



APPENDIX 4:

Investigation Borehole Logs and Core Photos



LOG OF AUGER HA01

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : JC
Reviewed By : HP
Latitude : -36.7472168
Longitude : 174.5806626

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remoulded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	FILL	ML	[FILL] Clayey SILT with minor sand and trace gravel; brownish grey with dark brown streaks. Low plasticity; sand is fine to coarse. Gravel is fine to medium, sub-angular, greywacke.					N/A	218/33						
0.5	UNDIFFERENTIATED TAKAANINI FORMATION	ML	Clayey SILT with minor sand and gravel; brownish grey with occasional light orange and white streaks. Low plasticity; sand is fine to coarse. Gravel is fine crushable silt clasts; white.		45		M	H	221+						
1.0									221+						
1.5								VSt	166/104						
2.0								H	218/85						
2.5		OL	Silty CLAY with some organics and trace sand; brownish black with dark grey streaks. High plasticity; organics are carbonaceous inclusions (5 - 10 mm).		44			H	221+						
3.0		ML	Organic SILT with some clay and sand; brownish black. Low plasticity; sand is fine to coarse. Organics are carbonaceous inclusions (2 - 10 mm).												
			SILT with some clay, sand and organics; blackish grey. Low plasticity; sand is fine to coarse. Organics are carbonaceous inclusions (2 - 10 mm)					VSt	105/48						
			2.75 m - Encountered 50 mm lens of brown orange mottling.												
			2.8 m - With some fine sand.		43				112/51						
			2.9 m - With minor fine sand.												
			End of Hole Depth: 3 m Termination Condition: Target depth												

Hand auger met target depth at 3 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable.



LOG OF AUGER HA02

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 11-03-2025
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 3230
Logged By : PM
Reviewed By : HP
Latitude : -36.7476039
Longitude : 174.5793901

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remoulded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	TS	OL	[TOPSOIL].					N/A							
0.5		ML	Clayey SILT; brown with orange streaks. Low plasticity.				D		178/31						
1.0								VSt	148/47						
1.5		CH	Silty CLAY with minor sand; light grey with occasional orange streaks. High plasticity; sand is fine.				M		139/45						
2.0								VSt	156/59						
2.5									193/74						
3.0		ML	Sandy SILT with some clay; light grey with orange mottles. Low plasticity; sand is fine to coarse.					VSt - H	206/89						
			2.45 m - Encountered trace carbonaceous inclusions (2 - 5 mm).					VSt	196/82						
		ML	Clayey SILT with minor organics and trace sand; light brown with light orange streaks. Low plasticity; sand is fine. Organics are carbonaceous inclusions (2 - 5 mm).					St	171/42						
			End of Hole Depth: 3 m Termination Condition: Target depth						82/39						
									62/45						
3.5															
4.0															
4.5															
5.0															

Hand Auger met target depth at 3 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; TS = Topsoil.



LOG OF AUGER HA03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : HM
Reviewed By : HP
Latitude : -36.7485428
Longitude : 174.579031

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remoulded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	F	ML	[FILL] Clayey SILT with trace sand and gravel; brown with grey and dark brown mottles. Low plasticity; sand is fine. Gravel is fine, sub-angular to angular, greywacke.				D	N/A	200+						
0.5			Clayey SILT with trace sand; light brown occasional light grey mottles. Low plasticity; sand is fine.						200+						
			0.5 m - Becomes light brown.												
1.0			0.8 m - Encountered 10 mm layer of fine, sub-angular gravel limonite nodules.		59				200+						
		ML	1.2 m - Encountered 10 mm layer of fine, sub-angular gravel limonite nodules.					VSt - H	188/58						
1.5			1.3 m - Becomes light brown with occasional light grey mottles.				M		200+						
			1.8 m - Becomes with dark pink streaks.		58				200+						
2.0									200+						
			2.2 m - Encountered trace partially decomposed rootlets. Becomes light brown with white mottles.						188/78						
2.5		ML	SILT with some sand, trace gravel and clay; light brown with occasional white speckles. Low plasticity; sand is fine. Gravel is fine, sub-angular, limonite.					VSt	173/84						
			2.4 m - Becomes with minor sand; light brown with light pink mottles.		57										
3.0			End of Hole Depth: 3 m Termination Condition: Target depth						152/75						
3.5															
4.0															
4.5															
5.0															

Hand Auger met target depth at 3 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; F = Fill.



LOG OF AUGER HA04

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : JC
Reviewed By : HP
Latitude : -36.7492572
Longitude : 174.5794494

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer						
										Blows per 100mm						
										2	4	6	8	10	12	
	FILL	OL	[FORESTRY SLASH].					N/A								
0.5	UNDIFFERENTIATED TAKAANINI FORMATION	ML	Clayey SILT with trace sand; light grey with light to dark orange streaks and mottles. Low plasticity.		63		M		UTP							
										112/47						
1.0										114/60						
1.5								VSt		123/76						
2.0			142/82													
			142/79													
2.5		ML	Clayey SILT with minor sand; purplish grey with light orange streaks. Low plasticity; sand is fine. 2.2 m - Becomes brown orange with light to dark grey streaks. 2.35 m - Becomes purplish grey with occasional orange streaks.		62				H	UTP						
									142/98							
								VSt	152/82							
3.0	End of Hole Depth: 3 m Termination Condition: Target depth								159/98							
3.5																
4.0																
4.5																
5.0																

Hand Auger met target depth at 3 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; UTP = Unable to Penetrate.



LOG OF AUGER HA05

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : JC
Reviewed By : HP
Latitude : -36.7502638
Longitude : 174.5790201

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
0.5 															



Client	: Rangitootupuni Developments	Shear Vane No	: 2093
Client Ref.	: 20190.000.003	Logged By	: HM
Date	: 13-03-2025	Reviewed By	: HP
Hole Depth	: 5 m	Latitude	: -36.7499406
Hole Diameter	: 50 mm	Longitude	: 174.5803504

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	F	ML	[FILL] Clayey SILT with trace sand and rootlets; brown with grey and dark brown mottles. Low plasticity; sand is fine.					N/A							
0.5		ML	Clayey SILT with minor sand; light grey with light brown mottles. Low plasticity; sand is fine.		65			VSt	185/66						
1.0		ML							124/43						
1.5		CH	Silty CLAY with minor sand; light grey with occasional dark red, light brown and orange streaks. High plasticity; sand is fine.		64				137/58						
2.0		CH						St - VSt	145/64						
2.5		CH	2.5 m - Becomes with trace sand; light orange brown with occasional red and light grey streaks.		63		M		116/58						
3.0		ML	Clayey SILT with some sand; brown. Low plasticity; sand is fine. 3.1 m - Becomes bluish grey.		62				139/72						
3.5		ML	3.5 m - Becomes interbedded with: Sandy SILT with some clay; dark grey. Low plasticity; sand is fine. Beds are sub-horizontal, moderately thin to thin, moderately spaced.		61			VSt - H	110/52						
4.0		ML							71/40						
4.5		ML							113/64						
5.0		ML							118/58						
			End of Hole Depth: 5 m Termination Condition: Target depth						145/75						
									127/72						
									179/87						
									147/66						
									200+						
									200+						

N/A = Not Applicable; F = Fill.

GEOTECH HAND AUGER HA01 - 20.GPJ NZ DATA TEMPLATE 2.GDT 23/03/25



LOG OF AUGER HA07

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 11-03-2025
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 3230
Logged By : PM
Reviewed By : HP
Latitude : -36.7514437
Longitude : 174.5841465

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	TS	OL	[TOPSOIL].					N/A							
0.5		ML	Clayey SILT with trace sand; light orange brown with occasional light grey streaks. Low plasticity; sand is fine.		88		D	VSt	190/45						
1.0		CH	Silty CLAY with trace sand; light grey with orange mottles. High plasticity; sand is fine.					VSt	166/85						
1.5					87			H	208/56						
2.0		ML	Clayey SILT with some sand; light brown with light grey streaks. Low plasticity; sand is fine.				M	VSt - H	202/50						
2.5		ML	Sandy SILT with some clay; light orange with light grey streaks. Low plasticity. Low plasticity; sand is fine to medium. 2.3 m - Becomes light pink with orange and light grey streaks.		86			VSt	188/53						
3.0		ML	2.5 m - Becomes light grey with orange mottles and occasional pink streaks. Clayey SILT with some sand; light grey with orange and pink streaks. Low plasticity; sand is fine.					VSt	184/59						
			End of Hole Depth: 3 m Termination Condition: Target depth						177/56						
3.5															
4.0															
4.5															
5.0															

Hand Auger met target depth at 3 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; TS = Topsoil.



LOG OF AUGER HA08

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : HM
Reviewed By : HP
Latitude : -36.7477456
Longitude : 174.5822501

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remoulded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
0.5	FILL	ML	[FILL] SILT with minor sand; brown with orange brown and dark grey mottles. Non plastic; sand is fine. 0.2 m - Becomes brownish grey with white mottles. 0.5 m - Becomes with dark brown and dark grey mottles.				D	H	UTP						
1.0	UNDIFFERENTIATED TAKAANINI FORMATION	ML	Clayey SILT with trace sand; orange brown with white streaks. Low plasticity; sand is fine.		53				UTP						
1.5									200+						
2.0									200+						
2.5									200+						
3.0									200+						
3.5	UNDIFFERENTIATED TAKAANINI FORMATION	CH	2.0 m - Becomes with minor fine gravel; white, sub-rounded, siltstone. 2.05 m - Gravel ceases.		52			VSt - H	173/72						
4.0			2.4 m - Becomes with minor fine gravel; white, sub-rounded. 2.5 m - Gravel ceases. 2.7 m - Encountered trace fine limonite gravel.						182/61						
4.5									101/58						
5.0	ECBF	ML	Silty CLAY with trace sand; light grey with occasional light brown streaks. High plasticity; sand is fine.		51		M		118/72						
									90/58						
		ML	3.8 m - Becomes with occasional bluish grey streaks.		50			St - VSt	81/52						
		ML	Clayey SILT with minor sand; dark bluish grey with bluish grey streaks. Low plasticity; sand is fine.						75/46						
		ML	Sandy SILT with trace clay; grey. Low plasticity; sand is fine.		49			VSt - H	162/79						
								H	200+						
									UTP						
			End of Hole Depth: 5 m Termination Condition: Target depth												

Hand Auger met target depth at 5 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

UTP = Unable to Penetrate.
ECBF = East Coast Bays Formation.

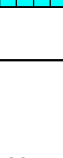


LOG OF AUGER HA09

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 11-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 3230
Logged By : PM
Reviewed By : HP
Latitude : -36.74883
Longitude : 174.5869041

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	TS	OL	[TOPSOIL].					N/A							
0.5		ML	Clayey SILT with minor sand; light brown with orange streaks and occasional black streaks. Low plasticity; sand is fine.		83			H	208+						
1.0			Clayey SILT with some sand; light grey with orange streaks. Low plasticity; sand is fine to medium.				D	VSt	154/15 138/15						
1.5		ML	1.6 m - 100 mm lens of SILT; light to dark orange. Low plasticity.		82			H	208+						
2.0			1.95 m - 50 mm lens of SILT; light to dark orange. Low plasticity.						122/27						
2.5			Sandy SILT with some clay; light grey with occasional orange and pink streaks. Low plasticity. Sand is fine to medium. 2.3 m - 50 mm lens of SILT; brown orange. Low plasticity.		81				131/28						
3.0			2.8 m - Becomes light to dark orange with light to dark pink streaks.						208+						
3.5							M		194/24						
4.0		ML			80			VSt - H	208+						
4.5			4.1 m - With some light grey streaks.						208+						
			4.4 m - 50 mm lens of SILT; brown orange. Low plasticity.		79				175/47						
									165/45						
5.0			End of Hole Depth: 5 m Termination Condition: Target depth												

Hand Auger met target depth at 5 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; TS = Topsoil.



LOG OF AUGER HA10

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 11-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 3230
Logged By : PM
Reviewed By : HP
Latitude : -36.7493099
Longitude : 174.585856

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	TS	OL	[TOPSOIL].					N/A							
0.5		CH	Silty CLAY; light brown with orange and light grey streaks. Low plasticity.				D	VSt	193/86						
1.0		ML	Sandy SILT with some clay; light brown with orange mottles and light grey streaks. Low plasticity; sand is fine to medium.		80			VSt	160/31						
1.5			Sandy SILT with some clay; light pink with light grey and orange streaks. Low plasticity; sand is fine to medium.						163/36						
2.0			Interbedded with						208+						
2.5			SILT with minor clay and trace sand; light to dark orange. Low plasticity. Beds are sub-horizontal, thin to moderately thin, moderately spaced.		79				177/42						
3.0					78		M	VSt - H	165/30						
3.5									82/37						
4.0									208+						
4.5									163/24						
5.0									137/42						
									172/45						
									180/50						
									145/39						
									208+						
									208+						
			End of Hole Depth: 5 m Termination Condition: Target depth		76										

Hand Auger met target depth at 5 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; TS = Topsoil.



LOG OF AUGER HA11

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : HM
Reviewed By : HP
Latitude : -36.7498995
Longitude : 174.5850466

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer															
										Blows per 100mm															
										2	4	6	8	10	12										
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0	F EAST COAST BAYS FORMATION	ML	[FILL] Clayey SILT with trace sand and rootlets; brown with gey and dark brown mottles. Low plasticity; sand is fine.		80			N/A	188/29																
		ML	SILT with some clay and trace sand; light greyish brown with light brown mottles. Low plasticity; sand is fine.					VSt																	
		ML	Clayey SILT with some sand; pink with light grey mottles. Low plasticity; sand is fine. 0.7 m - Becomes with orange mottles.					VSt - H																	
			1.2 m - Becomes with minor sand, and light brown with dark brown and light grey mottles.																						
			1.4 m - Becomes light pink with light grey and occasional light grey mottles.																						
			End of Hole Depth: 3 m Termination Condition: Target depth																						

Hand Auger met target depth at 3 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; F = Fill.



LOG OF AUGER HA12

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 12-03-2025
Hole Depth : 2.3 m
Hole Diameter : 50 mm

Shear Vane No : 3230
Logged By : PM
Reviewed By : HP
Latitude : -36.7476613
Longitude : 174.581721

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
0.5 															

Hand auger met practical refusal on hard material at 2.3 m depth.
Dip test showed standing water at 0.7 m depth post drilling.
Elevations and coordinates estimated from Auckland Council GeoMaps.

ECBF = East Coast Bays Formation.



LOG OF AUGER HA13

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : HM
Reviewed By : HP
Latitude : -36.7478273
Longitude : 174.584023

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remoulded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
		OL	[TOPSOIL].					N/A							
0.5			[FILL] Clayey SILT with trace sand; reddish brown with white streaks. Low plasticity; sand is fine.						98/23						
					53			St - VSt	142/40						
1.0									150/49						
		ML							95/32						
1.5								St	95/36						
			1.9 m - Becomes with minor fine sand.		52			VSt - H	173/52						
2.0									200+						
		ML	[FILL] Sandy SILT with minor organics and trace clays; dark grey with occasional light grey mottles. Low plasticity; sand is fine; organics are very decomposed woody debris. 2.6 m - Sand becomes fine to medium.				M	VSt - H	200+						
2.5					51				136/58						
3.0		CH	Silty CLAY some sand and trace organics; grey. High plasticity; sand is fine.					H	200+						
			Clayey SILT with trace sand; bluish grey. Low plasticity; sand is fine.						200+						
3.5									200+						
		ML			50			H	200+						
4.0									200+						
4.5									200+						
					49				200+						
5.0			End of Hole Depth: 5 m Termination Condition: Target depth												

Hand Auger met target depth at 5 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable.



Client	: Rangitootupuni Developments	Shear Vane No	: 2093
Client Ref.	: 20190.000.003	Logged By	: HM
Date	: 13-03-2025	Reviewed By	: HP
Hole Depth	: 5 m	Latitude	: -36.7496784
Hole Diameter	: 50 mm	Longitude	: 174.5848413

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer							
										Blows per 100mm							
										2	4	6	8	10	12		
	FILL	ML	[FILL] Clayey SILT with trace sand; light brown with light grey, dark brown and black mottles. Low plasticity; sand is fine.		76		D	N/A									
0.5	EAST COAST BAYS FORMATION	ML	Clayey SILT with trace sand; light brown. Low plasticity; sand is fine.		75		VSt - H		116/43								
									145/38								
1.0									156/64								
									145/49								
1.5								1.5 m - Becomes with fine to medium sand and light brown with light grey mottles.		200+							
2.0		ML	SILT with some sand and minor clay; light pink with occasional white and light brown speckles. Low plasticity; sand is fine.		74		M	VSt - H		200+							
									2.1 m - Becomes light brown with light grey mottles.		200+						
2.5									2.5 m - Becomes light pink with white mottles.		200+						
											173/61						
3.0									2.9 m - Becomes light brown with occasional light grey and light pink mottles.		173/55						
3.5							200+										
							200+										
4.0	ML	Sandy SILT with minor clay; brown with light grey mottles. Low plasticity; sand is fine to coarse.		72		VSt - H		200+									
							4.0 m - Becomes with light brown with light grey and brown mottles.		200+								
4.5	ML	Clayey SILT with minor sand; light brown with brown and light grey mottles.					VSt		173/78								
										173/90							
5.0	End of Hole Depth: 5 m Termination Condition: Target depth																

N/A = Not Applicable.



LOG OF AUGER HA15

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 12-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 3230
Logged By : PM
Reviewed By : HP
Latitude : -36.7477037
Longitude : 174.5806717

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remoulded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	T	OL	[TOPSOIL].					N/A							
0.5		CH	Silty CLAY with minor sand and trace rootlets; light grey with orange and white and brown streaks. High plasticity; sand is fine.		50			H	208+						
									208+						
1.0		ML	Clayey SILT with some sand; light grey with orange mottles and occasional grey specs. Low plasticity; sand is fine to medium.					H	208+						
					49			VSt	162/50						
1.5		CH	Silty CLAY; light purplish brown with light grey and orange streaks and occasional black staining. High plasticity.					St - VSt	95/49						
			Silty CLAY; light grey with orange mottles. High plasticity. 1.7 m - Becomes light grey with occasional orange streaks.						116/55						
2.0									110/30						
2.5		CH	2.2 m - 25 mm lens of fine to coarse SAND; light grey.		48		M	St - VSt	107/59						
									88/50						
3.0		CH	2.9 m - 50 mm lens of fine to coarse SAND; light brown with orange mottles and occasional light grey streaks.		47				71/45						
									74/43						
3.5									119/37						
4.0		ML	Clayey SILT with some organics; light brown. Low plasticity; organics are carbonaceous inclusions (2 - 10 mm). 3.8 m - 100 mm lens of organic SILT; black. Low plasticity.						145/45						
									147/39						
4.5			4.15 m - Encountered minor partially decomposed wood fragments (5 - 10 mm). 4.3 m - 150 mm lens of organic SILT; black. Low plasticity.		46			VSt	131/55						
									92/56						
5.0		OL	Organic SILT; black. Low plasticity.					St							
			End of Hole Depth: 5 m Termination Condition: Target depth												

Hand Auger met target depth at 5 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; T = Topsoil.



LOG OF AUGER HA16

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 12-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 3230
Logged By : PM
Reviewed By : HP
Latitude : -36.7470806
Longitude : 174.5794576

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	T	OL	[TOPSOIL].					N/A							
		ML	Clayey SILT; orange brown with orange streaks. Low plasticity.					VSt	145/27						
0.5			Silty CLAY; orange brown with occasional light grey and orange streaks. High plasticity.					St - VSt	101/30						
1.0					50				91/37						
1.5			1.1 m - Becomes white grey with occasional red and orange streaks.						110/45						
2.0		CH							144/53						
2.5									138/74						
3.0			2.5 m - Encountered 15 mm lens with some fine to coarse sand.		49		M	VSt	134/52						
3.5									154/86						
4.0			2.9 m - Becomes light orange brown with light brown mottles and orange and light grey streaks.						110/64						
4.5					48			St	71/46						
		ML	Clayey SILT with trace organics; brown with occasional light grey streaks. Organics are black carbonaceous inclusions (2 - 10 mm).						50/31						
									107/68						
			3.9 m - Becomes grey with occasional light grey streaks.					VSt	125/71						
					47				180/58						
		ML	Sandy SILT with some clay and trace organics; greyish brown with occasional orange specs and black staining. Low plasticity; sand is fine to coarse. Organics are partially decomposed wood fragments (5 - 10 mm).						208+						
								H	208+						
5.0			End of Hole Depth: 5 m Termination Condition: Target depth		46										

Hand Auger met target depth at 5 m.
Dip test showed standing water at 5 m depth post drilling.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; T = Topsoil.



LOG OF AUGER HA17

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : JC
Reviewed By : HP
Latitude : -36.7491935
Longitude : 174.5804682

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	TS	OL	[TOPSOIL].					N/A							
0.5			Clayey SILT with minor sand; brown orange with light to dark grey streaks and mottles. Low plasticity; sand is fine to medium.					H	205/111						
1.0					66				155/54						
1.5									137/73						
2.0			1.7 m - Becomes light grey with light to dark orange streaks and mottles.						114/65						
2.5									117/62						
3.0			2.3 m - Becomes with dark red mottles.		65			Vst	134/63						
3.5									142/77						
4.0									148/79						
4.5									148/85						
5.0			3.6 m - Becomes light orange with light grey streaks.		64				136/66						
									141/65						
									142/66						
			4.2 m - Encountered a light purple streak.		63			H	202/98						
									148/76						
									177/98						
									174/93						
			End of Hole Depth: 5 m Termination Condition: Target depth		62										

Hand Auger met target depth at 5 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable; TS = Topsoil.



LOG OF AUGER HA18

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : HM
Reviewed By : HP
Latitude : -36.7456766
Longitude : 174.5792822

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
	FILL	ML	[FILL] SILT with minor sand and trace gravel; brown. Low plasticity; sand is fine. Gravel is fine, sub-angular to angular, greywacke.					VSt	176/36						
0.5			Clayey SILT with trace sand; light brownish grey with occasional orange streaks. Low plasticity. Sand is fine.		44				142/17						
1.0		ML	0.9 m - With minor fine sand and trace rootlets, and becomes light grey with occasional light brown mottles.					VSt - H	200+						
1.5					43				200+						
		ML	SILT with trace clay; light grey. Low plasticity.					H	200+						
2.0		ML	Clayey SILT with minor sand and trace gravel; light grey with occasional light brown and light pink streaks. Low plasticity; sand is fine. Gravel is fine, sub-rounded, sedimentary.					VSt	133/87						
2.5			Silty CLAY with minor sand; light pink with dark pink and white streaks. High plasticity; sand is fine to medium.		42		M		173/87						
3.0		CH						VSt	118/75						
									136/75						
3.5			3.3 m - With minor fine sand, and becomes light orange brown with occasional light orange and brown streaks.		41				137/87						
		ML	Clayey SILT with minor sand; light brown with with light orange streaks. Low plasticity; sand is fine.					VSt	130/79						
4.0									200+						
4.5		ML	Sandy SILT with trace clay; light pink with light grey mottles. Low plasticity; sand is fine.		40			VSt - H	173/65						
									171/66						
5.0									173/66						
			End of Hole Depth: 5 m Termination Condition: Target depth												

Hand Auger met target depth at 5 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.



LOG OF AUGER HA19

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitooopuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 1.5 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : JC
Reviewed By : HP
Latitude : -36.7449452
Longitude : 174.5788147

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
										Blows per 100mm					
										2	4	6	8	10	12
0.5	FILL	ML	[FILL] SILT with some sand, clay, cobbles and gravel; intermixed light to dark brown and grey. Low plasticity; sand is fine to coarse. Gravel is fine to coarse, sub-angular, greywacke.		37			H	101/53						
			0.5 m - 200 mm possible void.					N/A							
1.0								VSt							
1.5			End of Hole Depth: 1.5 m Termination Condition: Practical refusal												>>
2.0															
2.5															
3.0															
3.5															
4.0															
4.5															
5.0															

Hand auger met practical refusal on hard material at 1.5 m depth.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.

N/A = Not Applicable.

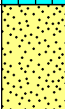


LOG OF AUGER HA20

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.003

Client : Rangitootuni Developments
Client Ref. : 20190.000.003
Date : 13-03-2025
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : JC
Reviewed By : HP
Latitude : -36.7441534
Longitude : 174.5787814

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer						
										Blows per 100mm						
										2	4	6	8	10	12	
0.5	FILL	ML	[FILL] SILT with some sand, clay, gravel and minor rootlets; light to dark brown. Low plasticity; sand is fine to coarse.		38			VSt	147/19							
1.0	UNDIFFERENTIATED TAKAANINI FORMATION	ML	Sandy SILT with some clay; orange brown with light to dark orange mottles. Low plasticity; sand is fine to coarse.						221+							
1.5		ML	1.5 m - With minor clay and fine, light grey crushable silt clasts, and becomes light grey with light to dark orange mottles.		37		M	VSt - H	177/35							
2.0																
2.5		SP	Silty fine to coarse SAND with minor gravel; light to dark orange with light grey streaks. Poorly graded.		36			MD								
3.0		ML	Sandy SILT with minor gravel; light grey with occasional light to dark orange streaks and mottles. Low plasticity; sand is fine to coarse. Gravel is fine crushable silt clasts; light grey.					VSt								
			End of Hole Depth: 3 m Termination Condition: Target depth													
3.5																
4.0																
4.5																
5.0																

Hand Auger met target depth at 3 m.
Standing groundwater was not encountered.
Elevations and coordinates estimated from Auckland Council GeoMaps.



BOREHOLE LOG MBH01

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 03-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 42 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7505189
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5843713

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
F	[FILL] Clayey SILT with some organics; dark brown. Low plasticity. Organics are wood fragments.		N/A					25 50 75	25 50 75				
	Clayey SILT with trace sand; light grey with pink and orange mottles. Low plasticity. 0.4 - 0.6 m - With pink streaks and minor fine to medium sand.		St										
1	1.1 - 1.5 m - No recovery.	NR	N/A	1 85		66/26 kPa							
	Clayey SILT with some sand; light grey with pink and orange mottles. Low plasticity. Sand is fine to coarse.		St			1/1/1/1/2/2 N=6							
2	1.6 - 1.7 m - Becomes orange.	NR	N/A	2 84									
	1.8 - 1.95 m - No recovery.												
	Sandy SILT with trace clay; pinkish light grey. Low plasticity. Sand is fine to medium.		St										
3				3 83		0/1/1/1/2/2 N=6							
	Clayey SILT with minor sand; light grey with orange mottles. Low plasticity. Sand is fine to medium.		St										
4	3.75 - 4.1 m - With some fine to coarse sand.			4 82									
	4.1 m - With minor fine to medium sand and becomes light grey with pink and orange streaks.	NR	N/A										
	4.2 - 4.5 m - No recovery.												
5	Sandy SILT with trace clay; orange with occasional light grey and pink mottles. Low plasticity. Sand is fine to coarse.		St	5 81		0/1/1/2/1/2 N=6							

Machine borehole met target depth at 42 m bgl

Dip test showed standing groundwater at 1.5 m [04/03/2025 15:00]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

F = Fill



BOREHOLE LOG MBH01

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 03-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 42 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7505189
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5843713

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Sandy SILT with trace clay; orange with occasional light grey and pink mottles. Low plasticity. Sand is fine to coarse.		St				25 50 75	25 50 75				
6	5.85 - 6 m - No recovery.	NR	N/A	6 80								
	Silty CLAY; light grey with pink and orange streaks. High plasticity.				0/2/2/1/3/3 N=9							
	6.8 - 6.95 m - With minor fine to medium sand.		VSt	7 79								
	Sandy SILT; orange with occasional dark orange staining. Low plasticity. Sand is fine to medium.				144/44 kPa 1/2/2/2/4/3 N=11							
	8.5 m - With light grey streaks and inclusions of silty CLAY (20 mm diameter).		VSt	8 78								
	Silty CLAY with trace sand; light grey with pink streaks. High plasticity.		VSt	9 77	1/2/2/2/3/3 N=10							
	Clayey SILT with some sand; orange with light grey mottles. Low plasticity.		VSt									
	Sandy SILT with trace clay; light pink with occasional light grey specks. Low plasticity. Sand is fine to coarse.			10 76								
	Interbedded with Silty CLAY; light grey with pink and orange streaks. High plasticity. Beds are sub-horizontal to gently inclined, moderately thin to moderately thick, moderately widely spaced.		VSt		1/1/2/2/2/1 N=7							

Machine borehole met target depth at 42 m bgl

Dip test showed standing groundwater at 1.5 m [04/03/2025 15:00]

Coordaintes and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

F = Fill



BOREHOLE LOG MBH01

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 03-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 42 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7505189
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5843713

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
1.1	Sandy SILT with trace clay; light pink with occasional light grey specks. Low plasticity. Sand is fine to coarse.			11 75	1/1/2/2/2/1 N=7	×	25 50 75	25 50 75				
	Interbedded with											
	Silty CLAY; light grey with pink and orange streaks. High plasticity. Beds are sub-horizontal to gently inclined, moderately thin to moderately thick, moderately widely spaced.		VSt									
1.2				12 74	1/2/1/3/3/3 N=10	×						
	Clayey SILT; light grey with pink and orange streaks. Low plasticity.											
	Interbedded with											
1.3	Sandy SILT; light pink. Low plasticity. Sand is fine to coarse. Beds are moderately inclined, thin, closely spaced.		VSt	13 73								
	Sandy SILT with trace clay; pink with occasional light grey specks. Low plasticity. Sand is fine to coarse.				144/44 kPa 1/2/2/2/2/3 N=9	×						
	Interbedded with											
1.4	Clayey SILT; light grey with pink streaks. Low plasticity. Beds are gently inclined, thin to moderately thin, moderately widely spaced.			14 72								
			VSt									
1.5				15 71	2/2/3/3/4/4 N=14	×						
1.6	16 - 16.2 m - Sandy SILT becomes grey.			16 70								

Machine borehole met target depth at 42 m bgl

Dip test showed standing groundwater at 1.5 m [04/03/2025 15:00]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

F = Fill



BOREHOLE LOG MBH01

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 03-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 42 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7505189
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5843713

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Sandy SILT; light orange and dark reddish orange. Low plasticity. Sand is fine to coarse.						25 50 75	25 50 75				
22	Interbedded with			22 64								
	Clayey SILT; grey. Low plasticity. Beds are sub-horizontal to gently inclined, very thin, very closely spaced.											
	22.65 m - Becomes light grey and clayey SILT beds become moderately thick to thick, moderately widely spaced.			23 63	3/4//5/6/7/8 N=26							
23												
	23.7 - 24 m -With dark orange and light orange brown staining.											
24	24 m - Becomes grey with orange and light brownish grey streaks.		VSt - H	24 62	4/3//4/6/7/8 N=25					M		
25	25.35 - 25.5 m - Becomes light pinkish grey.			25 61								
					3/4//4/6/6/7 N=23							
26				26 60								
	Silty fine to coarse SAND; pinkish orange. Well graded.											
	26.6 m - Becomes light greyish brown.		MD									
27				27 59								

Machine borehole met target depth at 42 m bgl
Dip test showed standing groundwater at 1.5 m [04/03/2025 15:00]
Coordaintes and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.
N/A = Not Assessed; NR = No Recovery
F = Fill



BOREHOLE LOG MBH01

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 03-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 42 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7505189
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5843713

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Sandy SILT with trace clay; orange with dark orange staining. Low plasticity. Sand is fine to coarse. 27.25 - 27.35 m - Encountered trace fine, rounded limonite gravel.		H			3/4//6/7/10/10 N=33		25 50 75	25 50 75				
	Sandy SILT; light brownish grey. Low plasticity. Sand is fine to coarse. Interbedded with Clayey SILT; grey with dark grey streaks. Low plasticity. Beds are gently inclined to moderately inclined, moderately thin, moderately widely spaced. 28.5 - 28.7 m -With occasional orange staining.		H	28 58									
	29.75 - 29.8 m -Encountered lens of dark brown, fine SAND.		H	29 57									
	Clayey SILT; dark grey. Low plasticity.		H	30 56									
	30.5 m - Becomes light grey with dark grey streaks.		H										
	30.9 m - With orange streaks and staining.		H	31 55									
	Silty fine to medium SAND; orange. Well graded.		N/A										
	Clayey SILT; dark grey. Low plasticity. (Completely weathered SILTSTONE; extremely weak.) Interbedded with Silty fine to medium SAND; light and dark orange. Well graded. Beds are gently inclined, moderately thin, moderately widely spaced. 31.8 m - With gently inclined orange bands		H	32 54									

Machine borehole met target depth at 42 m bgl

Dip test showed standing groundwater at 1.5 m [04/03/2025 15:00]

Coordaintes and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

F = Fill



BOREHOLE LOG MBH01

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 03-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 42 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7505189
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5843713

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	and sand beds become laminated to very thin.						25 50 75	25 50 75				
	32.8 - 33 m - No recovery.		H	33 53						M		
	Silty fine to coarse SAND; dark orange and light orange brown. Well graded. (Completely weathered SANDSTONE; extremely weak.).											
	Interbedded with											
	Highly weathered, dark grey with moderately inclined, laminated to very thin orange bands and staining SILTSTONE; very weak. Beds are gently to moderately inclined, very thin to thin, extremely closely spaced to closely spaced, Fe staining along bedding contacts.		VD	34 52								
	Highly weathered, dark grey with gently inclined, laminated to very thin orange bands and staining SILTSTONE; very weak.		VW	35 51					35.27-35.37 m: Drilling induced bedding partings; gently inclined, extremely closely spaced to very closely spaced	N/A		
	35.5 m - With gently inclined, very thin, extremely closely spaced to very closely spaced beds of light brownish grey, fine SAND.		D						35.45-35.97 m: Drilling induced bedding partings; closely spaced.			
	Silty fine to coarse SAND; light brownish grey. Well graded. (Completely weathered SANDSTONE; extremely weak.)			36 50					36.16 m: Bedding parting with Fe staining			
	Silty fine to coarse SAND; light brownish grey with orange staining. Well graded. (Completely weathered SANDSTONE; extremely weak.)											
	Interbedded with											
	Highly weathered, dark grey SILTSTONE; very weak. Beds are gently inclined, very thin to thin, very closely spaced to closely spaced, Fe staining along bedding contacts.		VW	37 49					36.5-36.9 m: Drilling induced bedding partings; closely spaced.			
	36.85 m - Sandstone beds become orange with dark orange staining.								36.7 m: Drilling induced bedding parting			
	37.2 - 37.5 m - No recovery.								36.9 m: Joint; gently inclined, stepped, planar, smooth, Fe staining			

Machine borehole met target depth at 42 m bgl

Dip test showed standing groundwater at 1.5 m [04/03/2025 15:00]

Coordaintes and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

F = Fill



Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client :	Rangitootpuni Developments	Core Diameter :	64 mm
Date :	03-03-2025	Energy Transfer Ratio :	97.1%
Hole Depth :	42 m	Logged By/Reviewed By :	JM / HP
Drilling Method :	Mud Rotary	Latitude :	-36.7505189
Drilling Contractor :	McMillan Drilling Group Ltd	Longitude :	174.5843713

[illegible]

End of Hole Depth: 42 m
Termination: met target depth

Machine borehole met target depth at 42 m bgl	Strengths inferred from shear vane, SPT and tactile assessment.
Dip test showed standing groundwater at 1.5 m [04/03/2025 15:00]	N/A = Not Assessed; NR = No Recovery
Coordaintes and elevation estimated using Auckland Council GeoMaps.	F = Fill



BOREHOLE LOG MBH02

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 21-02-2025 Energy Transfer Ratio : 93.9%
Hole Depth : 25.8 m Logged By/Reviewed By : JS / HP
Drilling Method : Mud Rotary Latitude : -36.7466927
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5791481

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	0 - 0.7 m: No Recovery (Inferred as below).	NR	N/A				25 50 75	25 50 75				
FILL	[FILL] Organic clayey SILT with minor roots and trace gravel; dark brown. Low plasticity; gravel is fine to medium, sub-angular to angular greywacke.	F-St		1 50						N/A		
	[FILL] Clayey SILT with trace sand; brownish orange with grey streaks. Low plasticity; sand is fine to medium.	St								M		
EAST COAST BAYS FORMATION	Silty CLAY with trace sand; light grey with orange and dark pink streaks High plasticity; sand is fine.				75/34 kPa 1.1/1.1.2.2 N=6							
	1.95-2.30: No Recovery.	St		2 49						N/A		
	2.5 m: With minor fine to medium sand.											
	Clayey SILT with minor sand; light grey with dark pink and orange streaks. Low plasticity; sand is fine to medium.			3 48	118/47 kPa 1.1/1.1.2.2 N=6					M		
	3.45-3.70 m: With occasional dark brownish orange streaks (limonite staining).	VSt										
	4.1 m: Lens of silty fine to coarse SAND with trace gravel; grey with white specks. Well graded; gravel is fine, sub-rounded hard siltstone clasts.	NR	N/A	4 47						N/A		
	4.15-4.50 m: No Recovery.											
	Silty CLAY; orange with pink and light grey streaks. High plasticity.				0.0/0.1.1.1 N=3							
	4.85-4.95 m: Lens of clayey SILT with minor sand; light grey. Low plasticity; sand is fine to medium.	St		5 46						M		

Machine borehole met target depth at 25.8 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 8.8 m depth on 18/02/2025 at 0800hrs.

N/A = Not Applicable; NR = No Recovery; F = Fill.

Coordinates and Elevation estimated using Auckland Council GeoMaps.

AC = Albany Conglomerate



BOREHOLE LOG MBH02

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 21-02-2025 Energy Transfer Ratio : 93.9%
Hole Depth : 25.8 m Logged By/Reviewed By : JS / HP
Drilling Method : Mud Rotary Latitude : -36.7466927
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5791481

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Clayey SILT with minor sand; light grey with orange and pink streaks. Low plasticity; sand is fine to medium.						25 50 75	25 50 75				
	6.05 m: With some fine to medium sand.		VSt	6 45	0.1/2.1.2.2 N=7							
AC	Sandy SILT with trace clay and gravel; bluish grey with white specks and black carbonaceous inclusions. Low plasticity; sand is fine to coarse; gravel is fine to medium, rounded to sub-rounded hard siltstone clasts. Chaotic fabric with discontinuous lenses of silty clay.		VSt	7 44								
	Clayey SILT with minor sand; grey with dark orange streaks. Low plasticity; sand is fine.											
	7.4 m: With some fine to coarse sand. Becomes dark orange.				1.0/2.3.3.4 N=12							
	7.95 m: With minor fine to medium sand.		VSt - H	8 43							M	
	8.30-8.35 m: With trace fine, sub-angular hard limonite concretions and dark brownish orange staining.											
	Silty fine to coarse SAND with trace clay; dark grey with dark orange staining. Well graded.		MD	9 42	2.2/4.4.5.6 N=19							
	Sandy SILT with minor clay; dark grey. Low plasticity; sand is fine to medium.											
			H	10 41								
	Silty fine to coarse SAND with trace clay; dark grey. Well graded.		MD		2.3/3.3.4.5 N=15							

Machine borehole met target depth at 25.8 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 8.8 m depth on 18/02/2025 at 0800hrs.

N/A = Not Applicable; NR = No Recovery; F = Fill.

Coordinates and Elevation estimated using Auckland Council GeoMaps.

AC = Albany Conglomerate



BOREHOLE LOG MBH02

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 21-02-2025 Energy Transfer Ratio : 93.9%
Hole Depth : 25.8 m Logged By/Reviewed By : JS / HP
Drilling Method : Mud Rotary Latitude : -36.7466927
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5791481

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
11	Silty fine to coarse SAND with trace clay; dark grey. Well graded.		MD	11 40	2.3/3.3.4.5 N=15		25 50 75	25 50 75				
12	Clayey SILT; dark grey. Low plasticity. Interbedded with: Sandy SILT with minor clay; dark grey. Low plasticity; sand is fine to medium. Beds are sub-horizontal to gently inclined, thin, very closely spaced to closely spaced.		H									
13	Silty fine to coarse SAND with trace clay; dark grey with occasional white specks. Well graded.		MD	12 39	3.4/4.5.5.5 N=19							
14	12.9 m: With trace fine, sub-rounded to sub-angular hard sedimentary clasts. 13.2 m: Sand becomes fine to medium. 13.35-13.40 m: With black carbonaceous laminations and specks.		MD	13 38								
15	Silty fine to medium SAND with trace clay; dark grey with black carbonaceous laminations and specks. Poorly graded. Beds are sub-horizontal, moderately thin to moderately thick.		D	14 37	5.6/8.8.10.12 N=38						M	
16	Interbedded with: Clayey SILT; dark grey. Low plasticity. Beds are sub-horizontal, thin to moderately thin. Clayey SILT; dark grey. Low plasticity.		H									
17	Interbedded with: Sandy SILT with minor clay; dark grey. Low plasticity; sand is fine to medium. Beds are sub-horizontal, very thin, very closely spaced.		MD	15 36	4.4/5.5.5.9 N=24							
18	Silty fine to coarse SAND; dark grey with occasional white specks. Well graded.		MD									
19	15.85 m: Sand becomes fine to medium. White specks cease. 15.90-15.95 m: Lens of clayey SILT; dark grey. Low plasticity.			16 35								

Machine borehole met target depth at 25.8 m bgl.

Dip test showed standing water at 8.8 m depth on 18/02/2025 at 0800hrs.

Coordinates and Elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Applicable; NR = No Recovery; F = Fill.

AC = Albany Conglomerate



BOREHOLE LOG MBH02

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 21-02-2025 Energy Transfer Ratio : 93.9%
Hole Depth : 25.8 m Logged By/Reviewed By : JS / HP
Drilling Method : Mud Rotary Latitude : -36.7466927
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5791481

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
EAST COAST BAYS FORMATION	Silty fine to coarse SAND with trace clay; dark grey. Well graded. Interbedded with: Clayey SILT; dark grey. Low plasticity. [Highly weathered, dark grey SILTSTONE; extremely weak.] Beds are sub-horizontal, thin to moderately thin, closely spaced to moderately widely spaced.		D - VD	22 29	8.4/14.14.16.6 for 35 mm N=50+		25 50 75	25 50 75		M		
	Moderately weathered, dark grey, fine to coarse SANDSTONE with occasional black carbonaceous laminations; very weak. Interbedded with: Slightly weathered, dark grey SILTSTONE; very weak. Beds are sub-horizontal to gently inclined, thin to moderately thin, closely spaced to moderately widely spaced.			23 28								
				24 27								
			VW	25 26	4.4/11.19.20 for 58 mm N=50+				23.25 m: Gently-inclined bedding parting; undulating, smooth, narrow. 23.35 m: Sub-horizontal joint; stepped, smooth, moderately narrow.	N/A		
					9.23/37.13 for 35 mm N=50+				24.9 m: Gently-inclined joint; undulating, rough, narrow. 25 m: Gently-inclined bedding parting; undulating, smooth, narrow.			

End of Hole Depth: 25.8 m
Termination: met target depth

Machine borehole met target depth at 25.8 m bgl.

Dip test showed standing water at 8.8 m depth on 18/02/2025 at 0800hrs.

Coordinates and Elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Applicable; NR = No Recovery; F = Fill.

AC = Albany Conglomerate



BOREHOLE LOG MBH03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Development
Date : 21-02-2025
Hole Depth : 37.5 m
Drilling Method : Mud Rotary
Drilling Contractor : McMillan Drilling Group Ltd
Core Diameter : 64 mm
Energy Transfer Ratio :
Logged By/Reviewed By : JS / HP
Latitude : -36.7497249
Longitude : 174.5795821

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
FILL	0.00-0.75 m: No Recovery (Inferred washout of gravelly material).	NR	N/A					25/50/75	25/50/75				
	[FILL] Silty CLAY with trace gravel; light orange-brown with dark orange mottles. High plasticity; gravel is fine, sub-angular greywacke.		VSt	62							N/A		
EAST COAST BAYS FORMATION	Silty CLAY; light grey with orange and dark pink streaks. High plasticity. Beds are sub-horizontal, moderately thin.			1							M		
	Interbedded with:												
	Clayey SILT with minor sand; light brownish orange. Low plasticity; sand is fine to medium. Beds are sub-horizontal, very thin to thin.		F - St	61		2.2/2.2.2.1 N=7					N/A		
	1.50-1.95 m: No Recovery.			2									
	Clayey SILT with some sand; light grey with orange mottles. Low plasticity; sand is fine to medium.		St	60									
	Silty CLAY with minor sand; light grey with orange streaks. High plasticity; sand is fine to medium.			3									
	3.0 m: Becomes light grey with pink streaks.		VSt			0.1/1.1.1.1 N=4							
	Clayey SILT with minor sand; light grey with orange and pink streaks. Low plasticity; sand is fine to medium.		VSt	59							M		
	Silty CLAY trace sand; light grey with orange and pink streaks. High plasticity; sand is fine to medium.		VSt	4									
	4.4 m: With minor fine to medium sand.												
	Clayey SILT with minor sand; light grey with pink and orange streaks. Low plasticity; sand is fine to medium.			58		0.0/1.1.1.2 N=5							
	4.95-5.10 m: Lens of silty CLAY; light grey with pink streaks. High plasticity.		VSt	5									

Machine borehole met target depth at 37.5 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 4.35 m depth on 20/02/2025 at 0800hrs. Coordinates and Elevation estimated using Auckland Council GeoMaps.

N/A = Not Applicable; NR = No Recovery; F = Fill.



BOREHOLE LOG MBH03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Development
Date : 21-02-2025
Hole Depth : 37.5 m
Drilling Method : Mud Rotary
Drilling Contractor : McMillan Drilling Group Ltd
Core Diameter : 64 mm
Energy Transfer Ratio :
Logged By/Reviewed By : JS / HP
Latitude : -36.7497249
Longitude : 174.5795821

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Clayey SILT with minor sand; light grey with pink and orange streaks. Low plasticity; sand is fine to medium. 5.5 m: With some fine to medium sand. Becomes orange with light grey streaks.	VSt		57				25	50	75			
	Clayey SILT; dark grey. Low plasticity. Beds are sub-horizontal; moderately thin to moderately thick.			6		0.1/1.1.2.2.2 N=6							
	Intebbed with:												
	Silty fine to coarse SAND with trace clay; dark grey. Well graded. Beds are sub-horizontal; thin to moderately thin.			56									
				7									
				55		0.1/1.2.2.2.2 N=7							
				8									
		VSt - H		54									
				9		0.1/2.2.2.3 N=9							
	9.45-9.80 m: No Recovery.			53									
				10									
						1.1/1.2.3.2 N=8							
				52									

Machine borehole met target depth at 37.5 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 4.35 m depth on 20/02/2025 at 0800hrs. Coordinates and Elevation estimated using Auckland Council GeoMaps.

N/A = Not Applicable; NR = No Recovery; F = Fill.



BOREHOLE LOG MBH03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Development
Date : 21-02-2025
Hole Depth : 37.5 m
Drilling Method : Mud Rotary
Drilling Contractor : McMillan Drilling Group Ltd
Core Diameter : 64 mm
Energy Transfer Ratio :
Logged By/Reviewed By : JS / HP
Latitude : -36.7497249
Longitude : 174.5795821

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
1.1	Clayey SILT; dark grey. Low plasticity. Beds are sub-horizontal; moderately thin to moderately thick. Intebedded with: Silty fine to coarse SAND with trace clay; dark grey. Well graded. Beds are sub-horizontal; thin to moderately thin.			11		1.1/1.2.3.2 N=8	×	255075	255075				
1.2	Sandy SILT with minor clay; dark grey. Low plasticity; sand is fine to medium. Beds are sub-horizontal, moderately thin to moderately thick. Interbedded with: Clayey SILT with trace sand; dark grey. Low plasticity; sand is fine. Beds are sub-horizontal, thin to moderately thin		VSt - H	51		0.2/2.2.3.2 N=9	×						
1.3			H	13		1.2/2.2.2.3 N=9	×					M	
1.4				14									
1.5				15		0.2/2.1.2.3 N=8	×						
1.6	Silty fine to coarse SAND with trace clay; dark grey. Well graded.		L	16									
			H	47									

Machine borehole met target depth at 37.5 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 4.35 m depth on 20/02/2025 at 0800hrs. Coordinates and Elevation estimated using Auckland Council GeoMaps.

N/A = Not Applicable; NR = No Recovery; F = Fill.



