

Appendix C (continued)

AB-9

Large-Diameter Borings

From:

Action Geotechnical Consultants, 1984b

SUMMARY SHEET

PROJECT

Mr. Thomas Weese

LITHOLOGICAL DESCRIPTION	DRY DENSITY lbs./cu. ft.	RELATIVE COMPACTION	MOISTURE %	PENETRATION N	DEPTH IN FEET	LOG AND LOCATION OF SAMPLE	UNIFIED SOIL CLASSIFICATION	ENGINEERING CLASSIFICATION/DESCRIPTION
bedrock					0	CORE		WHITE, fine to medium SANDSTONE
					5			BROWN SANDSTONE, dense, slightly clayey
					10			WHITE, fine to medium SANDSTONE
					10			BROWN SANDSTONE, dense, slightly clayey
					15			WHITE, fine to medium grained SANDSTONE
					20			Cemented SANDSTONE layer
					20			BROWN, clayey SANDSTONE
					25			WHITE, fine to medium grained SANDSTONE
					25			Clayey seams noted @ 28'
					30			
					35			Cemented fine to medium SANDSTONE
					35			BROWN, clayey, fine to medium SANDSTONE, very dense
					35			LIGHT BROWN SANDSTONE
					40			WHITE, fine to medium grained SANDSTONE
45								
remolded 26°, c=375 psf								
							BORING No. 9 SURFACE ELEV. see map EQUIP. Bucket Auger HOLE DIA. 24" LOGGED BY GW	
							JOB NO. 4137 DATE 10/5/84 SHEET OF 1 2	

SUMMARY SHEET

OBJECT

Mr. Thomas Weese

GEOLOGICAL DESCRIPTION							ENGINEERING CLASSIFICATION/DESCRIPTION			
					50			WHITE SANDSTONE (con't.)		
					55			BROWN, slightly clayey, fine SANDSTONE lense @ 50'		
					60			Hard drilling @ 53'		
								End @ 60'		
								No Groundwater Encountered		
								No Caving Occurred		
							CORE	BORING No. 9		
								SURFACE ELEV. see map		
								EQUIP. Bucket		
								Auger HOLE DIA. 24"		
								LOGGED BY GW		
	DRY DENSITY lbs./cu. ft.	RELATIVE COMPACTION	MOISTURE %	PENETRATION N	DEPTH IN FEET	LOG AND LOCATION OF SAMPLE	UNIFIED SOIL CLASSIFICATION	JOB NO.	DATE	SHEET
								4137	10/5/84	2 OF 2

Appendix C (continued)

GB-1 through GB-3

Large-Diameter Borings

From:

G.A. Nichols, 1992

LOG OF BORING

Drill Rig: Bucket Auger	Boring Diameter: 24 inches	Boring Elevation: 85± feet	Boring Number B-1
Date Drilled: 12/21/89 CHP	This log is a representation of subsurface conditions at the time and place of drilling. With the passage of time or at any other location there may be consequential changes in conditions.		

SAMPLE		DRIVE ENERGY FT. KIPS/FT.	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB/CU. FT.	SHEAR RESISTANCE KIPS/30. FT.	DEPTH, FEET	SOIL/ROCK SYMBOL	SOIL/ROCK TYPE	Description and Remarks
BULK	TUBE								
							SC	Clayey Silty SAND: fine- to medium-grained, light to dark brown, dry, loose, abundant, organic debris	
							CL	PAD FILL	
		11.0	15.4	104.6				Silty CLAY: black to dark brown, dry, stiff, adobe, open fractures to 2 feet @ 3½ feet-5 feet, caliche in pods, occasional pebbles	
		13.2	15.9	102.1		5		@ 4 feet, Sandy, dark brown, moist	
								TOPSOIL	
							ML	Sandy Clayey SILT: light brown, moist, medium stiff, occasional pebbels to 2"ø	
							SC	Clayey SAND: fine- to medium-grained, medium brown, moist, medium dense @ 10½ feet, becomes occasionally coarse-grained, 4" discontinuous Silty SAND, light yellow-brown, fragments of upper and lower Clayey SAND	
		11.0	21.1	109.1		10	ML	Clayey SILT: light gray-brown with heavy white mottling	
							SC	@ 12½ feet, 1"-4' thick red-brown Silty SAND, broken with up to 6¼ offsets @ 14 feet, start of shear (fault): N80E,80SE (crosshole)	
		8.8	8.2	107.4		15	CL	Silty Clayey SAND: fine-grained, medium brown, moist, medium dense @ 15.2 feet, CLAY bed 2"-4" thick @ 15½ feet, white, abundant broekn CLAY fragment mottled, crosshole bedding: N88E,20SE, very irregular	
							SM	@ 17 feet, Clayey on south side of hole, shear from 14' about 1" thick offsets CLAY bed about 6"	
		8.8	16.8	111.3		20		Silty CLAY: gray-brown, moist, medium stiff, thin, dark red-brown SAND beds, CaCO ₃ mottling	
								Clayey Silty SAND: gray to red-brown, fine-grained @ 20 feet, crosshole bedding: N80W,15SW, abundant vertical gypsum filled fractures @ 21 feet, medium-grained, gray-brown with dark red interbeds, moist, medium dense @ 23-23.8 feet, Clayey @ 23.8 feet, bed truncated by 16" shear rupture surface: N48E,5N (crosshole)	
		21.6	31.7 19.2	91.1 109.9		25		BEDROCK	



(Continued on Figure B-2.2)

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Tustin, California

Weese - Oceanside	
Project No.: 4142-02	Figure No.: B-2.1

LOG OF BORING

Drill Rig: Bucket Auger	Boring Diameter: 24 inches	Boring Elevation: 85± feet	Boring Number B-1
Date Drilled: 12/21/89 CHP		This log is a representation of subsurface conditions at the time and place of drilling. With the passage of time or at any other location there may be consequential changes in conditions.	

SAMPLE		DRIVE ENERGY FT. KIPS/FT.	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	SHEAR RESISTANCE KIPS/SQ. FT.	DEPTH, FEET	SOIL/ROCK SYMBOL	SOIL/ROCK TYPE	Description and Remarks
BULK	TUBE								
		31.2	11.9	125.1		35	BEDROCK	<p>(Continued from Figure B-2.1)</p> <p>Clayey SILTSTONE: brown, moist, highly sheared, and broken @ 24.2 feet, undulatory shear: EW, 35N... striations N52W @ 24.3 feet, planar shear: N45W, 8NE @ 25 feet, polished shear: N60W, 39N @ 25.3 feet, sheared contact with underlying SANDSTONE: N52W, 14N LANDSLIDE DEBRIS</p>	
						40		<p>Silty SANDSTONE: fine- to medium-grained, gray white, moist, dense, thick bedded @ 27 feet, 2' concretion, discontinuous, gray to gray-white @ 28.8 feet, seepage</p>	
						45		<p>@ 36 feet, siltier, medium gray-white @ 39 feet, light yellow-brown SANTIAGO FORMATION</p>	
						50		<p>Bottom of Boring at 40 feet. Note: 1) No caving. 2) Seepage at 28.8 feet. 3) Boring backfilled.</p>	
						55			



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Project No.:
4142-02

Figure No.:
B-2.2

LOG OF BORING

Drill Rig: Bucket Auger	Boring Diameter: 24 inches	Boring Elevation: 96± feet.	Boring Number B-2
Date Drilled: 12/27/89 AK		This log is a representation of subsurface conditions at the time and place of drilling. With the passage of time or at any other location there may be consequential changes in conditions.	

SAMPLE		DRIVE ENERGY FT. KIPS/FT.	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	SHEAR RESISTANCE KIPS/SQ. FT.	DEPTH, FEET	SOIL/ROCK SYMBOL	SOIL/ROCK TYPE	Description and Remarks
BULK	TUBE								
						0	SC	Clayey SAND: fine-grained, medium brown, dry, loose PAD FILL	
		11.0	7.4	113.4		5	SM	Clayey Silty SAND: fine-grained, light orange-brown, dense, dry, scattered crushed bedrock cobbles and pebbles, some roots present @ 5.5 feet, becomes slightly moist TOPSOIL	
		11.0	13.1	111.5		10	CL	Silty CLAY: fine-grained, white to light gray, soft to medium stiff @ 6½ feet, shear: ¼-½" thick CLAY zone, faint striations, abundant caliche present N28E, 20NW	
		39.6	11.7	117.4		10	SM	@ 6.6 feet, Silty SAND: fine-grained, orange-brown, very dense, massive	
						10	CL	@ 12.8-13.3 feet, Rs, CLAY zone, fine-grained, dark green brown, stiff, faint striations down dip N73W, 31NE; thin dark red brown Silty SAND interbed present N5W, 41NE	
						15	CL	@ 13.5-17.5 feet, Silty CLAY: fine-grained, light gray, soft to medium stiff	
		37.4	12.7	124.4		15			
						20		@ 17.5 feet, SANDSTONE: medium- to coarse-grained, very hard white to light gray, massive @ 19 feet, moderate to heavy seepage @ 23 feet, becomes less hard @ 24 feet, heavy seepage SANTIAGO FORMATION	
		77.0	9.0	110.5		25	BEDROCK	Bottom of Boring at 28 feet. Notes: 1) No caving. 2) Boring backfilled. 3) Seepage at 19 feet and 24 feet. 4) 6½ feet of standing water in bottom.	



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Project No.: 4142-02	Figure No.: B-3

LOG OF BORING

Drill Rig: Bucket Auger	Boring Diameter: 24 inches	Boring Elevation: 59± feet	Boring Number B-3
Date Drilled: 12/27/89 AK		This log is a representation of subsurface conditions at the time and place of drilling. With the passage of time or at any other location there may be consequential changes in conditions.	

SAMPLE		DRIVE ENERGY FT. KIPS/FT.	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB/CU. FT.	SHEAR RESISTANCE KIPS/SQ. FT.	DEPTH FEET	SOIL/ROCK SYMBOL	SOIL/ROCK TYPE	Description and Remarks
BULK	TUBE								
		6.6	12.1	106.8		0	SC	Silty CLAY: fine-grained, dark gray-brown, medium stiff, dry, very moist, contains roots TOPSOIL	
		4.4	8.2	103.7		5	CL	@ 3.5-5 feet, Silty CLAY: fine-grained, light gray, very soft, moist, caliche banding very abundant @ 5 feet, Silty SAND bed: fine-grained, light orange-brown, loose to medium dense @ 6 feet, Silty CLAY: fine-grained, light greenish-brown, soft, moist, abundant caliche bands @ 6½ feet, becomes very moist @ 9 feet, Sandy CLAY bed: fine-grained, light gray, soft, N79E, 34NW @ 10 feet, Silty CLAY: light gray to white, very soft, very moist, some organics present @ 12-13 feet, sheared surface: N10E, 26NW, CLAY zone, dark brown, very moist, distinct polishing, zone highly disturbed, abundant caliche, very faint striations	
		6.6	27.6	95.2		10			
		4.4	33.9	92.3		15	CL	@ 14 feet, heavy seepage, caving @ 14 feet, Sandy CLAY: dark green, sheared, contains small pieces of CLAYSTONE, very moist @ 18 feet, heavy seepage	
		28.6	12.3	124.7		20	SC	@ 20 feet, SANDSTONE: light gray, very hard @ 21 feet, heavy seepage and caving @ 25 feet, Silty CLAY: fine-grained, light gray-brown, very stiff @ 26 feet, shear surface: highly polished, dark green brown @ 29 feet, bulk of shear surface obtained	
		12.0	NR	NR		25			
		H.S.	25.1	104.1					

(Continued on Figure B-4.2)



NR = No Recovery
H.S. = Hand Sampled
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Tustin, California

Weese - Oceanside

Project No.:
4142-02

Figure No.:
B-4.1

LOG OF BORING

Drill Rig: Bucket Auger	Boring Diameter: 24 inches	Boring Elevation: 59± feet	Boring Number B-3
Date Drilled: 12/22/89 AK		This log is a representation of subsurface conditions at the time and place of drilling. With the passage of time or at any other location there may be consequential changes in conditions.	

SAMPLE		DRIVE ENERGY FT. KIPS/FT.	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB/CU. FT.	SHEAR RESISTANCE KIPS/SQ. FT.	DEPTH, FEET	SOIL/ROCK SYMBOL	SOIL/ROCK TYPE	Description and Remarks
BULK	TUBE								
		20.4	28.3	100.1			CL	(Continued from Figure B-4.1)	Silty CLAY layer: sheared, polished, dark greenish-gray, very moist
		14.4	15.3	118.1		35			@ 35 feet, caving LANDSLIDE DEBRIS
						40			@ 39 feet, Silty SANDSTONE: fine- to medium-coarse-grained, light, moist, dense
		33.6	10.4	125.1		45	BEDROCK		SANTIAGO FORMATION
						50			Bottom of Boring at 48 feet. Notes: 1) Caving intermittently from 14 feet to bottom of boring. 2) Heavy seepage from 14 feet to 39 feet. 3) Boring downhole logged to 14 feet. 4) Boring backfilled. 5) 7 feet of water existed upon completion of drilling.
						55			



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Project No.:
4142-02

Figure No.:
B-4.2

APPENDIX C

Previous Laboratory Testing Procedures and Test Results

APPENDIX D

Laboratory Testing Procedures and Test Results

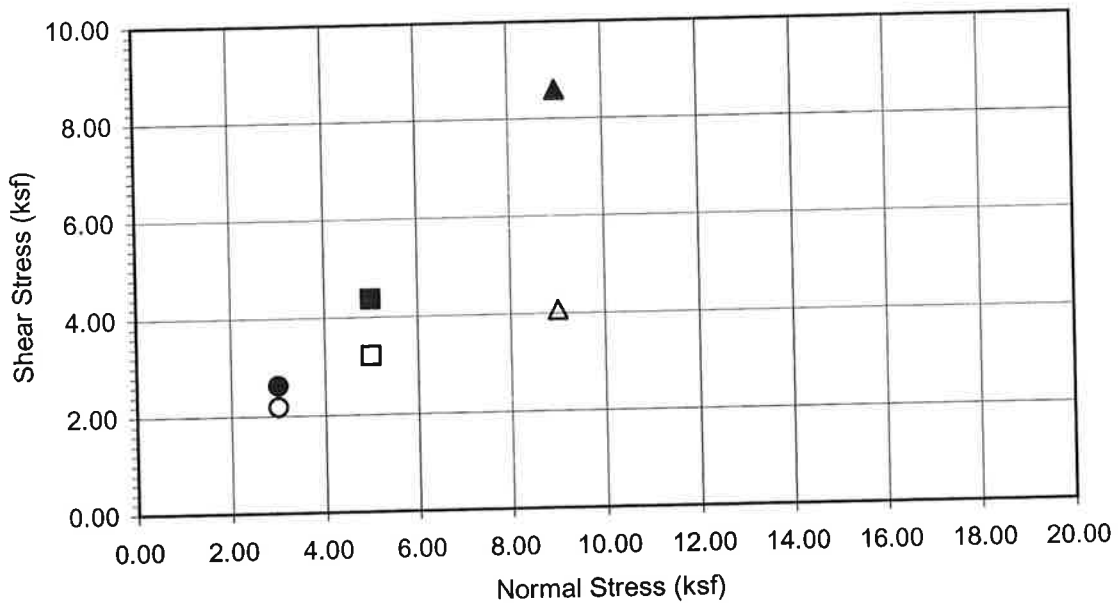
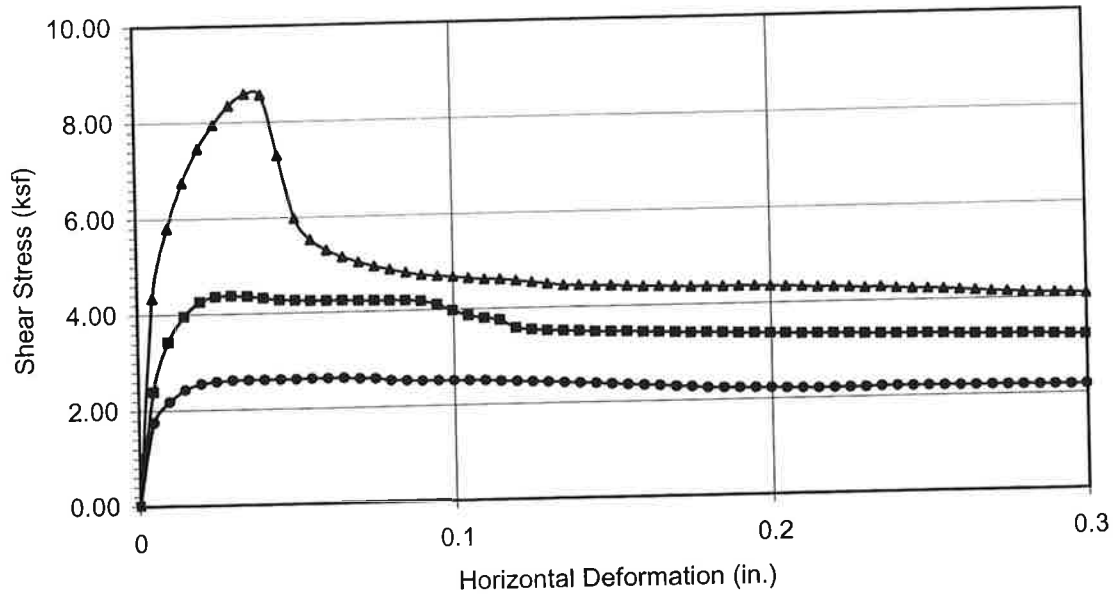
Consolidation Tests: Consolidation tests were performed on selected, relatively undisturbed samples recovered from the sampler. Samples were placed in a consolidometer and loads were applied in geometric progression. The percent consolidation for each load cycle was recorded as the ratio of the amount of vertical compression to the original 1-inch height. The consolidation pressure curves are presented in the test data. Where applicable, time-rates of consolidation were also recorded. A plot of these rates can be used to estimate time of consolidation.

Direct Shear Tests: Direct shear tests were performed on selected remolded and/or undisturbed samples that were soaked for a minimum of 24 hours under a surcharge equal to the applied normal force during testing. After transfer of the sample to the shear box, and reloading the sample, pore pressures set up in the sample due to the transfer were allowed to dissipate for a period of approximately 1 hour prior to application of shearing force. The samples were tested under various normal loads, a motor-driven, strain-controlled, direct-shear testing apparatus at a strain rate of 0.005 inches per minute.

Expansion Index Tests: The expansion potential of selected finish grade materials was evaluated by the Expansion Index Test, ASTM Test Method 4829. The prepared 1-inch thick by 4-inch diameter specimens are loaded to an equivalent 144 psf surcharge and are inundated with tap water until volumetric equilibrium is reached. The results of these tests are presented in the following tables.

Maximum Density Tests: The maximum dry density and optimum moisture content of typical materials were determined in accordance with ASTM D1557-78 (five layers). The results of these tests are presented in the test data.

Moisture and Density Tests: Moisture content and dry density determinations were performed on relatively undisturbed samples obtained from the test borings and/or trenches. The results of these tests are presented in the boring logs. Where applicable, only moisture content was determined from "undisturbed" or disturbed samples.



Boring No.	LB-13
Sample No.	R-5
Depth (ft)	46
Sample Type:	
Drive	
Soil Identification:	
Brown Silt, Siltstone (ML)	

Normal Stress (kip/ft ²)	3.000	5.000	9.000
Peak Shear Stress (kip/ft ²)	● 2.622	■ 4.374	▲ 8.586
Shear Stress @ End of Test (ksf)	○ 2.182	□ 3.221	△ 4.075
Deformation Rate (in./min.)	0.0010	0.0010	0.0010
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	16.29	16.29	16.29
Dry Density (pcf)	107.6	111.9	117.9
Saturation (%)	77.5	86.8	102.3
Soil Height Before Shearing (in.)	0.9923	0.9900	0.9905
Final Moisture Content (%)	23.8	20.6	33.4



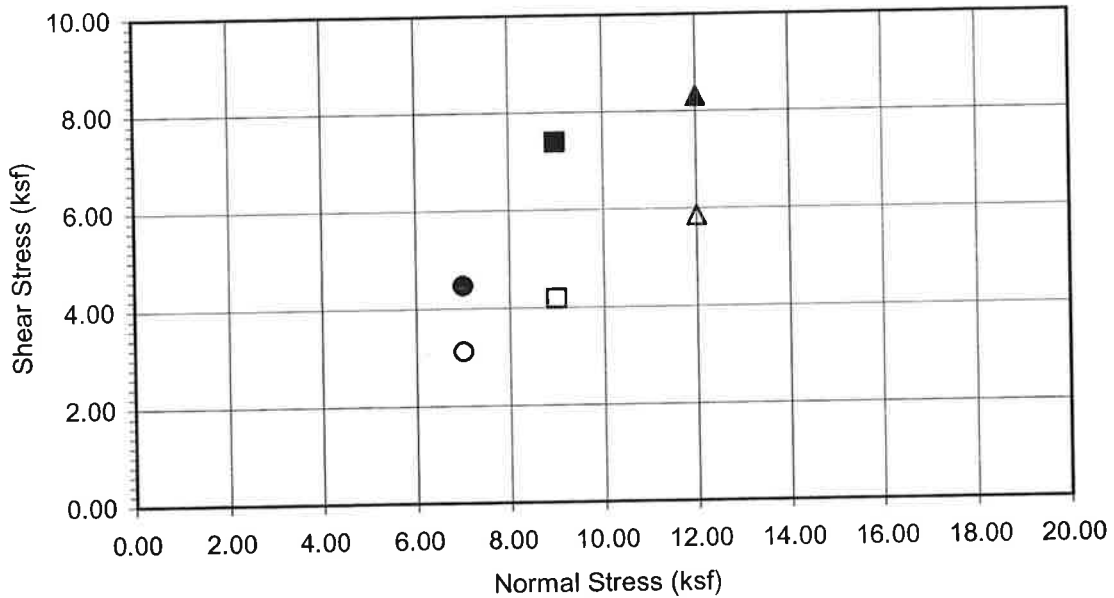
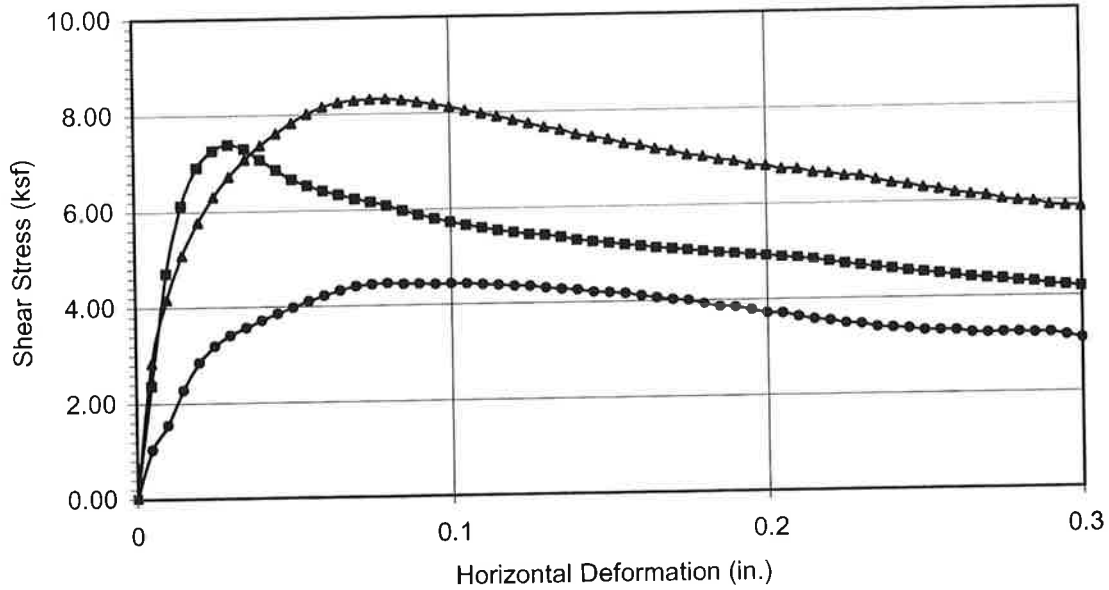
Teratest Labs, Inc.
A LEIGHTON GROUP COMPANY

DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 040963-001

Weese / Oceanside

07-03



Boring No.	LB-13
Sample No.	R-10a
Depth (ft)	100
<u>Sample Type:</u>	
Drive	
<u>Soil Identification:</u>	
Brown Lean Clay (CL)	

Normal Stress (kip/ft ²)	7.000	9.000	12.000
Peak Shear Stress (kip/ft ²)	● 4.462	■ 7.392	▲ 8.303
Shear Stress @ End of Test (ksf)	○ 3.115	□ 4.190	△ 5.858
Deformation Rate (in./min.)	0.0010	0.0010	0.0010
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	18.97	18.97	18.97
Dry Density (pcf)	111.5	113.0	113.7
Saturation (%)	100.2	104.0	106.2
Soil Height Before Shearing (in.)	0.9799	0.9838	0.9903
Final Moisture Content (%)	23.1	20.9	22.7



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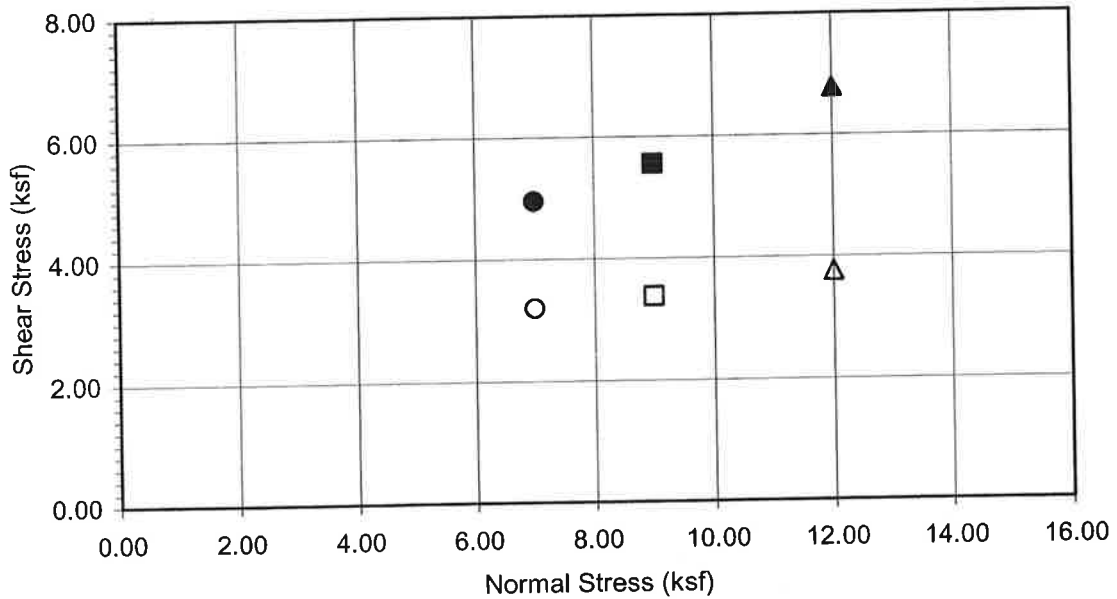
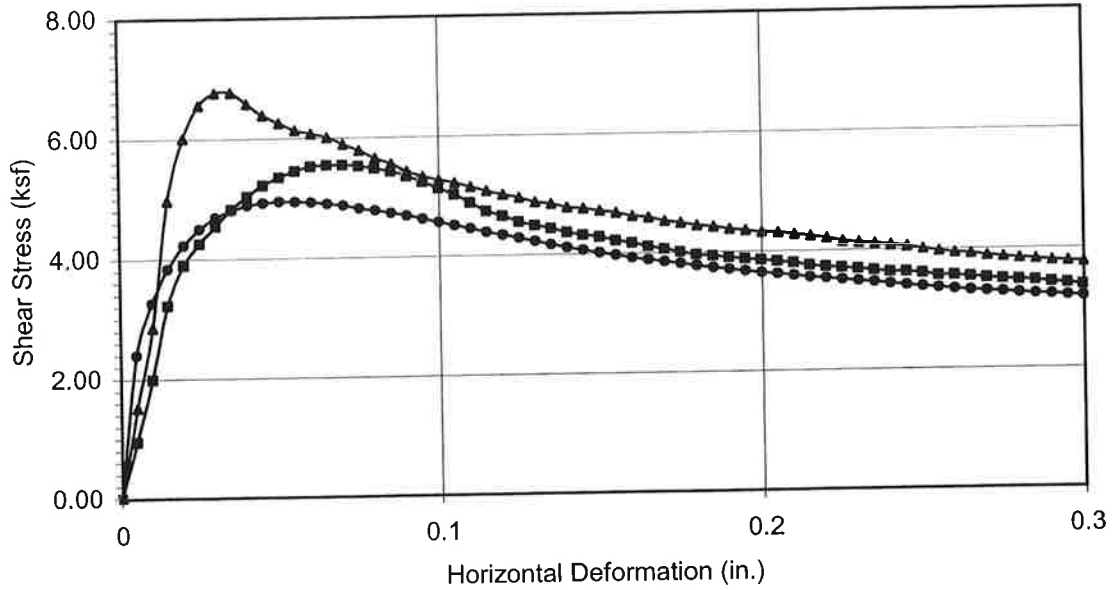
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.:

040963-001

Weese / Oceanside

07-03



Boring No.	LB-13
Sample No.	R-10b
Depth (ft)	100
<u>Sample Type:</u>	
Drive	
<u>Soil Identification:</u>	
Brown Silty Clay (CL-ML)	

Normal Stress (kip/ft ²)	7.000	9.000	12.000
Peak Shear Stress (kip/ft ²)	● 4.948	■ 5.550	▲ 6.772
Shear Stress @ End of Test (ksf)	○ 3.190	□ 3.377	△ 3.760
Deformation Rate (in./min.)	0.0010	0.0010	0.0010
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	20.70	20.70	20.70
Dry Density (pcf)	106.8	107.9	108.7
Saturation (%)	96.6	99.4	101.4
Soil Height Before Shearing (in.)	0.9965	0.9931	0.9956
Final Moisture Content (%)	25.3	25.6	25.7



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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 040963-001

Weese / Oceanside

07-03

EXPANSION INDEX TEST RESULTS

TEST NO.	SAMPLE LOCATION	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (PCF)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (%)	EXPANSION INDEX	EXPANSIVE POTENTIAL
1	Qa1 Area	11.2	89.9	34.3	14.1	141	Very High
2	Qa1 Area	8.3	94.9	32.3	13.1	131	Very High

MAXIMUM DENSITY TEST RESULTS

SAMPLE	DESCRIPTION	MAXIMUM DRY DENSITY (PCF)	OPTIMUM MOISTURE CONTENT (%)
1	Very dark brown clay	101.5	19.0
2	Dark gray sandy clay	106.0	15.0
3	Dark brown topsoil	123.0	9.0
4	Light brown to brown sandy silt	102.5	14.0
5	Pale brown silty sand	117.5	11.0
6	Reddish gray clayey sand	116.0	14.0



Project No.
4850512-02

WEESE PROPERTY
OCEANSIDE, CALIFORNIA

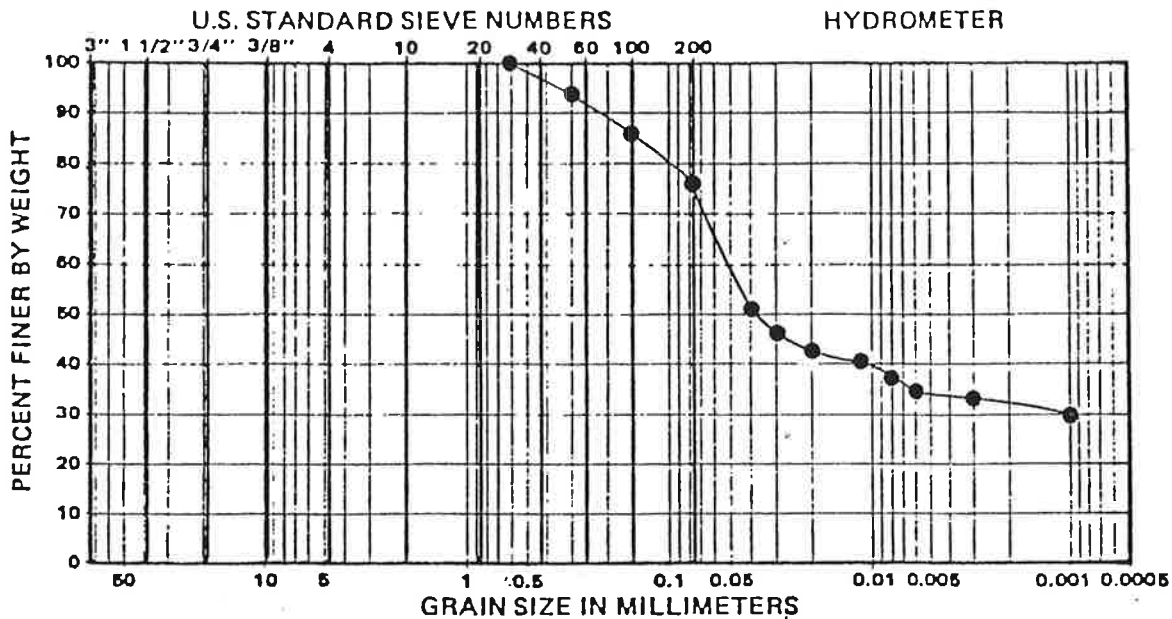
MAXIMUM DRY DENSITY TEST RESULTS

SAMPLE LOCATION	SOIL DESCRIPTION	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (PCF)
B-2 No. 1	Dark olive-brown clay with chunks of sandy clay	12.0	120.0

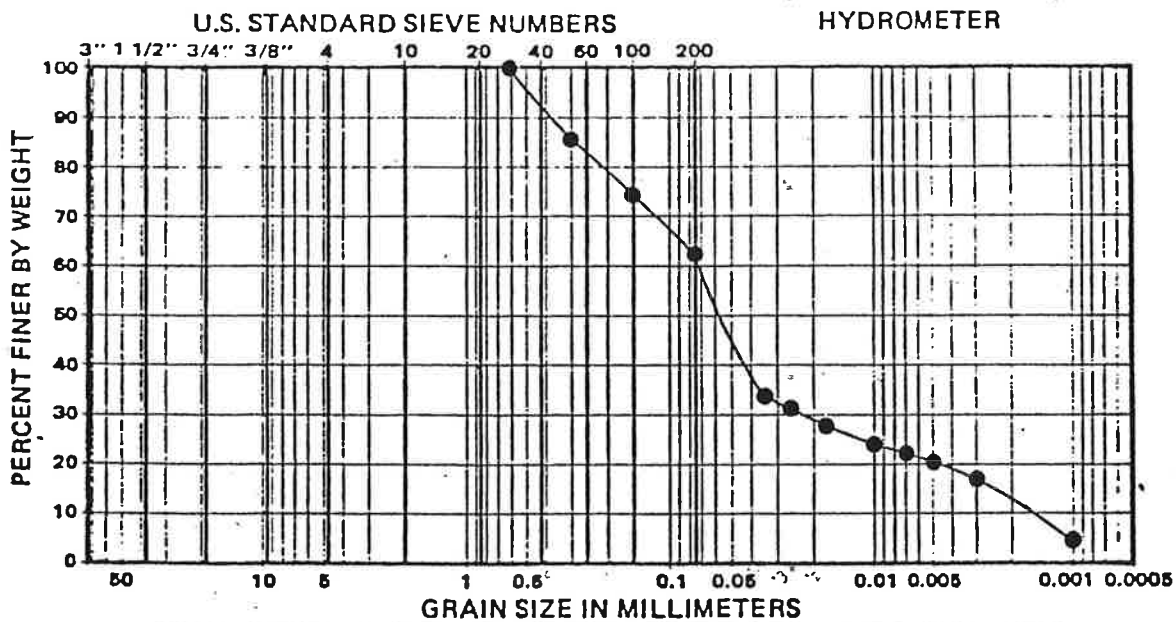
EXPANSION INDEX TEST RESULTS

TEST NO.	SAMPLE LOCATION	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (PCF)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (%)	EXPANSION INDEX	EXPANSION POTENTIAL
1	LB-1 No. 5	12.3	94.4	34.4	151	15.1	Very High
2	LB-2 No. 2	13.4	94.0	34.6	154	15.4	Very High

GRAVEL		SAND			FINES (Silt or Clay)
Coarse	Fine	Coarse	Medium	Fine	



SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH (FEET)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	SOIL TYPE
●	B-2	2	9				ML



SYMBOL	BORING NUMBER	SAMPLE NUMBER	DEPTH (FEET)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	SOIL TYPE
●	B-1	5	24				ML

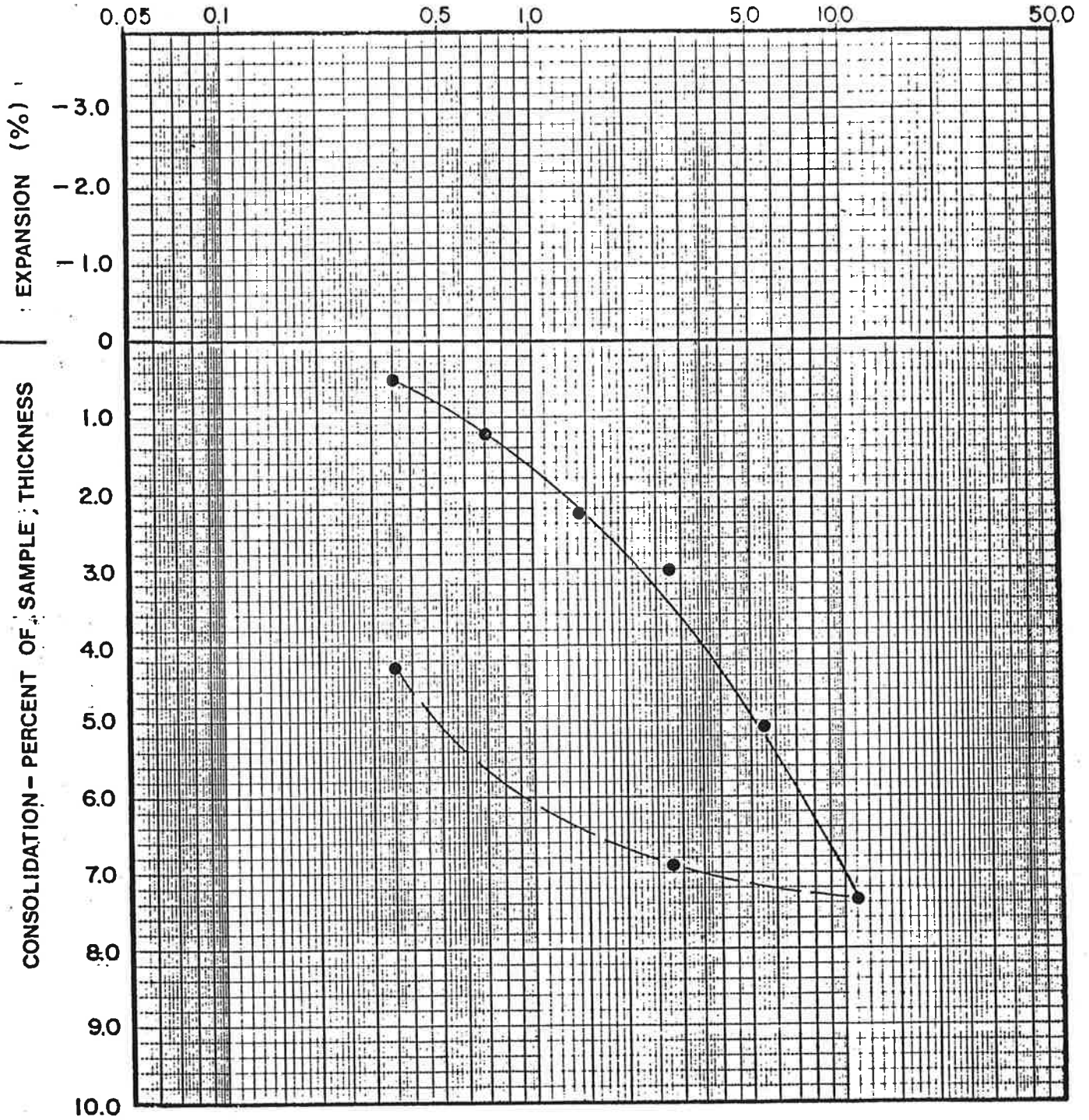


Project No. 4840512-01

WEESE PROPERTY

GRAIN SIZE DISTRIBUTION CURVES

STRESS IN KIPS PER SQUARE FOOT



O FIELD MOISTURE

● SATURATED

— LOADING

- - - REBOUND

BORING NO.: B-1

SAMPLE NO.: 3

DEPTH (FT): 14 - 15

SOIL TYPE : CL

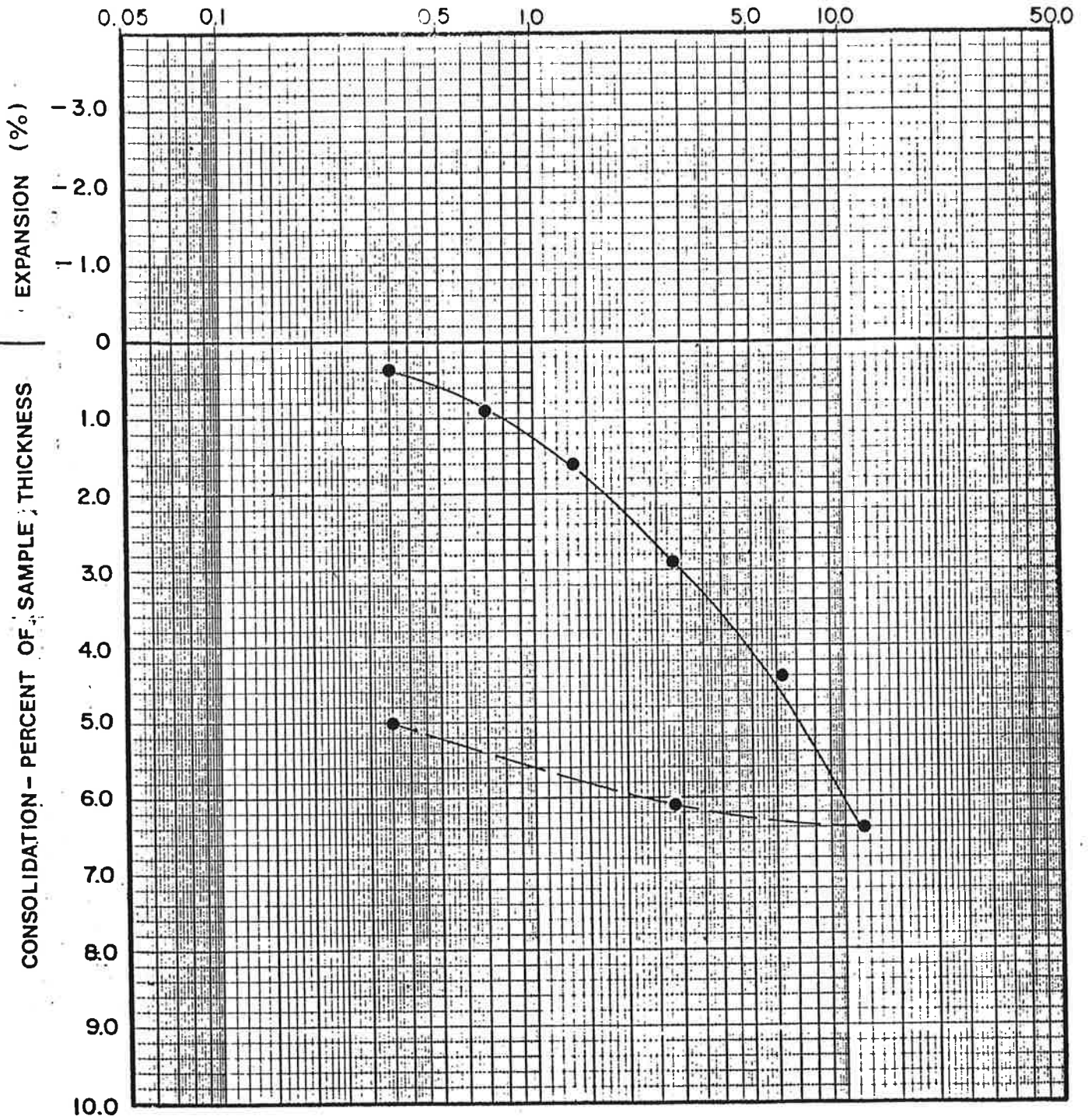


Project No. 4850512-01

WEESE/OCEANSIDE

CONSOLIDATION TEST RESULTS

STRESS IN KIPS PER SQUARE FOOT



O FIELD MOISTURE

BORING NO.: B-1

● SATURATED

SAMPLE NO.: 5

— LOADING

DEPTH (FT): 24 - 25

- - - REBOUND

SOIL TYPE : CL



Project No. 4850512-01

WEESE/OCEANSIDE

CONSOLIDATION TEST RESULTS

STRESS IN KIPS PER SQUARE FOOT

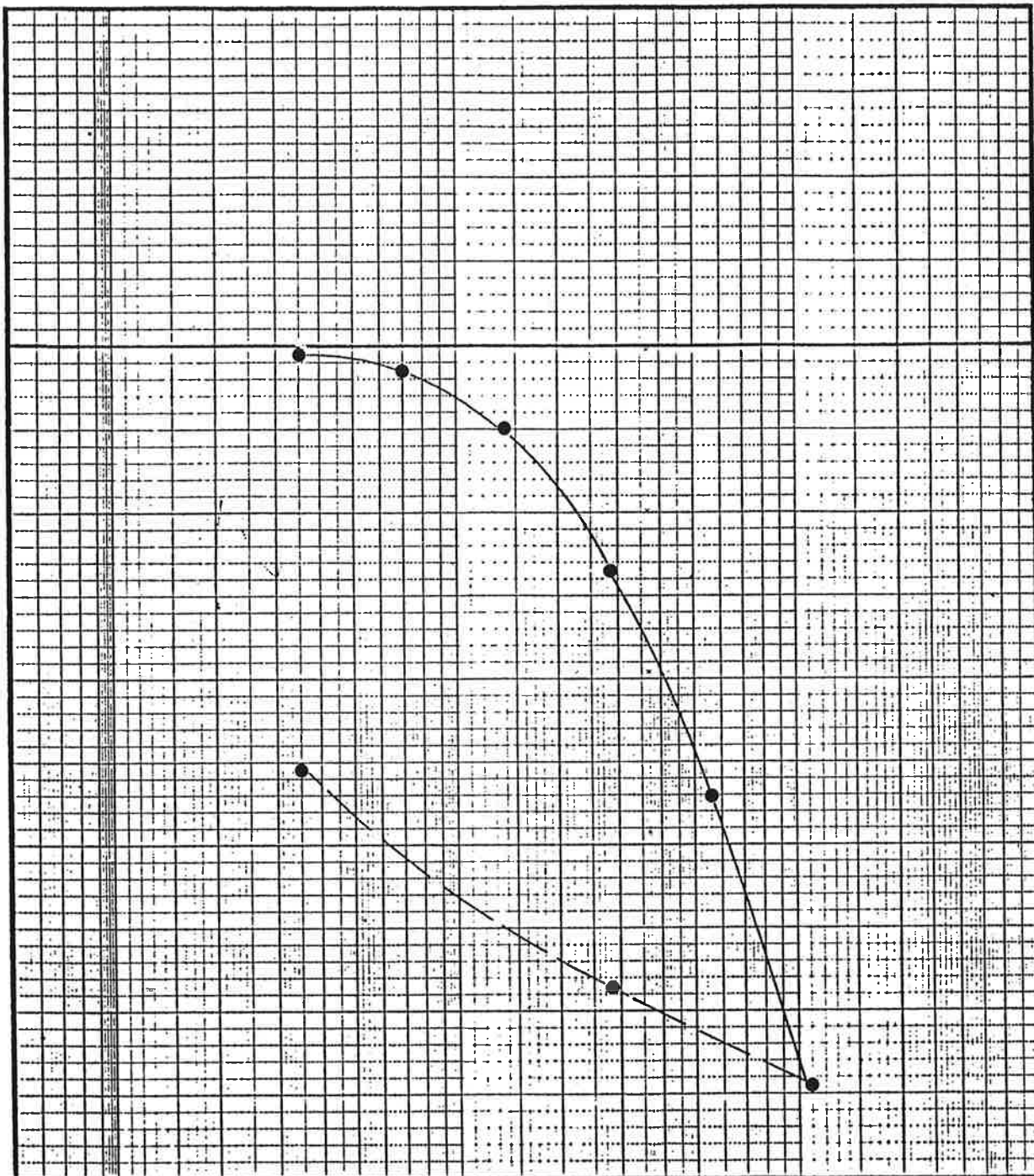
0.05 0.1 0.5 1.0 5.0 10.0 50.0

EXPANSION (%)

-3.0
-2.0
-1.0
0

CONSOLIDATION - PERCENT OF SAMPLE THICKNESS

1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0



○ FIELD MOISTURE

BORING NO.: B-2

● SATURATED

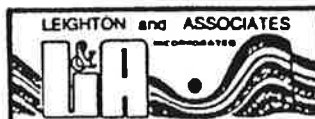
SAMPLE NO.: 2

— LOADING

DEPTH (FT) : 9 - 10

- - - REBOUND

SOIL TYPE : CL



Project No. 4850512-01

WEESE/OCEANSIDE

CONSOLIDATION TEST RESULTS

APPENDIX D

Slope Stability Analyses

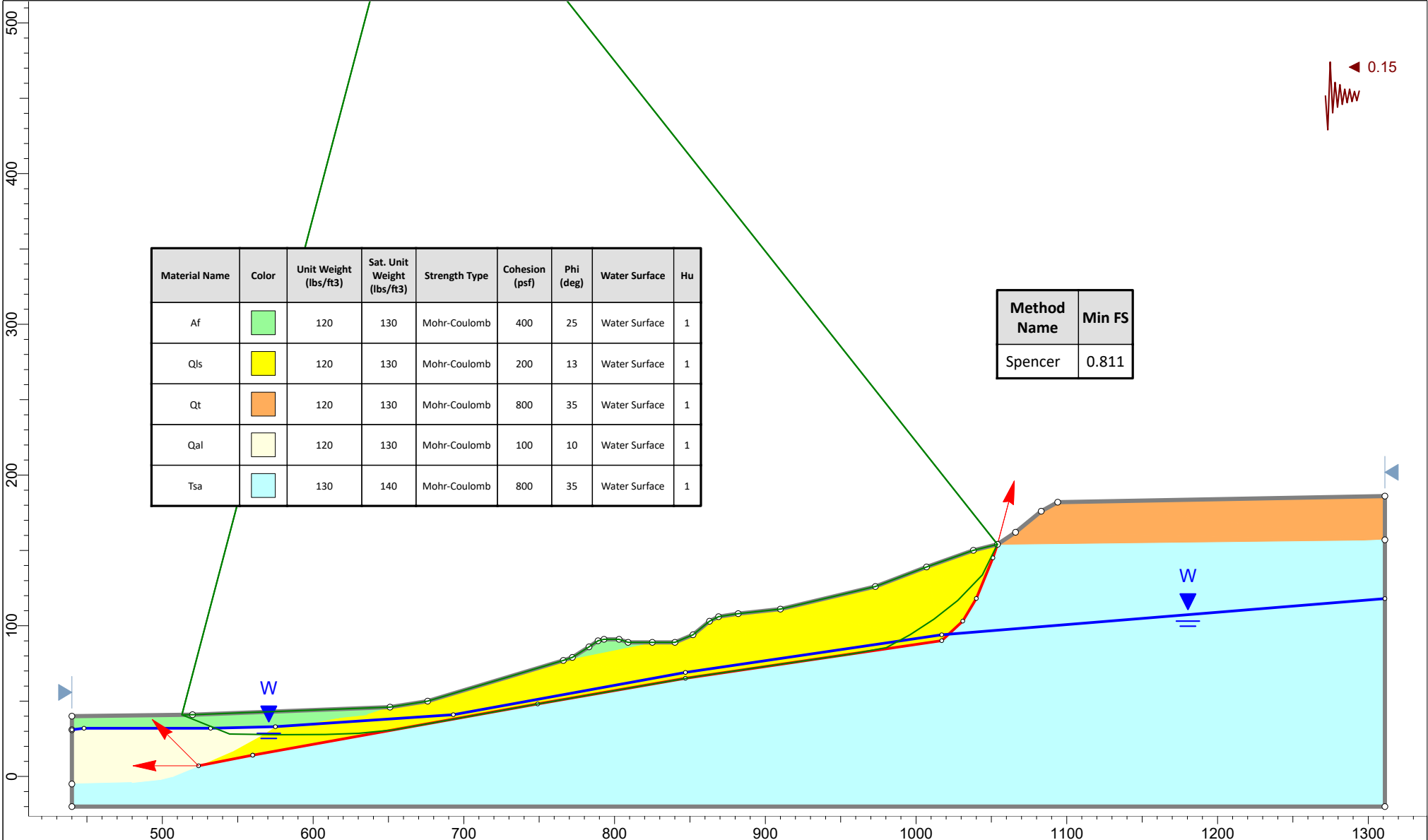
APPENDIX D

Slope Stability Analyses

Cross-section A-A'

Existing Slope

Cross Section A



Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu
Af	Green	120	130	Mohr-Coulomb	400	25	Water Surface	1
Qls	Yellow	120	130	Mohr-Coulomb	200	13	Water Surface	1
Qt	Orange	120	130	Mohr-Coulomb	800	35	Water Surface	1
Qal	Light Yellow	120	130	Mohr-Coulomb	100	10	Water Surface	1
Tsa	Light Blue	130	140	Mohr-Coulomb	800	35	Water Surface	1

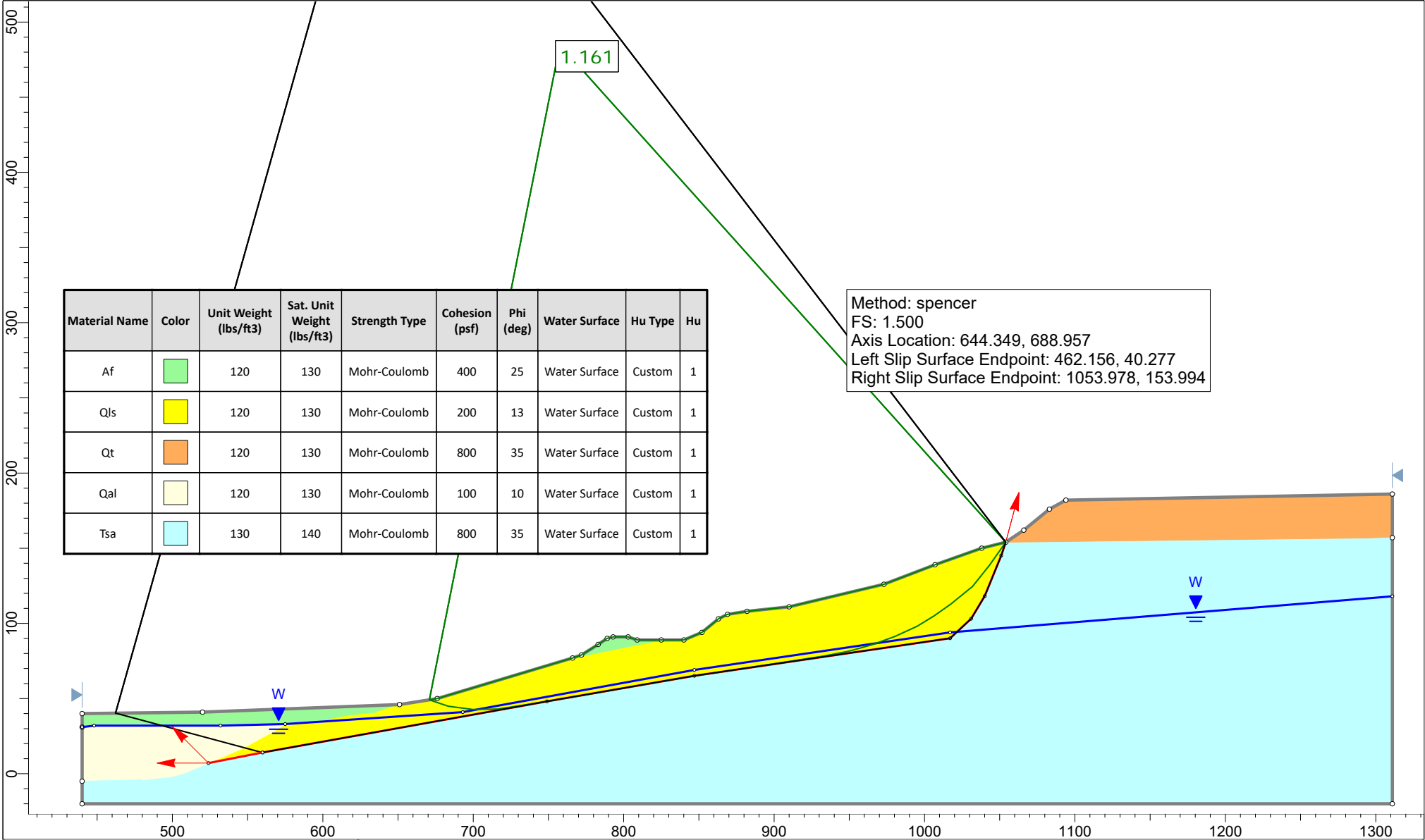
Method Name	Min FS
Spencer	0.811



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Existing Site - Check Failure Through Qal	
Drawn By	EDB	Unit	Feet
Date	9/19/2019	Scale	1:1080
Company		Leighton	
File Name		Section A - Existing 9-18-19.slm	

Cross Section A

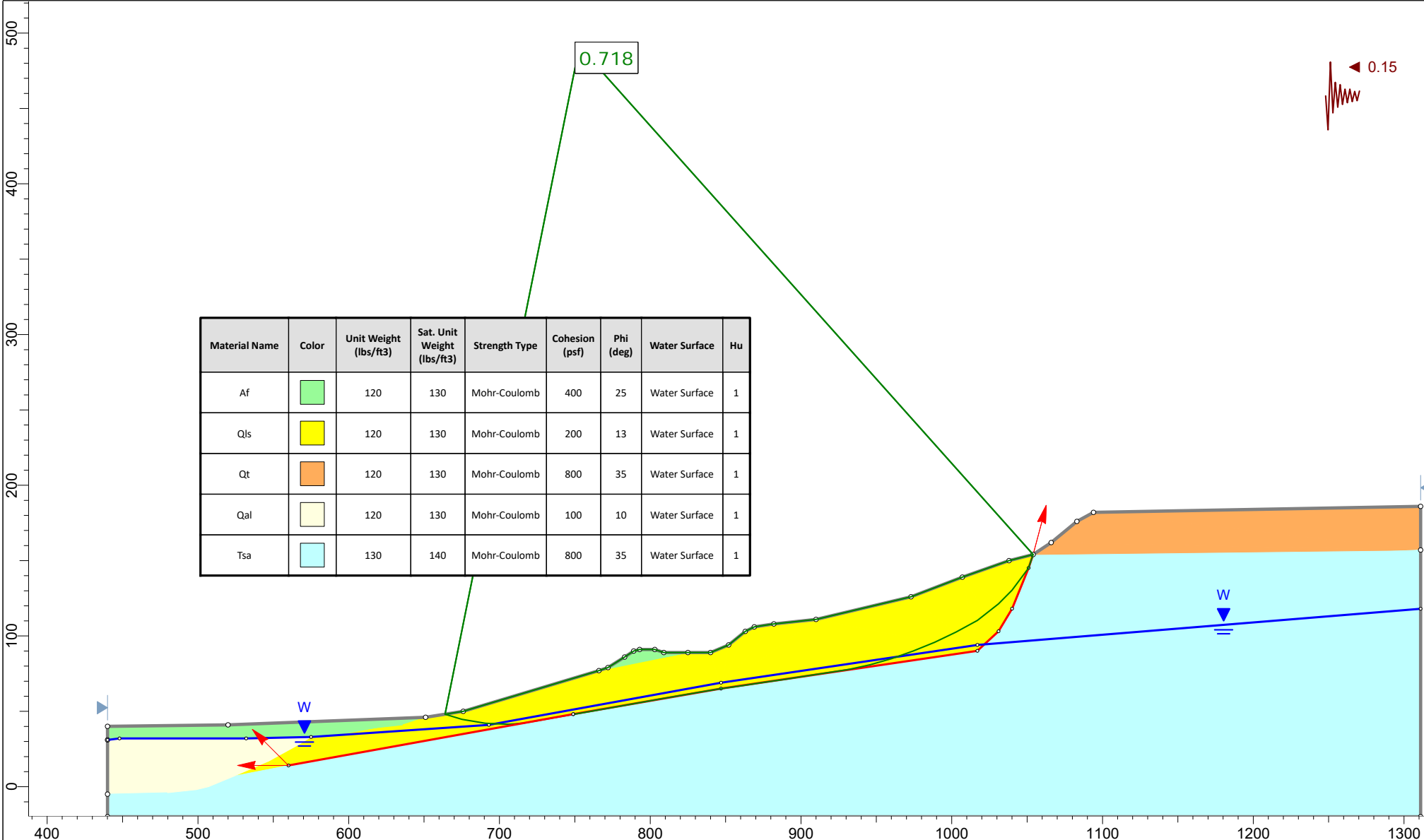


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af	Green	120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls	Yellow	120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt	Orange	120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal	Light Yellow	120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa	Light Blue	130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



Project		12085.002 Ocean Creek	
Analysis Description		Existing Site - Check Failure Through Qal	
Drawn By	EDB	Unit	Feet
Scale	1:1080	Company	Leighton
Date	9/18/2019	File Name	Section A - Existing 9-18-19.slm

Cross Section A



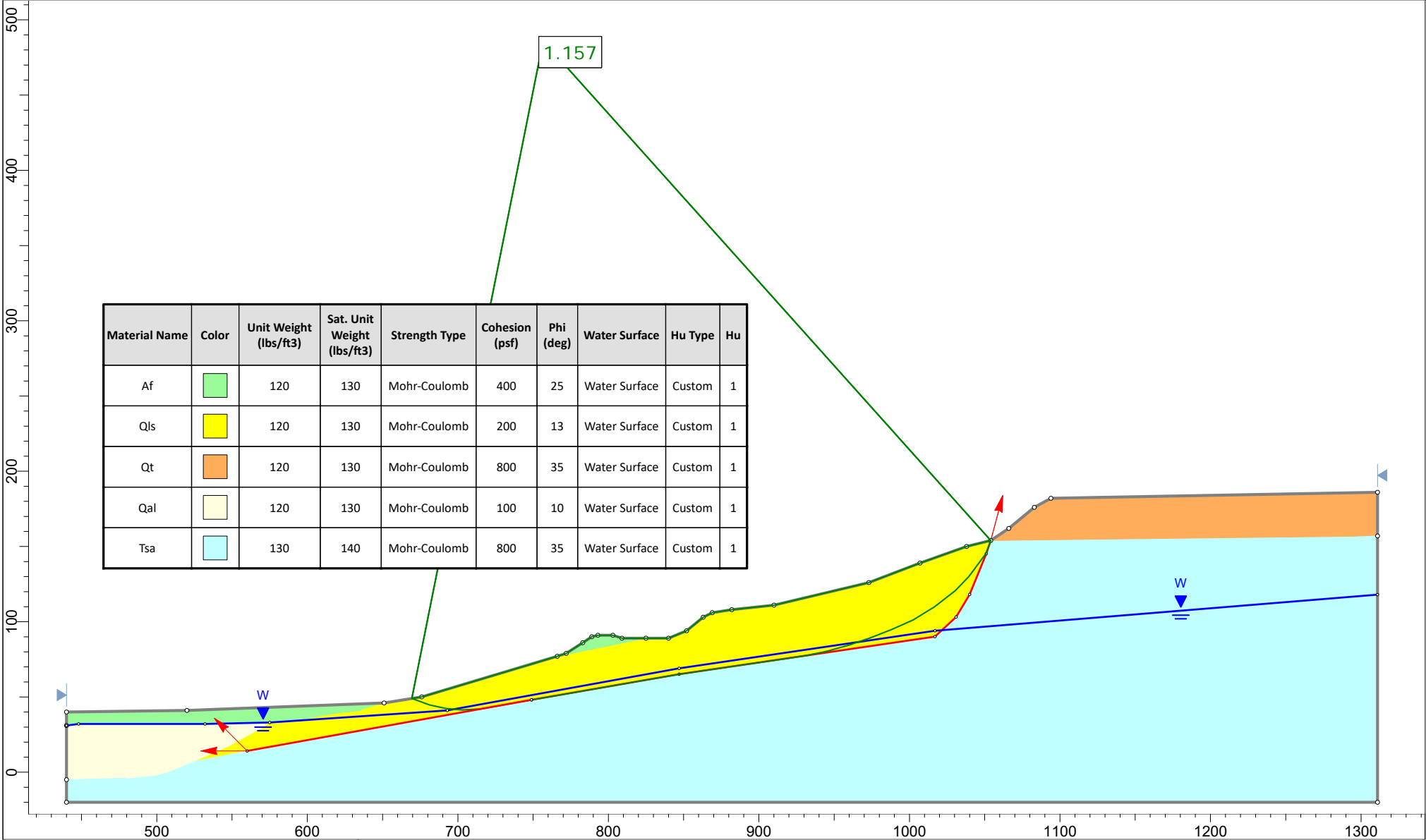
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu
Af	■	120	130	Mohr-Coulomb	400	25	Water Surface	1
Qls	■	120	130	Mohr-Coulomb	200	13	Water Surface	1
Qt	■	120	130	Mohr-Coulomb	800	35	Water Surface	1
Qal	■	120	130	Mohr-Coulomb	100	10	Water Surface	1
Tsa	■	130	140	Mohr-Coulomb	800	35	Water Surface	1



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Existing Site - Check Failure Through Qls Lower Slope	
Drawn By	EDB	Unit	Feet
		Scale	1:1080
Date		9/19/2019	
Company		Leighton	
File Name		Section A - Existing 9-18-19.slm	

Cross Section A



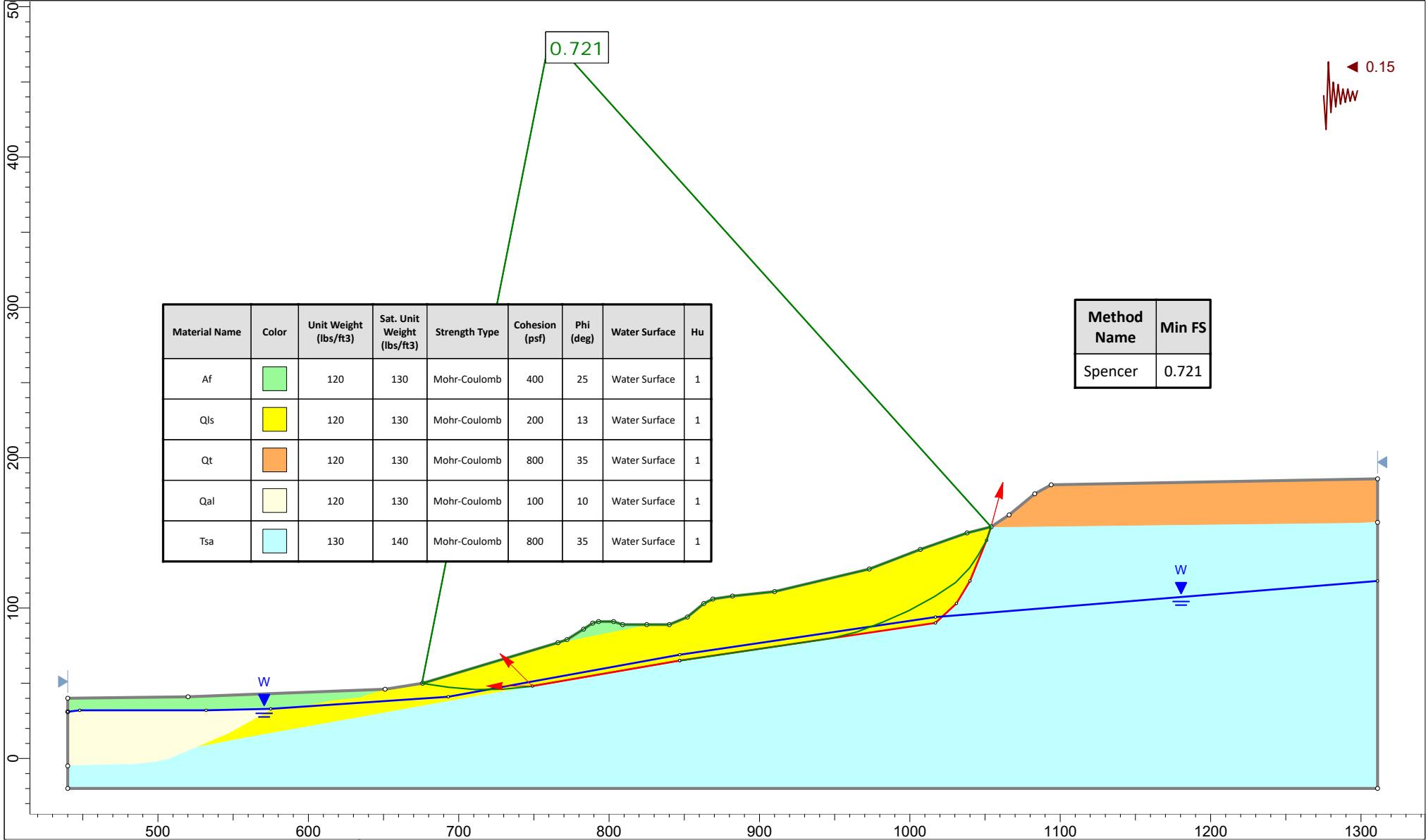
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.022

<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Existing Site - Check Failure Through Qls Lower Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:1080	<i>Company</i>	Leighton
<i>Date</i>	9/18/2019	<i>File Name</i>	Section A - Existing 9-18-19.slm

Cross Section A



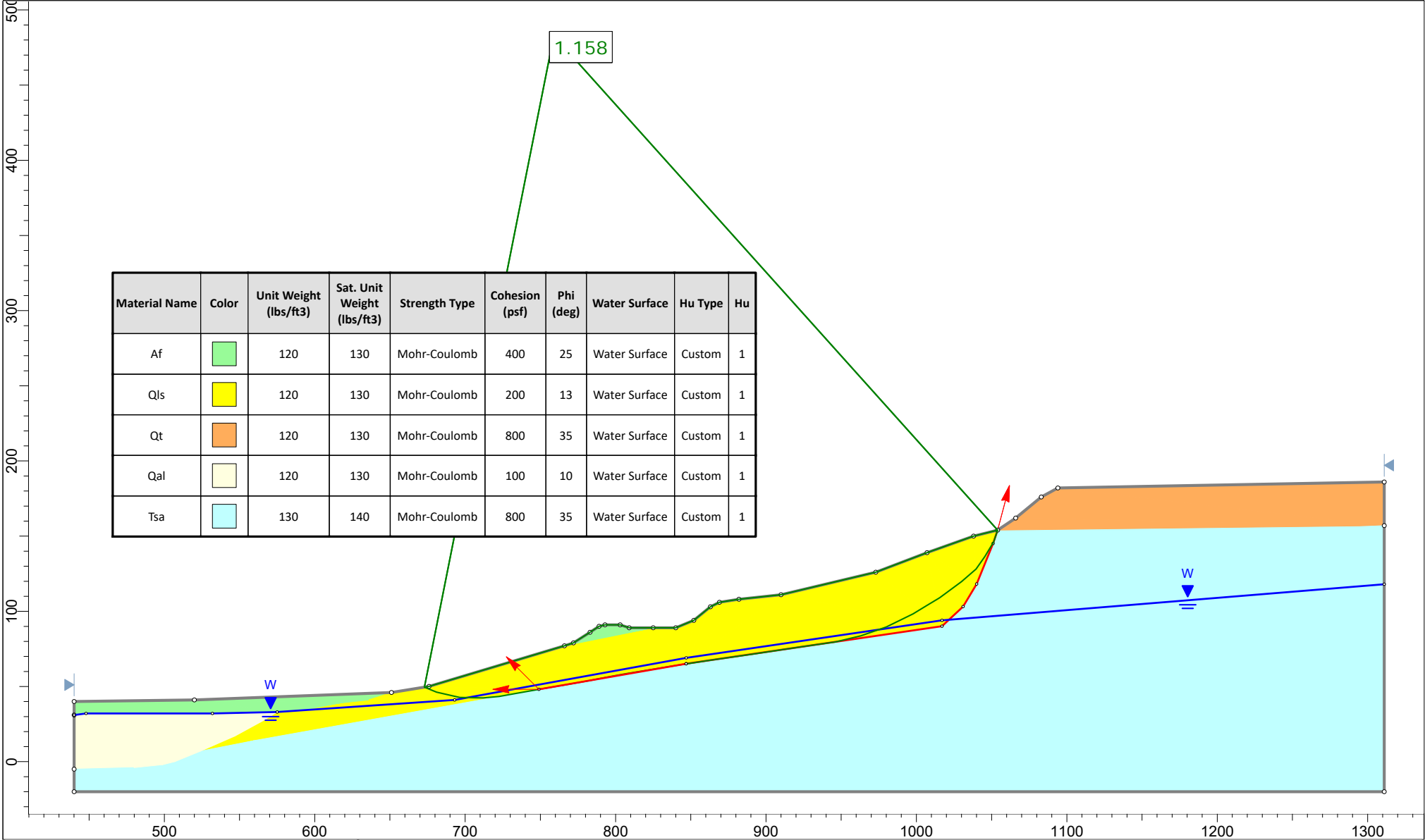
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu
Af	■	120	130	Mohr-Coulomb	400	25	Water Surface	1
Qls	■	120	130	Mohr-Coulomb	200	13	Water Surface	1
Qt	■	120	130	Mohr-Coulomb	800	35	Water Surface	1
Qal	■	120	130	Mohr-Coulomb	100	10	Water Surface	1
Tsa	■	130	140	Mohr-Coulomb	800	35	Water Surface	1

Method Name	Min FS
Spencer	0.721



<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Existing Site - Check Failure Through Qls Mid Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:1080	<i>Company</i>	Leighton
<i>Date</i>	9/18/2019	<i>File Name</i>	Section A - Existing 9-18-19.slm

Cross Section A



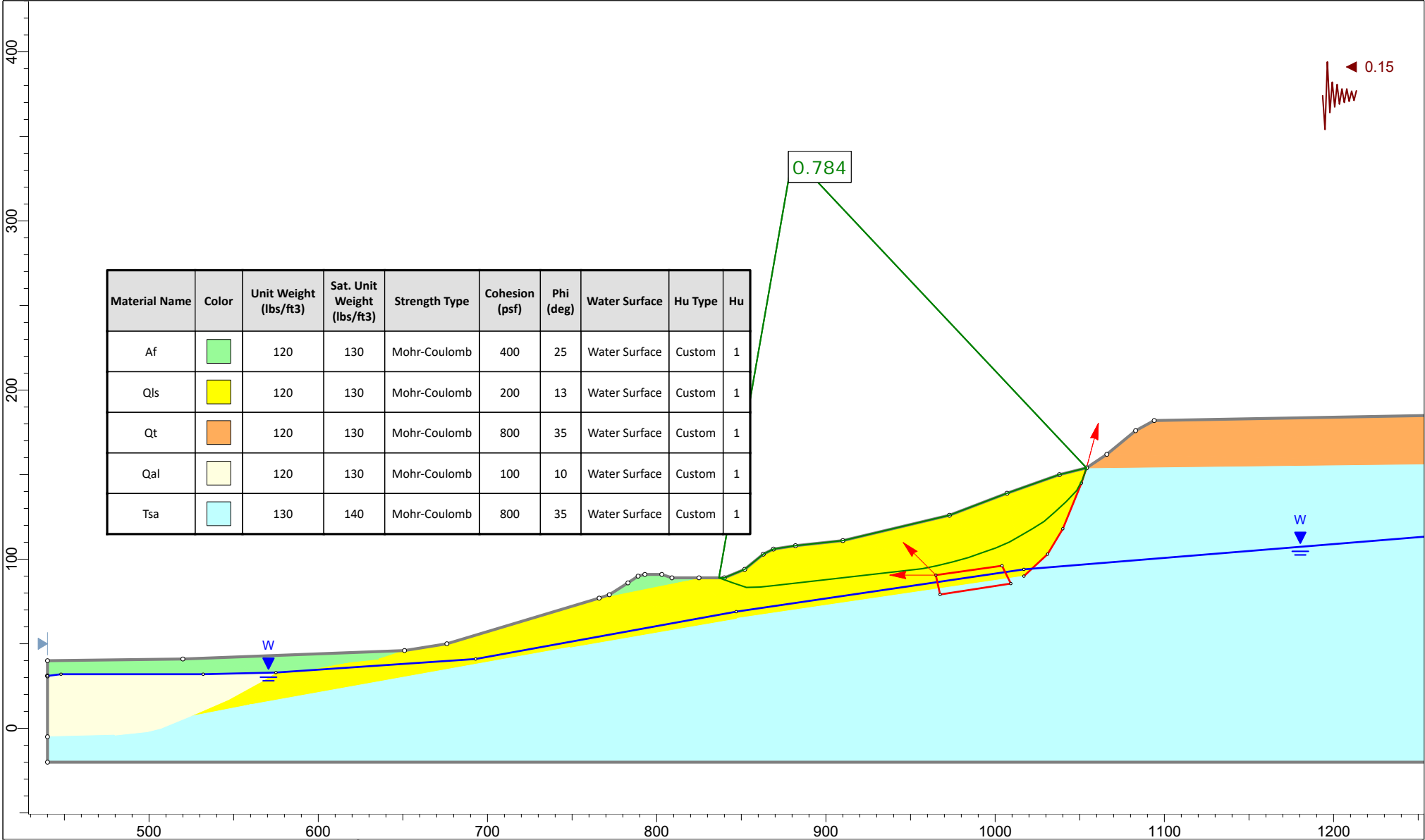
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1




SLIDEINTERPRET 8.022

Project		12085.002 Ocean Creek	
Analysis Description		Existing Site - Check Failure Through Qls Mid Slope	
Drawn By	EDB	Unit	Feet
		Scale	1:1080
Date		9/18/2019	
Company		Leighton	
File Name		Section A - Existing 9-18-19.slm	

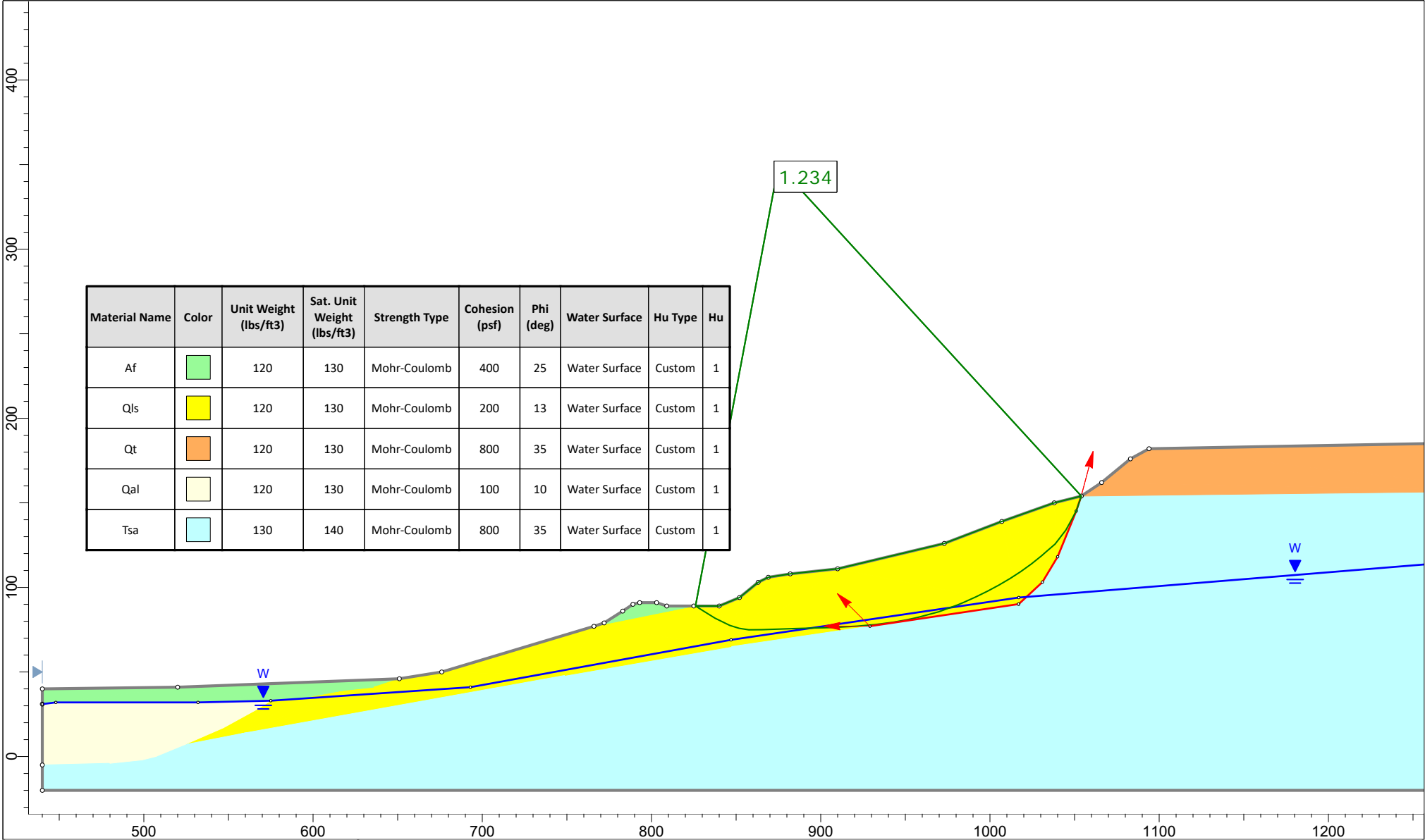
Cross Section A



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

	<i>Project</i>						
	12085.002 Ocean Creek						
	<i>Analysis Description</i>						
	Existing Site - Check Failure Through Qls Upper Slope						
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet	<i>Scale</i>	1:960	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019				<i>File Name</i>	Section A - Existing 9-18-19.slm	

Cross Section A



Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Existing Site - Check Failure Through Qls Upper Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:960	<i>Company</i>	Leighton
<i>Date</i>	9/18/2019	<i>File Name</i>	Section A - Existing 9-18-19.slm

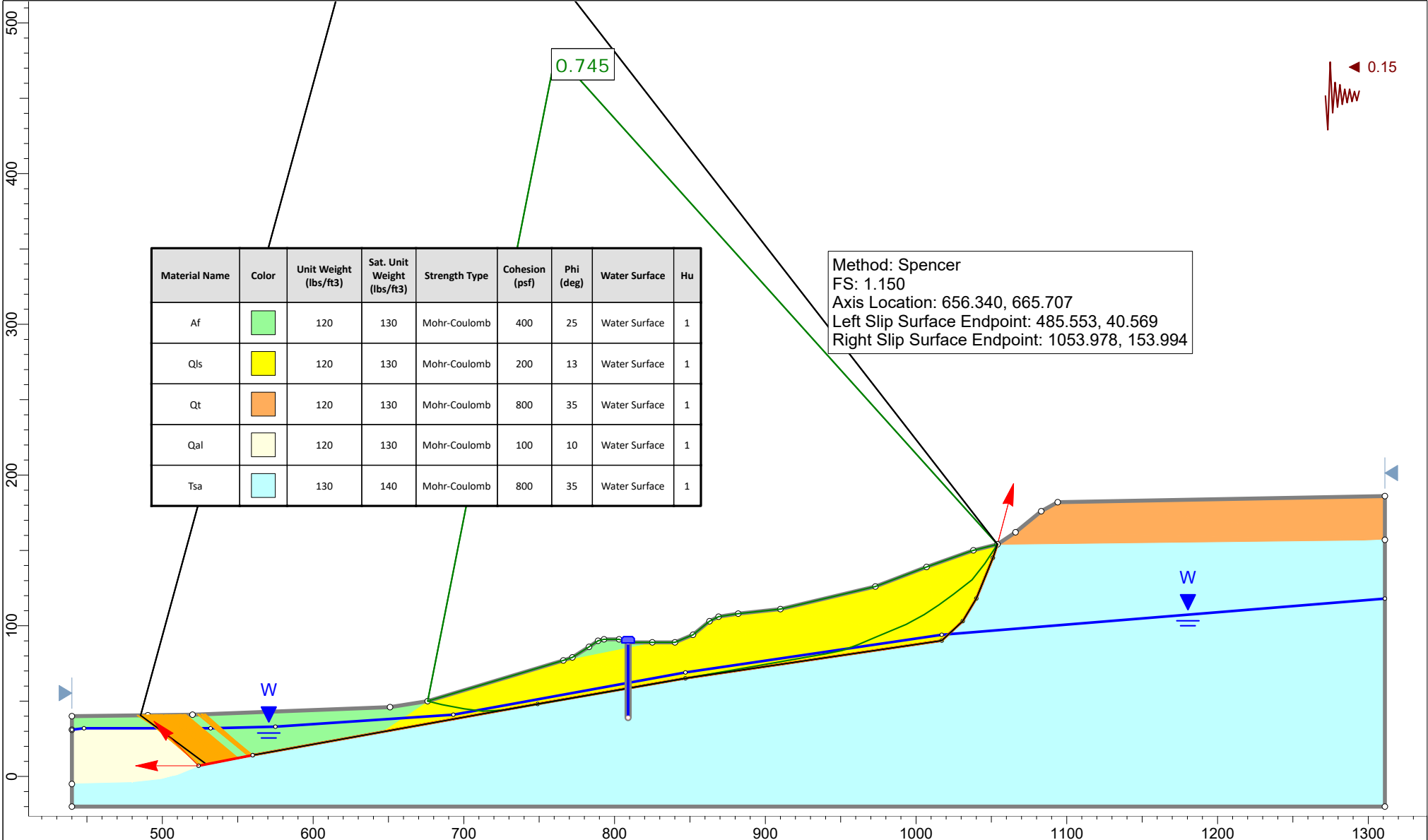
APPENDIX D

Slope Stability Analyses

Cross-section A-A'

Shear Pins

Cross Section A



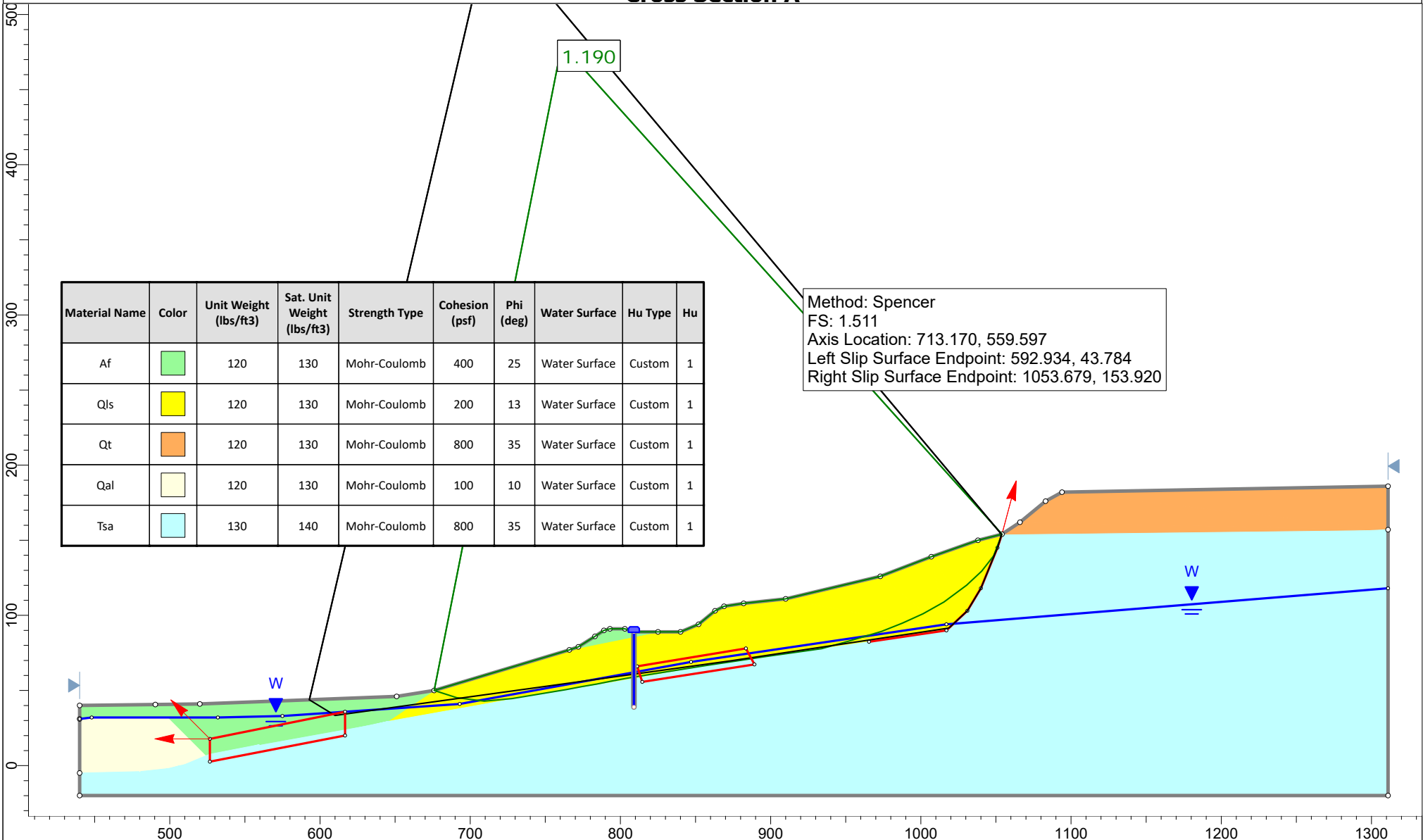
Material Name	Color	Unit Weight (lbs/R3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu
Af	Green	120	130	Mohr-Coulomb	400	25	Water Surface	1
Qls	Yellow	120	130	Mohr-Coulomb	200	13	Water Surface	1
Qt	Orange	120	130	Mohr-Coulomb	800	35	Water Surface	1
Qal	Light Yellow	120	130	Mohr-Coulomb	100	10	Water Surface	1
Tsa	Light Blue	130	140	Mohr-Coulomb	800	35	Water Surface	1

Method: Spencer
 FS: 1.150
 Axis Location: 656.340, 665.707
 Left Slip Surface Endpoint: 485.553, 40.569
 Right Slip Surface Endpoint: 1053.978, 153.994



Project		12085.002 Ocean Creek	
Analysis Description		95 K/ft Shear Pin & Pad Removal - Check Failure Through Qal	
Drawn By	EDB	Unit	Feet
Scale	1:1080	Company	Leighton
Date	9/19/2019	File Name	Section A - Shear Pins 9-18-19.slmd

Cross Section A



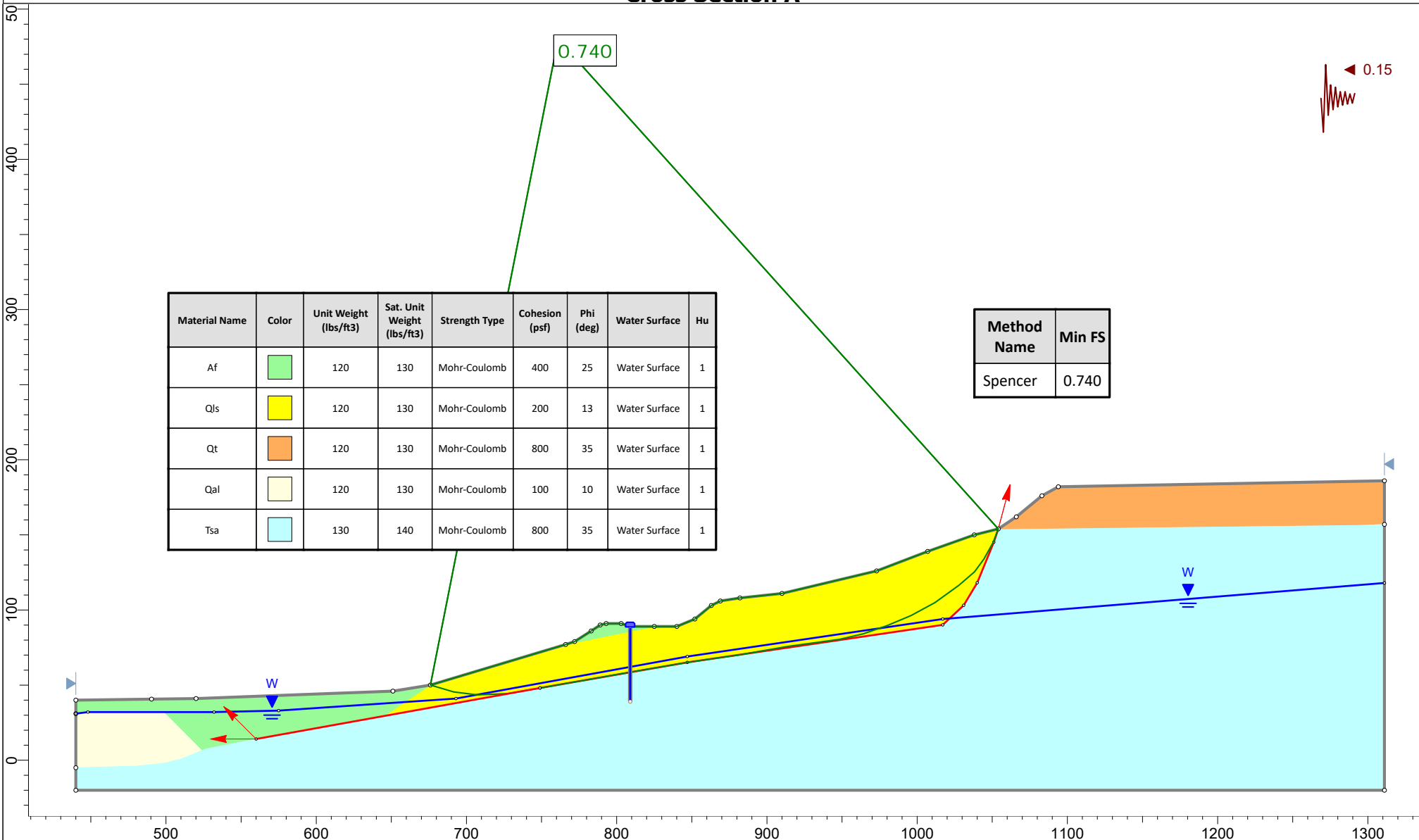
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

