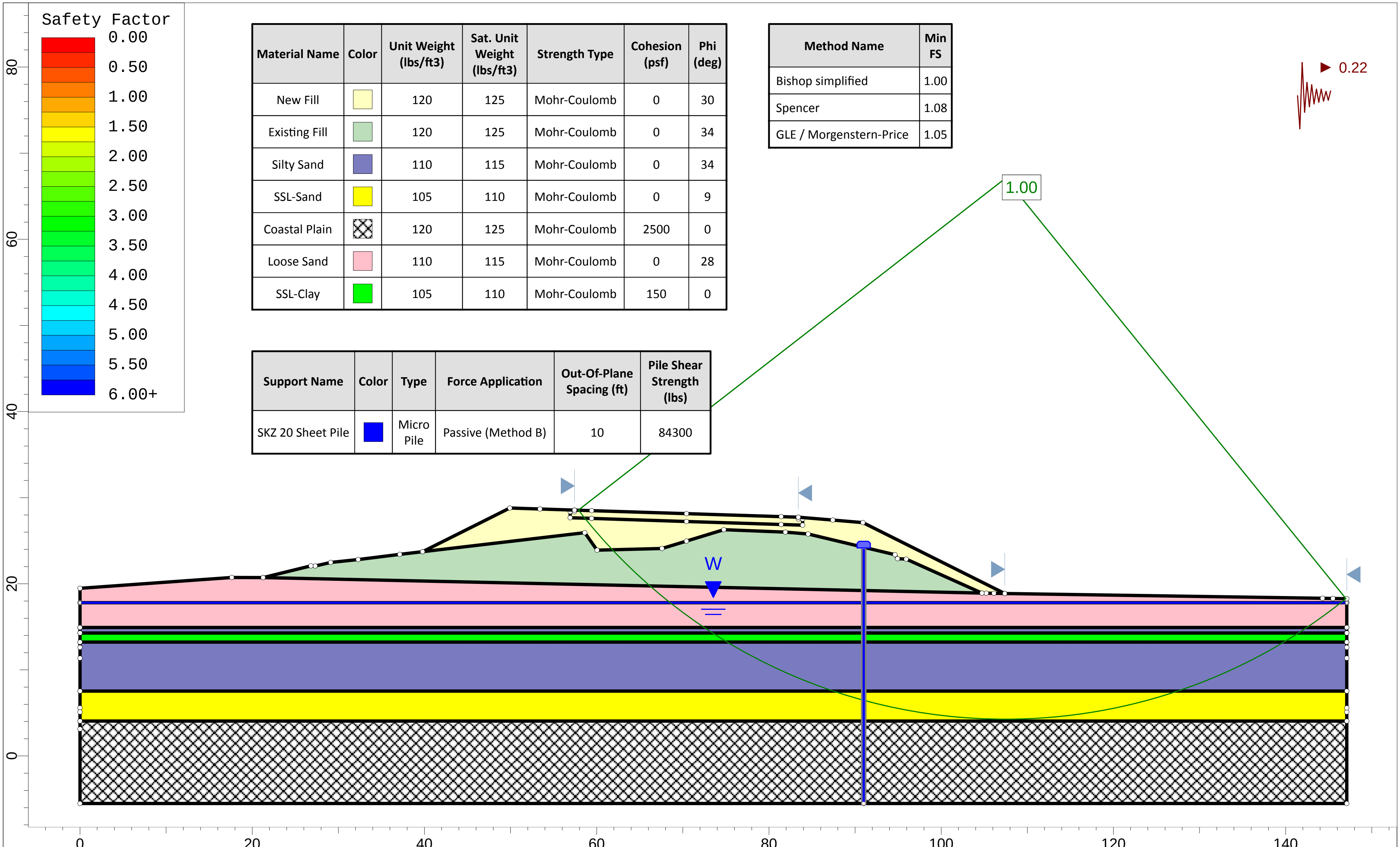




F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_RT Side Slope_SEE Newmark
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:45 PM
File Name	End Bridge_RT Side Slope_SEE Newmark.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Fill		120	125	Mohr-Coulomb	0	30
Existing Fill		120	125	Mohr-Coulomb	0	34
Silty Sand		110	115	Mohr-Coulomb	0	34
SSL-Sand		105	110	Mohr-Coulomb	0	9
Coastal Plain		120	125	Mohr-Coulomb	2500	0
Loose Sand		110	115	Mohr-Coulomb	0	28
SSL-Clay		105	110	Mohr-Coulomb	150	0

Method Name	Min FS
Bishop simplified	1.00
Spencer	1.08
GLE / Morgenstern-Price	1.05

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Pile Shear Strength (lbs)
SKZ 20 Sheet Pile		Micro Pile	Passive (Method B)	10	84300

F&ME CONSULTANTS

SLIDEINTERPRET 7.009

Project	S-51 Emergency Bridge Replacement over Black Mingo Creek
Analysis Description	End Bridge_RT Side Slope_SEE Newmark_Pin Pile
Drawn By	JFH
Scale	1:185
Company	F&ME, Inc.
Date	02/03/2016, 1:45 PM
File Name	End Bridge_RT Side Slope_SEE Newmark_Pin Pile.slim

APPENDIX

SECTION 11

EMBANKMENT SLOPE STABILITY ANALYSES

SUBSECTION B
NEWMARK DEFORMATION CALCULATIONS

F&ME CONSULTANTS

Project: S-51 over Black Mingo Creek - F**EE Newmark Displacement Calculations**
Calc. By: JFH
Date: 2/2/2016
Method: *SCDOT Geotechnical Design Manual (2010)* - Section 13.17.2

$$\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{\max}}\right) + 3.62\log\left[1-\left(\frac{k_y}{k_{\max}}\right)\right] - 0.85\log(k_{\max}) + 1.61\log(V_{peak})$$

End Bridge, End Slope

d = Displacement (in)
k_y = Yield Acceleration (%g) = 0.09
k_{max} = Peak Ground Acceleration (%g) = 0.14
V_{peak} = Peak Ground Velocity (in/sec) = 55 S_{D1} = 7.70

d = **0.15** inches => *GI-01 through GI-04 performance limits are 2.00" or greater*

F&ME CONSULTANTS

Project: S-51 over Black Mingo Creek - **SEE Newmark Displacement Calculations**
Calc. By: JFH
Date: 1/5/2016
Method: *SCDOT Geotechnical Design Manual (2010)* - Section 13.17.2

$$\log(d) = -1.49 - 0.75\log\left(\frac{k_y}{k_{\max}}\right) + 3.62\log\left[1 - \left(\frac{k_y}{k_{\max}}\right)\right] - 0.85\log(k_{\max}) + 1.61\log(V_{peak})$$

Begin Bridge, LT Side Slope, SKZ 20 Sheet Pile

d = Displacement (in)
k_y = Yield Acceleration (%g) = 0.175
k_{max} = Peak Ground Acceleration (%g) = 0.42
V_{peak} = Peak Ground Velocity (in/sec) = 55 S_{D1} = 27.50

d = **3.85** inches => *GI-01 through GI-04 performance limits are 4.00" or greater*

Begin Bridge, RT Side Slope, SKZ 20 Sheet Pile

d = Displacement (in)
k_y = Yield Acceleration (%g) = 0.173
k_{max} = Peak Ground Acceleration (%g) = 0.42
V_{peak} = Peak Ground Velocity (in/sec) = 55 S_{D1} = 27.50

d = **4.00** inches => *GI-01 through GI-04 performance limits are 4.00" or greater*

Begin Bridge, End Slope, SKZ 20 Sheet Pile

d = Displacement (in)
k_y = Yield Acceleration (%g) = 0.19
k_{max} = Peak Ground Acceleration (%g) = 0.42
V_{peak} = Peak Ground Velocity (in/sec) = 55 S_{D1} = 27.50

d = **2.88** inches => *GI-01 through GI-04 performance limits are 4.00" or greater*

End Bridge, End Slope, SKZ 20 Sheet Pile

d = Displacement (in)
k_y = Yield Acceleration (%g) = 0.24
k_{max} = Peak Ground Acceleration (%g) = 0.42
V_{peak} = Peak Ground Velocity (in/sec) = 55 S_{D1} = 27.50

d = **0.99** inches => *GI-01 through GI-04 performance limits are 4.00" or greater*

End Bridge, RT Side Slope, SKZ 20 Sheet Pile

d = Displacement (in)
k_y = Yield Acceleration (%g) = 0.22
k_{max} = Peak Ground Acceleration (%g) = 0.42
V_{peak} = Peak Ground Velocity (in/sec) = 55 S_{D1} = 27.50

d = **1.56** inches => *GI-01 through GI-04 performance limits are 4.00" or greater*

APPENDIX

SECTION 11

EMBANKMENT SLOPE STABILITY ANALYSES

SUBSECTION C
PIN PILE CALCULATIONS

==

LPile Plus for Windows, Version 2013-07.007

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This copy of LPile is used by:

Bradley Fischer
F&ME

Serial Number of Security Device: 291490957
This copy of LPile is licensed for exclusive use by: F&ME Consultants, Columbia, Sout

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Files Used for Analysis

Path to file locations: P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\SLIDE\Sheet Pile\
Name of input data file: SKZ 20_Begin Bridge_LT Side Slope_SEE.lp7d
Name of output report file: SKZ 20_Begin Bridge_LT Side Slope_SEE.lp7o
Name of plot output file: SKZ 20_Begin Bridge_LT Side Slope_SEE.lp7p
Name of runtime messeage file: SKZ 20_Begin Bridge_LT Side Slope_SEE.lp7r

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Date and Time of Analysis

Date: February 16, 2016   Time: 14:58:52

Problem Title

Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: SCDOT

Engineer: JFH

Description: Begin Bridge - Left Side Slope - SKZ 20 Sheet Pile

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Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Analysis includes loading by lateral soil movements acting on pile
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 30.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	57.0000000
2	30.000000	57.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Rectangular
Section Length	=	30.00000 ft
Top Width	=	57.00000 in
Bottom Width	=	57.00000 in
Top Section Depth	=	16.00000 in
Bottom Section Depth	=	16.00000 in
Top Area	=	28.50000 Sq. in
Bottom Area	=	28.50000 Sq. in
Moment of Inertia at Top	=	1204.00000 in^4
Moment of Inertia at Bottom	=	1204.00000 in^4
Elastic Modulus	=	29000000. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 8 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	6.50000 ft
Effective unit weight at top of layer	=	120.00000 pcf
Effective unit weight at bottom of layer	=	120.00000 pcf
Friction angle at top of layer	=	34.00000 deg.
Friction angle at bottom of layer	=	34.00000 deg.
Subgrade k at top of layer	=	90.00000 pci
Subgrade k at bottom of layer	=	90.00000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	6.50000 ft
Distance from top of pile to bottom of layer	=	7.50000 ft
Effective unit weight at top of layer	=	110.00000 pcf
Effective unit weight at bottom of layer	=	110.00000 pcf
Friction angle at top of layer	=	28.00000 deg.
Friction angle at bottom of layer	=	28.00000 deg.
Subgrade k at top of layer	=	25.00000 pci
Subgrade k at bottom of layer	=	25.00000 pci

Layer 3 is soft clay, p-y criteria by Matlock, 1970

```
   Distance from top of pile to top of layer           =      7.50000 ft
   Distance from top of pile to bottom of layer        =     11.25000 ft
   Effective unit weight at top of layer               =     53.00000 pcf
   Effective unit weight at bottom of layer            =     53.00000 pcf
   Undrained cohesion at top of layer                  =    300.00000 psf
   Undrained cohesion at bottom of layer               =    300.00000 psf
   Epsilon-50 at top of layer                          =      0.02000
   Epsilon-50 at bottom of layer                       =      0.02000


Layer 4 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =     11.25000 ft
   Distance from top of pile to bottom of layer        =     12.00000 ft
   Effective unit weight at top of layer               =     53.00000 pcf
   Effective unit weight at bottom of layer            =     53.00000 pcf
   Friction angle at top of layer                      =     28.00000 deg.
   Friction angle at bottom of layer                   =     28.00000 deg.
   Subgrade k at top of layer                          =     20.00000 pci
   Subgrade k at bottom of layer                       =     20.00000 pci


Layer 5 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =     12.00000 ft
   Distance from top of pile to bottom of layer        =     13.25000 ft
   Effective unit weight at top of layer               =     48.00000 pcf
   Effective unit weight at bottom of layer            =     48.00000 pcf
   Friction angle at top of layer                      =      4.00000 deg.
   Friction angle at bottom of layer                   =      4.00000 deg.
   Subgrade k at top of layer                          =     20.00000 pci
   Subgrade k at bottom of layer                       =     20.00000 pci


Layer 6 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =     13.25000 ft
   Distance from top of pile to bottom of layer        =     15.00000 ft
   Effective unit weight at top of layer               =     53.00000 pcf
   Effective unit weight at bottom of layer            =     53.00000 pcf
   Friction angle at top of layer                      =     28.00000 deg.
   Friction angle at bottom of layer                   =     28.00000 deg.
   Subgrade k at top of layer                          =     20.00000 pci
   Subgrade k at bottom of layer                       =     20.00000 pci


Layer 7 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =     15.00000 ft
   Distance from top of pile to bottom of layer        =     17.50000 ft
   Effective unit weight at top of layer               =     48.00000 pcf
   Effective unit weight at bottom of layer            =     48.00000 pcf
   Friction angle at top of layer                      =      4.00000 deg.
   Friction angle at bottom of layer                   =      4.00000 deg.
   Subgrade k at top of layer                          =     20.00000 pci
   Subgrade k at bottom of layer                       =     20.00000 pci


Layer 8 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =     17.50000 ft
   Distance from top of pile to bottom of layer        =     50.00000 ft
   Effective unit weight at top of layer               =     58.00000 pcf
```

Effective unit weight at bottom of layer = 58.00000 pcf
Friction angle at top of layer = 40.00000 deg.
Friction angle at bottom of layer = 40.00000 deg.
Subgrade k at top of layer = 125.00000 pci
Subgrade k at bottom of layer = 125.00000 pci

(Depth of lowest soil layer extends 20.00 ft below pile tip)

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	0.00	120.000	--	34.000	--	90.000
		6.500	120.000	--	34.000	--	90.000
2	Sand (Reese, et al.)	6.500	110.000	--	28.000	--	25.000
		7.500	110.000	--	28.000	--	25.000
3	Soft Clay	7.500	53.000	300.000	--	0.02000	--
		11.250	53.000	300.000	--	0.02000	--
4	Sand (Reese, et al.)	11.250	53.000	--	28.000	--	20.000
		12.000	53.000	--	28.000	--	20.000
5	Sand (Reese, et al.)	12.000	48.000	--	4.000	--	20.000
		13.250	48.000	--	4.000	--	20.000
6	Sand (Reese, et al.)	13.250	53.000	--	28.000	--	20.000
		15.000	53.000	--	28.000	--	20.000
7	Sand (Reese, et al.)	15.000	48.000	--	4.000	--	20.000
		17.500	48.000	--	4.000	--	20.000
8	Sand (Reese, et al.)	17.500	58.000	--	40.000	--	125.000
		50.000	58.000	--	40.000	--	125.000

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6700	1.0000
2	100.000	0.6700	1.0000

Lateral Soil Movements

Profile of soil movement with depth defined using 3 points

Point No.	Depth X ft	Soil Movement in
1	0.00000	3.85000
2	15.75000	3.85000
3	16.50000	0.00000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lb
Moment = 0. in- lb
Axial Load = 0. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
30.0000	4.8761319	5938891.	89730.
28.5000	4.8756449	5342605.	87473.
27.0000	4.8766942	4435045.	-83700.
25.5000	4.8730385	3195940.	74222.
24.0000	4.9087900	1999731.	65437.
22.5000	4.9546523	-2369753.	60933.
21.0000	5.0173158	-2639325.	55053.
19.5000	5.0868035	-2785552.	54435.
18.0000	4.1245778	-1126023.	26740.
16.5000	3.8603833	-61262.	1498.5373330
15.0000	3.8500000	-0.0003924	-0.0000585
13.5000	3.8500000	-0.0011698	-0.0000766
12.0000	3.8500000	-0.0028415	-0.0000987
10.5000	3.8500000	0.0018459	0.0001240
9.0000	3.8500000	0.0025657	0.0004924
7.5000	3.8500000	-0.0022780	0.0008614
6.0000	3.8500000	-0.0093621	-0.0045905
4.5000	3.8499998	-0.0738069	-0.0255535
3.0000	3.8499932	-1.0400631	0.2309790
1.5000	3.8464858	-51.4965227	-220.7796246

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Pile-head Pile-head Maximum
Maximum
Load Load Condition 1 Condition 2 Axial Pile-head Moment
Shear Pile-head

```
Case  Type    V(lbs) or     in-lb, rad.,       Loading      Deflection       in Pile
       in Pile       Rotation
 No.   No.    y(inches)     or in-lb/rad.        lbs          inches         in-lbs
         lbs           radians
----  ----  --------------  --------------  -------------  -------------
-------------  -------------  -------------
  1     1   V =      0.000  M =      0.000      0.0000000     4.87613190
5938891.         89730.    -0.01846245
```

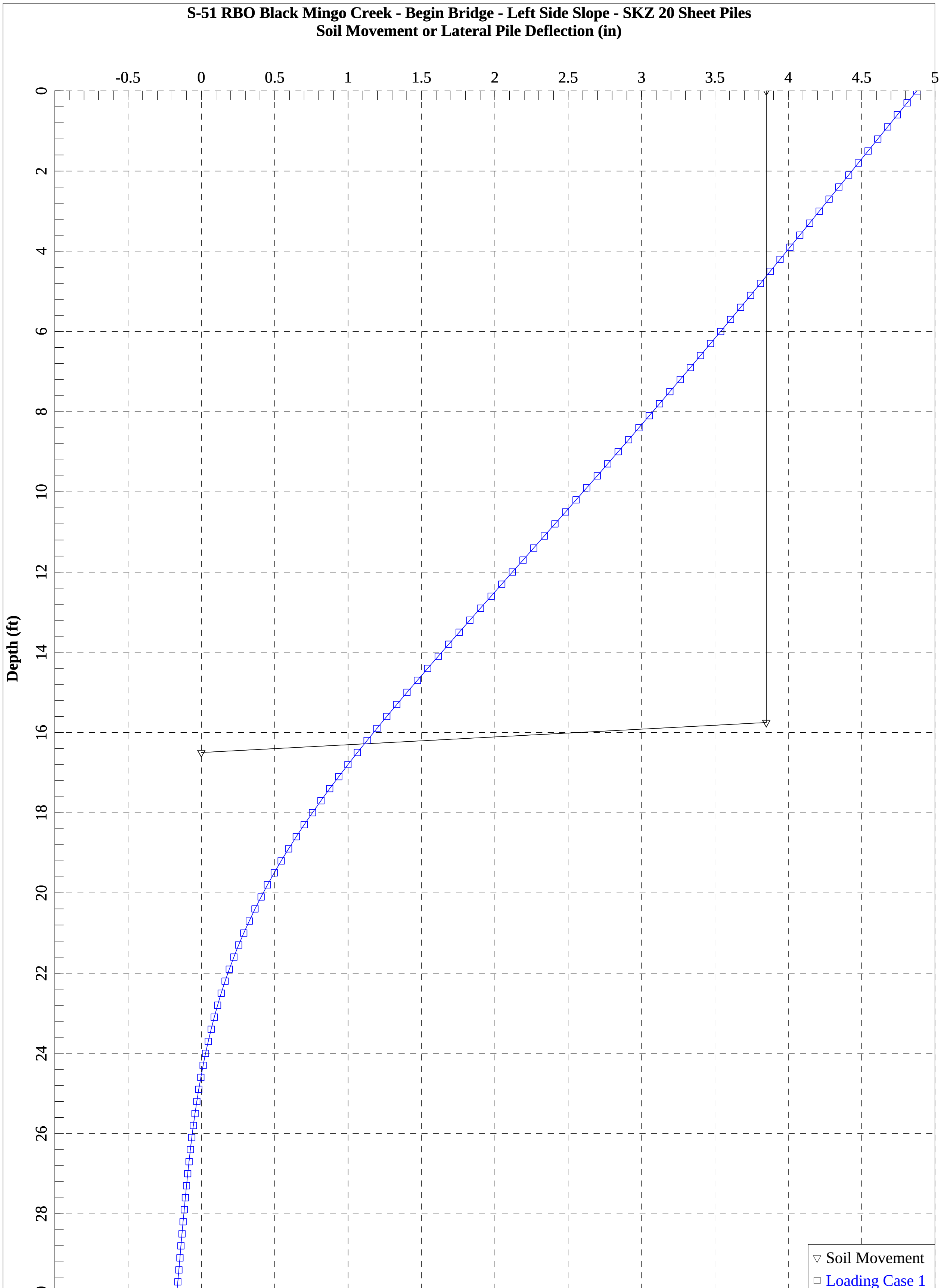
Summary of Warning Messages

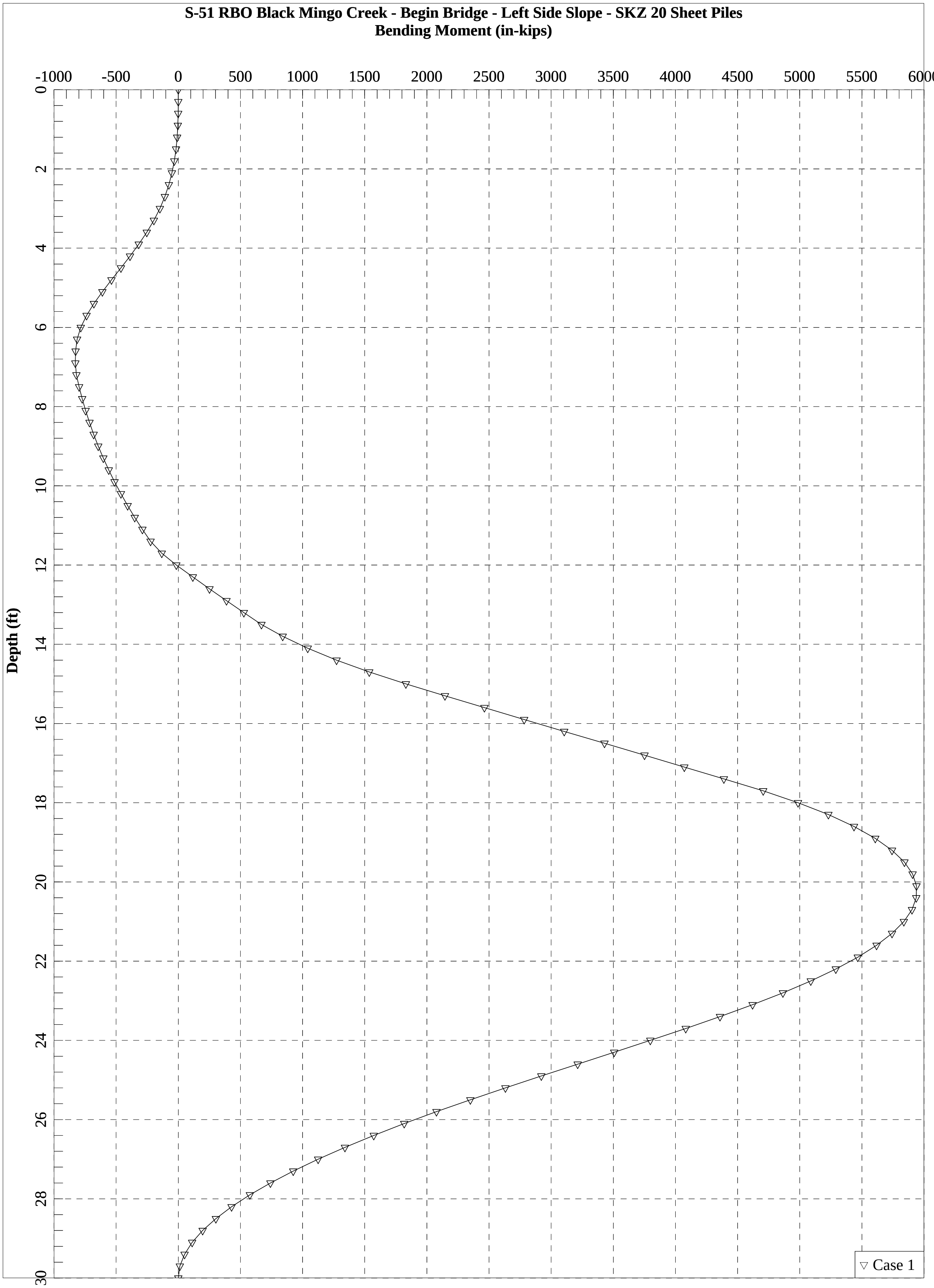
The following warning was reported 1294 times

**** Warning ****

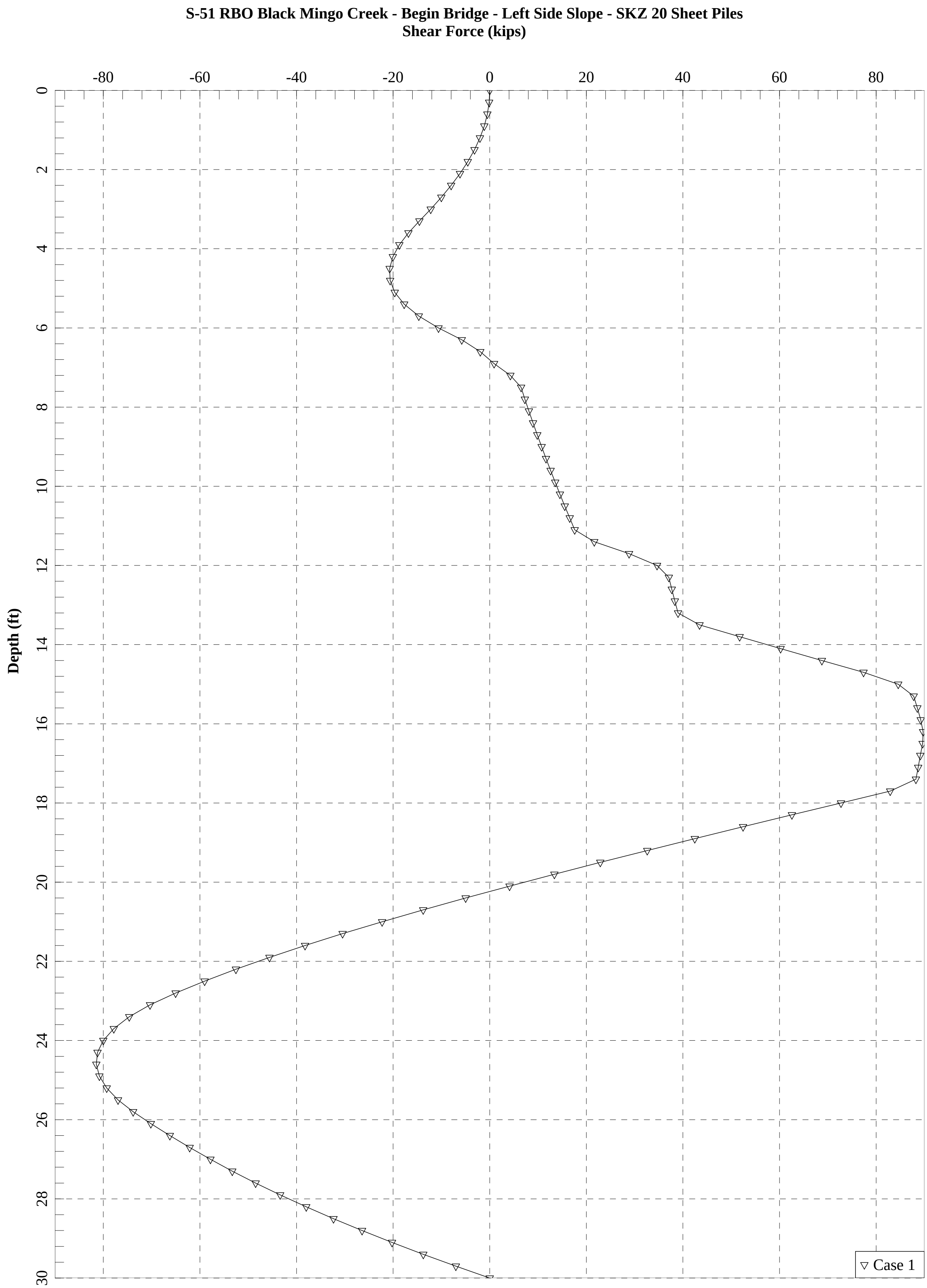
An unreasonable value was input for friction angle has been specified for a soil layer defined uisng the sand criteria. The input value is either smaller than 20 degrees or higher than 48 degrees. The input data should be checked for correctness.

The analysis ended normally.


S-51 RBO Black Mingo Creek - Begin Bridge - Left Side Slope - SKZ 20 Sheet Piles
Soil Movement or Lateral Pile Deflection (in)
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Soil Movement
Loading Case 1



S-51 RBO Black Mingo Creek - Begin Bridge - Left Side Slope - SKZ 20 Sheet Piles
Bending Moment (in-kips)
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1


S-51 RBO Black Mingo Creek - Begin Bridge - Left Side Slope - SKZ 20 Sheet Piles
Shear Force (kips)
-80
-60
-40
-20
0
20
40
60
80
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1

==

LPile Plus for Windows, Version 2013-07.007

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

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F&ME

Serial Number of Security Device: 291490957
This copy of LPile is licensed for exclusive use by: F&ME Consultants, Columbia, Sout

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Files Used for Analysis

Path to file locations: P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\SLIDE\Sheet Pile\
Name of input data file: SKZ 20_Begin Bridge_RT Side Slope_SEE.lp7d
Name of output report file: SKZ 20_Begin Bridge_RT Side Slope_SEE.lp7o
Name of plot output file: SKZ 20_Begin Bridge_RT Side Slope_SEE.lp7p
Name of runtime messeage file: SKZ 20_Begin Bridge_RT Side Slope_SEE.lp7r

----

Date and Time of Analysis

Date: February 16, 2016 Time: 15:22:31

Problem Title

Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: SCDOT

Engineer: JFH

Description: Begin Bridge - Right Side Slope - SKZ 20 Sheet Pile

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Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Analysis includes loading by lateral soil movements acting on pile
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 30.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	57.0000000
2	30.000000	57.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Rectangular
Section Length	=	30.00000 ft
Top Width	=	57.00000 in
Bottom Width	=	57.00000 in
Top Section Depth	=	16.00000 in
Bottom Section Depth	=	16.00000 in
Top Area	=	28.50000 Sq. in
Bottom Area	=	28.50000 Sq. in
Moment of Inertia at Top	=	1204.00000 in^4
Moment of Inertia at Bottom	=	1204.00000 in^4
Elastic Modulus	=	29000000. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 8 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	5.00000 ft
Effective unit weight at top of layer	=	120.00000 pcf
Effective unit weight at bottom of layer	=	120.00000 pcf
Friction angle at top of layer	=	34.00000 deg.
Friction angle at bottom of layer	=	34.00000 deg.
Subgrade k at top of layer	=	90.00000 pci
Subgrade k at bottom of layer	=	90.00000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	5.00000 ft
Distance from top of pile to bottom of layer	=	6.50000 ft
Effective unit weight at top of layer	=	110.00000 pcf
Effective unit weight at bottom of layer	=	110.00000 pcf
Friction angle at top of layer	=	28.00000 deg.
Friction angle at bottom of layer	=	28.00000 deg.
Subgrade k at top of layer	=	25.00000 pci
Subgrade k at bottom of layer	=	25.00000 pci

Layer 3 is soft clay, p-y criteria by Matlock, 1970

```
   Distance from top of pile to top of layer          =      6.50000 ft
   Distance from top of pile to bottom of layer       =     10.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Undrained cohesion at top of layer                 =    300.00000 psf
   Undrained cohesion at bottom of layer              =    300.00000 psf
   Epsilon-50 at top of layer                         =      0.02000
   Epsilon-50 at bottom of layer                      =      0.02000


Layer 4 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     10.00000 ft
   Distance from top of pile to bottom of layer       =     10.75000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     28.00000 deg.
   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 5 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     10.75000 ft
   Distance from top of pile to bottom of layer       =     12.00000 ft
   Effective unit weight at top of layer              =     48.00000 pcf
   Effective unit weight at bottom of layer           =     48.00000 pcf
   Friction angle at top of layer                     =      4.00000 deg.
   Friction angle at bottom of layer                  =      4.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 6 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     12.00000 ft
   Distance from top of pile to bottom of layer       =     13.50000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     28.00000 deg.
   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 7 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     13.50000 ft
   Distance from top of pile to bottom of layer       =     16.50000 ft
   Effective unit weight at top of layer              =     48.00000 pcf
   Effective unit weight at bottom of layer           =     48.00000 pcf
   Friction angle at top of layer                     =      4.00000 deg.
   Friction angle at bottom of layer                  =      4.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 8 is stiff clay without free water

   Distance from top of pile to top of layer          =     16.50000 ft
   Distance from top of pile to bottom of layer       =     50.00000 ft
   Effective unit weight at top of layer              =     63.00000 pcf
```

Effective unit weight at bottom of layer = 63.00000 pcf
Undrained cohesion at top of layer = 2500.00000 psf
Undrained cohesion at bottom of layer = 2500.00000 psf
Epsilon-50 at top of layer = 0.00400
Epsilon-50 at bottom of layer = 0.00400

(Depth of lowest soil layer extends 20.00 ft below pile tip)

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	0.00	120.000	--	34.000	--	90.000
		5.000	120.000	--	34.000	--	90.000
2	Sand (Reese, et al.)	5.000	110.000	--	28.000	--	25.000
		6.500	110.000	--	28.000	--	25.000
3	Soft Clay	6.500	53.000	300.000	--	0.02000	--
		10.000	53.000	300.000	--	0.02000	--
4	Sand (Reese, et al.)	10.000	53.000	--	28.000	--	20.000
		10.750	53.000	--	28.000	--	20.000
5	Sand (Reese, et al.)	10.750	48.000	--	4.000	--	20.000
		12.000	48.000	--	4.000	--	20.000
6	Sand (Reese, et al.)	12.000	53.000	--	28.000	--	20.000
		13.500	53.000	--	28.000	--	20.000
7	Sand (Reese, et al.)	13.500	48.000	--	4.000	--	20.000
		16.500	48.000	--	4.000	--	20.000
8	Stiff Clay w/o Free Water	16.500	63.000	2500.000	--	0.00400	--
		50.000	63.000	2500.000	--	0.00400	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6700	1.0000
2	100.000	0.6700	1.0000

Lateral Soil Movements

Profile of soil movement with depth defined using 3 points

Point No.	Depth X ft	Soil Movement in
1	0.00000	4.00000
2	14.00000	4.00000
3	14.75000	0.00000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lb
Moment = 0. in- lb
Axial Load = 0. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
30.0000	4.8961133	4673013.	73883.
28.5000	4.8929894	3788895.	68355.
27.0000	4.9247579	2758098.	63714.
25.5000	4.9614579	2022868.	55441.
24.0000	5.0550561	-2113356.	55833.
22.5000	5.1071167	-2226553.	48611.
21.0000	5.2216492	-2603804.	48699.
19.5000	5.3003521	-2834628.	49465.
18.0000	4.7697457	-1937861.	38070.
16.5000	4.0569569	-193363.	5430.4120096
15.0000	4.0161829	-61642.	1908.9735433
13.5000	4.0000000	-0.0019734	0.0000638
12.0000	4.0000000	-0.0024677	0.0000987
10.5000	4.0000000	-0.0026761	0.0001628
9.0000	4.0000000	-0.0071387	0.0003447
7.5000	4.0000000	-0.0047283	0.0002659
6.0000	4.0000000	0.0140581	0.0027003
4.5000	3.9999998	-0.0766251	0.0031019
3.0000	3.9999930	-0.9082157	-0.0486884
1.5000	3.9963489	-139.4269166	238.6889389

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Pile-head Pile-head Maximum
Maximum
Load Load Condition 1 Condition 2 Axial Pile-head Moment
Shear Pile-head

```
Case  Type    V(lbs) or     in-lb, rad.,       Loading      Deflection       in Pile
       in Pile       Rotation
 No.   No.    y(inches)     or in-lb/rad.        lbs          inches         in-lbs
         lbs           radians
----  ----  --------------  --------------  -------------  -------------
-------------  -------------  -------------
  1     1   V =      0.000  M =      0.000      0.0000000     4.89611329
4673013.         73883.    -0.01794198
```

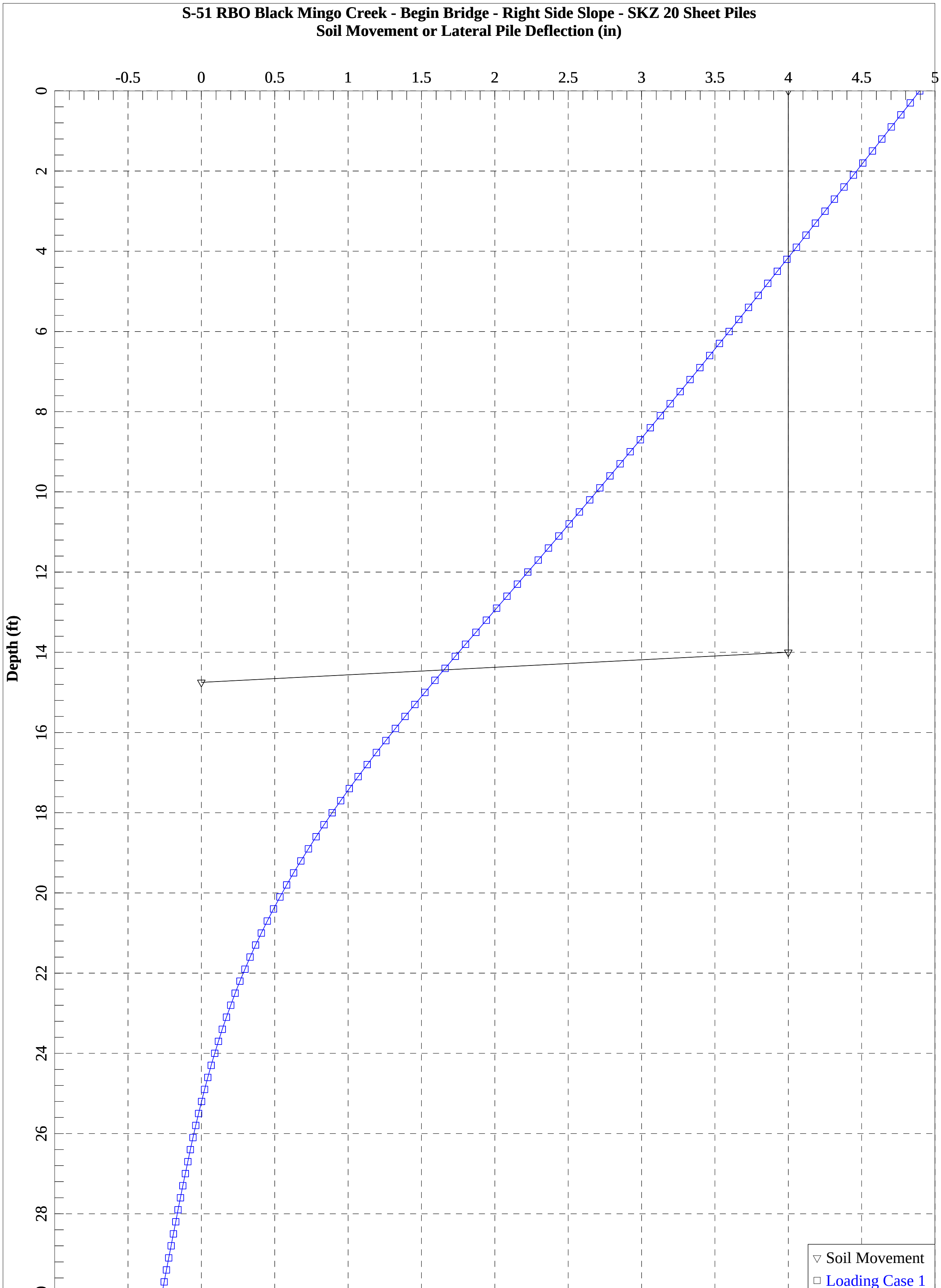
Summary of Warning Messages

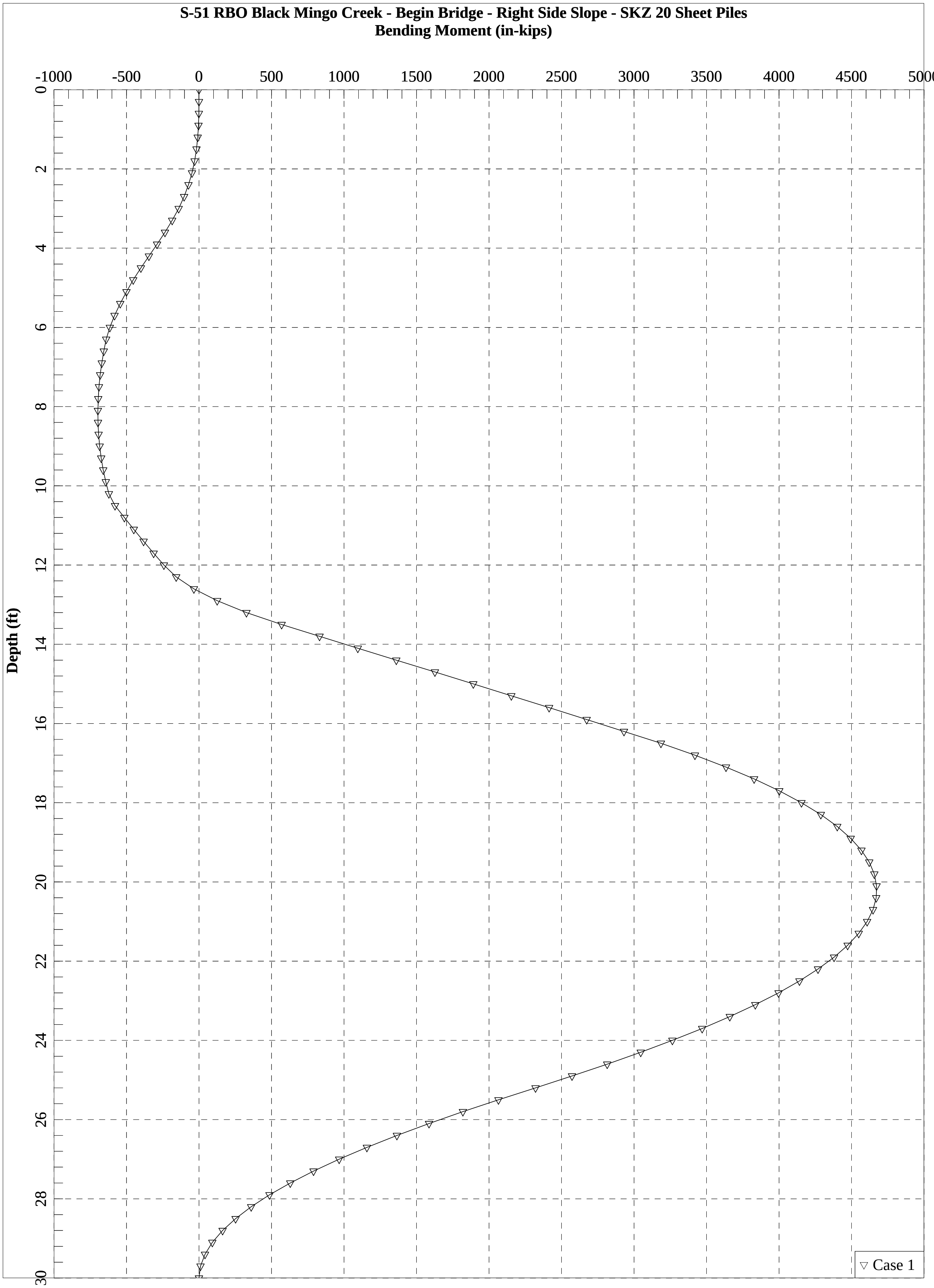
The following warning was reported 2295 times

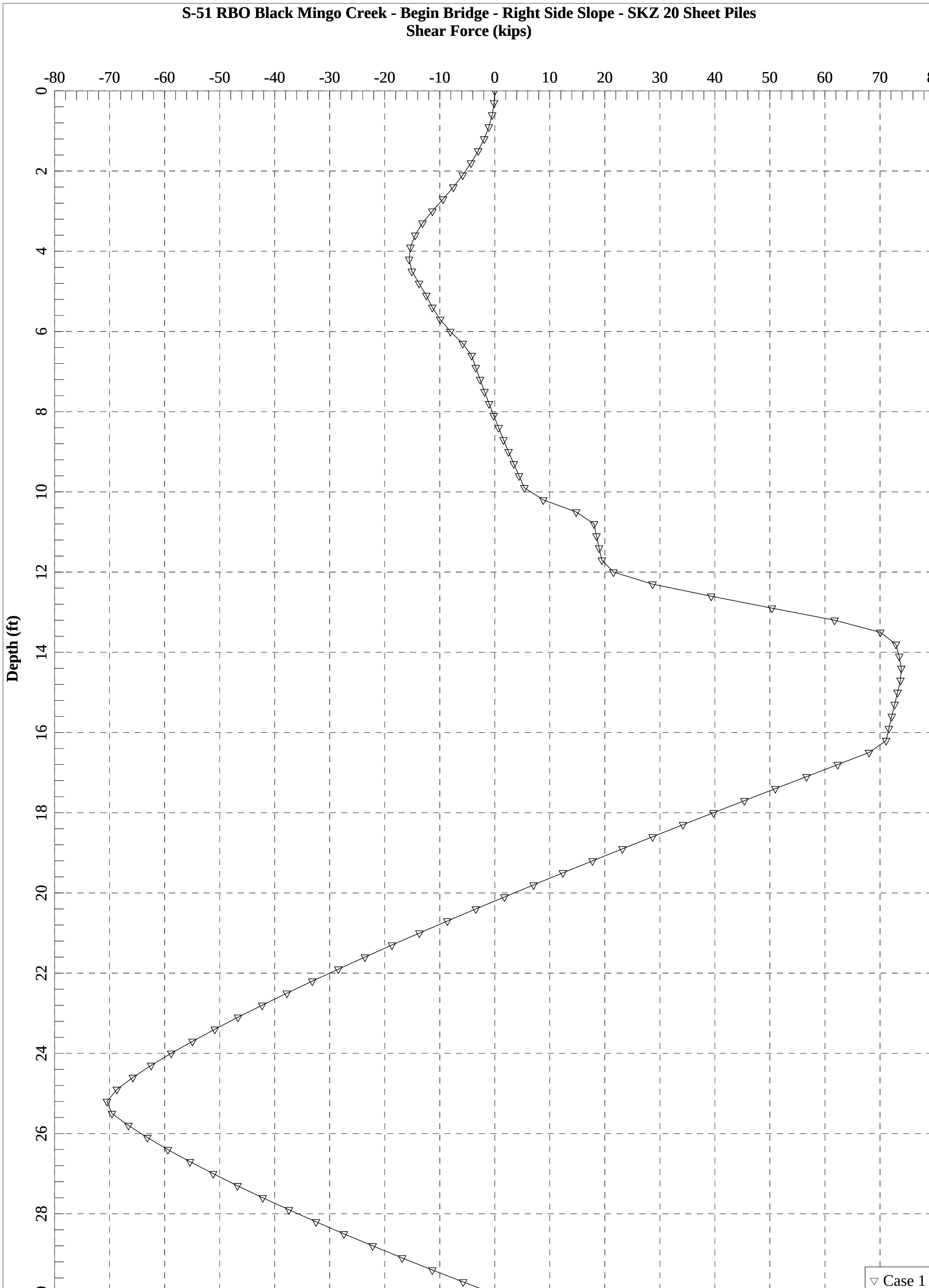
**** Warning ****

An unreasonable value was input for friction angle has been specified for a soil layer defined uisng the sand criteria. The input value is either smaller than 20 degrees or higher than 48 degrees. The input data should be checked for correctness.

The analysis ended normally.


S-51 RBO Black Mingo Creek - Begin Bridge - Right Side Slope - SKZ 20 Sheet Piles
Soil Movement or Lateral Pile Deflection (in)
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Soil Movement
Loading Case 1


S-51 RBO Black Mingo Creek - Begin Bridge - Right Side Slope - SKZ 20 Sheet Piles
Bending Moment (in-kips)
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1



S-51 RBO Black Mingo Creek - Begin Bridge - Right Side Slope - SKZ 20 Sheet Piles
Shear Force (kips)
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1

==

LPile Plus for Windows, Version 2013-07.007

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Bradley Fischer
F&ME

Serial Number of Security Device: 291490957
This copy of LPile is licensed for exclusive use by: F&ME Consultants, Columbia, Sout

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Files Used for Analysis

Path to file locations: P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\SLIDE\Sheet Pile\
Name of input data file: SKZ 20_Begin Bridge_End Slope_SEE.lp7d
Name of output report file: SKZ 20_Begin Bridge_End Slope_SEE.lp7o
Name of plot output file: SKZ 20_Begin Bridge_End Slope_SEE.lp7p
Name of runtime messeage file: SKZ 20_Begin Bridge_End Slope_SEE.lp7r

----

Date and Time of Analysis

Date: February 16, 2016 Time: 15:25:26

Problem Title

Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: SCDOT

Engineer: JFH

Description: Begin Bridge - End Slope - SKZ 20 Sheet Pile

Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Analysis includes loading by lateral soil movements acting on pile
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 30.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	57.0000000
2	30.000000	57.0000000

```
Input Structural Properties:
----------------------------

Pile Section No. 1:

   Section Type                                       =    Elastic Pile
   Cross-sectional Shape                              =     Rectangular
   Section Length                                     =     30.00000 ft
   Top Width                                          =     57.00000 in
   Bottom Width                                       =     57.00000 in
   Top Section Depth                                  =     16.00000 in
   Bottom Section Depth                               =     16.00000 in
   Top Area                                           =     28.50000 Sq. in
   Bottom Area                                        =     28.50000 Sq. in
   Moment of Inertia at Top                           =   1204.00000 in^4
   Moment of Inertia at Bottom                        =   1204.00000 in^4
   Elastic Modulus                                    =    29000000. lbs/in^2


--------------------------------------------------------------------------------
                      Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------

Ground Slope Angle                                    =        0.000 degrees
                                                      =        0.000 radians

Pile Batter Angle                                     =        0.000 degrees
                                                      =        0.000 radians


--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 8 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =       0.0000 ft
   Distance from top of pile to bottom of layer       =      5.00000 ft
   Effective unit weight at top of layer              =    125.00000 pcf
   Effective unit weight at bottom of layer           =    125.00000 pcf
   Friction angle at top of layer                     =     34.00000 deg.
   Friction angle at bottom of layer                  =     34.00000 deg.
   Subgrade k at top of layer                         =     90.00000 pci
   Subgrade k at bottom of layer                      =     90.00000 pci


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =      5.00000 ft
   Distance from top of pile to bottom of layer       =      7.00000 ft
   Effective unit weight at top of layer              =    115.00000 pcf
   Effective unit weight at bottom of layer           =    115.00000 pcf
   Friction angle at top of layer                     =     28.00000 deg.
   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 3 is soft clay, p-y criteria by Matlock, 1970
```

```
   Distance from top of pile to top of layer          =      7.00000 ft
   Distance from top of pile to bottom of layer       =     12.50000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Undrained cohesion at top of layer                 =    300.00000 psf
   Undrained cohesion at bottom of layer              =    300.00000 psf
   Epsilon-50 at top of layer                         =      0.02000
   Epsilon-50 at bottom of layer                      =      0.02000


Layer 4 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     12.50000 ft
   Distance from top of pile to bottom of layer       =     13.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     28.00000 deg.
   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 5 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     13.00000 ft
   Distance from top of pile to bottom of layer       =     14.00000 ft
   Effective unit weight at top of layer              =     48.00000 pcf
   Effective unit weight at bottom of layer           =     48.00000 pcf
   Friction angle at top of layer                     =      4.00000 deg.
   Friction angle at bottom of layer                  =      4.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 6 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     14.00000 ft
   Distance from top of pile to bottom of layer       =     15.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     28.00000 deg.
   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 7 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     15.00000 ft
   Distance from top of pile to bottom of layer       =     17.50000 ft
   Effective unit weight at top of layer              =     48.00000 pcf
   Effective unit weight at bottom of layer           =     48.00000 pcf
   Friction angle at top of layer                     =      4.00000 deg.
   Friction angle at bottom of layer                  =      4.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 8 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     17.50000 ft
   Distance from top of pile to bottom of layer       =     50.00000 ft
   Effective unit weight at top of layer              =     58.00000 pcf
```

Effective unit weight at bottom of layer = 58.00000 pcf
Friction angle at top of layer = 40.00000 deg.
Friction angle at bottom of layer = 40.00000 deg.
Subgrade k at top of layer = 125.00000 pci
Subgrade k at bottom of layer = 125.00000 pci

(Depth of lowest soil layer extends 20.00 ft below pile tip)

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	0.00	125.000	--	34.000	--	90.000
		5.000	125.000	--	34.000	--	90.000
2	Sand (Reese, et al.)	5.000	115.000	--	28.000	--	20.000
		7.000	115.000	--	28.000	--	20.000
3	Soft Clay	7.000	53.000	300.000	--	0.02000	--
		12.500	53.000	300.000	--	0.02000	--
4	Sand (Reese, et al.)	12.500	53.000	--	28.000	--	20.000
		13.000	53.000	--	28.000	--	20.000
5	Sand (Reese, et al.)	13.000	48.000	--	4.000	--	20.000
		14.000	48.000	--	4.000	--	20.000
6	Sand (Reese, et al.)	14.000	53.000	--	28.000	--	20.000
		15.000	53.000	--	28.000	--	20.000
7	Sand (Reese, et al.)	15.000	48.000	--	4.000	--	20.000
		17.500	48.000	--	4.000	--	20.000
8	Sand (Reese, et al.)	17.500	58.000	--	40.000	--	125.000
		50.000	58.000	--	40.000	--	125.000

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7100	1.0000
2	100.000	0.7100	1.0000

Lateral Soil Movements

Profile of soil movement with depth defined using 3 points

Point No.	Depth X ft	Soil Movement in
1	0.00000	2.90000
2	14.50000	2.90000
3	15.25000	0.00000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lb
Moment = 0. in- lb
Axial Load = 0. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
30.0000	3.5416368	4640995.	63364.
28.5000	3.5373599	4366500.	-64445.
27.0000	3.5337012	3870460.	-67722.
25.5000	3.5363777	3031985.	-63676.
24.0000	3.5587394	2040591.	-53407.
22.5000	3.5983526	1072830.	38629.
21.0000	3.6441124	-1450410.	34953.
19.5000	3.6915031	-1645520.	34012.
18.0000	3.3357116	-1161480.	26781.
16.5000	3.0002900	-293343.	9381.4299900
15.0000	2.9759621	-229388.	7524.2841879
13.5000	2.9000000	-0.0004608	-0.0000638
12.0000	2.9000000	-0.0013460	0.0000623
10.5000	2.9000000	0.0041704	-0.0001667
9.0000	2.9000000	0.0035361	0.0005293
7.5000	2.9000000	0.0025077	-0.0001808
6.0000	2.9000000	0.0064907	-0.0055875
4.5000	2.9000001	0.0215359	-0.0028065
3.0000	2.8999992	-0.2660877	0.2650442
1.5000	2.9002169	-29.3184266	90.1248489

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Pile-head Pile-head Maximum
Maximum
Load Load Condition 1 Condition 2 Axial Pile-head Moment
Shear Pile-head

```
Case  Type    V(lbs) or     in-lb, rad.,       Loading      Deflection       in Pile
       in Pile       Rotation
 No.   No.    y(inches)     or in-lb/rad.        lbs          inches         in-lbs
         lbs          radians
----  ----  --------------  --------------  -------------  -------------
-------------  -------------  -------------
  1     1   V =      0.000  M =      0.000      0.0000000     3.54163681
4640995.         63364.    -0.01443149
```

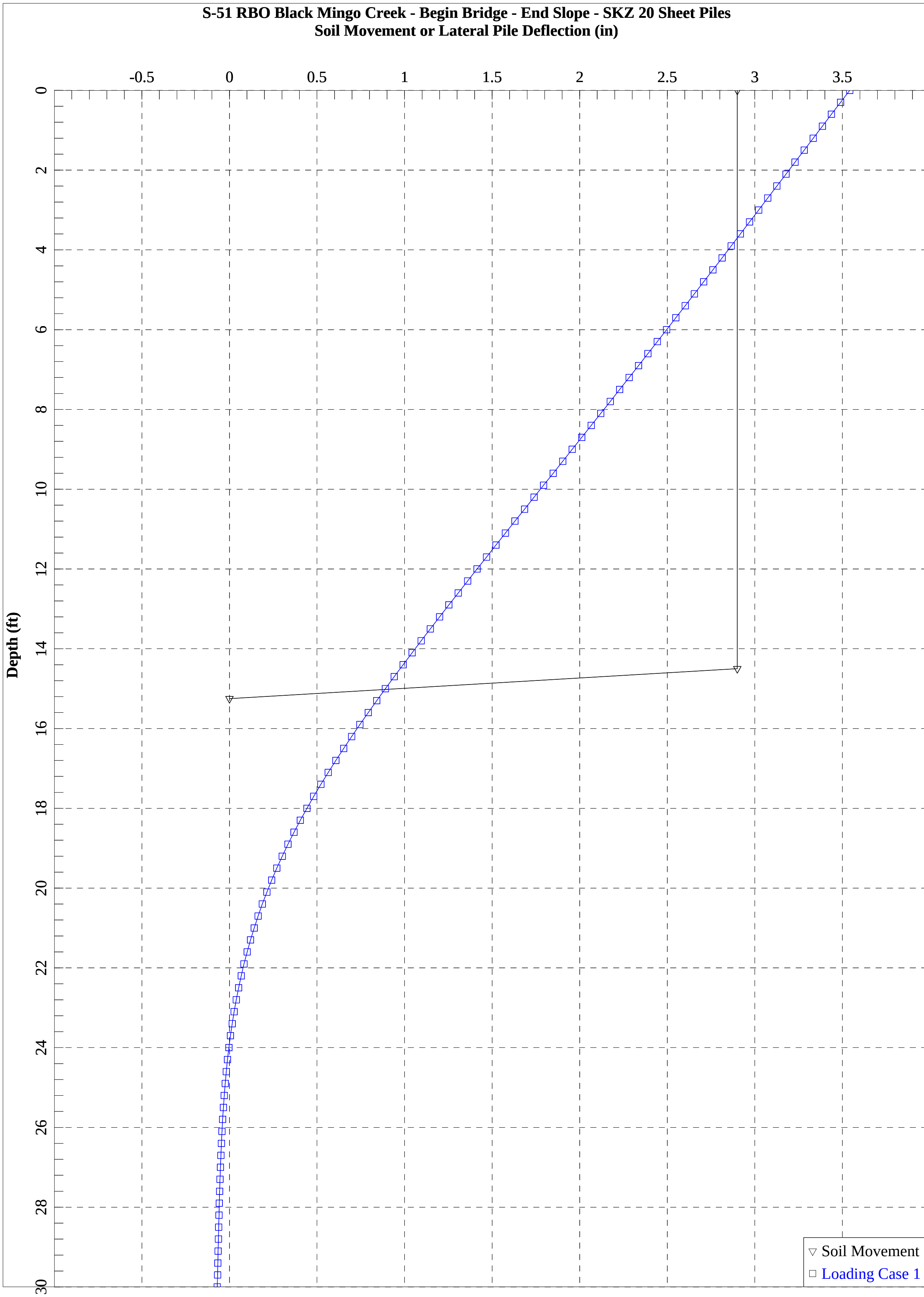
```
--------------------------------------------------------------------------------
                          Summary of Warning Messages
--------------------------------------------------------------------------------
```

The following warning was reported 1101 times

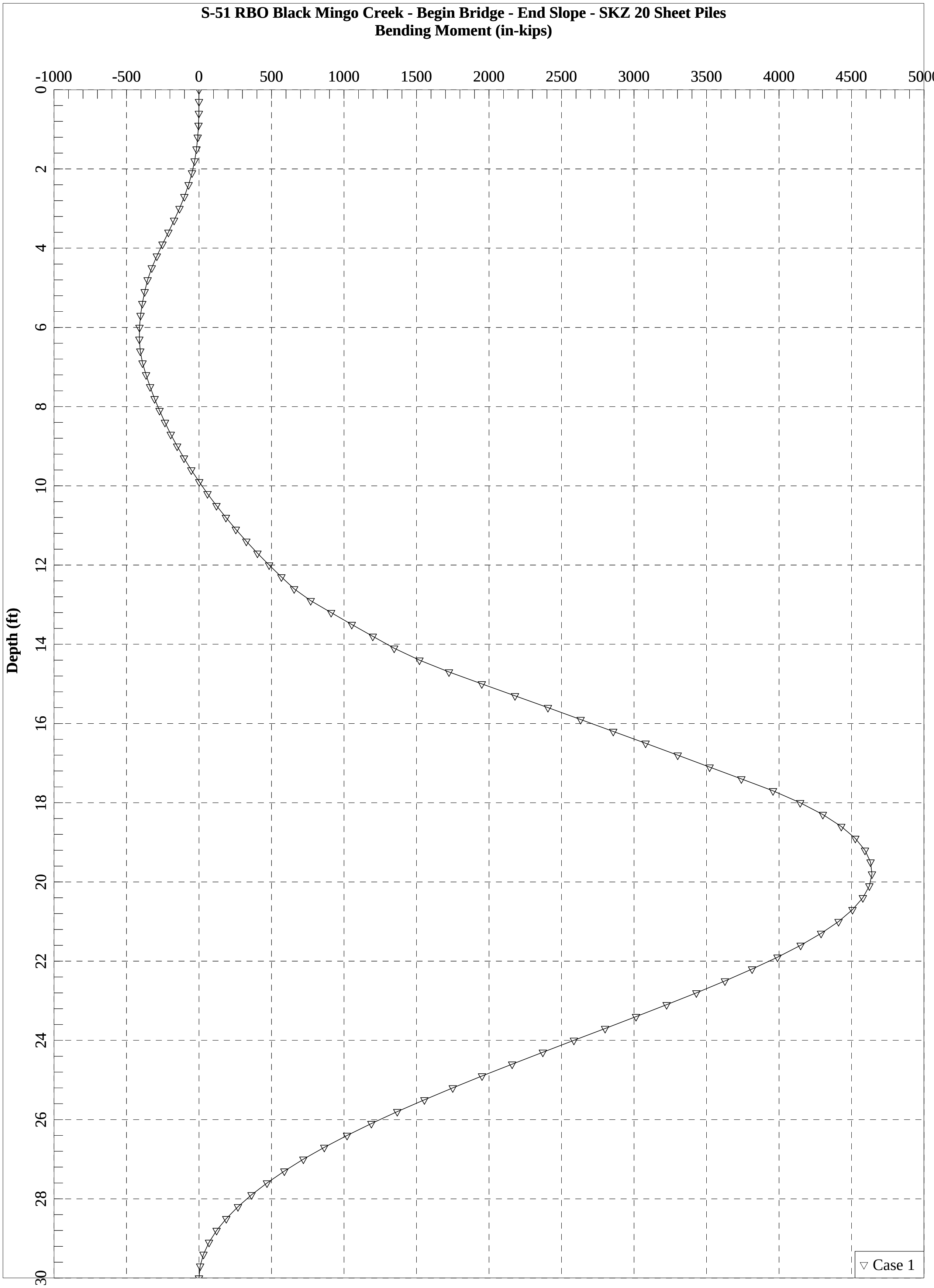
**** Warning ****

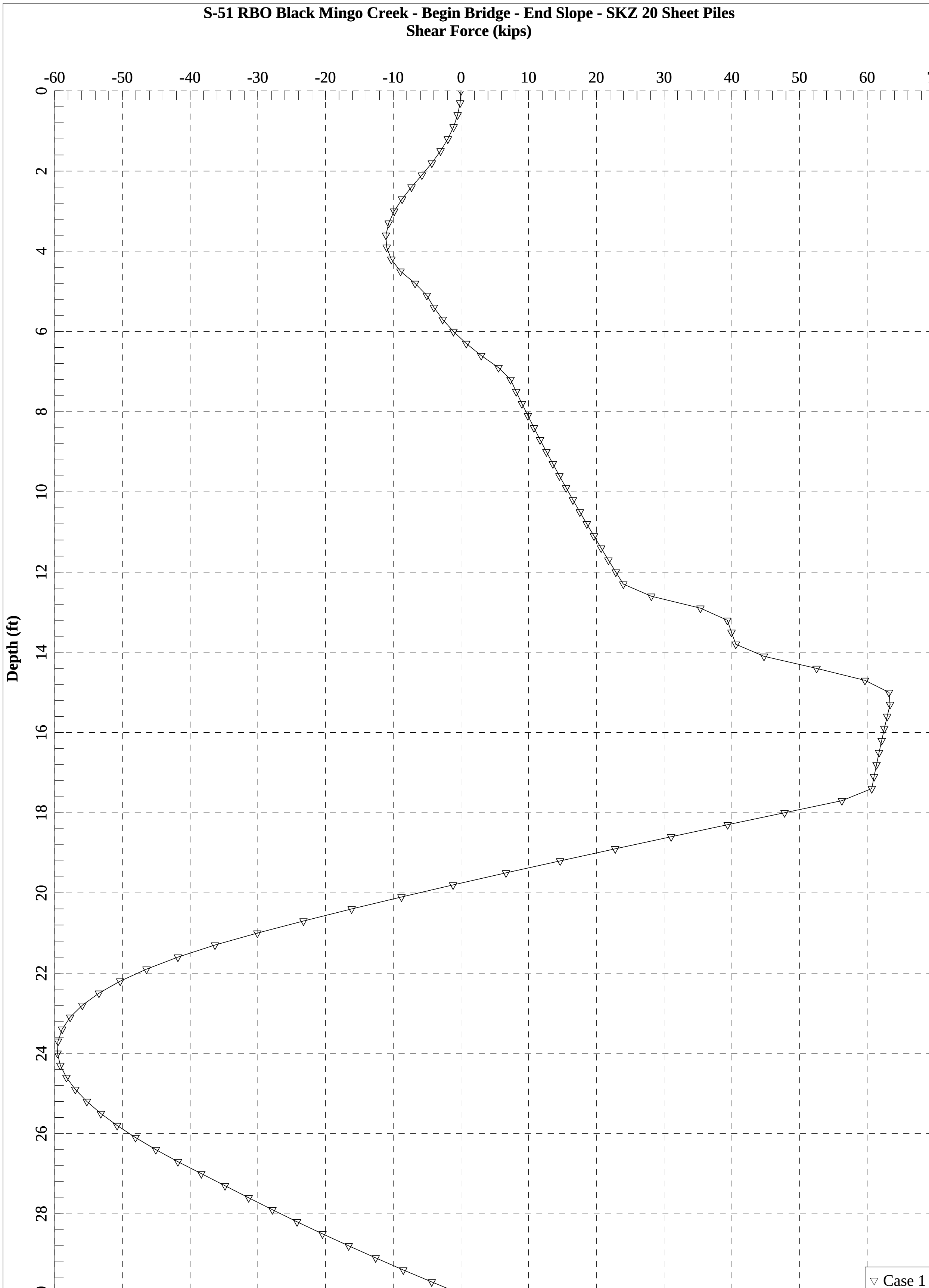
An unreasonable value was input for friction angle has been specified for a soil layer defined uisng the sand criteria. The input value is either smaller than 20 degrees or higher than 48 degrees. The input data should be checked for correctness.

The analysis ended normally.