BOREHOLE LOG MBH03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Development
Date : 21-02-2025
Hole Depth : 37.5 m
Drilling Method : Mud Rotary
Drilling Contractor : McMillan Drilling Group Ltd
Core Diameter : 64 mm
Energy Transfer Ratio :
Logged By/Reviewed By : JS / HP
Latitude : -36.7497249
Longitude : 174.5795821

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
17	Clayey SILT; dark grey. Low plasticity. Beds are sub-horizontal, moderately thin to moderately thick. Interbedded with: Sandy SILT with some clay; dark grey. Low plasticity; sand is fine to medium. Beds are sub-horizontal, very thin to thin. 17.3 m: With black carbonaceous lamination.		H	46	0.3/3.3.3.4 N=13			25	50				
18	Clayey SILT; dark grey with occasional black carbonaceous laminations. Low plasticity. Beds are sub-horizontal, thin to moderately thin. Interbedded with: Silty fine to coarse SAND with trace clay; dark grey. Well graded. Beds are sub-horizontal, thin to moderately thin.		H	45	2.2/3.3.3.5 N=14			25	50		M		
19	Silty fine to coarse SAND; dark grey. Well graded. Beds are sub-horizontal to gently inclined, moderately thin to moderately thick. Interbedded with: Clayey SILT; dark grey. Low plasticity. Beds are sub-horizontal to gently inclined, very thin to thin. 19.50-19.95 m: No Recovery.		MD	43	1.1/3.3.4.4 N=14						N/A		
20				42	2.3/4.4.5.5 N=18						M		
21													

Machine borehole met target depth at 37.5 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 4.35 m depth on 20/02/2025 at 0800hrs. Coordinates and Elevation estimated using Auckland Council GeoMaps.

N/A = Not Applicable; NR = No Recovery; F = Fill.



BOREHOLE LOG MBH03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Development
Date : 21-02-2025
Core Diameter : 64 mm
Energy Transfer Ratio :
Hole Depth : 37.5 m
Logged By/Reviewed By : JS / HP
Drilling Method : Mud Rotary
Latitude : -36.7497249
Drilling Contractor : McMillan Drilling Group Ltd
Longitude : 174.5795821

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
22	Silty fine to coarse SAND; dark grey. Well graded. Beds are sub-horizontal to gently inclined, moderately thin to moderately thick.			41				25	50	75			
	Interbedded with:			22									
	Clayey SILT; dark grey. Low plasticity. Beds are sub-horizontal to gently inclined, very thin to thin.												
23				40		2.3/3.4.4.6 N=17							
				23									
24				39									
			MD	24		3.4/4.4.5.5 N=18						M	
				38									
25				25									
	25.40-25.45: With black carbonaceous laminations and specks.			37		4.5/5.6.7.7 N=25							
26				26									
	26.5 m: With black carbonaceous laminations and specks.												
	Silty fine to coarse SAND with trace clay; dark grey with occasional black carbonaceous specks. Well graded.		MD	36									
27				27									

Machine borehole met target depth at 37.5 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 4.35 m depth on 20/02/2025 at 0800hrs. Coordinates and Elevation estimated using Auckland Council GeoMaps.

N/A = Not Applicable; NR = No Recovery; F = Fill.



BOREHOLE LOG MBH03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Development
Date : 21-02-2025
Hole Depth : 37.5 m
Drilling Method : Mud Rotary
Drilling Contractor : McMillan Drilling Group Ltd
Core Diameter : 64 mm
Energy Transfer Ratio :
Logged By/Reviewed By : JS / HP
Latitude : -36.7497249
Longitude : 174.5795821

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Silty fine to coarse SAND with trace clay; dark grey with occasional black carbonaceous specks. Well graded.		MD	35	3.2/3.5.6.6 N=20		255075	255075				
28	Sandy SILT with trace clay; dark grey. Low plasticity; sand is fine to medium. Beds are sub-horizontal, moderately thin.		MD	28								
	Interbedded with:											
	Clayey SILT with trace sand; dark grey with occasional black carbonaceous laminations. Low plasticity; sand is fine. Beds are sub-horizontal, very thin to thin.			34	4.3/5.3.4.4 N=16							
29	Silty fine to coarse SAND with trace clay; dark grey. Well graded.			29								
	29.25-29.55 m: With trace fine, sub-rounded to sub-angular hard sedimentary clasts.			33						M		
30			MD	30	3.3/4.4.6.6 N=20							
31				31								
32				32	3.4/3.4.5.5 N=17							

Machine borehole met target depth at 37.5 m bgl.

Strengths inferred from shear vane, SPT and tactile assessment.

Dip test showed standing water at 4.35 m depth on 20/02/2025 at 0800hrs. Coordinates and Elevation estimated using Auckland Council GeoMaps.

N/A = Not Applicable; NR = No Recovery; F = Fill.



BOREHOLE LOG MBH03

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Development
Date : 21-02-2025
Core Diameter : 64 mm
Energy Transfer Ratio :
Hole Depth : 37.5 m
Logged By/Reviewed By : JS / HP
Drilling Method : Mud Rotary
Latitude : -36.7497249
Drilling Contractor : McMillan Drilling Group Ltd
Longitude : 174.5795821

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Silty fine to coarse SAND with trace clay; dark grey. Well graded.			30				25	50	75			
33	33.15-33.2 m: With black carbonaceous specks.			33									
34				29									
				34									
			MD	28									
35				35							M		
36	35.6-35.9 m: With trace fine, sub-rounded to sub-angular hard sedimentary clasts.			27									
37	Silty fine to coarse SAND; dark grey. Well graded. [Highly weathered, dark grey, fine to coarse SANDSTONE; extremely weak].		D	26									
				37									

End of Hole Depth: 37.5 m
Termination: met target depth

Machine borehole met target depth at 37.5 m bgl. Strengths inferred from shear vane, SPT and tactile assessment.
Dip test showed standing water at 4.35 m depth on 20/02/2025 at 0800hrs. Coordinates and Elevation estimated using Auckland Council GeoMaps.
N/A = Not Applicable; NR = No Recovery; F = Fill.



BOREHOLE LOG MBH04

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 06-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 16.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7509991
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.578719

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
TAKAANINI FORMATION	Clayey SILT; grey with orange mottles. Low plasticity.		H	44	UTP 1/2//1/1/3/2 N=7		25 50 75	25 50 75				
	0.4 m - With minor fine to medium sand.											
	Sandy SILT; grey with occasional orange mottles. Low plasticity. Sand is fine to coarse.											
	1 - 1.5 m - No recovery.	H	43									
	1.95 -3 m - No recovery.		NR	2	0/0//0/0/2/1 N=3							
			N/A	42								
	Sandy SILT with minor clay; dark grey. Low plasticity. Sand is fine to coarse.			3	37/22 kPa 0/0//0/0/0/0 N=0							
	Interbedded with			41								
	Silty CLAY; dark grey. High plasticity. Beds are sub-horizontal, moderately thin, moderately widely spaced.		F	4								
	4.3 - 4.35 m - Encountered organic CLAY.			40								
Silty CLAY with some organics; dark blackish grey. High plasticity. Organics are amorphous.			5									
5.05 - 5.2 m - Encountered organic CLAY.		F	39									

Machine borehole met target depth at 16.5 m bgl

Dip test showed standing groundwater at 3.25 m bgl [05/03/2025 15:00]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

UTP = Unable to Penetrate



BOREHOLE LOG MBH04

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 06-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 16.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7509991
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.578719

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
TAKAANINI FORMATION	Silty CLAY with some organics; dark blackish grey. High plasticity. Organics are amorphous. 5.5 - 5.25 m - Encountered organic CLAY.		F				25 50 75	25 50 75				
	Clayey SILT with minor sand and trace organics; dark grey. Low plasticity. Sand is fine to medium. Organics are amorphous.		F	6 38	32/15 kPa 0/0/0/0/0/1 N=1							
EAST COAST BAYS FORMATION	Silty fine to coarse SAND; dark grey. Well graded. 7.25 - 7.5 m - No recovery.	 NR	MD N/A	37								
	Sandy SILT with trace gravel; dark grey with bluish green specks. Low plasticity. Sand is fine to coarse; gravel is fine crushable, rounded siltstone clasts.		H	8 36	2/4/5/5/6/7 N=23							
	Clayey SILT with trace sand; dark grey with occasional black carbonaceous inclusions. Low plasticity. Sand is fine.		H	9 35	2/3/5/4/7/8 N=24							
	Sandy SILT with minor clay; dark grey. Low plasticity. Interbedded with Clayey SILT; dark grey. Low plasticity. Beds are gently inclined, moderately thin, moderately widely spaced.		H	10 34	4/4/7/8/9/14 N=38							

Machine borehole met target depth at 16.5 m bgl

Dip test showed standing groundwater at 3.25 m bgl [05/03/2025 15:00]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

UTP = Unable to Penetrate



Client :	Rangitootpuni Developments	Core Diameter :	64 mm
Date :	06-03-2025	Energy Transfer Ratio :	97.1%
Hole Depth :	16.5 m	Logged By/Reviewed By :	JM / HP
Drilling Method :	Mud Rotary	Latitude :	-36.7509991
Drilling Contractor :	McMillan Drilling Group Ltd	Longitude :	174.578719

	Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
								X	25 50 75	25 50 75				
11		Silty fine to coarse SAND; dark grey. Well graded. (Completely weathered SANDSTONE; extremely weak.)	[Symbol]	H	11		4/4//7/8/9/14 N=38					M		
		Silty fine to coarse SAND; dark grey. Well graded. (Completely weathered, SANDSTONE; extremely weak.)	[Symbol]	D										
		Interbedded with	[Symbol]	H	33									
12		Clayey SILT; dark grey. Low plasticity. (Completely weathered, dark grey SILTSTONE; extremely weak. Beds are gently to moderately inclined, moderately thin, very closely spaced.)	[Symbol]		12									
		Highly weathered, dark grey SILTSTONE; very weak.	[Symbol]		32		5/12//12/16/17/ for 26 mm N=50+							
		Interbedded with	[Symbol]	EW - VW							12.4-12.8 m: Drilling induced bedding partings; moderately inclined, smooth, planar, closely spaced			
13		Silty fine to coarse SAND; dark grey. Well graded. (Completely weathered, SANDSTONE; extremely weak. Beds are moderately inclined, thin to moderately thin, extremely closely spaced to closely spaced.)	[Symbol]		13									
		Moderately weathered, dark grey SILTSTONE; very weak.	[Symbol]		31									
		Interbedded with	[Symbol]				7/29//46/4 for 6 mm N=50+							
14		Moderately weathered, dark grey, fine to medium SANDSTONE; very weak. Beds are moderately inclined, thin, moderately widely spaced.	[Symbol]		14									
			[Symbol]		30						14.03-14.55 m: Drilling induced bedding partings; very closely spaced to closely spaced			
15			[Symbol]	VW	15									
			[Symbol]		29		8/25//31/19 for 25 mm N=50+							
16		16 m - Beds become very thin to thin and very closely spaced to closely spaced.	[Symbol]		16						15.75 m: Joint set; sub-vertical and sub-horizontal, planar, smooth			
			[Symbol]								16.2 m: Joint; gently			

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

UTP = Unable to Penetrate



Client : Rangitoopuni Developments **Core Diameter :** 64 mm
Date : 06-03-2025 **Energy Transfer Ratio :** 97.1%
Hole Depth : 16.5 m **Logged By/Reviewed By :** JM / HP
Drilling Method : Mud Rotary **Latitude :** -36.7509991
Drilling Contractor : McMillan Drilling Group Ltd **Longitude :** 174.578719

End of Hole Depth: 16.5 m
Termination: met target depth

UTP = Unable to Penetrate



BOREHOLE LOG MBH05

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 07-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 19.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7480219
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5830162

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (m RL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
FILL	[FILL] Fine to coarse GRAVEL with trace cobble and trace rootlets; dark grey. Well graded. Gravel and cobble are greywacke, angular.		N/A	57			25 50 75	25 50 75				
	[FILL] SILT with minor sand and trace gravel and trace organics; dark brown with occasional orange mottles. Low plasticity. Gravel is fine, angular greywacke. Organics are carbonaceous inclusions.		N/A		200+ kPa							
	[FILL] SILT with minor clay and trace sand; light greyish brown with orange mottles. Low plasticity.	NR	N/A	1								
	0.5 - 1.5 m - No recovery.			56								
UTF	SILT with minor sand and minor clay; light grey with orange mottles. Low plasticity. Sand is fine to medium.		VSt	2	1/0/1/2/2/1 N=6							
				55								
	Sandy SILT with trace clay; light grey with orange mottles. Low plasticity. Sand is fine to coarse.	NR	N/A	3								
	2.65 - 3.0 m - No recovery.			54								
	Sandy SILT with trace clay; light grey with orange mottles. Low plasticity. Sand is fine.		F - St	4	0/0/0/0/0/0 N=0							
	Interbedded with			53								
	SILT with minor sand and trace clay; orange. Low plasticity. Sand is fine. Beds are sub-horizontal, moderately thin to moderately thick and moderately widely spaced.			53								
	4.3 - 4.5 m - No recovery.	NR	N/A		74/37 kPa							
	SILT with some sand and minor clay; dark grey. Low plasticity. Sand is fine to medium.		St - VSt	5	0/2/2/2/2/3 N=9							
				52								

Machine borehole met target depth at 19.5 m bgl

Dip test showed standing groundwater at 3.4 m bgl [06/03/2025 15:00]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

GEOTECH MACHINE BOREHOLE - ROCK MBH06-07.GPJ NZ DATA TEMPLATE 2.GDT 23/03/25



BOREHOLE LOG MBH05

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 07-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 19.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7480219
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5830162

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	SILT with some sand and minor clay; dark grey. Low plasticity. Sand is fine to medium.			6			25 50 75	25 50 75				
				51	1/2/2/3/4/5 N=14							
			St - VSt	7								
	7.1 - 7.3 m - With some fine to coarse sand.			50								
					121/27 kPa							
					2/2/2/4/5/4 N=15							
	7.95 - 8.25 m - With some fine to coarse sand.			8								
				49						M		
	Sandy SILT with trace clay; dark grey. Low plasticity. Sand is fine to coarse.											
	Interbedded with											
	Clayey SILT with trace sand; dark grey. Low plasticity. Sand is fine. Beds are sub-horizontal to gently inclined, moderately thin, closely spaced to moderately widely spaced.			9								
					200+ kPa							
				48	3/3/5/5/5/5 N=20							
			H									
				10								
				47								
					UTP 3/3/5/7/8/10 N=30							

Machine borehole met target depth at 19.5 m bgl

Dip test showed standing groundwater at 3.4 m bgl [06/03/2025 15:00]

Coordaintes and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery



BOREHOLE LOG MBH05

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 07-03-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 19.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7480219
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5830162

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
11	Silty fine to coarse SAND; dark grey. Well graded.			11		3/3//5/7/8/10 N=30	×	25 50 75	25 50 75				
	Interbedded with												
	Clayey SILT; dark grey. Low plasticity. (Completely weathered SILTSTONE; extremely weak.) Beds are gently inclined, thin to moderately thin, closely spaced.		D	46									
12	Silty fine to coarse SAND; dark grey. Well graded.			12									
			VD	45		7/12//14/13/13/1 for 48 mm N=50+							
13	Silty fine to coarse SAND; dark grey. Well graded. (Completely weathered SANDSTONE; extremely weak.)			13									
	Interbedded with												
	Moderately weathered, dark grey SILTSTONE; very weak. Beds are gently inclined to moderately inclined, thin, moderately widely spaced. 13.1 m - Siltstone beds become very widely spaced. 13.38 - 13.5 m - No recovery.			44		0/14//16/18/16 for 64 mm N=50+				13.13 m: Drilling induced bedding parting with siltstone gravel infill			
14				14									
			D - VD	43									
15				15									
				42		7/7//6/10/12/14 N=48							
16	15.55 - 15.65 m - Siltstone beds become very closely spaced.									15.75 m: Drilling induced bedding parting			
	16 m - Siltstone beds become extremely closely spaced to closely spaced.			16						16 m: Drilling induced bedding parting			

Machine borehole met target depth at 19.5 m bgl

Dip test showed standing groundwater at 3.4 m bgl [06/03/2025 15:00]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery



Client :	Rangitootpuni Developments	Core Diameter :	64 mm
Date :	07-03-2025	Energy Transfer Ratio :	97.1%
Hole Depth :	19.5 m	Logged By/Reviewed By :	JM / HP
Drilling Method :	Mud Rotary	Latitude :	-36.7480219
Drilling Contractor :	McMillan Drilling Group Ltd	Longitude :	174.5830162

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGS)	Elevation (m)	SPT N-Value N=50+	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
EAST COAST BAYS FORMATION			D - VD	41				25 50 75	25 50 75		M		
	Highly weathered, dark grey, fine to medium SANDSTONE; very weak.					11/19/21/20/9 for 30 mm N=50+							
	Interbedded with												
	Moderately weathered, dark grey, SILTSTONE; very weak. Beds are gently inclined, thin to moderately thin, very closely spaced.		VW	17	40								
				18		13/37 for 51 mm N=50+				16.91-18.93 m: Bedding parting	N/A		
	Moderately weathered, dark grey SILTSTONE; very weak.			39									
	Interbedded with												
	Moderately weathered, dark grey fine to medium SANDSTONE; very weak. Beds are gently inclined, thin to moderately thin, closely spaced.		VW	19	38					19.01-19.04 m: Joint; moderately inclined, undulating, rough 19.04-19.29 m: Joint; slightly inclined, undulating, rough 19.29-19.33 m: Cross joint; moderately inclined			

smooth, planar

Strengths inferred from shear vane, SPT and tactile assessment.
N/A = Not Assessed; NR = No Recovery



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
F	[FILL] Fine to coarse GRAVEL with trace cobbles; grey. Well graded. Gravel is greywacke, sub-angular to angular.		N/A				25 50 75	25 50 75				
	[FILL] Gravelly SILT with trace rootlets; dark orange brown. Low plasticity. Gravel is fine, greywacke, sub-angular to angular.		N/A									
	[FILL] Gravelly SILT with trace rootlets; dark orange brown. Low plasticity. Gravel is fine, greywacke, sub-angular to angular.		VSt	76	133/30 kPa							
	SILT with some sand and trace clay; orange brown with occasional light grey streaks. Low plasticity. Sand is fine to medium. 0.5 - 1.5 m - No recovery.		NR	1								
	Silty CLAY with minor sand; light grey with pink and orange streaks. High plasticity. Sand is fine.		St	75	1/1/1/1/1/2 N=5							
	Clayey SILT with some sand; light grey with pink mottles. Low plasticity. Sand is fine to coarse. 2.6 - 3.0 m - No recovery.		St	74	80/56 kPa							
	Silty CLAY with minor sand; light grey with pink, orange and red streaks. High plasticity.		NR	3								
	Silty CLAY with minor sand; light grey with pink, orange and red streaks. High plasticity.		St - VSt	73	0/1/1/1/2/2 N=6							
	Clayey SILT with minor sand; light grey with pink mottles. Low plasticity. Sand is fine to medium. 4.25 - 4.5 m - No recovery.		St	72	1/1/1/0/1/1 N=3							
	4.55 m - 4.6 m - Encountered dark orange staining and with trace fine, sub-rounded to sub-angular limonite gravels. 4.8 - 4.95 m - No recovery.		St									
	Silty CLAY; light grey with pink and orange streaks. High plasticity.		St - VSt	5								

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

UTF = Undifferentiated Takaani Formation



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Clayey SILT with minor sand; brownish grey with sub-horizontal pink streaks. Low plasticity. Sand is fine to medium.		VSt	71			25 50 75	25 50 75				
6	Silty fine to medium SAND; light brownish grey with orange streaks and staining. Well graded.		L	6	115/53 kPa							
	Clayey SILT with trace sand; light brownish grey with dark orange mottles. Low plasticity. Sand is fine.		VSt	70								
7	Sandy SILT with minor clay; light brownish grey. Low plasticity. Sand is fine to medium.			7								
	Interbedded with											
	Silty fine to medium SAND; light brownish grey. Well graded. Beds are sub-horizontal, very thin to thin, moderately widely spaced.		VSt	69	177/41 kPa							
8				8	2/2/3/4/5/6 N=18							
	Silty CLAY with trace sand; light brownish grey. High plasticity.		VSt	68								
	Sandy SILT with trace clay; light brownish grey. Low plasticity. Sand is fine to medium.		VSt									
9	Clayey SILT with trace sand; dark grey. Low plasticity. Sand is fine.			9	UTP							
	Interbedded with				2/3/3/4/5/5 N=17							
	Silty fine to coarse SAND; dark grey. Well graded. Beds are gently inclined, laminated to very thin, very closely spaced. 9.45 m - Beds become moderately widely spaced.		H	67								
10				10								
	Sandy SILT; light brownish grey. Low plasticity. Sand is fine to medium.		VSt									
			VSt	66	185/56 kPa							
					2/2/3/3/3/4 N=13							

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

UTF = Undifferentiated Takaani Formation



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
11	Clayey SILT; light grey with orange streaks. Low plasticity.			11		2/2/3/3/3/4 N=13	×	25 50 75	25 50 75				
	Interbedded with												
	Silty fine to coarse SAND; orange. Well graded. Beds are gently inclined, laminated to very thin, very closely spaced.	VSt		65									
12				12									
	12.2 - 12.25 m - Encountered orange staining and with trace fine, rounded limonite gravel.					1/5/4/2/3/3 N=12	×						
	Silty fine to coarse SAND; reddish pink with occasional orange streaks. Well graded.	MD		64									
13				13									
	Clayey SILT with trace sand; light grey with orange streaks. Low plasticity.	VSt		63									
	Interbedded with												
	Sandy SILT; orange. Low plasticity. Sand is fine to coarse. Beds are gently inclined, laminated to very thin, closely spaced.					2/3/4/5/5/5 N=19	×						
	Silty fine to coarse SAND; orange and pink. Well graded.			14									
	13.65 m - Becomes light grey and interbedded with clayey silt; light grey. Low plasticity. Beds are undulating, gently inclined, thin, very closely spaced to closely spaced.	MD		62						14.02-14.1 m: Joint; moderately inclined, smooth, planar			
15				15									
						3/3/5/5/6/8 N=24	×						
	Clayey SILT with trace sand; light grey. Low plasticity.	H		61									
16				16									

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

UTF = Undifferentiated Takaani Formation



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
17 18 19 20 21 EAST COAST BAYS FORMATION	Silty fine to coarse SAND; pink with occasional orange streaks and light grey silty clay inclusions. Well graded.		MD	60	1/3//4/6/6/8 N=24		25 50 75	25 50 75				
	17.15 - 18 m - No recovery.	NR	N/A	59								
	Silty fine to coarse SAND; orange. Well graded.		MD	18	3/4//5/6/7/8 N=26							
	Sandy SILT; orange. Low plasticity. Sand is fine to medium.		VSt	58								
	Silty fine to coarse SAND; orange. Well graded.			19								
				57	2/4//5/5/7/9 N=26							
			MD	20								
	20.6 - 20.62 m - Encountered inclusion of light grey silty CLAY. 20.8 m - Becomes pink with orange streaks.			56								
	21.2 - 23.3 m - Encountered inclusions of grey silty CLAY (5 - 60 mm diameter).			21	2/4//5/6/7/10 N=28							
				55								

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

UTF = Undifferentiated Takaanini Formation



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Silty fine to coarse SAND; pink with orange streaks. Well graded. With irregular shaped inclusions of grey silty CLAY.		MD	22			25 50 75	25 50 75				
	Silty fine to coarse SAND; orange with light grey and dark orange steeply inclined to very steeply inclined streaks. Well graded. Fe staining along upper contact.			54								
			MD	23								
	23.5 m - Streaks cease.			53								
	Silty fine to coarse SAND; light pink. Well graded.			24								
				52								
	24.8 - 24.83 m - Encountered, sub-horizontal, very thin lens of clayey SILT.		MD	25								
				51								
				26								
	Sandy SILT with minor clay; orange with occasional light grey mottles. Low plasticity. Sand is fine.		VSt	50								
	Silty fine to coarse SAND; light pinkish grey with dark pink and red streaks. Well graded.		MD									
				27								

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

UTF = Undifferentiated Takaanini Formation

GEOTECH MACHINE BOREHOLE - ROCK MBH06-07.GPJ NZ DATA TEMPLATE 2.GDT 23/03/25



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Silty fine to coarse SAND; light pinkish grey with dark pink and red streaks. Well graded. 27.1 m - Light pink with steeply inclined pink streaks.		MD	49	2/4/4/5/6/7 N=22		25 50 75	25 50 75				
28	Silty CLAY; dark grey. High plasticity.		VSt - H	28								
	Silty CLAY with trace sand; light grey. High plasticity.											
	Interbedded with											
	Sandy SILT; light grey. Low plasticity. Sand is fine to coarse. Beds are gently inclined, moderately thin, closely spaced.			48								
29			VSt - H	29								
				47								
30				30								
	Silty CLAY with trace sand; light grey with occasional orange streaks. High plasticity. Sand is fine.		VSt - H	46								
31				31								
	Silty fine to coarse SAND; pink. Well graded.		MD									
	Clayey SILT with some fine to medium sand; light grey with pink and orange streaks. Low plasticity.		VSt - H	45								
32	31.5 - 33 m - No Recovery.		NR	N/A								

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

UTF = Undifferentiated Takaani Formation



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	31.5 - 33 m - No Recovery.	NR	N/A	44			25 50 75	25 50 75				
	Sandy SILT with minor clay; pink with inclusions of light grey silty clay. Low plasticity. Sand is fine to medium.	VSt		33								
	Silty CLAY; light grey with pink streaks and pink inclusions of sandy silt. High plasticity.	VSt		43								
	Sandy SILT; orange. Low plasticity. Sand is fine to coarse.	VSt		34								
	Silty CLAY; light grey with dark orange Fe staining along upper contact. High plasticity.	VSt		42	147/42 kPa							
	Clayey SILT with some sand; light orange. Low plasticity. Sand is fine to coarse.	VSt										
	Silty CLAY with minor sand; grey with orange streaks. High plasticity. With inclusions of orange sandy silt.	VSt		35								
	Clayey SILT with trace sand; grey. Low plasticity.	VSt		41								
	Interbedded with			36								
	Sandy SILT with minor clay; grey. Low plasticity. Sand is fine to coarse. Beds are gently inclined, very thin to thin, closely spaced.	VSt		40								
				37								
				39								

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

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BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
38	Sandy SILT; light orange brown. Low plasticity. Sand is fine to medium.		VSt - H	38			25 50 75	25 50 75				
	Clayey SILT with minor sand; grey with orange streaks and staining. Low plasticity. Sand is fine to medium.		H	38								
39	Sandy SILT; dark grey. Low plasticity.											
	Interbedded with			39								
	Clayey SILT with trace sand; dark grey. Low plasticity. (Completely weathered, SILTSTONE; extremely weak).											
				37								
40			H	40								
				36							M	
41				41								
	Clayey SILT; dark grey. Low plasticity. (Completely weathered, SILTSTONE; extremely weak.)			35								
	Interbedded with											
42	Sandy SILT; dark grey. Low plasticity. Sand is fine to coarse. Beds are gently inclined, thin, closely spaced.		H	42								
	Sandy SILT; dark grey. Low plasticity. Sand is fine to coarse. (Completely weathered, SANDSTONE; extremely weak.)			34								
	Interbedded with											
43	Highly weathered, dark grey SILTSTONE; extremely weak. Beds are gently inclined, thin, closely spaced.		H	43								

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

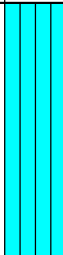
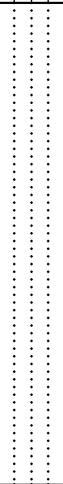
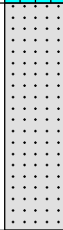
UTF = Undifferentiated Takaanini Formation



BOREHOLE LOG MBH06

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 24-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 45 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7510248
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5823707

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
EAST COAST BAYS FORMATION	Sandy SILT; dark grey. Low plasticity. Sand is fine to coarse. (Completely weathered, SANDSTONE; extremely weak.)		H	33							M	
	Interbedded with			44								
	Highly weathered, dark grey SILTSTONE; extremely weak. Beds are gently inclined, thin, closely spaced.		VW	32								
Highly weathered, dark grey SANDSTONE; very weak.												

End of Hole Depth: 45 m
Termination: met target depth

GEOTECH MACHINE BOREHOLE - ROCK MBH06-07.GPJ NZ DATA TEMPLATE 2.GDT 23/03/25

Machine borehole met target depth at 45 m bgl.

Dip test showed standing groundwater at 6.25 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery; F = Fill

UTF = Undifferentiated Takaanini Formation



Client :	Rangitootupuni Developments	Core Diameter :	64 mm
Date :	27-02-2025	Energy Transfer Ratio :	97.1%
Hole Depth :	40.5 m	Logged By/Reviewed By :	JM / HP
Drilling Method :	Mud Rotary	Latitude :	-36.7524966
Drilling Contractor :	McMillan Drilling Group Ltd	Longitude :	174.5864613

GEOTECH MACHINE BOREHOLE - ROCK MBH06-07.GPJ NZ DATA TEMPLATE 2.GDT 23/03/25



BOREHOLE LOG MBH07

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 27-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 40.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7524966
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5864613

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Silty fine to coarse SAND with trace gravel; orange. Well graded. Gravel is fine, crushable silt clasts. 5.45 - 6.0 m - No recovery.	NR	N/A					25 50 75	25 50 75				
ALBANY CONGLOMERATE	Sandy SILT with trace gravel; orange with occasional pink staining. Low plasticity. Sand is fine to medium. Gravel is fine crushable silt clasts. 6.45 - 6.7 m - Disturbed during drilling, recovered as saturated SILT. 6.7 - 6.9 m - Becomes reddish pink with light grey and orange streaks.			6 49		1/1/1/2/2/2 N=7							
	7.4 - 7.5 m - Becomes reddish pink.			7 48		59/29 kPa 1/2/2/2/2/2 N=8							
	8.05 - 8.25 m - With minor clay and becomes pinkish red with light grey streaks.			8 47									
	Silty fine to coarse SAND; orange with light grey specks. Well graded.	L - MD											
	8.85 - 9 m - No recovery.	NR	N/A										
EAST COAST BAYS FORMATION	Sandy SILT; dark orange. Low plasticity. Sand is fine to coarse.			9 46		103/48 kPa 2/2/3/3/4/5 N=15							
	Silty CLAY; grey. High plasticity. Sandy SILT; dark orange. Low plasticity. Sand is fine to coarse.	H VSt		10 45		UTP 1/2/2/3/3/4 N=12							

Machine borehole met target depth at 37.5 m bgl.

Dip test showed standing groundwater at 6.05 m bgl [28/02/2025 1200]

Coordaintes and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

F = Fill



BOREHOLE LOG MBH07

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitootuni Developments Core Diameter : 64 mm
Date : 27-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 40.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7524966
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5864613

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
11	Sandy SILT; dark orange. Low plasticity. Sand is fine to coarse.		VSt	11 44		1/2/2/3/3/4 N=12		25 50 75	25 50 75				
	Silty fine to coarse SAND; dark orange. Well graded.		MD										
12	Sandy SILT; dark orange. Low plasticity. Sand is fine to coarse.			12 43		2/1/2/2/3/3 N=10							
	12 m - Becomes dark orange with light grey specks.		St - VSt										
13				13 42									
	Sandy SILT; orange with light grey specks. Low plasticity. Sand is fine to coarse.			14 41		0/1/3/2/3/2 N=8							
14			VSt										
15				15 40		118/41 kPa 1/1/2/4/2/3 N=11							
16			MD										
				16 39									

Machine borehole met target depth at 37.5 m bgl.

Dip test showed standing groundwater at 6.05 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

Strengths inferred from shear vane, SPT and tactile assessment.

N/A = Not Assessed; NR = No Recovery

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BOREHOLE LOG MBH07

Stage 2 Geotechnical Investigation
Forestry Road
Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 27-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 40.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7524966
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5864613

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Silty fine to coarse SAND; dark grey. Well graded.						25 50 75	25 50 75				
	Interbedded with											
	Clayey SILT with minor sand; dark grey. Low plasticity. Beds are sub-horizontal to gently inclined, closely spaced to moderately widely spaced, thin to moderately thin.			17 38	1/1/2/2/3/4 N=11							
			MD									
				18 37	2/2/3/4/4/6 N=17							
	Silty fine to coarse SAND; dark grey. Well graded.			19 36								
			MD									
	Silty fine to coarse SAND; dark grey. Well graded.			20 35	2/2/4/4/4/6 N=18							
	Interbedded with											
	Clayey SILT; dark grey. Low plasticity. Beds are sub-horizontal, laminated to very thin and very closely spaced.											
	Clayey SILT; dark grey. Low plasticity.											
	Interbedded with											
	Silty fine to coarse SAND; dark grey. Well graded. Beds are gently inclined, laminated to very thin, very closely spaced to closely spaced.			21 34	3/3/4/5/6/6 N=21							
			H									
	Sandy SILT; dark grey. Low plasticity. Sand is fine to medium.											
			H									

Machine borehole met target depth at 37.5 m bgl.

Dip test showed standing groundwater at 6.05 m bgl [28/02/2025 1200]

Coordaintes and elevation estimated using Auckland Council GeoMaps.

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BOREHOLE LOG MBH07

Stage 2 Geotechnical Investigation
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Client : Rangitootuni Developments Core Diameter : 64 mm
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Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5864613

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL) Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
22	Sandy SILT; dark grey. Low plasticity. Sand is fine to medium.		H				25 50 75	25 50 75				
	Sandy SILT; dark grey. Low plasticity. Sand is fine to medium.			22 33								
	Interbedded with											
	Clayey SILT with trace sand; dark grey. Low plasticity. (Completely weathered, SILTSTONE; extremely weak.) Beds are gently inclined, moderately thick, moderately widely spaced.				2/3/4/5/6/6 N=21							
23			H	23 32								
24				24 31	4/3/7/9/11/12 N=39							
25	24.65 - 25.5 m - No recovery.	NR	N/A	25 30								
	Silty fine to coarse SAND; dark grey. Well graded.	MD - D										
	Clayey SILT; dark grey. Low plasticity.		H		4/4/6/8/8/8 N=30							
26	Sandy SILT; light orange brown with light grey mottles. Low plasticity. Sand is fine to coarse.		H	26 29								
	Clayey SILT; dark grey with orange streaks. Low plasticity.											
	Interbedded with											
	Silty fine to coarse SAND; orange. Well graded. Beds are sub-horizontal to moderately inclined, moderately thin, closely spaced.		H									
27				27 28								

Machine borehole met target depth at 37.5 m bgl.
Dip test showed standing groundwater at 6.05 m bgl [28/02/2025 1200]
Coordaintes and elevation estimated using Auckland Council GeoMaps.

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GEOTECH MACHINE BOREHOLE - ROCK MBH06-07.GPJ NZ DATA TEMPLATE 2.GDT 23/03/25

EAST COAST BAYS FORMATION



BOREHOLE LOG MBH07

Stage 2 Geotechnical Investigation
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Riverhead, Auckland
20190.000.001

Client : Rangitooopuni Developments Core Diameter : 64 mm
Date : 27-02-2025 Energy Transfer Ratio : 97.1%
Hole Depth : 40.5 m Logged By/Reviewed By : JM / HP
Drilling Method : Mud Rotary Latitude : -36.7524966
Drilling Contractor : McMillan Drilling Group Ltd Longitude : 174.5864613

Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
								25 50 75	25 50 75				
	Silty fine to coarse SAND; orange. Well graded.		H			2/4/5/6/7/8 N=26							
	Interbedded with		MD										
	Clayey SILT; dark grey. Low plasticity. Beds are moderately inclined, very thin, very closely spaced.		H										
	Clayey SILT; dark grey with orange streaks. Low plasticity.		MD										
28	Silty fine to coarse SAND; light brownish grey with orange staining. Well graded.			28	27								
	Sandy SILT; dark grey. Low plasticity. Sand is fine to coarse.												
	Interbedded with												
	Clayey SILT; dark grey. Low plasticity. Beds are gently inclined, moderately thin to moderately thick, moderately widely spaced.			29	26								
29													
			H	30	25								
30													
				31	24								
31													
	31.85 m - With gently inclined, thin, very closely spaced lens of orange Sandy SILT with trace limonite gravel and hardpan limonite bands along bedding planes.			32	23								
	Clayey SILT; dark grey. Low plasticity.		H										

Machine borehole met target depth at 37.5 m bgl.

Dip test showed standing groundwater at 6.05 m bgl [28/02/2025 1200]

Coordinates and elevation estimated using Auckland Council GeoMaps.

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BOREHOLE LOG MBH07

Stage 2 Geotechnical Investigation
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20190.000.001

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Material	DESCRIPTION	Log Symbol	Strength	Depth (m BGL)	Elevation (mRL)	SPT N-Value / Vane Shear Strength	Sample Type	TCR (%)	RQD (%)	Defect Description	Moisture	Water Level	Piezometer Construction
	Clayey SILT; dark grey. Low plasticity.		H	33 22				25 50 75	25 50 75				
	33.25 m - Encountered some fine to coarse angular limonite gravel and hard pan limonite bands along bedding planes.		H										
	Clayey SILT; dark grey. Low plasticity.												
	Sandy SILT; dark grey. Low plasticity. Sand is fine to coarse.		H	34 21									
	Sandy SILT; dark grey. Sand is fine to coarse. Low plasticity. (Completely weathered, SANDSTONE; extremely weak.)												
	35.17 m - Encountered gently inclined black carbonaceous band.		H	35 20							M		
	Sandy SILT; dark grey. Low plasticity. (Highly weathered, SANDSTONE; extremely weak.)												
	Interbedded with												
	Moderately weathered, dark grey SILTSTONE; very weak. Beds are gently inclined, moderately thin, moderately widely spaced.		H	37 18									
	37.3 - 37.5 m - No Recovery.												

Machine borehole met target depth at 37.5 m bgl.

Dip test showed standing groundwater at 6.05 m bgl [28/02/2025 1200]

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N/A = Not Assessed; NR = No Recovery

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Box 1: 0 – 3.95 m



Box 2: 3.95 – 7.50 m



Box 3: 7.5 – 9.0 m



Box 4: 9.00 – 12.55 m



Box 5: 12.55 – 15.75 m



Box 6: 15.75 – 18.80 m



Box 7: 18.80 – 21.85 m



Box 8: 21.85 – 25.05 m



Box 9: 25.05 – 27.90 m



Box 10: 27.9 – 30.9 m



Box 11: 30.9 – 34.2 m



Box 12: 34.2 – 37.2 m



Box 13: 37.2 – 40.5 m



Box 14: 40.5 – 42.0 m



Box 1: 0 – 5.20 m



Box 2: 5.20 – 8.55 m (Core sample disturbed from logging)



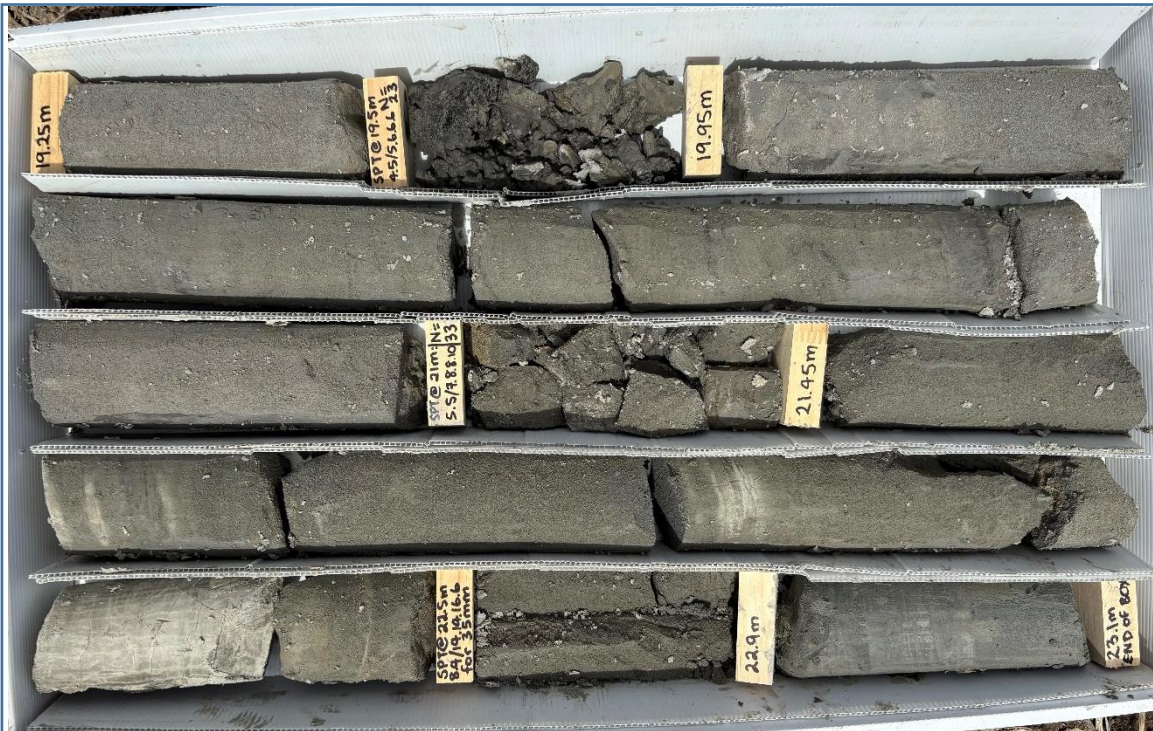
Box 3: 8.55 – 12.00 m



Box 4: 12.00 - 15.75 m



Box 5: 15.75 – 19.25 m



Box 6: 19.25 – 23.10 m



Box 7: 23.1 -25.8 m



Box 1: 0 – 4.95 m



Box 2: 4.95 – 8.55 m



Box 3: 8.55 – 12.45 m



Box 4: 12.45 – 15.90 m



Box 5: 15.9 – 19.3 m



Box 6: 19.3 - 23.3 m



Box 7: 23.30 – 26.55 m



Box 8: 26.55 – 29.85 m



Box 9: 29.85 – 33.40 m



Box 10: 33.4 – 36.5 m



Box 11: 36.5 – 37.5 m



Box 1: 0 – 4.95 m



Box 2: 4.95 – 8.40 m



Box 3: 8.40 – 11.55 m



Box 4: 11.55 – 15.00 m



Box 5: 15.0 – 16.5 m



Box 1: 0 – 4.75 m



Box 2: 4.75 – 8.05 m



Box 3: 8.05 – 11.30 m



Box 4: 11.30 – 15.45 m



Box 5: 15.45 – 18.55 m



Box 6: 18.55 – 19.50 m



Box 1: 0 – 4.95 m



Box 2: 4.95 – 8.20 m



Box 3: 8.20 – 11.25 m



Box 4: 11.25 – 14.70 m



Box 5: 14.7 – 18.7 m



Box 6: 18.70 – 21.85 m



Box 7: 21.85 – 25.05 m



Box 8: 25.05 – 28.35 m



Box 9: 28.35 – 31.30 m



Box 10: 31.30 - 35.75 m



Box 11: 35.75 – 38.85 m



Box 12: 38.85 – 41.70 m



Box 13: 41.7 – 44.6 m



Box 14: 44.6 – 45.0 m



Box 1: 0 – 3.85 m



Box 2: 3.85 – 7.95 m



Box 3: 7.95 – 11.40 m



Box 4: 11.4 – 15.0 m



Box 5: 15.00 – 18.75 m



Box 6: 18.75 – 21.80 m



Box 7: 21.80 – 26.25 m



Box 8: 26.25 – 29.20 m



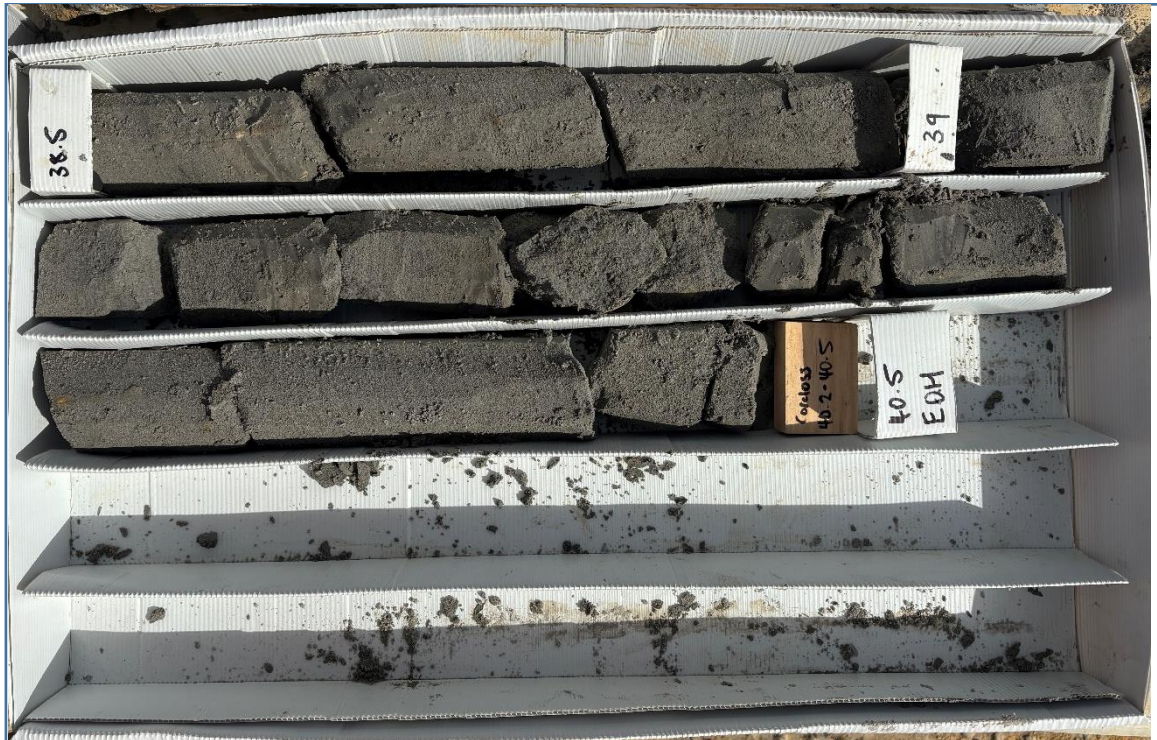
Box 9: 29.20 – 32.15 m



Box 10: 32.15 – 35.10 m



Box 11: 35.1 – 38.5 m



Box 12: 38.5 – 40.5 m

APPENDIX 5: Cone Penetration Test Results

CONE PENETRATION TEST (CPT) REPORT



Client: ENGEO

**Location: Riverhead Forest
Barlow & Forestry Road, Auckland**

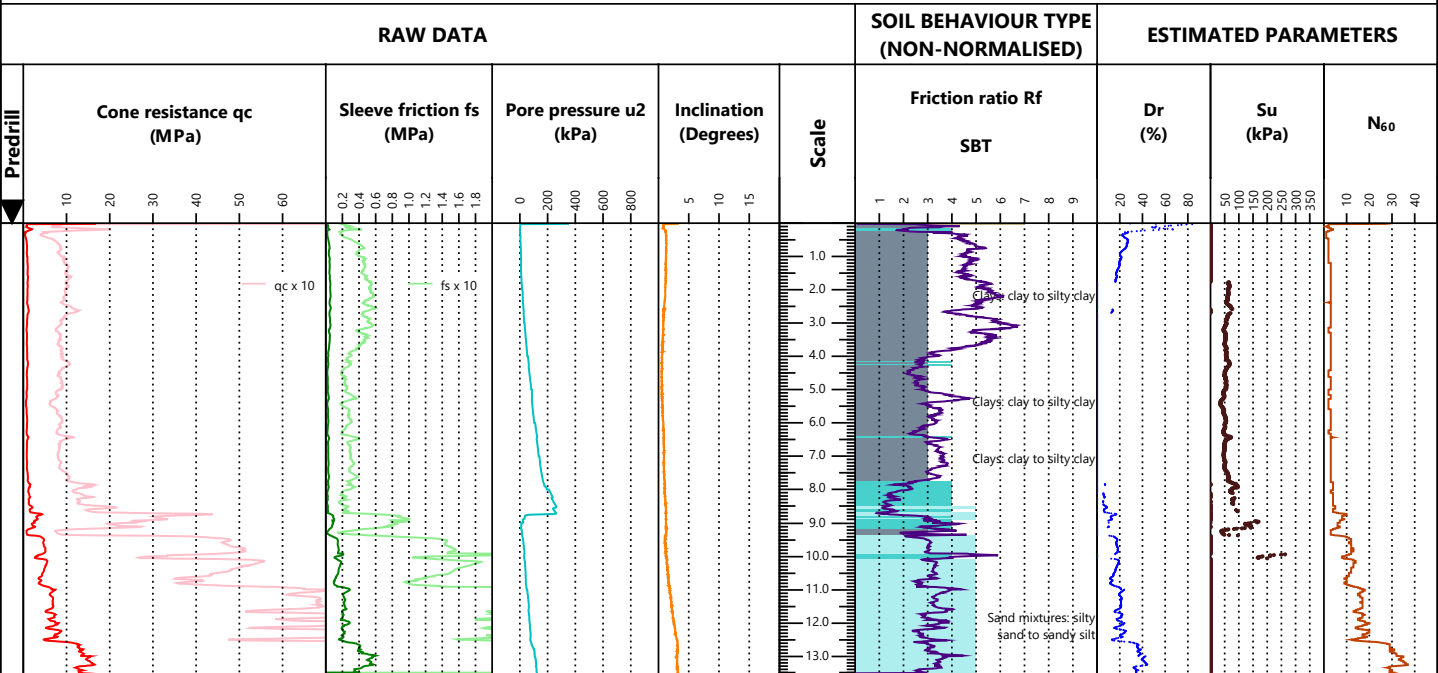
Printed: 10/03/2025

Client:	ENGEO	Bore No.:	CPTu001-S2
Project:	Riverhead Forest	Job No.:	302460

Date: 7/3/2025

Rig Operator: R. Negi

Equipment: Geomil Panther 100



EOH: 13.57m

Cone Type: Pagani Piezocone - Compression			Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986	
Cone Reference: 000963			Water Level: -		0 Undefined	5 Sand mixtures: silty sand to sandy silt
Cone Area Ratio: 0.79			Collapse: 0.90m	Target Depth	1 Sensitive fine-grained	6 Sands: clean sands to silty sands
Standards: ISO 22476-1:2012 - Application Class 2				Effective Refusal	2 Clay - organic soil	7 Dense sand to gravelly sand
Zero load outputs (MPa)	Before test	After test		Tip		
Tip Resistance	22.3082	22.2692		Gauge ☒	3 Clays: clay to silty clay	8 Stiff sand to clayey sand
Local Friction	0.2741	0.2735		Inclinometer	4 Silt mixtures: clayey silt & silty clay	9 Stiff fine-grained
Pore Pressure	2.9982	3.0062		Other		