Method: Spencer
 FS: 1.511
 Axis Location: 713.170, 559.597
 Left Slip Surface Endpoint: 592.934, 43.784
 Right Slip Surface Endpoint: 1053.679, 153.920



Project		12085.002 Ocean Creek			
Analysis Description		95 K/ft Shear Pin & Pad Removal - Check Failure Through Qal			
Drawn By	EDB	Unit	Feet	Scale	1:1080
Date		9/19/2019		Company	Leighton
				File Name	Section A - Shear Pins 9-18-19.slmd

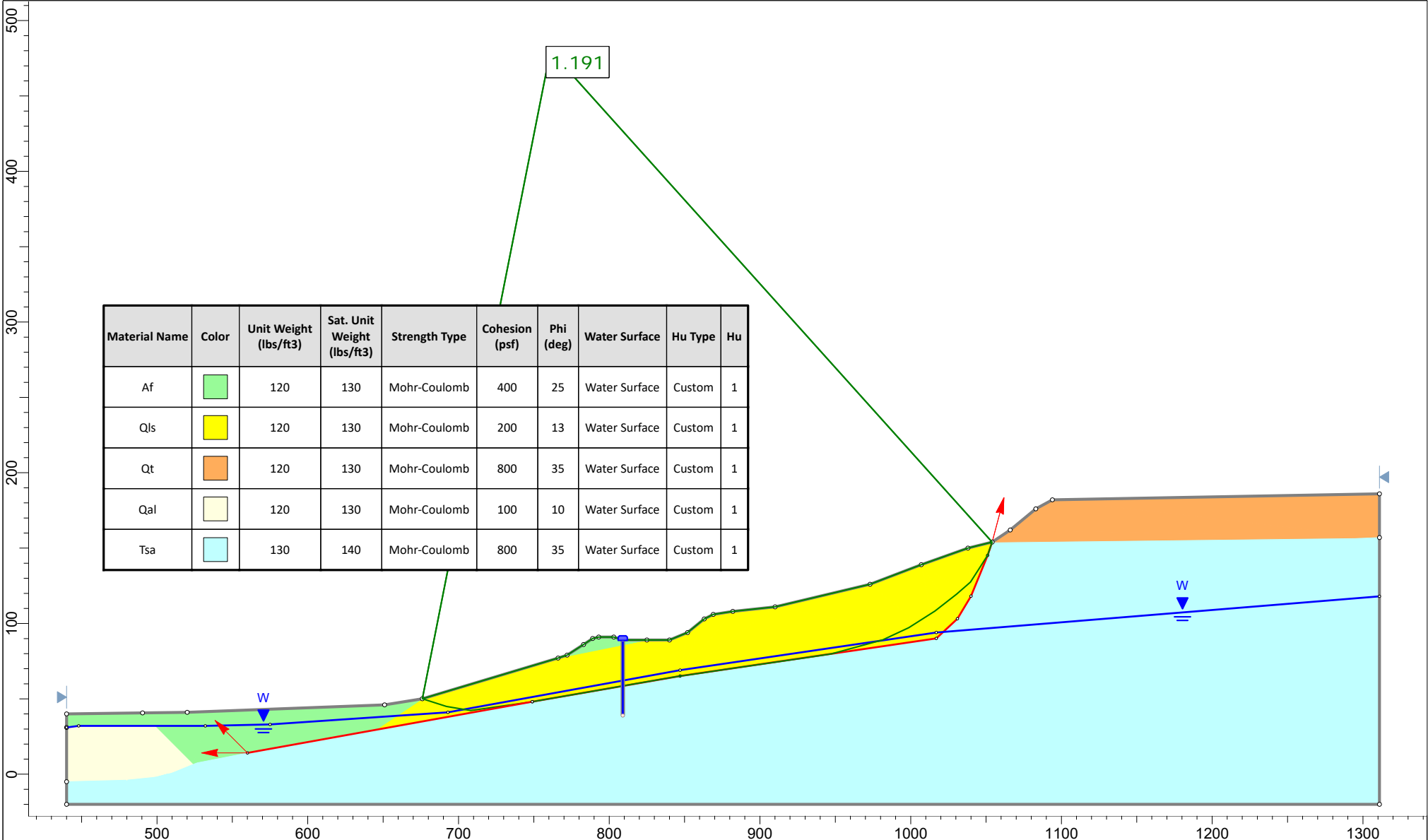
Cross Section A




SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		95 K/ft Shear Pin & Pad Removal - Check Failure Through Fill	
Drawn By	EDB	Unit	Feet
		Scale	1:1080
		Company	Leighton
Date	9/19/2019	File Name	Section A - Shear Pins 9-18-19.slmd

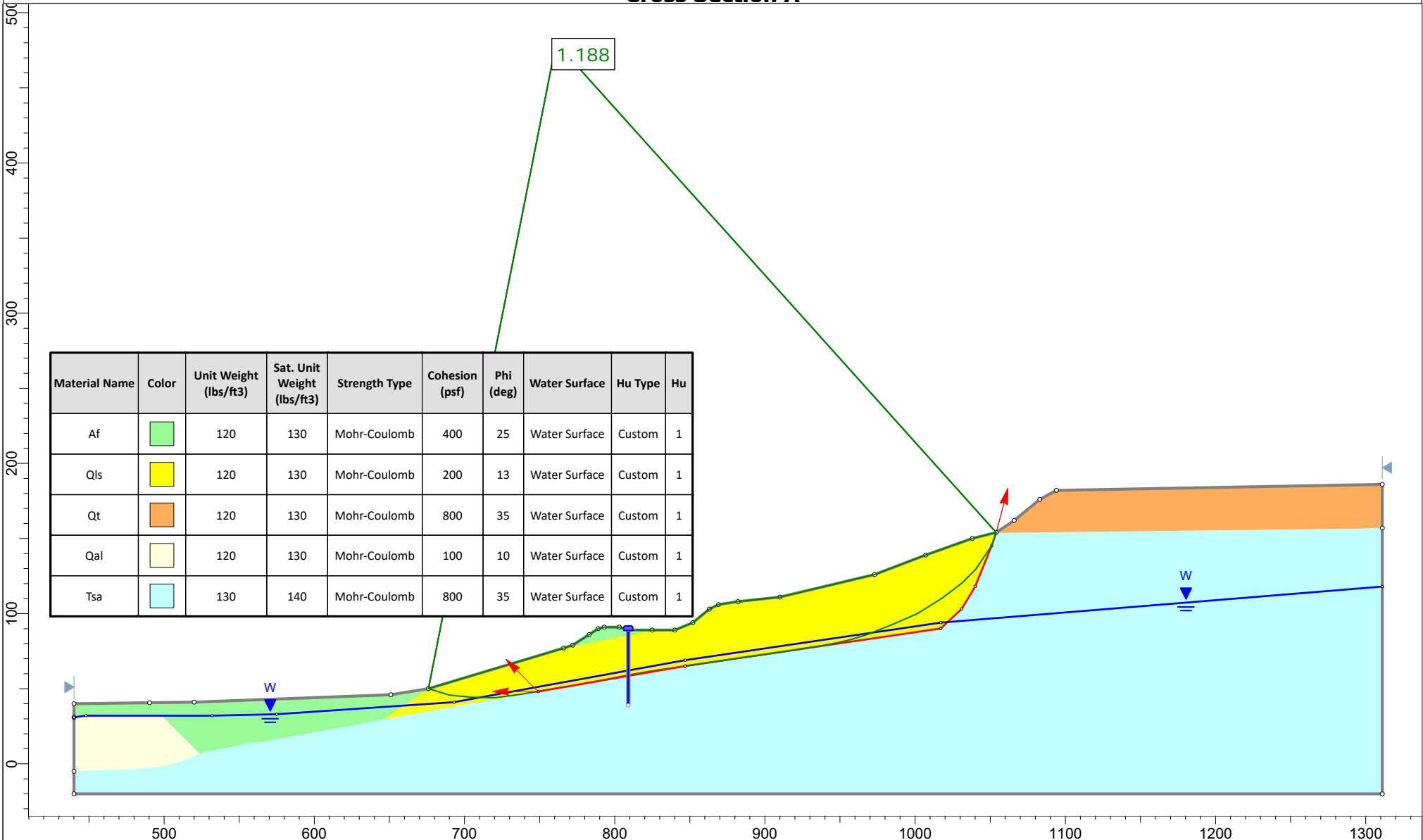
Cross Section A



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

	Project				12085.002 Ocean Creek			
	Analysis Description				95 K/ft Shear Pin & Pad Removal - Check Failure Through Fill			
	Drawn By	EDB	Unit	Feet	Scale	1:1080	Company	Leighton
	Date	9/19/2019				File Name	Section A - Shear Pins 9-18-19.slmd	

Cross Section A



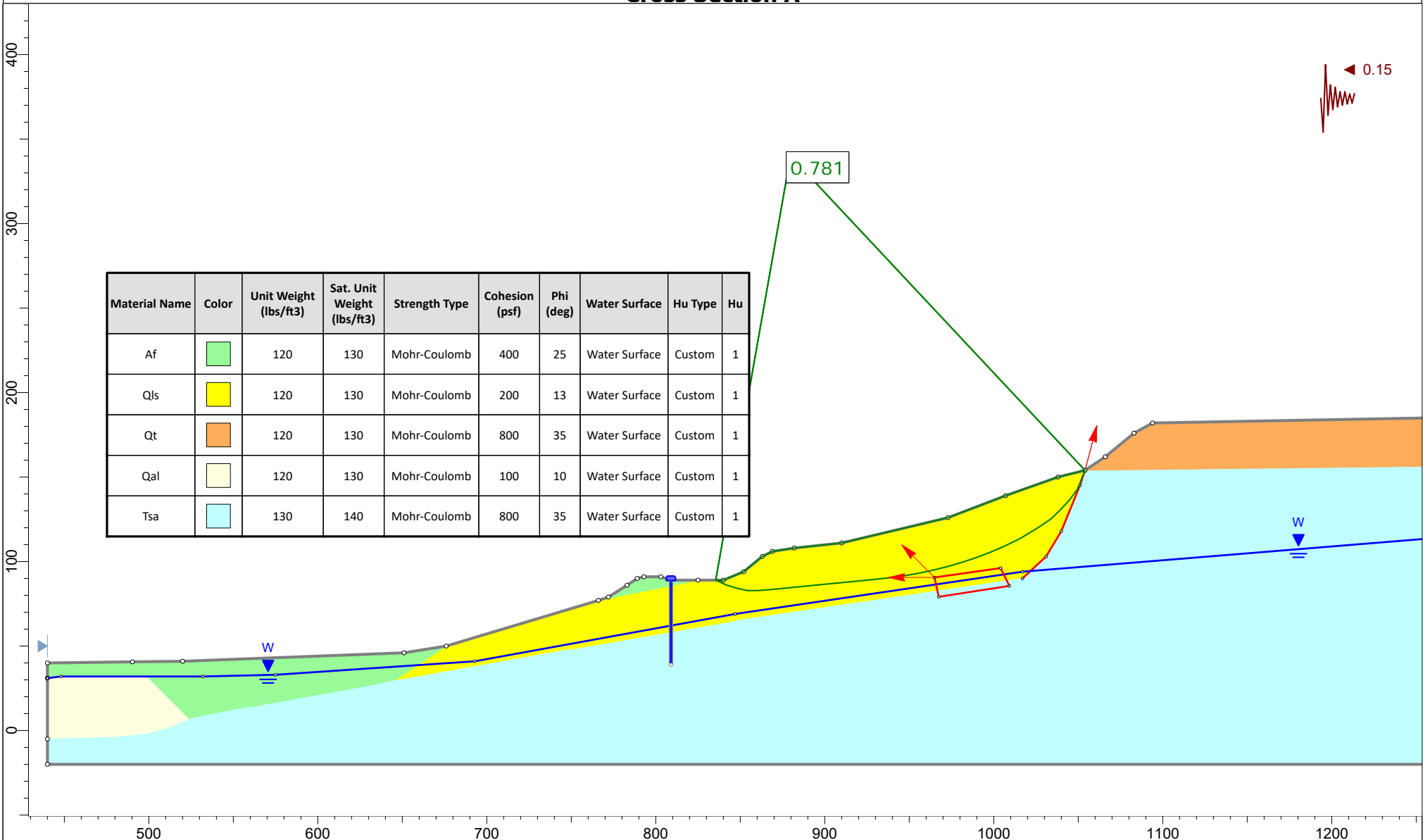
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek			
Analysis Description		95 K/ft Shear Pin & Pad Removal - Check Failure Through Qls Mid Slope			
Drawn By	EDB	Unit	Feet	Scale	1:1080
Date	9/19/2019	Company	Leighton		
File Name		Section A - Shear Pins 9-18-19.slmd			

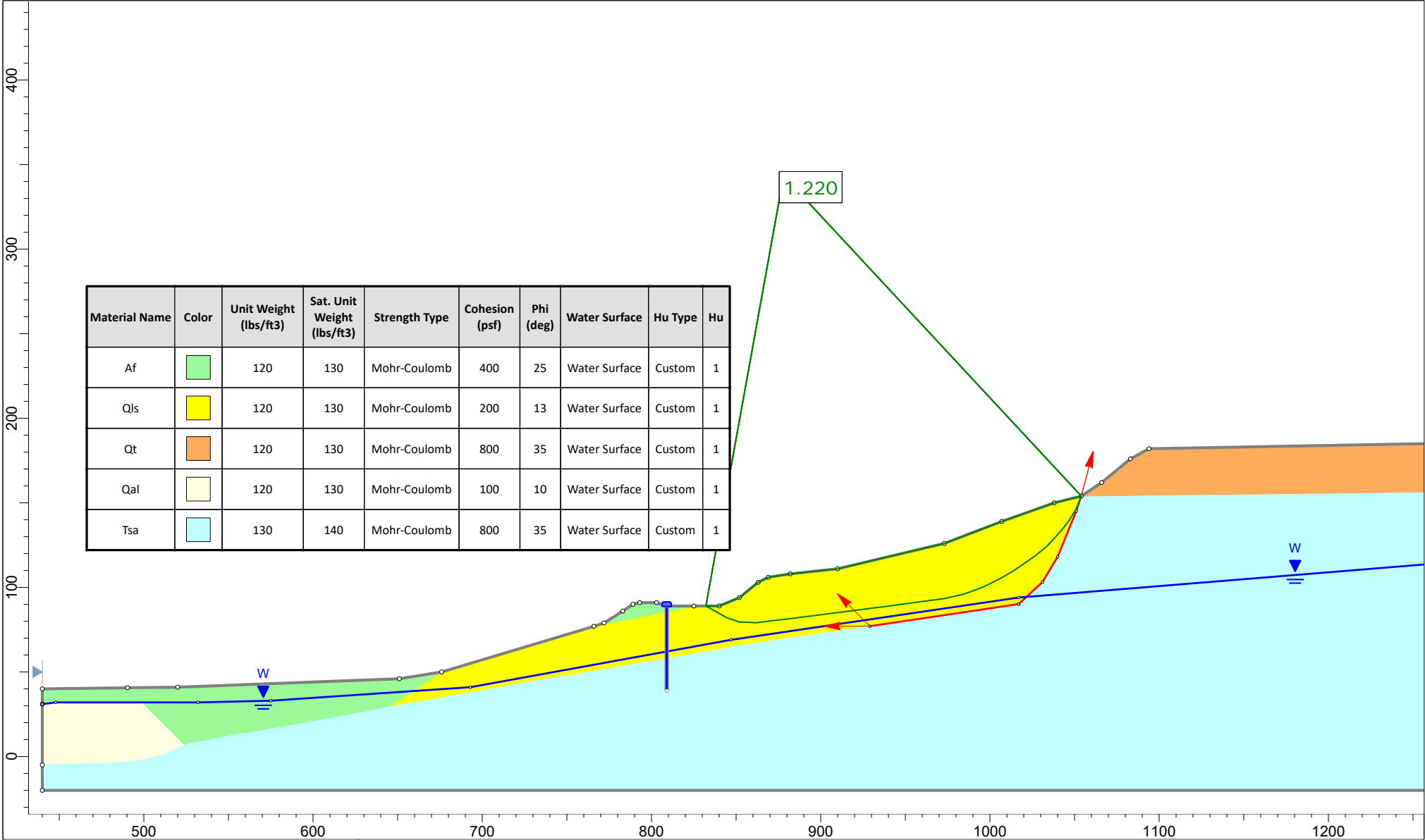
Cross Section A



SLIDEINTERPRET 8.023

<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		95 K/ft Shear Pin & Pad Removal - Check Failure Through Qls Upper Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:960	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019		<i>File Name</i>
		Section A - Shear Pins 9-18-19.slmd	

Cross Section A



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		95 K/ft Shear Pin & Pad Removal - Check Failure Through Qls Upper Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:960	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019	<i>File Name</i>	Section A - Shear Pins 9-18-19.slmd

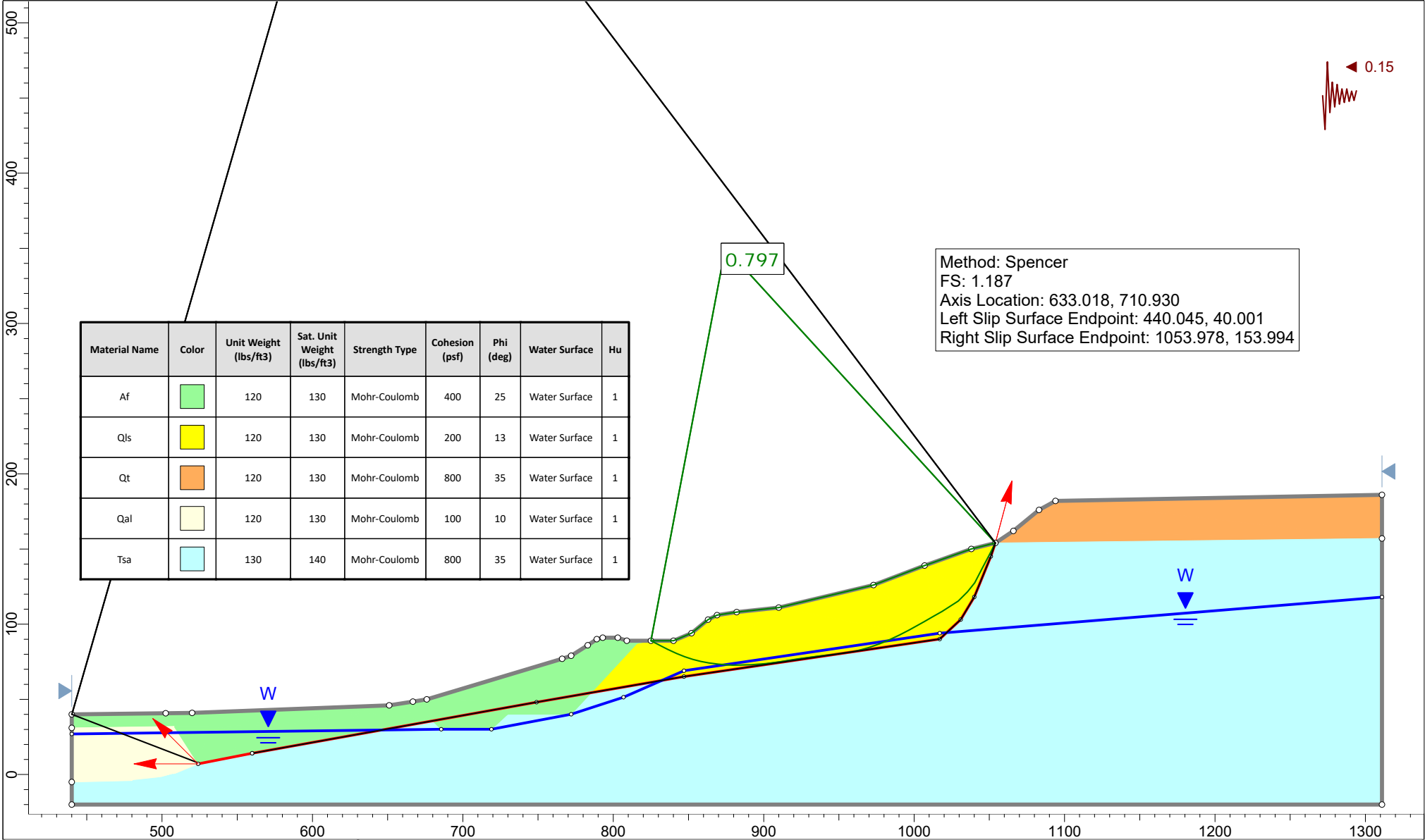
APPENDIX D

Slope Stability Analyses

Cross-section A-A'

Buttress Key

Cross Section A



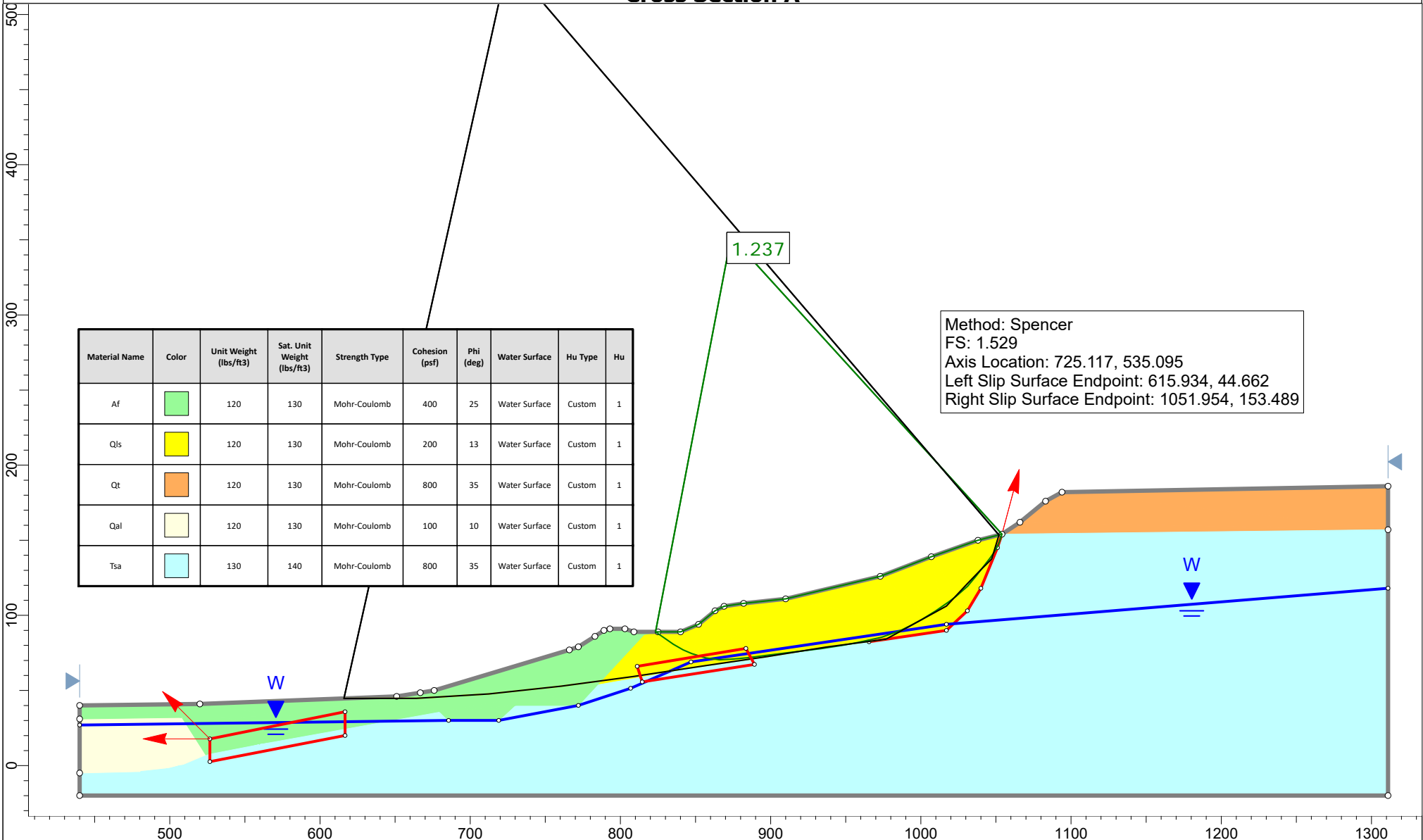
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu
Af	Green	120	130	Mohr-Coulomb	400	25	Water Surface	1
Qls	Yellow	120	130	Mohr-Coulomb	200	13	Water Surface	1
Qt	Orange	120	130	Mohr-Coulomb	800	35	Water Surface	1
Qal	Light Yellow	120	130	Mohr-Coulomb	100	10	Water Surface	1
Tsa	Light Blue	130	140	Mohr-Coulomb	800	35	Water Surface	1

Method: Spencer
 FS: 1.187
 Axis Location: 633.018, 710.930
 Left Slip Surface Endpoint: 440.045, 40.001
 Right Slip Surface Endpoint: 1053.978, 153.994



Project		12085.002 Ocean Creek	
Analysis Description		Buttress Key - Check Failure Through Qal	
Drawn By	EDB	Unit	Feet
		Scale	1:1080
		Company	Leighton
Date	9/19/2019	File Name	Section A - Buttress Key.slmd

Cross Section A



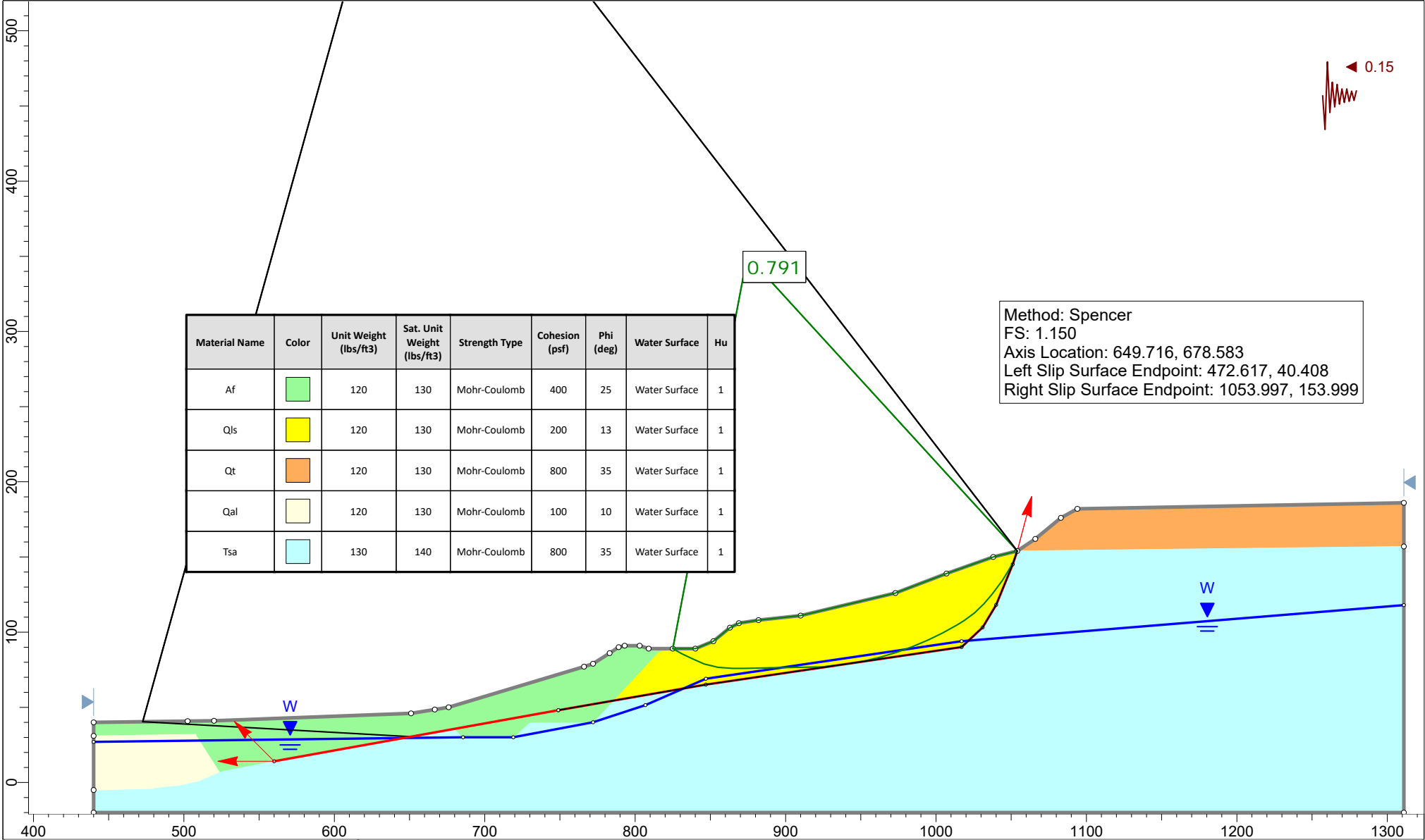
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af	Green	120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls	Yellow	120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt	Orange	120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal	Light Yellow	120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa	Light Blue	130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

Method: Spencer
 FS: 1.529
 Axis Location: 725.117, 535.095
 Left Slip Surface Endpoint: 615.934, 44.662
 Right Slip Surface Endpoint: 1051.954, 153.489



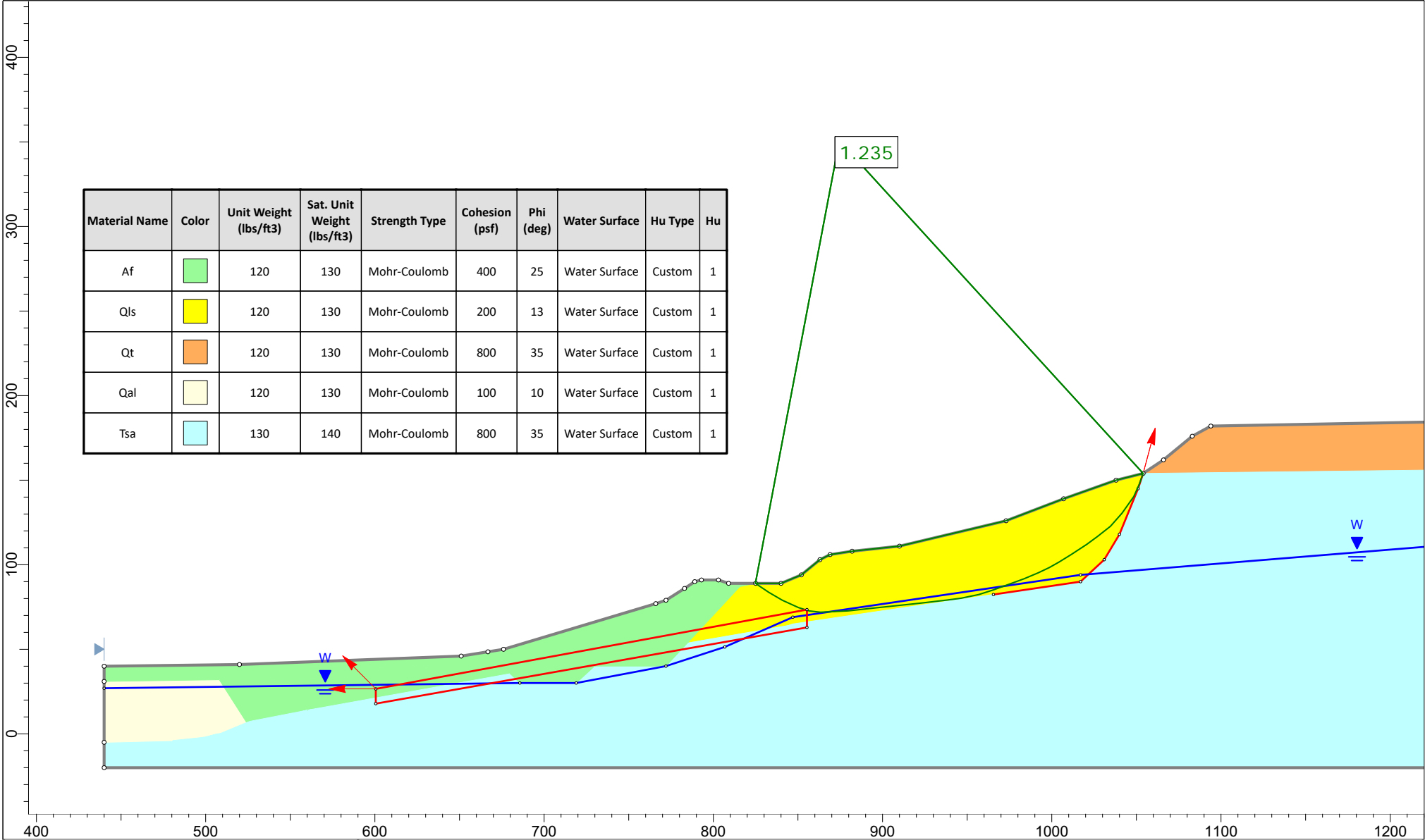
Project		12085.002 Ocean Creek			
Analysis Description		Buttress Key - Check Failure Through Qal			
Drawn By	EDB	Unit	Feet	Scale	1:1080
Date	9/19/2019			Company	Leighton
				File Name	Section A - Buttress Key.slmd

Cross Section A



Project				12085.002 Ocean Creek			
Analysis Description				Buttress Key - Check Failure Through Qls Lower Slope			
Drawn By	EDB	Unit	Feet	Scale	1:1080	Company	Leighton
Date	9/19/2019			File Name	Section A - Buttress Key.slmd		

Cross Section A



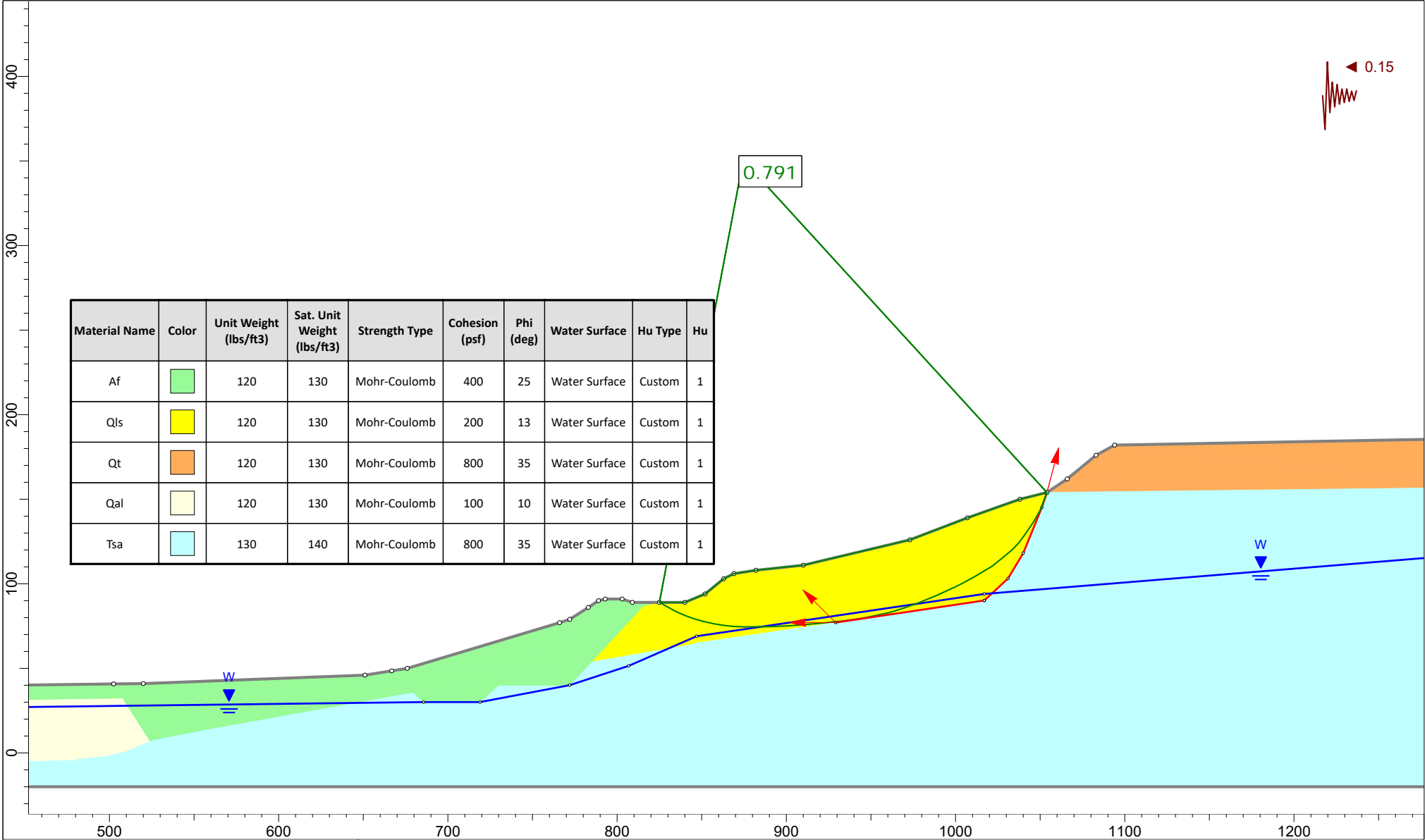
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek			
Analysis Description		Buttress Key - Check Failure Through Qls Lower Slope			
Drawn By	EDB	Unit	Feet	Scale	1:960
Date	9/19/2019			Company	Leighton
				File Name	Section A - Buttress Key.slmd

Cross Section A



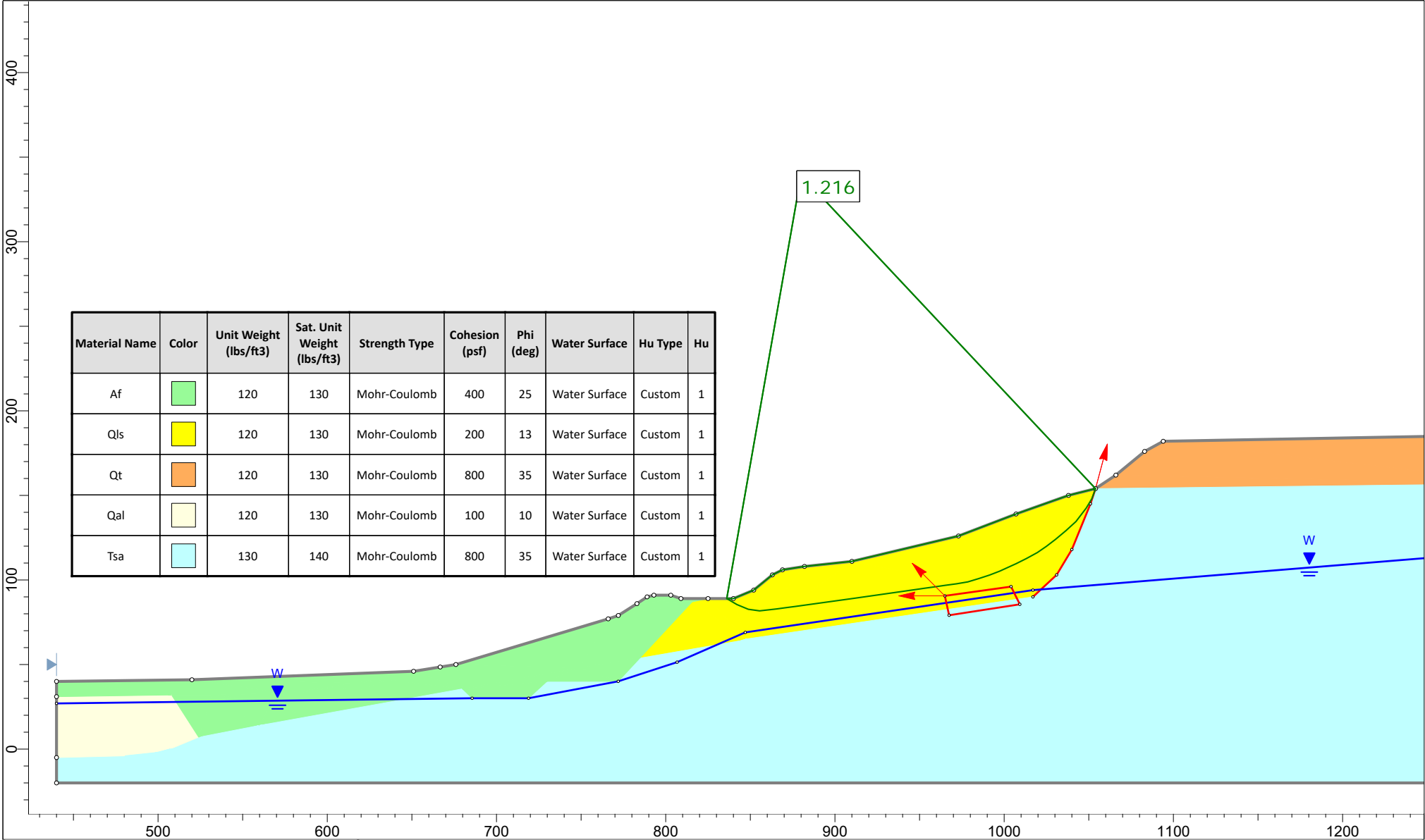
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Buttress Key - Check Failure Through Qls Upper Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:960	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019	<i>File Name</i>	Section A - Buttress Key.slmd

Cross Section A



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

1.216



SLIDEINTERPRET 8.023

<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Buttress Key - Check Failure Through Qls Upper Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:960	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019	<i>File Name</i>	Section A - Buttress Key.slmd

APPENDIX D

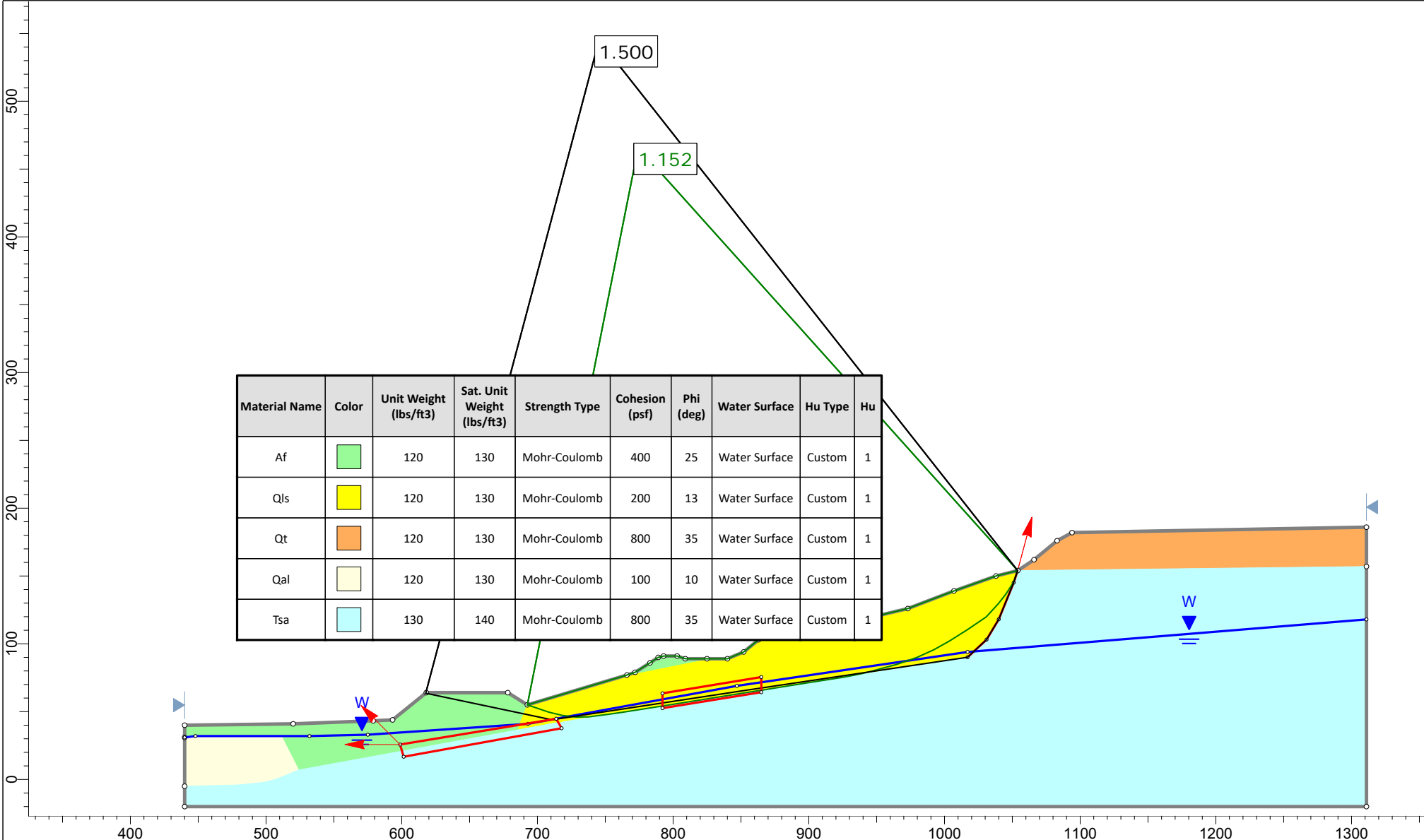
Slope Stability Analyses

Cross-section A-A'

Buttress Fill and

Landslide Removal

Cross Section A



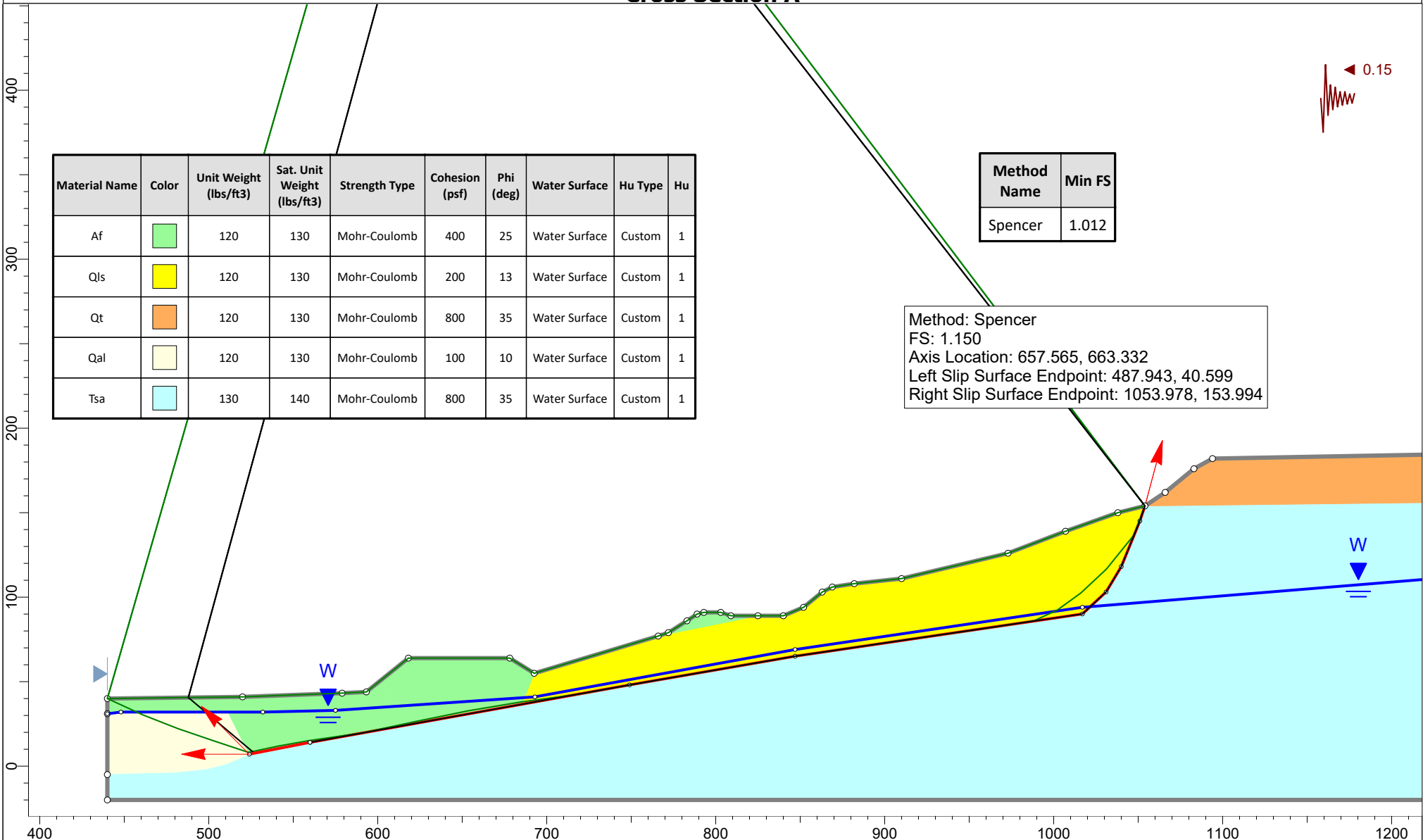
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af	■	120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls	■	120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt	■	120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal	■	120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa	■	130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

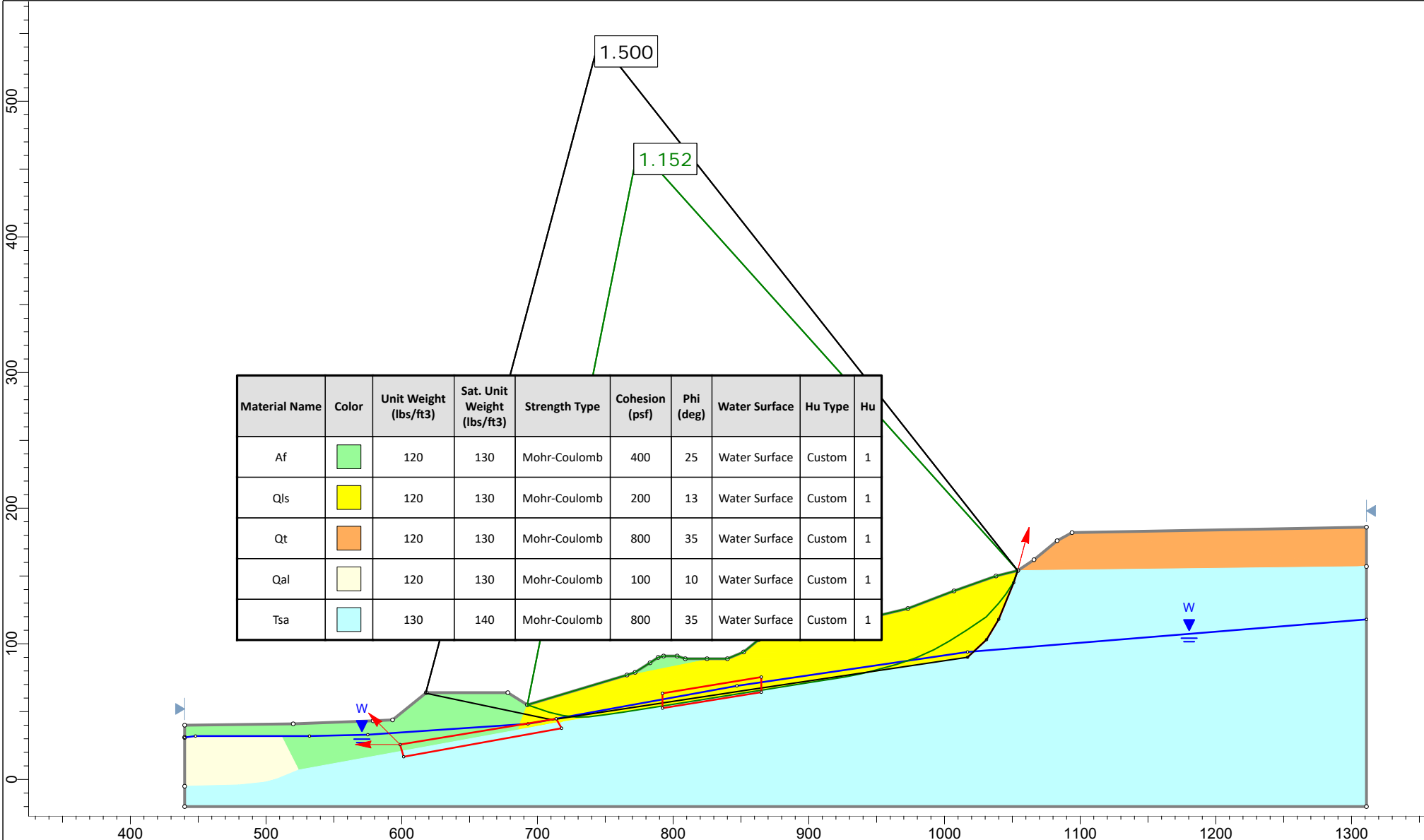
Project		12085.002 Ocean Creek	
Analysis Description		Fill and Partial Qls Removal - Check Failure Through Qal	
Drawn By	EDB	Unit	Feet
		Scale	1:1200
		Company	Leighton
Date	9/19/2019		File Name
			Section A - Fill Placement and Qls Toe Removal.slmd

Cross Section A



Project				12085.002 Ocean Creek			
Analysis Description				Fill and Partial Qls Removal - Check Failure Through Qal Toe			
Drawn By	EDB	Unit	Feet	Scale	1:960	Company	Leighton
Date	9/19/2019			File Name	Section A - Fill Placement and Qls Toe Removal.slmd		

Cross Section A



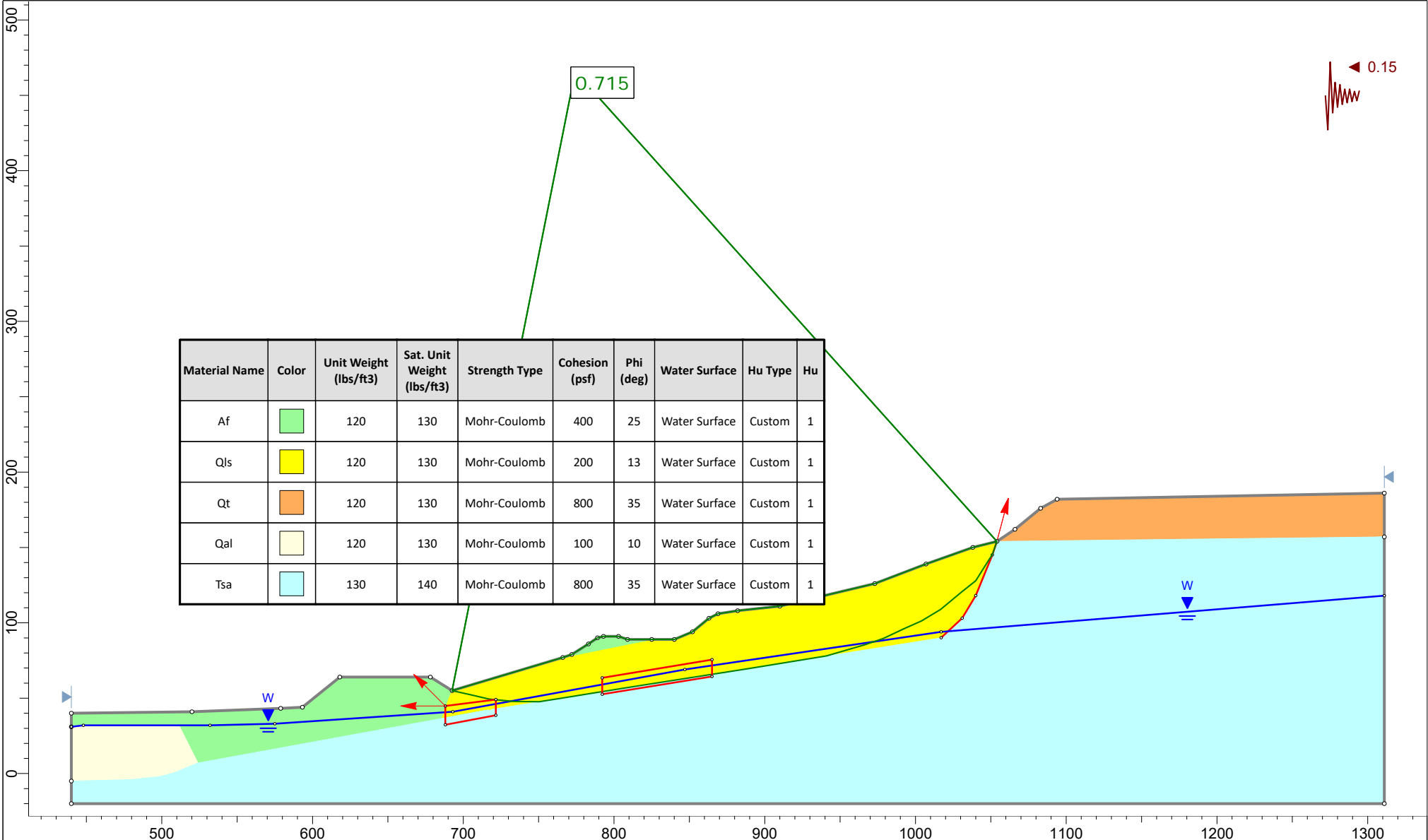
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Fill and Partial Qls Removal - Check Failure Through Qls Toe	
Drawn By	EDB	Unit	Feet
Scale	1:1200	Company	Leighton
Date	9/19/2019		File Name
			Section A - Fill Placement and Qls Toe Removal.slmd

Cross Section A



Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af	■	120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls	■	120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt	■	120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal	■	120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa	■	130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1








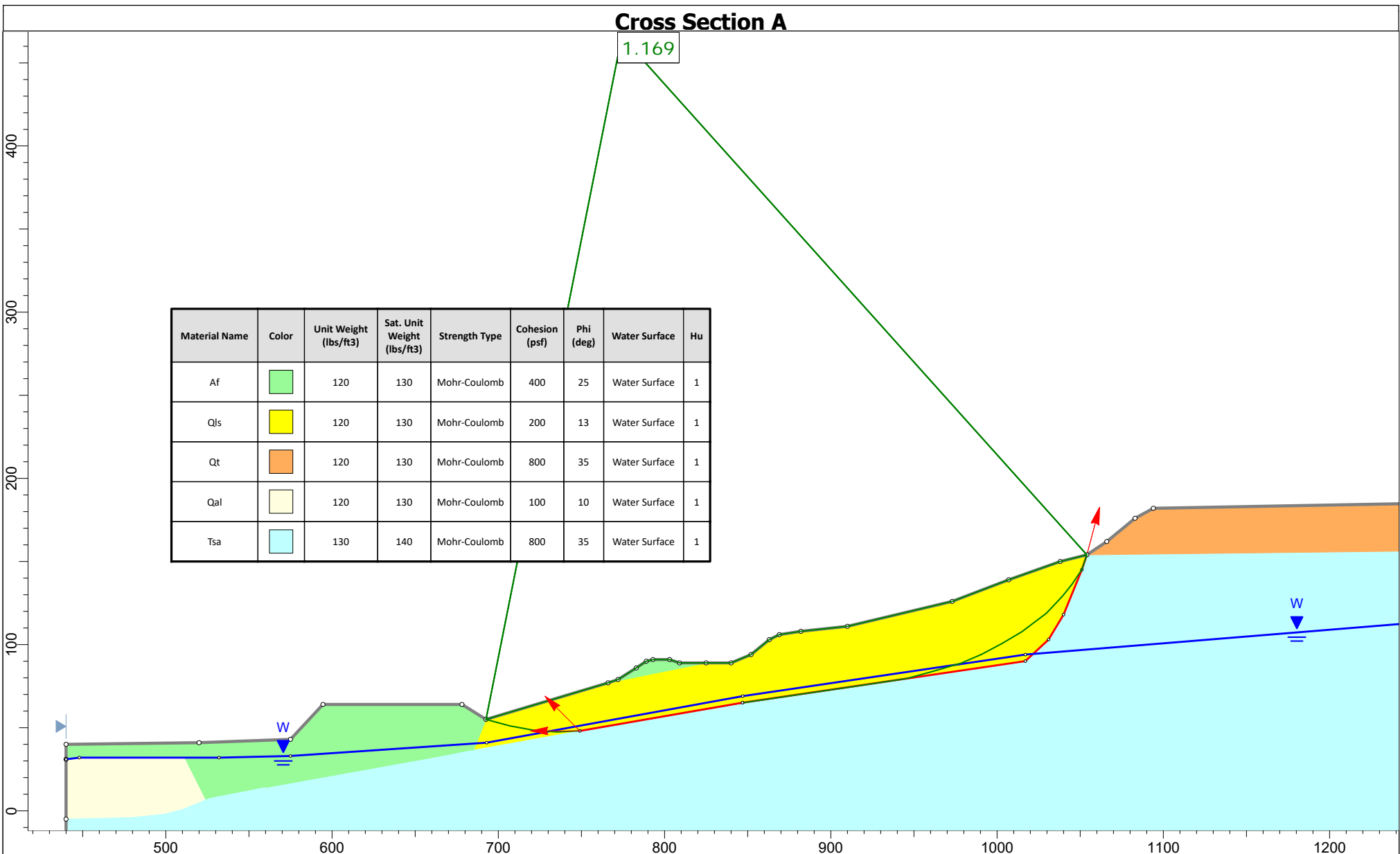
SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Fill and Partial Qls Removal - Check Failure Through Fill	
Drawn By	EDB	Unit	Feet
		Scale	1:1080
Date		9/19/2019	
Company		Leighton	
File Name		Section A - Fill Placement and Qls Toe Removal.slmd	

Cross Section A

1.169

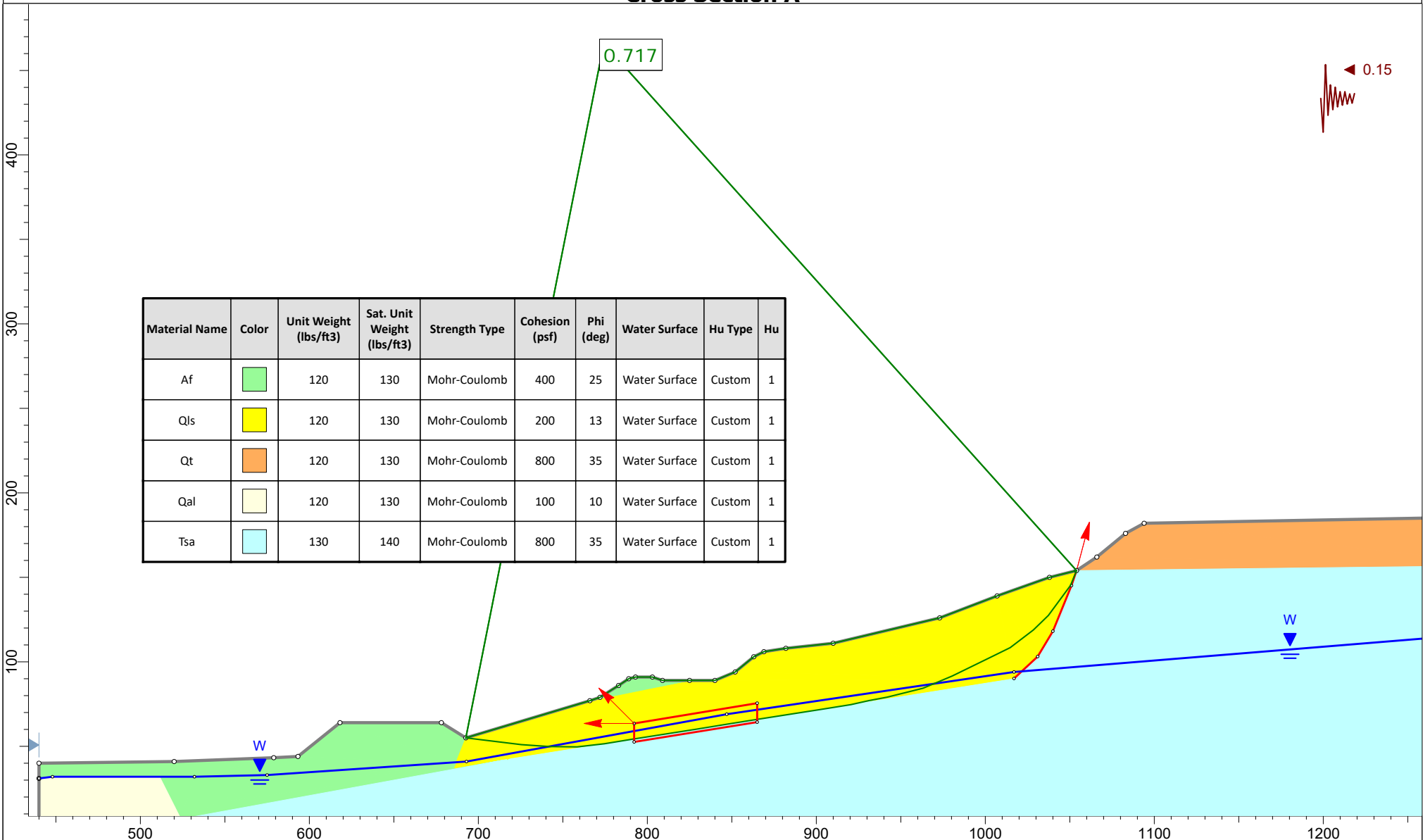
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	1



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Fill and Partial Qls Removal - Check Failure Through Qls Mid Slope	
Drawn By	EDB	Unit	Feet
		Scale	1:960
		Company	Leighton
Date	9/19/2019	File Name	Section A - Fill Placement and Qls Toe Removal.slmd

Cross Section A



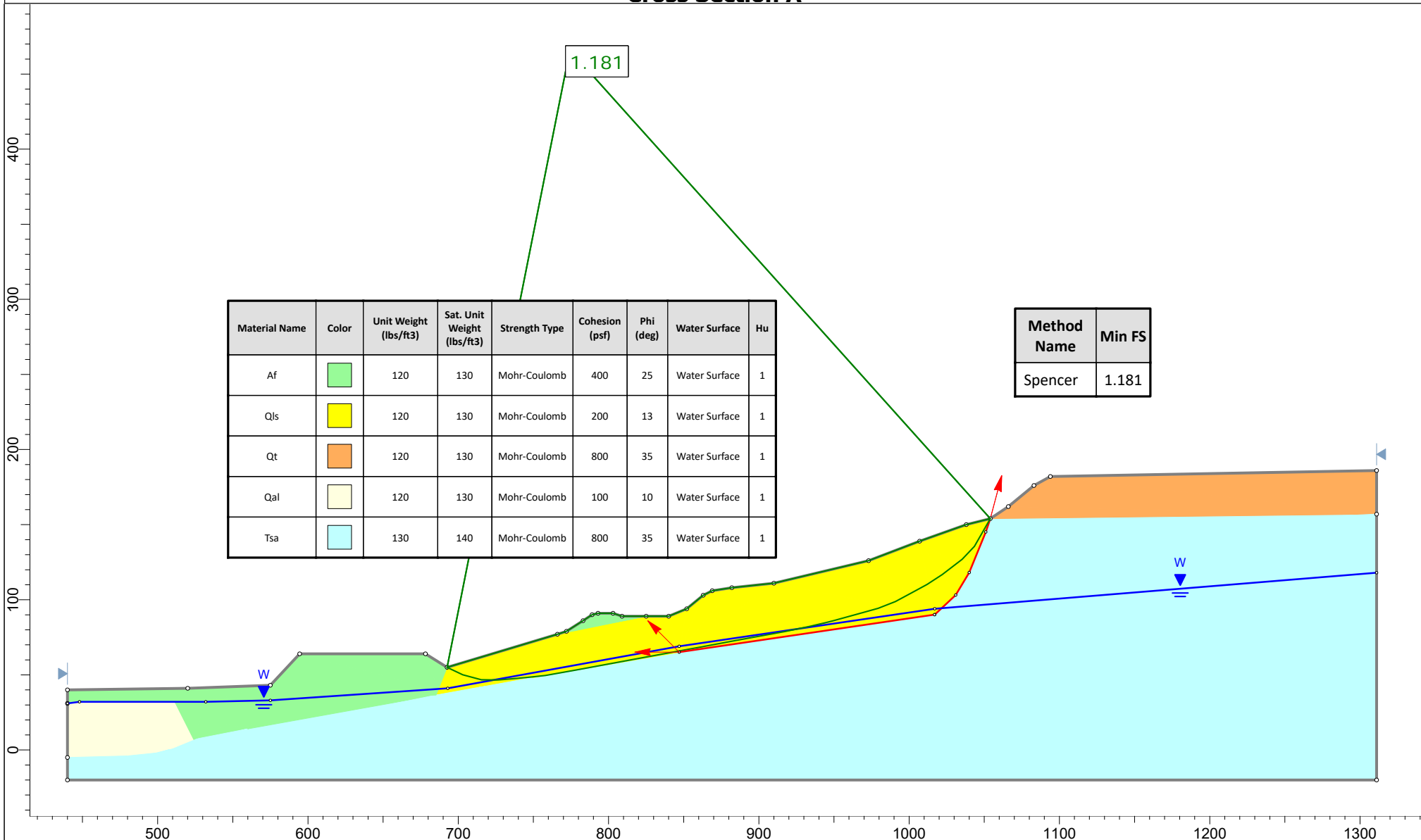
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023


Project		12085.002 Ocean Creek			
Analysis Description		Fill and Partial Qls Removal - Check Failure Through Qls Mid Slope			
Drawn By	EDB	Unit	Feet	Scale	1:960
Date		9/19/2019		Company	Leighton
				File Name	Section A - Fill Placement and Qls Toe Removal.slmd

Cross Section A

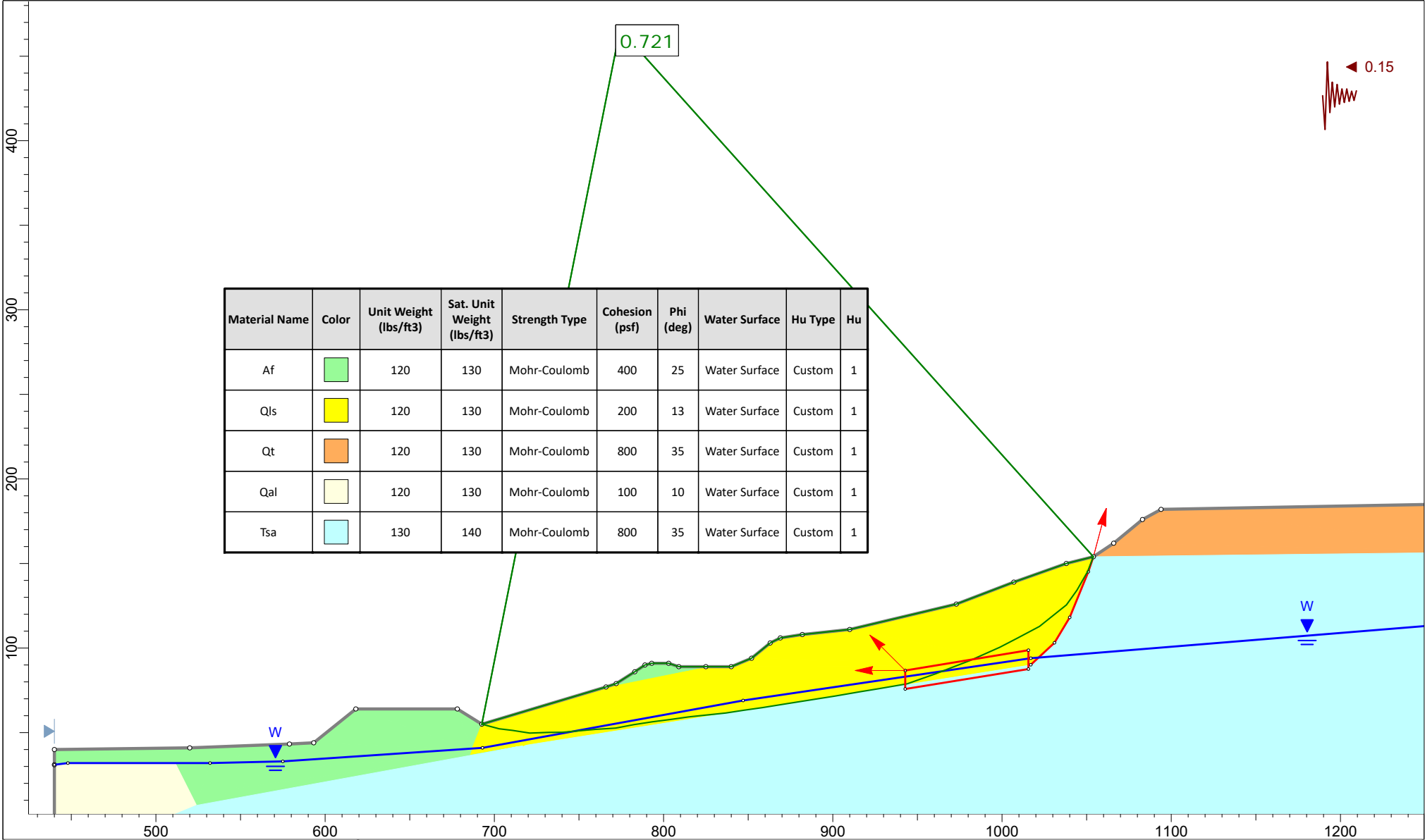


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	1

Method Name	Min FS
Spencer	1.181

	<i>Project</i> 12085.002 Ocean Creek				
	<i>Analysis Description</i> Fill and Partial Qls Removal - Check Failure Through Qls Upper Slope				
	<i>Drawn By</i> EDB	<i>Unit</i> Feet	<i>Scale</i> 1:1080	<i>Company</i> Leighton	
	<i>Date</i> 9/19/2019			<i>File Name</i> Section A - Fill Placement and Qls Toe Removal.slmd	

Cross Section A



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af	■	120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls	■	120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt	■	120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal	■	120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa	■	130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Fill and Partial Qls Removal - Check Failure Through Qls Upper Slope	
Drawn By	EDB	Unit	Feet
Scale	1:960	Company	Leighton
Date	9/19/2019	File Name	Section A - Fill Placement and Qls Toe Removal.slmd

APPENDIX D

Slope Stability Analyses

Cross-section D-D'

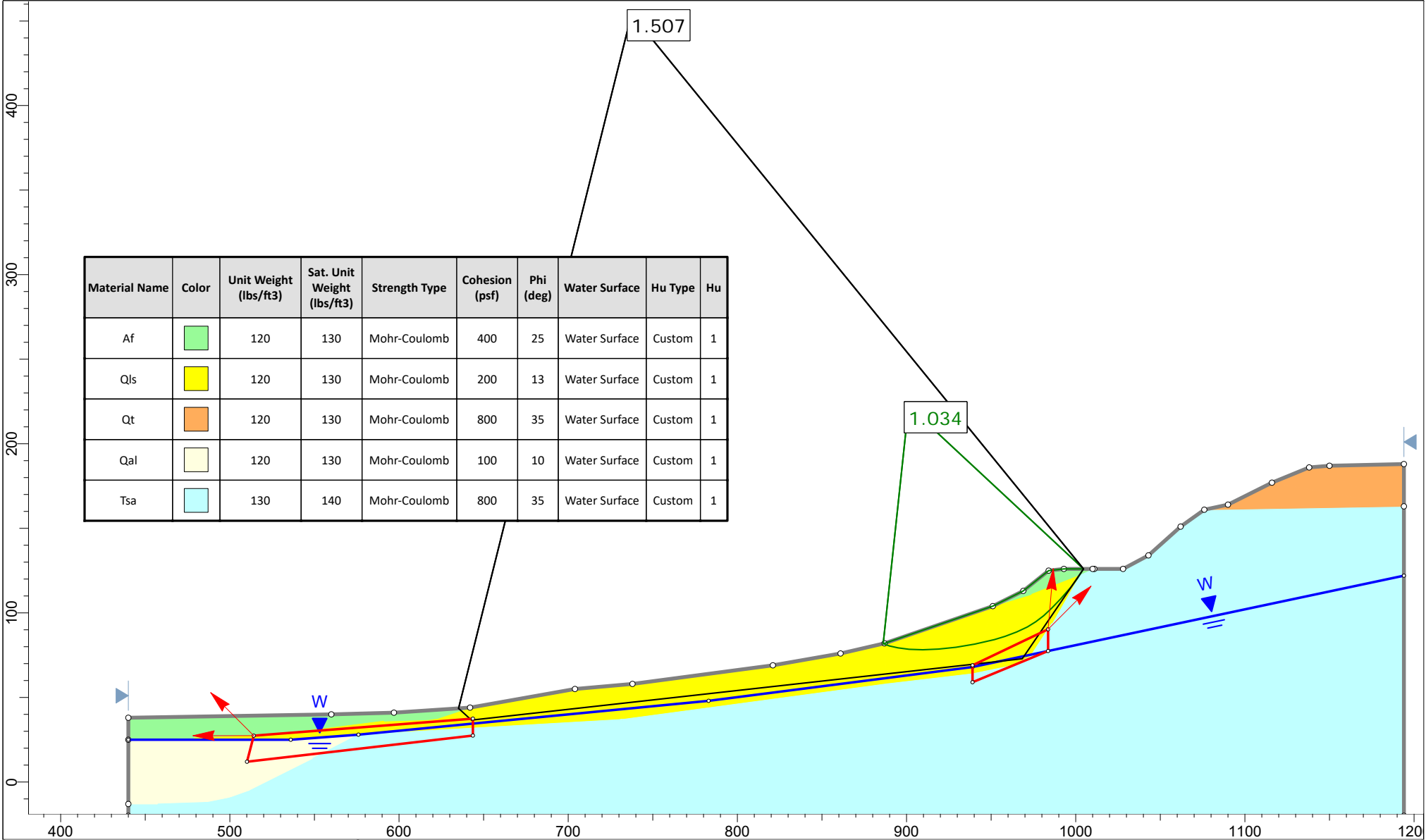
APPENDIX D

Slope Stability Analyses

Cross-section D-D'

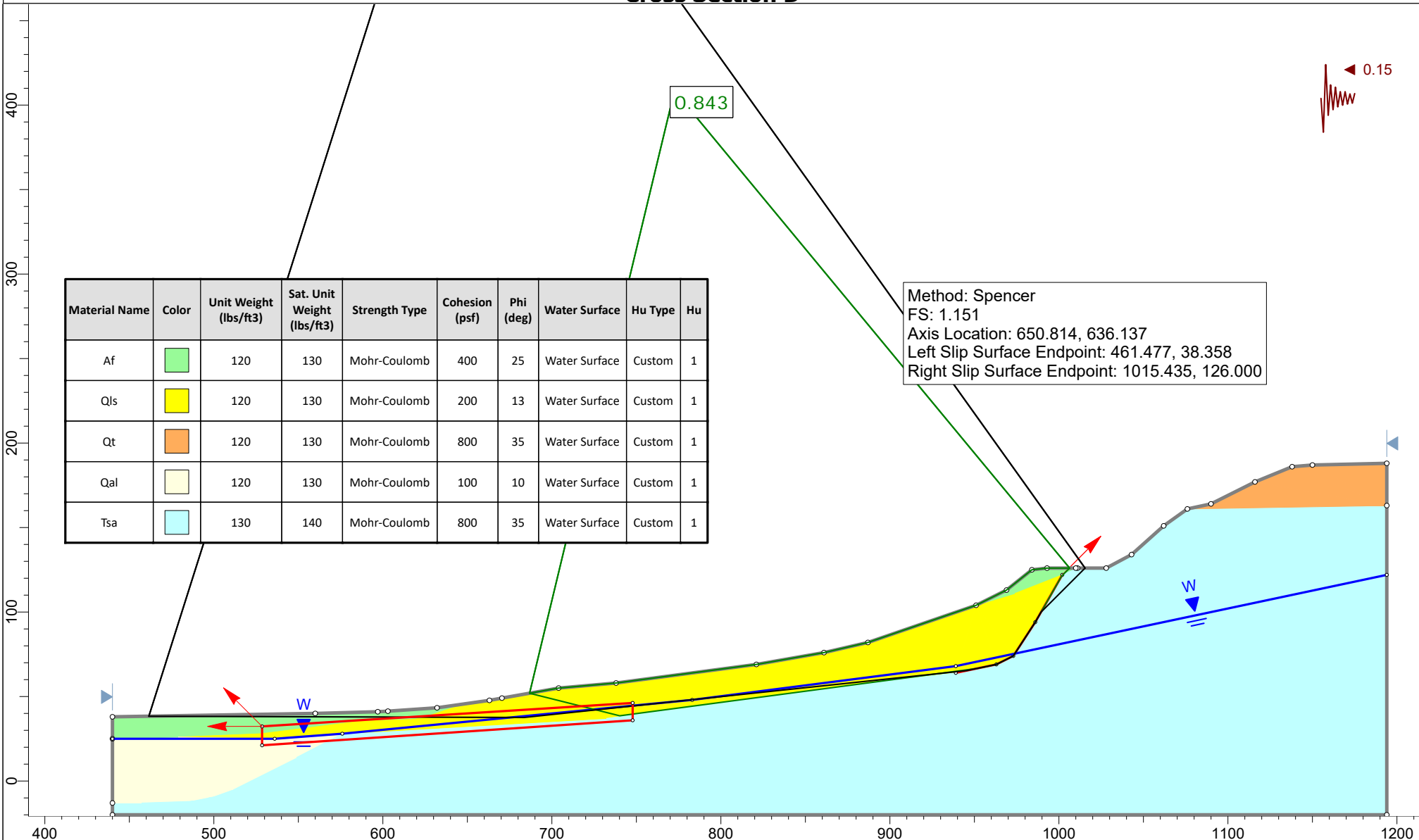
Existing Slope

Cross Section D



<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Existing Site - Check Failure Through Qal	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:960	<i>Company</i>	Leighton
<i>Date</i>	9/18/2019		<i>File Name</i>
		Section D - Existing.slmd	

Cross Section D








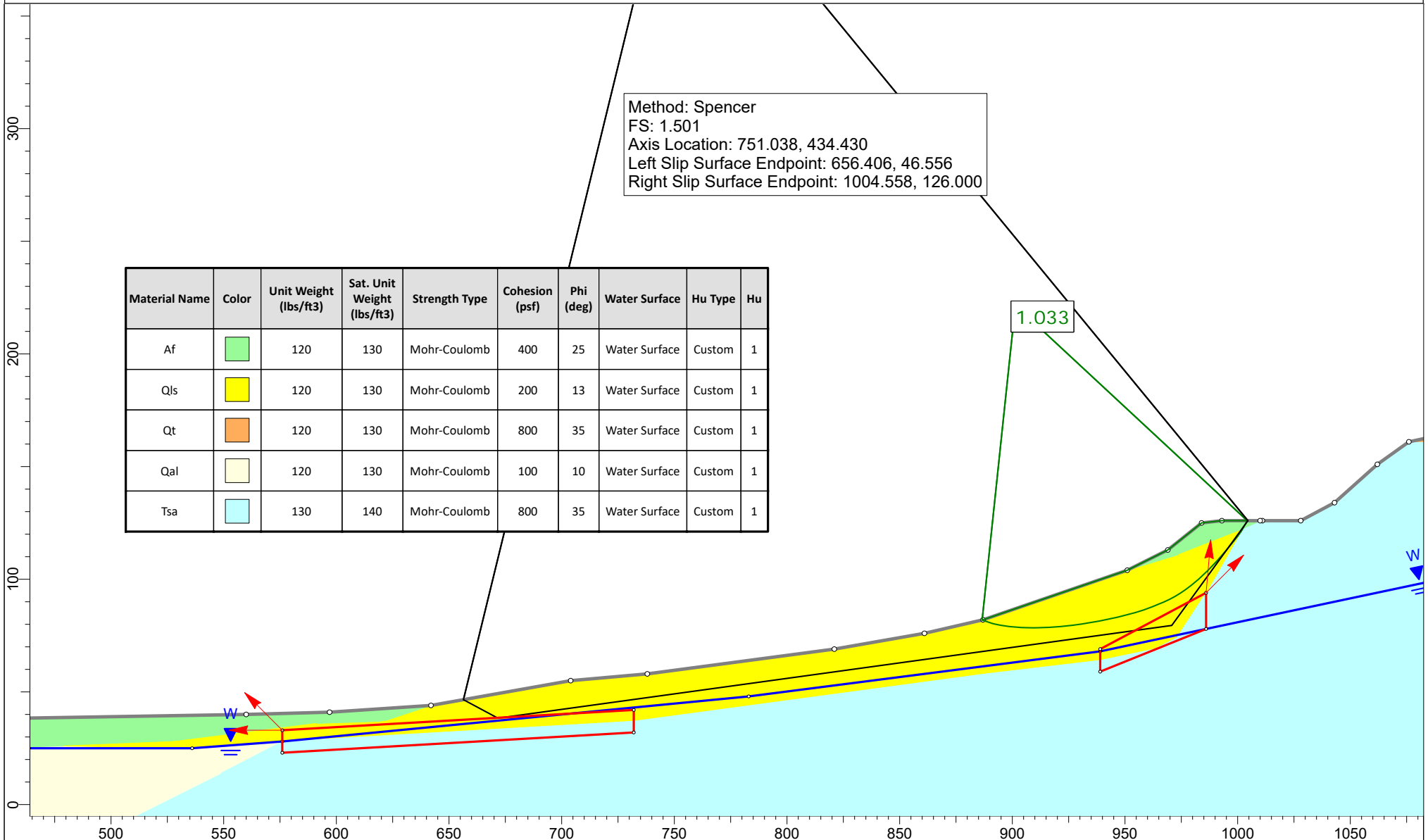
SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Cross Section D - Existing Site - Check Failure Through Qal	
Drawn By	EDB	Unit	Feet
Scale	1:960	Company	Leighton
Date	9/19/2019	File Name	Section D - Existing revised.slmd

Cross Section D

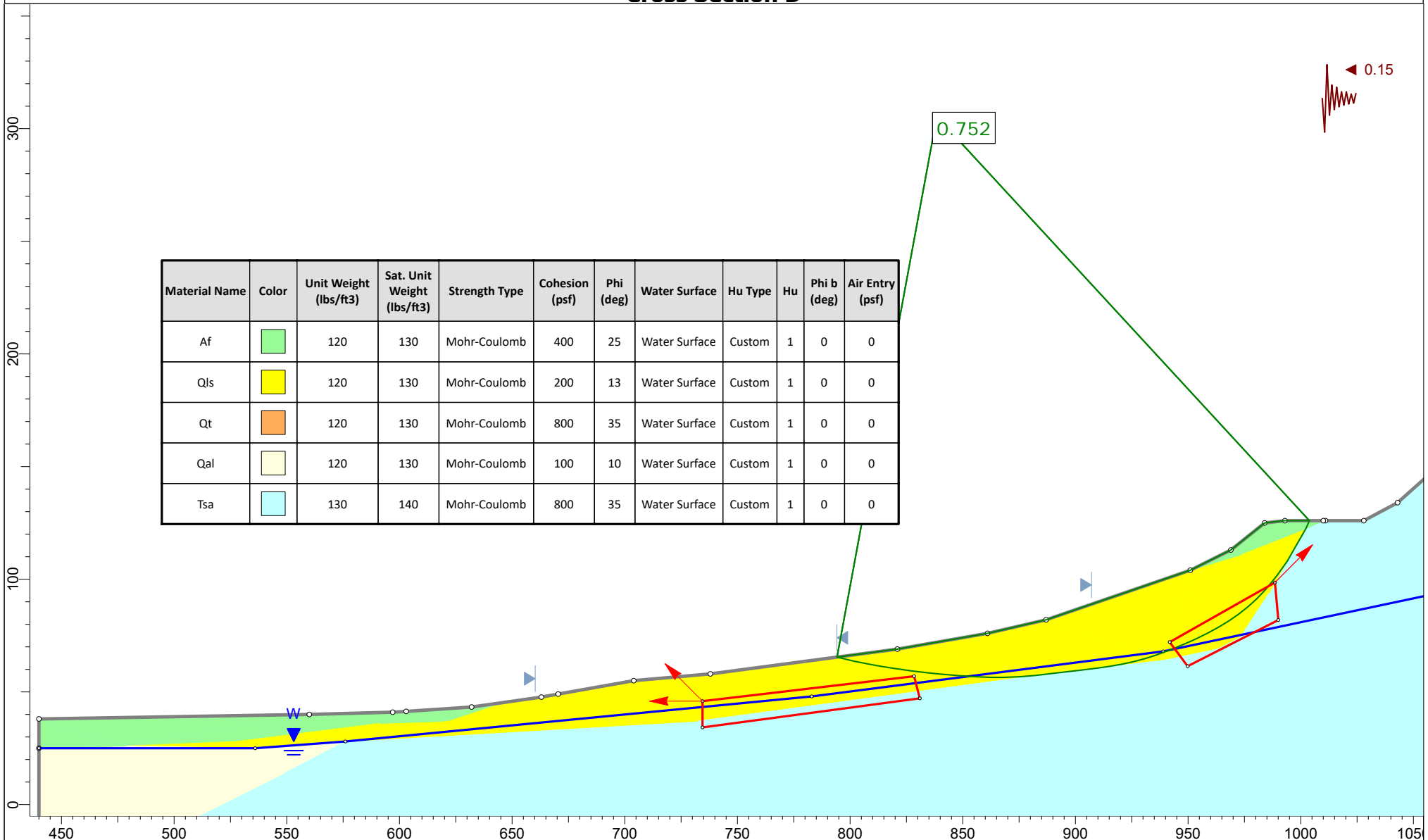
Method: Spencer
 FS: 1.501
 Axis Location: 751.038, 434.430
 Left Slip Surface Endpoint: 656.406, 46.556
 Right Slip Surface Endpoint: 1004.558, 126.000

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



Project		12085.002 Ocean Creek	
Analysis Description		Existing Site - Check Failure Through Qls Lower Slope	
Drawn By	EDB	Unit	Feet
Date	9/18/2019	Scale	1:720
Company		Leighton	
File Name		Section D - Existing.slmd	

Cross Section D

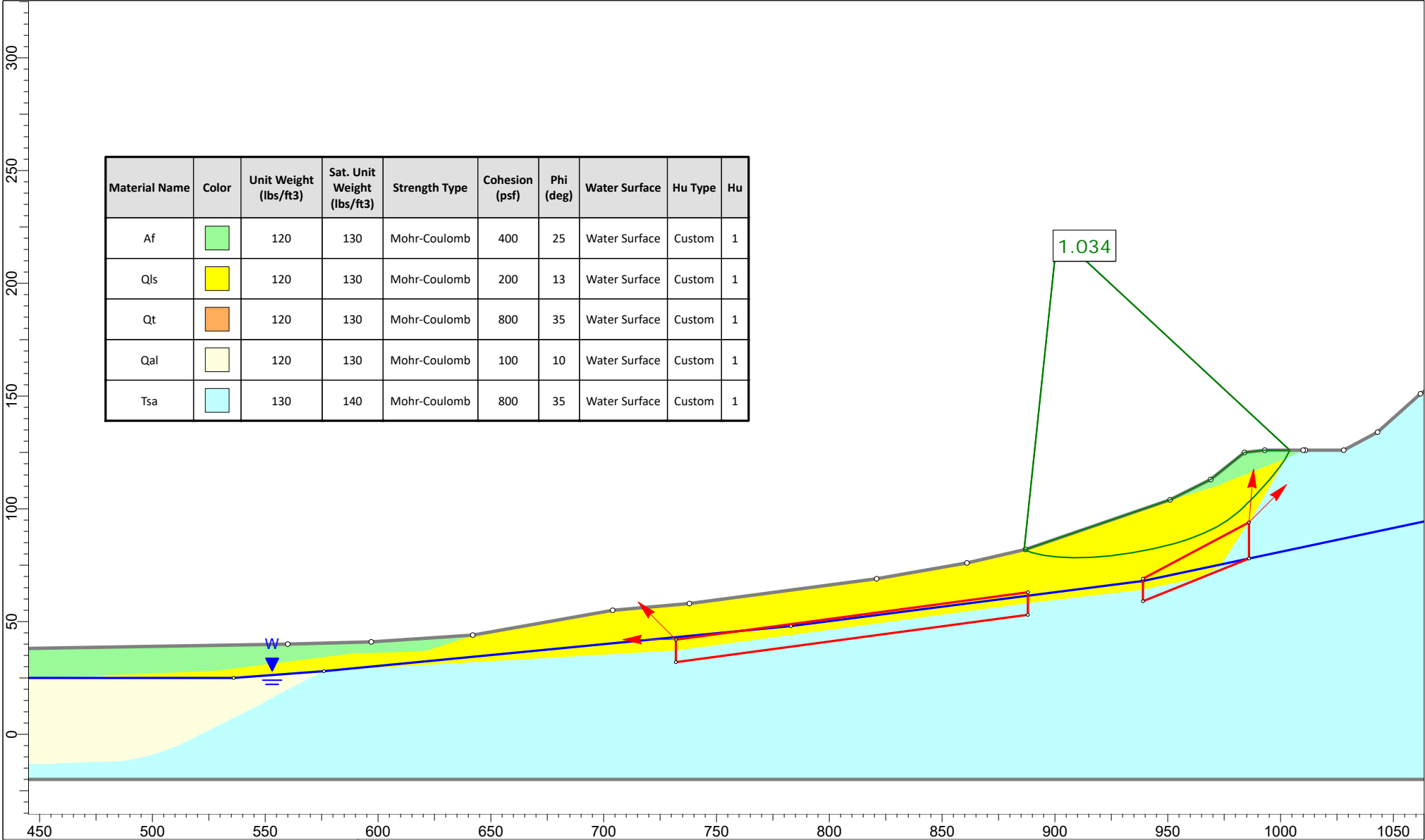


Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Phi b (deg)	Air Entry (psf)
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1	0	0
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1	0	0
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1	0	0
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1	0	0
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1	0	0



Project		12085.002 Ocean Creek	
Analysis Description		Existing Site - Check Failure Through Qls Mid Slope	
Drawn By	EDB	Unit	Feet
		Scale	1:720
Date		9/19/2019	
Company		Leighton	
File Name		Section D - Existing revised.slmd	