S-51 RBO Black Mingo Creek - Begin Bridge - End Slope - SKZ 20 Sheet Piles
Soil Movement or Lateral Pile Deflection (in)
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Soil Movement
Loading Case 1


S-51 RBO Black Mingo Creek - Begin Bridge - End Slope - SKZ 20 Sheet Piles
Bending Moment (in-kips)
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1


S-51 RBO Black Mingo Creek - Begin Bridge - End Slope - SKZ 20 Sheet Piles
Shear Force (kips)
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1

==

LPile Plus for Windows, Version 2013-07.007

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

This copy of LPile is used by:

Bradley Fischer
F&ME

Serial Number of Security Device: 291490957
This copy of LPile is licensed for exclusive use by: F&ME Consultants, Columbia, Sout

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Files Used for Analysis

Path to file locations: P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\SLIDE\Sheet Pile\
Name of input data file: SKZ 20_End Bridge_End Slope_SEE.lp7d
Name of output report file: SKZ 20_End Bridge_End Slope_SEE.lp7o
Name of plot output file: SKZ 20_End Bridge_End Slope_SEE.lp7p
Name of runtime messeage file: SKZ 20_End Bridge_End Slope_SEE.lp7r

----

Date and Time of Analysis

Date: February 16, 2016 Time: 15:31:48

Problem Title

Project Name: S-69 RBO Jumping Run Creek

Job Number: G5556.04 (F&ME); P029342 (SCDOT)

Client: ICE

Engineer: JFH

Description: IB2 Composite 18" Square PSC Pile - Longitudinal

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Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed	=	500
- Deflection tolerance for convergence	=	1.0000E-02 in
- Maximum allowable deflection	=	100.0000 in
- Number of pile increments	=	100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Analysis includes loading by lateral soil movements acting on pile
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections	=	1
Total length of pile	=	30.00 ft
Depth of ground surface below top of pile	=	0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	57.0000000
2	30.000000	57.0000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Rectangular
Section Length	=	30.00000 ft
Top Width	=	57.00000 in
Bottom Width	=	57.00000 in
Top Section Depth	=	16.00000 in
Bottom Section Depth	=	16.00000 in
Top Area	=	28.50000 Sq. in
Bottom Area	=	28.50000 Sq. in
Moment of Inertia at Top	=	1204.00000 in^4
Moment of Inertia at Bottom	=	1204.00000 in^4
Elastic Modulus	=	29000000. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 7 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	4.50000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Friction angle at top of layer	=	28.00000 deg.
Friction angle at bottom of layer	=	28.00000 deg.
Subgrade k at top of layer	=	25.00000 pci
Subgrade k at bottom of layer	=	25.00000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	4.50000 ft
Distance from top of pile to bottom of layer	=	7.00000 ft
Effective unit weight at top of layer	=	53.00000 pcf
Effective unit weight at bottom of layer	=	53.00000 pcf
Friction angle at top of layer	=	28.00000 deg.
Friction angle at bottom of layer	=	28.00000 deg.
Subgrade k at top of layer	=	20.00000 pci
Subgrade k at bottom of layer	=	20.00000 pci

Layer 3 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer           =      7.00000 ft
   Distance from top of pile to bottom of layer        =      7.50000 ft
   Effective unit weight at top of layer               =     53.00000 pcf
   Effective unit weight at bottom of layer            =     53.00000 pcf
   Friction angle at top of layer                      =     34.00000 deg.
   Friction angle at bottom of layer                   =     34.00000 deg.
   Subgrade k at top of layer                          =     60.00000 pci
   Subgrade k at bottom of layer                       =     60.00000 pci


Layer 4 is soft clay, p-y criteria by Matlock, 1970

   Distance from top of pile to top of layer           =      7.50000 ft
   Distance from top of pile to bottom of layer        =      8.50000 ft
   Effective unit weight at top of layer               =     48.00000 pcf
   Effective unit weight at bottom of layer            =     48.00000 pcf
   Undrained cohesion at top of layer                  =    150.00000 psf
   Undrained cohesion at bottom of layer               =    150.00000 psf
   Epsilon-50 at top of layer                          =      0.02000
   Epsilon-50 at bottom of layer                       =      0.02000


Layer 5 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =      8.50000 ft
   Distance from top of pile to bottom of layer        =     14.25000 ft
   Effective unit weight at top of layer               =     53.00000 pcf
   Effective unit weight at bottom of layer            =     53.00000 pcf
   Friction angle at top of layer                      =     34.00000 deg.
   Friction angle at bottom of layer                   =     34.00000 deg.
   Subgrade k at top of layer                          =     60.00000 pci
   Subgrade k at bottom of layer                       =     60.00000 pci


Layer 6 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =     14.25000 ft
   Distance from top of pile to bottom of layer        =     17.75000 ft
   Effective unit weight at top of layer               =     48.00000 pcf
   Effective unit weight at bottom of layer            =     48.00000 pcf
   Friction angle at top of layer                      =      9.00000 deg.
   Friction angle at bottom of layer                   =      9.00000 deg.
   Subgrade k at top of layer                          =     20.00000 pci
   Subgrade k at bottom of layer                       =     20.00000 pci


Layer 7 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer           =     17.75000 ft
   Distance from top of pile to bottom of layer        =     50.00000 ft
   Effective unit weight at top of layer               =     58.00000 pcf
   Effective unit weight at bottom of layer            =     58.00000 pcf
   Friction angle at top of layer                      =     40.00000 deg.
   Friction angle at bottom of layer                   =     40.00000 deg.
   Subgrade k at top of layer                          =    125.00000 pci
   Subgrade k at bottom of layer                       =    125.00000 pci

   (Depth of lowest soil layer extends   20.00 ft below pile tip)


--------------------------------------------------------------------------------
```

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	0.00	115.000	--	28.000	--	25.000
		4.500	115.000	--	28.000	--	25.000
2	Sand (Reese, et al.)	4.500	53.000	--	28.000	--	20.000
		7.000	53.000	--	28.000	--	20.000
3	Sand (Reese, et al.)	7.000	53.000	--	34.000	--	60.000
		7.500	53.000	--	34.000	--	60.000
4	Soft Clay	7.500	48.000	150.000	--	0.02000	--
		8.500	48.000	150.000	--	0.02000	--
5	Sand (Reese, et al.)	8.500	53.000	--	34.000	--	60.000
		14.250	53.000	--	34.000	--	60.000
6	Sand (Reese, et al.)	14.250	48.000	--	9.000	--	20.000
		17.750	48.000	--	9.000	--	20.000
7	Sand (Reese, et al.)	17.750	58.000	--	40.000	--	125.000
		50.000	58.000	--	40.000	--	125.000

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7100	1.0000
2	100.000	0.7100	1.0000

Lateral Soil Movements

Profile of soil movement with depth defined using 3 points

Point Depth X Soil Movement

No.	ft	in
1	0.00000	1.00000
2	7.50000	1.00000
3	8.25000	0.00000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lb
Moment = 0. in- lb
Axial Load = 0. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
30.0000	0.8592280	1690685.	30764.
28.5000	0.8804713	1733559.	33674.
27.0000	0.8775355	1722263.	32463.
25.5000	0.8838869	1727448.	32783.
24.0000	0.8827079	1718845.	32894.
22.5000	0.8760795	1682054.	32650.
21.0000	0.8868174	1620962.	31390.
19.5000	0.9317758	1517162.	31238.
18.0000	1.1346393	944578.	23611.
16.5000	1.2651520	624395.	19377.
15.0000	1.2851282	559550.	17984.
13.5000	1.3931288	386185.	16284.
12.0000	1.5689529	-156372.	12356.
10.5000	1.6996488	-237741.	11003.
9.0000	1.4428626	-152732.	8385.8603846
7.5000	1.0000000	-0.0021584	-0.0009678
6.0000	1.0000000	-0.0042174	0.0038012
4.5000	0.9999999	-0.0253911	0.0101426
3.0000	1.0000126	0.4704990	0.1590265
1.5000	0.9845086	-66.9172676	-105.2042602

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	1	V = 0.000	M = 0.000	0.0000000	0.85922798	1690685.	30764.	-0.00576769

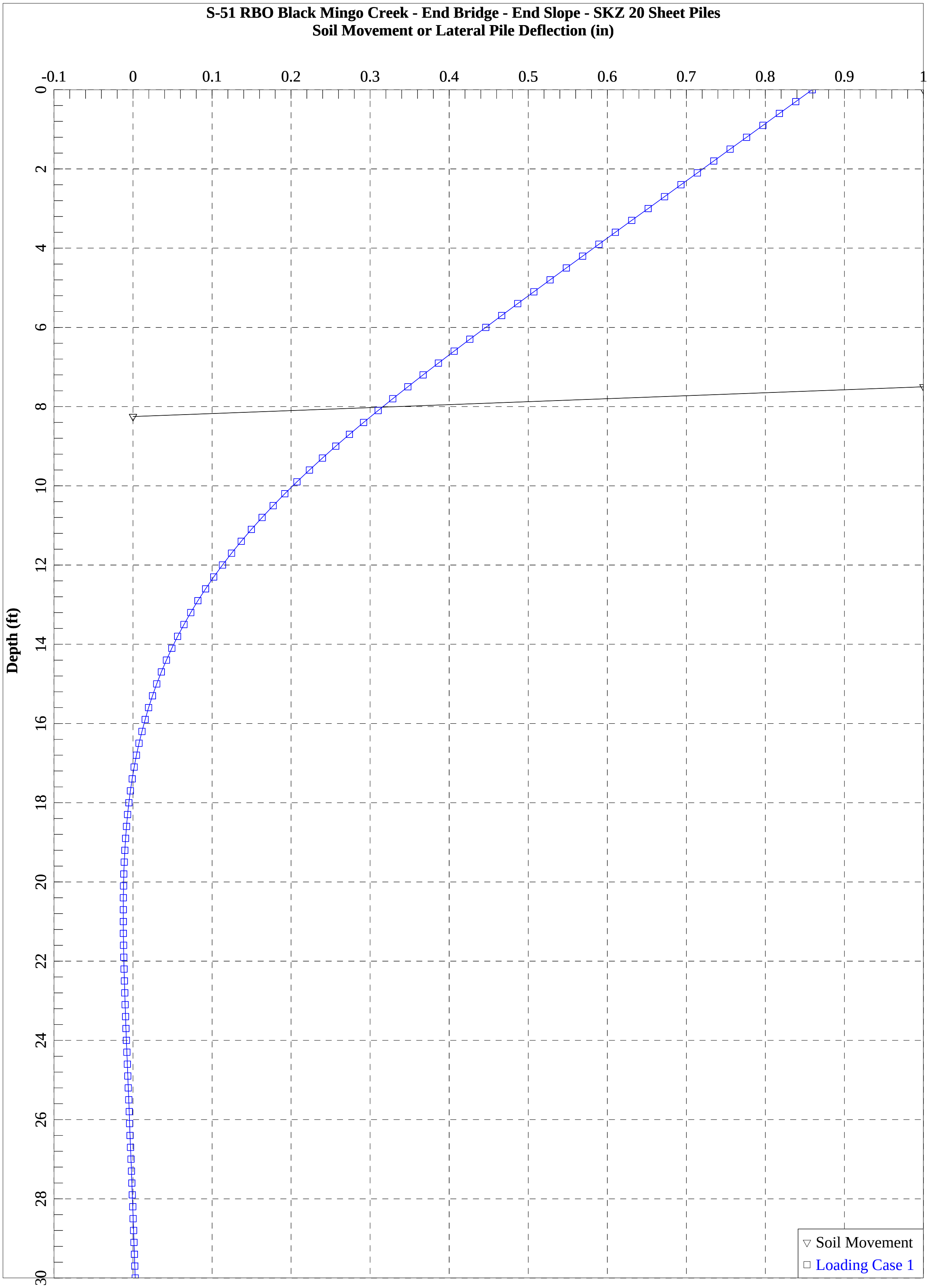
Summary of Warning Messages

The following warning was reported 990 times

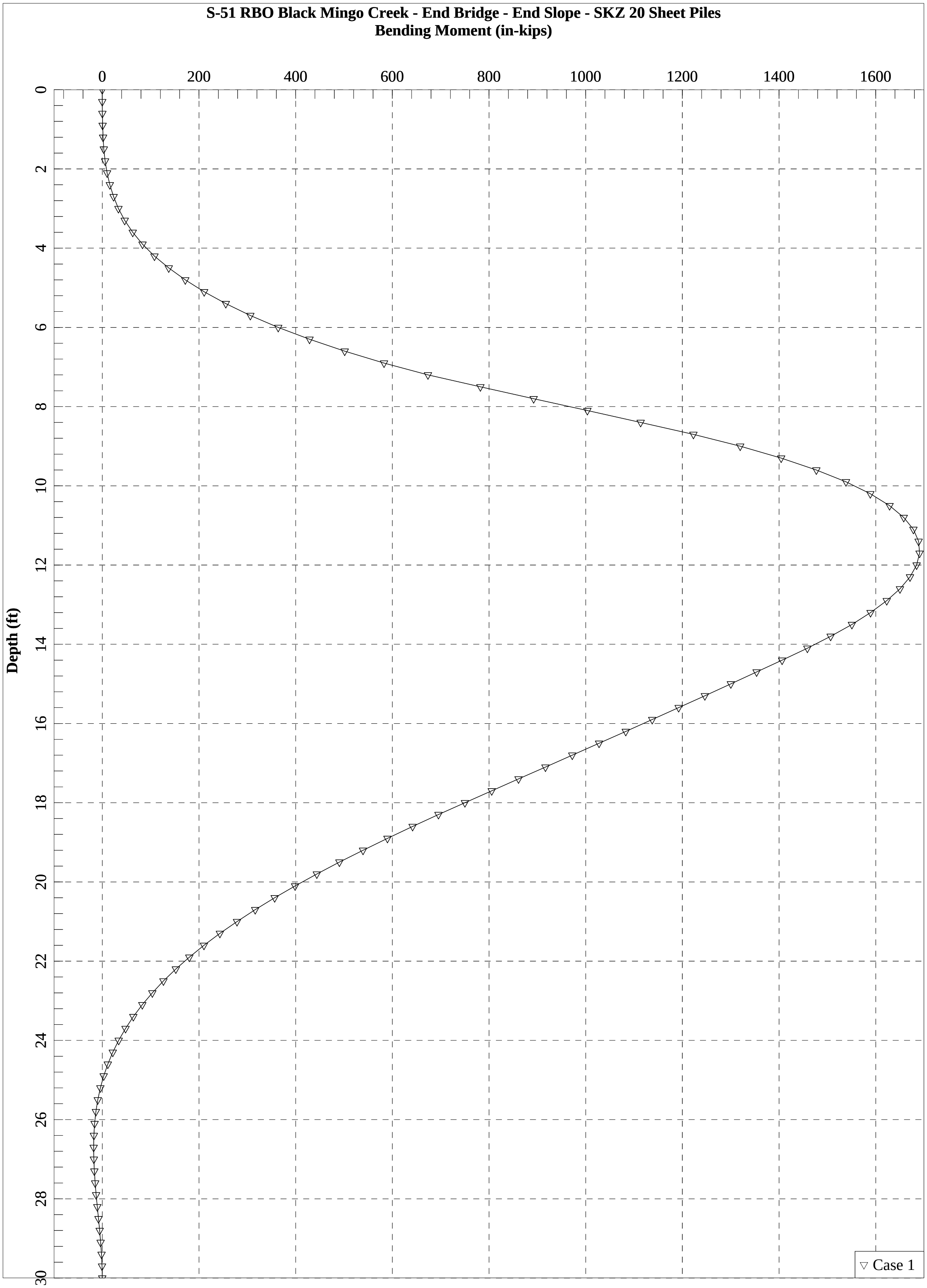
**** Warning ****

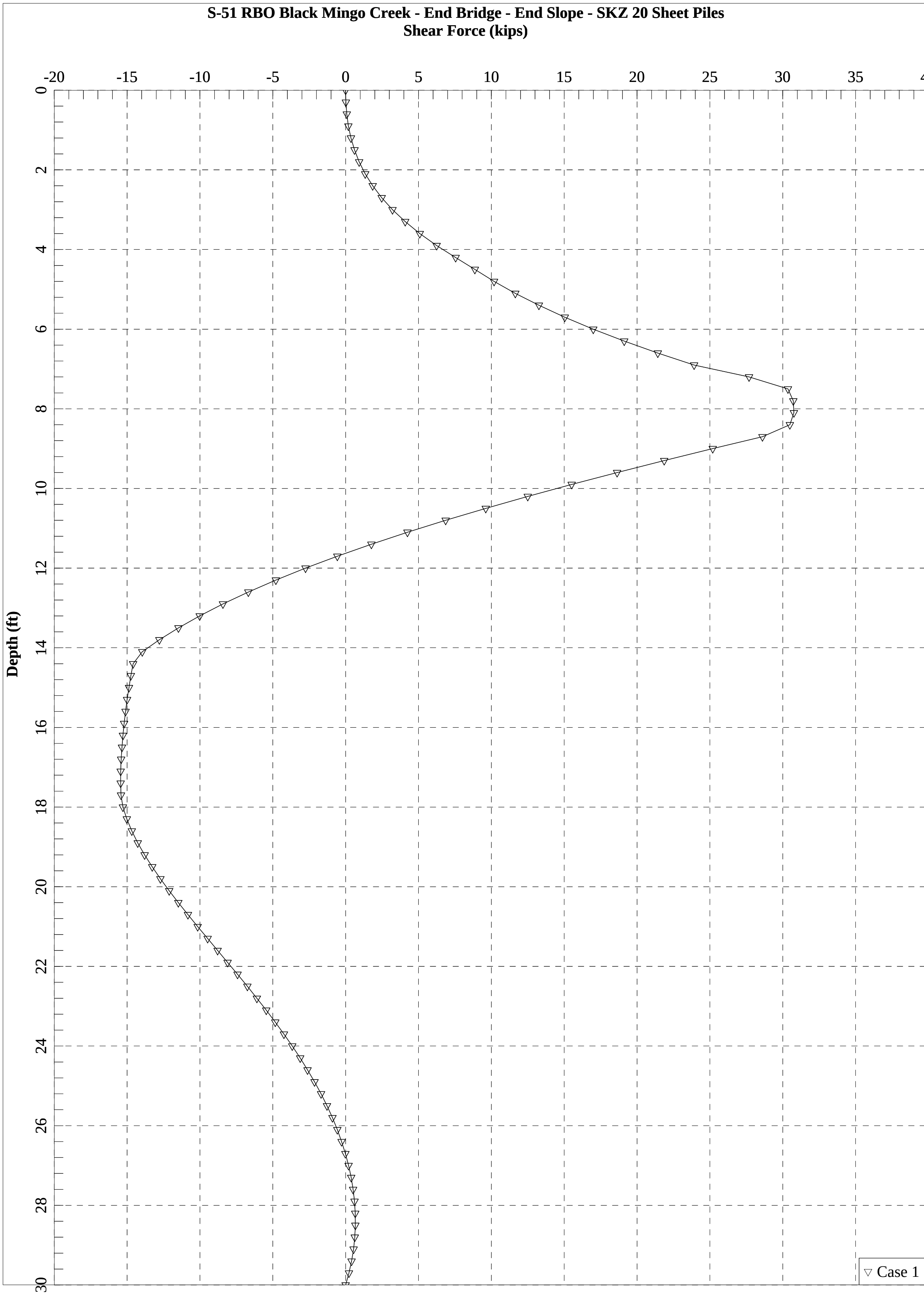
An unreasonable value was input for friction angle has been specified for a soil layer defined uisng the sand criteria. The input value is either smaller than 20 degrees or higher than 48 degrees. The input data should be checked for correctness.

The analysis ended normally.



S-51 RBO Black Mingo Creek - End Bridge - End Slope - SKZ 20 Sheet Piles
Soil Movement or Lateral Pile Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Soil Movement
Loading Case 1


S-51 RBO Black Mingo Creek - End Bridge - End Slope - SKZ 20 Sheet Piles
Bending Moment (in-kips)
0
200
400
600
800
1000
1200
1400
1600
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1


S-51 RBO Black Mingo Creek - End Bridge - End Slope - SKZ 20 Sheet Piles
Shear Force (kips)
-20
-15
-10
-5
0
5
10
15
20
25
30
35
40
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1

```
================================================================================

                  LPile Plus for Windows, Version 2013-07.007

                  Analysis of Individual Piles and Drilled Shafts
                 Subjected to Lateral Loading Using the p-y Method

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================================================================================

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--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:        P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge
Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final
Report\Bridge\SLIDE\Sheet Pile\
Name of input data file:       SKZ 20_End Bridge_RT Side Slope_SEE.lp7d
Name of output report file:    SKZ 20_End Bridge_RT Side Slope_SEE.lp7o
Name of plot output file:      SKZ 20_End Bridge_RT Side Slope_SEE.lp7p
Name of runtime messeage file: SKZ 20_End Bridge_RT Side Slope_SEE.lp7r


--------------------------------------------------------------------------------
                           Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  February 16, 2016     Time:  15:34:22


--------------------------------------------------------------------------------
                                 Problem Title
--------------------------------------------------------------------------------

Project Name: S-69 RBO Jumping Run Creek



Job Number: G5556.04 (F&ME); P029342 (SCDOT)



Client: ICE



Engineer: JFH
```

Description: IB2 Composite 18" Square PSC Pile - Longitudinal

---
Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Analysis includes loading by lateral soil movements acting on pile
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 30.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	57.0000000
2	30.000000	57.0000000

Input Structural Properties:

Pile Section No. 1:

```
   Section Type                                        =    Elastic Pile
   Cross-sectional Shape                               =     Rectangular
   Section Length                                      =     30.00000 ft
   Top Width                                           =     57.00000 in
   Bottom Width                                        =     57.00000 in
   Top Section Depth                                   =     16.00000 in
   Bottom Section Depth                                =     16.00000 in
   Top Area                                            =     28.50000 Sq. in
   Bottom Area                                         =     28.50000 Sq. in
   Moment of Inertia at Top                            =   1204.00000 in^4
   Moment of Inertia at Bottom                         =   1204.00000 in^4
   Elastic Modulus                                     =    29000000. lbs/in^2
```

Ground Slope and Pile Batter Angles

```
Ground Slope Angle                                     =        0.000 degrees
                                                       =        0.000 radians

Pile Batter Angle                                      =        0.000 degrees
                                                       =        0.000 radians
```

Soil and Rock Layering Information

The soil profile is modelled using 8 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer           =       0.0000 ft
   Distance from top of pile to bottom of layer        =      5.00000 ft
   Effective unit weight at top of layer               =    125.00000 pcf
   Effective unit weight at bottom of layer            =    125.00000 pcf
   Friction angle at top of layer                      =     34.00000 deg.
   Friction angle at bottom of layer                   =     34.00000 deg.
   Subgrade k at top of layer                          =     90.00000 pci
   Subgrade k at bottom of layer                       =     90.00000 pci
```

Layer 2 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer           =      5.00000 ft
   Distance from top of pile to bottom of layer        =      6.50000 ft
   Effective unit weight at top of layer               =    115.00000 pcf
   Effective unit weight at bottom of layer            =    115.00000 pcf
   Friction angle at top of layer                      =     28.00000 deg.
   Friction angle at bottom of layer                   =     28.00000 deg.
   Subgrade k at top of layer                          =     25.00000 pci
   Subgrade k at bottom of layer                       =     25.00000 pci
```

Layer 3 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer          =      6.50000 ft
   Distance from top of pile to bottom of layer       =      9.50000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     28.00000 deg.
   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 4 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =      9.50000 ft
   Distance from top of pile to bottom of layer       =     10.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     34.00000 deg.
   Friction angle at bottom of layer                  =     34.00000 deg.
   Subgrade k at top of layer                         =     60.00000 pci
   Subgrade k at bottom of layer                      =     60.00000 pci


Layer 5 is soft clay, p-y criteria by Matlock, 1970

   Distance from top of pile to top of layer          =     10.00000 ft
   Distance from top of pile to bottom of layer       =     11.00000 ft
   Effective unit weight at top of layer              =     48.00000 pcf
   Effective unit weight at bottom of layer           =     48.00000 pcf
   Undrained cohesion at top of layer                 =    150.00000 psf
   Undrained cohesion at bottom of layer              =    150.00000 psf
   Epsilon-50 at top of layer                         =      0.02000
   Epsilon-50 at bottom of layer                      =      0.02000


Layer 6 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     11.00000 ft
   Distance from top of pile to bottom of layer       =     16.50000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     34.00000 deg.
   Friction angle at bottom of layer                  =     34.00000 deg.
   Subgrade k at top of layer                         =     60.00000 pci
   Subgrade k at bottom of layer                      =     60.00000 pci


Layer 7 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     16.50000 ft
   Distance from top of pile to bottom of layer       =     20.00000 ft
   Effective unit weight at top of layer              =     48.00000 pcf
   Effective unit weight at bottom of layer           =     48.00000 pcf
   Friction angle at top of layer                     =      9.00000 deg.
   Friction angle at bottom of layer                  =      9.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 8 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     20.00000 ft
   Distance from top of pile to bottom of layer       =     50.00000 ft
   Effective unit weight at top of layer              =     58.00000 pcf
```

Effective unit weight at bottom of layer = 58.00000 pcf
Friction angle at top of layer = 40.00000 deg.
Friction angle at bottom of layer = 40.00000 deg.
Subgrade k at top of layer = 125.00000 pci
Subgrade k at bottom of layer = 125.00000 pci

(Depth of lowest soil layer extends 20.00 ft below pile tip)

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	0.00	125.000	--	34.000	--	90.000
		5.000	125.000	--	34.000	--	90.000
2	Sand (Reese, et al.)	5.000	115.000	--	28.000	--	25.000
		6.500	115.000	--	28.000	--	25.000
3	Sand (Reese, et al.)	6.500	53.000	--	28.000	--	20.000
		9.500	53.000	--	28.000	--	20.000
4	Sand (Reese, et al.)	9.500	53.000	--	34.000	--	60.000
		10.000	53.000	--	34.000	--	60.000
5	Soft Clay	10.000	48.000	150.000	--	0.02000	--
		11.000	48.000	150.000	--	0.02000	--
6	Sand (Reese, et al.)	11.000	53.000	--	34.000	--	60.000
		16.500	53.000	--	34.000	--	60.000
7	Sand (Reese, et al.)	16.500	48.000	--	9.000	--	20.000
		20.000	48.000	--	9.000	--	20.000
8	Sand (Reese, et al.)	20.000	58.000	--	40.000	--	125.000
		50.000	58.000	--	40.000	--	125.000

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7100	1.0000
2	100.000	0.7100	1.0000

Lateral Soil Movements

Profile of soil movement with depth defined using 3 points

Point No.	Depth X ft	Soil Movement in
1	0.00000	1.50000
2	17.75000	1.50000
3	18.50000	0.00000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lb
Moment = 0. in- lb
Axial Load = 0. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
30.0000	1.7832665	3236584.	84316.
28.5000	1.7707588	-2816702.	75815.
27.0000	1.7561550	-3005360.	70345.
25.5000	1.7609361	-3187939.	63432.
24.0000	1.7684530	-3447646.	59078.
22.5000	1.7767352	-3698967.	60233.
21.0000	1.6903477	-2635536.	46944.
19.5000	1.5246572	-327157.	8762.8268569
18.0000	1.5011080	-13307.	523.3344810
16.5000	1.5000000	0.0000890	0.000009988
15.0000	1.5000000	0.0003853	-0.0000140
13.5000	1.5000000	-0.0003604	0.0000155
12.0000	1.5000000	-0.0006356	-0.0000299
10.5000	1.5000000	0.0004297	-0.0000349
9.0000	1.5000000	-0.0008309	0.0004831
7.5000	1.5000000	0.0029959	0.0003084
6.0000	1.5000000	0.0033052	0.0035935
4.5000	1.5000001	0.0137989	-0.0058345
3.0000	1.4999996	-0.0393030	-0.0447833
1.5000	1.5001122	35.1089379	-93.0355112

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Pile-head Pile-head Maximum
Maximum
Load Load Condition 1 Condition 2 Axial Pile-head Moment
Shear Pile-head

```
Case  Type    V(lbs) or     in-lb, rad.,       Loading      Deflection       in Pile
       in Pile       Rotation
 No.   No.    y(inches)     or in-lb/rad.        lbs          inches         in-lbs
         lbs           radians
----  ----  --------------  --------------  -------------  -------------
-------------  -------------  -------------
  1     1   V =      0.000  M =      0.000      0.0000000     1.78326649
3236584.         84316.    -0.00216287
```

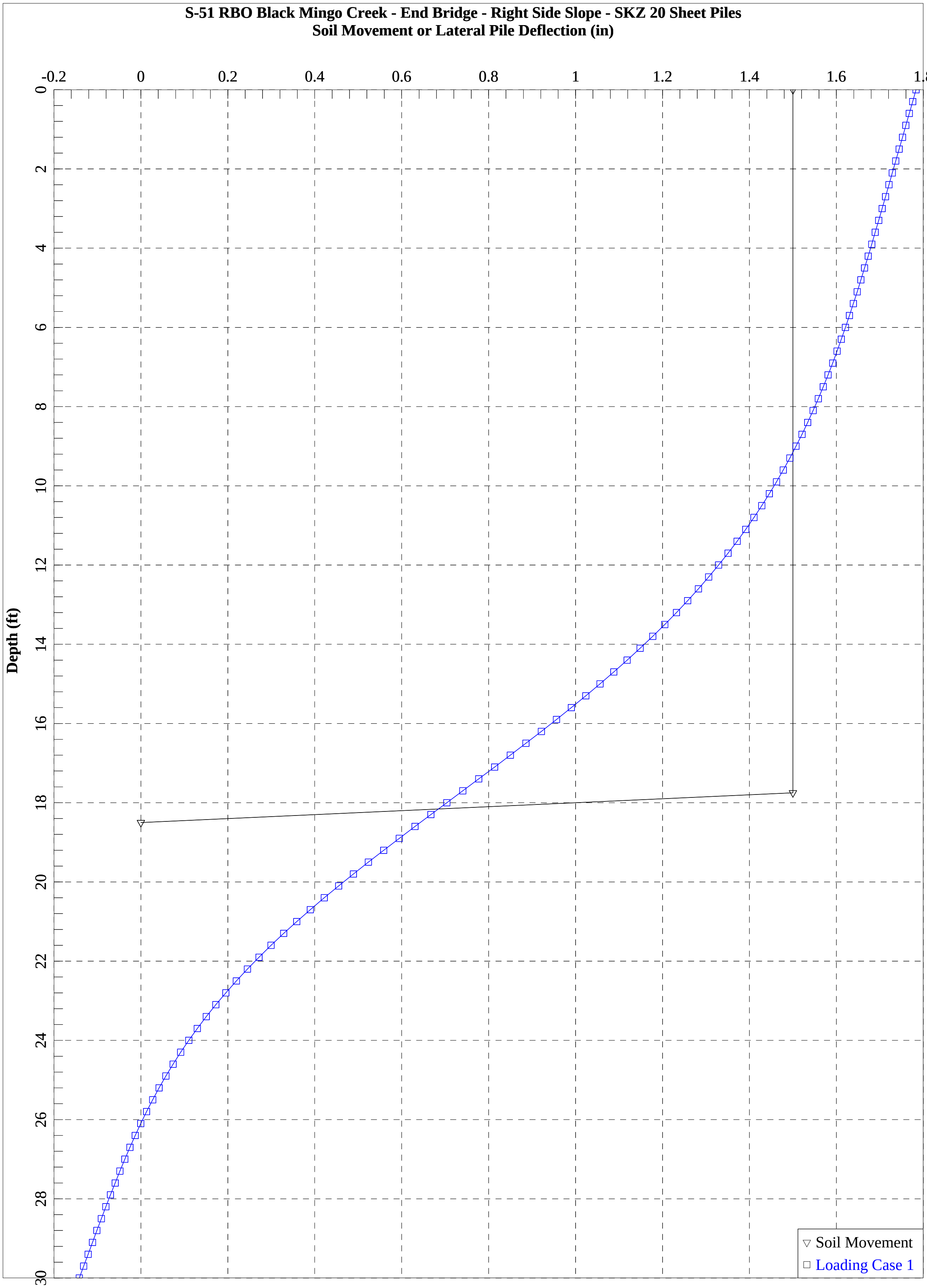
```
--------------------------------------------------------------------------------
                          Summary of Warning Messages
--------------------------------------------------------------------------------
```

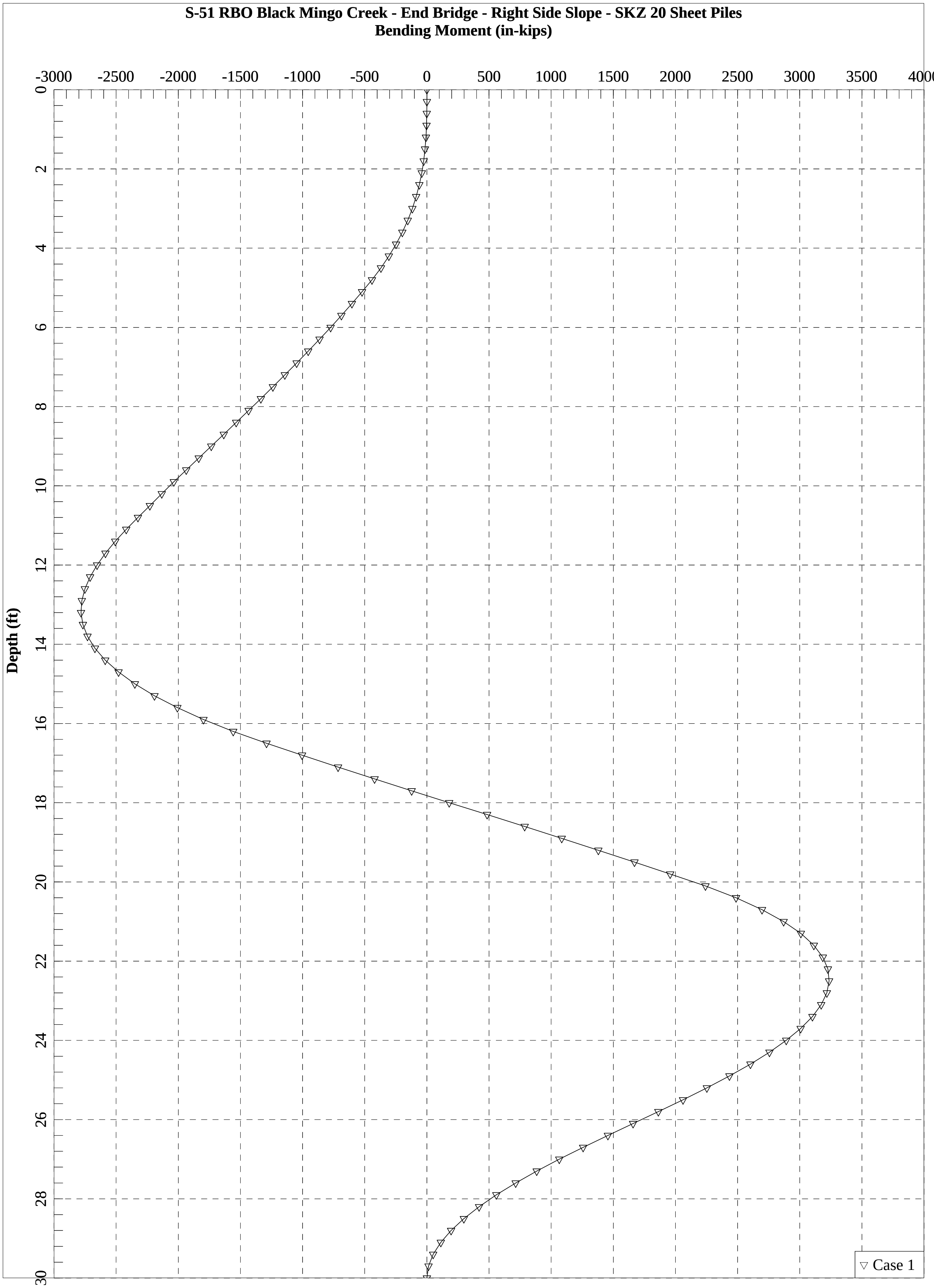
The following warning was reported 838 times

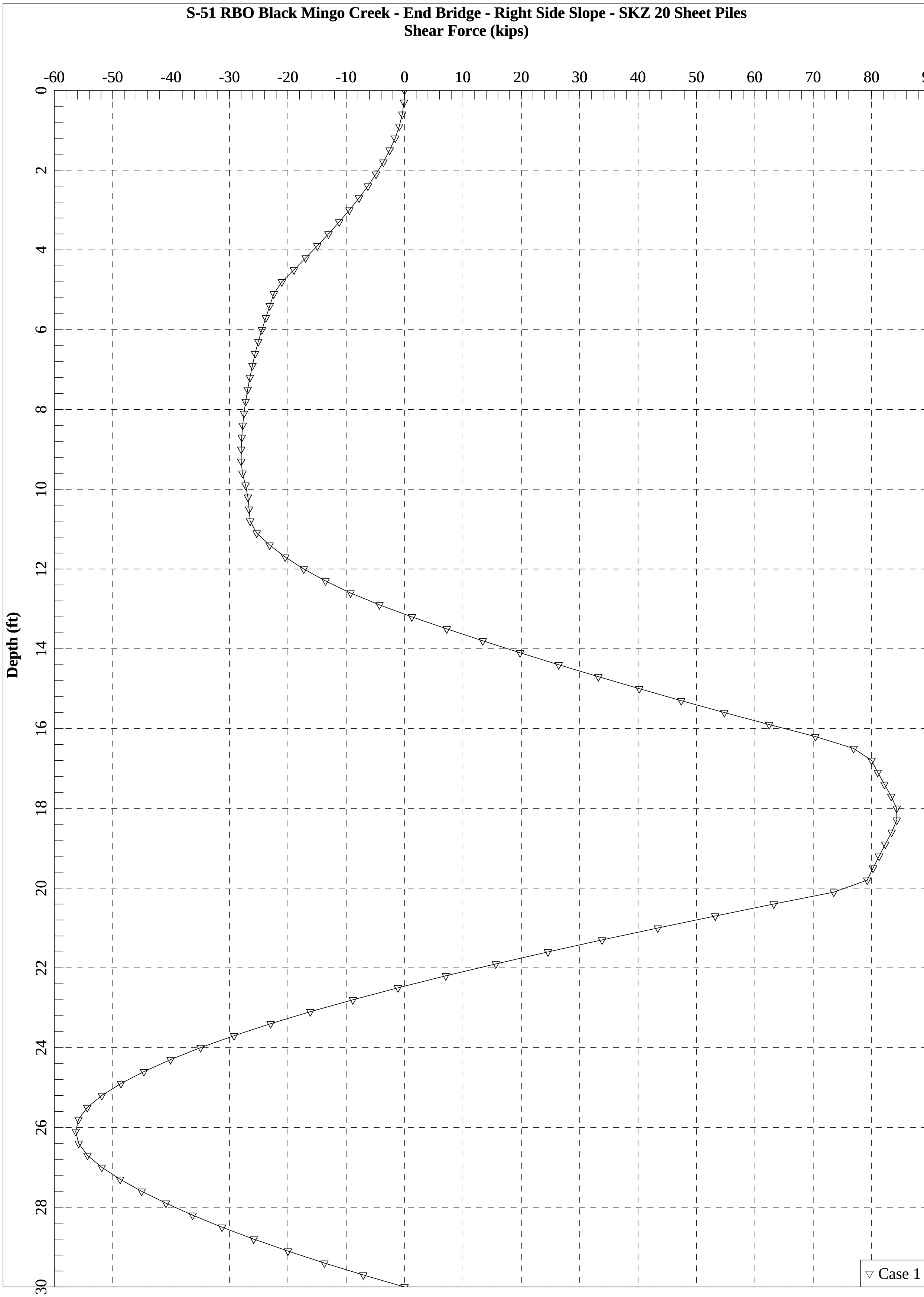
**** Warning ****

An unreasonable value was input for friction angle has been specified for a soil layer defined uisng the sand criteria. The input value is either smaller than 20 degrees or higher than 48 degrees. The input data should be checked for correctness.

The analysis ended normally.


S-51 RBO Black Mingo Creek - End Bridge - Right Side Slope - SKZ 20 Sheet Piles
Soil Movement or Lateral Pile Deflection (in)
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Soil Movement
Loading Case 1


S-51 RBO Black Mingo Creek - End Bridge - Right Side Slope - SKZ 20 Sheet Piles
Bending Moment (in-kips)
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
4000
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1



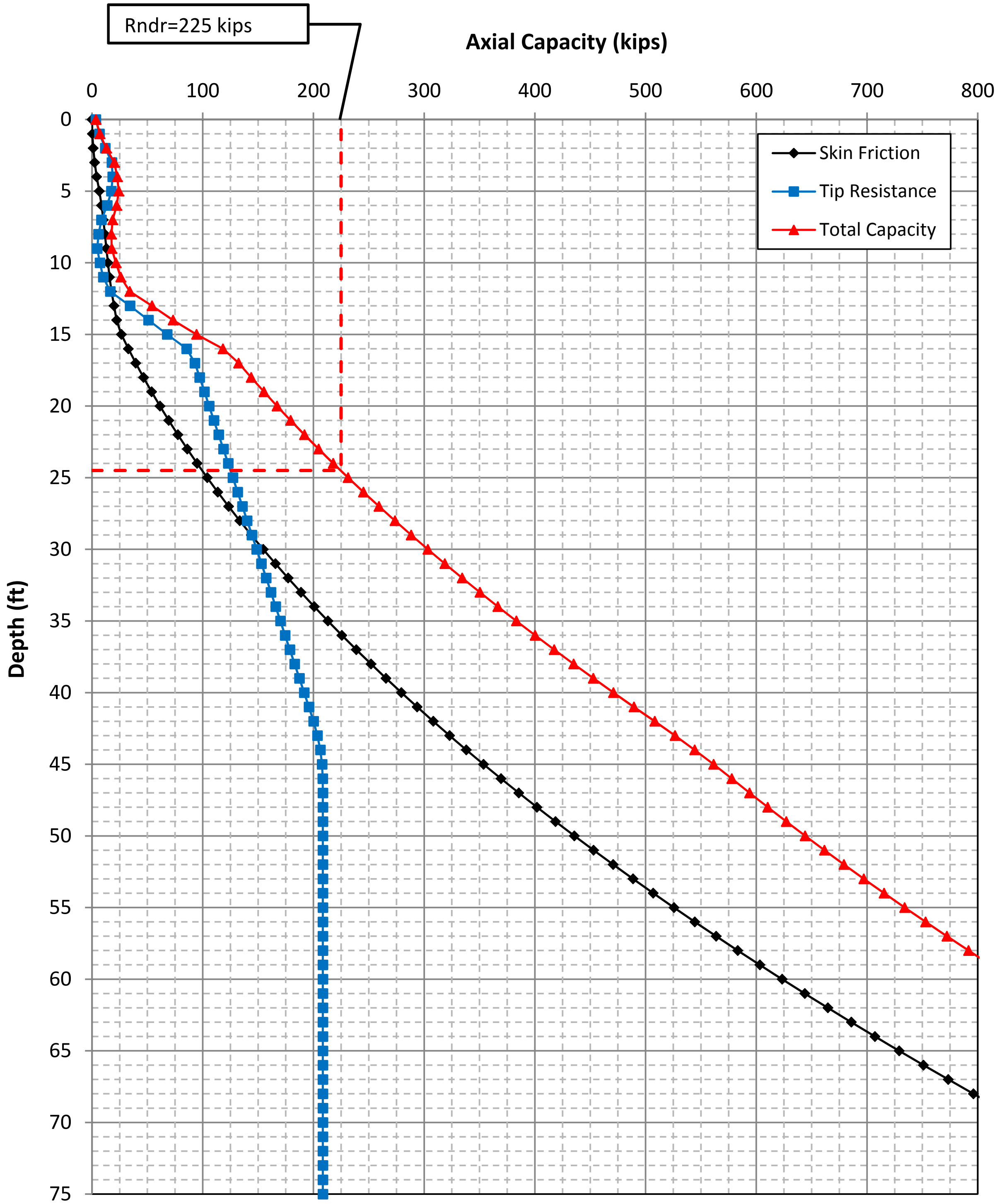
S-51 RBO Black Mingo Creek - End Bridge - Right Side Slope - SKZ 20 Sheet Piles
Shear Force (kips)
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Case 1

APPENDIX

SECTION 12

END BENT 1 DRIVEN PILE ANALYSES

Project: S-51 Emergency Bridge Replacement over Black Mingo Creek - **Axial Capacity Analysis**
Location : End Bent 1 - HP14x73 Pile
Calc. By: JFH
Date: 2/15/2016
Method: APILE 2014.6.4



[1]The axial capacities shown are unfactored.

```
================================================================================

                  LPile Plus for Windows, Version 2013-07.007

                Analysis of Individual Piles and Drilled Shafts
               Subjected to Lateral Loading Using the p-y Method

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--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:        P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 -
Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\LPile\
Name of input data file:       EB1_Long.lp7d
Name of output report file:    EB1_Long.lp7o
Name of plot output file:      EB1_Long.lp7p
Name of runtime messeage file: EB1_Long.lp7r


--------------------------------------------------------------------------------
                           Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  February 15, 2016     Time:  17:07:38


--------------------------------------------------------------------------------
                                 Problem Title
--------------------------------------------------------------------------------

Project Name: S-51 RBO Black Mingo Creek


Job Number: G5556.02 (F&ME); P029461(SCDOT)


Client: UIG


Engineer: JFH


Description: EB1 - Longitudinal Loads




--------------------------------------------------------------------------------
                           Program Options and Settings
--------------------------------------------------------------------------------

Engineering Units of Input Data and Computations:
 - Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed                 =          500
- Deflection tolerance for convergence                 =   1.0000E-05 in
- Maximum allowable deflection                         =     100.0000 in
- Number of pile increments                            =          100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

Computational Options:
 - Use unfactored loads in computations (conventional analysis)
 - Compute pile response under loading and nonlinear bending properties of pile
```

(only if nonlinear pile properties are input)
- Use of p-y modification factors for p-y curves not selected
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 25.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	14.6000000
2	25.000000	14.6000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Strong H-Pile
Section Length	=	25.00000 ft
Flange Width	=	14.60000 in
Section Depth	=	13.60000 in
Flange Thickness	=	0.50500 in
Web Thickness	=	0.50500 in
Section Area	=	21.40000 Sq. in
Moment of Inertia	=	729.00000 in^4
Elastic Modulus	=	29000000. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	5.00000 ft
Effective unit weight at top of layer	=	125.00000 pcf
Effective unit weight at bottom of layer	=	125.00000 pcf
Friction angle at top of layer	=	34.00000 deg.
Friction angle at bottom of layer	=	34.00000 deg.
Subgrade k at top of layer	=	90.00000 pci
Subgrade k at bottom of layer	=	90.00000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 5.00000 ft
Distance from top of pile to bottom of layer = 7.00000 ft
Effective unit weight at top of layer = 43.00000 pcf
Effective unit weight at bottom of layer = 43.00000 pcf
Friction angle at top of layer = 28.00000 deg.
Friction angle at bottom of layer = 28.00000 deg.
Subgrade k at top of layer = 20.00000 pci
Subgrade k at bottom of layer = 20.00000 pci

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 7.00000 ft
Distance from top of pile to bottom of layer = 11.00000 ft
Effective unit weight at top of layer = 53.00000 pcf
Effective unit weight at bottom of layer = 53.00000 pcf
Undrained cohesion at top of layer = 300.00000 psf
Undrained cohesion at bottom of layer = 300.00000 psf
Epsilon-50 at top of layer = 0.02000
Epsilon-50 at bottom of layer = 0.02000

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 11.00000 ft
Distance from top of pile to bottom of layer = 14.00000 ft
Effective unit weight at top of layer = 53.00000 pcf
Effective unit weight at bottom of layer = 53.00000 pcf
Friction angle at top of layer = 28.00000 deg.
Friction angle at bottom of layer = 28.00000 deg.
Subgrade k at top of layer = 20.00000 pci
Subgrade k at bottom of layer = 20.00000 pci

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 14.00000 ft
Distance from top of pile to bottom of layer = 50.00000 ft
Effective unit weight at top of layer = 63.00000 pcf
Effective unit weight at bottom of layer = 63.00000 pcf
Friction angle at top of layer = 40.00000 deg.
Friction angle at bottom of layer = 40.00000 deg.
Subgrade k at top of layer = 125.00000 pci
Subgrade k at bottom of layer = 125.00000 pci

(Depth of lowest soil layer extends 25.00 ft below pile tip)

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	0.00	125.000	--	34.000	--	90.000
		5.000	125.000	--	34.000	--	90.000
2	Sand (Reese, et al.)	5.000	43.000	--	28.000	--	20.000
		7.000	43.000	--	28.000	--	20.000
3	Soft Clay	7.000	53.000	300.000	--	0.02000	--
		11.000	53.000	300.000	--	0.02000	--
4	Sand (Reese, et al.)	11.000	53.000	--	28.000	--	20.000
		14.000	53.000	--	28.000	--	20.000
5	Sand (Reese, et al.)	14.000	63.000	--	40.000	--	125.000
		50.000	63.000	--	40.000		

-- 125.000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 4

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 2000.00000 lbs	M = 168000. in-lbs	94000.	Yes
2	1	V = 2000.00000 lbs	M = 216000. in-lbs	98000.	Yes
3	1	V = 3000.00000 lbs	M = 276000. in-lbs	127000.	Yes
4	1	V = 3000.00000 lbs	M = 348000. in-lbs	133000.	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

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Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 2000. lb
Moment = 168000. in- lb
Axial Load = 94000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
25.0000	0.0560189	215691.	-2138.0205429
23.7500	0.0555894	215977.	-2162.0201616
22.5000	0.0557487	215849.	-2138.2610546
21.2500	0.0558330	215744.	-2144.8314533
20.0000	0.0560487	215631.	-2122.3904034
18.7500	0.0559642	215676.	-2104.6390681
17.5000	0.0559593	215687.	-2094.0911503
16.2500	0.0561311	215576.	-2123.9640576
15.0000	0.0568378	215155.	-2240.8577727
13.7500	0.0627491	212436.	-2574.8096695
12.5000	0.0691674	210278.	-2789.9089444
11.2500	0.0881968	206786.	-3138.7305711
10.0000	0.1422502	205123.	-4002.2188338
8.7500	0.2296429	206582.	-5258.6262149
7.5000	0.3483193	209403.	-6397.7978725

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head	=	2000.0 lbs
Applied moment at pile head	=	216000.0 in-lbs
Axial thrust load on pile head	=	98000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0646	216000.	2000.0000	-0.001222	6742.4022	2.114E+10	0.000	0.000	0.000
0.250	0.0610	222355.	1975.3087	-0.001191	6806.0378	2.114E+10	-16.4609	810.0000	0.000
0.500	0.0574	228552.	1904.0909	-0.001159	6868.0970	2.114E+10	-31.0176	1620.0000	0.000
0.750	0.0540	234461.	1791.9408	-0.001126	6927.2652	2.114E+10	-43.7491	2430.0000	0.000
1.000	0.0507	239966.	1644.2121	-0.001093	6982.3928	2.114E+10	-54.7367	3240.0000	0.000
1.250	0.0475	244969.	1466.0101	-0.001058	7032.4869	2.114E+10	-64.0646	4050.0000	0.000
1.500	0.0443	249384.	1262.1848	-0.001023	7076.7051	2.114E+10	-71.8189	4860.0000	0.000
1.750	0.0413	253143.	1037.3251	-0.000988	7114.3464	2.114E+10	-78.0876	5670.0000	0.000
2.000	0.0384	256189.	795.7533	-0.000951	7144.8445	2.114E+10	-82.9602	6480.0000	0.000
2.250	0.0356	258477.	541.5221	-0.000915	7167.7589	2.114E+10	-86.5272	7290.0000	0.000
2.500	0.0329	259976.	278.4120	-0.000878	7182.7672	2.114E+10	-88.8795	8100.0000	0.000
2.750	0.0303	260664.	9.9307	-0.000841	7189.6568	2.114E+10	-90.1081	8910.0000	0.000
3.000	0.0279	260530.	-260.6869	-0.000804	7188.3166	2.114E+10	-90.3036	9720.0000	0.000
3.250	0.0255	259573.	-530.4760	-0.000767	7178.7290	2.114E+10	-89.5558	10530.	0.000
3.500	0.0233	257799.	-796.7389	-0.000731	7160.9620	2.114E+10	-87.9528	11340.	0.000
3.750	0.0211	255222.	-1057.0400	-0.000694	7135.1607	2.114E+10	-85.5812	12150.	0.000
4.000	0.0191	251865.	-1309.1996	-0.000658	7101.5398	2.114E+10	-82.5252	12960.	0.000
4.250	0.0172	247754.	-1551.2865	-0.000623	7060.3763	2.114E+10	-78.8661	13770.	0.000
4.500	0.0154	242923.	-1781.6090	-0.000588	7012.0016	2.114E+10	-74.6823	14580.	0.000
4.750	0.0137	237410.	-1998.7054	-0.000554	6956.7947	2.114E+10	-70.0487	15390.	0.000
5.000	0.0120	231256.	-2127.8657	-0.000521	6895.1757	2.114E+10	-16.0582	3999.9538	0.000
5.250	0.0105	224949.	-2173.9631	-0.000488	6832.0128	2.114E+10	-14.6734	4179.9538	0.000
5.500	0.009115	218500.	-2215.8427	-0.000457	6767.4336	2.114E+10	-13.2463	4359.9538	0.000
5.750	0.007791	211922.	-2253.3972	-0.000426	6701.5692	2.114E+10	-11.7900	4539.9538	0.000
6.000	0.006557	205230.	-2286.5574	-0.000397	6634.5538	2.114E+10	-10.3168	4719.9538	0.000
6.250	0.005411	198436.	-2315.2899	-0.000368	6566.5228	2.114E+10	-8.8382	4899.9538	0.000
6.500	0.004350	191555.	-2339.5950	-0.000340	6497.6124	2.114E+10	-7.3652	5079.9538	0.000
6.750	0.003369	184599.	-2359.5044	-0.000314	6427.9582	2.114E+10	-5.9077	5259.9538	0.000
7.000	0.002468	177582.	-2399.1297	-0.000288	6357.6945	2.114E+10	-20.5091	24931.	0.000
7.250	0.001642	170373.	-2456.7275	-0.000263	6285.5082	2.114E+10	-17.8895	32684.	0.000
7.500	0.000889	162996.	-2505.3835	-0.000240	6211.6384	2.114E+10	-14.5478	49112.	0.000
7.750	0.000205	155482.	-2540.3804	-0.000217	6136.3895	2.114E+10	-8.7834	128758.	0.000