Notes & Limitations

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

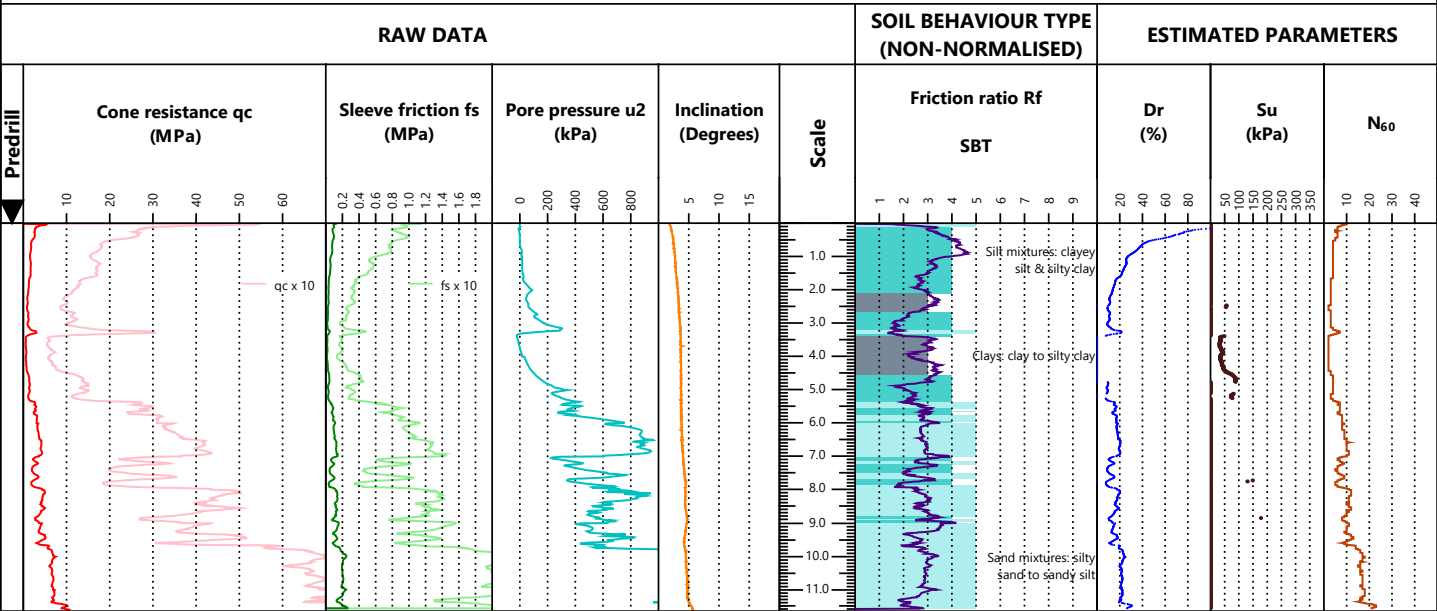
Remarks

Generated with Core-GS by Geroc



Client:	ENGEO	Bore No.:	CPTu002-S2
Project:	Riverhead Forest	Job No.:	302460

Site Location: Barlow & Forestry Road, Auckland		Date: 6/3/2025	
Grid Reference: 1741128.18m E, 5931985.81m N (NZTM) - Handheld GPS		Rig Operator: R. Negi	
Elevation: 0.00m	Datum: Ground	Equipment: Geomil Panther 100	

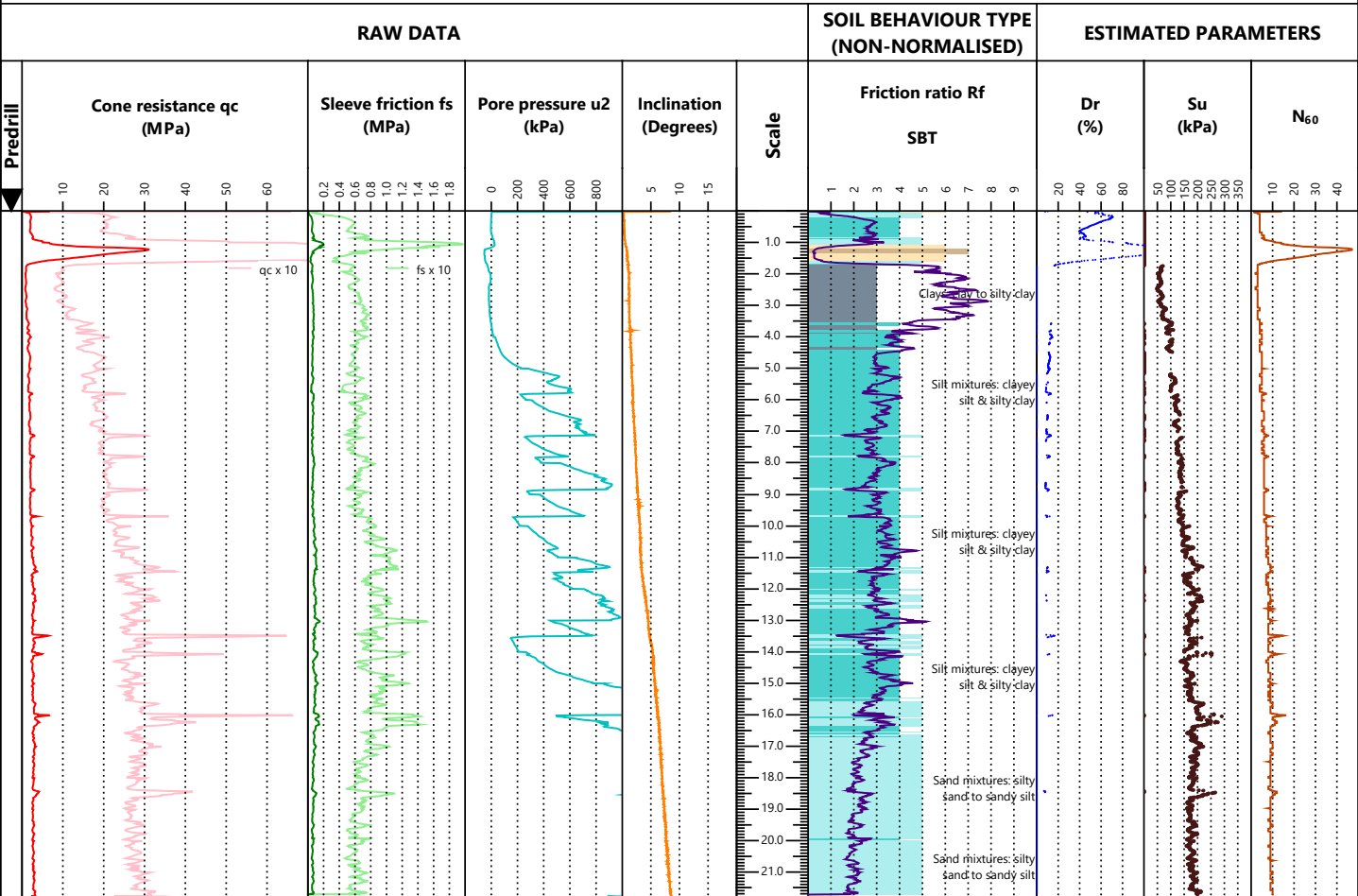


Cone Type: Pagani Piezocone - Compression		Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986	
Cone Reference: 000963		Water Level: -	Target Depth ☐	0 Undefined	5 Sand mixtures: silty sand to sandy silt
Cone Area Ratio: 0.79		Collapse: 1.05m	Effective Refusal	1 Sensitive fine-grained	6 Sands: clean sands to silty sands
Standards: ISO 22476-1:2012 - Application Class 2			Tip ☐	2 Clay - organic soil	7 Dense sand to gravelly sand
Zero load outputs (MPa)	Before test	After test	Gauge ☐	3 Clays: clay to silty clay	8 Stiff sand to clayey sand
Tip Resistance	22.3082	22.2803	Inclinometer ☐	4 Silt mixtures: clayey silt & silty clay	9 Stiff fine-grained
Local Friction	0.2747	0.2740	Other: Pore pressure ☒		
Pore Pressure	2.9979	2.9972			

Notes & Limitations		Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.		
		Sheet 1 of 1

Client:	ENGEO	Bore No.:	CPTu003-S2
Project:	Riverhead Forest	Job No.:	302460

Site Location: Barlow & Forestry Road, Auckland	Date: 6/3/2025
Grid Reference: 1741127.12m E, 5931640.51m N (NZTM) - Handheld GPS	Rig Operator: R. Negi
Elevation: 0.00m	Equipment: Geomil Panther 100
Datum: Ground	



EOH: 21.78m

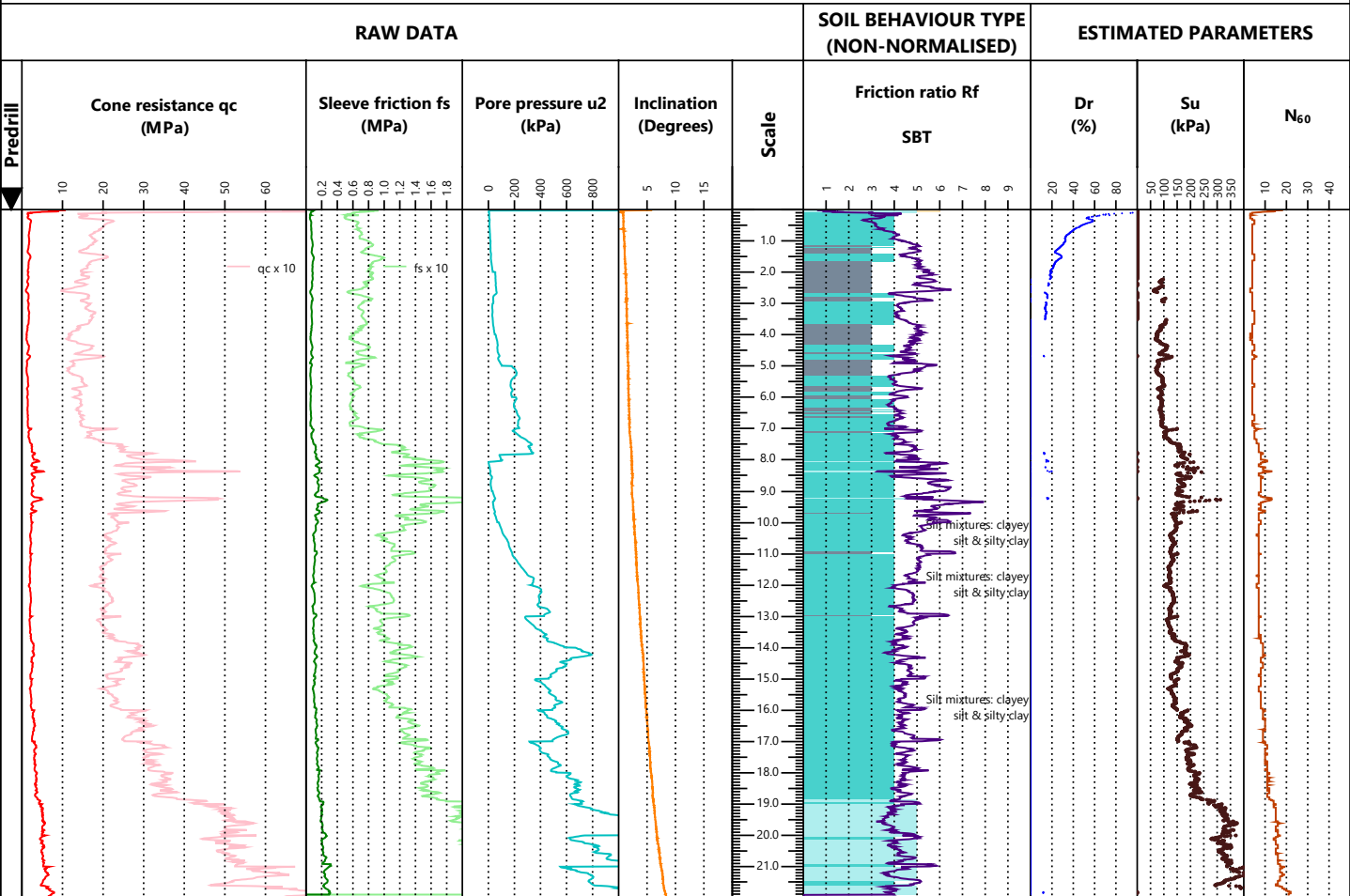
Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: 000963	Water Level: -	Target Depth ☐	0 Undefined
Cone Area Ratio: 0.79	Collapse: 0.90m	Effective Refusal	1 Sensitive fine-grained
Standards: ISO 22476-1:2012 - Application Class 2		Tip ☐	2 Clay - organic soil
Zero load outputs (MPa)	Before test	Gauge ☒	3 Clays: clay to silty clay
Tip Resistance	22.3026	Inclinometer ☐	4 Silt mixtures: clayey silt & silty clay
Local Friction	0.2738	Other ☐	5 Sand mixtures: silty sand to sandy silt
Pore Pressure	2.9968		6 Sands: clean sands to silty sands
			7 Dense sand to gravelly sand
			8 Stiff sand to clayey sand
			9 Stiff fine-grained

Notes & Limitations	Remarks
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	
	Sheet 1 of 1

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Client:	ENGEO	Bore No.:	CPTu004-S2
Project:	Riverhead Forest	Job No.:	302460

Site Location: Barlow & Forestry Road, Auckland	Date: 6/3/2025
Grid Reference: 1741429.74m E, 5931630.66m N (NZTM) - Handheld GPS	Rig Operator: R. Negi
Elevation: 0.00m	Equipment: Geomil Panther 100
Datum: Ground	



EOH: 21.97m

Cone Type: Pagani Piezocone - Compression	Predrill: -	Termination	Soil Behaviour Type (SBT) - Robertson et al. 1986
Cone Reference: 000963	Water Level: -	Target Depth ☐	0 Undefined
Cone Area Ratio: 0.79	Collapse: 0.60m	Effective Refusal	1 Sensitive fine-grained
Standards: ISO 22476-1:2012 - Application Class 2		Tip ☐	2 Clay - organic soil
Zero load outputs (MPa)	Before test	Gauge ☒	3 Clays: clay to silty clay
Tip Resistance	22.3137	Inclinometer ☐	4 Silt mixtures: clayey silt & silty clay
Local Friction	0.2743	Other ☐	5 Sand mixtures: silty sand to sandy silt
Pore Pressure	2.9968		6 Sands: clean sands to silty sands
			7 Dense sand to gravelly sand
			8 Stiff sand to clayey sand
			9 Stiff fine-grained

Notes & Limitations Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal, Guide to Cone Penetration Testing for Geotechnical Engineering. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. No warranty is provided as to the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.	Remarks
	Sheet 1 of 1

Generated with Core-GS by Geroc

McMILLANDrilling		Client: ENGEO		Bore No.: CPTu005-S2					
		Project: Riverhead Forest		Job No.: 302460					
Site Location: Barlow & Forestry Road, Auckland				Date: 7/3/2025					
Grid Reference: 1740930.48m E, 5931590.02m N (NZTM) - Handheld GPS				Rig Operator: R. Negi					
Elevation: 0.00m		Datum: Ground		Equipment: Geomil Panther 100					
RAW DATA					SOIL BEHAVIOUR TYPE (NON-NORMALISED)	ESTIMATED PARAMETERS			
Predrill	Cone resistance qc (MPa)	Sleeve friction fs (MPa)	Pore pressure u2 (kPa)	Inclination (Degrees)	Scale	Friction ratio Rf	Dr (%)	Su (kPa)	N60
						SBT			
	qc x 10	fs x 10							
						Sand mixtures: silty sand to sandy silt			
EOH: 12m									

TEST DETAIL

PointID: CPTu001-S2
Sounding: 1

Operator: R. Negi
Cone Type: Pagani Piezocone - Compression
Cone Reference: 000963
Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	22.3082	22.2692
Local Friction	0.2741	0.2735
Pore Pressure	2.9982	3.0062

Date: 7/3/2025
Predrill: 0.00m
Water Level: -
Collapse: 0.90m

Termination
Target Depth ☐
Effective Refusal
Tip ☐
Gauge ☒
Inclinometer ☐
Other ☐

PointID: CPTu002-S2
Sounding: 1

Operator: R. Negi
Cone Type: Pagani Piezocone - Compression
Cone Reference: 000963
Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	22.3082	22.2803
Local Friction	0.2747	0.2740
Pore Pressure	2.9979	2.9972

Date: 6/3/2025
Predrill: 0.00m
Water Level: -
Collapse: 1.05m

Termination
Target Depth ☐
Effective Refusal
Tip ☐
Gauge ☐
Inclinometer ☐
Other: Pore pressure ☒

PointID: CPTu003-S2
Sounding: 1

Operator: R. Negi
Cone Type: Pagani Piezocone - Compression
Cone Reference: 000963
Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	22.3026	22.2748
Local Friction	0.2738	0.2733
Pore Pressure	2.9968	2.9966

Date: 6/3/2025
Predrill: 0.00m
Water Level: -
Collapse: 0.90m

Termination
Target Depth ☐
Effective Refusal
Tip ☐
Gauge ☒
Inclinometer ☐
Other ☐

PointID: CPTu004-S2
Sounding: 1

Operator: R. Negi
Cone Type: Pagani Piezocone - Compression
Cone Reference: 000963
Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	22.3137	22.2748
Local Friction	0.2743	0.2736
Pore Pressure	2.9968	2.9965

Date: 6/3/2025
Predrill: 0.00m
Water Level: -
Collapse: 0.60m

Termination
Target Depth ☐
Effective Refusal
Tip ☐
Gauge ☒
Inclinometer ☐
Other ☐

PointID: CPTu005-S2
Sounding: 1

Operator: R. Negi
Cone Type: Pagani Piezocone - Compression
Cone Reference: 000963
Cone Area Ratio: 0.79

Zero load outputs (MPa)	Before test	After test
Tip Resistance	22.3082	22.2748
Local Friction	0.2740	0.2736
Pore Pressure	2.9944	2.9943

Date: 7/3/2025
Predrill: 0.00m
Water Level: -
Collapse: 1.80m

Termination
Target Depth ☐
Effective Refusal
Tip ☐
Gauge ☒
Inclinometer ☐
Other ☐

CPT CALIBRATION AND TECHNICAL NOTES

These notes describe the technical specifications and associated calibration references pertaining to the Pagani piezocone types measuring cone resistance, sleeve friction, inclination and pore pressure (piezocone, 10cm²)

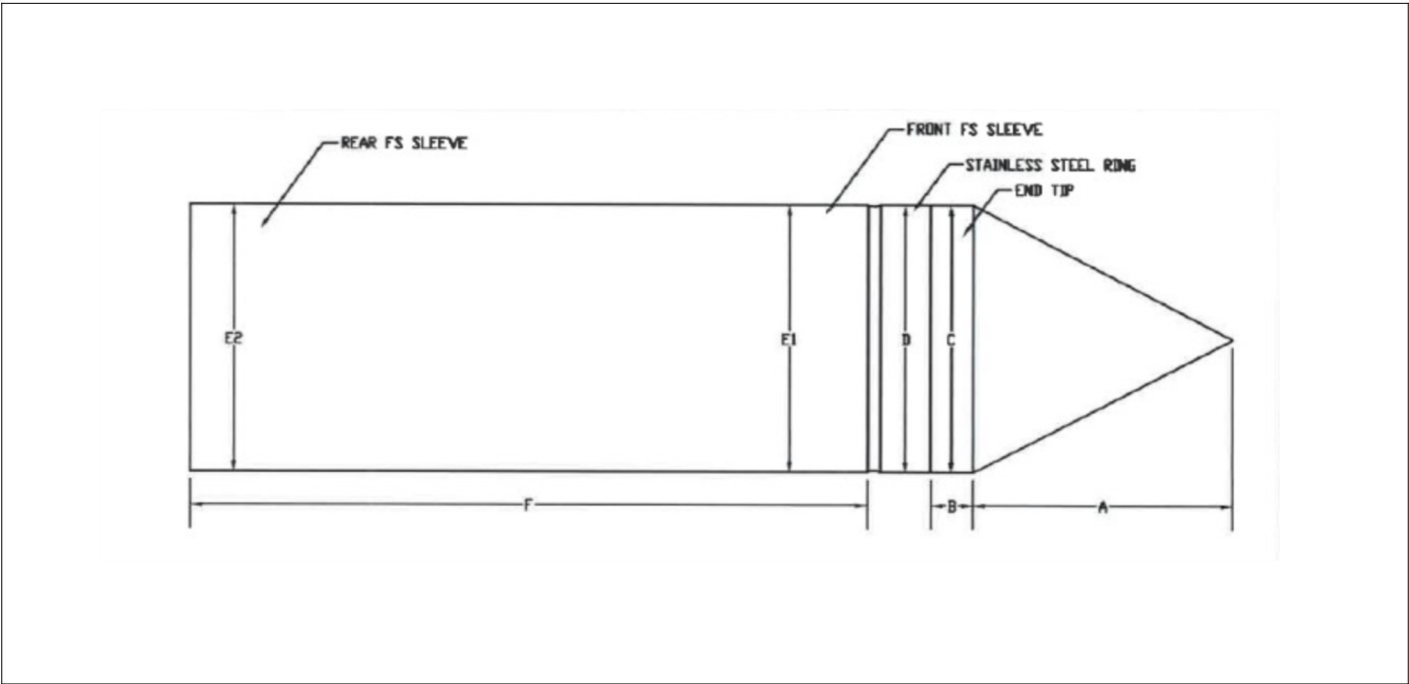
Dimensions

Dimensional specifications are detailed below. All tolerances are routinely checked prior to testing and measurements taken are electronically recorded. All records are kept on file and available on request.

Technical specifications

	Tip	Friction	Pore Pressure	Inclination
Maximum Measuring Range:	50 - 100 MPa	1.60 MPa	2.50 MPa	0° - 20°
Resolution:	24 bit	24 bit	24 bit	12 bit
Accuracy:	0.005 MPa	0.04 MPa	0.04 MPa	0.5°

Length:	320 mm	Weight:	1.8 kg
Diameter:	35.8 mm	Opening angle of bit:	60°
Cone base area:	10 cm ²	Side sleeve surfaces:	150 cm ²
Cone area ratio:	Varies - refer to cone certificate	Tip and Local Friction sensor displacement:	80 mm



CONE CERTIFICATES



CONE CALIBRATION CERTIFICATE		
N°	Z169/24	02/07/2024
Calibrated system (Sistema tarato):		
Type	P-C	
Serial number	000963	
Sensor	TIP RESISTANCE	
Max. Capacity [MPa]:	100	
Scaling Factor:	179710	
Tip net area ratio (a _n):	0,79	
Sleeve net ratio (b _n):	0,00	

Addressee (destinatario):	
McMillan Drilling Ltd	
36 Hickory Place, Islington	
Christchurch 8042, New Zealand	
Applied load measurement system:	
(Sistema di rilevamento del carico applicato)	

Load cell:	
Manufacturer	AEP transducers
Model	KAL 200 kN
Serial Number	138913
Power press:	
Manufacturer	Easydur Italiana
Model	Aura 20T
Serial Number	29084
The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)	
Last verification date:	11/01/2024
Certificate N.	LAT 091 2024-010
Temperature of calibration	22°C
Humidity	45%
Factory calibration in accordance with:	
ASTM D5778-12 Validity 12 Months	



CONE CALIBRATION CERTIFICATE		
N°	Z169/24	02/07/2024
Calibrated system (Sistema tarato):		
Type	P-C	
Serial number	000963	
Sensor	SLEEVE FRICTION	
Max. Capacity [kPa]:	1600	
Scaling Factor:	31361	

Addressee (destinatario):	
McMillan Drilling Ltd	
36 Hickory Place, Islington	
Christchurch 8042, New Zealand	
Applied load measurement system:	
(Sistema di rilevamento del carico applicato)	

Load cell:	
Manufacturer	AEP transducers
Model	KAL 50 kN
Serial Number	65495
Power press:	
Manufacturer	Easydur Italiana
Model	Aura 10T
Serial Number	29002
The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)	
Last verification date:	11/01/2024
Certificate N.	LAT 091 2024-009
Temperature of calibration	22°C
Humidity	45%
Factory calibration in accordance with:	
ASTM D5778-12 Validity 12 Months	



CONE CALIBRATION CERTIFICATE		
N°	Z169/24	02/07/2024
Calibrated system (Sistema tarato):		
Type	P-C	
Serial number	000963	
Sensor	PORE PRESSURE	
Max. Capacity [kPa]:	2500	
Scaling Factor:	10504	

Sensor	TILT ANGLE	
Max. Inclination [°]:	20	
Scaling Factor:	336351	

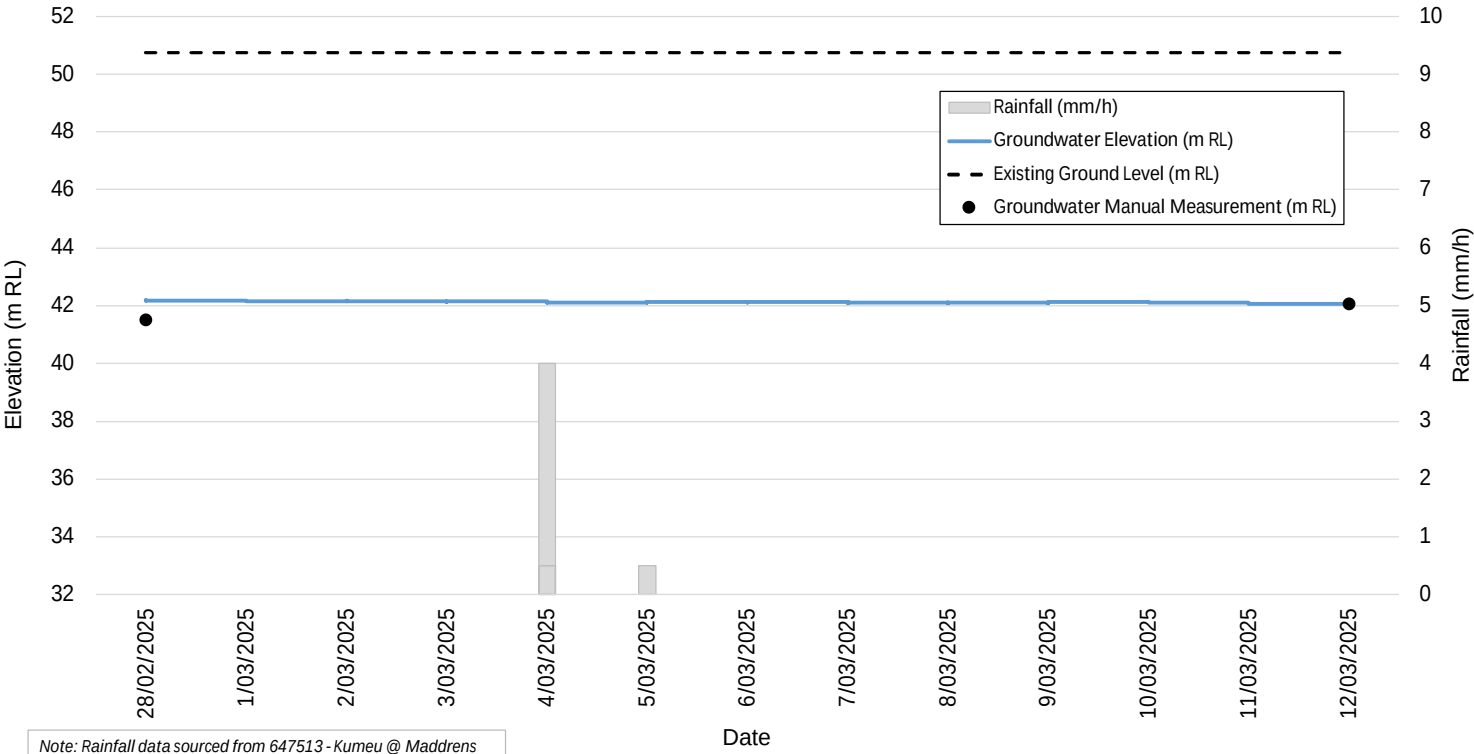
Addressee (destinatario):	
McMillan Drilling Ltd	
36 Hickory Place, Islington	
Christchurch 8042, New Zealand	
Applied load measurement system:	
(Sistema di rilevamento del carico applicato)	

Pressure Generator:	
Manufacturer	MENSOR
Model	CPC 4000
Serial Number	41000V56
Sensor Descr	Silicon Pressure Transducer
Sensor Serial Number	41000V3Y

The measurement system is periodically checked in a SIT calibration center. (Il sistema di rilevamento è sottoposto a verifica periodica presso un centro SIT)	
Last verification date:	09/05/2024
Certificate N.	0269-SP-24
Temperature of calibration	22°C
Humidity	45%
Factory calibration in accordance with:	
ASTM D5778-12 Validity 12 Months	

APPENDIX 6: Groundwater Monitoring Plots

MBH02 - 28.02.2025 - 12.03.2025



Note: Rainfall data sourced from 647513 - Kumeu @ Maddrens rainfall gauge.

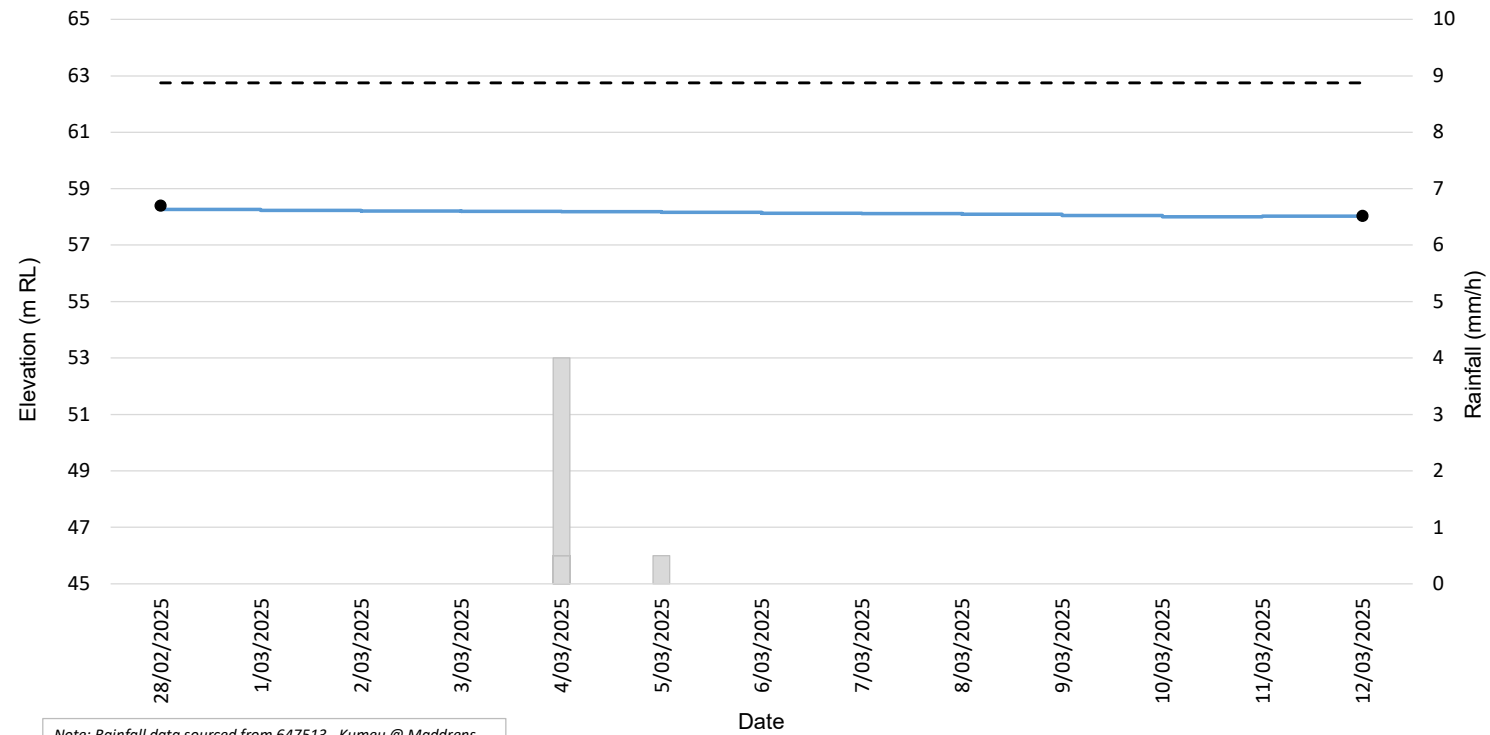


Auckland Office
Level 1, 1-7 The Strand, Takapuna
Auckland 0622
Tel: 09 972 2205

Site Address:
**Forestry Road, Riverhead
Auckland**

Date:	13/3/2025	Client:	Rangitoopuni Developments LP
Drawn:	JS	Project:	Geotechnical Investigation
Approved:	RB	Description:	Groundwater Monitoring February - March 2025
Appendix:	7	Project No.	20190.000.001

MBH03 - 28.02.2025 - 12.03.2025



Note: Rainfall data sourced from 647513 - Kumeu @ Maddrens rainfall gauge.

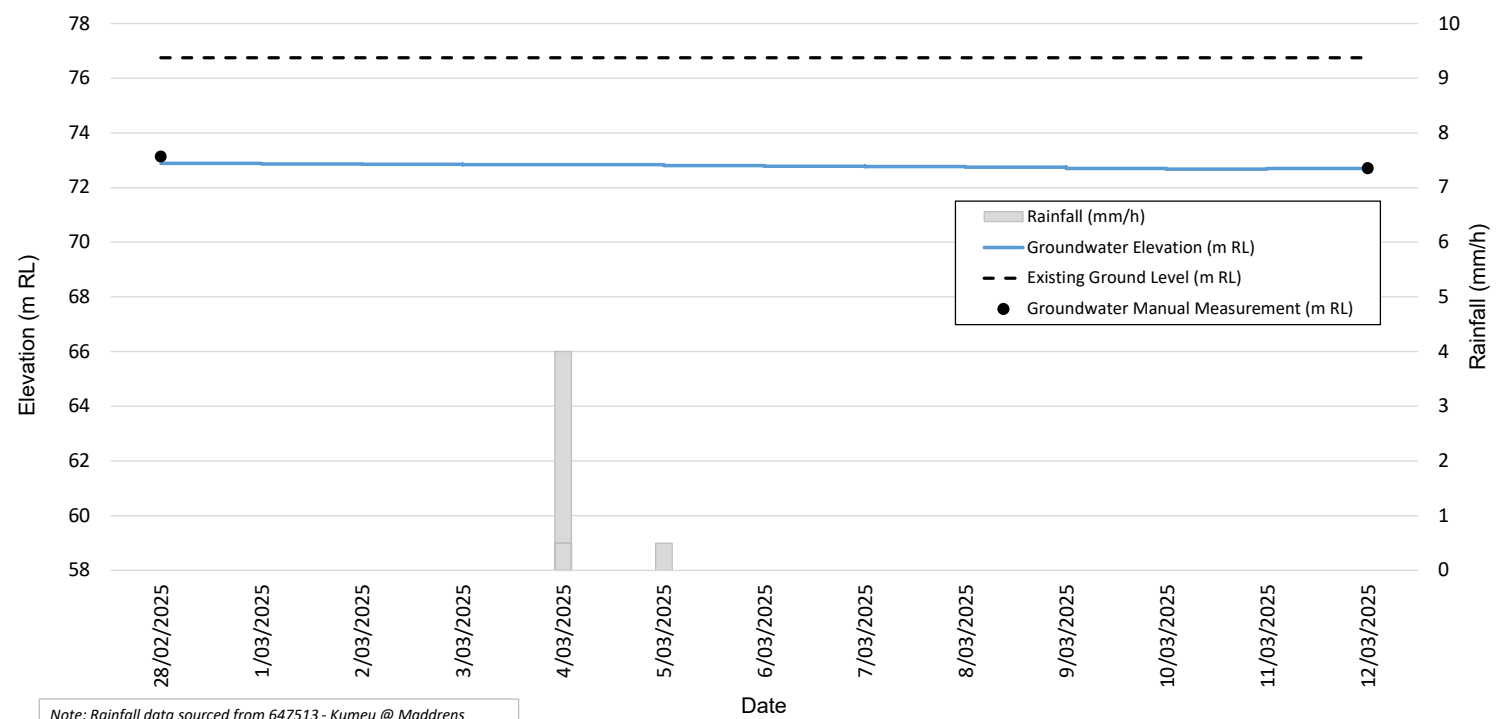


Auckland Office
Level 1, 1-7 The Strand, Takapuna
Auckland 0622
Tel: 09 972 2205

Site Address:
Forestry Road, Riverhead
Auckland

Date:	13/3/2025	Client:	Rangitopuni Developments LP
Drawn:	JS	Project:	Geotechnical Investigation
Approved:	RB	Description:	Groundwater Monitoring February - March 2025
Appendix:	7	Project No.	20190.000.001

MBH06 - 28.02.2025 - 12.03.2025



Note: Rainfall data sourced from 647513 - Kumeu @ Maddrens rainfall gauge.



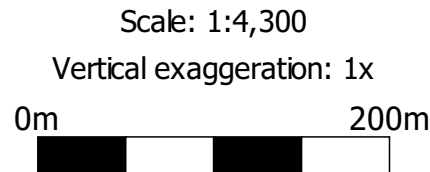
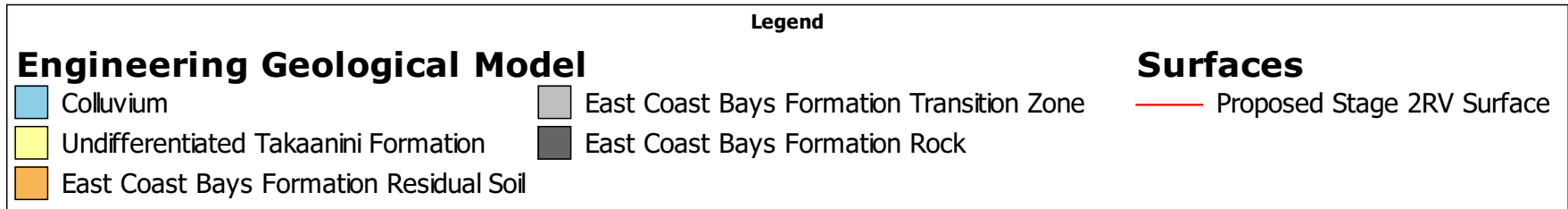
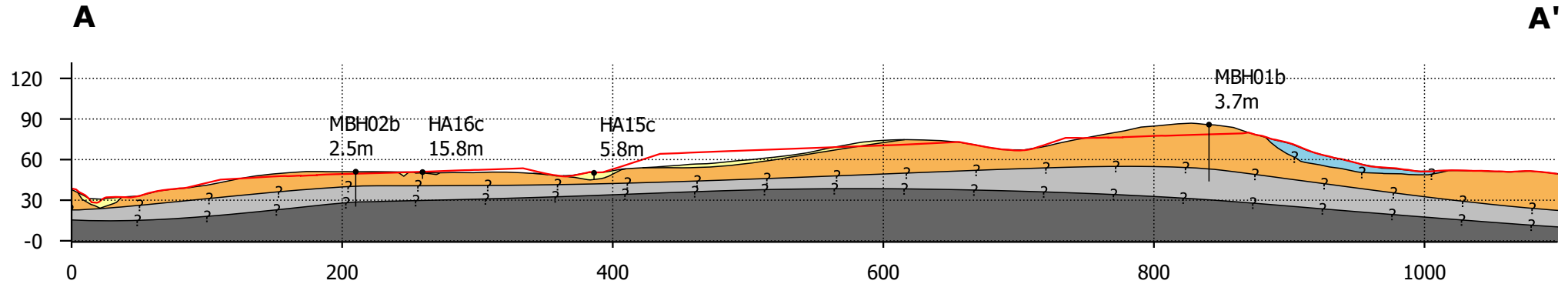
Auckland Office
Level 1, 1-7 The Strand, Takapuna
Auckland 0622
Tel: 09 972 2205

Site Address:
Forestry Road, Riverhead
Auckland

Date:	13/3/2025	Client:	Rangitootuni Developments LP
Drawn:	JS	Project:	Geotechnical Investigation
Approved:	RB	Description:	Groundwater Monitoring February - March 2025
Appendix:	7	Project No.	20190.000.001

APPENDIX 7: Geological Cross Sections

Stage 2RV Geological Cross Section A-A'

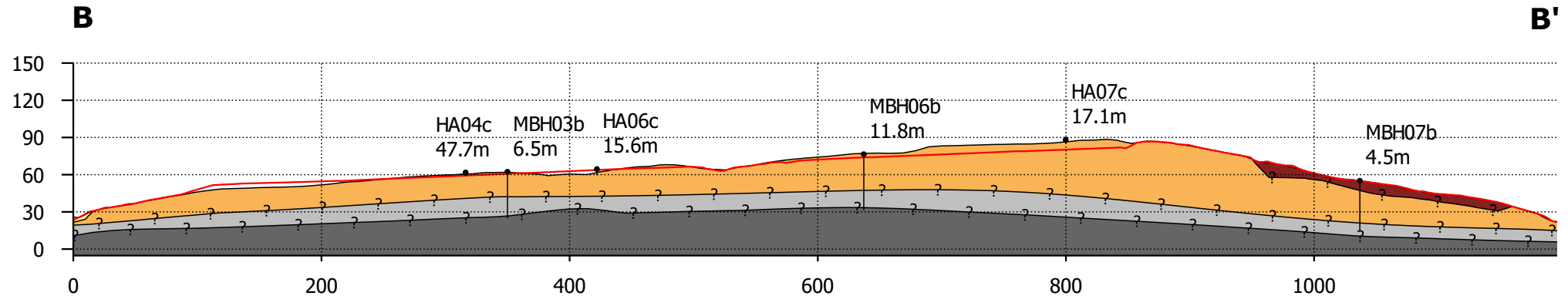


Location

A: 383324, 814887, 132
A': 384139, 814151, 132

Responsible dept. ENGEO AKL	Technical reference 20190.000.001	Creator Luke Mackinnon	Approved by Harrison Palmer		
Legal owner 		Document type Conceptual Ground Model		Document status Final	
		Title Rangitopuni Riverhead Stage 2RV Cross Section A-A'		Identification number 20190.000.001_01	
				Rev. 01	Date of issue 21.03.2025

Stage 2RV Geological Cross Section B-B'



Engineering Geological Model

- Undifferentiated Takaanini Formation
- Albany Conglomerate
- East Coast Bays Formation Residual Soil

- East Coast Bays Formation Transition Zone
- East Coast Bays Formation Rock

Surfaces

- Proposed Stage 2RV Surface

Scale: 1:4,700

Vertical exaggeration: 1x

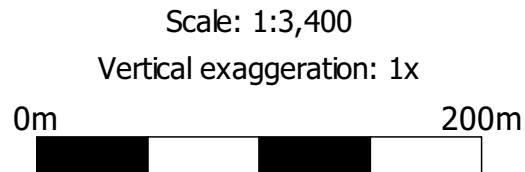
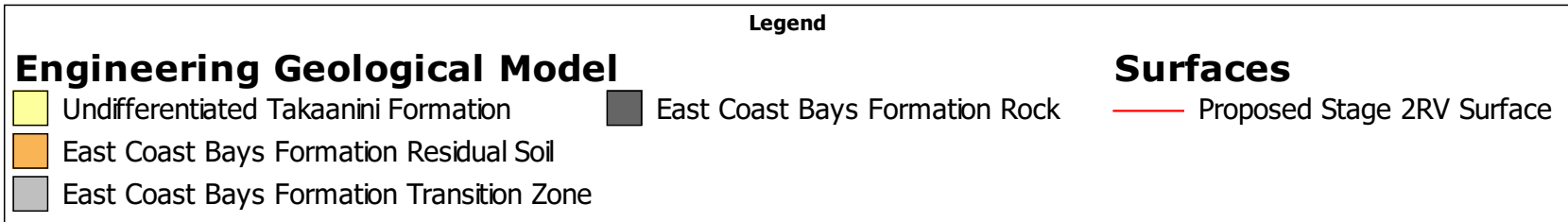
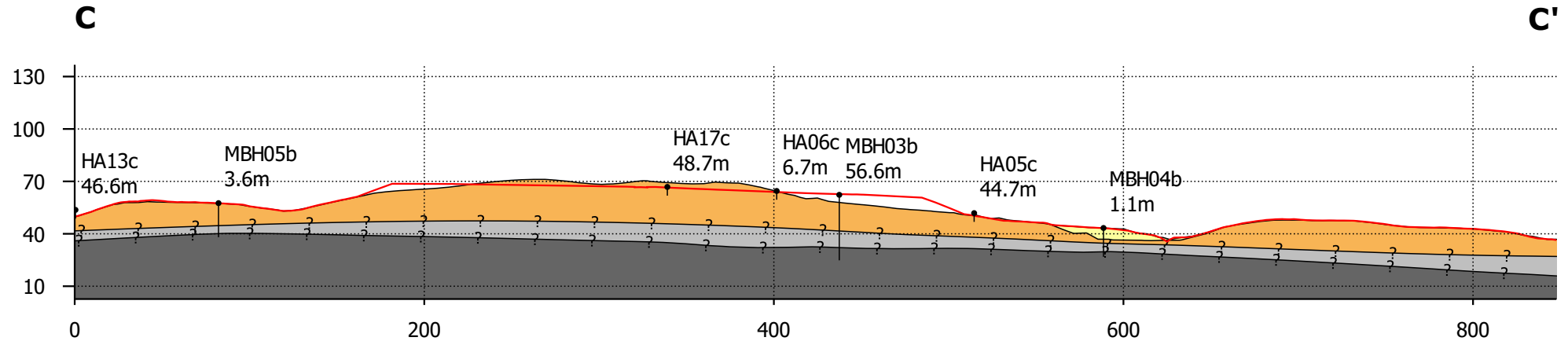


Location

B: 383201, 814557, 150
B': 384273, 814027, 150

Responsible dept. ENGEO AKL	Technical reference 20190.000.001	Creator Luke Mackinnon	Approved by Harrison Palmer		
Legal owner 		Document type Conceptual Ground Model		Document status Final	
		Title Rangitopuni Riverhead Stage 2RV Cross Section B-B'		Identification number 20190.000.001_01	
				Rev. 01	Date of issue 21.03.2025
				Sheet 1	