Cross Section D



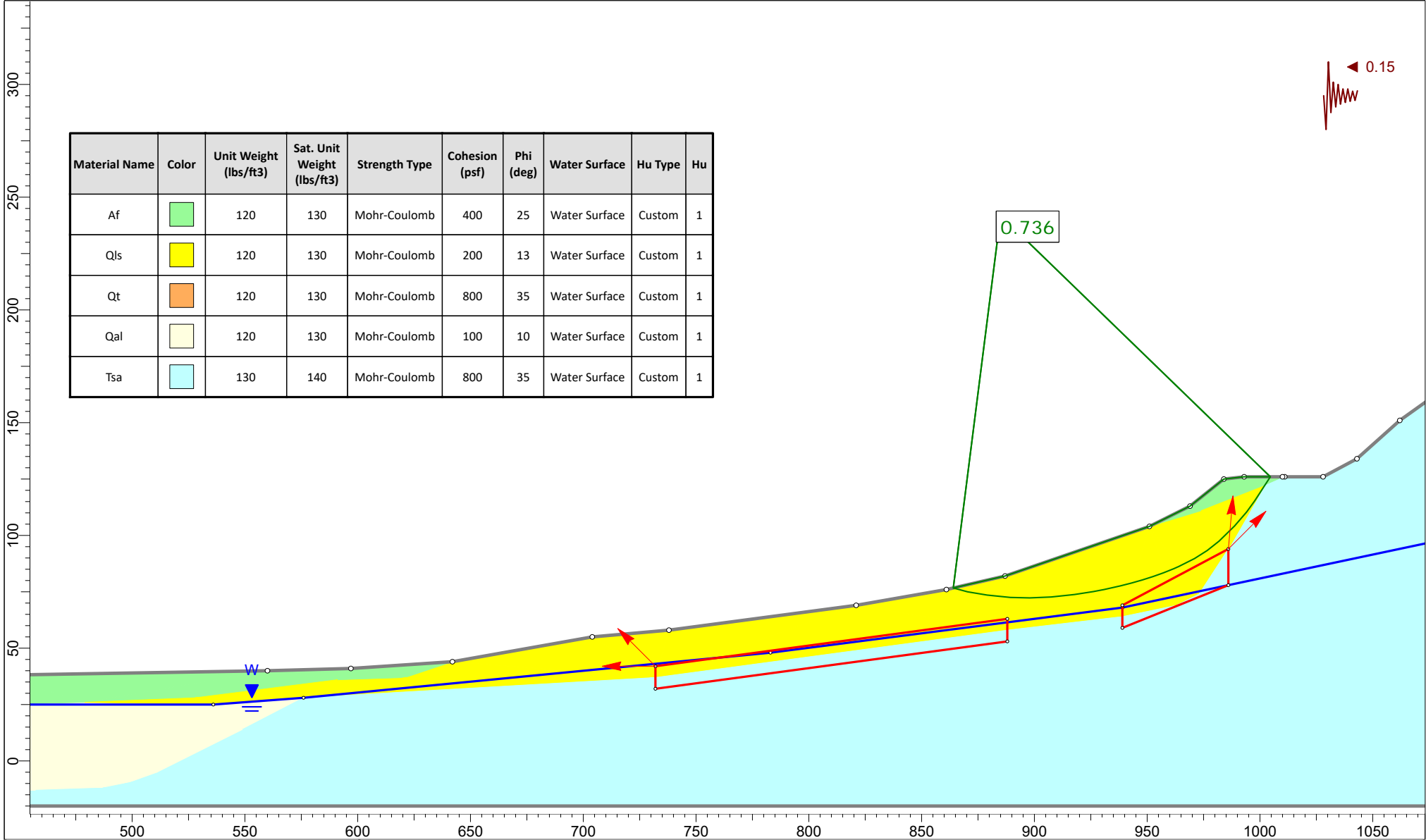
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

1.034



<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Existing Site - Check Failure Through Qls Mid Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:720	<i>Company</i>	Leighton
<i>Date</i>	9/18/2019	<i>File Name</i>	Section D - Existing.slmd

Cross Section D

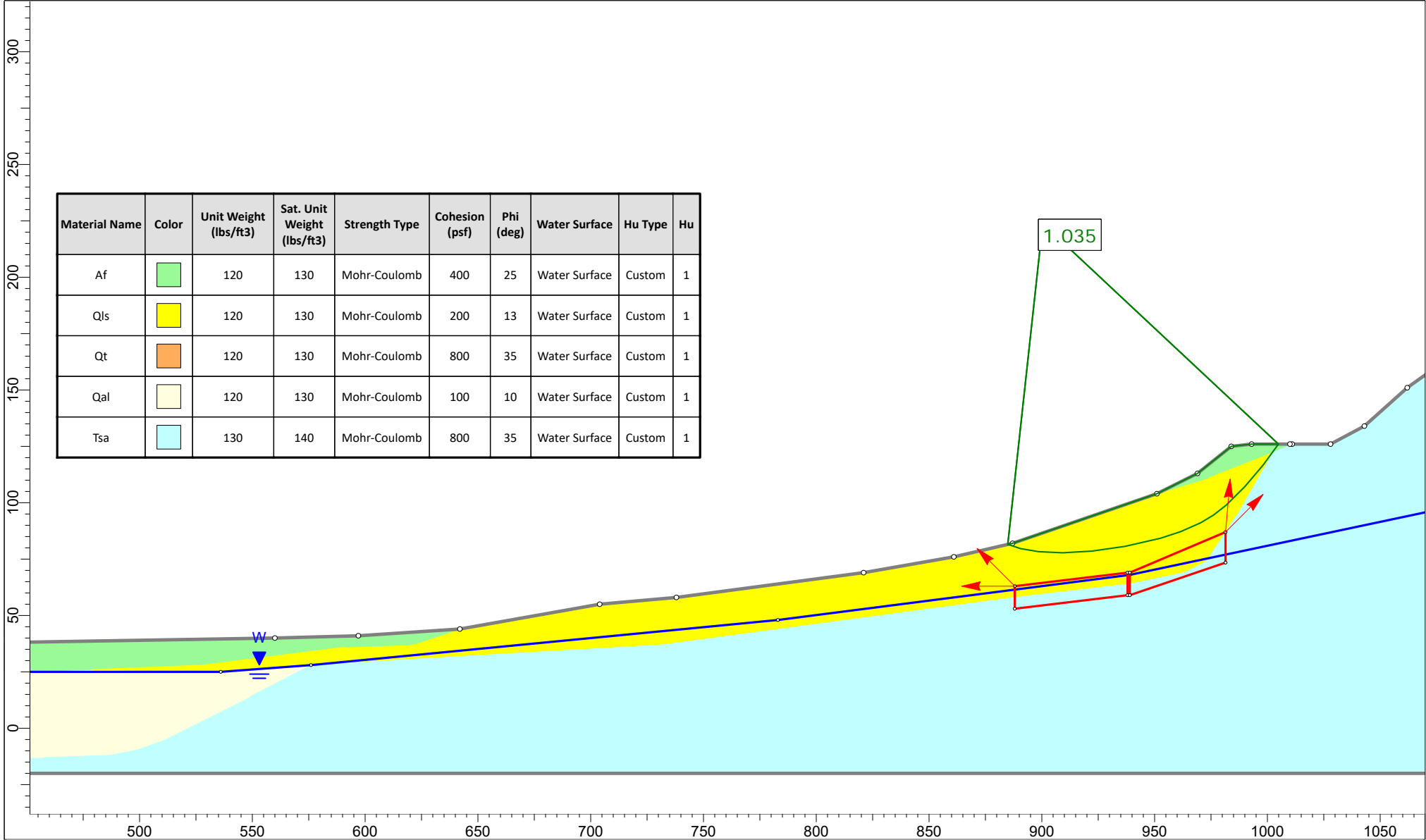


Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Existing Site - Check Failure Through Qls Mid Slope	
<i>Drawn By</i>	EDB	<i>Scale</i>	1:720
<i>Date</i>	9/20/2019	<i>Company</i>	Leighton
		<i>File Name</i>	Section D - Existing.slmd

Cross Section D



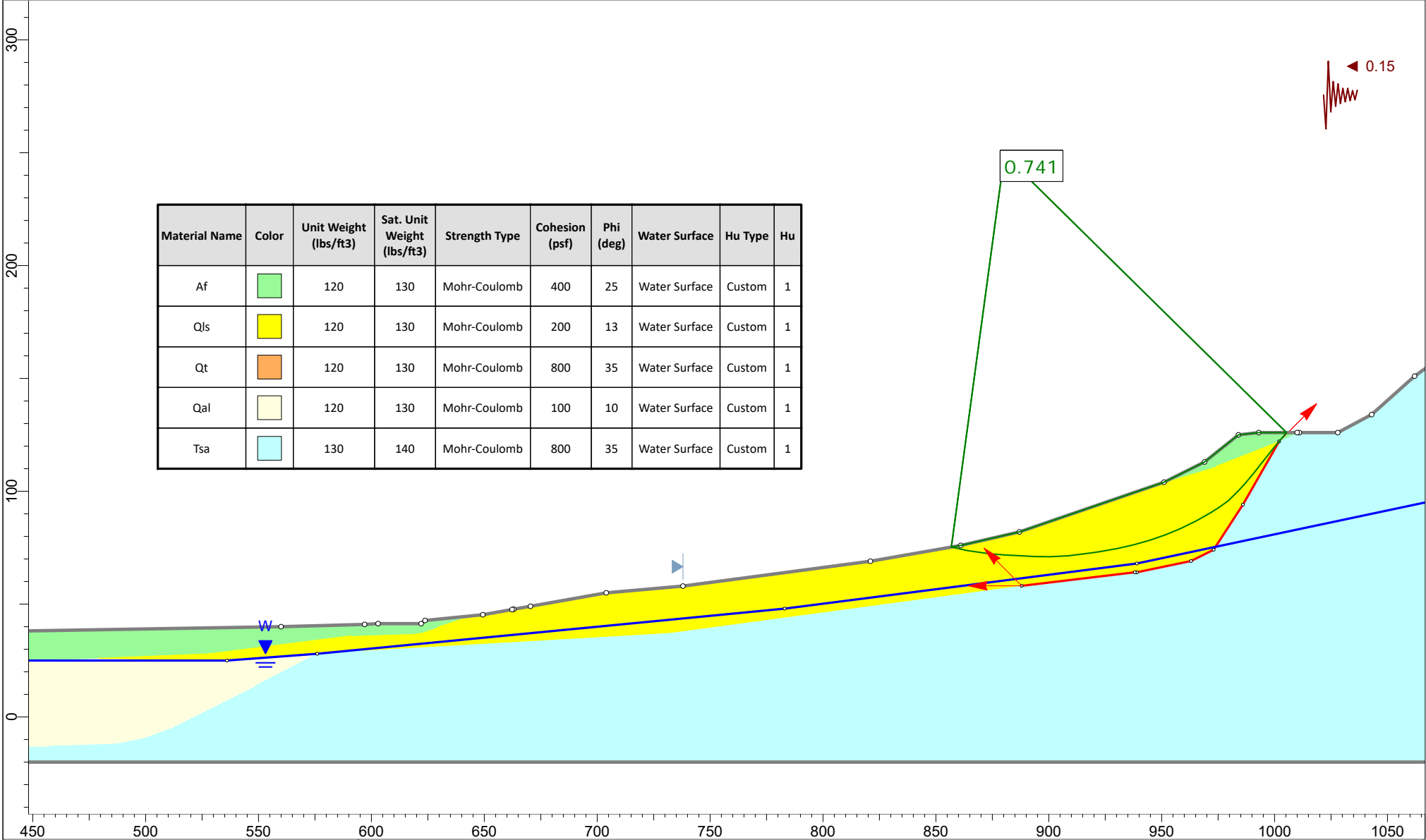
Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

1.035



<i>Project</i>				12085.002 Ocean Creek				
<i>Analysis Description</i>				Existing Site - Check Failure Through Qls Upper Slope				
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet	<i>Scale</i>	1:720	<i>Company</i>	Leighton	
<i>Date</i>		9/18/2019			<i>File Name</i>			Section D - Existing.slmd

Cross Section D



Material Name	Color	Unit Weight (lbs/ft ³)	Sat. Unit Weight (lbs/ft ³)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

<i>Project</i>				12085.002 Ocean Creek			
<i>Analysis Description</i>				Cross Section D - Existing Site - Check Failure Through Qls Upper Slope			
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet	<i>Scale</i>	1:720	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019			<i>File Name</i>	Section D - Existing revised.slmd		

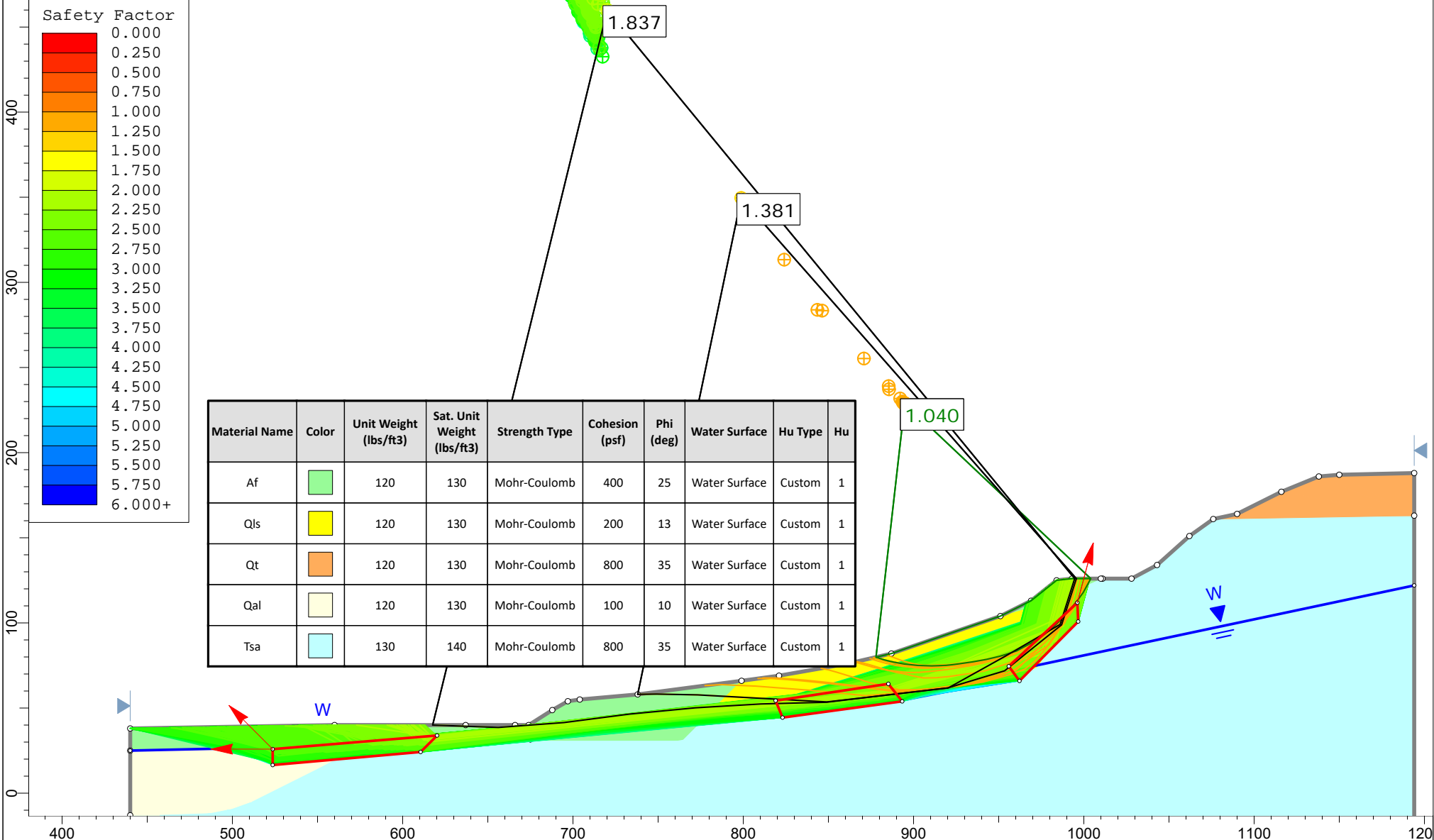
APPENDIX D

Slope Stability Analyses

Cross-section D-D'

Buttress Key

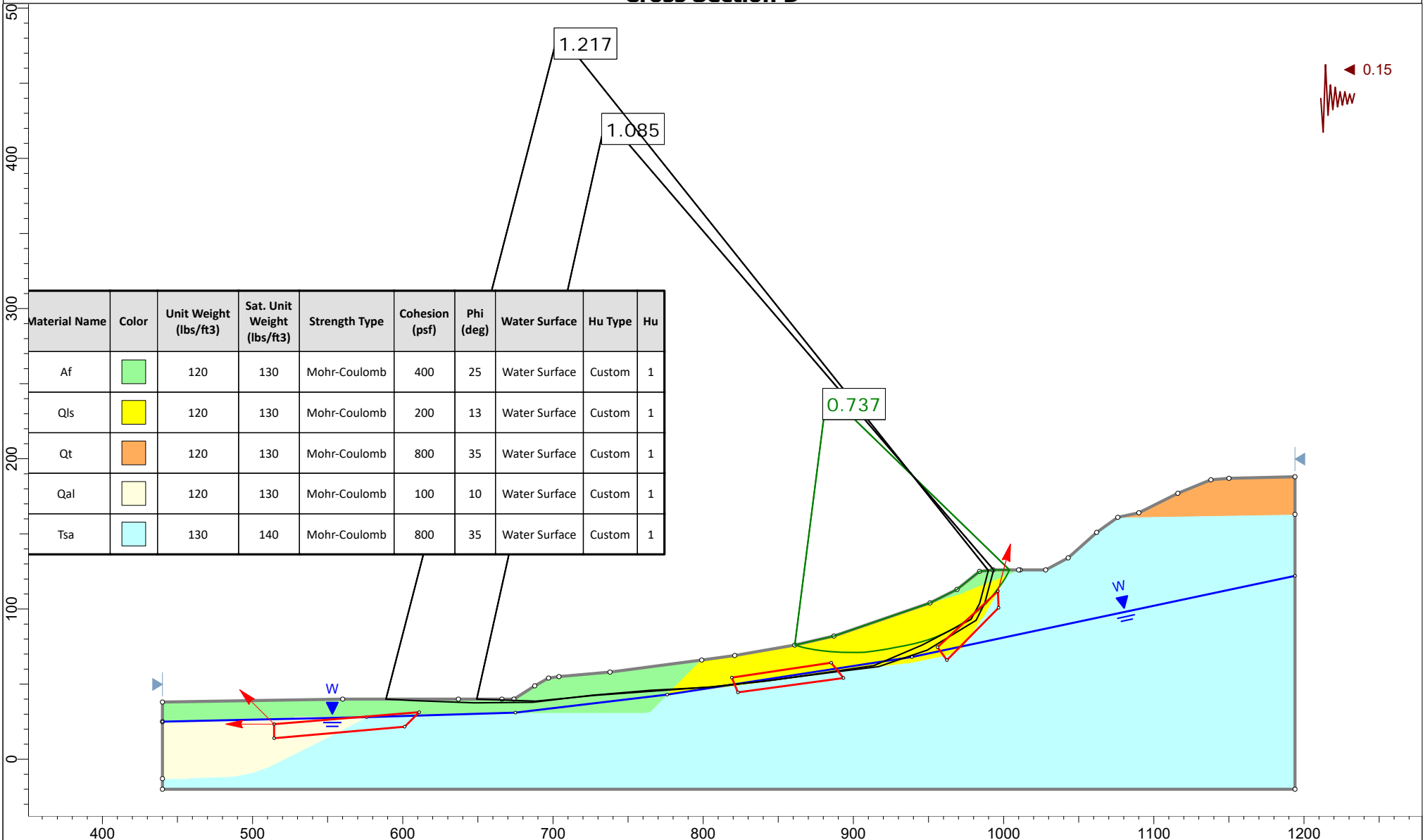
Cross Section D



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek			
Analysis Description		Buttress Design with Pad Removals - Check Failure Through Qal			
Drawn By	EDB	Unit	Feet	Scale	1:960
Date		9/19/2019		Company	Leighton
				File Name	Section D - Original Buttress Revised.slmd

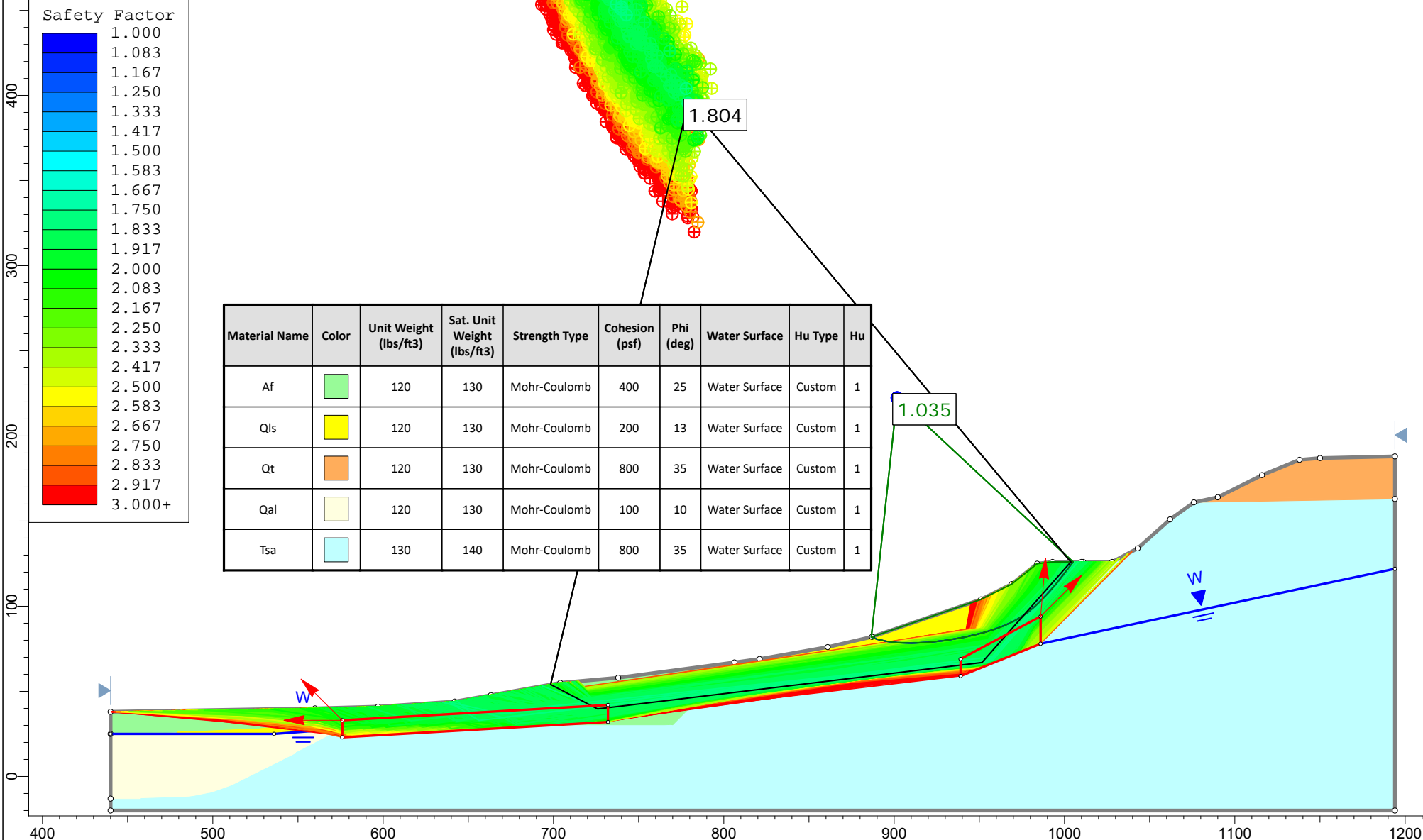
Cross Section D



SLIDEINTERPRET 8.023

<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Buttress Design with Pad Removals - Check Failure Through Qal	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:1080	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019		<i>File Name</i>
		Section D - Original Buttress Revised.slmd	

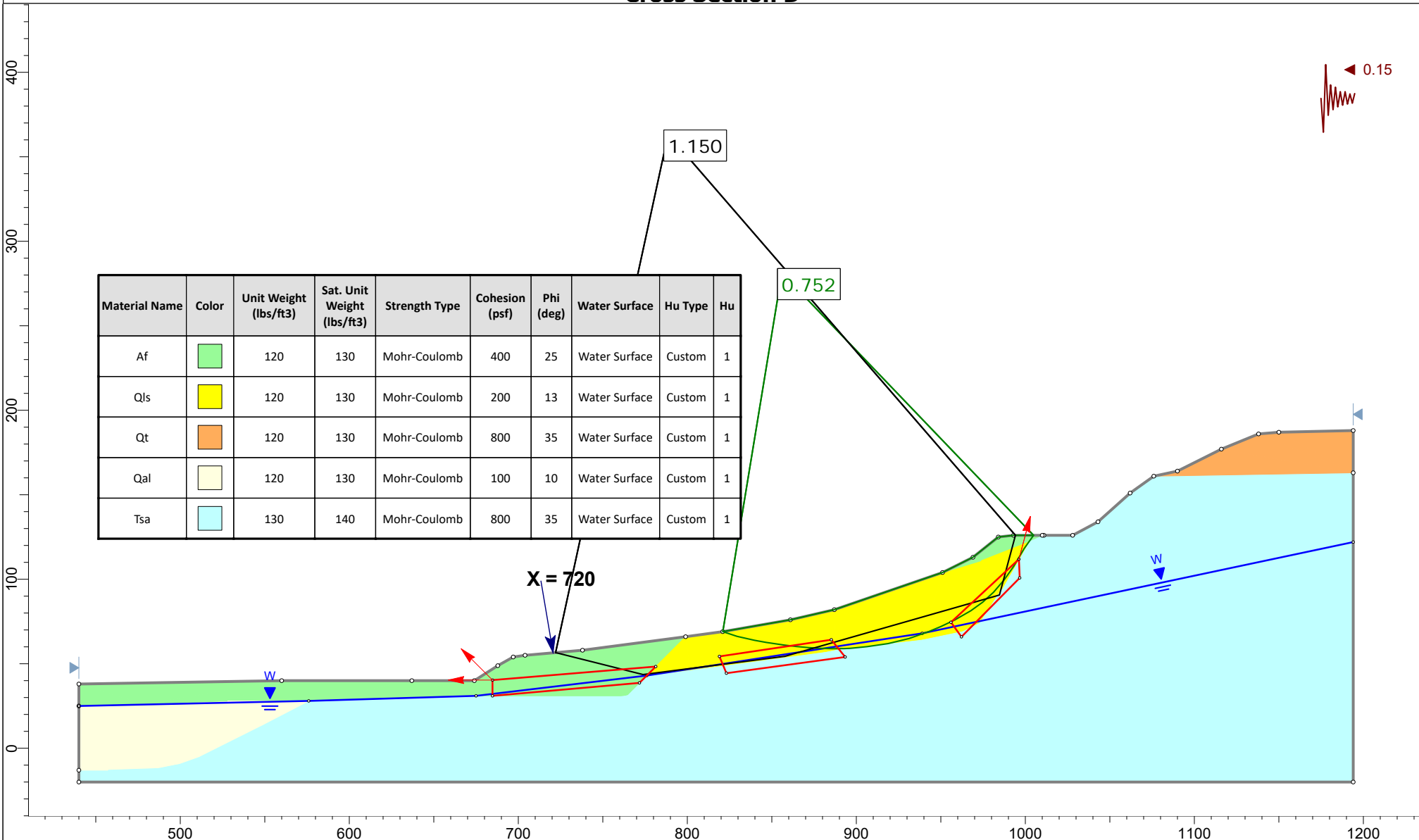
Cross Section D




SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek	
Analysis Description		Buttress Key - Check Failure Through Qls Upper Slope	
Drawn By	EDB	Unit	Feet
		Scale	1:960
		Company	Leighton
Date	9/19/2019	File Name	Section D - Buttress Key.slmd

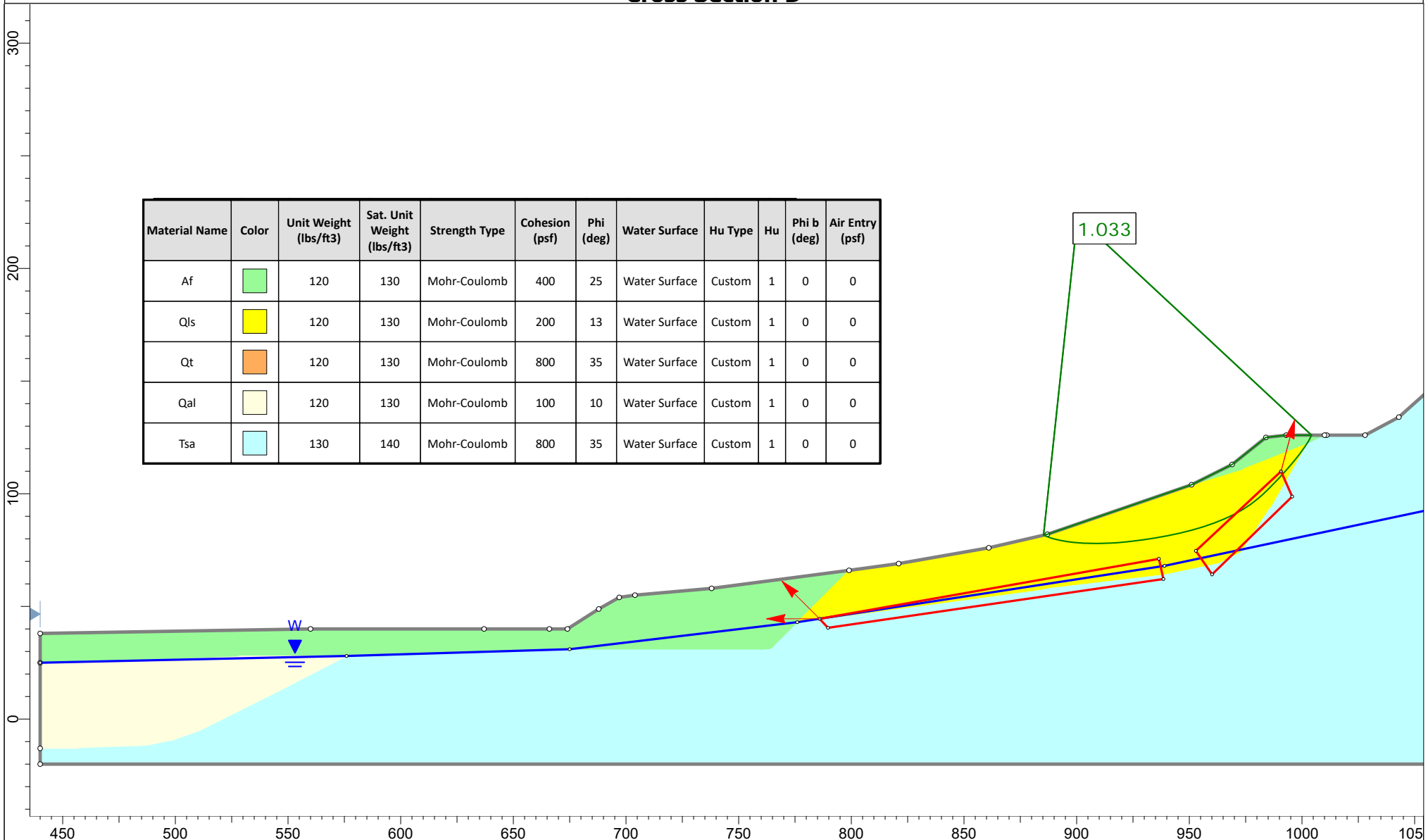
Cross Section D



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

	<i>Project</i>			
	12085.002 Ocean Creek			
	<i>Analysis Description</i>			
	Buttress Design with Pad Removals - Check Failure Through Buttress			
	<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
		<i>Scale</i>	1:960	
			<i>Company</i>	
			Leighton	
<i>Date</i>		<i>File Name</i>		
9/19/2019		Section D - Original Buttress Revised.slmd		

Cross Section D

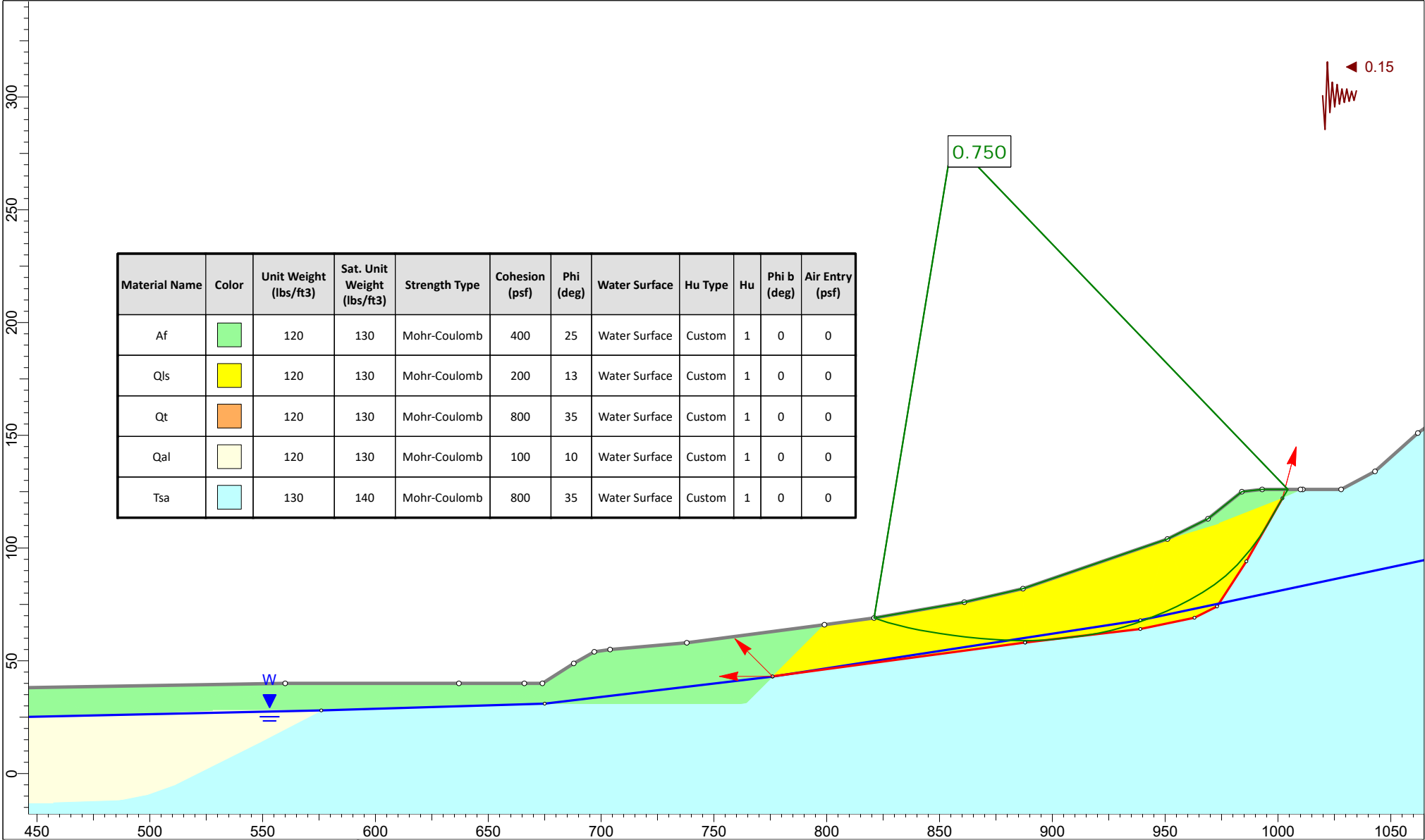


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Phi b (deg)	Air Entry (psf)
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1	0	0
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1	0	0
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1	0	0
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1	0	0
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1	0	0



<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Buttress Design with Pad Removals - Check Failure Through Qal Toe	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:720	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019	<i>File Name</i>	Section D - Original Buttress Revised.slmd

Cross Section D

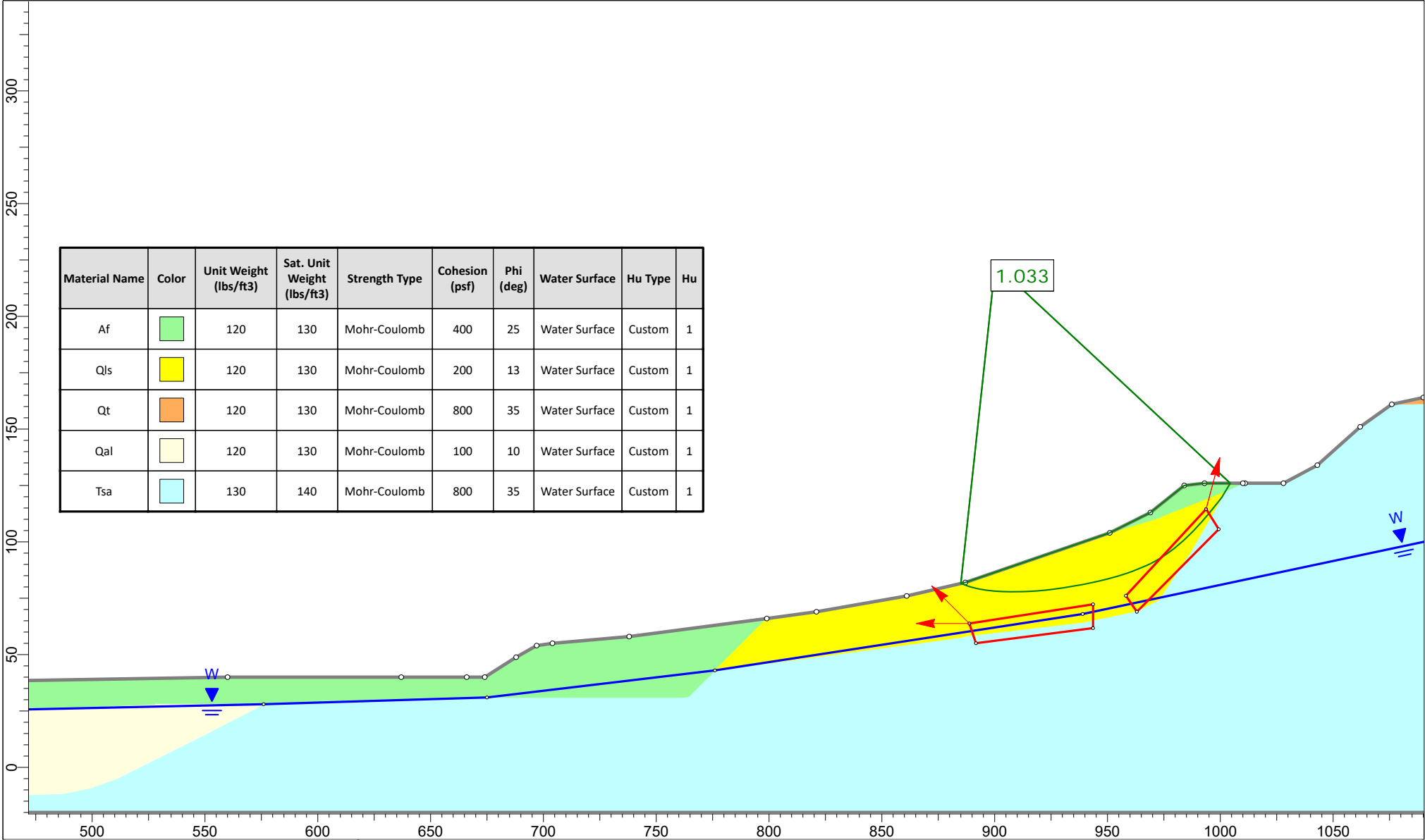


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Phi b (deg)	Air Entry (psf)
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1	0	0
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1	0	0
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1	0	0
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1	0	0
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1	0	0



Project		12085.002 Ocean Creek	
Analysis Description		Buttress Design with Pad Removals - Check Failure Through Qal Toe	
Drawn By	EDB	Unit	Feet
		Scale	1:720
		Company	Leighton
Date	9/19/2019		File Name
			Section D - Original Buttress Revised.slmd

Cross Section D



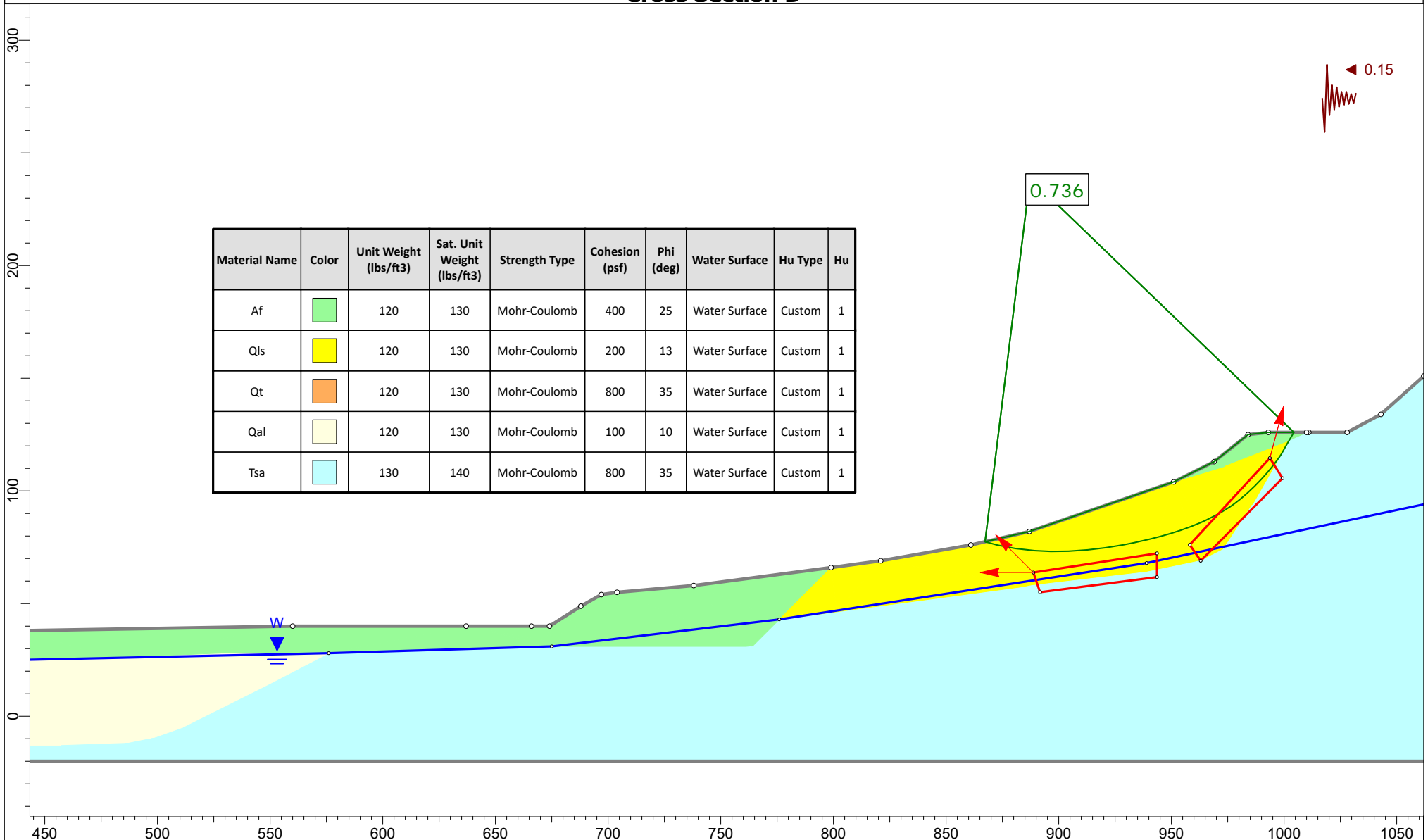
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

1.033



Project		12085.002 Ocean Creek	
Analysis Description		Buttress Design with Pad Removals - Check Failure Through Qal Scarp	
Drawn By	EDB	Unit	Feet
Scale	1:720	Company	Leighton
Date	9/19/2019	File Name	Section D - Original Buttress Revised.slmd

Cross Section D



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



SLIDEINTERPRET 8.023

Project		12085.002 Ocean Creek		
Analysis Description		Buttress Design with Pad Removals - Check Failure Through Qal Scarp		
Drawn By	EDB	Unit	Feet	Scale
				1:720
Date	9/19/2019		Company	Leighton
			File Name	Section D - Original Buttress Revised.slmd

APPENDIX D

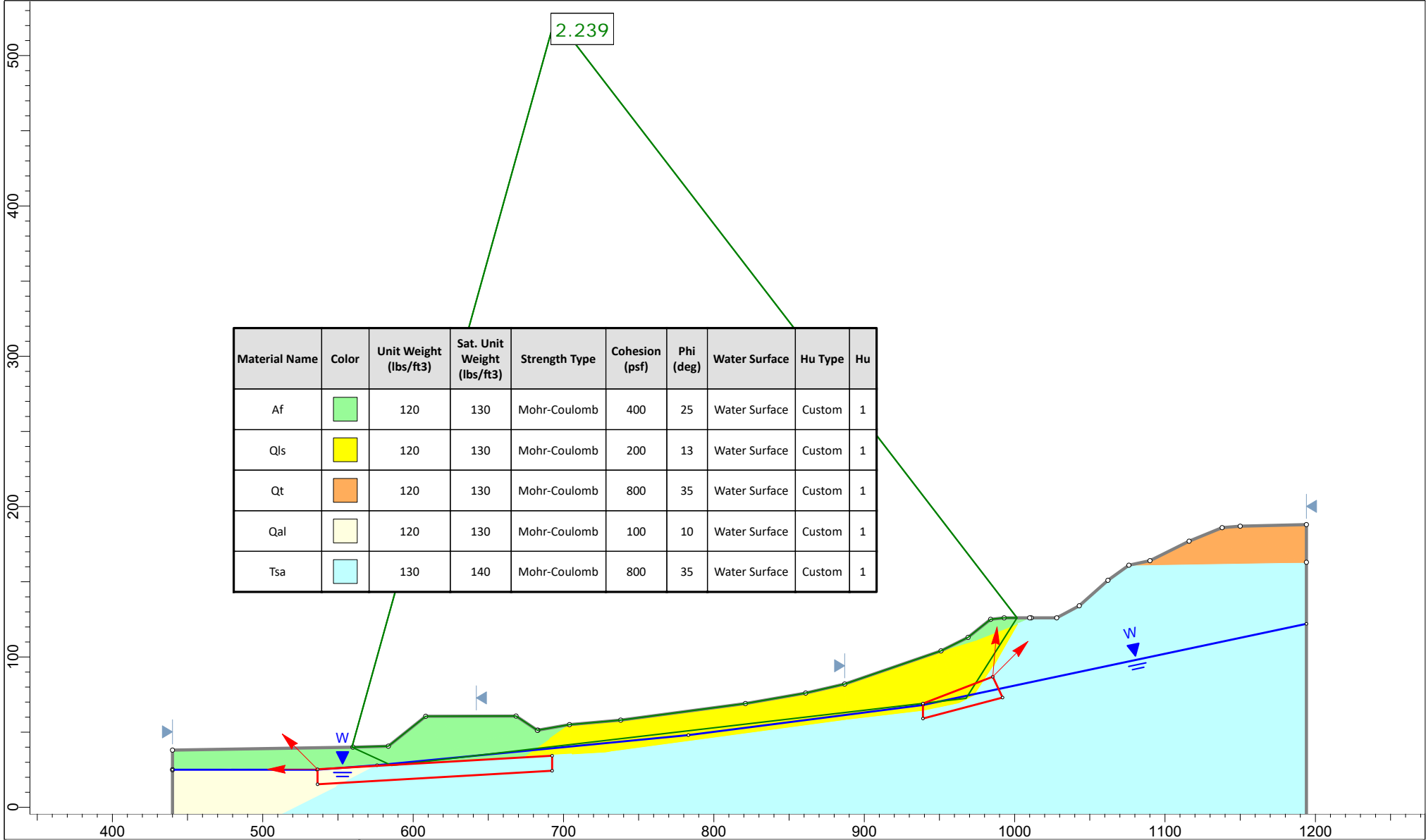
Slope Stability Analyses

Cross-section D-D'

Buttress Fill and

Landslide Removal

Cross Section D

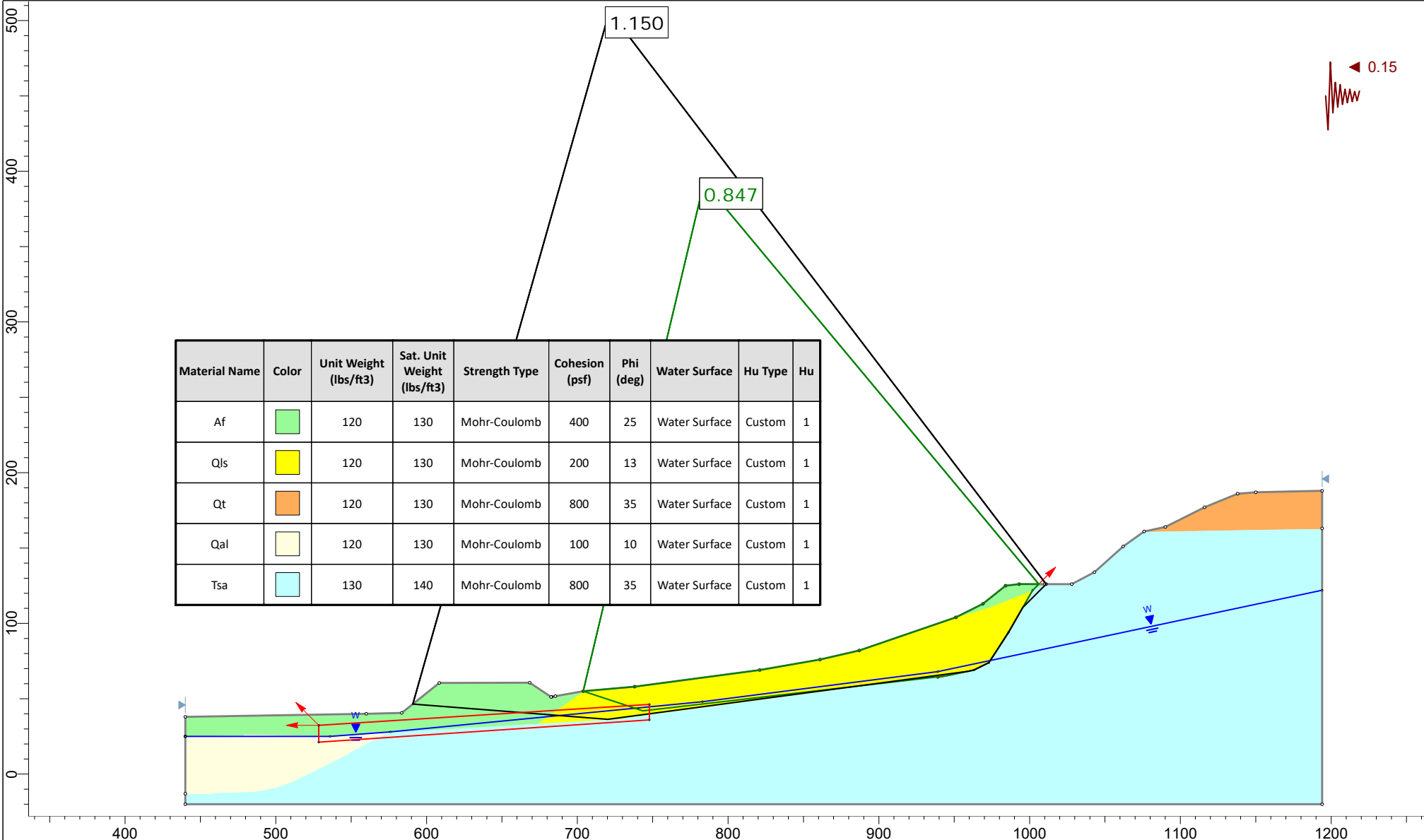


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1




<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Fill and Qls Toe removal - Check Failure Through Fill	
<i>Drawn By</i>	EDB	<i>Scale</i>	1:1080
<i>Date</i>	9/20/2019	<i>Company</i>	Leighton
		<i>File Name</i>	Section D - Fill on toe.slmd

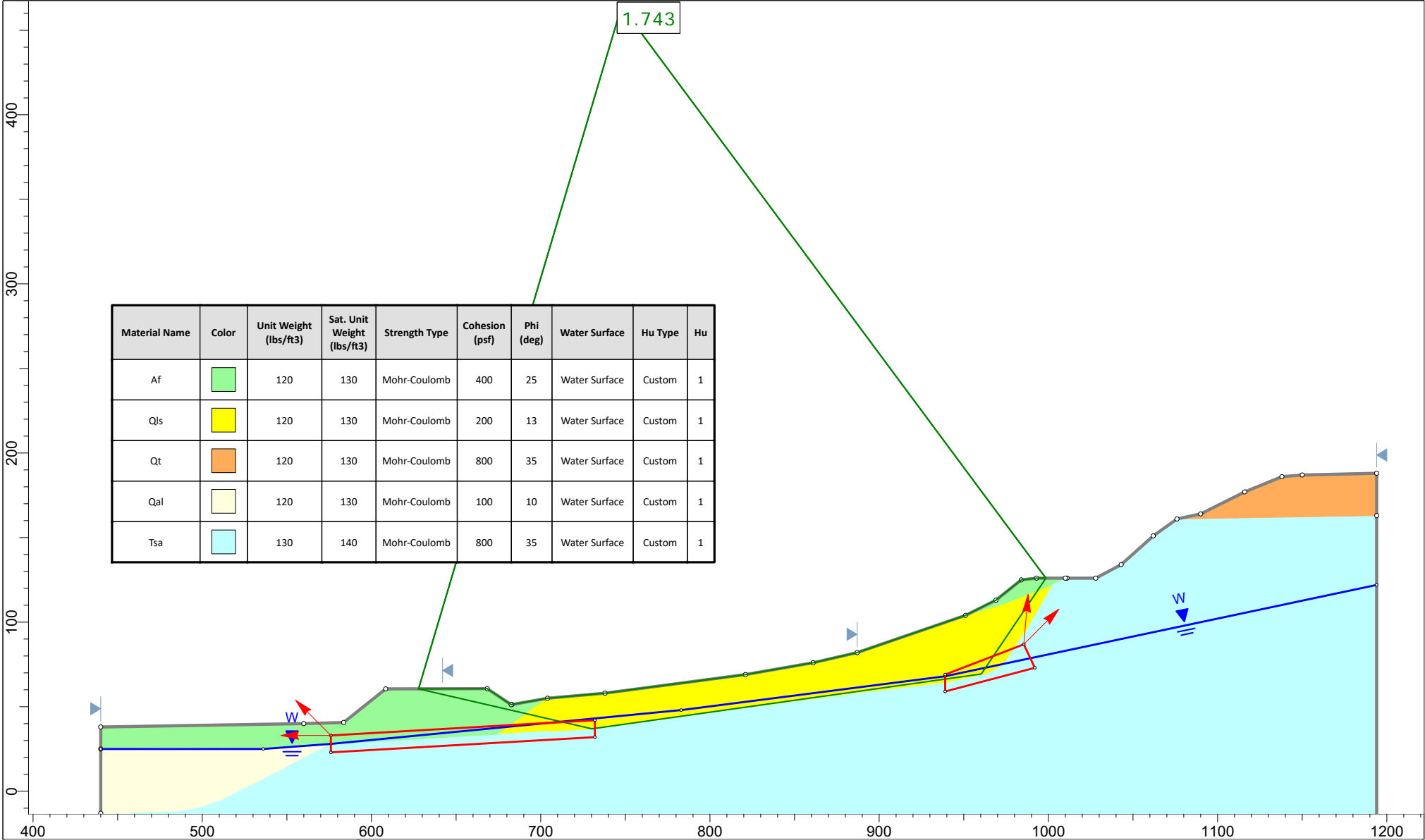
Cross Section D



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af	Green	120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls	Yellow	120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt	Orange	120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal	Light Yellow	120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa	Light Blue	130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

	Project		12085.002 Ocean Creek					
	Analysis Description		Fill and Qls Toe removal - Check Failure Through Fill					
	Drawn By	EDB	Unit	Feet	Scale	1:1080	Company	Leighton
	Date	9/19/2019		File Name	Section D - Fill on toe.slmd			

Cross Section D



1.743

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

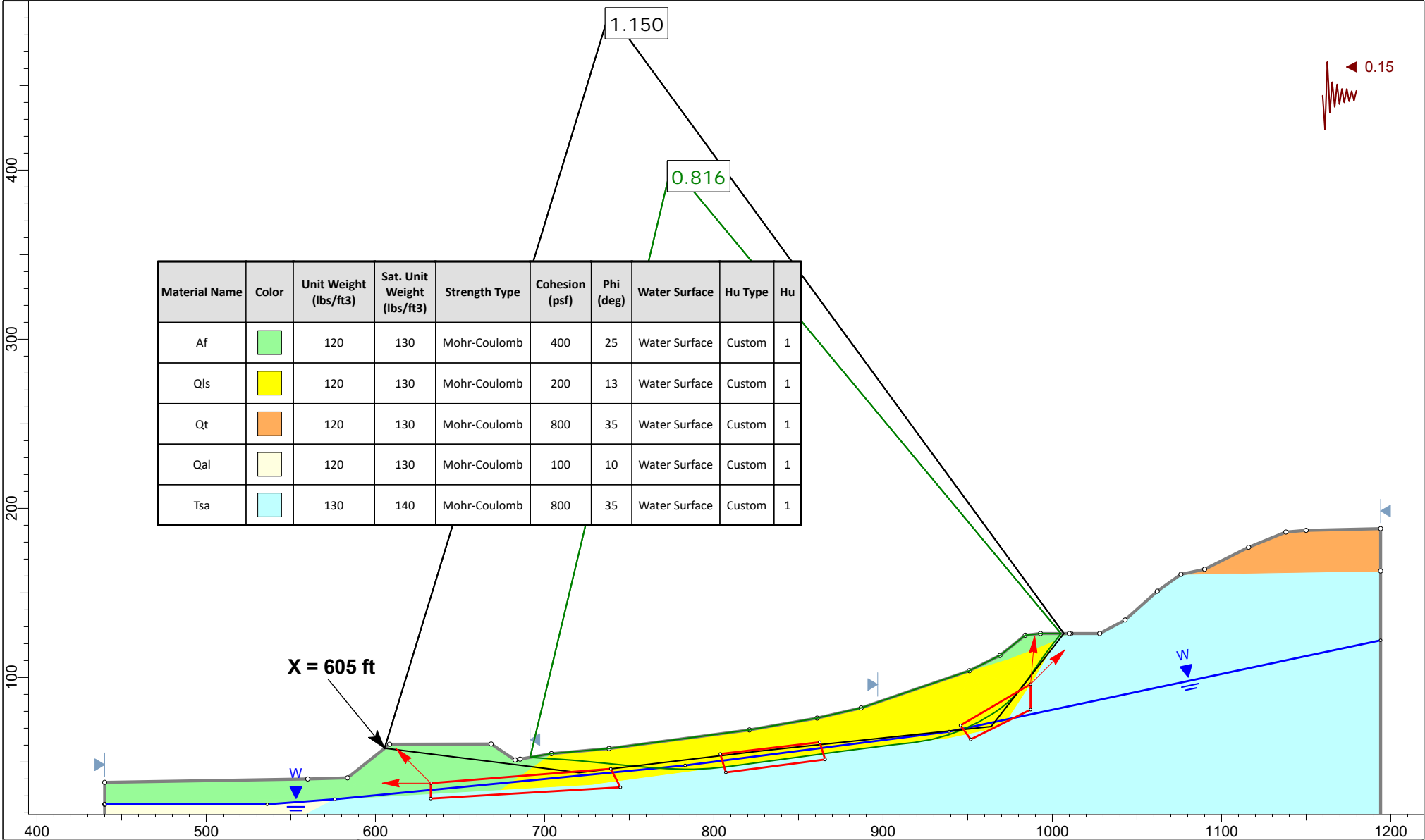



Leighton

SLIDEINTERPRET 8.022

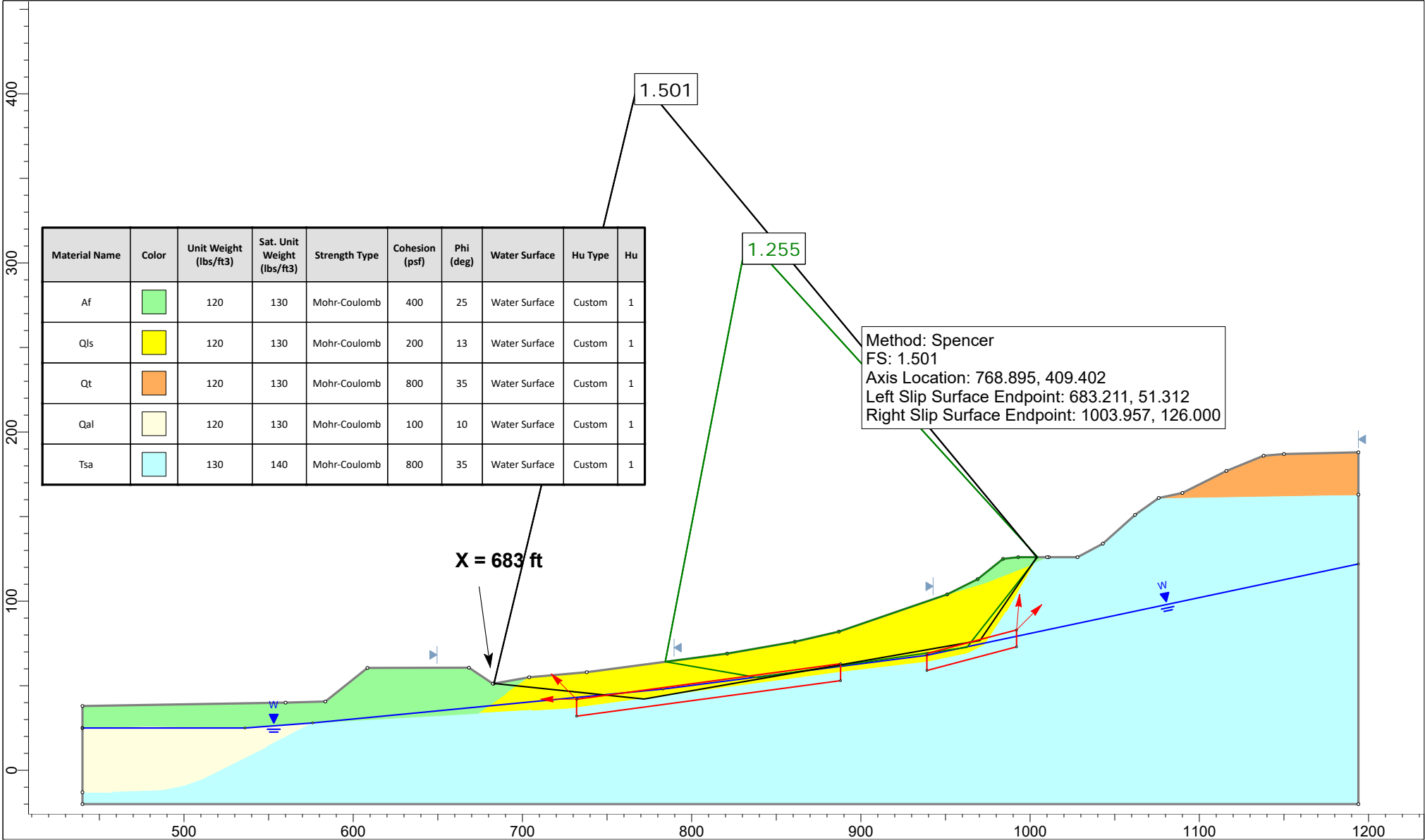
Project		12085.002 Ocean Creek	
Analysis Description		Fill and Qls Toe removal - Check Failure Through Fill	
Drawn By	EDB	Scale	1:960
Date	9/20/2019	Company	Leighton
		File Name	Section D - Fill on toe.slmd

Cross Section D



	Project			12085.002 Ocean Creek		
	Analysis Description			Fill and Qls Toe removal - Check Failure Through Fill		
	Drawn By	EDB	Scale	1:960	Company	Leighton
	Date	9/20/2019	File Name	Section D - Fill on toe.slm		

Cross Section D



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af	Green	120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls	Yellow	120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt	Orange	120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal	Light Yellow	120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa	Light Blue	130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

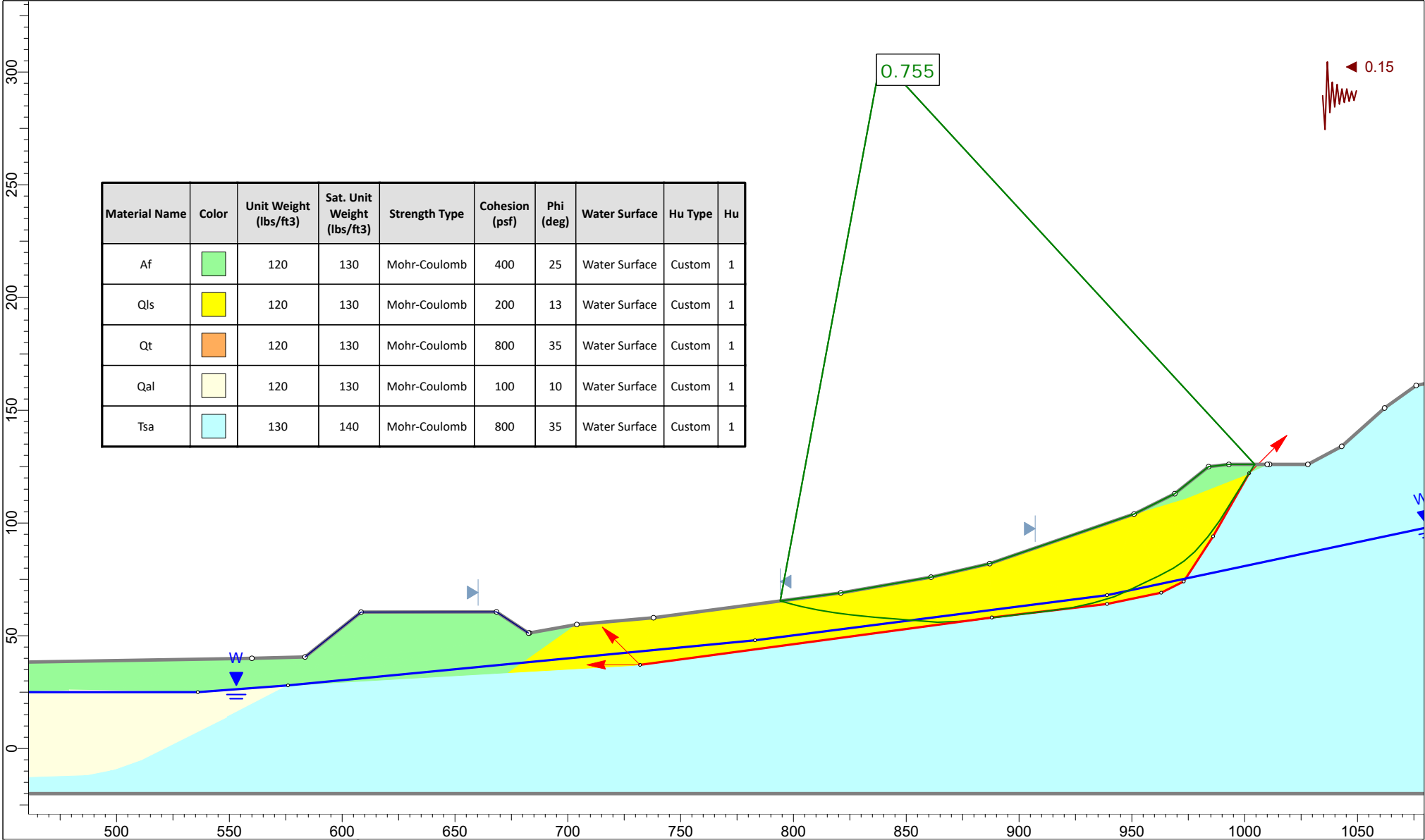
Method: Spencer
 FS: 1.501
 Axis Location: 768.895, 409.402
 Left Slip Surface Endpoint: 683.211, 51.312
 Right Slip Surface Endpoint: 1003.957, 126.000

X = 683 ft




Project		12085.002 Ocean Creek	
Analysis Description		Fill and Qls Toe removal - Check Failure Through Qls	
Drawn By	EDB	Scale	1:960
		Company	Leighton
Date	9/20/2019	File Name	Section D - Fill on toe.slmd

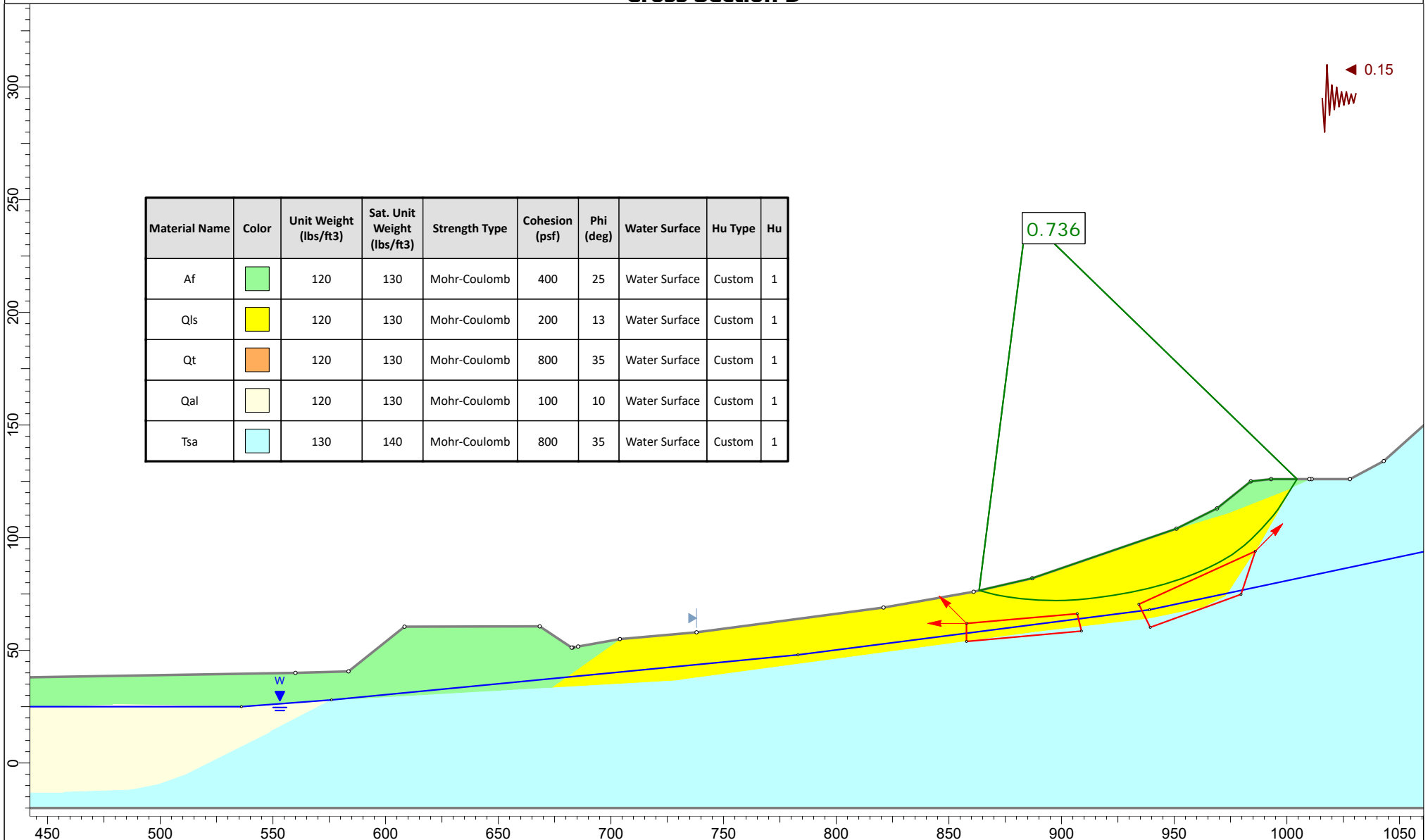
Cross Section D



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

	Project				12085.002 Ocean Creek			
	Analysis Description				Cross Section D - Existing Site - Check Failure Through Qls			
	Drawn By	EDB	Unit	Feet	Scale	1:720	Company	Leighton
	Date	9/19/2019				File Name	Section D - Fill on toe.slmd	
	<small>SLIDEINTERPRET 8.023</small>							

Cross Section D



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1

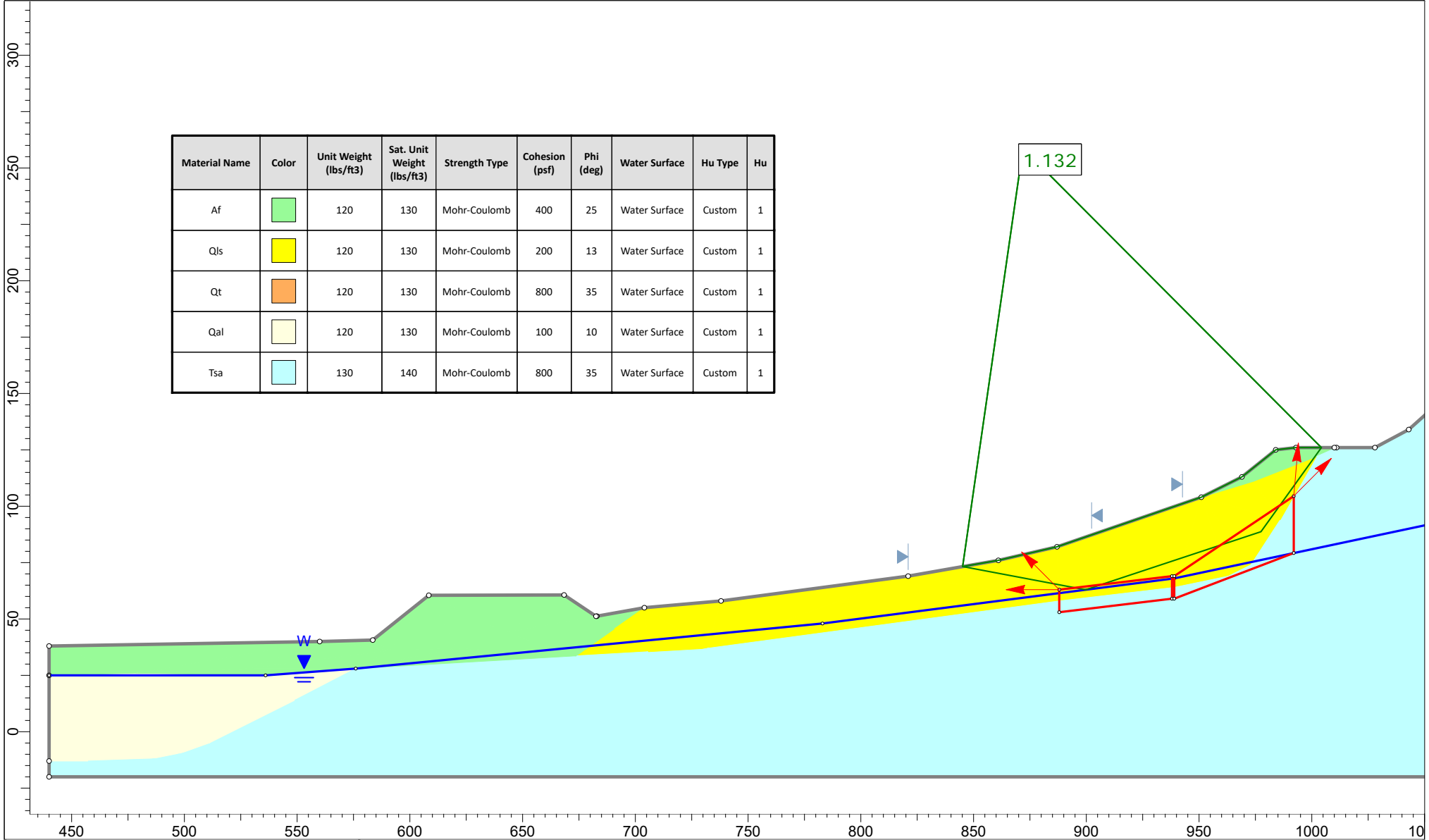


SLIDEINTERPRET 8.023

Project				12085.002 Ocean Creek			
Analysis Description				Fill and Qls Toe removal - Check Failure Through Qls			
Drawn By	EDB	Unit	Feet	Scale	1:720	Company	Leighton
Date	9/19/2019				File Name	Section D - Fill on toe.slmd	

Cross Section D

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Af		120	130	Mohr-Coulomb	400	25	Water Surface	Custom	1
Qls		120	130	Mohr-Coulomb	200	13	Water Surface	Custom	1
Qt		120	130	Mohr-Coulomb	800	35	Water Surface	Custom	1
Qal		120	130	Mohr-Coulomb	100	10	Water Surface	Custom	1
Tsa		130	140	Mohr-Coulomb	800	35	Water Surface	Custom	1



<i>Project</i>		12085.002 Ocean Creek	
<i>Analysis Description</i>		Fill and Qls Toe removal - Check Failure Through Qls Upper Slope	
<i>Drawn By</i>	EDB	<i>Unit</i>	Feet
<i>Scale</i>	1:720	<i>Company</i>	Leighton
<i>Date</i>	9/19/2019	<i>File Name</i>	Section D - Fill on toe.slmd

APPENDIX E

Liquefaction Analysis

TABLE OF CONTENTS

CPT-1 results	
Summary data report	1
Vertical settlements summary report	8
Lateral displacements summary report	9
CPT-2 results	
Summary data report	10
Vertical settlements summary report	17
Lateral displacements summary report	18
CPT-3 results	
Summary data report	19
Vertical settlements summary report	26
Lateral displacements summary report	27

LIQUEFACTION ANALYSIS REPORT

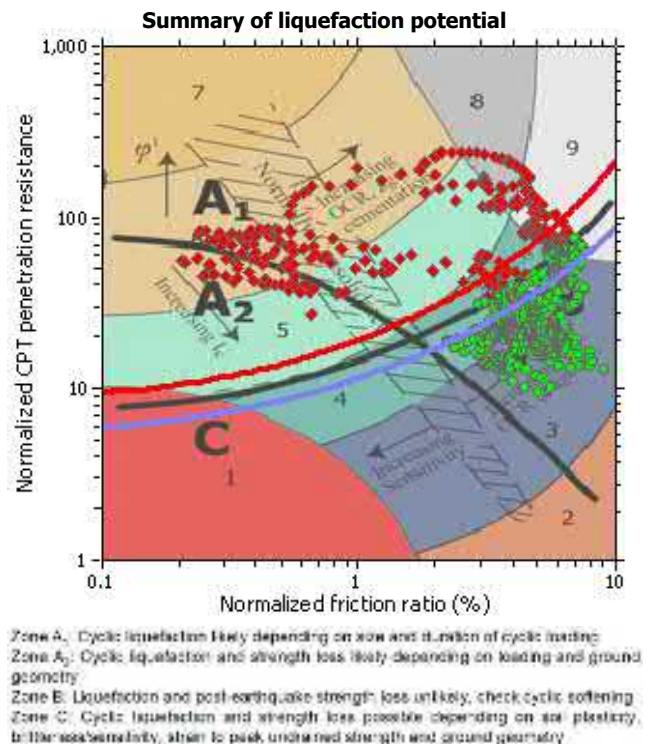
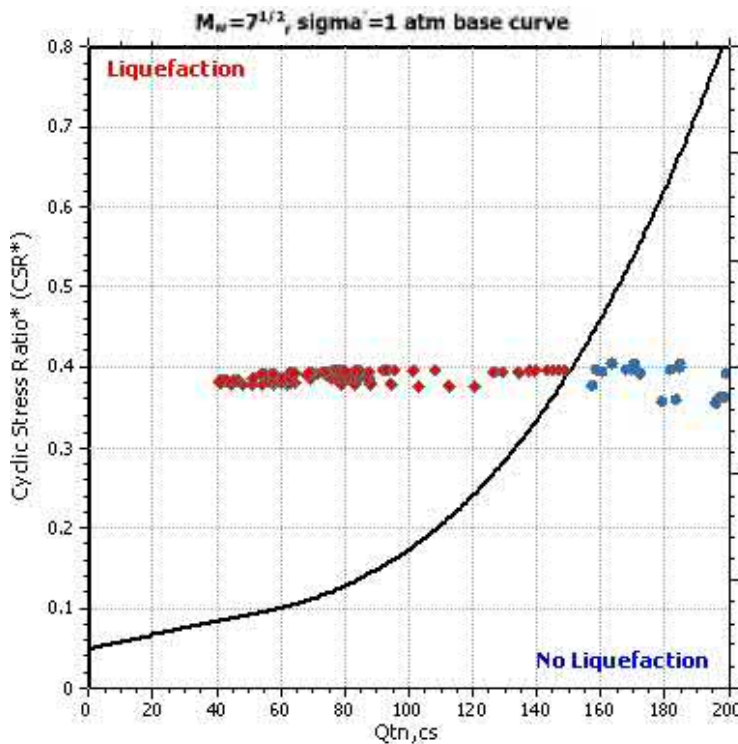
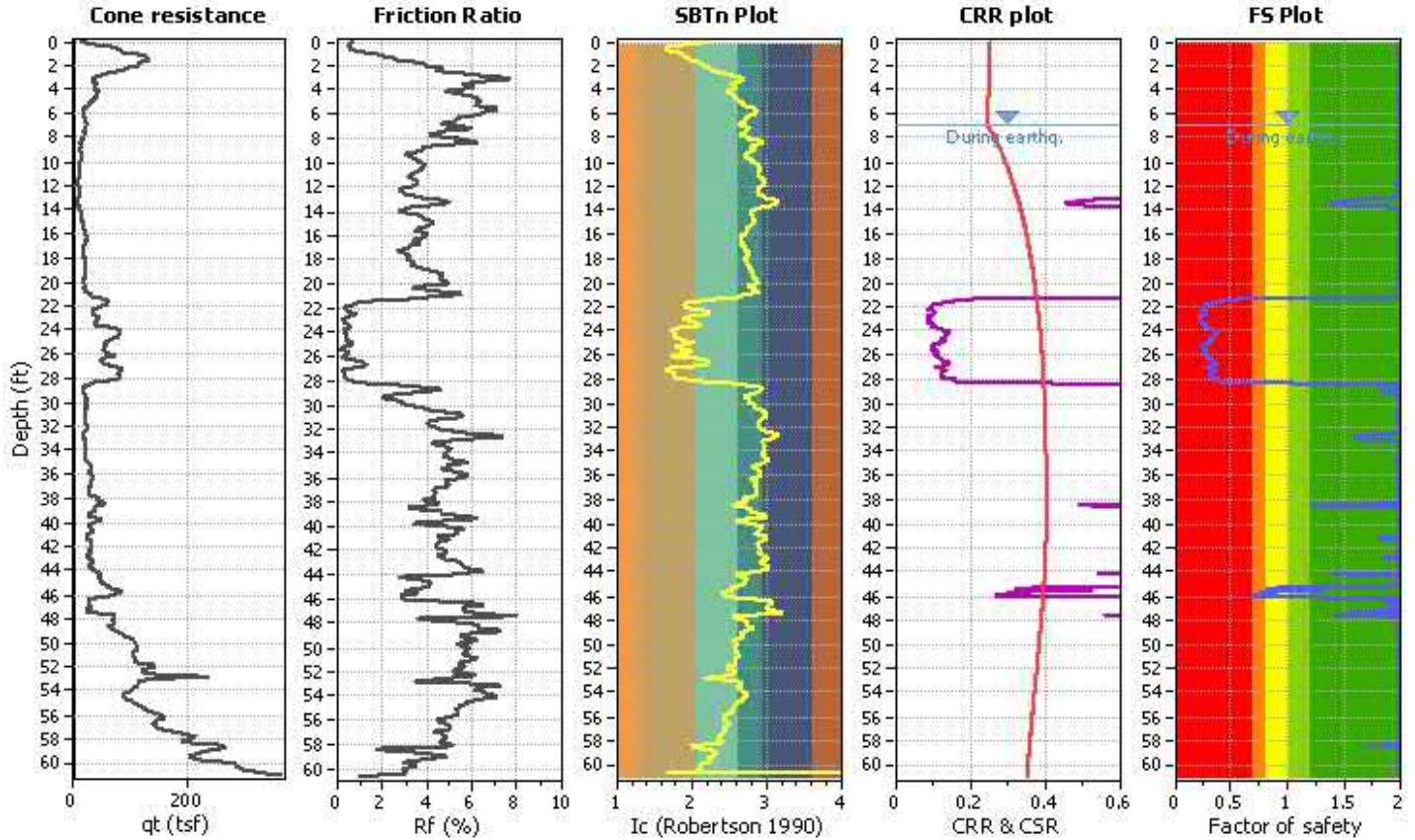
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Location :

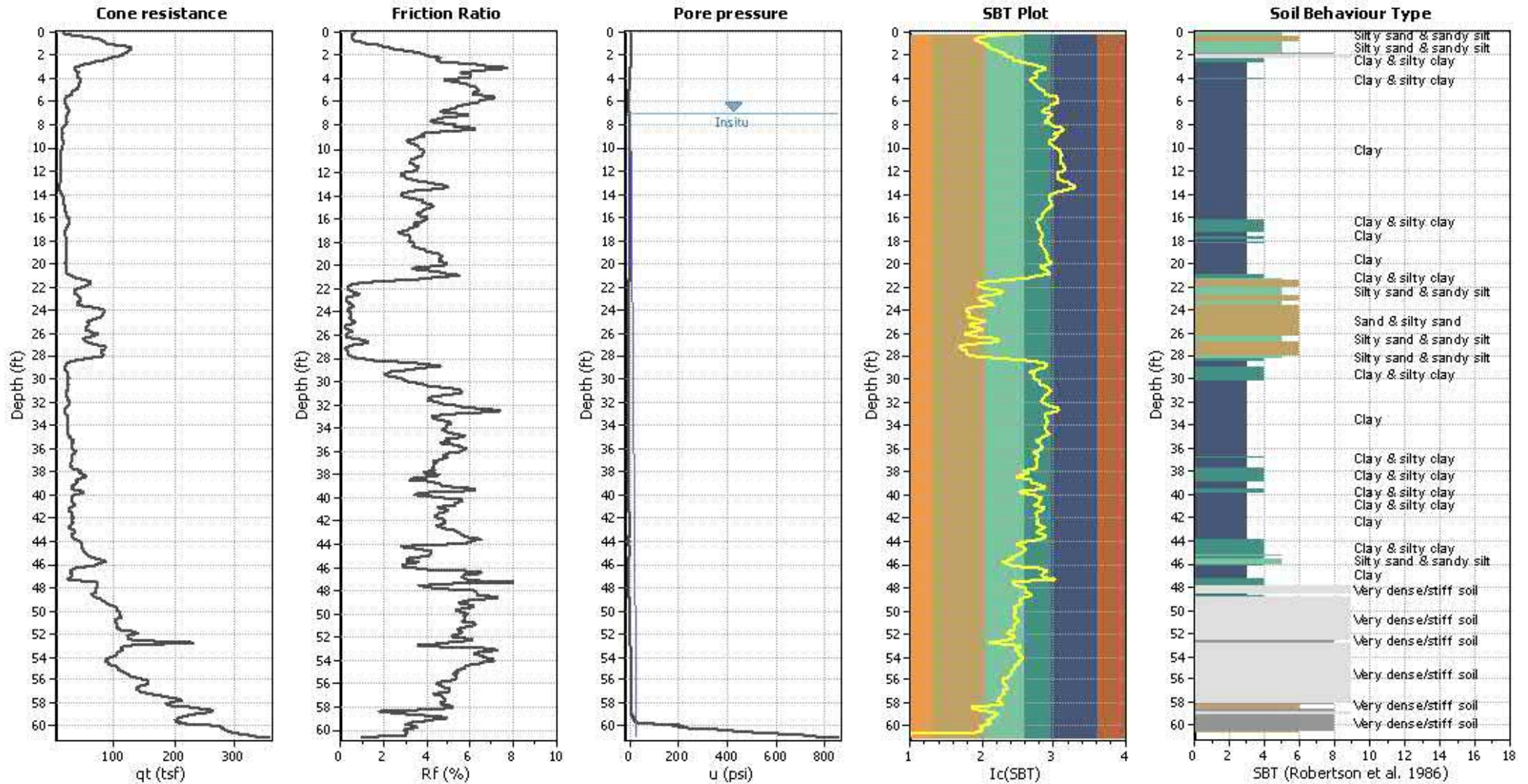
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	7.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.48	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



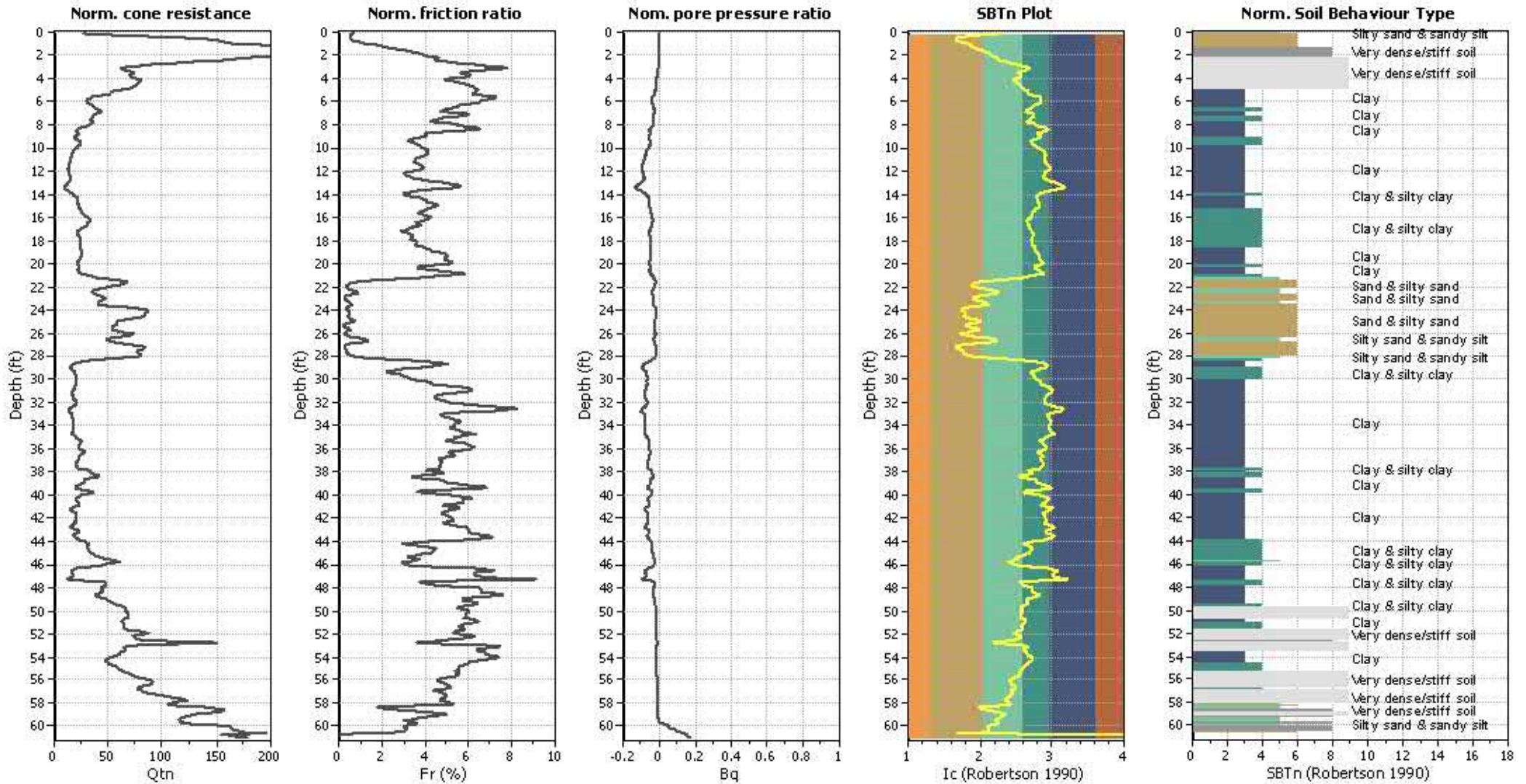
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



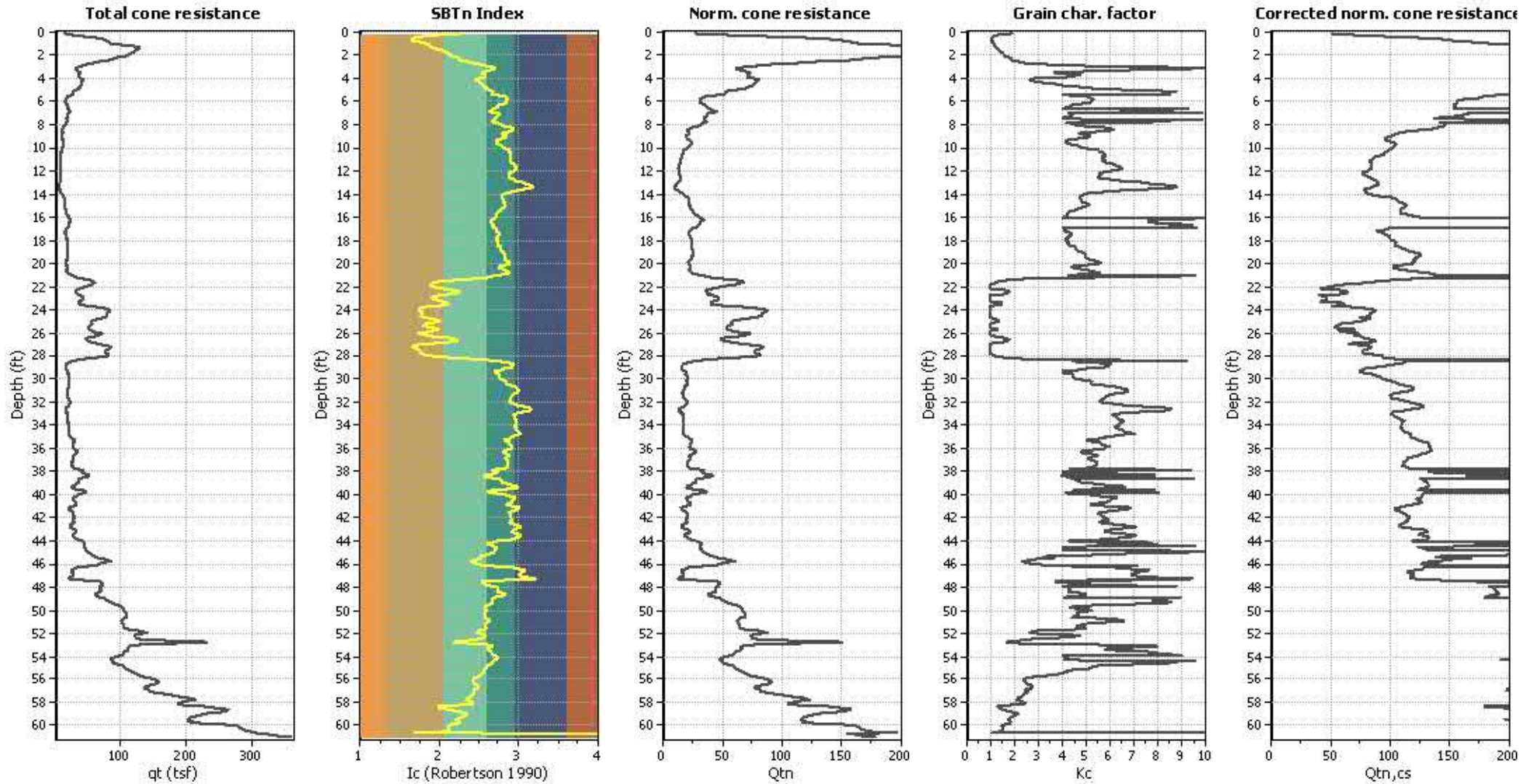
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