8.000	-0.000413	147882.	-2536.4030	-0.000195	6060.2841	2.114E+10	11.4351	83032.	0.000
8.250	-0.000968	140378.	-2496.5993	-0.000175	5985.1474	2.114E+10	15.1008	46800.	0.000
8.500	-0.001463	133005.	-2447.9908	-0.000156	5911.3130	2.114E+10	17.3048	35483.	0.000
8.750	-0.001902	125782.	-2393.7250	-0.000137	5838.9826	2.114E+10	18.8724	29774.	0.000
9.000	-0.002286	118723.	-2335.3251	-0.000120	5768.3005	2.114E+10	20.0608	26321.	0.000
9.250	-0.002621	111840.	-2273.7497	-0.000104	5699.3767	2.114E+10	20.9894	24026.	0.000
9.500	-0.002908	105142.	-2209.6782	-8.813E-05	5632.2979	2.114E+10	21.7249	22415.	0.000
9.750	-0.003150	98634.	-2143.6277	-7.367E-05	5567.1331	2.114E+10	22.3088	21249.	0.000
10.000	-0.003350	92323.	-2076.0108	-6.012E-05	5503.9376	2.114E+10	22.7691	20392.	0.000
10.250	-0.003510	86213.	-2007.1685	-4.745E-05	5442.7556	2.114E+10	23.1258	19764.	0.000
10.500	-0.003634	80308.	-1937.3896	-3.564E-05	5383.6217	2.114E+10	23.3934	19310.	0.000
10.750	-0.003724	74610.	-1866.9245	-2.465E-05	5326.5626	2.114E+10	23.5833	18997.	0.000
11.000	-0.003782	69121.	-1817.8603	-1.445E-05	5271.5977	2.114E+10	9.1262	7238.6541	0.000
11.250	-0.003811	63711.	-1790.0352	-5.025E-06	5217.4264	2.114E+10	9.4239	7418.6541	0.000
11.500	-0.003812	58384.	-1761.4147	3.638E-06	5164.0779	2.114E+10	9.6564	7598.6541	0.000
11.750	-0.003789	53141.	-1732.1932	1.155E-05	5111.5752	2.114E+10	9.8246	7778.6541	0.000
12.000	-0.003743	47984.	-1702.5612	1.873E-05	5059.9357	2.114E+10	9.9300	7958.6541	0.000
12.250	-0.003677	42914.	-1672.7044	2.518E-05	5009.1711	2.114E+10	9.9745	8138.6541	0.000
12.500	-0.003592	37933.	-1642.8022	3.091E-05	4959.2875	2.114E+10	9.9603	8318.6541	0.000
12.750	-0.003491	33039.	-1613.0262	3.595E-05	4910.2857	2.114E+10	9.8903	8498.6541	0.000
13.000	-0.003376	28233.	-1583.5397	4.029E-05	4862.1615	2.114E+10	9.7674	8678.6541	0.000
13.250	-0.003249	23514.	-1554.4955	4.397E-05	4814.9058	2.114E+10	9.5953	8858.6541	0.000
13.500	-0.003113	18881.	-1526.0359	4.697E-05	4768.5050	2.114E+10	9.3778	9038.6541	0.000
13.750	-0.002968	14331.	-1498.2904	4.933E-05	4722.9414	2.114E+10	9.1192	9218.6541	0.000
14.000	-0.002817	9861.9228	-1413.9325	5.105E-05	4678.1938	2.114E+10	47.1195	50188.	0.000
14.250	-0.002661	5816.9493	-1274.9727	5.216E-05	4637.6885	2.114E+10	45.5204	51313.	0.000
14.500	-0.002504	2181.4164	-1141.0498	5.273E-05	4601.2833	2.114E+10	43.7616	52438.	0.000
14.750	-0.002345	-1060.3534	-1012.6056	5.281E-05	4590.0573	2.114E+10	41.8679	53563.	0.000
15.000	-0.002187	-3925.2679	-890.0086	5.245E-05	4618.7458	2.114E+10	39.8635	54688.	0.000
15.250	-0.002030	-6431.2475	-773.5562	5.172E-05	4643.8399	2.114E+10	37.7715	55813.	0.000
15.500	-0.001876	-8597.0156	-663.4779	5.065E-05	4665.5273	2.114E+10	35.6141	56938.	0.000
15.750	-0.001726	-10442.	-559.9386	4.930E-05	4684.0015	2.114E+10	33.4121	58063.	0.000
16.000	-0.001581	-11986.	-463.0425	4.771E-05	4699.4600	2.114E+10	31.1853	59188.	0.000
16.250	-0.001440	-13248.	-372.8368	4.592E-05	4712.1031	2.114E+10	28.9518	60313.	0.000
16.500	-0.001305	-14250.	-289.3165	4.397E-05	4722.1313	2.114E+10	26.7284	61438.	0.000
16.750	-0.001176	-15010.	-212.4286	4.189E-05	4729.7447	2.114E+10	24.5303	62563.	0.000
17.000	-0.001054	-15549.	-142.0765	3.972E-05	4735.1412	2.114E+10	22.3711	63688.	0.000
17.250	-0.000938	-15886.	-78.1251	3.749E-05	4738.5149	2.114E+10	20.2631	64813.	0.000
17.500	-0.000829	-16040.	-20.4051	3.523E-05	4740.0559	2.114E+10	18.2169	65938.	0.000
17.750	-0.000727	-16029.	31.2825	3.295E-05	4739.9483	2.114E+10	16.2415	67063.	0.000
18.000	-0.000631	-15871.	77.1614	3.069E-05	4738.3704	2.114E+10	14.3444	68188.	0.000
18.250	-0.000542	-15584.	117.4760	2.846E-05	4735.4930	2.114E+10	12.5319		

```
69313.      0.000
    18.500  -0.000460    -15183.   152.4869  2.628E-05  4731.4797  2.114E+10    10.8087
70438.      0.000
    18.750  -0.000385    -14685.   182.4670  2.416E-05  4726.4860  2.114E+10     9.1781
71563.      0.000
    19.000  -0.000315    -14103.   207.6975  2.211E-05  4720.6589  2.114E+10     7.6422
72688.      0.000
    19.250  -0.000252    -13451.   228.4640  2.016E-05  4714.1372  2.114E+10     6.2021
73813.      0.000
    19.500  -0.000194    -12744.   245.0533  1.830E-05  4707.0510  2.114E+10     4.8575
74938.      0.000
    19.750  -0.000142    -11992.   257.7505  1.654E-05  4699.5216  2.114E+10     3.6072
76063.      0.000
    20.000 -9.519E-05    -11207.   266.8351  1.490E-05  4691.6621  2.114E+10     2.4492
77188.      0.000
    20.250 -5.288E-05    -10400.   272.5795  1.337E-05  4683.5773  2.114E+10     1.3804
78313.      0.000
    20.500 -1.500E-05 -9579.2981   275.2457  1.195E-05  4675.3636  2.114E+10     0.3971
79438.      0.000
    20.750  1.881E-05 -8755.0873   275.0836  1.065E-05  4667.1102  2.114E+10    -0.5052
80563.      0.000
    21.000  4.889E-05 -7935.0576   272.3290  9.463E-06  4658.8987  2.114E+10    -1.3312
81688.      0.000
    21.250  7.559E-05 -7126.6779   267.2022  8.395E-06  4650.8038  2.114E+10    -2.0866
82813.      0.000
    21.500  9.926E-05 -6336.7806   259.9065  7.439E-06  4642.8940  2.114E+10    -2.7772
83938.      0.000
    21.750   0.000120 -5571.6135   250.6273  6.594E-06  4635.2318  2.114E+10    -3.4090
85063.      0.000
    22.000   0.000139 -4836.8946   239.5313  5.856E-06  4627.8745  2.114E+10    -3.9883
86188.      0.000
    22.250   0.000155 -4137.8689   226.7662  5.219E-06  4620.8747  2.114E+10    -4.5217
87313.      0.000
    22.500   0.000170 -3479.3662   212.4602  4.679E-06  4614.2806  2.114E+10    -5.0156
88438.      0.000
    22.750   0.000183 -2865.8589   196.7223  4.229E-06  4608.1372  2.114E+10    -5.4763
89563.      0.000
    23.000   0.000196 -2301.5191   179.6425  3.862E-06  4602.4860  2.114E+10    -5.9102
90688.      0.000
    23.250   0.000207 -1790.2747   161.2927  3.572E-06  4597.3666  2.114E+10    -6.3231
91813.      0.000
    23.500   0.000217 -1335.8632   141.7271  3.350E-06  4592.8162  2.114E+10    -6.7207
92938.      0.000
    23.750   0.000227  -941.8820   120.9838  3.188E-06  4588.8710  2.114E+10    -7.1082
94063.      0.000
    24.000   0.000236  -611.8353    99.0860  3.078E-06  4585.5660  2.114E+10    -7.4903
95188.      0.000
    24.250   0.000245  -349.1759    76.0439  3.010E-06  4582.9358  2.114E+10    -7.8711
96313.      0.000
    24.500   0.000254  -157.3419    51.8563  2.974E-06  4581.0148  2.114E+10    -8.2539
97438.      0.000
    24.750   0.000263   -39.7864    26.5137  2.960E-06  4579.8377  2.114E+10    -8.6412
98563.      0.000
    25.000   0.000272      0.000      0.000  2.957E-06  4579.4393  2.114E+10    -9.0346
49844.      0.000

* The above values of total stress are combined axial and bending stresses.


Output Summary for Load Case No. 2:

Pile-head deflection              =      0.0645871 inches
Computed slope at pile head       =     -0.0012223 radians
Maximum bending moment            =        260664. inch-lbs
Maximum shear force               =  -2540.3804336 lbs
Depth of maximum bending moment  =      2.7500000 feet below pile head
Depth of maximum shear force      =      7.7500000 feet below pile head
Number of iterations              =              8
Number of zero deflection points =              2



--------------------------------------------------------------------------------
            Pile-head Deflection vs. Pile Length for Load Case 2
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Boundary Condition Type 1, Shear and Moment

Shear      =           2000.  lb
Moment     =         216000. in- lb
Axial Load =          98000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
25.0000	0.0645871	260664.	-2540.3804336
23.7500	0.0641248	260923.	-2567.8346033
22.5000	0.0642961	260790.	-2542.3501313
21.2500	0.0643899	260727.	-2546.9434783
20.0000	0.0646502	260627.	-2521.0116888
18.7500	0.0645393	260692.	-2502.3107454
17.5000	0.0645488	260680.	-2486.7951010
16.2500	0.0647223	260551.	-2514.5634939
15.0000	0.0655204	260214.	-2644.8025977
13.7500	0.0725664	257800.	-3040.1236101
12.5000	0.0804636	255962.	-3300.7316068
11.2500	0.1079871	253337.	-3802.5960228
10.0000	0.2024039	254238.	-5281.4619537
8.7500	0.3502890	257572.	-6956.5261694
7.5000	0.5177517	261890.	-8253.2390804

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 3

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 3000.0 lbs
Applied moment at pile head = 276000.0 in-lbs
Axial thrust load on pile head = 127000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0892	276000.	3000.0000	-0.001654	8698.3654	2.114E+10	0.000	0.000	0.000
0.250	0.0843	285623.	2972.5378	-0.001614	8794.7249	2.114E+10	-18.3081	651.5209	0.000
0.500	0.0795	295065.	2887.7195	-0.001573	8889.2798	2.114E+10	-38.2375	1442.5634	0.000
0.750	0.0749	304148.	2741.9705	-0.001531	8980.2289	2.114E+10	-58.9285	2361.4388	0.000
1.000	0.0703	312683.	2539.6325	-0.001487	9065.7024	2.114E+10	-75.9635	3240.0000	0.000
1.250	0.0659	320518.	2292.1529	-0.001442	9144.1605	2.114E+10	-89.0229	4050.0000	0.000
1.500	0.0617	327535.	2008.7227	-0.001396	9214.4221	2.114E+10	-99.9306	4860.0000	0.000
1.750	0.0576	333634.	1695.6224	-0.001349	9275.5003	2.114E+10	-108.8029	5670.0000	0.000
2.000	0.0536	338737.	1358.7803	-0.001301	9326.5921	2.114E+10	-115.7584	6480.0000	0.000
2.250	0.0498	342779.	1003.7666	-0.001253	9367.0680	2.114E+10	-120.9174	7290.0000	0.000
2.500	0.0461	345714.	635.7886	-0.001204	9396.4608	2.114E+10	-124.4013	8100.0000	0.000
2.750	0.0425	347511.	259.6887	-0.001155	9414.4550	2.114E+10	-126.3320	8910.0000	0.000
3.000	0.0391	348152.	-120.0561	-0.001105	9420.8755	2.114E+10	-126.8312	9720.0000	0.000
3.250	0.0359	347633.	-499.3326	-0.001056	9415.6772	2.114E+10	-126.0198	10530.	0.000
3.500	0.0328	345961.	-874.3875	-0.001007	9398.9332	2.114E+10	-124.0168	11340.	0.000
3.750	0.0299	343154.	-1241.8219	-0.000958	9370.8251	2.114E+10	-120.9394	12150.	0.000
4.000	0.0271	339240.	-1598.5836	-0.000910	9331.6318	2.114E+10	-116.9017	12960.	0.000
4.250	0.0244	334255.	-1941.9575	-0.000862	9281.7192	2.114E+10	-112.0143	13770.	0.000
4.500	0.0219	328245.	-2269.5547	-0.000815	9221.5306	2.114E+10	-106.3838	14580.	0.000
4.750	0.0195	321259.	-2579.2993	-0.000769	9151.5765	2.114E+10	-100.1126	15390.	0.000
5.000	0.0173	313355.	-2764.0224	-0.000724	9072.4260	2.114E+10	-23.0362	3999.9538	0.000
5.250	0.0152	305226.	-2830.2877	-0.000680	8991.0298	2.114E+10	-21.1407		

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4179.9538      0.000
     5.500     0.0132    296891. -2890.7711  -0.000637  8907.5631  2.114E+10   -19.1816
4359.9538      0.000
     5.750     0.0114    288367. -2945.3087  -0.000596  8822.2069  2.114E+10   -17.1768
4539.9538      0.000
     6.000   0.009625    279673. -2993.7888  -0.000555  8735.1466  2.114E+10   -15.1433
4719.9538      0.000
     6.250   0.008019    270828. -3036.1498  -0.000516  8646.5700  2.114E+10   -13.0973
4899.9538      0.000
     6.500   0.006528    261850. -3072.3765  -0.000478  8556.6665  2.114E+10   -11.0538
5079.9538      0.000
     6.750   0.005148    252758. -3102.4975  -0.000442  8465.6250  2.114E+10    -9.0268
5259.9538      0.000
     7.000   0.003877    243571. -3151.8266  -0.000407  8373.6332  2.114E+10   -23.8592
18464.      0.000
     7.250   0.002708    234157. -3219.3601  -0.000373  8279.3592  2.114E+10   -21.1631
23442.      0.000
     7.500   0.001640    224539. -3277.9389  -0.000340  8183.0511  2.114E+10   -17.8894
32727.      0.000
     7.750   0.000667    214748. -3324.5954  -0.000309  8085.0092  2.114E+10   -13.2150
59442.      0.000
     8.000  -0.000215    204827. -3330.5503  -0.000279  7985.6600  2.114E+10     9.2451
129279.      0.000
     8.250  -0.001009    194978. -3293.7379  -0.000251  7887.0332  2.114E+10    15.2965
45488.      0.000
     8.500  -0.001720    185256. -3243.4200  -0.000224  7789.6794  2.114E+10    18.2488
31827.      0.000
     8.750  -0.002353    175688. -3185.6784  -0.000198  7693.8699  2.114E+10    20.2456
25817.      0.000
     9.000  -0.002910    166293. -3122.7195  -0.000174  7599.7899  2.114E+10    21.7270
22398.      0.000
     9.250  -0.003397    157084. -3055.8199  -0.000151  7507.5780  2.114E+10    22.8727
20200.      0.000
     9.500  -0.003817    148073. -2985.8468  -0.000129  7417.3424  2.114E+10    23.7760
18687.      0.000
     9.750  -0.004174    139268. -2913.4431  -0.000109  7329.1695  2.114E+10    24.4930
17604.      0.000
    10.000  -0.004472    130676. -2839.1132 -8.994E-05  7243.1285  2.114E+10    25.0603
16813.      0.000
    10.250  -0.004714    122302. -2763.2681 -7.199E-05  7159.2753  2.114E+10    25.5031
16232.      0.000
    10.500  -0.004903    114151. -2686.2532 -5.521E-05  7077.6543  2.114E+10    25.8401
15809.      0.000
    10.750  -0.005045    106226. -2608.3654 -3.958E-05  6998.3003  2.114E+10    26.0851
15512.      0.000
    11.000  -0.005141     98531. -2550.6309 -2.505E-05  6921.2397  2.114E+10    12.4045
7238.6541      0.000
    11.250  -0.005195     90942. -2512.7536 -1.161E-05  6845.2437  2.114E+10    12.8470
7418.6541      0.000
    11.500  -0.005211     83463. -2473.6864  7.672E-07  6770.3563  2.114E+10    13.1978
7598.6541      0.000
    11.750  -0.005191     76099. -2433.7020  1.209E-05  6696.6131  2.114E+10    13.4585
7778.6541      0.000
    12.000  -0.005138     68852. -2393.0682  2.237E-05  6624.0416  2.114E+10    13.6307
7958.6541      0.000
    12.250  -0.005056     61724. -2352.0465  3.164E-05  6552.6613  2.114E+10    13.7171
8138.6541      0.000
    12.500  -0.004948     54715. -2310.8894  3.990E-05  6482.4838  2.114E+10    13.7209
8318.6541      0.000
    12.750  -0.004817     47828. -2269.8394  4.717E-05  6413.5133  2.114E+10    13.6457
8498.6541      0.000
    13.000  -0.004665     41060. -2229.1271  5.348E-05  6345.7467  2.114E+10    13.4959
8678.6541      0.000
    13.250  -0.004496     34412. -2188.9690  5.884E-05  6279.1741  2.114E+10    13.2762
8858.6541      0.000
    13.500  -0.004312     27882. -2149.5666  6.326E-05  6213.7794  2.114E+10    12.9921
9038.6541      0.000
    13.750  -0.004116     21467. -2111.1043  6.676E-05  6149.5405  2.114E+10    12.6494
9218.6541      0.000
    14.000  -0.003912     15164. -1993.9718  6.936E-05  6086.4300  2.114E+10    65.4389
50188.      0.000
    14.250  -0.003700  9449.9796 -1800.8762  7.110E-05  6029.2089  2.114E+10    63.2916
51313.      0.000
    14.500  -0.003485  4304.8174 -1614.5654  7.208E-05  5977.6867  2.114E+10    60.9155
52438.      0.000
    14.750  -0.003268  -292.3376 -1435.6742  7.236E-05  5937.5068  2.114E+10    58.3453
53563.      0.000
    15.000  -0.003051 -4364.3693 -1264.7347  7.203E-05  5978.2830  2.114E+10    55.6144
54688.      0.000
    15.250  -0.002836 -7935.6354 -1102.1801  7.116E-05  6014.0446  2.114E+10    52.7553
55813.      0.000
    15.500  -0.002624    -11032.  -948.3485  6.982E-05  6045.0475  2.114E+10    49.7990
56938.      0.000
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15.750	-0.002417	-13679.	-803.4879	6.806E-05	6071.5563	2.114E+10	46.7747	58063.	0.000
16.000	-0.002215	-15904.	-667.7608	6.596E-05	6093.8423	2.114E+10	43.7100	59188.	0.000
16.250	-0.002021	-17736.	-541.2501	6.358E-05	6112.1803	2.114E+10	40.6305	60313.	0.000
16.500	-0.001834	-19200.	-423.9649	6.096E-05	6126.8469	2.114E+10	37.5597	61438.	0.000
16.750	-0.001655	-20326.	-315.8467	5.815E-05	6138.1182	2.114E+10	34.5191	62563.	0.000
17.000	-0.001485	-21140.	-216.7758	5.521E-05	6146.2674	2.114E+10	31.5282	63688.	0.000
17.250	-0.001324	-21669.	-126.5775	5.217E-05	6151.5638	2.114E+10	28.6041	64813.	0.000
17.500	-0.001172	-21939.	-45.0286	4.908E-05	6154.2706	2.114E+10	25.7619	65938.	0.000
17.750	-0.001030	-21976.	28.1360	4.596E-05	6154.6437	2.114E+10	23.0145	67063.	0.000
18.000	-0.000896	-21805.	93.2171	4.286E-05	6152.9308	2.114E+10	20.3729	68188.	0.000
18.250	-0.000772	-21450.	150.5452	3.979E-05	6149.3700	2.114E+10	17.8458	69313.	0.000
18.500	-0.000658	-20932.	200.4744	3.678E-05	6144.1893	2.114E+10	15.4403	70438.	0.000
18.750	-0.000552	-20275.	243.3765	3.386E-05	6137.6057	2.114E+10	13.1611	71563.	0.000
19.000	-0.000454	-19498.	279.6357	3.103E-05	6129.8250	2.114E+10	11.0117	72688.	0.000
19.250	-0.000366	-18621.	309.6438	2.833E-05	6121.0414	2.114E+10	8.9936	73813.	0.000
19.500	-0.000285	-17662.	333.7944	2.575E-05	6111.4371	2.114E+10	7.1068	74938.	0.000
19.750	-0.000211	-16638.	352.4794	2.332E-05	6101.1827	2.114E+10	5.3499	76063.	0.000
20.000	-0.000145	-15564.	366.0842	2.104E-05	6090.4372	2.114E+10	3.7200	77188.	0.000
20.250	-8.479E-05	-14457.	374.9842	1.891E-05	6079.3481	2.114E+10	2.2133	78313.	0.000
20.500	-3.115E-05	-13329.	379.5414	1.693E-05	6068.0516	2.114E+10	0.8248	79438.	0.000
20.750	1.682E-05	-12193.	380.1010	1.512E-05	6056.6736	2.114E+10	-0.4516	80563.	0.000
21.000	5.959E-05	-11060.	376.9895	1.347E-05	6045.3296	2.114E+10	-1.6227	81688.	0.000
21.250	9.766E-05	-9941.0172	370.5116	1.198E-05	6034.1260	2.114E+10	-2.6959	82813.	0.000
21.500	0.000131	-8845.9107	360.9491	1.065E-05	6023.1599	2.114E+10	-3.6792	83938.	0.000
21.750	0.000162	-7783.4386	348.5587	9.471E-06	6012.5206	2.114E+10	-4.5811	85063.	0.000
22.000	0.000188	-6761.7754	333.5716	8.439E-06	6002.2899	2.114E+10	-5.4103	86188.	0.000
22.250	0.000212	-5788.4396	316.1922	7.548E-06	5992.5432	2.114E+10	-6.1759	87313.	0.000
22.500	0.000234	-4870.3740	296.5983	6.792E-06	5983.3500	2.114E+10	-6.8867	88438.	0.000
22.750	0.000253	-4014.0255	274.9407	6.162E-06	5974.7748	2.114E+10	-7.5517	89563.	0.000
23.000	0.000271	-3225.4252	251.3439	5.648E-06	5966.8779	2.114E+10	-8.1795	90688.	0.000
23.250	0.000287	-2510.2660	225.9068	5.241E-06	5959.7165	2.114E+10	-8.7785	91813.	0.000
23.500	0.000302	-1873.9780	198.7040	4.930E-06	5953.3449	2.114E+10	-9.3566	92938.	0.000
23.750	0.000316	-1321.7985	169.7874	4.703E-06	5947.8156	2.114E+10	-9.9211	94063.	0.000
24.000	0.000330	-858.8377	139.1878	4.549E-06	5943.1796	2.114E+10	-10.4786	95188.	0.000
24.250	0.000344	-490.1375	106.9180	4.453E-06	5939.4875	2.114E+10	-11.0346	96313.	0.000
24.500	0.000357	-220.7225	72.9751	4.402E-06	5936.7897	2.114E+10	-11.5940	97438.	0.000
24.750	0.000370	-55.6417	37.3437	4.383E-06	5935.1366	2.114E+10	-12.1602	98563.	0.000
25.000	0.000383	0.000	0.000	4.379E-06	5934.5794	2.114E+10	-12.7356	49844.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 3:

Pile-head deflection = 0.0892053 inches

Computed slope at pile head	=	-0.0016541 radians
Maximum bending moment	=	348152. inch-lbs
Maximum shear force	=	-3330.5502505 lbs
Depth of maximum bending moment	=	3.0000000 feet below pile head
Depth of maximum shear force	=	8.0000000 feet below pile head
Number of iterations	=	8
Number of zero deflection points	=	2

Pile-head Deflection vs. Pile Length for Load Case 3

Boundary Condition Type 1, Shear and Moment

Shear = 3000. lb
Moment = 276000. in- lb
Axial Load = 127000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
25.0000	0.0892053	348152.	-3330.5502505
23.7500	0.0884507	348511.	-3369.9354294
22.5000	0.0887251	348282.	-3338.7670957
21.2500	0.0888807	348247.	-3338.9582011
20.0000	0.0892347	348107.	-3301.1051408
18.7500	0.0890796	348205.	-3274.4947922
17.5000	0.0890488	348204.	-3255.8003772
16.2500	0.0893564	347970.	-3298.6084267
15.0000	0.0905632	347510.	-3476.1593366
13.7500	0.1014225	344376.	-4026.3888258
12.5000	0.1146674	342571.	-4403.9510585
11.2500	0.1819518	342521.	-5463.1914635
10.0000	0.6205937	355147.	-9847.9001322

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 4

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head	=	3000.0 lbs
Applied moment at pile head	=	348000.0 in-lbs
Axial thrust load on pile head	=	133000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1028	348000.	3000.0000	-0.001957	9699.7269	2.114E+10	0.000	0.000	0.000
0.250	0.0970	357771.	2971.4896	-0.001907	9797.5706	2.114E+10	-19.0070	588.0580	0.000
0.500	0.0913	367351.	2883.3671	-0.001855	9893.4985	2.114E+10	-39.7413	1305.5584	0.000
0.750	0.0858	376552.	2731.8308	-0.001803	9985.6365	2.114E+10	-61.2829	2141.9531	0.000
1.000	0.0805	385180.	2515.6492	-0.001749	10072.	2.114E+10	-82.8382	3086.9644	0.000
1.250	0.0753	393041.	2238.8269	-0.001693	10151.	2.114E+10	-101.7100	4050.0000	0.000
1.500	0.0703	399964.	1915.3253	-0.001637	10220.	2.114E+10	-113.9577	4860.0000	0.000
1.750	0.0655	405839.	1558.6448	-0.001580	10279.	2.114E+10	-123.8292	5670.0000	0.000
2.000	0.0609	410577.	1175.6994	-0.001522	10326.	2.114E+10	-131.4678	6480.0000	0.000
2.250	0.0564	414108.	772.9705	-0.001463	10362.	2.114E+10	-137.0182	7290.0000	0.000
2.500	0.0521	416383.	356.5040	-0.001405	10384.	2.114E+10	-140.6261	8100.0000	0.000
2.750	0.0480	417368.	-68.0911	-0.001345	10394.	2.114E+10	-142.4373	8910.0000	0.000

3.000	0.0440	417048.	-495.6419	-0.001286	10391.	2.114E+10	-142.5966	9720.0000	0.000
3.250	0.0402	415421.	-921.4080	-0.001227	10375.	2.114E+10	-141.2475	10530.	0.000
3.500	0.0366	412499.	-1341.0759	-0.001168	10346.	2.114E+10	-138.5311	11340.	0.000
3.750	0.0332	408307.	-1750.7513	-0.001110	10304.	2.114E+10	-134.5858	12150.	0.000
4.000	0.0300	402880.	-2146.9489	-0.001053	10249.	2.114E+10	-129.5459	12960.	0.000
4.250	0.0269	396265.	-2526.5805	-0.000996	10183.	2.114E+10	-123.5418	13770.	0.000
4.500	0.0240	388515.	-2886.9411	-0.000940	10105.	2.114E+10	-116.6986	14580.	0.000
4.750	0.0213	379693.	-3225.6932	-0.000886	10017.	2.114E+10	-109.1361	15390.	0.000
5.000	0.0187	369868.	-3426.7925	-0.000833	9918.7060	2.114E+10	-24.9301	3999.9538	0.000
5.250	0.0163	359797.	-3498.2101	-0.000781	9817.8593	2.114E+10	-22.6817	4179.9538	0.000
5.500	0.0140	349502.	-3562.7811	-0.000730	9714.7645	2.114E+10	-20.3656	4359.9538	0.000
5.750	0.0119	339003.	-3620.3338	-0.000682	9609.6361	2.114E+10	-18.0029	4539.9538	0.000
6.000	0.009924	328324.	-3670.7578	-0.000634	9502.6930	2.114E+10	-15.6131	4719.9538	0.000
6.250	0.008091	317485.	-3714.0000	-0.000588	9394.1566	2.114E+10	-13.2150	4899.9538	0.000
6.500	0.006393	306509.	-3750.0610	-0.000544	9284.2493	2.114E+10	-10.8257	5079.9538	0.000
6.750	0.004826	295419.	-3778.9919	-0.000501	9173.1925	2.114E+10	-8.4616	5259.9538	0.000
7.000	0.003385	284235.	-3825.8738	-0.000460	9061.2056	2.114E+10	-22.7930	20203.	0.000
7.250	0.002064	272831.	-3889.0322	-0.000421	8947.0035	2.114E+10	-19.3126	28068.	0.000
7.500	0.000860	261237.	-3939.5704	-0.000383	8830.9061	2.114E+10	-14.3795	50165.	0.000
7.750	-0.000233	249499.	-3946.8255	-0.000347	8713.3646	2.114E+10	9.5427	122803.	0.000
8.000	-0.001220	237833.	-3908.0564	-0.000312	8596.5417	2.114E+10	16.3034	40092.	0.000
8.250	-0.002106	226300.	-3854.3134	-0.000279	8481.0533	2.114E+10	19.5253	27820.	0.000
8.500	-0.002895	214929.	-3792.4785	-0.000248	8367.1963	2.114E+10	21.6981	22487.	0.000
8.750	-0.003593	203742.	-3724.9662	-0.000218	8255.1729	2.114E+10	23.3102	19465.	0.000
9.000	-0.004204	192754.	-3653.1634	-0.000190	8145.1348	2.114E+10	24.5584	17527.	0.000
9.250	-0.004733	181975.	-3578.0089	-0.000163	8037.2007	2.114E+10	25.5447	16193.	0.000
9.500	-0.005184	171416.	-3500.1970	-0.000138	7931.4656	2.114E+10	26.3299	15237.	0.000
9.750	-0.005563	161084.	-3420.2714	-0.000115	7828.0062	2.114E+10	26.9538	14537.	0.000
10.000	-0.005872	150986.	-3338.6750	-9.260E-05	7726.8847	2.114E+10	27.4438	14020.	0.000
10.250	-0.006118	141126.	-3255.7792	-7.187E-05	7628.1509	2.114E+10	27.8200	13641.	0.000
10.500	-0.006304	131509.	-3171.9031	-5.253E-05	7531.8443	2.114E+10	28.0974	13372.	0.000
10.750	-0.006433	122137.	-3087.3253	-3.453E-05	7437.9954	2.114E+10	28.2877	13191.	0.000
11.000	-0.006511	113012.	-3021.3285	-1.785E-05	7346.6267	2.114E+10	15.7101	7238.6541	0.000
11.250	-0.006540	104023.	-2973.5027	-2.451E-06	7256.6097	2.114E+10	16.1737	7418.6541	0.000
11.500	-0.006526	95173.	-2924.4491	1.168E-05	7167.9913	2.114E+10	16.5287	7598.6541	0.000
11.750	-0.006470	86467.	-2874.4908	2.457E-05	7080.8087	2.114E+10	16.7768	7778.6541	0.000
12.000	-0.006378	77907.	-2823.9445	3.623E-05	6995.0890	2.114E+10	16.9207	7958.6541	0.000
12.250	-0.006253	69494.	-2773.1183	4.669E-05	6910.8500	2.114E+10	16.9635	8138.6541	0.000
12.500	-0.006098	61231.	-2722.3092	5.597E-05	6828.1005	2.114E+10	16.9092	8318.6541	0.000
12.750	-0.005917	53116.	-2671.8015	6.408E-05	6746.8402	2.114E+10	16.7626	8498.6541	0.000
13.000	-0.005714	45149.	-2621.8646	7.105E-05	6667.0605	2.114E+10	16.5287	8678.6541	0.000
13.250	-0.005491	37328.	-2572.7508	7.690E-05	6588.7448	2.114E+10	16.2138		

```
8858.6541      0.000
   13.500  -0.005252     29651. -2524.6939  8.166E-05  6511.8691  2.114E+10    15.8242
9038.6541      0.000
   13.750  -0.005001     22115. -2477.9070  8.533E-05  6436.4028  2.114E+10    15.3671
9218.6541      0.000
   14.000  -0.004740     14715. -2335.9060  8.794E-05  6362.3089  2.114E+10    79.3001
50188.     0.000
   14.250  -0.004473  8029.0061 -2102.1885  8.956E-05  6295.3535  2.114E+10    76.5116
51313.     0.000
   14.500  -0.004203  2030.7825 -1877.2266  9.027E-05  6235.2890  2.114E+10    73.4630
52438.     0.000
   14.750  -0.003932 -3306.3890 -1661.7378  9.018E-05  6248.0625  2.114E+10    70.1962
53563.     0.000
   15.000  -0.003662 -8011.6072 -1456.3158  8.938E-05  6295.1792  2.114E+10    66.7517
54688.     0.000
   15.250  -0.003395    -12116. -1261.4359  8.795E-05  6336.2755  2.114E+10    63.1682
55813.     0.000
   15.500  -0.003134    -15650. -1077.4593  8.598E-05  6371.6720  2.114E+10    59.4828
56938.     0.000
   15.750  -0.002879    -18649.  -904.6394  8.354E-05  6401.6988  2.114E+10    55.7305
58063.     0.000
   16.000  -0.002633    -21145.  -743.1281  8.072E-05  6426.6924  2.114E+10    51.9437
59188.     0.000
   16.250  -0.002395    -23172.  -592.9830  7.758E-05  6446.9927  2.114E+10    48.1530
60313.     0.000
   16.500  -0.002167    -24765.  -454.1744  7.418E-05  6462.9401  2.114E+10    44.3860
61438.     0.000
   16.750  -0.001950    -25956.  -326.5931  7.058E-05  6474.8733  2.114E+10    40.6681
62563.     0.000
   17.000  -0.001744    -26781.  -210.0583  6.683E-05  6483.1266  2.114E+10    37.0218
63688.     0.000
   17.250  -0.001549    -27270.  -104.3249  6.300E-05  6488.0281  2.114E+10    33.4671
64813.     0.000
   17.500  -0.001366    -27457.    -9.0919  5.912E-05  6489.8981  2.114E+10    30.0216
65938.     0.000
   17.750  -0.001194    -27372.    75.9903  5.523E-05  6489.0468  2.114E+10    26.6999
67063.     0.000
   18.000  -0.001035    -27045.   151.3116  5.137E-05  6485.7737  2.114E+10    23.5144
68188.     0.000
   18.250  -0.000886    -26505.   217.2958  4.757E-05  6480.3661  2.114E+10    20.4750
69313.     0.000
   18.500  -0.000749    -25779.   274.3923  4.386E-05  6473.0982  2.114E+10    17.5894
70438.     0.000
   18.750  -0.000623    -24894.   323.0704  4.026E-05  6464.2304  2.114E+10    14.8627
71563.     0.000
   19.000  -0.000508    -23873.   363.8117  3.680E-05  6454.0091  2.114E+10    12.2982
72688.     0.000
   19.250  -0.000402    -22740.   397.1048  3.349E-05  6442.6659  2.114E+10     9.8972
73813.     0.000
   19.500  -0.000307    -21517.   423.4390  3.035E-05  6430.4178  2.114E+10     7.6590
74938.     0.000
   19.750  -0.000220    -20224.   443.2993  2.739E-05  6417.4672  2.114E+10     5.5813
76063.     0.000
   20.000  -0.000142    -18879.   457.1616  2.462E-05  6404.0022  2.114E+10     3.6602
77188.     0.000
   20.250 -7.242E-05    -17500.   465.4878  2.204E-05  6390.1966  2.114E+10     1.8906
78313.     0.000
   20.500 -1.004E-05    -16104.   468.7225  1.965E-05  6376.2107  2.114E+10     0.2659
79438.     0.000
   20.750  4.549E-05    -14704.   467.2890  1.747E-05  6362.1917  2.114E+10    -1.2216
80563.     0.000
   21.000  9.476E-05    -13314.   461.5863  1.548E-05  6348.2745  2.114E+10    -2.5802
81688.     0.000
   21.250   0.000138    -11947.   451.9871  1.369E-05  6334.5823  2.114E+10    -3.8193
82813.     0.000
   21.500   0.000177    -10613.   438.8348  1.209E-05  6321.2274  2.114E+10    -4.9488
83938.     0.000
   21.750   0.000211 -9323.1466   422.4428  1.067E-05  6308.3126  2.114E+10    -5.9792
85063.     0.000
   22.000   0.000241 -8086.7182   403.0927  9.436E-06  6295.9314  2.114E+10    -6.9209
86188.     0.000
   22.250   0.000267 -6912.1203   381.0337  8.372E-06  6284.1693  2.114E+10    -7.7850
87313.     0.000
   22.500   0.000291 -5807.1965   356.4826  7.469E-06  6273.1049  2.114E+10    -8.5823
88438.     0.000
   22.750   0.000312 -4779.1850   329.6237  6.718E-06  6262.8107  2.114E+10    -9.3236
89563.     0.000
   23.000   0.000331 -3834.8151   300.6096  6.107E-06  6253.3540  2.114E+10   -10.0192
90688.     0.000
   23.250   0.000349 -2980.4007   269.5621  5.623E-06  6244.7982  2.114E+10   -10.6792
91813.     0.000
   23.500   0.000365 -2221.9301   236.5738  5.254E-06  6237.2031  2.114E+10   -11.3130
92938.     0.000
```

23.750	0.000380	-1565.1506	201.7103	4.985E-06	6230.6262	2.114E+10	-11.9293	94063.	0.000
24.000	0.000395	-1015.6464	165.0124	4.802E-06	6225.1237	2.114E+10	-12.5360	95188.	0.000
24.250	0.000409	-578.9086	126.4988	4.689E-06	6220.7503	2.114E+10	-13.1397	96313.	0.000
24.500	0.000423	-260.3955	86.1701	4.630E-06	6217.5608	2.114E+10	-13.7461	97438.	0.000
24.750	0.000437	-65.5827	44.0119	4.607E-06	6215.6100	2.114E+10	-14.3593	98563.	0.000
25.000	0.000451	0.000	0.000	4.602E-06	6214.9533	2.114E+10	-14.9820	49844.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 4:

```
Pile-head deflection             =      0.1027615 inches
Computed slope at pile head      =     -0.0019569 radians
Maximum bending moment           =        417368. inch-lbs
Maximum shear force              =  -3946.8255259 lbs
Depth of maximum bending moment  =      2.7500000 feet below pile head
Depth of maximum shear force     =      7.7500000 feet below pile head
Number of iterations             =              8
Number of zero deflection points =              2
```

Pile-head Deflection vs. Pile Length for Load Case 4

Boundary Condition Type 1, Shear and Moment

```
Shear      =           3000.  lb
Moment     =         348000. in- lb
Axial Load =         133000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
25.0000	0.1027615	417368.	-3946.8255259
23.7500	0.1019049	417674.	-3990.5108478
22.5000	0.1022195	417473.	-3957.0521931
21.2500	0.1024186	417468.	-3954.9928493
20.0000	0.1028317	417345.	-3911.1076368
18.7500	0.1026216	417455.	-3879.1142327
17.5000	0.1026115	417457.	-3852.1698612
16.2500	0.1029100	417303.	-3893.8400440
15.0000	0.1043869	416891.	-4095.5513884
13.7500	0.1178259	414885.	-4762.1309276
12.5000	0.1355453	414253.	-5221.2679997
11.2500	0.2469228	416186.	-6752.5486922

Summary of Pile Response(s)

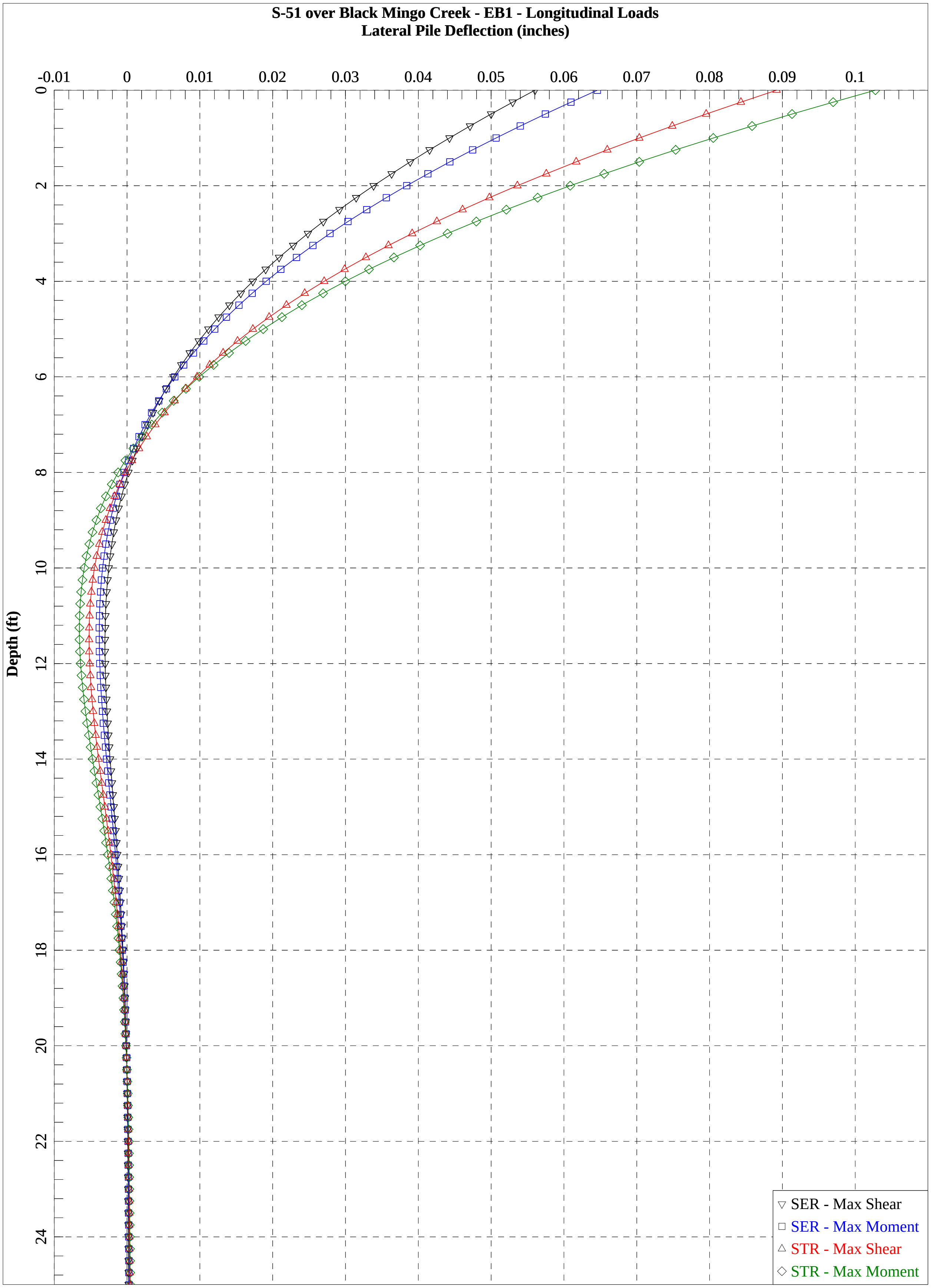
Definitions of Pile-head Loading Conditions:

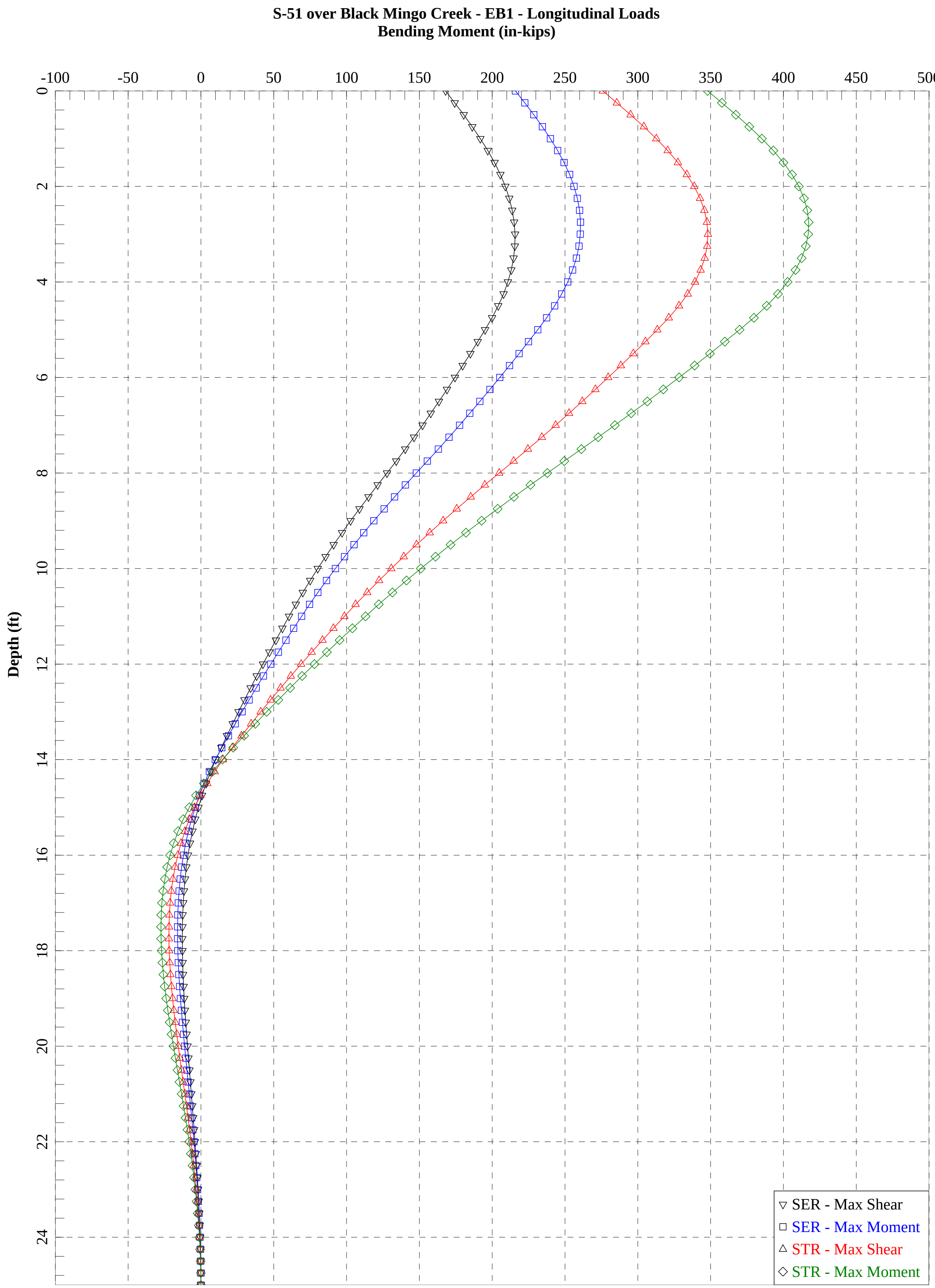
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

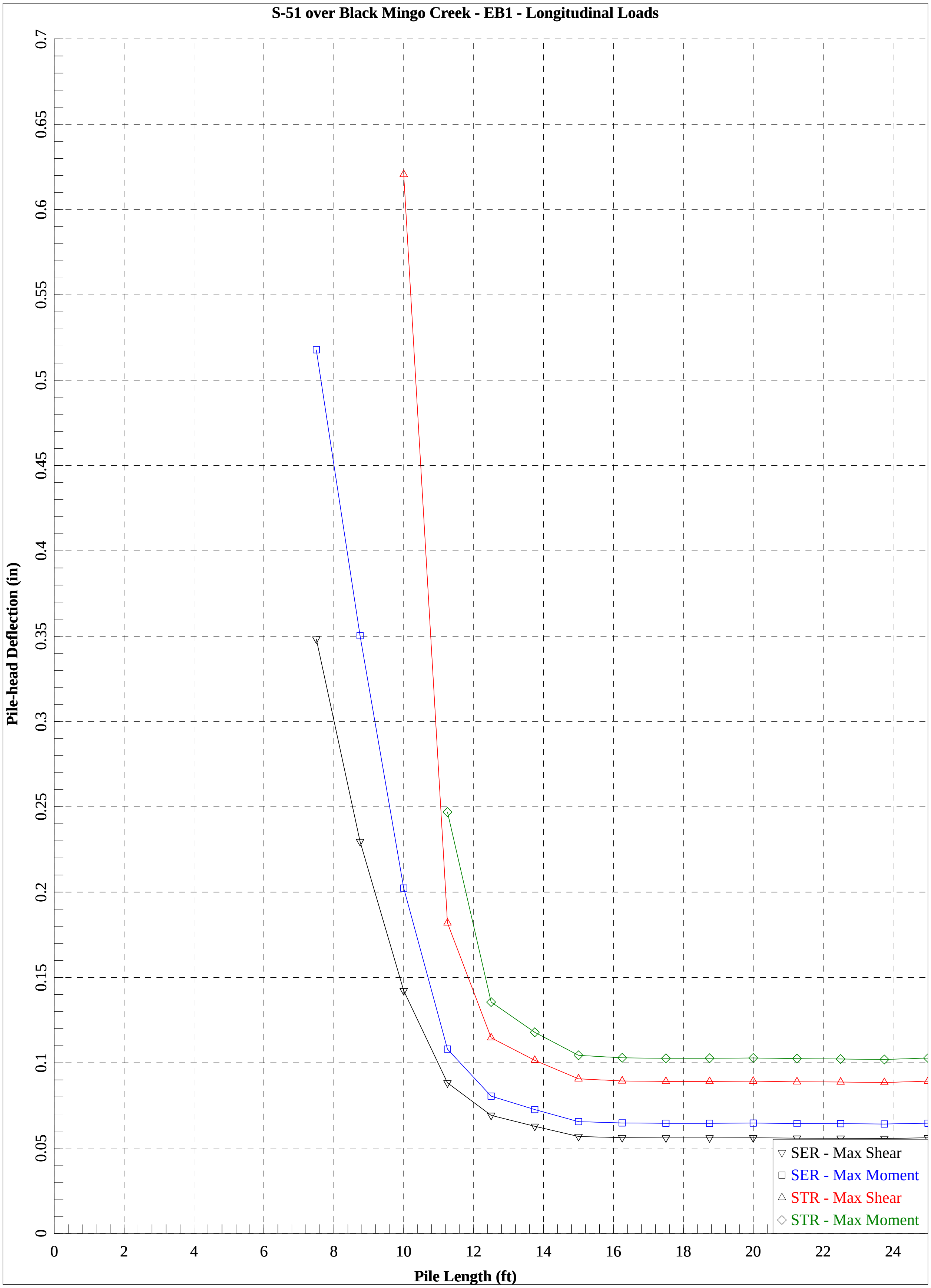
Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians

```
  1     1   V =  2000.0000  M =    168000.         94000.     0.05601888         215691.
-2138.0205    -0.00102780
  2     1   V =  2000.0000  M =    216000.         98000.     0.06458707         260664.
-2540.3804    -0.00122227
  3     1   V =  3000.0000  M =    276000.        127000.     0.08920530         348152.
-3330.5503    -0.00165410
  4     1   V =  3000.0000  M =    348000.        133000.     0.10276149         417368.
-3946.8255    -0.00195694
```

The analysis ended normally.


S-51 over Black Mingo Creek - EB1 - Longitudinal Loads
Lateral Pile Deflection (inches)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Moment


S-51 over Black Mingo Creek - EB1 - Longitudinal Loads
Bending Moment (in-kips)
Depth (ft)
-100
-50
0
50
100
150
200
250
300
350
400
450
500
0
2
4
6
8
10
12
14
16
18
20
22
24
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Moment


S-51 over Black Mingo Creek - EB1 - Longitudinal Loads
Pile-head Deflection (in)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0
2
4
6
8
10
12
14
16
18
20
22
24
Pile Length (ft)
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Moment

==

LPile Plus for Windows, Version 2013-07.007

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

This copy of LPile is used by:

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Serial Number of Security Device: 228740981
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Files Used for Analysis

Path to file locations: P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\LPile\
Name of input data file: EB1_Trans.lp7d
Name of output report file: EB1_Trans.lp7o
Name of plot output file: EB1_Trans.lp7p
Name of runtime messeage file: EB1_Trans.lp7r

Date and Time of Analysis

Date: February 15, 2016   Time: 17:17:03

Problem Title

Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461(SCDOT)

Client: UIG

Engineer: JFH

Description: EB1 - Longitudinal Loads

Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed	=	500
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in
- Number of pile increments	=	100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Use of p-y modification factors for p-y curves not selected
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections	=	1
Total length of pile	=	25.00 ft
Depth of ground surface below top of pile	=	0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	13.6000000

```
  2        25.000000        13.6000000


Input Structural Properties:
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Pile Section No. 1:

   Section Type                                      =    Elastic Pile
   Cross-sectional Shape                             =     Weak H-Pile
   Section Length                                    =     25.00000 ft
   Flange Width                                      =     14.60000 in
   Section Depth                                     =     13.60000 in
   Flange Thickness                                  =      0.50500 in
   Web Thickness                                     =      0.50500 in
   Section Area                                      =     21.40000 Sq. in
   Moment of Inertia                                 =    261.00000 in^4
   Elastic Modulus                                   =    29000000. lbs/in^2


--------------------------------------------------------------------------------
                      Ground Slope and Pile Batter Angles
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Ground Slope Angle                                   =        0.000 degrees
                                                     =        0.000 radians

Pile Batter Angle                                    =        0.000 degrees
                                                     =        0.000 radians


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                       Soil and Rock Layering Information
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The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer         =       0.0000 ft
   Distance from top of pile to bottom of layer      =      5.00000 ft
   Effective unit weight at top of layer             =    125.00000 pcf
   Effective unit weight at bottom of layer          =    125.00000 pcf
   Friction angle at top of layer                    =     34.00000 deg.
   Friction angle at bottom of layer                 =     34.00000 deg.
   Subgrade k at top of layer                        =     90.00000 pci
   Subgrade k at bottom of layer                     =     90.00000 pci


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer         =      5.00000 ft
   Distance from top of pile to bottom of layer      =      7.00000 ft
   Effective unit weight at top of layer             =     43.00000 pcf
   Effective unit weight at bottom of layer          =     43.00000 pcf
   Friction angle at top of layer                    =     28.00000 deg.
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   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 3 is soft clay, p-y criteria by Matlock, 1970

   Distance from top of pile to top of layer          =      7.00000 ft
   Distance from top of pile to bottom of layer       =     11.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Undrained cohesion at top of layer                 =    300.00000 psf
   Undrained cohesion at bottom of layer              =    300.00000 psf
   Epsilon-50 at top of layer                         =      0.02000
   Epsilon-50 at bottom of layer                      =      0.02000


Layer 4 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     11.00000 ft
   Distance from top of pile to bottom of layer       =     14.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     28.00000 deg.
   Friction angle at bottom of layer                  =     28.00000 deg.
   Subgrade k at top of layer                         =     20.00000 pci
   Subgrade k at bottom of layer                      =     20.00000 pci


Layer 5 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     14.00000 ft
   Distance from top of pile to bottom of layer       =     50.00000 ft
   Effective unit weight at top of layer              =     63.00000 pcf
   Effective unit weight at bottom of layer           =     63.00000 pcf
   Friction angle at top of layer                     =     40.00000 deg.
   Friction angle at bottom of layer                  =     40.00000 deg.
   Subgrade k at top of layer                         =    125.00000 pci
   Subgrade k at bottom of layer                      =    125.00000 pci


   (Depth of lowest soil layer extends   25.00 ft below pile tip)


--------------------------------------------------------------------------------
                           Summary of Soil Properties
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Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	0.00	125.000	--	34.000	--	90.000
		5.000	125.000	--	34.000	--	90.000
2	Sand (Reese, et al.)	5.000	43.000	--	28.000	--	20.000

		7.000	43.000	--	28.000	--	20.000
3	Soft Clay	7.000	53.000	300.000	--	0.02000	--
		11.000	53.000	300.000	--	0.02000	--
4	Sand (Reese, et al.)	11.000	53.000	--	28.000	--	20.000
		14.000	53.000	--	28.000	--	20.000
5	Sand (Reese, et al.)	14.000	63.000	--	40.000	--	125.000
		50.000	63.000	--	40.000	--	125.000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	2	V = 1000.00000 lbs	S = 0.0000 in/in	65000.	Yes
2	2	V = 1000.00000 lbs	S = 0.0000 in/in	55000.	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

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Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 2, Shear and Slope

Shear = 1000. lb
Slope = 0.00000
Axial Load = 65000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
25.0000	0.0074401	-36105.	1000.0000000
23.7500	0.0073533	-36014.	1000.0000000
22.5000	0.0073972	-36008.	1000.0000000
21.2500	0.0073838	-36064.	1000.0000000
20.0000	0.0074321	-36090.	1000.0000000
18.7500	0.0074305	-36034.	1000.0000000
17.5000	0.0074365	-36023.	1000.0000000
16.2500	0.0074475	-36028.	1000.0000000
15.0000	0.0074077	-36011.	1000.0000000
13.7500	0.0075694	-35946.	1000.0000000
12.5000	0.0077573	-36009.	1000.0000000
11.2500	0.0078458	-36027.	1000.0000000
10.0000	0.0081369	-36641.	1000.0000000
8.7500	0.0084912	-38022.	1000.0000000
7.5000	0.0086684	-39702.	1000.0000000
6.2500	0.0087034	-38757.	1000.0000000
5.0000	0.0088784	-37294.	1000.0000000
3.7500	0.0122090	-29558.	1000.0000000
2.5000	0.0250649	-19991.	1000.0000002
1.2500	0.2476692	-10194.	1006.0287814

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 1000.0 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 55000.0 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.007435	-36081.	1000.0000	0.000	3510.1424	7.569E+09	0.000	0.000	0.000
0.250	0.007413	-33080.	996.9977	-1.371E-05	3431.9508	7.569E+09	-2.0015	810.0000	0.000
0.500	0.007352	-30095.	988.0400	-2.623E-05	3354.1721	7.569E+09	-3.9703	1620.0000	0.000
0.750	0.007256	-27143.	973.2688	-3.757E-05	3277.2731	7.569E+09	-5.8772	2430.0000	0.000
1.000	0.007127	-24243.	952.9074	-4.775E-05	3201.7059	7.569E+09	-7.6971	3240.0000	0.000

1.250	0.006969	-21410.	927.2490	-5.680E-05	3127.9022	7.569E+09	-9.4085	4050.0000	0.000
1.500	0.006786	-18661.	896.6460	-6.474E-05	3056.2683	7.569E+09	-10.9935	4860.0000	0.000
1.750	0.006581	-16009.	861.4991	-7.161E-05	2987.1803	7.569E+09	-12.4377	5670.0000	0.000
2.000	0.006356	-13468.	822.2476	-7.745E-05	2920.9814	7.569E+09	-13.7300	6480.0000	0.000
2.250	0.006116	-11050.	779.3595	-8.231E-05	2857.9791	7.569E+09	-14.8621	7290.0000	0.000
2.500	0.005863	-8764.5868	733.3228	-8.624E-05	2798.4428	7.569E+09	-15.8290	8100.0000	0.000
2.750	0.005599	-6621.3326	684.6373	-8.929E-05	2742.6033	7.569E+09	-16.6280	8910.0000	0.000
3.000	0.005327	-4627.2976	633.8068	-9.152E-05	2690.6514	7.569E+09	-17.2590	9720.0000	0.000
3.250	0.005050	-2788.2912	581.3324	-9.299E-05	2642.7386	7.569E+09	-17.7239	10530.	0.000
3.500	0.004769	-1108.6179	527.7066	-9.376E-05	2598.9770	7.569E+09	-18.0266	11340.	0.000
3.750	0.004487	408.8887	473.4082	-9.390E-05	2580.7465	7.569E+09	-18.1724	12150.	0.000
4.000	0.004206	1762.8174	418.8977	-9.347E-05	2616.0213	7.569E+09	-18.1680	12960.	0.000
4.250	0.003926	2953.1191	364.6139	-9.253E-05	2647.0330	7.569E+09	-18.0212	13770.	0.000
4.500	0.003650	3981.0364	310.9709	-9.116E-05	2673.8139	7.569E+09	-17.7407	14580.	0.000
4.750	0.003379	4849.0270	258.3566	-8.941E-05	2696.4283	7.569E+09	-17.3355	15390.	0.000
5.000	0.003114	5560.6808	226.1467	-8.735E-05	2714.9694	7.569E+09	-4.1377	3986.3770	0.000
5.250	0.002855	6234.7313	213.9923	-8.501E-05	2732.5309	7.569E+09	-3.9652	4166.3770	0.000
5.500	0.002604	6872.6870	202.3857	-8.241E-05	2749.1520	7.569E+09	-3.7724	4346.3770	0.000
5.750	0.002361	7476.2413	191.3844	-7.957E-05	2764.8768	7.569E+09	-3.5618	4526.3770	0.000
6.000	0.002126	8047.2503	181.0377	-7.649E-05	2779.7536	7.569E+09	-3.3360	4706.3770	0.000
6.250	0.001902	8587.7094	171.3874	-7.319E-05	2793.8345	7.569E+09	-3.0976	4886.3770	0.000
6.500	0.001687	9099.7287	162.4668	-6.969E-05	2807.1745	7.569E+09	-2.8495	5066.3770	0.000
6.750	0.001484	9585.5076	154.3008	-6.599E-05	2819.8308	7.569E+09	-2.5946	5246.3770	0.000
7.000	0.001291	10047.	126.6487	-6.209E-05	2831.8624	7.569E+09	-15.8402	36799.	0.000
7.250	0.001111	10366.	80.2762	-5.805E-05	2840.1626	7.569E+09	-15.0748	40704.	0.000
7.500	0.000943	10548.	36.2381	-5.390E-05	2844.9104	7.569E+09	-14.2840	45439.	0.000
7.750	0.000788	10601.	-5.3851	-4.971E-05	2846.2909	7.569E+09	-13.4648	51286.	0.000
8.000	0.000645	10532.	-44.5008	-4.553E-05	2844.4961	7.569E+09	-12.6124	58681.	0.000
8.250	0.000514	10349.	-80.9979	-4.139E-05	2839.7259	7.569E+09	-11.7190	68335.	0.000
8.500	0.000396	10060.	-114.7345	-3.734E-05	2832.1902	7.569E+09	-10.7721	81510.	0.000
8.750	0.000290	9673.0425	-145.5181	-3.343E-05	2822.1114	7.569E+09	-9.7503	100718.	0.000
9.000	0.000196	9197.8117	-173.0641	-2.969E-05	2809.7299	7.569E+09	-8.6137	131924.	0.000
9.250	0.000112	8644.4563	-196.8995	-2.616E-05	2795.3130	7.569E+09	-7.2766	194442.	0.000
9.500	3.894E-05	8025.0462	-216.1138	-2.285E-05	2779.1751	7.569E+09	-5.5329	426269.	0.000
9.750	-2.485E-05	7355.3148	-218.9418	-1.980E-05	2761.7262	7.569E+09	3.6476	440394.	0.000
10.000	-7.989E-05	6717.9306	-204.5463	-1.702E-05	2745.1200	7.569E+09	5.9495	223415.	0.000
10.250	-0.000127	6133.6524	-185.0135	-1.447E-05	2729.8974	7.569E+09	7.0724	167140.	0.000
10.500	-0.000167	5612.6244	-162.6962	-1.214E-05	2716.3228	7.569E+09	7.8058	140474.	0.000
10.750	-0.000200	5161.4817	-138.4961	-1.001E-05	2704.5688	7.569E+09	8.3276	125046.	0.000
11.000	-0.000227	4784.9499	-125.1925	-8.035E-06	2694.7588	7.569E+09	0.5415	7164.0164	0.000
11.250	-0.000248	4412.9783	-123.4697	-6.212E-06	2685.0676	7.569E+09	0.6071	7344.0164	0.000
11.500	-0.000264	4046.1819	-121.5658	-4.536E-06	2675.5112	7.569E+09	0.6621	7524.0164	0.000
11.750	-0.000275	3685.0802	-119.5125	-3.003E-06	2666.1032	7.569E+09	0.7067	7704.0164	0.000
12.000	-0.000282	3330.0982	-117.3406	-1.613E-06	2656.8546	7.569E+09	0.7412	7884.0164	0.000
12.250	-0.000285	2981.5689	-115.0802	-3.623E-07	2647.7742	7.569E+09	0.7658	8064.0164	0.000
12.500	-0.000284	2639.7368	-112.7600	7.517E-07	2638.8682	7.569E+09	0.7810	8244.0164	0.000
12.750	-0.000280	2304.7609	-110.4075	1.732E-06	2630.1409	7.569E+09	0.7873	8424.0164	0.000
13.000	-0.000274	1976.7201	-108.0486	2.580E-06	2621.5942	7.569E+09	0.7853	8604.0164	0.000
13.250	-0.000265	1655.6177	-105.7072	3.300E-06	2613.2283	7.569E+09	0.7756	8784.0164	0.000
13.500	-0.000254	1341.3876	-103.4053	3.894E-06	2605.0415	7.569E+09	0.7590	8964.0164	0.000
13.750	-0.000242	1033.9008	-101.1625	4.365E-06	2597.0303	7.569E+09	0.7362	9144.0164	0.000
14.000	-0.000228	732.9722	-94.3848	4.715E-06	2589.1901	7.569E+09	3.7823	49805.	0.000
14.250	-0.000213	466.0363	-83.2810	4.952E-06	2582.2354	7.569E+09	3.6202	50930.	0.000
14.500	-0.000198	231.6518	-72.6944	5.091E-06	2576.1288	7.569E+09	3.4376	52055.	0.000
14.750	-0.000183	28.1903	-62.6799	5.142E-06	2570.8279	7.569E+09	3.2387	53180.	0.000
15.000	-0.000167	-146.1248	-53.2804	5.119E-06	2573.9005	7.569E+09	3.0277	54305.	0.000

15.250	-0.000152	-293.1812	-44.5265	5.032E-06	2577.7319	7.569E+09	2.8083	55430.	0.000
15.500	-0.000137	-414.9440	-36.4381	4.891E-06	2580.9043	7.569E+09	2.5840	56555.	0.000
15.750	-0.000123	-513.4238	-29.0251	4.707E-06	2583.4700	7.569E+09	2.3580	57680.	0.000
16.000	-0.000109	-590.6480	-22.2884	4.489E-06	2585.4820	7.569E+09	2.1332	58805.	0.000
16.250	-9.571E-05	-648.6352	-16.2207	4.243E-06	2586.9928	7.569E+09	1.9120	59930.	0.000
16.500	-8.337E-05	-689.3721	-10.8077	3.978E-06	2588.0541	7.569E+09	1.6967	61055.	0.000
16.750	-7.184E-05	-714.7939	-6.0291	3.700E-06	2588.7164	7.569E+09	1.4891	62180.	0.000
17.000	-6.117E-05	-726.7672	-1.8592	3.414E-06	2589.0284	7.569E+09	1.2908	63305.	0.000
17.250	-5.136E-05	-727.0759	1.7316	3.126E-06	2589.0364	7.569E+09	1.1031	64430.	0.000
17.500	-4.242E-05	-717.4094	4.7764	2.839E-06	2588.7846	7.569E+09	0.9269	65555.	0.000
17.750	-3.432E-05	-699.3543	7.3111	2.559E-06	2588.3142	7.569E+09	0.7629	66680.	0.000
18.000	-2.706E-05	-674.3872	9.3730	2.286E-06	2587.6637	7.569E+09	0.6117	67805.	0.000
18.250	-2.061E-05	-643.8709	11.0007	2.025E-06	2586.8686	7.569E+09	0.4734	68930.	0.000
18.500	-1.491E-05	-609.0515	12.2332	1.777E-06	2585.9615	7.569E+09	0.3482	70055.	0.000
18.750	-9.944E-06	-571.0581	13.1094	1.543E-06	2584.9716	7.569E+09	0.2359	71180.	0.000
19.000	-5.654E-06	-530.9040	13.6678	1.325E-06	2583.9254	7.569E+09	0.1363	72305.	0.000
19.250	-1.996E-06	-489.4887	13.9455	1.122E-06	2582.8464	7.569E+09	0.0489	73430.	0.000
19.500	1.080E-06	-447.6017	13.9785	9.367E-07	2581.7551	7.569E+09	-0.0268	74555.	0.000
19.750	3.624E-06	-405.9270	13.8010	7.676E-07	2580.6693	7.569E+09	-0.0914	75680.	0.000
20.000	5.686E-06	-365.0487	13.4455	6.148E-07	2579.6043	7.569E+09	-0.1456	76805.	0.000
20.250	7.313E-06	-325.4566	12.9422	4.780E-07	2578.5728	7.569E+09	-0.1900	77930.	0.000
20.500	8.554E-06	-287.5530	12.3192	3.565E-07	2577.5853	7.569E+09	-0.2254	79055.	0.000
20.750	9.452E-06	-251.6592	11.6021	2.496E-07	2576.6501	7.569E+09	-0.2526	80180.	0.000
21.000	1.005E-05	-218.0225	10.8146	1.565E-07	2575.7737	7.569E+09	-0.2724	81305.	0.000
21.250	1.039E-05	-186.8232	9.9777	7.630E-08	2574.9609	7.569E+09	-0.2855	82430.	0.000
21.500	1.051E-05	-158.1814	9.1104	7.927E-09	2574.2147	7.569E+09	-0.2927	83555.	0.000
21.750	1.044E-05	-132.1634	8.2294	-4.961E-08	2573.5368	7.569E+09	-0.2947	84680.	0.000
22.000	1.021E-05	-108.7887	7.3493	-9.736E-08	2572.9278	7.569E+09	-0.2921	85805.	0.000
22.250	9.855E-06	-88.0354	6.4829	-1.364E-07	2572.3871	7.569E+09	-0.2856	86930.	0.000
22.500	9.393E-06	-69.8463	5.6410	-1.677E-07	2571.9132	7.569E+09	-0.2757	88055.	0.000
22.750	8.849E-06	-54.1340	4.8329	-1.922E-07	2571.5038	7.569E+09	-0.2630	89180.	0.000
23.000	8.240E-06	-40.7855	4.0663	-2.110E-07	2571.1561	7.569E+09	-0.2480	90305.	0.000
23.250	7.582E-06	-29.6666	3.3476	-2.250E-07	2570.8664	7.569E+09	-0.2311	91430.	0.000
23.500	6.890E-06	-20.6255	2.6821	-2.350E-07	2570.6308	7.569E+09	-0.2126	92555.	0.000
23.750	6.173E-06	-13.4961	2.0742	-2.417E-07	2570.4451	7.569E+09	-0.1927	93680.	0.000
24.000	5.439E-06	-8.1006	1.5272	-2.460E-07	2570.3045	7.569E+09	-0.1719	94805.	0.000
24.250	4.697E-06	-4.2517	1.0441	-2.485E-07	2570.2042	7.569E+09	-0.1502	95930.	0.000
24.500	3.949E-06	-1.7540	0.6272	-2.496E-07	2570.1392	7.569E+09	-0.1277	97055.	0.000
24.750	3.199E-06	-0.4060	0.2786	-2.501E-07	2570.1040	7.569E+09	-0.1047	98180.	0.000
25.000	2.448E-06	0.000	0.000	-2.502E-07	2570.0935	7.569E+09	-0.0810	49652.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      0.0074346 inches
Computed slope at pile head       =       0.000000 radians
Maximum bending moment            =        -36081. inch-lbs
Maximum shear force               =   1000.0000000 lbs
Depth of maximum bending moment   =       0.000000 feet below pile head
Depth of maximum shear force      =       0.000000 feet below pile head
Number of iterations              =              7
Number of zero deflection points  =              2
```

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 2, Shear and Slope

Shear = 1000. lb
Slope = 0.00000
Axial Load = 55000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
25.0000	0.0074346	-36081.	1000.0000000
23.7500	0.0073479	-35991.	1000.0000000
22.5000	0.0073917	-35985.	1000.0000000
21.2500	0.0073783	-36040.	1000.0000000
20.0000	0.0074265	-36066.	1000.0000000
18.7500	0.0074250	-36011.	1000.0000000
17.5000	0.0074309	-36000.	1000.0000000
16.2500	0.0074406	-36011.	1000.0000000
15.0000	0.0074022	-35988.	1000.0000000
13.7500	0.0075633	-35923.	1000.0000000
12.5000	0.0077503	-35985.	1000.0000000
11.2500	0.0078386	-36003.	1000.0000000
10.0000	0.0081285	-36612.	1000.0000000
8.7500	0.0084814	-37986.	1000.0000000
7.5000	0.0086585	-39657.	1000.0000000
6.2500	0.0086965	-38700.	1000.0000000
5.0000	0.0088742	-37252.	1000.0000000
3.7500	0.0122078	-29537.	1000.0000001
2.5000	0.0250647	-19985.	1000.0000002
1.2500	0.2476710	-10194.	1005.9269298

Summary of Pile Response(s)

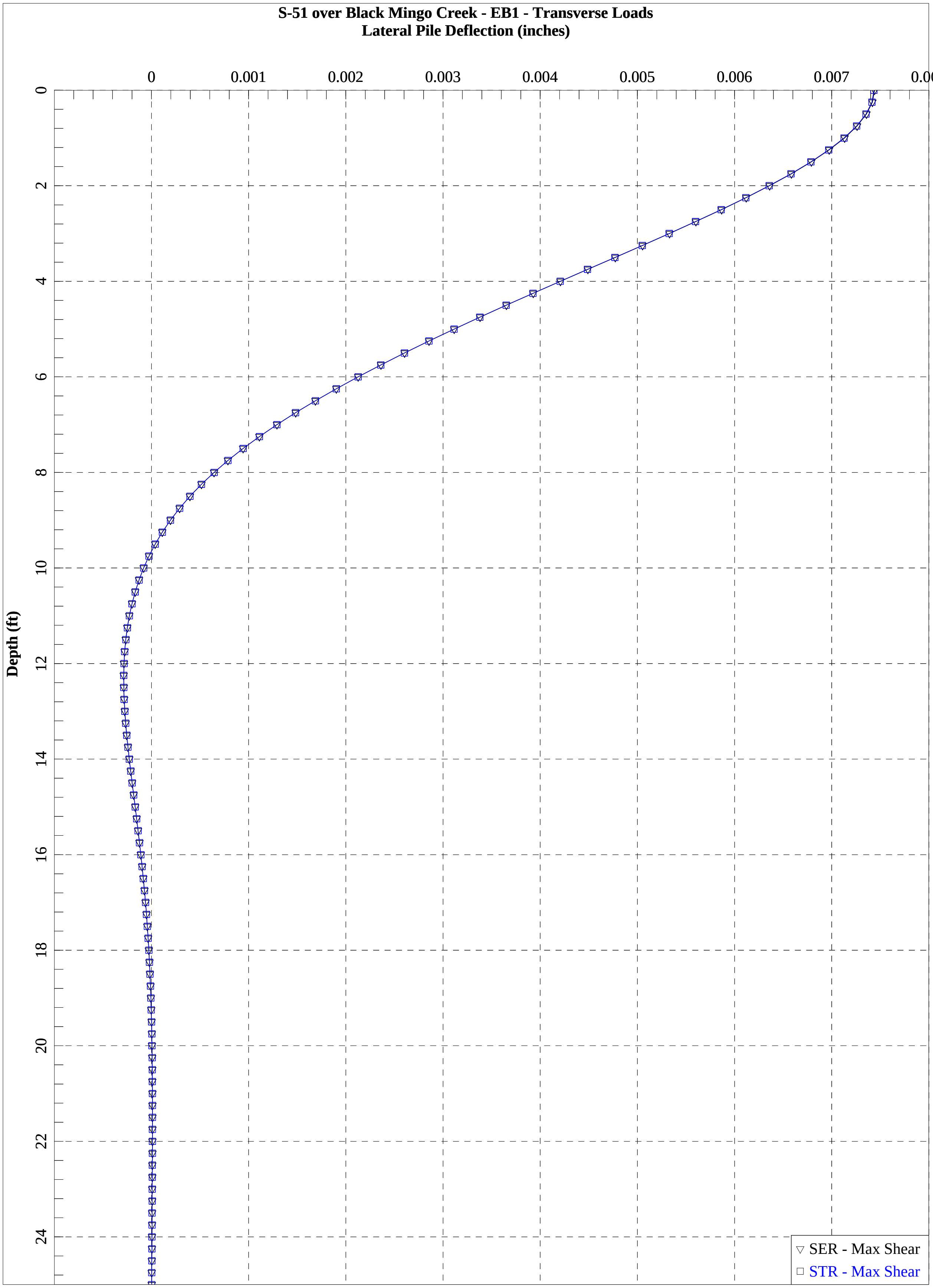
Definitions of Pile-head Loading Conditions:

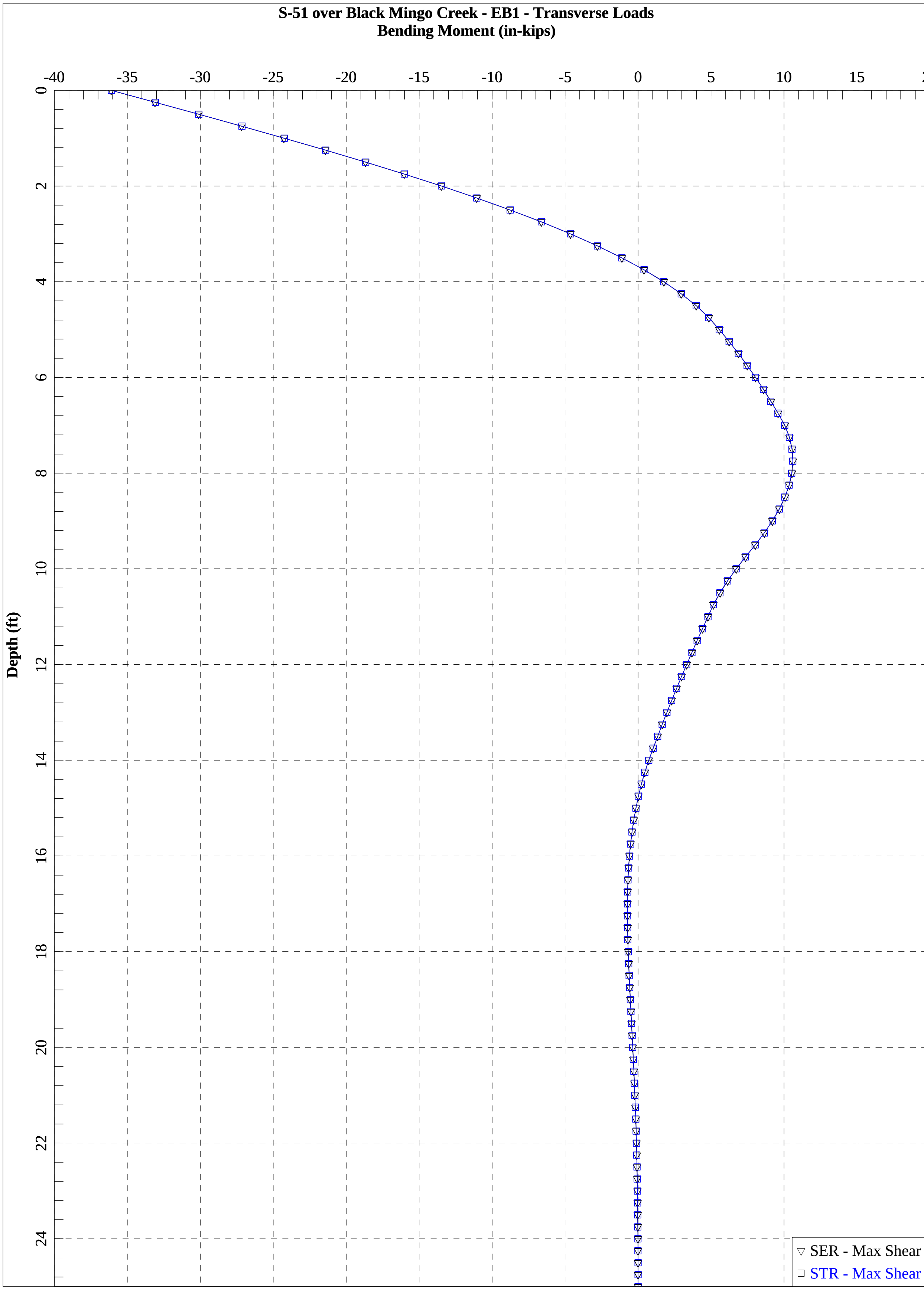
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case	Load Type	Pile-head Condition 1 V(lbs) or	Pile-head Condition 2 in-lb, rad.,	Axial Loading	Pile-head Deflection	Maximum Moment in Pile	Maximum Shear in Pile	Pile-head Rotation

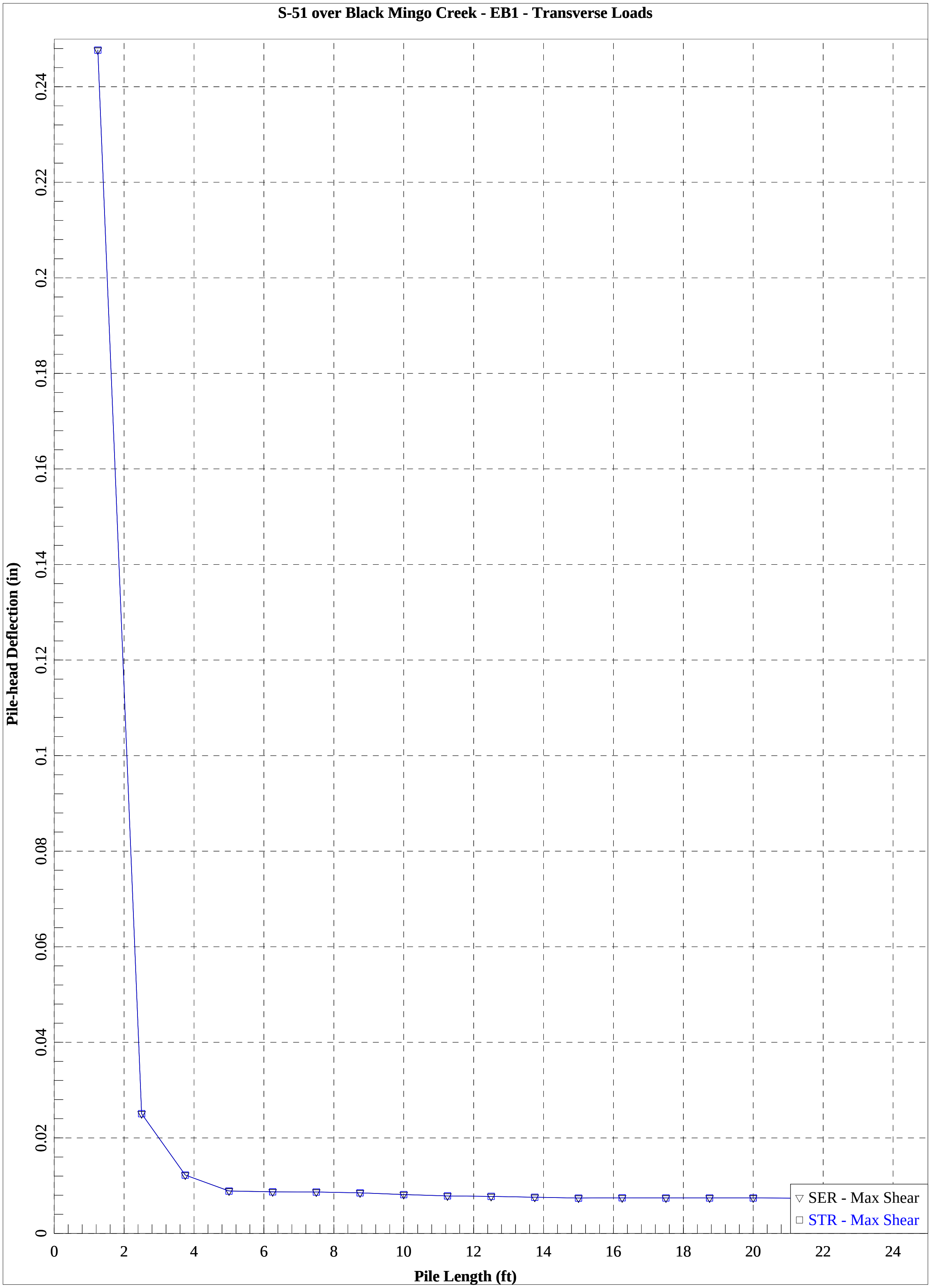
No.	No.	y(inches)	or in-lb/rad.	lbs	inches	in-lbs	lbs	radians
1	2	V = 1000.0000	S = 0.000	65000.	0.00744013	-36105.	1000.0000	-0.00000000
2	2	V = 1000.0000	S = 0.000	55000.	0.00743458	-36081.	1000.0000	-0.00000000

The analysis ended normally.