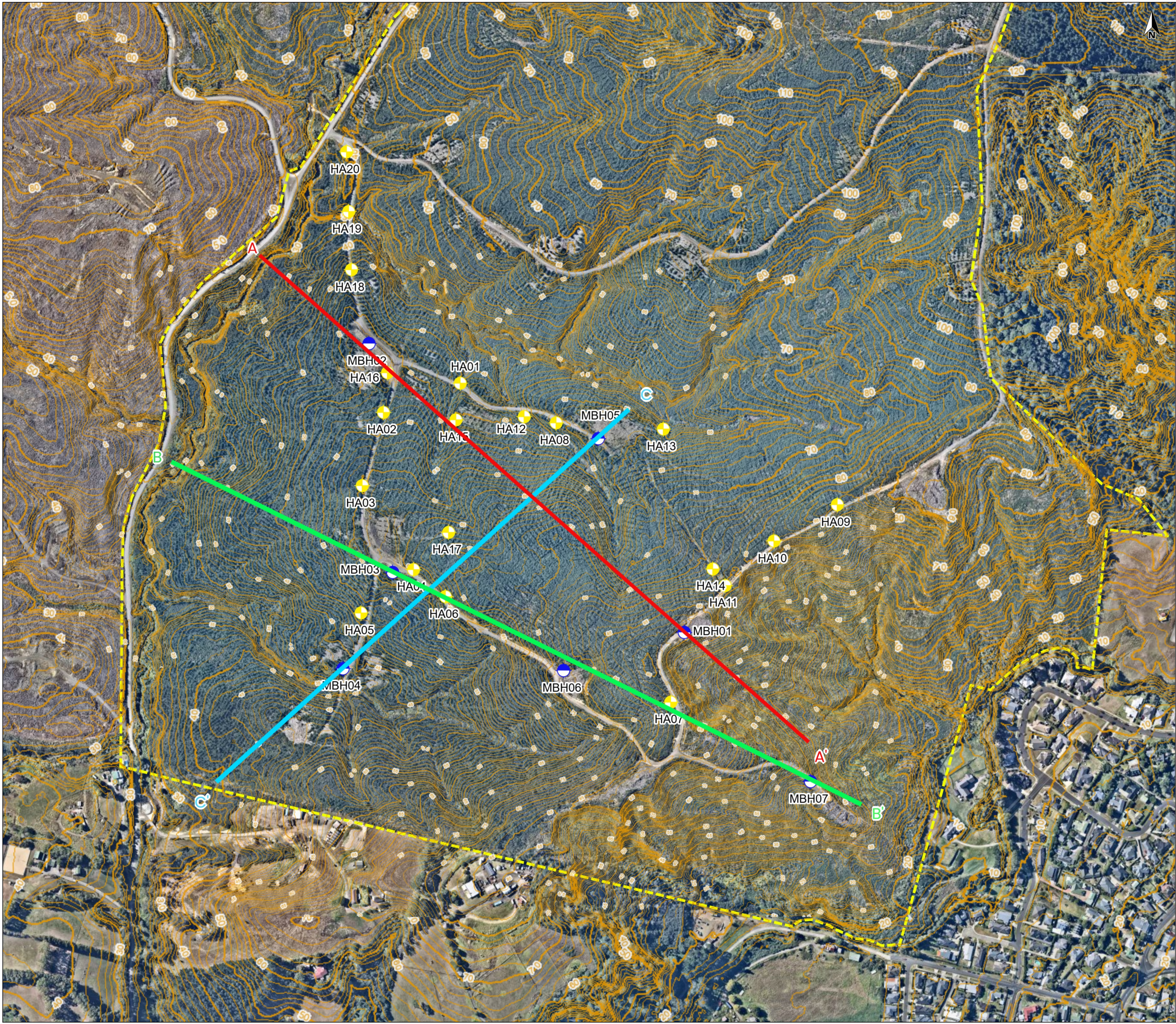
Stage 2RV Geological Cross Section C-C'



Location

C: 383883, 814655, 137
C': 383247, 814094, 137

Responsible dept. ENGEO AKL	Technical reference 20190.000.001	Creator Luke Mackinnon	Approved by Harrison Palmer		
Legal owner 		Document type Conceptual Ground Model		Document status Final	
		Title Rangitopuni Riverhead Stage 2RV Cross Section C-C'		Identification number 20190.000.001_01	
				Rev. 01	Date of issue 21.03.2025



- Legend**
- Stage 2RV EGM Cross Section A-A'
 - Stage 2RV EGM Cross Section B-B'
 - Stage 2RV EGM Cross Section C-C'
 - Hand Auger Boreholes (ENGEO, 2025)
 - Machine Boreholes (ENGEO, 2025)
 - Stage 2 Site Boundary

0 50 m 100 m
© Nearmap,

ENGEO

Produced by **Datanest.earth**

APPENDIX 8: Liquefaction Assessment

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CPT-Test CPT03 results	
Summary data report	15
CPT-Test CPT04 results	
Summary data report	22
CPT-Test CPT05 results	
Summary data report	29

LIQUEFACTION ANALYSIS REPORT

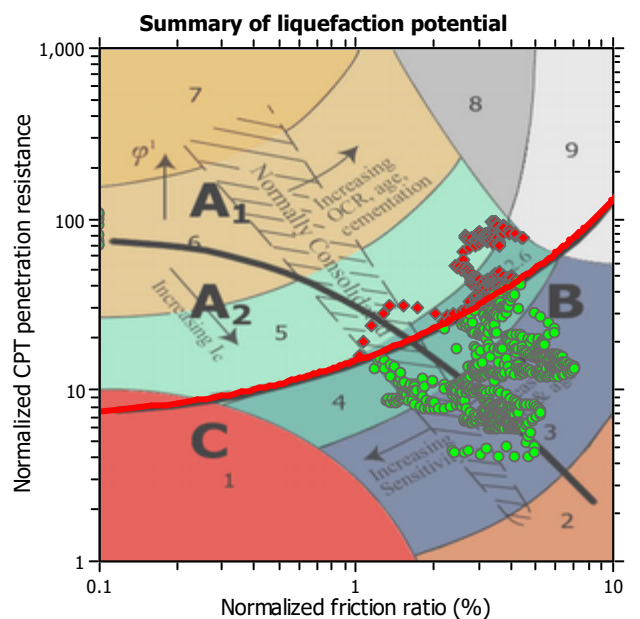
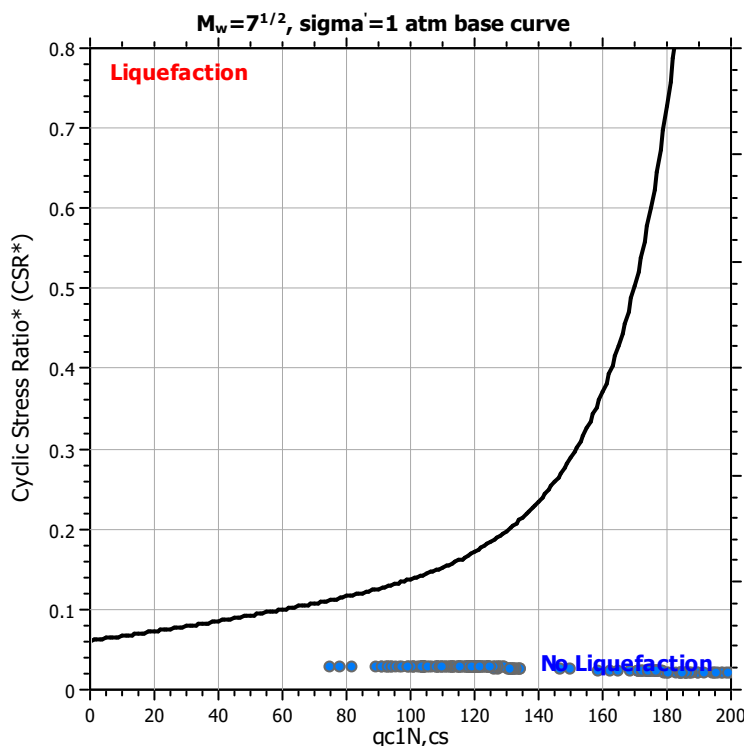
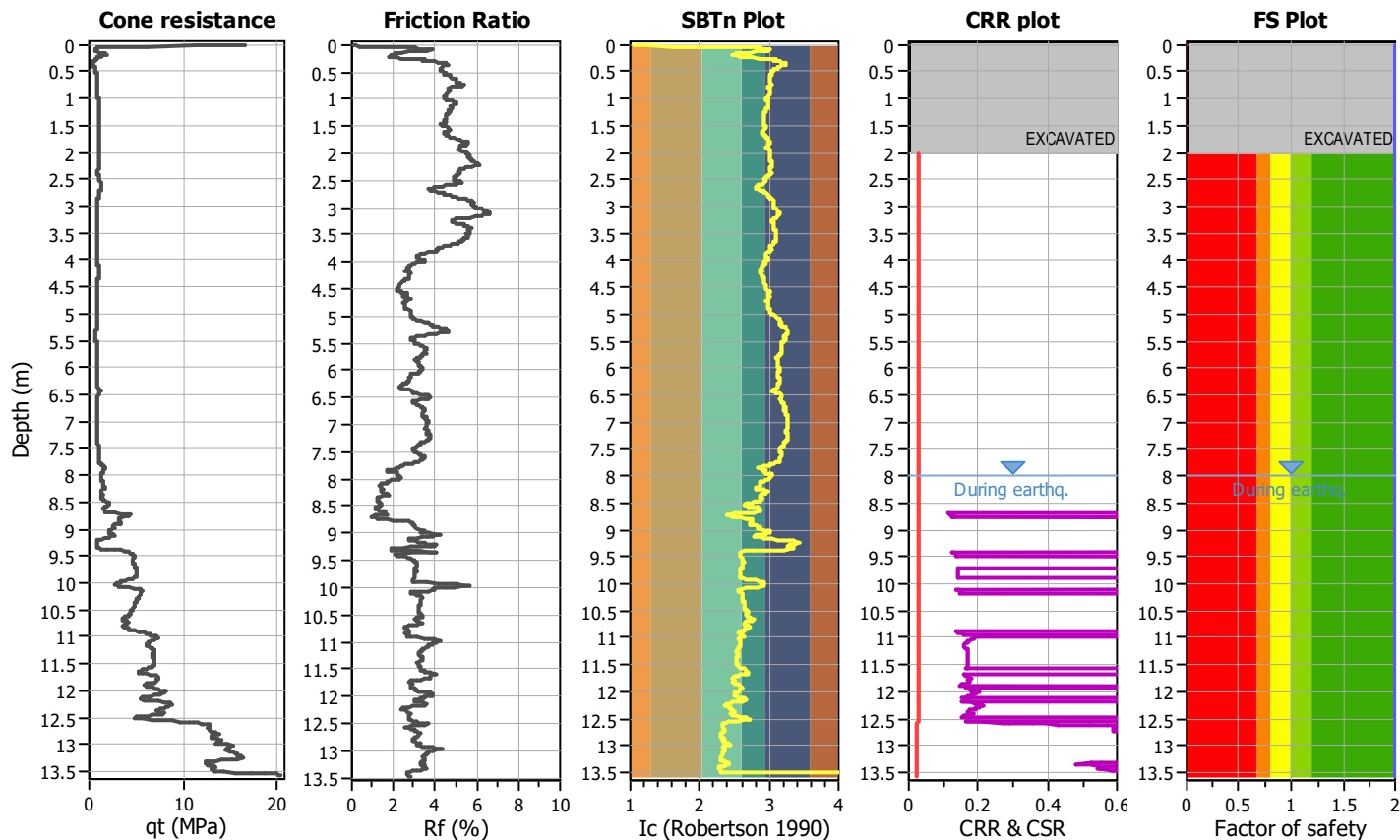
Project title :

Location :

CPT file : CPT-Test CPT01

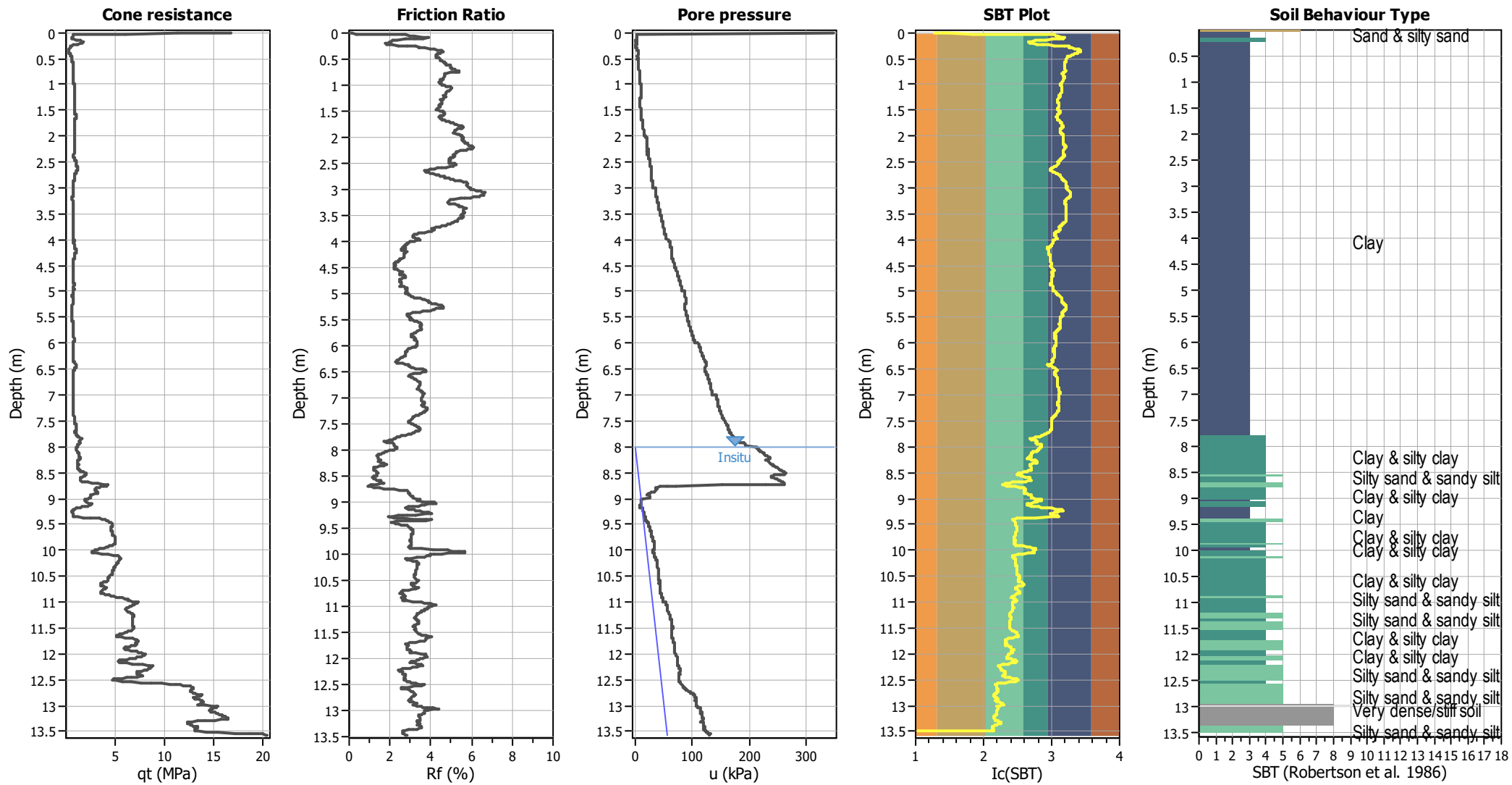
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 m	Excavation:	Yes	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 m	Excavation depth:	2.00 m	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	36.00 kPa	Limit depth:	N/A
Earthquake magnitude M_w :	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.05	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots

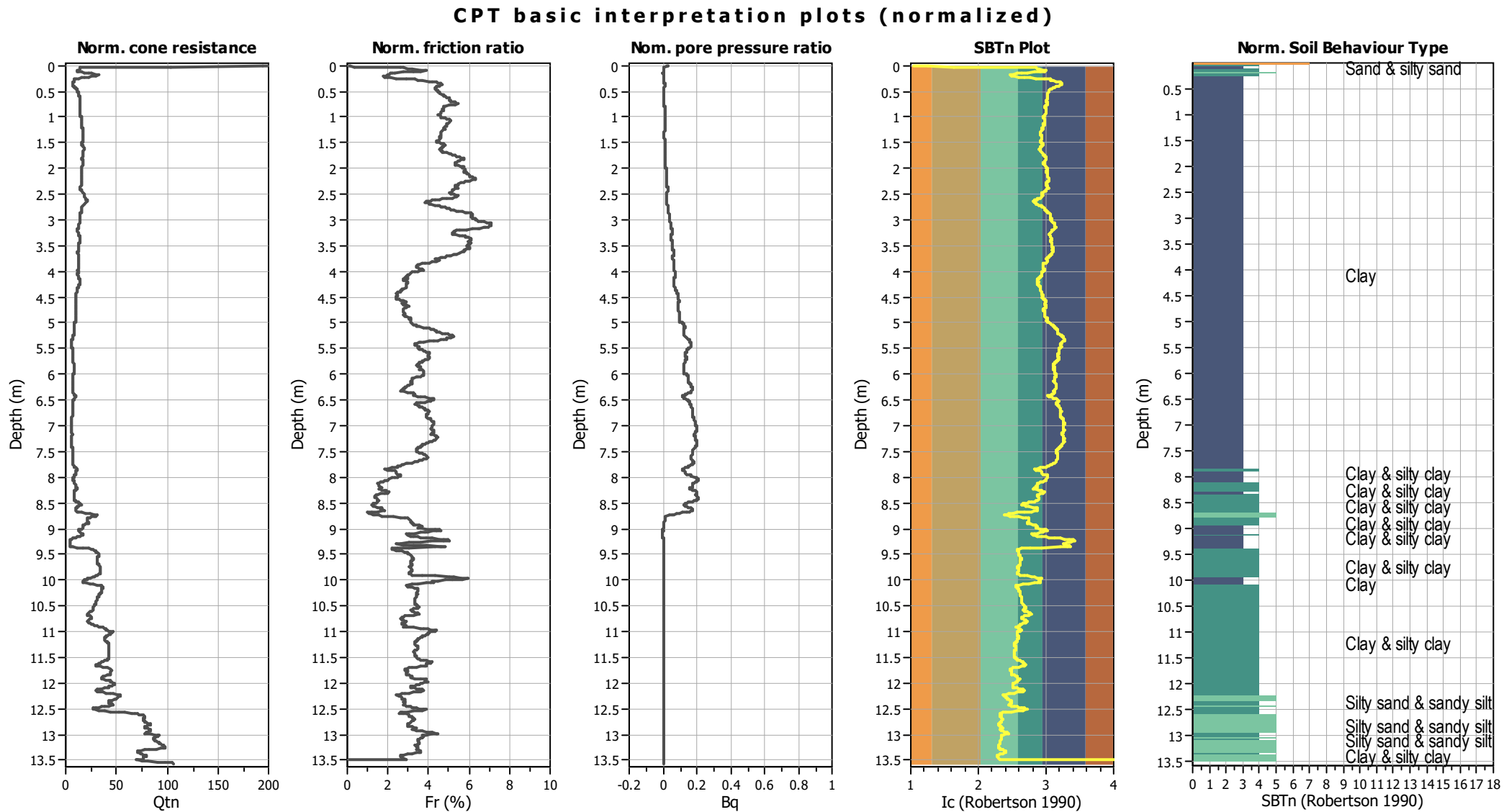


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	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



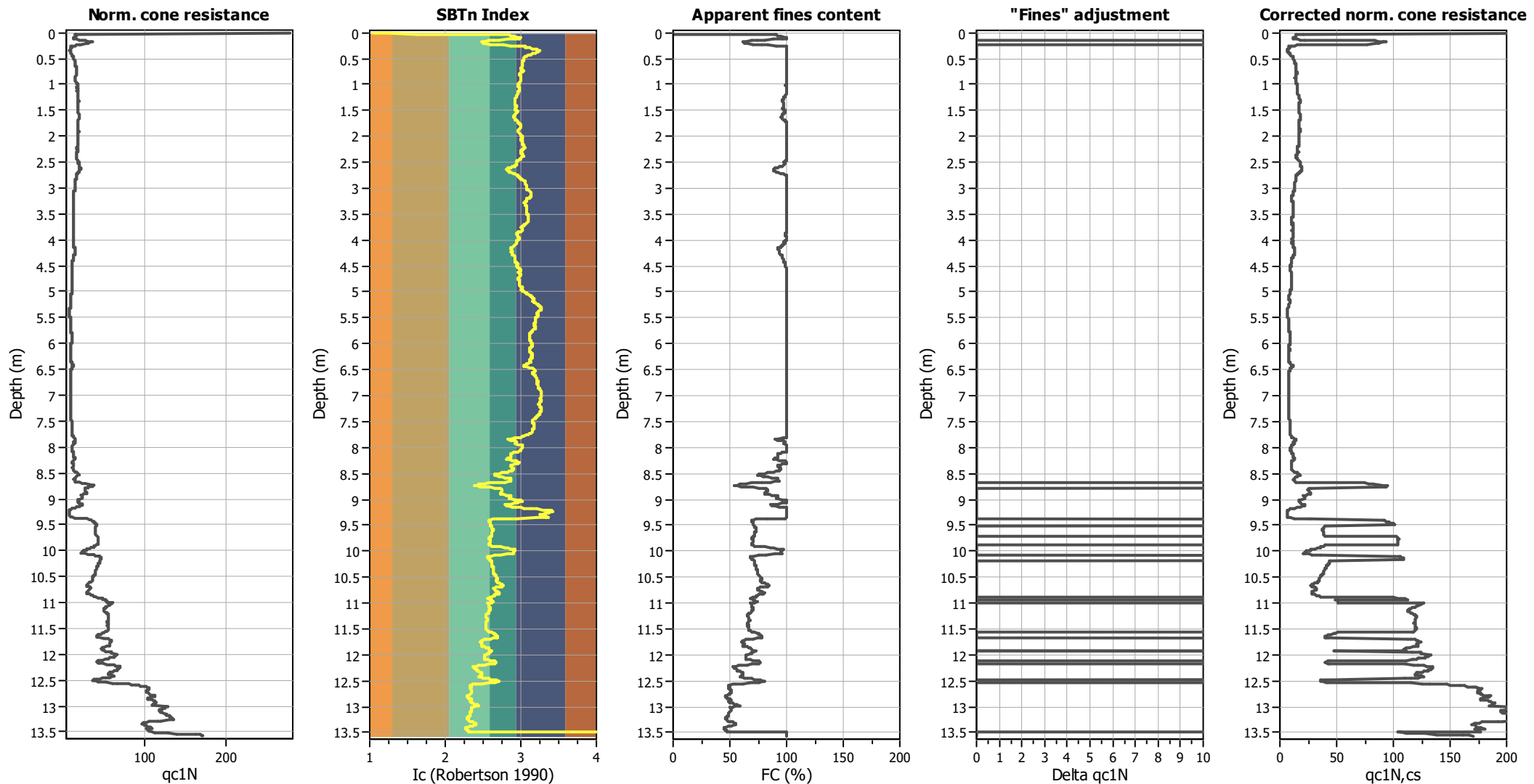
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A

SBTn legend

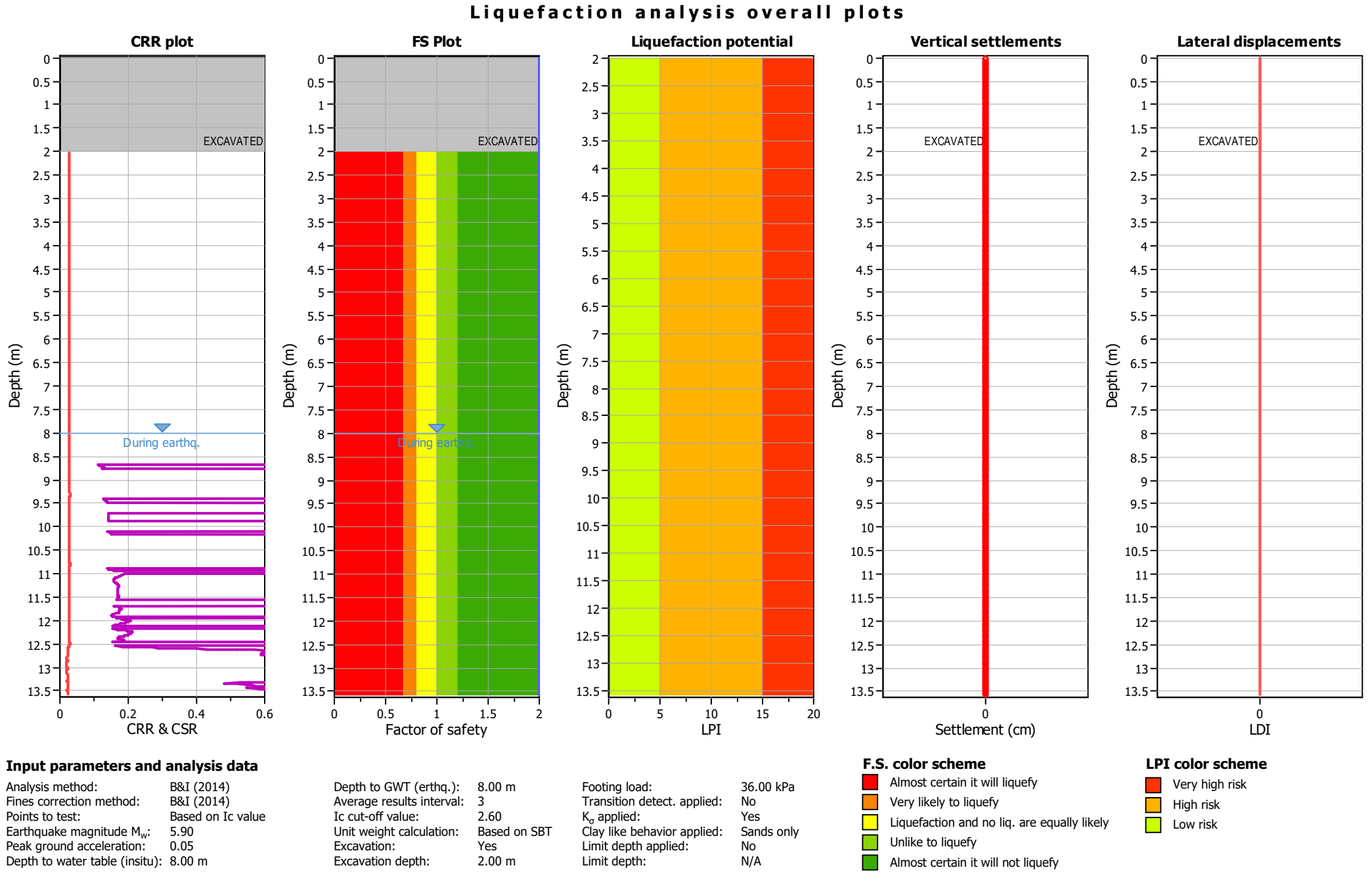
1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)

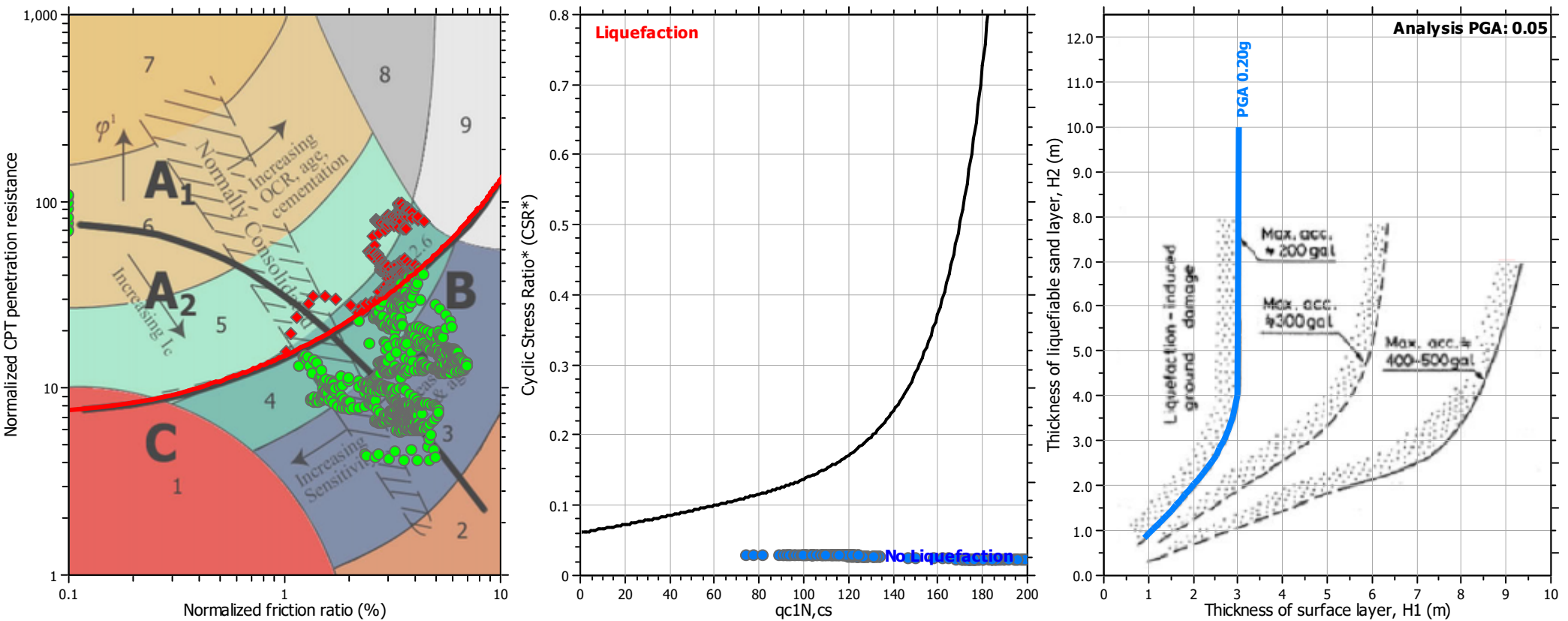


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _q applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A

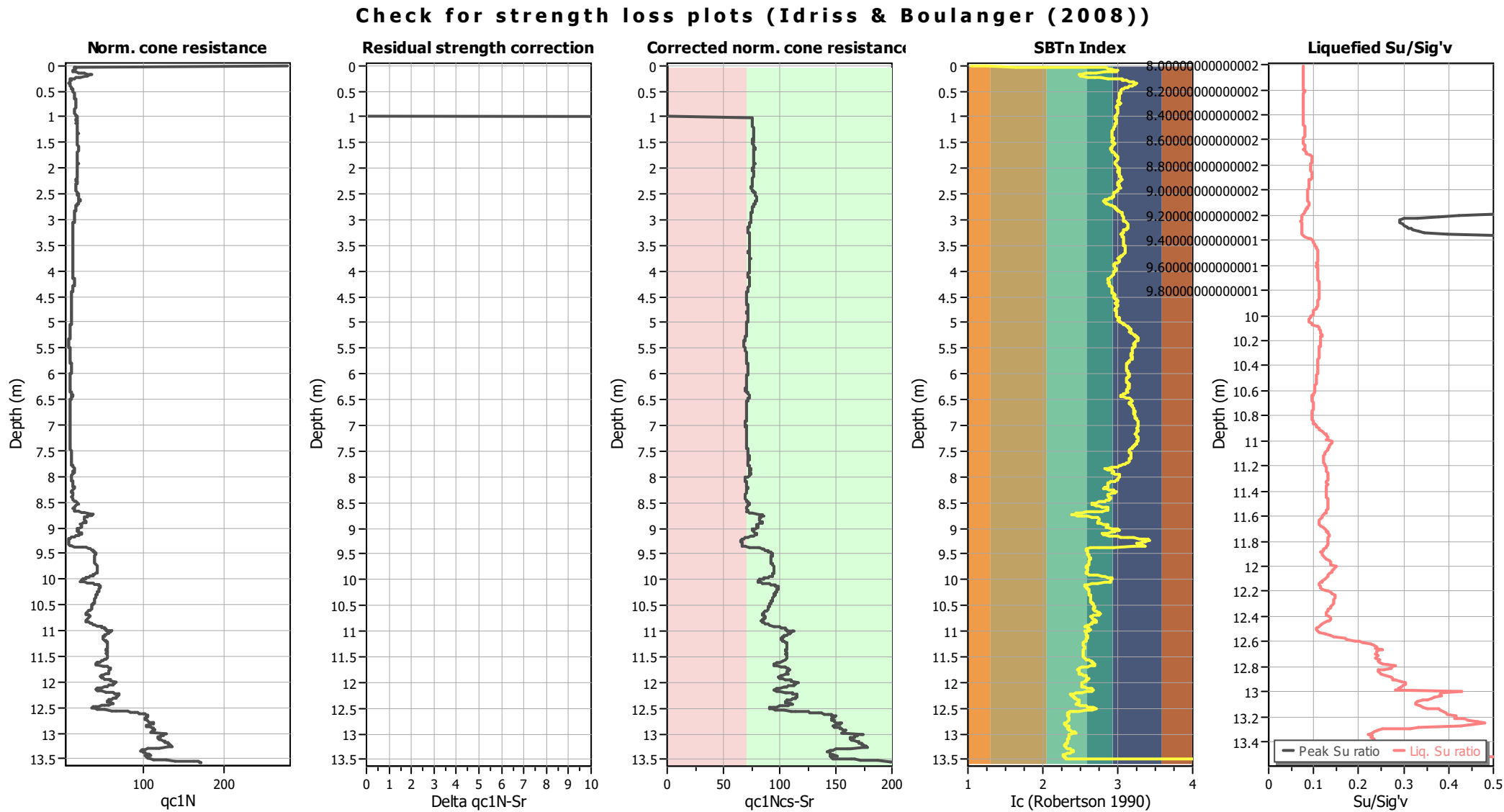


Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

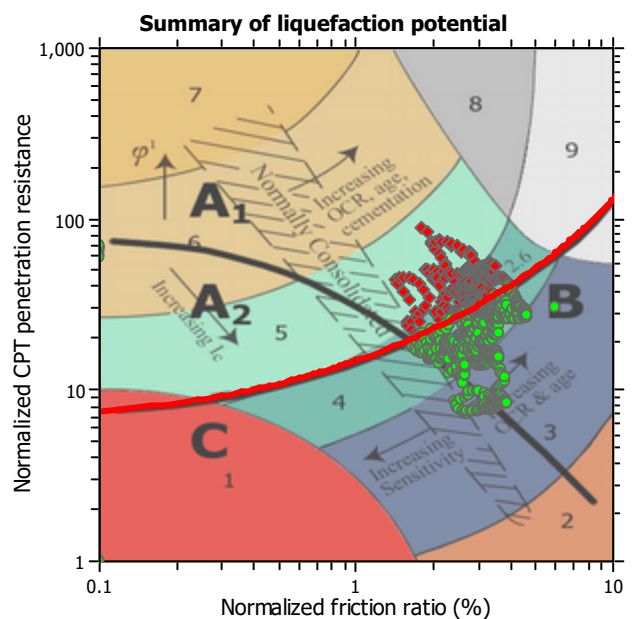
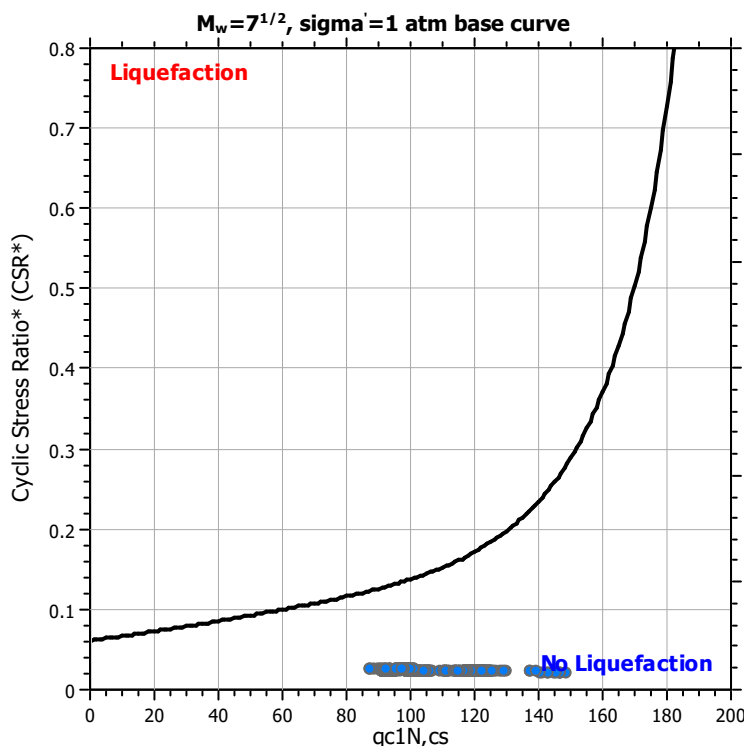
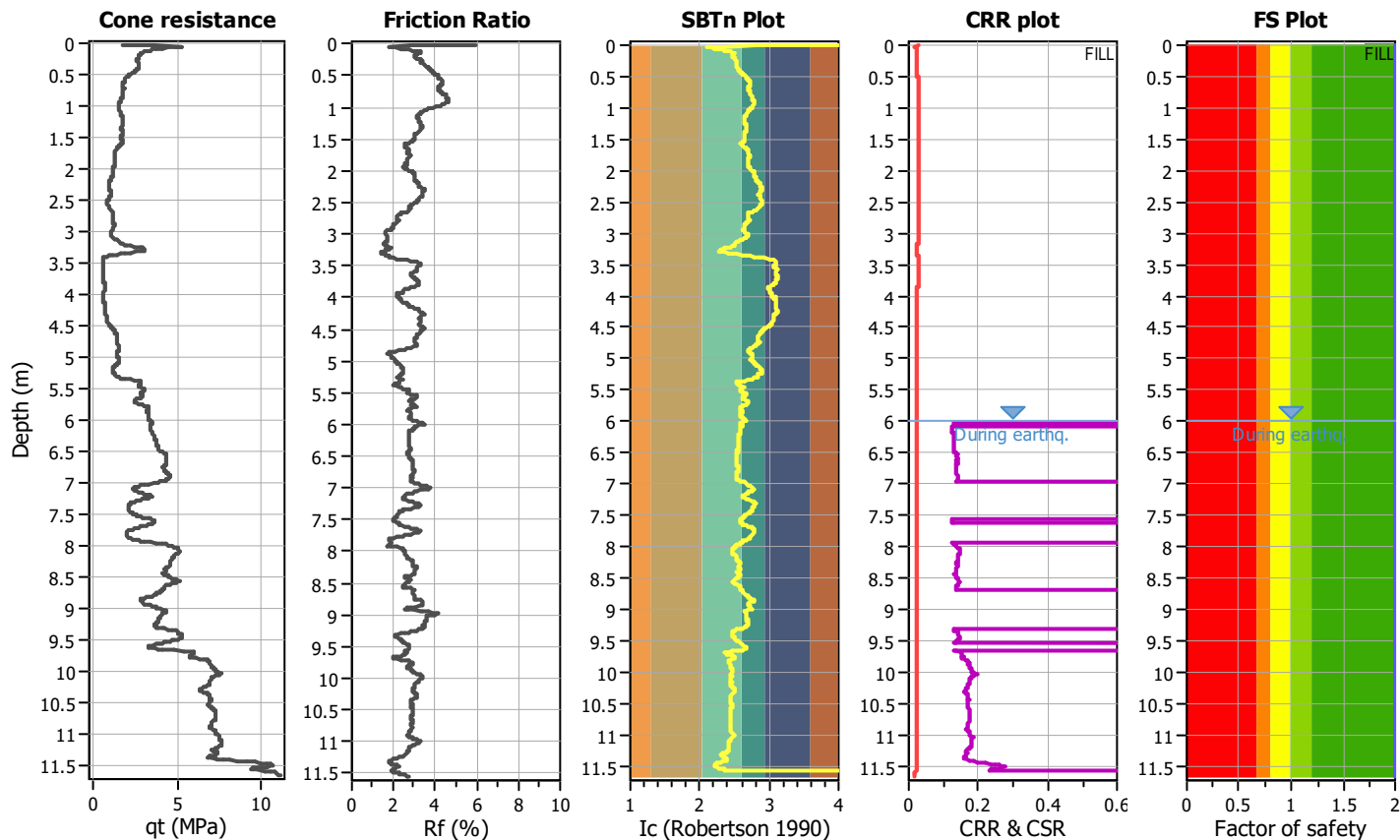
Project title :

Location :

CPT file : CPT-Test CPT02

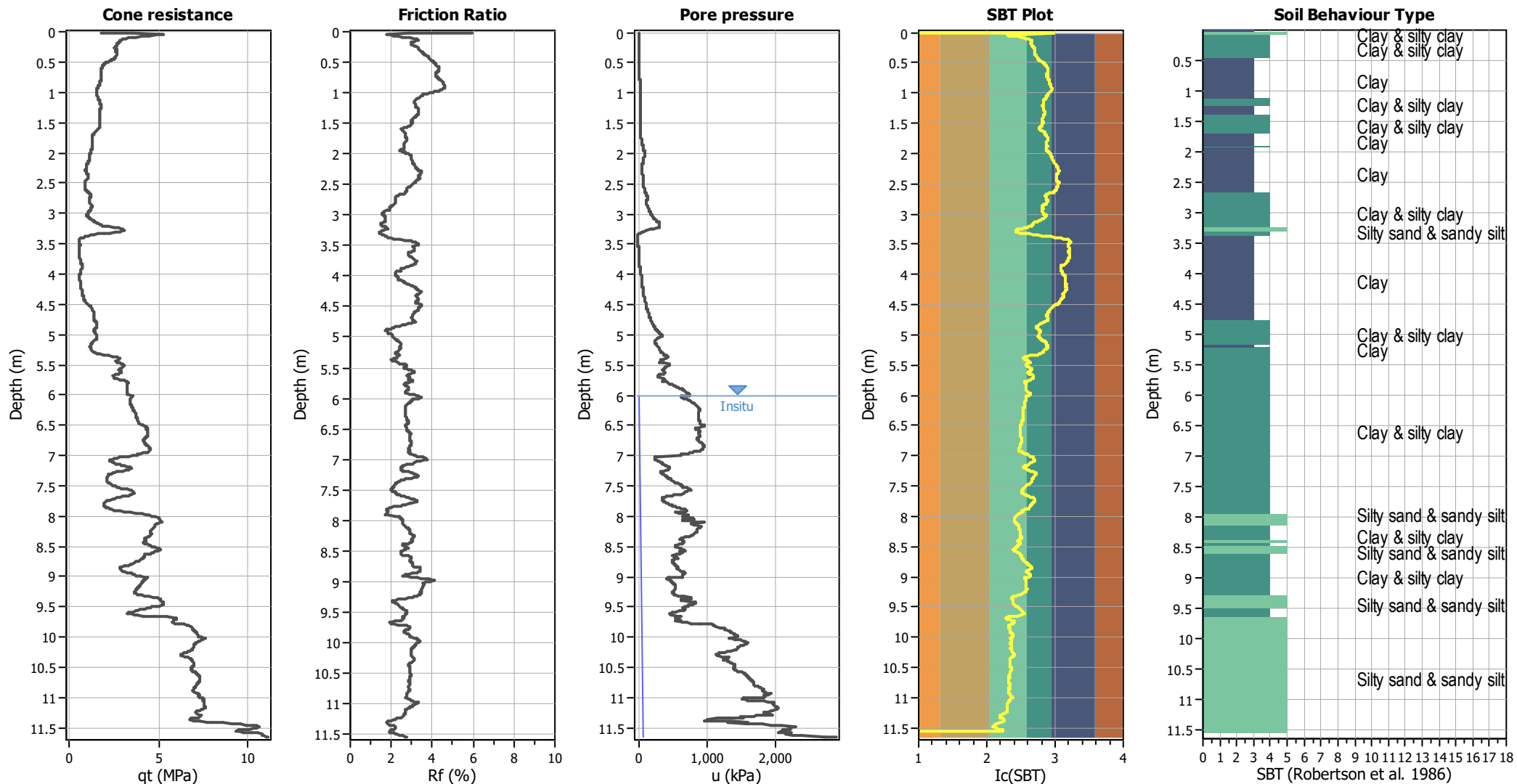
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 m	Use fill:	Yes	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	11.00 m	Fill height:	5.00 m	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	19.00 kN/m ³	Limit depth applied:	No
Earthquake magnitude M_w :	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.05	Unit weight calculation:	Based on SBT	K_g applied:	Yes	MSF method:	Method



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots

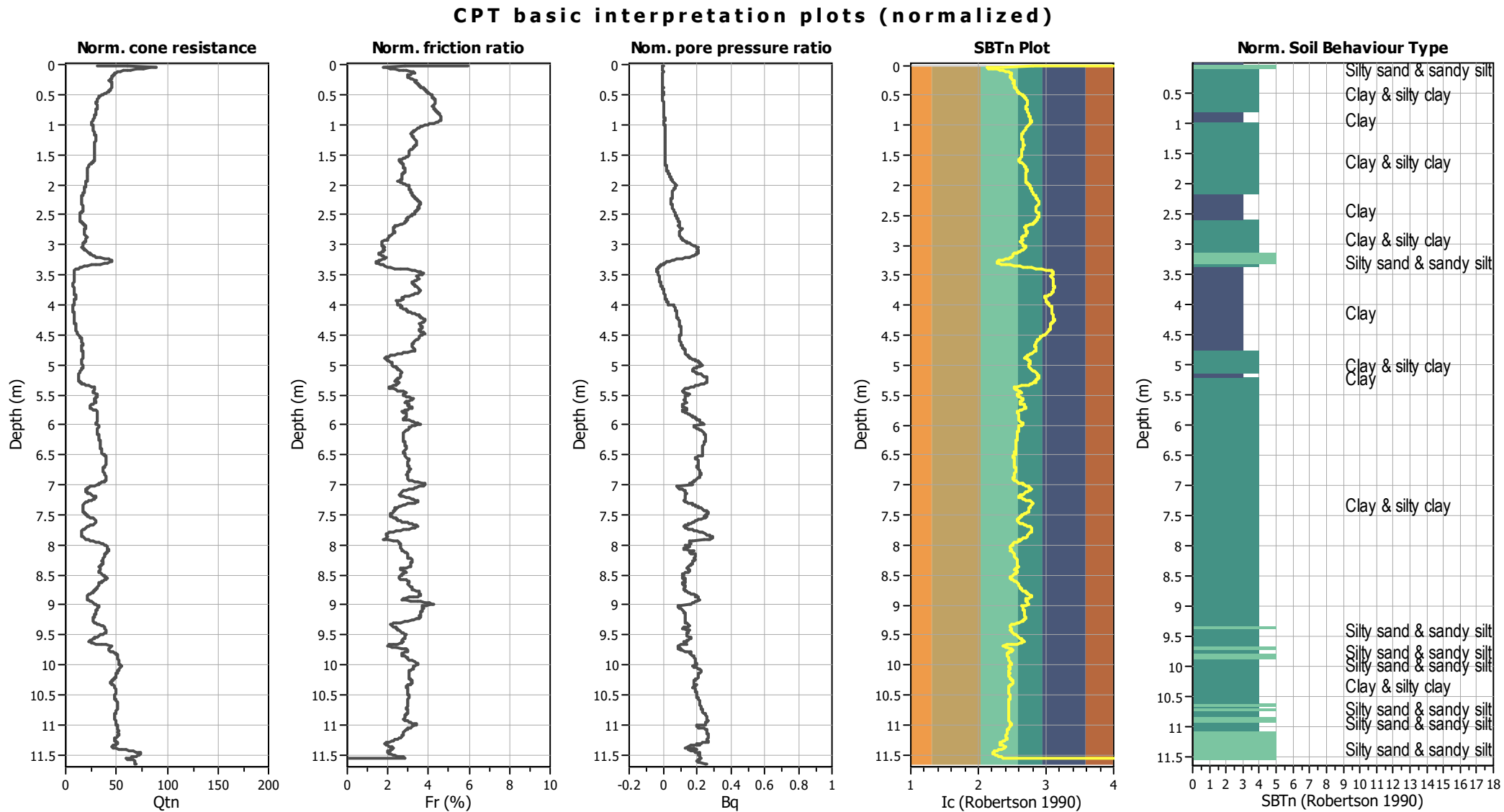


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained

2. Organic material

3. Clay to silty clay

4. Clayey silt to silty

5. Silty sand to sandy silt

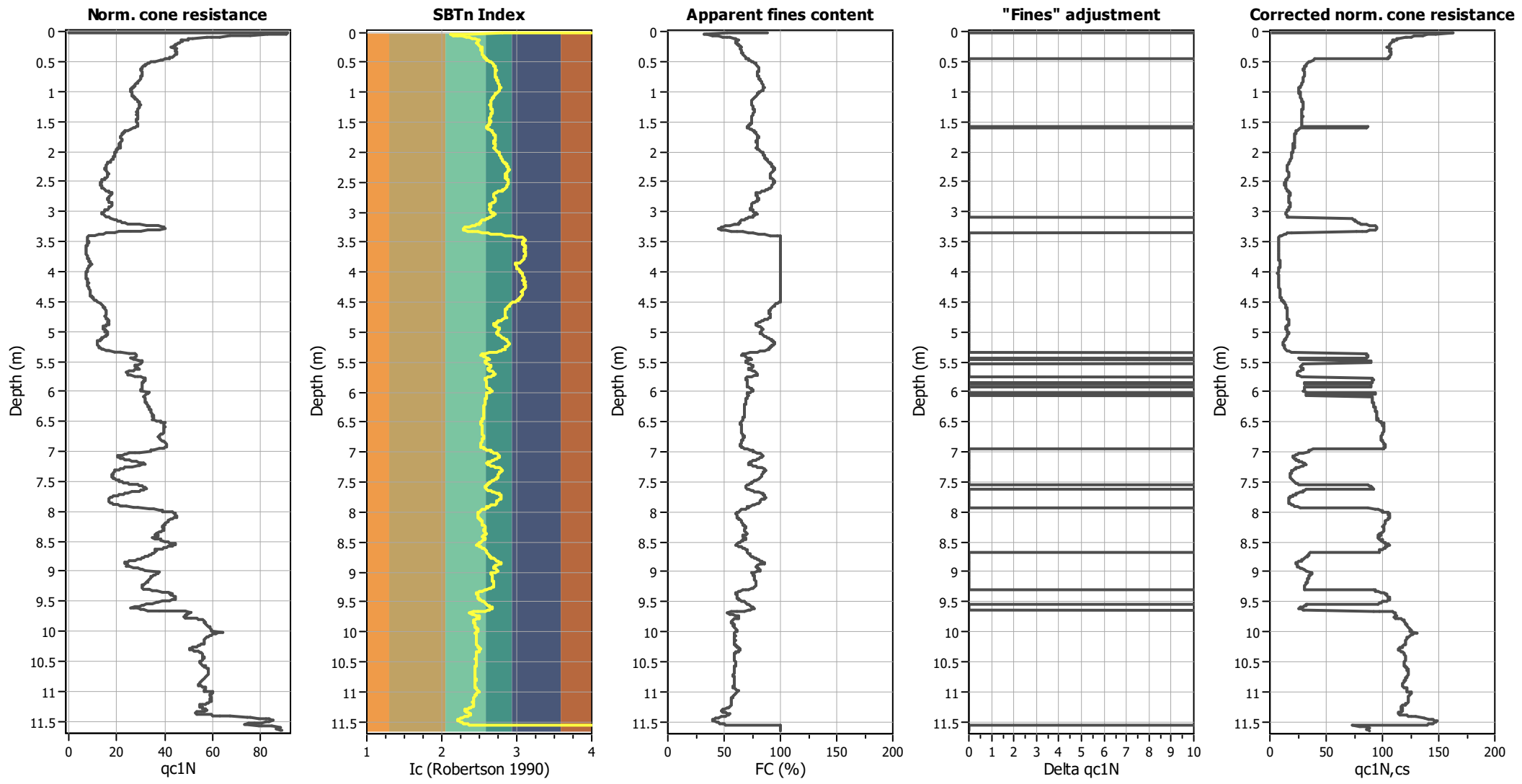
6. Clean sand to silty sand

7. Gravely sand to sand

8. Very stiff sand to

9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _σ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