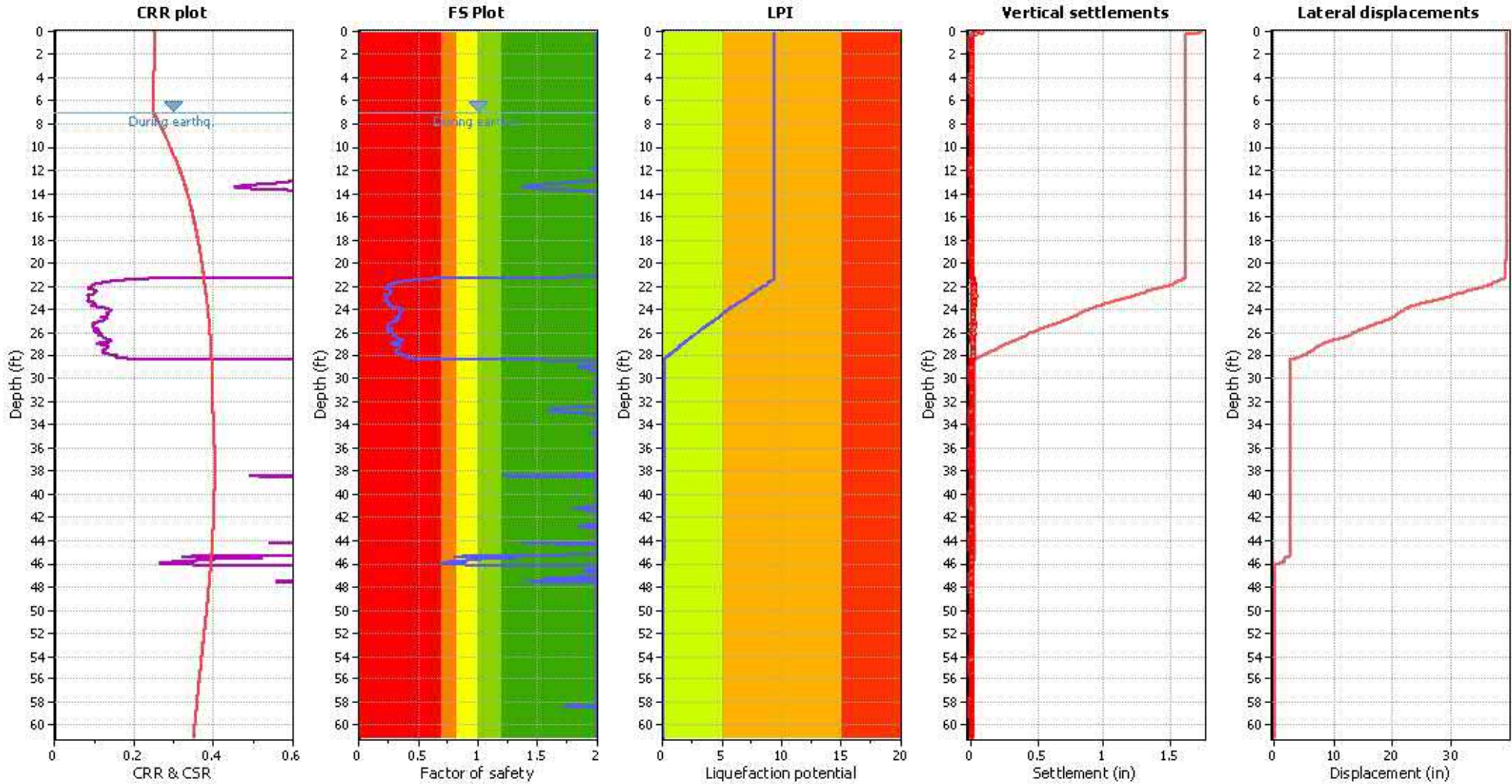
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{cs} applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

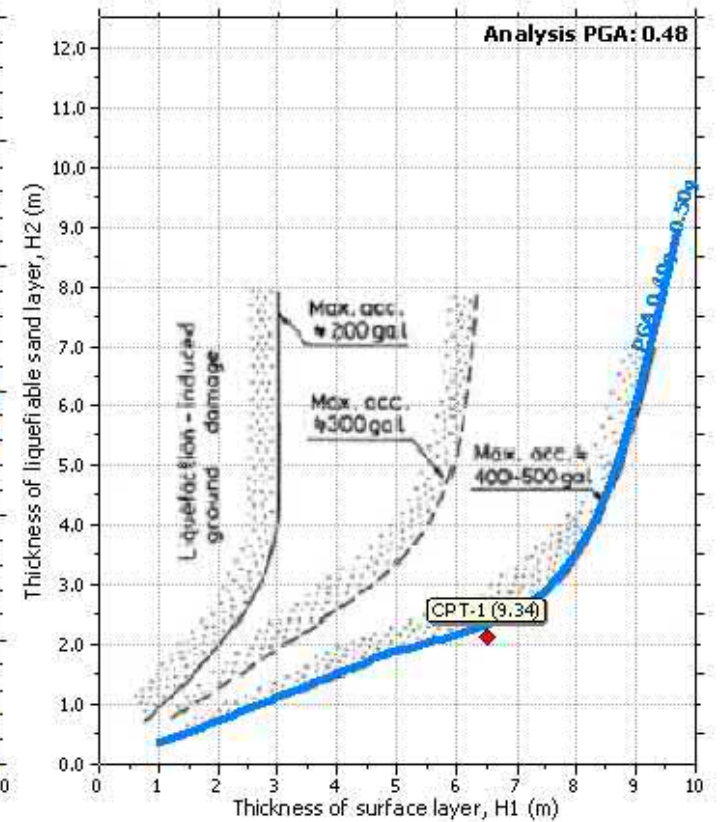
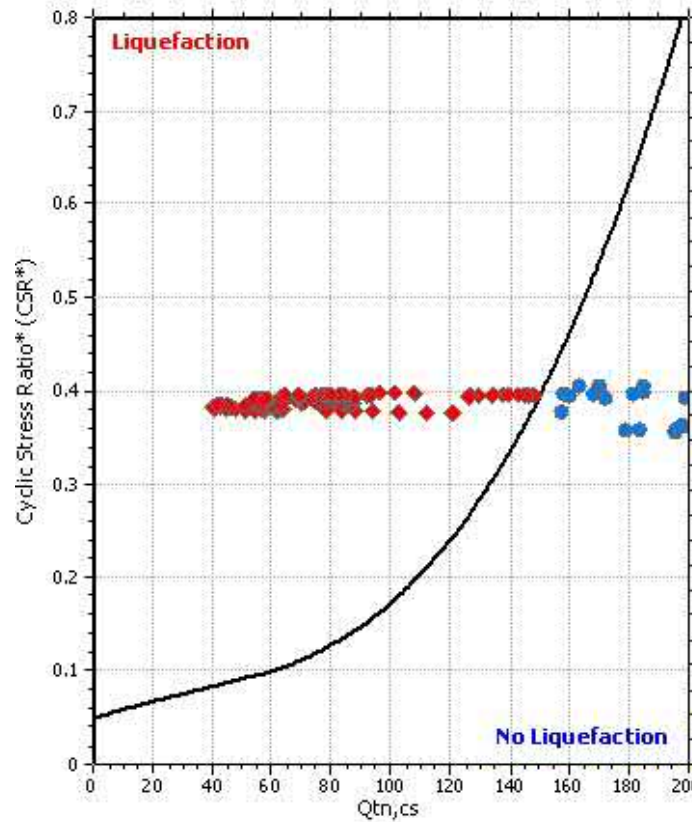
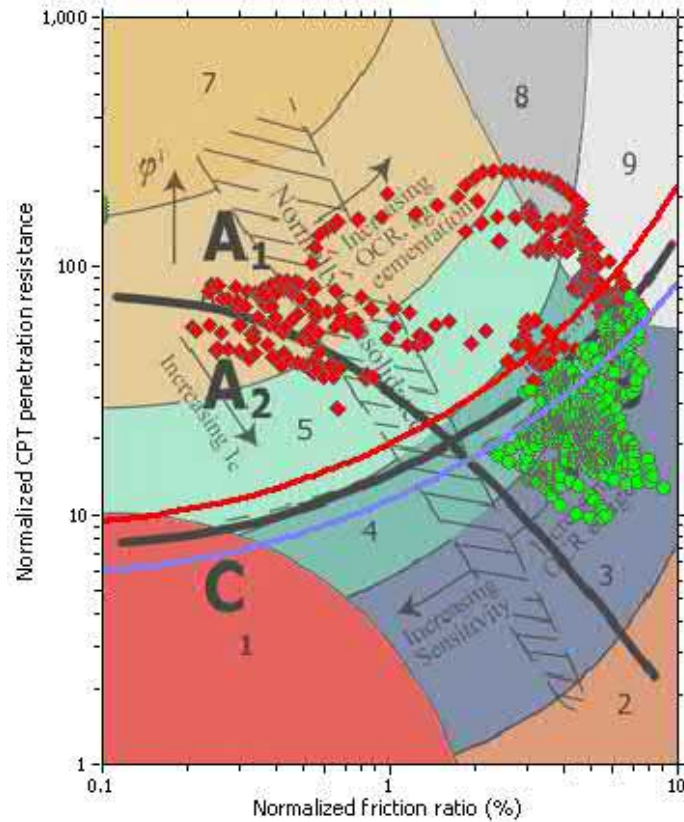
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

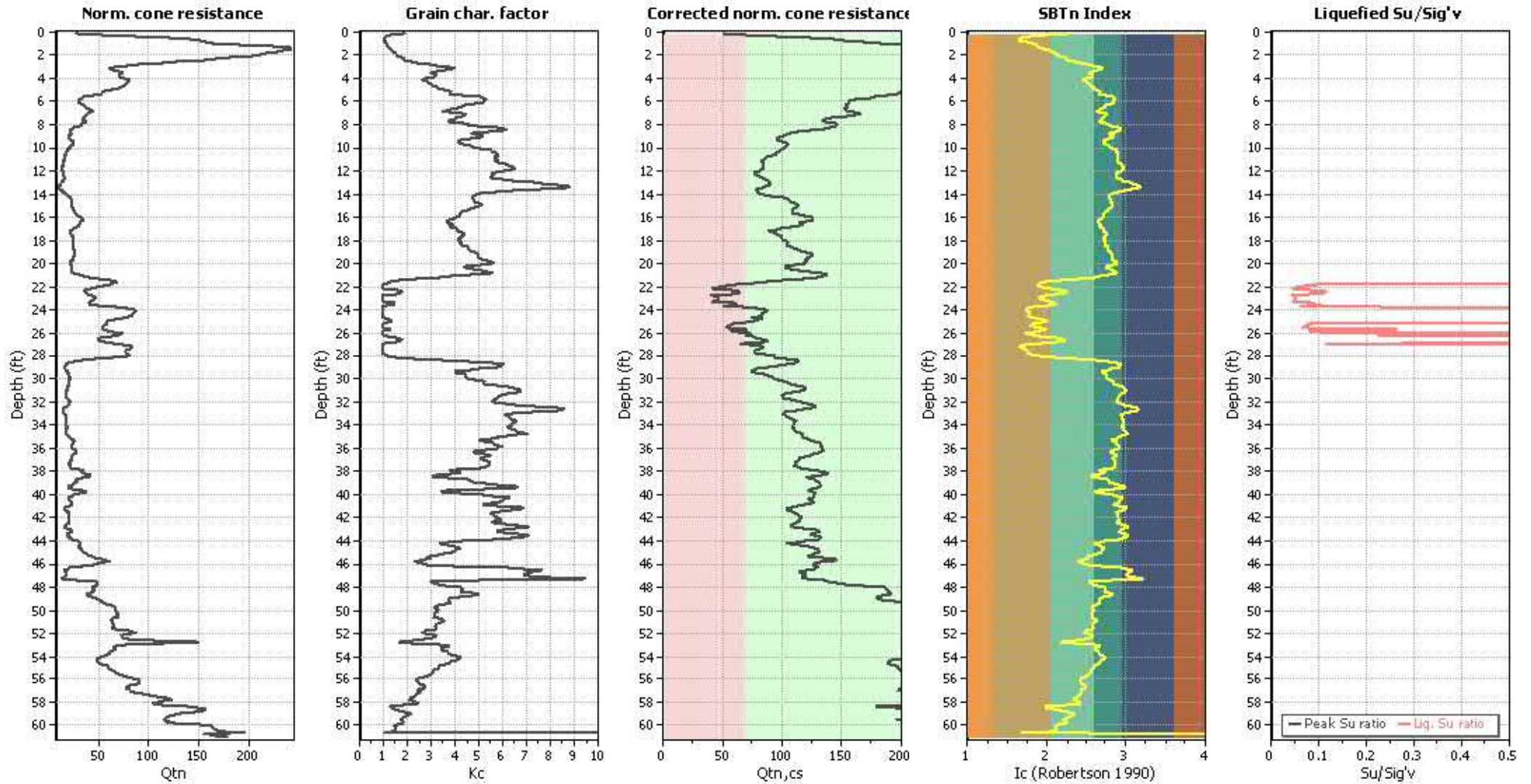
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

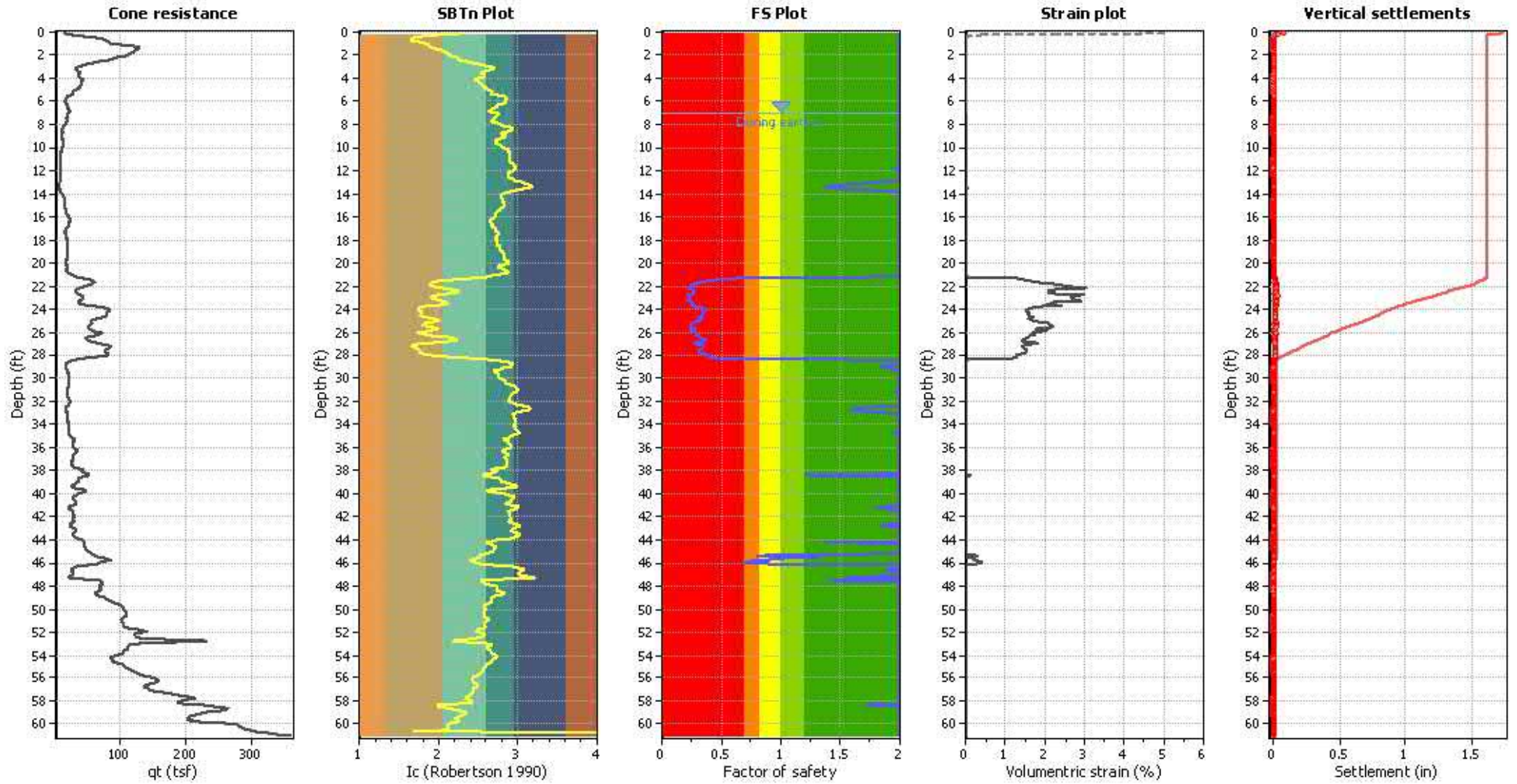
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

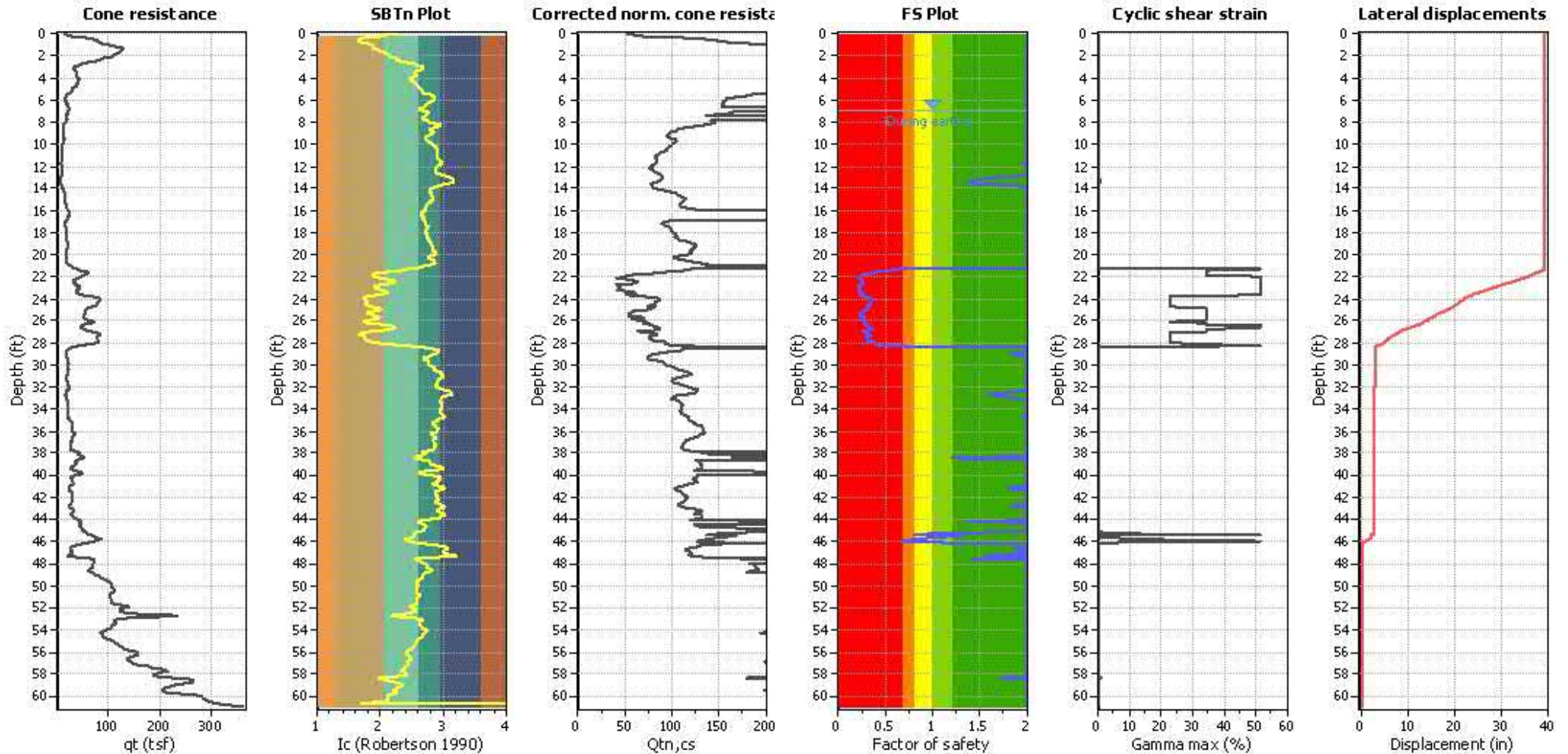


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

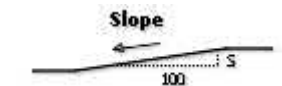


Abbreviations

qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
 Ic: Soil Behaviour Type Index
 $Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance

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

Surface condition



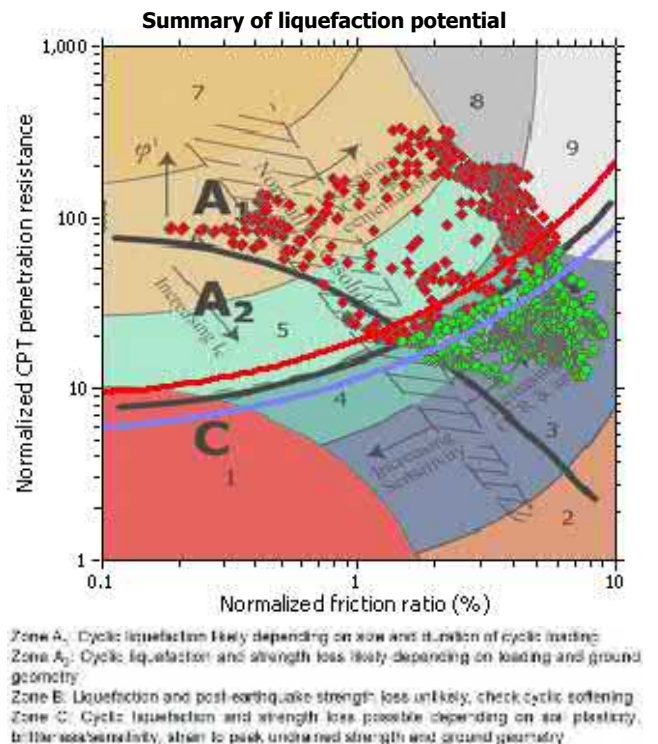
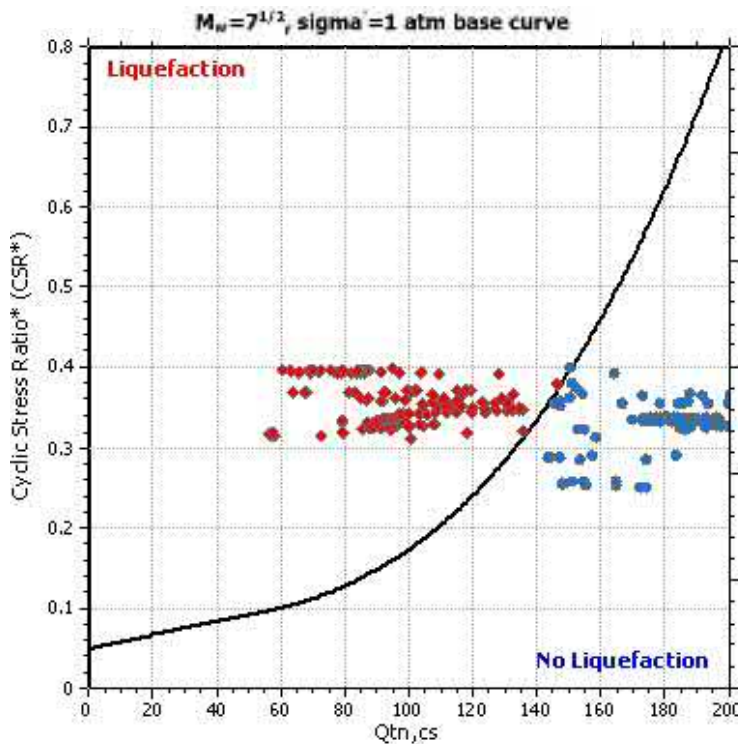
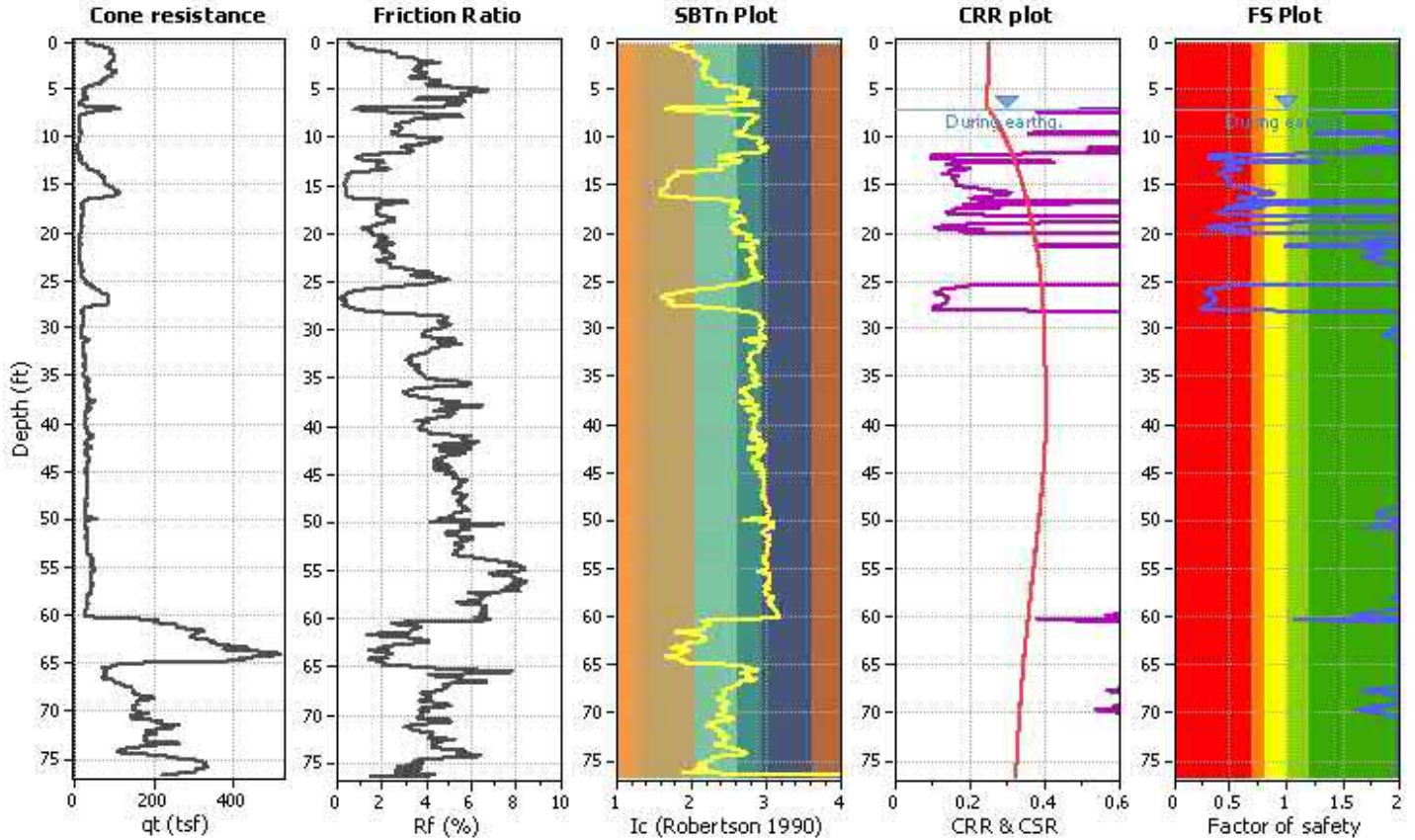
LIQUEFACTION ANALYSIS REPORT

Project title : 12085.002 - JPI Ocean Creek
CPT file : CPT-2

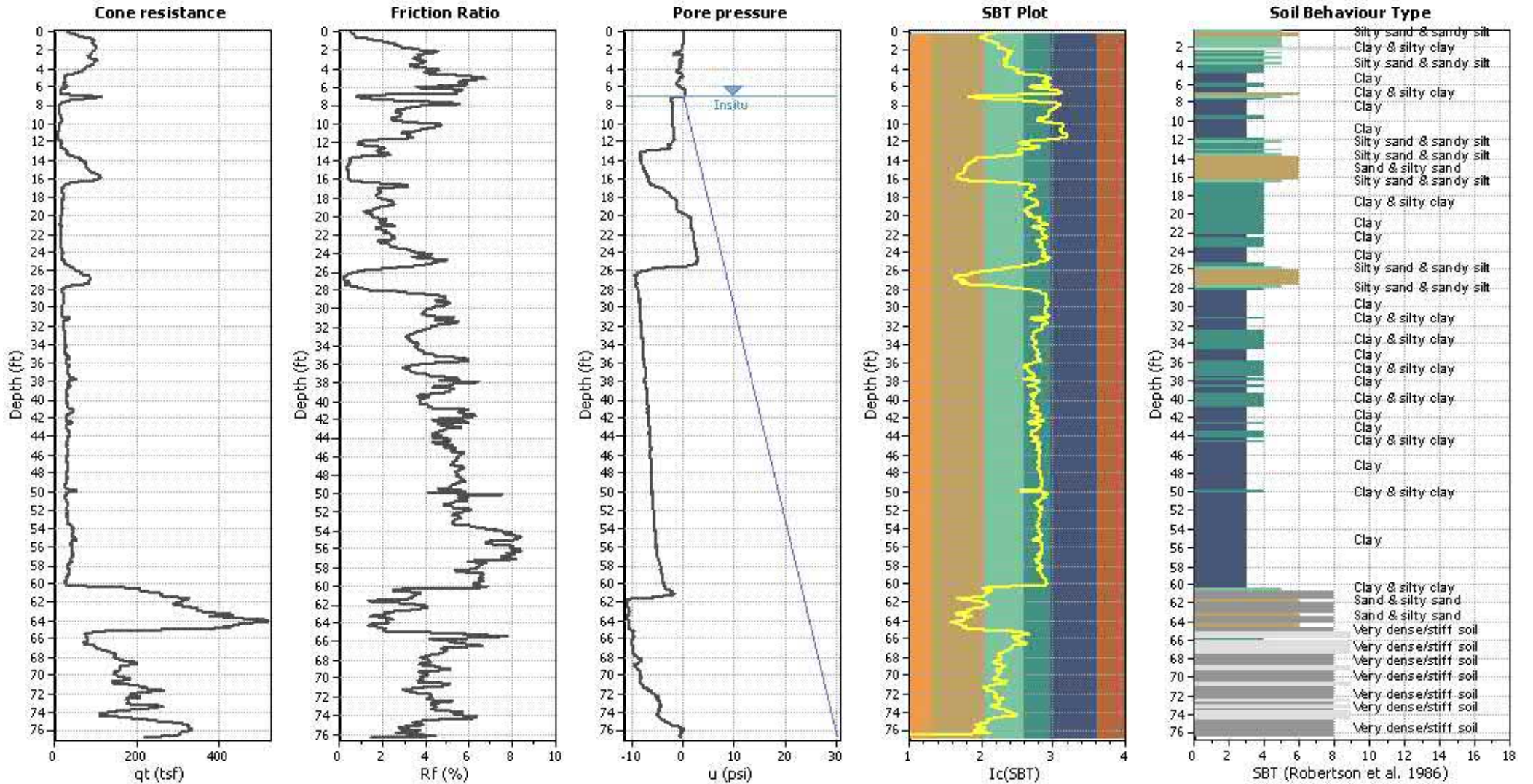
Location :

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	7.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.48	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



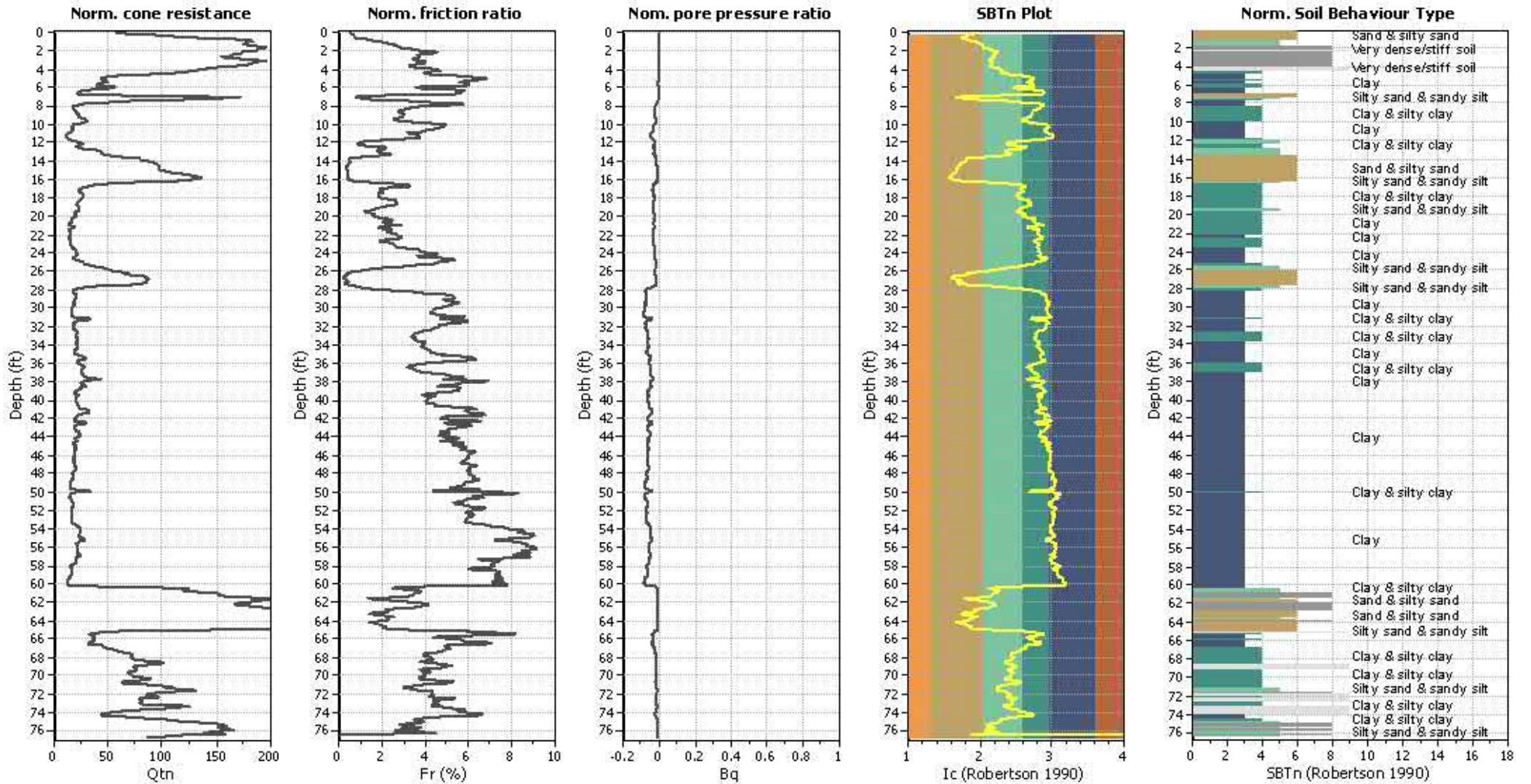
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



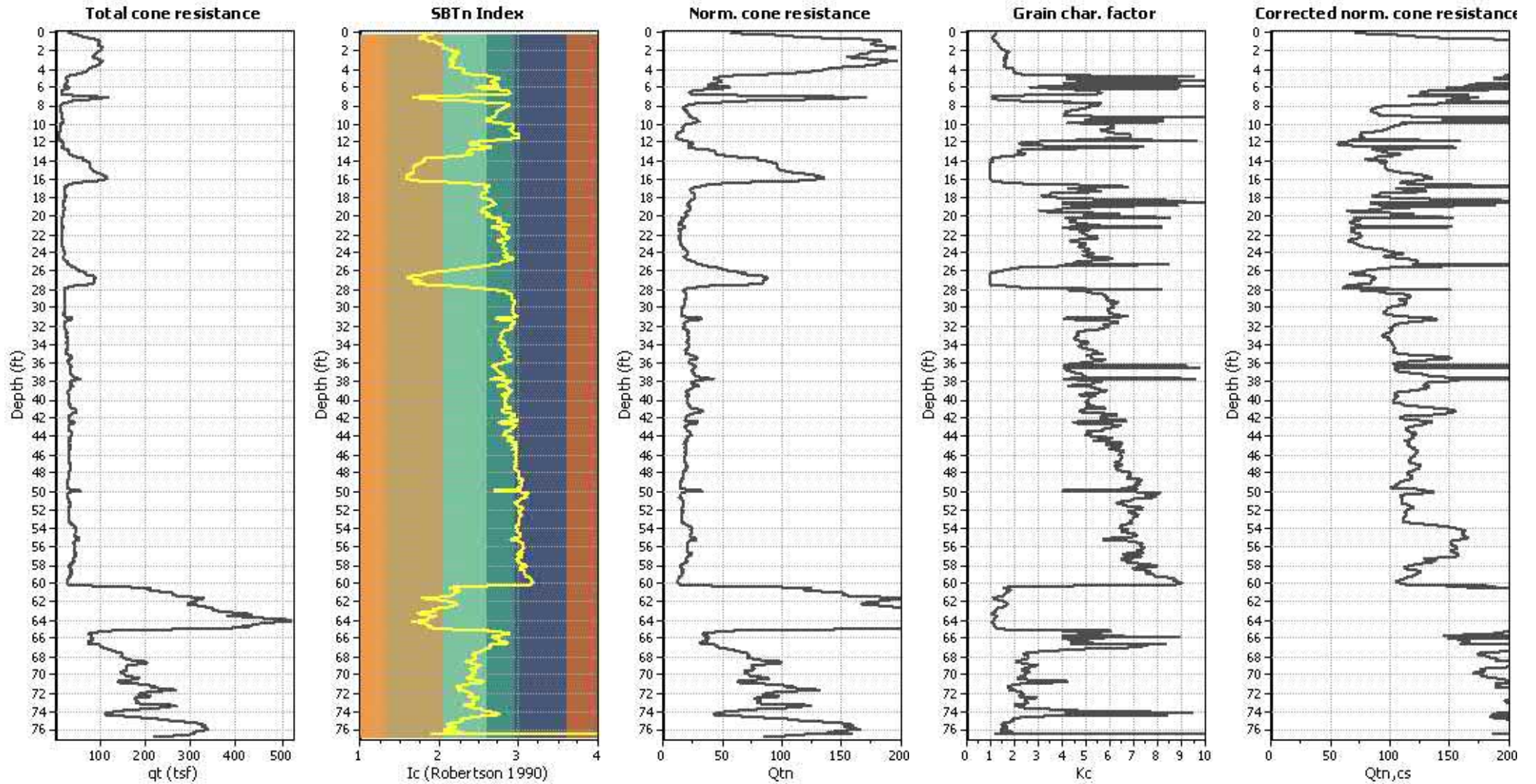
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

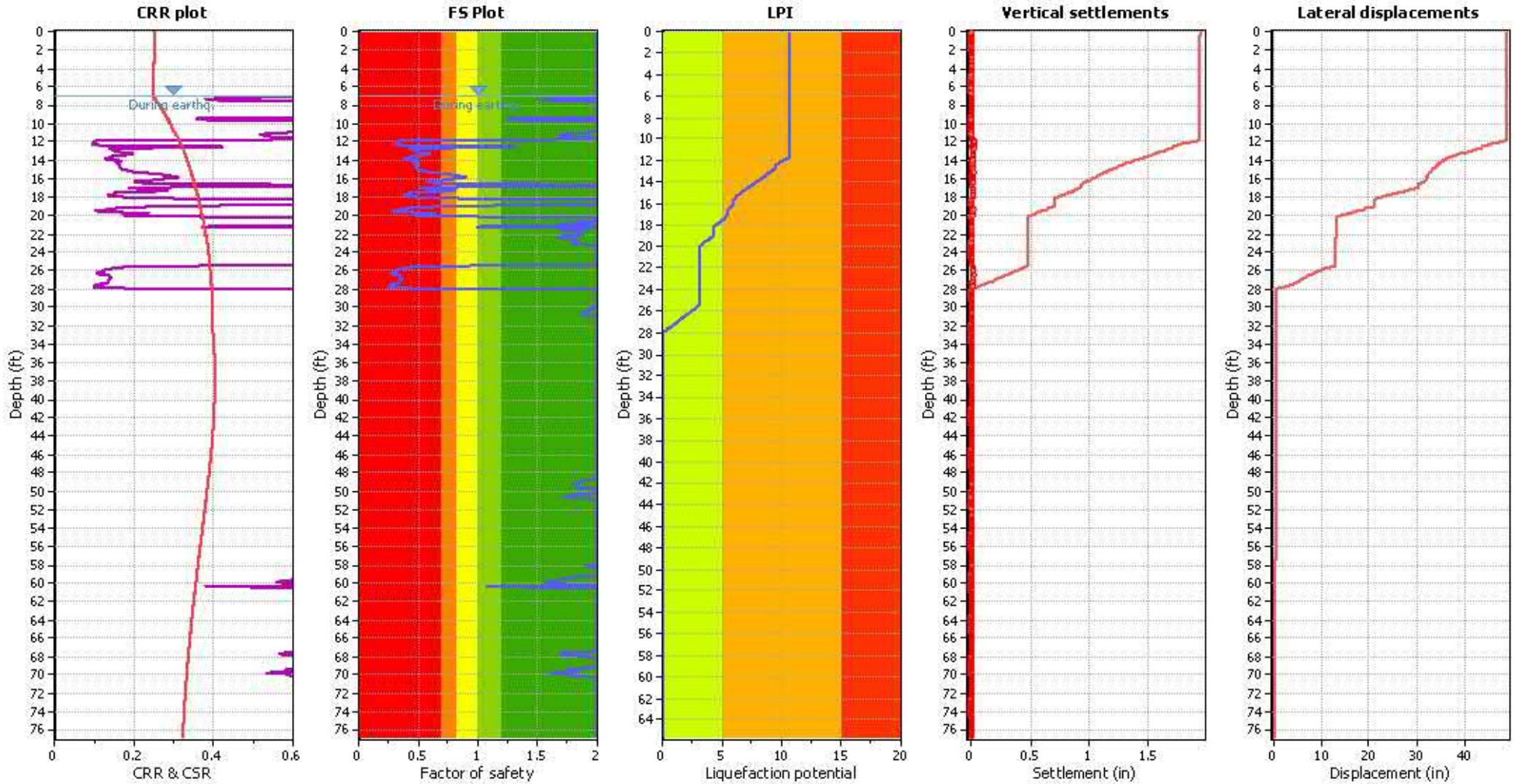
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

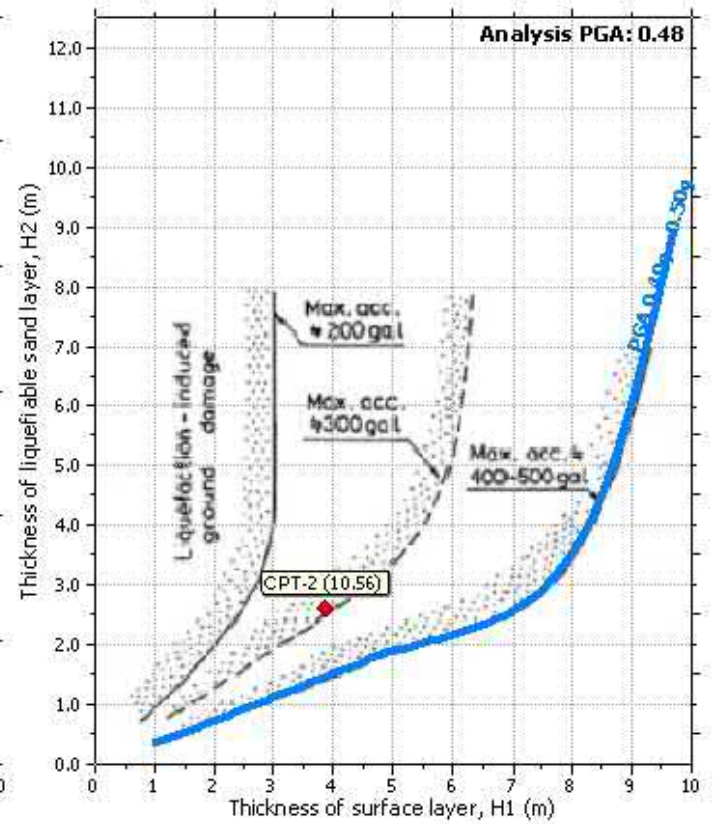
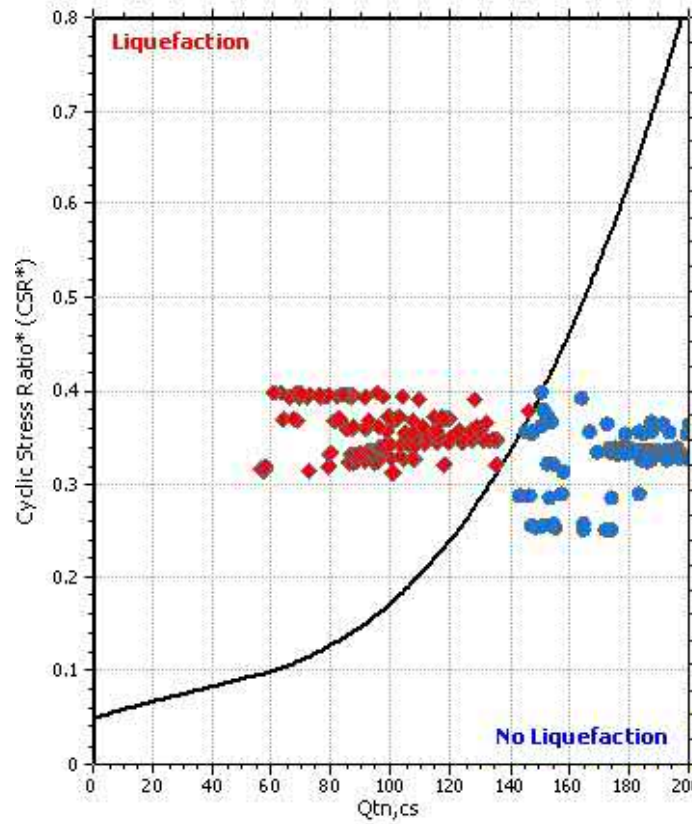
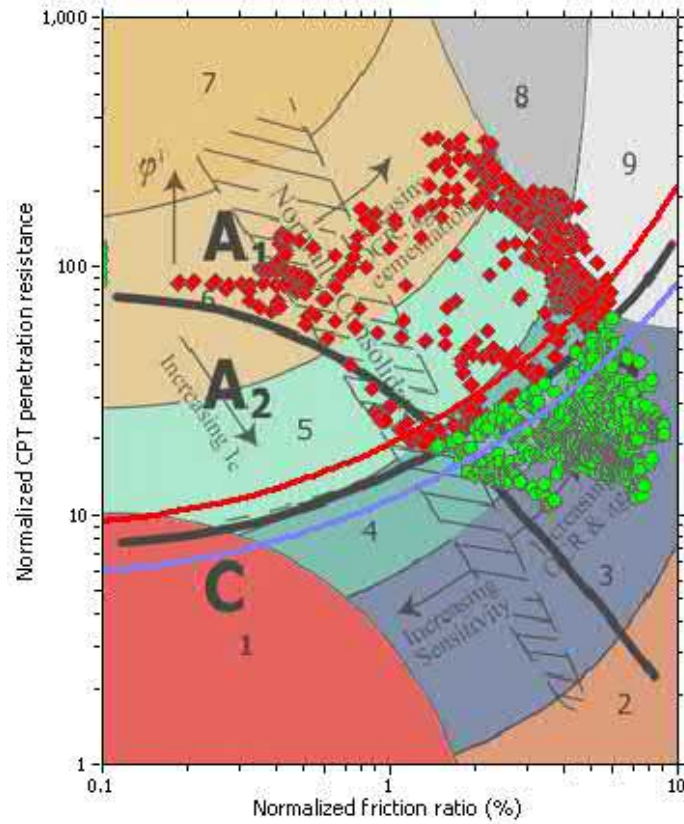
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

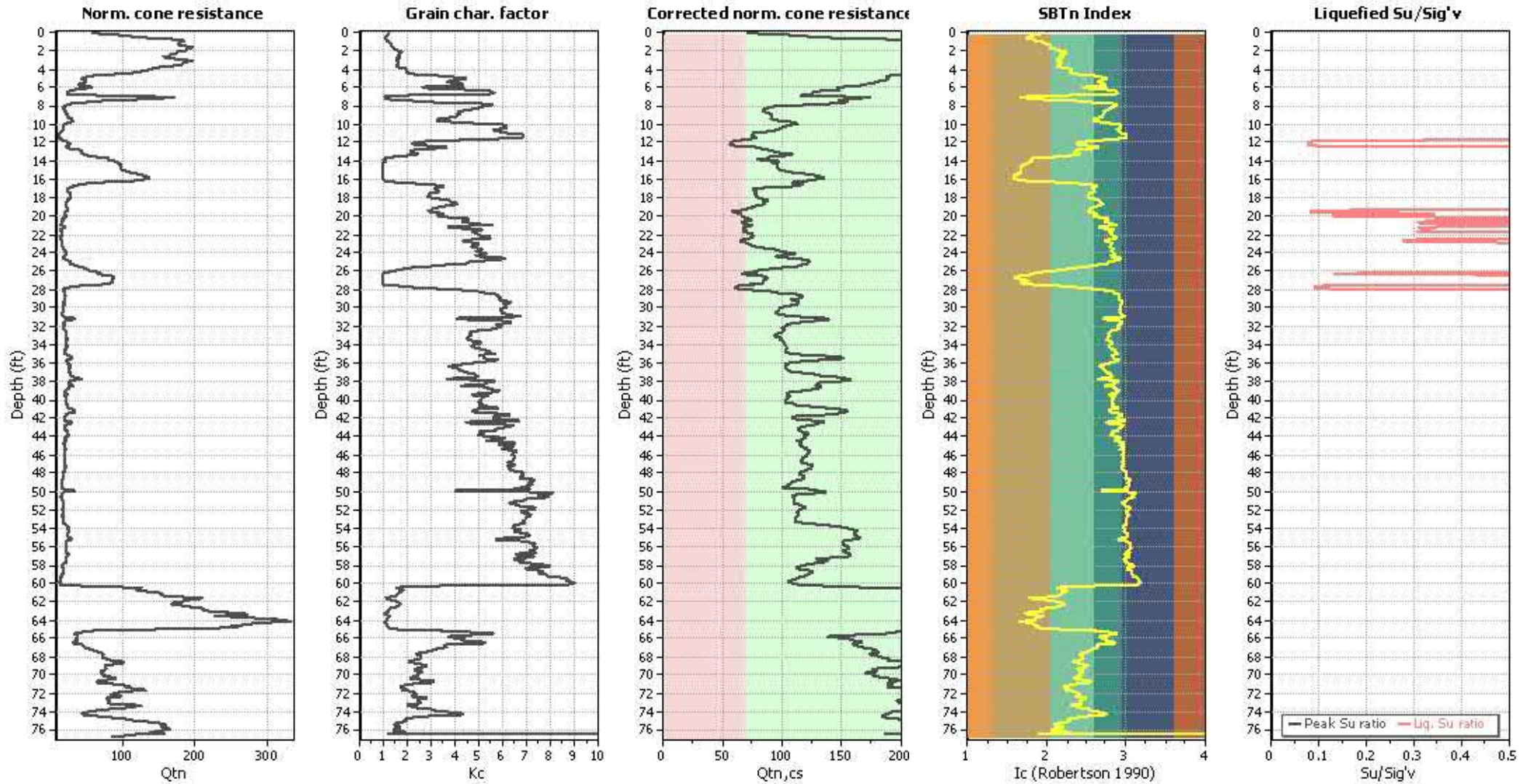
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

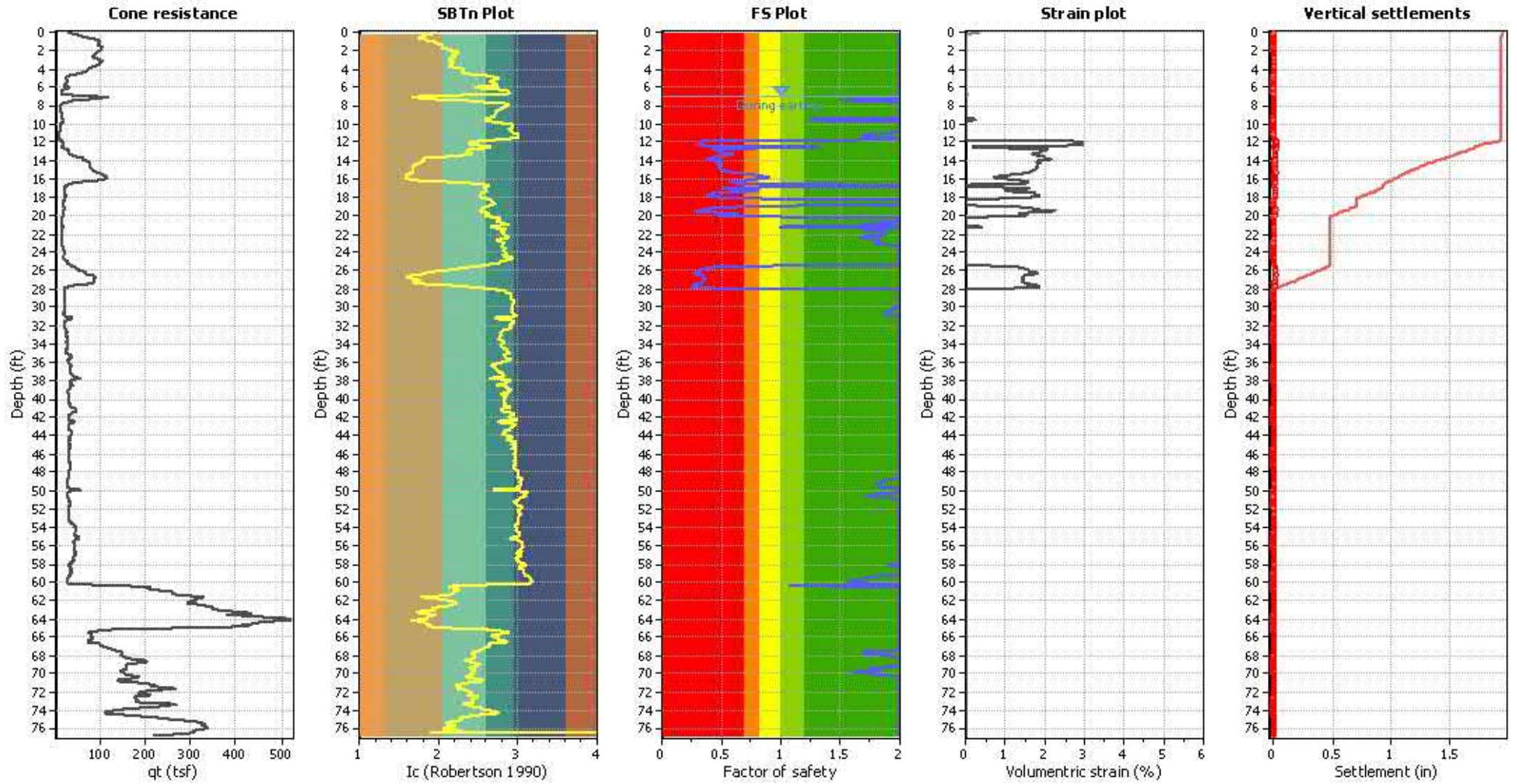
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

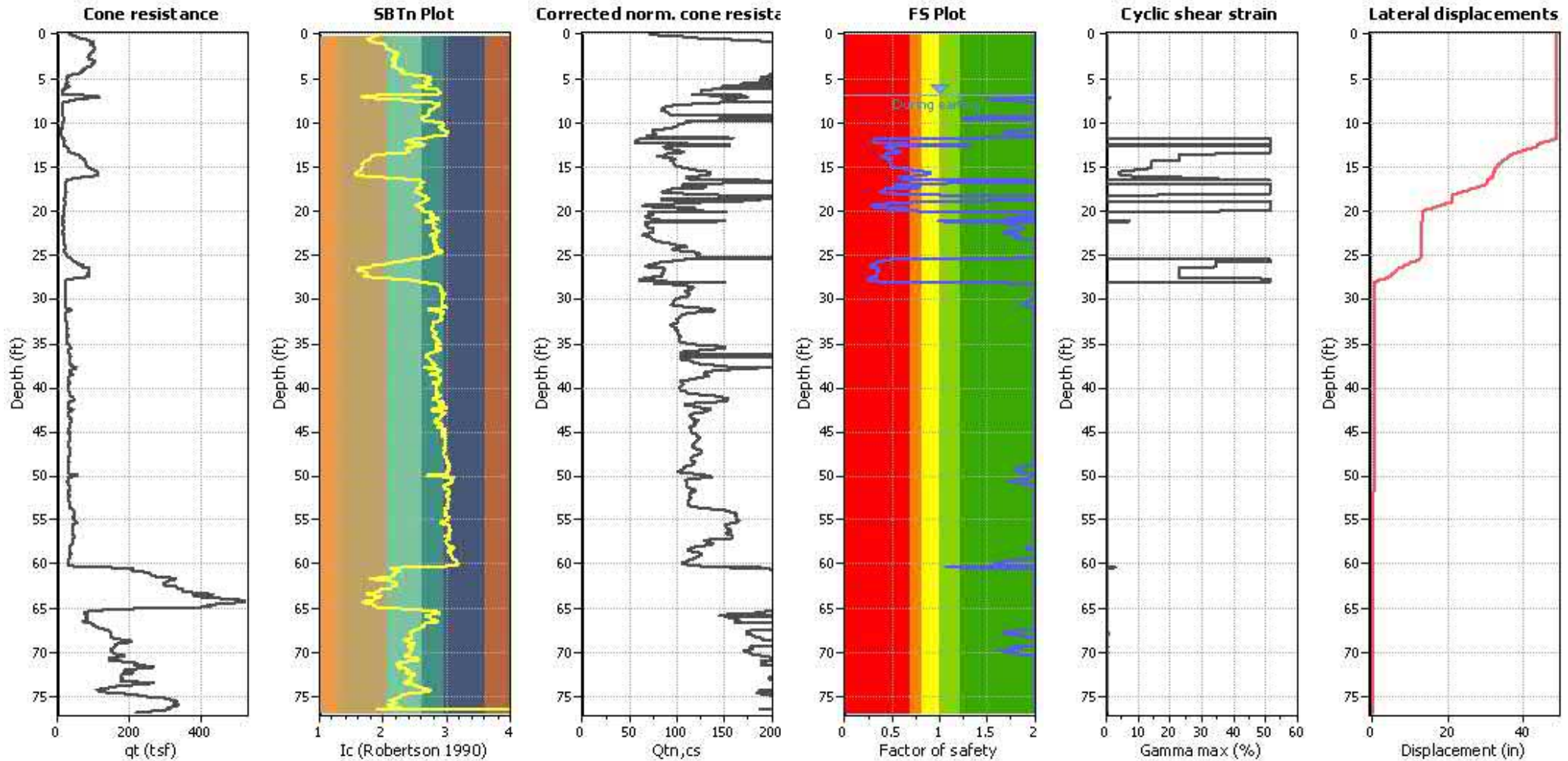


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

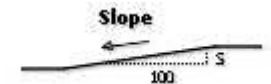


Abbreviations

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

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

Surface condition



LIQUEFACTION ANALYSIS REPORT

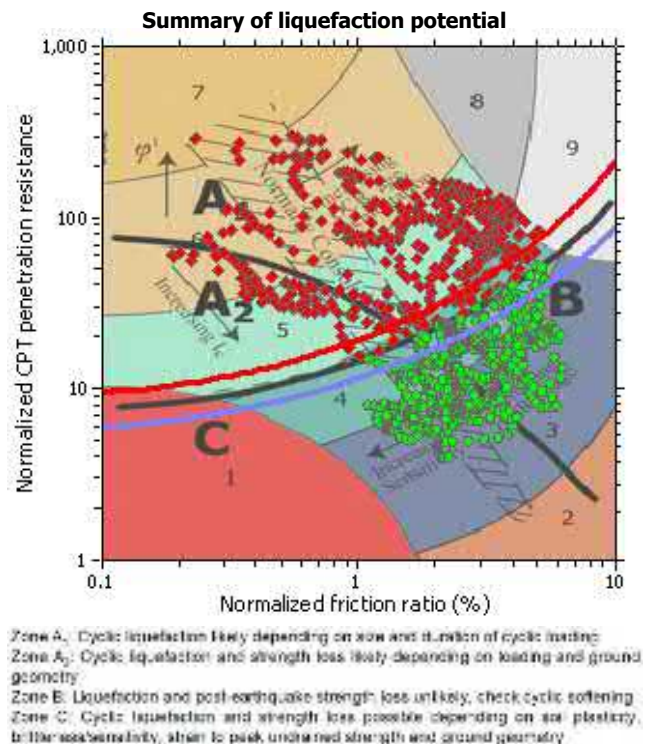
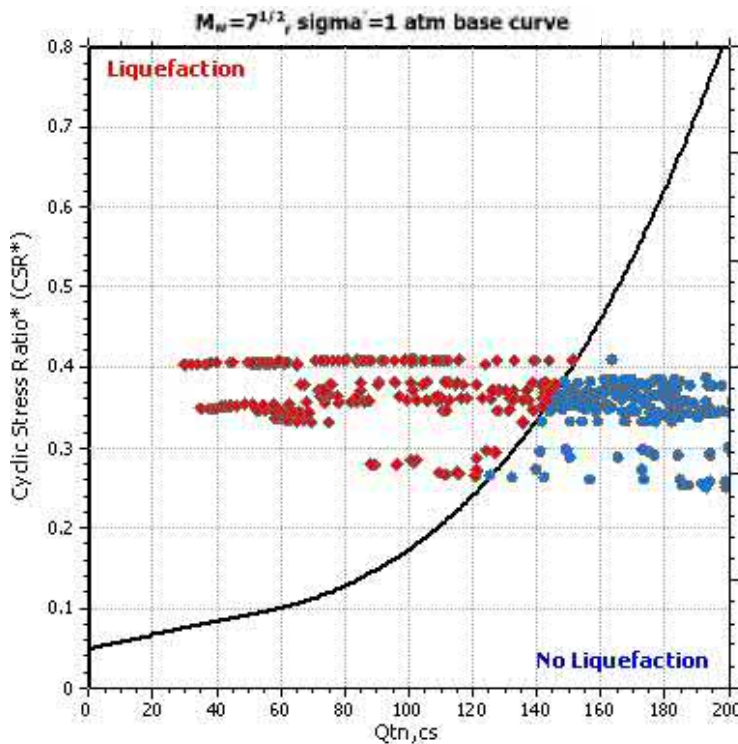
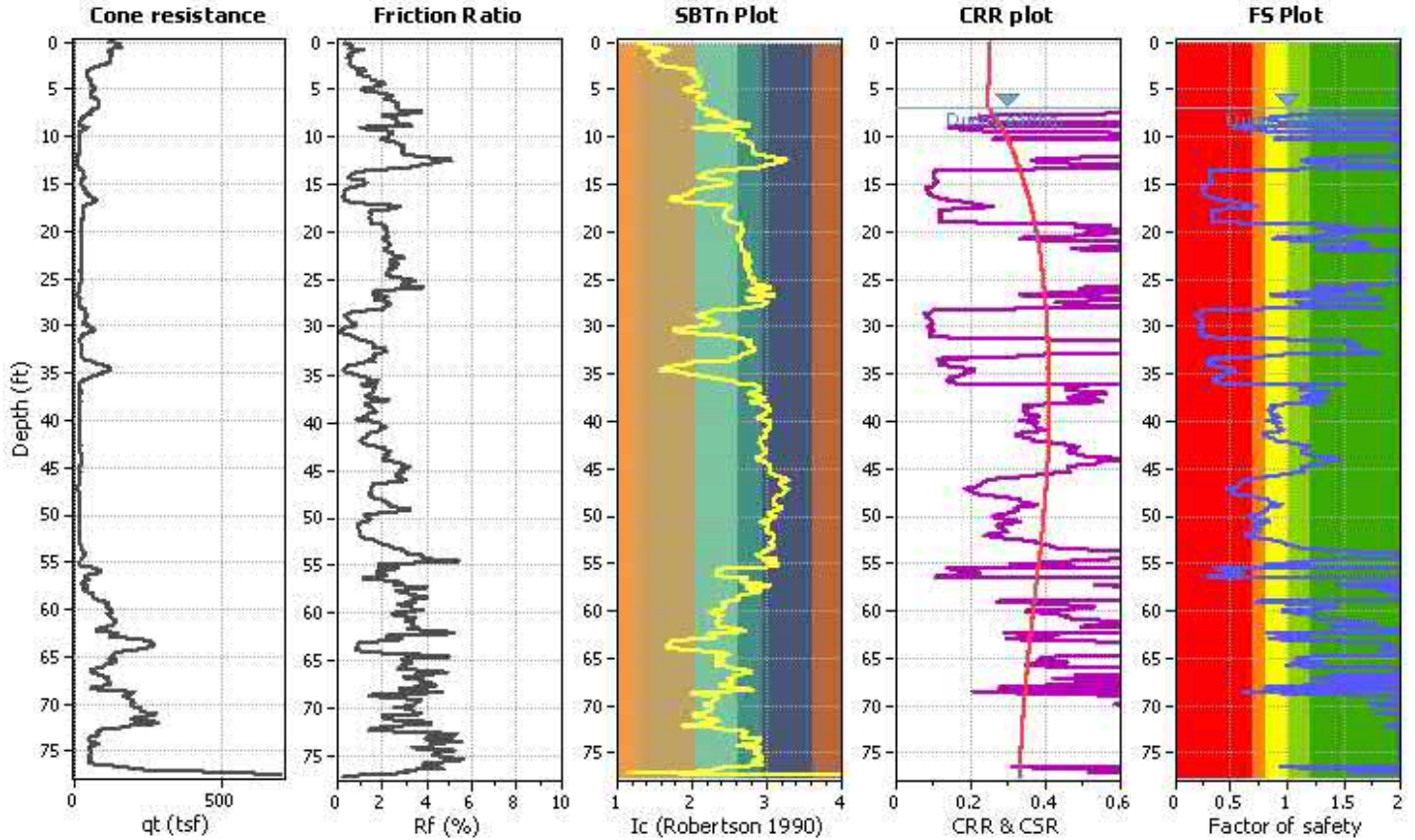
Project title : 12085.002 - JPI Ocean Creek

Location :

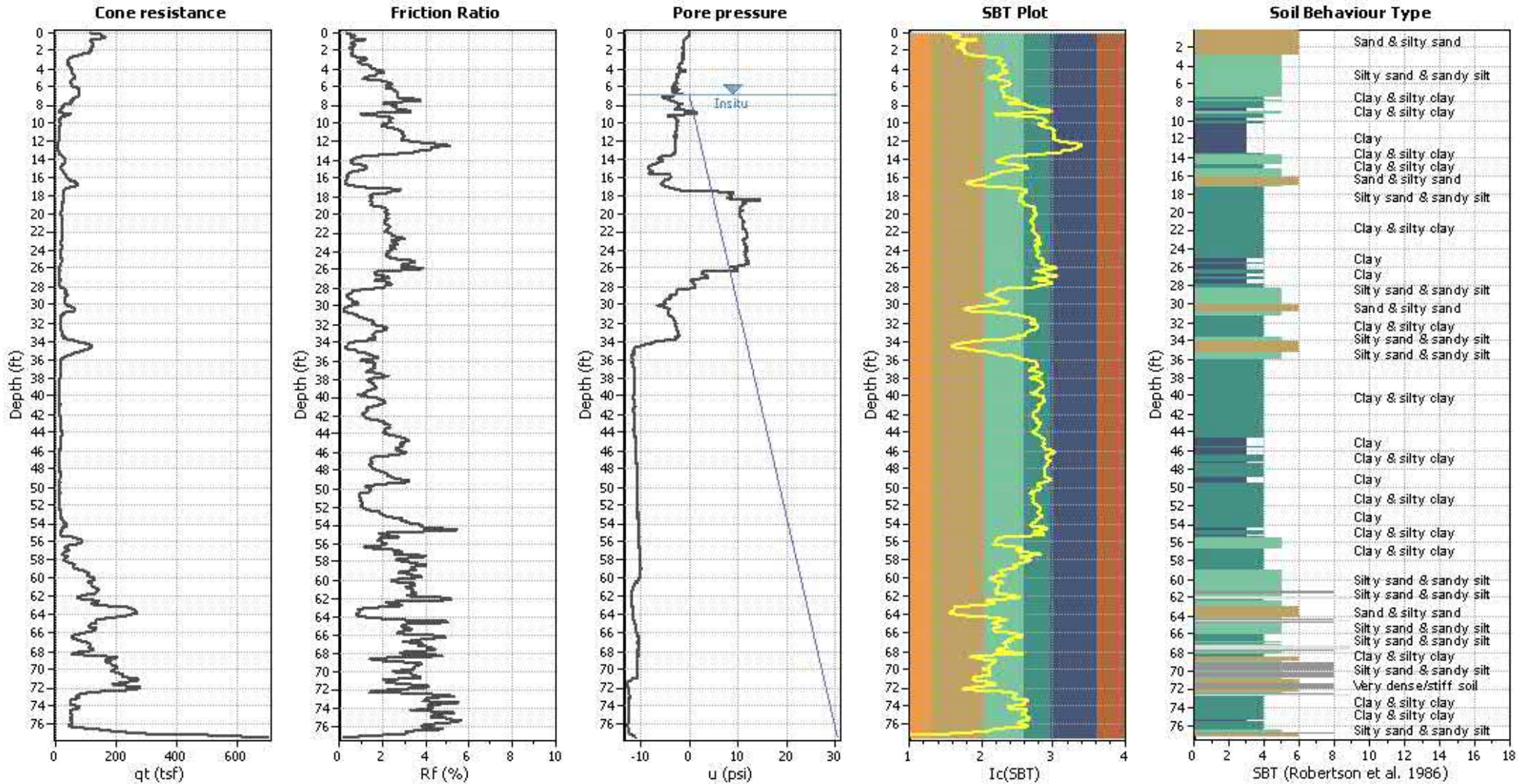
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	7.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.48	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



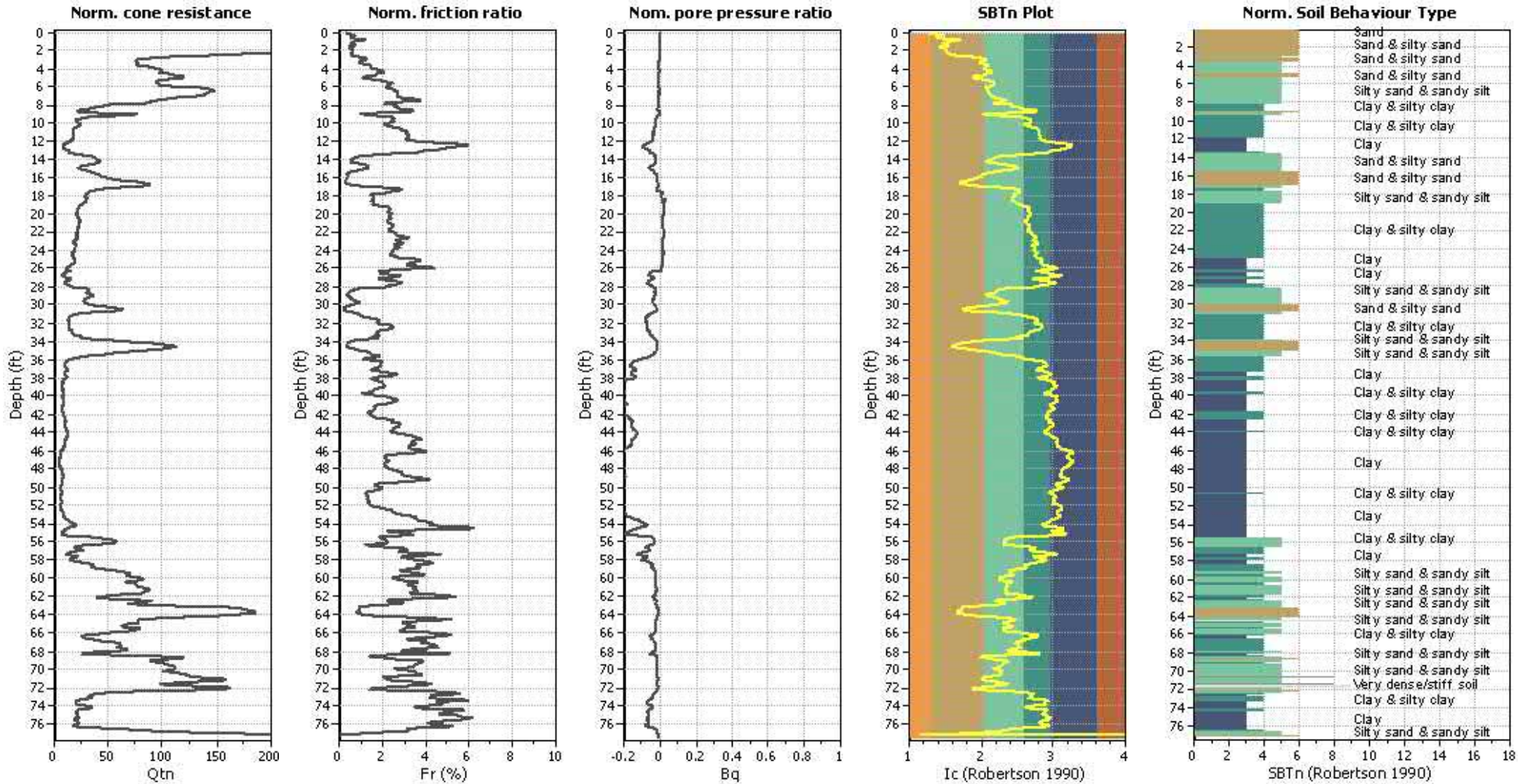
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

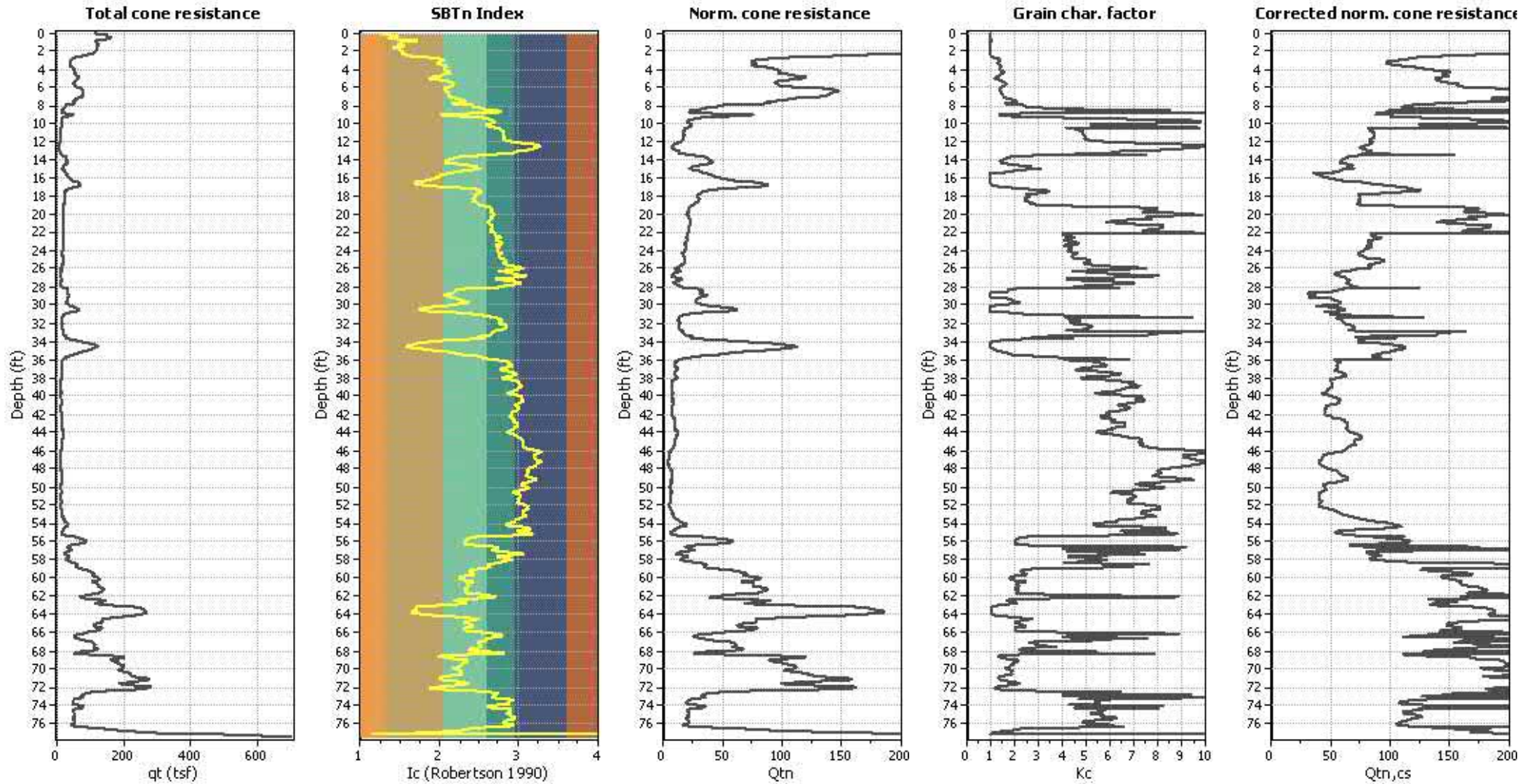
CPT basic interpretation plots (normaliz



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

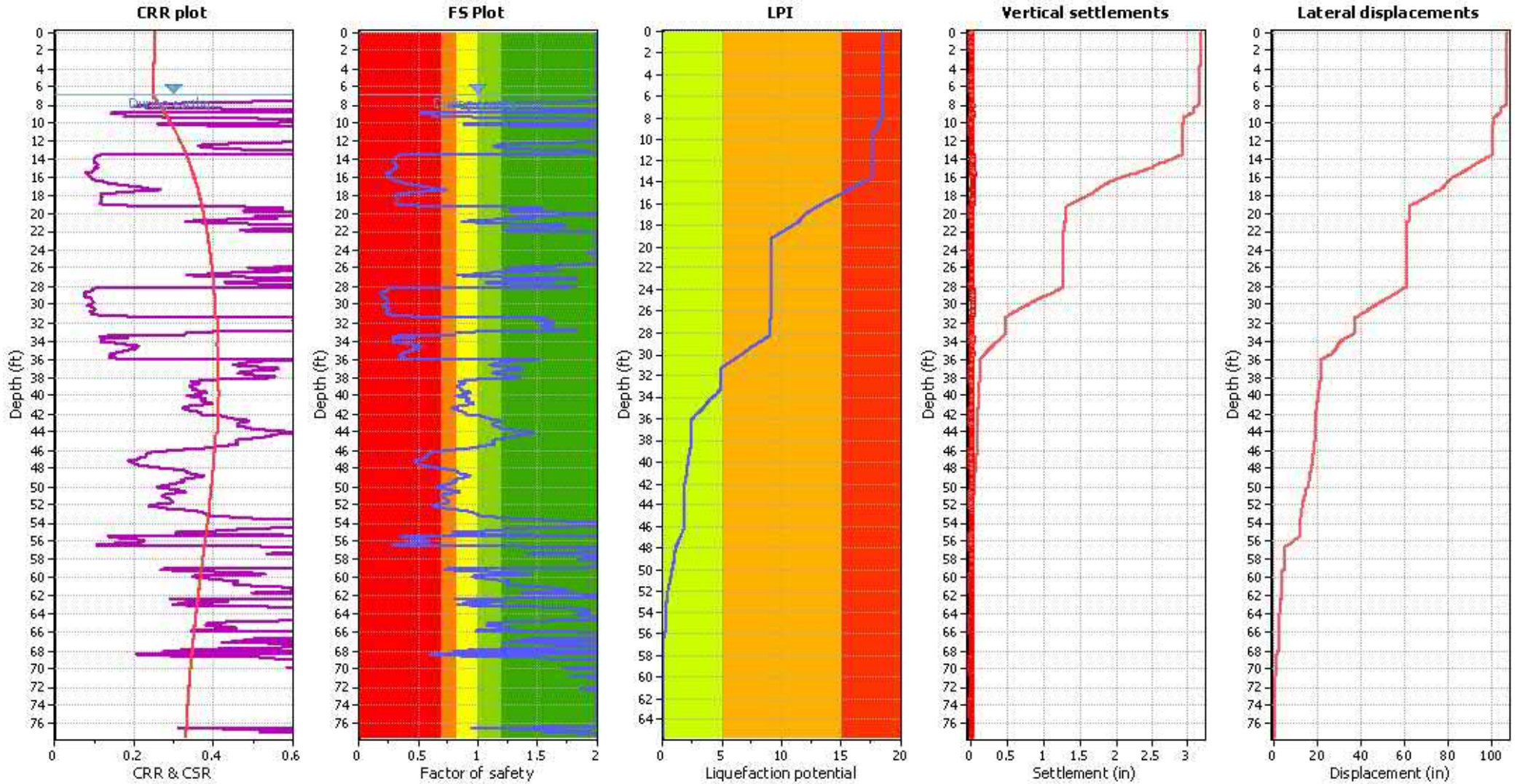
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _{cs} applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

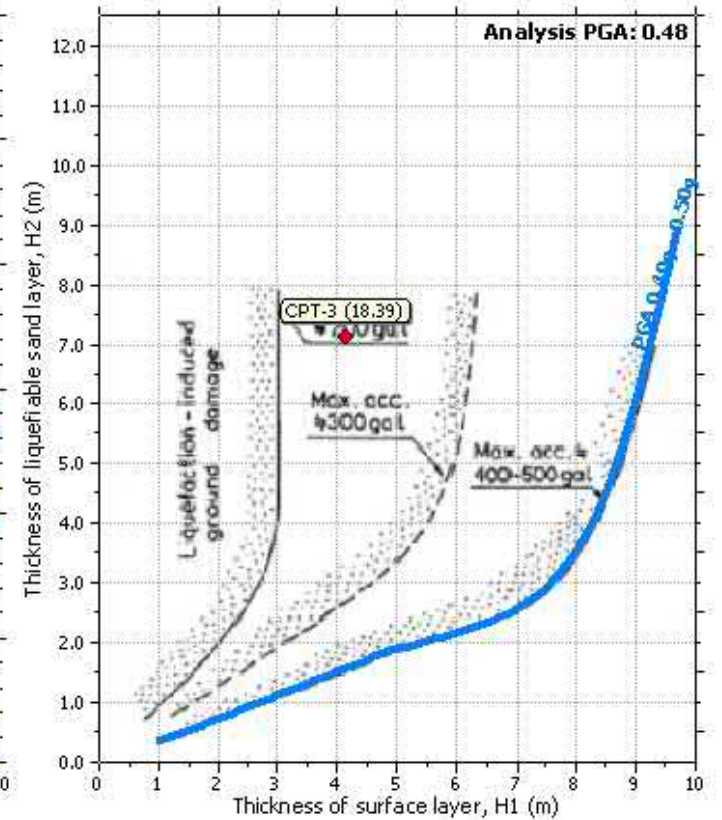
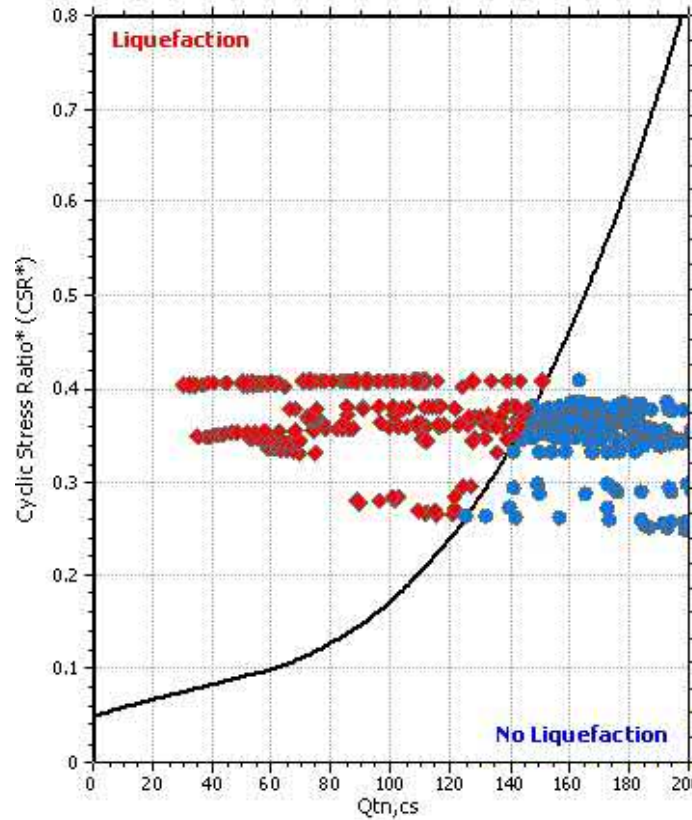
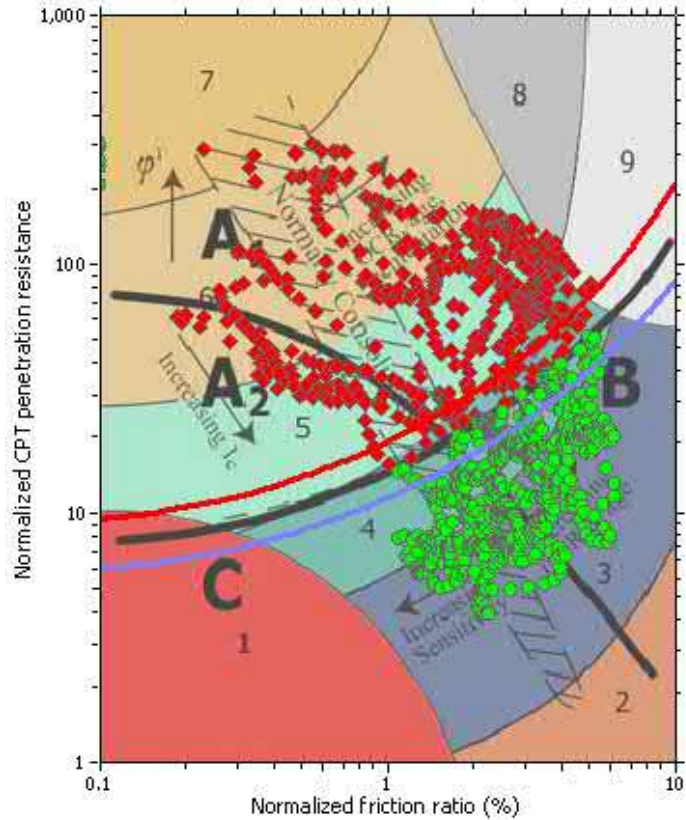
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

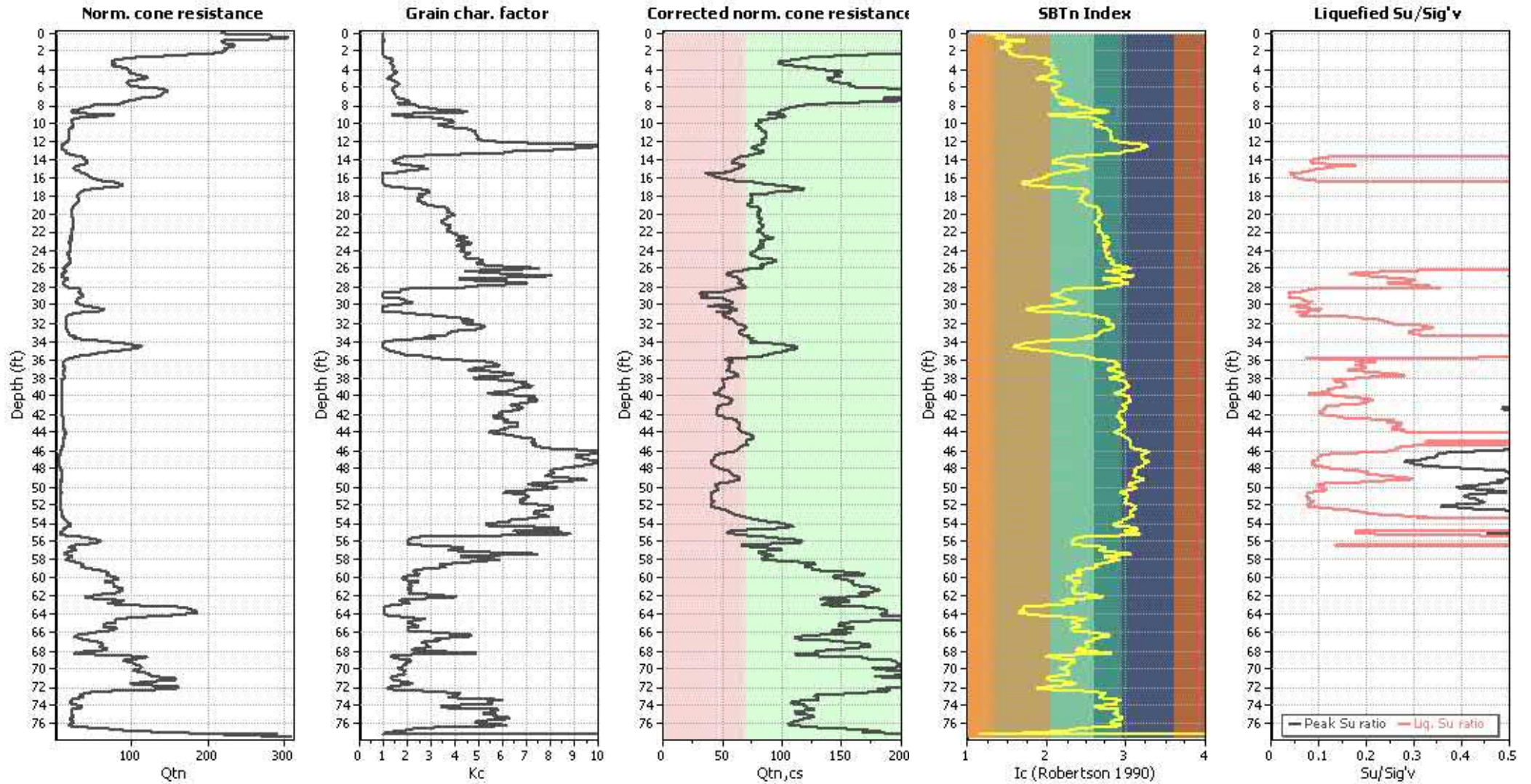
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

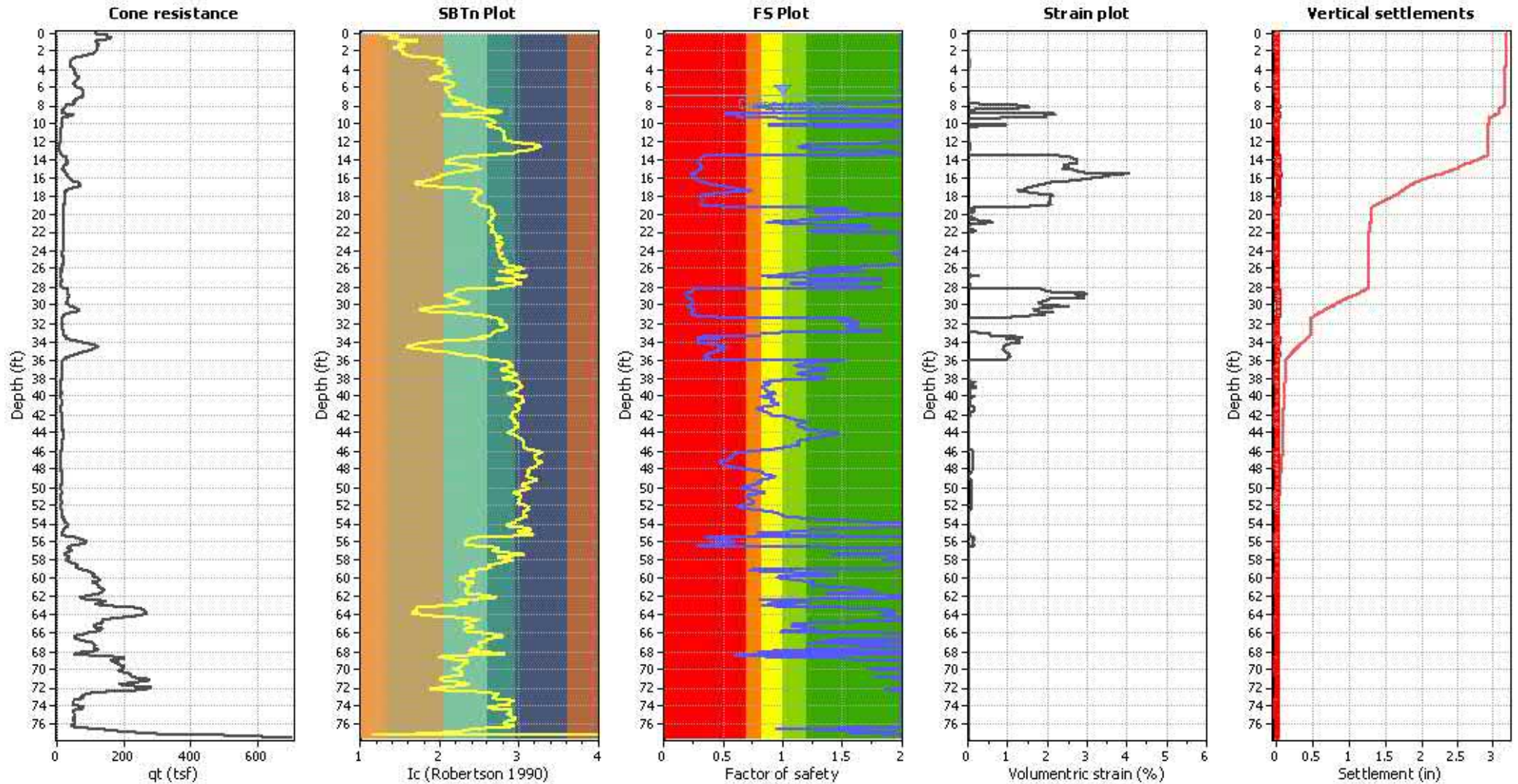
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.48	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