S-51 over Black Mingo Creek - EB1 - Transverse Loads
Lateral Pile Deflection (inches)
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
SER - Max Shear
STR - Max Shear



S-51 over Black Mingo Creek - EB1 - Transverse Loads
Bending Moment (in-kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
SER - Max Shear
STR - Max Shear

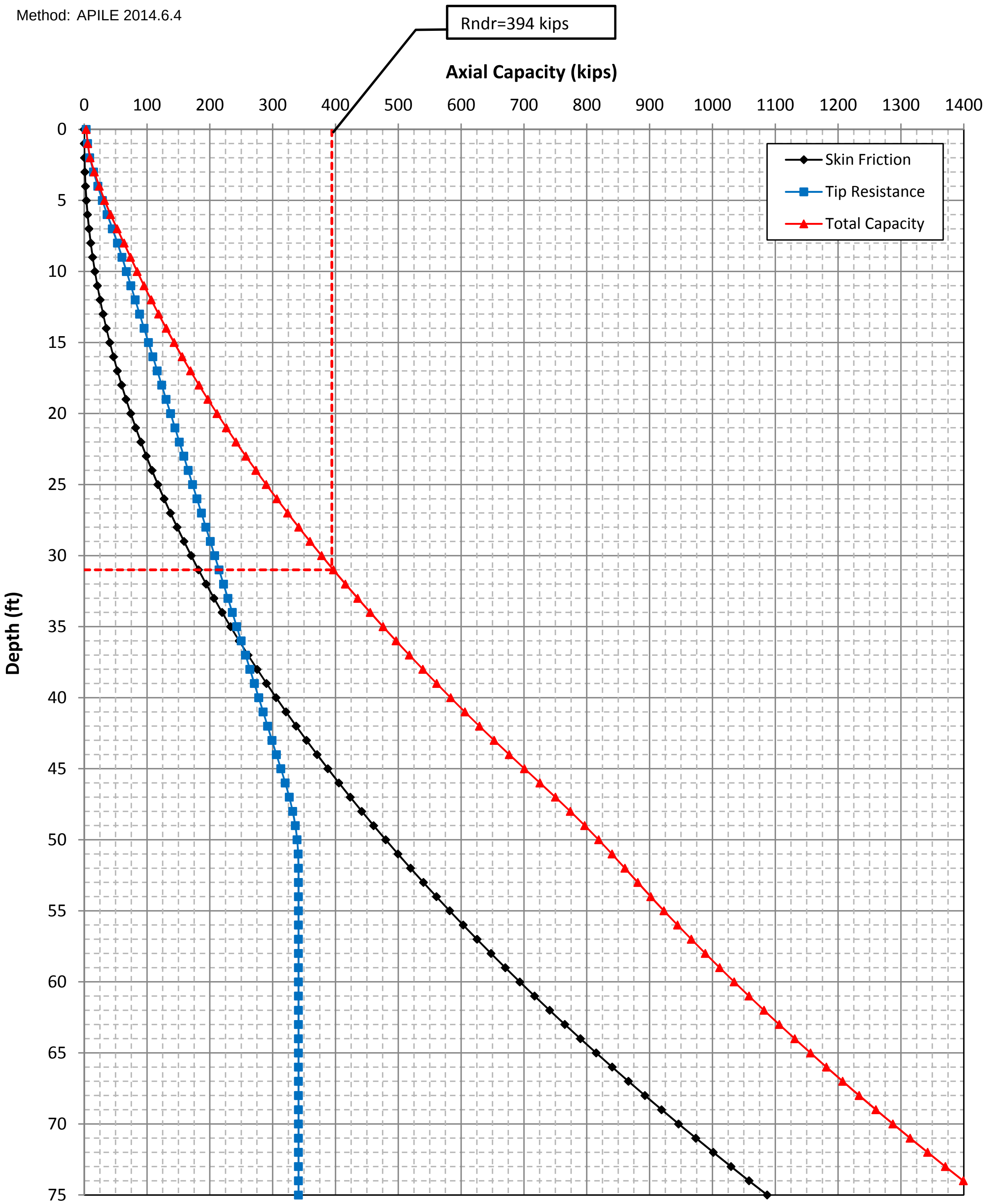

S-51 over Black Mingo Creek - EB1 - Transverse Loads
Pile-head Deflection (in)
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Pile Length (ft)
SER - Max Shear
STR - Max Shear

APPENDIX

SECTION 13

INTERIOR BENT 2 DRIVEN PILE ANALYSES

Project: S-51 Emergency Bridge Replacement over Black Mingo Creek - **Axial Capacity Analysis**
Location : Interior Bent 2 - 18" Square PSC Pile
Calc. By: JFH
Date: 2/15/2016
Method: APILE 2014.6.4



[1]Axial capacity analyses were modeled with a 18" Square PSC pile with no stinger
[2]The axial capacities shown are unfactored.

==

LPile Plus for Windows, Version 2013-07.007

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

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Files Used for Analysis

Path to file locations: P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\LPile\
Name of input data file: IB2_Long.lp7d
Name of output report file: IB2_Long.lp7o
Name of plot output file: IB2_Long.lp7p
Name of runtime messeage file: IB2_Long.lp7r

Date and Time of Analysis

Date: February 15, 2016 Time: 18:45:40

Problem Title

Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: ICE

Engineer: JFH

Description: IB2 18" Square PSC Pile - Longitudinal Loads

Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Use of p-y modification factors for p-y curves not selected
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 2

Total length of pile = 42.50 ft

Depth of ground surface below top of pile = 21.50 ft

Pile diameter values used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	40.000000	18.0000000
3	40.000000	8.2200000
4	42.500000	8.2200000

Input Structural Properties:

Pile Section No. 1:

```
   Section Type                                         =    Elastic Pile
   Cross-sectional Shape                                =     Rectangular
   Section Length                                       =     40.00000 ft
   Top Width                                            =     18.00000 in
   Bottom Width                                         =     18.00000 in
   Top Section Depth                                    =     18.00000 in
   Bottom Section Depth                                 =     18.00000 in
   Top Area                                             =    324.00000 Sq. in
   Bottom Area                                          =    324.00000 Sq. in
   Moment of Inertia at Top                             =   8748.00000 in^4
   Moment of Inertia at Bottom                          =   8748.00000 in^4
   Elastic Modulus                                      =     5422453. lbs/in^2

Pile Section No. 2:

   Section Type                                         =    Elastic Pile
   Cross-sectional Shape                                =   Strong H-Pile
   Section Length                                       =      2.50000 ft
   Flange Width                                         =      8.22000 in
   Section Depth                                        =      8.75000 in
   Flange Thickness                                     =      0.81000 in
   Web Thickness                                        =      0.51000 in
   Section Area                                         =     17.10000 Sq. in
   Moment of Inertia                                    =    228.00000 in^4
   Elastic Modulus                                      =    29000000. lbs/in^2


--------------------------------------------------------------------------------
                      Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------

Ground Slope Angle                                      =        0.000 degrees
                                                        =        0.000 radians

Pile Batter Angle                                       =        0.000 degrees
                                                        =        0.000 radians


--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer            =     21.50000 ft
   Distance from top of pile to bottom of layer         =     26.00000 ft
   Effective unit weight at top of layer                =     48.00000 pcf
   Effective unit weight at bottom of layer             =     48.00000 pcf
   Friction angle at top of layer                       =     32.00000 deg.
   Friction angle at bottom of layer                    =     32.00000 deg.
   Subgrade k at top of layer                           =     30.00000 pci
   Subgrade k at bottom of layer                        =     30.00000 pci


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer            =     26.00000 ft
   Distance from top of pile to bottom of layer         =     36.00000 ft
   Effective unit weight at top of layer                =     53.00000 pcf
```

```
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     40.00000 deg.
   Friction angle at bottom of layer                  =     40.00000 deg.
   Subgrade k at top of layer                         =    125.00000 pci
   Subgrade k at bottom of layer                      =    125.00000 pci
```

Layer 3 is stiff clay without free water

```
   Distance from top of pile to top of layer          =     36.00000 ft
   Distance from top of pile to bottom of layer       =    100.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Undrained cohesion at top of layer                 =   2500.00000 psf
   Undrained cohesion at bottom of layer              =   2500.00000 psf
   Epsilon-50 at top of layer                         =      0.00500
   Epsilon-50 at bottom of layer                      =      0.00500
```

(Depth of lowest soil layer extends 57.50 ft below pile tip)

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	21.500	48.000	--	32.000	--	30.000
		26.000	48.000	--	32.000	--	30.000
2	Sand (Reese, et al.)	26.000	53.000	--	40.000	--	125.000
		36.000	53.000	--	40.000	--	125.000
3	Stiff Clay w/o Free Water	36.000	53.000	2500.000	--	0.00500	--
		100.000	53.000	2500.000	--	0.00500	--

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 4

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = -2000.00000 lbs	M = -456000. in-lbs	65000.	Yes
2	1	V = -1000.00000 lbs	M = -564000. in-lbs	157000.	Yes
3	1	V = -3000.00000 lbs	M = -708000. in-lbs	89000.	Yes
4	1	V = -2000.00000 lbs	M = -900000. in-lbs	225000.	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

Pile Section No. 2:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = -2000. lb
Moment = -456000. in- lb
Axial Load = 65000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
42.5000	-1.5534227	-1113957.	10783.
40.3750	-1.5518882	-1114025.	10577.
38.2500	-1.5455580	-1113685.	10387.
36.1250	-1.7339357	-1120463.	13604.
34.0000	-2.8976226	-1174355.	18308.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = -1000.0 lbs
Applied moment at pile head = -564000.0 in-lbs
Axial thrust load on pile head = 157000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-1.4796	-564000.	-1000.0000	0.007073	1064.8148	4.744E+10	0.000	0.000	0.000
0.425	-1.4437	-574739.	-1000.0000	0.007012	1075.8634	4.744E+10	0.000	0.000	0.000
0.850	-1.4081	-585429.	-1000.0000	0.006950	1086.8611	4.744E+10	0.000	0.000	0.000
1.275	-1.3728	-596068.	-1000.0000	0.006886	1097.8070	4.744E+10	0.000	0.000	0.000
1.700	-1.3378	-606656.	-1000.0000	0.006821	1108.7000	4.744E+10	0.000	0.000	0.000
2.125	-1.3032	-617192.	-1000.0000	0.006756	1119.5394	4.744E+10	0.000	0.000	0.000
2.550	-1.2689	-627675.	-1000.0000	0.006689	1130.3240	4.744E+10	0.000	0.000	0.000
2.975	-1.2350	-638104.	-1000.0000	0.006621	1141.0531	4.744E+10	0.000	0.000	0.000
3.400	-1.2014	-648477.	-1000.0000	0.006552	1151.7257	4.744E+10	0.000	0.000	0.000
3.825	-1.1682	-658795.	-1000.0000	0.006481	1162.3408	4.744E+10	0.000	0.000	0.000
4.250	-1.1353	-669056.	-1000.0000	0.006410	1172.8976	4.744E+10	0.000	0.000	0.000
4.675	-1.1028	-679260.	-1000.0000	0.006337	1183.3951	4.744E+10	0.000	0.000	0.000
5.100	-1.0706	-689405.	-1000.0000	0.006264	1193.8325	4.744E+10	0.000	0.000	0.000
5.525	-1.0389	-699491.	-1000.0000	0.006189	1204.2088	4.744E+10	0.000	0.000	0.000
5.950	-1.0075	-709516.	-1000.0000	0.006113	1214.5231	4.744E+10	0.000	0.000	0.000
6.375	-0.9765	-719481.	-1000.0000	0.006037	1224.7747	4.744E+10	0.000	0.000	0.000
6.800	-0.9459	-729384.	-1000.0000	0.005959	1234.9625	4.744E+10	0.000	0.000	0.000
7.225	-0.9158	-739223.	-1000.0000	0.005880	1245.0857	4.744E+10	0.000	0.000	0.000
7.650	-0.8860	-748999.	-1000.0000	0.005800	1255.1434	4.744E+10	0.000	0.000	0.000
8.075	-0.8566	-758711.	-1000.0000	0.005719	1265.1348	4.744E+10	0.000	0.000	0.000
8.500	-0.8276	-768357.	-1000.0000	0.005637	1275.0590	4.744E+10	0.000	0.000	0.000
8.925	-0.7991	-777937.	-1000.0000	0.005553	1284.9151	4.744E+10	0.000	0.000	0.000
9.350	-0.7710	-787451.	-1000.0000	0.005469	1294.7024	4.744E+10	0.000	0.000	0.000
9.775	-0.7433	-796896.	-1000.0000	0.005384	1304.4199	4.744E+10	0.000	0.000	0.000
10.200	-0.7161	-806273.	-1000.0000	0.005298	1314.0668	4.744E+10	0.000	0.000	0.000
10.625	-0.6893	-815580.	-1000.0000	0.005211	1323.6423	4.744E+10	0.000	0.000	0.000
11.050	-0.6629	-824818.	-1000.0000	0.005123	1333.1456	4.744E+10	0.000	0.000	0.000
11.475	-0.6370	-833984.	-1000.0000	0.005033	1342.5758	4.744E+10	0.000	0.000	0.000
11.900	-0.6116	-843078.	-1000.0000	0.004943	1351.9322	4.744E+10	0.000	0.000	0.000
12.325	-0.5866	-852100.	-1000.0000	0.004852	1361.2139	4.744E+10	0.000	0.000	0.000
12.750	-0.5621	-861048.	-1000.0000	0.004760	1370.4201	4.744E+10	0.000	0.000	0.000
13.175	-0.5380	-869923.	-1000.0000	0.004667	1379.5501	4.744E+10	0.000	0.000	0.000
13.600	-0.5145	-878722.	-1000.0000	0.004573	1388.6030	4.744E+10	0.000	0.000	0.000
14.025	-0.4914	-887446.	-1000.0000	0.004478	1397.5781	4.744E+10	0.000	0.000	0.000
14.450	-0.4688	-896093.	-1000.0000	0.004382	1406.4746	4.744E+10	0.000	0.000	0.000
14.875	-0.4467	-904664.	-1000.0000	0.004285	1415.2918	4.744E+10	0.000	0.000	0.000
15.300	-0.4251	-913156.	-1000.0000	0.004188	1424.0288	4.744E+10	0.000	0.000	0.000
15.725	-0.4040	-921570.	-1000.0000	0.004089	1432.6849	4.744E+10	0.000	0.000	0.000
16.150	-0.3834	-929904.	-1000.0000	0.003990	1441.2594	4.744E+10	0.000	0.000	0.000
16.575	-0.3633	-938159.	-1000.0000	0.003889	1449.7516	4.744E+10	0.000	0.000	0.000
17.000	-0.3437	-946332.	-1000.0000	0.003788	1458.1607	4.744E+10	0.000	0.000	0.000
17.425	-0.3247	-954424.	-1000.0000	0.003686	1466.4859	4.744E+10	0.000	0.000	0.000
17.850	-0.3061	-962434.	-1000.0000	0.003583	1474.7267	4.744E+10	0.000	0.000	0.000
18.275	-0.2881	-970361.	-1000.0000	0.003479	1482.8822	4.744E+10	0.000	0.000	0.000
18.700	-0.2706	-978205.	-1000.0000	0.003374	1490.9517	4.744E+10	0.000	0.000	0.000
19.125	-0.2537	-985964.	-1000.0000	0.003268	1498.9346	4.744E+10	0.000	0.000	0.000
19.550	-0.2373	-993639.	-1000.0000	0.003162	1506.8302	4.744E+10	0.000	0.000	0.000
19.975	-0.2215	-1001228.	-1000.0000	0.003055	1514.6378	4.744E+10	0.000	0.000	0.000
20.400	-0.2061	-1008731.	-1000.0000	0.002947	1522.3567	4.744E+10	0.000	0.000	0.000
20.825	-0.1914	-1016147.	-1000.0000	0.002838	1529.9863	4.744E+10	0.000	0.000	0.000
21.250	-0.1772	-1023475.	-1000.0000	0.002728	1537.5259	4.744E+10	0.000	0.000	0.000
21.675	-0.1636	-1030715.	-984.8268	0.002618	1544.9748	4.744E+10	5.9503	185.5234	0.000
22.100	-0.1505	-1037712.	-914.2863	0.002507	1552.1732	4.744E+10	21.7127	735.7597	0.000
22.525	-0.1380	-1044055.	-761.4622	0.002395	1558.6987	4.744E+10	38.2184	1412.3654	0.000
22.950	-0.1261	-1049314.	-525.9086	0.002282	1564.1090	4.744E+10	54.1556	2190.6401	0.000
23.375	-0.1147	-1053074.	-212.8131	0.002169	1567.9773	4.744E+10	68.6269	3050.6702	0.000

23.800	-0.1040	-1054958.	167.3825	0.002056	1569.9158	4.744E+10	80.4694	3947.8179	0.000
24.225	-0.0938	-1054659.	603.2105	0.001942	1569.6077	4.744E+10	90.4436	4919.6254	0.000
24.650	-0.0841	-1051916.	1077.1576	0.001829	1566.7859	4.744E+10	95.4181	5783.4000	0.000
25.075	-0.0751	-1046601.	1566.9506	0.001716	1561.3176	4.744E+10	96.6576	6563.7000	0.000
25.500	-0.0666	-1038681.	2058.1185	0.001604	1553.1702	4.744E+10	95.9573	7344.0000	0.000
25.925	-0.0587	-1028177.	2541.4222	0.001493	1542.3630	4.744E+10	93.5736	8124.3000	0.000
26.350	-0.0514	-1015150.	3209.2476	0.001383	1528.9608	4.744E+10	168.3187	16698.	0.000
26.775	-0.0446	-997658.	4066.2257	0.001275	1510.9646	4.744E+10	167.7511	19169.	0.000
27.200	-0.0384	-975716.	4900.6327	0.001169	1488.3912	4.744E+10	159.4673	21178.	0.000
27.625	-0.0327	-949543.	5690.4849	0.001065	1461.4641	4.744E+10	150.2787	23432.	0.000
28.050	-0.0275	-919379.	6416.6229	0.000965	1430.4315	4.744E+10	134.4813	24908.	0.000
28.475	-0.0229	-885639.	7048.1193	0.000868	1395.7189	4.744E+10	113.1643	25240.	0.000
28.900	-0.0187	-848879.	7593.1297	0.000775	1357.8997	4.744E+10	100.5653	27453.	0.000
29.325	-0.0150	-809429.	8091.1064	0.000686	1317.3143	4.744E+10	94.7197	32282.	0.000
29.750	-0.0117	-767447.	8553.4426	0.000601	1274.1225	4.744E+10	86.5886	37777.	0.000
30.175	-0.008836	-723146.	8969.6731	0.000521	1228.5457	4.744E+10	76.6390	44234.	0.000
30.600	-0.006379	-676790.	9342.9701	0.000445	1180.8541	4.744E+10	69.7520	55766.	0.000
31.025	-0.004293	-628561.	9658.2608	0.000375	1131.2360	4.744E+10	53.8915	64021.	0.000
31.450	-0.002552	-578877.	9881.5161	0.000310	1080.1202	4.744E+10	33.6596	67272.	0.000
31.875	-0.001128	-528267.	10007.	0.000251	1028.0524	4.744E+10	15.5968	70523.	0.000
32.300	6.319E-06	-477206.	10047.	0.000197	975.5204	4.744E+10	-0.0914	73774.	0.000
32.725	0.000879	-426106.	10013.	0.000148	922.9486	4.744E+10	-13.2738	77026.	0.000
33.150	0.001518	-375315.	9917.8067	0.000105	870.6943	4.744E+10	-23.8911	80277.	0.000
33.575	0.001951	-325113.	9775.4057	6.745E-05	819.0460	4.744E+10	-31.9525	83528.	0.000
34.000	0.002206	-275714.	9598.2184	3.515E-05	768.2240	4.744E+10	-37.5328	86779.	0.000
34.425	0.002309	-227267.	9398.5484	8.112E-06	718.3819	4.744E+10	-40.7692	90031.	0.000
34.850	0.002289	-179861.	9187.8475	-1.377E-05	669.6106	4.744E+10	-41.8586	93282.	0.000
35.275	0.002169	-133529.	8976.4191	-3.062E-05	621.9435	4.744E+10	-41.0545	96533.	0.000
35.700	0.001976	-88253.	8773.1331	-4.254E-05	575.3632	4.744E+10	-38.6655	99784.	0.000
36.125	0.001735	-43975.	7865.1824	-4.965E-05	529.8097	4.744E+10	-317.3936	932954.	0.000
36.550	0.001470	-7948.6142	6261.2371	-5.244E-05	492.7455	4.744E+10	-311.6046	1081256.	0.000
36.975	0.001200	19974.	4693.8494	-5.180E-05	505.1169	4.744E+10	-303.0573	1287865.	0.000
37.400	0.000941	40012.	3177.0526	-4.857E-05	525.7321	4.744E+10	-291.7650	1580567.	0.000
37.825	0.000705	52457.	1725.1281	-4.360E-05	538.5363	4.744E+10	-277.6172	2009178.	0.000
38.250	0.000497	57678.	353.5052	-3.768E-05	543.9071	4.744E+10	-260.2741	2672389.	0.000
38.675	0.000320	56123.	-857.0926	-3.156E-05	542.3080	4.744E+10	-214.4701	3414357.	0.000
39.100	0.000175	48986.	-1708.1826	-2.591E-05	534.9649	4.744E+10	-119.2907	3481041.	0.000
39.525	5.605E-05	38741.	-2111.7957	-2.120E-05	524.4254	4.744E+10	-38.9889	3547727.	0.000
39.950	-4.143E-05	27480.	-2136.3429	-1.764E-05	512.8390	4.744E+10	29.3626	3614413.	0.000
40.375	-0.000124	16979.	-1814.7505	-9.611E-06	9487.3554	6.612E+09	96.7521	3984375.	0.000
40.800	-0.000139	8984.4884	-1290.1959	4.022E-07	9343.2438	6.612E+09	108.9555	3984375.	0.000
41.225	-0.000120	3818.3595	-773.8134	5.340E-06	9250.1175	6.612E+09	93.5474	3984375.	0.000
41.650	-8.500E-05	1083.0402	-365.9361	7.230E-06	9200.8098	6.612E+09	66.4045	3984375.	0.000
42.075	-4.599E-05	74.2327	-104.9752	7.676E-06	9182.6247	6.612E+09	35.9331	3984375.	0.000
42.500	-6.699E-06	0.000	0.000	7.705E-06	9181.2865	6.612E+09	5.2336	1992187.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =     -1.4795938 inches
Computed slope at pile head       =      0.0070732 radians
Maximum bending moment            =      -1054958. inch-lbs
Maximum shear force               =         10047. lbs
Depth of maximum bending moment   =     23.8000000 feet below pile head
Depth of maximum shear force      =     32.3000000 feet below pile head
Number of iterations              =              6
Number of zero deflection points  =              3
```

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 1, Shear and Moment

Shear = -1000. lb
Moment = -564000. in- lb
Axial Load = 157000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
42.5000	-1.4795938	-1054958.	10047.
40.3750	-1.4785636	-1054995.	9880.5304254
38.2500	-1.4722839	-1054395.	9649.2182432
36.1250	-1.6229546	-1071539.	12482.
34.0000	-3.1746354	-1261460.	19857.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 3

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = -3000.0 lbs
Applied moment at pile head = -708000.0 in-lbs
Axial thrust load on pile head = 89000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-2.6143	-708000.	-3000.0000	0.0116	1003.0864	4.744E+10	0.000	0.000	0.000
0.425	-2.5554	-728544.	-3000.0000	0.0115	1024.2218	4.744E+10	0.000	0.000	0.000
0.850	-2.4969	-749052.	-3000.0000	0.0114	1045.3205	4.744E+10	0.000	0.000	0.000
1.275	-2.4388	-769523.	-3000.0000	0.0114	1066.3817	4.744E+10	0.000	0.000	0.000
1.700	-2.3811	-789957.	-3000.0000	0.0113	1087.4042	4.744E+10	0.000	0.000	0.000
2.125	-2.3239	-810352.	-3000.0000	0.0112	1108.3871	4.744E+10	0.000	0.000	0.000
2.550	-2.2671	-830708.	-3000.0000	0.0111	1129.3293	4.744E+10	0.000	0.000	0.000
2.975	-2.2107	-851023.	-3000.0000	0.0110	1150.2298	4.744E+10	0.000	0.000	0.000
3.400	-2.1548	-871297.	-3000.0000	0.0109	1171.0875	4.744E+10	0.000	0.000	0.000
3.825	-2.0994	-891528.	-3000.0000	0.0108	1191.9015	4.744E+10	0.000	0.000	0.000
4.250	-2.0445	-911716.	-3000.0000	0.0107	1212.6708	4.744E+10	0.000	0.000	0.000
4.675	-1.9901	-931859.	-3000.0000	0.0106	1233.3943	4.744E+10	0.000	0.000	0.000
5.100	-1.9362	-951957.	-3000.0000	0.0105	1254.0709	4.744E+10	0.000	0.000	0.000
5.525	-1.8828	-972008.	-3000.0000	0.0104	1274.6998	4.744E+10	0.000	0.000	0.000
5.950	-1.8299	-992012.	-3000.0000	0.0103	1295.2799	4.744E+10	0.000	0.000	0.000
6.375	-1.7776	-1011968.	-3000.0000	0.0102	1315.8102	4.744E+10	0.000	0.000	0.000
6.800	-1.7259	-1031874.	-3000.0000	0.0101	1336.2897	4.744E+10	0.000	0.000	0.000
7.225	-1.6747	-1051729.	-3000.0000	0.009980	1356.7174	4.744E+10	0.000	0.000	0.000
7.650	-1.6241	-1071534.	-3000.0000	0.009866	1377.0922	4.744E+10	0.000	0.000	0.000
8.075	-1.5740	-1091286.	-3000.0000	0.009750	1397.4133	4.744E+10	0.000	0.000	0.000
8.500	-1.5246	-1110985.	-3000.0000	0.009631	1417.6796	4.744E+10	0.000	0.000	0.000
8.925	-1.4758	-1130629.	-3000.0000	0.009511	1437.8901	4.744E+10	0.000	0.000	0.000
9.350	-1.4276	-1150219.	-3000.0000	0.009388	1458.0438	4.744E+10	0.000	0.000	0.000

9.775	-1.3800	-1169752.	-3000.0000	0.009264	1478.1398	4.744E+10	0.000	0.000	0.000
10.200	-1.3331	-1189228.	-3000.0000	0.009137	1498.1771	4.744E+10	0.000	0.000	0.000
10.625	-1.2868	-1208646.	-3000.0000	0.009008	1518.1546	4.744E+10	0.000	0.000	0.000
11.050	-1.2412	-1228005.	-3000.0000	0.008877	1538.0715	4.744E+10	0.000	0.000	0.000
11.475	-1.1963	-1247305.	-3000.0000	0.008744	1557.9267	4.744E+10	0.000	0.000	0.000
11.900	-1.1521	-1266543.	-3000.0000	0.008609	1577.7193	4.744E+10	0.000	0.000	0.000
12.325	-1.1085	-1285720.	-3000.0000	0.008472	1597.4483	4.744E+10	0.000	0.000	0.000
12.750	-1.0656	-1304834.	-3000.0000	0.008332	1617.1128	4.744E+10	0.000	0.000	0.000
13.175	-1.0235	-1323884.	-3000.0000	0.008191	1636.7117	4.744E+10	0.000	0.000	0.000
13.600	-0.9821	-1342869.	-3000.0000	0.008048	1656.2442	4.744E+10	0.000	0.000	0.000
14.025	-0.9414	-1361789.	-3000.0000	0.007902	1675.7092	4.744E+10	0.000	0.000	0.000
14.450	-0.9015	-1380643.	-3000.0000	0.007755	1695.1059	4.744E+10	0.000	0.000	0.000
14.875	-0.8623	-1399429.	-3000.0000	0.007605	1714.4333	4.744E+10	0.000	0.000	0.000
15.300	-0.8239	-1418147.	-3000.0000	0.007454	1733.6904	4.744E+10	0.000	0.000	0.000
15.725	-0.7863	-1436796.	-3000.0000	0.007300	1752.8763	4.744E+10	0.000	0.000	0.000
16.150	-0.7495	-1455374.	-3000.0000	0.007145	1771.9901	4.744E+10	0.000	0.000	0.000
16.575	-0.7134	-1473882.	-3000.0000	0.006987	1791.0308	4.744E+10	0.000	0.000	0.000
17.000	-0.6782	-1492318.	-3000.0000	0.006828	1809.9975	4.744E+10	0.000	0.000	0.000
17.425	-0.6438	-1510680.	-3000.0000	0.006667	1828.8893	4.744E+10	0.000	0.000	0.000
17.850	-0.6102	-1528969.	-3000.0000	0.006503	1847.7052	4.744E+10	0.000	0.000	0.000
18.275	-0.5774	-1547184.	-3000.0000	0.006338	1866.4444	4.744E+10	0.000	0.000	0.000
18.700	-0.5455	-1565323.	-3000.0000	0.006170	1885.1059	4.744E+10	0.000	0.000	0.000
19.125	-0.5145	-1583385.	-3000.0000	0.006001	1903.6888	4.744E+10	0.000	0.000	0.000
19.550	-0.4843	-1601371.	-3000.0000	0.005830	1922.1922	4.744E+10	0.000	0.000	0.000
19.975	-0.4550	-1619278.	-3000.0000	0.005657	1940.6152	4.744E+10	0.000	0.000	0.000
20.400	-0.4266	-1637106.	-3000.0000	0.005482	1958.9569	4.744E+10	0.000	0.000	0.000
20.825	-0.3991	-1654854.	-3000.0000	0.005305	1977.2164	4.744E+10	0.000	0.000	0.000
21.250	-0.3725	-1672522.	-3000.0000	0.005126	1995.3928	4.744E+10	0.000	0.000	0.000
21.675	-0.3468	-1690108.	-2981.4189	0.004945	2013.4853	4.744E+10	7.2867	107.1470	0.000
22.100	-0.3221	-1707422.	-2894.1984	0.004763	2031.2979	4.744E+10	26.9174	426.2301	0.000
22.525	-0.2983	-1723952.	-2703.5338	0.004578	2048.3045	4.744E+10	47.8531	818.2601	0.000
22.950	-0.2754	-1739154.	-2407.0924	0.004392	2063.9440	4.744E+10	68.3985	1266.7318	0.000
23.375	-0.2535	-1752491.	-2009.7252	0.004204	2077.6660	4.744E+10	87.4318	1759.2759	0.000
23.800	-0.2325	-1763469.	-1522.6749	0.004015	2088.9603	4.744E+10	103.5683	2271.8558	0.000
24.225	-0.2125	-1771668.	-958.0208	0.003825	2097.3947	4.744E+10	117.8646	2828.7209	0.000
24.650	-0.1935	-1776714.	-329.6780	0.003634	2102.5862	4.744E+10	128.5443	3388.3475	0.000
25.075	-0.1754	-1778330.	345.1583	0.003443	2104.2487	4.744E+10	136.0974	3956.5226	0.000
25.500	-0.1584	-1776319.	1049.6389	0.003252	2102.1800	4.744E+10	140.1695	4514.2443	0.000
25.925	-0.1423	-1770576.	1764.0433	0.003062	2096.2714	4.744E+10	139.9891	5018.6570	0.000
26.350	-0.1271	-1761105.	2708.6042	0.002872	2086.5278	4.744E+10	230.4270	9243.9452	0.000
26.775	-0.1130	-1745555.	3899.6874	0.002683	2070.5298	4.744E+10	236.6645	10684.	0.000
27.200	-0.0998	-1723764.	5100.0521	0.002497	2048.1112	4.744E+10	234.0668	11966.	0.000
27.625	-0.0875	-1695801.	6287.6571	0.002313	2019.3425	4.744E+10	231.6607	13503.	0.000
28.050	-0.0762	-1661730.	7439.5440	0.002132	1984.2897	4.744E+10	220.0597	14734.	0.000
28.475	-0.0657	-1621853.	8509.1671	0.001956	1943.2648	4.744E+10	199.4004	15467.	0.000
28.900	-0.0562	-1576712.	9497.8057	0.001784	1896.8227	4.744E+10	188.3011	17082.	0.000
29.325	-0.0476	-1526595.	10452.	0.001617	1845.2626	4.744E+10	185.8596	19933.	0.000
29.750	-0.0397	-1471570.	11384.	0.001456	1788.6524	4.744E+10	179.7534	23077.	0.000
30.175	-0.0327	-1411798.	12277.	0.001301	1727.1582	4.744E+10	170.4918	26588.	0.000
30.600	-0.0265	-1347522.	13136.	0.001153	1661.0310	4.744E+10	166.3452	32068.	0.000
31.025	-0.0209	-1278854.	13967.	0.001011	1590.3848	4.744E+10	159.3867	38808.	0.000
31.450	-0.0161	-1205978.	14755.	0.000878	1515.4093	4.744E+10	149.5319	47254.	0.000
31.875	-0.0120	-1129154.	15484.	0.000752	1436.3719	4.744E+10	136.6809	58127.	0.000
32.300	-0.008465	-1048719.	16141.	0.000635	1353.6204	4.744E+10	120.6700	72702.	0.000
32.725	-0.005513	-965095.	16661.	0.000527	1267.5871	4.744E+10	83.2591	77026.	0.000
33.150	-0.003090	-879258.	16997.	0.000428	1179.2775	4.744E+10	48.6340	80277.	0.000
33.575	-0.001149	-792113.	17169.	0.000338	1089.6223	4.744E+10	18.8156	83528.	0.000
34.000	0.000358	-704440.	17202.	0.000258	999.4238	4.744E+10	-6.0869	86779.	0.000
34.425	0.001478	-616891.	17119.	0.000187	909.3529	4.744E+10	-26.0917	90031.	0.000
34.850	0.002260	-529991.	16948.	0.000125	819.9491	4.744E+10	-41.3379	93282.	0.000
35.275	0.002752	-444139.	16709.	7.248E-05	731.6250	4.744E+10	-52.0807	96533.	0.000

35.700	0.002999	-359621.	16427.	2.928E-05	644.6721	4.744E+10	-58.6852	99784.	0.000
36.125	0.003050	-276612.	15340.	-4.925E-06	559.2716	4.744E+10	-367.6022	614653.	0.000
36.550	0.002949	-203151.	13449.	-3.072E-05	483.6940	4.744E+10	-373.8444	646489.	0.000
36.975	0.002737	-139403.	11537.	-4.913E-05	418.1100	4.744E+10	-376.1851	701011.	0.000
37.400	0.002448	-85433.	9620.9865	-6.122E-05	362.5854	4.744E+10	-375.0233	781286.	0.000
37.825	0.002112	-41213.	7719.8122	-6.803E-05	317.0918	4.744E+10	-370.5353	894584.	0.000
38.250	0.001754	-6629.1294	5850.0603	-7.060E-05	281.5115	4.744E+10	-362.7008	1054493.	0.000
38.675	0.001392	18521.	4029.4605	-6.996E-05	293.7464	4.744E+10	-351.2600	1286647.	0.000
39.100	0.001041	34535.	2278.0419	-6.711E-05	310.2211	4.744E+10	-335.5709	1644617.	0.000
39.525	0.000708	41818.	621.0169	-6.300E-05	317.7144	4.744E+10	-314.2428	2264116.	0.000
39.950	0.000398	40926.	-899.5747	-5.855E-05	316.7967	4.744E+10	-282.0676	3614413.	0.000
40.375	0.000111	32696.	-1839.1880	-4.374E-05	5794.0650	6.612E+09	-86.4082	3984375.	0.000
40.800	-4.818E-05	22206.	-1963.5462	-2.257E-05	5604.9785	6.612E+09	37.6403	3984375.	0.000
41.225	-0.000120	12688.	-1629.2840	-9.112E-06	5433.4002	6.612E+09	93.4430	3984375.	0.000
41.650	-0.000141	5596.0085	-1109.8629	-2.060E-06	5305.5538	6.612E+09	110.2516	3984375.	0.000
42.075	-0.000141	1369.4850	-548.5726	6.259E-07	5229.3651	6.612E+09	109.8623	3984375.	0.000
42.500	-0.000135	0.000	0.000	1.154E-06	5204.6784	6.612E+09	105.2642	1992187.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 3:

```
Pile-head deflection             =     -2.6143359 inches
Computed slope at pile head      =      0.0115903 radians
Maximum bending moment           =      -1778330. inch-lbs
Maximum shear force              =         17202. lbs
Depth of maximum bending moment  =     25.0750000 feet below pile head
Depth of maximum shear force     =     34.0000000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              2
```

Pile-head Deflection vs. Pile Length for Load Case 3

Boundary Condition Type 1, Shear and Moment

```
Shear      =         -3000.  lb
Moment     =       -708000. in- lb
Axial Load =         89000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
42.5000	-2.6143359	-1778330.	17202.
40.3750	-2.6109999	-1778322.	16782.
38.2500	-2.6529654	-1779946.	18200.
36.1250	-3.3707546	-1821748.	24150.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 4

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = -2000.0 lbs
Applied moment at pile head = -900000.0 in-lbs
Axial thrust load on pile head = 225000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-3.1589	-900000.	-2000.0000	0.0142	1620.3704	4.744E+10	0.000	0.000	0.000
0.425	-3.0869	-926405.	-2000.0000	0.0141	1647.5359	4.744E+10	0.000	0.000	0.000
0.850	-3.0154	-952695.	-2000.0000	0.0140	1674.5838	4.744E+10	0.000	0.000	0.000
1.275	-2.9444	-978868.	-2000.0000	0.0139	1701.5108	4.744E+10	0.000	0.000	0.000
1.700	-2.8740	-1004921.	-2000.0000	0.0138	1728.3135	4.744E+10	0.000	0.000	0.000
2.125	-2.8040	-1030849.	-2000.0000	0.0137	1754.9888	4.744E+10	0.000	0.000	0.000
2.550	-2.7347	-1056650.	-2000.0000	0.0135	1781.5331	4.744E+10	0.000	0.000	0.000
2.975	-2.6660	-1082321.	-2000.0000	0.0134	1807.9434	4.744E+10	0.000	0.000	0.000
3.400	-2.5978	-1107858.	-2000.0000	0.0133	1834.2162	4.744E+10	0.000	0.000	0.000
3.825	-2.5302	-1133259.	-2000.0000	0.0132	1860.3485	4.744E+10	0.000	0.000	0.000
4.250	-2.4633	-1158519.	-2000.0000	0.0131	1886.3369	4.744E+10	0.000	0.000	0.000
4.675	-2.3970	-1183637.	-2000.0000	0.0129	1912.1783	4.744E+10	0.000	0.000	0.000
5.100	-2.3313	-1208609.	-2000.0000	0.0128	1937.8694	4.744E+10	0.000	0.000	0.000
5.525	-2.2663	-1233432.	-2000.0000	0.0127	1963.4071	4.744E+10	0.000	0.000	0.000
5.950	-2.2020	-1258102.	-2000.0000	0.0125	1988.7883	4.744E+10	0.000	0.000	0.000
6.375	-2.1384	-1282617.	-2000.0000	0.0124	2014.0098	4.744E+10	0.000	0.000	0.000
6.800	-2.0755	-1306975.	-2000.0000	0.0123	2039.0685	4.744E+10	0.000	0.000	0.000
7.225	-2.0133	-1331170.	-2000.0000	0.0121	2063.9613	4.744E+10	0.000	0.000	0.000
7.650	-1.9518	-1355202.	-2000.0000	0.0120	2088.6851	4.744E+10	0.000	0.000	0.000
8.075	-1.8911	-1379066.	-2000.0000	0.0118	2113.2369	4.744E+10	0.000	0.000	0.000
8.500	-1.8311	-1402761.	-2000.0000	0.0117	2137.6137	4.744E+10	0.000	0.000	0.000
8.925	-1.7719	-1426282.	-2000.0000	0.0115	2161.8124	4.744E+10	0.000	0.000	0.000
9.350	-1.7135	-1449627.	-2000.0000	0.0114	2185.8301	4.744E+10	0.000	0.000	0.000
9.775	-1.6559	-1472793.	-2000.0000	0.0112	2209.6639	4.744E+10	0.000	0.000	0.000
10.200	-1.5990	-1495778.	-2000.0000	0.0111	2233.3106	4.744E+10	0.000	0.000	0.000
10.625	-1.5430	-1518578.	-2000.0000	0.0109	2256.7675	4.744E+10	0.000	0.000	0.000
11.050	-1.4879	-1541191.	-2000.0000	0.0107	2280.0317	4.744E+10	0.000	0.000	0.000
11.475	-1.4335	-1563613.	-2000.0000	0.0106	2303.1003	4.744E+10	0.000	0.000	0.000
11.900	-1.3801	-1585843.	-2000.0000	0.0104	2325.9704	4.744E+10	0.000	0.000	0.000
12.325	-1.3275	-1607877.	-2000.0000	0.0102	2348.6392	4.744E+10	0.000	0.000	0.000
12.750	-1.2758	-1629713.	-2000.0000	0.0101	2371.1039	4.744E+10	0.000	0.000	0.000
13.175	-1.2249	-1651348.	-2000.0000	0.009876	2393.3618	4.744E+10	0.000	0.000	0.000
13.600	-1.1750	-1672779.	-2000.0000	0.009697	2415.4100	4.744E+10	0.000	0.000	0.000
14.025	-1.1260	-1694003.	-2000.0000	0.009516	2437.2460	4.744E+10	0.000	0.000	0.000
14.450	-1.0780	-1715019.	-2000.0000	0.009333	2458.8669	4.744E+10	0.000	0.000	0.000
14.875	-1.0308	-1735823.	-2000.0000	0.009148	2480.2702	4.744E+10	0.000	0.000	0.000
15.300	-0.9847	-1756412.	-2000.0000	0.008960	2501.4531	4.744E+10	0.000	0.000	0.000
15.725	-0.9394	-1776786.	-2000.0000	0.008770	2522.4131	4.744E+10	0.000	0.000	0.000
16.150	-0.8952	-1796939.	-2000.0000	0.008578	2543.1476	4.744E+10	0.000	0.000	0.000
16.575	-0.8519	-1816872.	-2000.0000	0.008384	2563.6540	4.744E+10	0.000	0.000	0.000
17.000	-0.8097	-1836580.	-2000.0000	0.008187	2583.9298	4.744E+10	0.000	0.000	0.000
17.425	-0.7684	-1856061.	-2000.0000	0.007989	2603.9724	4.744E+10	0.000	0.000	0.000
17.850	-0.7282	-1875314.	-2000.0000	0.007788	2623.7795	4.744E+10	0.000	0.000	0.000
18.275	-0.6890	-1894335.	-2000.0000	0.007585	2643.3486	4.744E+10	0.000	0.000	0.000
18.700	-0.6508	-1913122.	-2000.0000	0.007381	2662.6772	4.744E+10	0.000	0.000	0.000
19.125	-0.6137	-1931674.	-2000.0000	0.007174	2681.7630	4.744E+10	0.000	0.000	0.000
19.550	-0.5777	-1949987.	-2000.0000	0.006965	2700.6036	4.744E+10	0.000	0.000	0.000
19.975	-0.5427	-1968059.	-2000.0000	0.006755	2719.1968	4.744E+10	0.000	0.000	0.000
20.400	-0.5088	-1985889.	-2000.0000	0.006542	2737.5401	4.744E+10	0.000	0.000	0.000
20.825	-0.4759	-2003474.	-2000.0000	0.006328	2755.6313	4.744E+10	0.000	0.000	0.000
21.250	-0.4442	-2020811.	-2000.0000	0.006111	2773.4683	4.744E+10	0.000	0.000	0.000
21.675	-0.4136	-2037899.	-1980.3560	0.005893	2791.0488	4.744E+10	7.7035	94.9897	0.000

22.100	-0.3841	-2054536.	-1888.1396	0.005673	2808.1644	4.744E+10	28.4597	377.8757	0.000
22.525	-0.3557	-2070179.	-1686.6772	0.005452	2824.2578	4.744E+10	50.5452	724.6386	0.000
22.950	-0.3285	-2084251.	-1373.6988	0.005228	2838.7358	4.744E+10	72.1915	1120.7770	0.000
23.375	-0.3024	-2096189.	-954.1779	0.005003	2851.0174	4.744E+10	92.3265	1557.0486	0.000
23.800	-0.2775	-2105467.	-439.4432	0.004778	2860.5625	4.744E+10	109.5302	2013.2357	0.000
24.225	-0.2537	-2111636.	158.3179	0.004551	2866.9093	4.744E+10	124.8859	2510.7401	0.000
24.650	-0.2310	-2114296.	824.7906	0.004324	2869.6463	4.744E+10	136.4760	3012.4963	0.000
25.075	-0.2096	-2113146.	1541.9303	0.004096	2868.4629	4.744E+10	144.7553	3522.6070	0.000
25.500	-0.1893	-2107970.	2292.5863	0.003870	2863.1377	4.744E+10	149.6196	4031.7489	0.000
25.925	-0.1701	-2098642.	3057.2373	0.003643	2853.5413	4.744E+10	150.2435	4504.4966	0.000
26.350	-0.1521	-2085148.	4066.0639	0.003419	2839.6581	4.744E+10	245.3747	8227.5568	0.000
26.775	-0.1352	-2065014.	5337.3030	0.003195	2818.9442	4.744E+10	253.1504	9546.6820	0.000
27.200	-0.1195	-2038041.	6625.0729	0.002975	2791.1941	4.744E+10	251.8574	10748.	0.000
27.625	-0.1049	-2004265.	7907.4972	0.002758	2756.4458	4.744E+10	251.0541	12206.	0.000
28.050	-0.0914	-1963713.	9160.9232	0.002544	2714.7250	4.744E+10	240.4855	13422.	0.000
28.475	-0.0789	-1916663.	10335.	0.002336	2666.3198	4.744E+10	220.0836	14218.	0.000
28.900	-0.0676	-1863652.	11430.	0.002132	2611.7821	4.744E+10	209.1911	15792.	0.000
29.325	-0.0572	-1804971.	12492.	0.001935	2551.4100	4.744E+10	207.1074	18468.	0.000
29.750	-0.0478	-1740679.	13532.	0.001745	2485.2668	4.744E+10	200.9353	21431.	0.000
30.175	-0.0394	-1670947.	14532.	0.001561	2413.5257	4.744E+10	191.1786	24748.	0.000
30.600	-0.0319	-1596036.	15495.	0.001386	2336.4568	4.744E+10	186.6262	29843.	0.000
31.025	-0.0253	-1516074.	16427.	0.001218	2254.1913	4.744E+10	178.8918	36112.	0.000
31.450	-0.0195	-1431272.	17312.	0.001060	2166.9463	4.744E+10	167.8592	43976.	0.000
31.875	-0.0145	-1341927.	18131.	0.000911	2075.0279	4.744E+10	153.3859	54120.	0.000
32.300	-0.0102	-1248427.	18867.	0.000772	1978.8347	4.744E+10	135.2427	67773.	0.000
32.725	-0.006585	-1151256.	19465.	0.000643	1878.8641	4.744E+10	99.4515	77026.	0.000
33.150	-0.003624	-1051356.	19864.	0.000524	1776.0860	4.744E+10	57.0393	80277.	0.000
33.575	-0.001239	-949842.	20062.	0.000417	1671.6482	4.744E+10	20.2933	83528.	0.000
34.000	0.000625	-847683.	20086.	0.000320	1566.5468	4.744E+10	-10.6311	86779.	0.000
34.425	0.002024	-745697.	19968.	0.000234	1461.6223	4.744E+10	-35.7267	90031.	0.000
34.850	0.003014	-644547.	19736.	0.000159	1357.5591	4.744E+10	-55.1274	93282.	0.000
35.275	0.003651	-544752.	19420.	9.557E-05	1254.8893	4.744E+10	-69.1009	96533.	0.000
35.700	0.003989	-446688.	19044.	4.227E-05	1153.9995	4.744E+10	-78.0421	99784.	0.000
36.125	0.004082	-350597.	17831.	-5.910E-07	1055.1413	4.744E+10	-397.7200	496925.	0.000
36.550	0.003983	-264809.	15782.	-3.367E-05	966.8813	4.744E+10	-405.7226	519541.	0.000
36.975	0.003738	-189540.	13703.	-5.810E-05	889.4445	4.744E+10	-409.8283	559099.	0.000
37.400	0.003390	-124908.	11611.	-7.500E-05	822.9504	4.744E+10	-410.4572	617480.	0.000
37.825	0.002973	-70936.	9524.3652	-8.553E-05	767.4239	4.744E+10	-407.8190	699503.	0.000
38.250	0.002518	-27563.	7459.4501	-9.082E-05	722.8014	4.744E+10	-401.9516	814212.	0.000
38.675	0.002047	5358.7836	5433.0625	-9.202E-05	699.9576	4.744E+10	-392.7102	978441.	0.000
39.100	0.001579	28065.	3463.4018	-9.022E-05	723.3184	4.744E+10	-379.7058	1226309.	0.000
39.525	0.001127	40893.	1571.5431	-8.651E-05	736.5150	4.744E+10	-362.1995	1639504.	0.000
39.950	0.000697	44294.	-217.1016	-8.194E-05	740.0142	4.744E+10	-339.2297	2483309.	0.000
40.375	0.000291	38866.	-1570.6514	-6.456E-05	13859.	6.612E+09	-191.5741	3358014.	0.000
40.800	3.812E-05	28421.	-2135.1043	-3.861E-05	13670.	6.612E+09	-29.7799	3984375.	0.000
41.225	-0.000103	17177.	-2006.0166	-2.103E-05	13468.	6.612E+09	80.4025	3984375.	0.000
41.650	-0.000176	8008.1818	-1479.7505	-1.132E-05	13302.	6.612E+09	125.9764	3642594.	0.000
42.075	-0.000218	2109.2186	-786.7841	-7.414E-06	13196.	6.612E+09	145.7751	3404995.	0.000
42.500	-0.000252	0.000	0.000	-6.601E-06	13158.	6.612E+09	162.7676	1647008.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 4:

```
Pile-head deflection            =     -3.1589342 inches
Computed slope at pile head     =      0.0141703 radians
Maximum bending moment          =      -2114296. inch-lbs
Maximum shear force             =         20086. lbs
Depth of maximum bending moment =     24.6500000 feet below pile head
Depth of maximum shear force    =     34.0000000 feet below pile head
```

Number of iterations = 6
Number of zero deflection points = 2

Pile-head Deflection vs. Pile Length for Load Case 4

Boundary Condition Type 1, Shear and Moment

Shear = -2000. lb
Moment = -900000. in- lb
Axial Load = 225000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
42.5000	-3.1589342	-2114296.	20086.
40.3750	-3.1540889	-2113718.	19632.
38.2500	-3.2923497	-2136248.	22425.
36.1250	-4.9656123	-2427013.	33524.

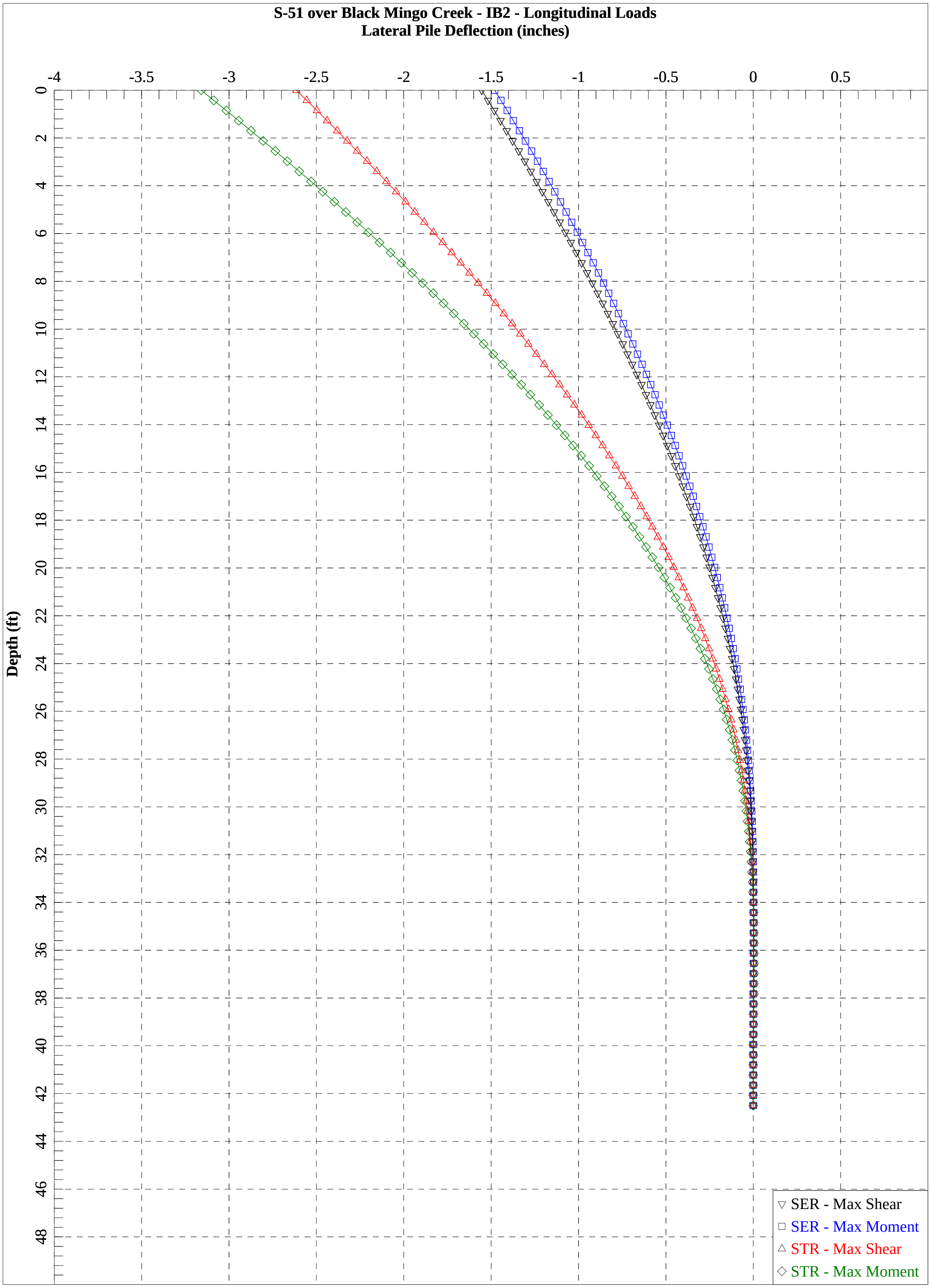
Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

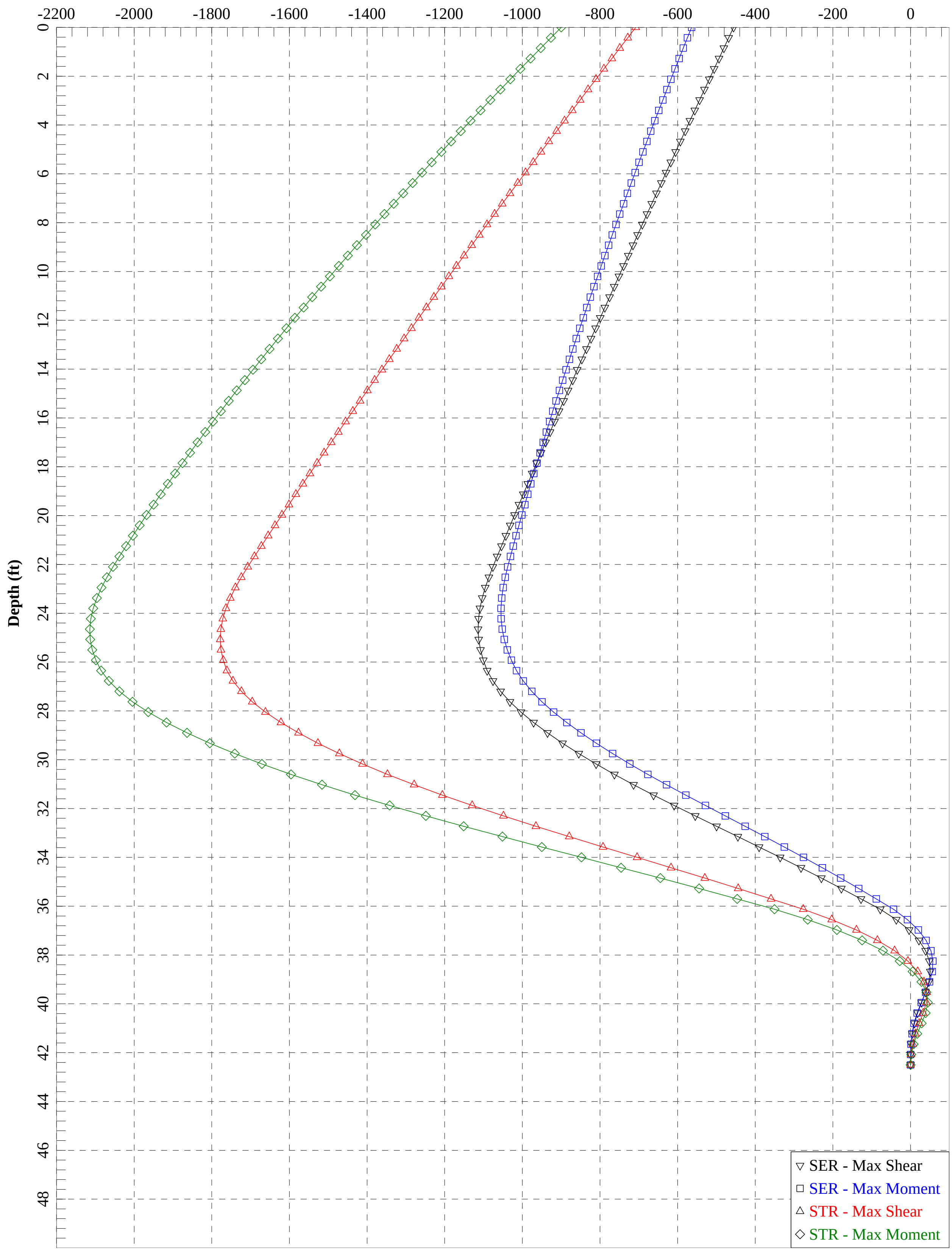
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

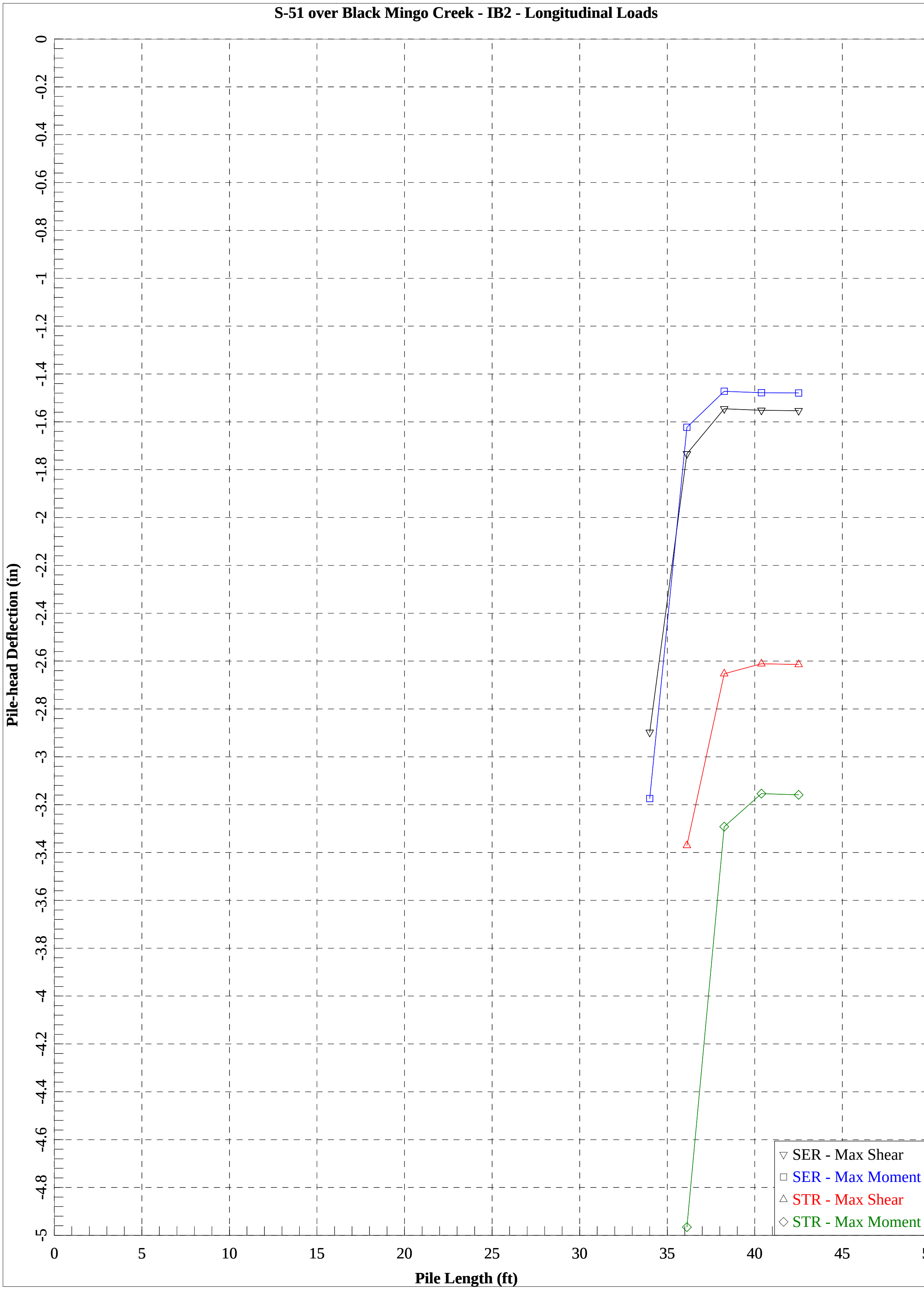
Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	1	V = -2000.0000	M = -456000.	65000.	-1.55342274	-1113957.	10783.	0.00707618
2	1	V = -1000.0000	M = -564000.	157000.	-1.47959379	-1054958.	10047.	0.00707321
3	1	V = -3000.0000	M = -708000.	89000.	-2.61433591	-1778330.	17202.	0.01159030
4	1	V = -2000.0000	M = -900000.	225000.	-3.15893419	-2114296.	20086.	0.01417027

The analysis ended normally.