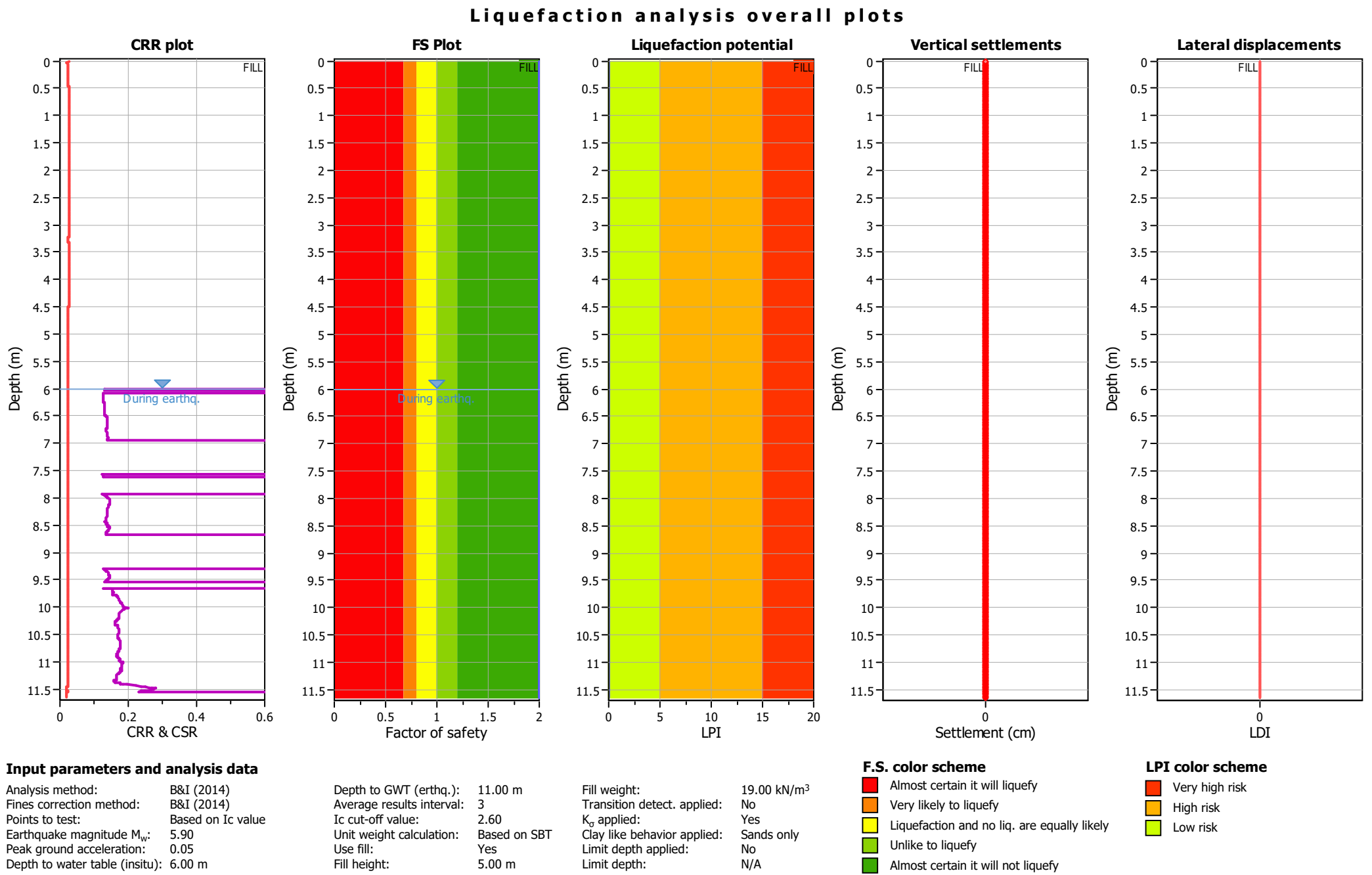
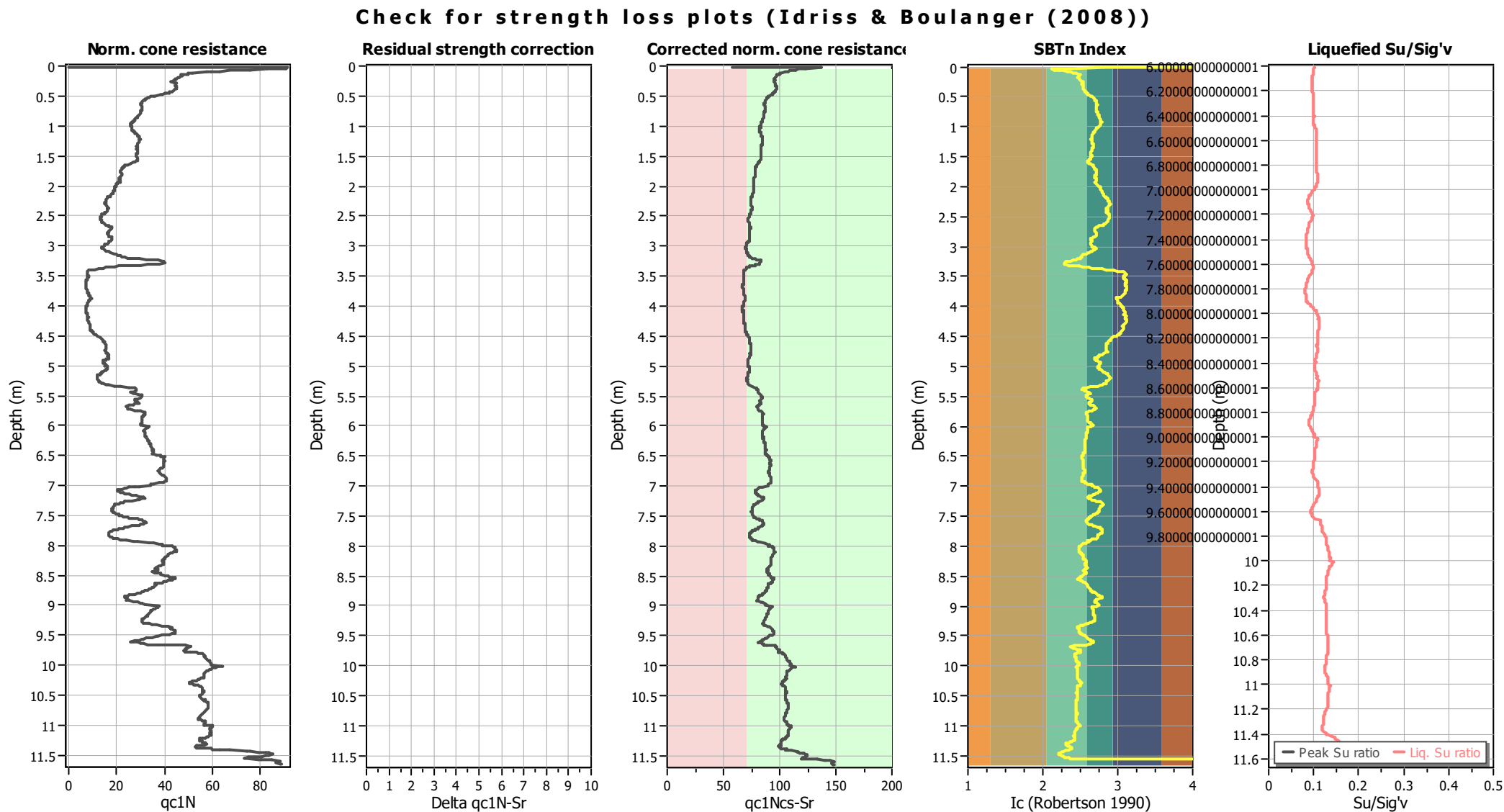


Figure 10 consists of three plots related to sand liquefaction:

- Left Plot:** Normalized CPT penetration resistance (log scale, 1 to 1,000) vs. Normalized friction ratio (%) (log scale, 0.1 to 10). The plot is divided into regions 1 through 9, color-coded and labeled with soil types (A1, A2, B, C). Arrows indicate trends: ϕ' (increasing), OCR, age, cementation (increasing), Consolidated (increasing), I_c (increasing), Sensitivity (increasing), and OCR & age (increasing).
- Middle Plot:** Cyclic Stress Ratio* (CSR*) (log scale, 0 to 0.8) vs. $qc_{1N,cs}$ (linear scale, 0 to 200). A black curve separates the "Liquefaction" region (above) from the "No Liquefaction" region (below).
- Right Plot:** Thickness of liquefiable sand layer, H2 (m) (linear scale, 0.0 to 12.0) vs. Thickness of surface layer, H1 (m) (linear scale, 0 to 10). The plot shows the "Liquefaction - induced ground damage" region. A blue curve represents the "Analysis PGA: 0.05". Three dashed curves represent "Max. acc. 200 gal", "Max. acc. 400 gal", and "Max. acc. 400-500 gal".

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _σ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

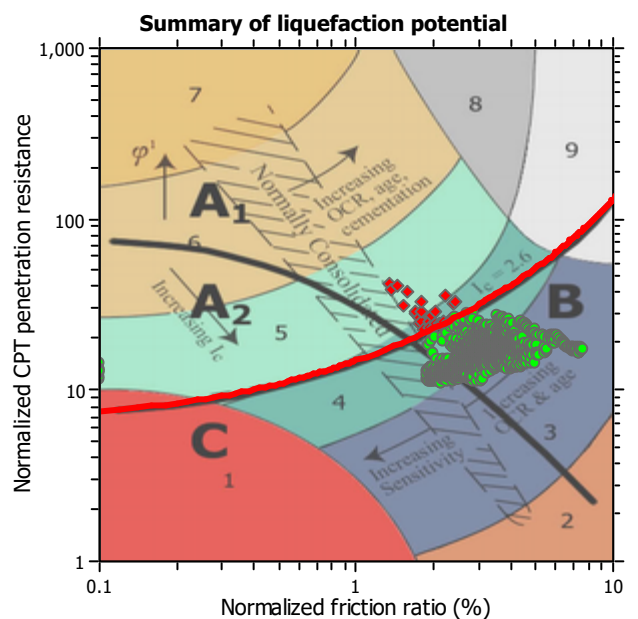
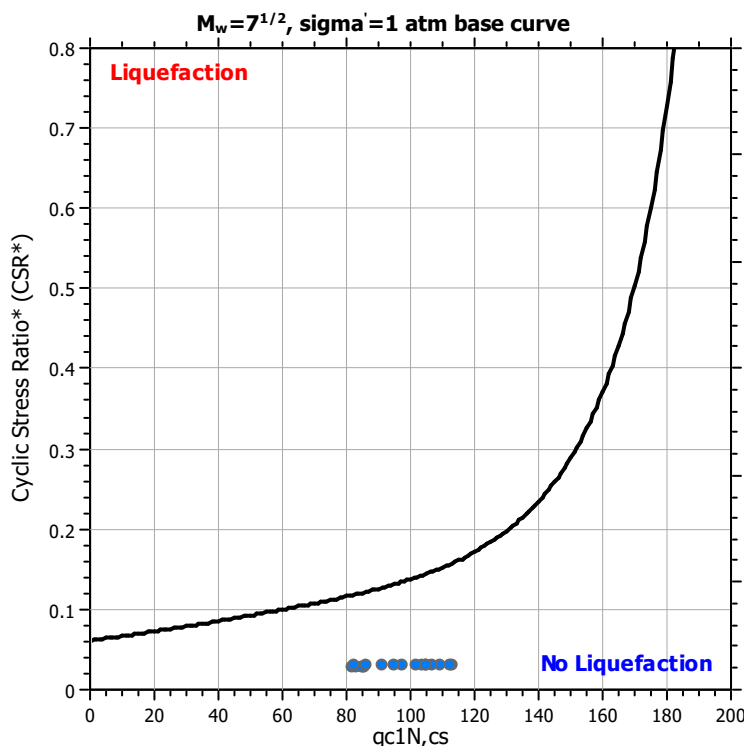
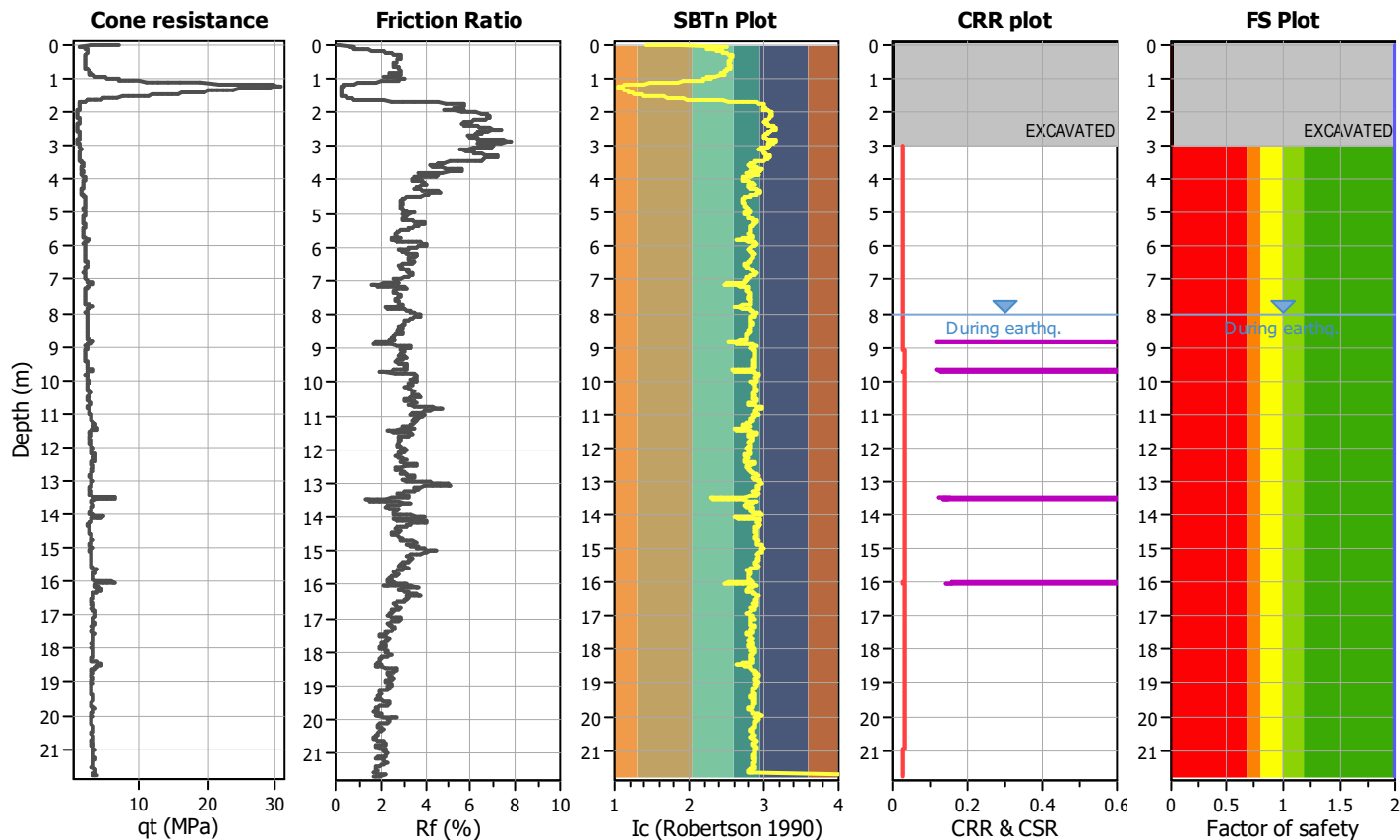
Project title :

Location :

CPT file : CPT-Test CPT03

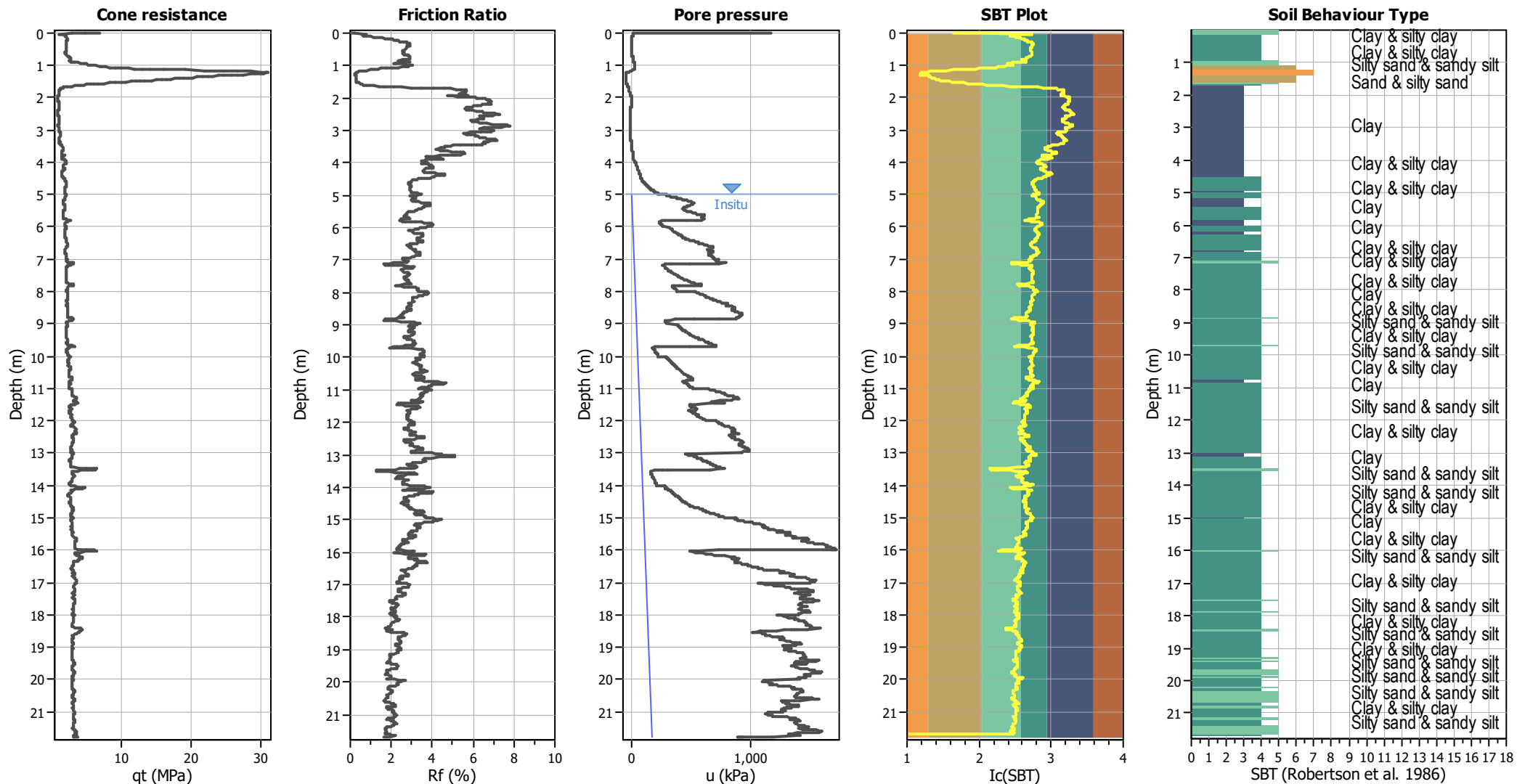
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 m	Excavation:	Yes	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 m	Excavation depth:	3.00 m	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	54.00 kPa	Limit depth applied:	No
Earthquake magnitude M_w :	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.05	Unit weight calculation:	Based on SBT	K_g applied:	Yes	MSF method:	Method



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots

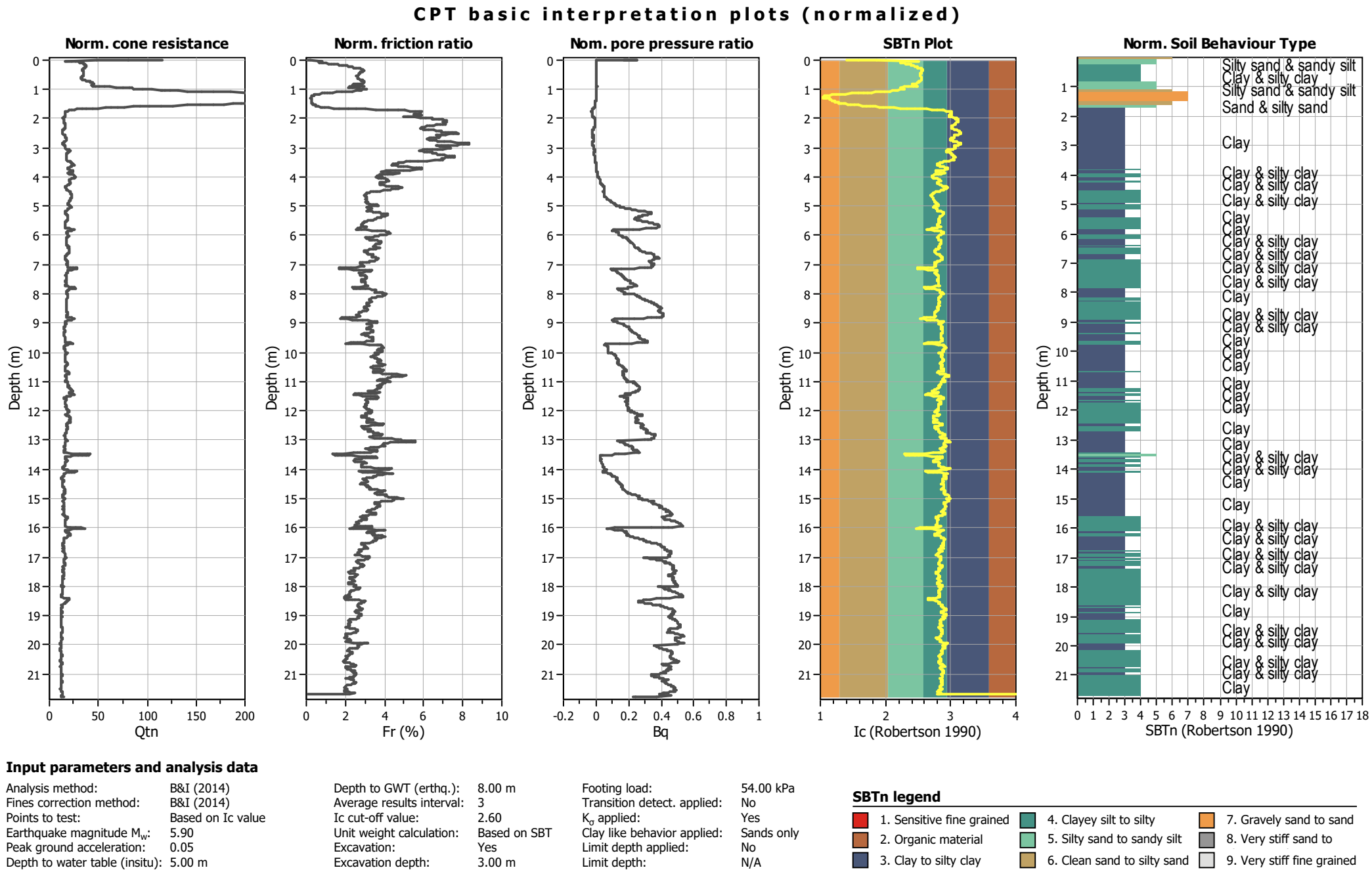


Input parameters and analysis data

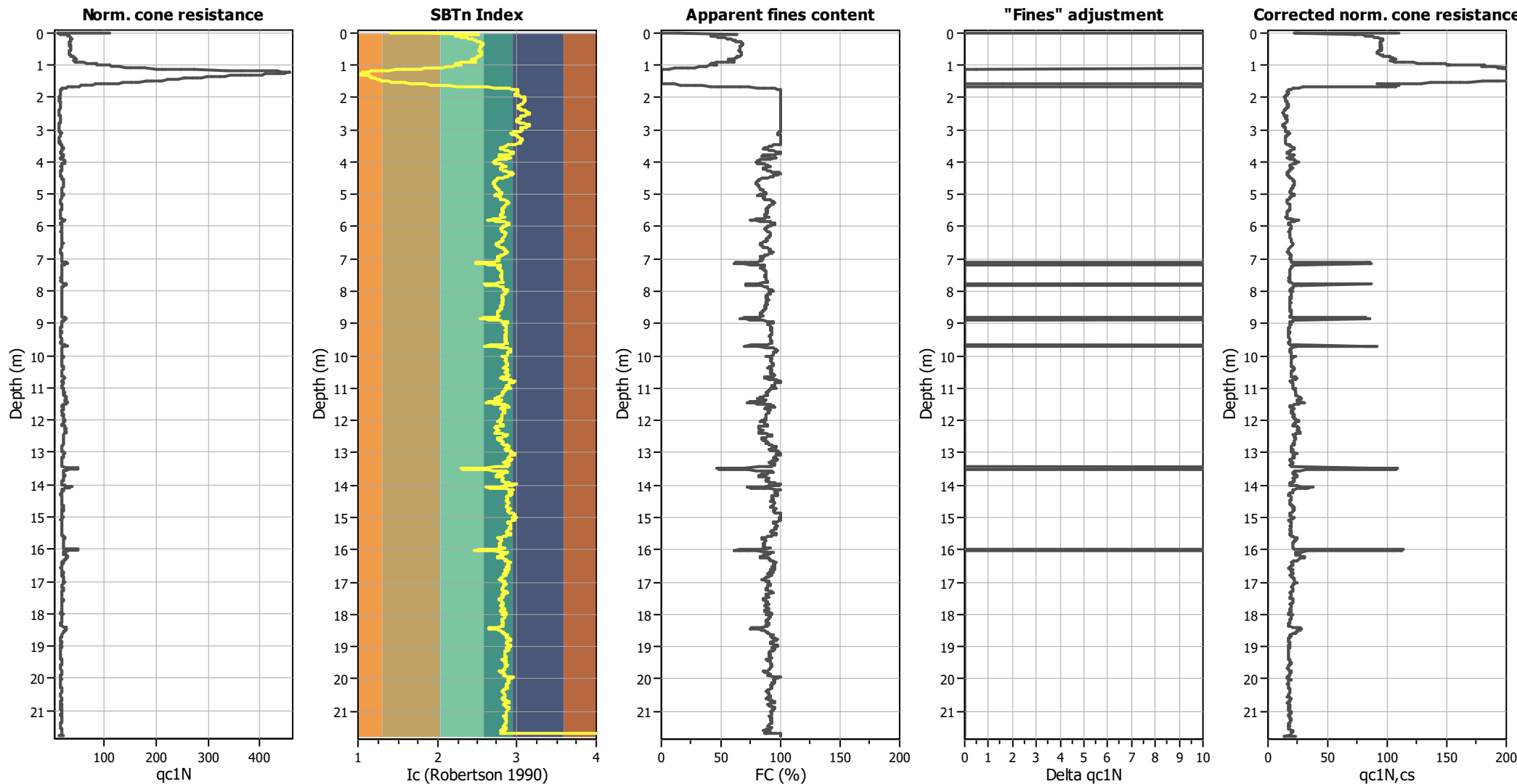
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	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



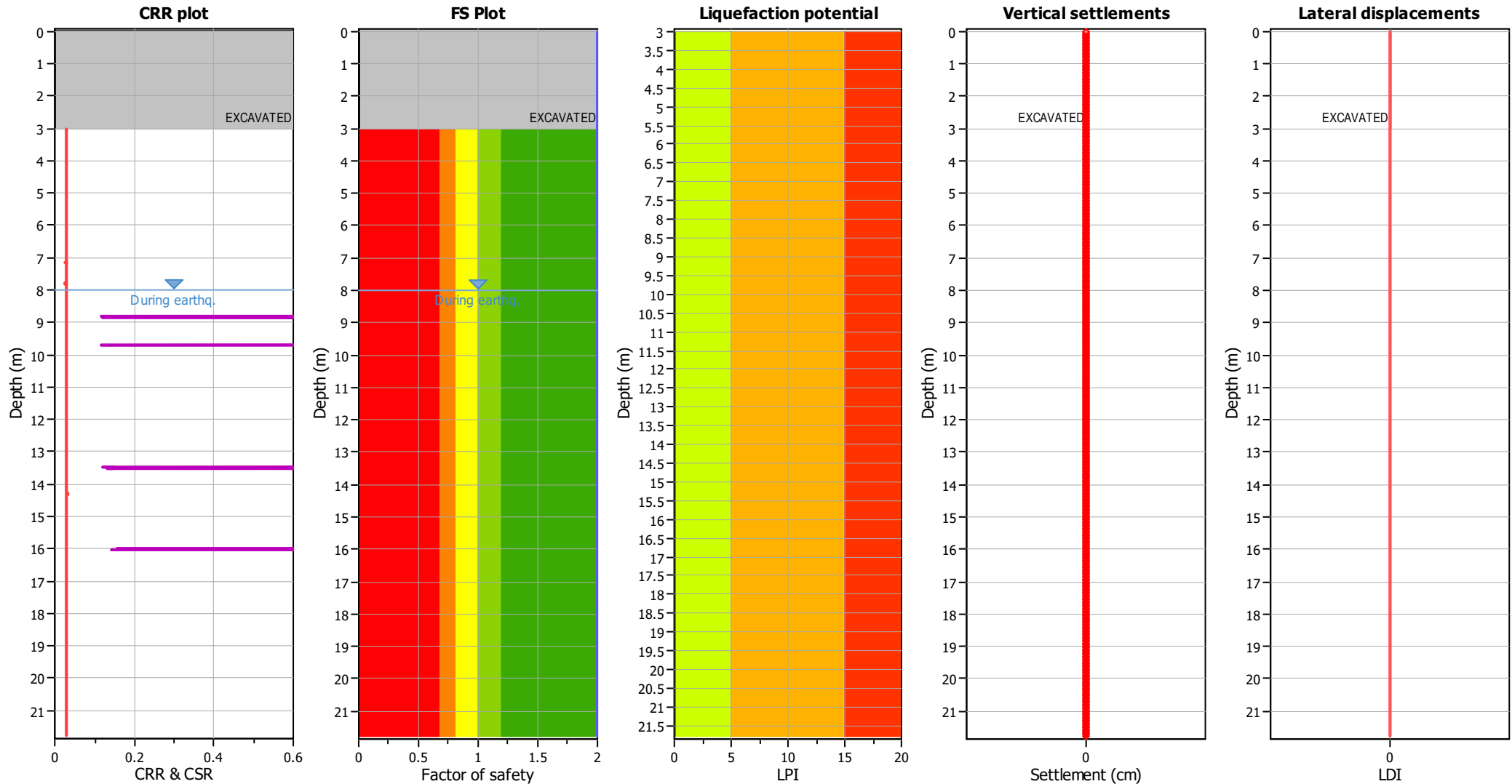
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _σ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

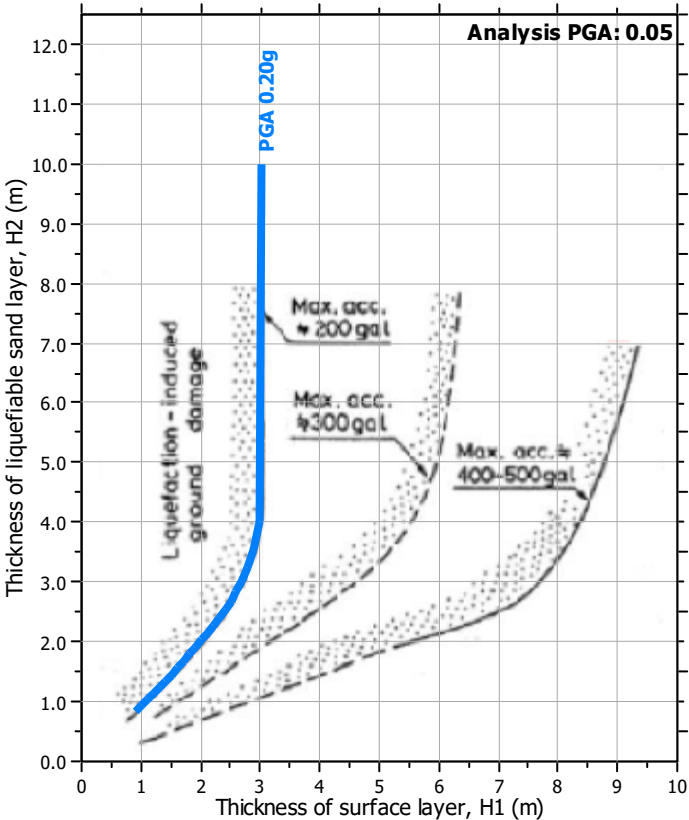
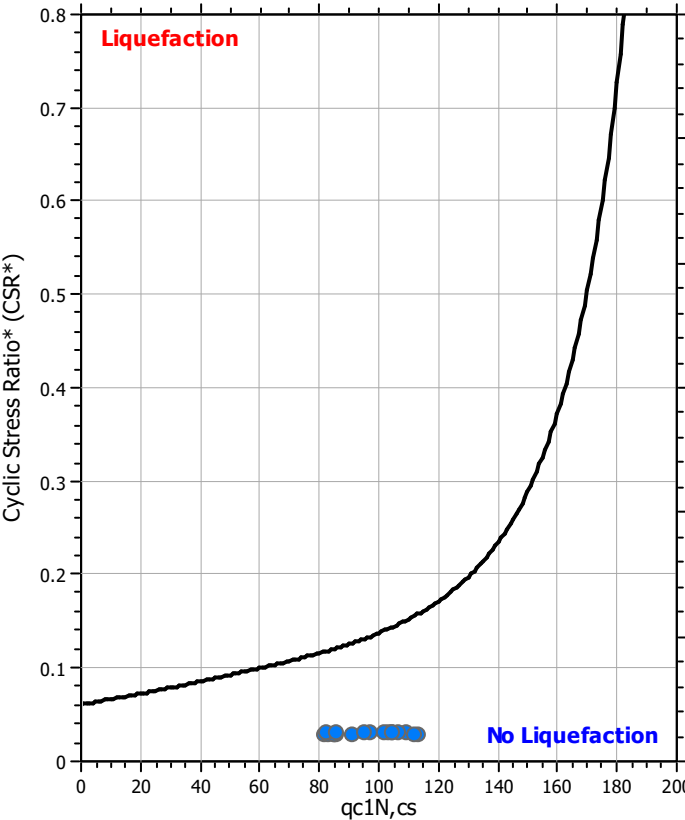
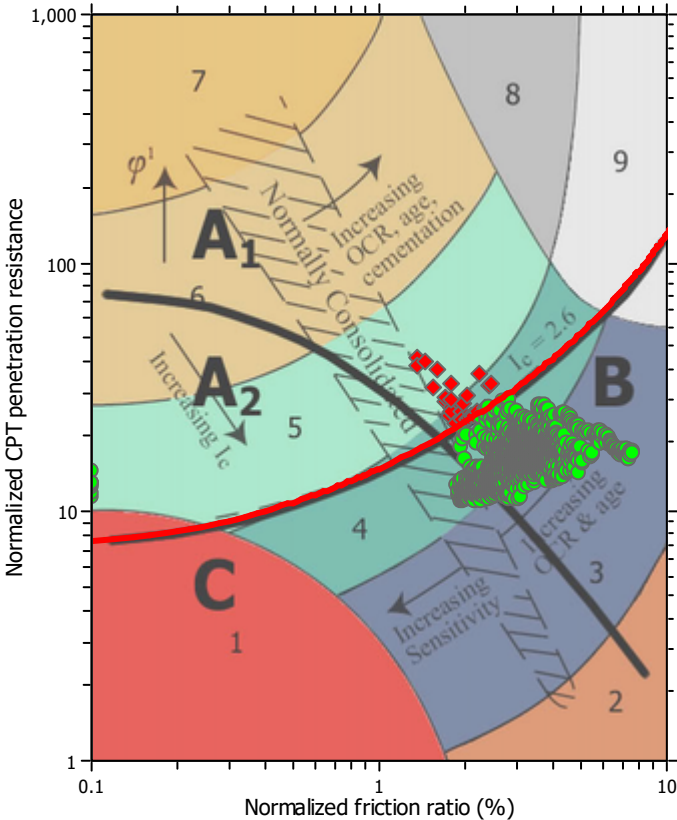
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

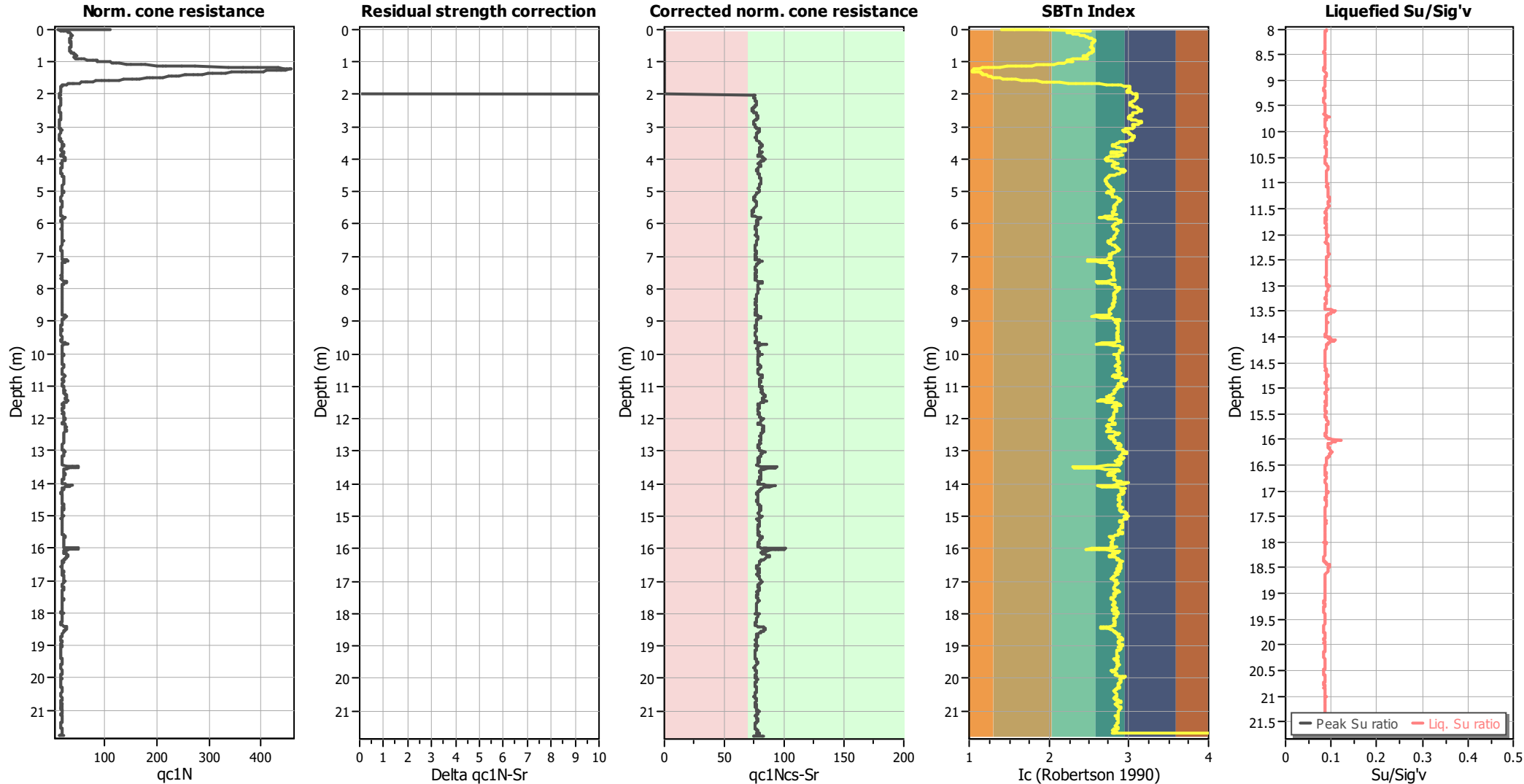
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

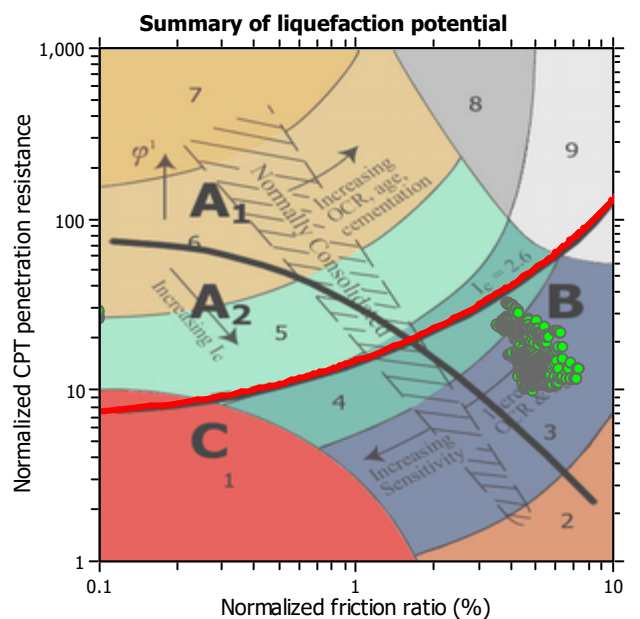
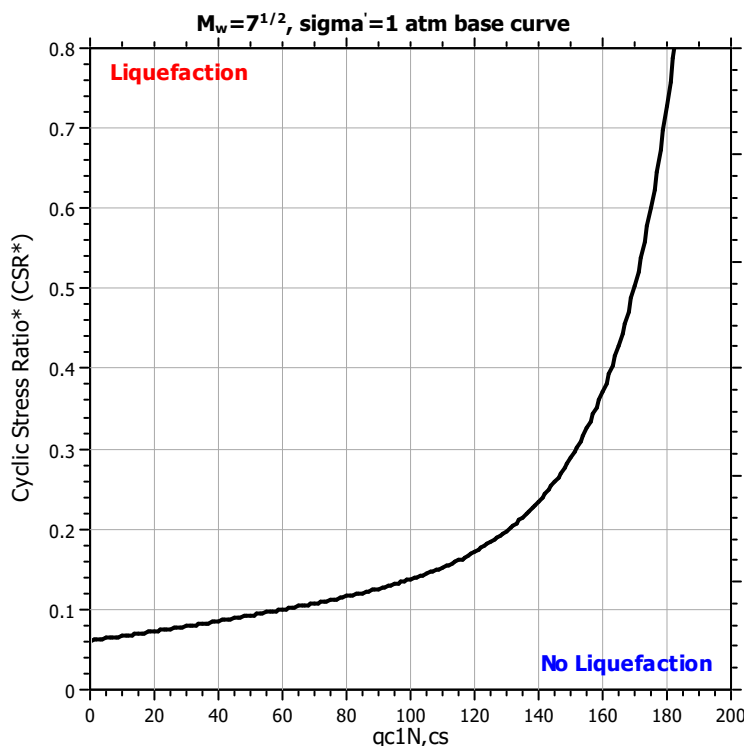
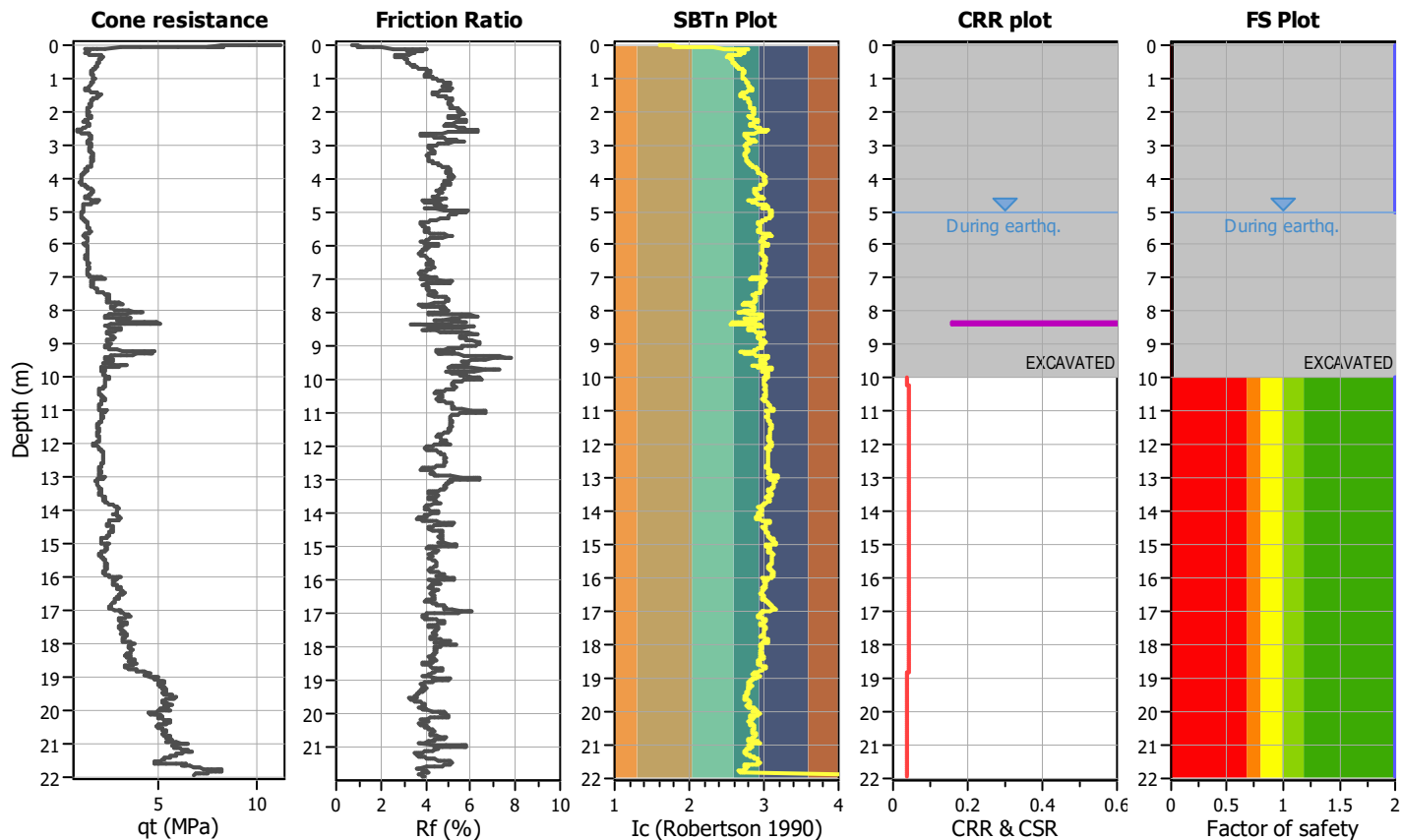
Project title :