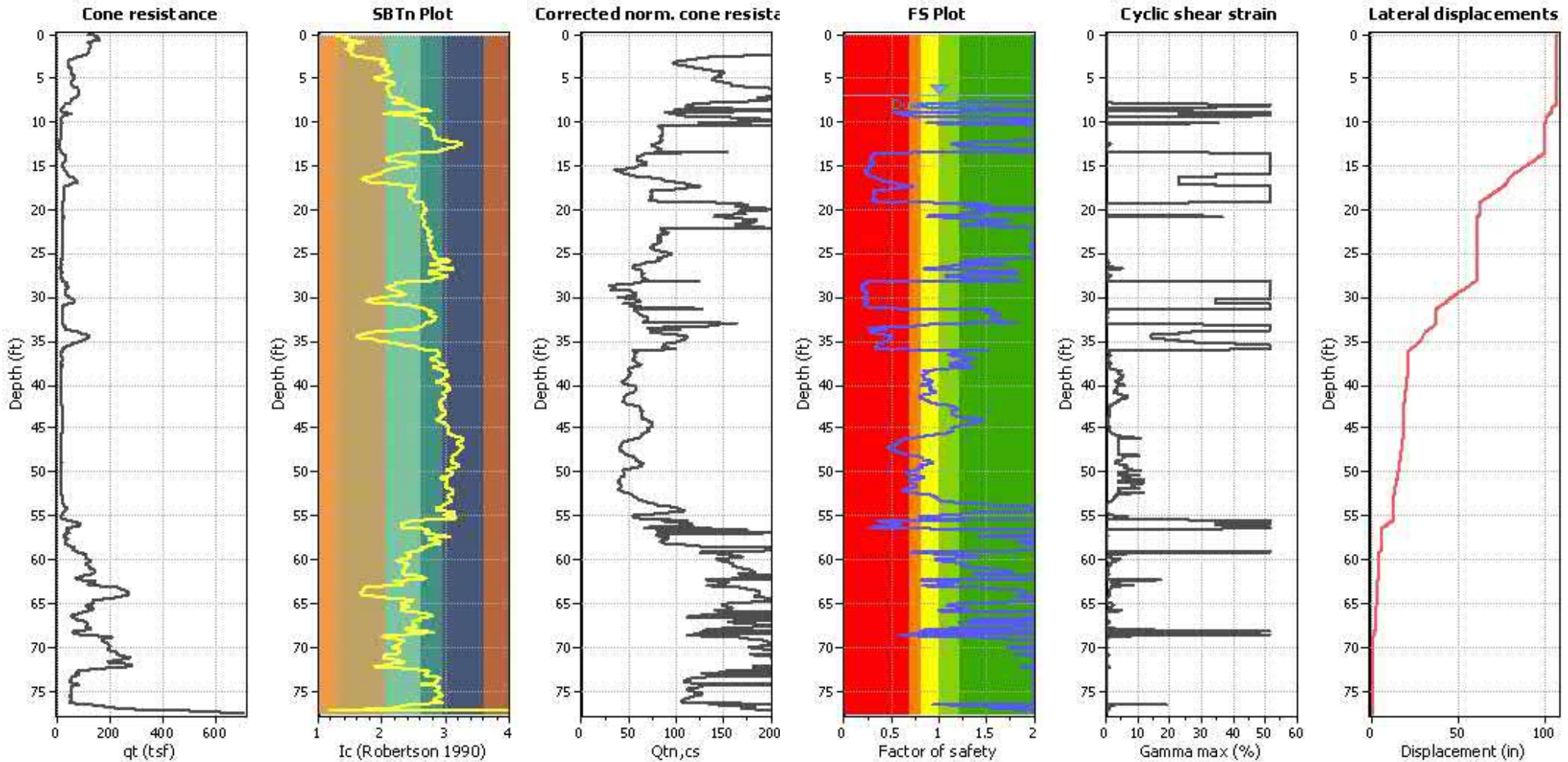


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

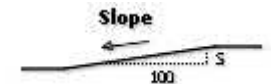


Abbreviations

qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
 Ic: Soil Behaviour Type Index
 $Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance

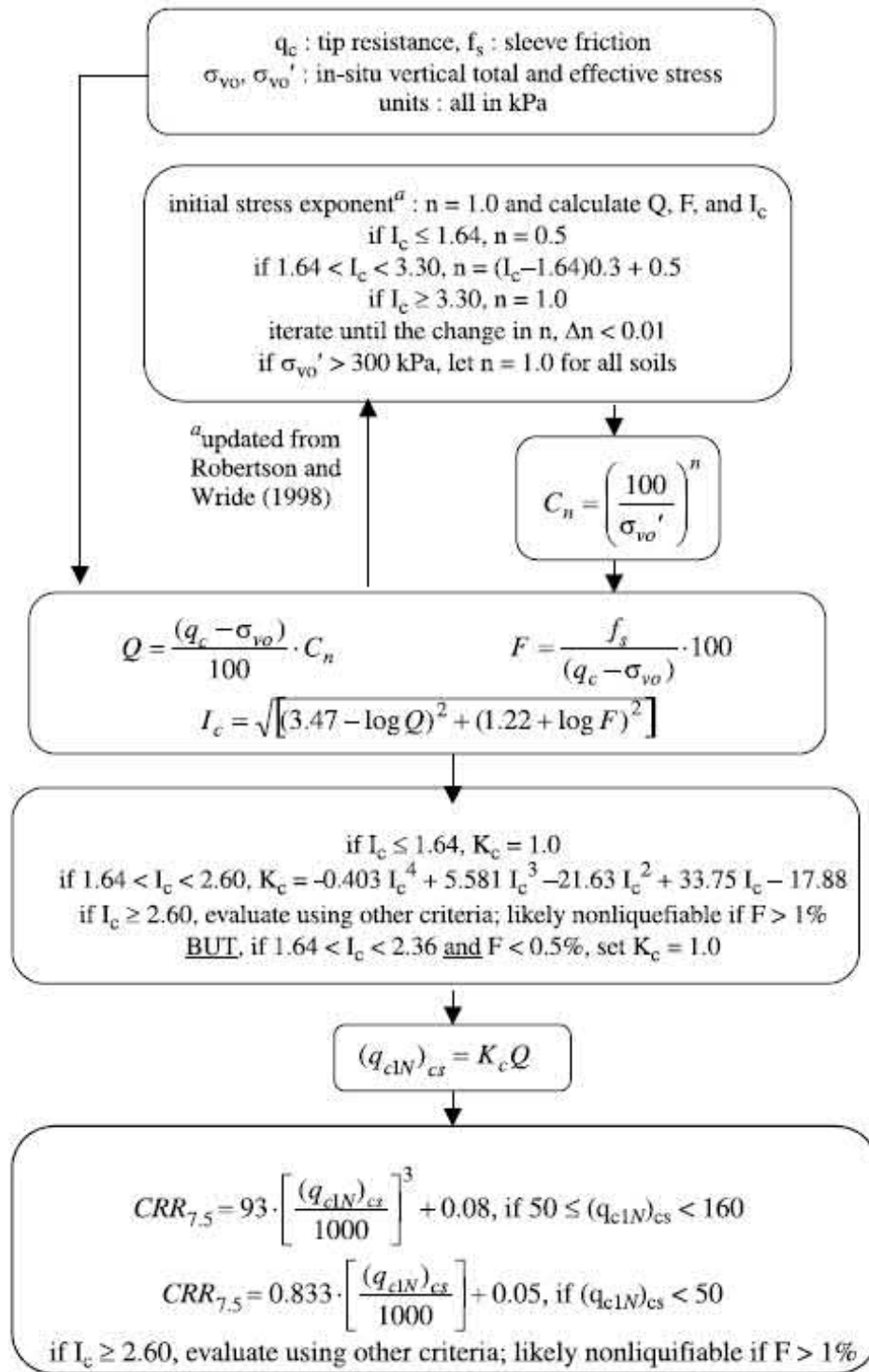
F.S.: Factor of safety
 γ_{max} : Maximum cyclic shear strain
 LDI: Lateral displacement index

Surface condition



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

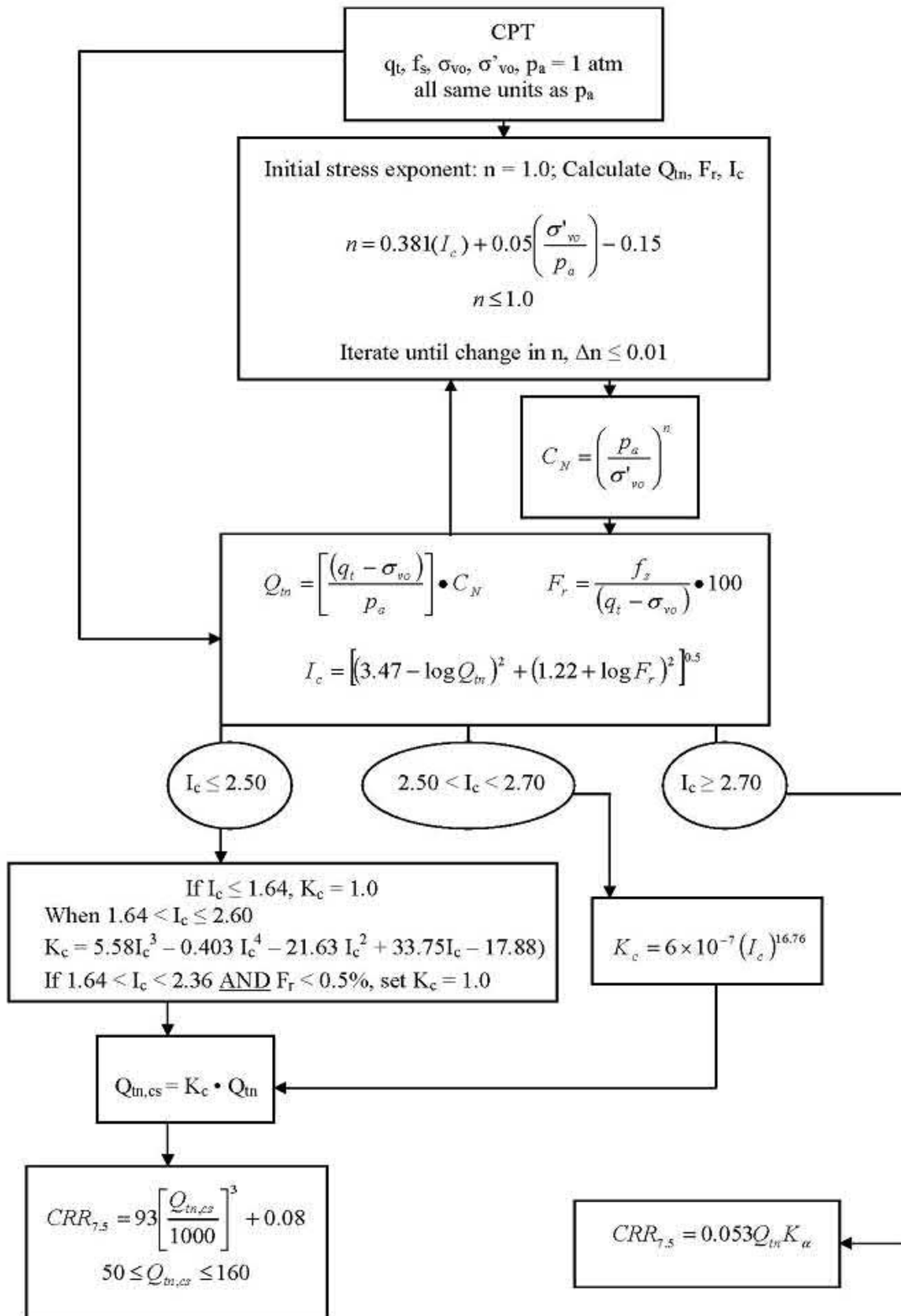
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart¹:



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

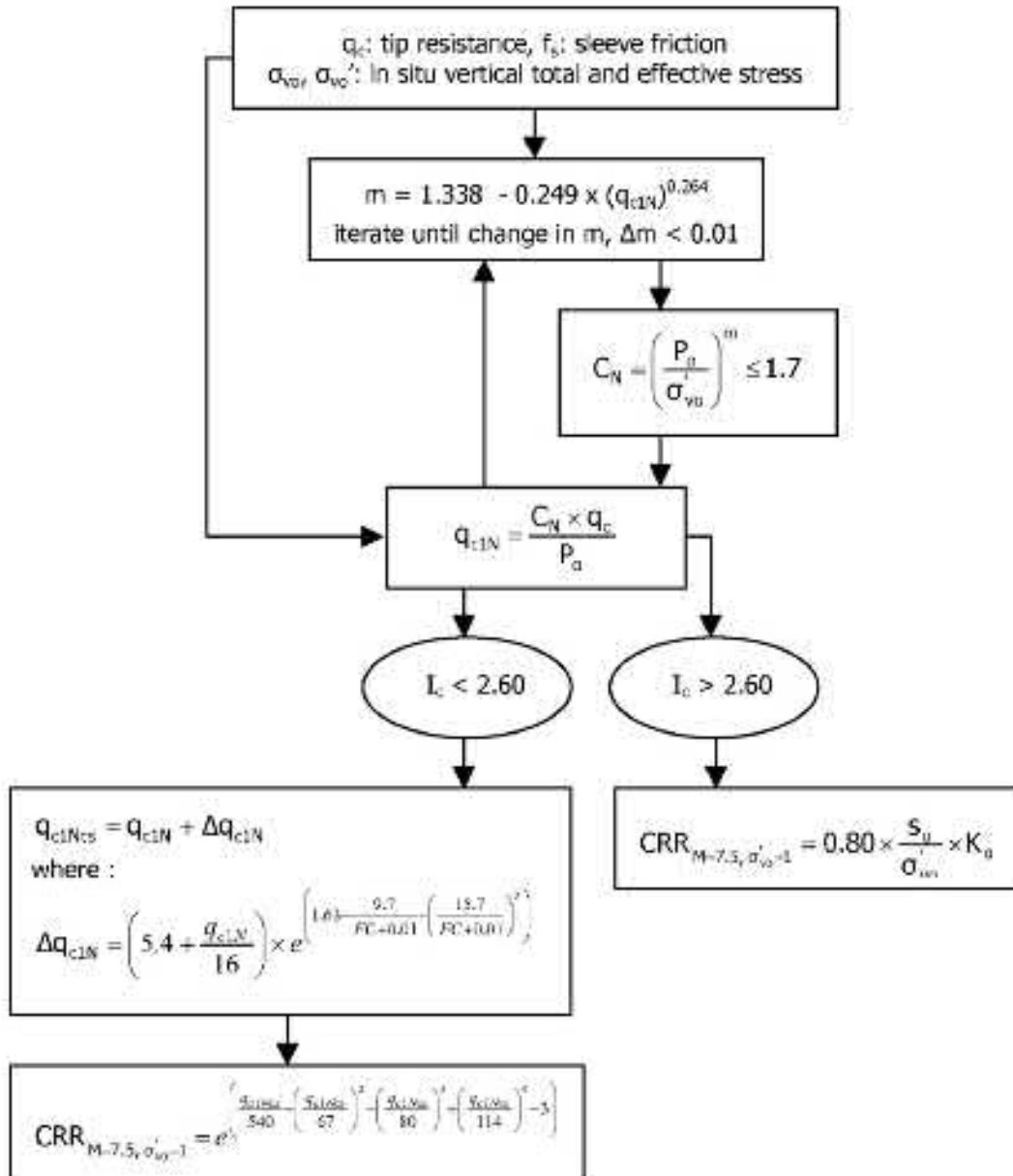
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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 flowchart¹:

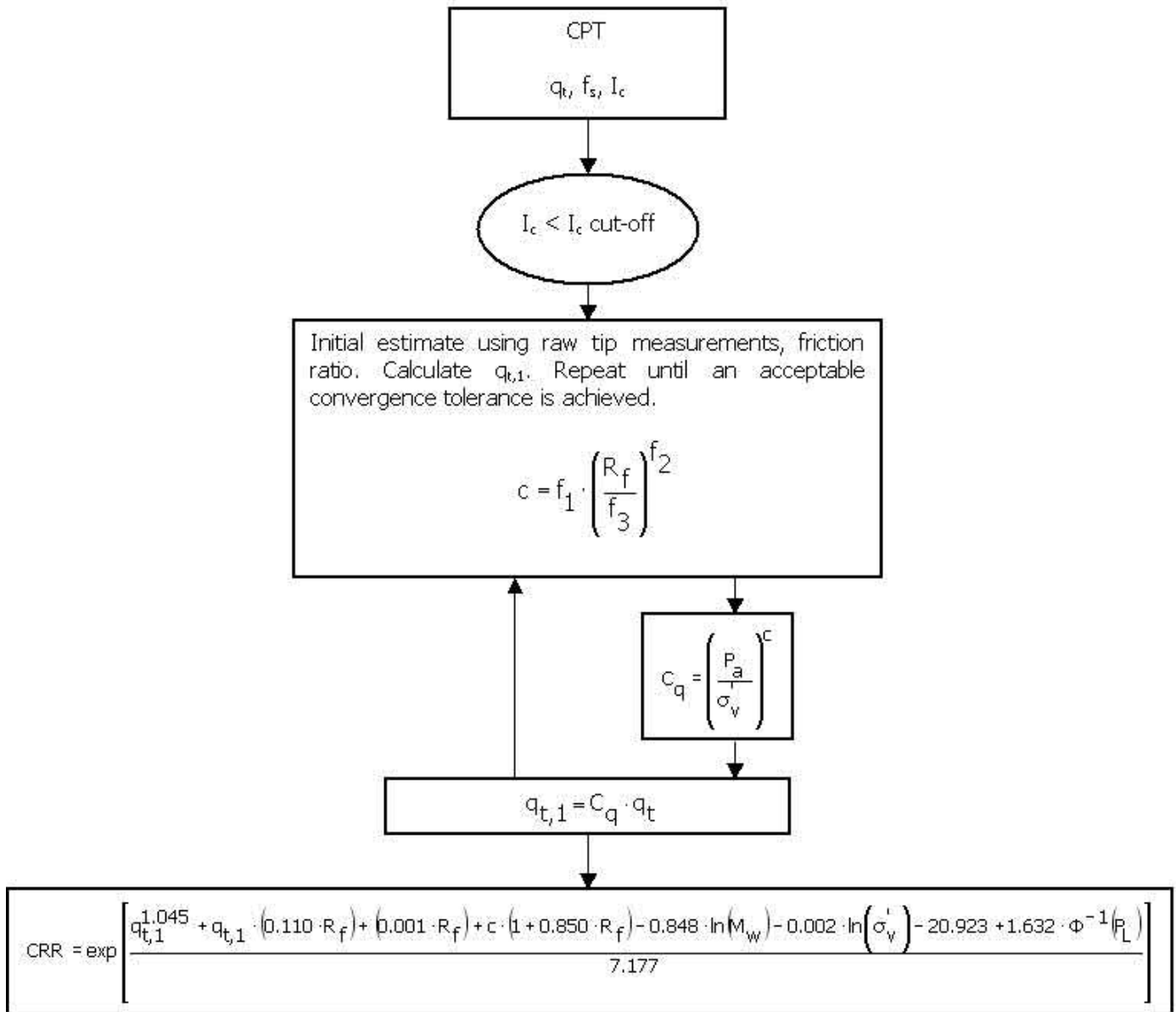


¹ P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

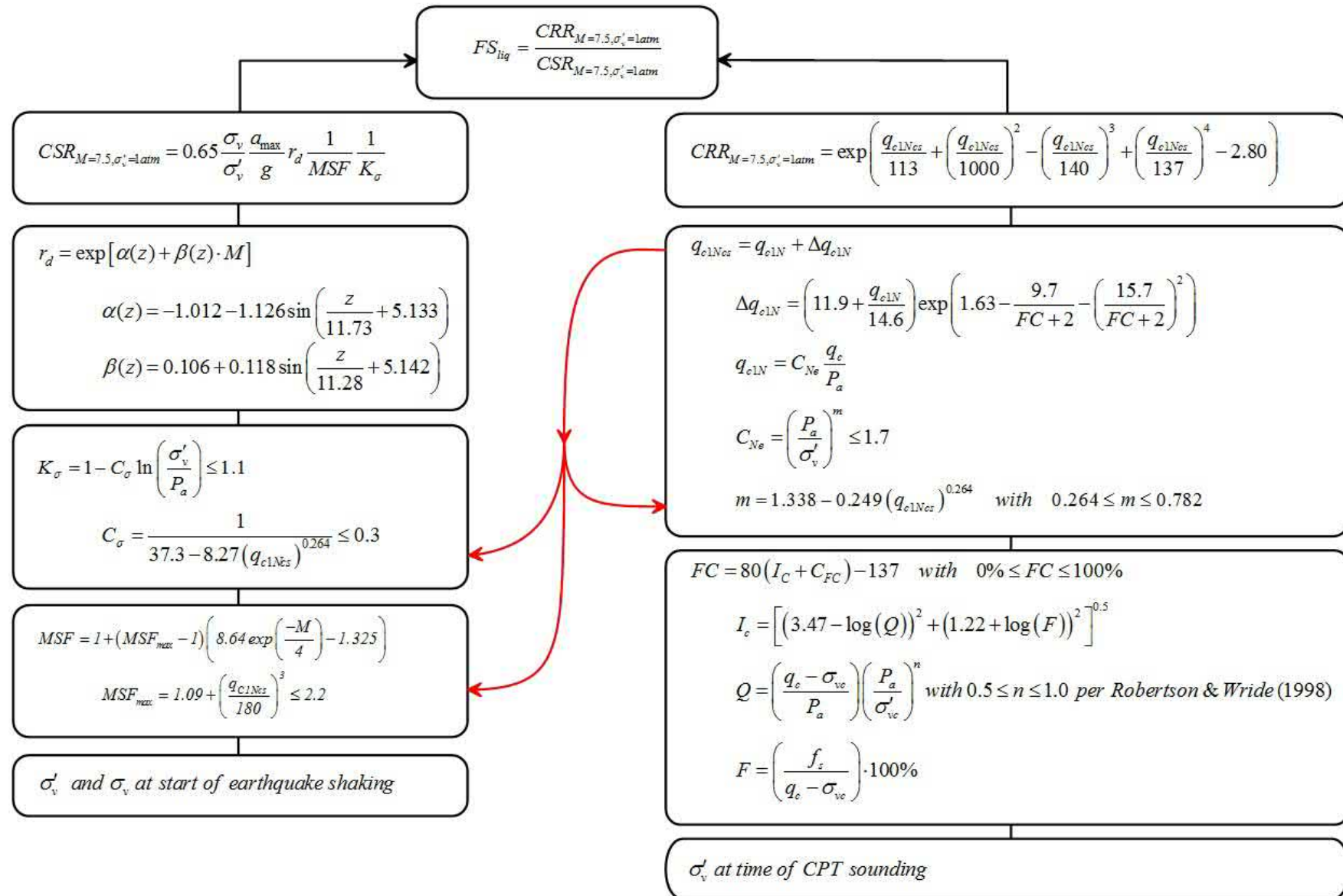
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



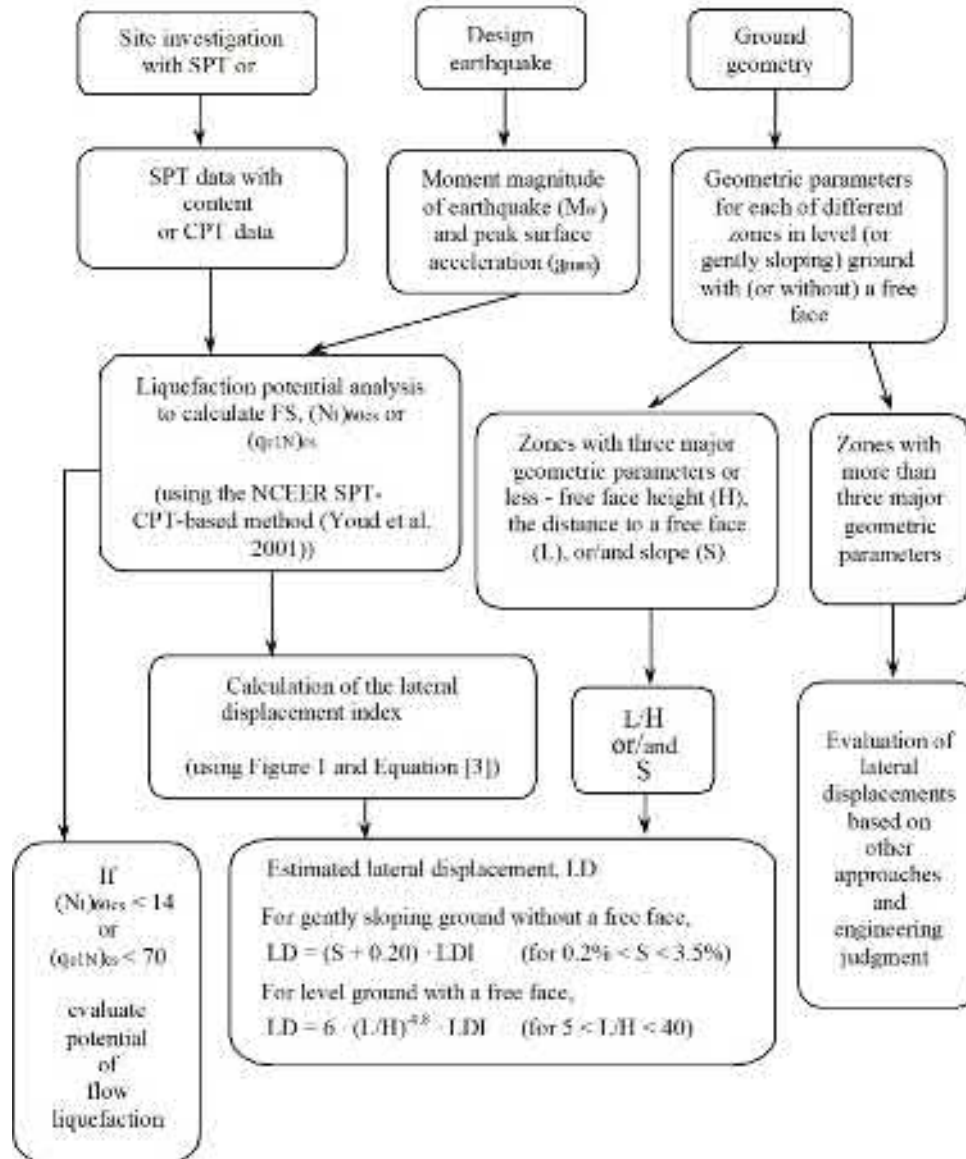
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



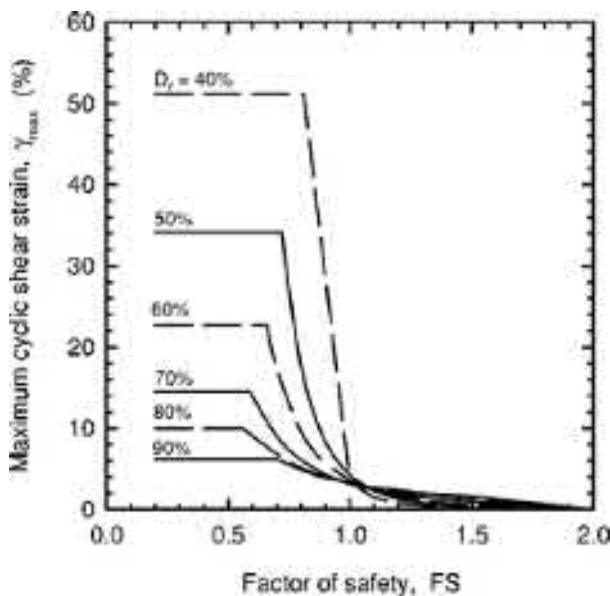
Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)



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



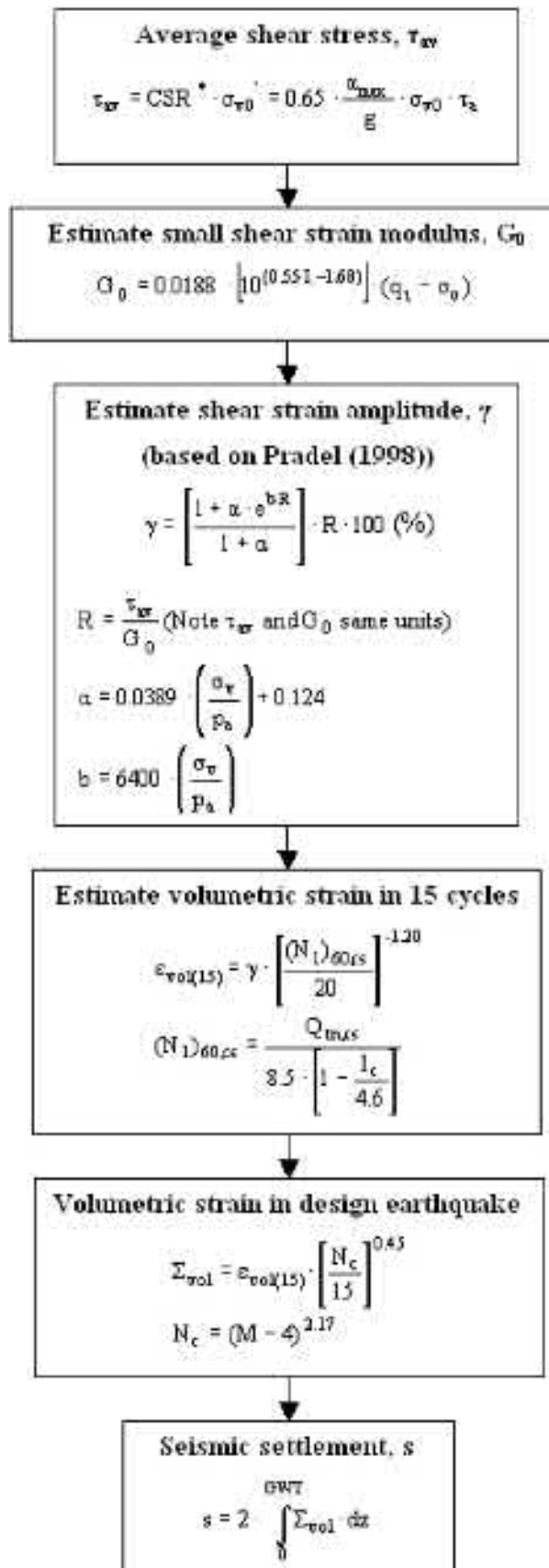
¹ Figure 1

$$LDI = \int_0^{Z_{max}} \gamma_{max} dz$$

¹ Equation [3]

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

Procedure for the estimation of seismic induced settlements in dry sands



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 methodology 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:

$$LPI = \int_0^{20} (10 - 0,5z) \times F_L \times d_z$$

where:

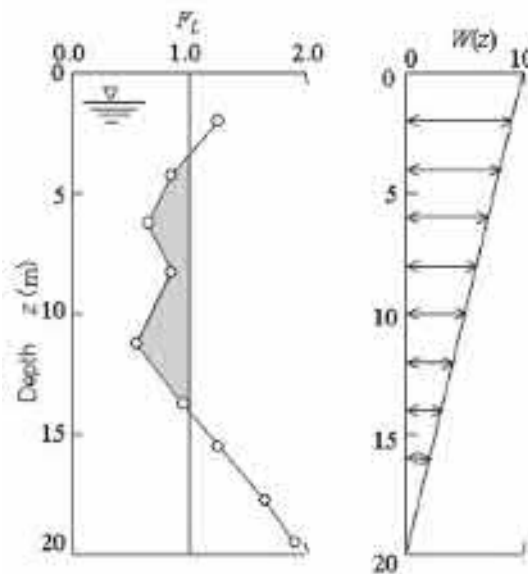
$F_L = 1 - F.S.$ when F.S. less than 1

$F_L = 0$ when F.S. greater than 1

z depth of measurement 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
- $0 < LPI \leq 5$: Liquefaction risk is low
- $5 < LPI \leq 15$: Liquefaction risk is high
- $LPI > 15$: Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

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- 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
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- 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
- I. M. Idriss and R. W. Boulanger, 2008. Soil liquefaction during earthquakes, Earthquake Engineering Research Institute

APPENDIX E

Liquefaction Analysis

Previous Exploratio

(Leighton, 2003)

TABLE OF CONTENTS

CPT-1 results	
Summary data report	1
Vertical settlements summary report	8
Lateral displacements summary report	9
CPT-2 results	
Summary data report	10
Vertical settlements summary report	17
Lateral displacements summary report	18
CPT-3 results	
Summary data report	19
Vertical settlements summary report	26
Lateral displacements summary report	27
CPT-4 results	
Summary data report	28
Vertical settlements summary report	35
Lateral displacements summary report	36
CPT-5 results	
Summary data report	37
Vertical settlements summary report	44
Lateral displacements summary report	45
CPT-6 results	
Summary data report	46
Vertical settlements summary report	53
Lateral displacements summary report	54
CPT-7 results	
Summary data report	55
Vertical settlements summary report	62
Lateral displacements summary report	63

LIQUEFACTION ANALYSIS REPORT

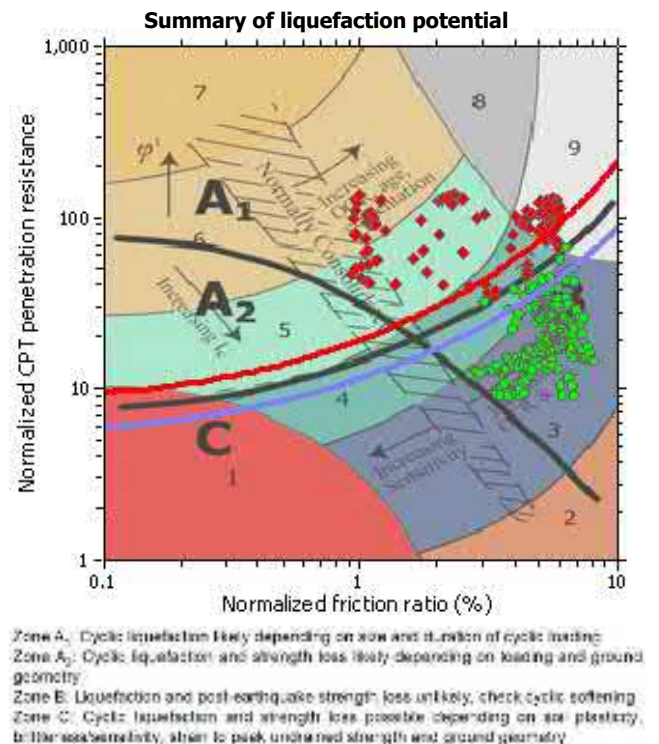
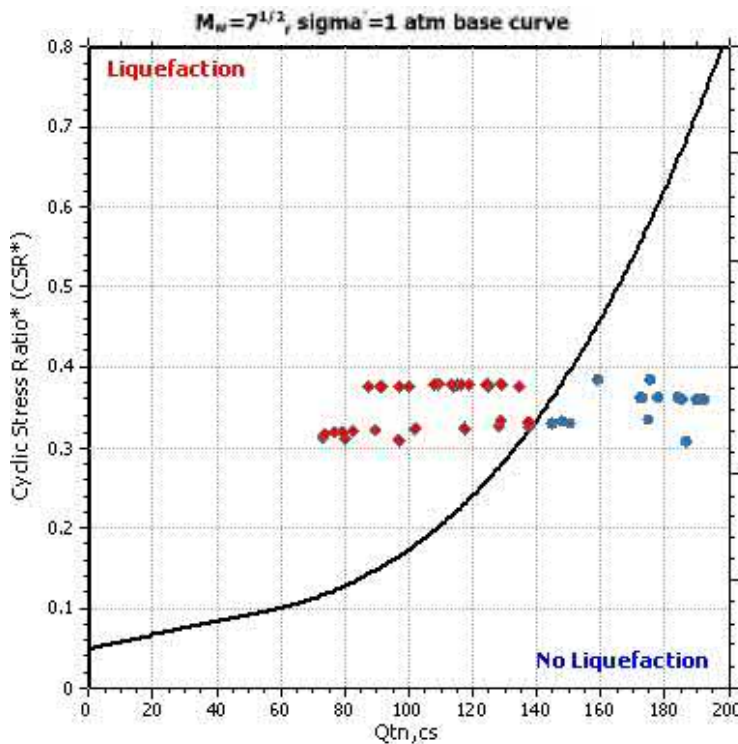
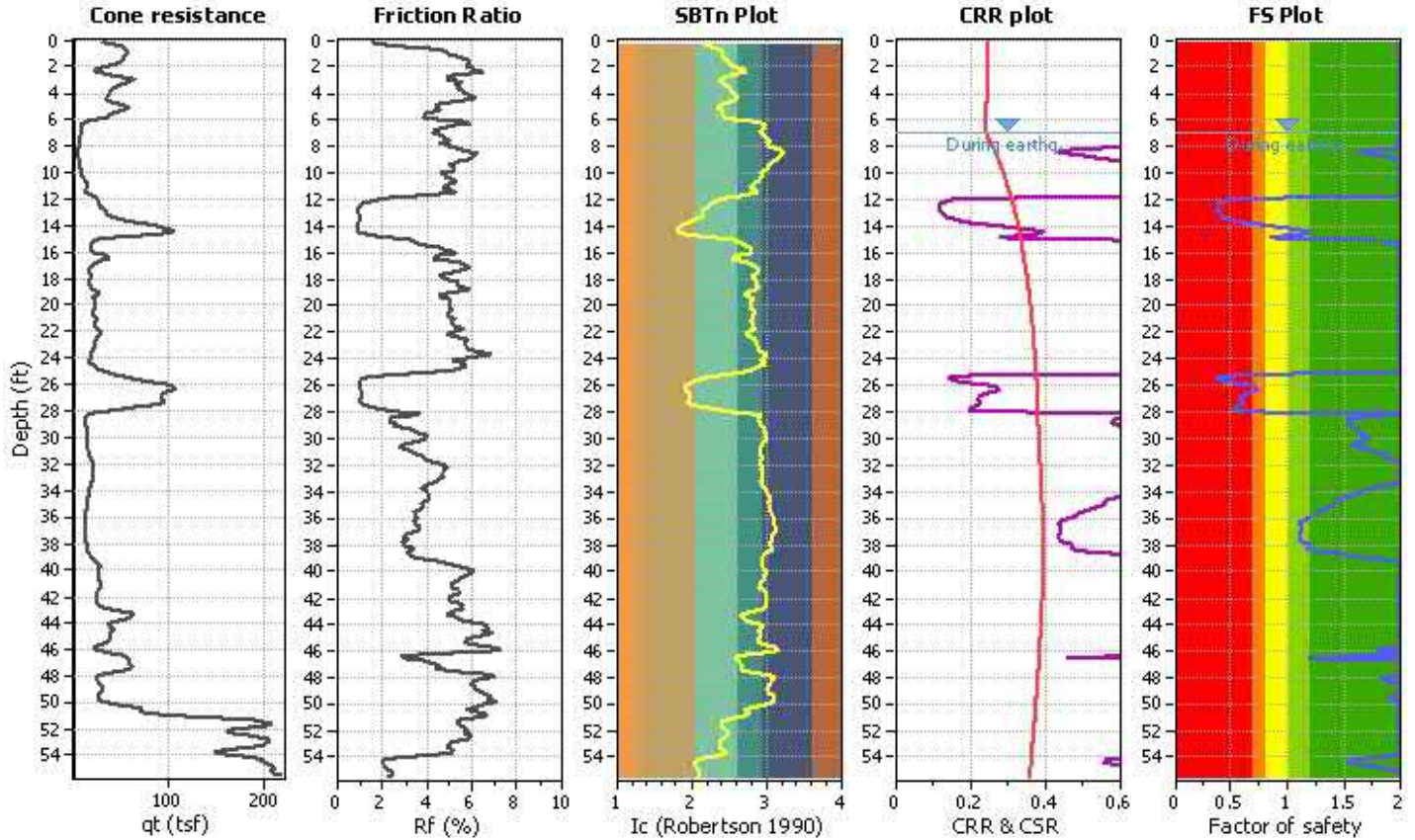
Project title : 12085.002 - JPI Ocean Creek

Location :

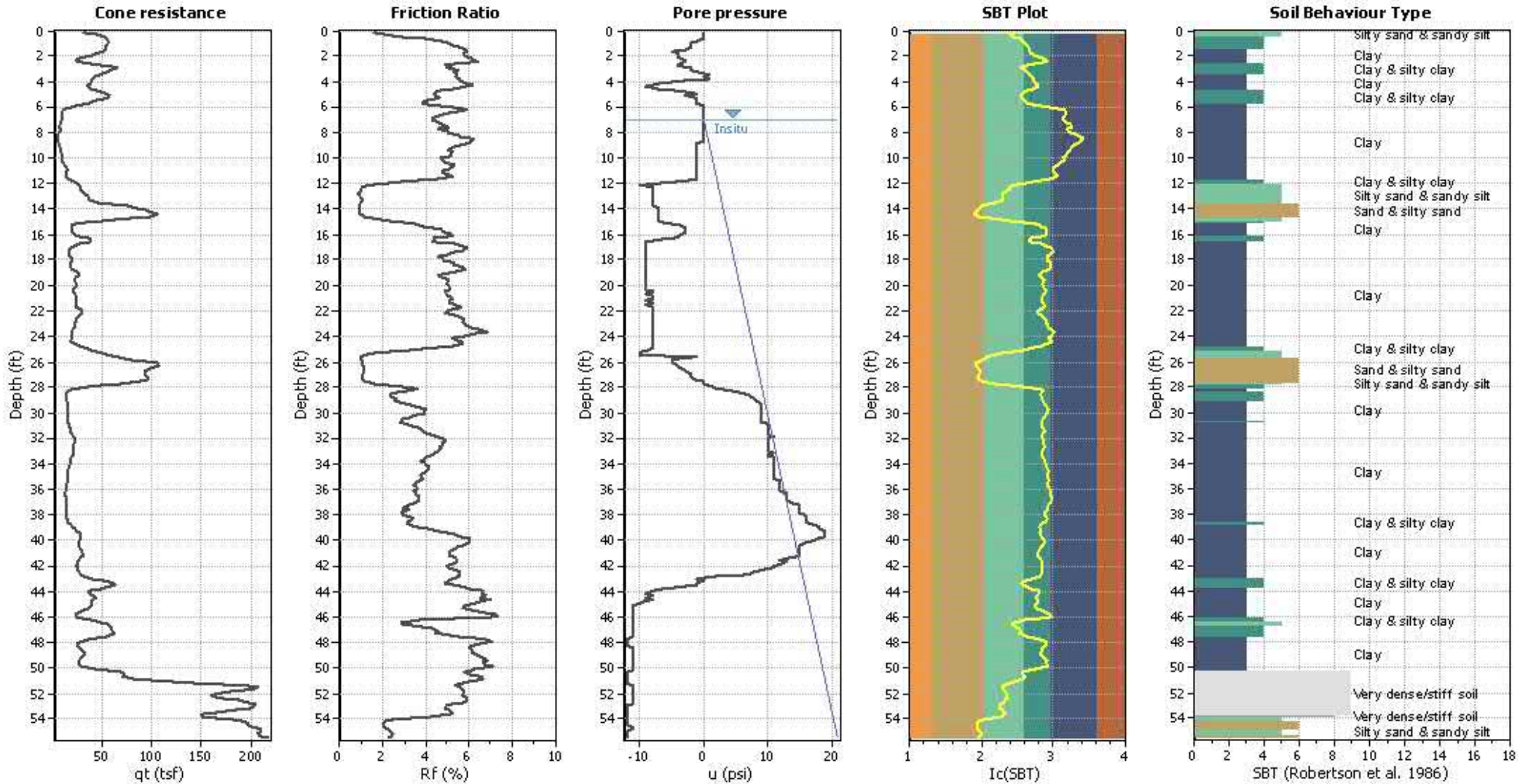
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	7.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



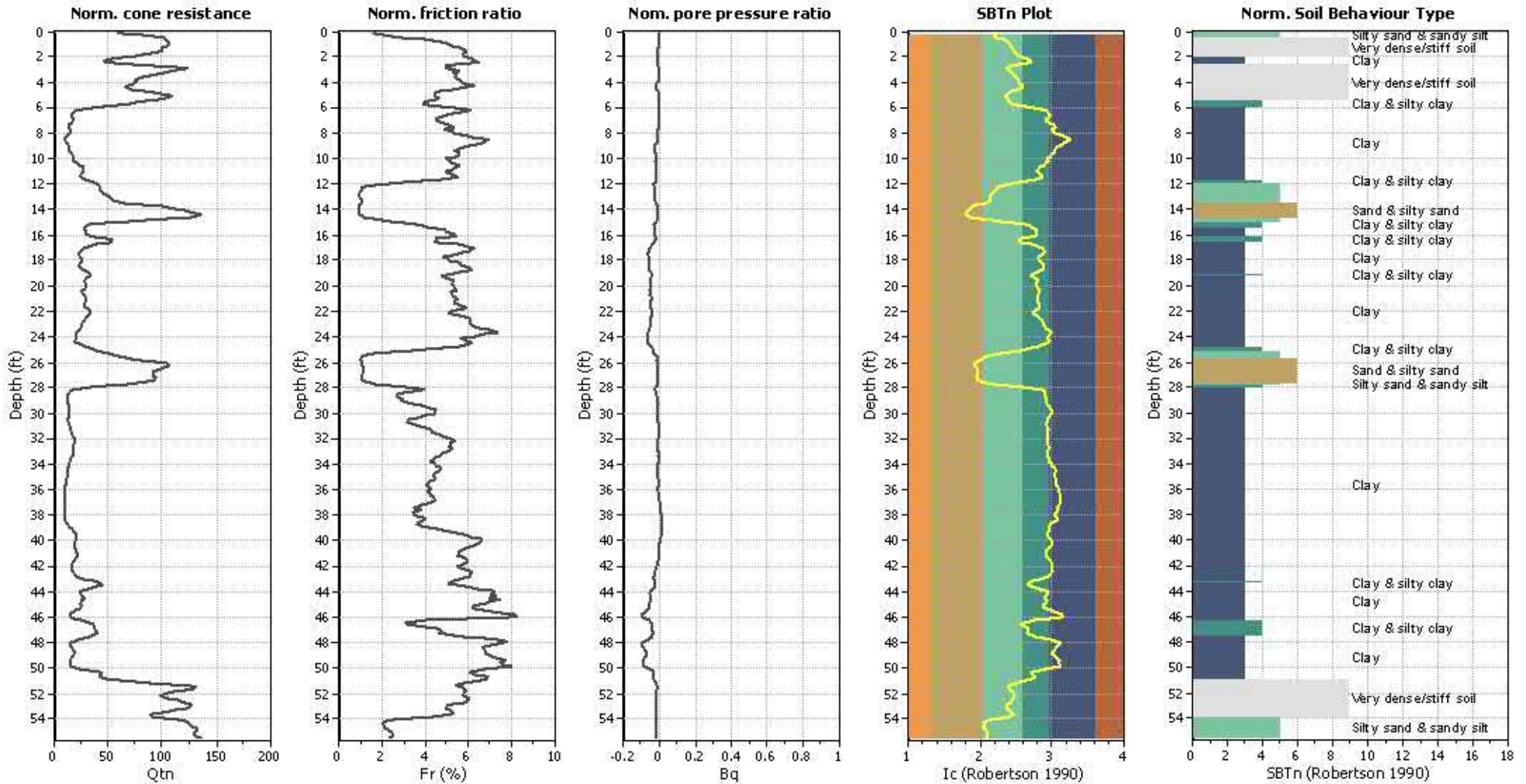
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



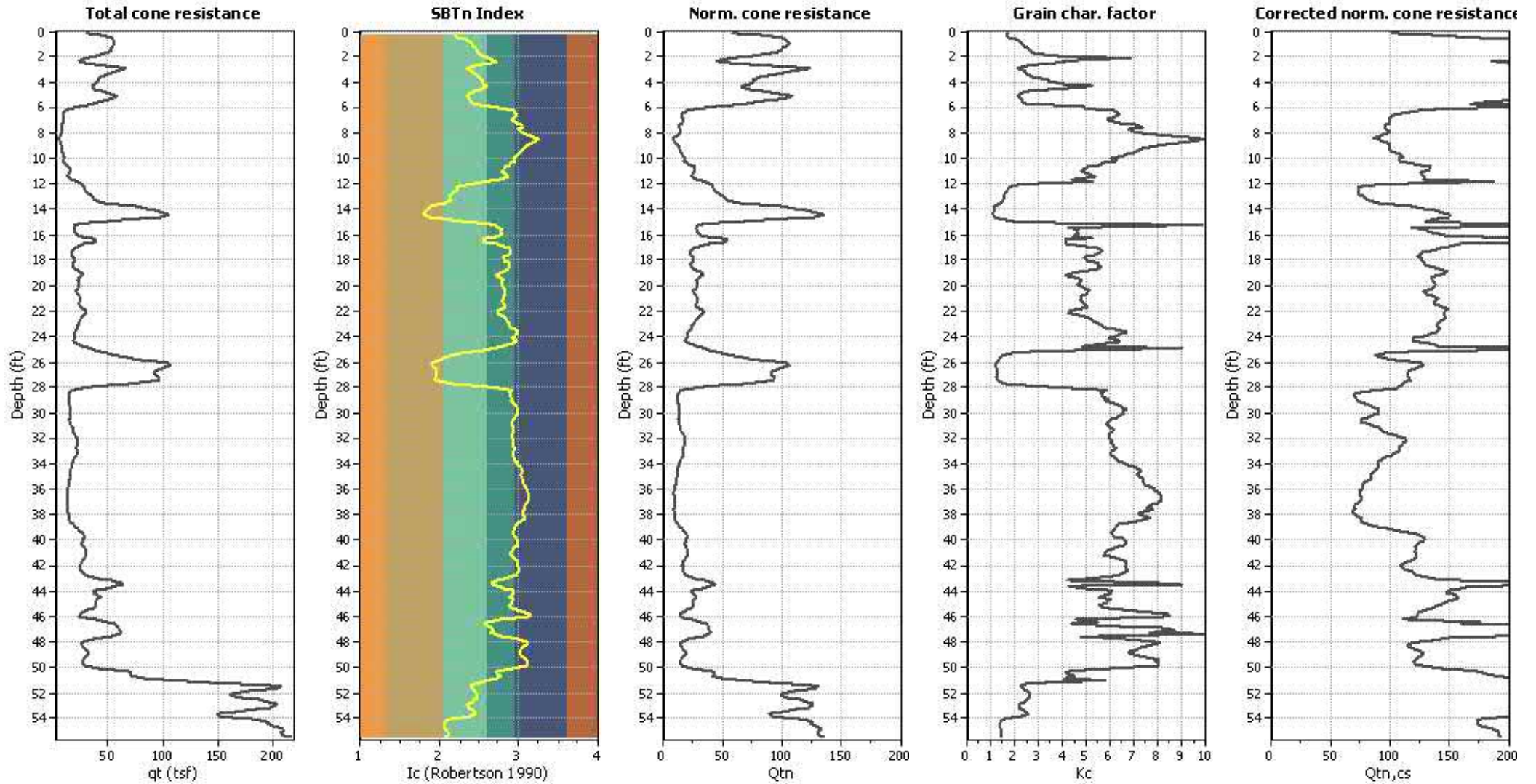
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

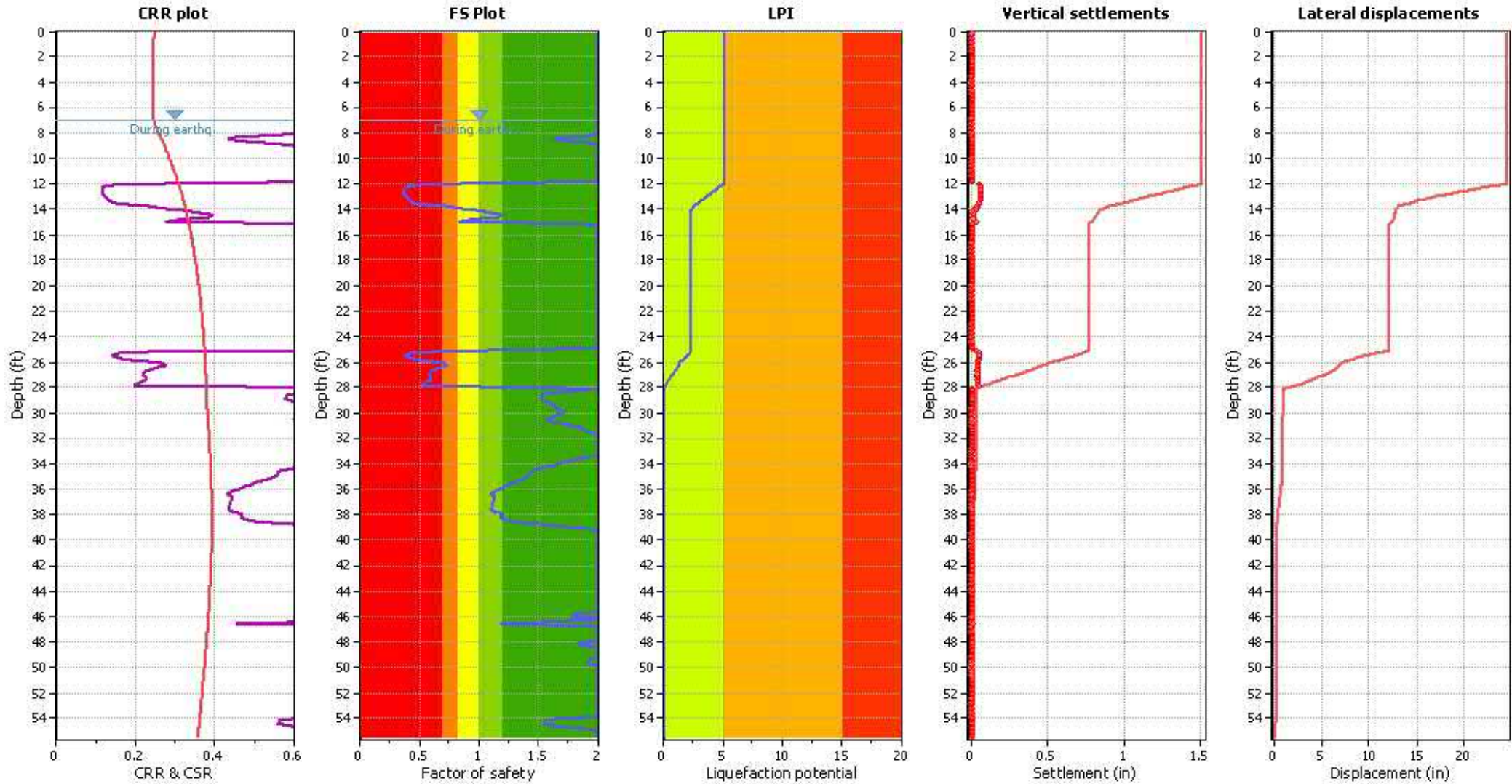
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Flines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	7.00 ft	Fill weight:	N/A
Finer correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{cs} applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

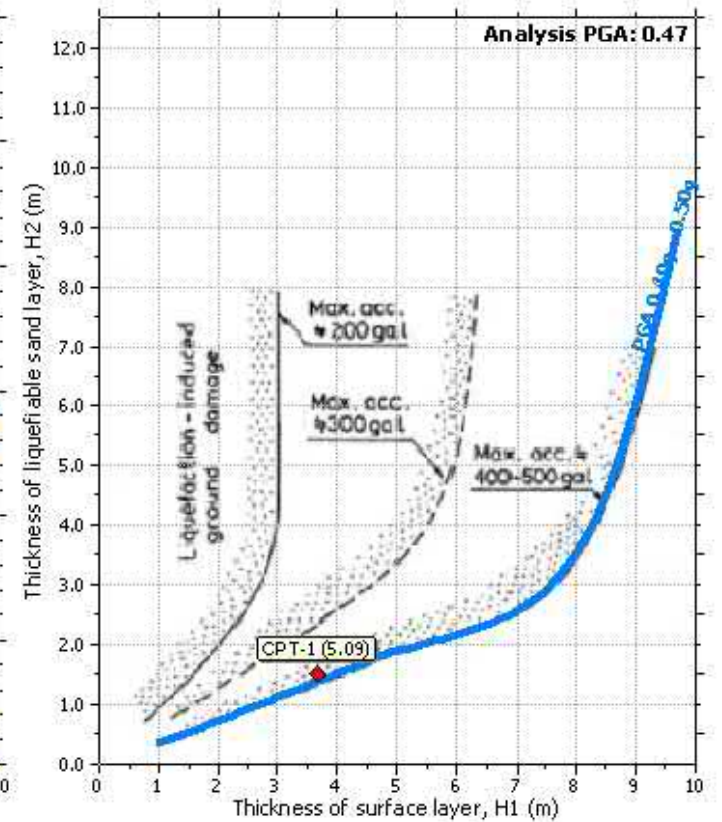
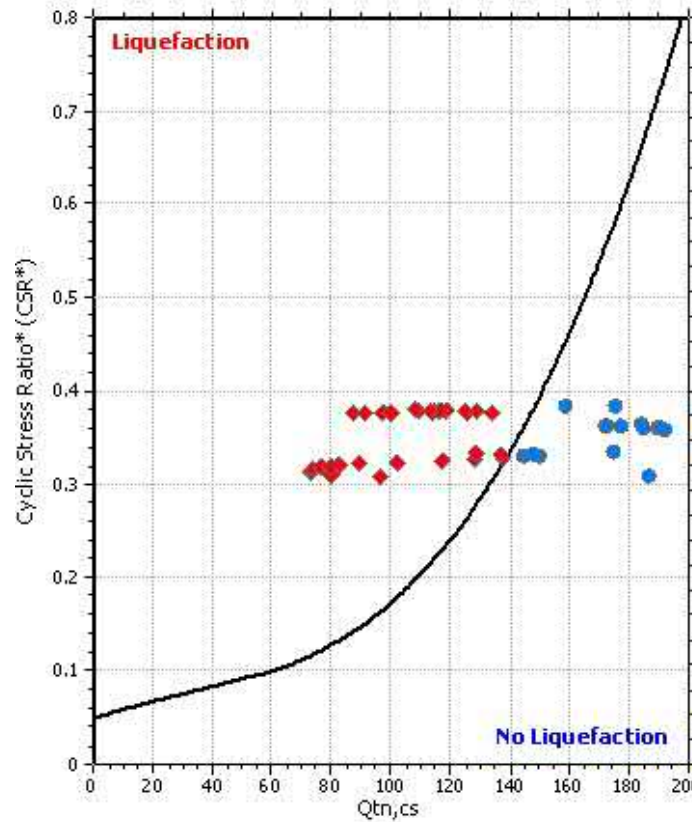
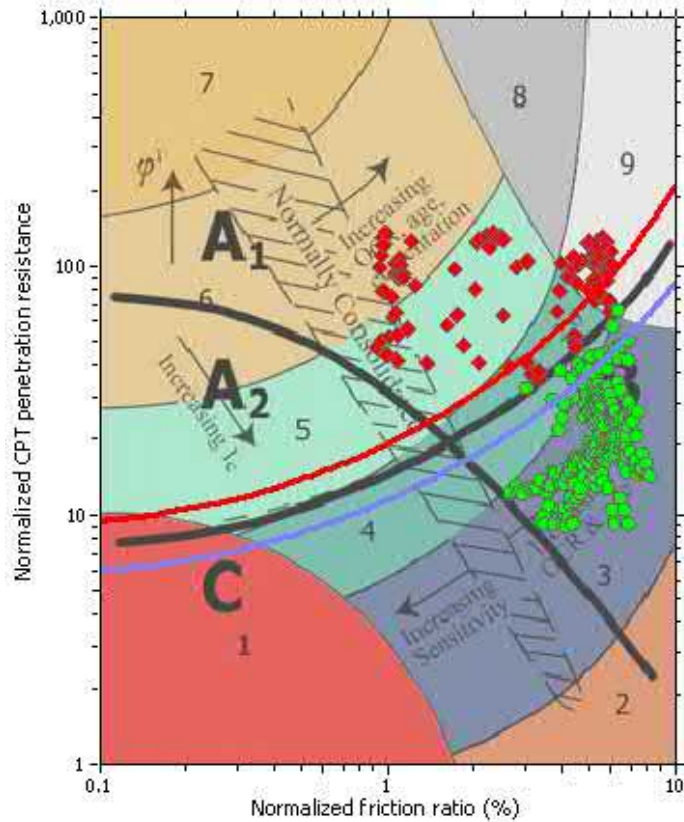
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

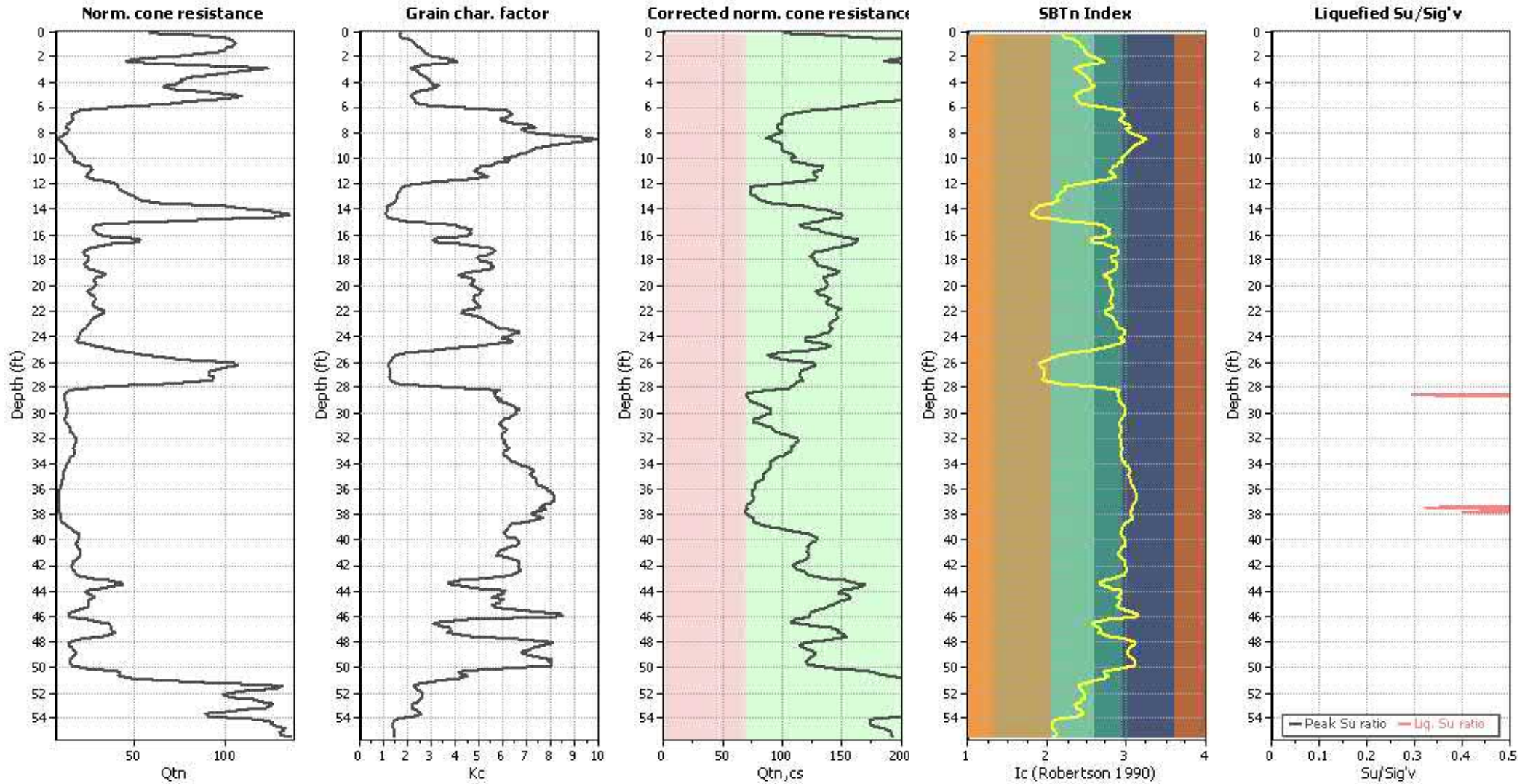
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_c applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

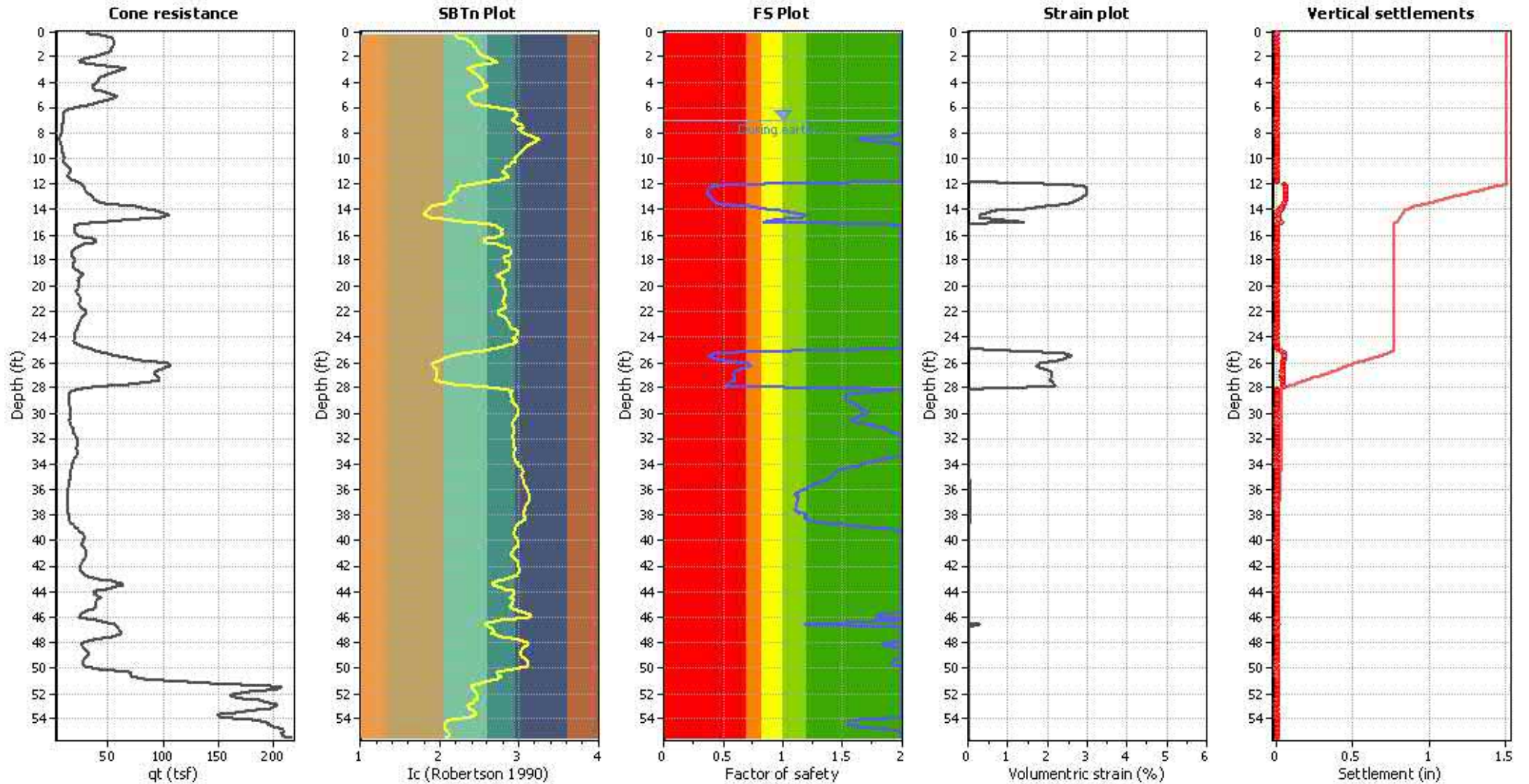
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

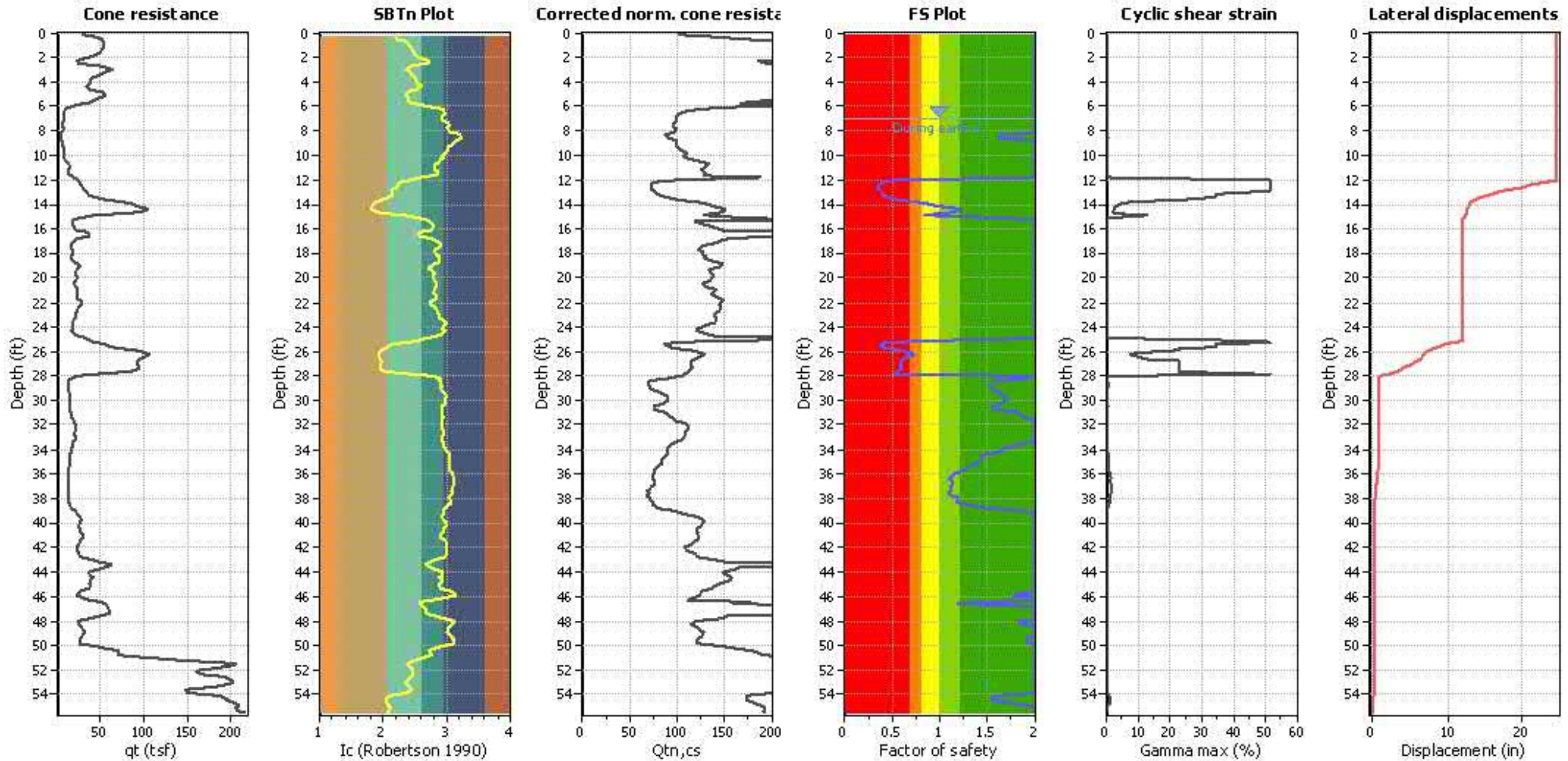


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

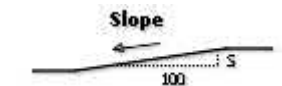


Abbreviations

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

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

Surface condition



LIQUEFACTION ANALYSIS REPORT

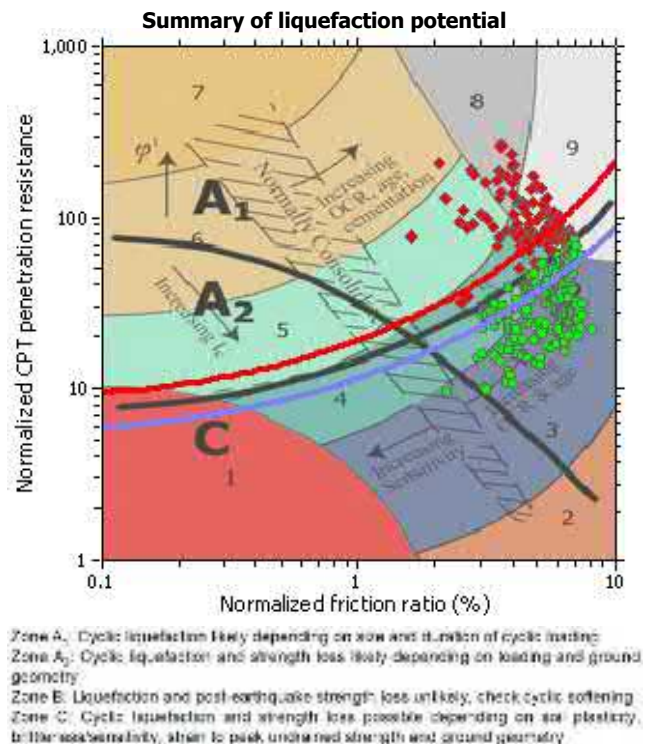
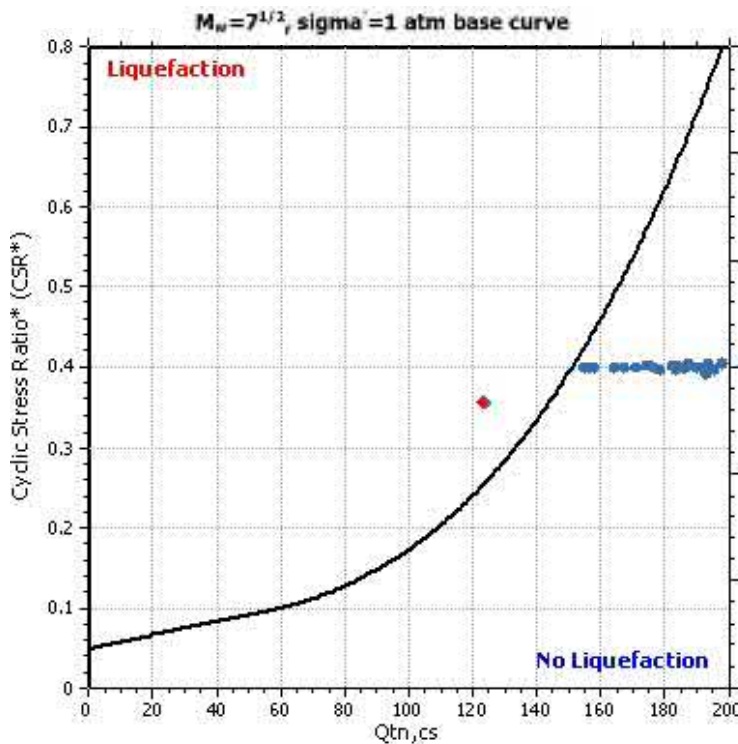
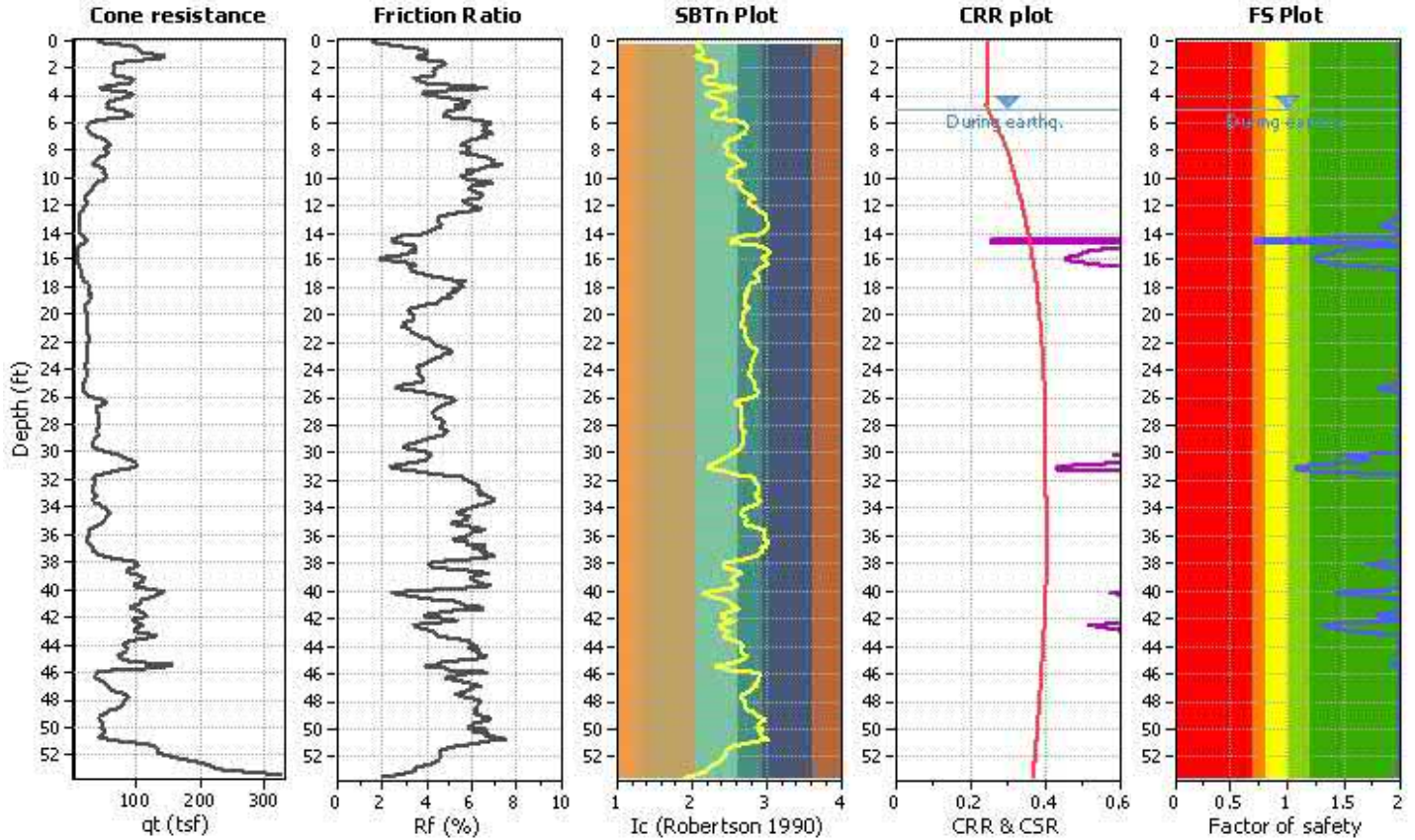
Project title : 12085.002 - JPI Ocean Creek

Location :

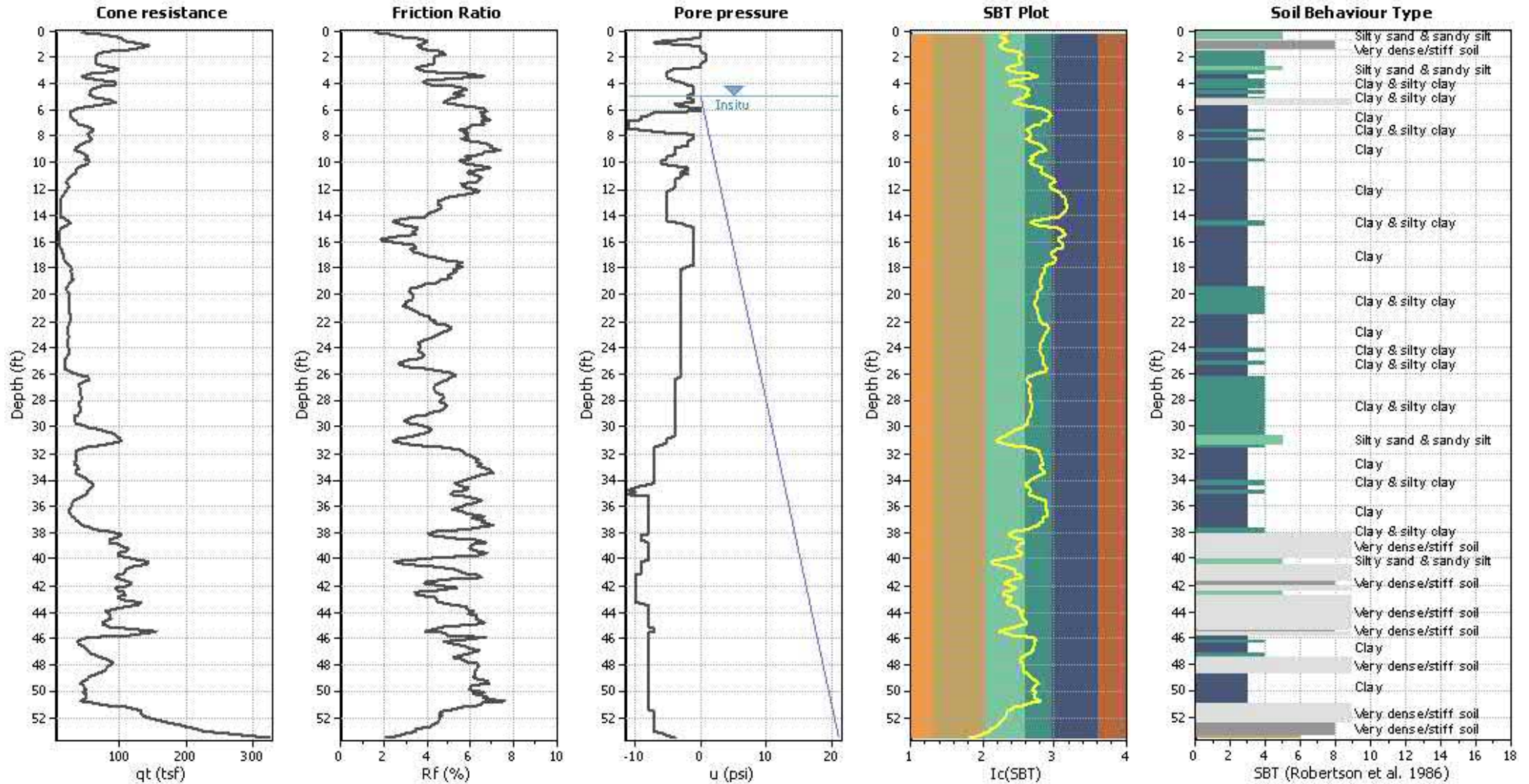
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



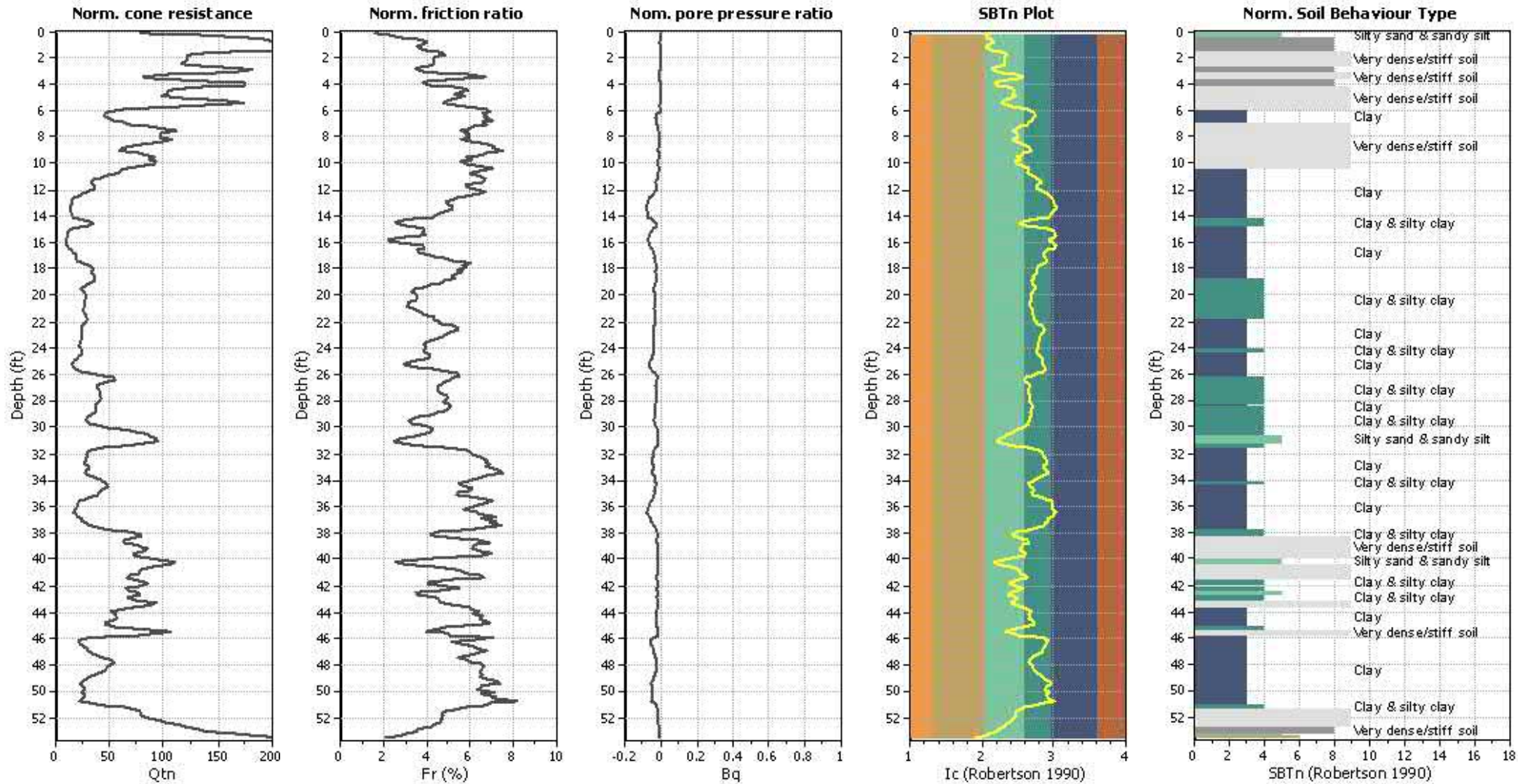
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



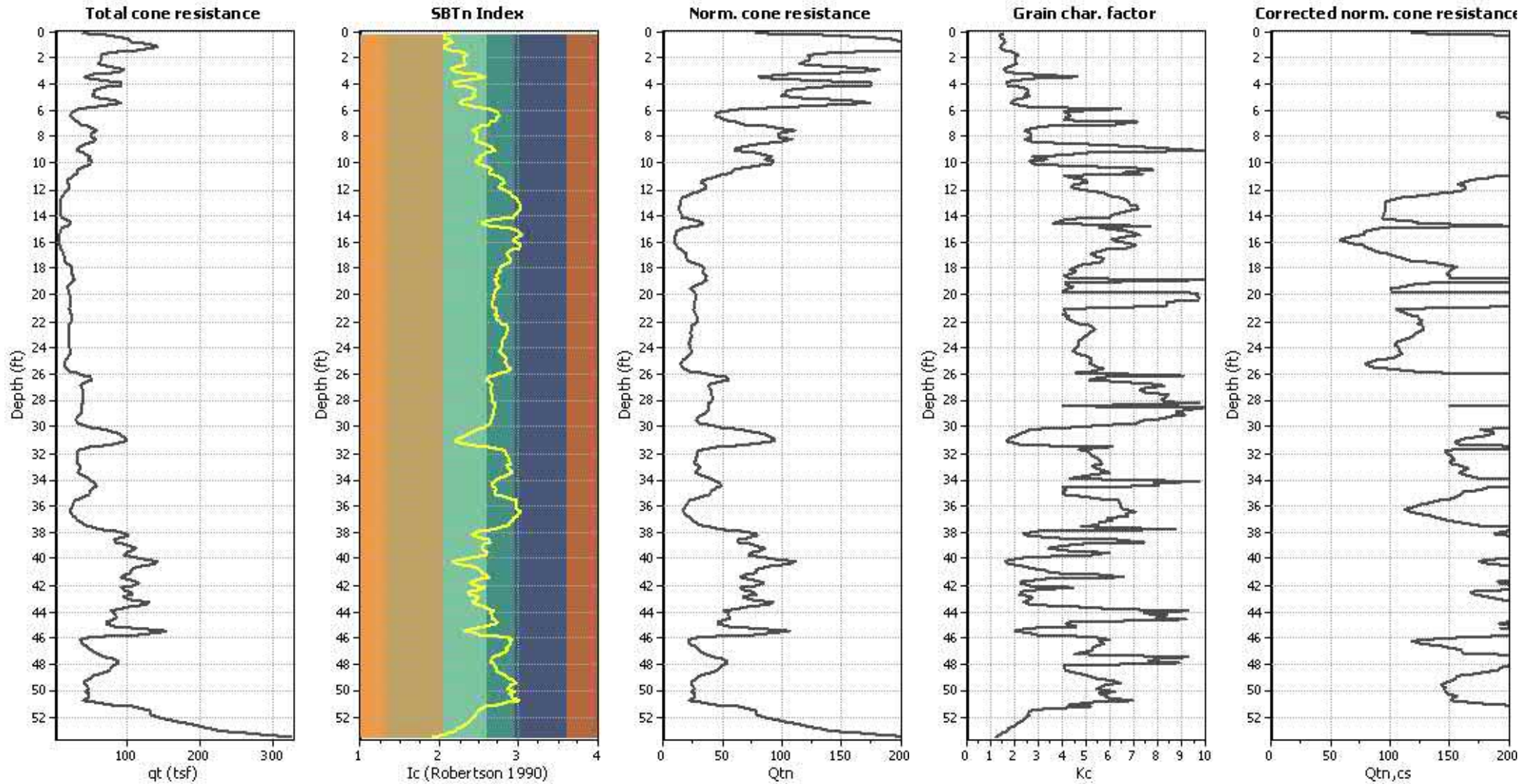
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

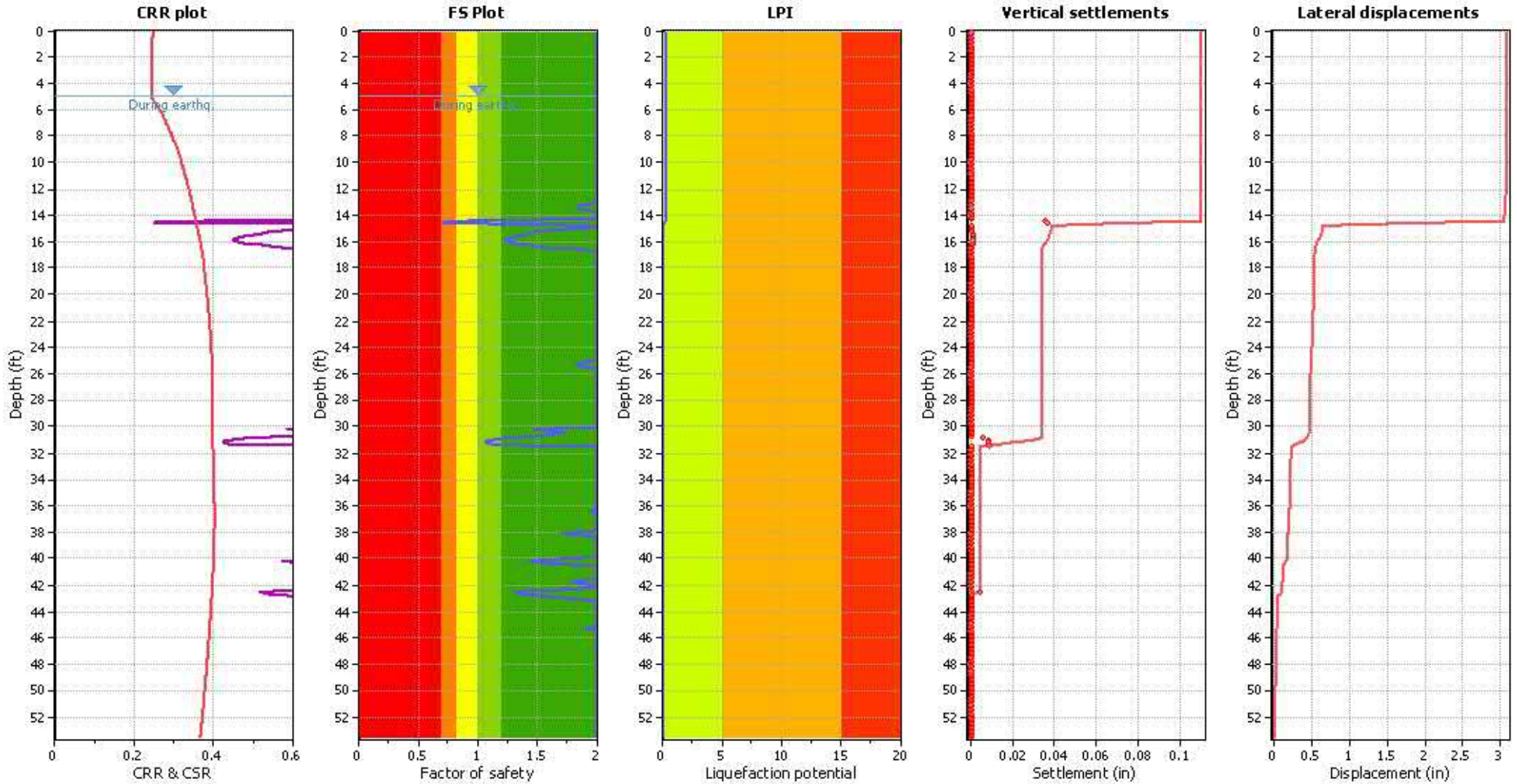
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	5.00 ft	Fill weight:	N/A
Flines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