S-51 over Black Mingo Creek - IB2 - Longitudinal Loads
Lateral Pile Deflection (inches)
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Moment

S-51 over Black Mingo Creek - IB2 - Longitudinal Loads
Bending Moment (in-kips)




S-51 over Black Mingo Creek - IB2 - Longitudinal Loads
Pile-head Deflection (in)
Pile Length (ft)
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
-3
-3.2
-3.4
-3.6
-3.8
-4
-4.2
-4.4
-4.6
-4.8
-5
0
5
10
15
20
25
30
35
40
45
50
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Moment

```
===============================================================================

                 LPile Plus for Windows, Version 2013-07.007

               Analysis of Individual Piles and Drilled Shafts
              Subjected to Lateral Loading Using the p-y Method
```



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-------------------------------------------------------------------------------
                           Files Used for Analysis
-------------------------------------------------------------------------------

Path to file locations:        P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo
Creek\Reports\Final Report\Bridge\LPile\
Name of input data file:       IB2_Trans.lp7d
Name of output report file:    IB2_Trans.lp7o
Name of plot output file:      IB2_Trans.lp7p
Name of runtime messeage file: IB2_Trans.lp7r


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                          Date and Time of Analysis
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              Date:  February 15, 2016     Time:  18:51:00


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                               Problem Title
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Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: ICE

Engineer: JFH

Description: IB2 18" Square PSC Pile - Transverse Loads
```

Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Use of p-y modification factors for p-y curves not selected
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 2

Total length of pile = 42.50 ft

Depth of ground surface below top of pile = 21.50 ft

Pile diameter values used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000

```
  2         40.000000         18.0000000
  3         40.000000          8.2200000
  4         42.500000          8.2200000
```

Input Structural Properties:

Pile Section No. 1:

```
   Section Type                                         =    Elastic Pile
   Cross-sectional Shape                                =     Rectangular
   Section Length                                       =     40.00000 ft
   Top Width                                            =     18.00000 in
   Bottom Width                                         =     18.00000 in
   Top Section Depth                                    =     18.00000 in
   Bottom Section Depth                                 =     18.00000 in
   Top Area                                             =    324.00000 Sq. in
   Bottom Area                                          =    324.00000 Sq. in
   Moment of Inertia at Top                             =   8748.00000 in^4
   Moment of Inertia at Bottom                          =   8748.00000 in^4
   Elastic Modulus                                      =     5422453. lbs/in^2
```

Pile Section No. 2:

```
   Section Type                                         =    Elastic Pile
   Cross-sectional Shape                                =   Strong H-Pile
   Section Length                                       =      2.50000 ft
   Flange Width                                         =      8.22000 in
   Section Depth                                        =      8.75000 in
   Flange Thickness                                     =      0.81000 in
   Web Thickness                                        =      0.51000 in
   Section Area                                         =     17.10000 Sq. in
   Moment of Inertia                                    =     75.00000 in^4
   Elastic Modulus                                      =    29000000. lbs/in^2
```

Ground Slope and Pile Batter Angles

```
Ground Slope Angle                                      =        0.000 degrees
                                                        =        0.000 radians

Pile Batter Angle                                       =        0.000 degrees
                                                        =        0.000 radians
```

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer          =     21.50000 ft
   Distance from top of pile to bottom of layer       =     26.00000 ft
   Effective unit weight at top of layer              =     48.00000 pcf
   Effective unit weight at bottom of layer           =     48.00000 pcf
   Friction angle at top of layer                     =     32.00000 deg.
   Friction angle at bottom of layer                  =     32.00000 deg.
   Subgrade k at top of layer                         =     30.00000 pci
   Subgrade k at bottom of layer                      =     30.00000 pci


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     26.00000 ft
   Distance from top of pile to bottom of layer       =     36.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     40.00000 deg.
   Friction angle at bottom of layer                  =     40.00000 deg.
   Subgrade k at top of layer                         =    125.00000 pci
   Subgrade k at bottom of layer                      =    125.00000 pci


Layer 3 is stiff clay without free water

   Distance from top of pile to top of layer          =     36.00000 ft
   Distance from top of pile to bottom of layer       =    100.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Undrained cohesion at top of layer                 =   2500.00000 psf
   Undrained cohesion at bottom of layer              =   2500.00000 psf
   Epsilon-50 at top of layer                         =      0.00500
   Epsilon-50 at bottom of layer                      =      0.00500

   (Depth of lowest soil layer extends   57.50 ft below pile tip)
```

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	21.500	48.000	--	32.000	--	30.000
		26.000	48.000	--	32.000	--	30.000
2	Sand (Reese, et al.)	26.000	53.000	--	40.000	--	125.000
		36.000	53.000	--	40.000	--	125.000
3	Stiff Clay w/o Free Water	36.000	53.000	2500.000	--	0.00500	--
		100.000	53.000	2500.000	--	0.00500	--

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	2	V = 2000.00000 lbs	S = 0.0000 in/in	92000.	Yes
2	2	V = 3000.00000 lbs	S = 0.0000 in/in	122000.	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

Pile Section No. 2:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 2, Shear and Slope

```
Shear      =        2000.  lb
Slope      =      0.00000
Axial Load =       92000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
42.5000	0.1870996	-377990.	-2758.7838397
40.3750	0.1866880	-377761.	-2714.0264433
38.2500	0.1855242	-377081.	-2618.8087284
36.1250	0.1915432	-381196.	-3026.1113910
34.0000	0.2136025	-397865.	-3602.5685706
31.8750	0.2733102	-449941.	-3481.4695949
29.7500	0.3643478	-540049.	-2212.3969083
27.6250	0.4163203	-603561.	2000.0000013
25.5000	0.4208999	-608508.	2000.0000006
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.
25.5000	0.000000	2131957412.	348502857.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 3000.0 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 122000.0 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2846	-571985.	3000.0000	0.000	965.0052	4.744E+10	0.000	0.000	0.000
0.425	0.2844	-556666.	3000.0000	-6.067E-05	949.2447	4.744E+10	0.000	0.000	0.000
0.850	0.2839	-541310.	3000.0000	-0.000120	933.4460	4.744E+10	0.000	0.000	0.000
1.275	0.2832	-525917.	3000.0000	-0.000177	917.6100	4.744E+10	0.000	0.000	0.000
1.700	0.2821	-510489.	3000.0000	-0.000233	901.7378	4.744E+10	0.000	0.000	0.000
2.125	0.2808	-495027.	3000.0000	-0.000287	885.8305	4.744E+10	0.000	0.000	0.000
2.550	0.2792	-479532.	3000.0000	-0.000339	869.8891	4.744E+10	0.000	0.000	0.000
2.975	0.2774	-464005.	3000.0000	-0.000390	853.9147	4.744E+10	0.000	0.000	0.000
3.400	0.2752	-448447.	3000.0000	-0.000439	837.9084	4.744E+10	0.000	0.000	0.000
3.825	0.2729	-432859.	3000.0000	-0.000486	821.8712	4.744E+10	0.000	0.000	0.000
4.250	0.2703	-417242.	3000.0000	-0.000532	805.8043	4.744E+10	0.000	0.000	0.000

4.675	0.2675	-401597.	3000.0000	-0.000576	789.7086	4.744E+10	0.000	0.000	0.000
5.100	0.2644	-385925.	3000.0000	-0.000618	773.5852	4.744E+10	0.000	0.000	0.000
5.525	0.2611	-370227.	3000.0000	-0.000659	757.4354	4.744E+10	0.000	0.000	0.000
5.950	0.2577	-354505.	3000.0000	-0.000698	741.2600	4.744E+10	0.000	0.000	0.000
6.375	0.2540	-338759.	3000.0000	-0.000735	725.0602	4.744E+10	0.000	0.000	0.000
6.800	0.2502	-322990.	3000.0000	-0.000771	708.8371	4.744E+10	0.000	0.000	0.000
7.225	0.2462	-307199.	3000.0000	-0.000805	692.5918	4.744E+10	0.000	0.000	0.000
7.650	0.2420	-291388.	3000.0000	-0.000837	676.3254	4.744E+10	0.000	0.000	0.000
8.075	0.2376	-275558.	3000.0000	-0.000867	660.0389	4.744E+10	0.000	0.000	0.000
8.500	0.2331	-259709.	3000.0000	-0.000896	643.7334	4.744E+10	0.000	0.000	0.000
8.925	0.2285	-243843.	3000.0000	-0.000923	627.4100	4.744E+10	0.000	0.000	0.000
9.350	0.2237	-227960.	3000.0000	-0.000949	611.0699	4.744E+10	0.000	0.000	0.000
9.775	0.2188	-212062.	3000.0000	-0.000972	594.7141	4.744E+10	0.000	0.000	0.000
10.200	0.2138	-196150.	3000.0000	-0.000994	578.3437	4.744E+10	0.000	0.000	0.000
10.625	0.2087	-180225.	3000.0000	-0.001014	561.9598	4.744E+10	0.000	0.000	0.000
11.050	0.2034	-164288.	3000.0000	-0.001033	545.5635	4.744E+10	0.000	0.000	0.000
11.475	0.1981	-148339.	3000.0000	-0.001050	529.1559	4.744E+10	0.000	0.000	0.000
11.900	0.1927	-132381.	3000.0000	-0.001065	512.7380	4.744E+10	0.000	0.000	0.000
12.325	0.1873	-116414.	3000.0000	-0.001078	496.3111	4.744E+10	0.000	0.000	0.000
12.750	0.1817	-100440.	3000.0000	-0.001090	479.8761	4.744E+10	0.000	0.000	0.000
13.175	0.1762	-84458.	3000.0000	-0.001100	463.4343	4.744E+10	0.000	0.000	0.000
13.600	0.1705	-68471.	3000.0000	-0.001108	446.9866	4.744E+10	0.000	0.000	0.000
14.025	0.1648	-52479.	3000.0000	-0.001115	430.5342	4.744E+10	0.000	0.000	0.000
14.450	0.1592	-36484.	3000.0000	-0.001119	414.0782	4.744E+10	0.000	0.000	0.000
14.875	0.1534	-20486.	3000.0000	-0.001122	397.6197	4.744E+10	0.000	0.000	0.000
15.300	0.1477	-4487.2923	3000.0000	-0.001124	381.1598	4.744E+10	0.000	0.000	0.000
15.725	0.1420	11512.	3000.0000	-0.001123	388.3869	4.744E+10	0.000	0.000	0.000
16.150	0.1362	27511.	3000.0000	-0.001121	404.8463	4.744E+10	0.000	0.000	0.000
16.575	0.1305	43507.	3000.0000	-0.001117	421.3039	4.744E+10	0.000	0.000	0.000
17.000	0.1248	59501.	3000.0000	-0.001112	437.7584	4.744E+10	0.000	0.000	0.000
17.425	0.1192	75491.	3000.0000	-0.001105	454.2089	4.744E+10	0.000	0.000	0.000
17.850	0.1136	91476.	3000.0000	-0.001096	470.6541	4.744E+10	0.000	0.000	0.000
18.275	0.1080	107454.	3000.0000	-0.001085	487.0931	4.744E+10	0.000	0.000	0.000
18.700	0.1025	123426.	3000.0000	-0.001073	503.5247	4.744E+10	0.000	0.000	0.000
19.125	0.0971	139389.	3000.0000	-0.001058	519.9477	4.744E+10	0.000	0.000	0.000
19.550	0.0917	155343.	3000.0000	-0.001043	536.3612	4.744E+10	0.000	0.000	0.000
19.975	0.0864	171287.	3000.0000	-0.001025	552.7640	4.744E+10	0.000	0.000	0.000
20.400	0.0813	187219.	3000.0000	-0.001006	569.1550	4.744E+10	0.000	0.000	0.000
20.825	0.0762	203138.	3000.0000	-0.000985	585.5331	4.744E+10	0.000	0.000	0.000
21.250	0.0712	219044.	3000.0000	-0.000962	601.8973	4.744E+10	0.000	0.000	0.000
21.675	0.0664	234935.	2989.3380	-0.000938	618.2463	4.744E+10	-4.1812	321.3000	0.000
22.100	0.0617	250702.	2944.7189	-0.000912	634.4673	4.744E+10	-13.3165	1101.6000	0.000
22.525	0.0571	266106.	2857.0619	-0.000884	650.3148	4.744E+10	-21.0588	1881.9000	0.000
22.950	0.0526	280944.	2733.2986	-0.000854	665.5803	4.744E+10	-27.4758	2662.2000	0.000
23.375	0.0484	295049.	2580.0040	-0.000823	680.0914	4.744E+10	-32.6398	3442.5000	0.000
23.800	0.0442	308285.	2403.3715	-0.000791	693.7087	4.744E+10	-36.6279	4222.8000	0.000
24.225	0.0403	320548.	2209.1903	-0.000757	706.3246	4.744E+10	-39.5216	5003.1000	0.000
24.650	0.0365	331761.	2002.8249	-0.000722	717.8609	4.744E+10	-41.4060	5783.4000	0.000
25.075	0.0329	341875.	1789.1966	-0.000686	728.2664	4.744E+10	-42.3698	6563.7000	0.000
25.500	0.0295	350864.	1572.7675	-0.000649	737.5146	4.744E+10	-42.5044	7344.0000	0.000
25.925	0.0263	358724.	1357.5269	-0.000611	745.6012	4.744E+10	-41.9037	8124.3000	0.000
26.350	0.0233	365471.	923.7256	-0.000572	752.5418	4.744E+10	-128.2145	28077.	0.000
26.775	0.0205	368858.	275.5437	-0.000532	756.0264	4.744E+10	-125.9746	31379.	0.000
27.200	0.0179	368943.	-345.2980	-0.000492	756.1146	4.744E+10	-117.4928	33547.	0.000
27.625	0.0155	365948.	-921.0210	-0.000453	753.0334	4.744E+10	-108.2809	35740.	0.000
28.050	0.0132	360113.	-1438.1959	-0.000414	747.0295	4.744E+10	-94.5327	36409.	0.000

28.475	0.0112	351794.	-1876.6386	-0.000376	738.4711	4.744E+10	-77.4055	35155.	0.000
28.900	0.009410	341438.	-2247.8141	-0.000338	727.8173	4.744E+10	-68.1535	36937.	0.000
29.325	0.007778	329287.	-2586.7408	-0.000302	715.3162	4.744E+10	-64.7589	42462.	0.000
29.750	0.006326	315430.	-2905.0678	-0.000268	701.0595	4.744E+10	-60.0752	48430.	0.000
30.175	0.005048	299989.	-3197.1752	-0.000235	685.1736	4.744E+10	-54.4768	55041.	0.000
30.600	0.003934	283111.	-3455.6099	-0.000203	667.8092	4.744E+10	-46.8702	60769.	0.000
31.025	0.002975	264994.	-3670.3466	-0.000174	649.1712	4.744E+10	-37.3403	64021.	0.000
31.450	0.002161	245889.	-3838.2509	-0.000146	629.5157	4.744E+10	-28.5045	67272.	0.000
31.875	0.001482	226026.	-3963.2011	-0.000121	609.0806	4.744E+10	-20.4956	70523.	0.000
32.300	0.000927	205615.	-4049.6710	-9.774E-05	588.0814	4.744E+10	-13.4141	73774.	0.000
32.725	0.000485	184841.	-4102.5632	-7.675E-05	566.7092	4.744E+10	-7.3279	77026.	0.000
33.150	0.000144	163865.	-4127.0465	-5.801E-05	545.1281	4.744E+10	-2.2734	80277.	0.000
33.575	-0.000106	142818.	-4128.3963	-4.152E-05	523.4749	4.744E+10	1.7441	83528.	0.000
34.000	-0.000279	121807.	-4111.8393	-2.730E-05	501.8586	4.744E+10	4.7489	86779.	0.000
34.425	-0.000385	100911.	-4082.4027	-1.532E-05	480.3609	4.744E+10	6.7948	90031.	0.000
34.850	-0.000435	80185.	-4044.7688	-5.588E-06	459.0382	4.744E+10	7.9636	93282.	0.000
35.275	-0.000442	59661.	-4003.1321	1.929E-06	437.9230	4.744E+10	8.3645	96533.	0.000
35.700	-0.000416	39351.	-3961.0617	7.252E-06	417.0275	4.744E+10	8.1337	99784.	0.000
36.125	-0.000368	19249.	-3394.9690	1.040E-05	396.3470	4.744E+10	213.8634	2964342.	0.000
36.550	-0.000310	4709.1294	-2372.6648	1.169E-05	381.3880	4.744E+10	187.0401	3080955.	0.000
36.975	-0.000249	-4966.4351	-1504.2991	1.168E-05	381.6527	4.744E+10	153.4954	3147632.	0.000
37.400	-0.000191	-10649.	-806.6961	1.084E-05	387.4992	4.744E+10	120.0744	3214312.	0.000
37.825	-0.000138	-13208.	-273.8409	9.554E-06	390.1319	4.744E+10	88.8884	3280992.	0.000
38.250	-9.306E-05	-13454.	108.5980	8.121E-06	390.3851	4.744E+10	61.0876	3347674.	0.000
38.675	-5.534E-05	-12111.	358.8393	6.747E-06	389.0027	4.744E+10	37.0462	3414357.	0.000
39.100	-2.425E-05	-9802.5517	495.5119	5.569E-06	386.6281	4.744E+10	16.5508	3481041.	0.000
39.525	1.464E-06	-7063.3346	535.1192	4.662E-06	383.8100	4.744E+10	-1.0185	3547727.	0.000
39.950	2.330E-05	-4350.1373	490.4074	4.048E-06	381.0187	4.744E+10	-16.5155	3614413.	0.000
40.375	4.276E-05	-2066.2174	363.1111	1.392E-06	7247.7316	2.175E+09	-33.4046	3984375.	0.000
40.800	3.750E-05	-648.1368	203.2163	-1.790E-06	7170.0208	2.175E+09	-29.2992	3984375.	0.000
41.225	2.450E-05	8.8171	79.7002	-2.540E-06	7134.9861	2.175E+09	-19.1385	3984375.	0.000
41.650	1.160E-05	167.9661	7.7937	-2.333E-06	7143.7075	2.175E+09	-9.0601	3984375.	0.000
42.075	7.053E-07	91.2159	-16.7148	-2.029E-06	7139.5016	2.175E+09	-0.5510	3984375.	0.000
42.500	-9.095E-06	0.000	0.000	-1.922E-06	7134.5029	2.175E+09	7.1059	1992187.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      0.2845687 inches
Computed slope at pile head       =       0.000000 radians
Maximum bending moment            =       -571985. inch-lbs
Maximum shear force               =  -4128.3963445 lbs
Depth of maximum bending moment  =       0.000000 feet below pile head
Depth of maximum shear force      =     33.5750000 feet below pile head
Number of iterations              =              6
Number of zero deflection points =              3
```

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 2, Shear and Slope

```
Shear      =          3000.  lb
Slope      =        0.00000
Axial Load =        122000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
42.5000	0.2845687	-571985.	-4128.3963445
40.3750	0.2836994	-571503.	-4061.7781239
38.2500	0.2815841	-570277.	-3916.0563040
36.1250	0.2951638	-579321.	-4604.8386773
34.0000	0.3411847	-613590.	-5284.6099862
31.8750	0.4459600	-706118.	-4799.3429626
29.7500	0.5886405	-850874.	3000.0000000
27.6250	0.6546065	-937362.	3000.0000012
25.5000	0.6619076	-938152.	3000.0000008
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.
25.5000	0.000000	3352727747.	548049554.

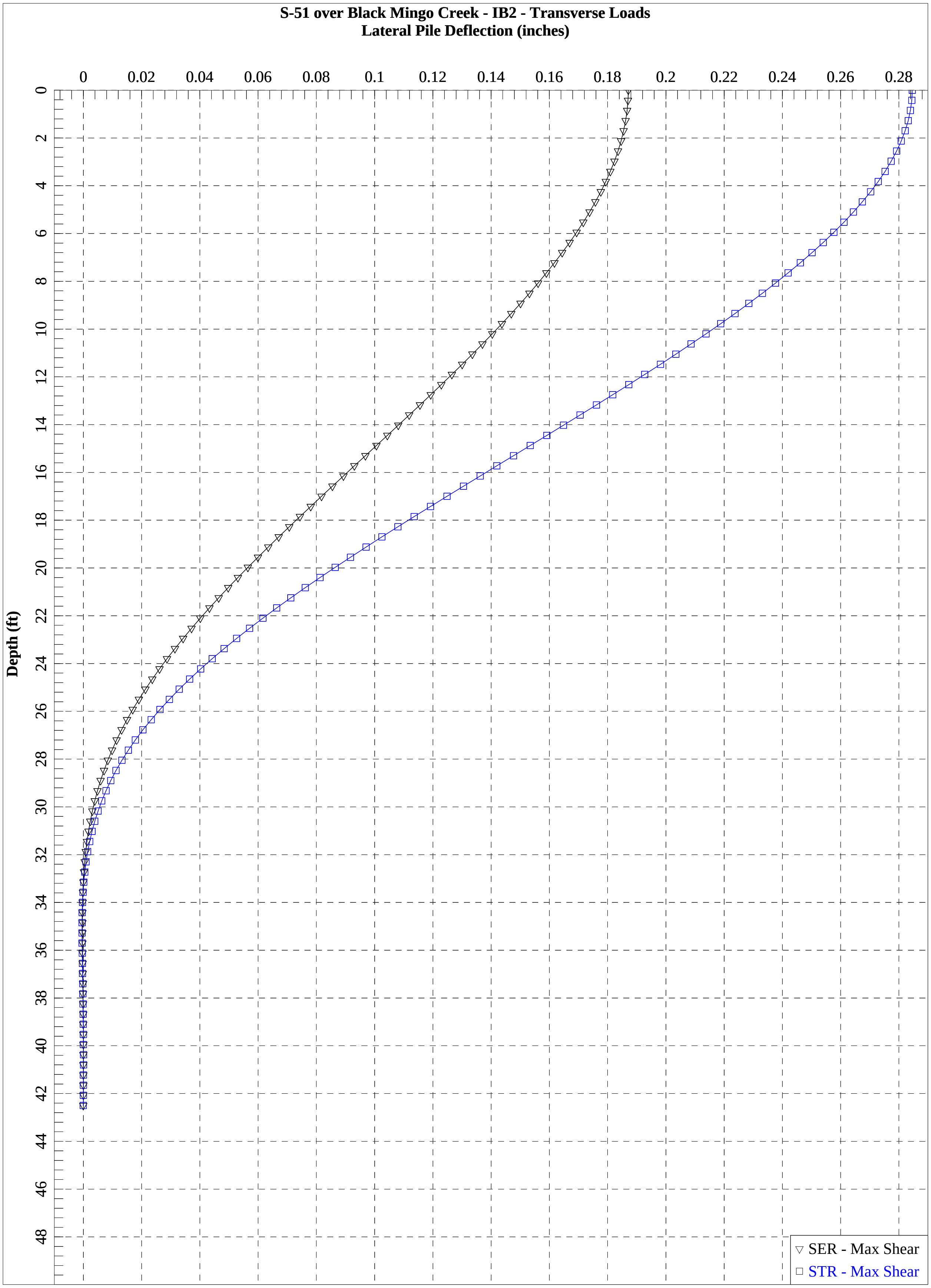
Summary of Pile Response(s)

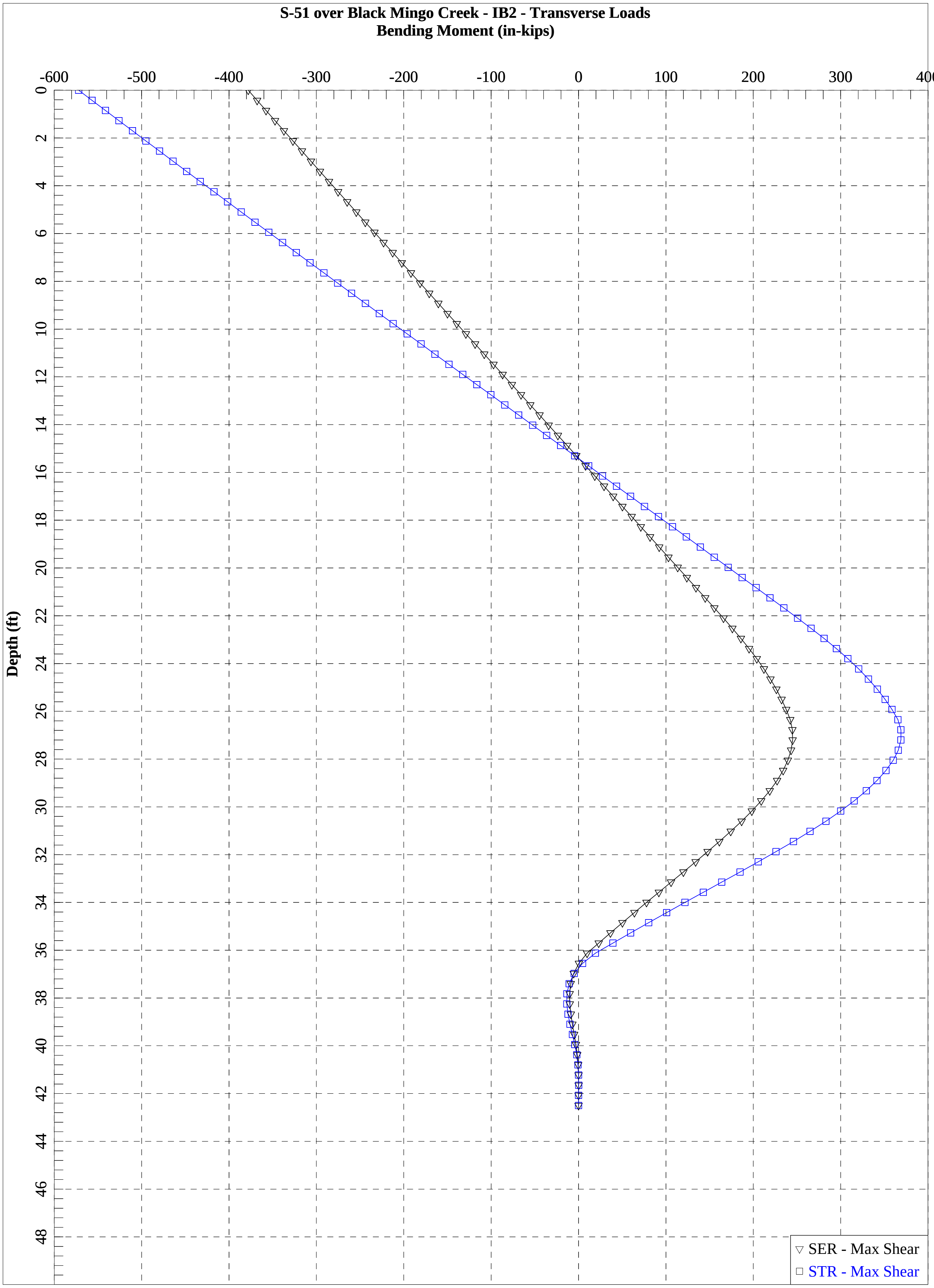
Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

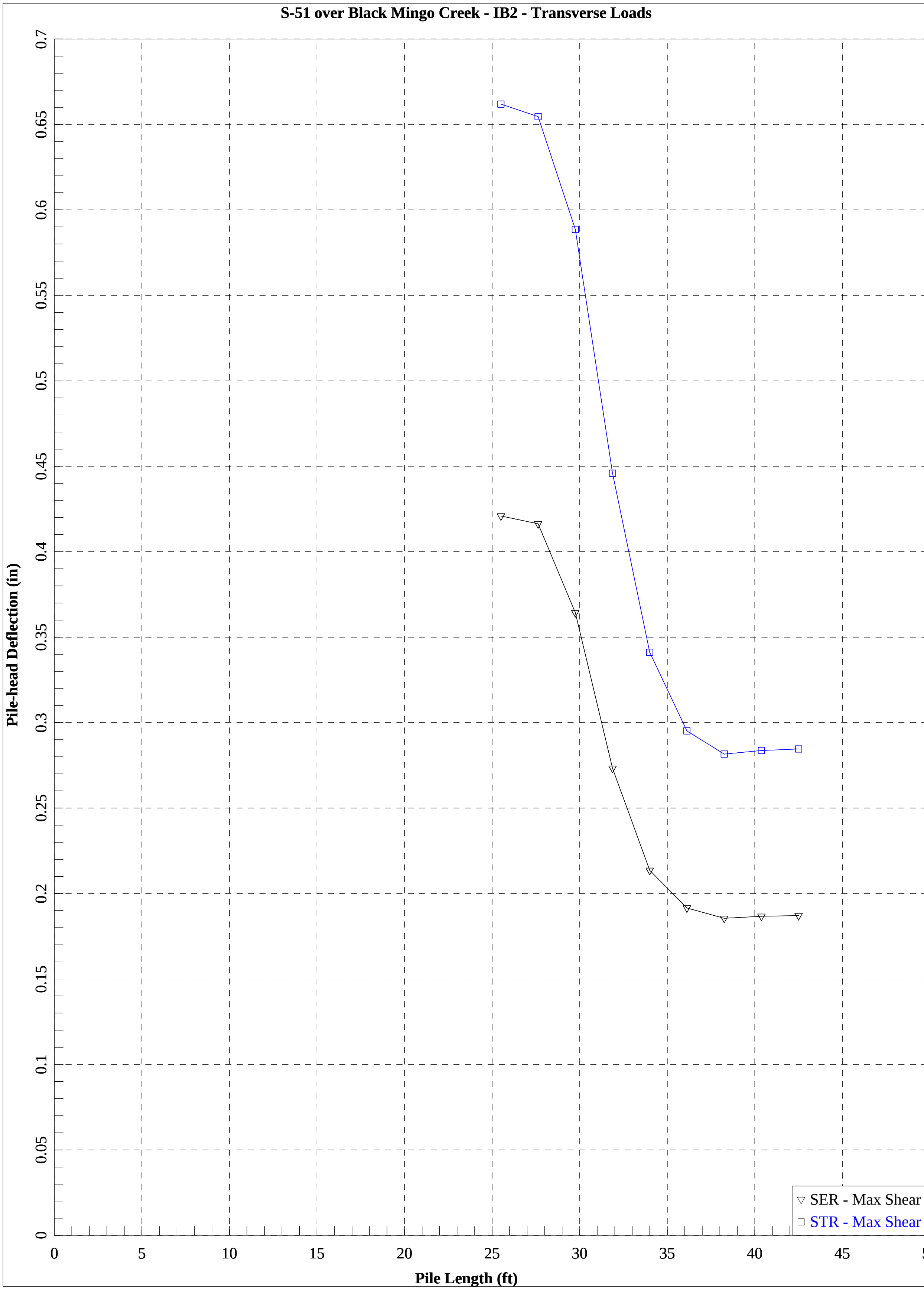
Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	2	V = 2000.0000	S = 0.000	92000.	0.18709959	-377990.	-2758.7838	0.00000000
2	2	V = 3000.0000	S = 0.000	122000.	0.28456867	-571985.	-4128.3963	0.00000000

The analysis ended normally.


S-51 over Black Mingo Creek - IB2 - Transverse Loads
Lateral Pile Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
SER - Max Shear
STR - Max Shear



S-51 over Black Mingo Creek - IB2 - Transverse Loads
Bending Moment (in-kips)
-600
-500
-400
-300
-200
-100
0
100
200
300
400
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
SER - Max Shear
STR - Max Shear


S-51 over Black Mingo Creek - IB2 - Transverse Loads
Pile-head Deflection (in)
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
45
50
Pile Length (ft)
SER - Max Shear
STR - Max Shear

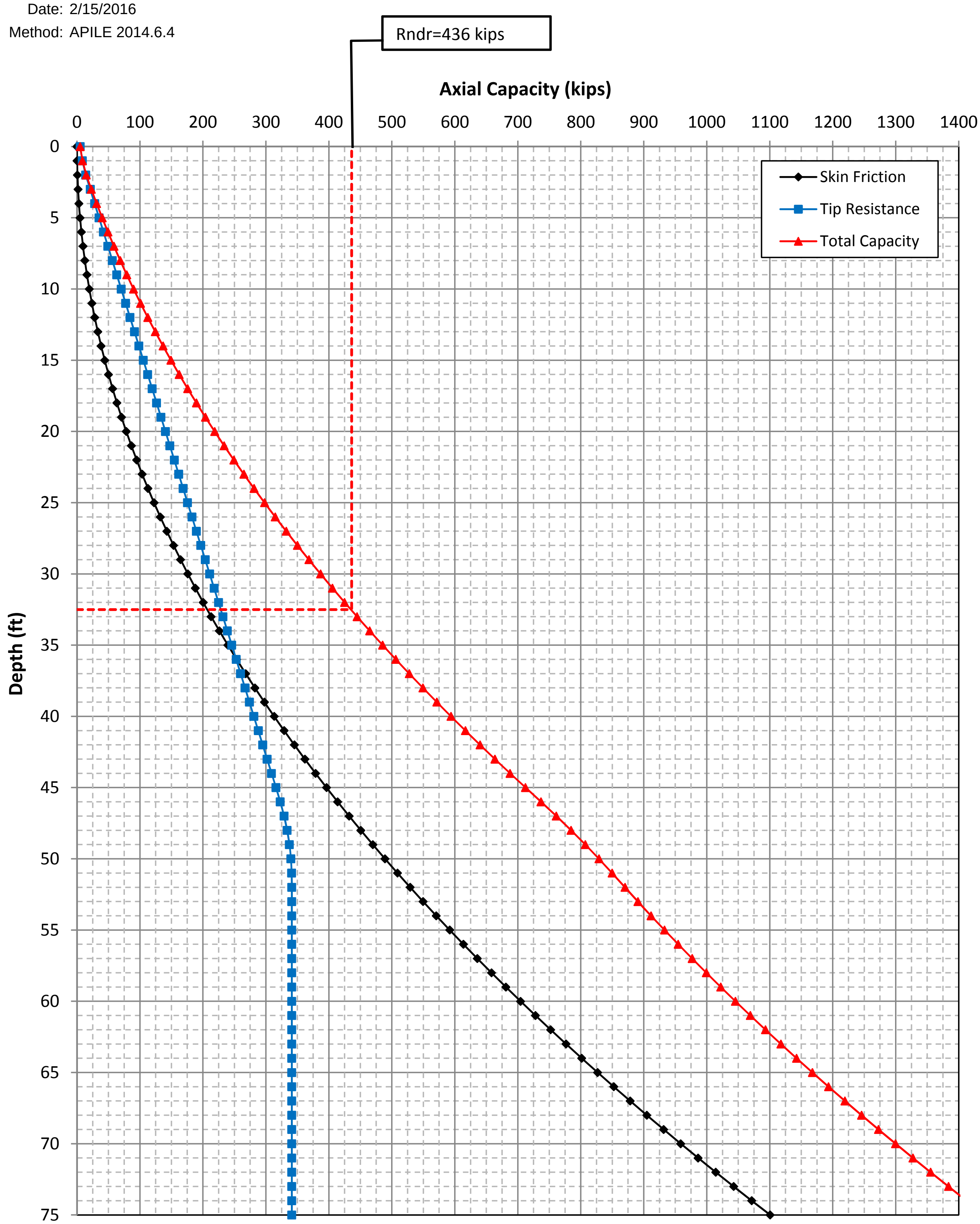
APPENDIX

SECTION 14

INTERIOR BENT 3 DRIVEN PILE ANALYSES

F&ME CONSULTANTS

Project: S-51 Emergency Bridge Replacement over Black Mingo Creek - **Axial Capacity Analysis**
Location : Interior Bent 3 - 18" Square PSC Pile
Calc. By: JFH
Date: 2/15/2016
Method: APILE 2014.6.4



[1]Axial capacity analyses were modeled with a 18" Square PSC pile with no stinger
[2]The axial capacities shown are unfactored.

```
===============================================================================

                  LPile Plus for Windows, Version 2013-07.007

                Analysis of Individual Piles and Drilled Shafts
               Subjected to Lateral Loading Using the p-y Method

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-------------------------------------------------------------------------------
                            Files Used for Analysis
-------------------------------------------------------------------------------

Path to file locations:        P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black
Mingo Creek\Reports\Final Report\Bridge\LPile\
Name of input data file:       IB3_Long.lp7d
Name of output report file:    IB3_Long.lp7o
Name of plot output file:      IB3_Long.lp7p
Name of runtime messeage file: IB3_Long.lp7r


-------------------------------------------------------------------------------
                           Date and Time of Analysis
-------------------------------------------------------------------------------

               Date:  February 15, 2016     Time:  18:56:33


-------------------------------------------------------------------------------
                                 Problem Title
-------------------------------------------------------------------------------

Project Name: S-51 RBO Jumping Run Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: ICE

Engineer: JFH

Description: IB3 18" Square PSC Pile - Longitudinal Loads


-------------------------------------------------------------------------------
                           Program Options and Settings
```

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 2

Total length of pile = 51.50 ft

Depth of ground surface below top of pile = 22.50 ft

Pile diameter values used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	49.000000	18.0000000
3	49.000000	8.2200000
4	51.500000	8.2200000

Input Structural Properties:

Pile Section No. 1:

```
   Section Type                                       =    Elastic Pile
   Cross-sectional Shape                              =     Rectangular
   Section Length                                     =     49.00000 ft
   Top Width                                          =     18.00000 in
   Bottom Width                                       =     18.00000 in
   Top Section Depth                                  =     18.00000 in
   Bottom Section Depth                               =     18.00000 in
   Top Area                                           =    324.00000 Sq. in
   Bottom Area                                        =    324.00000 Sq. in
   Moment of Inertia at Top                           =   8748.00000 in^4
   Moment of Inertia at Bottom                        =   8748.00000 in^4
   Elastic Modulus                                    =     5422453. lbs/in^2

Pile Section No. 2:

   Section Type                                       =    Elastic Pile
   Cross-sectional Shape                              =   Strong H-Pile
   Section Length                                     =      2.50000 ft
   Flange Width                                       =      8.22000 in
   Section Depth                                      =      8.75000 in
   Flange Thickness                                   =      0.81000 in
   Web Thickness                                      =      0.51000 in
   Section Area                                       =     17.10000 Sq. in
   Moment of Inertia                                  =    228.00000 in^4
   Elastic Modulus                                    =    29000000. lbs/in^2


--------------------------------------------------------------------------------
                      Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------

Ground Slope Angle                                    =        0.000 degrees
                                                      =        0.000 radians

Pile Batter Angle                                     =        0.000 degrees
                                                      =        0.000 radians


--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =     22.50000 ft
   Distance from top of pile to bottom of layer       =     38.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
   Effective unit weight at bottom of layer           =     53.00000 pcf
   Friction angle at top of layer                     =     40.00000 deg.
   Friction angle at bottom of layer                  =     40.00000 deg.
   Subgrade k at top of layer                         =    125.00000 pci
   Subgrade k at bottom of layer                      =    125.00000 pci


Layer 2 is stiff clay without free water

   Distance from top of pile to top of layer          =     38.00000 ft
   Distance from top of pile to bottom of layer       =     75.00000 ft
   Effective unit weight at top of layer              =     53.00000 pcf
```

Effective unit weight at bottom of layer = 53.00000 pcf
Undrained cohesion at top of layer = 2500.00000 psf
Undrained cohesion at bottom of layer = 2500.00000 psf
Epsilon-50 at top of layer = 0.00500
Epsilon-50 at bottom of layer = 0.00500

(Depth of lowest soil layer extends 23.50 ft below pile tip)

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	22.500	53.000	--	40.000	--	125.000
		38.000	53.000	--	40.000	--	125.000
2	Stiff Clay w/o Free Water	38.000	53.000	2500.000	--	0.00500	--
		75.000	53.000	2500.000	--	0.00500	--

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	22.500	0.8700	1.0000
2	51.000	0.8700	1.0000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 4

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 2000.00000 lbs	M = 360000. in-lbs	77000.	Yes
2	1	V = 1000.00000 lbs	M = 468000. in-lbs	173000.	Yes
3	1	V = 3000.00000 lbs	M = 588000. in-lbs	104000.	Yes
4	1	V = 2000.00000 lbs	M = 780000. in-lbs	245000.	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

Pile Section No. 2:

Moment-curvature properties were derived from elastic section properties

---

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 2000. lb
Moment = 360000. in- lb
Axial Load = 77000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
51.5000	1.4225990	1041562.	-9486.9131997
48.9250	1.4237786	1042555.	-9498.2926765
46.3500	1.4221674	1041987.	-9502.1123044
43.7750	1.4226607	1042002.	-9492.0573444
41.2000	1.4258254	1042020.	-9325.4336874
38.6250	1.4368030	1042486.	-9669.6563722
36.0500	1.6403077	1052793.	-12916.
33.4750	3.7888690	1180777.	-19848.
30.9000	-24.7633459	-674227.	24441.
28.3250	-15.6730454	360000.	10520.
25.7500	-12.2580699	360000.	3480.1916615
25.7500	0.000000	-61529107680.	9956166291.
25.7500	0.000000	-61529107680.	9956166291.
25.7500	0.000000	-61529107680.	9956166291.
25.7500	0.000000	-61529107680.	9956166291.
25.7500	0.000000	-61529107680.	9956166291.
25.7500	0.000000	-61529107680.	9956166291.

25.7500	0.000000	-61529107680.	9956166291.
25.7500	0.000000	-61529107680.	9956166291.
25.7500	0.000000	-61529107680.	9956166291.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 1000.0 lbs
Applied moment at pile head = 468000.0 in-lbs
Axial thrust load on pile head = 173000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.3323	468000.	1000.0000	-0.006307	1015.4321	4.744E+10	0.000	0.000	0.000
0.515	1.2935	480890.	1000.0000	-0.006245	1028.6935	4.744E+10	0.000	0.000	0.000
1.030	1.2551	493713.	1000.0000	-0.006181	1041.8859	4.744E+10	0.000	0.000	0.000
1.545	1.2171	506467.	1000.0000	-0.006116	1055.0076	4.744E+10	0.000	0.000	0.000
2.060	1.1795	519151.	1000.0000	-0.006049	1068.0568	4.744E+10	0.000	0.000	0.000
2.575	1.1424	531763.	1000.0000	-0.005981	1081.0315	4.744E+10	0.000	0.000	0.000
3.090	1.1056	544300.	1000.0000	-0.005911	1093.9300	4.744E+10	0.000	0.000	0.000
3.605	1.0693	556762.	1000.0000	-0.005839	1106.7505	4.744E+10	0.000	0.000	0.000
4.120	1.0335	569146.	1000.0000	-0.005766	1119.4913	4.744E+10	0.000	0.000	0.000
4.635	0.9981	581450.	1000.0000	-0.005691	1132.1505	4.744E+10	0.000	0.000	0.000
5.150	0.9631	593674.	1000.0000	-0.005614	1144.7263	4.744E+10	0.000	0.000	0.000
5.665	0.9287	605815.	1000.0000	-0.005536	1157.2171	4.744E+10	0.000	0.000	0.000
6.180	0.8947	617872.	1000.0000	-0.005456	1169.6211	4.744E+10	0.000	0.000	0.000
6.695	0.8612	629842.	1000.0000	-0.005375	1181.9365	4.744E+10	0.000	0.000	0.000
7.210	0.8283	641725.	1000.0000	-0.005292	1194.1617	4.744E+10	0.000	0.000	0.000
7.725	0.7958	653519.	1000.0000	-0.005208	1206.2949	4.744E+10	0.000	0.000	0.000
8.240	0.7639	665221.	1000.0000	-0.005122	1218.3345	4.744E+10	0.000	0.000	0.000
8.755	0.7325	676831.	1000.0000	-0.005035	1230.2787	4.744E+10	0.000	0.000	0.000
9.270	0.7017	688346.	1000.0000	-0.004946	1242.1260	4.744E+10	0.000	0.000	0.000
9.785	0.6714	699766.	1000.0000	-0.004855	1253.8746	4.744E+10	0.000	0.000	0.000
10.300	0.6416	711088.	1000.0000	-0.004763	1265.5229	4.744E+10	0.000	0.000	0.000
10.815	0.6125	722311.	1000.0000	-0.004670	1277.0693	4.744E+10	0.000	0.000	0.000
11.330	0.5839	733434.	1000.0000	-0.004575	1288.5122	4.744E+10	0.000	0.000	0.000
11.845	0.5559	744454.	1000.0000	-0.004479	1299.8500	4.744E+10	0.000	0.000	0.000
12.360	0.5286	755371.	1000.0000	-0.004381	1311.0812	4.744E+10	0.000	0.000	0.000
12.875	0.5018	766182.	1000.0000	-0.004282	1322.2040	4.744E+10	0.000	0.000	0.000
13.390	0.4756	776887.	1000.0000	-0.004182	1333.2171	4.744E+10	0.000	0.000	0.000
13.905	0.4501	787484.	1000.0000	-0.004080	1344.1189	4.744E+10	0.000	0.000	0.000
14.420	0.4252	797970.	1000.0000	-0.003976	1354.9078	4.744E+10	0.000	0.000	0.000
14.935	0.4010	808346.	1000.0000	-0.003872	1365.5824	4.744E+10	0.000	0.000	0.000
15.450	0.3774	818609.	1000.0000	-0.003766	1376.1411	4.744E+10	0.000	0.000	0.000
15.965	0.3544	828758.	1000.0000	-0.003658	1386.5825	4.744E+10	0.000	0.000	0.000
16.480	0.3321	838792.	1000.0000	-0.003550	1396.9052	4.744E+10	0.000	0.000	0.000
16.995	0.3105	848709.	1000.0000	-0.003440	1407.1076	4.744E+10	0.000	0.000	0.000
17.510	0.2896	858507.	1000.0000	-0.003329	1417.1884	4.744E+10	0.000	0.000	0.000
18.025	0.2694	868186.	1000.0000	-0.003216	1427.1462	4.744E+10	0.000	0.000	0.000
18.540	0.2499	877744.	1000.0000	-0.003102	1436.9796	4.744E+10	0.000	0.000	0.000
19.055	0.2311	887180.	1000.0000	-0.002987	1446.6872	4.744E+10	0.000	0.000	0.000
19.570	0.2130	896492.	1000.0000	-0.002871	1456.2677	4.744E+10	0.000	0.000	0.000
20.085	0.1956	905680.	1000.0000	-0.002754	1465.7197	4.744E+10	0.000	0.000	0.000
20.600	0.1789	914741.	1000.0000	-0.002635	1475.0419	4.744E+10	0.000	0.000	0.000

21.115	0.1630	923675.	1000.0000	-0.002516	1484.2331	4.744E+10	0.000	0.000	0.000
21.630	0.1478	932480.	1000.0000	-0.002395	1493.2918	4.744E+10	0.000	0.000	0.000
22.145	0.1334	941155.	1000.0000	-0.002273	1502.2170	4.744E+10	0.000	0.000	0.000
22.660	0.1197	949699.	977.2827	-0.002149	1511.0073	4.744E+10	-7.3519	379.4618	0.000
23.175	0.1068	957830.	845.9745	-0.002025	1519.3726	4.744E+10	-35.1427	2032.9058	0.000
23.690	0.0947	964486.	533.9750	-0.001900	1526.2198	4.744E+10	-65.8280	4295.6966	0.000
24.205	0.0834	968493.	36.7085	-0.001774	1530.3422	4.744E+10	-95.0996	7051.1559	0.000
24.720	0.0728	968733.	-626.3367	-0.001648	1530.5891	4.744E+10	-119.4782	10146.	0.000
25.235	0.0630	964275.	-1424.7265	-0.001522	1526.0027	4.744E+10	-138.9004	13629.	0.000
25.750	0.0540	954377.	-2321.3781	-0.001397	1515.8202	4.744E+10	-151.2781	17324.	0.000
26.265	0.0457	938569.	-3271.6346	-0.001274	1499.5569	4.744E+10	-156.2483	21121.	0.000
26.780	0.0382	916663.	-4221.2176	-0.001153	1477.0197	4.744E+10	-151.0601	24423.	0.000
27.295	0.0315	888860.	-5119.1244	-0.001035	1448.4156	4.744E+10	-139.5246	27400.	0.000
27.810	0.0254	855604.	-5928.6935	-0.000921	1414.2019	4.744E+10	-122.4719	29763.	0.000
28.325	0.0201	817552.	-6610.5083	-0.000813	1375.0532	4.744E+10	-98.1802	30217.	0.000
28.840	0.0154	775636.	-7176.2754	-0.000709	1331.9297	4.744E+10	-84.9159	34104.	0.000
29.355	0.0113	730368.	-7674.6035	-0.000611	1285.3585	4.744E+10	-76.3553	41685.	0.000
29.870	0.007840	682083.	-8110.6371	-0.000519	1235.6824	4.744E+10	-64.7559	51042.	0.000
30.385	0.004910	631230.	-8466.8478	-0.000433	1183.3641	4.744E+10	-50.5226	63592.	0.000
30.900	0.002488	578359.	-8707.2271	-0.000354	1128.9702	4.744E+10	-27.2700	67745.	0.000
31.415	0.000531	524366.	-8810.5849	-0.000282	1073.4219	4.744E+10	-6.1791	71899.	0.000
31.930	-0.001003	470064.	-8791.5287	-0.000218	1017.5557	4.744E+10	12.3462	76052.	0.000
32.445	-0.002159	416168.	-8666.7909	-0.000160	962.1072	4.744E+10	28.0220	80205.	0.000
32.960	-0.002980	363285.	-8454.5085	-0.000109	907.7002	4.744E+10	40.6778	84359.	0.000
33.475	-0.003508	311904.	-8173.5491	-6.517E-05	854.8394	4.744E+10	50.2476	88512.	0.000
33.990	-0.003786	262399.	-7842.8894	-2.776E-05	803.9083	4.744E+10	56.7621	92666.	0.000
34.505	-0.003851	215025.	-7481.0462	3.337E-06	755.1699	4.744E+10	60.3393	96819.	0.000
35.020	-0.003744	169926.	-7105.5623	2.841E-05	708.7716	4.744E+10	61.1765	100973.	0.000
35.535	-0.003500	127140.	-6732.5408	4.776E-05	664.7527	4.744E+10	59.5424	105126.	0.000
36.050	-0.003154	86610.	-6376.2250	6.169E-05	623.0552	4.744E+10	55.7702	109279.	0.000
36.565	-0.002738	48198.	-6048.6150	7.047E-05	583.5366	4.744E+10	50.2525	113433.	0.000
37.080	-0.002283	11698.	-5759.1143	7.437E-05	545.9857	4.744E+10	43.4371	117586.	0.000
37.595	-0.001819	-23144.	-5514.1952	7.363E-05	557.7614	4.744E+10	35.8247	121740.	0.000
38.110	-0.001373	-56615.	-4426.9149	6.843E-05	592.1963	4.744E+10	316.0459	1422634.	0.000
38.625	-0.000973	-78007.	-2532.8386	5.966E-05	614.2048	4.744E+10	296.9238	1886264.	0.000
39.140	-0.000636	-88048.	-770.5092	4.884E-05	624.5352	4.744E+10	273.4094	2658728.	0.000
39.655	-0.000369	-87635.	830.4792	3.740E-05	624.1101	4.744E+10	244.7099	4097155.	0.000
40.170	-0.000173	-77863.	1950.5263	2.662E-05	614.0571	4.744E+10	117.7649	4200469.	0.000
40.685	-4.011E-05	-63583.	2398.6525	1.740E-05	599.3656	4.744E+10	27.2598	4200469.	0.000
41.200	4.186E-05	-48253.	2394.9755	1.012E-05	583.5940	4.744E+10	-28.4497	4200469.	0.000
41.715	8.497E-05	-34003.	2128.6098	4.761E-06	568.9333	4.744E+10	-57.7528	4200469.	0.000
42.230	0.000101	-21954.	1738.6498	1.116E-06	556.5369	4.744E+10	-68.4478	4200469.	0.000
42.745	9.876E-05	-12516.	1319.7182	-1.129E-06	546.8270	4.744E+10	-67.1287	4200469.	0.000
43.260	8.675E-05	-5639.7762	930.1029	-2.312E-06	539.7529	4.744E+10	-58.9604	4200469.	0.000
43.775	7.019E-05	-1014.7949	600.5047	-2.745E-06	534.9946	4.744E+10	-47.7057	4200469.	0.000
44.290	5.281E-05	1788.3320	342.1763	-2.695E-06	535.7905	4.744E+10	-35.8957	4200469.	0.000
44.805	3.688E-05	3220.2669	153.8098	-2.369E-06	537.2636	4.744E+10	-25.0643	4200469.	0.000
45.320	2.353E-05	3694.4858	26.9356	-1.918E-06	537.7515	4.744E+10	-15.9953	4200469.	0.000
45.835	1.316E-05	3557.2928	-50.1390	-1.446E-06	537.6104	4.744E+10	-8.9480	4200469.	0.000
46.350	5.661E-06	3077.8599	-89.6766	-1.014E-06	537.1171	4.744E+10	-3.8474	4200469.	0.000
46.865	6.343E-07	2451.0578	-102.8972	-6.536E-07	536.4723	4.744E+10	-0.4311	4200469.	0.000
47.380	-2.418E-06	1807.4480	-99.1502	-3.762E-07	535.8101	4.744E+10	1.6438	4200469.	0.000
47.895	-4.016E-06	1226.3661	-85.6365	-1.786E-07	535.2123	4.744E+10	2.7296	4200469.	0.000
48.410	-4.626E-06	749.3624	-67.4864	-4.991E-08	534.7216	4.744E+10	3.1442	4200469.	0.000
48.925	-4.633E-06	392.3406	-48.0408	2.446E-08	534.3543	4.744E+10	3.1488	4200469.	0.000
49.440	-4.324E-06	155.5258	-29.2303	1.227E-07	10120.	6.612E+09	2.9387	4200469.	0.000
49.955	-3.116E-06	30.7923	-13.6050	2.098E-07	10118.	6.612E+09	2.1180	4200469.	0.000
50.470	-1.731E-06	-13.0803	-3.4253	2.181E-07	10117.	6.612E+09	1.1764	4200469.	0.000
50.985	-4.210E-07	-12.0104	1.0940	2.063E-07	10117.	6.612E+09	0.2861	4200469.	0.000
51.500	8.194E-07	0.000	0.000	2.007E-07	10117.	6.612E+09	-0.6402	2414062.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

```
Pile-head deflection             =      1.3323299 inches
Computed slope at pile head      =     -0.0063066 radians
Maximum bending moment           =        968733. inch-lbs
Maximum shear force              =  -8810.5849283 lbs
Depth of maximum bending moment  =     24.7200000 feet below pile head
Depth of maximum shear force     =     31.4150000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              4
```

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 1, Shear and Moment

```
Shear      =          1000.  lb
Moment     =        468000. in- lb
Axial Load =        173000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
51.5000	1.3323299	968733.	-8810.5849283
48.9250	1.3335667	969595.	-8808.0112772
46.3500	1.3319135	968954.	-8824.9913865
43.7750	1.3323802	969056.	-8817.7170065
41.2000	1.3359262	969325.	-8704.0570534
38.6250	1.3419627	970221.	-8809.7434434
36.0500	1.5049353	991589.	-11701.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 3

Pile-head conditions are Shear and Moment (Loading Type 1)

```
Shear force at pile head                          =       3000.0 lbs
Applied moment at pile head                       =     588000.0 in-lbs
Axial thrust load on pile head                    =     104000.0 lbs
```

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	2.4636	588000.	3000.0000	-0.0108	925.9259	4.744E+10	0.000	0.000	0.000
0.515	2.3973	613435.	3000.0000	-0.0107	952.0939	4.744E+10	0.000	0.000	0.000
1.030	2.3315	638819.	3000.0000	-0.0106	978.2091	4.744E+10	0.000	0.000	0.000
1.545	2.2662	664150.	3000.0000	-0.0105	1004.2692	4.744E+10	0.000	0.000	0.000
2.060	2.2014	689425.	3000.0000	-0.0104	1030.2722	4.744E+10	0.000	0.000	0.000
2.575	2.1372	714642.	3000.0000	-0.0103	1056.2157	4.744E+10	0.000	0.000	0.000

3.090	2.0736	739799.	3000.0000	-0.0102	1082.0976	4.744E+10	0.000	0.000	0.000
3.605	2.0106	764894.	3000.0000	-0.0101	1107.9159	4.744E+10	0.000	0.000	0.000
4.120	1.9481	789926.	3000.0000	-0.0100	1133.6682	4.744E+10	0.000	0.000	0.000
4.635	1.8864	814891.	3000.0000	-0.009944	1159.3525	4.744E+10	0.000	0.000	0.000
5.150	1.8252	839788.	3000.0000	-0.009836	1184.9666	4.744E+10	0.000	0.000	0.000
5.665	1.7648	864614.	3000.0000	-0.009725	1210.5083	4.744E+10	0.000	0.000	0.000
6.180	1.7050	889368.	3000.0000	-0.009611	1235.9756	4.744E+10	0.000	0.000	0.000
6.695	1.6460	914048.	3000.0000	-0.009493	1261.3662	4.744E+10	0.000	0.000	0.000
7.210	1.5877	938651.	3000.0000	-0.009372	1286.6781	4.744E+10	0.000	0.000	0.000
7.725	1.5302	963176.	3000.0000	-0.009249	1311.9092	4.744E+10	0.000	0.000	0.000
8.240	1.4734	987620.	3000.0000	-0.009121	1337.0572	4.744E+10	0.000	0.000	0.000
8.755	1.4174	1011981.	3000.0000	-0.008991	1362.1202	4.744E+10	0.000	0.000	0.000
9.270	1.3623	1036257.	3000.0000	-0.008858	1387.0960	4.744E+10	0.000	0.000	0.000
9.785	1.3079	1060447.	3000.0000	-0.008721	1411.9826	4.744E+10	0.000	0.000	0.000
10.300	1.2545	1084548.	3000.0000	-0.008582	1436.7777	4.744E+10	0.000	0.000	0.000
10.815	1.2019	1108558.	3000.0000	-0.008439	1461.4795	4.744E+10	0.000	0.000	0.000
11.330	1.1502	1132475.	3000.0000	-0.008293	1486.0857	4.744E+10	0.000	0.000	0.000
11.845	1.0994	1156298.	3000.0000	-0.008144	1510.5944	4.744E+10	0.000	0.000	0.000
12.360	1.0495	1180023.	3000.0000	-0.007991	1535.0035	4.744E+10	0.000	0.000	0.000
12.875	1.0006	1203650.	3000.0000	-0.007836	1559.3109	4.744E+10	0.000	0.000	0.000
13.390	0.9527	1227176.	3000.0000	-0.007678	1583.5147	4.744E+10	0.000	0.000	0.000
13.905	0.9057	1250600.	3000.0000	-0.007516	1607.6127	4.744E+10	0.000	0.000	0.000
14.420	0.8598	1273918.	3000.0000	-0.007352	1631.6030	4.744E+10	0.000	0.000	0.000
14.935	0.8148	1297130.	3000.0000	-0.007184	1655.4835	4.744E+10	0.000	0.000	0.000
15.450	0.7710	1320233.	3000.0000	-0.007014	1679.2523	4.744E+10	0.000	0.000	0.000
15.965	0.7281	1343226.	3000.0000	-0.006840	1702.9074	4.744E+10	0.000	0.000	0.000
16.480	0.6864	1366106.	3000.0000	-0.006664	1726.4467	4.744E+10	0.000	0.000	0.000
16.995	0.6458	1388872.	3000.0000	-0.006484	1749.8684	4.744E+10	0.000	0.000	0.000
17.510	0.6063	1411522.	3000.0000	-0.006302	1773.1704	4.744E+10	0.000	0.000	0.000
18.025	0.5679	1434053.	3000.0000	-0.006117	1796.3508	4.744E+10	0.000	0.000	0.000
18.540	0.5307	1456464.	3000.0000	-0.005928	1819.4077	4.744E+10	0.000	0.000	0.000
19.055	0.4946	1478754.	3000.0000	-0.005737	1842.3391	4.744E+10	0.000	0.000	0.000
19.570	0.4597	1500919.	3000.0000	-0.005543	1865.1431	4.744E+10	0.000	0.000	0.000
20.085	0.4261	1522959.	3000.0000	-0.005346	1887.8178	4.744E+10	0.000	0.000	0.000
20.600	0.3937	1544871.	3000.0000	-0.005146	1910.3613	4.744E+10	0.000	0.000	0.000
21.115	0.3625	1566654.	3000.0000	-0.004944	1932.7718	4.744E+10	0.000	0.000	0.000
21.630	0.3326	1588306.	3000.0000	-0.004738	1955.0472	4.744E+10	0.000	0.000	0.000
22.145	0.3039	1609825.	3000.0000	-0.004530	1977.1859	4.744E+10	0.000	0.000	0.000
22.660	0.2766	1631209.	2971.6281	-0.004319	1999.1858	4.744E+10	-9.1818	205.1618	0.000
23.175	0.2505	1652105.	2804.9569	-0.004105	2020.6845	4.744E+10	-44.7571	1103.9754	0.000
23.690	0.2258	1671154.	2404.2078	-0.003888	2040.2822	4.744E+10	-84.9352	2324.1519	0.000
24.205	0.2025	1686819.	1757.6832	-0.003670	2056.3986	4.744E+10	-124.2960	3793.5389	0.000
24.720	0.1805	1697596.	884.0948	-0.003449	2067.4858	4.744E+10	-158.4187	5424.2655	0.000
25.235	0.1599	1702180.	-185.0415	-0.003228	2072.2021	4.744E+10	-187.5802	7251.6980	0.000
25.750	0.1406	1699458.	-1408.8214	-0.003006	2069.4012	4.744E+10	-208.4651	9163.1594	0.000
26.265	0.1227	1688631.	-2733.3103	-0.002785	2058.2628	4.744E+10	-220.1721	11089.	0.000
26.780	0.1062	1669255.	-4101.6512	-0.002567	2038.3278	4.744E+10	-222.6567	12960.	0.000
27.295	0.0910	1641234.	-5464.2282	-0.002351	2009.5002	4.744E+10	-218.3067	14829.	0.000
27.810	0.0771	1604739.	-6778.1072	-0.002139	1971.9534	4.744E+10	-206.8969	16581.	0.000
28.325	0.0645	1560207.	-7984.0435	-0.001933	1926.1389	4.744E+10	-183.3738	17560.	0.000
28.840	0.0532	1508541.	-9082.9877	-0.001733	1872.9847	4.744E+10	-172.2716	20005.	0.000
29.355	0.0431	1450169.	-10132.	-0.001541	1812.9315	4.744E+10	-167.2704	23978.	0.000
29.870	0.0342	1385288.	-11135.	-0.001356	1746.1810	4.744E+10	-157.3786	28460.	0.000
30.385	0.0264	1314280.	-12085.	-0.001180	1673.1273	4.744E+10	-150.0901	35198.	0.000
30.900	0.0196	1237429.	-12985.	-0.001014	1594.0629	4.744E+10	-141.1404	44529.	0.000
31.415	0.0138	1155084.	-13817.	-0.000858	1509.3462	4.744E+10	-127.8561	57171.	0.000
31.930	0.008983	1067760.	-14551.	-0.000713	1419.5061	4.744E+10	-109.7429	75499.	0.000
32.445	0.005005	976155.	-15091.	-0.000580	1325.2620	4.744E+10	-64.9556	80205.	0.000
32.960	0.001813	881987.	-15368.	-0.000459	1228.3816	4.744E+10	-24.7462	84359.	0.000
33.475	-0.000669	786800.	-15415.	-0.000350	1130.4528	4.744E+10	9.5833	88512.	0.000
33.990	-0.002518	691913.	-15268.	-0.000254	1032.8327	4.744E+10	37.7501	92666.	0.000

34.505	-0.003809	598411.	-14967.	-0.000170	936.6364	4.744E+10	59.6739	96819.	0.000
35.020	-0.004619	507137.	-14550.	-9.797E-05	842.7333	4.744E+10	75.4616	100973.	0.000
35.535	-0.005020	418702.	-14053.	-3.766E-05	751.7515	4.744E+10	85.3917	105126.	0.000
36.050	-0.005084	333494.	-13511.	1.134E-05	664.0890	4.744E+10	89.9002	109279.	0.000
36.565	-0.004880	251692.	-12956.	4.946E-05	579.9301	4.744E+10	89.5663	113433.	0.000
37.080	-0.004473	173289.	-12417.	7.714E-05	499.2688	4.744E+10	85.1021	117586.	0.000
37.595	-0.003926	98122.	-11915.	9.482E-05	421.9365	4.744E+10	77.3424	121740.	0.000
38.110	-0.003301	25901.	-10448.	0.000103	347.6347	4.744E+10	397.3656	744000.	0.000
38.625	-0.002654	-31146.	-8025.6680	0.000103	353.0310	4.744E+10	386.5324	899953.	0.000
39.140	-0.002033	-73428.	-5682.6380	9.575E-05	396.5310	4.744E+10	371.7297	1129979.	0.000
39.655	-0.001471	-101507.	-3443.3682	8.435E-05	425.4184	4.744E+10	352.9530	1482971.	0.000
40.170	-0.000990	-116097.	-1333.9695	7.018E-05	440.4286	4.744E+10	329.7002	2057257.	0.000
40.685	-0.000603	-118085.	600.7296	5.492E-05	442.4740	4.744E+10	296.4160	3035634.	0.000
41.200	-0.000312	-108742.	2170.9902	4.015E-05	432.8623	4.744E+10	211.7590	4200469.	0.000
41.715	-0.000107	-91303.	3050.4928	2.712E-05	414.9207	4.744E+10	72.8697	4200469.	0.000
42.230	2.362E-05	-71073.	3226.0517	1.654E-05	394.1080	4.744E+10	-16.0545	4200469.	0.000
42.745	9.723E-05	-51450.	2972.2423	8.559E-06	373.9199	4.744E+10	-66.0844	4200469.	0.000
43.260	0.000129	-34347.	2496.2496	2.970E-06	356.3241	4.744E+10	-87.9585	4200469.	0.000
43.775	0.000134	-20600.	1943.1554	-6.092E-07	342.1814	4.744E+10	-91.0364	4200469.	0.000
44.290	0.000122	-10329.	1405.8751	-2.624E-06	331.6140	4.744E+10	-82.8408	4200469.	0.000
44.805	0.000102	-3220.3555	936.7094	-3.507E-06	324.3008	4.744E+10	-68.9928	4200469.	0.000
45.320	7.854E-05	1253.3967	558.5698	-3.635E-06	322.2772	4.744E+10	-53.3825	4200469.	0.000
45.835	5.658E-05	3688.2389	274.7824	-3.313E-06	324.7821	4.744E+10	-38.4581	4200469.	0.000
46.350	3.759E-05	4653.9656	76.9910	-2.769E-06	325.7757	4.744E+10	-25.5521	4200469.	0.000
46.865	2.235E-05	4643.4081	-48.9109	-2.164E-06	325.7648	4.744E+10	-15.1929	4200469.	0.000
47.380	1.085E-05	4052.2086	-118.6451	-1.597E-06	325.1566	4.744E+10	-7.3748	4200469.	0.000
47.895	2.610E-06	3179.0081	-146.9157	-1.126E-06	324.2582	4.744E+10	-1.7743	4200469.	0.000
48.410	-3.070E-06	2237.7777	-145.9508	-7.734E-07	323.2899	4.744E+10	2.0866	4200469.	0.000
48.925	-6.948E-06	1376.0508	-124.9098	-5.380E-07	322.4033	4.744E+10	4.7228	4200469.	0.000
49.440	-9.719E-06	694.5835	-89.9039	-1.237E-07	6094.3921	6.612E+09	6.6060	4200469.	0.000
49.955	-8.478E-06	264.9973	-51.6862	3.247E-07	6086.6483	6.612E+09	5.7622	4200469.	0.000
50.470	-5.706E-06	55.3249	-21.8977	4.744E-07	6082.8686	6.612E+09	3.8781	4200469.	0.000
50.985	-2.614E-06	-6.2679	-4.4244	4.973E-07	6081.9843	6.612E+09	1.7767	4200469.	0.000
51.500	4.414E-07	0.000	0.000	4.944E-07	6081.8713	6.612E+09	-0.3449	2414062.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 3:

```
Pile-head deflection            =      2.4635864 inches
Computed slope at pile head     =     -0.0107666 radians
Maximum bending moment          =       1702180. inch-lbs
Maximum shear force             =        -15415. lbs
Depth of maximum bending moment =     25.2350000 feet below pile head
Depth of maximum shear force    =     33.4750000 feet below pile head
Number of iterations            =              6
Number of zero deflection points =             4
```

Pile-head Deflection vs. Pile Length for Load Case 3

Boundary Condition Type 1, Shear and Moment

```
Shear      =          3000.  lb
Moment     =        588000. in- lb
Axial Load =        104000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
51.5000	2.4635864	1702180.	-15415.
48.9250	2.4652852	1702633.	-15408.
46.3500	2.4629545	1701530.	-15447.
43.7750	2.4643077	1702012.	-15404.
41.2000	2.4679103	1702061.	-14994.
38.6250	2.5518239	1707694.	-17225.
36.0500	3.3455502	1766914.	-23579.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 4

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 2000.0 lbs
Applied moment at pile head = 780000.0 in-lbs
Axial thrust load on pile head = 245000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	3.0199	780000.	2000.0000	-0.0134	1558.6420	4.744E+10	0.000	0.000	0.000
0.515	2.9375	812548.	2000.0000	-0.0133	1592.1276	4.744E+10	0.000	0.000	0.000
1.030	2.8557	844936.	2000.0000	-0.0132	1625.4484	4.744E+10	0.000	0.000	0.000
1.545	2.7747	877157.	2000.0000	-0.0131	1658.5976	4.744E+10	0.000	0.000	0.000
2.060	2.6943	909205.	2000.0000	-0.0129	1691.5689	4.744E+10	0.000	0.000	0.000
2.575	2.6147	941074.	2000.0000	-0.0128	1724.3556	4.744E+10	0.000	0.000	0.000
3.090	2.5358	972757.	2000.0000	-0.0127	1756.9514	4.744E+10	0.000	0.000	0.000
3.605	2.4577	1004248.	2000.0000	-0.0126	1789.3497	4.744E+10	0.000	0.000	0.000
4.120	2.3805	1035541.	2000.0000	-0.0124	1821.5443	4.744E+10	0.000	0.000	0.000
4.635	2.3040	1066630.	2000.0000	-0.0123	1853.5286	4.744E+10	0.000	0.000	0.000
5.150	2.2284	1097508.	2000.0000	-0.0122	1885.2966	4.744E+10	0.000	0.000	0.000
5.665	2.1537	1128170.	2000.0000	-0.0120	1916.8417	4.744E+10	0.000	0.000	0.000
6.180	2.0799	1158610.	2000.0000	-0.0119	1948.1580	4.744E+10	0.000	0.000	0.000
6.695	2.0071	1188820.	2000.0000	-0.0117	1979.2391	4.744E+10	0.000	0.000	0.000
7.210	1.9352	1218797.	2000.0000	-0.0116	2010.0789	4.744E+10	0.000	0.000	0.000
7.725	1.8642	1248533.	2000.0000	-0.0114	2040.6714	4.744E+10	0.000	0.000	0.000
8.240	1.7943	1278022.	2000.0000	-0.0112	2071.0105	4.744E+10	0.000	0.000	0.000
8.755	1.7254	1307260.	2000.0000	-0.0111	2101.0903	4.744E+10	0.000	0.000	0.000
9.270	1.6576	1336239.	2000.0000	-0.0109	2130.9048	4.744E+10	0.000	0.000	0.000
9.785	1.5908	1364955.	2000.0000	-0.0107	2160.4480	4.744E+10	0.000	0.000	0.000
10.300	1.5252	1393402.	2000.0000	-0.0105	2189.7143	4.744E+10	0.000	0.000	0.000
10.815	1.4606	1421574.	2000.0000	-0.0104	2218.6978	4.744E+10	0.000	0.000	0.000
11.330	1.3973	1449466.	2000.0000	-0.0102	2247.3928	4.744E+10	0.000	0.000	0.000
11.845	1.3350	1477071.	2000.0000	-0.009973	2275.7936	4.744E+10	0.000	0.000	0.000
12.360	1.2740	1504386.	2000.0000	-0.009779	2303.8947	4.744E+10	0.000	0.000	0.000
12.875	1.2142	1531403.	2000.0000	-0.009581	2331.6905	4.744E+10	0.000	0.000	0.000
13.390	1.1556	1558119.	2000.0000	-0.009380	2359.1754	4.744E+10	0.000	0.000	0.000
13.905	1.0982	1584527.	2000.0000	-0.009175	2386.3442	4.744E+10	0.000	0.000	0.000
14.420	1.0422	1610622.	2000.0000	-0.008967	2413.1914	4.744E+10	0.000	0.000	0.000
14.935	0.9874	1636400.	2000.0000	-0.008755	2439.7118	4.744E+10	0.000	0.000	0.000
15.450	0.9339	1661855.	2000.0000	-0.008540	2465.9000	4.744E+10	0.000	0.000	0.000
15.965	0.8818	1686982.	2000.0000	-0.008322	2491.7510	4.744E+10	0.000	0.000	0.000

16.480	0.8311	1711776.	2000.0000	-0.008101	2517.2597	4.744E+10	0.000	0.000	0.000
16.995	0.7817	1736233.	2000.0000	-0.007876	2542.4209	4.744E+10	0.000	0.000	0.000
17.510	0.7337	1760347.	2000.0000	-0.007649	2567.2298	4.744E+10	0.000	0.000	0.000
18.025	0.6872	1784114.	2000.0000	-0.007418	2591.6814	4.744E+10	0.000	0.000	0.000
18.540	0.6421	1807529.	2000.0000	-0.007184	2615.7710	4.744E+10	0.000	0.000	0.000
19.055	0.5984	1830588.	2000.0000	-0.006947	2639.4937	4.744E+10	0.000	0.000	0.000
19.570	0.5562	1853285.	2000.0000	-0.006707	2662.8450	4.744E+10	0.000	0.000	0.000
20.085	0.5155	1875617.	2000.0000	-0.006464	2685.8201	4.744E+10	0.000	0.000	0.000
20.600	0.4763	1897579.	2000.0000	-0.006218	2708.4146	4.744E+10	0.000	0.000	0.000
21.115	0.4386	1919166.	2000.0000	-0.005969	2730.6240	4.744E+10	0.000	0.000	0.000
21.630	0.4025	1940375.	2000.0000	-0.005718	2752.4439	4.744E+10	0.000	0.000	0.000
22.145	0.3680	1961202.	2000.0000	-0.005464	2773.8700	4.744E+10	0.000	0.000	0.000
22.660	0.3350	1981641.	1970.2150	-0.005207	2794.8981	4.744E+10	-9.6392	177.8296	0.000
23.175	0.3036	2001321.	1794.8844	-0.004948	2815.1453	4.744E+10	-47.1021	958.7889	0.000
23.690	0.2738	2018808.	1372.6206	-0.004686	2833.1356	4.744E+10	-89.5529	2021.0763	0.000
24.205	0.2457	2032476.	690.2598	-0.004422	2847.1974	4.744E+10	-131.2758	3302.0910	0.000
24.720	0.2192	2040729.	-233.3372	-0.004156	2855.6886	4.744E+10	-167.6229	4726.2950	0.000
25.235	0.1943	2042178.	-1366.1205	-0.003890	2857.1793	4.744E+10	-198.9736	6328.1651	0.000
25.750	0.1711	2035625.	-2666.0201	-0.003625	2850.4374	4.744E+10	-221.7058	8008.1178	0.000
26.265	0.1495	2020203.	-4076.6075	-0.003361	2834.5709	4.744E+10	-234.7950	9705.1069	0.000
26.780	0.1296	1995415.	-5540.9079	-0.003099	2809.0688	4.744E+10	-239.0887	11405.	0.000
27.295	0.1112	1961102.	-7010.6367	-0.002841	2773.7673	4.744E+10	-236.5517	13146.	0.000
27.810	0.0944	1917367.	-8442.1524	-0.002589	2728.7731	4.744E+10	-226.7220	14837.	0.000
28.325	0.0792	1864596.	-9772.4297	-0.002342	2674.4812	4.744E+10	-203.7885	15899.	0.000
28.840	0.0655	1803673.	-10999.	-0.002103	2611.8036	4.744E+10	-193.1134	18224.	0.000
29.355	0.0532	1735019.	-12178.	-0.001873	2541.1720	4.744E+10	-188.4468	21885.	0.000
29.870	0.0423	1658826.	-13311.	-0.001652	2462.7838	4.744E+10	-178.2928	26024.	0.000
30.385	0.0328	1575496.	-14389.	-0.001441	2377.0533	4.744E+10	-170.5722	32139.	0.000
30.900	0.0245	1485340.	-15413.	-0.001242	2284.3008	4.744E+10	-160.8380	40524.	0.000
31.415	0.0175	1388749.	-16362.	-0.001054	2184.9272	4.744E+10	-146.2389	51783.	0.000
31.930	0.0115	1286299.	-17204.	-0.000880	2079.5256	4.744E+10	-126.2229	67859.	0.000
32.445	0.006573	1178774.	-17858.	-0.000720	1968.9034	4.744E+10	-85.3118	80205.	0.000
32.960	0.002601	1067759.	-18231.	-0.000573	1854.6898	4.744E+10	-35.5010	84359.	0.000
33.475	-0.000512	955176.	-18318.	-0.000442	1738.8646	4.744E+10	7.3368	88512.	0.000
33.990	-0.002856	842686.	-18163.	-0.000324	1623.1339	4.744E+10	42.8274	92666.	0.000
34.505	-0.004522	731665.	-17812.	-0.000222	1508.9149	4.744E+10	70.8392	96819.	0.000
35.020	-0.005598	623206.	-17310.	-0.000134	1397.3309	4.744E+10	91.4647	100973.	0.000
35.535	-0.006173	518116.	-16703.	-5.923E-05	1289.2143	4.744E+10	105.0016	105126.	0.000
36.050	-0.006330	416935.	-16033.	1.681E-06	1185.1183	4.744E+10	111.9343	109279.	0.000
36.565	-0.006152	319947.	-15338.	4.968E-05	1085.3359	4.744E+10	112.9172	113433.	0.000
37.080	-0.005716	227208.	-14653.	8.532E-05	989.9254	4.744E+10	108.7590	117586.	0.000
37.595	-0.005097	138577.	-14007.	0.000109	898.7422	4.744E+10	100.4114	121740.	0.000
38.110	-0.004367	53755.	-12385.	0.000122	811.4763	4.744E+10	424.4859	600723.	0.000
38.625	-0.003593	-14866.	-9792.3480	0.000124	771.4670	4.744E+10	414.4628	712818.	0.000
39.140	-0.002832	-67655.	-7274.3043	0.000119	825.7763	4.744E+10	400.4381	873943.	0.000
39.655	-0.002124	-105136.	-4855.2790	0.000108	864.3376	4.744E+10	382.4180	1112439.	0.000
40.170	-0.001502	-127992.	-2561.5496	9.240E-05	887.8514	4.744E+10	359.8893	1480837.	0.000
40.685	-0.000982	-137077.	-439.7706	7.513E-05	897.1983	4.744E+10	326.7706	2055528.	0.000
41.200	-0.000573	-133655.	1466.4414	5.749E-05	893.6776	4.744E+10	290.1265	3127346.	0.000
41.715	-0.000272	-119126.	2933.8057	4.103E-05	878.7301	4.744E+10	184.7487	4200469.	0.000
42.230	-6.622E-05	-97517.	3643.7513	2.692E-05	856.4990	4.744E+10	45.0072	4200469.	0.000
42.745	6.086E-05	-74170.	3654.9947	1.573E-05	832.4798	4.744E+10	-41.3686	4200469.	0.000
43.260	0.000128	-52389.	3257.8570	7.488E-06	810.0710	4.744E+10	-87.1550	4200469.	0.000
43.775	0.000153	-33926.	2666.3485	1.865E-06	791.0760	4.744E+10	-104.2718	4200469.	0.000
44.290	0.000151	-19439.	2026.4263	-1.611E-06	776.1714	4.744E+10	-102.8228	4200469.	0.000
44.805	0.000133	-8874.4104	1428.3291	-3.456E-06	765.3029	4.744E+10	-90.7362	4200469.	0.000
45.320	0.000109	-1773.9452	919.9338	-4.149E-06	757.9979	4.744E+10	-73.7931	4200469.	0.000
45.835	8.221E-05	2508.5356	519.2465	-4.101E-06	758.7536	4.744E+10	-55.8792	4200469.	0.000
46.350	5.788E-05	4656.3613	225.0251	-3.635E-06	760.9633	4.744E+10	-39.3381	4200469.	0.000
46.865	3.729E-05	5300.8524	25.1539	-2.986E-06	761.6264	4.744E+10	-25.3452	4200469.	0.000
47.380	2.097E-05	4976.3053	-97.2047	-2.317E-06	761.2925	4.744E+10	-14.2531	4200469.	0.000

47.895	8.657E-06	4106.4167	-159.4292	-1.725E-06	760.3975	4.744E+10	-5.8843	4200469.	0.000
48.410	-3.491E-07	3010.9830	-176.8784	-1.261E-06	759.2706	4.744E+10	0.2373	4200469.	0.000
48.925	-6.931E-06	1924.0185	-161.5877	-9.398E-07	758.1523	4.744E+10	4.7112	4200469.	0.000
49.440	-1.196E-05	1016.6047	-121.9021	-3.393E-07	14346.	6.612E+09	8.1321	4200469.	0.000
49.955	-1.113E-05	418.3361	-73.4080	3.313E-07	14335.	6.612E+09	7.5618	4200469.	0.000
50.470	-7.870E-06	108.2791	-33.5132	5.774E-07	14329.	6.612E+09	5.3491	4200469.	0.000
50.985	-3.989E-06	2.3649	-8.6063	6.291E-07	14328.	6.612E+09	2.7113	4200469.	0.000
51.500	-9.456E-08	0.000	0.000	6.302E-07	14327.	6.612E+09	0.0739	2414062.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 4:

```
Pile-head deflection             =      3.0198860 inches
Computed slope at pile head      =     -0.0133842 radians
Maximum bending moment           =       2042178. inch-lbs
Maximum shear force              =        -18318. lbs
Depth of maximum bending moment  =     25.2350000 feet below pile head
Depth of maximum shear force     =     33.4750000 feet below pile head
Number of iterations             =              7
Number of zero deflection points =              4
```

Pile-head Deflection vs. Pile Length for Load Case 4

Boundary Condition Type 1, Shear and Moment

```
Shear      =           2000.  lb
Moment     =         780000. in- lb
Axial Load =         245000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
51.5000	3.0198860	2042178.	-18318.
48.9250	3.0222233	2043211.	-18313.
46.3500	3.0189016	2042113.	-18349.
43.7750	3.0218705	2042520.	-18282.
41.2000	3.0261071	2043809.	-17836.
38.6250	3.1804577	2072107.	-21174.
36.0500	5.4386392	2512470.	-35353.