Location :

CPT file : CPT-Test CPT04

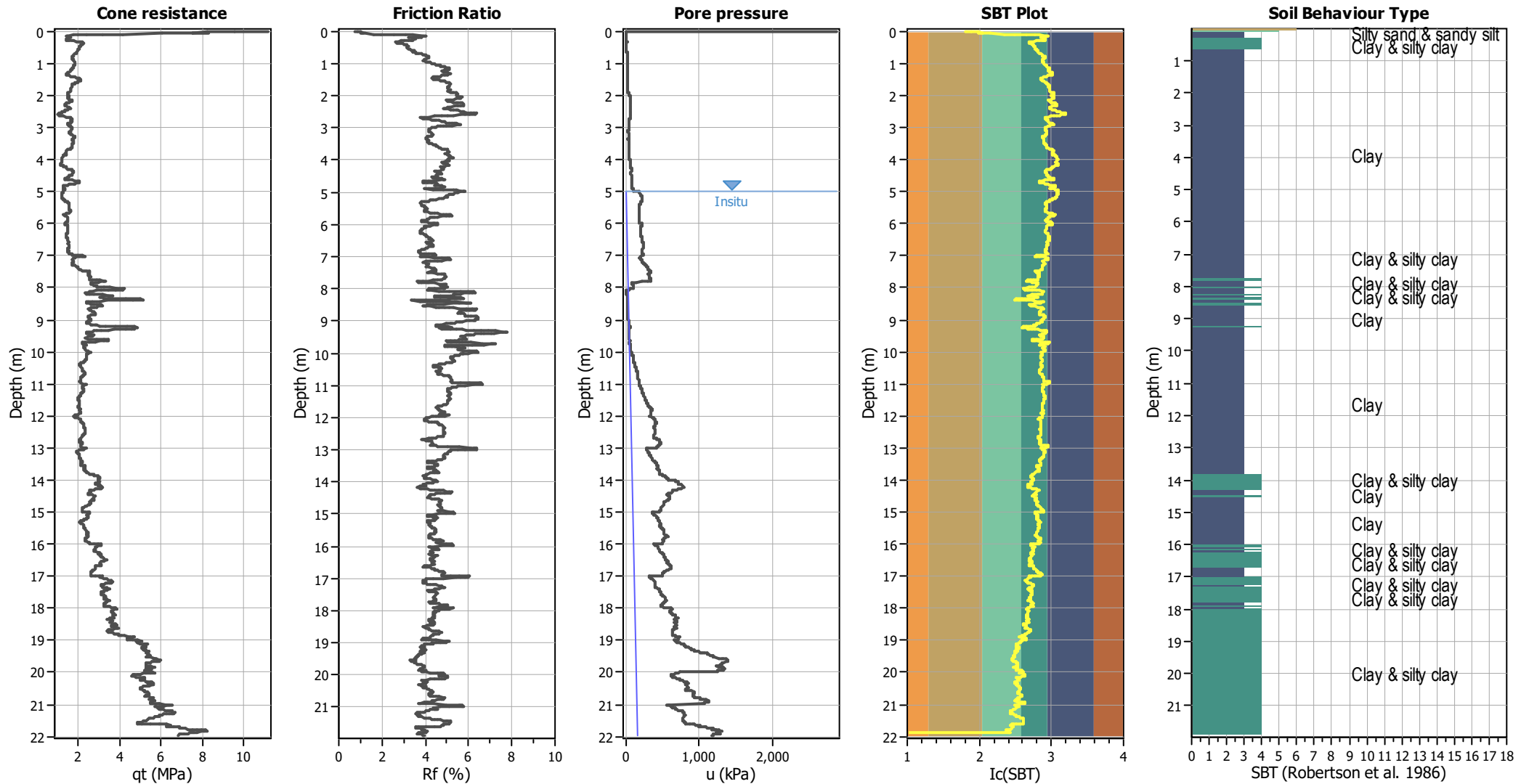
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 m	Excavation:	Yes	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 m	Excavation depth:	10.00 m	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	180.00 kPa	Limit depth applied:	No
Earthquake magnitude M_w :	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.05	Unit weight calculation:	Based on SBT	K_g applied:	Yes	MSF method:	Method



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	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 :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

SBT legend

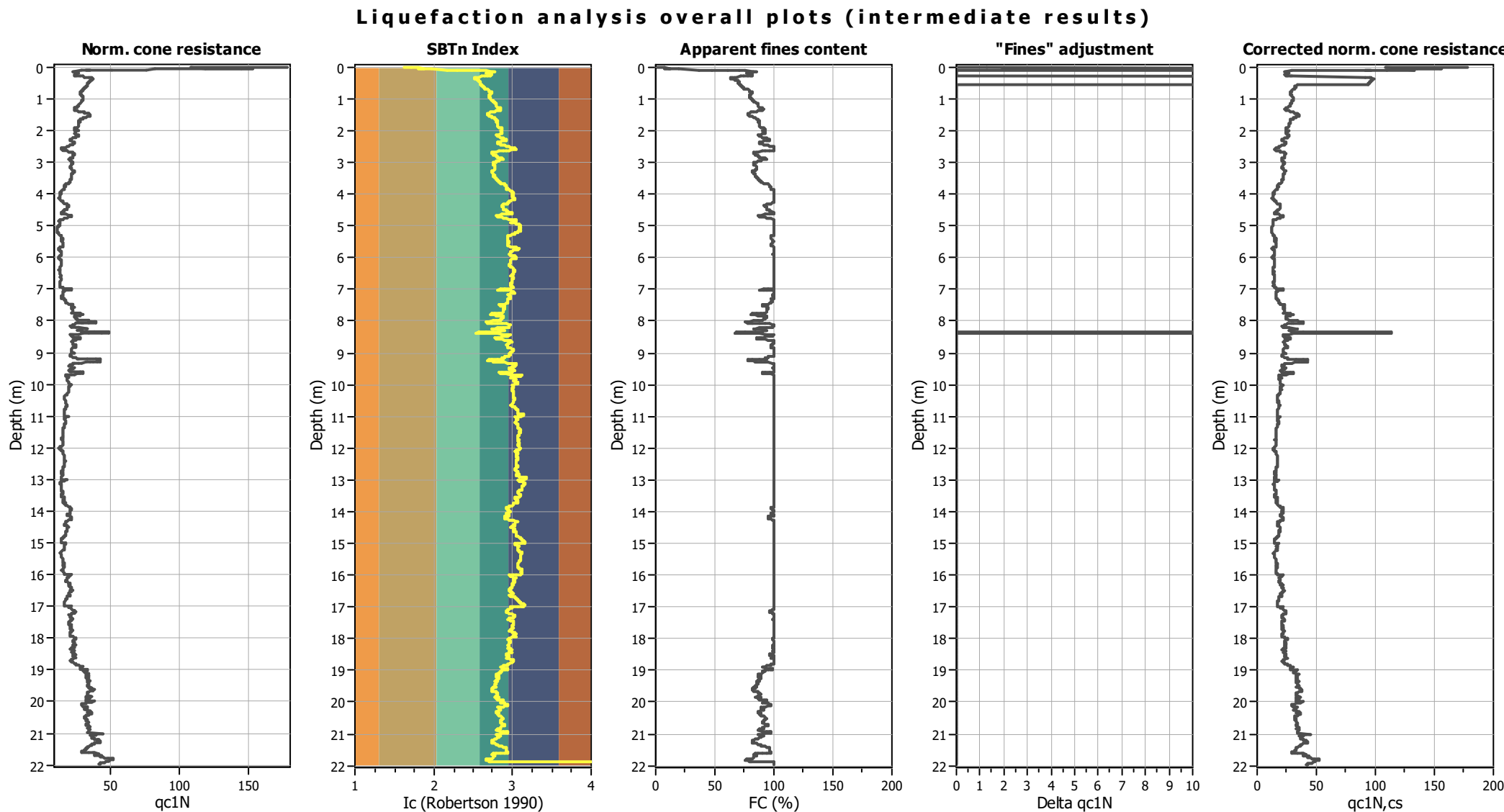
- | | | | | | |
|---|---------------------------|---|-----------------------------|---|----------------------------|
|  | 1. Sensitive fine grained |  | 4. Clayey silt to silty |  | 7. Gravely sand to sand |
|  | 2. Organic material |  | 5. Silty sand to sandy silt |  | 8. Very stiff sand to |
|  | 3.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

Figure 1 displays five vertical plots showing geotechnical data versus depth (0 to 22 meters).

- Norm. cone resistance:** The y-axis is Depth (m) from 0 to 22. The x-axis is Qtn (kN/m²) from 0 to 200. The plot shows a highly variable, jagged line representing cone resistance, generally staying below 50 kN/m².
- Norm. friction ratio:** The y-axis is Depth (m) from 0 to 22. The x-axis is Fr (%) from 0 to 10. The plot shows a highly variable, jagged line representing the friction ratio, generally staying below 8%.
- Nom. pore pressure ratio:** The y-axis is Depth (m) from 0 to 22. The x-axis is Bq (kPa) from -0.2 to 1. The plot shows a highly variable, jagged line representing the pore pressure ratio, generally staying below 0.2.
- SBTn Plot:** The y-axis is Depth (m) from 0 to 22. The x-axis is Ic (Robertson 1990) from 1 to 4. The plot shows a vertical bar with a yellow line indicating the SBTn value, which fluctuates between approximately 2.5 and 3.5.
- Norm. Soil Behaviour Type:** The y-axis is Depth (m) from 0 to 22. The x-axis is SBTn (Robertson 1990) from 0 to 18. The plot shows a vertical bar with a yellow line indicating the soil behavior type, which is mostly in the range of 2.5 to 3.5, corresponding to clay and silty clay.

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

	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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _σ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

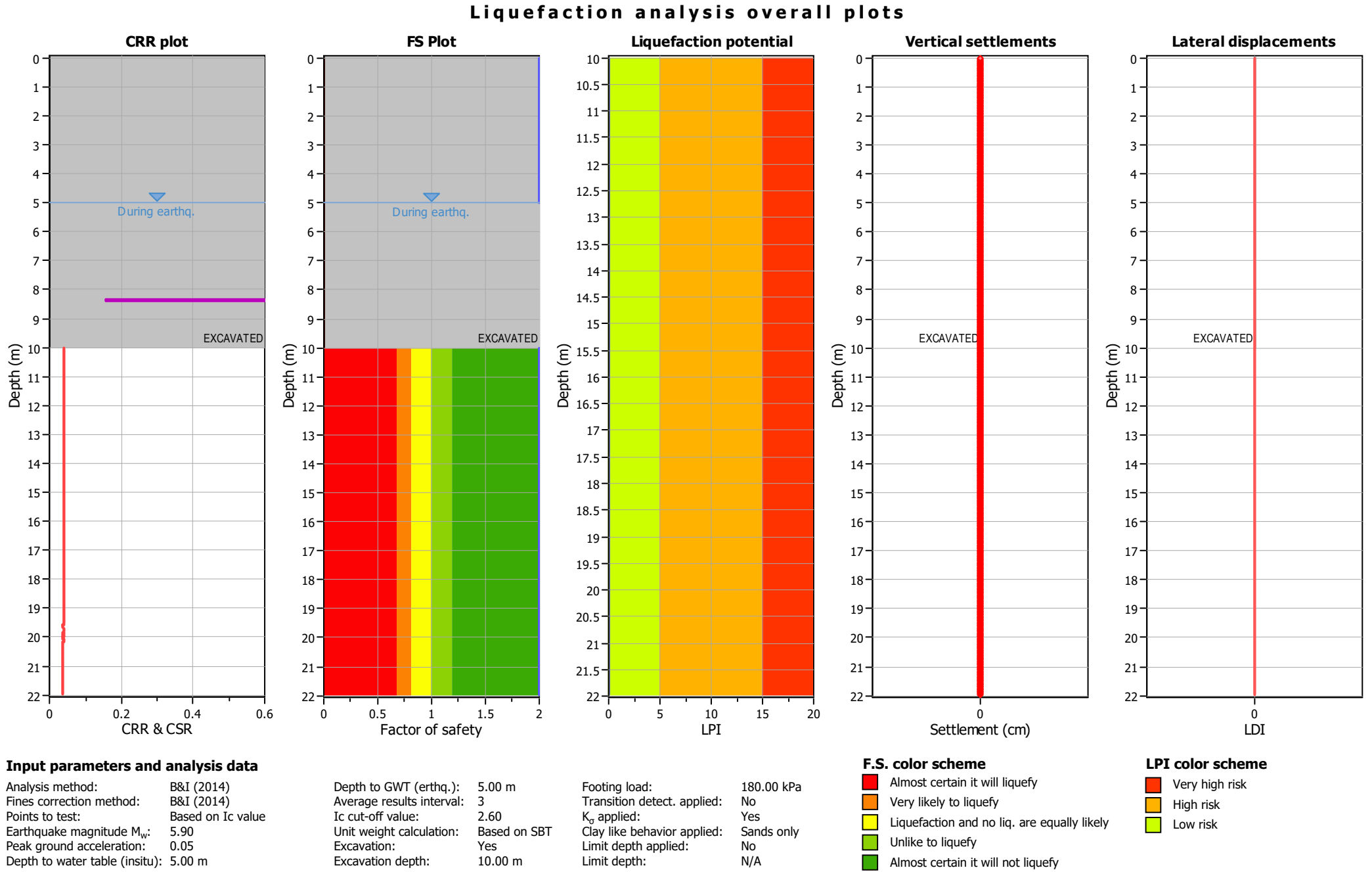
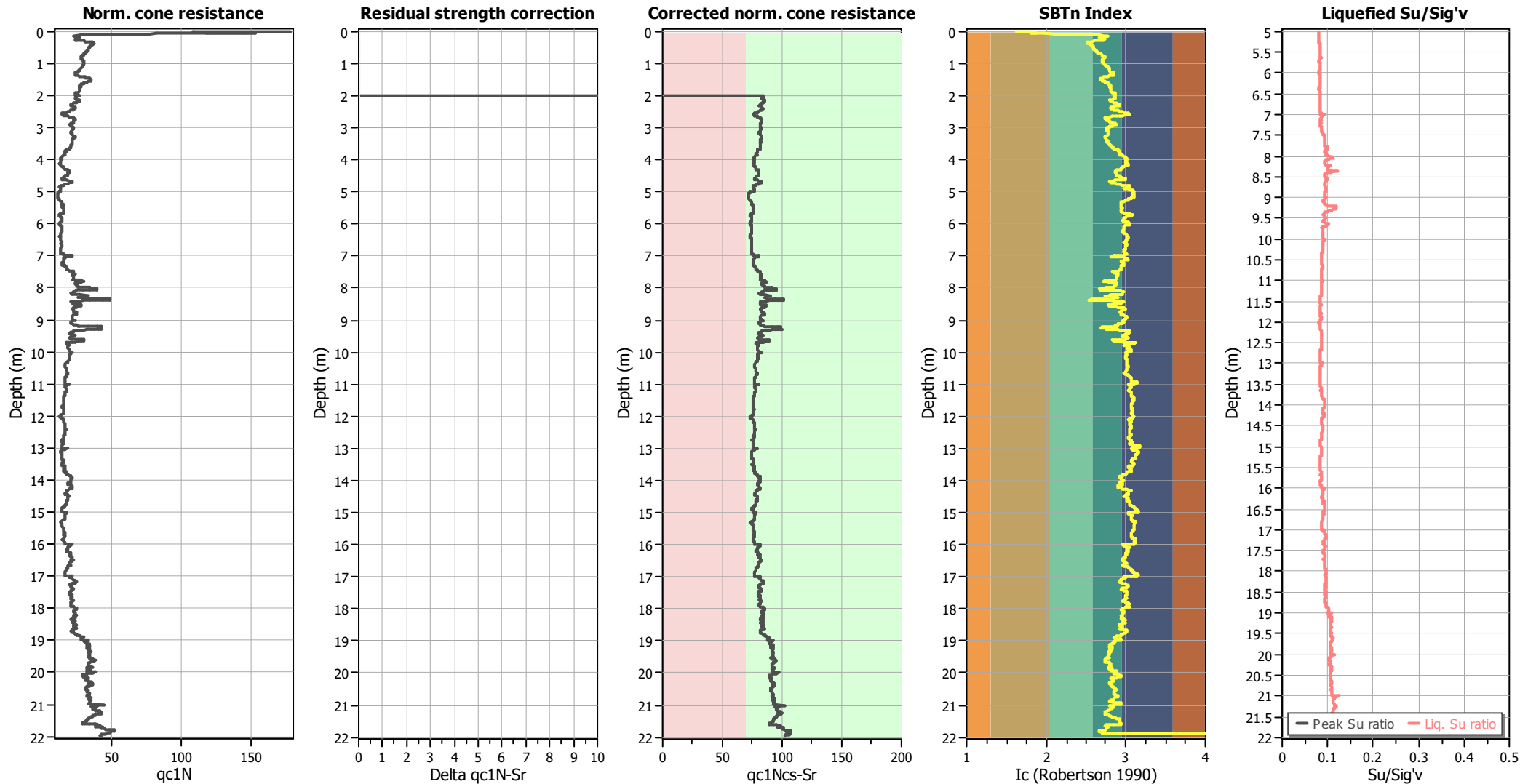


Figure 10 consists of three plots. The left plot shows Normalized CPT penetration resistance (log scale, 1 to 1,000) versus Normalized friction ratio (%) (log scale, 0.1 to 10). It features several regions labeled 1 through 9, with arrows indicating trends like 'Increasing ϕ' ', 'Normally Consolidated', 'Increasing OCR, age, cementation', 'Increasing I_c ', and 'Increasing Sensitivity'. A red curve separates regions 1 and 2, and a black curve separates regions 4 and 5. A cluster of green dots is labeled 'B'. The middle plot shows Cyclic Stress Ratio* (CSR*) (log scale, 0 to 0.8) versus $qc1N,cs$ (linear scale, 0 to 200). A black curve separates the 'Liquefaction' region (top) from the 'No Liquefaction' region (bottom). The right plot shows the Thickness of liquefiable sand layer, H_2 (m) (linear scale, 0.0 to 12.0) versus the Thickness of surface layer, H_1 (m) (linear scale, 0 to 10). It includes a blue curve for 'PGA 0.20g' and dashed lines for 'Max. acc. $\approx$ 200 gal', 'Max. acc. $\approx$ 300 gal', and 'Max. acc. $\approx$ 400-500 gal'. A shaded region is labeled 'Liquefaction-induced ground damage'. The title 'Analysis PGA: 0.05' is in the top right corner.

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

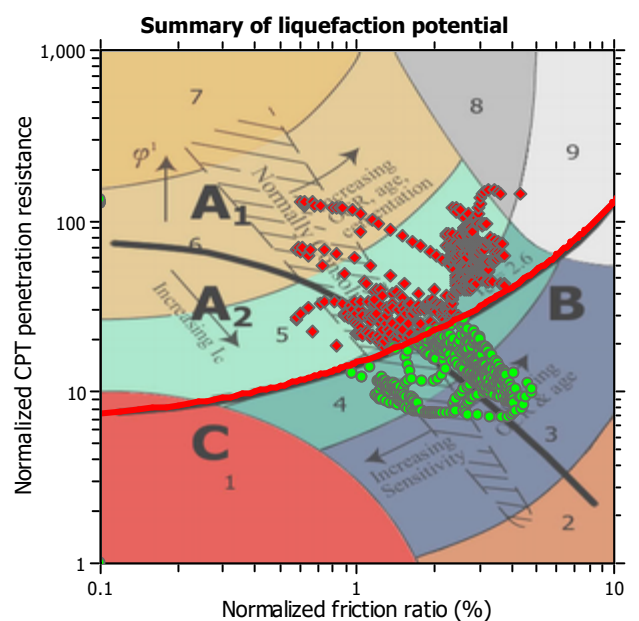
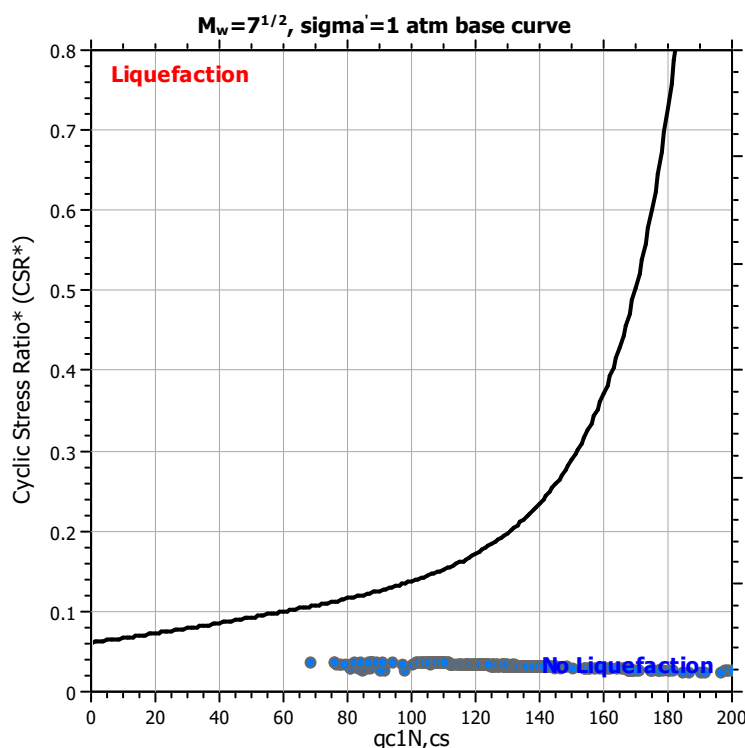
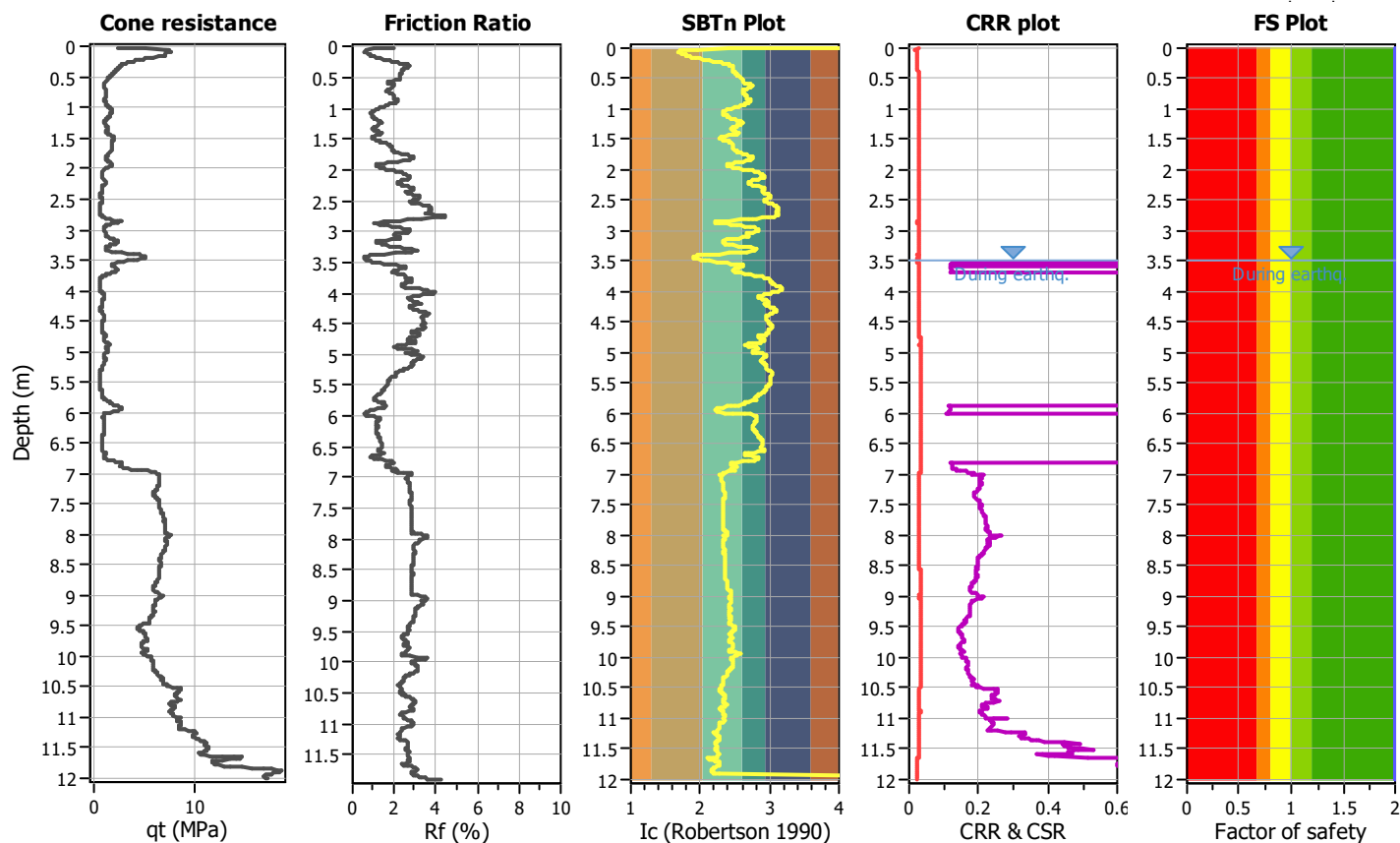
Project title :

Location :

CPT file : CPT-Test CPT05

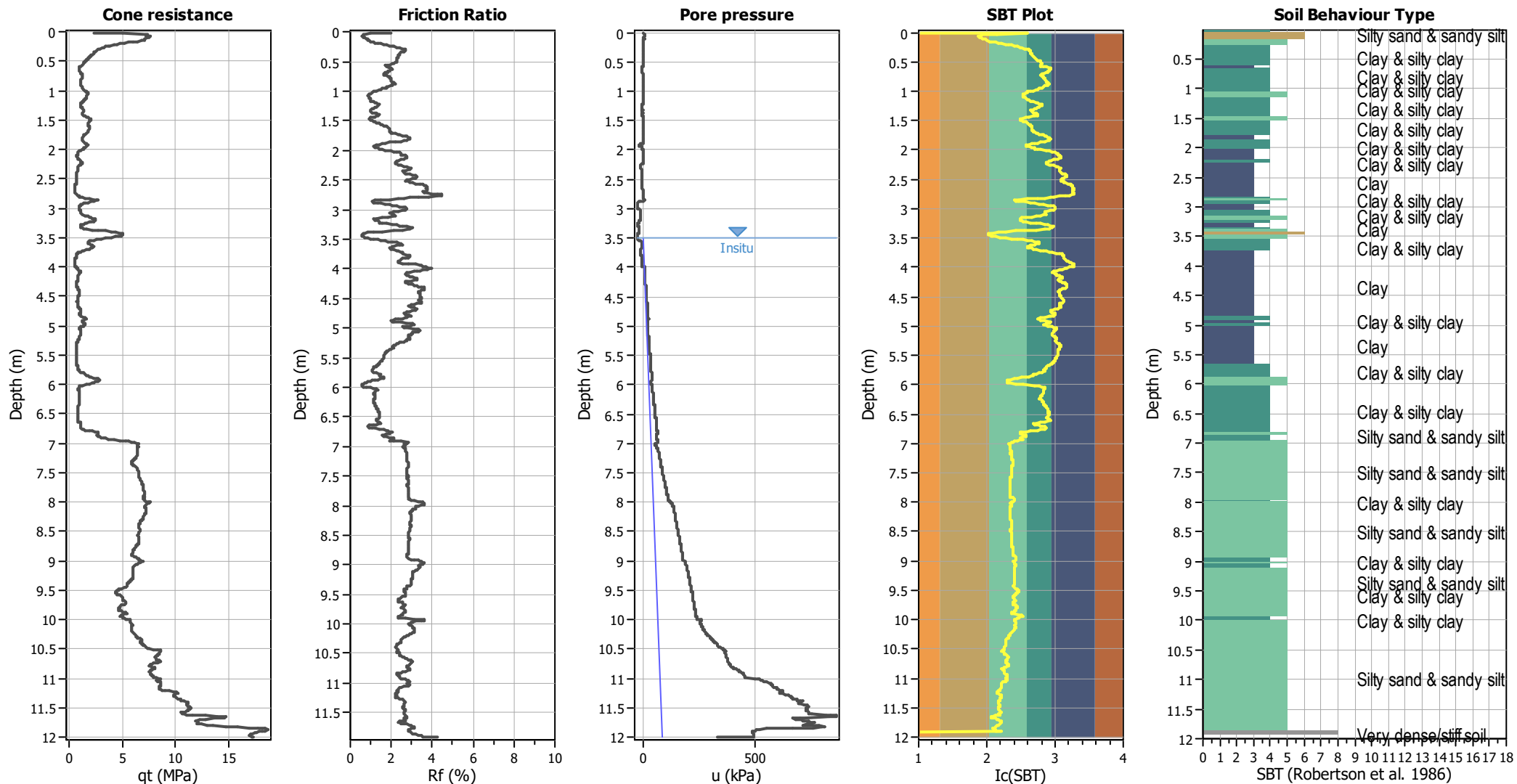
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	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 :	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.05	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



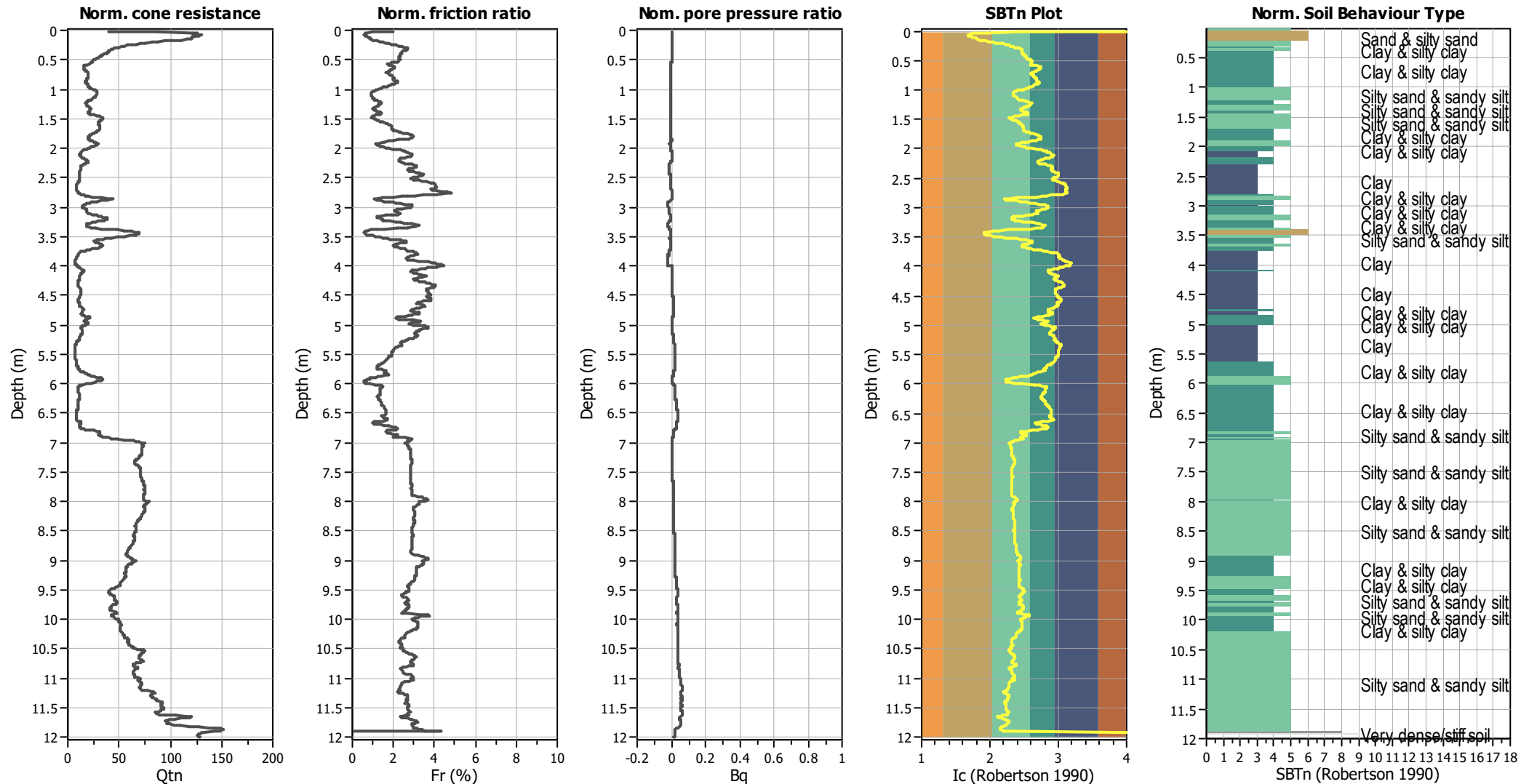
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



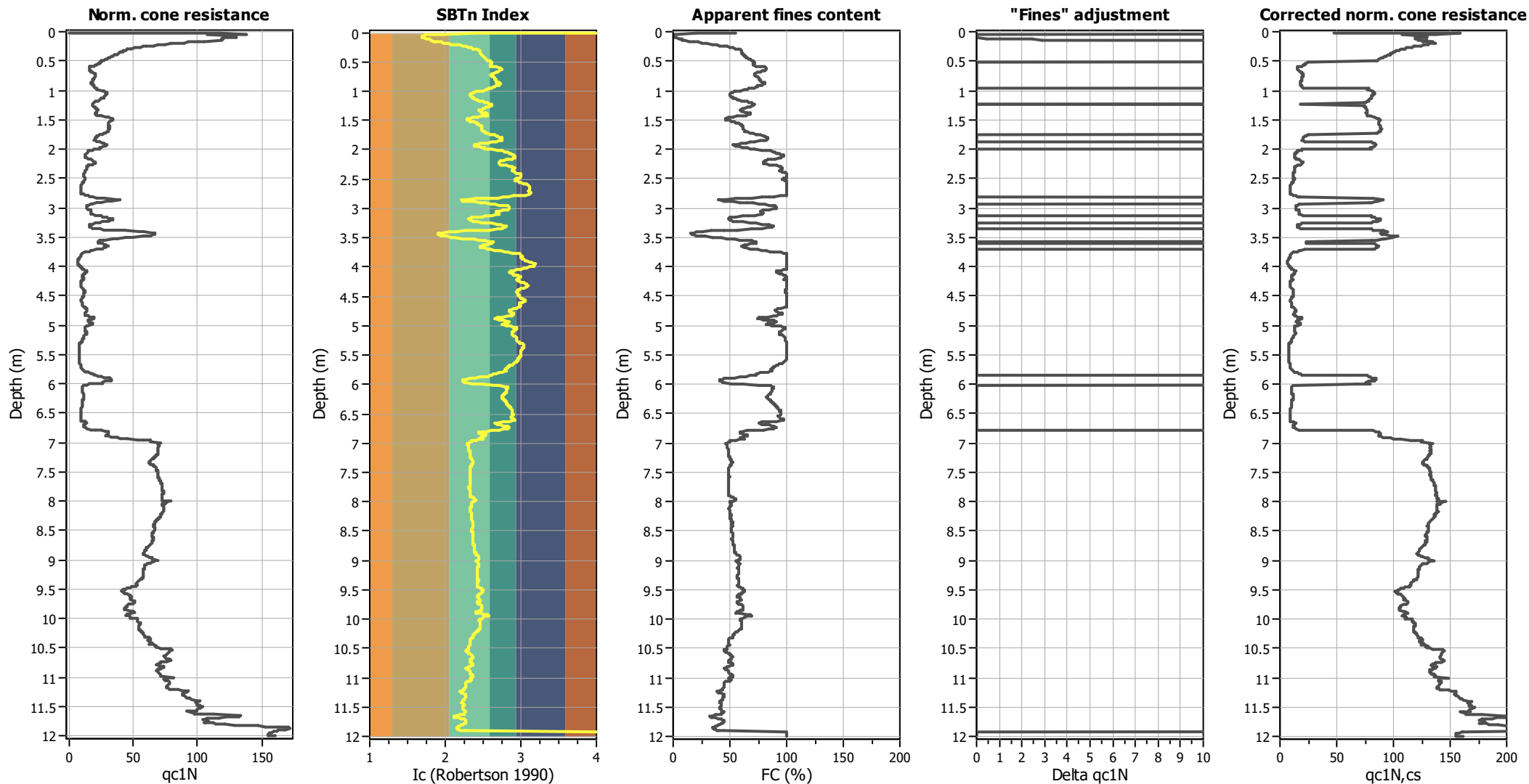
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

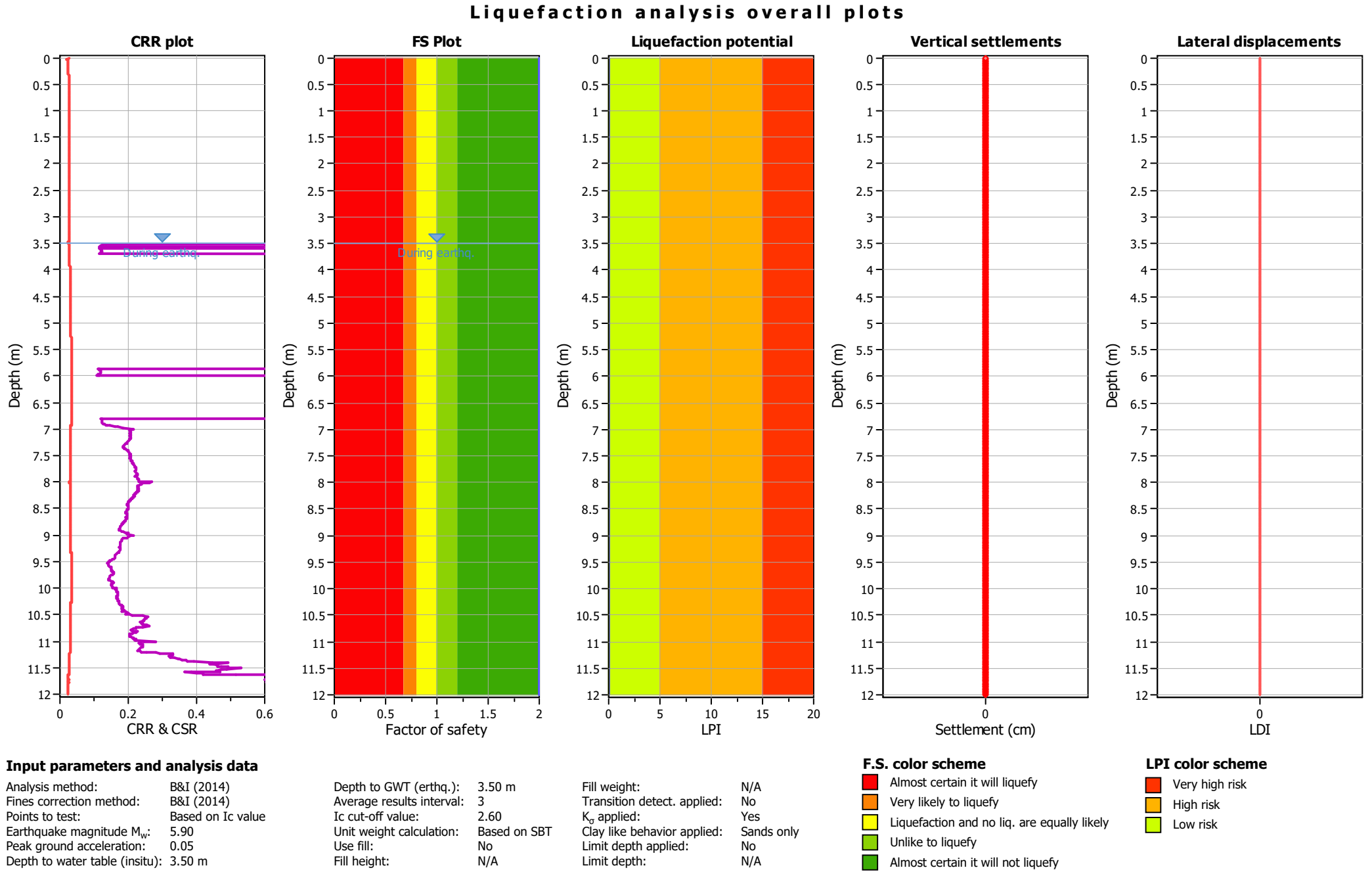
1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)

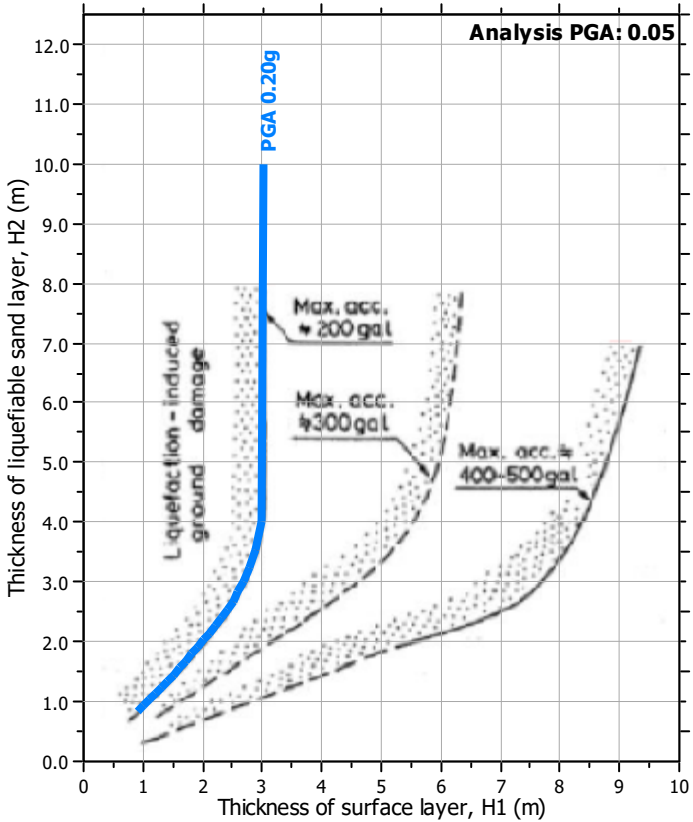
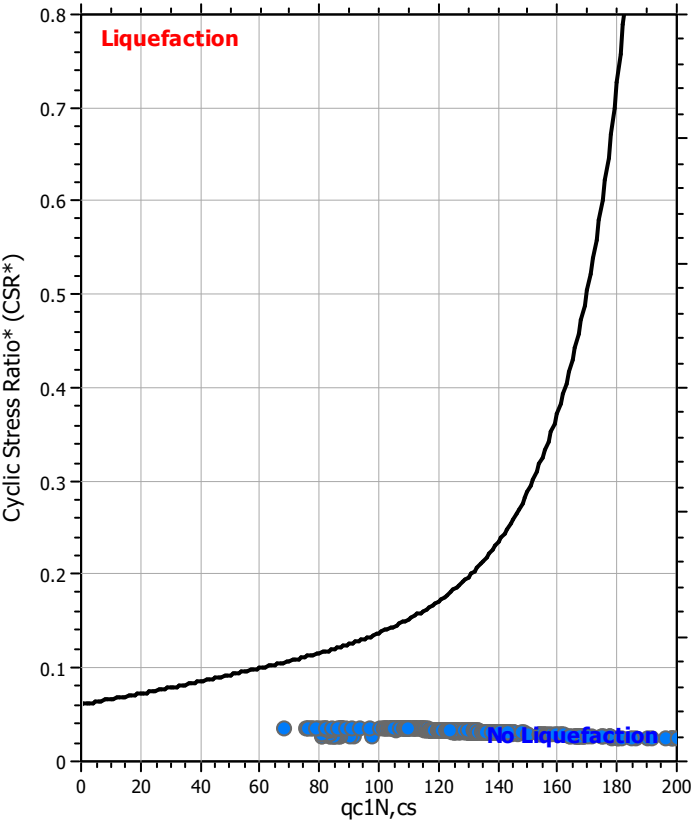
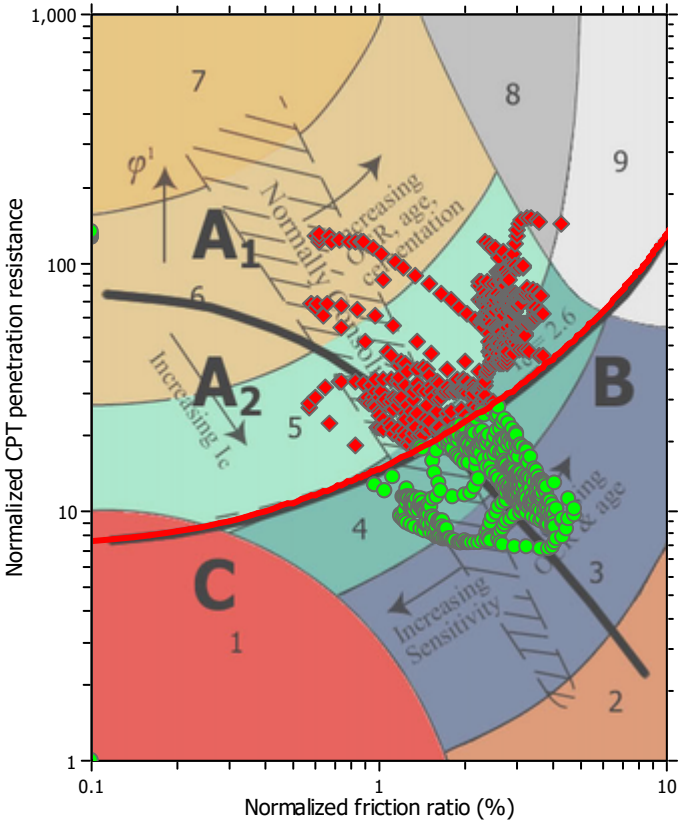


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _q applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A



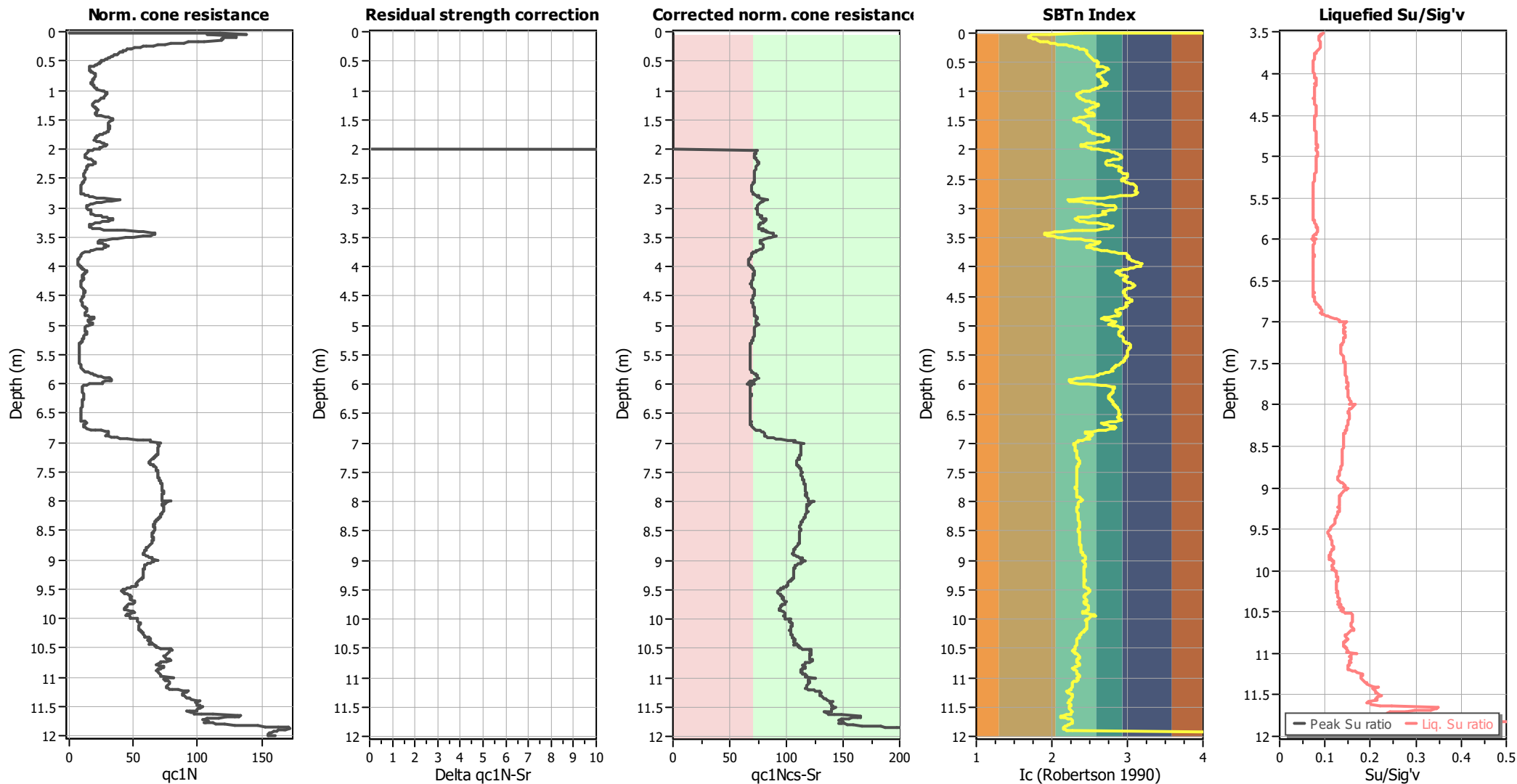
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I _c value	I _c cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