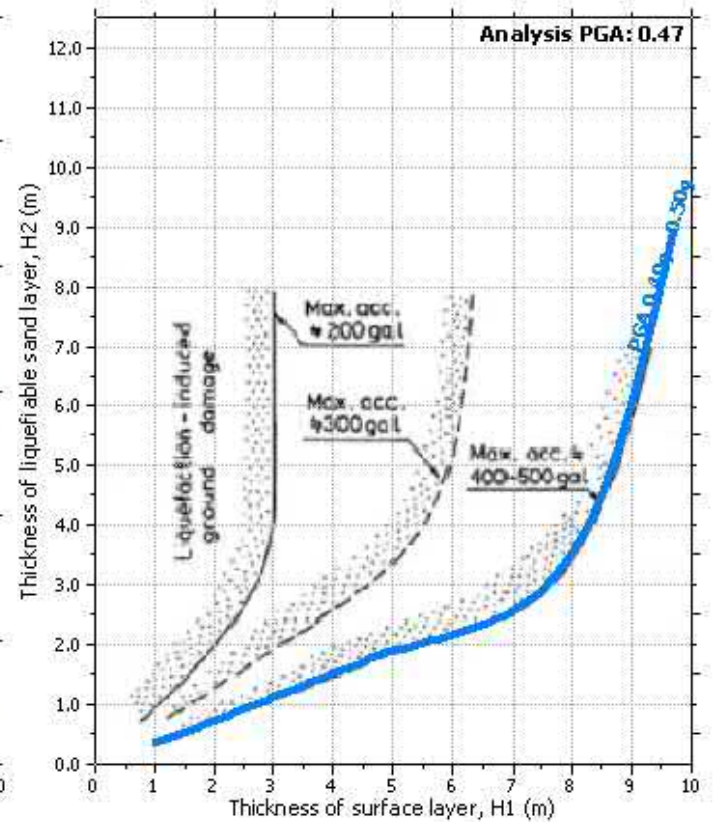
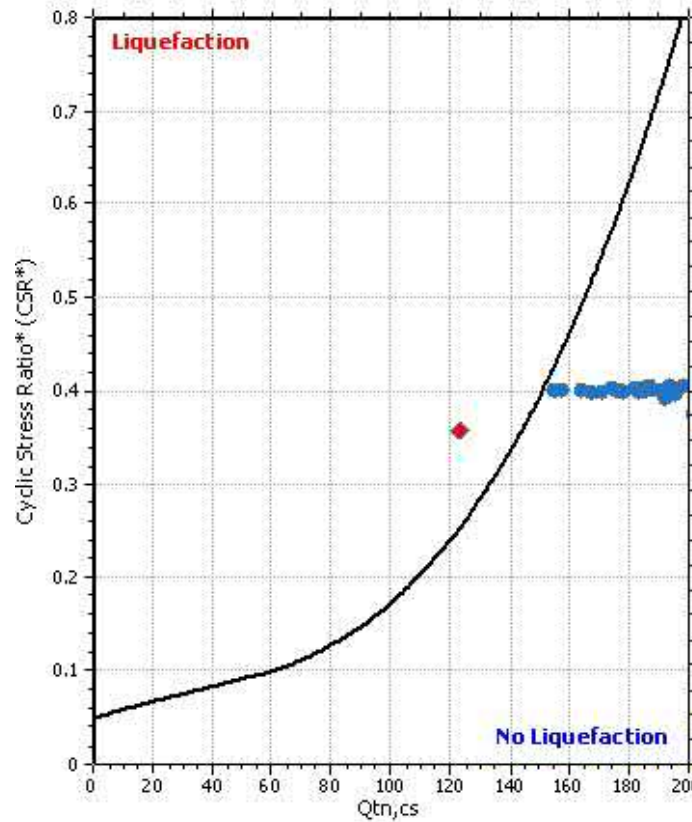
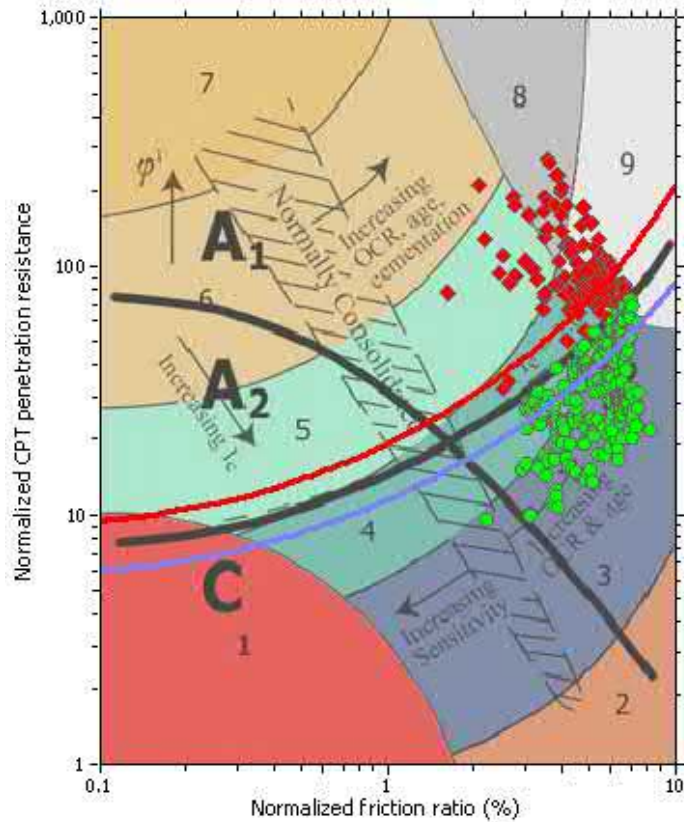
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

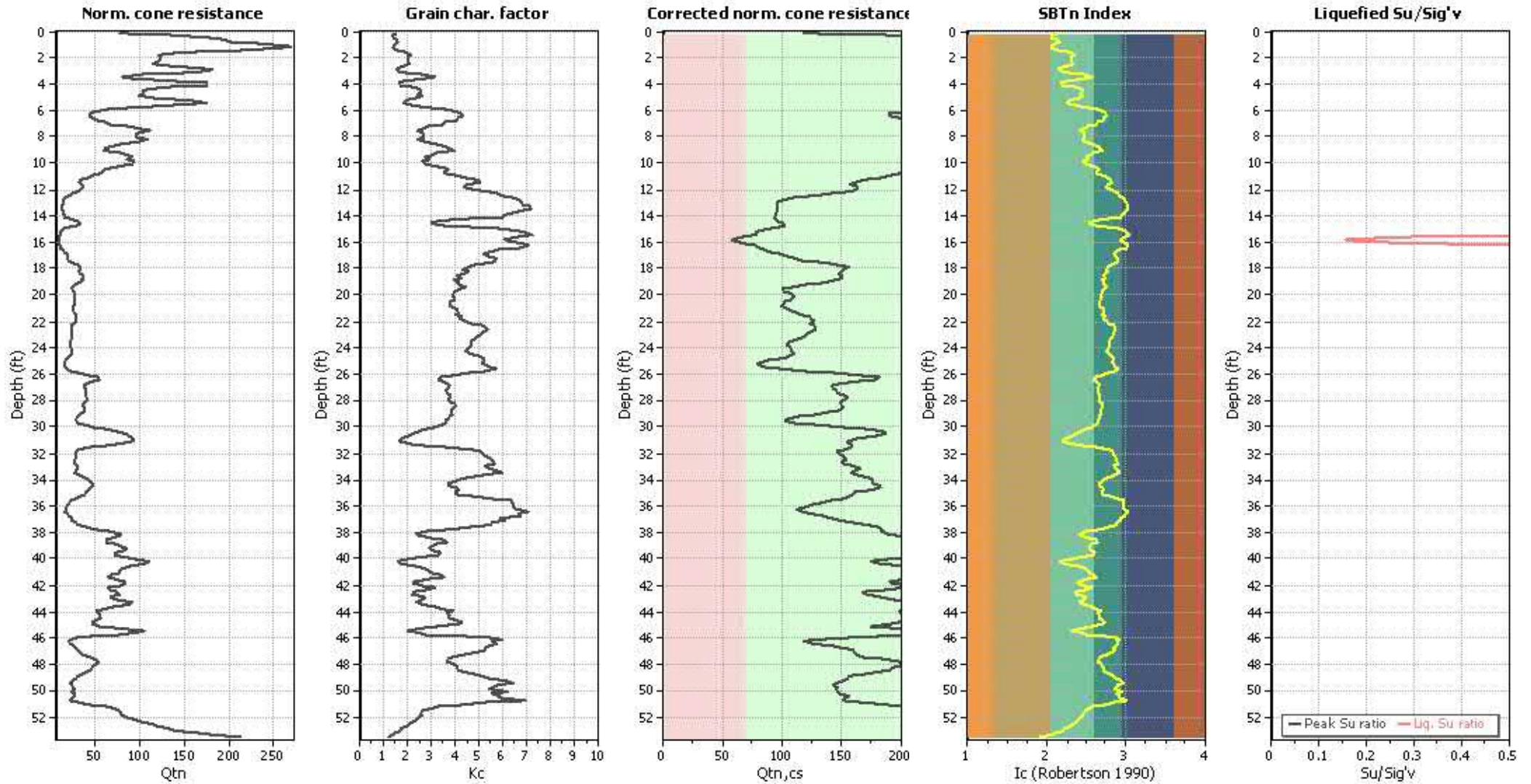
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

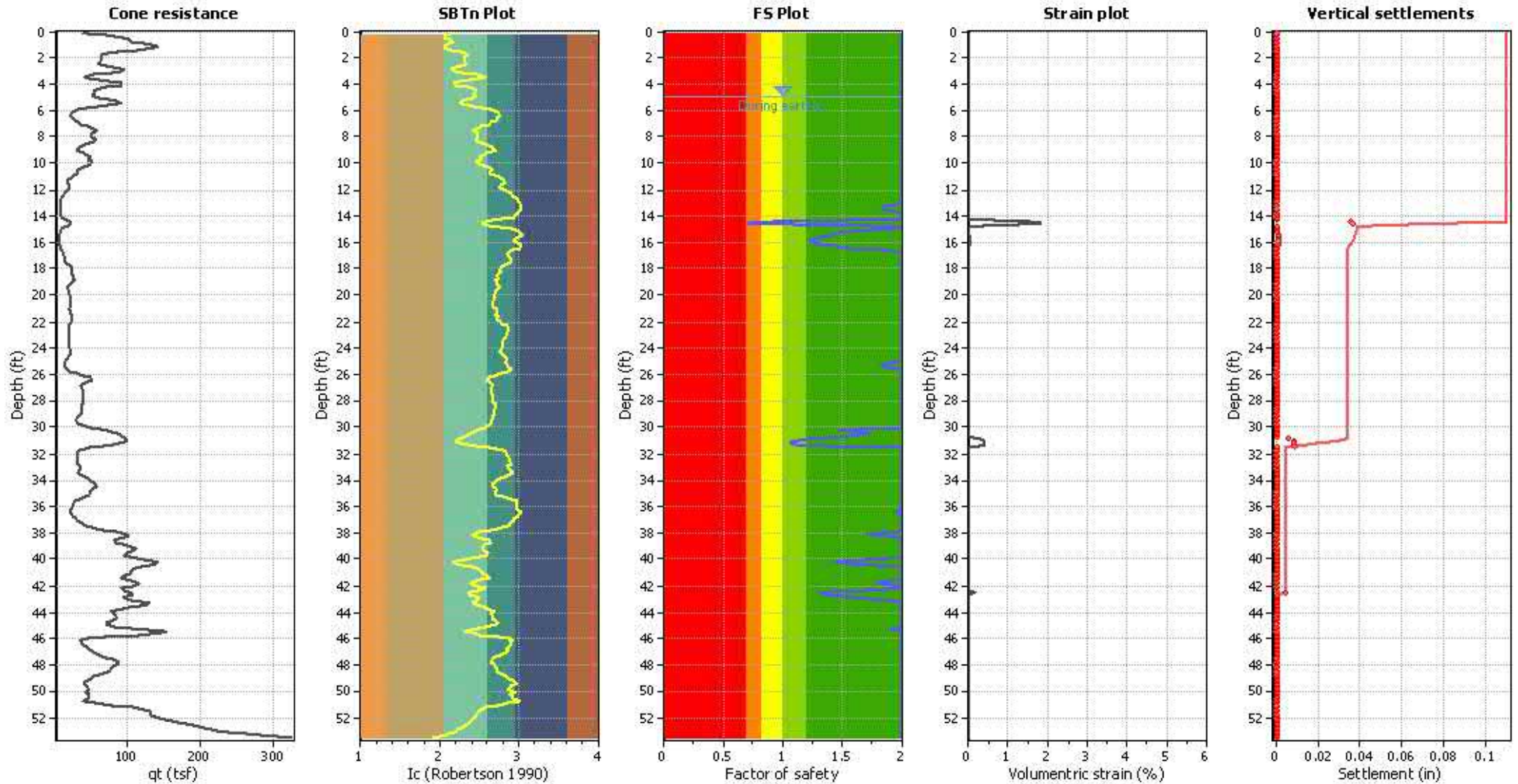
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Flines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

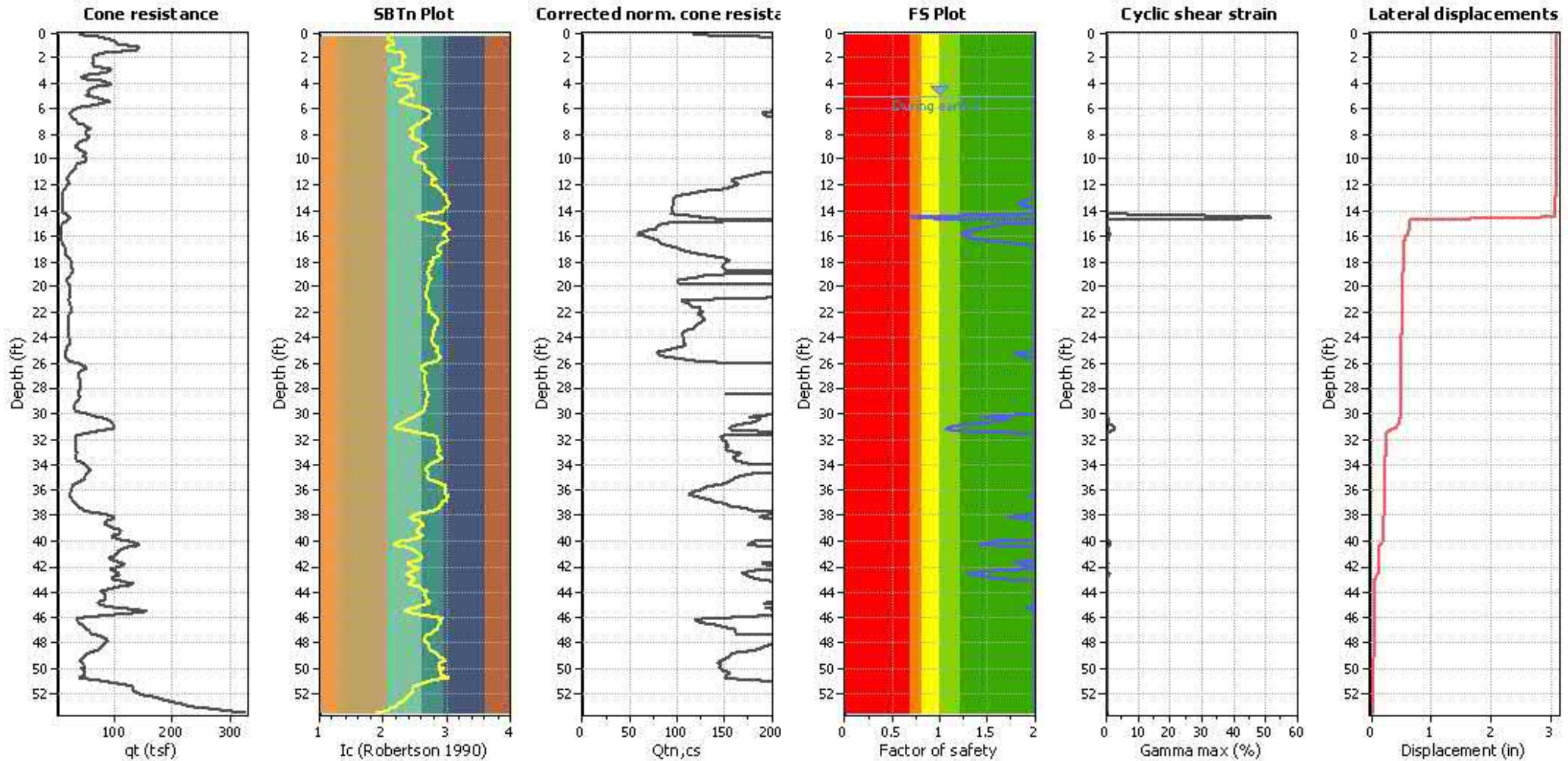


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

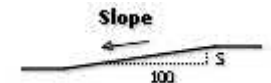


Abbreviations

qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
 Ic: Soil Behaviour Type Index
 $Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance

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

Surface condition



LIQUEFACTION ANALYSIS REPORT

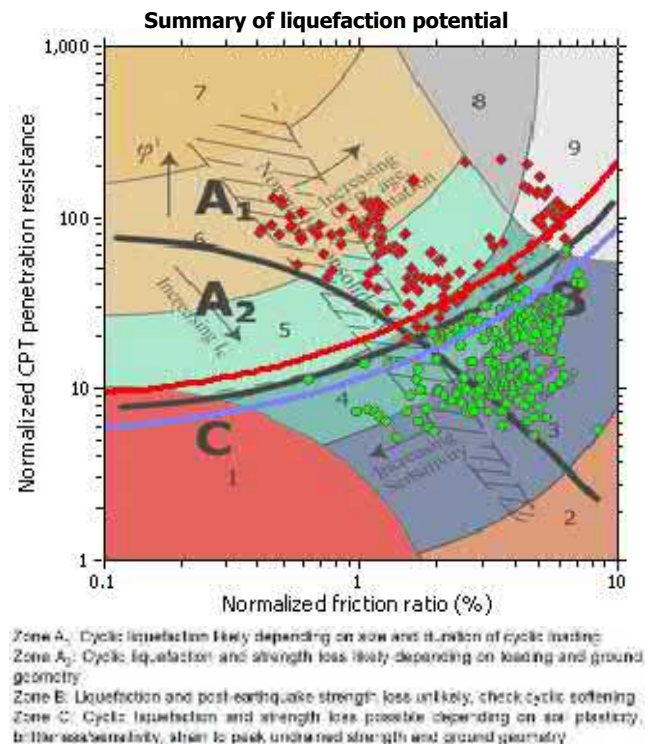
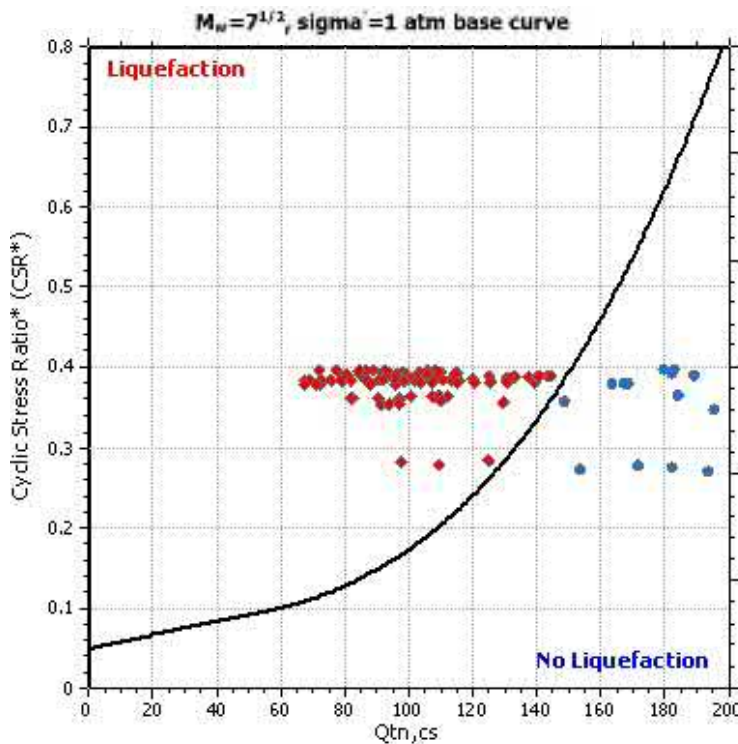
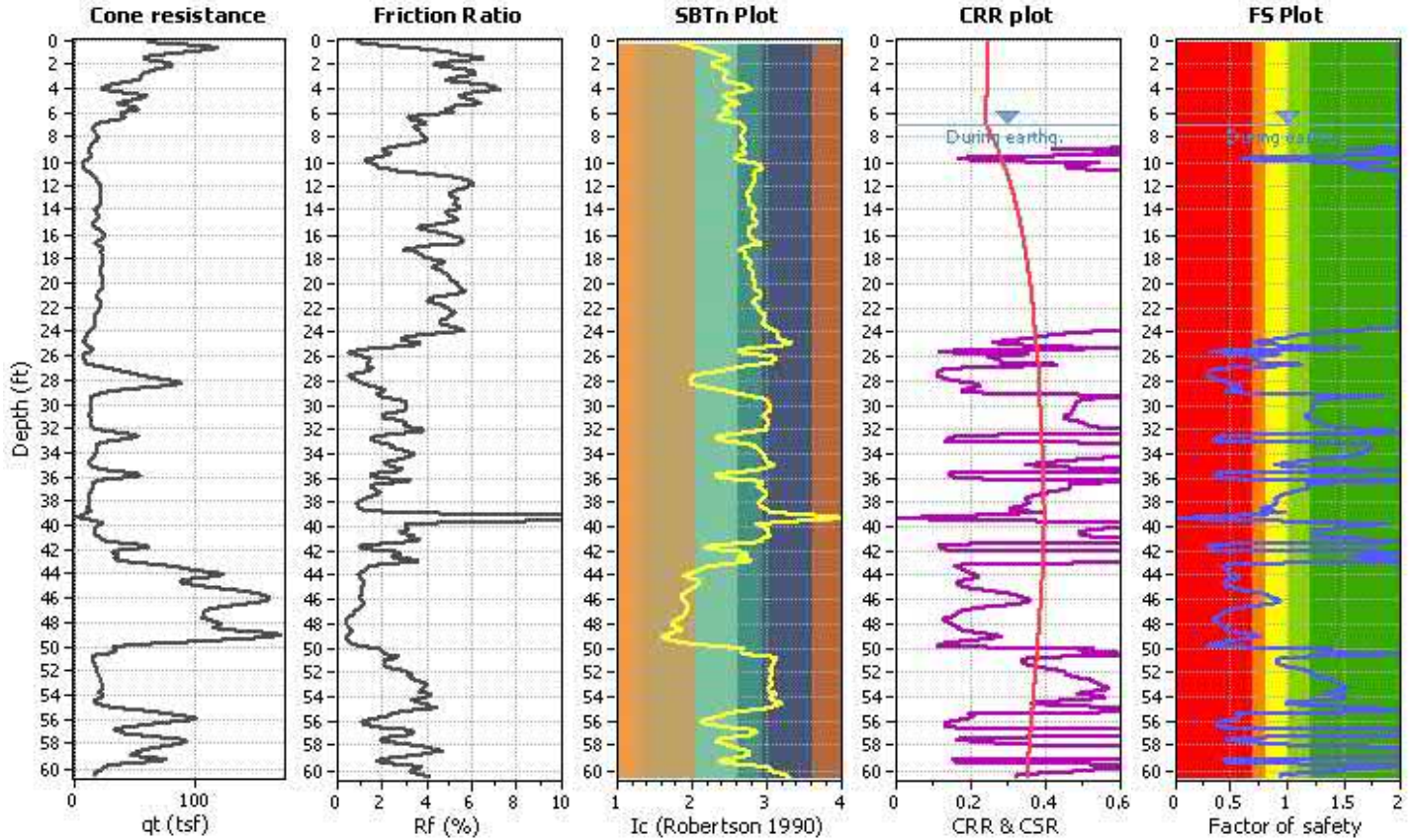
Project title : 12085.002 - JPI Ocean Creek

Location :

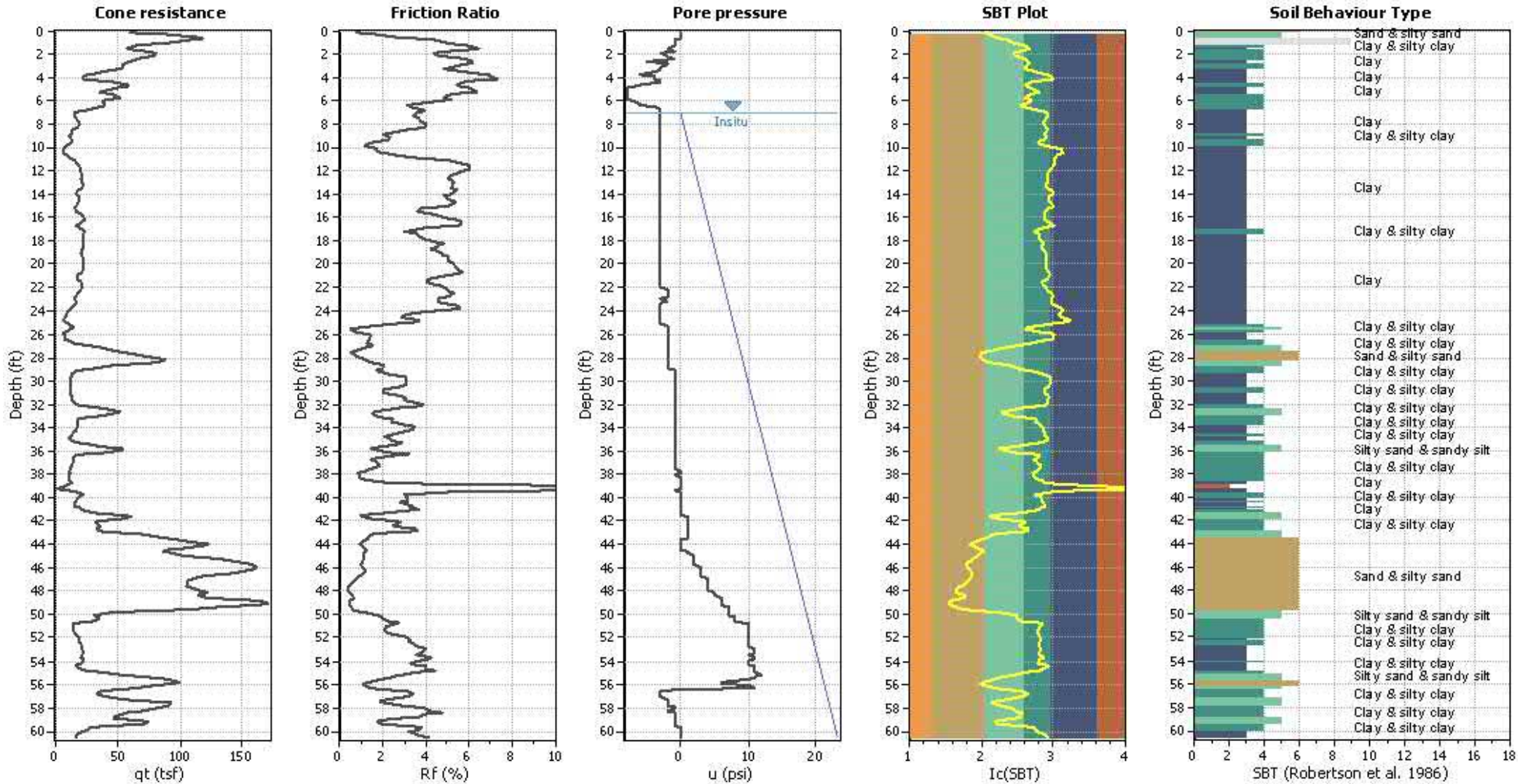
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Finest correction method:	Robertson (2009)	G.W.T. (earthq.):	7.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



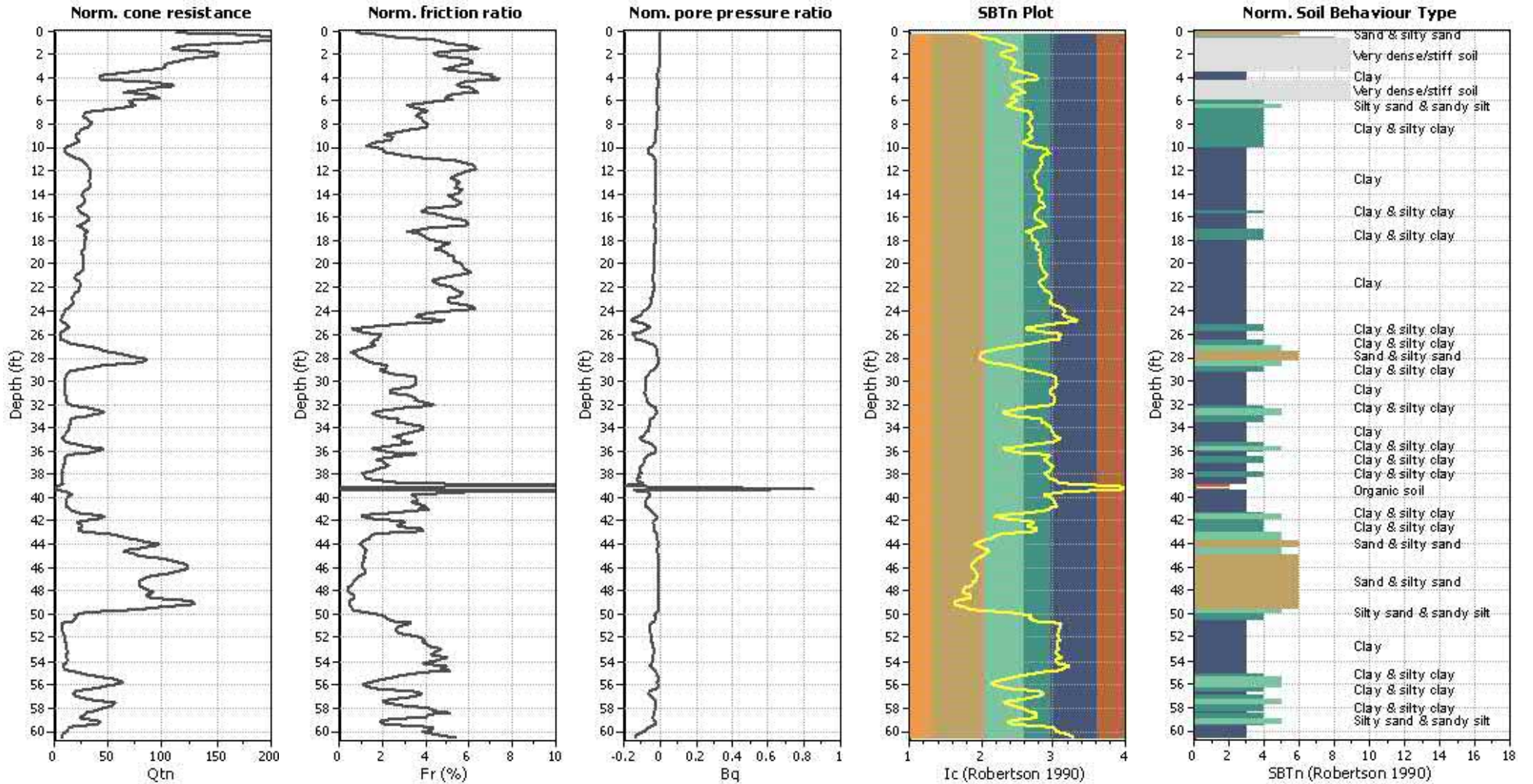
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



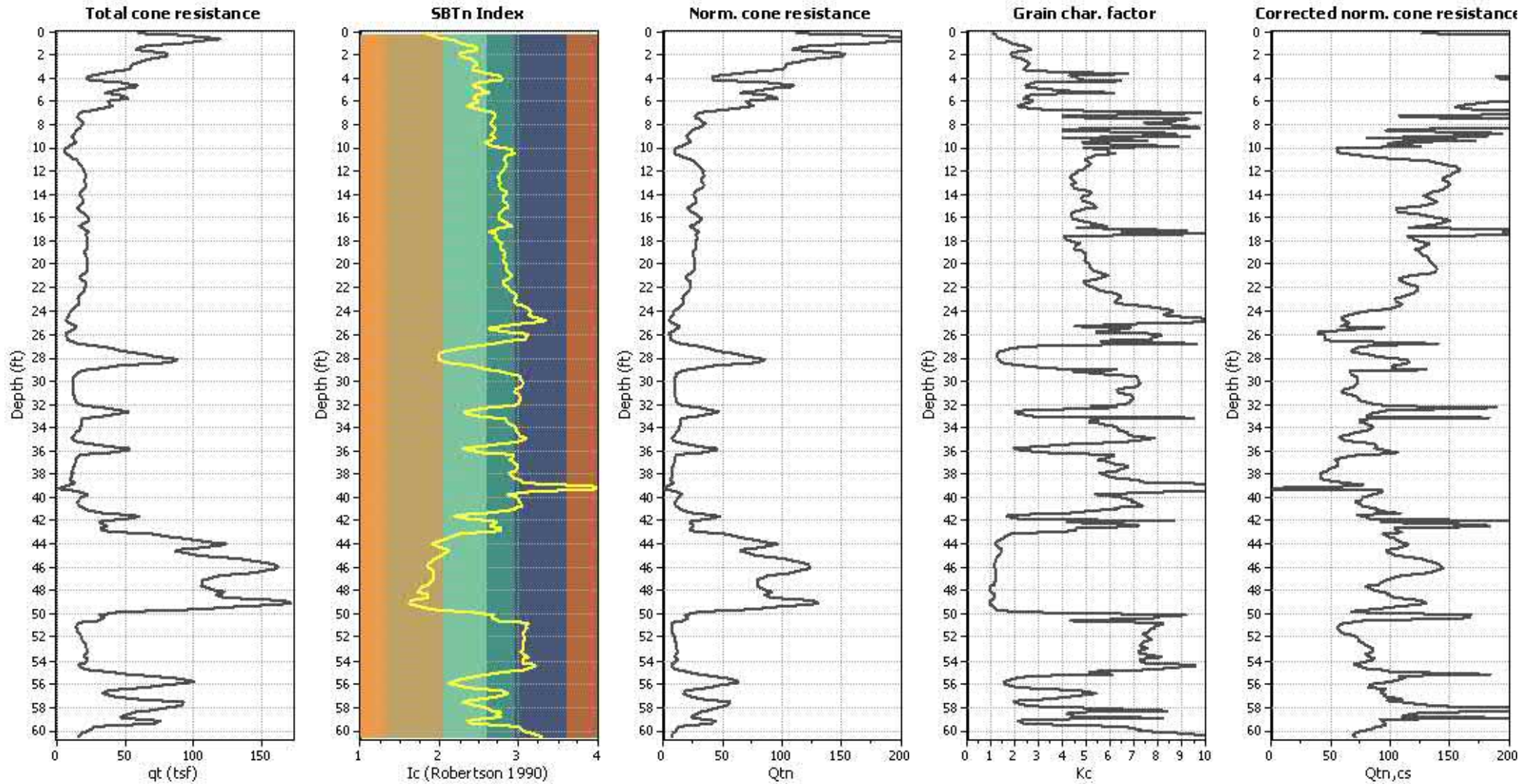
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

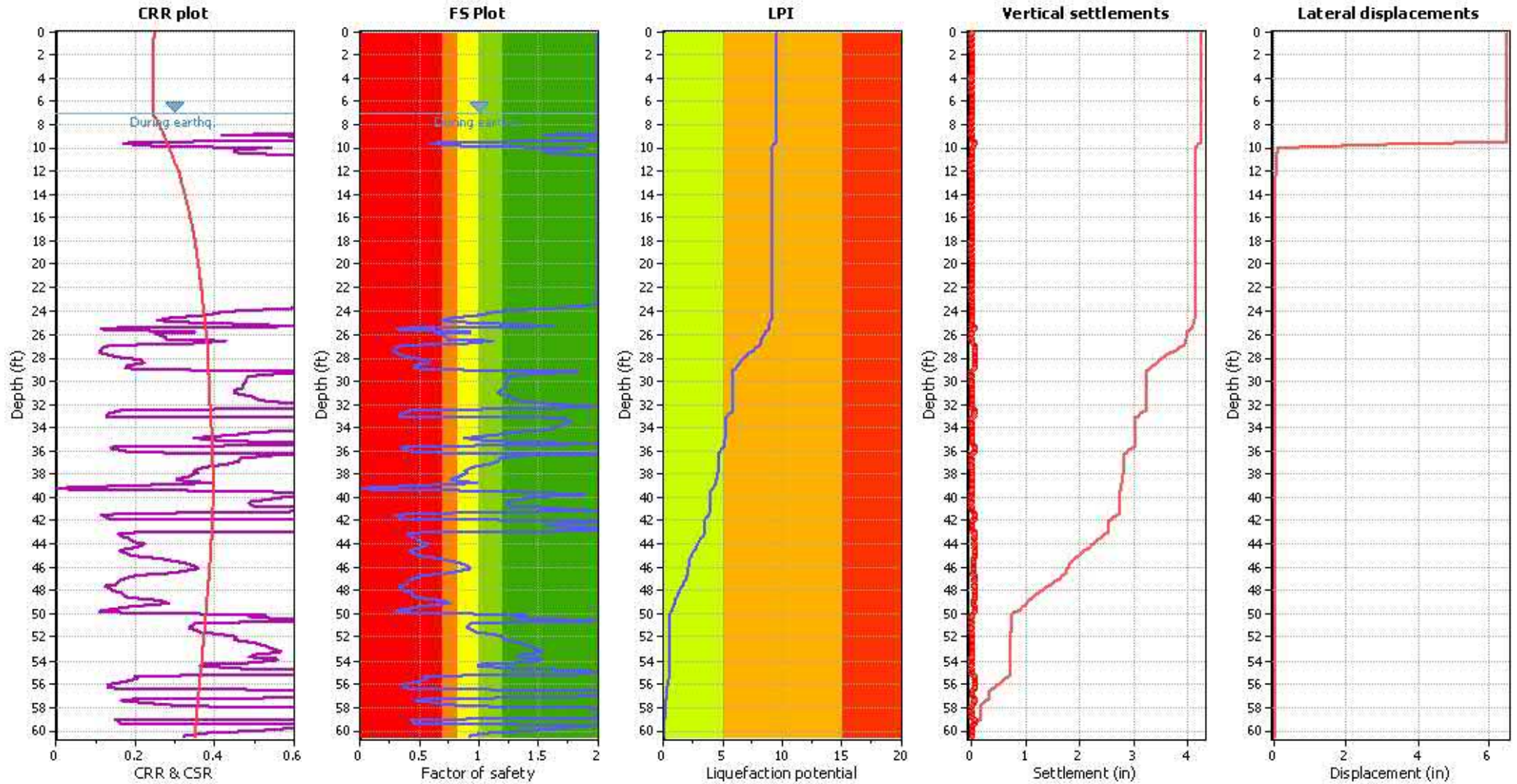
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_c applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	7.00 ft	Fill weight:	N/A
Finer correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{cs} applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

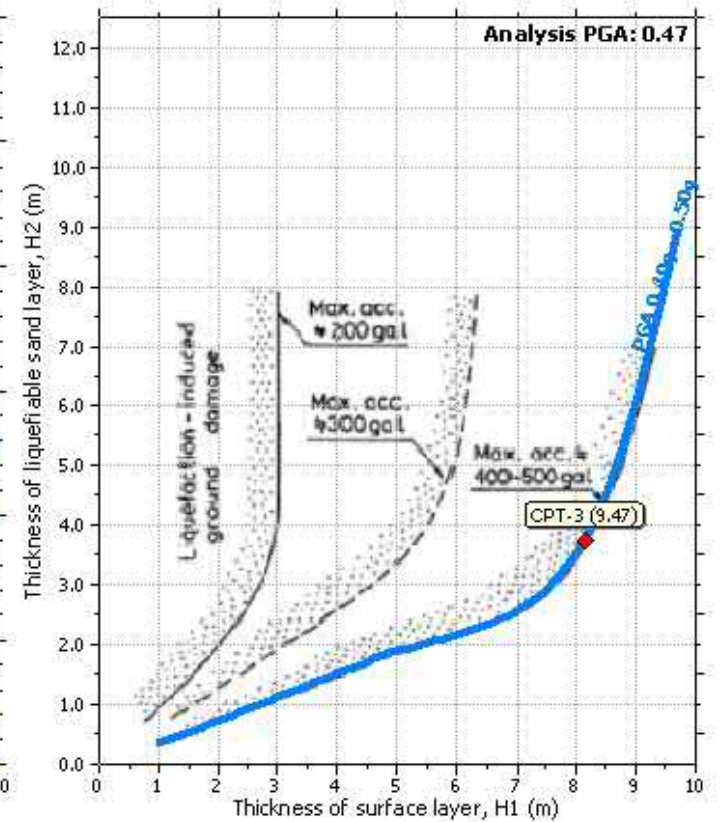
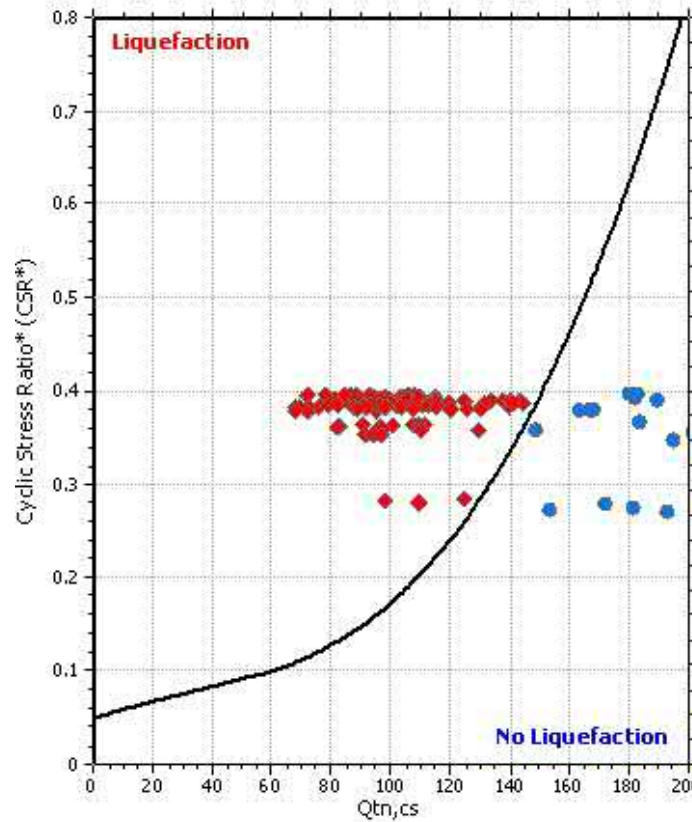
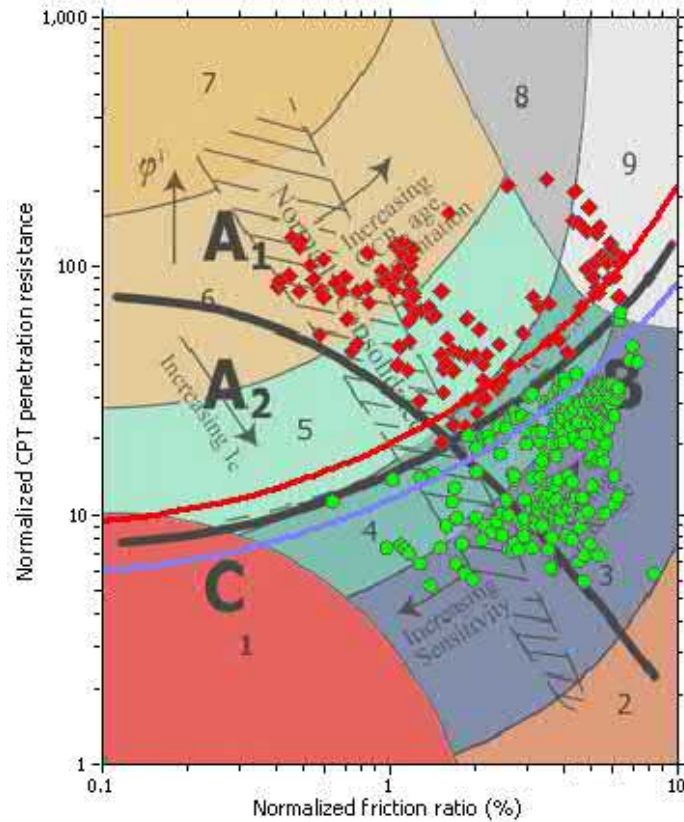
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

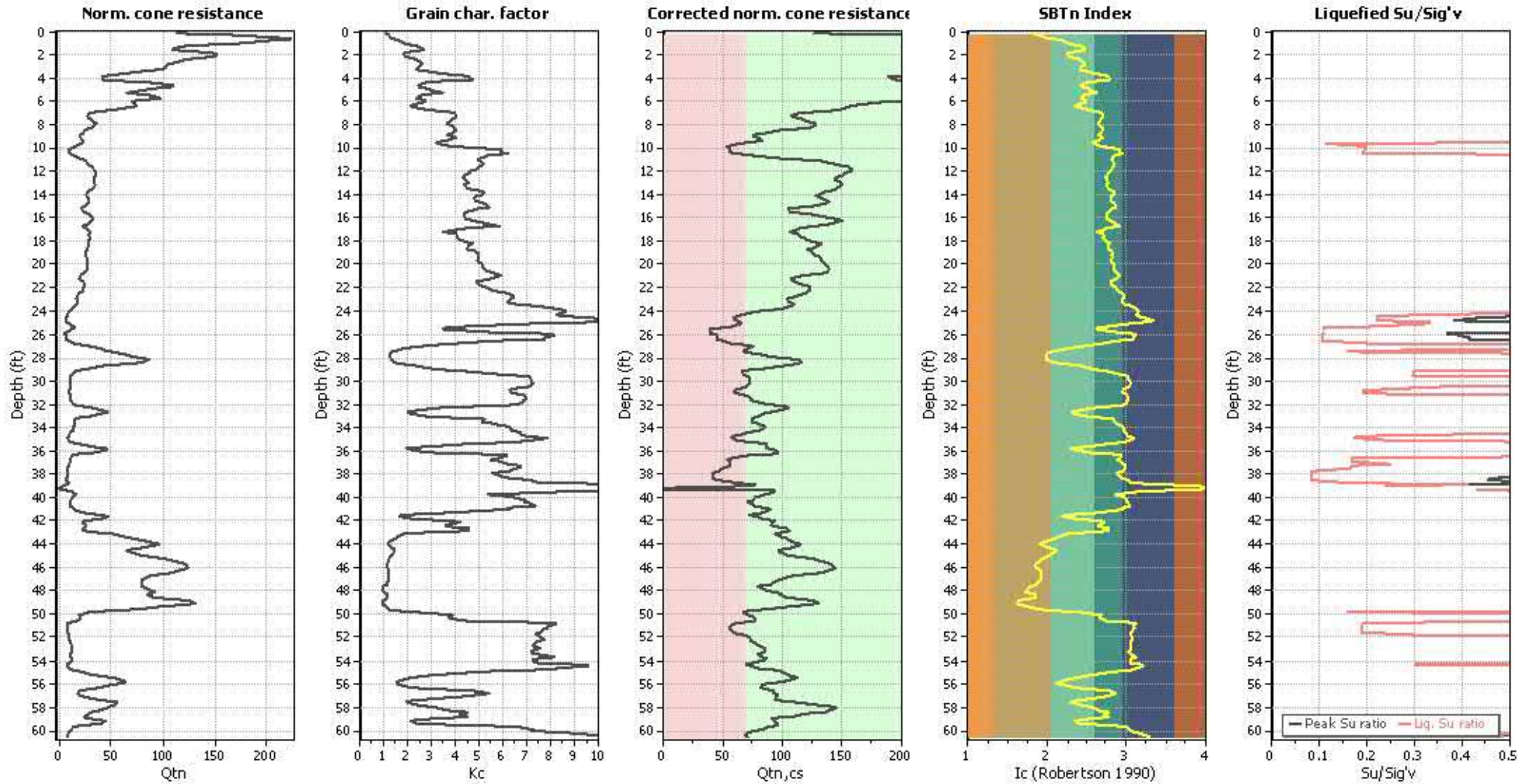
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

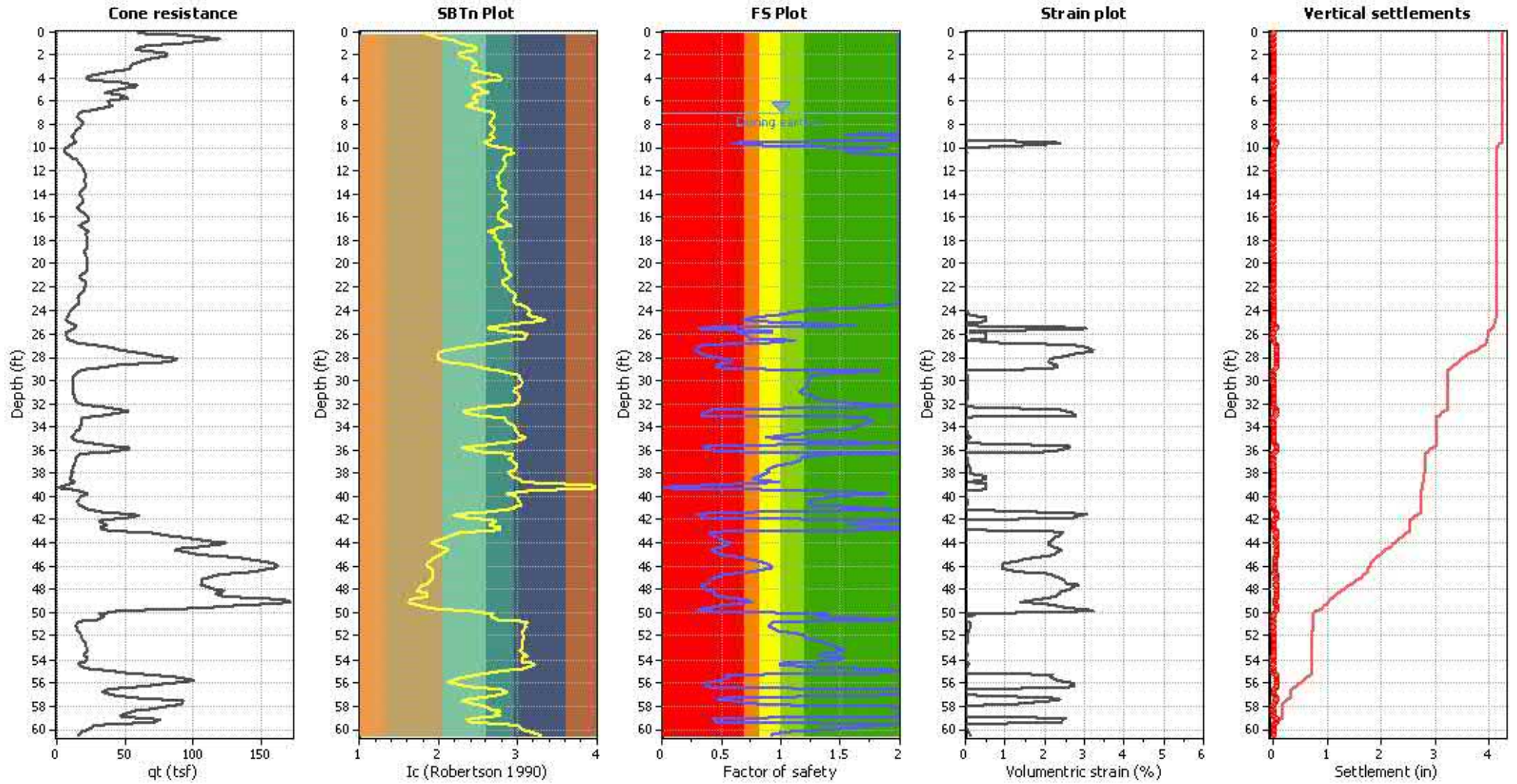
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	7.00 ft	Fill weight:	N/A
Flines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

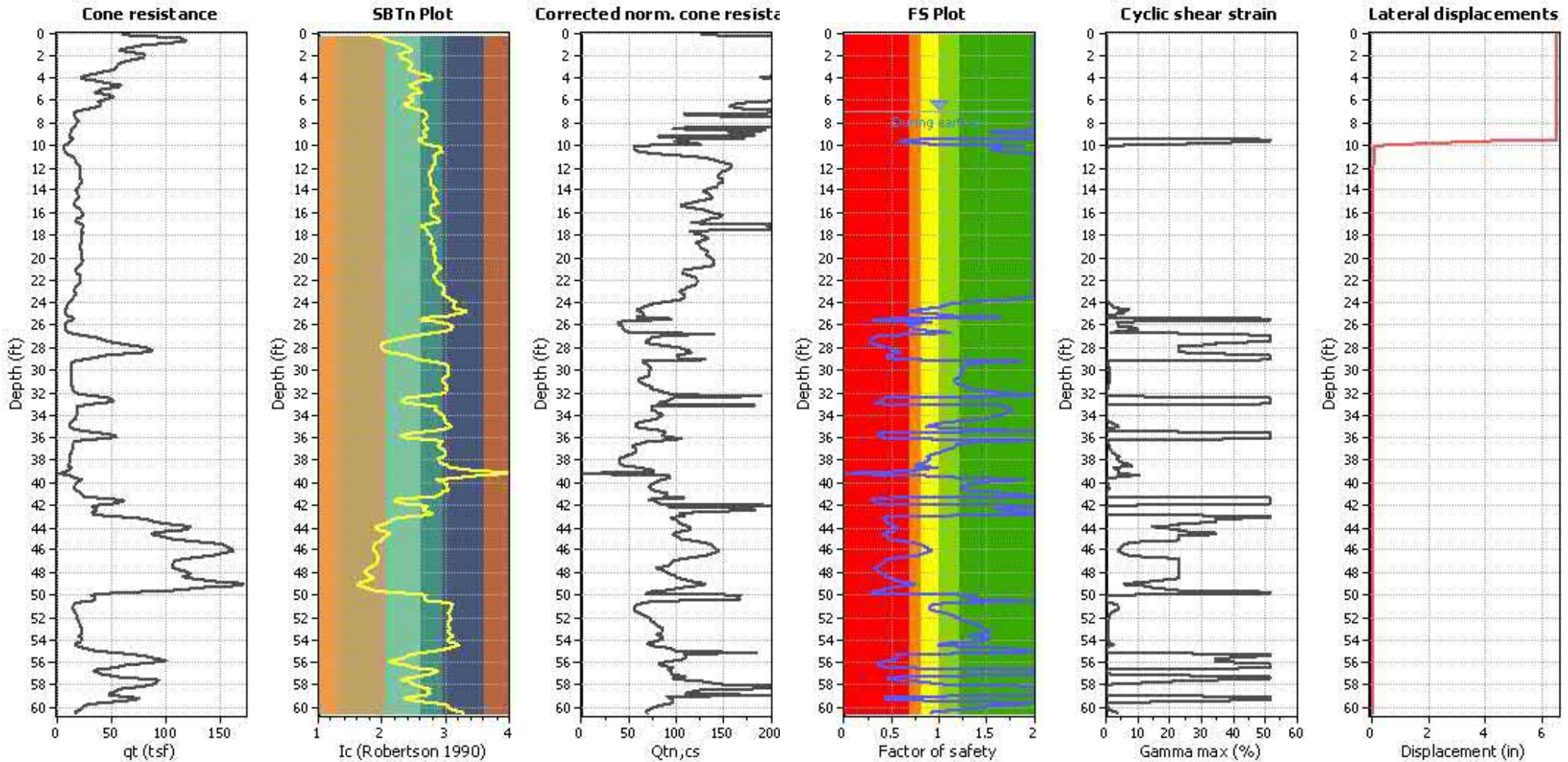


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Level ground (or gently sloping) with free face (L: 20.00 ft - H: 7.00 ft)

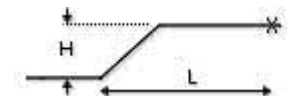


Abbreviations

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

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

Surface condition



LIQUEFACTION ANALYSIS REPORT

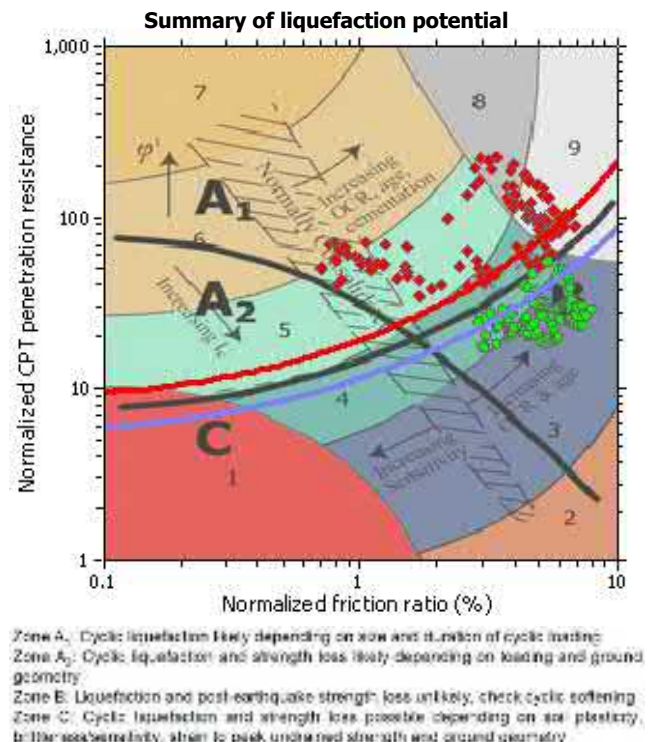
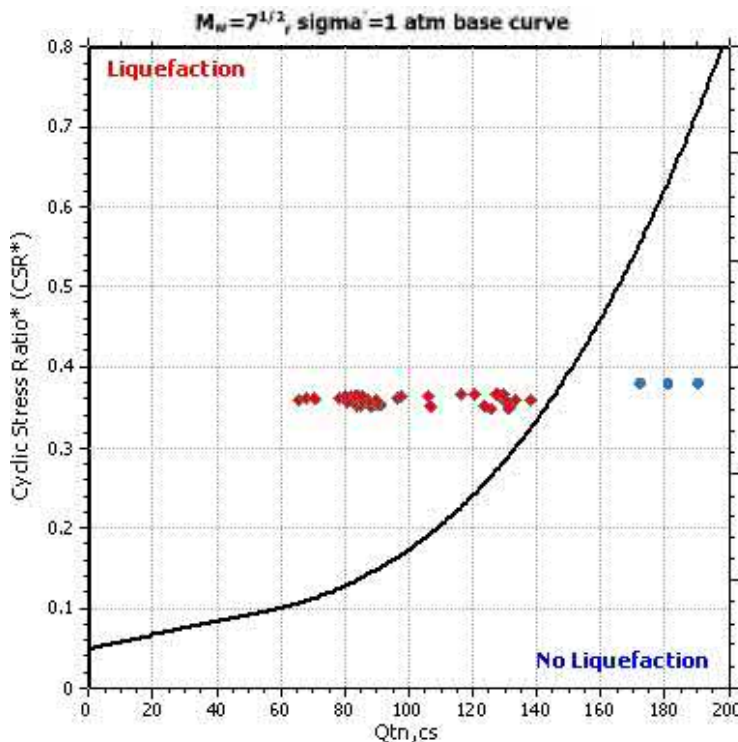
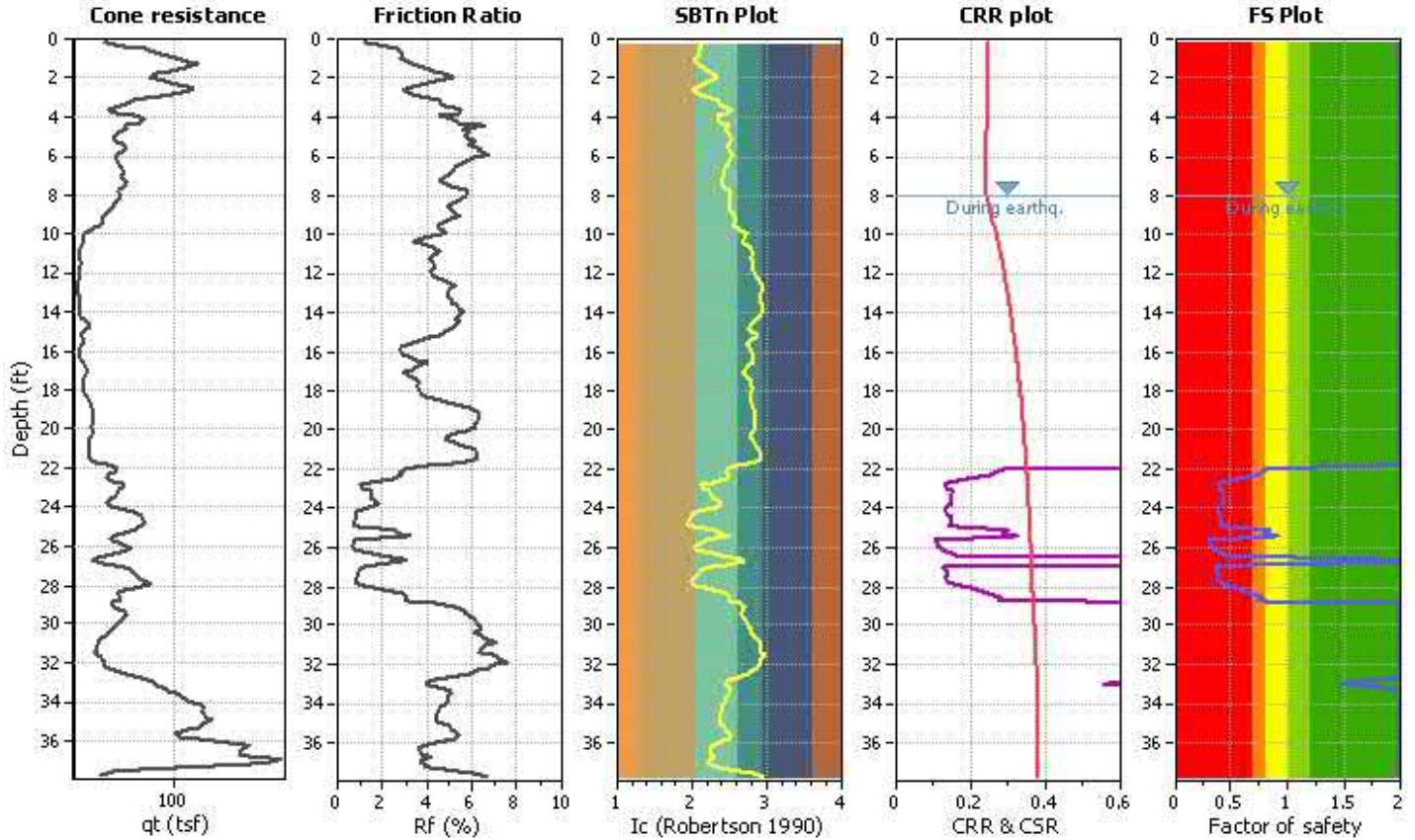
Project title : 12085.002 - JPI Ocean Creek

Location :

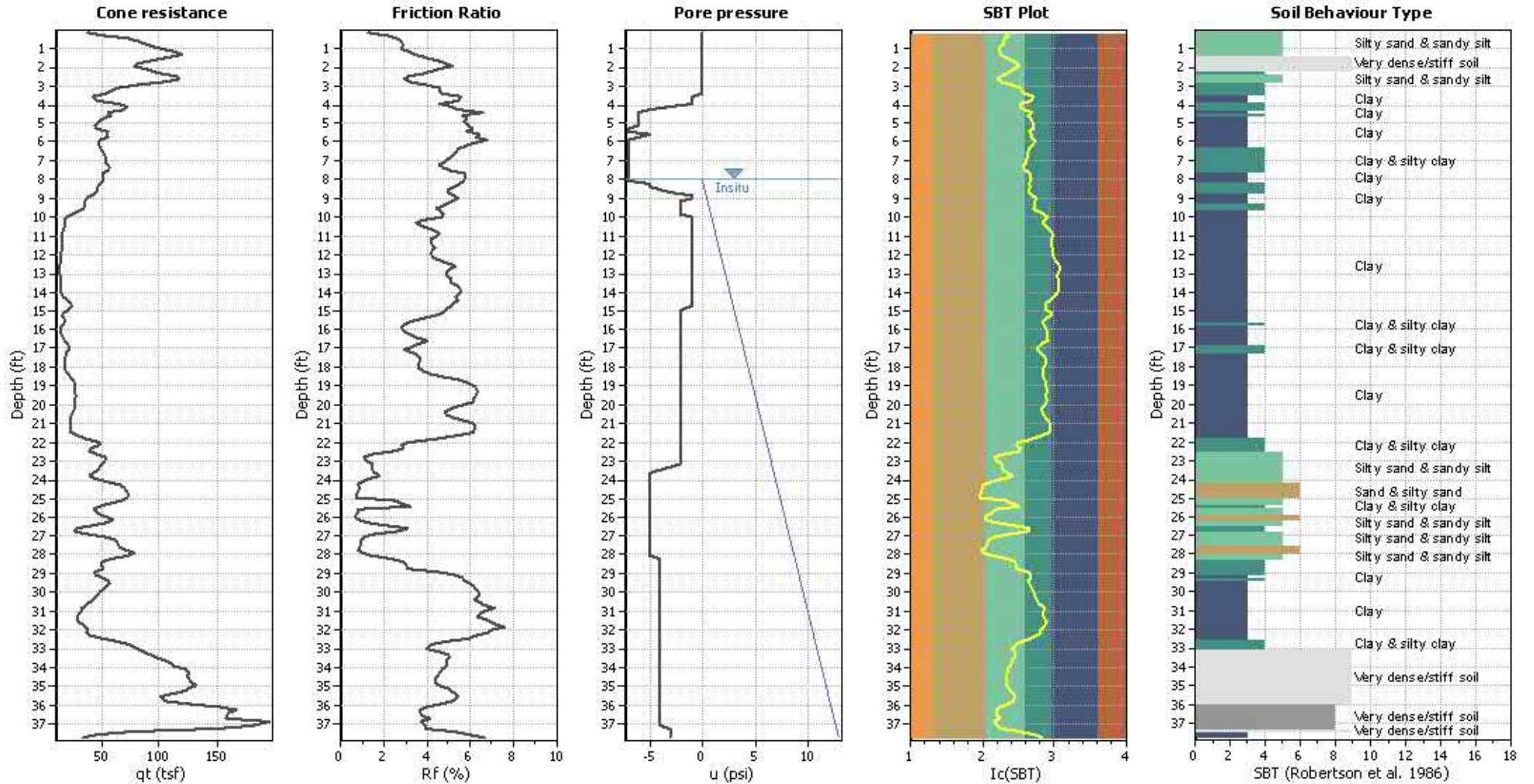
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



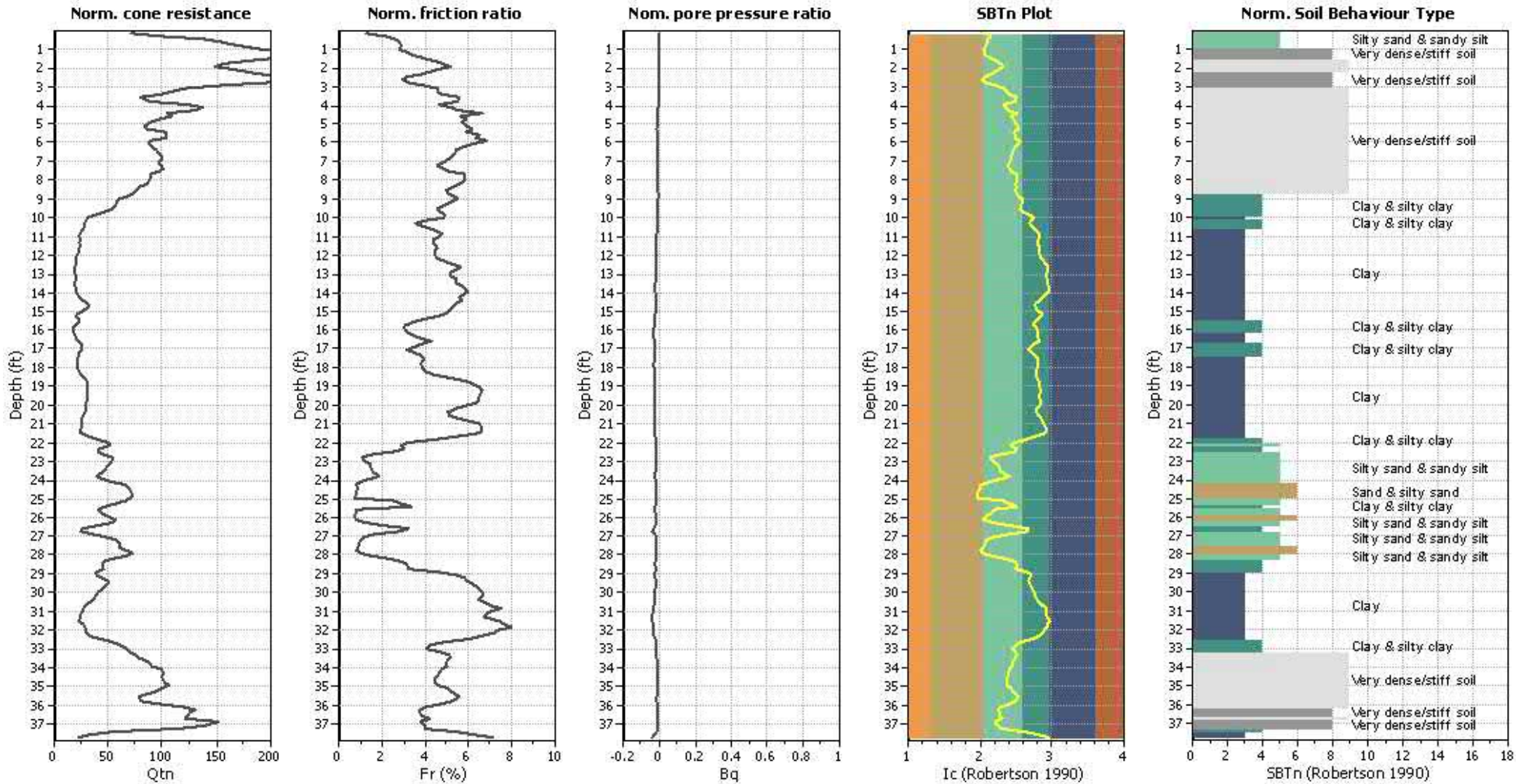
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	8.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



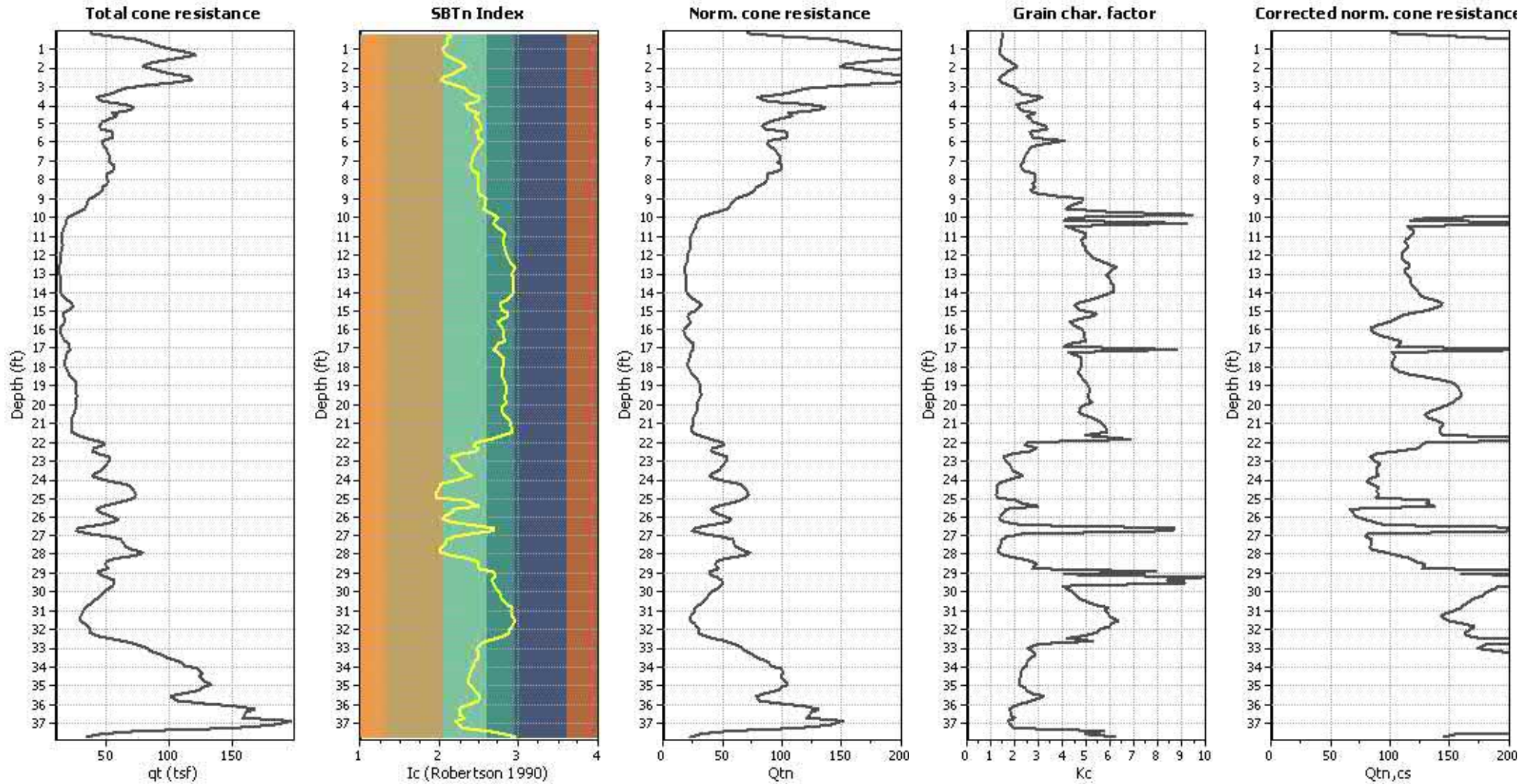
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	8.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insbu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

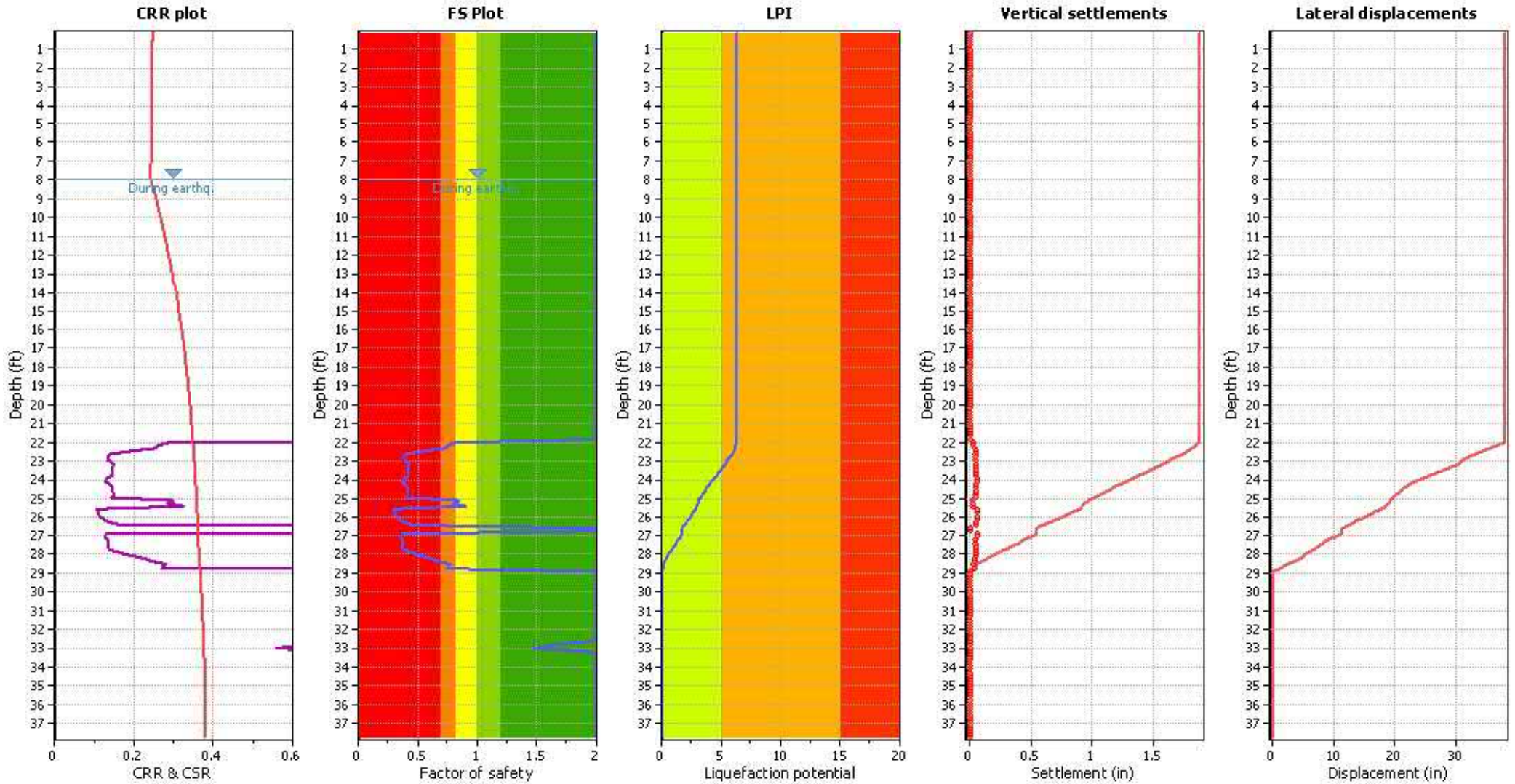
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

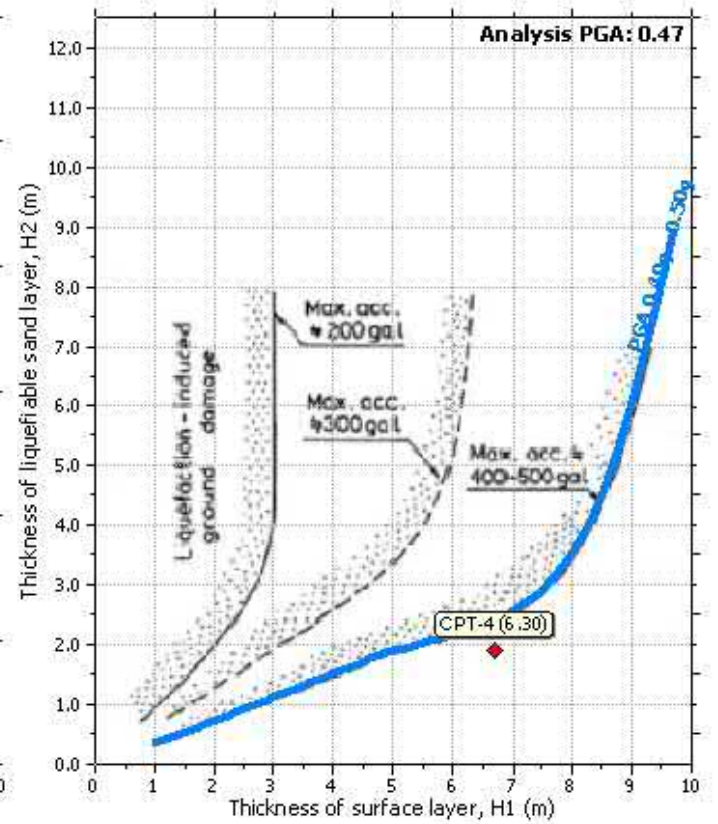
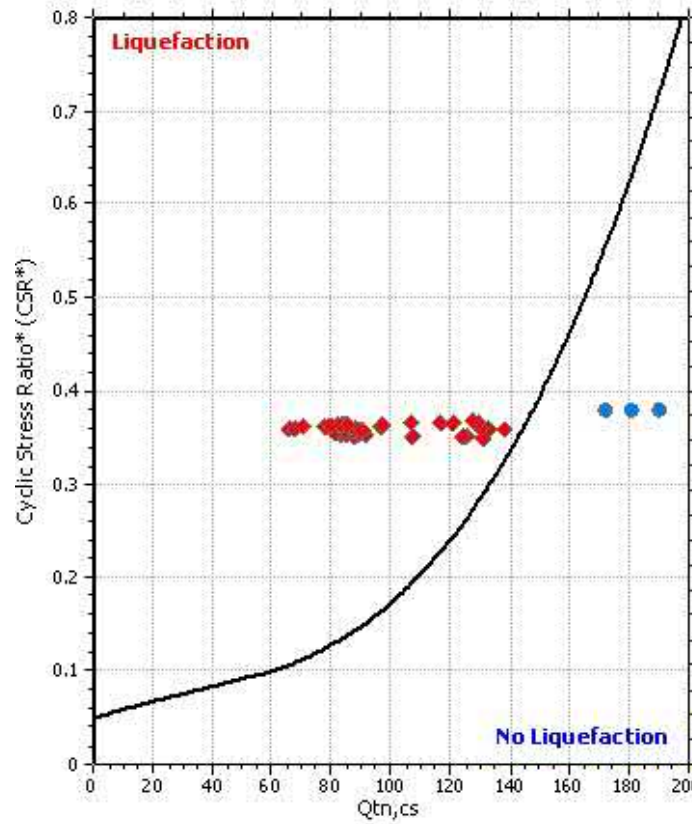
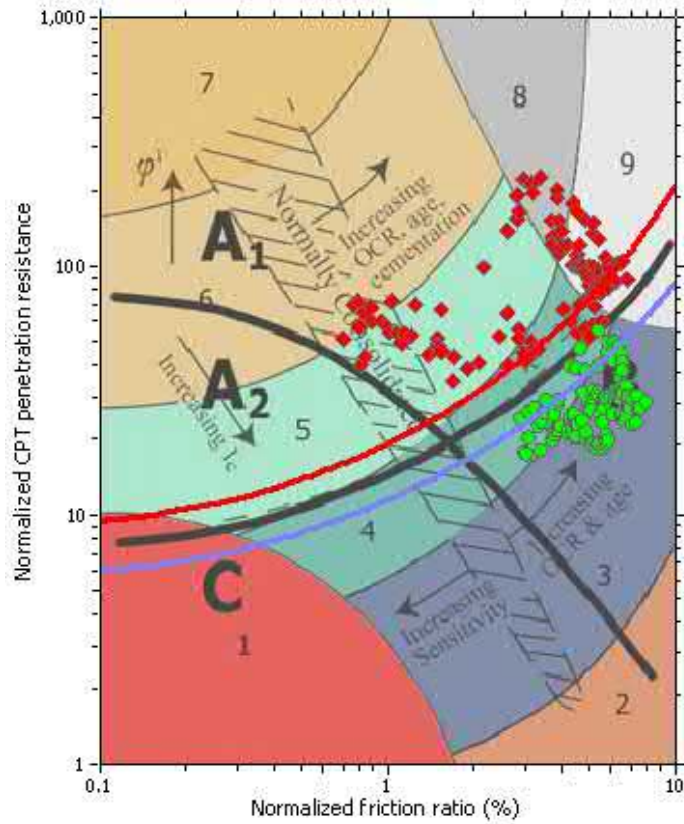
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

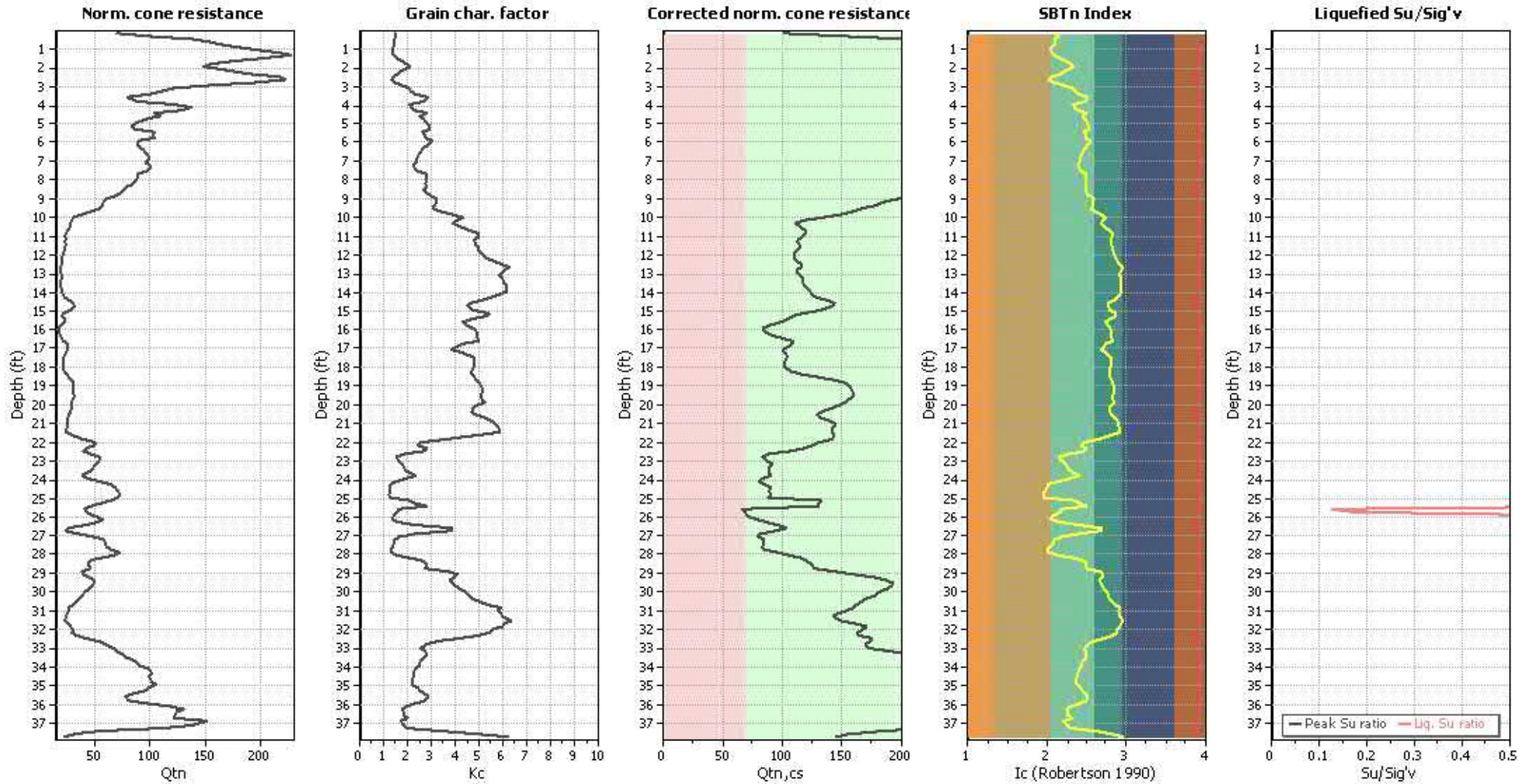
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_c applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

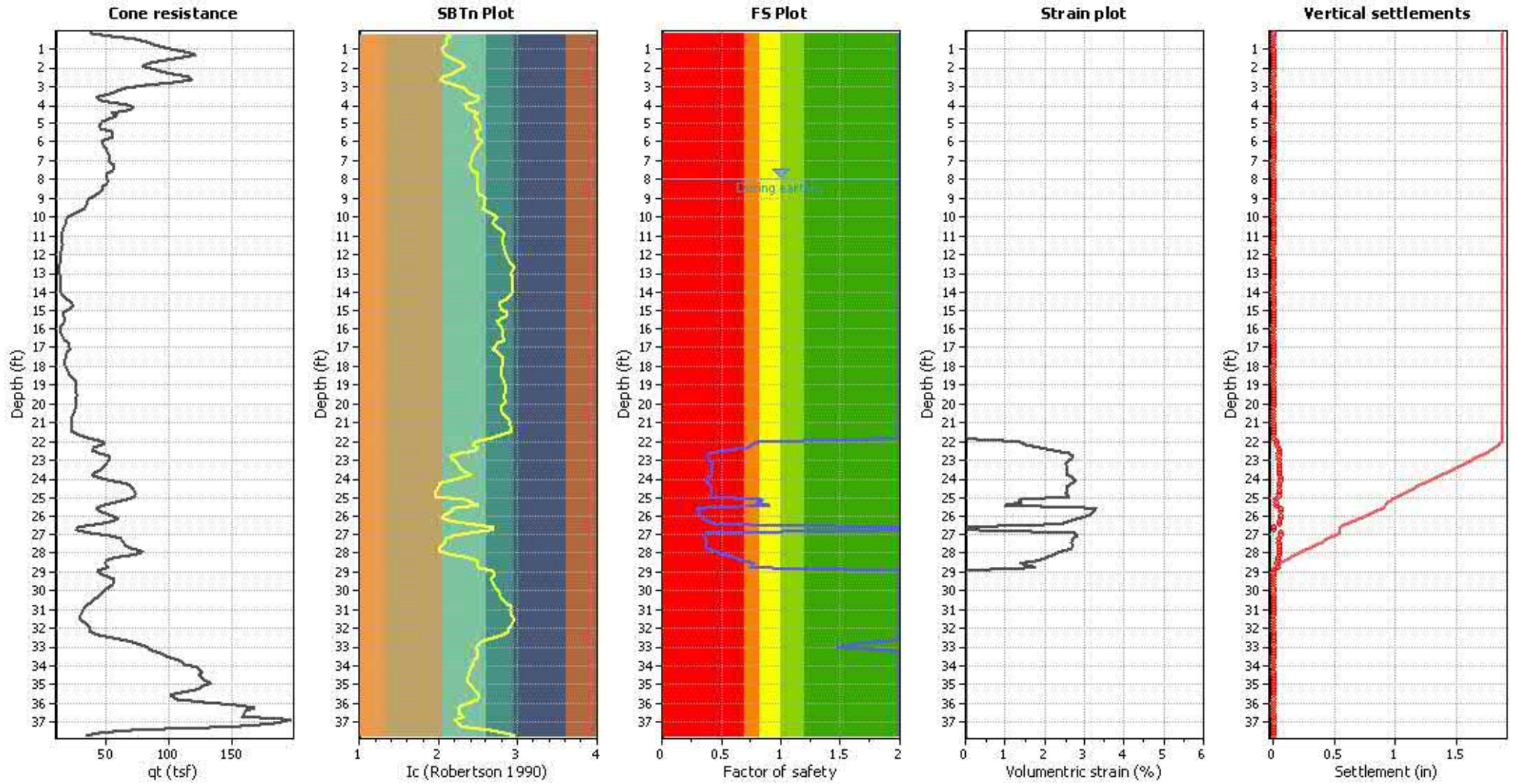
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