Summary of Pile Response(s)

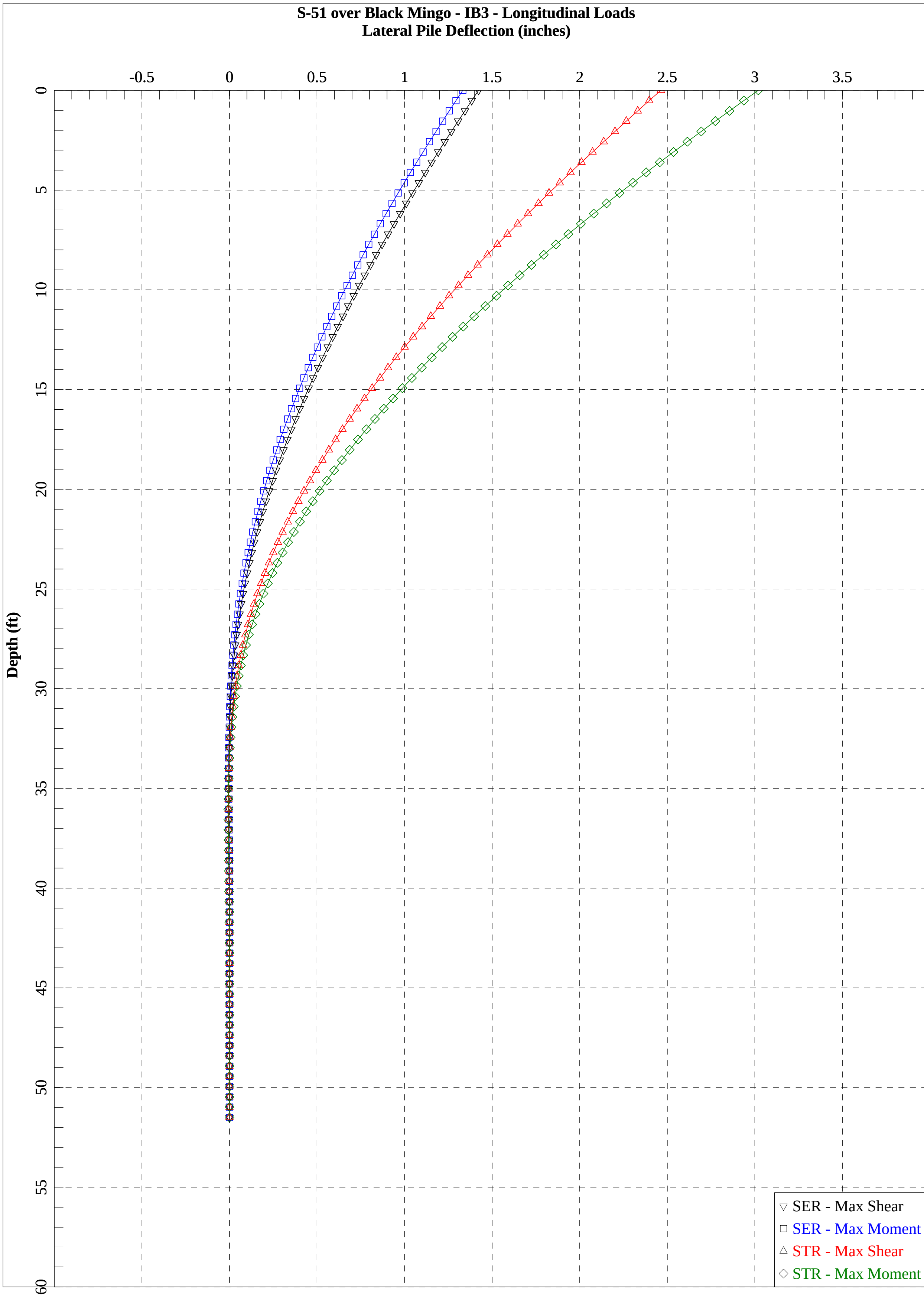
Definitions of Pile-head Loading Conditions:

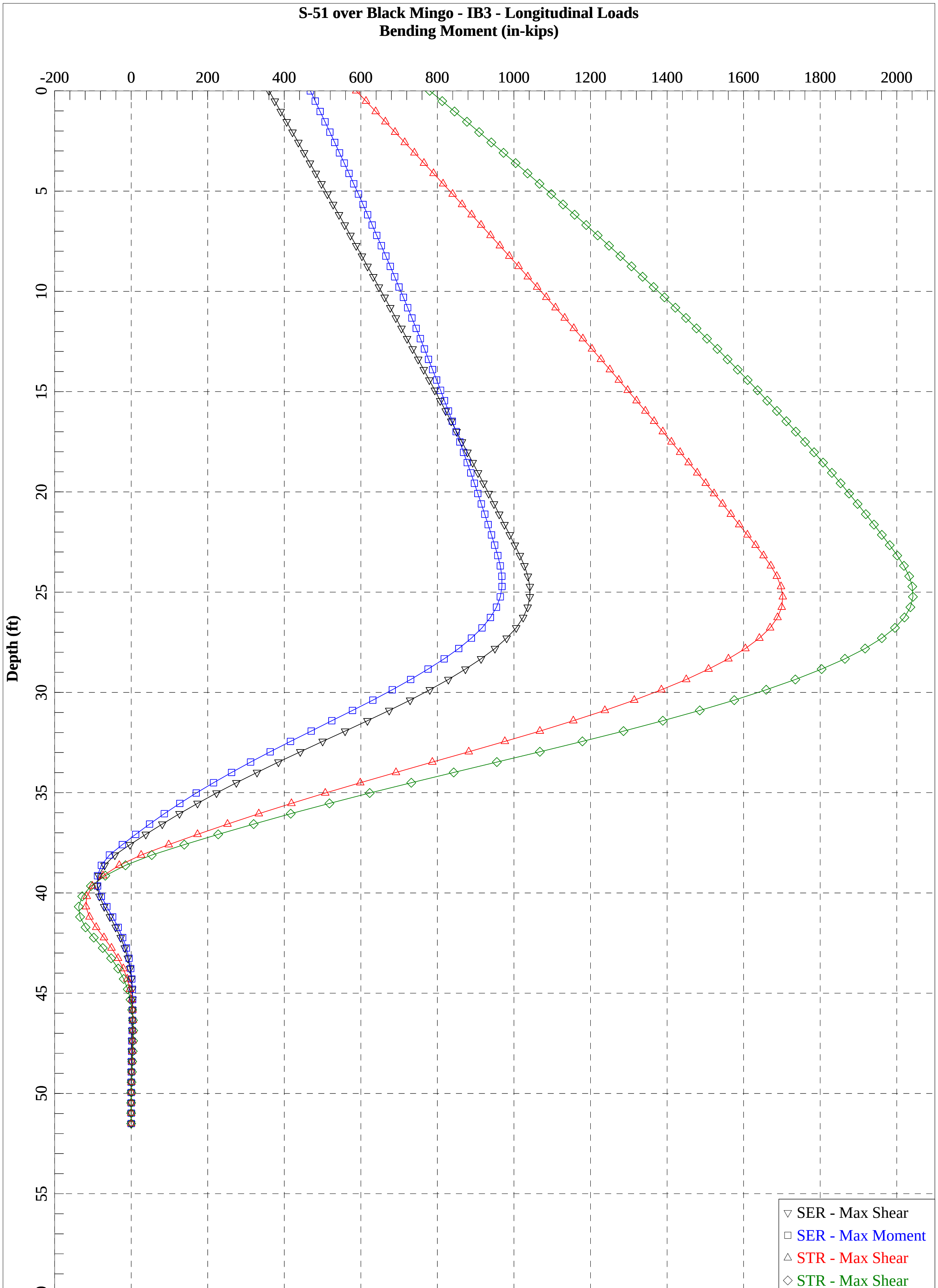
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs

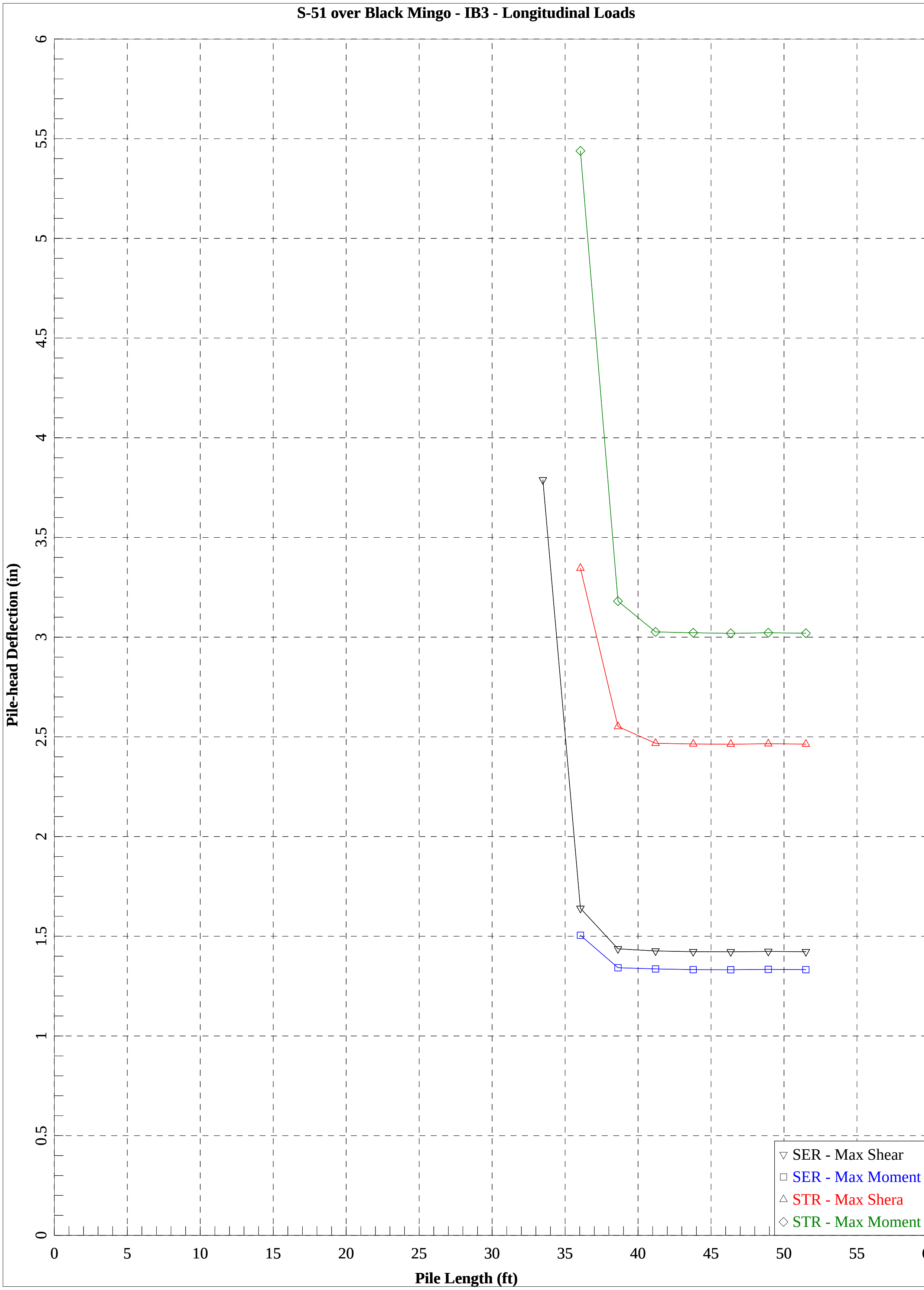
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	1	V = 2000.0000	M = 360000.	77000.	1.42259898	1041562.	-9486.9132	-0.00637234
2	1	V = 1000.0000	M = 468000.	173000.	1.33232991	968733.	-8810.5849	-0.00630660
3	1	V = 3000.0000	M = 588000.	104000.	2.46358641	1702180.	-15415.	-0.01076662
4	1	V = 2000.0000	M = 780000.	245000.	3.01988597	2042178.	-18318.	-0.01338417

The analysis ended normally.


S-51 over Black Mingo - IB3 - Longitudinal Loads
Lateral Pile Deflection (inches)
Depth (ft)
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
0
5
10
15
20
25
30
35
40
45
50
55
60
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Moment


S-51 over Black Mingo - IB3 - Longitudinal Loads
Bending Moment (in-kips)
-200
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Shear



S-51 over Black Mingo - IB3 - Longitudinal Loads
Pile-head Deflection (in)
Pile Length (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
0
5
10
15
20
25
30
35
40
45
50
55
60
SER - Max Shear
SER - Max Moment
STR - Max Shera
STR - Max Moment

```
==============================================================================

                 LPile Plus for Windows, Version 2013-07.007

               Analysis of Individual Piles and Drilled Shafts
              Subjected to Lateral Loading Using the p-y Method

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------------------------------------------------------------------------------
                           Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:        P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo
Creek\Reports\Final Report\Bridge\LPile\
Name of input data file:       IB3_Trans.lp7d
Name of output report file:    IB3_Trans.lp7o
Name of plot output file:      IB3_Trans.lp7p
Name of runtime messeage file: IB3_Trans.lp7r


------------------------------------------------------------------------------
                          Date and Time of Analysis
------------------------------------------------------------------------------

               Date:  February 15, 2016     Time:  19:01:08


------------------------------------------------------------------------------
                              Problem Title
------------------------------------------------------------------------------

Project Name: S-51 RBO Jumping Run Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: ICE

Engineer: JFH

Description: IB3 18" Square PSC Pile - Transverse Loads
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Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Analysis uses p-y modification factors for p-y curves
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Report only summary tables of pile-head deflection, maximum bending moment, and maximum shear force in output report file.

Pile Structural Properties and Geometry

Total number of pile sections = 2

Total length of pile = 51.50 ft

Depth of ground surface below top of pile = 22.50 ft

Pile diameter values used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000

```
  2         49.000000         18.0000000
  3         49.000000          8.7500000
  4         51.500000          8.7500000
```

Input Structural Properties:

Pile Section No. 1:

```
   Section Type                                        =    Elastic Pile
   Cross-sectional Shape                               =     Rectangular
   Section Length                                      =     49.00000 ft
   Top Width                                           =     18.00000 in
   Bottom Width                                        =     18.00000 in
   Top Section Depth                                   =     18.00000 in
   Bottom Section Depth                                =     18.00000 in
   Top Area                                            =    324.00000 Sq. in
   Bottom Area                                         =    324.00000 Sq. in
   Moment of Inertia at Top                            =   8748.00000 in^4
   Moment of Inertia at Bottom                         =   8748.00000 in^4
   Elastic Modulus                                     =     5422453. lbs/in^2
```

Pile Section No. 2:

```
   Section Type                                        =    Elastic Pile
   Cross-sectional Shape                               =     Weak H-Pile
   Section Length                                      =      2.50000 ft
   Flange Width                                        =      8.22000 in
   Section Depth                                       =      8.75000 in
   Flange Thickness                                    =      0.81000 in
   Web Thickness                                       =      0.51000 in
   Section Area                                        =     17.10000 Sq. in
   Moment of Inertia                                   =     75.10000 in^4
   Elastic Modulus                                     =    29000000. lbs/in^2
```

Ground Slope and Pile Batter Angles

```
Ground Slope Angle                                     =        0.000 degrees
                                                       =        0.000 radians

Pile Batter Angle                                      =        0.000 degrees
                                                       =        0.000 radians
```

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	22.50000 ft
Distance from top of pile to bottom of layer	=	38.00000 ft
Effective unit weight at top of layer	=	53.00000 pcf
Effective unit weight at bottom of layer	=	53.00000 pcf
Friction angle at top of layer	=	40.00000 deg.
Friction angle at bottom of layer	=	40.00000 deg.
Subgrade k at top of layer	=	125.00000 pci
Subgrade k at bottom of layer	=	125.00000 pci

Layer 2 is stiff clay without free water

Distance from top of pile to top of layer	=	38.00000 ft
Distance from top of pile to bottom of layer	=	75.00000 ft
Effective unit weight at top of layer	=	53.00000 pcf
Effective unit weight at bottom of layer	=	53.00000 pcf
Undrained cohesion at top of layer	=	2500.00000 psf
Undrained cohesion at bottom of layer	=	2500.00000 psf
Epsilon-50 at top of layer	=	0.00500
Epsilon-50 at bottom of layer	=	0.00500

(Depth of lowest soil layer extends 23.50 ft below pile tip)

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Strain Factor Epsilon 50	kpy pci
1	Sand (Reese, et al.)	22.500	53.000	--	40.000	--	125.000
		38.000	53.000	--	40.000	--	125.000
2	Stiff Clay w/o Free Water	38.000	53.000	2500.000	--	0.00500	--
		75.000	53.000	2500.000	--	0.00500	--

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	22.500	0.8700	1.0000
2	51.000	0.8700	1.0000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	2	V = 2000.00000 lbs	S = 0.0000 in/in	106000.	Yes
2	2	V = 3000.00000 lbs	S = 0.0000 in/in	142000.	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

Pile Section No. 2:

Moment-curvature properties were derived from elastic section properties

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Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 2, Shear and Slope

Shear = 2000. lb
Slope = 0.00000
Axial Load = 106000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
51.5000	0.1793470	-373492.	-2361.1376621
48.9250	0.1795041	-373627.	-2360.4162191
46.3500	0.1792787	-373443.	-2365.8601550
43.7750	0.1793077	-373477.	-2361.6144497
41.2000	0.1795021	-373675.	-2330.5765567
38.6250	0.1797740	-373990.	-2260.8910126
36.0500	0.1861668	-378290.	-2894.4968785
33.4750	0.2086751	-396487.	-3424.0967010
30.9000	0.3022700	-482586.	-3116.8039281
28.3250	0.4039130	-592925.	2000.0000009
25.7500	0.4210900	-628978.	2000.0000007
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.
25.7500	0.000000	2091689559.	338607536.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 3000.0 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 142000.0 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2745	-567139.	3000.0000	0.000	1021.7479	4.744E+10	0.000	0.000	0.000
0.515	0.2742	-548567.	3000.0000	-7.268E-05	1002.6404	4.744E+10	0.000	0.000	0.000
1.030	0.2736	-529931.	3000.0000	-0.000143	983.4685	4.744E+10	0.000	0.000	0.000
1.545	0.2725	-511236.	3000.0000	-0.000211	964.2342	4.744E+10	0.000	0.000	0.000
2.060	0.2710	-492481.	3000.0000	-0.000276	944.9398	4.744E+10	0.000	0.000	0.000
2.575	0.2691	-473671.	3000.0000	-0.000339	925.5874	4.744E+10	0.000	0.000	0.000
3.090	0.2668	-454806.	3000.0000	-0.000400	906.1794	4.744E+10	0.000	0.000	0.000
3.605	0.2641	-435890.	3000.0000	-0.000458	886.7178	4.744E+10	0.000	0.000	0.000
4.120	0.2611	-416923.	3000.0000	-0.000513	867.2050	4.744E+10	0.000	0.000	0.000
4.635	0.2578	-397909.	3000.0000	-0.000566	847.6431	4.744E+10	0.000	0.000	0.000
5.150	0.2541	-378849.	3000.0000	-0.000617	828.0345	4.744E+10	0.000	0.000	0.000

5.665	0.2502	-359747.	3000.0000	-0.000665	808.3812	4.744E+10	0.000	0.000	0.000
6.180	0.2459	-340602.	3000.0000	-0.000711	788.6857	4.744E+10	0.000	0.000	0.000
6.695	0.2414	-321419.	3000.0000	-0.000754	768.9501	4.744E+10	0.000	0.000	0.000
7.210	0.2366	-302200.	3000.0000	-0.000794	749.1766	4.744E+10	0.000	0.000	0.000
7.725	0.2316	-282945.	3000.0000	-0.000832	729.3677	4.744E+10	0.000	0.000	0.000
8.240	0.2263	-263659.	3000.0000	-0.000868	709.5254	4.744E+10	0.000	0.000	0.000
8.755	0.2208	-244342.	3000.0000	-0.000901	689.6522	4.744E+10	0.000	0.000	0.000
9.270	0.2152	-224997.	3000.0000	-0.000932	669.7502	4.744E+10	0.000	0.000	0.000
9.785	0.2093	-205627.	3000.0000	-0.000960	649.8217	4.744E+10	0.000	0.000	0.000
10.300	0.2033	-186233.	3000.0000	-0.000985	629.8691	4.744E+10	0.000	0.000	0.000
10.815	0.1971	-166817.	3000.0000	-0.001008	609.8945	4.744E+10	0.000	0.000	0.000
11.330	0.1908	-147383.	3000.0000	-0.001029	589.9003	4.744E+10	0.000	0.000	0.000
11.845	0.1844	-127932.	3000.0000	-0.001047	569.8888	4.744E+10	0.000	0.000	0.000
12.360	0.1779	-108466.	3000.0000	-0.001062	549.8623	4.744E+10	0.000	0.000	0.000
12.875	0.1713	-88988.	3000.0000	-0.001075	529.8230	4.744E+10	0.000	0.000	0.000
13.390	0.1646	-69500.	3000.0000	-0.001085	509.7732	4.744E+10	0.000	0.000	0.000
13.905	0.1579	-50003.	3000.0000	-0.001093	489.7152	4.744E+10	0.000	0.000	0.000
14.420	0.1511	-30501.	3000.0000	-0.001098	469.6514	4.744E+10	0.000	0.000	0.000
14.935	0.1443	-10996.	3000.0000	-0.001101	449.5839	4.744E+10	0.000	0.000	0.000
15.450	0.1375	8511.2018	3000.0000	-0.001101	447.0280	4.744E+10	0.000	0.000	0.000
15.965	0.1307	28017.	3000.0000	-0.001099	467.0957	4.744E+10	0.000	0.000	0.000
16.480	0.1239	47520.	3000.0000	-0.001094	487.1601	4.744E+10	0.000	0.000	0.000
16.995	0.1172	67017.	3000.0000	-0.001086	507.2190	4.744E+10	0.000	0.000	0.000
17.510	0.1105	86506.	3000.0000	-0.001076	527.2699	4.744E+10	0.000	0.000	0.000
18.025	0.1039	105986.	3000.0000	-0.001064	547.3107	4.744E+10	0.000	0.000	0.000
18.540	0.0973	125454.	3000.0000	-0.001049	567.3390	4.744E+10	0.000	0.000	0.000
19.055	0.0909	144907.	3000.0000	-0.001031	587.3526	4.744E+10	0.000	0.000	0.000
19.570	0.0846	164343.	3000.0000	-0.001011	607.3491	4.744E+10	0.000	0.000	0.000
20.085	0.0784	183761.	3000.0000	-0.000988	627.3263	4.744E+10	0.000	0.000	0.000
20.600	0.0724	203158.	3000.0000	-0.000963	647.2818	4.744E+10	0.000	0.000	0.000
21.115	0.0665	222532.	3000.0000	-0.000935	667.2135	4.744E+10	0.000	0.000	0.000
21.630	0.0608	241880.	3000.0000	-0.000905	687.1190	4.744E+10	0.000	0.000	0.000
22.145	0.0553	261200.	3000.0000	-0.000872	706.9960	4.744E+10	0.000	0.000	0.000
22.660	0.0500	280491.	2982.0100	-0.000837	726.8423	4.744E+10	-5.8220	719.1343	0.000
23.175	0.0450	299527.	2879.2204	-0.000799	746.4269	4.744E+10	-27.4432	3771.2021	0.000
23.690	0.0402	317481.	2636.5824	-0.000759	764.8979	4.744E+10	-51.0804	7861.8367	0.000
24.205	0.0356	333447.	2251.9351	-0.000717	781.3245	4.744E+10	-73.4009	12746.	0.000
24.720	0.0313	346573.	1744.9755	-0.000672	794.8278	4.744E+10	-90.6637	17904.	0.000
25.235	0.0273	356195.	1163.9750	-0.000627	804.7279	4.744E+10	-97.3624	22058.	0.000
25.750	0.0235	362059.	554.4980	-0.000580	810.7604	4.744E+10	-99.8794	26211.	0.000
26.265	0.0201	364067.	-59.4710	-0.000533	812.8259	4.744E+10	-98.8161	30364.	0.000
26.780	0.0170	362259.	-657.6500	-0.000485	810.9658	4.744E+10	-94.7693	34518.	0.000
27.295	0.0141	356790.	-1223.3989	-0.000438	805.3393	4.744E+10	-88.3209	38671.	0.000
27.810	0.0115	347907.	-1743.5988	-0.000392	796.2006	4.744E+10	-80.0285	42825.	0.000
28.325	0.009263	335928.	-2190.3705	-0.000348	783.8764	4.744E+10	-64.5578	43069.	0.000
28.840	0.007248	321445.	-2559.6526	-0.000305	768.9760	4.744E+10	-54.9510	46851.	0.000
29.355	0.005492	304826.	-2881.2686	-0.000264	751.8786	4.744E+10	-49.1319	55285.	0.000
29.870	0.003981	286296.	-3151.4105	-0.000226	732.8149	4.744E+10	-38.2927	59438.	0.000
30.385	0.002701	266271.	-3355.6204	-0.000190	712.2129	4.744E+10	-27.7947	63592.	0.000
30.900	0.001635	245154.	-3496.8969	-0.000157	690.4874	4.744E+10	-17.9259	67745.	0.000
31.415	0.000767	223324.	-3579.8532	-0.000126	668.0288	4.744E+10	-8.9208	71899.	0.000
31.930	7.810E-05	201128.	-3610.3881	-9.834E-05	645.1933	4.744E+10	-0.9610	76052.	0.000
32.445	-0.000449	178872.	-3595.3654	-7.358E-05	622.2964	4.744E+10	5.8227	80205.	0.000
32.960	-0.000831	156818.	-3542.3057	-5.172E-05	599.6073	4.744E+10	11.3487	84359.	0.000
33.475	-0.001088	135180.	-3459.0938	-3.269E-05	577.3457	4.744E+10	15.5807	88512.	0.000
33.990	-0.001235	114121.	-3353.7054	-1.645E-05	555.6804	4.744E+10	18.5255	92666.	0.000

34.505	-0.001291	93757.	-3233.9532	-2.913E-06	534.7295	4.744E+10	20.2293	96819.	0.000
35.020	-0.001272	74155.	-3107.2514	8.025E-06	514.5625	4.744E+10	20.7746	100973.	0.000
35.535	-0.001192	55337.	-2980.3998	1.646E-05	495.2031	4.744E+10	20.2777	105126.	0.000
36.050	-0.001068	37288.	-2859.3833	2.249E-05	476.6339	4.744E+10	18.8862	109279.	0.000
36.565	-0.000914	19956.	-2749.1839	2.622E-05	458.8024	4.744E+10	16.7770	113433.	0.000
37.080	-0.000744	3262.1990	-2653.6037	2.773E-05	441.6278	4.744E+10	14.1551	117586.	0.000
37.595	-0.000571	-12891.	-2575.0935	2.711E-05	451.5342	4.744E+10	11.2528	121740.	0.000
38.110	-0.000409	-28614.	-1822.1958	2.440E-05	467.7094	4.744E+10	232.4035	3512476.	0.000
38.625	-0.000270	-35456.	-571.6705	2.023E-05	474.7494	4.744E+10	172.2973	3949498.	0.000
39.140	-0.000159	-35715.	281.1918	1.559E-05	475.0153	4.744E+10	103.7099	4034714.	0.000
39.655	-7.686E-05	-32008.	759.9823	1.118E-05	471.2020	4.744E+10	51.2384	4119929.	0.000
40.170	-2.064E-05	-26341.	961.6490	7.382E-06	465.3715	4.744E+10	14.0259	4200469.	0.000
40.685	1.438E-05	-20135.	974.7898	4.354E-06	458.9869	4.744E+10	-9.7732	4200469.	0.000
41.200	3.318E-05	-14300.	874.9006	2.111E-06	452.9839	4.744E+10	-22.5534	4200469.	0.000
41.715	4.047E-05	-9325.2073	720.2117	5.720E-07	447.8654	4.744E+10	-27.5078	4200469.	0.000
42.230	4.025E-05	-5399.5615	550.6735	-3.872E-07	443.8267	4.744E+10	-27.3590	4200469.	0.000
42.745	3.569E-05	-2518.2029	391.1855	-9.029E-07	440.8623	4.744E+10	-24.2553	4200469.	0.000
43.260	2.909E-05	-562.9238	255.1365	-1.104E-06	438.8507	4.744E+10	-19.7735	4200469.	0.000
43.775	2.205E-05	637.2212	147.7366	-1.099E-06	438.9272	4.744E+10	-14.9837	4200469.	0.000
44.290	1.551E-05	1265.0292	68.8602	-9.749E-07	439.5731	4.744E+10	-10.5426	4200469.	0.000
44.805	9.995E-06	1490.0444	15.2906	-7.954E-07	439.8046	4.744E+10	-6.7938	4200469.	0.000
45.320	5.680E-06	1455.4173	-17.6309	-6.035E-07	439.7689	4.744E+10	-3.8604	4200469.	0.000
45.835	2.536E-06	1273.1853	-34.8852	-4.258E-07	439.5815	4.744E+10	-1.7235	4200469.	0.000
46.350	4.168E-07	1024.9834	-41.0862	-2.761E-07	439.3261	4.744E+10	-0.2833	4200469.	0.000
46.865	-8.768E-07	765.8440	-40.1202	-1.594E-07	439.0595	4.744E+10	0.5960	4200469.	0.000
47.380	-1.554E-06	529.3779	-35.0153	-7.507E-08	438.8162	4.744E+10	1.0561	4200469.	0.000
47.895	-1.805E-06	333.1868	-27.9618	-1.888E-08	438.6144	4.744E+10	1.2266	4200469.	0.000
48.410	-1.787E-06	183.8034	-20.4183	1.480E-08	438.4607	4.744E+10	1.2147	4200469.	0.000
48.925	-1.622E-06	80.7912	-13.2589	3.204E-08	438.3547	4.744E+10	1.1022	4200469.	0.000
49.440	-1.391E-06	19.8669	-6.9312	6.549E-08	8305.2509	2.178E+09	0.9456	4200469.	0.000
49.955	-8.123E-07	-4.9933	-2.3034	8.659E-08	8304.3845	2.178E+09	0.5521	4200469.	0.000
50.470	-3.209E-07	-8.7553	0.0766	6.708E-08	8304.6036	2.178E+09	0.2181	4200469.	0.000
50.985	1.686E-08	-4.1640	0.7153	4.875E-08	8304.3361	2.178E+09	-0.0115	4200469.	0.000
51.500	2.816E-07	0.000	0.000	4.284E-08	8304.0936	2.178E+09	-0.2200	2414062.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

```
Pile-head deflection             =      0.2744668 inches
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =       -567139. inch-lbs
Maximum shear force              =  -3610.3880840 lbs
Depth of maximum bending moment  =       0.000000 feet below pile head
Depth of maximum shear force     =     31.9300000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              4
```

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 2, Shear and Slope

Shear = 3000. lb
Slope = 0.00000
Axial Load = 142000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
51.5000	0.2744668	-567139.	-3610.3880840
48.9250	0.2747020	-567337.	-3606.5583775
46.3500	0.2743649	-567065.	-3617.5362291
43.7750	0.2744274	-567130.	-3611.0913207
41.2000	0.2747498	-567466.	-3558.3336054
38.6250	0.2752088	-567963.	-3471.3709416
36.0500	0.2879765	-576602.	-4465.6185051
33.4750	0.3524237	-627024.	-5246.8961065
30.9000	0.5359689	-795173.	-4228.5128704
28.3250	0.6674305	-947528.	3000.0000008
25.7500	0.6736510	-976965.	3000.0000026
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.
25.7500	0.000000	3346256334.	541688575.

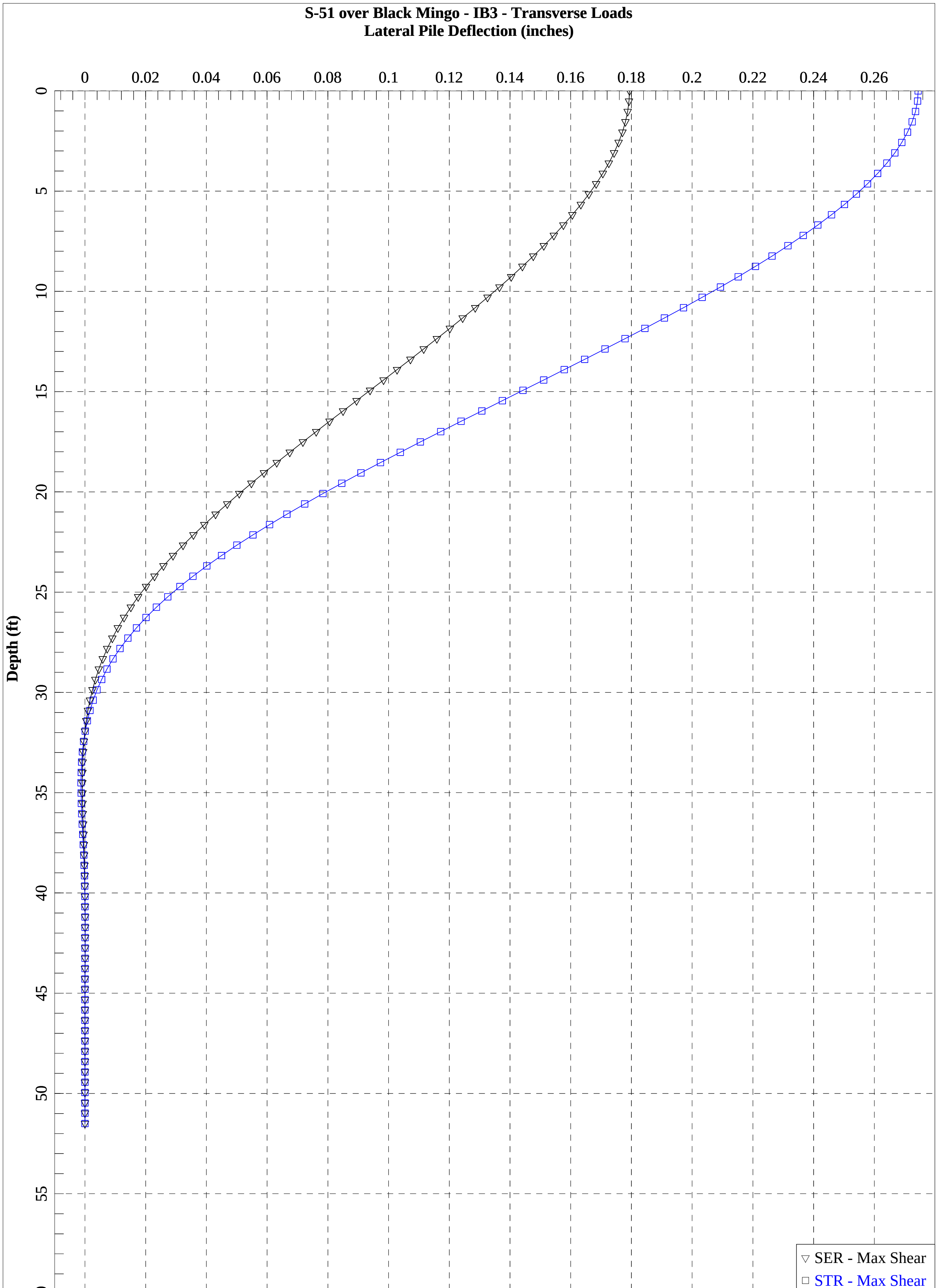
Summary of Pile Response(s)

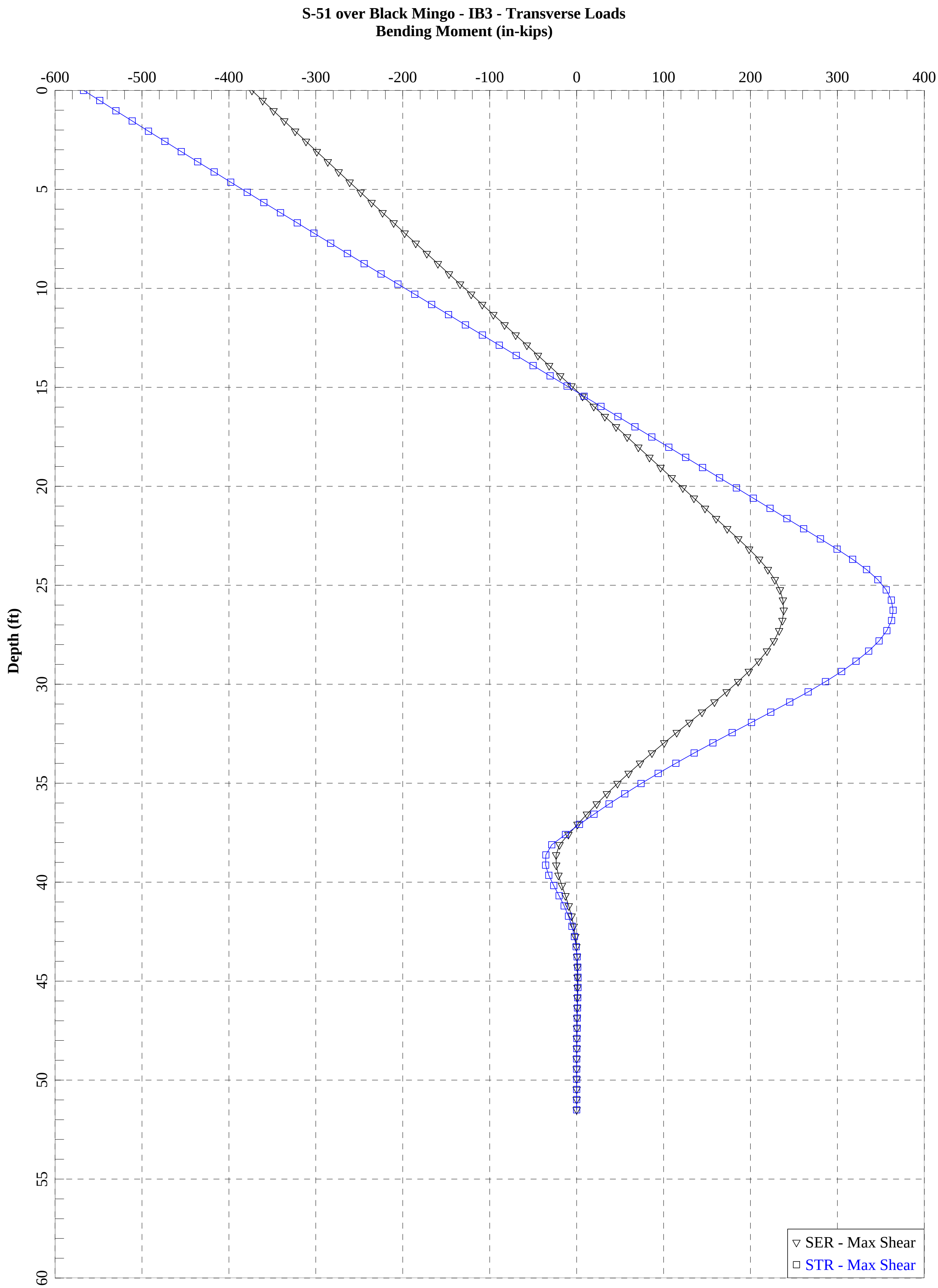
Definitions of Pile-head Loading Conditions:

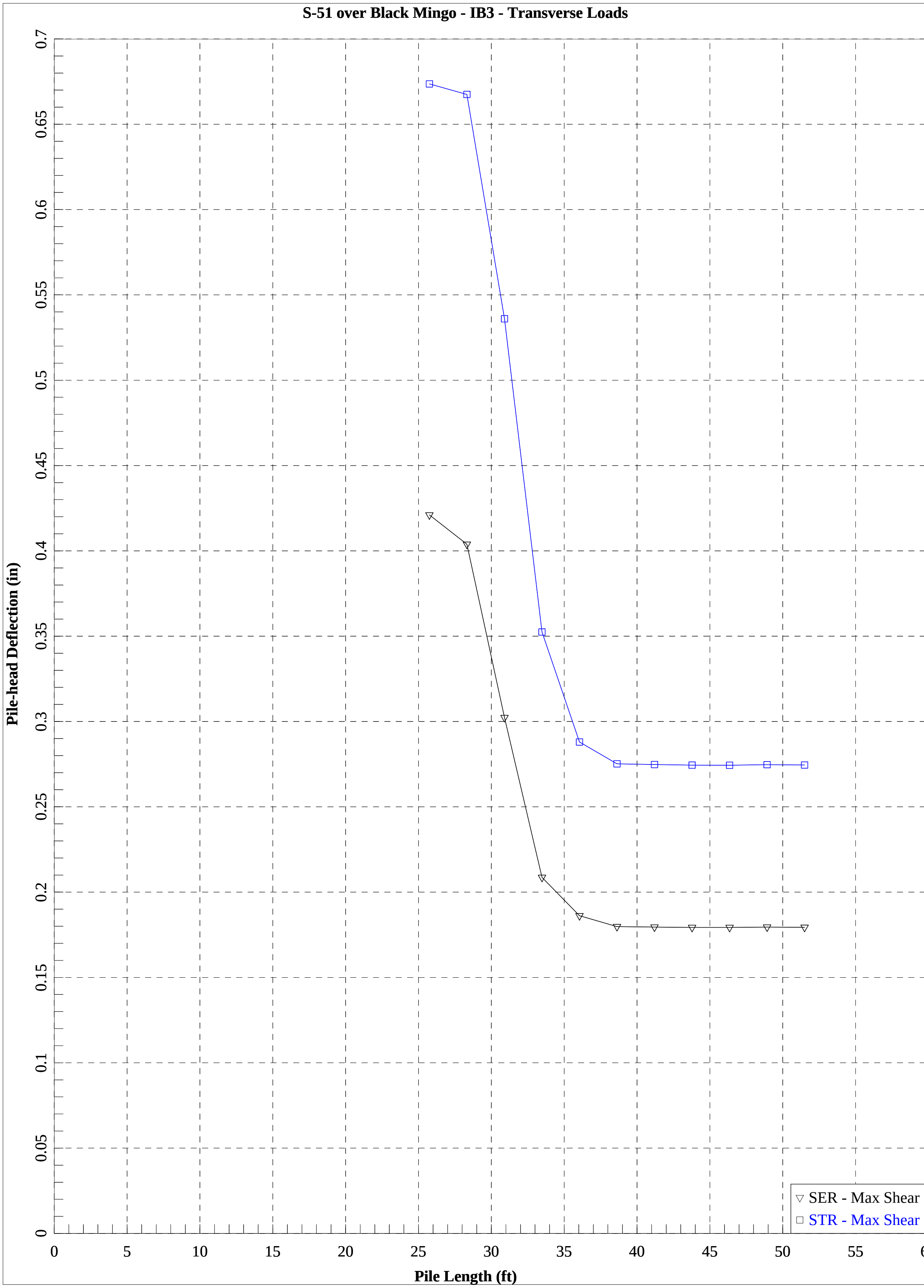
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	2	V = 2000.0000	S = 0.000	106000.	0.17934697	-373492.	-2361.1377	-0.00000000
2	2	V = 3000.0000	S = 0.000	142000.	0.27446684	-567139.	-3610.3881	-0.00000000

The analysis ended normally.


S-51 over Black Mingo - IB3 - Transverse Loads
Lateral Pile Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
SER - Max Shear
STR - Max Shear


S-51 over Black Mingo - IB3 - Transverse Loads
Bending Moment (in-kips)
-600
-500
-400
-300
-200
-100
0
100
200
300
400
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
SER - Max Shear
STR - Max Shear


S-51 over Black Mingo - IB3 - Transverse Loads
Pile-head Deflection (in)
Pile Length (ft)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0
5
10
15
20
25
30
35
40
45
50
55
60
SER - Max Shear
STR - Max Shear

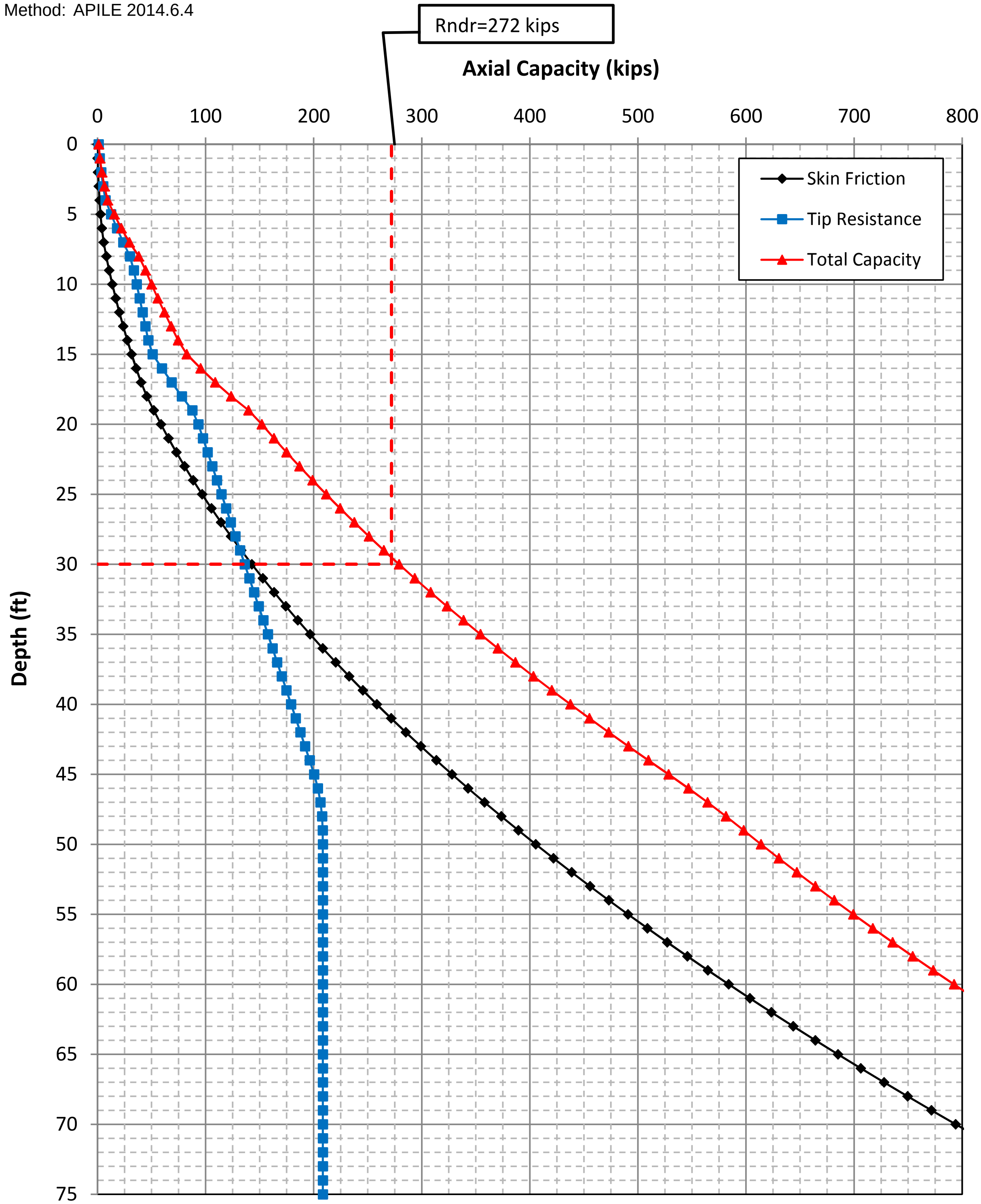
APPENDIX

SECTION 15

END BENT 4 DRIVEN PILE ANALYSES

F&ME CONSULTANTS

Project: S-51 Emergency Bridge Replacement over Black Mingo Creek - **Axial Capacity Analysis**
Location : End Bent 4 - HP14x73 Pile
Calc. By: JFH
Date: 2/15/2016
Method: APILE 2014.6.4



[1]The axial capacities shown are unfactored.

==

LPile Plus for Windows, Version 2013-07.007

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

Files Used for Analysis

Path to file locations: P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo Creek\Reports\Final Report\Bridge\LPile\
Name of input data file: EB4_Long.lp7d
Name of output report file: EB4_Long.lp7o
Name of plot output file: EB4_Long.lp7p
Name of runtime messeage file: EB4_Long.lp7r

Date and Time of Analysis

Date: February 15, 2016   Time: 17:24:05

Problem Title

Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: UIG

Engineer: JFH

Description: EB4 - Longitudinal Loads

Program Options and Settings

Engineering Units of Input Data and Computations:
- Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

Computational Options:
- Use unfactored loads in computations (conventional analysis)
- Compute pile response under loading and nonlinear bending properties of pile (only if nonlinear pile properties are input)
- Use of p-y modification factors for p-y curves not selected
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- No p-y curves to be computed and reported for user-specified depths
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

Pile Structural Properties and Geometry

Total number of pile sections = 1

Total length of pile = 32.00 ft

Depth of ground surface below top of pile = 0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	14.6000000
2	32.000000	14.6000000

Input Structural Properties:

Pile Section No. 1:

Section Type = Elastic Pile

```
   Cross-sectional Shape                                  =   Strong H-Pile
   Section Length                                         =     32.00000 ft
   Flange Width                                           =     14.60000 in
   Section Depth                                          =     13.60000 in
   Flange Thickness                                       =      0.50500 in
   Web Thickness                                          =      0.50500 in
   Section Area                                           =     21.40000 Sq. in
   Moment of Inertia                                      =    729.00000 in^4
   Elastic Modulus                                        =    29000000. lbs/in^2
```

Ground Slope and Pile Batter Angles

```
Ground Slope Angle                                        =        0.000 degrees
                                                          =        0.000 radians

Pile Batter Angle                                         =        0.000 degrees
                                                          =        0.000 radians
```

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer              =       0.0000 ft
   Distance from top of pile to bottom of layer           =      3.00000 ft
   Effective unit weight at top of layer                  =    115.00000 pcf
   Effective unit weight at bottom of layer               =    115.00000 pcf
   Friction angle at top of layer                         =     28.00000 deg.
   Friction angle at bottom of layer                      =     28.00000 deg.
   Subgrade k at top of layer                             =     25.00000 pci
   Subgrade k at bottom of layer                          =     25.00000 pci
```

Layer 2 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer              =      3.00000 ft
   Distance from top of pile to bottom of layer           =      6.00000 ft
   Effective unit weight at top of layer                  =     53.00000 pcf
   Effective unit weight at bottom of layer               =     53.00000 pcf
   Friction angle at top of layer                         =     28.00000 deg.
   Friction angle at bottom of layer                      =     28.00000 deg.
   Subgrade k at top of layer                             =     20.00000 pci
   Subgrade k at bottom of layer                          =     20.00000 pci
```

Layer 3 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer              =      6.00000 ft
   Distance from top of pile to bottom of layer           =     17.00000 ft
   Effective unit weight at top of layer                  =     53.00000 pcf
   Effective unit weight at bottom of layer               =     53.00000 pcf
   Friction angle at top of layer                         =     34.00000 deg.
   Friction angle at bottom of layer                      =     34.00000 deg.
   Subgrade k at top of layer                             =     60.00000 pci
```

Subgrade k at bottom of layer = 60.00000 pci

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	17.00000 ft
Distance from top of pile to bottom of layer	=	50.00000 ft
Effective unit weight at top of layer	=	63.00000 pcf
Effective unit weight at bottom of layer	=	63.00000 pcf
Friction angle at top of layer	=	40.00000 deg.
Friction angle at bottom of layer	=	40.00000 deg.
Subgrade k at top of layer	=	125.00000 pci
Subgrade k at bottom of layer	=	125.00000 pci

(Depth of lowest soil layer extends 18.00 ft below pile tip)

Summary of Soil Properties

Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	0.00	115.000	28.000	25.000
		3.000	115.000	28.000	25.000
2	Sand (Reese, et al.)	3.000	53.000	28.000	20.000
		6.000	53.000	28.000	20.000
3	Sand (Reese, et al.)	6.000	53.000	34.000	60.000
		17.000	53.000	34.000	60.000
4	Sand (Reese, et al.)	17.000	63.000	40.000	125.000
		50.000	63.000	40.000	125.000

Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 4

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 3000.00000 lbs	M = 180000. in-lbs	111000.	Yes
2	1	V = 3000.00000 lbs	M = 228000. in-lbs	116000.	Yes
3	1	V = 4000.00000 lbs	M = 288000. in-lbs	151000.	Yes
4	1	V = 4000.00000 lbs	M = 360000. in-lbs	157000.	Yes

V = perpendicular shear force applied to pile head

M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness
----

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

----
Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 3000.0 lbs
Applied moment at pile head = 180000.0 in-lbs
Axial thrust load on pile head = 111000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1281	180000.	3000.0000	-0.001788	6989.3850	2.114E+10	0.000	0.000	0.000
0.320	0.1213	192275.	2977.6466	-0.001754	7112.3039	2.114E+10	-11.6424	368.6400	0.000
0.640	0.1146	204364.	2913.0444	-0.001718	7233.3546	2.114E+10	-22.0046	737.2800	0.000
0.960	0.1081	216112.	2811.0309	-0.001680	7350.9977	2.114E+10	-31.1275	1105.9200	0.000
1.280	0.1017	227384.	2676.2799	-0.001639	7463.8770	2.114E+10	-39.0553	1474.5600	0.000
1.600	0.0955	238063.	2513.2897	-0.001597	7570.8132	2.114E+10	-45.8354	1843.2000	0.000
1.920	0.0894	248048.	2326.3721	-0.001553	7670.7969	2.114E+10	-51.5175	2211.8400	0.000
2.240	0.0836	257254.	2119.6421	-0.001507	7762.9812	2.114E+10	-56.1543	2580.4800	0.000
2.560	0.0779	265612.	1897.0089	-0.001460	7846.6745	2.114E+10	-59.8005	2949.1200	0.000
2.880	0.0724	273067.	1662.1674	-0.001411	7921.3318	2.114E+10	-62.5128	3317.7600	0.000
3.200	0.0670	279580.	1441.6822	-0.001361	7986.5469	2.114E+10	-52.3233	2997.4517	0.000
3.520	0.0619	285299.	1239.3169	-0.001309	8043.8192	2.114E+10	-53.0754	3292.3637	0.000
3.840	0.0570	290214.	1035.2186	-0.001257	8093.0334	2.114E+10	-53.2259	3587.2757	0.000
4.160	0.0523	294321.	831.6027	-0.001204	8134.1634	2.114E+10	-52.8241	3882.1877	0.000
4.480	0.0477	297627.	630.4947	-0.001150	8167.2652	2.114E+10	-51.9197	4177.0997	0.000
4.800	0.0434	300144.	433.7284	-0.001096	8192.4699	2.114E+10	-50.5628	4472.0117	0.000
5.120	0.0393	301892.	242.9455	-0.001041	8209.9760	2.114E+10	-48.8033	4766.9237	0.000
5.440	0.0354	302897.	59.5963	-0.000986	8220.0417	2.114E+10	-46.6911	5061.8357	0.000
5.760	0.0317	303190.	-115.0599	-0.000931	8222.9783	2.114E+10	-44.2757	5356.7477	0.000
6.080	0.0283	302807.	-395.0376	-0.000876	8219.1422	2.114E+10	-101.5460	13794.	0.000
6.400	0.0250	300903.	-779.5451	-0.000821	8200.0772	2.114E+10	-98.7184	15157.	0.000
6.720	0.0220	297521.	-1148.6244	-0.000767	8166.2024	2.114E+10	-93.5104	16351.	0.000
7.040	0.0191	292736.	-1492.9322	-0.000713	8118.2893	2.114E+10	-85.8166	17235.	0.000
7.360	0.0165	286663.	-1807.0315	-0.000661	8057.4777	2.114E+10	-77.7768	18120.	0.000