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

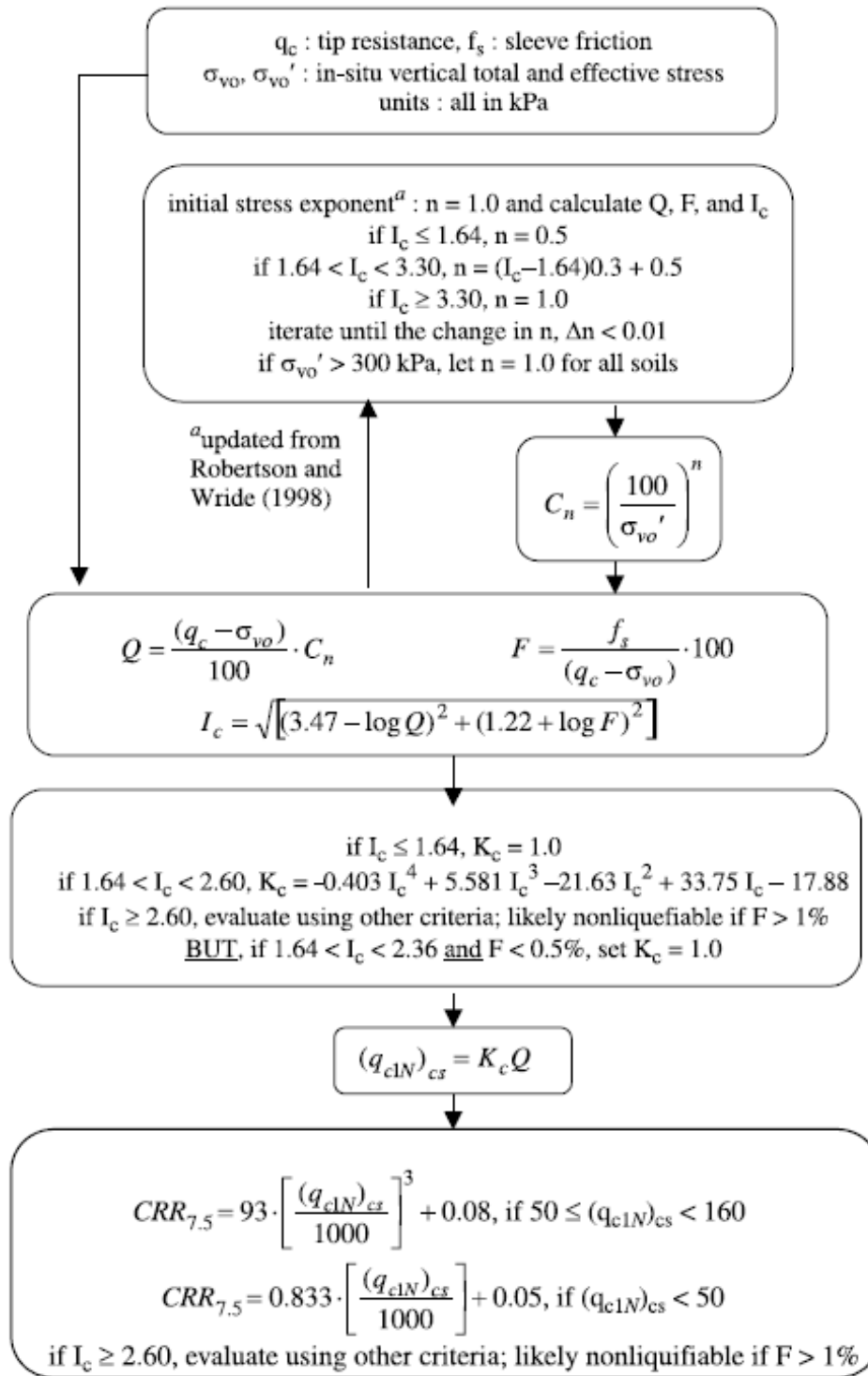


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _q applied:	Yes
Earthquake magnitude M _w :	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.05	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

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

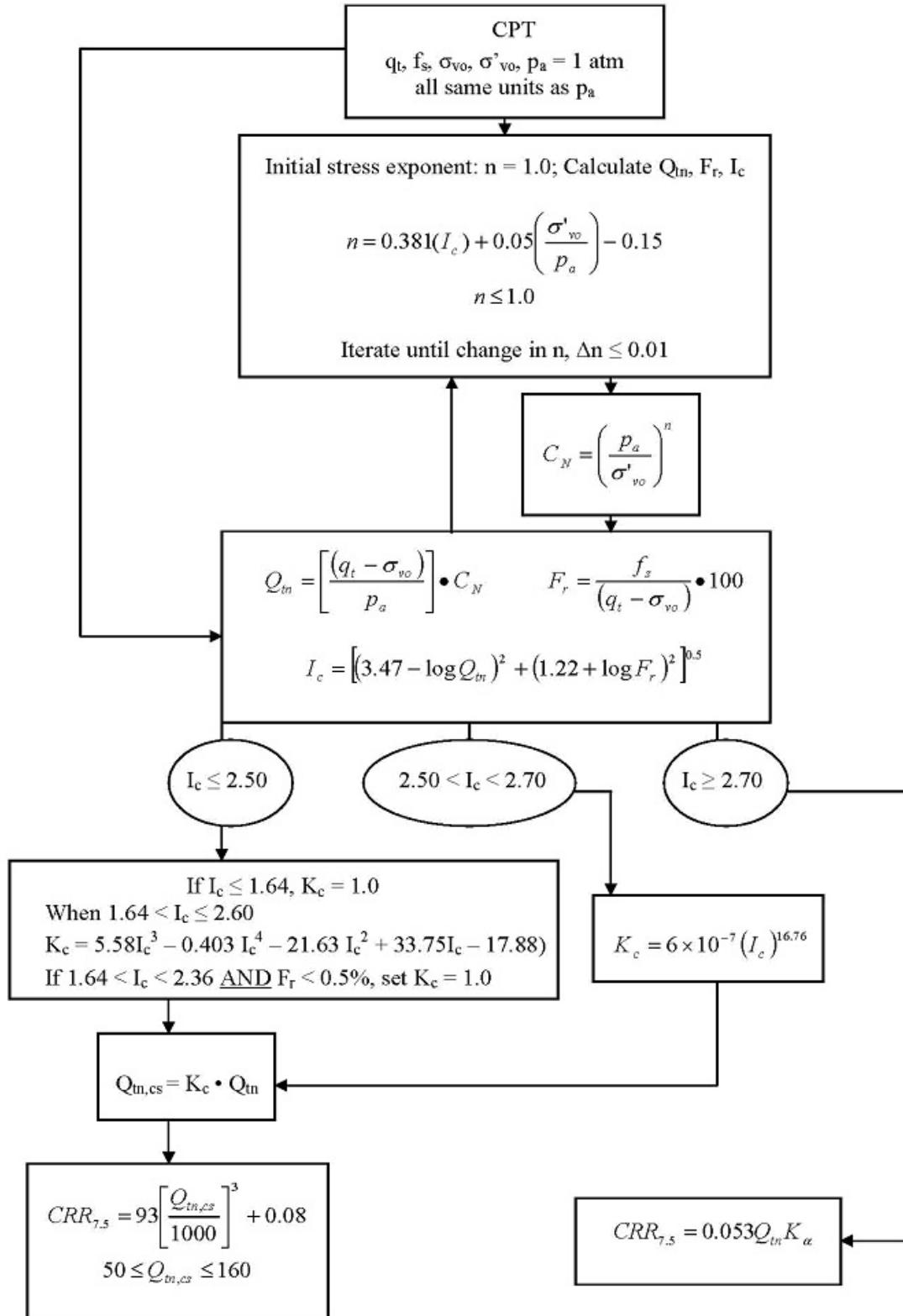
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of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

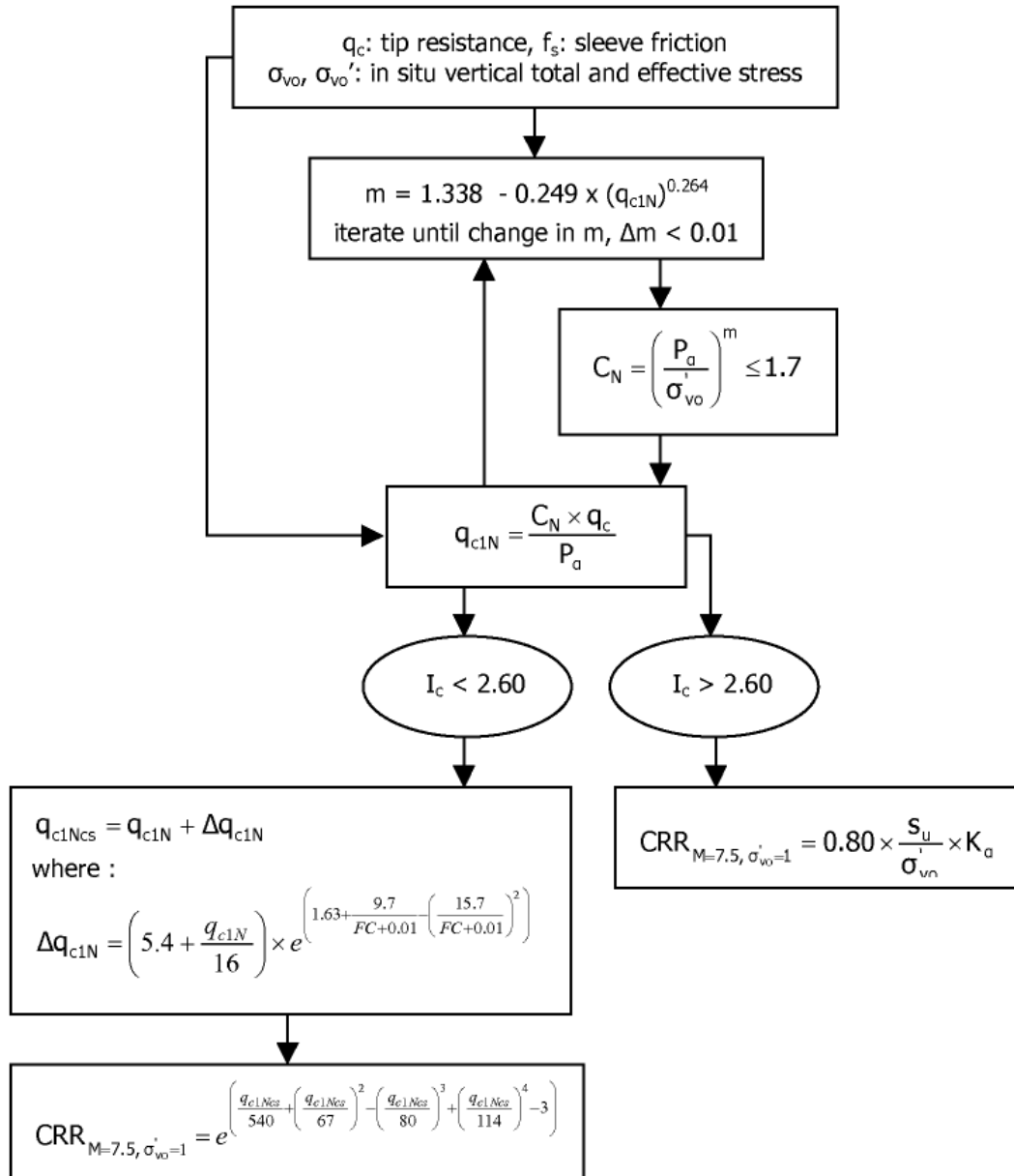
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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

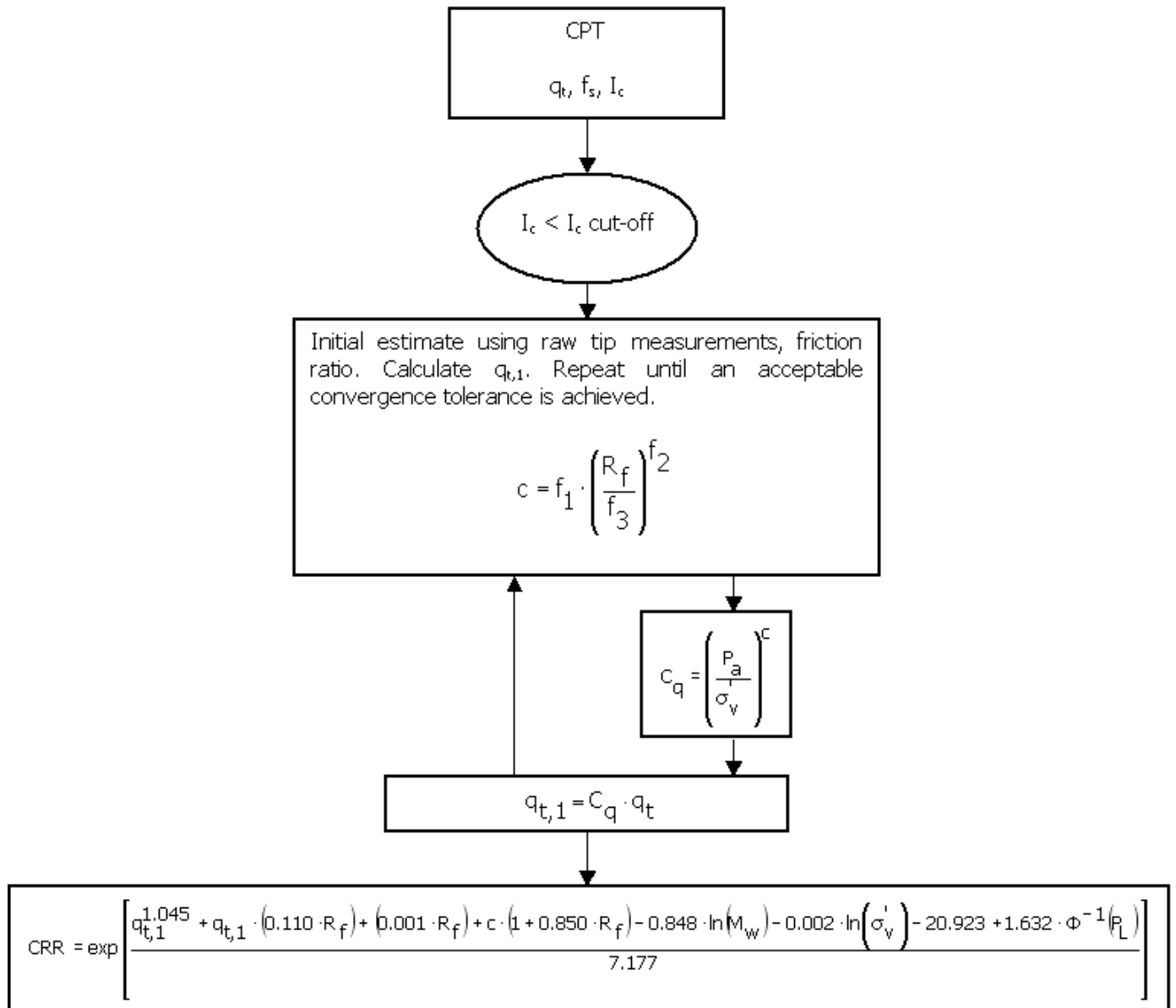


¹ P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

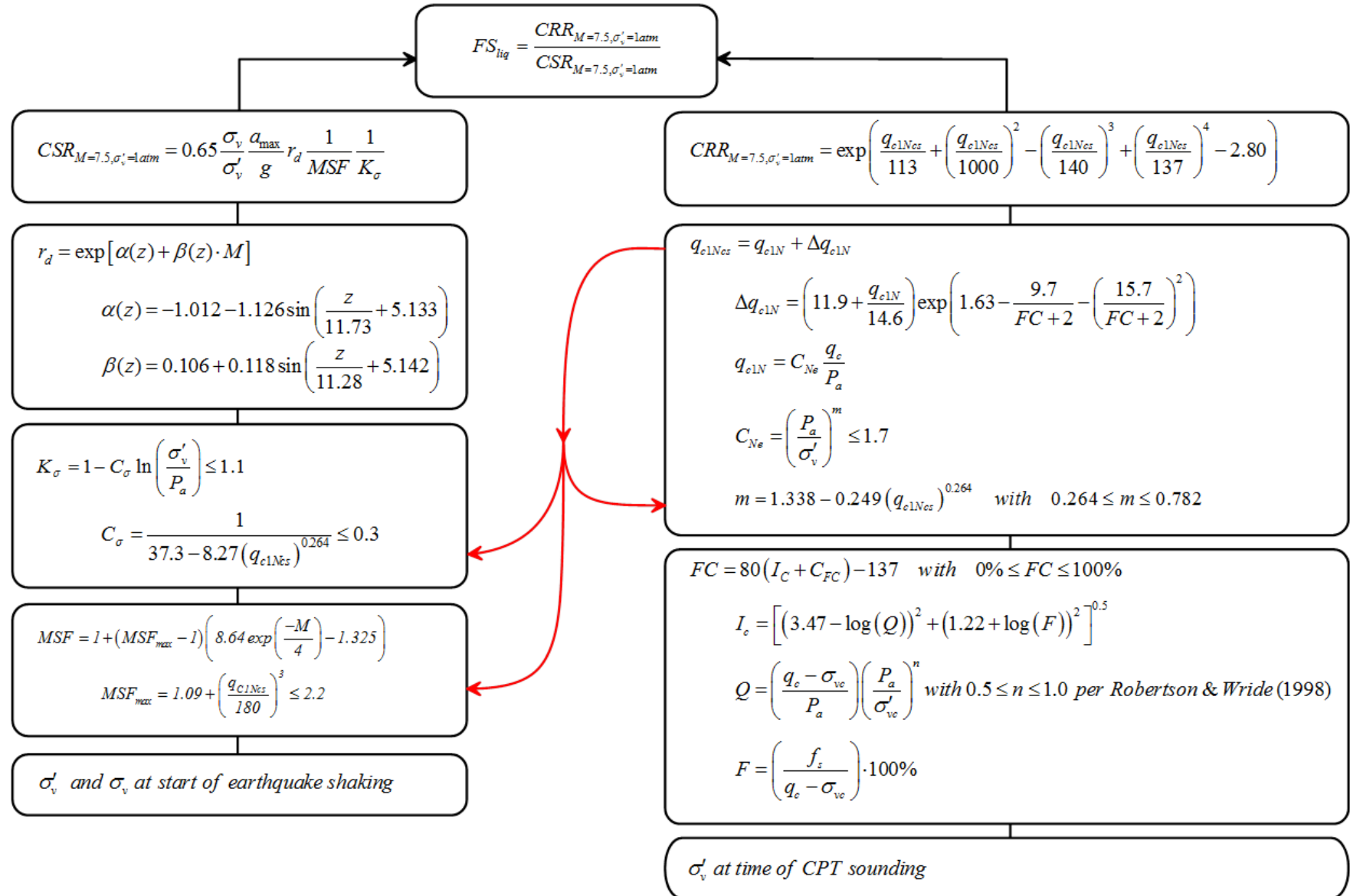
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



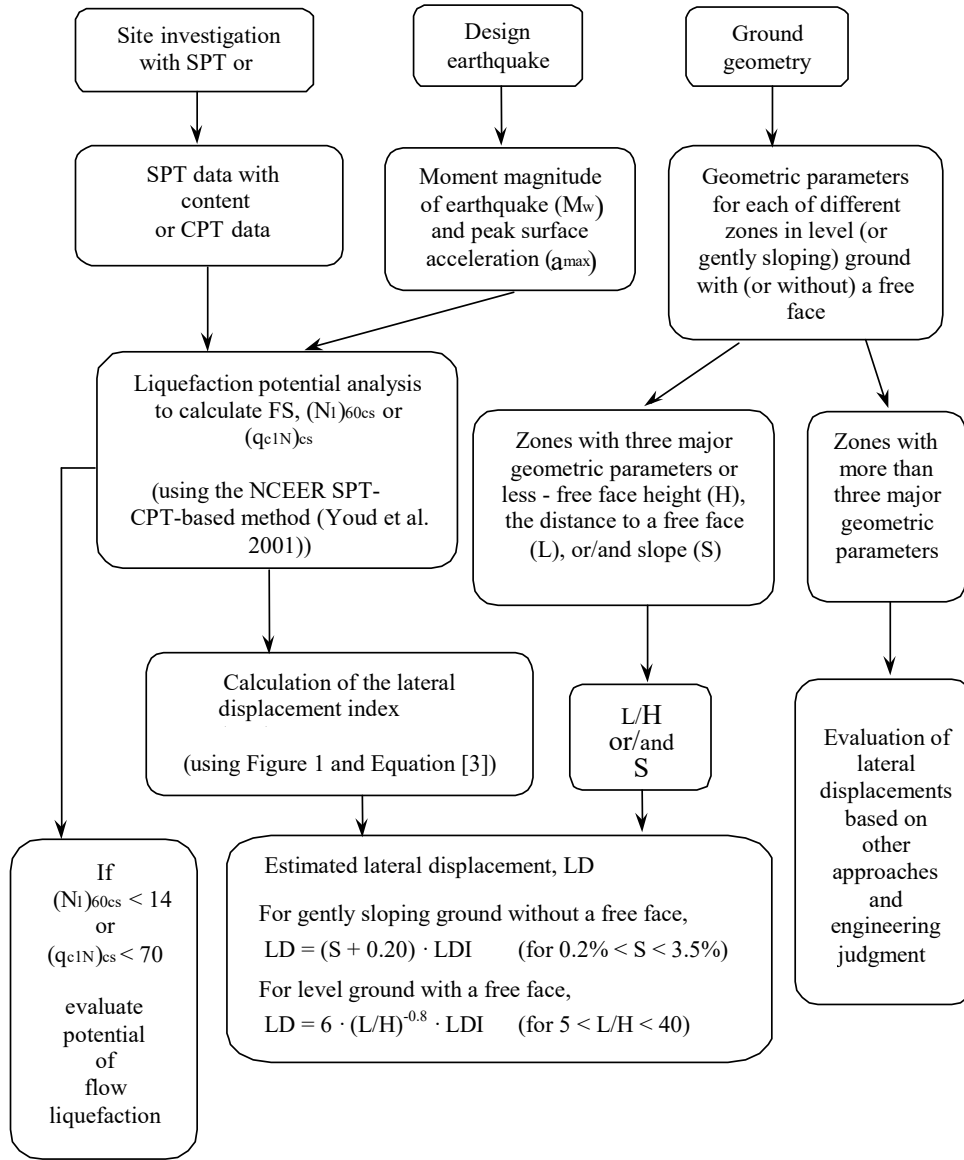
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



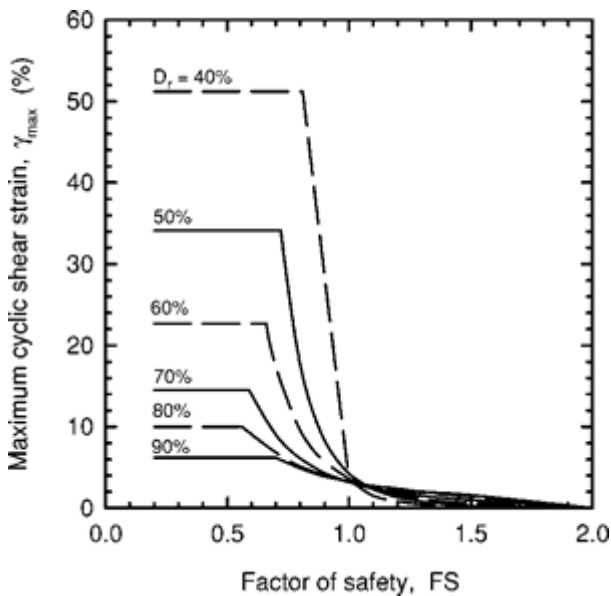
Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)



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



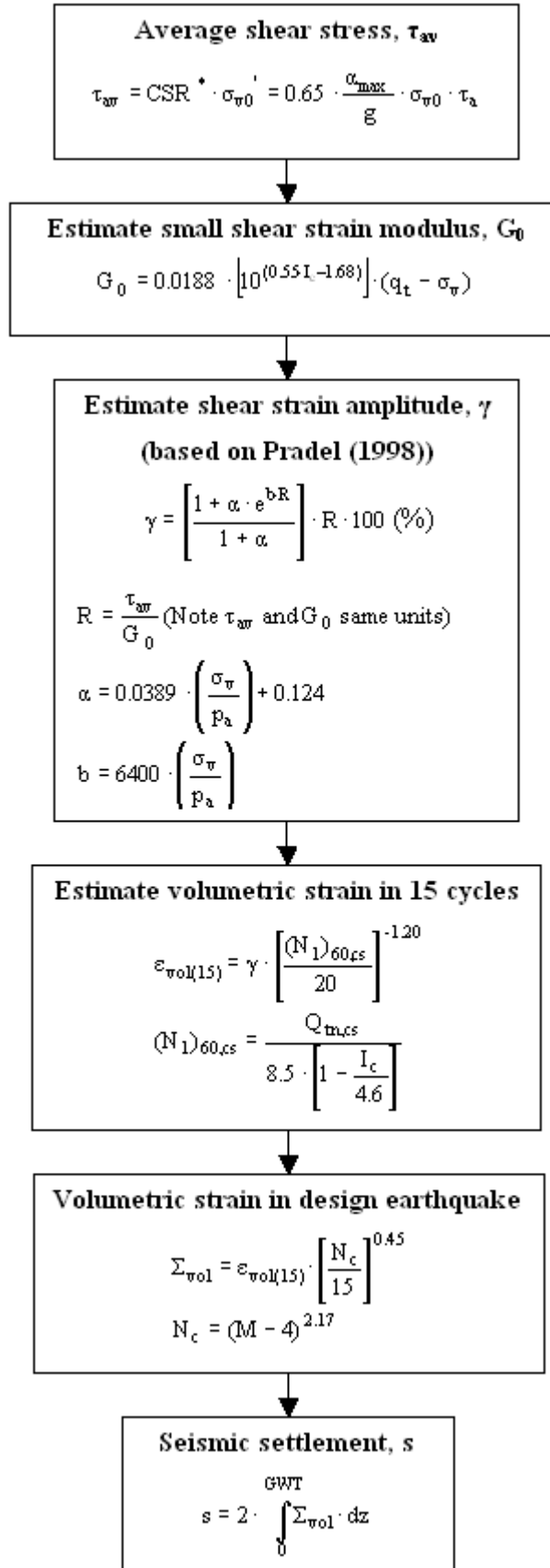
¹ Figure 1

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

¹ Equation [3]

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

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

where:

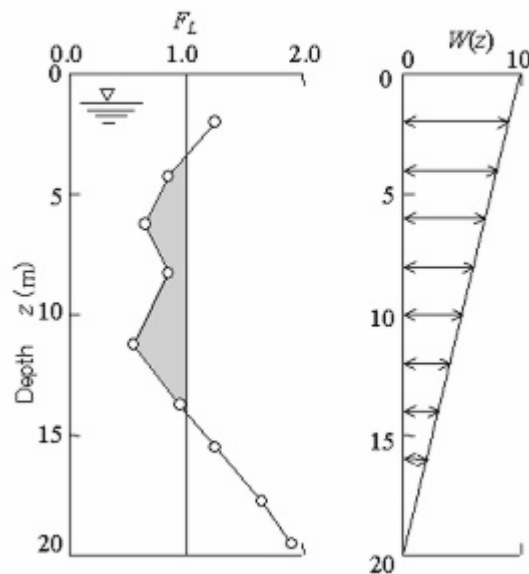
$F_L = 1 - F.S.$ when F.S. less than 1

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

z depth of 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

Shear-Induced Building Settlement (Ds) calculation procedure

The shear-induced building settlement (Ds) due to liquefaction below the building can be estimated using the relationship developed by Bray and Macedo (2017):

$$\begin{aligned} \ln(Ds) = & c1 + c2 * LBS + 0.58 * \ln\left(\tanh\left(\frac{HL}{6}\right)\right) + \\ & 4.59 * \ln(Q) - 0.42 * \ln(Q)^2 - 0.02 * B + \\ & 0.84 * \ln(CAVdp) + 0.41 * \ln(Sa1) + \varepsilon \end{aligned}$$

where Ds is in the units of mm, c1= -8.35 and c2= 0.072 for $LBS \leq 16$, and c1= -7.48 and c2= 0.014 otherwise. Q is the building contact pressure in units of kPa, HL is the cumulative thickness of the liquefiable layers in the units of m, B is the building width in the units of m, CAVdp is a standardized version of the cumulative absolute velocity in the units of g-s, Sa1 is 5%-damped pseudo-acceleration response spectral value at a period of 1 s in the units of g, and ε is a normal random variable with zero mean and 0.50 standard deviation in Ln units. The liquefaction-induced building settlement index (LBS) is:

$$LBS = \sum W * \frac{\varepsilon_{shear}}{z} dz$$

where z (m) is the depth measured from the ground surface > 0 , W is a foundation-weighting factor wherein $W = 0.0$ for z less than Df, which is the embedment depth of the foundation, and $W = 1.0$ otherwise. The shear strain parameter (ε_{shear}) is the liquefaction-induced free-field shear strain (in %) estimated using Zhang et al. (2004). It is calculated based on the estimated Dr of the liquefied soil layer and the calculated safety factor against liquefaction triggering (FSL).

References

- Lunne, T., Robertson, P.K., and Powell, J.J.M 1997. Cone penetration testing in geotechnical practice, E & FN Spon Routledge, 352 p, ISBN 0-7514-0393-8.
- Boulanger, R.W. and Idriss, I. M., 2007. Evaluation of Cyclic Softening in Silts and Clays. ASCE Journal of Geotechnical and Geoenvironmental Engineering June, Vol. 133, No. 6 pp 641-652
- Boulanger, R.W. and Idriss, I. M., 2014. CPT AND SPT BASED LIQUEFACTION TRIGGERING PROCEDURES. DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA AT DAVIS
- Robertson, P.K. and Cabal, K.L., 2007, Guide to Cone Penetration Testing for Geotechnical Engineering. Available at no cost at <http://www.geologismiki.gr/>
- Robertson, P.K. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27 (1), 151-8.
- Robertson, P.K. and Wride, C.E., 1998. Cyclic Liquefaction and its Evaluation based on the CPT Canadian Geotechnical Journal, 1998, Vol. 35, August.
- Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833
- Zhang, G., Robertson. P.K., Brachman, R., 2002, Estimating Liquefaction Induced Ground Settlements from the CPT, Canadian Geotechnical Journal, 39: pp 1168-1180
- Zhang, G., Robertson. P.K., Brachman, R., 2004, Estimating Liquefaction Induced Lateral Displacements using the SPT and CPT, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 130, No. 8, 861-871
- Pradel, D., 1998, Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 124, No. 4, 364-368
- Iwasaki, T., 1986, Soil liquefaction studies in Japan: state-of-the-art, Soil Dynamics and Earthquake Engineering, Vol. 5, No. 1, 2-70
- Papathanassiou G., 2008, LPI-based approach for calibrating the severity of liquefaction-induced failures and for assessing the probability of liquefaction surface evidence, Eng. Geol. 96:94–104
- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355
- P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering - from case history to practice, IS-Tokyo, June 2009
- Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, *Symposium in honor of professor I. M. Idriss*, SAN diego, CA
- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006
- I. M. Idriss and R. W. Boulanger, 2008. Soil liquefaction during earthquakes, Earthquake Engineering Research Institute MNO-12
- Jonathan D. Bray & Jorge Macedo, Department of Civil & Environmental Engineering, Univ. of California, Berkeley, CA, USA, Simplified procedure for estimating liquefaction-induced building settlement, *Proceedings of the 19th International Conference on Soil Mechanics and Geotechnical Engineering, Seoul 201*

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LIQUEFACTION ANALYSIS REPORT

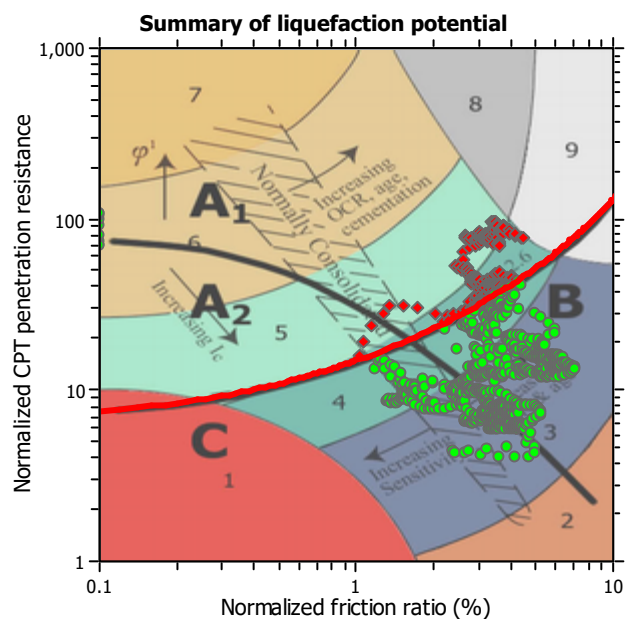
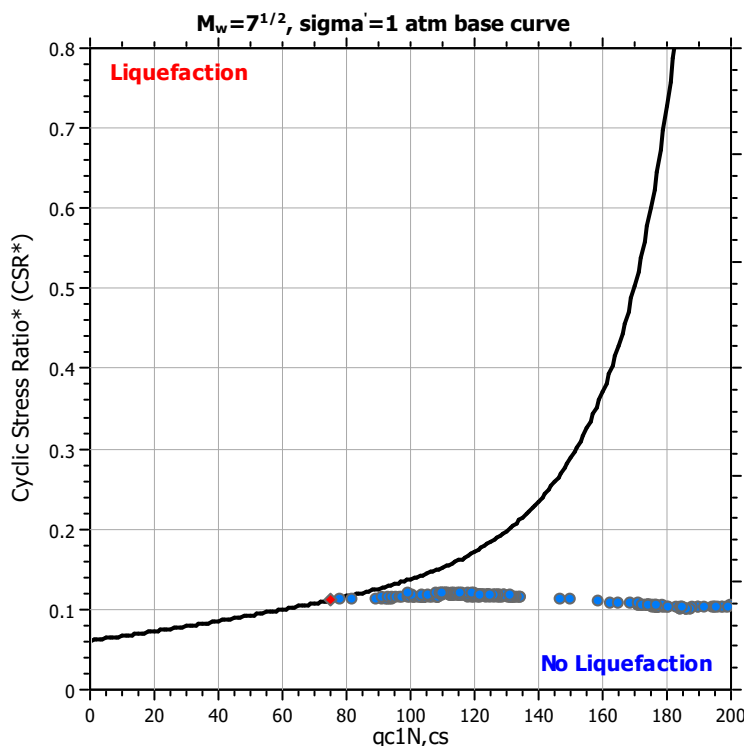
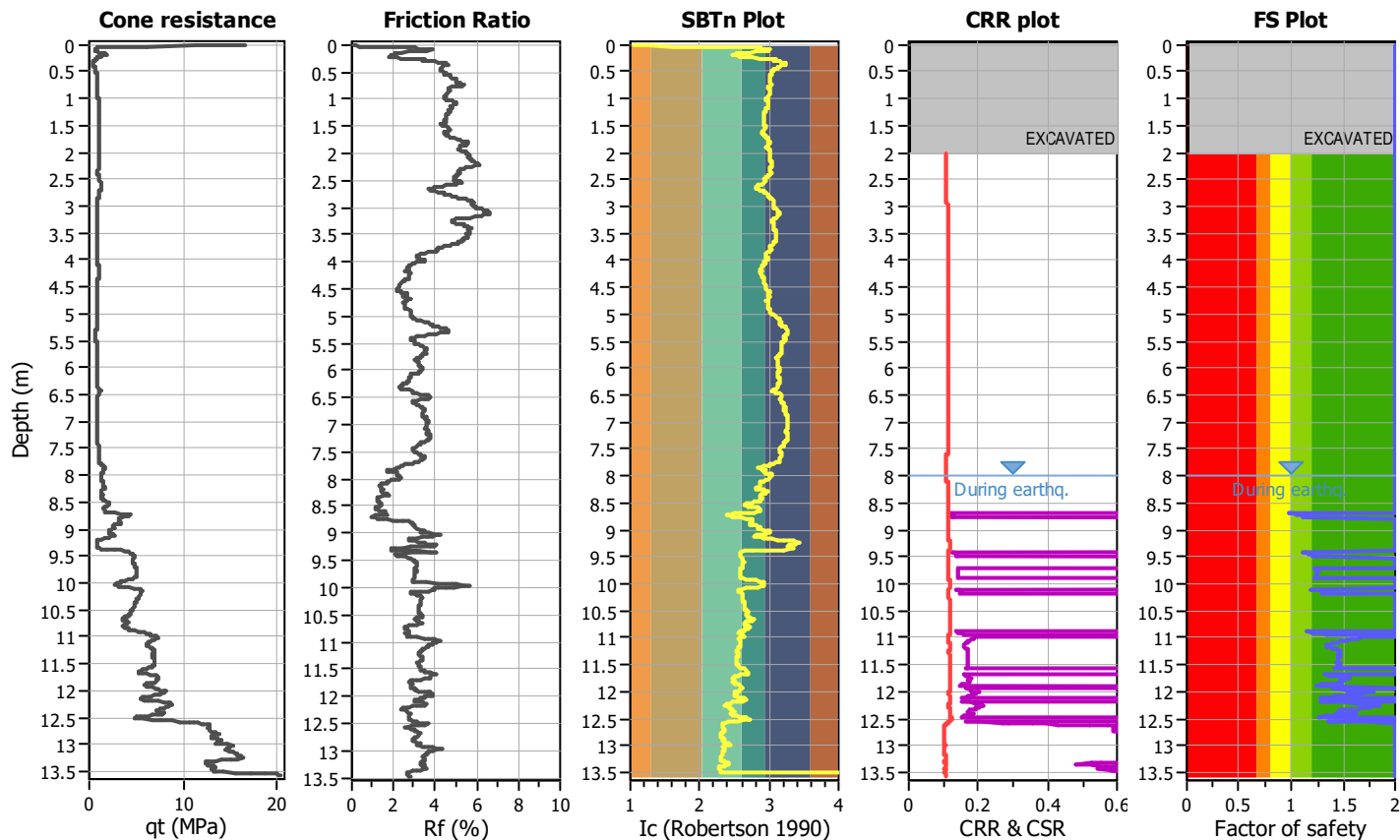
Project title :

Location :

CPT file : CPT-Test CPT01

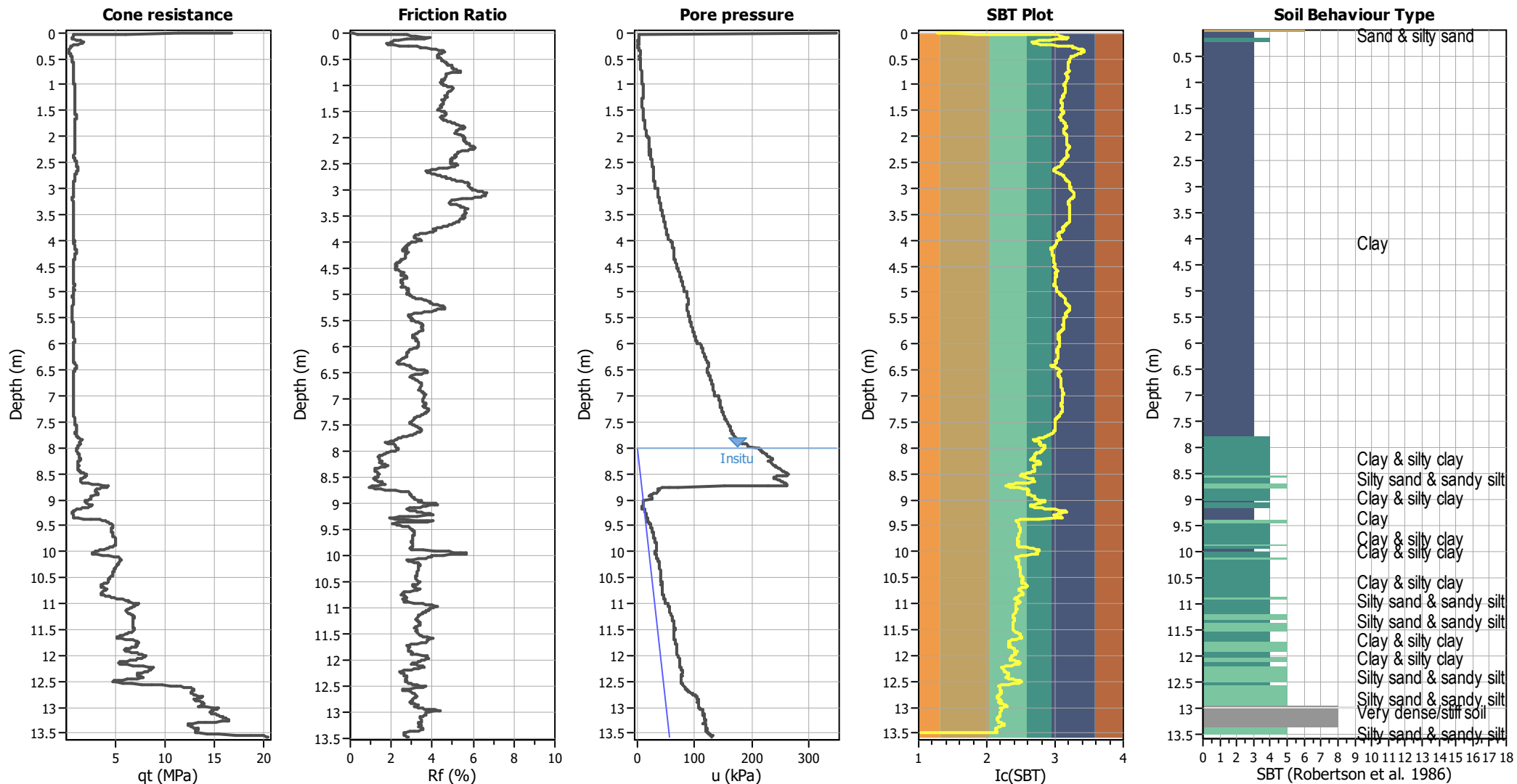
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	8.00 m	Excavation:	Yes	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 m	Excavation depth:	2.00 m	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	36.00 kPa	Limit depth:	N/A
Earthquake magnitude M_w :	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots

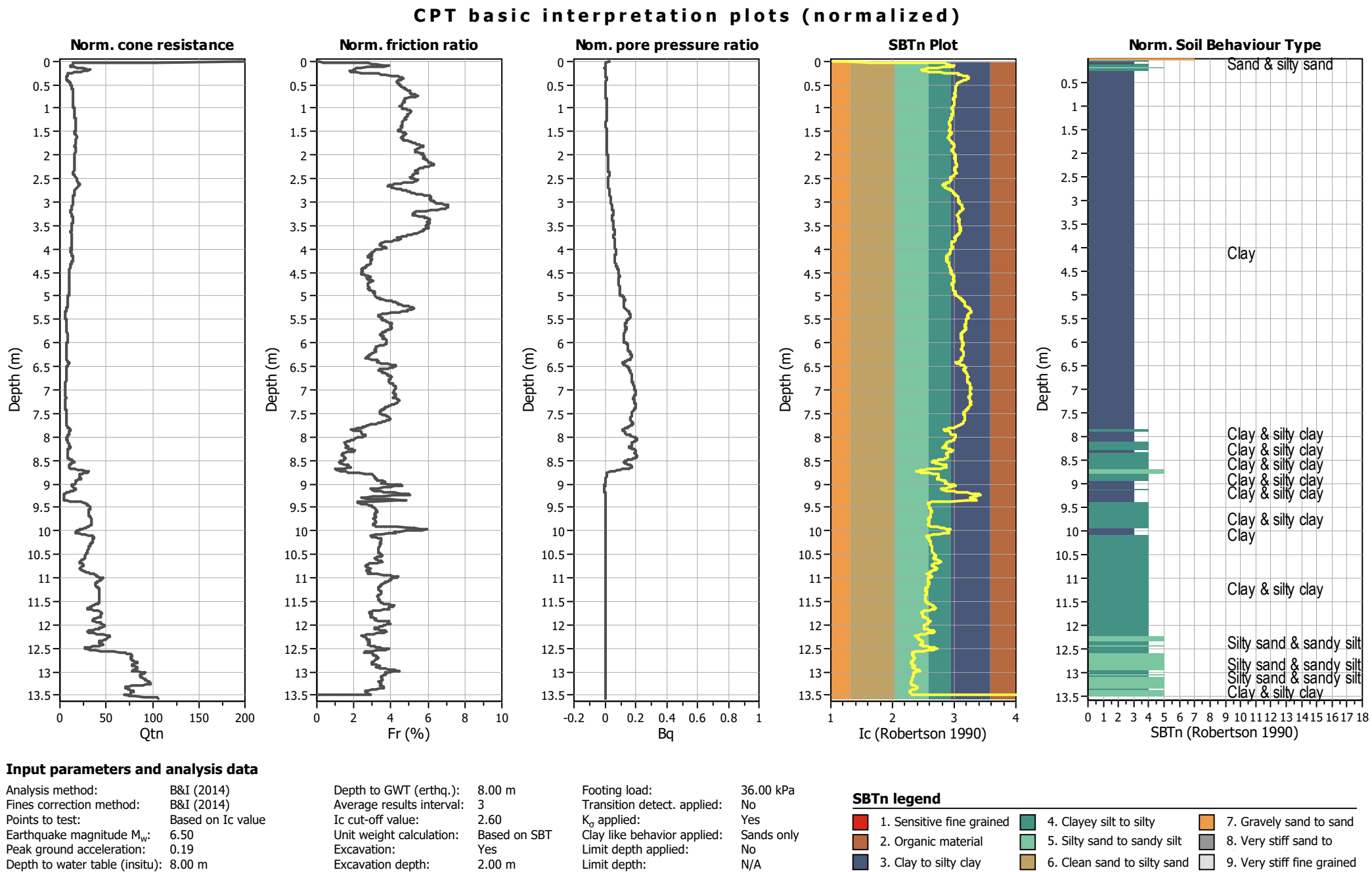


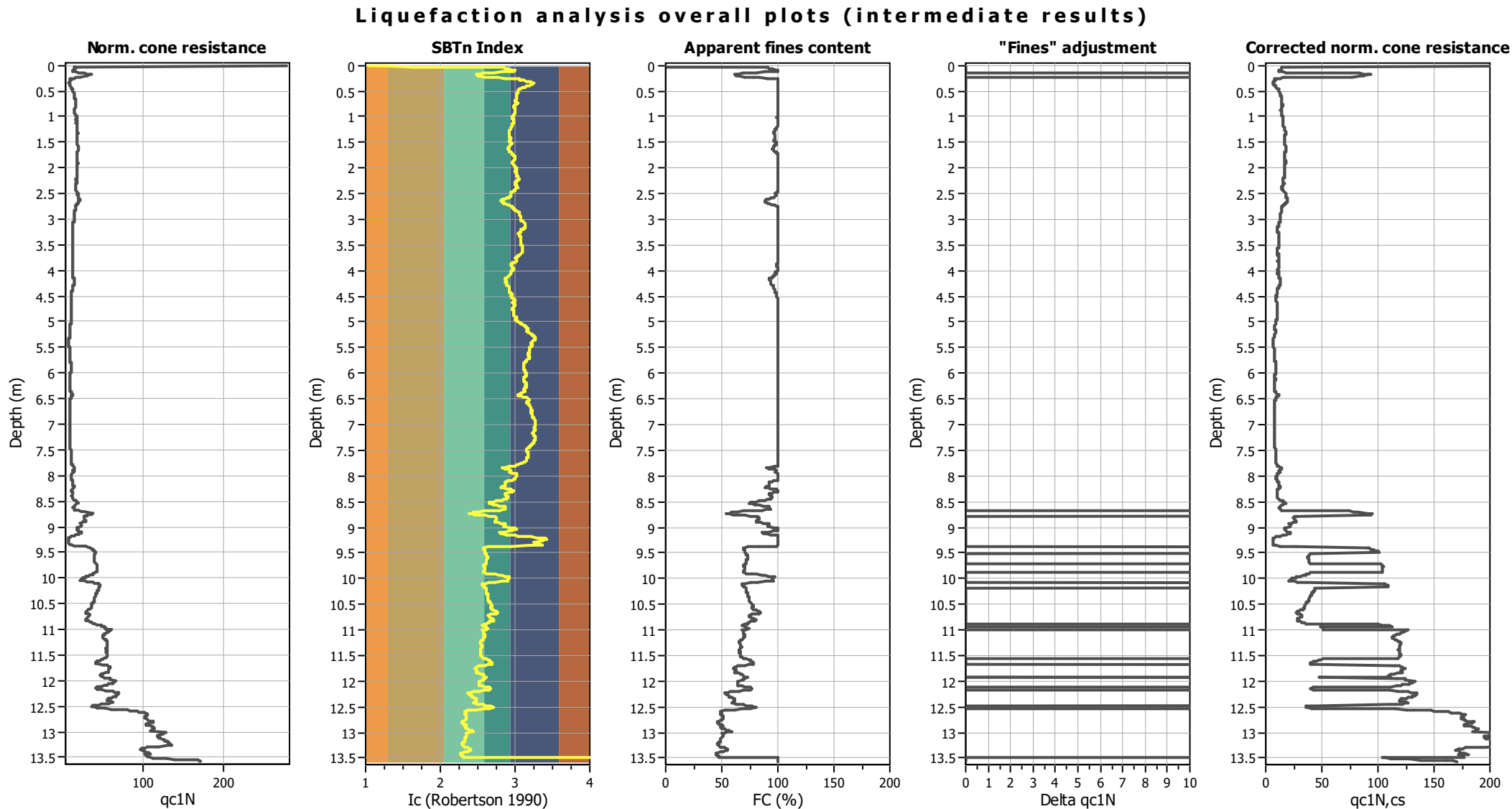
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_0 applied:	Yes
Earthquake magnitude M_w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	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