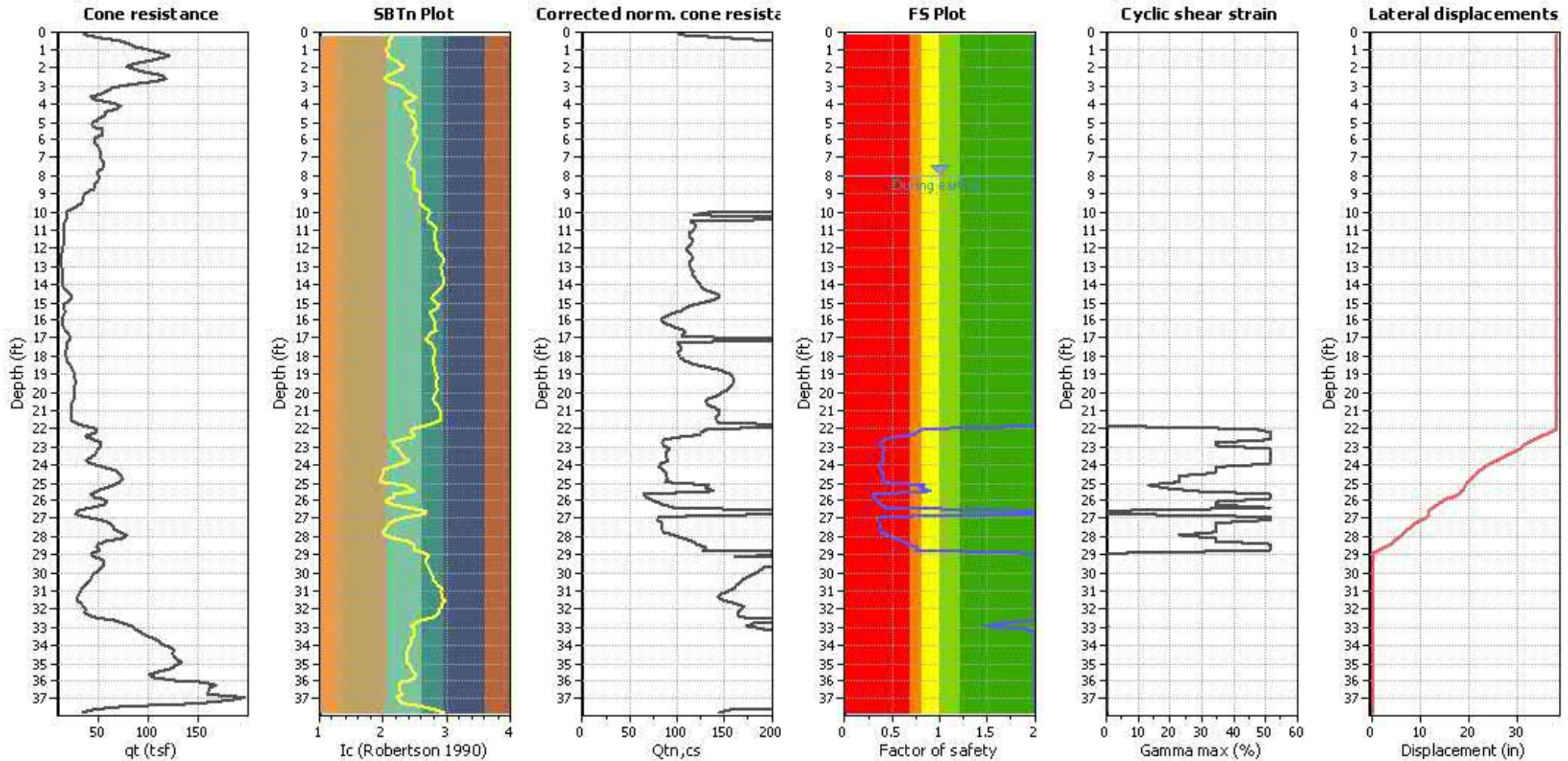


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

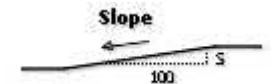


Abbreviations

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

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

Surface condition



LIQUEFACTION ANALYSIS REPORT

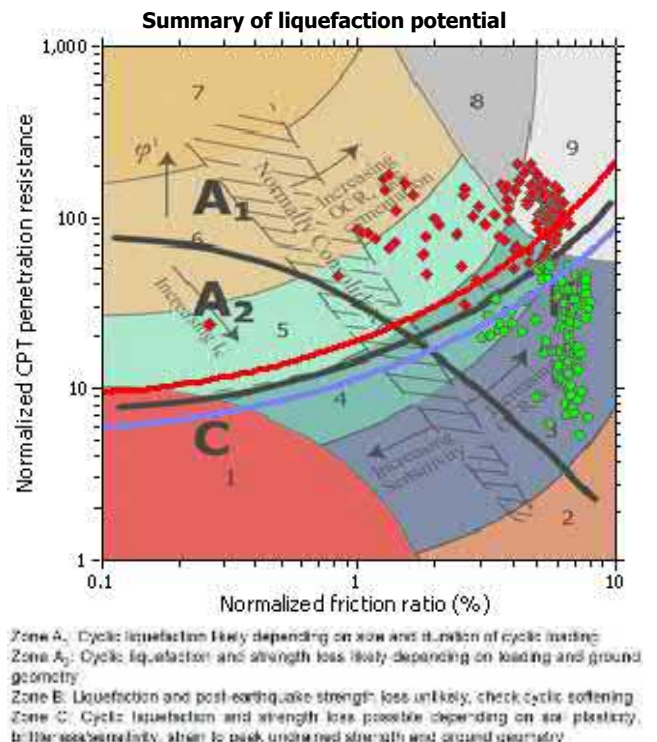
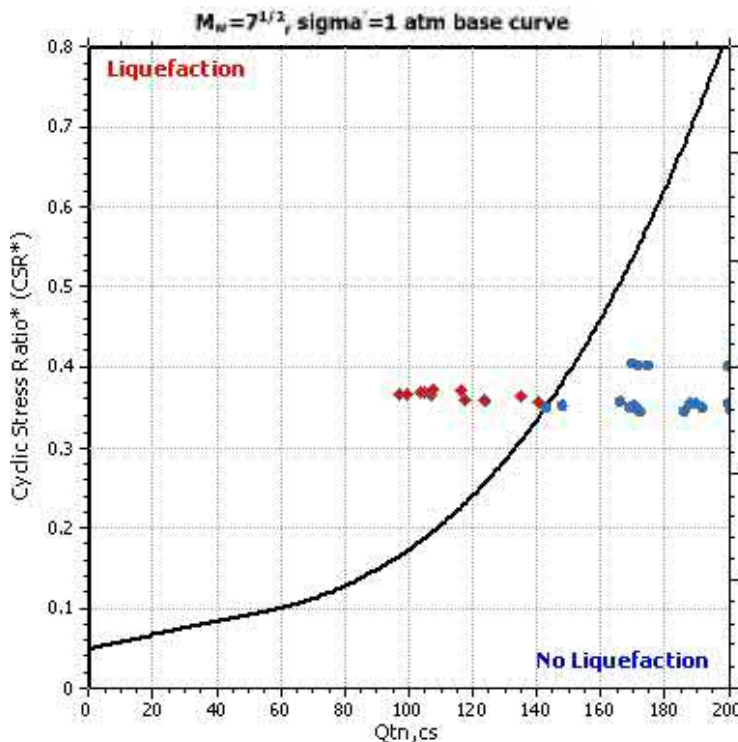
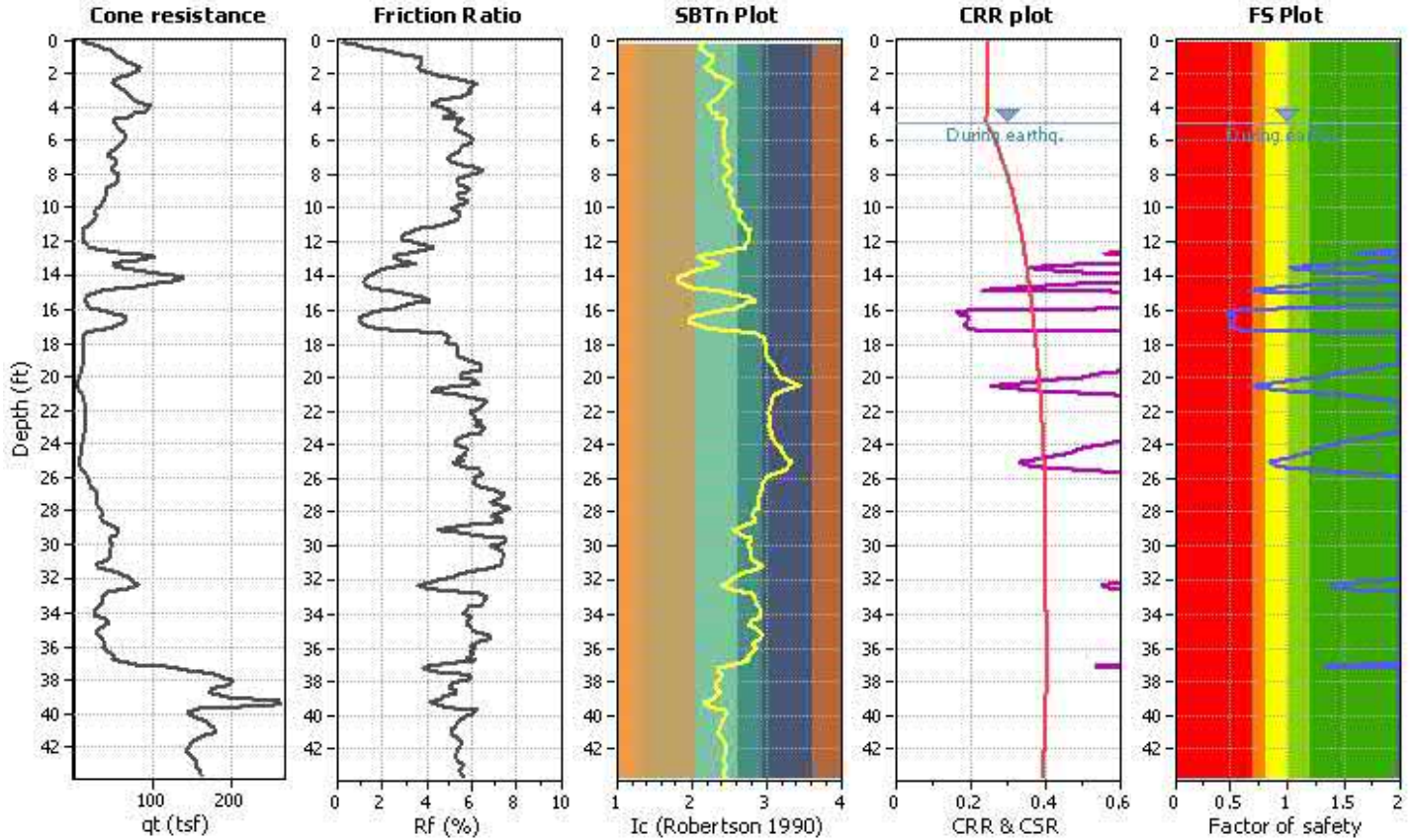
Project title : 12085.002 - JPI Ocean Creek

Location :

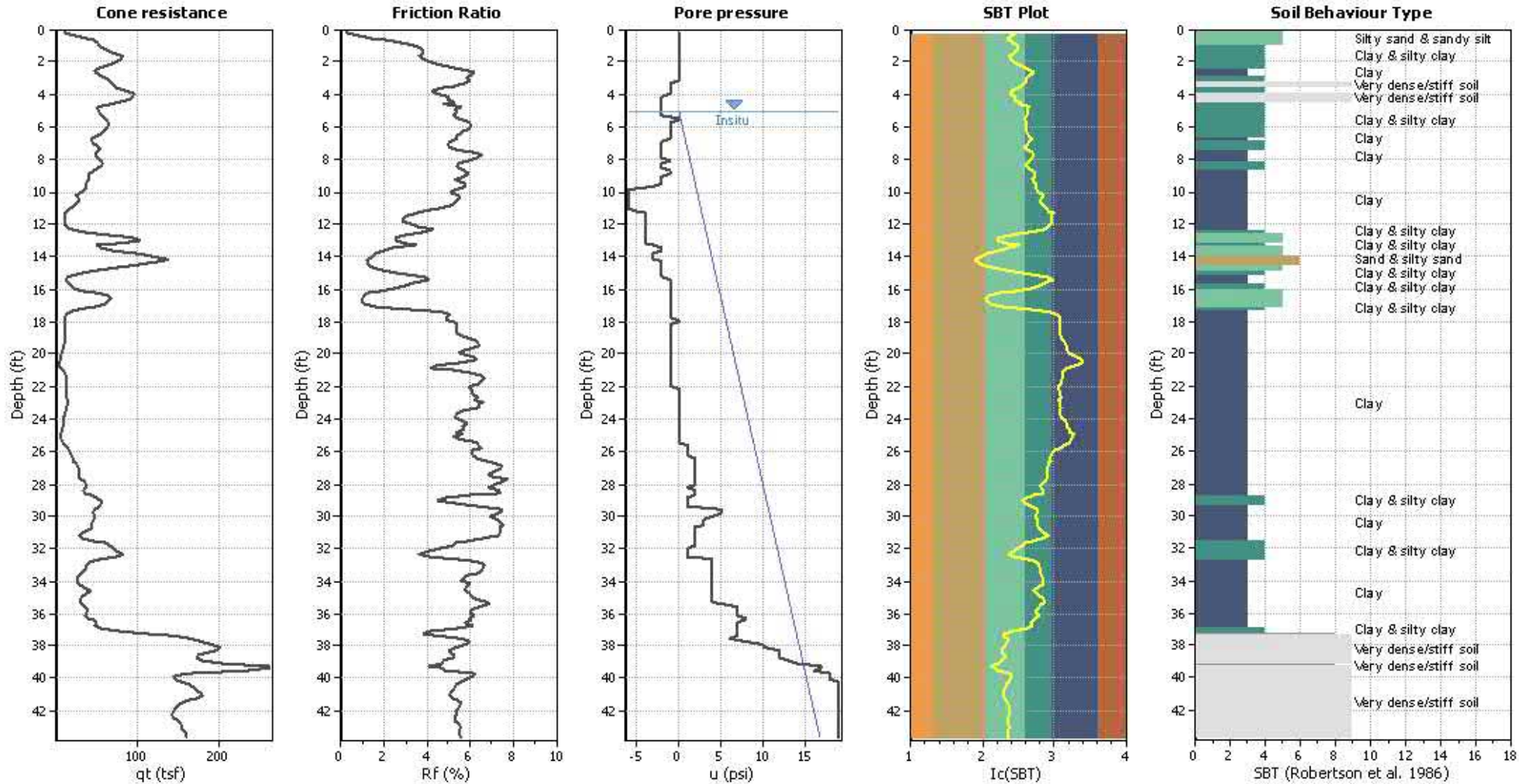
CPT file : CPT-5

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



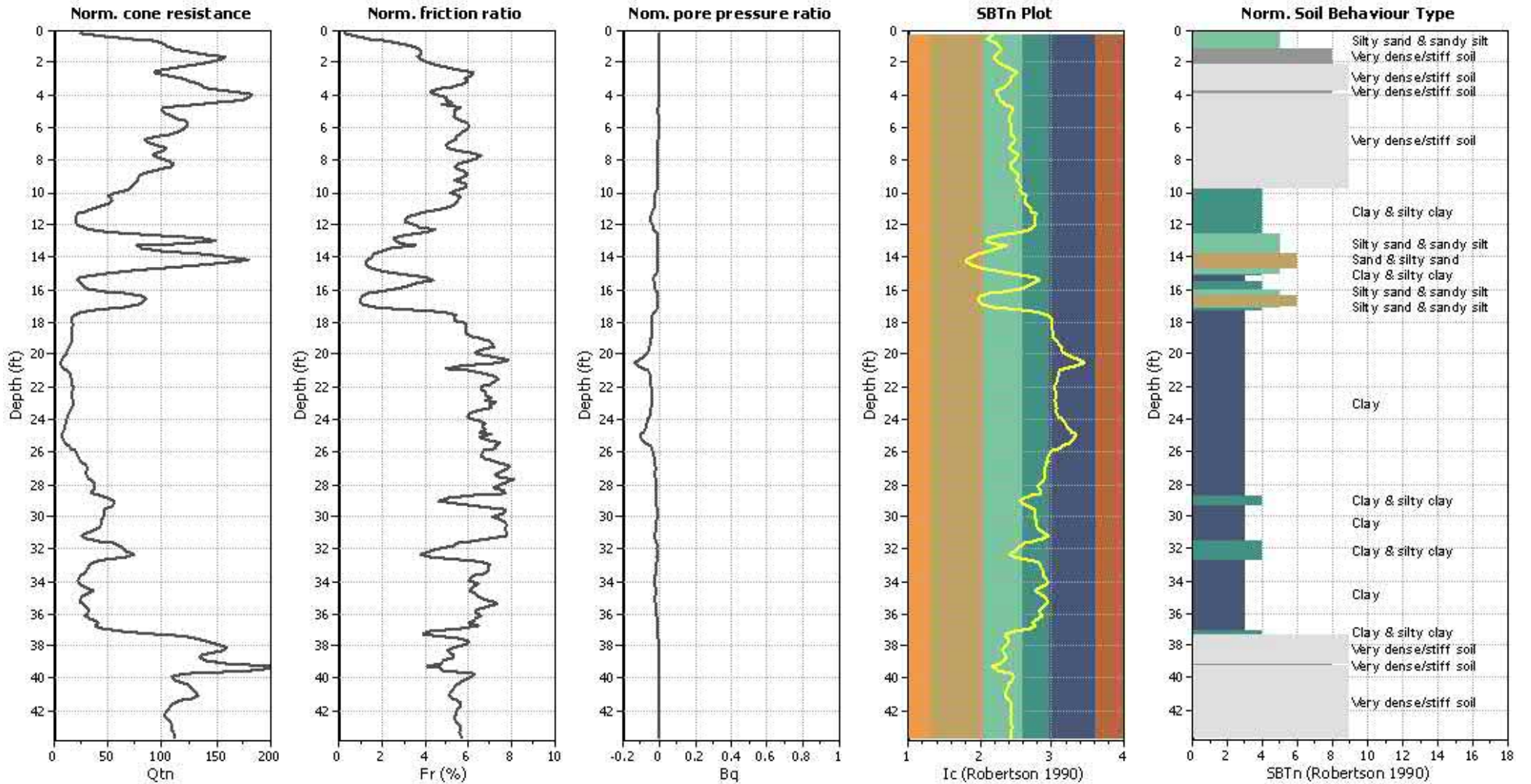
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



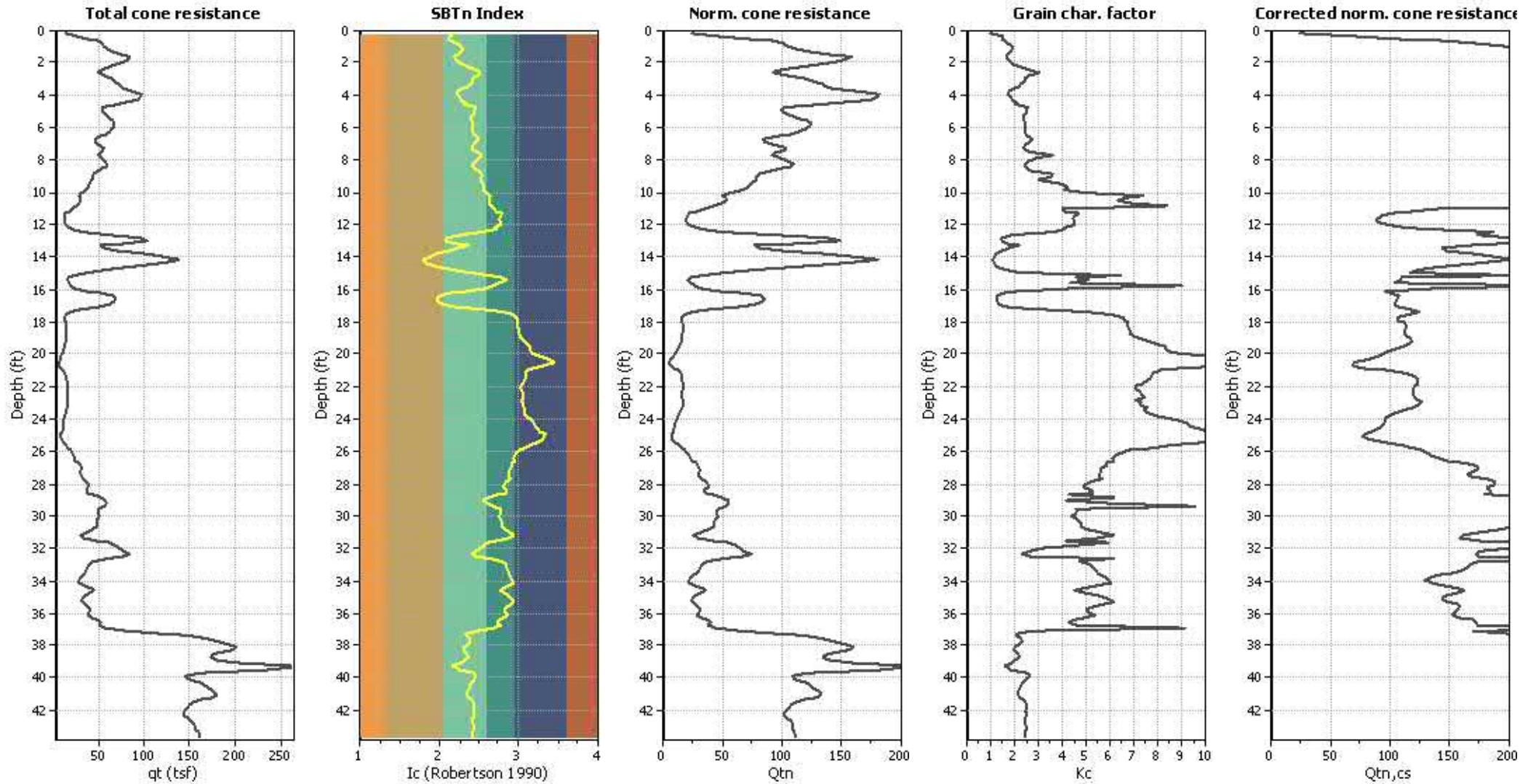
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

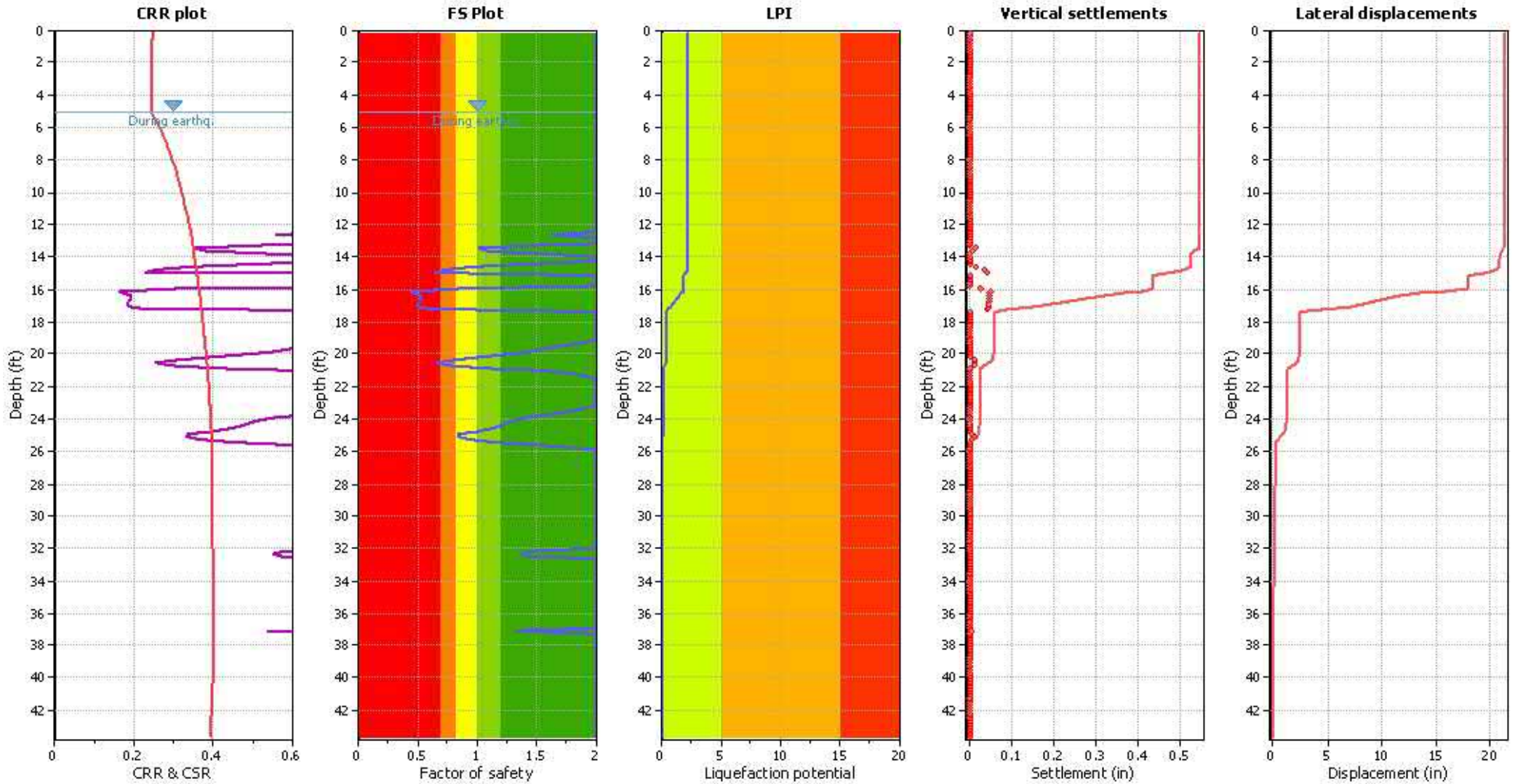
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

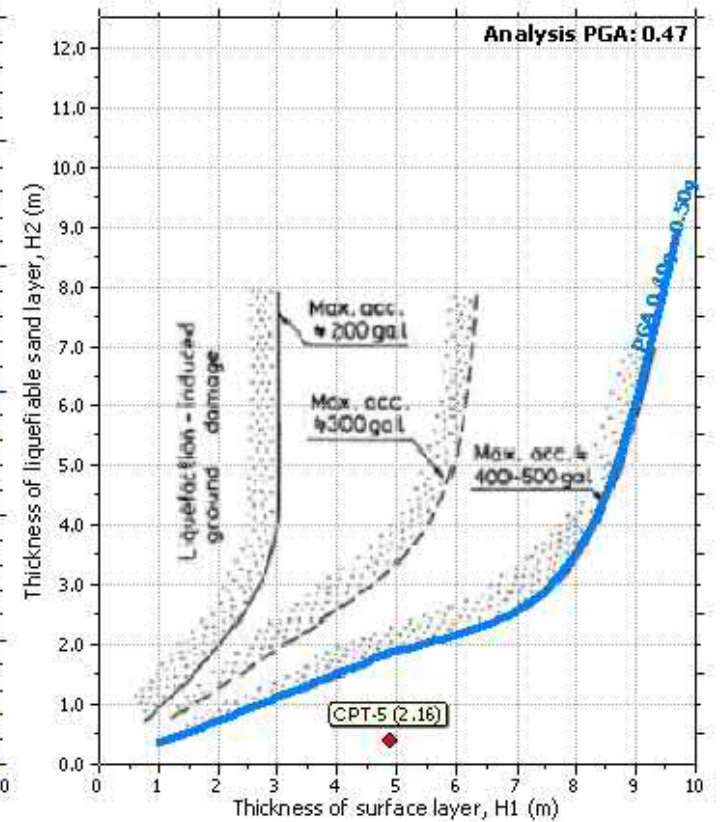
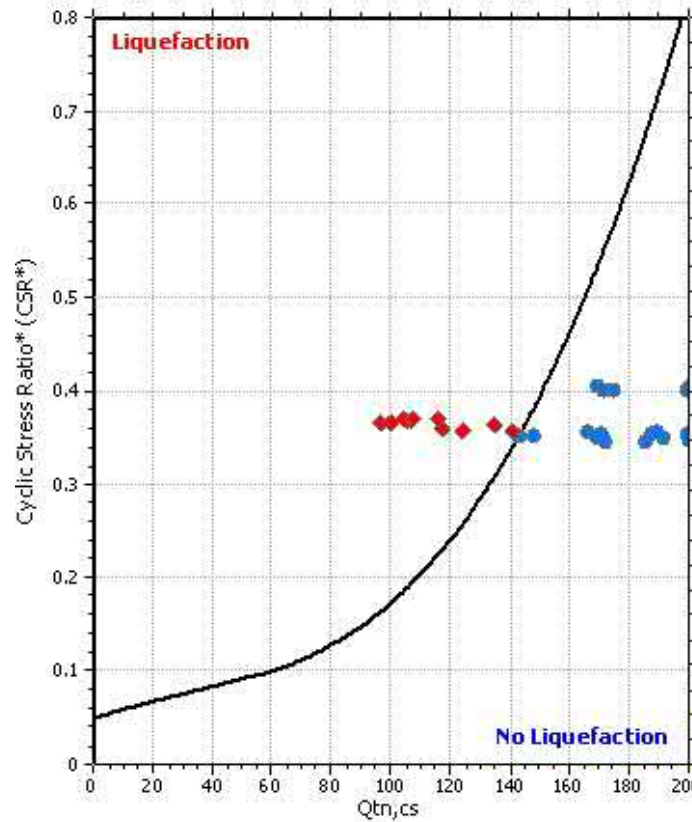
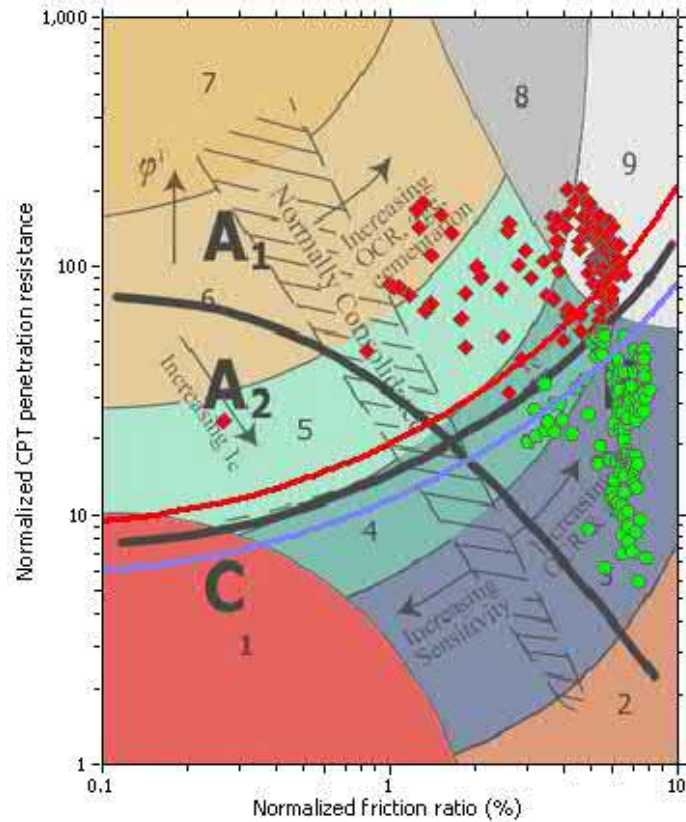
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

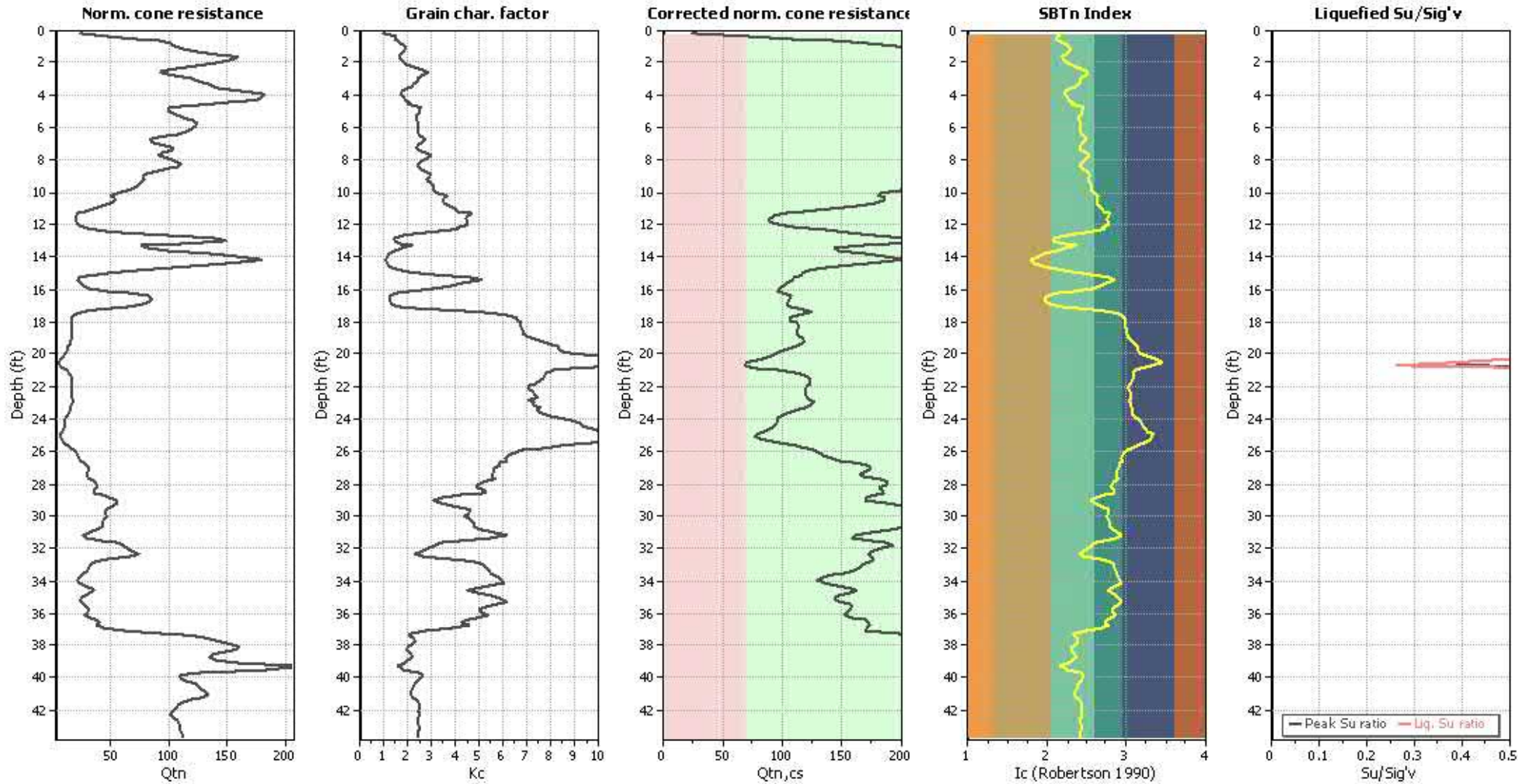
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on i_c value	i_c cut-off value:	2.60	K_c applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

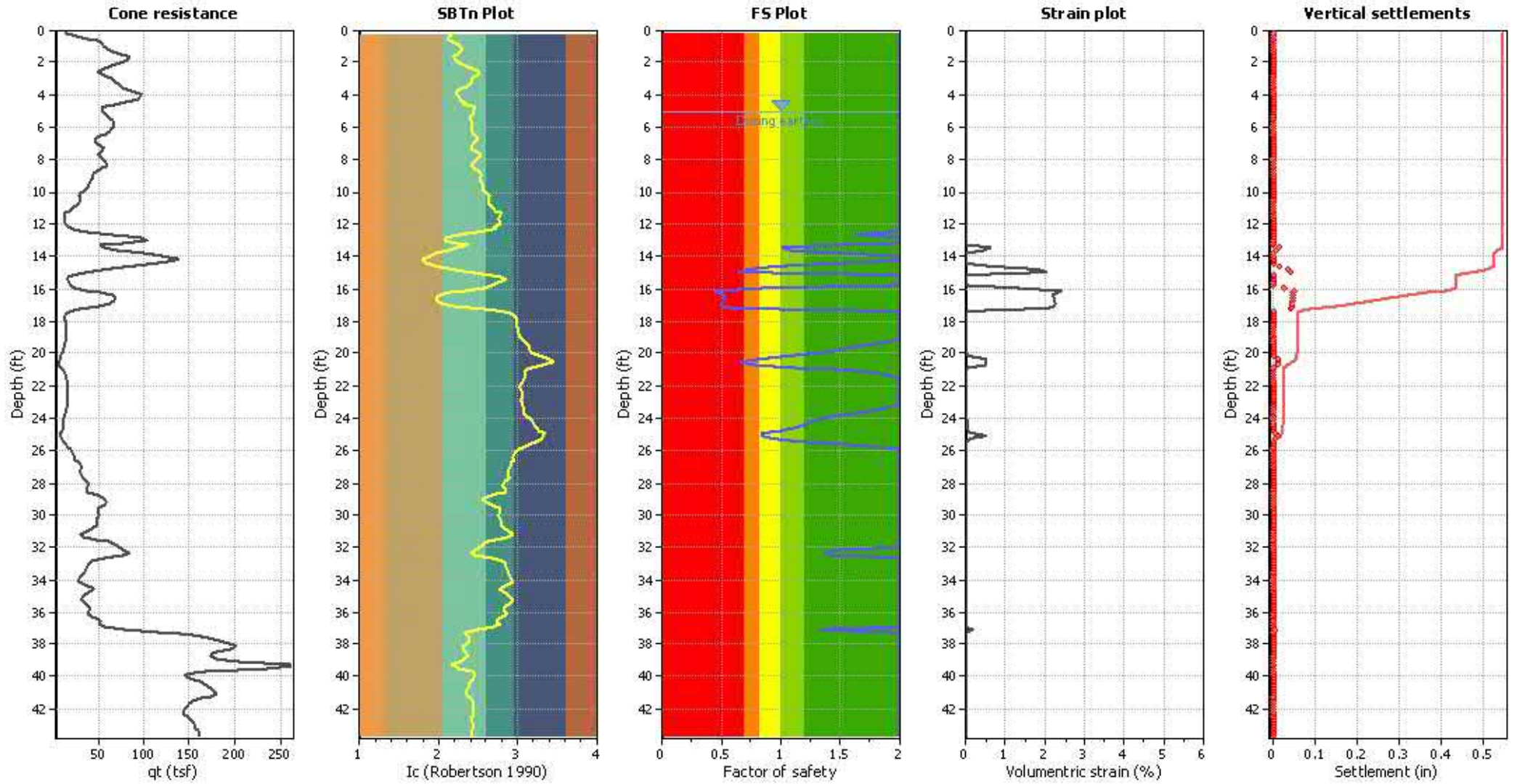
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

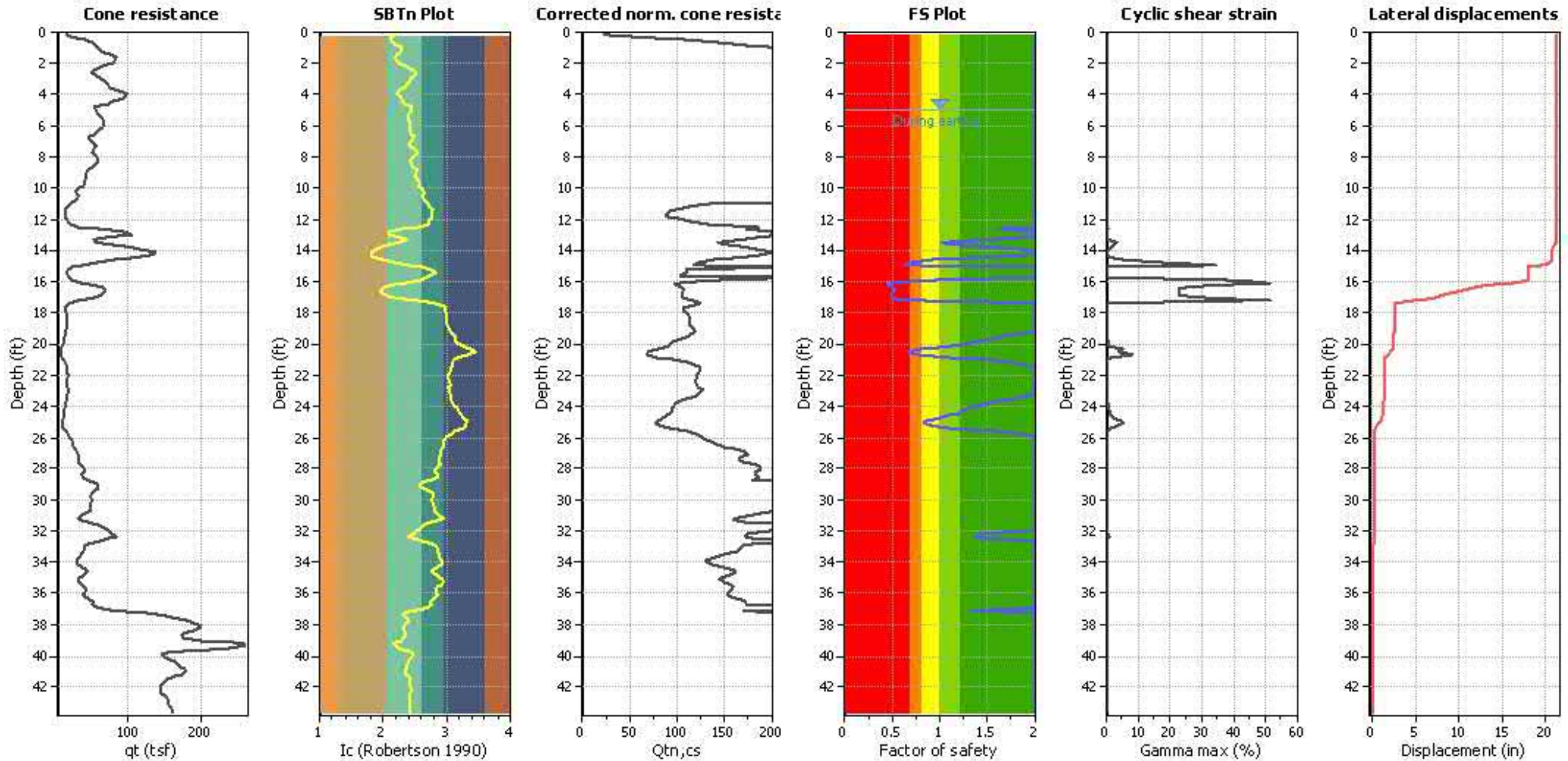


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Level ground (or gently sloping) with free face (L: 20.00 ft - H: 7.00 ft)

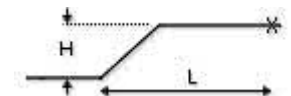


Abbreviations

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

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

Surface condition



LIQUEFACTION ANALYSIS REPORT

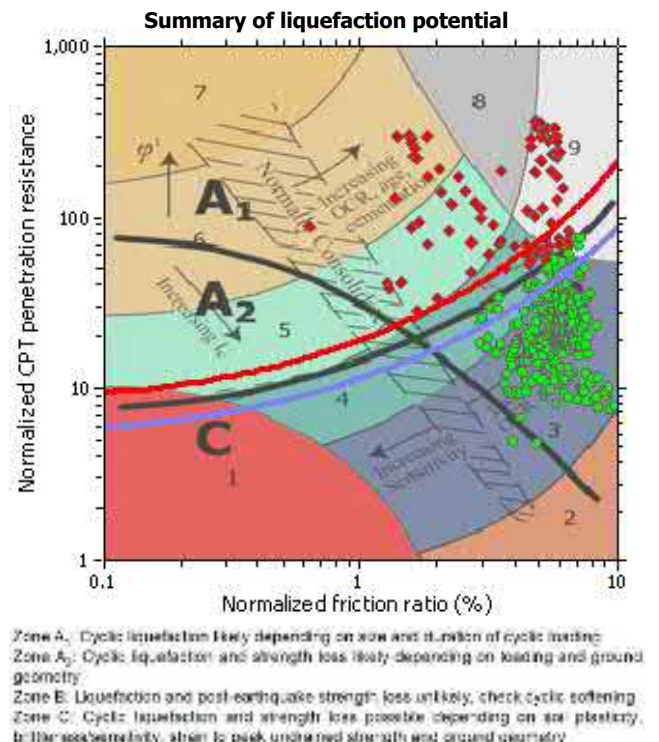
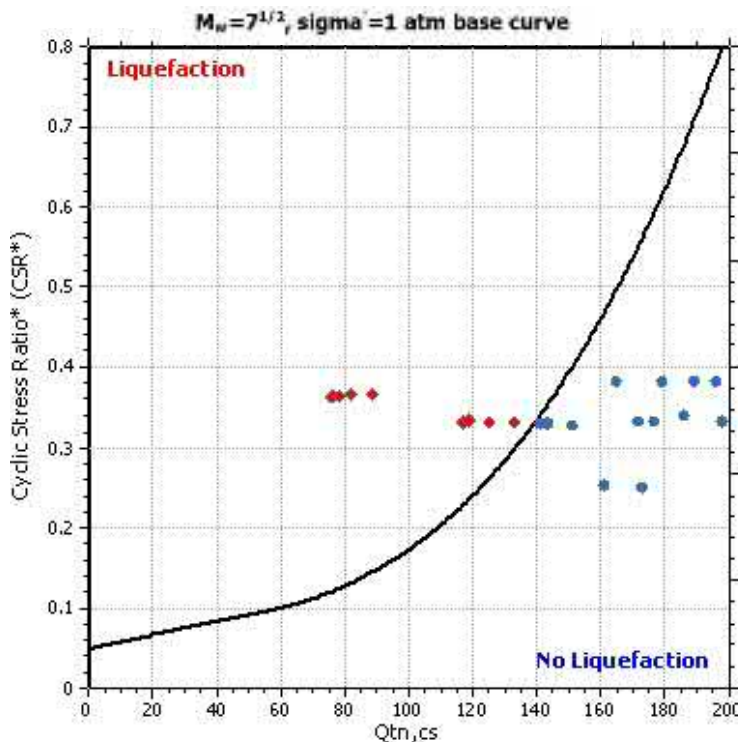
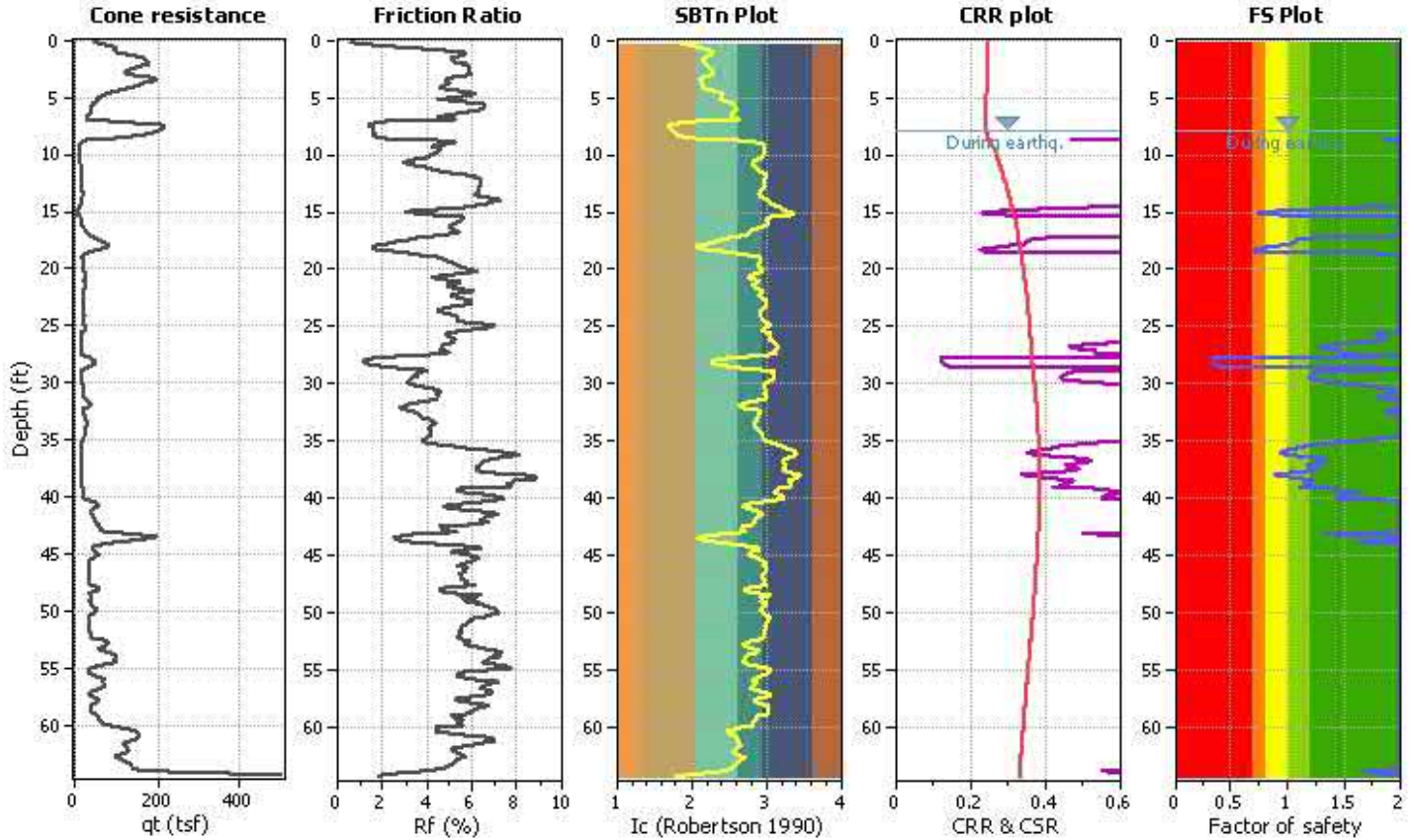
Project title : 12085.002 - JPI Ocean Creek

Location :

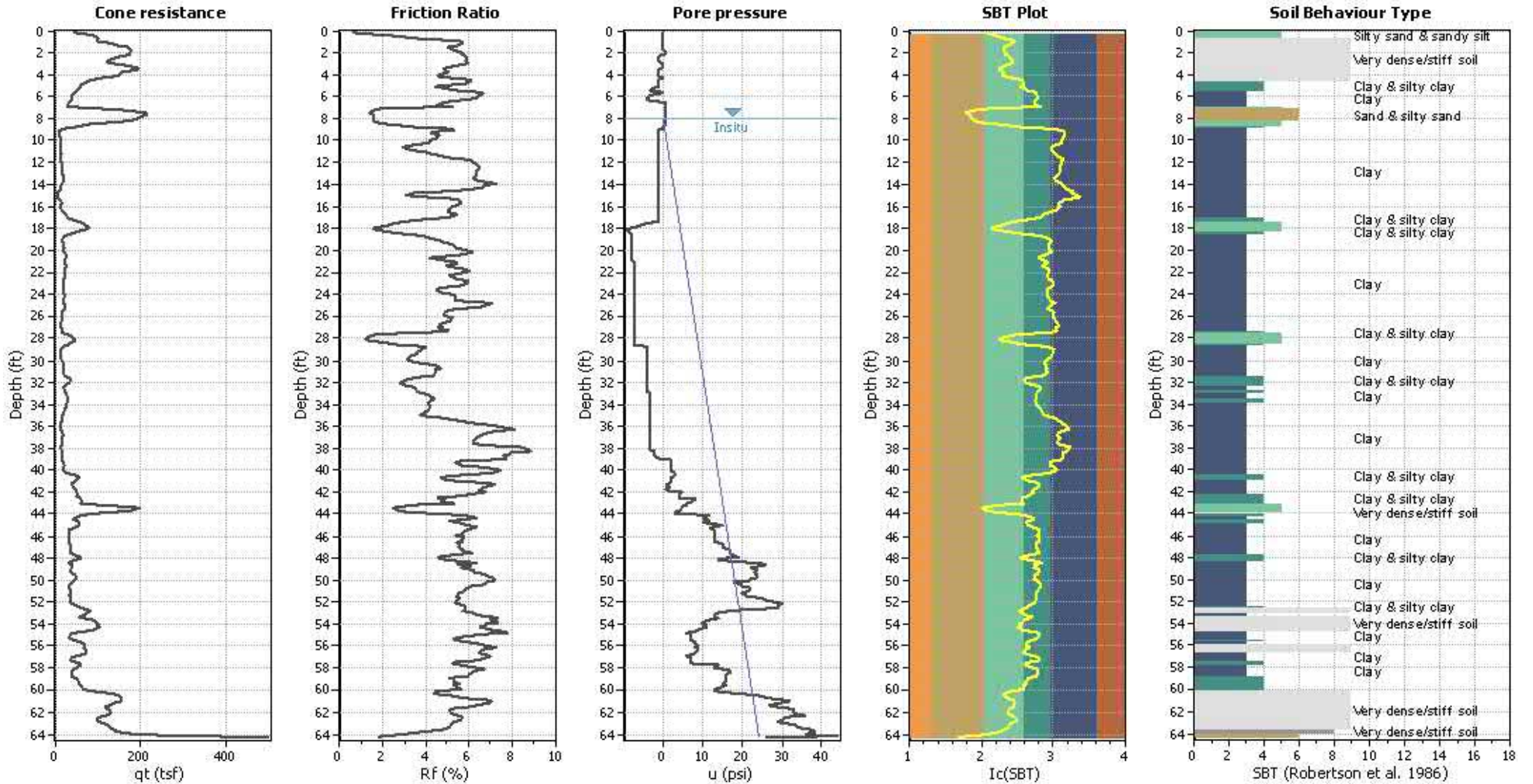
CPT file : CPT-6

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	8.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	8.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_v applied:	Yes		



CPT basic interpretation plo



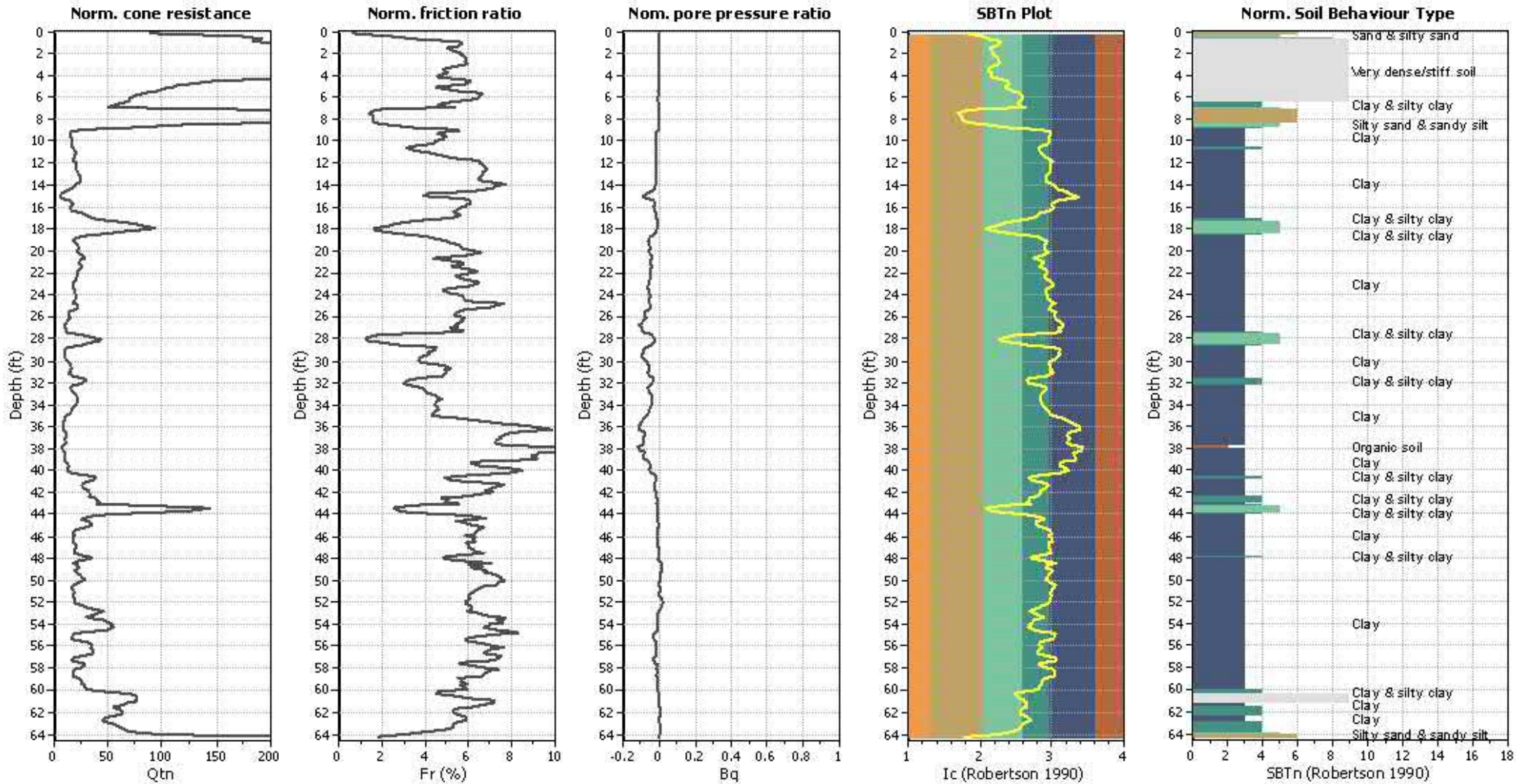
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	8.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



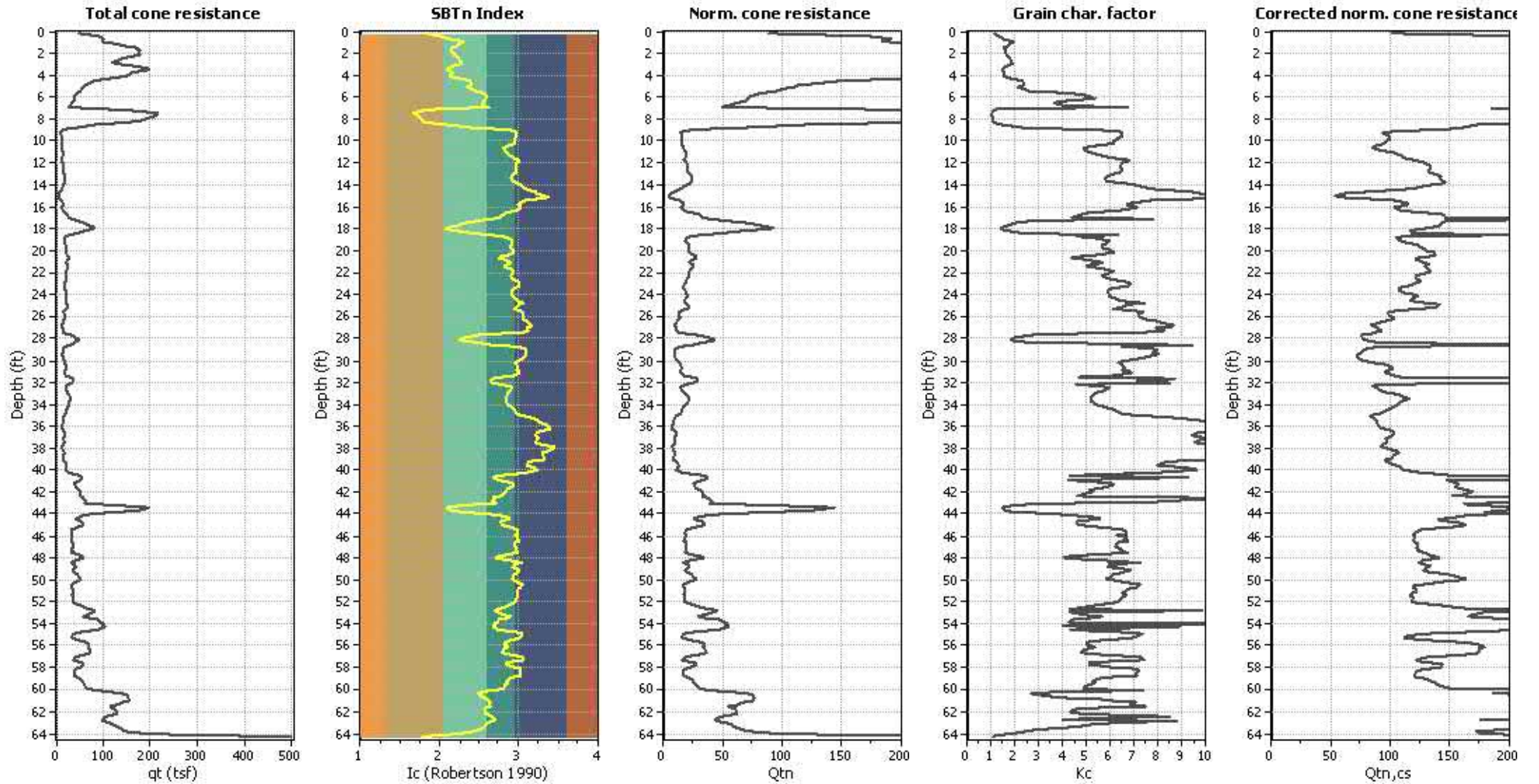
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

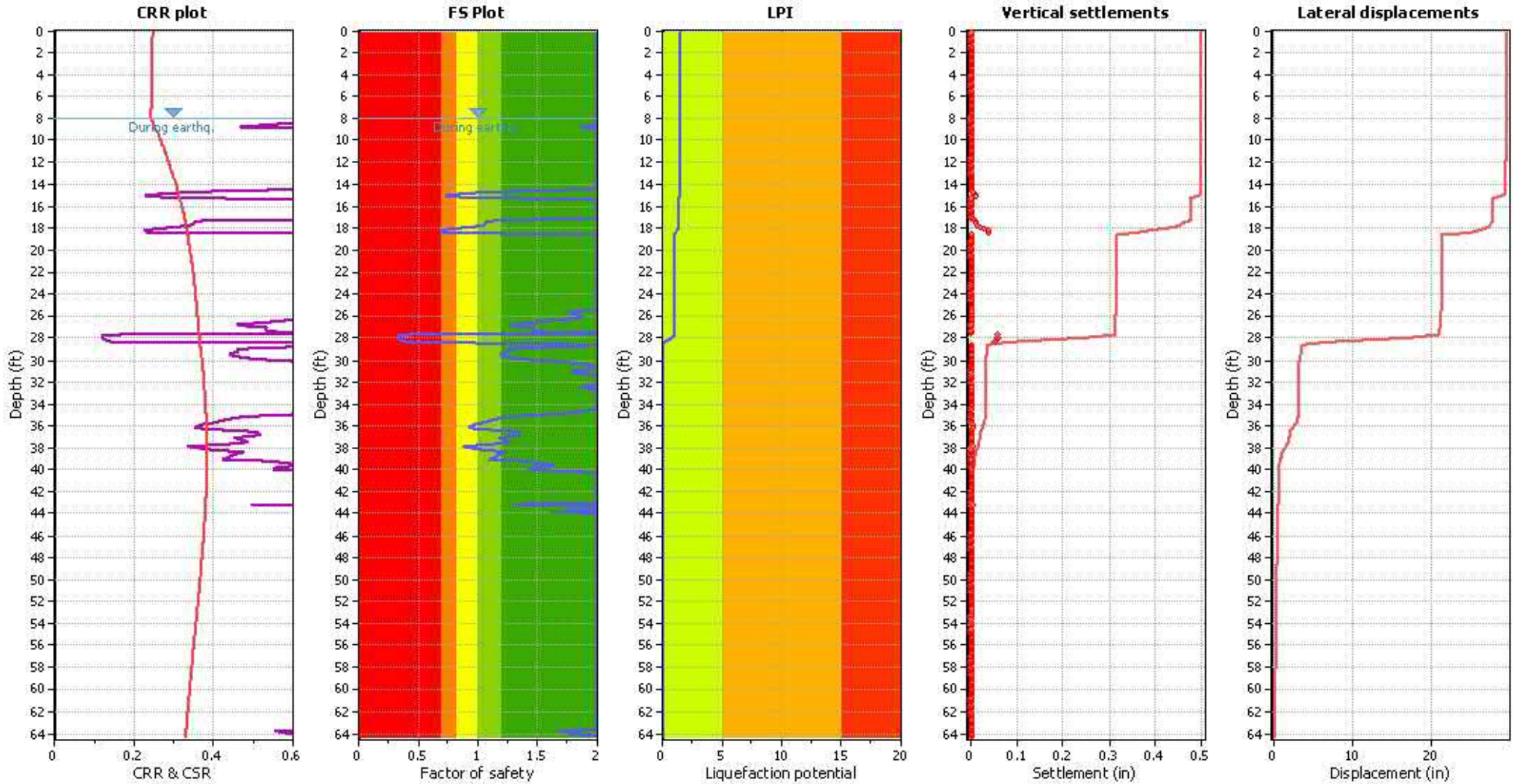
Liquefaction analysis overall plots (intermediate resu



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _{cs} applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

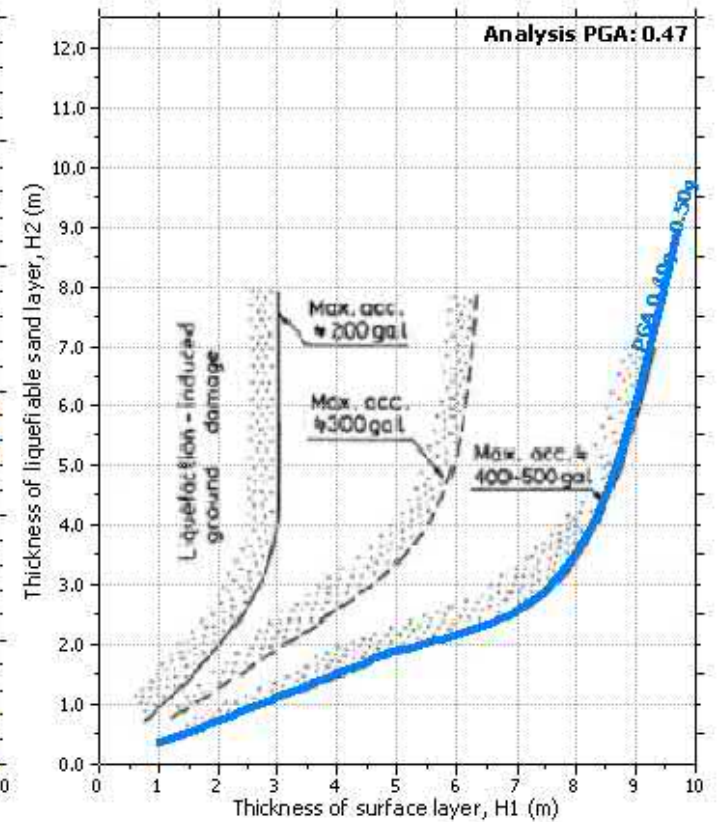
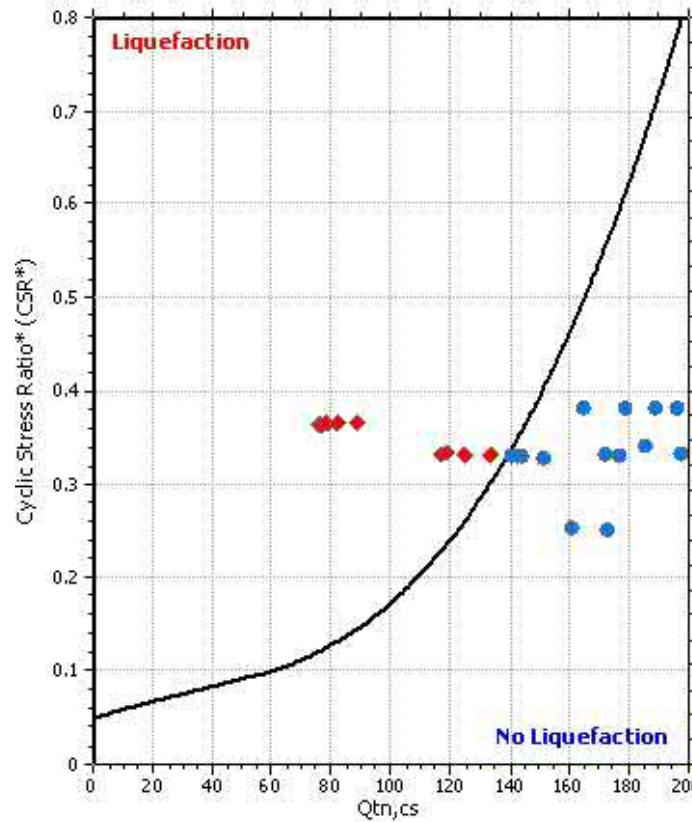
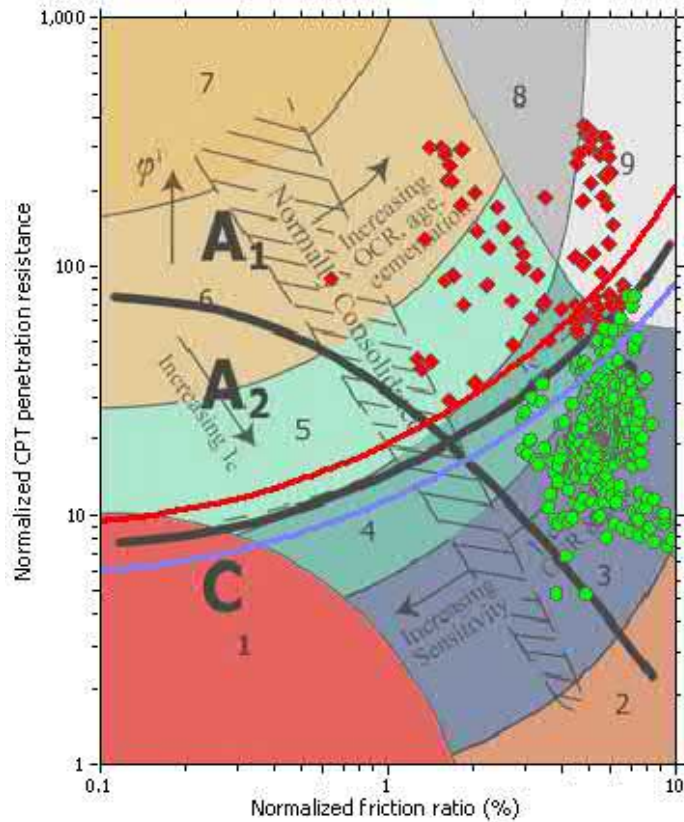
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

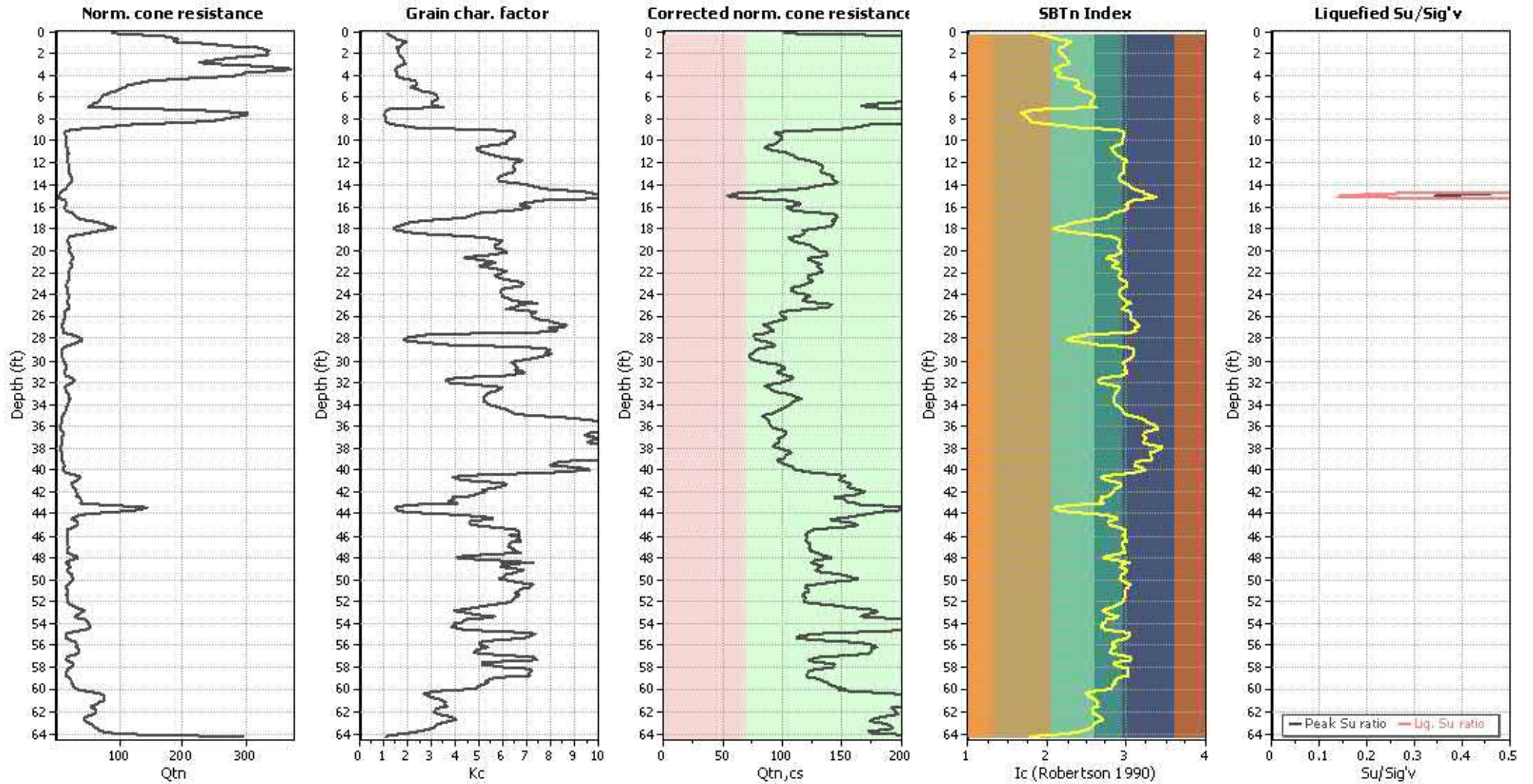
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

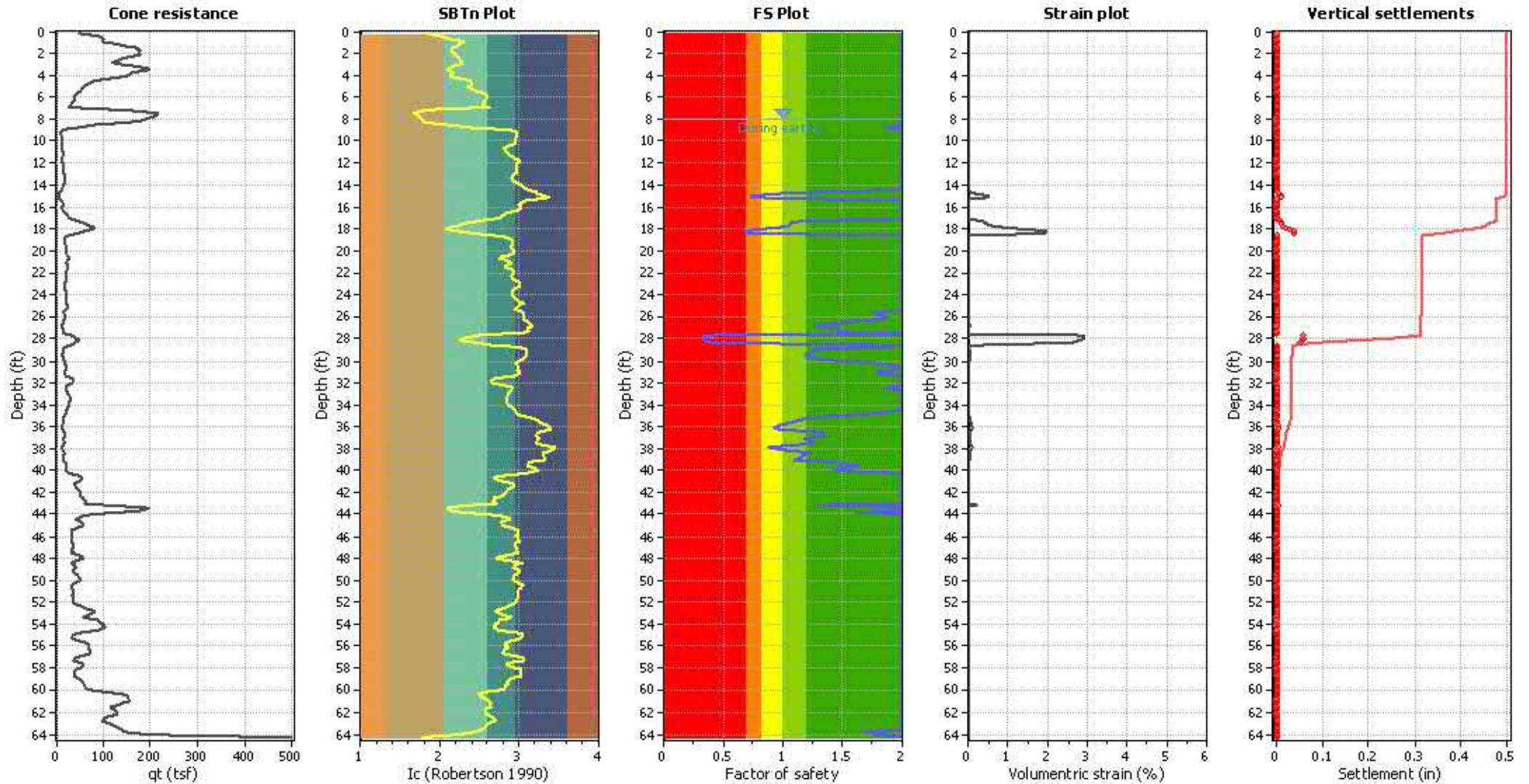
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	8.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

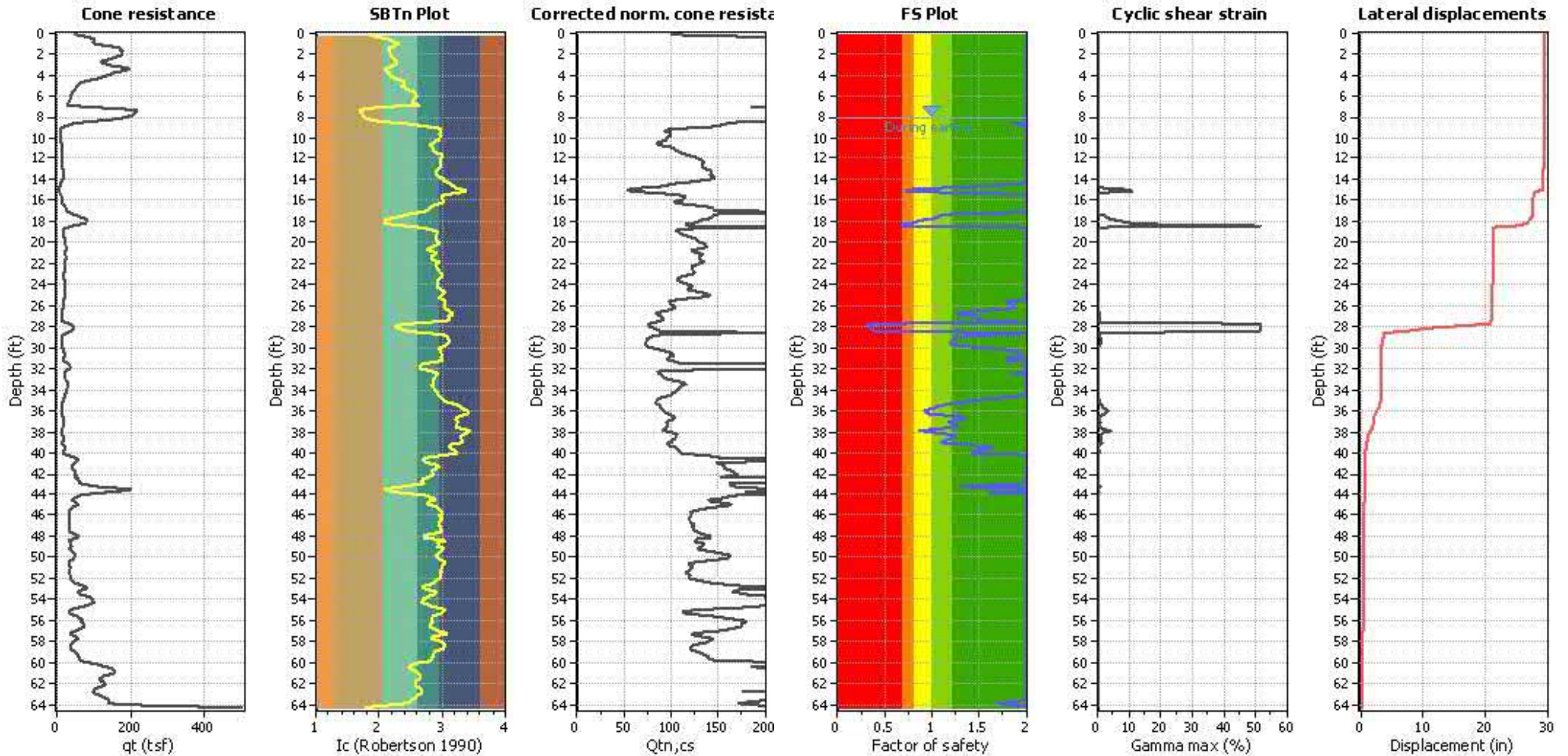


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Level ground (or gently sloping) with free face (L: 16.00 ft - H: 8.00 ft)

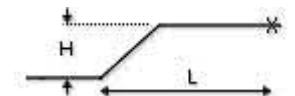


Abbreviations

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

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

Surface condition



LIQUEFACTION ANALYSIS REPORT

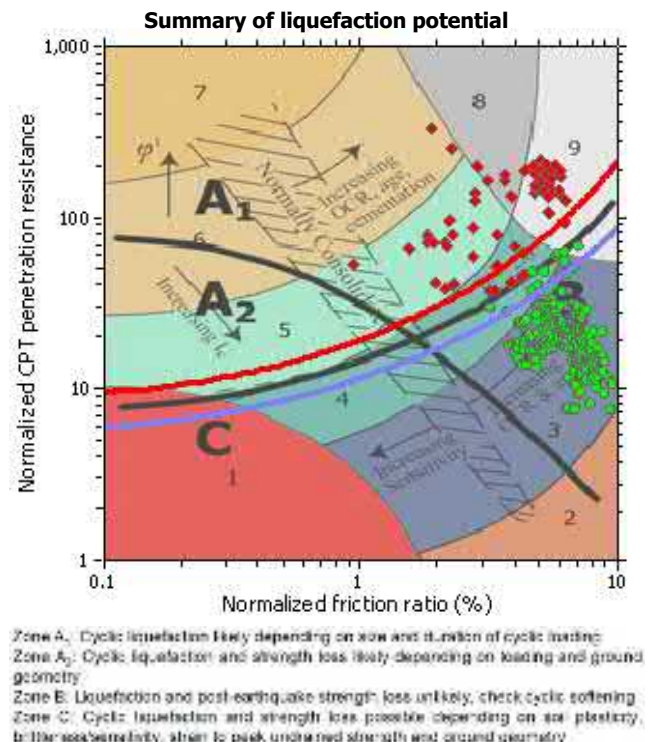
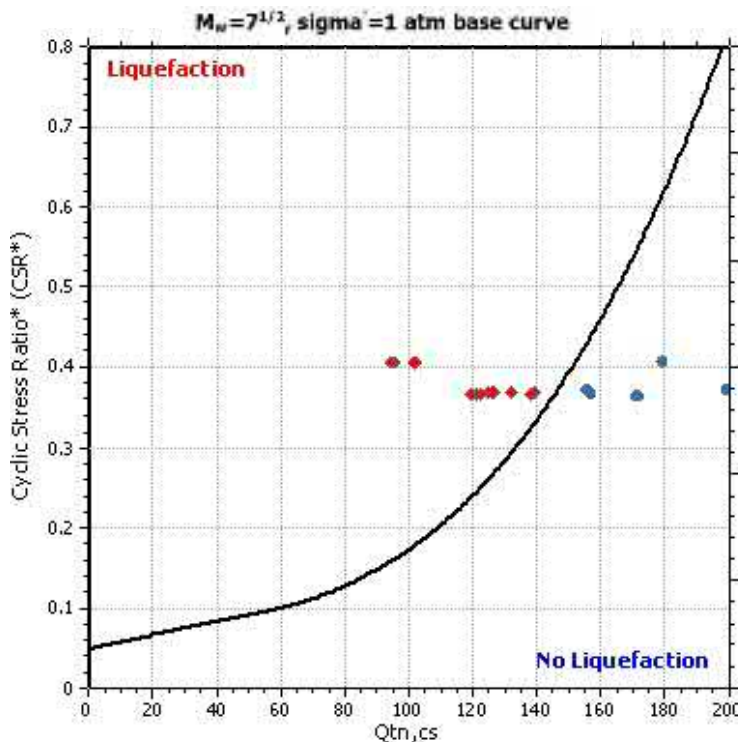
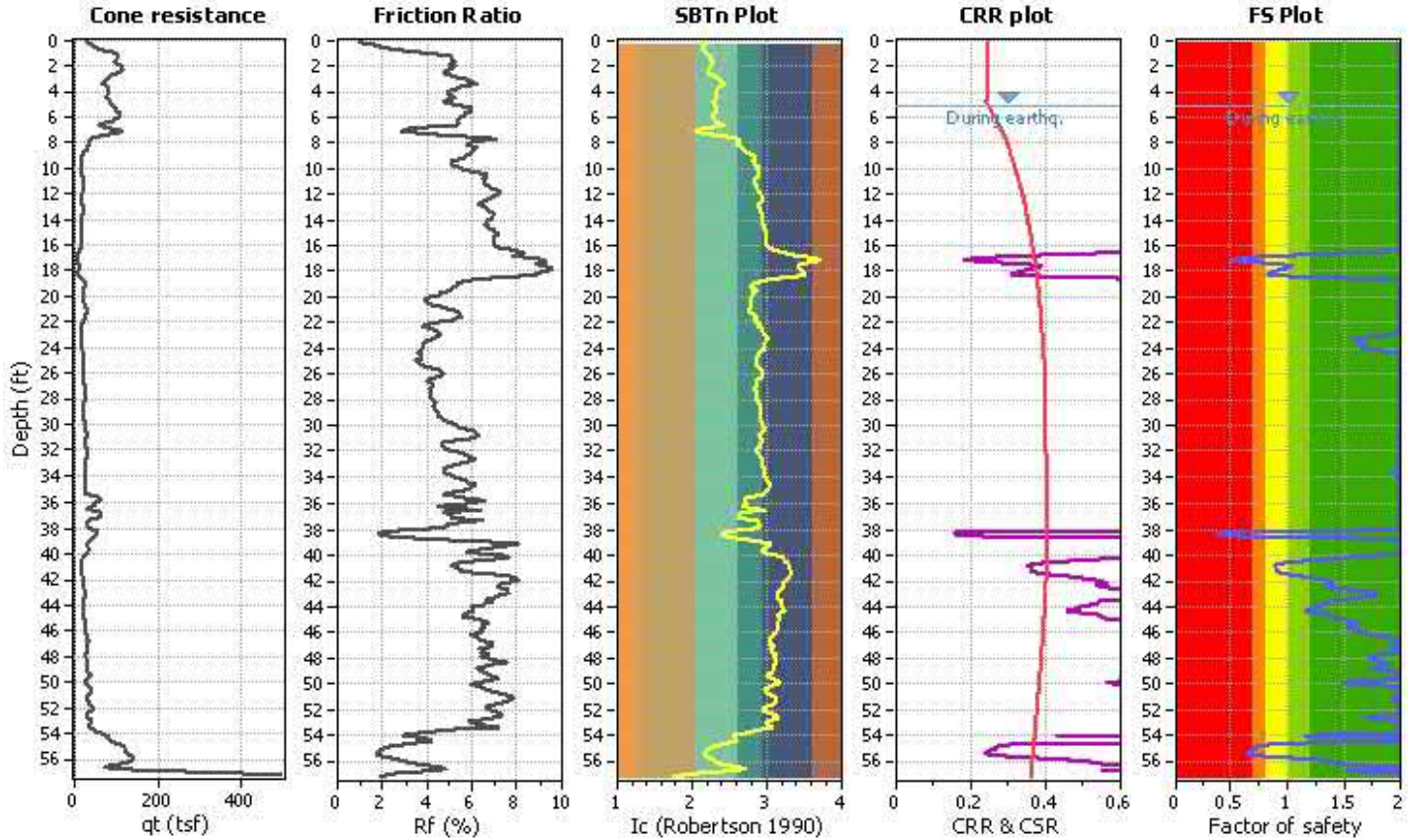
Project title : 12085.002 - JPI Ocean Creek

Location :

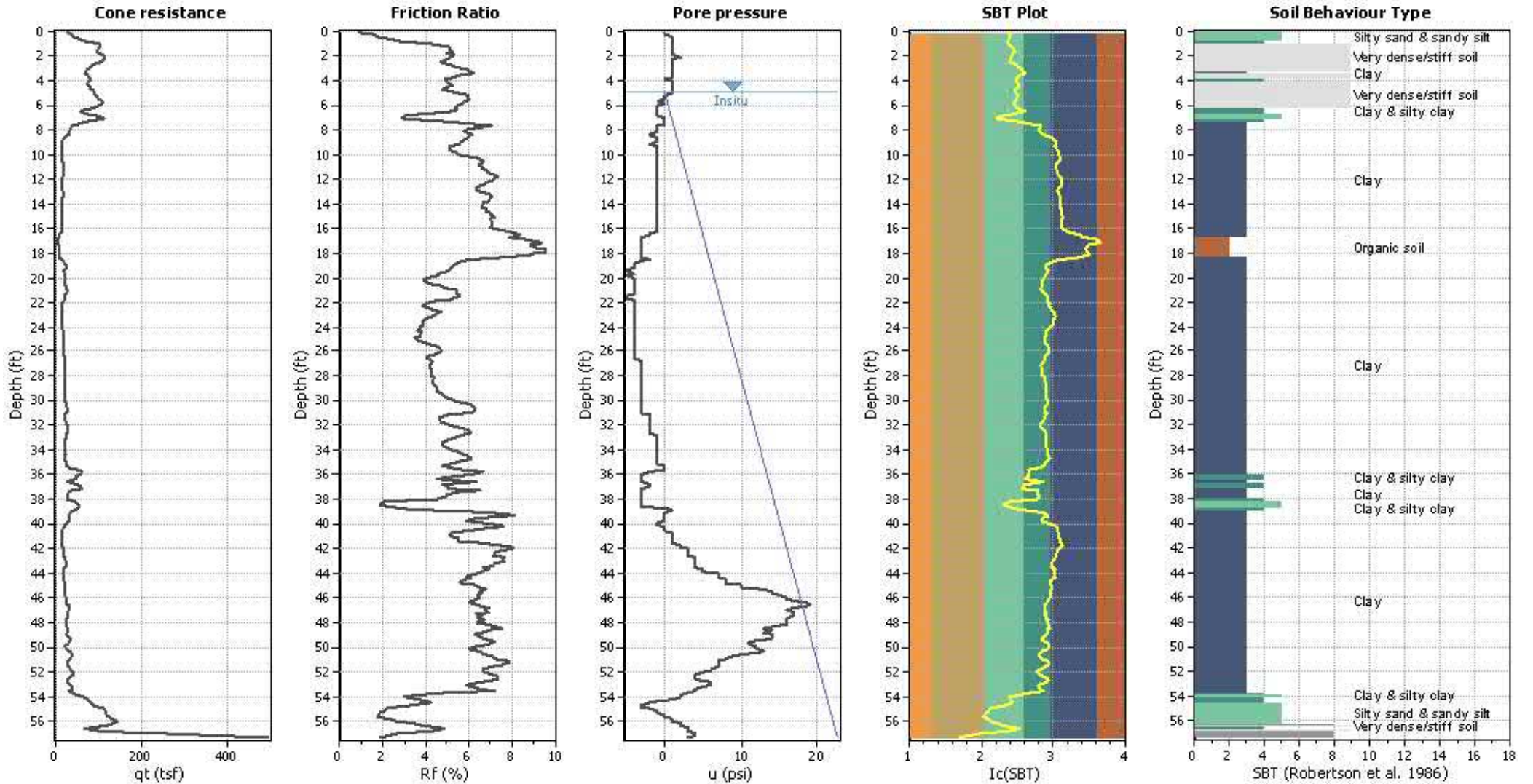
CPT file : CPT-7

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.47	Unit weight calculation:	Based on SBT	K_u applied:	Yes		



CPT basic interpretation plo



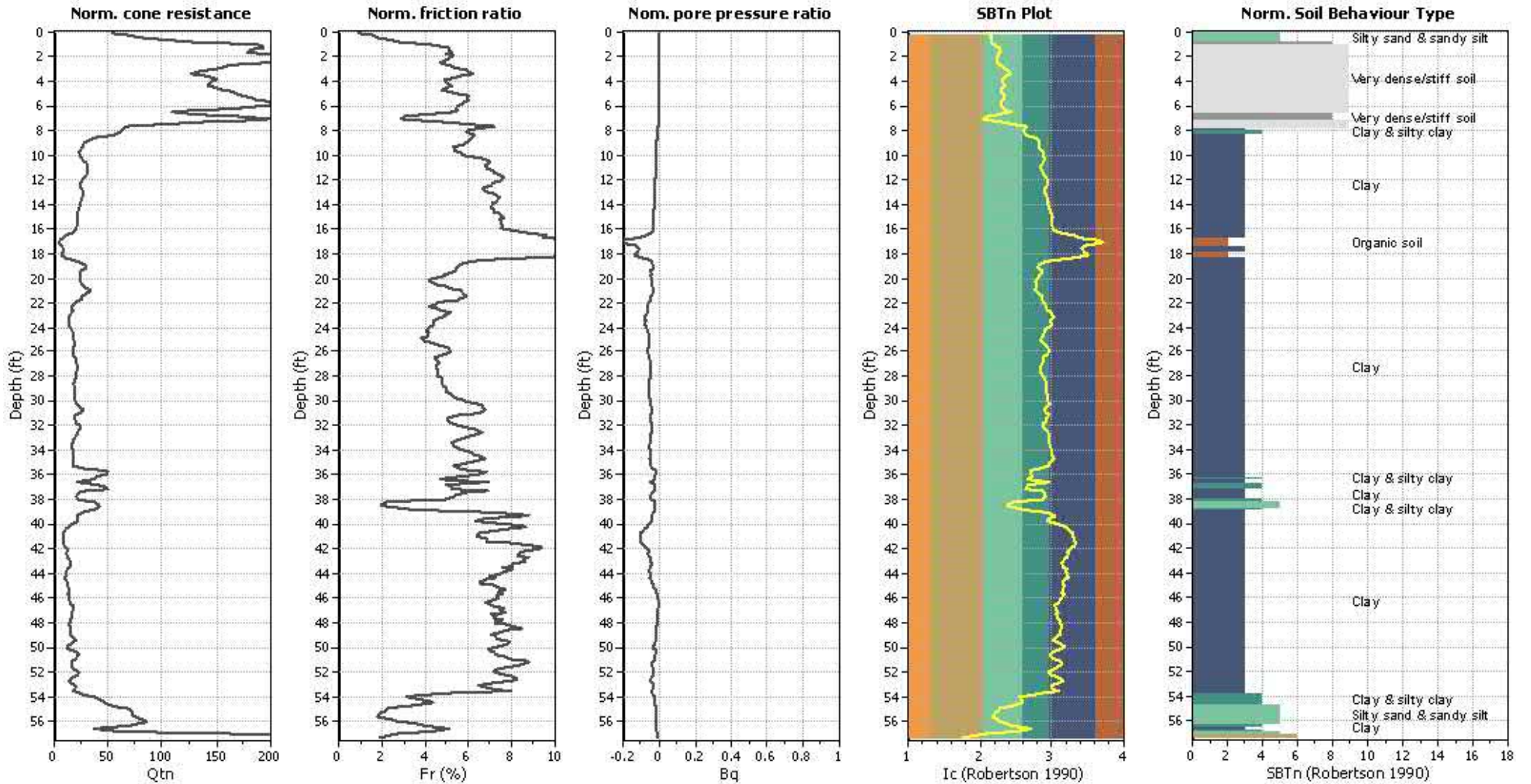
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normaliz



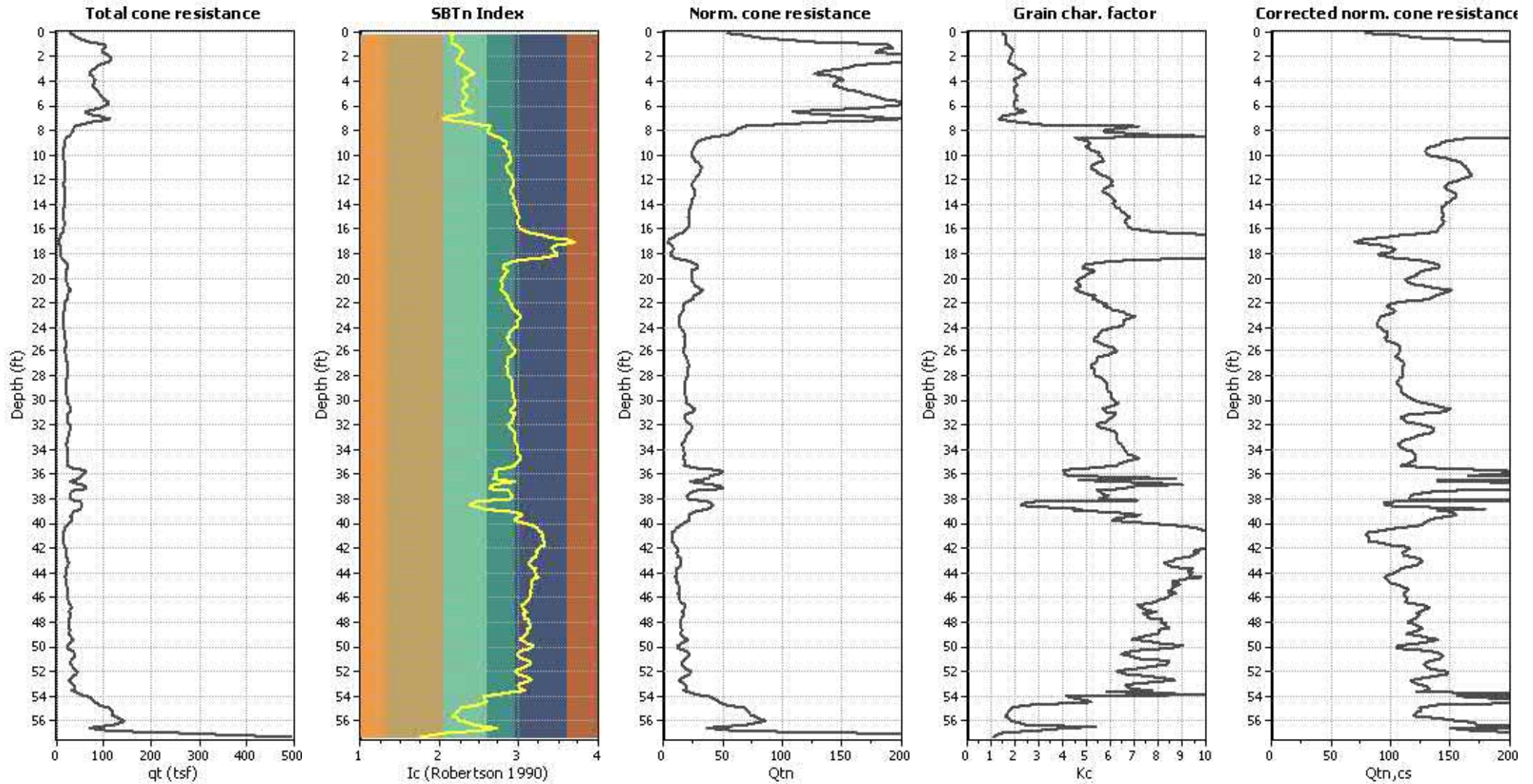
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Lines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