7.680	0.0140	279421.	-2089.8248	-0.000609	7984.9595	2.114E+10	-69.5114	19005.	0.000
8.000	0.0118	271133.	-2340.6605	-0.000559	7901.9608	2.114E+10	-61.1322	19890.	0.000
8.320	0.009749	261922.	-2559.3006	-0.000511	7809.7252	2.114E+10	-52.7428	20774.	0.000
8.640	0.007878	251913.	-2745.8872	-0.000464	7709.4985	2.114E+10	-44.4377	21659.	0.000
8.960	0.006184	241229.	-2900.9077	-0.000419	7602.5150	2.114E+10	-36.3021	22544.	0.000
9.280	0.004657	229991.	-3025.1587	-0.000377	7489.9842	2.114E+10	-28.4120	23429.	0.000
9.600	0.003290	218317.	-3119.7111	-0.000336	7373.0798	2.114E+10	-20.8341	24313.	0.000
9.920	0.002076	206318.	-3185.8740	-0.000297	7252.9298	2.114E+10	-13.6258	25198.	0.000
10.240	0.001006	194103.	-3225.1597	-0.000261	7130.6079	2.114E+10	-6.8355	26083.	0.000
10.560	7.161E-05	181772.	-3239.2495	-0.000227	7007.1262	2.114E+10	-0.5029	26968.	0.000
10.880	-0.000736	169419.	-3229.9607	-0.000195	6883.4293	2.114E+10	5.3408	27852.	0.000
11.200	-0.001426	157132.	-3199.2150	-0.000165	6760.3897	2.114E+10	10.6725	28737.	0.000
11.520	-0.002006	144990.	-3149.0085	-0.000138	6638.8042	2.114E+10	15.4767	29622.	0.000
11.840	-0.002485	133065.	-3081.3833	-0.000113	6519.3915	2.114E+10	19.7448	30506.	0.000
12.160	-0.002872	121421.	-2998.4015	-8.956E-05	6402.7911	2.114E+10	23.4749	31391.	0.000
12.480	-0.003173	110114.	-2902.1211	-6.853E-05	6289.5629	2.114E+10	26.6712	32276.	0.000
12.800	-0.003398	99191.	-2794.5736	-4.952E-05	6180.1875	2.114E+10	29.3432	33161.	0.000
13.120	-0.003554	88694.	-2677.7445	-3.246E-05	6075.0680	2.114E+10	31.5053	34045.	0.000
13.440	-0.003647	78654.	-2553.5554	-1.726E-05	5974.5317	2.114E+10	33.1765	34930.	0.000
13.760	-0.003686	69097.	-2423.8488	-3.841E-06	5878.8333	2.114E+10	34.3791	35815.	0.000
14.080	-0.003677	60042.	-2290.3740	7.887E-06	5788.1576	2.114E+10	35.1390	36700.	0.000
14.400	-0.003625	51500.	-2154.7763	1.802E-05	5702.6239	2.114E+10	35.4848	37584.	0.000
14.720	-0.003538	43478.	-2018.5871	2.664E-05	5622.2900	2.114E+10	35.4471	38469.	0.000
15.040	-0.003421	35975.	-1883.2167	3.386E-05	5547.1563	2.114E+10	35.0584	39354.	0.000
15.360	-0.003278	28986.	-1749.9474	3.976E-05	5477.1715	2.114E+10	34.3527	40239.	0.000
15.680	-0.003116	22501.	-1619.9299	4.443E-05	5412.2366	2.114E+10	33.3648	41123.	0.000
16.000	-0.002937	16507.	-1494.1797	4.798E-05	5352.2109	2.114E+10	32.1301	42008.	0.000
16.320	-0.002747	10985.	-1373.5753	5.047E-05	5296.9167	2.114E+10	30.6847	42893.	0.000
16.640	-0.002549	5914.7712	-1258.8573	5.201E-05	5246.1447	2.114E+10	29.0643	43777.	0.000
16.960	-0.002348	1272.6472	-1150.6285	5.266E-05	5199.6598	2.114E+10	27.3049	44662.	0.000
17.280	-0.002145	-2966.9486	-1010.5109	5.251E-05	5216.6261	2.114E+10	45.6731	81765.	0.000
17.600	-0.001944	-6532.8380	-841.5352	5.164E-05	5252.3339	2.114E+10	42.3351	83609.	0.000
17.920	-0.001748	-9473.9651	-685.5523	5.019E-05	5281.7855	2.114E+10	38.9060	85452.	0.000
18.240	-0.001559	-11841.	-542.8102	4.826E-05	5305.4850	2.114E+10	35.4389	87295.	0.000
18.560	-0.001378	-13684.	-413.3628	4.594E-05	5323.9424	2.114E+10	31.9816	89138.	0.000
18.880	-0.001206	-15054.	-297.0910	4.333E-05	5337.6669	2.114E+10	28.5766	90981.	0.000
19.200	-0.001045	-16002.	-193.7235	4.051E-05	5347.1602	2.114E+10	25.2606	92825.	0.000
19.520	-0.000895	-16577.	-102.8580	3.755E-05	5352.9111	2.114E+10	22.0651	94668.	0.000
19.840	-0.000757	-16824.	-23.9817	3.451E-05	5355.3910	2.114E+10	19.0163	96511.	0.000
20.160	-0.000630	-16790.	43.5091	3.146E-05	5355.0500	2.114E+10	16.1351	98354.	0.000
20.480	-0.000515	-16517.	100.2894	2.844E-05	5352.3135	2.114E+10	13.4380	100197.	0.000
20.800	-0.000412	-16044.	147.0884	2.548E-05	5347.5800	2.114E+10	10.9365	102041.	0.000
21.120	-0.000319	-15409.	184.6727	2.262E-05	5341.2191	2.114E+10	8.6386	103884.	0.000
21.440	-0.000238	-14645.	213.8310	1.989E-05	5333.5708	2.114E+10	6.5480	105727.	0.000
21.760	-0.000167	-13784.	235.3605	1.731E-05	5324.9442	2.114E+10	4.6653	107570.	0.000
22.080	-0.000105	-12853.	250.0551	1.489E-05	5315.6181	2.114E+10	2.9881	109413.	0.000
22.400	-5.217E-05	-11876.	258.6945	1.265E-05	5305.8408	2.114E+10	1.5115	111257.	0.000
22.720	-7.749E-06	-10877.	262.0347	1.058E-05	5295.8311	2.114E+10	0.2282	113100.	0.000
23.040	2.908E-05	-9872.7896	260.8014	8.695E-06	5285.7792	2.114E+10	-0.8706	114943.	0.000
23.360	5.903E-05	-8881.0552	255.6827	6.992E-06	5275.8483	2.114E+10	-1.7954	116786.	0.000
23.680	8.279E-05	-7915.1069	247.3253	5.467E-06	5266.1755	2.114E+10	-2.5575	118629.	0.000
24.000	0.000101	-6986.2577	236.3299	4.114E-06	5256.8743	2.114E+10	-3.1692	120473.	0.000
24.320	0.000114	-6103.6001	223.2498	2.925E-06	5248.0356	2.114E+10	-3.6433	122316.	0.000
24.640	0.000123	-5274.1924	208.5891	1.891E-06	5239.7302	2.114E+10	-3.9925	124159.	0.000
24.960	0.000129	-4503.2480	192.8024	1.003E-06	5232.0101	2.114E+10	-4.2297	126002.	0.000
25.280	0.000131	-3794.3251	176.2955	2.499E-07	5224.9112	2.114E+10	-4.3676	127845.	0.000
25.600	0.000131	-3149.5114	159.4266	-3.807E-07	5218.4542	2.114E+10	-4.4183	129689.	0.000
25.920	0.000128	-2569.6044	142.5081	-9.001E-07	5212.6472	2.114E+10	-4.3934	131532.	0.000
26.240	0.000124	-2054.2818	125.8095	-1.320E-06	5207.4869	2.114E+10	-4.3038	133375.	0.000
26.560	0.000118	-1602.2618	109.5600	-1.652E-06	5202.9605	2.114E+10	-4.1595	135218.	0.000
26.880	0.000111	-1211.4526	93.9516	-1.908E-06	5199.0470	2.114E+10	-3.9698	137061.	0.000

27.200	0.000103	-879.0872	79.1431	-2.098E-06	5195.7188	2.114E+10	-3.7430	138905.	0.000
27.520	9.511E-05	-601.8458	65.2632	-2.232E-06	5192.9426	2.114E+10	-3.4862	140748.	0.000
27.840	8.633E-05	-375.9632	52.4147	-2.321E-06	5190.6807	2.114E+10	-3.2057	142591.	0.000
28.160	7.729E-05	-197.3222	40.6782	-2.373E-06	5188.8918	2.114E+10	-2.9070	144434.	0.000
28.480	6.811E-05	-61.5319	30.1154	-2.396E-06	5187.5321	2.114E+10	-2.5944	146277.	0.000
28.800	5.888E-05	36.0070	20.7732	-2.399E-06	5187.2765	2.114E+10	-2.2713	148121.	0.000
29.120	4.968E-05	100.0512	12.6868	-2.386E-06	5187.9178	2.114E+10	-1.9403	149964.	0.000
29.440	4.056E-05	135.4762	5.8830	-2.365E-06	5188.2725	2.114E+10	-1.6033	151807.	0.000
29.760	3.152E-05	147.2491	0.3831	-2.339E-06	5188.3904	2.114E+10	-1.2613	153650.	0.000
30.080	2.259E-05	140.4124	-3.7949	-2.313E-06	5188.3219	2.114E+10	-0.9147	155493.	0.000
30.400	1.376E-05	120.0765	-6.6333	-2.290E-06	5188.1183	2.114E+10	-0.5636	157337.	0.000
30.720	5.006E-06	91.4204	-8.1139	-2.270E-06	5187.8313	2.114E+10	-0.2075	159180.	0.000
31.040	-3.680E-06	59.6971	-8.2161	-2.257E-06	5187.5137	2.114E+10	0.1543	161023.	0.000
31.360	-1.232E-05	30.2448	-6.9161	-2.248E-06	5187.2188	2.114E+10	0.5227	162866.	0.000
31.680	-2.095E-05	8.4980	-4.1873	-2.245E-06	5187.0010	2.114E+10	0.8985	164709.	0.000
32.000	-2.957E-05	0.000	0.000	-2.244E-06	5186.9159	2.114E+10	1.2824	83276.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      0.1280774 inches
Computed slope at pile head      =     -0.0017878 radians
Maximum bending moment           =        303190. inch-lbs
Maximum shear force              =  -3239.2494672 lbs
Depth of maximum bending moment  =      5.7600000 feet below pile head
Depth of maximum shear force     =     10.5600000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              3
```

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

```
Shear      =          3000.  lb
Moment     =        180000. in- lb
Axial Load =        111000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
32.0000	0.1280774	303190.	-3239.2494672
30.4000	0.1284139	303595.	-3245.4804447
28.8000	0.1279987	303275.	-3239.9744933
27.2000	0.1288951	301908.	-3229.8162852
25.6000	0.1287667	302876.	-3239.4548159
24.0000	0.1284007	302935.	-3238.0734925
22.4000	0.1282538	302935.	-3227.4498486
20.8000	0.1282678	302983.	-3205.9000833
19.2000	0.1290077	302491.	-3204.1459411
17.6000	0.1295625	301397.	-3329.4521385
16.0000	0.1329713	299045.	-3718.8493124
14.4000	0.1420246	292978.	-4231.0356084
12.8000	0.1634572	282598.	-4803.1878197

11.2000	0.2095552	269614.	-5337.9575018
9.6000	0.3177421	259067.	-5894.2946346

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 3000.0 lbs
Applied moment at pile head = 228000.0 in-lbs
Axial thrust load on pile head = 116000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1424	228000.	3000.0000	-0.002036	7703.6883	2.114E+10	0.000	0.000	0.000
0.320	0.1346	240418.	2975.1847	-0.001993	7828.0337	2.114E+10	-12.9246	368.6400	0.000
0.640	0.1271	252625.	2903.5292	-0.001948	7950.2759	2.114E+10	-24.3959	737.2800	0.000
0.960	0.1197	264452.	2790.5168	-0.001901	8068.7112	2.114E+10	-34.4647	1105.9200	0.000
1.280	0.1125	275750.	2641.4301	-0.001852	8181.8432	2.114E+10	-43.1847	1474.5600	0.000
1.600	0.1054	286389.	2461.3385	-0.001801	8288.3752	2.114E+10	-50.6130	1843.2000	0.000
1.920	0.0986	296258.	2255.0879	-0.001748	8387.2017	2.114E+10	-56.8092	2211.8400	0.000
2.240	0.0920	305265.	2027.2904	-0.001694	8477.3999	2.114E+10	-61.8354	2580.4800	0.000
2.560	0.0856	313336.	1782.3148	-0.001637	8558.2202	2.114E+10	-65.7560	2949.1200	0.000
2.880	0.0794	320412.	1524.2798	-0.001580	8629.0773	2.114E+10	-68.6372	3317.7600	0.000
3.200	0.0735	326450.	1282.3608	-0.001521	8689.5399	2.114E+10	-57.3623	2997.4517	0.000
3.520	0.0678	331616.	1060.6821	-0.001461	8741.2680	2.114E+10	-58.0954	3292.3637	0.000
3.840	0.0623	335898.	837.4624	-0.001401	8784.1492	2.114E+10	-58.1649	3587.2757	0.000
4.160	0.0570	339295.	615.1421	-0.001339	8818.1697	2.114E+10	-57.6270	3882.1877	0.000
4.480	0.0520	341816.	395.9447	-0.001278	8843.4062	2.114E+10	-56.5383	4177.0997	0.000
4.800	0.0472	343475.	181.8766	-0.001215	8860.0174	2.114E+10	-54.9554	4472.0117	0.000
5.120	0.0426	344295.	-25.2725	-0.001153	8868.2358	2.114E+10	-52.9347	4766.9237	0.000
5.440	0.0383	344308.	-223.9288	-0.001090	8868.3589	2.114E+10	-50.5321	5061.8357	0.000
5.760	0.0343	343547.	-412.7320	-0.001028	8860.7415	2.114E+10	-47.8029	5356.7477	0.000
6.080	0.0304	342053.	-707.9485	-0.000966	8845.7874	2.114E+10	-105.9556	13366.	0.000
6.400	0.0269	338970.	-1108.9995	-0.000904	8814.9109	2.114E+10	-102.9251	14719.	0.000
6.720	0.0235	334341.	-1496.0877	-0.000843	8768.5620	2.114E+10	-98.6833	16126.	0.000
7.040	0.0204	328231.	-1861.1913	-0.000782	8707.3708	2.114E+10	-91.4748	17235.	0.000
7.360	0.0175	320745.	-2195.2854	-0.000724	8632.4067	2.114E+10	-82.5325	18120.	0.000
7.680	0.0148	312016.	-2494.6096	-0.000666	8544.9961	2.114E+10	-73.3656	19005.	0.000
8.000	0.0124	302179.	-2758.5381	-0.000610	8446.4996	2.114E+10	-64.0972	19890.	0.000
8.320	0.0101	291374.	-2986.8988	-0.000556	8338.2939	2.114E+10	-54.8407	20774.	0.000
8.640	0.008102	279736.	-3179.9352	-0.000504	8221.7544	2.114E+10	-45.6991	21659.	0.000
8.960	0.006262	267401.	-3338.2671	-0.000455	8098.2404	2.114E+10	-36.7654	22544.	0.000
9.280	0.004609	254503.	-3462.8508	-0.000407	7969.0811	2.114E+10	-28.1219	23429.	0.000
9.600	0.003134	241169.	-3554.9388	-0.000362	7835.5631	2.114E+10	-19.8406	24313.	0.000
9.920	0.001826	227524.	-3616.0401	-0.000320	7698.9201	2.114E+10	-11.9830	25198.	0.000
10.240	0.000677	213683.	-3647.8813	-0.000280	7560.3234	2.114E+10	-4.6010	26083.	0.000
10.560	-0.000322	199757.	-3652.3687	-0.000242	7420.8742	2.114E+10	2.2638	26968.	0.000
10.880	-0.001183	185849.	-3631.5513	-0.000207	7281.5974	2.114E+10	8.5786	27852.	0.000
11.200	-0.001914	172052.	-3587.5862	-0.000175	7143.4368	2.114E+10	14.3199	28737.	0.000
11.520	-0.002524	158452.	-3522.7056	-0.000145	7007.2511	2.114E+10	19.4721	29622.	0.000
11.840	-0.003024	145126.	-3439.1858	-0.000117	6873.8124	2.114E+10	24.0278	30506.	0.000
12.160	-0.003424	132143.	-3339.3183	-9.191E-05	6743.8039	2.114E+10	27.9865	31391.	0.000
12.480	-0.003730	119562.	-3225.3837	-6.905E-05	6617.8209	2.114E+10	31.3544	32276.	0.000
12.800	-0.003954	107434.	-3099.6276	-4.843E-05	6496.3707	2.114E+10	34.1436	33161.	0.000
13.120	-0.004102	95800.	-2964.2391	-2.998E-05	6379.8750	2.114E+10	36.3713	34045.	0.000

13.440	-0.004184	84695.	-2821.3316	-1.358E-05	6268.6722	2.114E+10	38.0597	34930.	0.000
13.760	-0.004207	74144.	-2672.9264	8.409E-07	6163.0207	2.114E+10	39.2347	35815.	0.000
14.080	-0.004178	64166.	-2520.9379	1.340E-05	6063.1024	2.114E+10	39.9260	36700.	0.000
14.400	-0.004104	54772.	-2367.1618	2.420E-05	5969.0275	2.114E+10	40.1657	37584.	0.000
14.720	-0.003992	45965.	-2213.2652	3.335E-05	5880.8391	2.114E+10	39.9888	38469.	0.000
15.040	-0.003848	37744.	-2060.7780	4.095E-05	5798.5180	2.114E+10	39.4316	39354.	0.000
15.360	-0.003677	30102.	-1911.0874	4.712E-05	5721.9888	2.114E+10	38.5322	40239.	0.000
15.680	-0.003486	23025.	-1765.4330	5.194E-05	5651.1249	2.114E+10	37.3294	41123.	0.000
16.000	-0.003278	16497.	-1624.9041	5.553E-05	5585.7542	2.114E+10	35.8627	42008.	0.000
16.320	-0.003059	10496.	-1490.4376	5.798E-05	5525.6657	2.114E+10	34.1719	42893.	0.000
16.640	-0.002833	4998.5031	-1362.8178	5.939E-05	5470.6143	2.114E+10	32.2967	43777.	0.000
16.960	-0.002603	-23.2568	-1242.6769	5.984E-05	5420.7936	2.114E+10	30.2767	44662.	0.000
17.280	-0.002373	-4598.5670	-1087.5161	5.942E-05	5466.6095	2.114E+10	50.5363	81765.	0.000
17.600	-0.002147	-8428.3177	-900.7414	5.824E-05	5504.9595	2.114E+10	46.7422	83609.	0.000
17.920	-0.001926	-11568.	-728.7021	5.642E-05	5536.4009	2.114E+10	42.8615	85452.	0.000
18.240	-0.001713	-14075.	-571.6194	5.409E-05	5561.5040	2.114E+10	38.9524	87295.	0.000
18.560	-0.001511	-16006.	-429.5023	5.136E-05	5580.8440	2.114E+10	35.0670	89138.	0.000
18.880	-0.001319	-17419.	-302.1710	4.833E-05	5594.9932	2.114E+10	31.2514	90981.	0.000
19.200	-0.001140	-18370.	-189.2808	4.508E-05	5604.5137	2.114E+10	27.5456	92825.	0.000
19.520	-0.000973	-18913.	-90.3455	4.169E-05	5609.9520	2.114E+10	23.9833	94668.	0.000
19.840	-0.000819	-19101.	-4.7600	3.824E-05	5611.8337	2.114E+10	20.5925	96511.	0.000
20.160	-0.000679	-18984.	68.1772	3.478E-05	5610.6592	2.114E+10	17.3956	98354.	0.000
20.480	-0.000552	-18608.	129.2434	3.136E-05	5606.9007	2.114E+10	14.4097	100197.	0.000
20.800	-0.000438	-18019.	179.2718	2.804E-05	5600.9995	2.114E+10	11.6468	102041.	0.000
21.120	-0.000337	-17257.	219.1334	2.483E-05	5593.3639	2.114E+10	9.1145	103884.	0.000
21.440	-0.000248	-16358.	249.7206	2.178E-05	5584.3685	2.114E+10	6.8163	105727.	0.000
21.760	-0.000170	-15358.	271.9316	1.890E-05	5574.3534	2.114E+10	4.7519	107570.	0.000
22.080	-0.000102	-14287.	286.6579	1.621E-05	5563.6241	2.114E+10	2.9180	109413.	0.000
22.400	-4.515E-05	-13171.	294.7722	1.371E-05	5552.4524	2.114E+10	1.3082	111257.	0.000
22.720	2.918E-06	-12035.	297.1189	1.143E-05	5541.0769	2.114E+10	-0.0860	113100.	0.000
23.040	4.259E-05	-10899.	294.5059	9.343E-06	5529.7043	2.114E+10	-1.2750	114943.	0.000
23.360	7.467E-05	-9781.6267	287.6977	7.464E-06	5518.5112	2.114E+10	-2.2709	116786.	0.000
23.680	9.992E-05	-8696.5397	277.4107	5.786E-06	5507.6454	2.114E+10	-3.0869	118629.	0.000
24.000	0.000119	-7656.2670	264.3094	4.301E-06	5497.2284	2.114E+10	-3.7368	120473.	0.000
24.320	0.000133	-6670.4755	249.0036	3.000E-06	5487.3570	2.114E+10	-4.2350	122316.	0.000
24.640	0.000142	-5746.5917	232.0481	1.872E-06	5478.1055	2.114E+10	-4.5960	124159.	0.000
24.960	0.000147	-4890.0142	213.9416	9.062E-07	5469.5280	2.114E+10	-4.8344	126002.	0.000
25.280	0.000149	-4104.3275	195.1282	8.936E-08	5461.6603	2.114E+10	-4.9642	127845.	0.000
25.600	0.000148	-3391.5090	175.9988	-5.914E-07	5454.5224	2.114E+10	-4.9990	129689.	0.000
25.920	0.000145	-2752.1298	156.8932	-1.149E-06	5448.1198	2.114E+10	-4.9518	131532.	0.000
26.240	0.000139	-2185.5450	138.1035	-1.598E-06	5442.4462	2.114E+10	-4.8345	133375.	0.000
26.560	0.000132	-1690.0715	119.8769	-1.950E-06	5437.4846	2.114E+10	-4.6585	135218.	0.000
26.880	0.000124	-1263.1530	102.4200	-2.218E-06	5433.2096	2.114E+10	-4.4337	137061.	0.000
27.200	0.000115	-901.5097	85.9023	-2.415E-06	5429.5882	2.114E+10	-4.1693	138905.	0.000
27.520	0.000106	-601.2721	70.4607	-2.551E-06	5426.5817	2.114E+10	-3.8732	140748.	0.000
27.840	9.567E-05	-358.0991	56.2034	-2.638E-06	5424.1467	2.114E+10	-3.5524	142591.	0.000
28.160	8.541E-05	-167.2798	43.2145	-2.686E-06	5422.2358	2.114E+10	-3.2126	144434.	0.000
28.480	7.504E-05	-23.8187	31.5580	-2.703E-06	5420.7993	2.114E+10	-2.8585	146277.	0.000
28.800	6.465E-05	77.4942	21.2817	-2.698E-06	5421.3368	2.114E+10	-2.4938	148121.	0.000
29.120	5.432E-05	142.0286	12.4209	-2.678E-06	5421.9830	2.114E+10	-2.1212	149964.	0.000
29.440	4.408E-05	175.2728	5.0023	-2.650E-06	5422.3159	2.114E+10	-1.7426	151807.	0.000
29.760	3.397E-05	182.8067	-0.9531	-2.617E-06	5422.3913	2.114E+10	-1.3591	153650.	0.000
30.080	2.398E-05	170.2847	-5.4270	-2.585E-06	5422.2659	2.114E+10	-0.9711	155493.	0.000
30.400	1.411E-05	143.4300	-8.4018	-2.557E-06	5421.9970	2.114E+10	-0.5783	157337.	0.000
30.720	4.347E-06	108.0363	-9.8581	-2.534E-06	5421.6426	2.114E+10	-0.1802	159180.	0.000
31.040	-5.345E-06	69.9769	-9.7737	-2.518E-06	5421.2615	2.114E+10	0.2241	161023.	0.000
31.360	-1.499E-05	35.2168	-8.1229	-2.508E-06	5420.9134	2.114E+10	0.6357	162866.	0.000
31.680	-2.461E-05	9.8273	-4.8760	-2.504E-06	5420.6592	2.114E+10	1.0554	164709.	0.000
32.000	-3.422E-05	0.000	0.000	-2.503E-06	5420.5607	2.114E+10	1.4841	83276.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

```
Pile-head deflection             =      0.1423688 inches
Computed slope at pile head      =     -0.0020356 radians
Maximum bending moment           =        344308. inch-lbs
Maximum shear force              =  -3652.3687147 lbs
Depth of maximum bending moment  =      5.4400000 feet below pile head
Depth of maximum shear force     =     10.5600000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              3
```

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 1, Shear and Moment

```
Shear      =          3000.  lb
Moment     =        228000. in- lb
Axial Load =        116000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
32.0000	0.1423688	344308.	-3652.3687147
30.4000	0.1427414	344703.	-3657.7707478
28.8000	0.1422907	344416.	-3654.4106196
27.2000	0.1432001	343291.	-3640.6639903
25.6000	0.1430978	344117.	-3654.8469694
24.0000	0.1427226	344162.	-3651.0183826
22.4000	0.1425604	344140.	-3640.1372107
20.8000	0.1425776	344189.	-3618.7734403
19.2000	0.1433466	343788.	-3610.9336751
17.6000	0.1439331	342805.	-3739.3810190
16.0000	0.1476722	340746.	-4159.3847658
14.4000	0.1576594	335295.	-4732.9707828
12.8000	0.1814704	325809.	-5390.9480495
11.2000	0.2333589	314094.	-6036.2287649
9.6000	0.3736506	307894.	-6883.7670624

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 3

Pile-head conditions are Shear and Moment (Loading Type 1)

```
Shear force at pile head                          =       4000.0 lbs
Applied moment at pile head                       =     288000.0 in-lbs
Axial thrust load on pile head                    =     151000.0 lbs
```

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch

0.00	0.1880	288000.	4000.0000	-0.002660	9940.0254	2.114E+10	0.000	0.000	0.000
0.320	0.1779	304887.	3967.2063	-0.002606	10109.	2.114E+10	-17.0801	368.6400	0.000
0.640	0.1680	321491.	3872.4753	-0.002549	10275.	2.114E+10	-32.2589	737.2800	0.000
0.960	0.1583	337585.	3722.9839	-0.002490	10437.	2.114E+10	-45.6012	1105.9200	0.000
1.280	0.1489	352970.	3525.6523	-0.002427	10591.	2.114E+10	-57.1757	1474.5600	0.000
1.600	0.1397	367476.	3287.1287	-0.002361	10736.	2.114E+10	-67.0554	1843.2000	0.000
1.920	0.1308	380954.	3013.7735	-0.002294	10871.	2.114E+10	-75.3171	2211.8400	0.000
2.240	0.1221	393281.	2711.6462	-0.002223	10994.	2.114E+10	-82.0409	2580.4800	0.000
2.560	0.1137	404358.	2386.4929	-0.002151	11105.	2.114E+10	-87.3098	2949.1200	0.000
2.880	0.1056	414104.	2043.7353	-0.002076	11203.	2.114E+10	-91.2097	3317.7600	0.000
3.200	0.0977	422462.	1722.1305	-0.002000	11286.	2.114E+10	-76.2928	2997.4517	0.000
3.520	0.0902	429650.	1427.1572	-0.001923	11358.	2.114E+10	-77.3392	3292.3637	0.000
3.840	0.0830	435652.	1129.8502	-0.001844	11419.	2.114E+10	-77.5082	3587.2757	0.000
4.160	0.0760	440466.	833.4378	-0.001765	11467.	2.114E+10	-76.8732	3882.1877	0.000
4.480	0.0694	444100.	540.8661	-0.001685	11503.	2.114E+10	-75.5079	4177.0997	0.000
4.800	0.0631	446573.	254.7983	-0.001604	11528.	2.114E+10	-73.4858	4472.0117	0.000
5.120	0.0571	447916.	-22.3853	-0.001522	11541.	2.114E+10	-70.8806	4766.9237	0.000
5.440	0.0514	448167.	-288.5856	-0.001441	11544.	2.114E+10	-67.7653	5061.8357	0.000
5.760	0.0460	447371.	-541.9822	-0.001360	11536.	2.114E+10	-64.2121	5356.7477	0.000
6.080	0.0410	445581.	-906.5412	-0.001279	11518.	2.114E+10	-125.6624	11779.	0.000
6.400	0.0362	441892.	-1383.3743	-0.001198	11481.	2.114E+10	-122.6882	13011.	0.000
6.720	0.0318	436347.	-1846.0129	-0.001118	11426.	2.114E+10	-118.2694	14298.	0.000
7.040	0.0276	429011.	-2293.7771	-0.001040	11352.	2.114E+10	-114.9412	15979.	0.000
7.360	0.0238	419936.	-2729.9093	-0.000963	11261.	2.114E+10	-112.2110	18120.	0.000
7.680	0.0202	409162.	-3137.5865	-0.000887	11153.	2.114E+10	-100.1209	19005.	0.000
8.000	0.0170	396868.	-3498.5350	-0.000814	11030.	2.114E+10	-87.8731	19890.	0.000
8.320	0.0140	383237.	-3812.4394	-0.000743	10894.	2.114E+10	-75.6187	20774.	0.000
8.640	0.0113	368451.	-4079.5381	-0.000675	10746.	2.114E+10	-63.4952	21659.	0.000
8.960	0.008794	352689.	-4300.5726	-0.000609	10588.	2.114E+10	-51.6269	22544.	0.000
9.280	0.006576	336129.	-4476.7351	-0.000547	10422.	2.114E+10	-40.1244	23429.	0.000
9.600	0.004594	318942.	-4609.6161	-0.000487	10250.	2.114E+10	-29.0845	24313.	0.000
9.920	0.002833	301292.	-4701.1523	-0.000431	10073.	2.114E+10	-18.5906	25198.	0.000
10.240	0.001283	283337.	-4753.5752	-0.000378	9893.3324	2.114E+10	-8.7130	26083.	0.000
10.560	-6.995E-05	265223.	-4769.3609	-0.000328	9711.9468	2.114E+10	0.4912	26968.	0.000
10.880	-0.001238	247089.	-4751.1819	-0.000282	9530.3541	2.114E+10	8.9770	27852.	0.000
11.200	-0.002233	229061.	-4701.8608	-0.000238	9349.8263	2.114E+10	16.7111	28737.	0.000
11.520	-0.003069	211255.	-4624.3264	-0.000198	9171.5244	2.114E+10	23.6714	29622.	0.000
11.840	-0.003757	193776.	-4521.5726	-0.000162	8996.4950	2.114E+10	29.8462	30506.	0.000
12.160	-0.004310	176717.	-4396.6202	-0.000128	8825.6683	2.114E+10	35.2332	31391.	0.000
12.480	-0.004740	160159.	-4252.4813	-9.739E-05	8659.8577	2.114E+10	39.8391	32276.	0.000
12.800	-0.005058	144171.	-4092.1276	-6.975E-05	8499.7607	2.114E+10	43.6784	33161.	0.000
13.120	-0.005276	128812.	-3918.4613	-4.496E-05	8345.9612	2.114E+10	46.7728	34045.	0.000
13.440	-0.005403	114129.	-3734.2893	-2.290E-05	8198.9322	2.114E+10	49.1501	34930.	0.000
13.760	-0.005451	100159.	-3542.3007	-3.436E-06	8059.0403	2.114E+10	50.8439	35815.	0.000
14.080	-0.005430	86928.	-3345.0475	1.355E-05	7926.5502	2.114E+10	51.8922	36700.	0.000
14.400	-0.005347	74453.	-3144.9275	2.821E-05	7801.6308	2.114E+10	52.3370	37584.	0.000
14.720	-0.005213	62743.	-2944.1712	4.067E-05	7684.3609	2.114E+10	52.2236	38469.	0.000
15.040	-0.005035	51795.	-2744.8301	5.107E-05	7574.7360	2.114E+10	51.5999	39354.	0.000
15.360	-0.004821	41603.	-2548.7685	5.956E-05	7472.6756	2.114E+10	50.5155	40239.	0.000
15.680	-0.004578	32151.	-2357.6571	6.625E-05	7378.0305	2.114E+10	49.0217	41123.	0.000
16.000	-0.004312	23419.	-2172.9681	7.130E-05	7290.5898	2.114E+10	47.1705	42008.	0.000
16.320	-0.004030	15380.	-1995.9730	7.482E-05	7210.0896	2.114E+10	45.0144	42893.	0.000
16.640	-0.003737	8003.5335	-1827.7415	7.695E-05	7136.2199	2.114E+10	42.6061	43777.	0.000
16.960	-0.003439	1254.0934	-1669.1415	7.779E-05	7068.6329	2.114E+10	39.9981	44662.	0.000
17.280	-0.003140	-4905.6836	-1463.9805	7.746E-05	7105.1989	2.114E+10	66.8566	81765.	0.000
17.600	-0.002844	-10079.	-1216.7200	7.610E-05	7157.0041	2.114E+10	61.9249	83609.	0.000
17.920	-0.002555	-14338.	-988.6421	7.388E-05	7199.6549	2.114E+10	56.8657	85452.	0.000
18.240	-0.002277	-17758.	-780.0871	7.096E-05	7233.8939	2.114E+10	51.7567	87295.	0.000
18.560	-0.002010	-20412.	-591.1124	6.750E-05	7260.4718	2.114E+10	46.6676	89138.	0.000
18.880	-0.001758	-22376.	-421.5229	6.361E-05	7280.1374	2.114E+10	41.6603	90981.	0.000

19.200	-0.001522	-23723.	-270.9020	5.943E-05	7293.6279	2.114E+10	36.7881	92825.	0.000
19.520	-0.001302	-24525.	-138.6426	5.504E-05	7301.6613	2.114E+10	32.0969	94668.	0.000
19.840	-0.001099	-24851.	-23.9773	5.056E-05	7304.9295	2.114E+10	27.6245	96511.	0.000
20.160	-0.000914	-24768.	73.9925	4.605E-05	7304.0924	2.114E+10	23.4014	98354.	0.000
20.480	-0.000745	-24337.	156.2691	4.159E-05	7299.7738	2.114E+10	19.4510	100197.	0.000
20.800	-0.000594	-23616.	223.9320	3.724E-05	7292.5575	2.114E+10	15.7901	102041.	0.000
21.120	-0.000459	-22660.	278.1141	3.304E-05	7282.9847	2.114E+10	12.4297	103884.	0.000
21.440	-0.000341	-21518.	319.9794	2.902E-05	7271.5527	2.114E+10	9.3751	105727.	0.000
21.760	-0.000237	-20236.	350.7028	2.523E-05	7258.7136	2.114E+10	6.6267	107570.	0.000
22.080	-0.000147	-18854.	371.4531	2.168E-05	7244.8747	2.114E+10	4.1807	109413.	0.000
22.400	-7.005E-05	-17409.	383.3767	1.839E-05	7230.3987	2.114E+10	2.0295	111257.	0.000
22.720	-5.510E-06	-15931.	387.5849	1.536E-05	7215.6045	2.114E+10	0.1623	113100.	0.000
23.040	4.792E-05	-14450.	385.1427	1.260E-05	7200.7697	2.114E+10	-1.4343	114943.	0.000
23.360	9.126E-05	-12988.	377.0597	1.011E-05	7186.1313	2.114E+10	-2.7756	116786.	0.000
23.680	0.000126	-11566.	364.2834	7.879E-06	7171.8892	2.114E+10	-3.8787	118629.	0.000
24.000	0.000152	-10199.	347.6939	5.902E-06	7158.2075	2.114E+10	-4.7616	120473.	0.000
24.320	0.000171	-8902.1300	328.1008	4.168E-06	7145.2182	2.114E+10	-5.4431	122316.	0.000
24.640	0.000184	-7684.3017	306.2410	2.661E-06	7133.0232	2.114E+10	-5.9422	124159.	0.000
24.960	0.000191	-6553.2856	282.7785	1.368E-06	7121.6975	2.114E+10	-6.2778	126002.	0.000
25.280	0.000194	-5514.1493	258.3057	2.722E-07	7111.2919	2.114E+10	-6.4685	127845.	0.000
25.600	0.000193	-4569.8135	233.3447	-6.436E-07	7101.8356	2.114E+10	-6.5321	129689.	0.000
25.920	0.000189	-3721.3159	208.3506	-1.397E-06	7093.3390	2.114E+10	-6.4857	131532.	0.000
26.240	0.000183	-2968.0613	183.7153	-2.004E-06	7085.7961	2.114E+10	-6.3452	133375.	0.000
26.560	0.000174	-2308.0581	159.7717	-2.483E-06	7079.1870	2.114E+10	-6.1255	135218.	0.000
26.880	0.000164	-1738.1352	136.7983	-2.851E-06	7073.4800	2.114E+10	-5.8399	137061.	0.000
27.200	0.000152	-1254.1414	115.0248	-3.123E-06	7068.6334	2.114E+10	-5.5005	138905.	0.000
27.520	0.000140	-851.1233	94.6375	-3.314E-06	7064.5977	2.114E+10	-5.1179	140748.	0.000
27.840	0.000127	-523.4829	75.7842	-3.439E-06	7061.3168	2.114E+10	-4.7014	142591.	0.000
28.160	0.000113	-265.1129	58.5807	-3.510E-06	7058.7295	2.114E+10	-4.2587	144434.	0.000
28.480	9.965E-05	-69.5121	43.1156	-3.541E-06	7056.7708	2.114E+10	-3.7961	146277.	0.000
28.800	8.603E-05	70.1206	29.4555	-3.541E-06	7056.7769	2.114E+10	-3.3185	148121.	0.000
29.120	7.246E-05	160.8122	17.6506	-3.520E-06	7057.6851	2.114E+10	-2.8298	149964.	0.000
29.440	5.900E-05	209.7591	7.7389	-3.486E-06	7058.1752	2.114E+10	-2.3325	151807.	0.000
29.760	4.569E-05	224.2891	-0.2498	-3.446E-06	7058.3207	2.114E+10	-1.8282	153650.	0.000
30.080	3.253E-05	211.8378	-6.2893	-3.407E-06	7058.1961	2.114E+10	-1.3174	155493.	0.000
30.400	1.953E-05	179.9385	-10.3546	-3.371E-06	7057.8766	2.114E+10	-0.8000	157337.	0.000
30.720	6.642E-06	136.2238	-12.4193	-3.343E-06	7057.4389	2.114E+10	-0.2753	159180.	0.000
31.040	-6.146E-06	88.4346	-12.4531	-3.322E-06	7056.9603	2.114E+10	0.2577	161023.	0.000
31.360	-1.887E-05	44.4363	-10.4215	-3.310E-06	7056.5197	2.114E+10	0.8004	162866.	0.000
31.680	-3.157E-05	12.2359	-6.2850	-3.305E-06	7056.1973	2.114E+10	1.3540	164709.	0.000
32.000	-4.425E-05	0.000	0.000	-3.304E-06	7056.0748	2.114E+10	1.9194	83276.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 3:

```
Pile-head deflection              =      0.1880322 inches
Computed slope at pile head       =     -0.0026602 radians
Maximum bending moment            =        448167. inch-lbs
Maximum shear force               =  -4769.3608726 lbs
Depth of maximum bending moment   =      5.4400000 feet below pile head
Depth of maximum shear force      =     10.5600000 feet below pile head
Number of iterations              =              6
Number of zero deflection points =              3
```

Pile-head Deflection vs. Pile Length for Load Case 3

Boundary Condition Type 1, Shear and Moment

```
Shear      =          4000.  lb
Moment     =        288000. in- lb
Axial Load =        151000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
32.0000	0.1880322	448167.	-4769.3608726
30.4000	0.1885354	448671.	-4776.8729816
28.8000	0.1879745	448186.	-4768.0931291
27.2000	0.1888868	446805.	-4756.7060037
25.6000	0.1889172	447947.	-4770.5317282
24.0000	0.1885291	447847.	-4766.9736875
22.4000	0.1882822	447909.	-4752.1929487
20.8000	0.1883119	447946.	-4721.0240035
19.2000	0.1891951	447506.	-4716.1077012
17.6000	0.1900094	446147.	-4895.4811819
16.0000	0.1954041	443064.	-5463.0991110
14.4000	0.2093636	435438.	-6221.5209891
12.8000	0.2423312	422901.	-7081.2983023
11.2000	0.3226841	410038.	-8029.6074186
9.6000	0.7085374	418407.	-10465.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 4

Pile-head conditions are Shear and Moment (Loading Type 1)

```
Shear force at pile head                          =      4000.0 lbs
Applied moment at pile head                       =    360000.0 in-lbs
Axial thrust load on pile head                    =    157000.0 lbs
```

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.2100	360000.	4000.0000	-0.003037	10941.	2.114E+10	0.000	0.000	0.000
0.320	0.1984	377171.	3963.4244	-0.002970	11113.	2.114E+10	-19.0498	368.6400	0.000
0.640	0.1872	394020.	3857.8529	-0.002900	11282.	2.114E+10	-35.9353	737.2800	0.000
0.960	0.1762	410296.	3691.4445	-0.002827	11445.	2.114E+10	-50.7357	1105.9200	0.000
1.280	0.1655	425778.	3472.0457	-0.002751	11600.	2.114E+10	-63.5345	1474.5600	0.000
1.600	0.1550	440278.	3207.1746	-0.002672	11745.	2.114E+10	-74.4192	1843.2000	0.000
1.920	0.1449	453631.	2904.0057	-0.002591	11879.	2.114E+10	-83.4813	2211.8400	0.000
2.240	0.1351	465705.	2569.3562	-0.002507	12000.	2.114E+10	-90.8154	2580.4800	0.000
2.560	0.1257	476387.	2209.6741	-0.002422	12107.	2.114E+10	-96.5191	2949.1200	0.000
2.880	0.1165	485595.	1831.0281	-0.002334	12199.	2.114E+10	-100.6924	3317.7600	0.000
3.200	0.1077	493265.	1476.2155	-0.002246	12276.	2.114E+10	-84.1059	2997.4517	0.000
3.520	0.0993	499640.	1151.2729	-0.002155	12340.	2.114E+10	-85.1351	3292.3637	0.000
3.840	0.0912	504705.	824.2454	-0.002064	12390.	2.114E+10	-85.1917	3587.2757	0.000
4.160	0.0834	508459.	498.7066	-0.001972	12428.	2.114E+10	-84.3597	3882.1877	0.000
4.480	0.0760	510913.	177.9076	-0.001880	12453.	2.114E+10	-82.7231	4177.0997	0.000
4.800	0.0690	512092.	-135.2222	-0.001787	12464.	2.114E+10	-80.3654	4472.0117	0.000
5.120	0.0623	512029.	-438.0737	-0.001694	12464.	2.114E+10	-77.3698	4766.9237	0.000

5.440	0.0560	510770.	-728.3556	-0.001601	12451.	2.114E+10	-73.8186	5061.8357	0.000
5.760	0.0500	508366.	-1004.0897	-0.001508	12427.	2.114E+10	-69.7929	5356.7477	0.000
6.080	0.0444	504877.	-1390.8399	-0.001416	12392.	2.114E+10	-131.6395	11381.	0.000
6.400	0.0392	499392.	-1890.2166	-0.001325	12337.	2.114E+10	-128.4525	12598.	0.000
6.720	0.0342	491958.	-2374.3983	-0.001235	12263.	2.114E+10	-123.7254	13875.	0.000
7.040	0.0297	482645.	-2842.4452	-0.001146	12170.	2.114E+10	-120.0490	15537.	0.000
7.360	0.0254	471510.	-3299.4677	-0.001060	12058.	2.114E+10	-117.9836	17812.	0.000
7.680	0.0215	458583.	-3730.5903	-0.000975	11929.	2.114E+10	-106.5595	19005.	0.000
8.000	0.0179	444035.	-4113.6472	-0.000893	11783.	2.114E+10	-92.9493	19890.	0.000
8.320	0.0147	428068.	-4444.4860	-0.000814	11623.	2.114E+10	-79.3626	20774.	0.000
8.640	0.0117	410883.	-4723.4870	-0.000738	11451.	2.114E+10	-65.9504	21659.	0.000
8.960	0.009002	392681.	-4951.5818	-0.000665	11269.	2.114E+10	-52.8490	22544.	0.000
9.280	0.006585	373657.	-5130.1950	-0.000595	11078.	2.114E+10	-40.1787	23429.	0.000
9.600	0.004429	353999.	-5261.1848	-0.000529	10881.	2.114E+10	-28.0451	24313.	0.000
9.920	0.002520	333889.	-5346.7847	-0.000467	10680.	2.114E+10	-16.5382	25198.	0.000
10.240	0.000844	313499.	-5389.5461	-0.000408	10476.	2.114E+10	-5.7334	26083.	0.000
10.560	-0.000613	292989.	-5392.2824	-0.000353	10270.	2.114E+10	4.3082	26968.	0.000
10.880	-0.001867	272511.	-5358.0156	-0.000302	10065.	2.114E+10	13.5392	27852.	0.000
11.200	-0.002930	252203.	-5289.9241	-0.000254	9861.9421	2.114E+10	21.9252	28737.	0.000
11.520	-0.003817	232191.	-5191.2951	-0.000210	9661.5439	2.114E+10	29.4441	29622.	0.000
11.840	-0.004542	212587.	-5065.4787	-0.000170	9465.2388	2.114E+10	36.0853	30506.	0.000
12.160	-0.005119	193493.	-4915.8460	-0.000133	9274.0288	2.114E+10	41.8485	31391.	0.000
12.480	-0.005561	174994.	-4745.7499	-9.922E-05	9088.7860	2.114E+10	46.7432	32276.	0.000
12.800	-0.005881	157165.	-4558.4907	-6.905E-05	8910.2532	2.114E+10	50.7876	33161.	0.000
13.120	-0.006092	140068.	-4357.2839	-4.206E-05	8739.0474	2.114E+10	54.0076	34045.	0.000
13.440	-0.006204	123752.	-4145.2327	-1.810E-05	8575.6626	2.114E+10	56.4358	34930.	0.000
13.760	-0.006231	108254.	-3925.3033	2.974E-06	8420.4753	2.114E+10	58.1108	35815.	0.000
14.080	-0.006181	93602.	-3700.3039	2.131E-05	8273.7499	2.114E+10	59.0764	36700.	0.000
14.400	-0.006067	79810.	-3472.8671	3.706E-05	8135.6449	2.114E+10	59.3803	37584.	0.000
14.720	-0.005897	66885.	-3245.4352	5.038E-05	8006.2204	2.114E+10	59.0738	38469.	0.000
15.040	-0.005680	54824.	-3020.2488	6.143E-05	7885.4453	2.114E+10	58.2108	39354.	0.000
15.360	-0.005425	43616.	-2799.3374	7.037E-05	7773.2054	2.114E+10	56.8472	40239.	0.000
15.680	-0.005140	33241.	-2584.5133	7.735E-05	7669.3116	2.114E+10	55.0403	41123.	0.000
16.000	-0.004831	23674.	-2377.3672	8.252E-05	7573.5085	2.114E+10	52.8483	42008.	0.000
16.320	-0.004506	14883.	-2179.2658	8.602E-05	7485.4830	2.114E+10	50.3296	42893.	0.000
16.640	-0.004170	6833.0353	-1991.3510	8.799E-05	7404.8727	2.114E+10	47.5427	43777.	0.000
16.960	-0.003830	-516.6541	-1814.5412	8.857E-05	7341.6222	2.114E+10	44.5458	44662.	0.000
17.280	-0.003490	-7209.4328	-1586.3300	8.787E-05	7408.6418	2.114E+10	74.3142	81765.	0.000
17.600	-0.003155	-12806.	-1311.7470	8.605E-05	7464.6804	2.114E+10	68.6978	83609.	0.000
17.920	-0.002829	-17387.	-1058.9666	8.331E-05	7510.5611	2.114E+10	62.9587	85452.	0.000
18.240	-0.002515	-21039.	-828.2960	7.982E-05	7547.1265	2.114E+10	57.1823	87295.	0.000
18.560	-0.002216	-23845.	-619.7310	7.574E-05	7575.2253	2.114E+10	51.4453	89138.	0.000
18.880	-0.001934	-25890.	-432.9910	7.122E-05	7595.7016	2.114E+10	45.8151	90981.	0.000
19.200	-0.001669	-27256.	-267.5535	6.640E-05	7609.3845	2.114E+10	40.3503	92825.	0.000
19.520	-0.001424	-28025.	-122.6886	6.138E-05	7617.0796	2.114E+10	35.1002	94668.	0.000
19.840	-0.001198	-28272.	2.5069	5.626E-05	7619.5610	2.114E+10	30.1058	96511.	0.000
20.160	-0.000992	-28073.	109.0770	5.115E-05	7617.5661	2.114E+10	25.3995	98354.	0.000
20.480	-0.000805	-27496.	198.1761	4.610E-05	7611.7900	2.114E+10	21.0063	100197.	0.000
20.800	-0.000638	-26607.	271.0396	4.119E-05	7602.8819	2.114E+10	16.9435	102041.	0.000
21.120	-0.000489	-25464.	328.9573	3.646E-05	7591.4429	2.114E+10	13.2220	103884.	0.000
21.440	-0.000358	-24124.	373.2492	3.195E-05	7578.0235	2.114E+10	9.8467	105727.	0.000
21.760	-0.000243	-22636.	405.2430	2.771E-05	7563.1238	2.114E+10	6.8168	107570.	0.000
22.080	-0.000145	-21046.	426.2552	2.374E-05	7547.1927	2.114E+10	4.1271	109413.	0.000
22.400	-6.103E-05	-19391.	437.5739	2.007E-05	7530.6291	2.114E+10	1.7681	111257.	0.000
22.720	9.269E-06	-17709.	440.4445	1.670E-05	7513.7832	2.114E+10	-0.2730	113100.	0.000
23.040	6.721E-05	-16029.	436.0577	1.363E-05	7496.9582	2.114E+10	-2.0118	114943.	0.000
23.360	0.000114	-14377.	425.5398	1.087E-05	7480.4127	2.114E+10	-3.4663	116786.	0.000
23.680	0.000151	-12774.	409.9454	8.406E-06	7464.3632	2.114E+10	-4.6558	118629.	0.000
24.000	0.000179	-11238.	390.2521	6.225E-06	7448.9872	2.114E+10	-5.6011	120473.	0.000
24.320	0.000199	-9784.3057	367.3570	4.316E-06	7434.4259	2.114E+10	-6.3234	122316.	0.000
24.640	0.000212	-8422.3427	342.0750	2.663E-06	7420.7876	2.114E+10	-6.8443	124159.	0.000

24.960	0.000219	-7160.3804	315.1388	1.247E-06	7408.1506	2.114E+10	-7.1850	126002.	0.000
25.280	0.000221	-6003.5811	287.2000	5.190E-08	7396.5668	2.114E+10	-7.3664	127845.	0.000
25.600	0.000219	-4954.7470	258.8318	-9.433E-07	7386.0640	2.114E+10	-7.4087	129689.	0.000
25.920	0.000214	-4014.6157	230.5322	-1.758E-06	7376.6498	2.114E+10	-7.3307	131532.	0.000
26.240	0.000206	-3182.1404	202.7286	-2.412E-06	7368.3137	2.114E+10	-7.1503	133375.	0.000
26.560	0.000195	-2454.7526	175.7826	-2.923E-06	7361.0298	2.114E+10	-6.8840	135218.	0.000
26.880	0.000183	-1828.6048	149.9959	-3.312E-06	7354.7597	2.114E+10	-6.5466	137061.	0.000
27.200	0.000170	-1298.7900	125.6157	-3.596E-06	7349.4543	2.114E+10	-6.1514	138905.	0.000
27.520	0.000156	-859.5398	102.8412	-3.792E-06	7345.0558	2.114E+10	-5.7103	140748.	0.000
27.840	0.000141	-504.3968	81.8298	-3.916E-06	7341.4995	2.114E+10	-5.2331	142591.	0.000
28.160	0.000126	-226.3645	62.7034	-3.983E-06	7338.7153	2.114E+10	-4.7285	144434.	0.000
28.480	0.000110	-18.0322	45.5544	-4.005E-06	7336.6292	2.114E+10	-4.2033	146277.	0.000
28.800	9.496E-05	128.3223	30.4516	-3.995E-06	7337.7336	2.114E+10	-3.6628	148121.	0.000
29.120	7.966E-05	220.6530	17.4459	-3.963E-06	7338.6582	2.114E+10	-3.1110	149964.	0.000
29.440	6.452E-05	267.0857	6.5755	-3.919E-06	7339.1231	2.114E+10	-2.5506	151807.	0.000
29.760	4.956E-05	275.8783	-2.1295	-3.870E-06	7339.2112	2.114E+10	-1.9832	153650.	0.000
30.080	3.480E-05	255.3972	-8.6428	-3.821E-06	7339.0061	2.114E+10	-1.4092	155493.	0.000
30.400	2.022E-05	214.1088	-12.9388	-3.779E-06	7338.5926	2.114E+10	-0.8283	157337.	0.000
30.720	5.780E-06	160.5832	-14.9892	-3.745E-06	7338.0566	2.114E+10	-0.2396	159180.	0.000
31.040	-8.544E-06	103.5070	-14.7614	-3.721E-06	7337.4851	2.114E+10	0.3583	161023.	0.000
31.360	-2.279E-05	51.7021	-12.2173	-3.707E-06	7336.9663	2.114E+10	0.9668	162866.	0.000
31.680	-3.701E-05	14.1476	-7.3130	-3.701E-06	7336.5903	2.114E+10	1.5875	164709.	0.000
32.000	-5.122E-05	0.000	0.000	-3.699E-06	7336.4486	2.114E+10	2.2214	83276.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 4:

```
Pile-head deflection            =      0.2099709 inches
Computed slope at pile head     =     -0.0030367 radians
Maximum bending moment          =        512092. inch-lbs
Maximum shear force             =  -5392.2824498 lbs
Depth of maximum bending moment =      4.8000000 feet below pile head
Depth of maximum shear force    =     10.5600000 feet below pile head
Number of iterations            =              6
Number of zero deflection points =             3
```

Pile-head Deflection vs. Pile Length for Load Case 4

Boundary Condition Type 1, Shear and Moment

```
Shear      =          4000.  lb
Moment     =        360000. in- lb
Axial Load =        157000.  lb
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
32.0000	0.2099709	512092.	-5392.2824498
30.4000	0.2105322	512629.	-5402.2001272
28.8000	0.2099047	512230.	-5396.8747709
27.2000	0.2108215	511082.	-5376.6973707
25.6000	0.2108846	511986.	-5397.4402421
24.0000	0.2104959	511840.	-5391.2482619

22.4000	0.2102319	511931.	-5376.8610620
20.8000	0.2102815	511954.	-5344.3223239
19.2000	0.2111913	511608.	-5333.5343146
17.6000	0.2120502	510422.	-5517.3288260
16.0000	0.2180139	507704.	-6133.2835134
14.4000	0.2335622	500959.	-6986.0212504
12.8000	0.2708509	490087.	-7987.5084940
11.2000	0.3769257	482631.	-9290.3048087
9.6000	1.1553067	521454.	-14041.

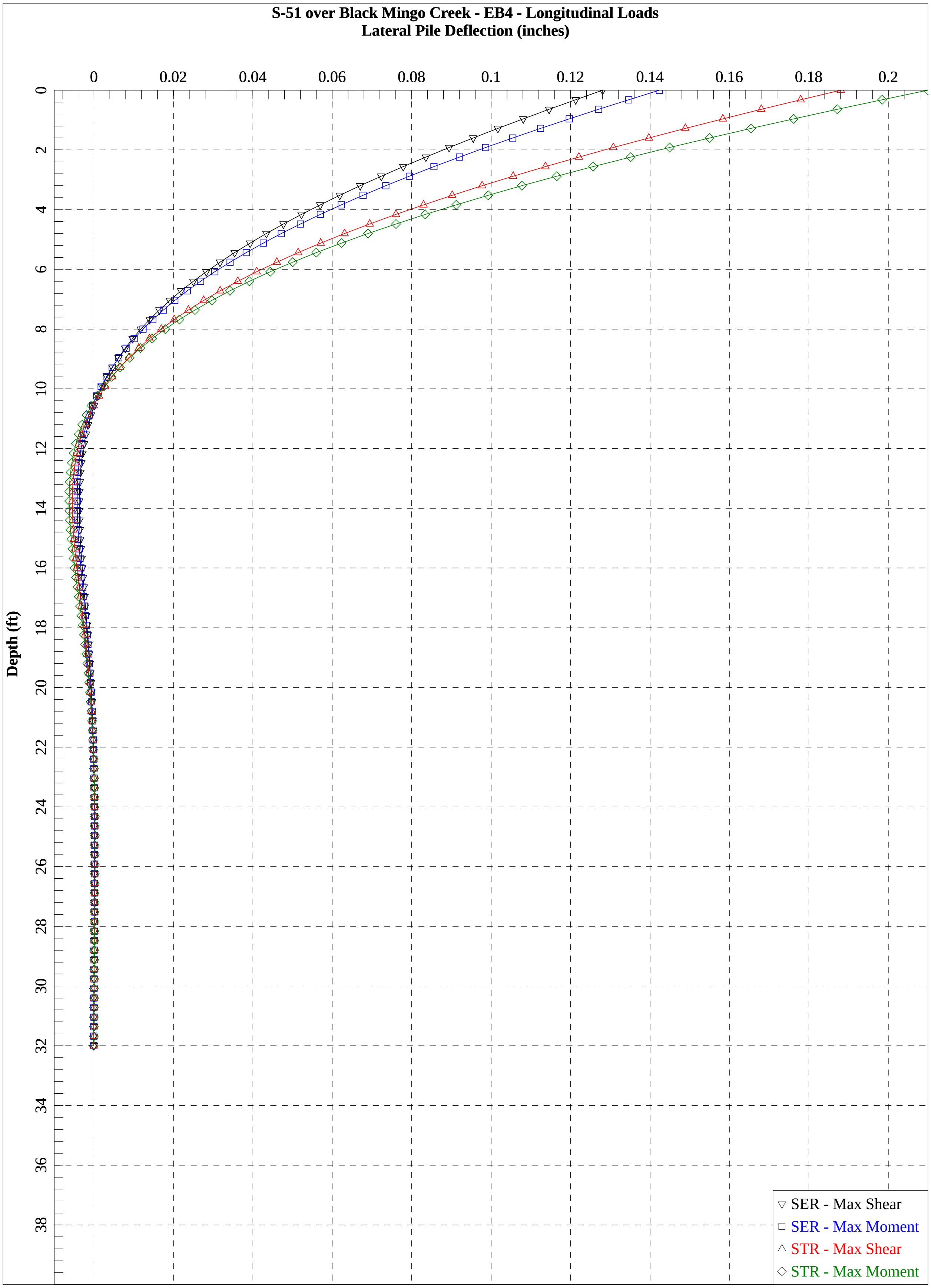
Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

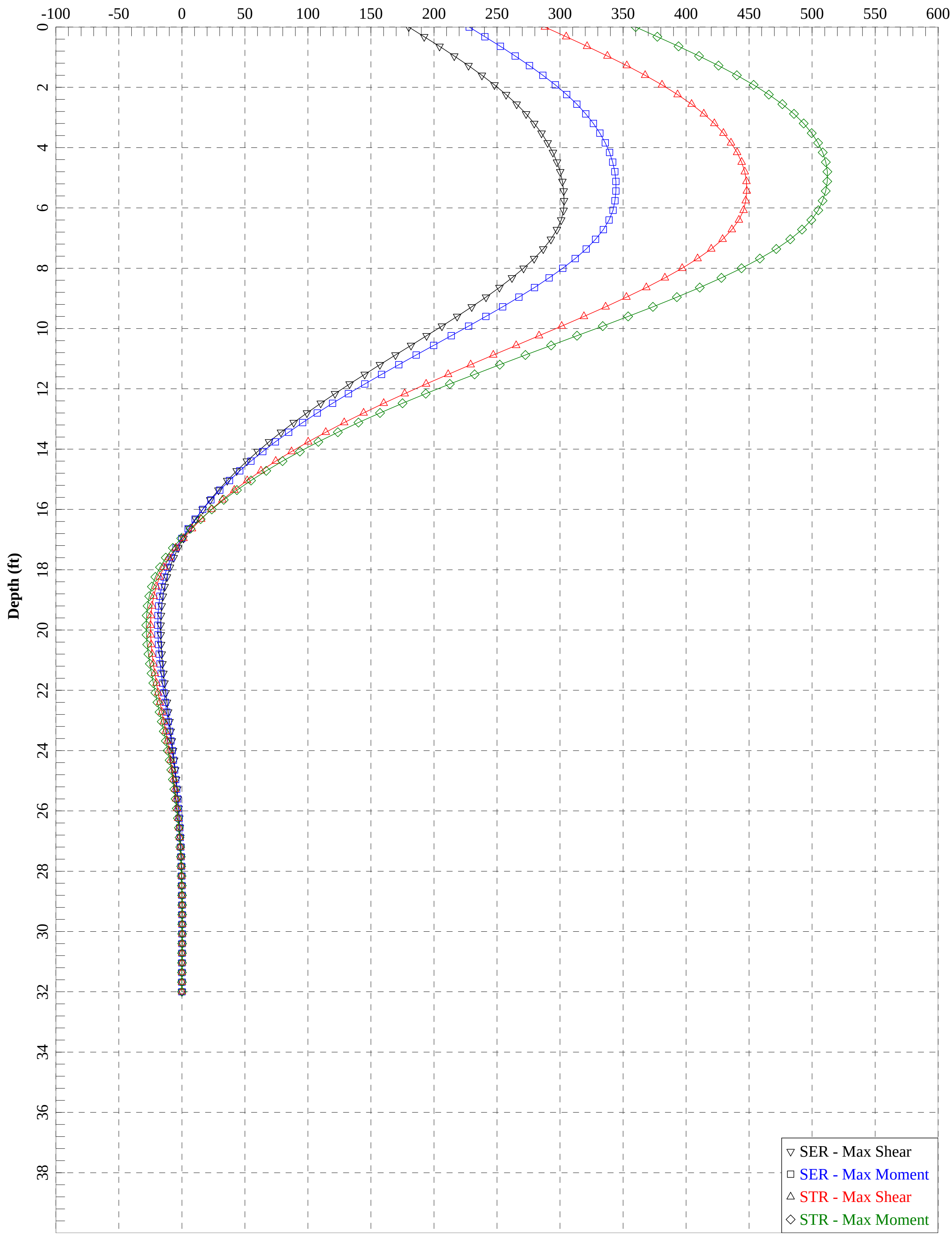
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

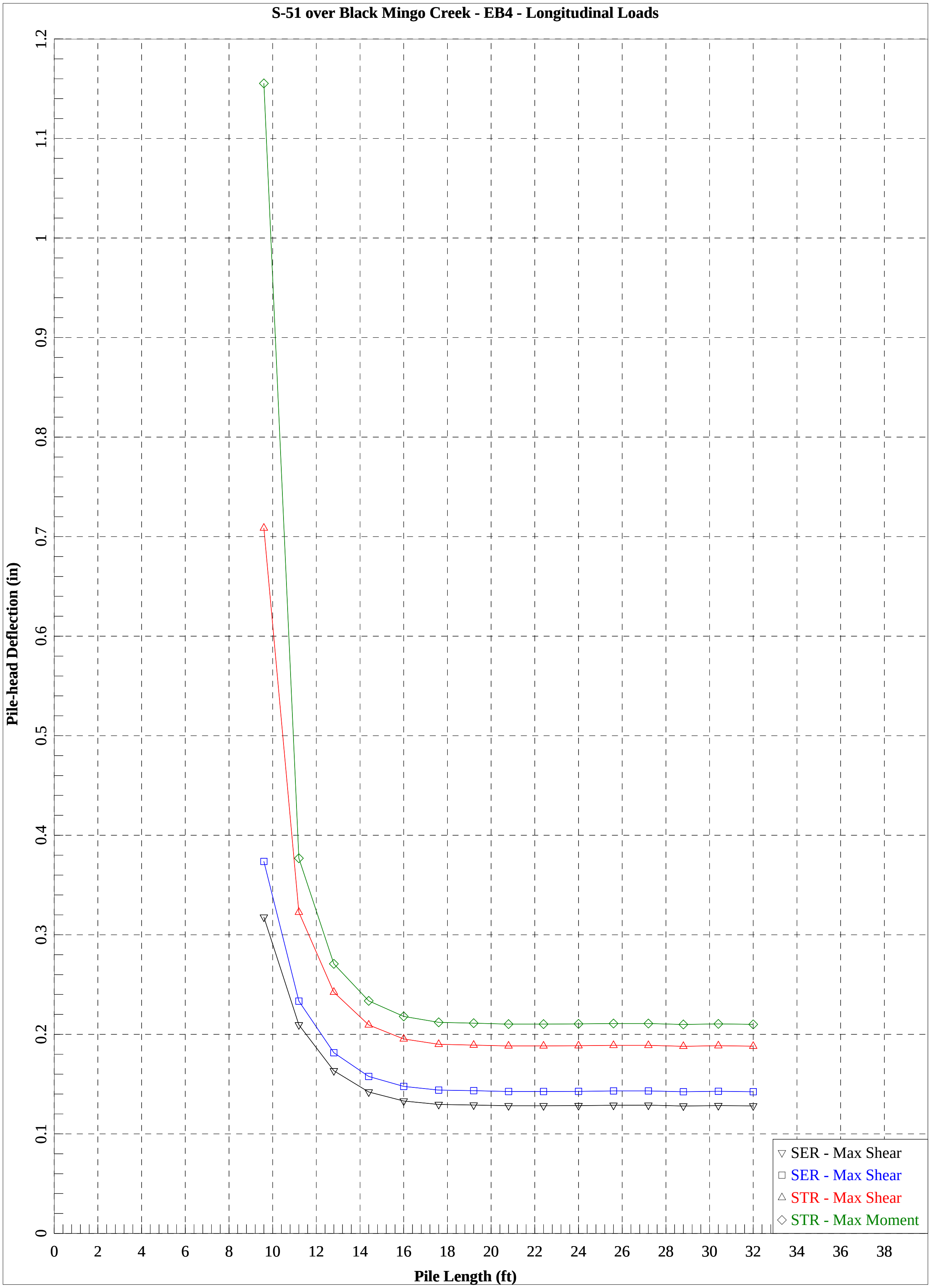
Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	1	V = 3000.0000	M = 180000.	111000.	0.12807739	303190.	-3239.2495	-0.00178776
2	1	V = 3000.0000	M = 228000.	116000.	0.14236875	344308.	-3652.3687	-0.00203558
3	1	V = 4000.0000	M = 288000.	151000.	0.18803224	448167.	-4769.3609	-0.00266021
4	1	V = 4000.0000	M = 360000.	157000.	0.20997092	512092.	-5392.2824	-0.00303670

The analysis ended normally.


S-51 over Black Mingo Creek - EB4 - Longitudinal Loads
Lateral Pile Deflection (inches)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
SER - Max Shear
SER - Max Moment
STR - Max Shear
STR - Max Moment

S-51 over Black Mingo Creek - EB4 - Longitudinal Loads
Bending Moment (in-kips)




S-51 over Black Mingo Creek - EB4 - Longitudinal Loads
Pile-head Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Pile Length (ft)
SER - Max Shear
SER - Max Shear
STR - Max Shear
STR - Max Moment

```
================================================================================

                 LPile Plus for Windows, Version 2013-07.007

               Analysis of Individual Piles and Drilled Shafts
              Subjected to Lateral Loading Using the p-y Method
```



```
================================================================================

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--------------------------------------------------------------------------------
                           Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:        P:\Geotechnical\G5500's\G5556.000 - Emergency Bridge Pkg 4 - Design Build\G5556.02 - S-51 over Black Mingo
Creek\Reports\Final Report\Bridge\LPile\
Name of input data file:       EB4_Trans.lp7d
Name of output report file:    EB4_Trans.lp7o
Name of plot output file:      EB4_Trans.lp7p
Name of runtime messeage file: EB4_Trans.lp7r


--------------------------------------------------------------------------------
                          Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  February 15, 2016     Time:  17:27:55


--------------------------------------------------------------------------------
                               Problem Title
--------------------------------------------------------------------------------

Project Name: S-51 RBO Black Mingo Creek

Job Number: G5556.02 (F&ME); P029461 (SCDOT)

Client: UIG

Engineer: JFH

Description: EB4 - Longitudinal Loads
```

```
--------------------------------------------------------------------------------
                          Program Options and Settings
--------------------------------------------------------------------------------

Engineering Units of Input Data and Computations:
 - Engineering units are US Customary Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed                =          500
- Deflection tolerance for convergence                =   1.0000E-05 in
- Maximum allowable deflection                        =     100.0000 in
- Number of pile increments                           =          100

Loading Type and Number of Cycles of Loading:
 - Static loading specified

Computational Options:
 - Use unfactored loads in computations (conventional analysis)
 - Compute pile response under loading and nonlinear bending properties of pile
   (only if nonlinear pile properties are input)
 - Use of p-y modification factors for p-y curves not selected
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - No p-y curves to be computed and reported for user-specified depths
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1


--------------------------------------------------------------------------------
                   Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Total number of pile sections                         =         1

Total length of pile                                  =      23.00 ft

Depth of ground surface below top of pile             =       0.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile.

Point         Depth             Pile
                X             Diameter
                ft               in
-----       ---------        -----------
```

1	0.00000	13.6000000
2	23.000000	13.6000000

Input Structural Properties:

Pile Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Weak H-Pile
Section Length	=	23.00000 ft
Flange Width	=	14.60000 in
Section Depth	=	13.60000 in
Flange Thickness	=	0.50500 in
Web Thickness	=	0.50500 in
Section Area	=	21.40000 Sq. in
Moment of Inertia	=	261.00000 in^4
Elastic Modulus	=	29000000. lbs/in^2

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	3.00000 ft
Effective unit weight at top of layer	=	115.00000 pcf
Effective unit weight at bottom of layer	=	115.00000 pcf
Friction angle at top of layer	=	28.00000 deg.
Friction angle at bottom of layer	=	28.00000 deg.
Subgrade k at top of layer	=	25.00000 pci
Subgrade k at bottom of layer	=	25.00000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	3.00000 ft
Distance from top of pile to bottom of layer	=	6.00000 ft
Effective unit weight at top of layer	=	53.00000 pcf
Effective unit weight at bottom of layer	=	53.00000 pcf

```
   Friction angle at top of layer                       =     28.00000 deg.
   Friction angle at bottom of layer                    =     28.00000 deg.
   Subgrade k at top of layer                           =     20.00000 pci
   Subgrade k at bottom of layer                        =     20.00000 pci


Layer 3 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer            =      6.00000 ft
   Distance from top of pile to bottom of layer         =     17.00000 ft
   Effective unit weight at top of layer                =     53.00000 pcf
   Effective unit weight at bottom of layer             =     53.00000 pcf
   Friction angle at top of layer                       =     34.00000 deg.
   Friction angle at bottom of layer                    =     34.00000 deg.
   Subgrade k at top of layer                           =     60.00000 pci
   Subgrade k at bottom of layer                        =     60.00000 pci


Layer 4 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer            =     17.00000 ft
   Distance from top of pile to bottom of layer         =     50.00000 ft
   Effective unit weight at top of layer                =     63.00000 pcf
   Effective unit weight at bottom of layer             =     63.00000 pcf
   Friction angle at top of layer                       =     40.00000 deg.
   Friction angle at bottom of layer                    =     40.00000 deg.
   Subgrade k at top of layer                           =    125.00000 pci
   Subgrade k at bottom of layer                        =    125.00000 pci


   (Depth of lowest soil layer extends   27.00 ft below pile tip)


--------------------------------------------------------------------------------
                           Summary of Soil Properties
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Layer Num.	Layer Soil Type (p-y Curve Criteria)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	0.00	115.000	28.000	25.000
		3.000	115.000	28.000	25.000
2	Sand (Reese, et al.)	3.000	53.000	28.000	20.000
		6.000	53.000	28.000	20.000
3	Sand (Reese, et al.)	6.000	53.000	34.000	60.000
		17.000	53.000	34.000	60.000
4	Sand (Reese, et al.)	17.000	63.000	40.000	125.000
		50.000	63.000	40.000	125.000

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--------------------------------------------------------------------------------
                                 Loading Type
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Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	2	V = 1000.00000 lbs	S = 0.0000 in/in	77000.	Yes
2	2	V = 1000.00000 lbs	S = 0.0000 in/in	66000.	Yes

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

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Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 1000.0 lbs
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 77000.0 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch

0.00	0.0143	-47278.	1000.0000	0.000	4829.9056	7.569E+09	0.000	0.000	0.000
0.230	0.0143	-44517.	998.6369	-1.674E-05	4757.9498	7.569E+09	-0.9878	190.4400	0.000
0.460	0.0142	-41759.	994.5607	-3.247E-05	4686.1002	7.569E+09	-1.9660	380.8800	0.000
0.690	0.0141	-39013.	987.8094	-4.719E-05	4614.5565	7.569E+09	-2.9262	571.3200	0.000
0.920	0.0140	-36286.	978.4443	-6.092E-05	4543.5147	7.569E+09	-3.8602	761.7600	0.000
1.150	0.0138	-33586.	966.5472	-7.366E-05	4473.1658	7.569E+09	-4.7609	952.2000	0.000
1.380	0.0136	-30919.	952.2188	-8.542E-05	4403.6940	7.569E+09	-5.6219	1142.6400	0.000
1.610	0.0133	-28293.	935.5767	-9.622E-05	4335.2755	7.569E+09	-6.4375	1333.0800	0.000
1.840	0.0130	-25714.	916.7531	-0.000106	4268.0775	7.569E+09	-7.2027	1523.5200	0.000
2.070	0.0127	-23188.	895.8931	-0.000115	4202.2571	7.569E+09	-7.9133	1713.9600	0.000
2.300	0.0124	-20720.	873.1524	-0.000123	4137.9604	7.569E+09	-8.5655	1904.4000	0.000
2.530	0.0121	-18316.	848.6961	-0.000130	4075.3218	7.569E+09	-9.1565	2094.8400	0.000
2.760	0.0117	-15980.	822.6963	-0.000136	4014.4635	7.569E+09	-9.6839	2285.2800	0.000
2.990	0.0113	-13716.	795.3308	-0.000142	3955.4948	7.569E+09	-10.1461	2475.7200	0.000
3.220	0.0109	-11529.	769.4743	-0.000146	3898.5122	7.569E+09	-8.5904	2172.5990	0.000
3.450	0.0105	-9406.7593	745.4097	-0.000150	3843.2112	7.569E+09	-8.8476	2324.9510	0.000
3.680	0.0101	-7350.8445	720.7095	-0.000153	3789.6471	7.569E+09	-9.0511	2477.3030	0.000
3.910	0.009657	-5363.3079	695.5212	-0.000156	3737.8645	7.569E+09	-9.2012	2629.6550	0.000
4.140	0.009225	-3445.4469	669.9911	-0.000157	3687.8973	7.569E+09	-9.2988	2782.0070	0.000
4.370	0.008790	-1598.1536	644.2626	-0.000158	3639.7686	7.569E+09	-9.3450	2934.3590	0.000
4.600	0.008353	178.0769	618.4755	-0.000158	3602.7704	7.569E+09	-9.3413	3086.7110	0.000
4.830	0.007916	1883.1350	592.7647	-0.000158	3647.1934	7.569E+09	-9.2896	3239.0630	0.000
5.060	0.007481	3517.2826	567.2602	-0.000157	3689.7689	7.569E+09	-9.1920	3391.4150	0.000
5.290	0.007049	5081.1368	542.0851	-0.000155	3730.5130	7.569E+09	-9.0509	3543.7670	0.000
5.520	0.006623	6575.6515	517.3557	-0.000153	3769.4505	7.569E+09	-8.8689	3696.1190	0.000
5.750	0.006203	8002.0967	493.1807	-0.000151	3806.6146	7.569E+09	-8.6492	3848.4710	0.000
5.980	0.005791	9362.0357	469.6601	-0.000147	3842.0459	7.569E+09	-8.3947	4000.8230	0.000
6.210	0.005389	10657.	428.9570	-0.000144	3875.7923	7.569E+09	-21.1003	10807.	0.000
6.440	0.004997	11791.	371.6941	-0.000140	3905.3295	7.569E+09	-20.3946	11264.	0.000
6.670	0.004618	12768.	316.4884	-0.000135	3930.7953	7.569E+09	-19.6096	11721.	0.000
6.900	0.004251	13596.	263.5446	-0.000130	3952.3434	7.569E+09	-18.7555	12178.	0.000
7.130	0.003898	14279.	213.0391	-0.000125	3970.1417	7.569E+09	-17.8426	12635.	0.000
7.360	0.003559	14825.	165.1207	-0.000120	3984.3701	7.569E+09	-16.8809	13092.	0.000
7.590	0.003235	15241.	119.9104	-0.000115	3995.2182	7.569E+09	-15.8802	13549.	0.000
7.820	0.002926	15535.	77.5027	-0.000109	4002.8839	7.569E+09	-14.8501	14006.	0.000
8.050	0.002633	15715.	37.9661	-0.000103	4007.5710	7.569E+09	-13.7997	14463.	0.000
8.280	0.002356	15789.	1.3444	-9.752E-05	4009.4875	7.569E+09	-12.7378	14920.	0.000
8.510	0.002095	15764.	-32.3419	-9.177E-05	4008.8442	7.569E+09	-11.6726	15377.	0.000
8.740	0.001850	15649.	-63.0947	-8.604E-05	4005.8525	7.569E+09	-10.6120	15834.	0.000
8.970	0.001620	15452.	-90.9363	-8.037E-05	4000.7230	7.569E+09	-9.5631	16292.	0.000
9.200	0.001406	15182.	-115.9081	-7.478E-05	3993.6644	7.569E+09	-8.5325	16749.	0.000
9.430	0.001207	14844.	-138.0691	-6.931E-05	3984.8817	7.569E+09	-7.5262	17206.	0.000
9.660	0.001023	14449.	-157.4939	-6.397E-05	3974.5753	7.569E+09	-6.5498	17663.	0.000
9.890	0.000854	14002.	-174.2715	-5.878E-05	3962.9399	7.569E+09	-5.6079	18120.	0.000
10.120	0.000699	13512.	-188.5030	-5.377E-05	3950.1632	7.569E+09	-4.7048	18577.	0.000
10.350	0.000557	12985.	-200.3004	-4.893E-05	3936.4255	7.569E+09	-3.8441	19034.	0.000
10.580	0.000429	12427.	-209.7849	-4.430E-05	3921.8987	7.569E+09	-3.0287	19491.	0.000
10.810	0.000313	11845.	-217.0851	-3.988E-05	3906.7457	7.569E+09	-2.2612	19948.	0.000
11.040	0.000209	11246.	-222.3355	-3.567E-05	3891.1200	7.569E+09	-1.5435	20405.	0.000
11.270	0.000116	10633.	-225.6754	-3.168E-05	3875.1652	7.569E+09	-0.8767	20862.	0.000
11.500	3.391E-05	10013.	-227.2468	-2.791E-05	3859.0150	7.569E+09	-0.2620	21319.	0.000
11.730	-3.809E-05	9390.6924	-227.1936	-2.437E-05	3842.7926	7.569E+09	0.3005	21776.	0.000
11.960	-0.000101	8769.5988	-225.6602	-2.106E-05	3826.6108	7.569E+09	0.8107	22233.	0.000
12.190	-0.000154	8154.0010	-222.7903	-1.798E-05	3810.5722	7.569E+09	1.2690	22690.	0.000
12.420	-0.000200	7547.4380	-218.7258	-1.512E-05	3794.7691	7.569E+09	1.6763	23147.	0.000

12.650	-0.000238	6953.0594	-213.6060	-1.247E-05	3779.2833	7.569E+09	2.0337	23604.	0.000
12.880	-0.000269	6373.6339	-207.5666	-1.004E-05	3764.1872	7.569E+09	2.3427	24061.	0.000
13.110	-0.000293	5811.5600	-200.7390	-7.820E-06	3749.5431	7.569E+09	2.6049	24519.	0.000
13.340	-0.000312	5268.8786	-193.2495	-5.800E-06	3735.4043	7.569E+09	2.8223	24976.	0.000
13.570	-0.000325	4747.2881	-185.2188	-3.974E-06	3721.8150	7.569E+09	2.9970	25433.	0.000
13.800	-0.000334	4248.1597	-176.7617	-2.334E-06	3708.8109	7.569E+09	3.1314	25890.	0.000
14.030	-0.000338	3772.5554	-167.9862	-8.714E-07	3696.4196	7.569E+09	3.2277	26347.	0.000
14.260	-0.000339	3321.2463	-158.9936	4.220E-07	3684.6614	7.569E+09	3.2886	26804.	0.000
14.490	-0.000336	2894.7312	-149.8783	1.555E-06	3673.5491	7.569E+09	3.3167	27261.	0.000
14.720	-0.000330	2493.2570	-140.7272	2.538E-06	3663.0893	7.569E+09	3.3146	27718.	0.000
14.950	-0.000322	2116.8386	-131.6199	3.378E-06	3653.2822	7.569E+09	3.2849	28175.	0.000
15.180	-0.000311	1765.2793	-122.6287	4.086E-06	3644.1228	7.569E+09	3.2304	28632.	0.000
15.410	-0.000299	1438.1914	-113.8185	4.670E-06	3635.6010	7.569E+09	3.1538	29089.	0.000
15.640	-0.000286	1135.0162	-105.2468	5.139E-06	3627.7021	7.569E+09	3.0576	29546.	0.000
15.870	-0.000271	855.0447	-96.9639	5.502E-06	3620.4079	7.569E+09	2.9445	30003.	0.000
16.100	-0.000255	597.4369	-89.0130	5.767E-06	3613.6962	7.569E+09	2.8170	30460.	0.000
16.330	-0.000239	361.2417	-81.4304	5.942E-06	3607.5425	7.569E+09	2.6776	30917.	0.000
16.560	-0.000222	145.4156	-74.2456	6.034E-06	3601.9194	7.569E+09	2.5287	31374.	0.000
16.790	-0.000206	-51.1589	-67.4817	6.051E-06	3599.4637	7.569E+09	2.3727	31831.	0.000
17.020	-0.000189	-229.6556	-58.7516	6.000E-06	3604.1142	7.569E+09	3.9536	57719.	0.000
17.250	-0.000173	-378.0178	-48.2321	5.889E-06	3607.9796	7.569E+09	3.6692	58672.	0.000
17.480	-0.000157	-498.4001	-38.5018	5.729E-06	3611.1160	7.569E+09	3.3817	59624.	0.000
17.710	-0.000141	-592.9831	-29.5651	5.530E-06	3613.5802	7.569E+09	3.0942	60576.	0.000
17.940	-0.000126	-663.9499	-21.4184	5.301E-06	3615.4292	7.569E+09	2.8092	61528.	0.000
18.170	-0.000112	-713.4658	-14.0517	5.050E-06	3616.7192	7.569E+09	2.5290	62480.	0.000
18.400	-9.814E-05	-743.6615	-7.4491	4.784E-06	3617.5059	7.569E+09	2.2555	63433.	0.000
18.630	-8.531E-05	-756.6183	-1.5903	4.511E-06	3617.8435	7.569E+09	1.9900	64385.	0.000
18.860	-7.324E-05	-754.3574	3.5484	4.235E-06	3617.7846	7.569E+09	1.7337	65337.	0.000
19.090	-6.193E-05	-738.8312	7.9935	3.963E-06	3617.3801	7.569E+09	1.4873	66289.	0.000
19.320	-5.136E-05	-711.9178	11.7728	3.699E-06	3616.6789	7.569E+09	1.2513	67241.	0.000
19.550	-4.151E-05	-675.4174	14.9149	3.446E-06	3615.7279	7.569E+09	1.0256	68194.	0.000
19.780	-3.234E-05	-631.0519	17.4484	3.208E-06	3614.5720	7.569E+09	0.8102	69146.	0.000
20.010	-2.380E-05	-580.4657	19.4008	2.987E-06	3613.2541	7.569E+09	0.6046	70098.	0.000
20.240	-1.585E-05	-525.2290	20.7983	2.785E-06	3611.8150	7.569E+09	0.4081	71050.	0.000
20.470	-8.431E-06	-466.8427	21.6650	2.604E-06	3610.2938	7.569E+09	0.2200	72002.	0.000
20.700	-1.479E-06	-406.7448	22.0225	2.445E-06	3608.7280	7.569E+09	0.0391	72955.	0.000
20.930	5.065E-06	-346.3176	21.8893	2.308E-06	3607.1537	7.569E+09	-0.1356	73907.	0.000
21.160	1.126E-05	-286.8967	21.2807	2.192E-06	3605.6055	7.569E+09	-0.3054	74859.	0.000
21.390	1.717E-05	-229.7798	20.2086	2.098E-06	3604.1174	7.569E+09	-0.4715	75811.	0.000
21.620	2.284E-05	-176.2368	18.6813	2.024E-06	3602.7225	7.569E+09	-0.6352	76763.	0.000
21.850	2.834E-05	-127.5191	16.7036	1.969E-06	3601.4532	7.569E+09	-0.7979	77716.	0.000
22.080	3.371E-05	-84.8698	14.2767	1.930E-06	3600.3420	7.569E+09	-0.9607	78668.	0.000
22.310	3.899E-05	-49.5322	11.3987	1.905E-06	3599.4213	7.569E+09	-1.1248	79620.	0.000
22.540	4.422E-05	-22.7589	8.0649	1.892E-06	3598.7238	7.569E+09	-1.2910	80572.	0.000
22.770	4.943E-05	-5.8181	4.2683	1.887E-06	3598.2824	7.569E+09	-1.4602	81524.	0.000
23.000	5.464E-05	0.000	0.000	1.886E-06	3598.1308	7.569E+09	-1.6328	41238.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

```
Pile-head deflection            =     0.0143391 inches
Computed slope at pile head     =      0.000000 radians
Maximum bending moment          =        -47278. inch-lbs
Maximum shear force             =  1000.0000000 lbs
```

Depth of maximum bending moment =   0.000000 feet below pile head
Depth of maximum shear force   =   0.000000 feet below pile head
Number of iterations   =   6
Number of zero deflection points =   2

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 2, Shear and Slope

Shear   =   1000. lb
Slope   =   0.00000
Axial Load =   77000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
23.0000	0.0143391	-47278.	1000.0000000
21.8500	0.0143020	-47298.	1000.0000000
20.7000	0.0141915	-47218.	1000.0000000
19.5500	0.0142420	-47248.	1000.0000000
18.4000	0.0142559	-47255.	1000.0000000
17.2500	0.0142436	-47227.	1000.0000000
16.1000	0.0143841	-47269.	1000.0000000
14.9500	0.0145229	-47279.	1000.0000000
13.8000	0.0148264	-47537.	1000.0000000
12.6500	0.0154366	-48268.	1000.0000000
11.5000	0.0163554	-49815.	1000.0000000
10.3500	0.0173091	-52332.	1000.0000000
9.2000	0.0181086	-55230.	1000.0000000
8.0500	0.0181668	-56450.	1000.0000000
6.9000	0.0186010	-53533.	1000.0000000
5.7500	0.0234974	-43434.	1000.0000000
4.6000	0.0315111	-35463.	1000.0000000
3.4500	0.0498854	-27097.	1000.0000000
2.3000	0.1053117	-18431.	999.9999991

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head   =   1000.0 lbs
Rotation of pile head   =   0.000E+00 radians
Axial load at pile head   =   66000.0 lbs

(Zero slope for this load indicates fixed-head conditions)

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.0143	-47221.	1000.0000	0.000	4314.3991	7.569E+09	0.000	0.000	0.000
0.230	0.0143	-44460.	998.6387	-1.672E-05	4242.4502	7.569E+09	-0.9864	190.4400	0.000
0.460	0.0142	-41703.	994.5680	-3.242E-05	4170.6201	7.569E+09	-1.9634	380.8800	0.000
0.690	0.0141	-38958.	987.8259	-4.713E-05	4099.1075	7.569E+09	-2.9222	571.3200	0.000
0.920	0.0140	-36233.	978.4734	-6.084E-05	4028.1075	7.569E+09	-3.8550	761.7600	0.000
1.150	0.0138	-33535.	966.5924	-7.356E-05	3957.8098	7.569E+09	-4.7545	952.2000	0.000
1.380	0.0136	-30870.	952.2834	-8.530E-05	3888.3977	7.569E+09	-5.6143	1142.6400	0.000
1.610	0.0133	-28247.	935.6638	-9.608E-05	3820.0465	7.569E+09	-6.4288	1333.0800	0.000
1.840	0.0130	-25671.	916.8656	-0.000106	3752.9222	7.569E+09	-7.1930	1523.5200	0.000
2.070	0.0127	-23147.	896.0337	-0.000115	3687.1812	7.569E+09	-7.9026	1713.9600	0.000
2.300	0.0124	-20683.	873.3236	-0.000123	3622.9684	7.569E+09	-8.5540	1904.4000	0.000
2.530	0.0120	-18282.	848.9001	-0.000130	3560.4175	7.569E+09	-9.1442	2094.8400	0.000
2.760	0.0117	-15949.	822.9350	-0.000136	3499.6499	7.569E+09	-9.6710	2285.2800	0.000
2.990	0.0113	-13690.	795.6059	-0.000142	3440.7739	7.569E+09	-10.1327	2475.7200	0.000
3.220	0.0109	-11506.	769.7836	-0.000146	3383.8853	7.569E+09	-8.5791	2172.5990	0.000
3.450	0.0105	-9387.0694	745.7507	-0.000150	3328.6795	7.569E+09	-8.8360	2324.9510	0.000
3.680	0.0101	-7334.8245	721.0827	-0.000153	3275.2110	7.569E+09	-9.0393	2477.3030	0.000
3.910	0.009645	-5350.9506	695.9270	-0.000155	3223.5239	7.569E+09	-9.1894	2629.6550	0.000
4.140	0.009214	-3436.7223	670.4296	-0.000157	3173.6513	7.569E+09	-9.2870	2782.0070	0.000
4.370	0.008779	-1593.0103	644.7337	-0.000158	3125.6159	7.569E+09	-9.3333	2934.3590	0.000
4.600	0.008342	179.7105	618.9787	-0.000158	3088.7943	7.569E+09	-9.3298	3086.7110	0.000
4.830	0.007906	1881.3489	593.2996	-0.000158	3133.1281	7.569E+09	-9.2783	3239.0630	0.000
5.060	0.007472	3512.1841	567.8258	-0.000157	3175.6173	7.569E+09	-9.1810	3391.4150	0.000
5.290	0.007041	5072.8491	542.6805	-0.000155	3216.2783	7.569E+09	-9.0402	3543.7670	0.000
5.520	0.006615	6564.3120	517.9799	-0.000153	3255.1364	7.569E+09	-8.8588	3696.1190	0.000
5.750	0.006196	7987.8563	493.8321	-0.000150	3292.2249	7.569E+09	-8.6396	3848.4710	0.000
5.980	0.005785	9345.0572	470.3373	-0.000147	3327.5849	7.569E+09	-8.3857	4000.8230	0.000
6.210	0.005383	10638.	429.6769	-0.000144	3361.2645	7.569E+09	-21.0783	10807.	0.000
6.440	0.004992	11769.	372.4723	-0.000140	3390.7423	7.569E+09	-20.3743	11264.	0.000
6.670	0.004613	12745.	317.3202	-0.000135	3416.1562	7.569E+09	-19.5910	11721.	0.000
6.900	0.004247	13570.	264.4251	-0.000130	3437.6598	7.569E+09	-18.7388	12178.	0.000
7.130	0.003894	14252.	213.9633	-0.000125	3455.4209	7.569E+09	-17.8278	12635.	0.000
7.360	0.003556	14797.	166.0832	-0.000120	3469.6192	7.569E+09	-16.8680	13092.	0.000
7.590	0.003233	15212.	120.9058	-0.000114	3480.4442	7.569E+09	-15.8693	13549.	0.000
7.820	0.002925	15506.	78.5254	-0.000109	3488.0933	7.569E+09	-14.8411	14006.	0.000
8.050	0.002632	15685.	39.0106	-0.000103	3492.7701	7.569E+09	-13.7928	14463.	0.000
8.280	0.002355	15759.	2.4053	-9.738E-05	3494.6823	7.569E+09	-12.7328	14920.	0.000
8.510	0.002095	15734.	-31.2701	-9.164E-05	3494.0403	7.569E+09	-11.6696	15377.	0.000
8.740	0.001850	15619.	-62.0172	-8.592E-05	3491.0550	7.569E+09	-10.6109	15834.	0.000
8.970	0.001620	15423.	-89.8583	-8.026E-05	3485.9368	7.569E+09	-9.5638	16292.	0.000
9.200	0.001406	15153.	-114.8346	-7.469E-05	3478.8938	7.569E+09	-8.5350	16749.	0.000
9.430	0.001208	14816.	-137.0048	-6.922E-05	3470.1306	7.569E+09	-7.5304	17206.	0.000
9.660	0.001024	14422.	-156.4434	-6.389E-05	3459.8473	7.569E+09	-6.5555	17663.	0.000
9.890	0.000855	13976.	-173.2388	-5.871E-05	3448.2380	7.569E+09	-5.6151	18120.	0.000
10.120	0.000700	13487.	-187.4921	-5.371E-05	3435.4901	7.569E+09	-4.7134	18577.	0.000
10.350	0.000559	12961.	-199.3149	-4.888E-05	3421.7834	7.569E+09	-3.8539	19034.	0.000
10.580	0.000430	12404.	-208.8281	-4.426E-05	3407.2894	7.569E+09	-3.0397	19491.	0.000
10.810	0.000315	11824.	-216.1599	-3.984E-05	3392.1706	7.569E+09	-2.2732	19948.	0.000
11.040	0.000211	11226.	-221.4446	-3.564E-05	3376.5803	7.569E+09	-1.5563	20405.	0.000
11.270	0.000118	10615.	-224.8210	-3.166E-05	3360.6616	7.569E+09	-0.8903	20862.	0.000
11.500	3.575E-05	9996.1368	-226.4308	-2.790E-05	3344.5479	7.569E+09	-0.2762	21319.	0.000
11.730	-3.622E-05	9374.8863	-226.4175	-2.437E-05	3328.3621	7.569E+09	0.2858	21776.	0.000

11.960	-9.876E-05	8755.1900	-224.9253	-2.106E-05	3312.2167	7.569E+09	0.7956	22233.	0.000
12.190	-0.000152	8140.9724	-222.0974	-1.798E-05	3296.2141	7.569E+09	1.2536	22690.	0.000
12.420	-0.000198	7535.7637	-218.0756	-1.512E-05	3280.4462	7.569E+09	1.6608	23147.	0.000
12.650	-0.000236	6942.7053	-212.9987	-1.248E-05	3264.9949	7.569E+09	2.0181	23604.	0.000
12.880	-0.000267	6364.5589	-207.0023	-1.006E-05	3249.9321	7.569E+09	2.3271	24061.	0.000
13.110	-0.000291	5803.7168	-200.2174	-7.840E-06	3235.3201	7.569E+09	2.5895	24519.	0.000
13.340	-0.000310	5262.2149	-192.7701	-5.822E-06	3221.2120	7.569E+09	2.8071	24976.	0.000
13.570	-0.000324	4741.7469	-184.7809	-3.998E-06	3207.6519	7.569E+09	2.9822	25433.	0.000
13.800	-0.000332	4243.6810	-176.3642	-2.360E-06	3194.6755	7.569E+09	3.1169	25890.	0.000
14.030	-0.000337	3769.0762	-167.6280	-8.989E-07	3182.3103	7.569E+09	3.2137	26347.	0.000
14.260	-0.000337	3318.7018	-158.6735	3.934E-07	3170.5764	7.569E+09	3.2751	26804.	0.000
14.490	-0.000334	2893.0554	-149.5946	1.526E-06	3159.4868	7.569E+09	3.3037	27261.	0.000
14.720	-0.000329	2492.3835	-140.4784	2.508E-06	3149.0478	7.569E+09	3.3022	27718.	0.000
14.950	-0.000321	2116.7010	-131.4043	3.348E-06	3139.2599	7.569E+09	3.2732	28175.	0.000
15.180	-0.000310	1765.8119	-122.4445	4.056E-06	3130.1180	7.569E+09	3.2194	28632.	0.000
15.410	-0.000298	1439.3296	-113.6638	4.640E-06	3121.6119	7.569E+09	3.1434	29089.	0.000
15.640	-0.000285	1136.6971	-105.1197	5.110E-06	3113.7272	7.569E+09	3.0480	29546.	0.000
15.870	-0.000270	857.2072	-96.8624	5.474E-06	3106.4455	7.569E+09	2.9356	30003.	0.000
16.100	-0.000255	600.0225	-88.9351	5.739E-06	3099.7449	7.569E+09	2.8088	30460.	0.000
16.330	-0.000238	364.1943	-81.3742	5.915E-06	3093.6007	7.569E+09	2.6701	30917.	0.000
16.560	-0.000222	148.6819	-74.2091	6.009E-06	3087.9859	7.569E+09	2.5219	31374.	0.000
16.790	-0.000205	-47.6292	-67.4630	6.027E-06	3085.3531	7.569E+09	2.3666	31831.	0.000
17.020	-0.000189	-225.9098	-58.7547	5.977E-06	3089.9979	7.569E+09	3.9439	57719.	0.000
17.250	-0.000172	-374.1326	-48.2605	5.868E-06	3093.8597	7.569E+09	3.6606	58672.	0.000
17.480	-0.000156	-494.4452	-38.5523	5.709E-06	3096.9942	7.569E+09	3.3743	59624.	0.000
17.710	-0.000141	-589.0212	-29.6347	5.512E-06	3099.4583	7.569E+09	3.0878	60576.	0.000
17.940	-0.000126	-660.0367	-21.5044	5.284E-06	3101.3085	7.569E+09	2.8038	61528.	0.000
18.170	-0.000112	-709.6503	-14.1513	5.034E-06	3102.6011	7.569E+09	2.5245	62480.	0.000
18.400	-9.798E-05	-739.9860	-7.5599	4.770E-06	3103.3915	7.569E+09	2.2519	63433.	0.000
18.630	-8.519E-05	-753.1187	-1.7099	4.498E-06	3103.7336	7.569E+09	1.9872	64385.	0.000
18.860	-7.315E-05	-751.0635	3.4222	4.224E-06	3103.6801	7.569E+09	1.7317	65337.	0.000
19.090	-6.187E-05	-735.7668	7.8627	3.953E-06	3103.2816	7.569E+09	1.4861	66289.	0.000
19.320	-5.133E-05	-709.1012	11.6394	3.689E-06	3102.5868	7.569E+09	1.2506	67241.	0.000
19.550	-4.151E-05	-672.8615	14.7806	3.437E-06	3101.6426	7.569E+09	1.0256	68194.	0.000
19.780	-3.236E-05	-628.7646	17.3147	3.200E-06	3100.4938	7.569E+09	0.8107	69146.	0.000
20.010	-2.385E-05	-578.4501	19.2693	2.980E-06	3099.1829	7.569E+09	0.6056	70098.	0.000
20.240	-1.591E-05	-523.4836	20.6704	2.779E-06	3097.7508	7.569E+09	0.4096	71050.	0.000
20.470	-8.507E-06	-465.3619	21.5420	2.599E-06	3096.2365	7.569E+09	0.2219	72002.	0.000
20.700	-1.569E-06	-405.5187	21.9054	2.440E-06	3094.6774	7.569E+09	0.0415	72955.	0.000
20.930	4.961E-06	-345.3326	21.7794	2.303E-06	3093.1093	7.569E+09	-0.1328	73907.	0.000
21.160	1.114E-05	-286.1355	21.1790	2.188E-06	3091.5670	7.569E+09	-0.3022	74859.	0.000
21.390	1.704E-05	-229.2216	20.1162	2.094E-06	3090.0842	7.569E+09	-0.4680	75811.	0.000
21.620	2.270E-05	-175.8571	18.5991	2.020E-06	3088.6939	7.569E+09	-0.6314	76763.	0.000
21.850	2.819E-05	-127.2904	16.6326	1.965E-06	3087.4285	7.569E+09	-0.7937	77716.	0.000
22.080	3.354E-05	-84.7612	14.2178	1.926E-06	3086.3205	7.569E+09	-0.9561	78668.	0.000
22.310	3.882E-05	-49.5097	11.3530	1.901E-06	3085.4021	7.569E+09	-1.1198	79620.	0.000
22.540	4.404E-05	-22.7851	8.0335	1.888E-06	3084.7058	7.569E+09	-1.2857	80572.	0.000
22.770	4.924E-05	-5.8529	4.2520	1.883E-06	3084.2646	7.569E+09	-1.4545	81524.	0.000
23.000	5.444E-05	0.000	0.000	1.882E-06	3084.1121	7.569E+09	-1.6267	41238.	0.000

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 2:

Pile-head deflection = 0.0143197 inches

Computed slope at pile head = 0.000000 radians
Maximum bending moment = -47221. inch-lbs
Maximum shear force = 1000.0000000 lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 0.000000 feet below pile head
Number of iterations = 6
Number of zero deflection points = 2

Pile-head Deflection vs. Pile Length for Load Case 2

Boundary Condition Type 2, Shear and Slope

Shear = 1000. lb
Slope = 0.00000
Axial Load = 66000. lb

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
23.0000	0.0143197	-47221.	1000.0000000
21.8500	0.0142826	-47241.	1000.0000000
20.7000	0.0141724	-47161.	1000.0000000
19.5500	0.0142228	-47191.	1000.0000000
18.4000	0.0142366	-47198.	1000.0000000
17.2500	0.0142245	-47170.	1000.0000000
16.1000	0.0143646	-47212.	1000.0000000
14.9500	0.0145028	-47222.	1000.0000000
13.8000	0.0148045	-47478.	1000.0000000
12.6500	0.0154108	-48204.	1000.0000000
11.5000	0.0163228	-49739.	1000.0000000
10.3500	0.0172681	-52234.	1000.0000000
9.2000	0.0180620	-55105.	1000.0000000
8.0500	0.0181249	-56311.	1000.0000000
6.9000	0.0185740	-53410.	1000.0000000
5.7500	0.0234876	-43357.	1000.0000000
4.6000	0.0315077	-35421.	999.9999998
3.4500	0.0498845	-27079.	1000.0000000
2.3000	0.1053116	-18426.	999.9999991

Summary of Pile Response(s)

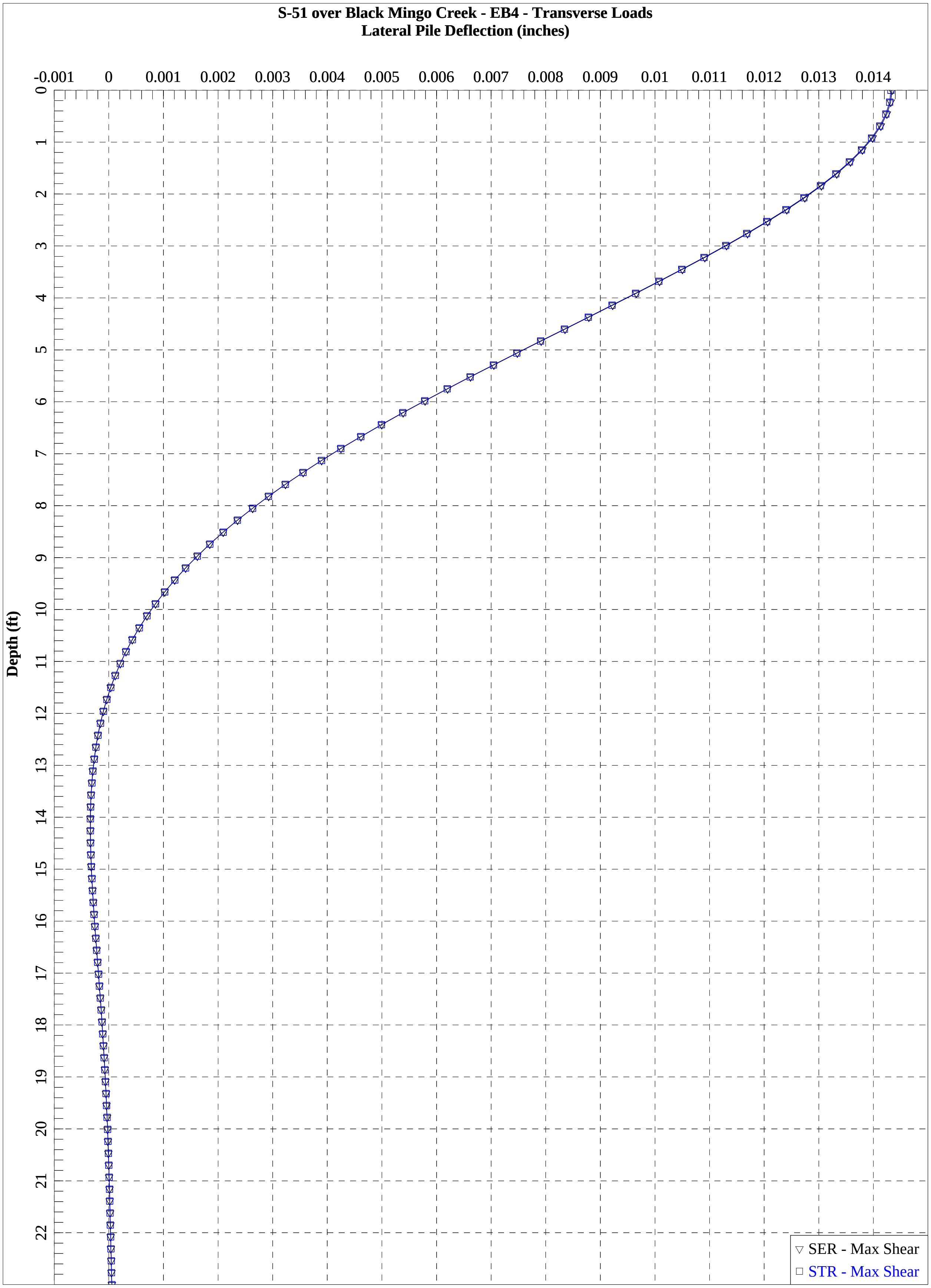
Definitions of Pile-head Loading Conditions:

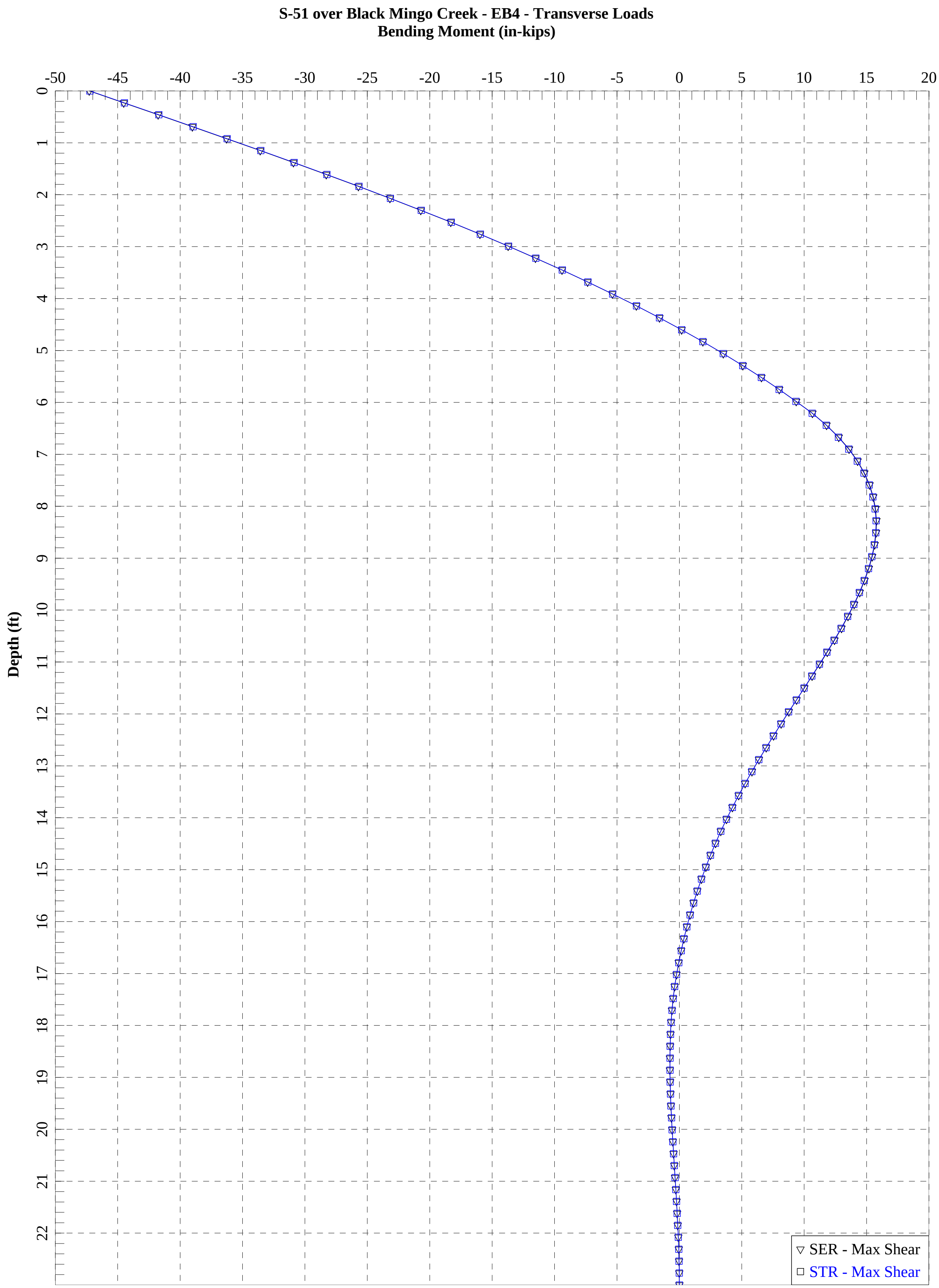
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians

Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

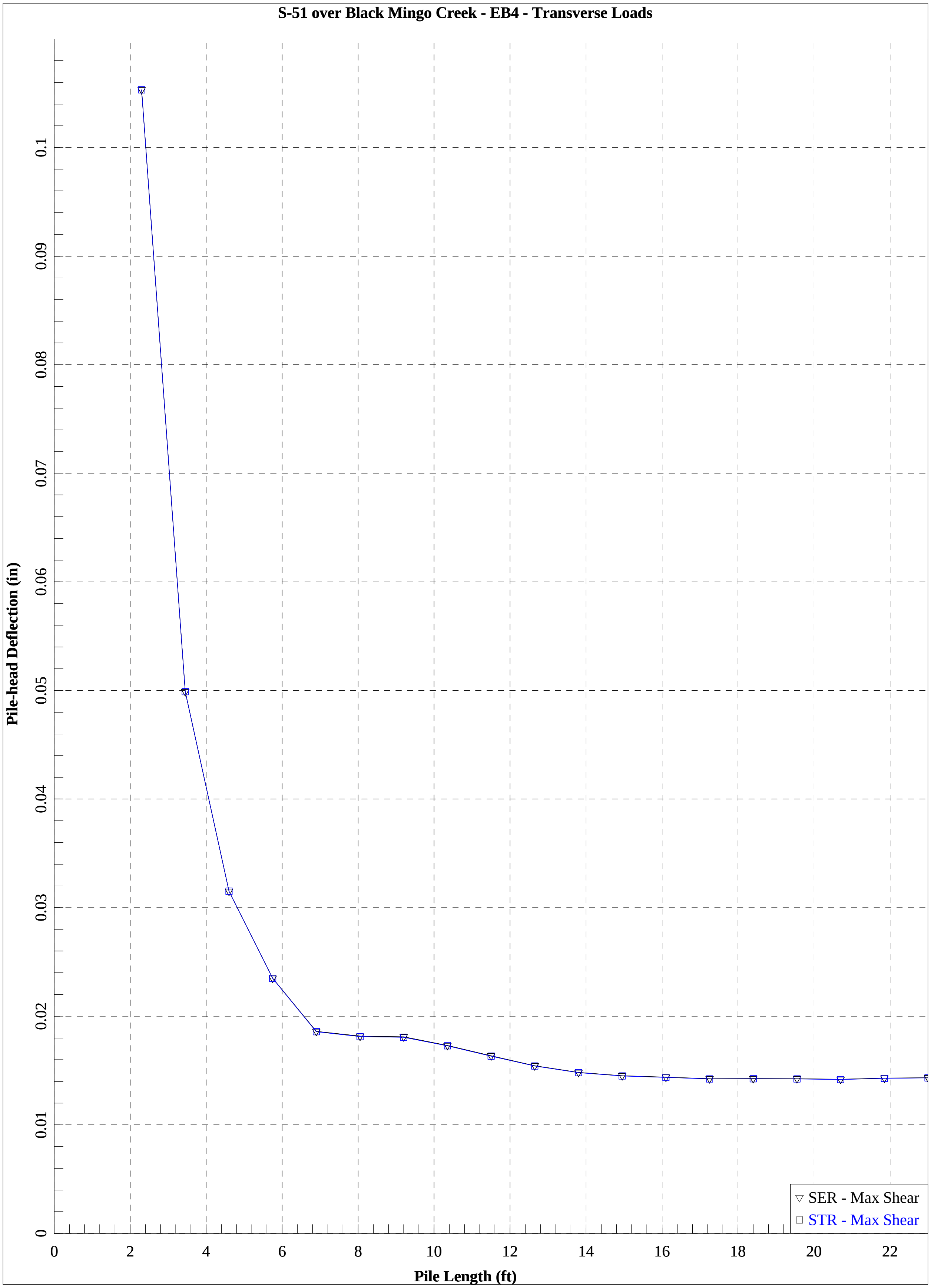
Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in Pile in-lbs	Maximum Shear in Pile lbs	Pile-head Rotation radians
1	2	V = 1000.0000	S = 0.000	77000.	0.01433905	-47278.	1000.0000	0.00000000
2	2	V = 1000.0000	S = 0.000	66000.	0.01431969	-47221.	1000.0000	0.00000000

The analysis ended normally.


S-51 over Black Mingo Creek - EB4 - Transverse Loads
Lateral Pile Deflection (inches)
-0.001
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
SER - Max Shear
STR - Max Shear



S-51 over Black Mingo Creek - EB4 - Transverse Loads
Bending Moment (in-kips)
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
SER - Max Shear
STR - Max Shear

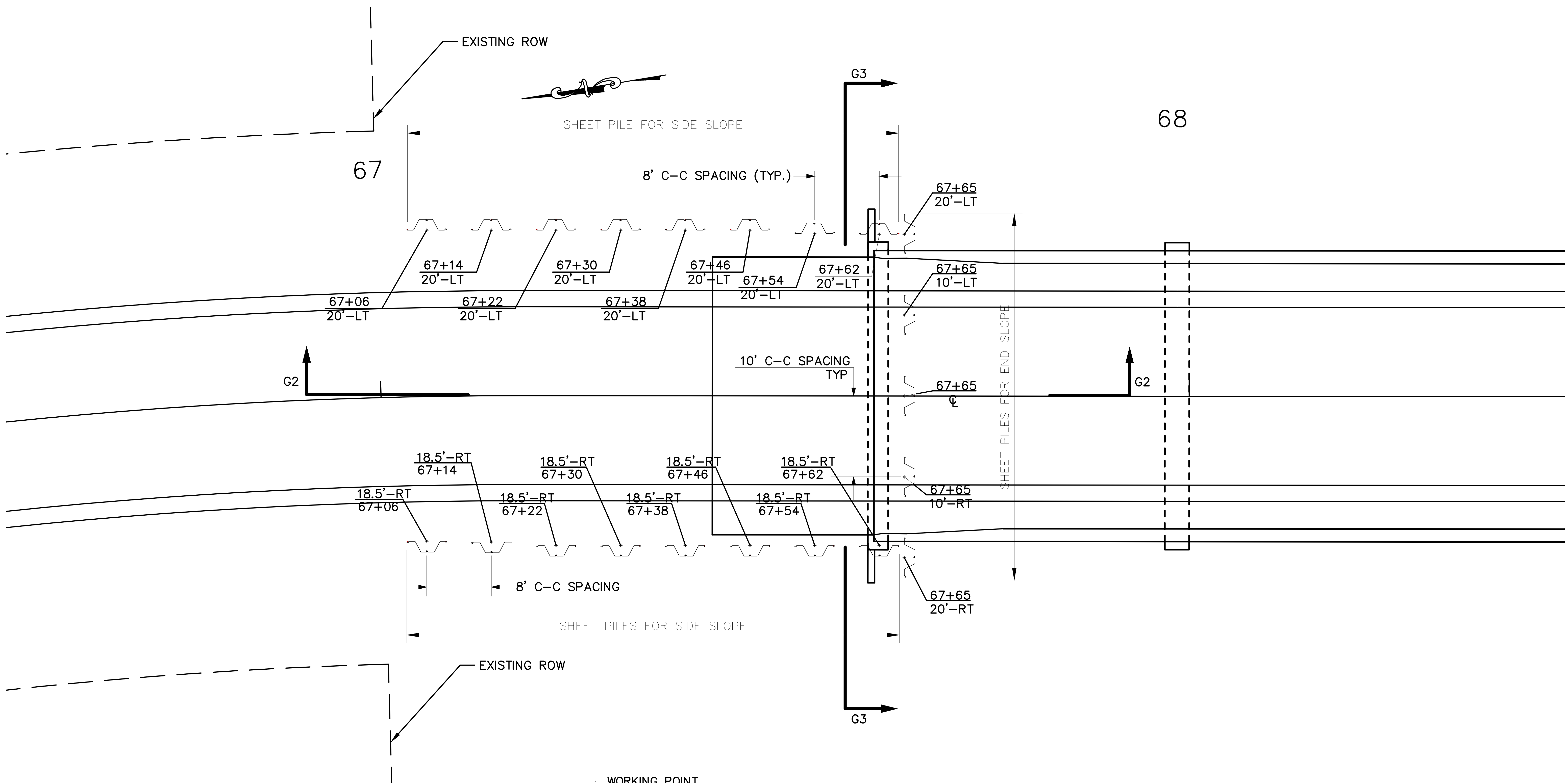

S-51 over Black Mingo Creek - EB4 - Transverse Loads
Pile-head Deflection (in)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
2
4
6
8
10
12
14
16
18
20
22
Pile Length (ft)
SER - Max Shear
STR - Max Shear

APPENDIX

SECTION 16

GEOTECHNICAL DETAILS AND SPECIFICATIONS

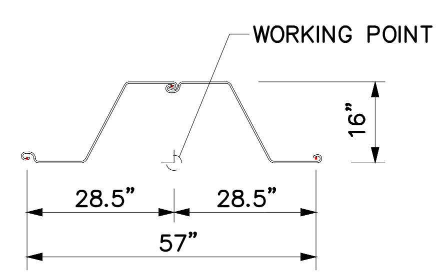
FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	G1



SEQUENCE:

1. INSTALL SHEET PILES FOR END SLOPE AS SHOWN. SHEET PILES FOR SIDE SLOPE CAN BE INSTALLED AT ANY TIME.
2. INSTALL EB H-PILES.

SHEET PILE LOCATIONS MAY BE ADJUSTED IN THE FIELD TO ACCOMMODATE EXISTING UTILITIES. THE MAXIMUM CENTER-TO-CENTER SPACING SHALL BE MAINTAINED, AS SHOWN.



SKZ 20 SHEET PILE SET

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.______ DATE______
DWG. CTC DATE 2/15/2016 GROUP ___ - ___
R/W______ DATE______

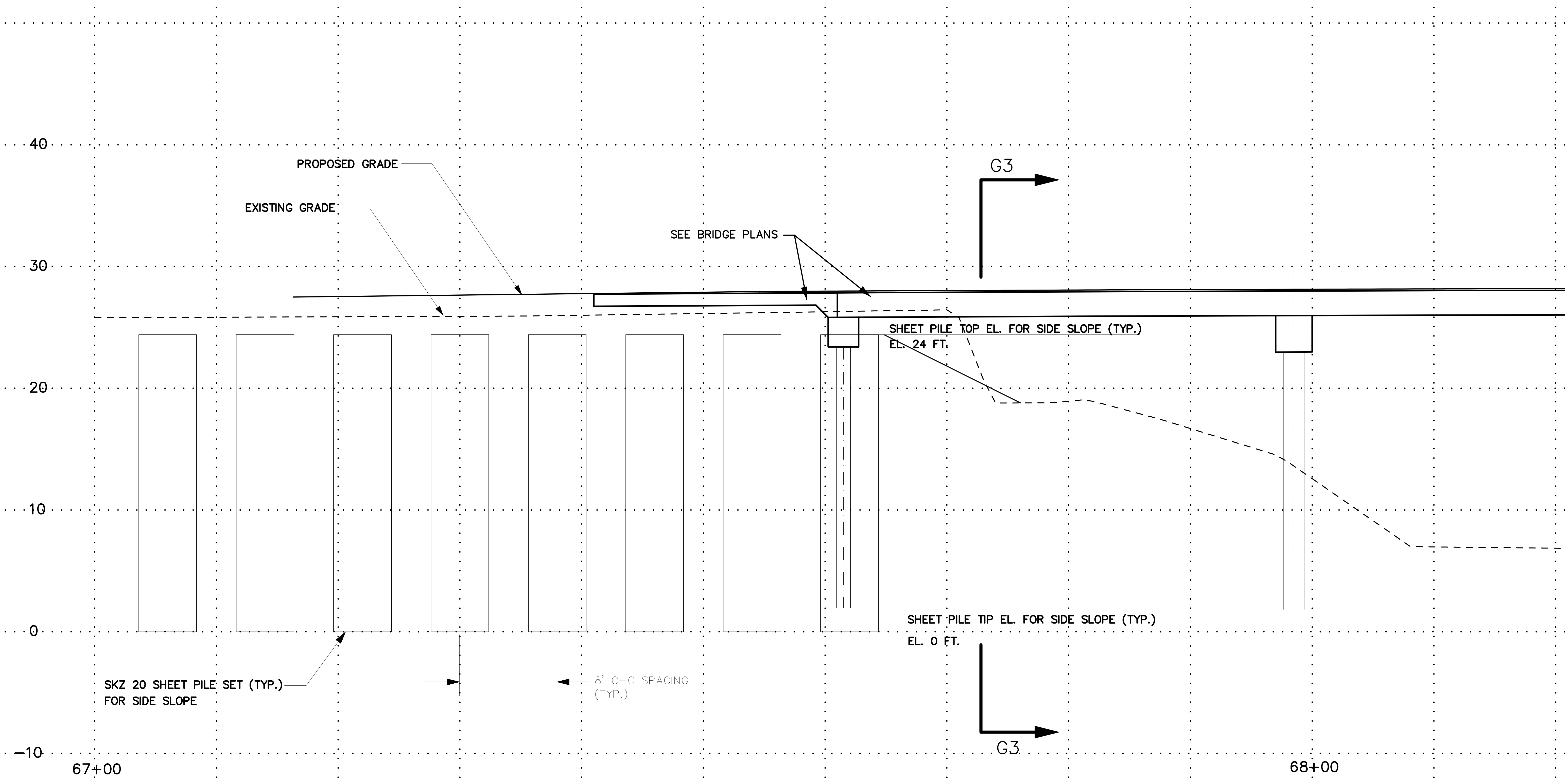
F&ME CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

END & SIDE SLOPE SHEET PILE LAYOUT (PLAN)
BEGIN BRIDGE

SCALE = NTS

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	G2



NOTES:

1. TOP SHEET PILE ELEVATION SHALL EITHER BE INSTALLED FLUSH WITH THE EXISTING GROUND OR CUT FLUSH WITH THE EXISTING GROUND. NO SHEET PILE SECTION IS ALLOWED TO EXTEND ABOVE THE EXISTING GROUND.
2. STEEL SHEET PILES SHALL BE SKZ 20 ATSM A572 GRADE 50 KSI BY SKYLINE STEEL, OR EQ.

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.____ DATE____
DWG. CTC DATE 2/15/2016 GROUP ___ - ___
R/W____ DATE____

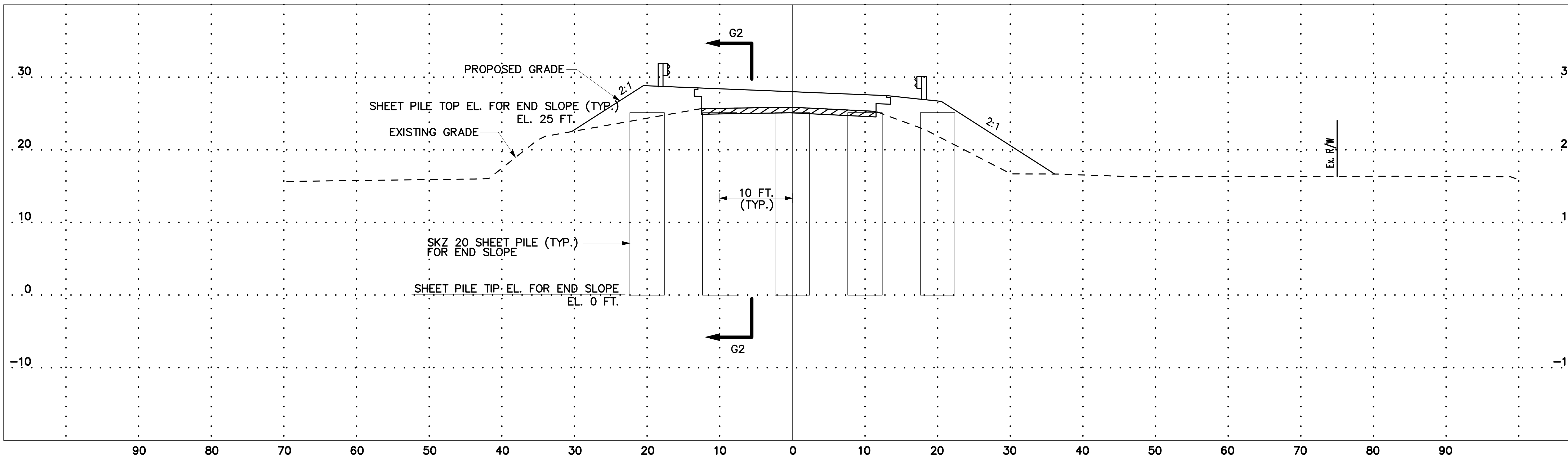
F&ME CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

SIDE SLOPE SHEET PILE LAYOUT (PROFILE)
BEGIN BRIDGE

SCALE = NTS

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	G3



BEGIN BRIDGE EMBANKMENT (TYP.)

NOTE:

END BENT AND PILES NOT SHOWN FOR CLARITY

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.____ DATE____
DWG. CTC DATE 2/15/2016 GROUP ___ - ___
R/W____ DATE____

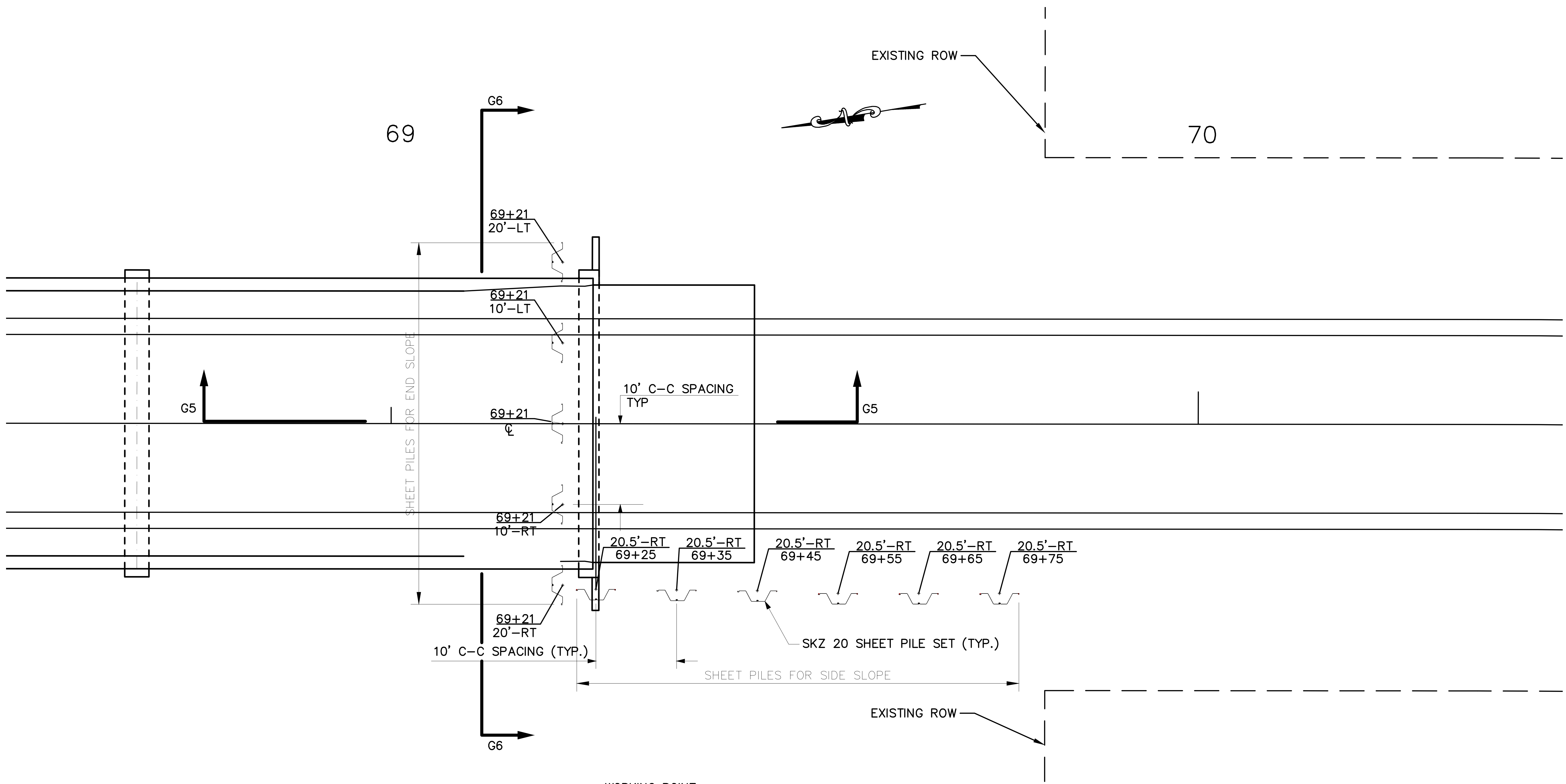
F&ME CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

END SLOPE SHEET PILE LAYOUT (SECTION)
BEGIN BRIDGE

SCALE = NTS

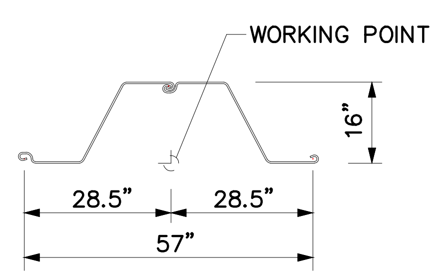
FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	G4



SEQUENCE:

1. INSTALL SHEET PILES FOR END SLOPE AS SHOWN. SHEET PILES FOR SIDE SLOPE CAN BE INSTALLED AT ANY TIME.
2. INSTALL EB H-PILES.

SHEET PILE LOCATIONS MAY BE ADJUSTED IN THE FIELD TO ACCOMMODATE EXISTING UTILITIES. THE MAXIMUM 10 FT. CENTER-TO-CENTER SPACING SHALL BE MAINTAINED, AS SHOWN.



SKZ 20 SHEET PILE SET

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.______ DATE______
DWG. CTC DATE 2/15/2016 GROUP ___ - ___
R/W______ DATE______

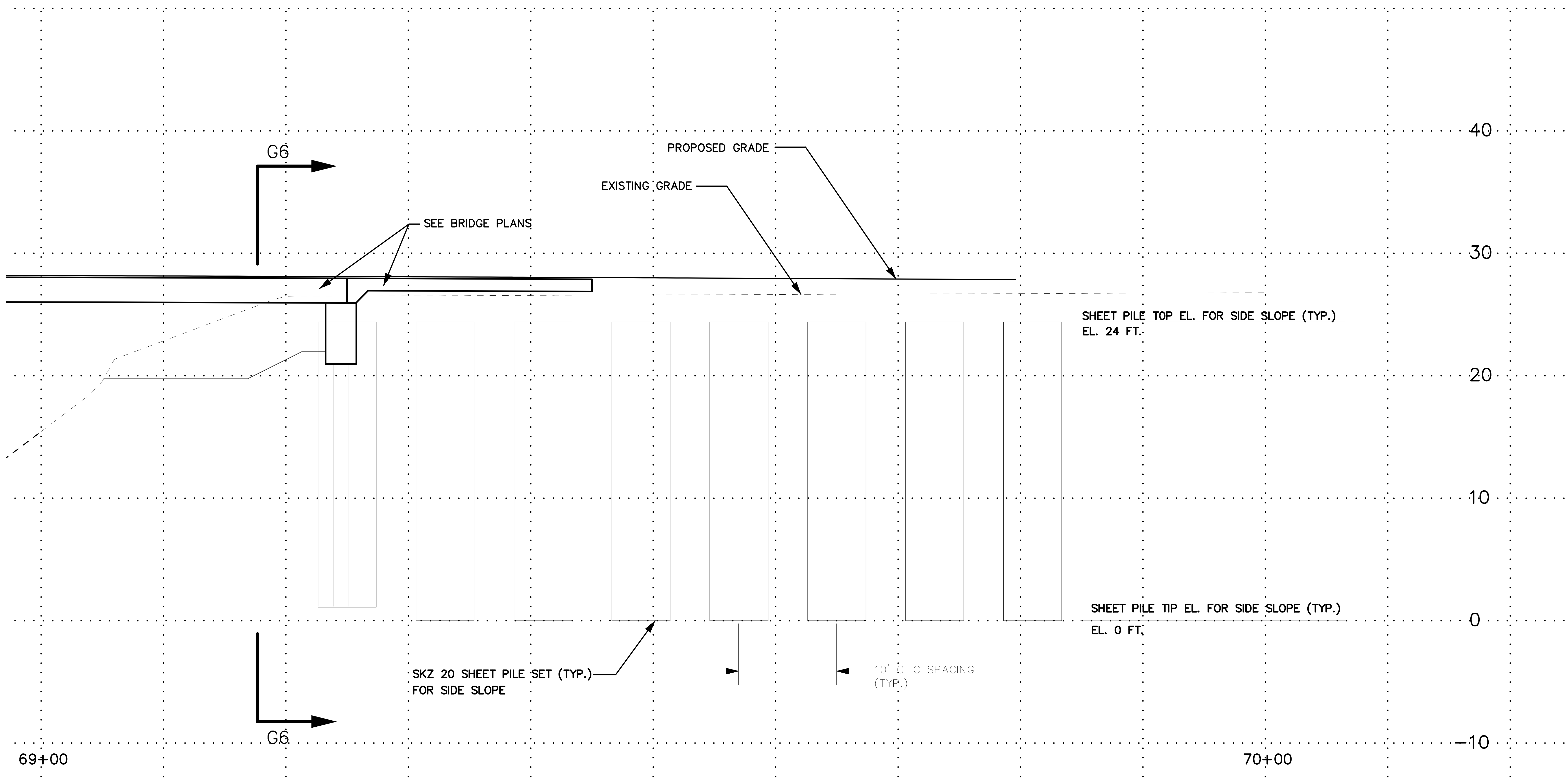
F&ME CONSULTANTS
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

END & SIDE SLOPE SHEET PILE LAYOUT (PLAN)
END BRIDGE

SCALE = NTS

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	G5



NOTES:

1. TOP SHEET PILE ELEVATION SHALL EITHER BE INSTALLED FLUSH WITH THE EXISTING GROUND OR CUT FLUSH WITH THE EXISTING GROUND. NO SHEET PILE SECTION IS ALLOWED TO EXTEND ABOVE THE EXISTING GROUND.
2. STEEL SHEET PILES SHALL BE SKZ 20 ATSM A572 GRADE 50 KSI BY SKYLINE STEEL, OR EQ.

SEQUENCE:

1. INSTALL SHEET PILES FOR END SLOPE AS SHOWN. SHEET PILES FOR SIDE SLOPE CAN BE INSTALLED AT ANY TIME.
2. INSTALL EB H-PILES.

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.______ DATE______
DWG. CTC DATE 2/15/2016 GROUP ___ - ____
R/W______ DATE______

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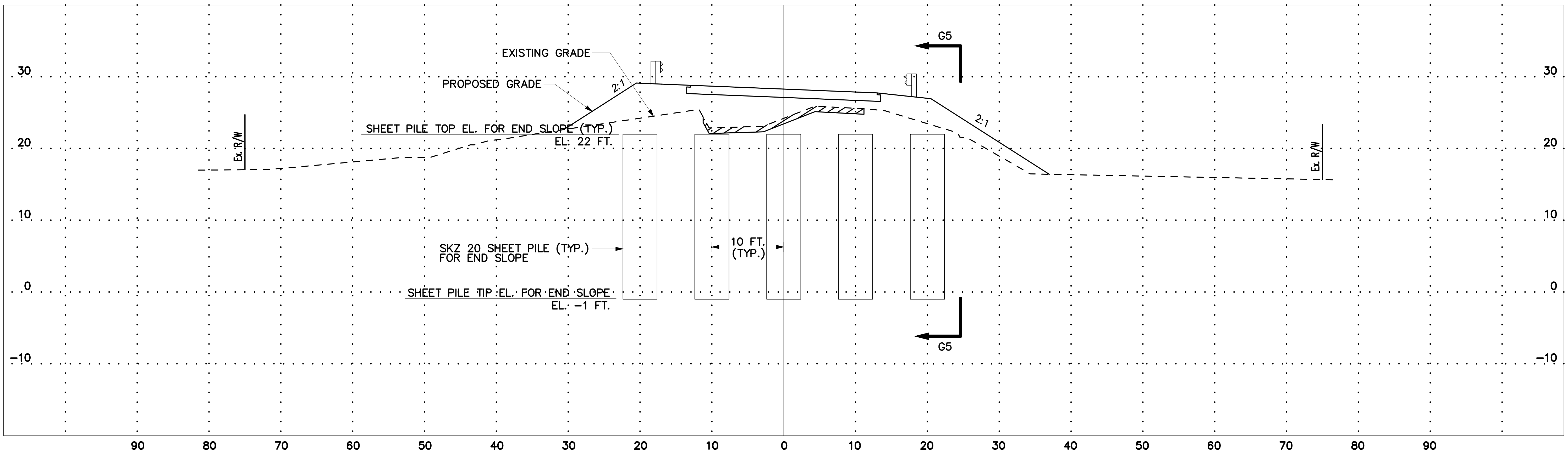
GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

SIDE SLOPE SHEET PILE LAYOUT (PROFILE)
END BRIDGE

SCALE = NTS

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-45-51	G6



END OF BRIDGE EMBANKMENT (TYP.)

NOTE:

END BENT AND PILES NOT SHOWN FOR CLARITY

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO.______ DATE______
DWG. CTC DATE 2/15/2016 GROUP ___ - ____
R/W______ DATE______

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GEOTECHNICAL – ENVIRONMENTAL – MATERIALS
COLUMBIA, SOUTH CAROLINA

S-45-51 (BATTERY PARK ROAD)
OVER BLACK MINGO CREEK, WILLIAMSBURG COUNTY

END SLOPE SHEET PILE LAYOUT (SECTION)
END BRIDGE

SCALE = NTS