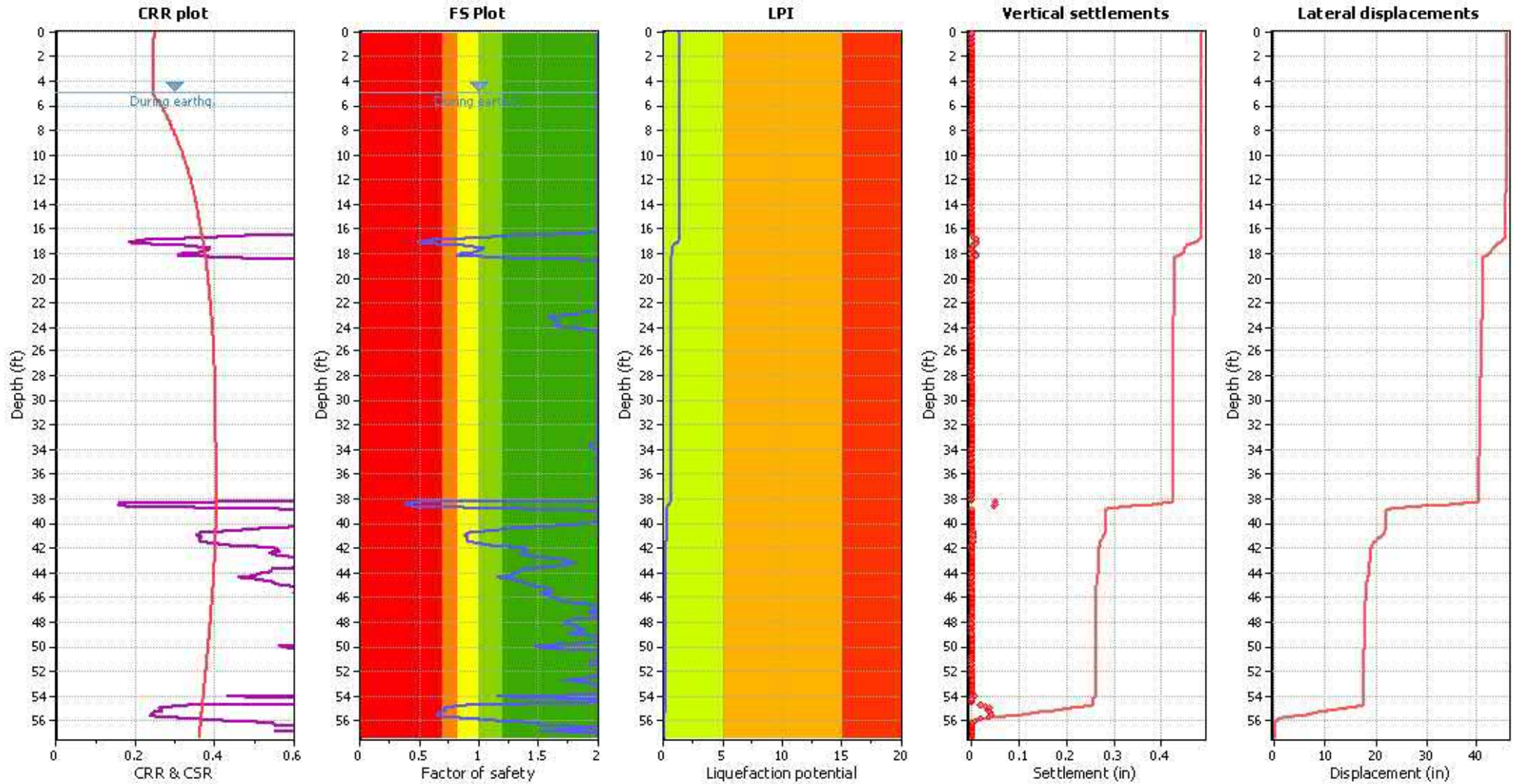
Liquefaction analysis overall plots (intermediate res)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Flines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plot



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

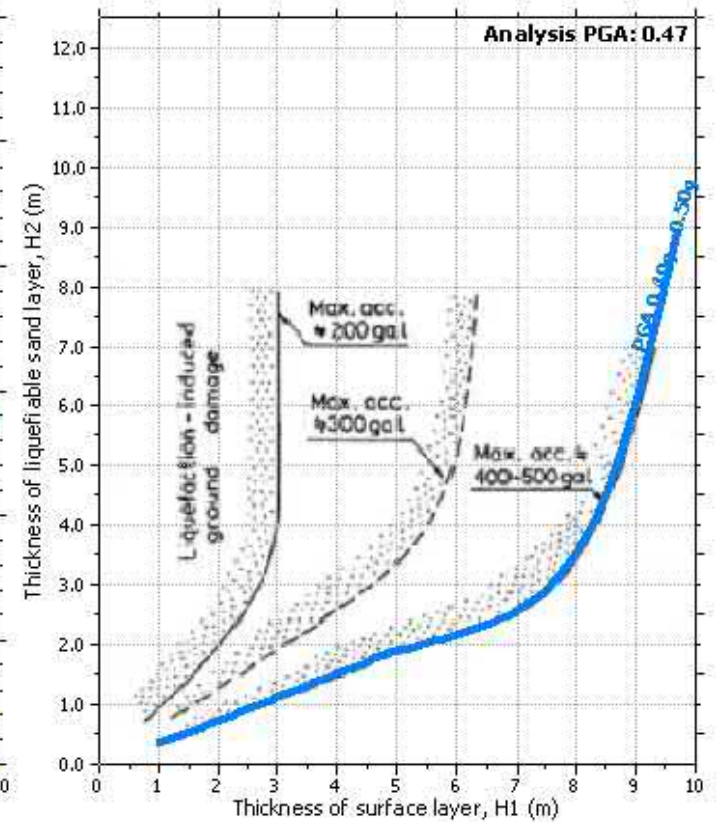
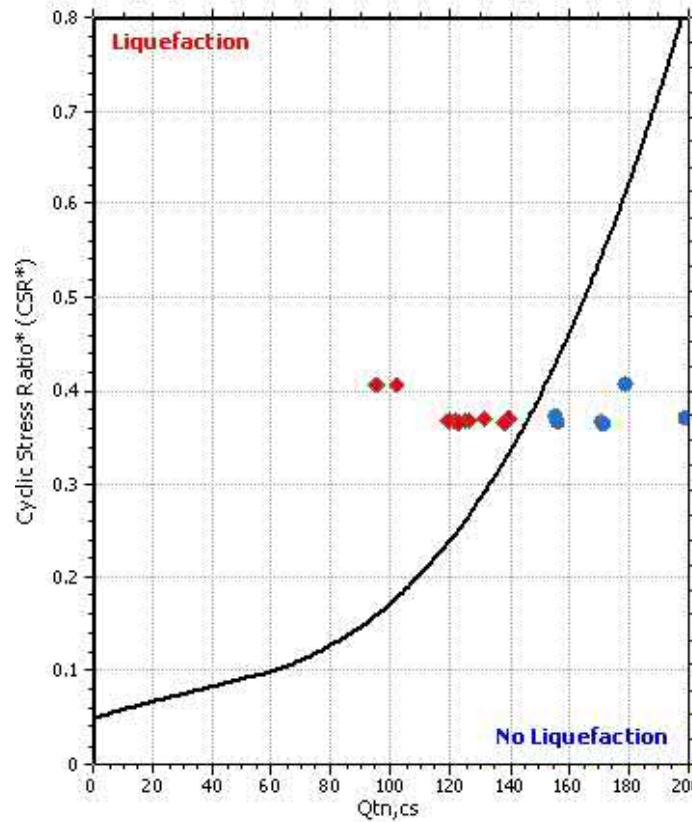
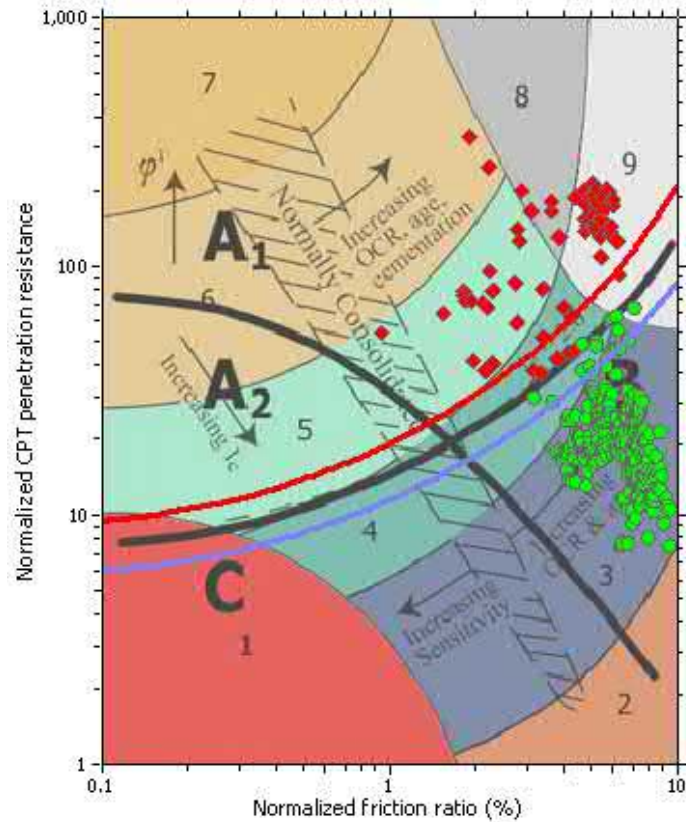
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

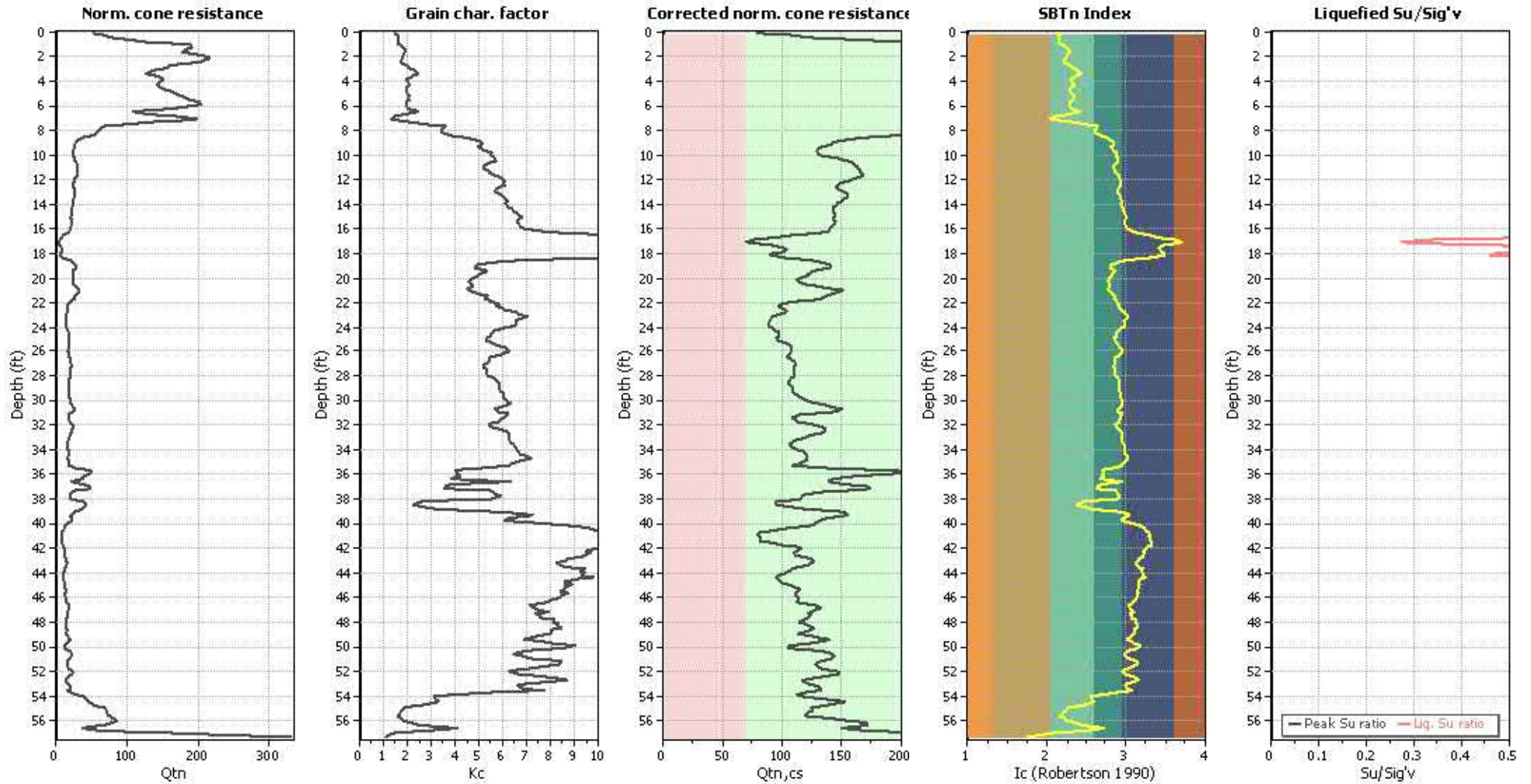
Liquefaction analysis summary plo



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (earthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_c applied:	Yes
Earthquake magnitude M_w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

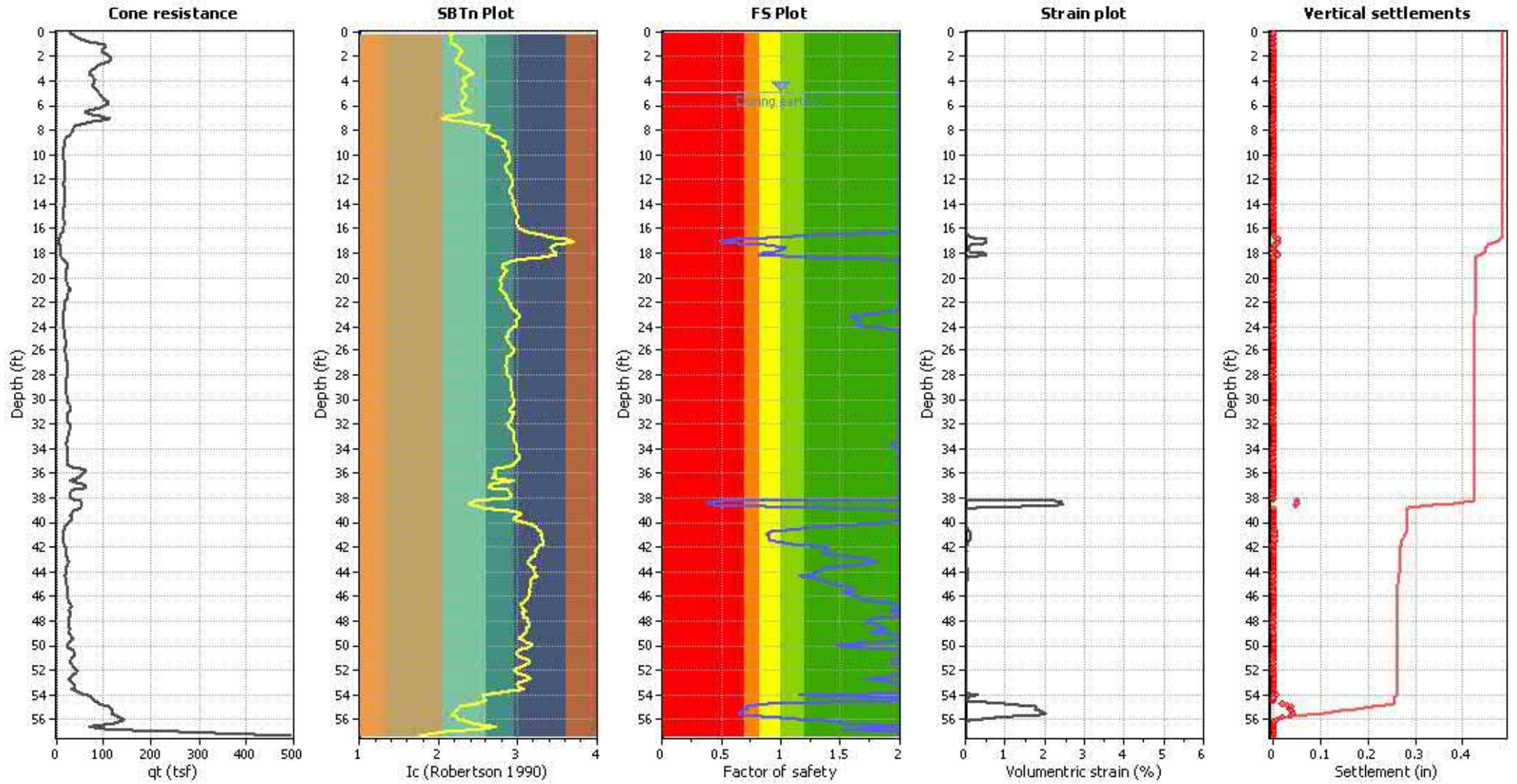
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _c applied:	Yes
Earthquake magnitude M _w :	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.47	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements

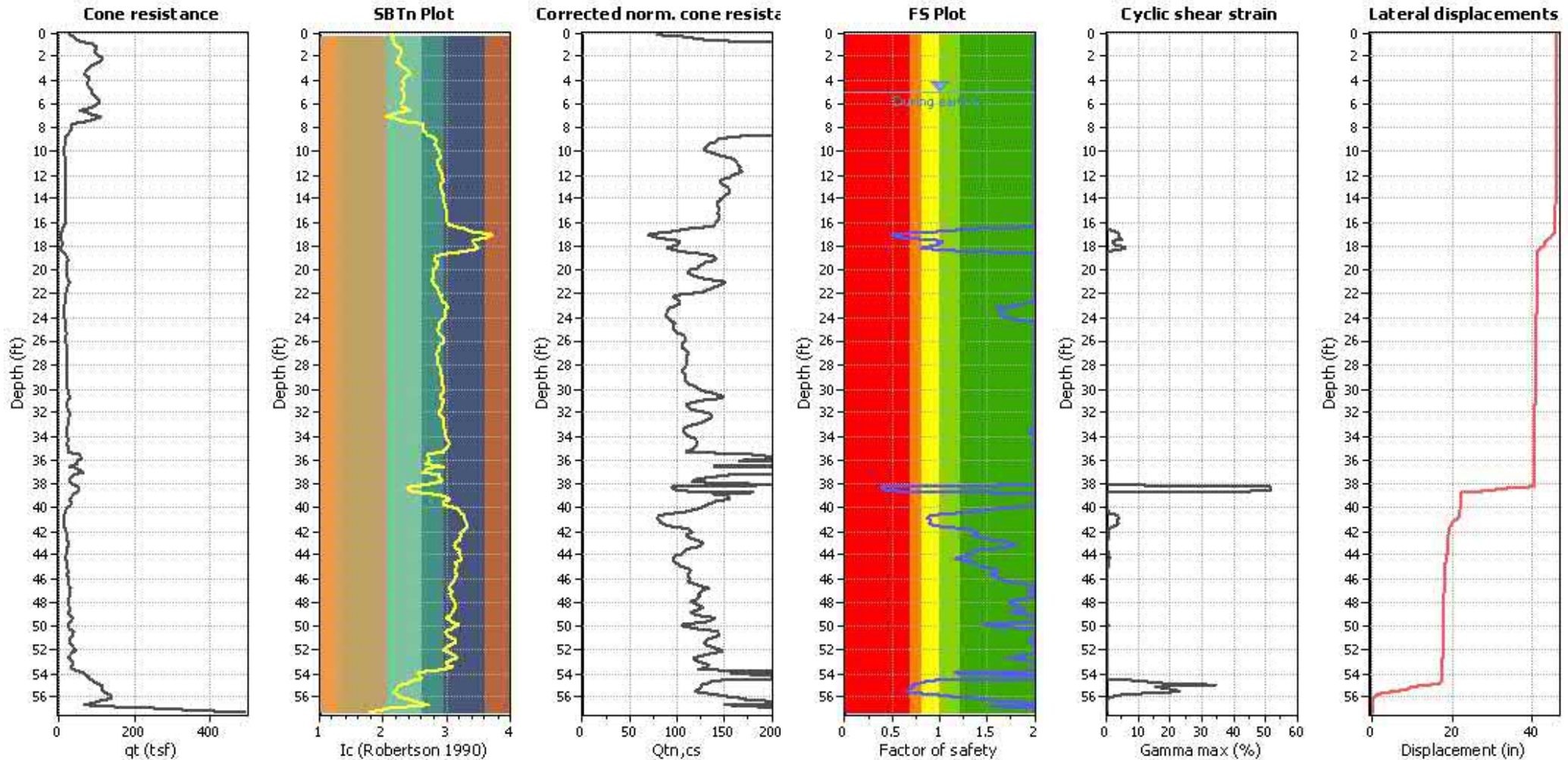


Abbreviations

- q_c: 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
- Volumetric strain: Post-liquefaction volumetric strain

Estimation of post-earthquake lateral Displacements

Geometric parameters: Level ground (or gently sloping) with free face (L: 8.00 ft - H: 8.00 ft)

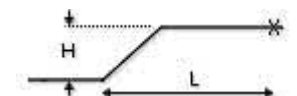


Abbreviations

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

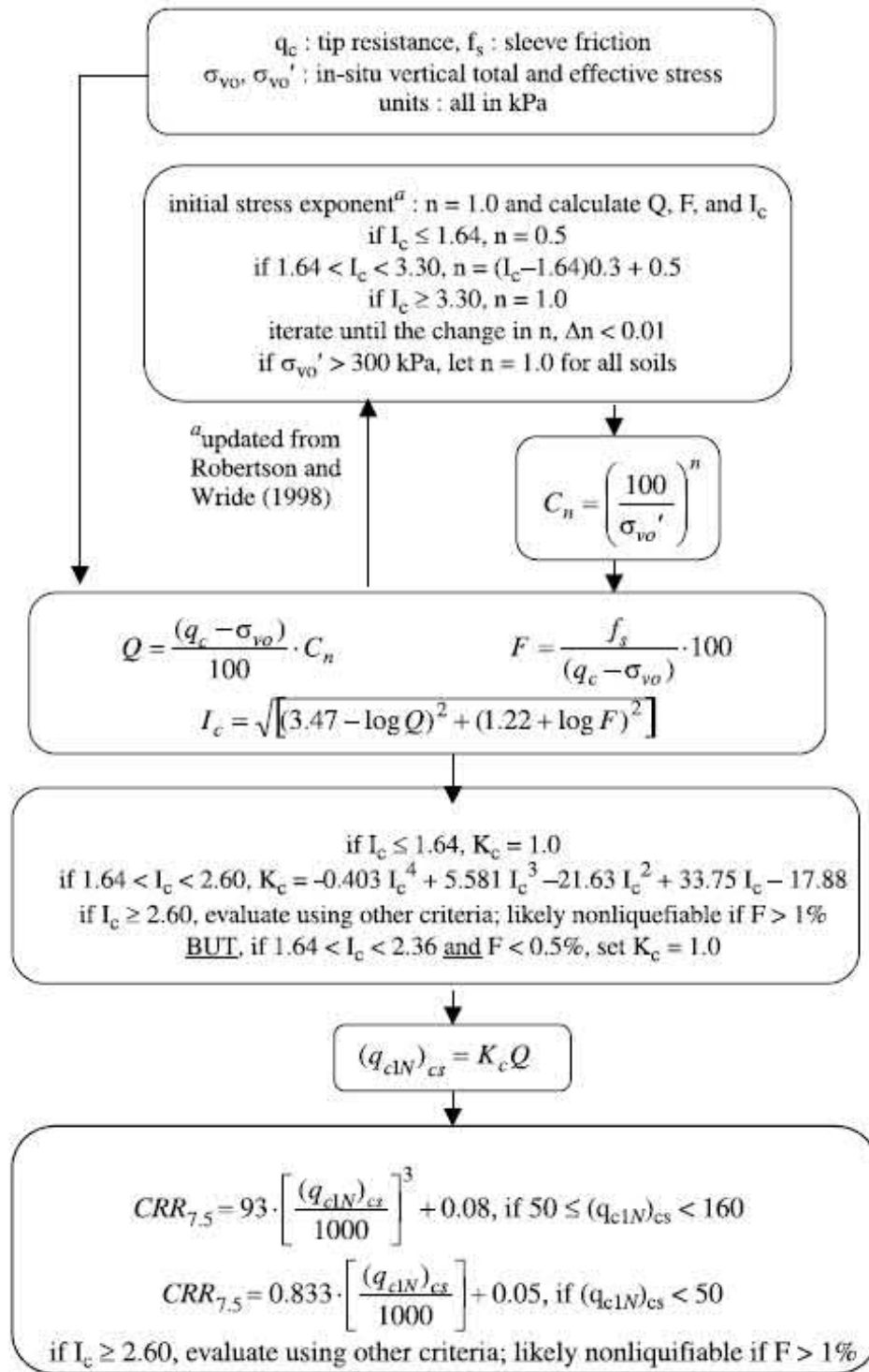
F.S.: Factor of safety
 γ_{max} : Maximum cyclic shear strain
 LDI: Lateral displacement index

Surface condition



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

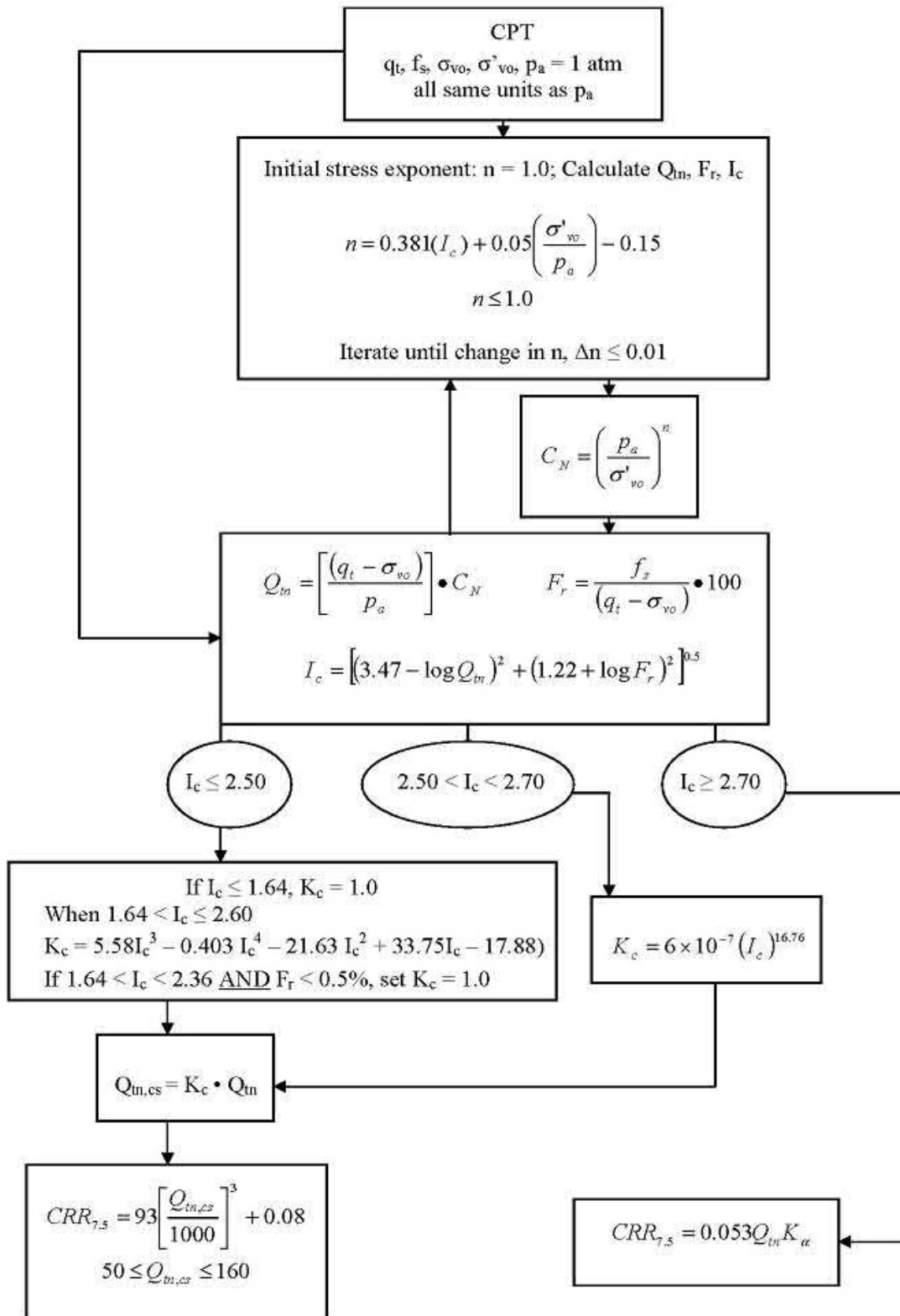
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart¹:



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

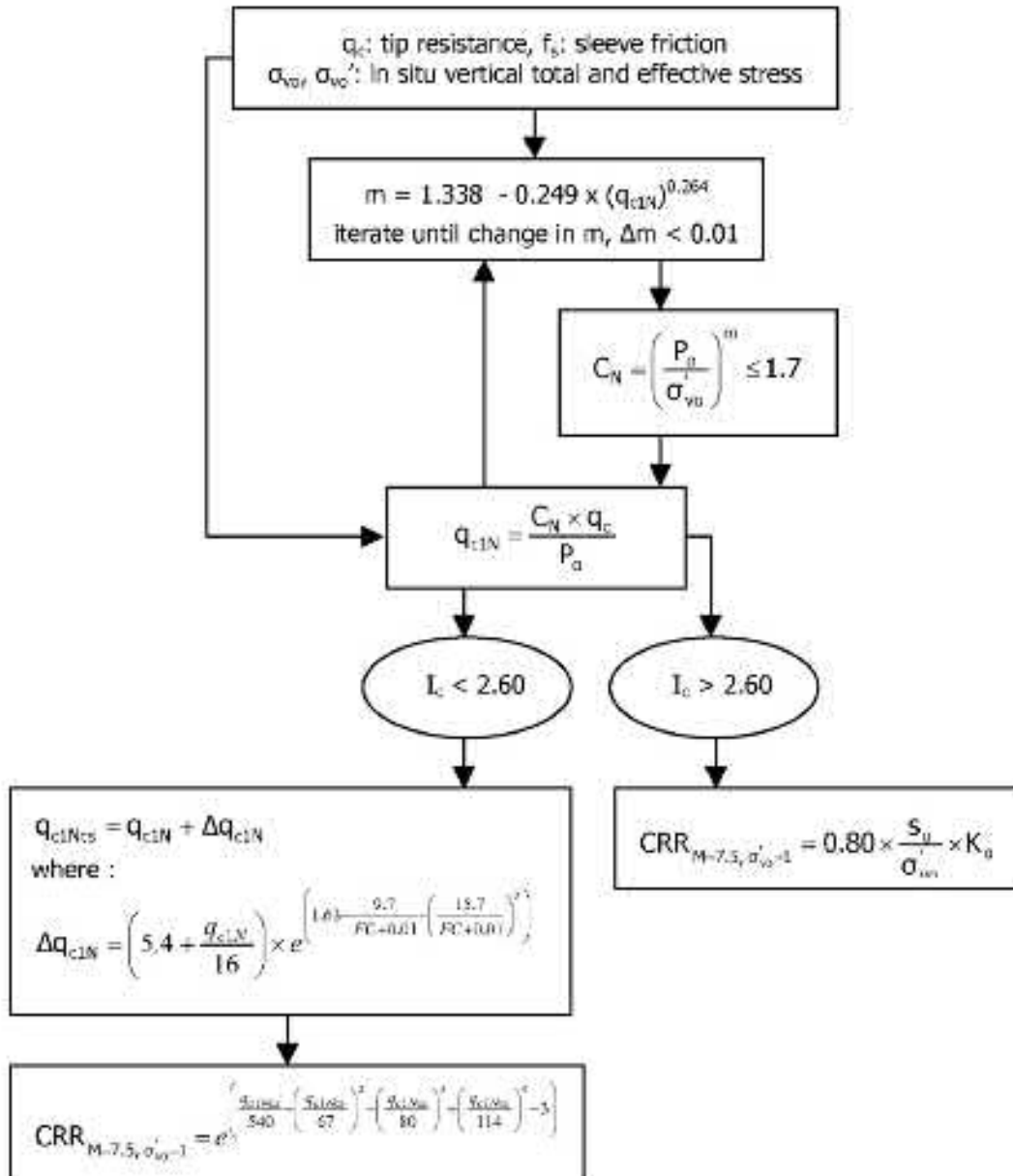
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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 flowchart¹:

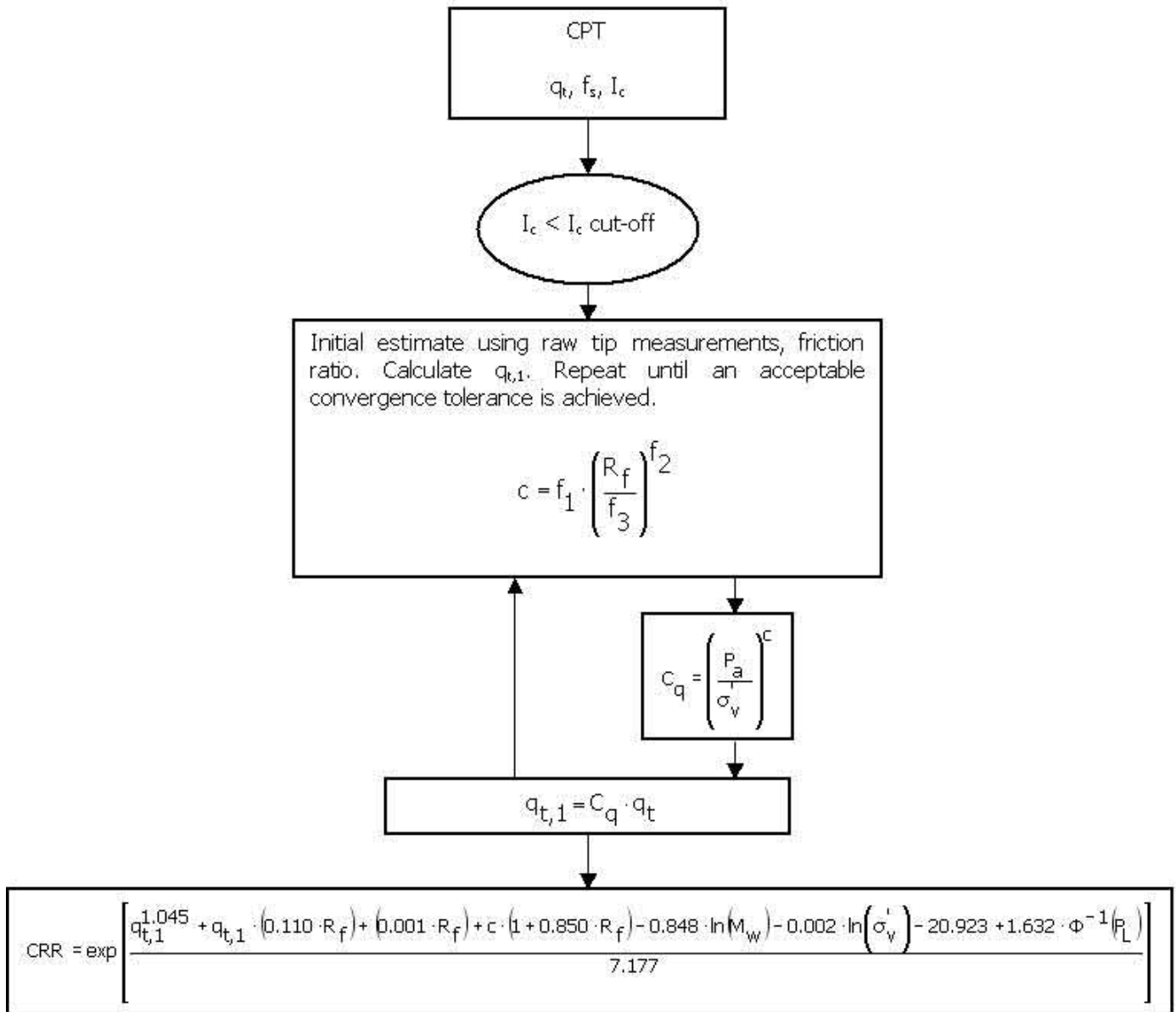


¹ P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

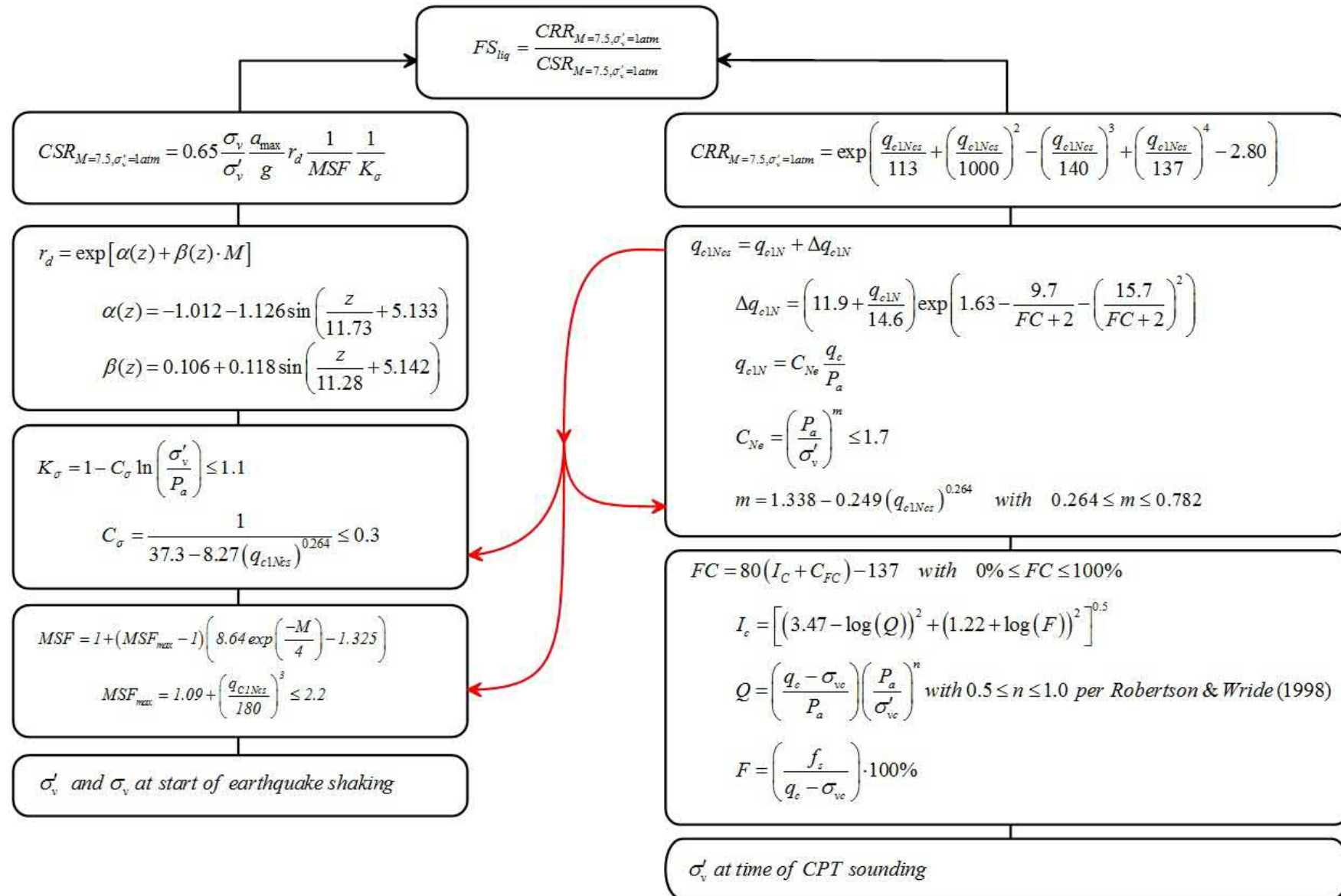
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



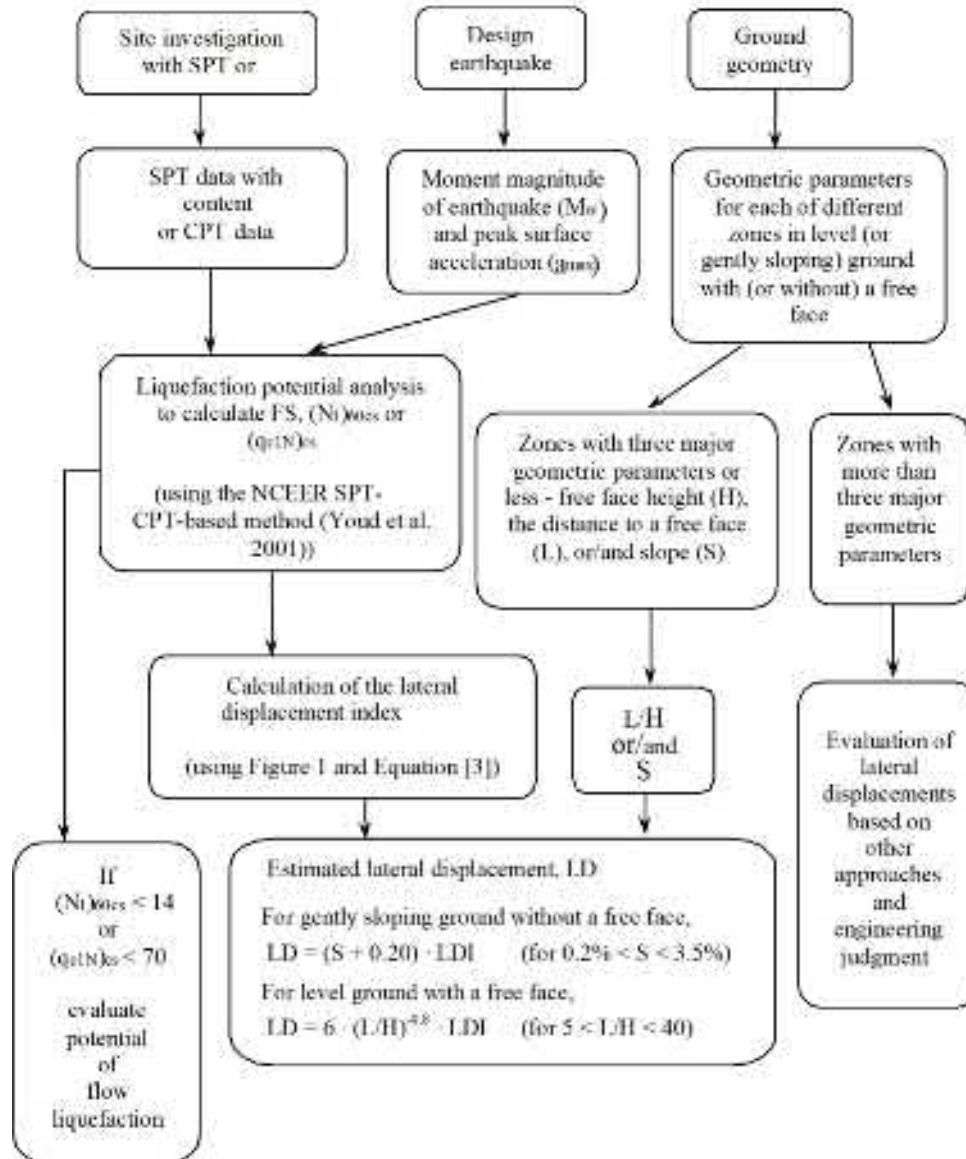
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



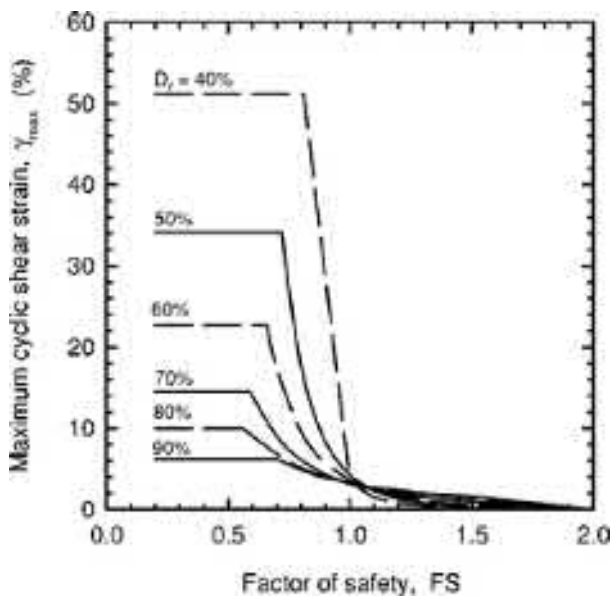
Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)



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



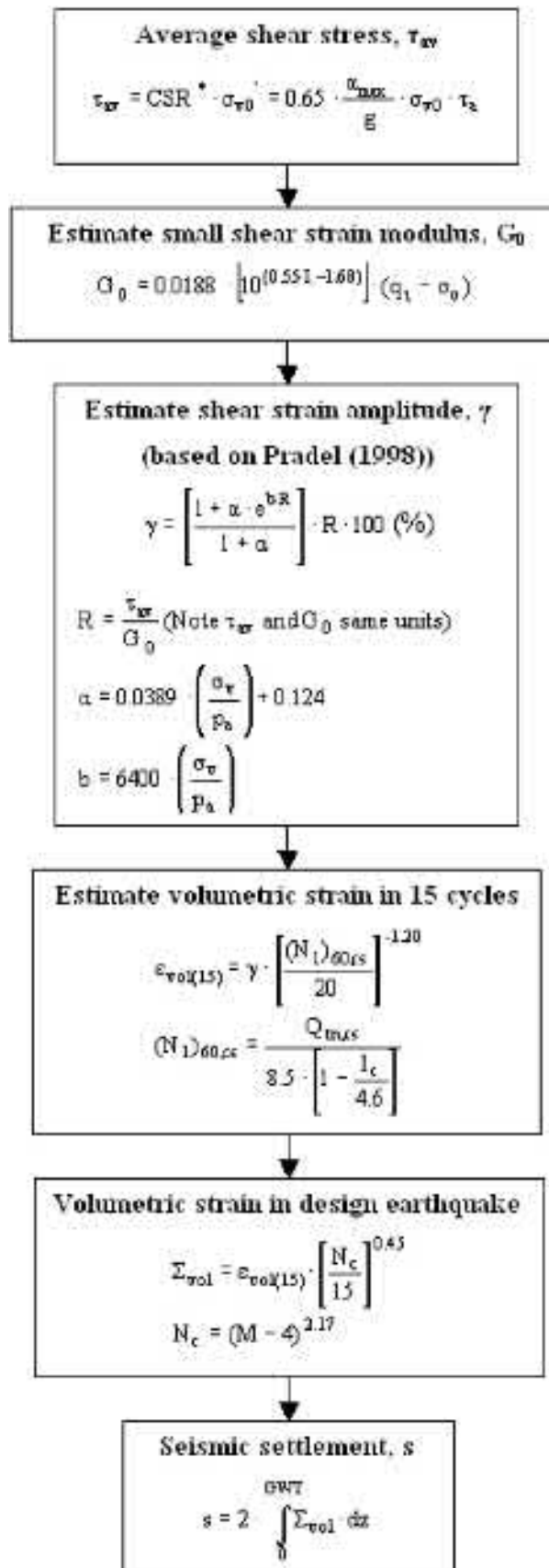
¹ Figure 1

$$LDI = \int_0^{z_{max}} \gamma_{max} dz$$

¹ Equation [3]

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

Procedure for the estimation of seismic induced settlements in dry sands



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 methodology 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:

$$LPI = \int_0^{20} (10 - 0,5z) \times F_L \times d_z$$

where:

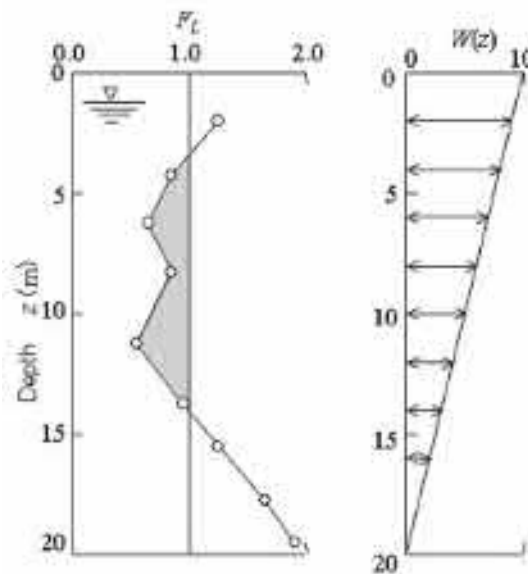
$F_L = 1 - F.S.$ when F.S. less than 1

$F_L = 0$ when F.S. greater than 1

z depth of measurement 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
- $0 < LPI \leq 5$: Liquefaction risk is low
- $5 < LPI \leq 15$: Liquefaction risk is high
- $LPI > 15$: Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

References

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- 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
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- Iwasaki, T., 1986, Soil liquefaction studies in Japan: state-of-the-art, Soil Dynamics and Earthquake Engineering, Vol. 5, No. 1, 2-70
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- 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
- I. M. Idriss and R. W. Boulanger, 2008. Soil liquefaction during earthquakes, Earthquake Engineering Research Institute

APPENDIX F

General Earthwork and Grading Specifications

LEIGHTON AND ASSOCIATES, INC.
General Earthwork and Grading Specifications

1.0 General

1.1 Intent

These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 The Geotechnical Consultant of Record

Prior to commencement of work, the owner shall employ the Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultants shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include natural ground after it has been cleared for receiving fill but before fill is placed, bottoms of all "remedial removal" areas, all key bottoms, and benches made on sloping ground to receive fill.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to determine the attained level of compaction. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor

The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the plans and specifications.

The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "spreads" of work and the estimated quantities of daily earthwork contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified.

2.0 Preparation of Areas to be Filled

2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

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General Earthwork and Grading Specifications

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

2.2 Processing

Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be overexcavated as specified in the following section. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 Overexcavation

In addition to removals and overexcavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical

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General Earthwork and Grading Specifications

Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

2.5 Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 General

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of Section 3.1. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 Fill Moisture Conditioning

Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557).

4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557.

4.5 Compaction Testing

Field-tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to

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General Earthwork and Grading Specifications

inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 Frequency of Compaction Testing

Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 Compaction Test Locations

The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

5.0 Subdrain Installation

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 Excavation

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 Trench Backfills

7.1 Safety

The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations.

7.2 Bedding and Backfill

All bedding and backfill of utility trenches shall be performed in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified. Backfill shall be placed and densified to a minimum of 90 percent of relative compaction from 1 foot above the top of the conduit to the surface.

The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

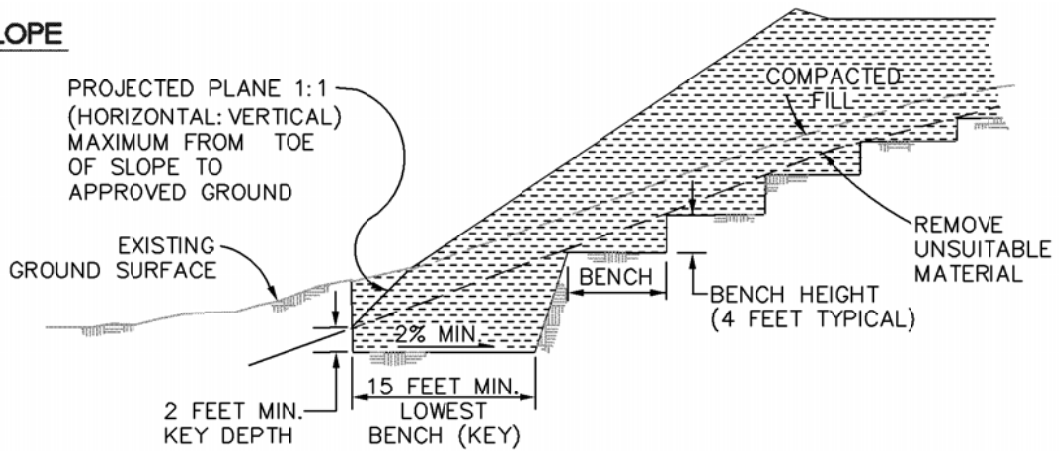
7.3 Lift Thickness

Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

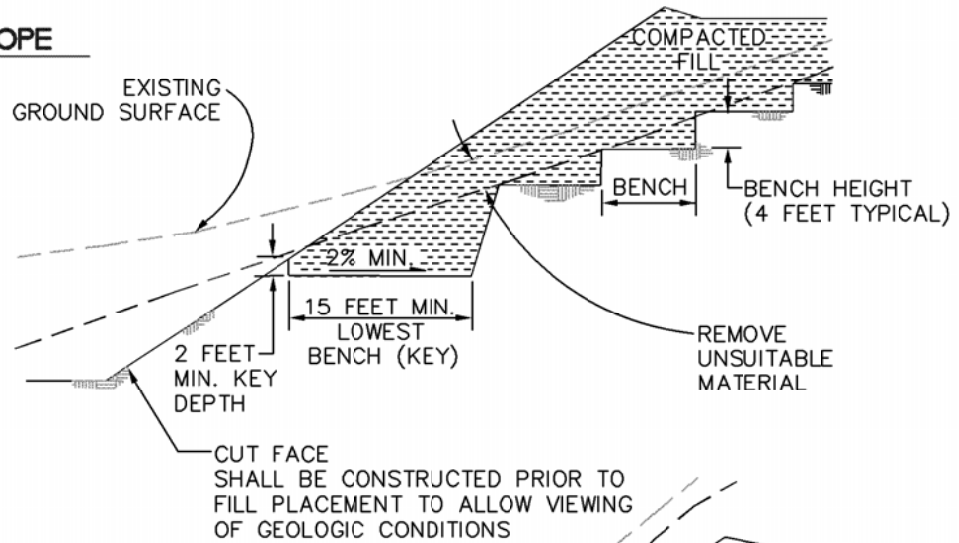
7.4 Observation and Testing

The densification of the bedding around the conduits shall be observed by the Geotechnical Consultant.

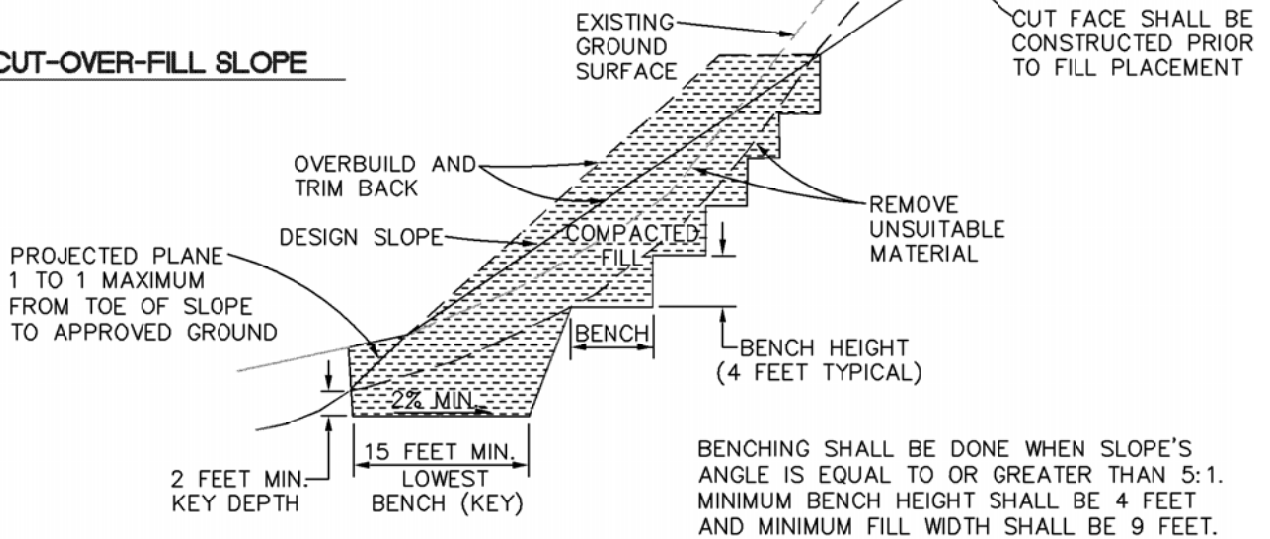
FILL SLOPE



FILL-OVER-CUT SLOPE



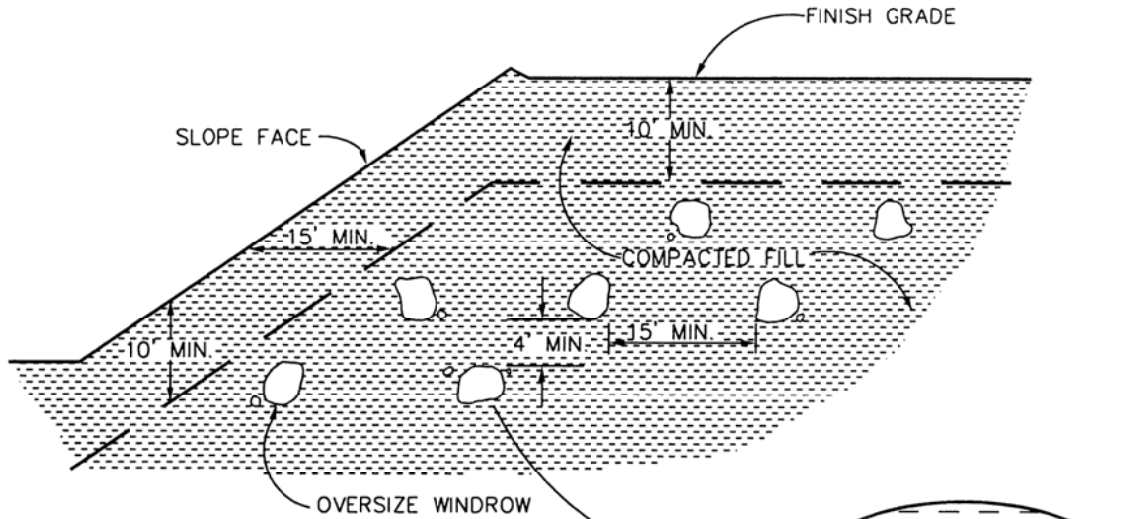
CUT-OVER-FILL SLOPE



KEYING AND BENCHING

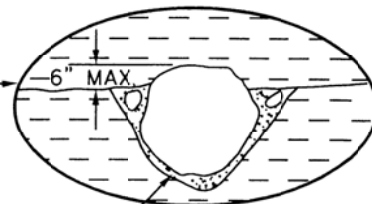
GENERAL EARTHWORK AND
GRADING SPECIFICATIONS
STANDARD DETAIL A



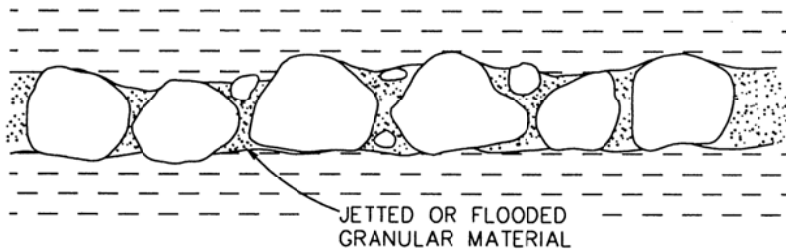


- * OVERSIZE ROCK IS LARGER THAN 8 INCHES IN LARGEST DIMENSION.
- * EXCAVATE A TRENCH IN THE COMPACTED FILL DEEP ENOUGH TO BURY ALL THE ROCK.
- * BACKFILL WITH GRANULAR SOIL JETTED OR FLOODED IN PLACE TO FILL ALL THE VOIDS.
- * DO NOT BURY ROCK WITHIN 10 FEET OF FINISH GRADE.
- * WINDROW OF BURIED ROCK SHALL BE PARALLEL TO THE FINISHED SLOPE.

GRANULAR MATERIAL TO BE DENSIFIED IN PLACE BY FLOODING OR JETTING.



DETAIL

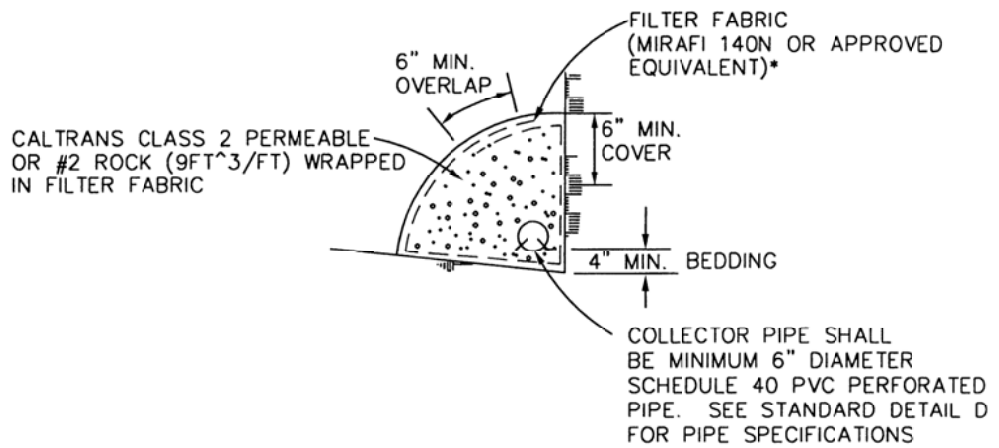
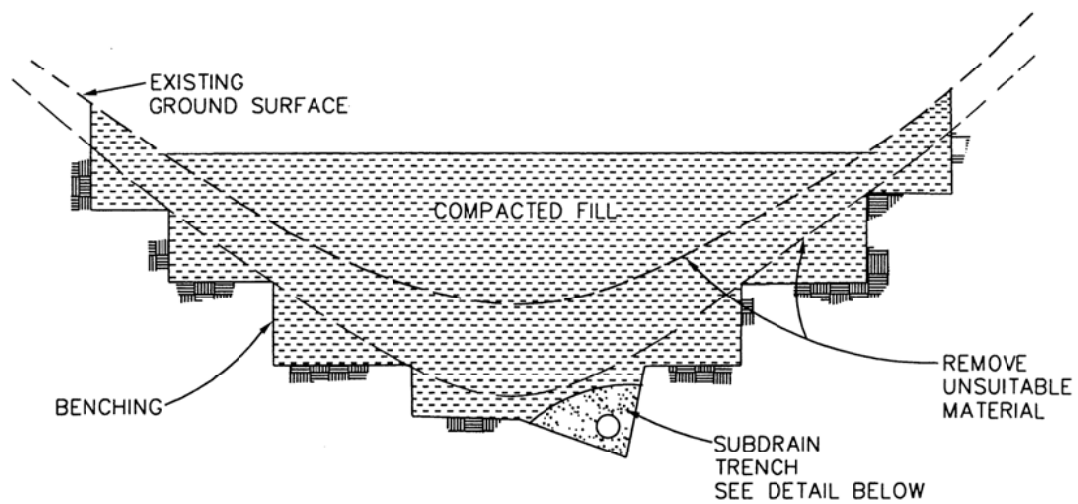


TYPICAL PROFILE ALONG WINDROW

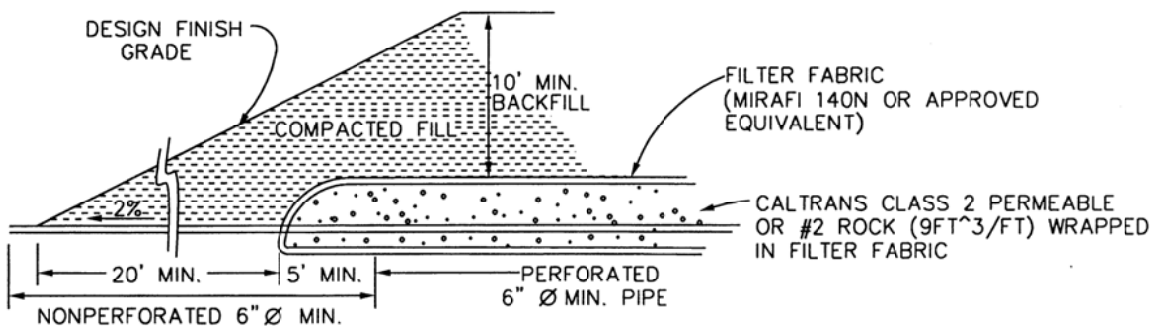
OVERSIZE ROCK DISPOSAL

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAIL B





SUBDRAIN DETAIL

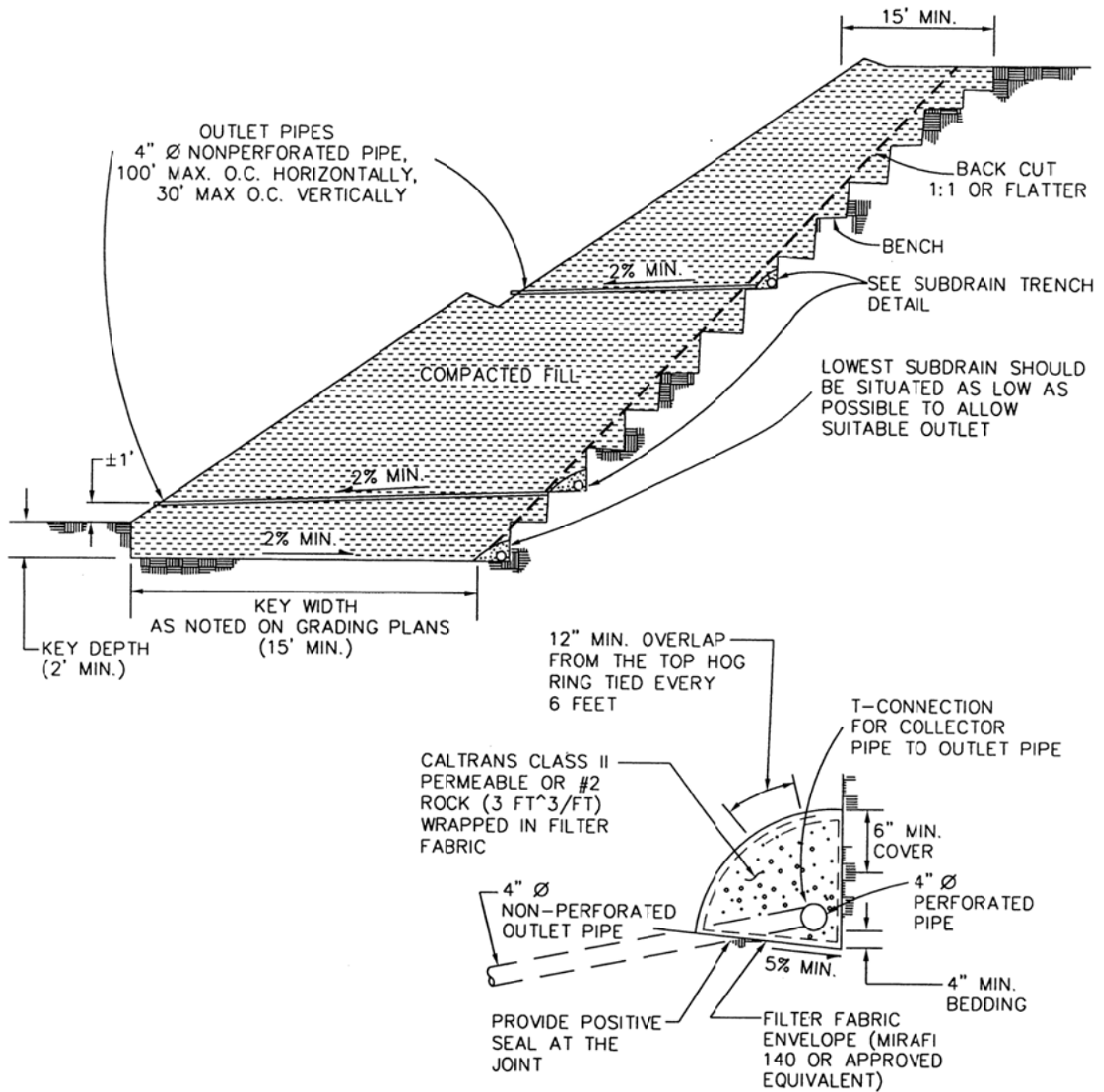


DETAIL OF CANYON SUBDRAIN OUTLET

CANYON SUBDRAINS

GENERAL EARTHWORK AND GRADING SPECIFICATIONS
STANDARD DETAIL C





SUBDRAIN TRENCH DETAIL

SUBDRAIN INSTALLATION – subdrain collector pipe shall be installed with perforation down or, unless otherwise designated by the geotechnical consultant. Outlet pipes shall be non-perforated pipe. The subdrain pipe shall have at least 8 perforations uniformly spaced per foot. Perforation shall be 1/4" to 1/2" if drill holes are used. All subdrain pipes shall have a gradient of at least 2% towards the outlet.

SUBDRAIN PIPE – Subdrain pipe shall be ASTM D2751, SDR 23.5 or ASTM D1527, Schedule 40, or ASTM D3034, SDR 23.5, Schedule 40 Polyvinyl Chloride Plastic (PVC) pipe.

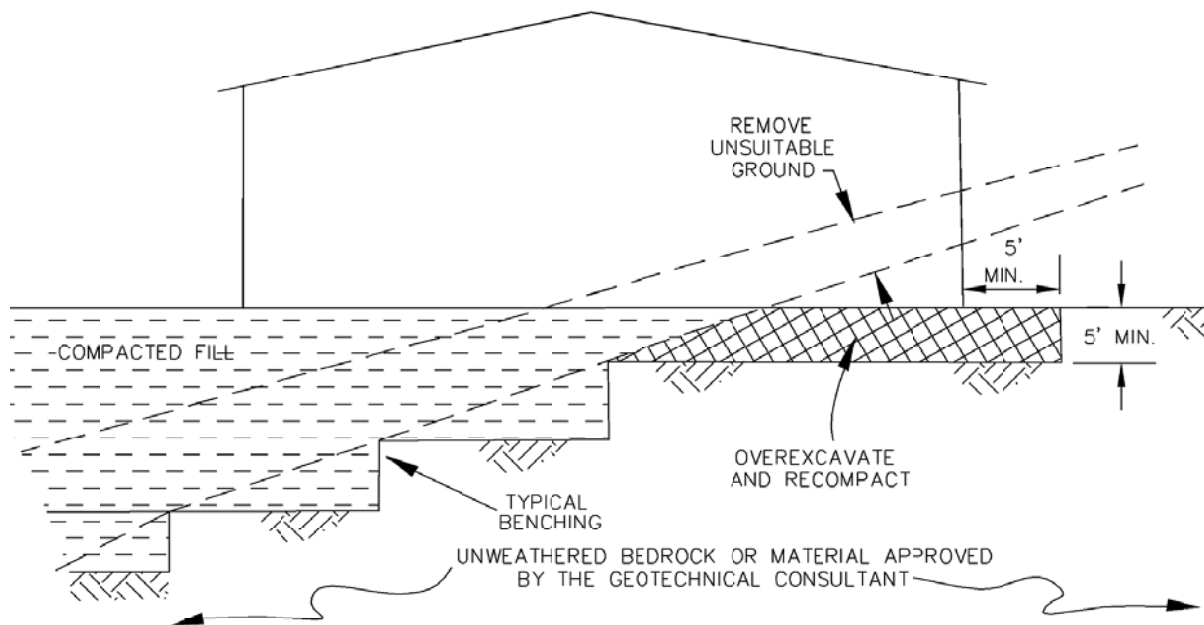
All outlet pipe shall be placed in a trench no wider than twice the subdrain pipe.

**BUTTRESS OR
REPLACEMENT
FILL SUBDRAINS**

**GENERAL EARTHWORK AND
GRADING SPECIFICATIONS
STANDARD DETAIL D**



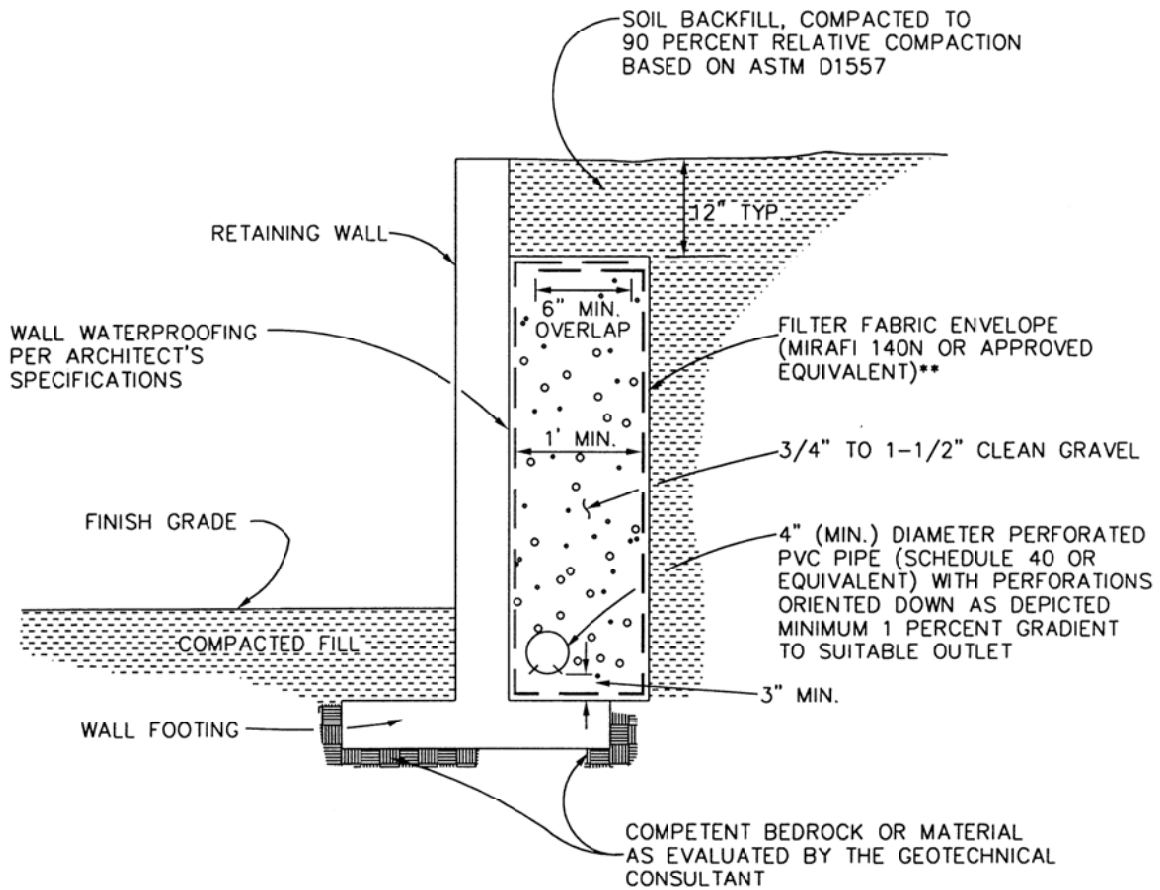
CUT-FILL TRANSITION LOT OVEREXCAVATION



TRANSITION LOT FILLS

GENERAL EARTHWORK AND
GRADING SPECIFICATIONS
STANDARD DETAIL E



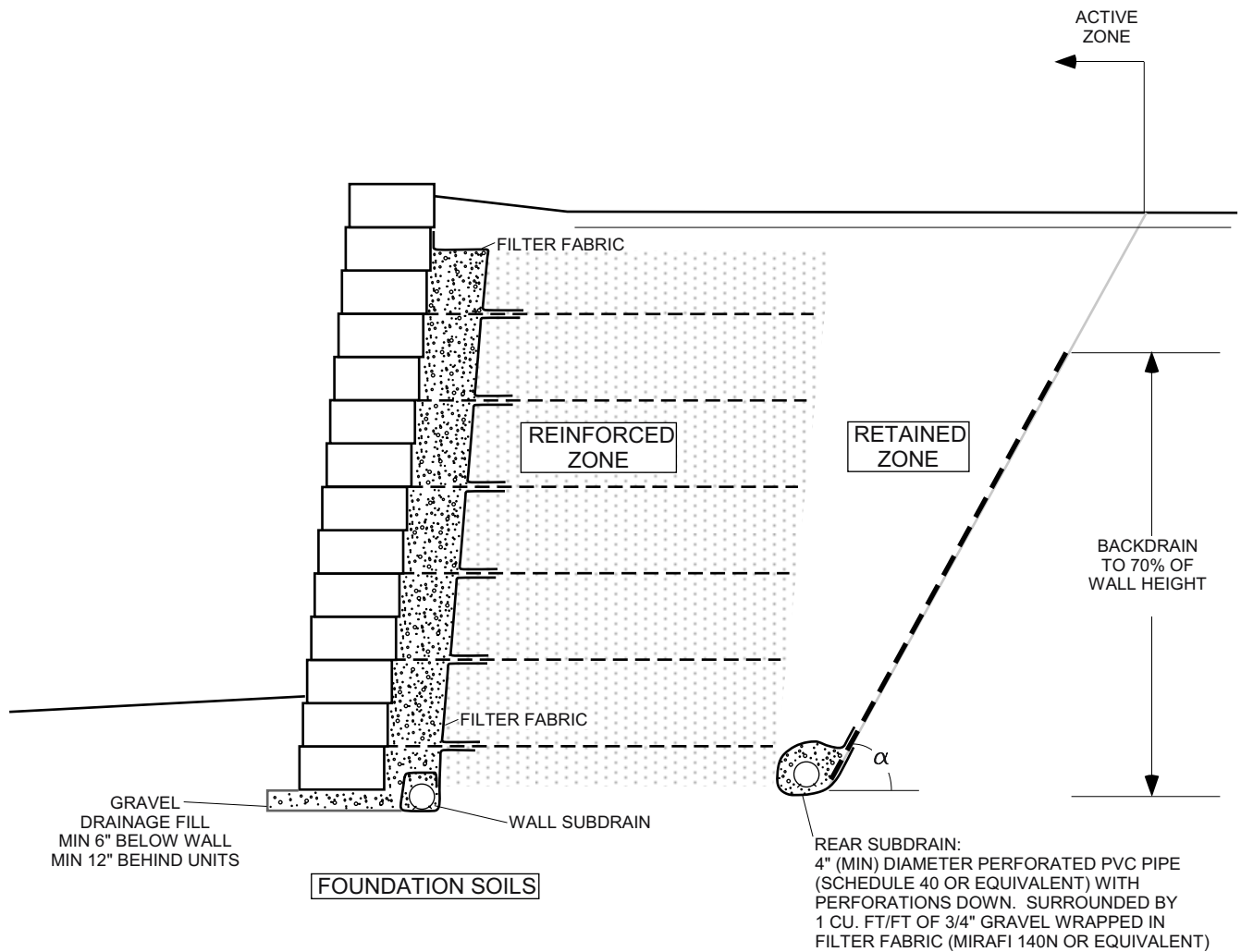


NOTE: UPON REVIEW BY THE GEOTECHNICAL CONSULTANT, COMPOSITE DRAINAGE PRODUCTS SUCH AS MIRADRAIN OR J-DRAIN MAY BE USED AS AN ALTERNATIVE TO GRAVEL OR CLASS 2 PERMEABLE MATERIAL. INSTALLATION SHOULD BE PERFORMED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.

RETAINING WALL DRAINAGE

GENERAL EARTHWORK AND
GRADING SPECIFICATIONS
STANDARD DETAIL F





NOTES:

1) MATERIAL GRADATION AND PLASTICITY
REINFORCED ZONE:

SIEVE SIZE	% PASSING
1 INCH	100
NO. 4	20-100
NO. 40	0-60
NO. 200	0-35

FOR WALL HEIGHT < 10 FEET, PLASTICITY INDEX < 20
 FOR WALL HEIGHT 10 TO 20 FEET, PLASTICITY INDEX < 10
 FOR TIERED WALLS, USE COMBINED WALL HEIGHTS
 WALL DESIGNER TO REQUEST SITE-SPECIFIC CRITERIA FOR WALL HEIGHT > 20 FEET

GRAVEL DRAINAGE FILL:

SIEVE SIZE	% PASSING
1 INCH	100
3/4 INCH	75-100
NO. 4	0-60
NO. 40	0-50
NO. 200	0-5

OUTLET SUBDRAINS EVERY 100 FEET, OR CLOSER, BY TIGHTLINE TO SUITABLE PROTECTED OUTLET

- CONTRACTOR TO USE SOILS WITHIN THE RETAINED AND REINFORCED ZONES THAT MEET THE STRENGTH REQUIREMENTS OF WALL DESIGN.
- GEOGRID REINFORCEMENT TO BE DESIGNED BY WALL DESIGNER CONSIDERING INTERNAL, EXTERNAL, AND COMPOUND STABILITY.
- GEOGRID TO BE PRETENSIONED DURING INSTALLATION.
- IMPROVEMENTS WITHIN THE ACTIVE ZONE ARE SUSCEPTIBLE TO POST-CONSTRUCTION SETTLEMENT. ANGLE $\alpha = 45 + \phi/2$, WHERE ϕ IS THE FRICTION ANGLE OF THE MATERIAL IN THE RETAINED ZONE.
- BACKDRAIN SHOULD CONSIST OF J-DRAIN 302 (OR EQUIVALENT) OR 6-INCH THICK DRAINAGE FILL WRAPPED IN FILTER FABRIC. PERCENT COVERAGE OF BACKDRAIN TO BE PER GEOTECHNICAL REVIEW.

SEGMENTAL RETAINING WALLS

GENERAL EARTHWORK AND
 GRADING SPECIFICATIONS
 STANDARD DETAIL G



APPENDIX G

GBC Insert

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it.* A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may

perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old*.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration*. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists*.



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Categorization of Infiltration Feasibility Condition		Form I-8	
<p>Part 1 - Full Infiltration Feasibility Screening Criteria</p> <p>Would infiltration of the full design volume be feasible from a physical perspective without any undesirable consequences that cannot be reasonably mitigated?</p>			
Criteria	Screening Question	Yes	No
1	<p>Is the estimated reliable infiltration rate below proposed facility locations greater than 0.5 inches per hour? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<p>Provide basis:</p> <p>Based on our field percolation testing, the in-situ infiltration rates of the soils within the limits of proposed residential development are generally less than 0.5 inches per hour (Leighton, 2020). The calculated infiltration rates via the Porchet Method and applied safety factor of 2 ranges from 0.03 to 0.04 inches per hour.</p> <p>Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</p>			
2	<p>Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.</p>	X	<input type="checkbox"/>
<p>Provide basis:</p> <p>The risk of geotechnical hazards would be increased provided mitigation is performed for any underground utilities/structures, slopes (i.e., setbacks) and undocumented fill depths greater than 5 feet within the proposed limits of Hydromodification Basins at the subject site. In addition, compressible alluvium and landslide deposits are present across the site.</p> <p>Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</p>			



Form I-8 Page 2 of 4

Criteria	Screening Question	Yes	No
3	Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of groundwater contamination (shallow water table, storm water pollutants or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<p>Provide basis:</p> <p>If the infiltration rates were greater than 0.5 inches per hour, it may be possible that the risk of groundwater contamination would not be increased provided there are no known contaminated soil or groundwater sites within 250 feet of the proposed Hydromodification Basins at the subject site.</p> <p>Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</p>			
4	Can infiltration greater than 0.5 inches per hour be allowed without causing potential water balance issues such as change of seasonality of ephemeral streams or increased discharge of contaminated groundwater to surface waters? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<p>Provide basis:</p> <p>If the infiltration rates were greater than 0.5 inches per hour, it may be possible that potential water balance issues would not be affected provided there are no unlined site drainages/creeks/streams within 250 feet of the proposed Hydromodification Basins at the subject site.</p> <p>Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability.</p>			
Part 1 Result *	<p>If all answers to rows 1 - 4 are "Yes" a full infiltration design is potentially feasible. The feasibility screening category is Full Infiltration</p> <p>If any answer from row 1-4 is "No", infiltration may be possible to some extent but would not generally be feasible or desirable to achieve a "full infiltration" design. Proceed to Part 2</p>	<input type="checkbox"/> Full Infiltration <input checked="" type="checkbox"/> No	

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by Agency/Jurisdictions to substantiate findings



Form I-8 Page 3 of 4

Part 2 – Partial Infiltration vs. No Infiltration Feasibility Screening Criteria

Would infiltration of water in any appreciable amount be physically feasible without any negative consequences that cannot be reasonably mitigated?

Criteria	Screening Question	Yes	No
5	Do soil and geologic conditions allow for infiltration in any appreciable rate or volume? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2 and Appendix D.	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Provide basis:

Based on our field percolation testing, the in-situ infiltration rates of the soils within the limits of proposed the Basin sites are less than 0.5 inches per hour (Leighton, 2020), but greater than 0.01 inches per hour. The calculated infiltration rates via the Porchet Method and applied safety factor of 2 are between 0.03 and 0.04 inches per hour.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.

6	Can Infiltration in any appreciable quantity be allowed without increasing risk of geotechnical hazards (slope stability, groundwater mounding, utilities, or other factors) that cannot be mitigated to an acceptable level? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.2.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
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Provide basis:

For a partial infiltration condition (greater than 0.01 inches per hour), the risk of geotechnical hazards will be increased by partial infiltration provided mitigation is performed for any underground utilities/structures, slopes (i.e., setbacks) and undocumented fill depths greater than 5 feet within the vicinity of proposed Hydromodification Basins at the subject site. In addition to fill material, Alluvium and Landslide Deposits are considered compressible and may settle if water is introduced to compressible sand layers.

Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.



Form I-8 Page 4 of 4

Criteria	Screening Question	Yes	No
7	<p>Can Infiltration in any appreciable quantity be allowed without posing significant risk for groundwater related concerns (shallow water table, storm water pollutants or other factors)? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</p>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<p>Provide basis: For a partial infiltration condition (greater than 0.01 inches per hour), the risk of groundwater contamination will not be increased by partial infiltration provided there are no known contaminated soil or groundwater sites within 250 feet of the proposed Hydromodification Basins at the subject site.</p> <p>Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.</p>			
8	<p>Can infiltration be allowed without violating downstream water rights? The response to this Screening Question shall be based on a comprehensive evaluation of the factors presented in Appendix C.3.</p>	<input type="checkbox"/>	<input type="checkbox"/>
<p>Provide basis: For a partial infiltration condition (greater than 0.01 inches per hour), violation of downstream water rights is not anticipated based on the site location and that there are no unlined site drainages/creeks/streams within 250 feet of the proposed Hydromodification Basins at the subject site.</p> <p>Summarize findings of studies; provide reference to studies, calculations, maps, data sources, etc. Provide narrative discussion of study/data source applicability and why it was not feasible to mitigate low infiltration rates.</p>			
Part 2 Result*	<p>If all answers from row 1-4 are yes then partial infiltration design is potentially feasible. The feasibility screening category is Partial Infiltration.</p> <p>If any answer from row 5-8 is no, then infiltration of any volume is considered to be infeasible within the drainage area. The feasibility screening category is No Infiltration.</p>	<input type="checkbox"/>	<input type="checkbox"/> Partial Infiltration <input checked="" type="checkbox"/> No Infiltration

*To be completed using gathered site information and best professional judgment considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by Agency/Jurisdictions to substantiate findings



ATTACHMENT 7
Storm Water Quality Assessment Form

This is the cover sheet for Attachment 7.






City of Oceanside – Engineering Division – Clean Water Program
**STORM WATER QUALITY ASSESSMENT FOR PLANNING,
 ENGINEERING, AND BUILDING PERMIT APPLICATIONS**

All applications for Planning, Engineering, or Building Division permits are required to complete this assessment form and include it as part of the initial permit application submittal. Staff will review the permit application content to determine the applicability of State and City storm water requirements. Please note a storm water assessment cannot be provided without a complete permit application package.

Section 1 – Project Information	
Applicant Name: JPI	Phone Number: 858.369.5679
Project Name: Jefferson Oceanside	Email Address (Optional):
Project Site Address: SW corner of Oceanside Blvd and Crouch St, Oceanside, CA	Street Intersection: Oceanside Blvd, Crouch St.
Assessor Parcel Number(s): 151-270-50, -52, -53, -56	Total Parcel Area (acres or square feet): 27 acres, disturbed area 9.91 acres
Project Description: 287 Residential Apartments, Dedication and construction of South Oceanside Blvd extension and removal and remediation of historic landslide area on Crouch St.	Proposed Project Impervious Area (acres or square feet): 7.36 acres
Section 2 – Identify Project Type	
<input checked="" type="checkbox"/>	New Development Project – go to Section 3
<input type="checkbox"/>	Redevelopment Project go to Section 3
<input type="checkbox"/>	None of the above – Skip Section 3 and go to Section 4
Section 3 – Identify Applicable Priority Development Project Categories	
<input checked="" type="checkbox"/>	New Development Project – A project that creates 10,000 square feet or more of impervious surfaces (collectively over the entire project site). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
<input type="checkbox"/>	Redevelopment Project – A project that creates and/or replaces 5,000 square feet or more of impervious surface (collectively over the entire project site on an existing site of 10,000 square feet or more of impervious surfaces). This includes commercial, industrial, residential, mixed-use, and public development projects on public or private land.
<input type="checkbox"/>	Restaurants – Category is defined as a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC code 5812); where new or redevelopment projects that create and/or replace 5,000 square feet or more impervious surface (collectively over the entire project site).
<input type="checkbox"/>	Hillside Development – Category includes development on any natural slope that is twenty-five percent or greater; where new or redevelopment projects that create and/or replace 5,000 square feet or more impervious surface (collectively over the entire project site).
<input type="checkbox"/>	Parking Lots – Category is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce; where new or redevelopment projects that create and/or replace 5,000 square feet or more impervious surface (collectively over the entire project site).
<input type="checkbox"/>	Streets, Roads, Highways, Freeways, and Driveways – Category is defined as any paved impervious surface used for the transportation of automobiles, trucks, motorcycles, and other vehicles; where new or redevelopment projects that create and/or replace 5,000 square feet or more impervious surface (collectively over the entire project site).
<input type="checkbox"/>	Water Quality Environmentally Sensitive Area – New or redevelopment projects that create and/or replace 2,500 square feet or more of impervious surface (collectively over the entire project site), and discharging directly to a Water Quality Environmentally Sensitive Area (WQESA). “Discharging directly to” includes flow that is conveyed overland a distance of 200 feet or less from the project to the WQESA, or conveyed in a pipe or open channel any distance as an isolated flow from the project to the ESA (i.e. not commingled with flows from adjacent lands).
<input type="checkbox"/>	Automotive Repair Shop – Category is defined as a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539, where new or redevelopment projects that create and/or replace 5,000 square feet or more impervious surface (collectively over the entire project site).
<input type="checkbox"/>	Retail Gasoline Outlet (RGOs) – Category includes RGOs that meet the following criteria (a) 5,000 square feet or more or (b) a projected Average Daily Traffic (ADT) of 100 or more vehicles per day; where new or redevelopment projects that create and/or replace 5,000 square feet or more impervious surface (collectively over the entire project site).
<input checked="" type="checkbox"/>	Development Projects greater than one acre – New or redevelopment projects that result in the disturbance of one



City of Oceanside – Engineering Division – Clean Water Program
**STORM WATER QUALITY ASSESSMENT FOR PLANNING,
 ENGINEERING, AND BUILDING PERMIT APPLICATIONS**

or more acres of land and are expected to generate pollutants post construction.	
<input type="checkbox"/> None of the Above	
Section 4 – Identify Permit Application Type	
<input checked="" type="checkbox"/>	Discretionary Permit Application: Specific Plan (S), General Plan Amendment (GPA), Zone Amendment (ZA), Tentative Map (T), Tentative Parcel Map (P), Development Plan (D), Conditional Use Permit (CUP), Variance (V), Regular Coastal Permit (RC), Historic Permit (H), Reclamation Plan, Planned Development Permit, Planned Unit Development Permit, Planning Commission Approval of Plans, Site Plan Review, Tentative Map Amendments to Conditions of Approval or Time Extension, Variance.
<input type="checkbox"/>	Administrative Permit Application: Administrative Clearing Permit, Lot Line Adjustment, Final Map Modification, Grading Plan (including modification or renewal), Improvement Plan (including modification), Landscape Plan, Building Permit, Construction Right-of-Way Permit, Encroachment Permit, Excavation Permit, On-site Wastewater System Permit, Underground Tank Permit, Well Permit, or etc.
Section 5 – Applicant Certification	
Name of Responsible Party: Bryan Smith, Fuscoe Engineering	Phone Number: 858.554.1500
Email Address (optional)	FAX Number (optional):
I understand and acknowledge the City of Oceanside has adopted minimum requirements, as mandated by the San Diego Regional Water Quality Control Board – Order No. R9-2013-0001, as amended by Order Nos. R9-2015-0001 and R9-2015-0100 (NPDES NO. CAS0109266) for mitigating impacts associated with urban runoff, including storm water from construction and land development activities. I certify this assessment has been accurately completed to the best of my knowledge and is consistent with the proposed project. I acknowledge that non-compliance with the City Best Management Practice (BMP) Design Manual, Grading Ordinance, and Erosion Control Ordinance may result in enforcement action by the City, the California State Water Resources Control Board, and/or the San Diego Regional Water Quality Control Board. Enforcement action may include stop work orders, notice of violation, fines, or other actions.	
Applicant Signature: 	Date: 3/5/20