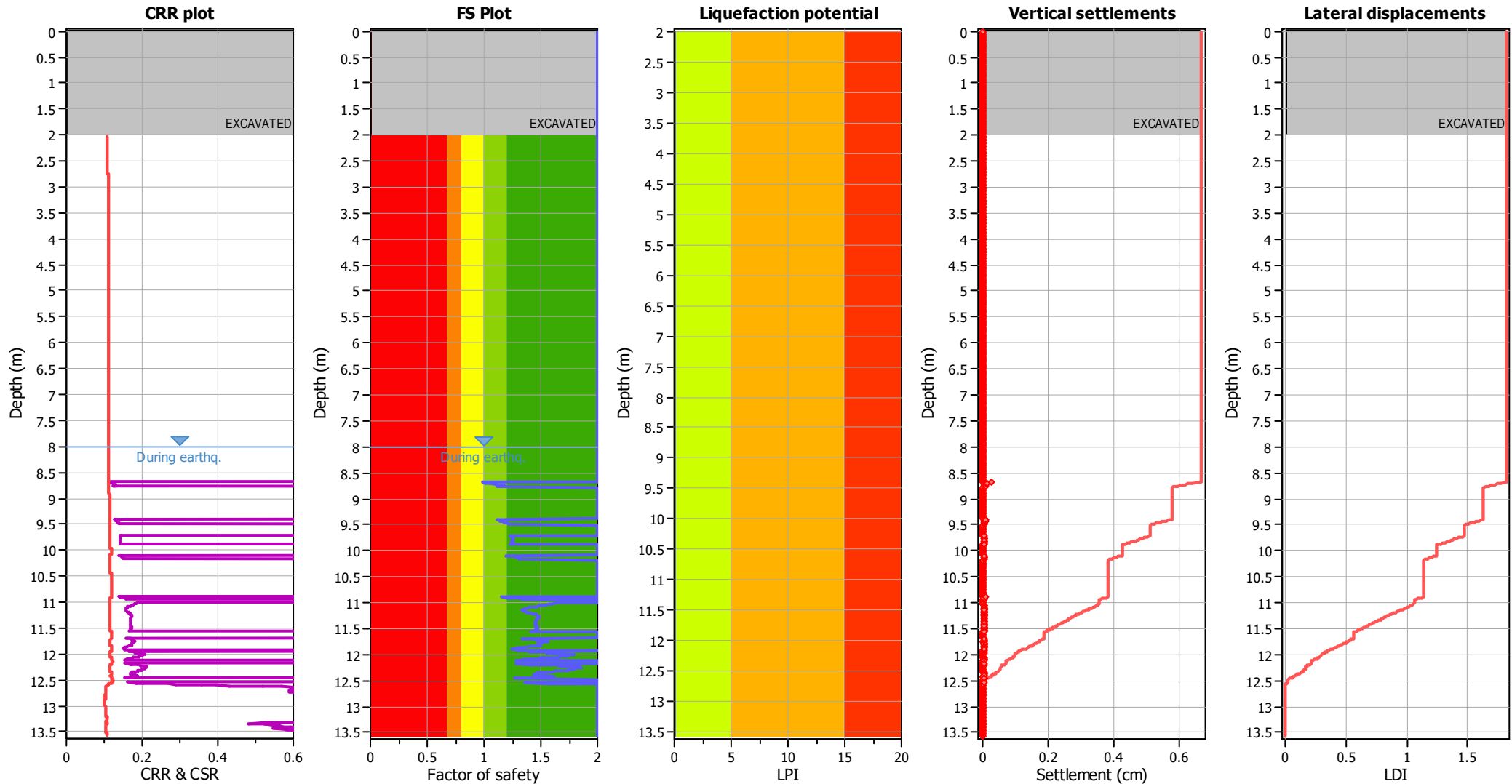




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A

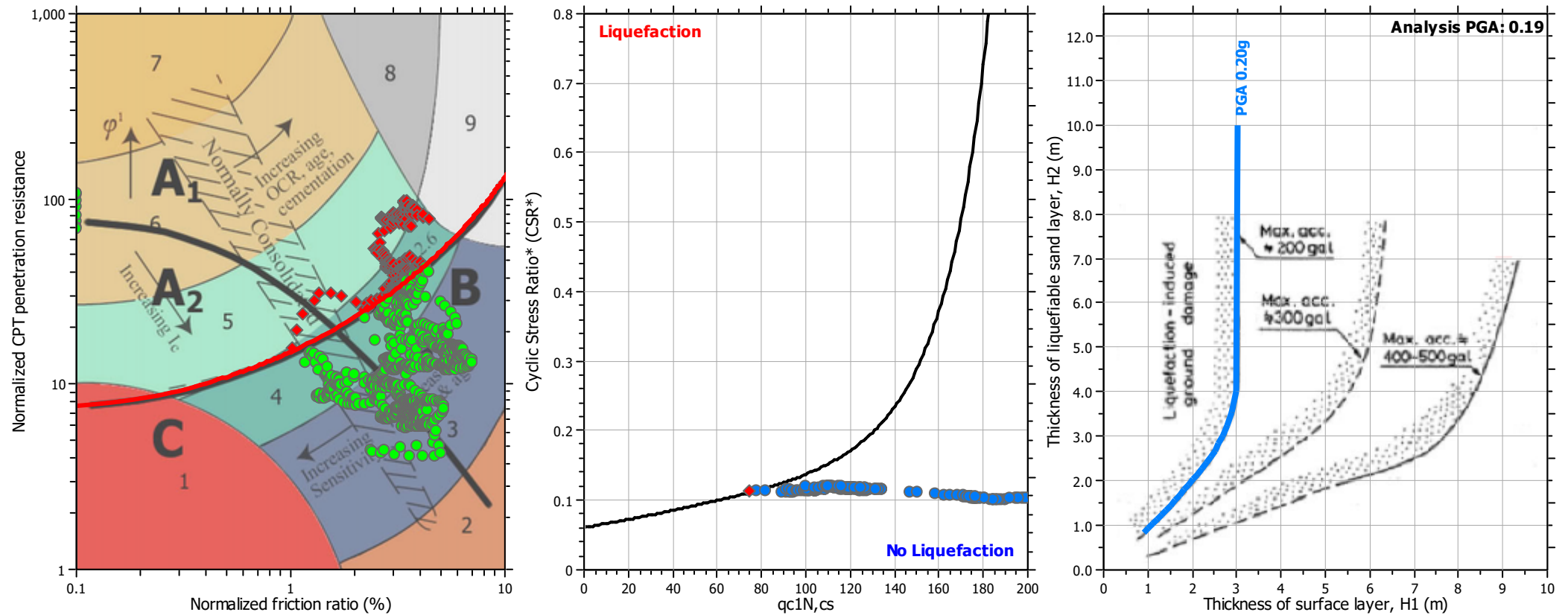
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Green	Unlike to liquefy
Dark green	Almost certain it will not liquefy

LPI color scheme

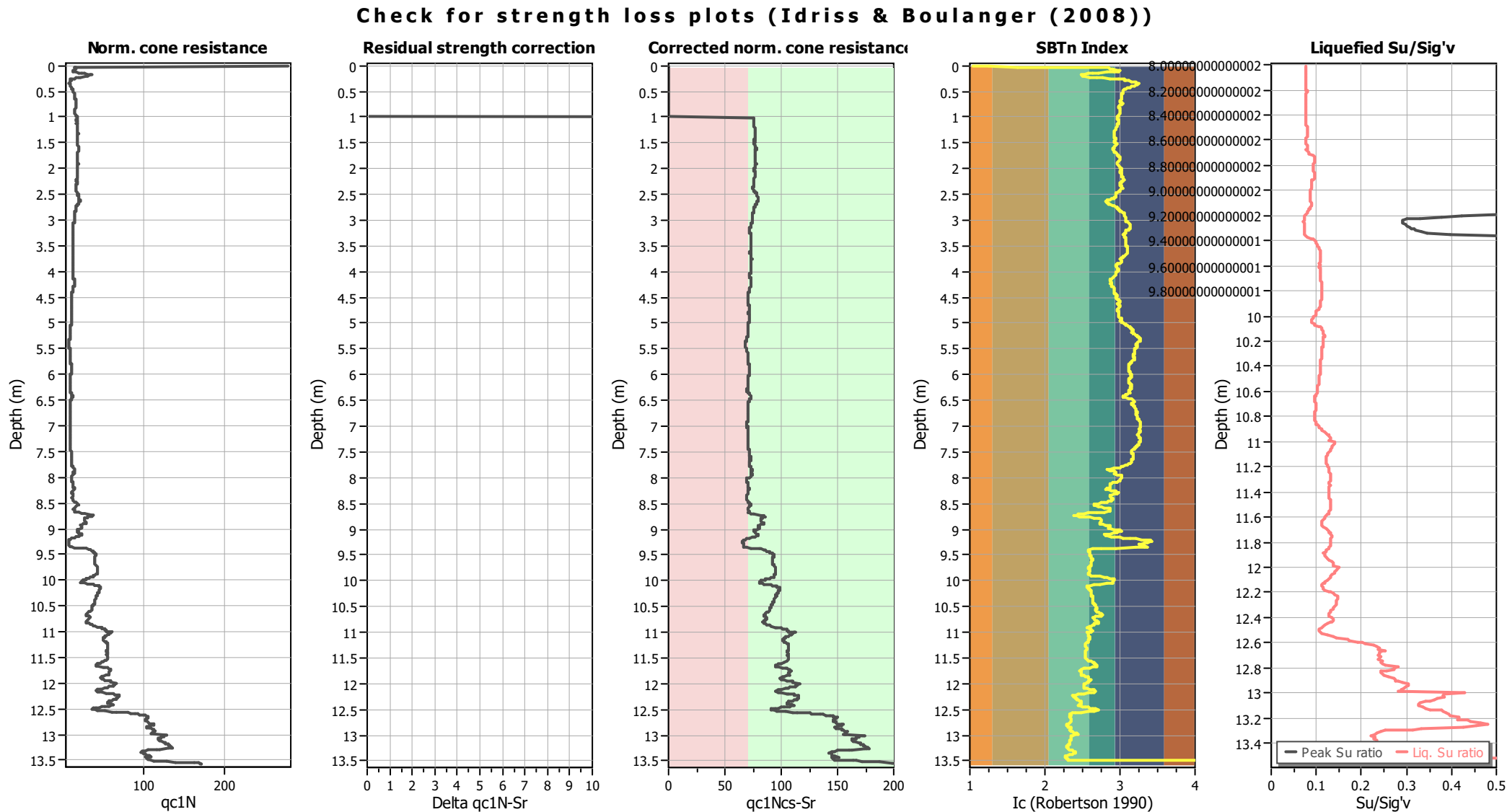
Red	Very high risk
Orange	High risk
Yellow	Low risk

Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	36.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	8.00 m	Excavation depth:	2.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

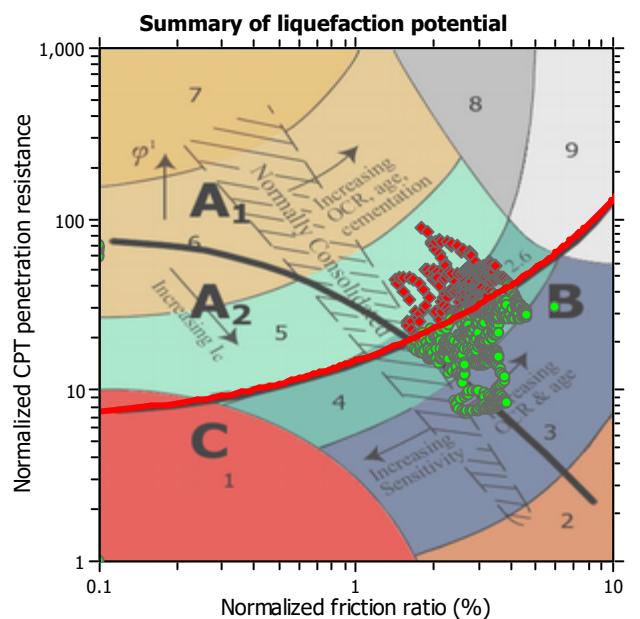
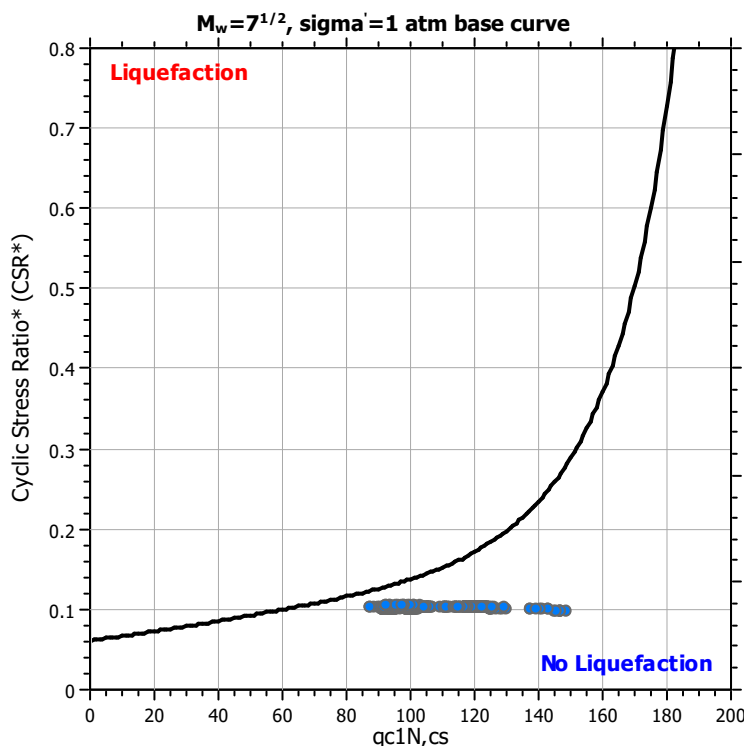
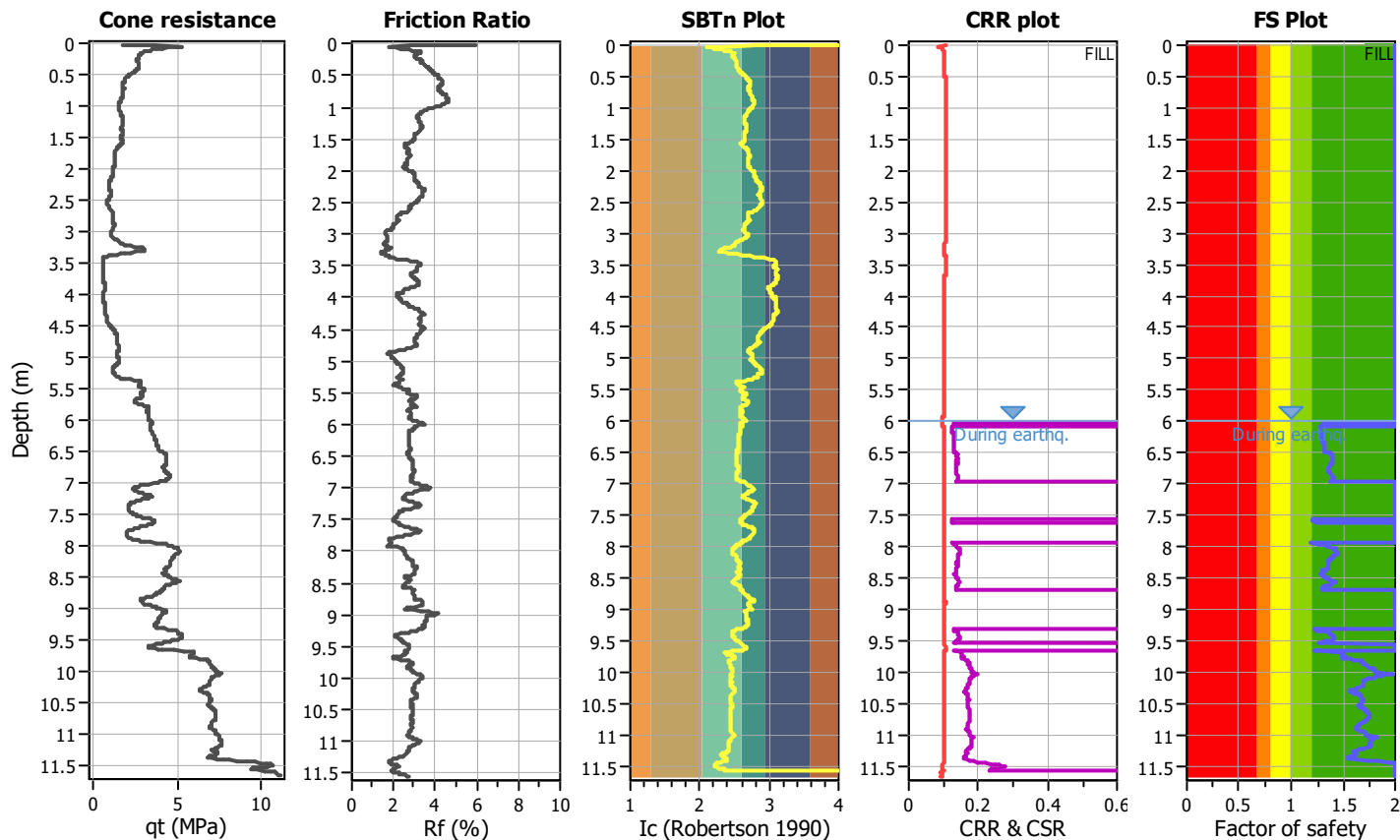
Project title :

Location :

CPT file : CPT-Test CPT02

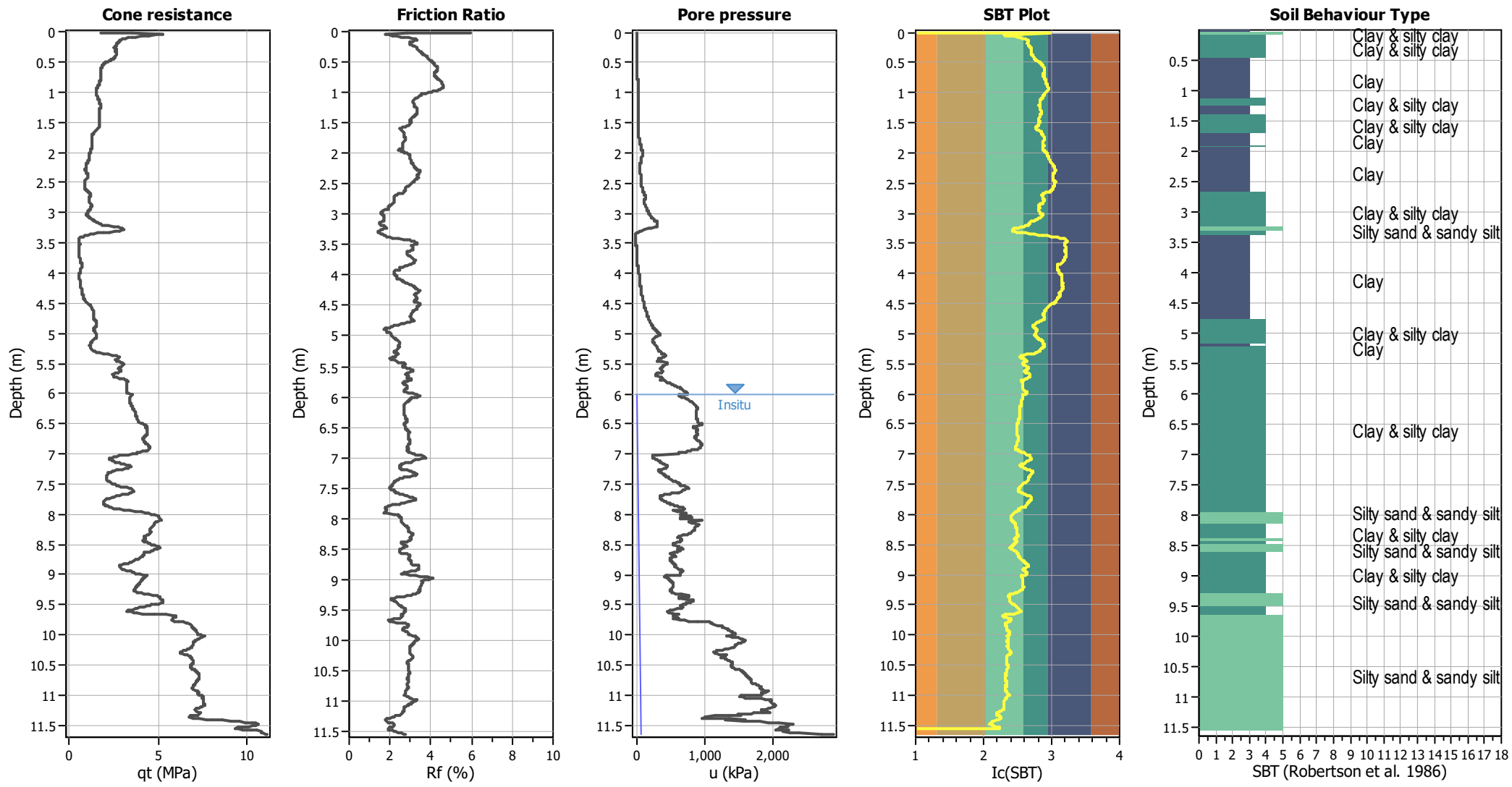
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 m	Use fill:	Yes	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	11.00 m	Fill height:	5.00 m	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	19.00 kN/m ³	Limit depth applied:	No
Earthquake magnitude M_w :	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes	MSF method:	Method



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots

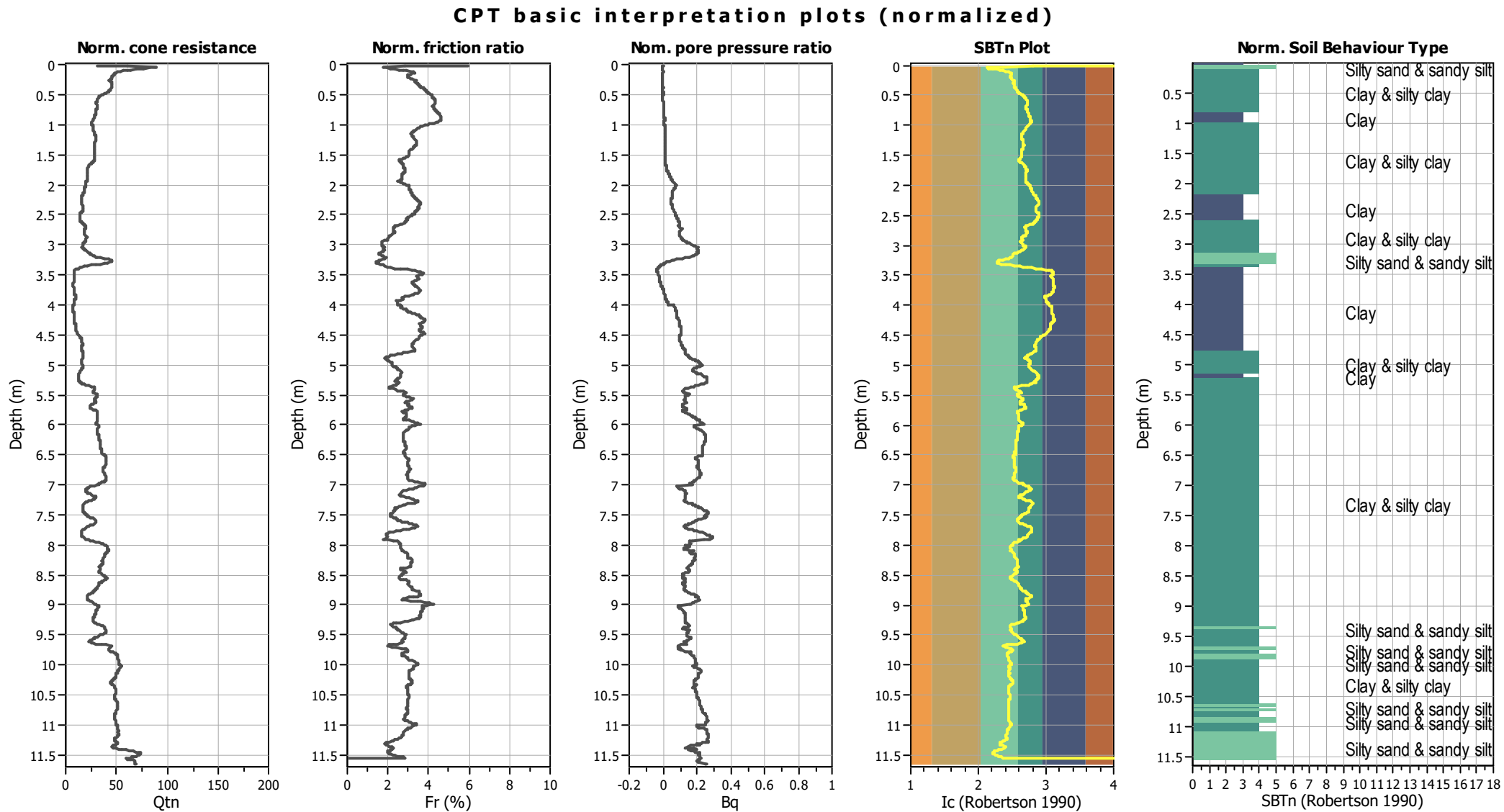


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained

2. Organic material

3. Clay to silty clay

4. Clayey silt to silty

5. Silty sand to sandy silt

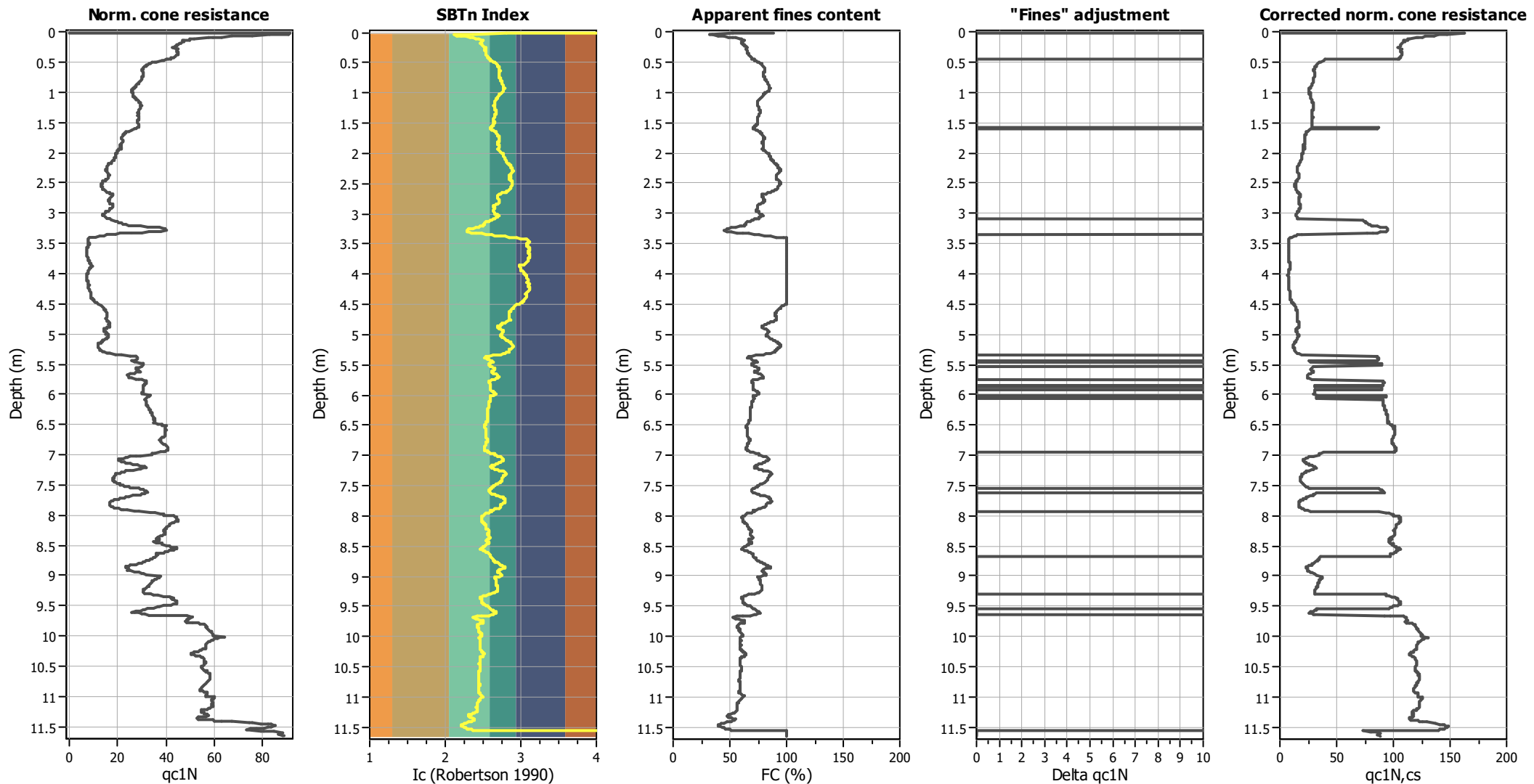
6. Clean sand to silty sand

7. Gravely sand to sand

8. Very stiff sand to

9. Very stiff fine grained

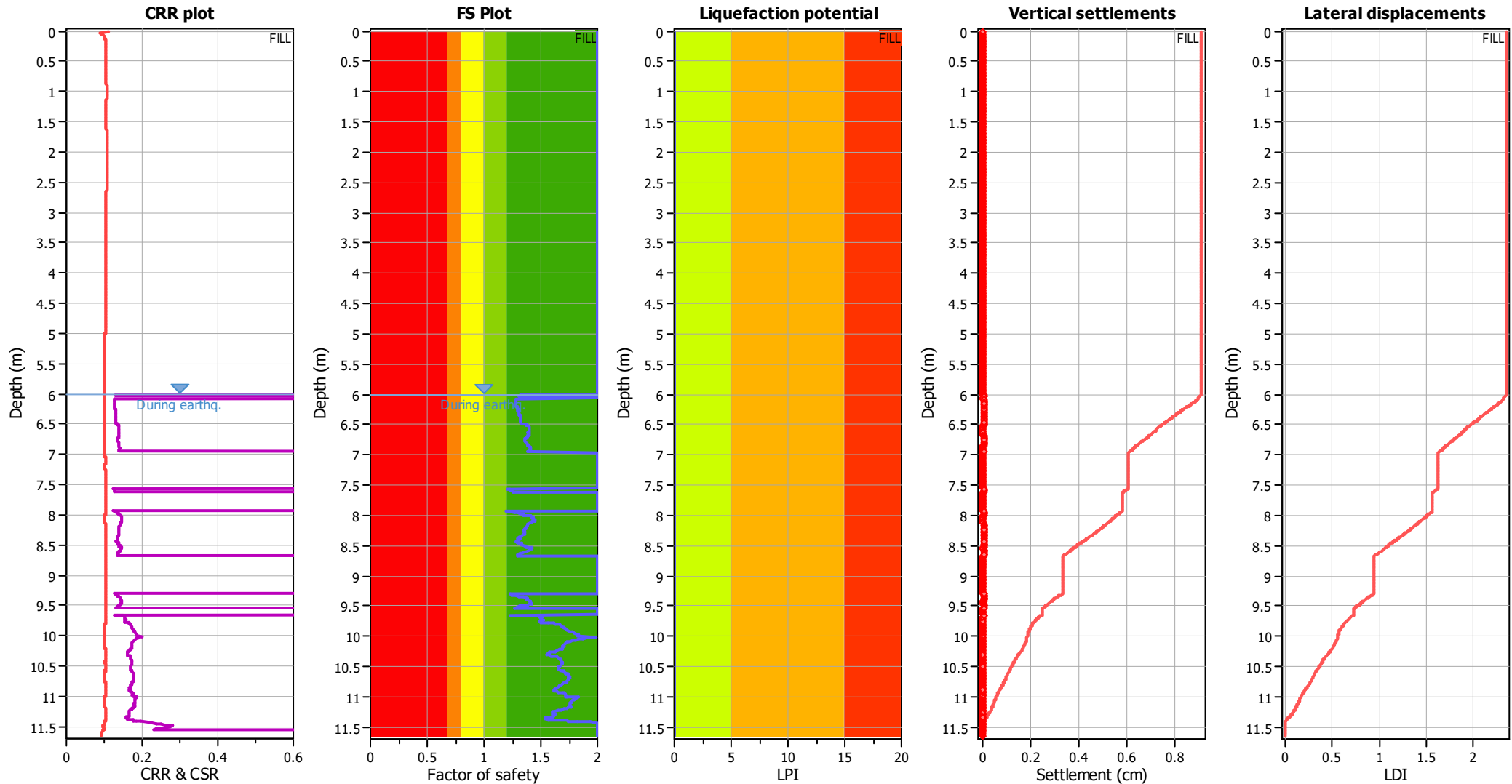
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _σ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

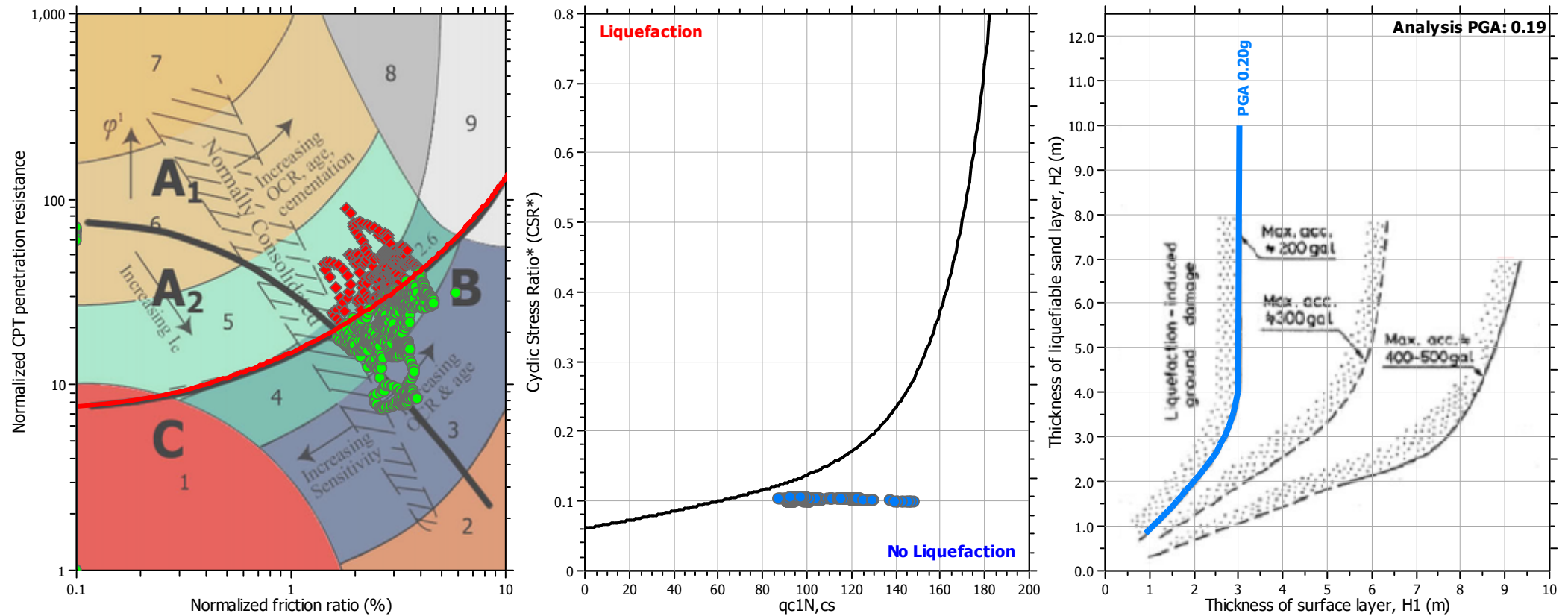
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

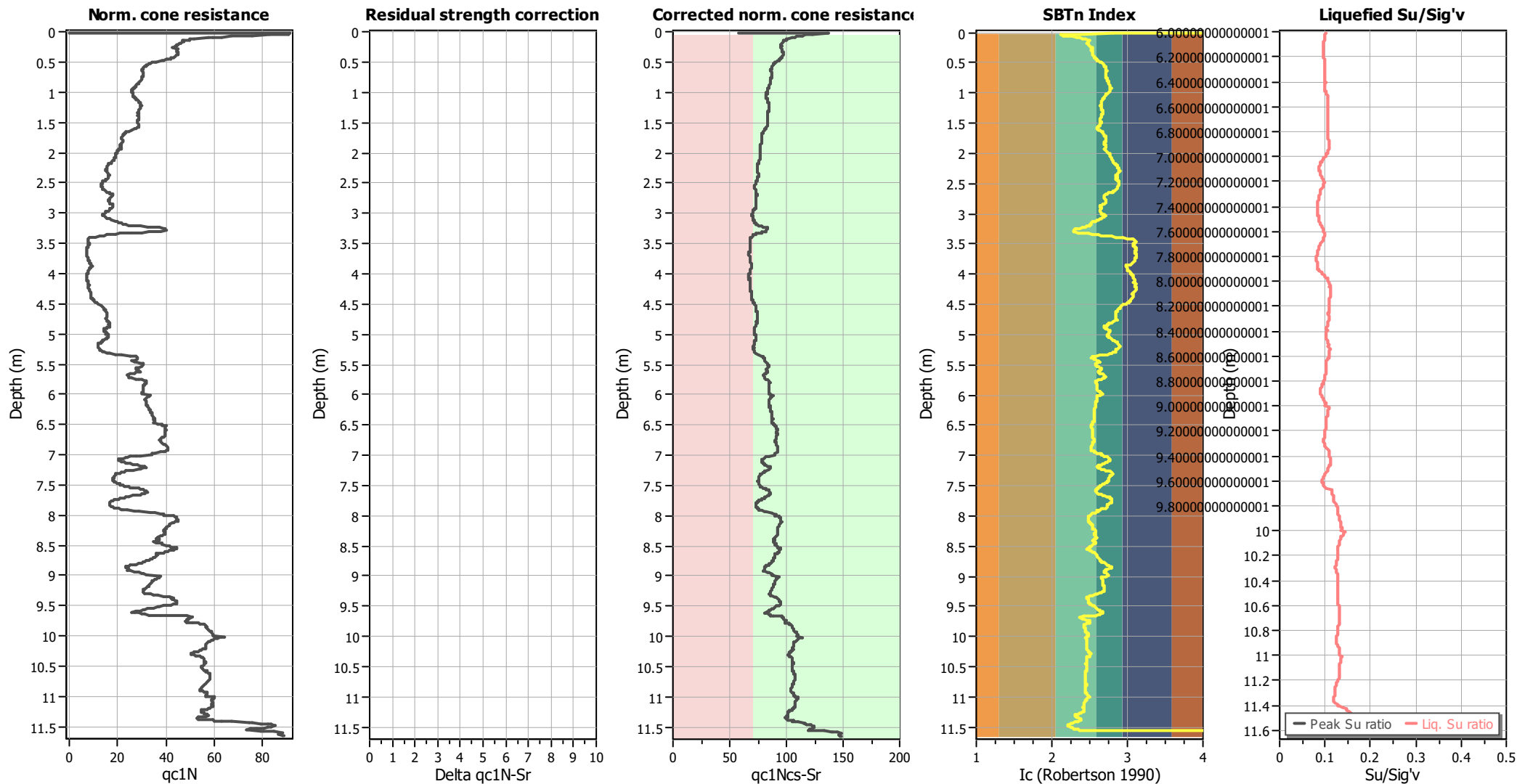
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	11.00 m	Fill weight:	19.00 kN/m ³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	Yes	Limit depth applied:	No
Depth to water table (insitu):	6.00 m	Fill height:	5.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

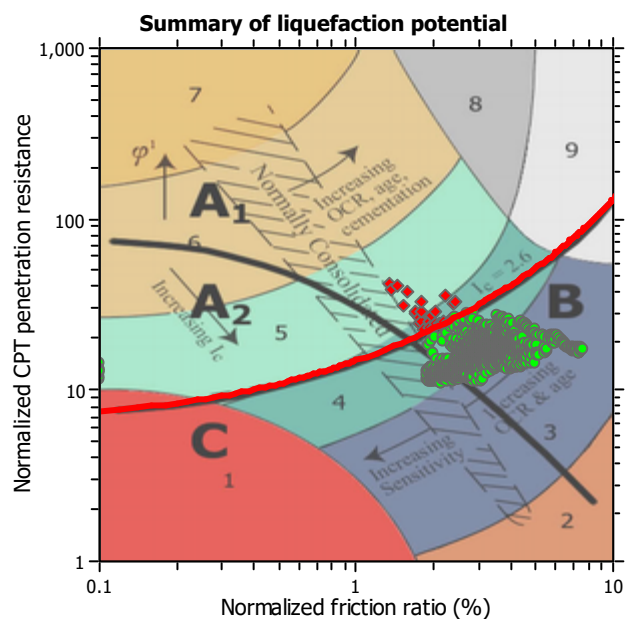
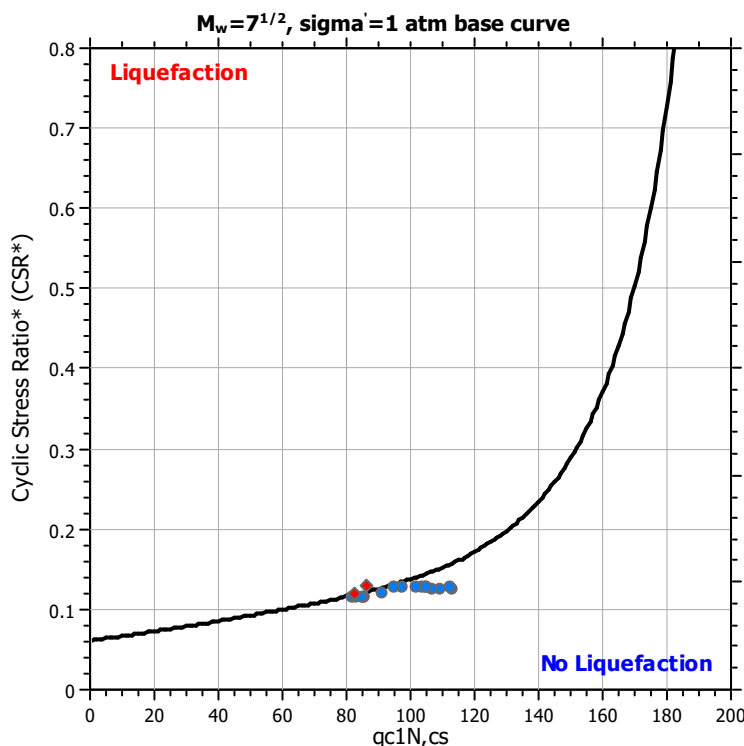
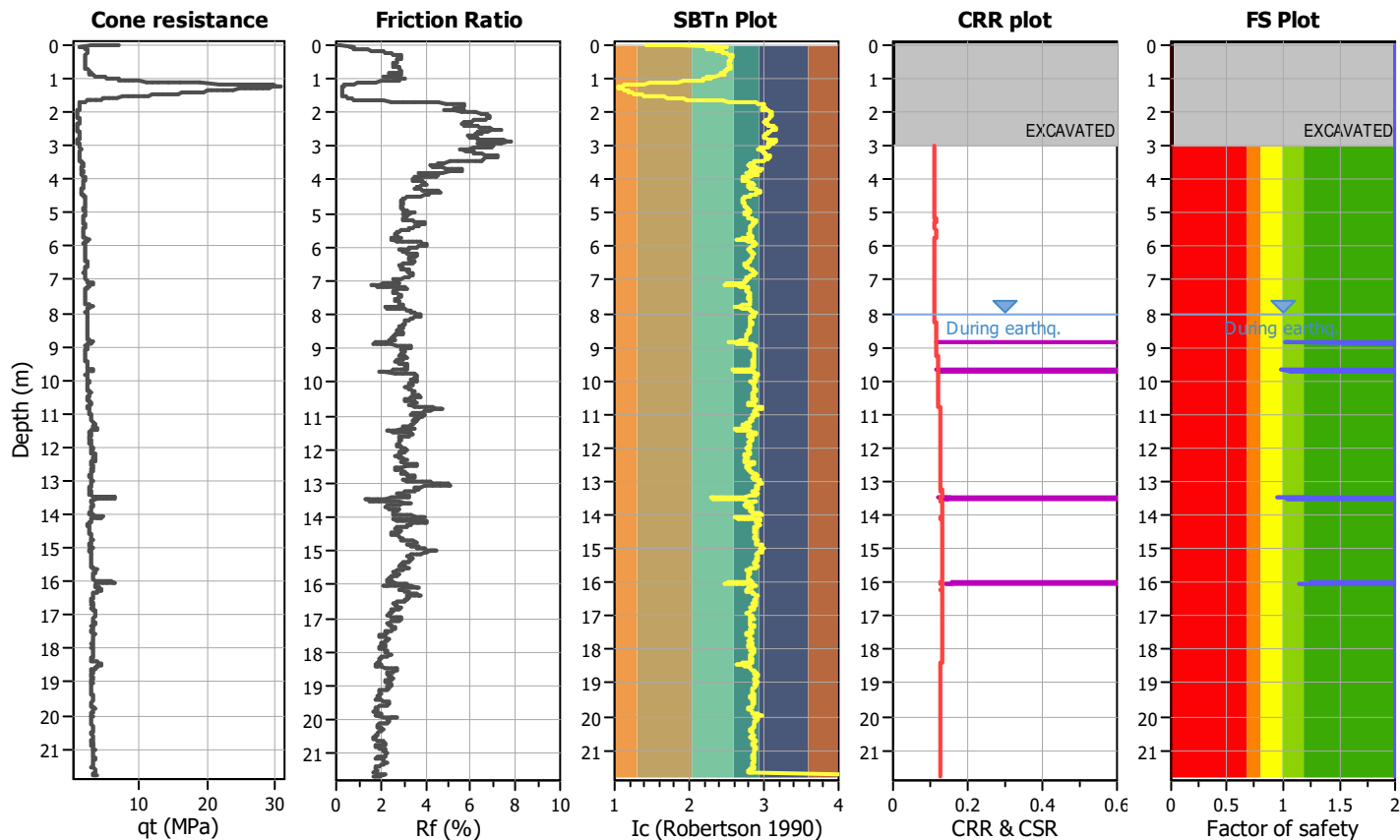
Project title :

Location :

CPT file : CPT-Test CPT03

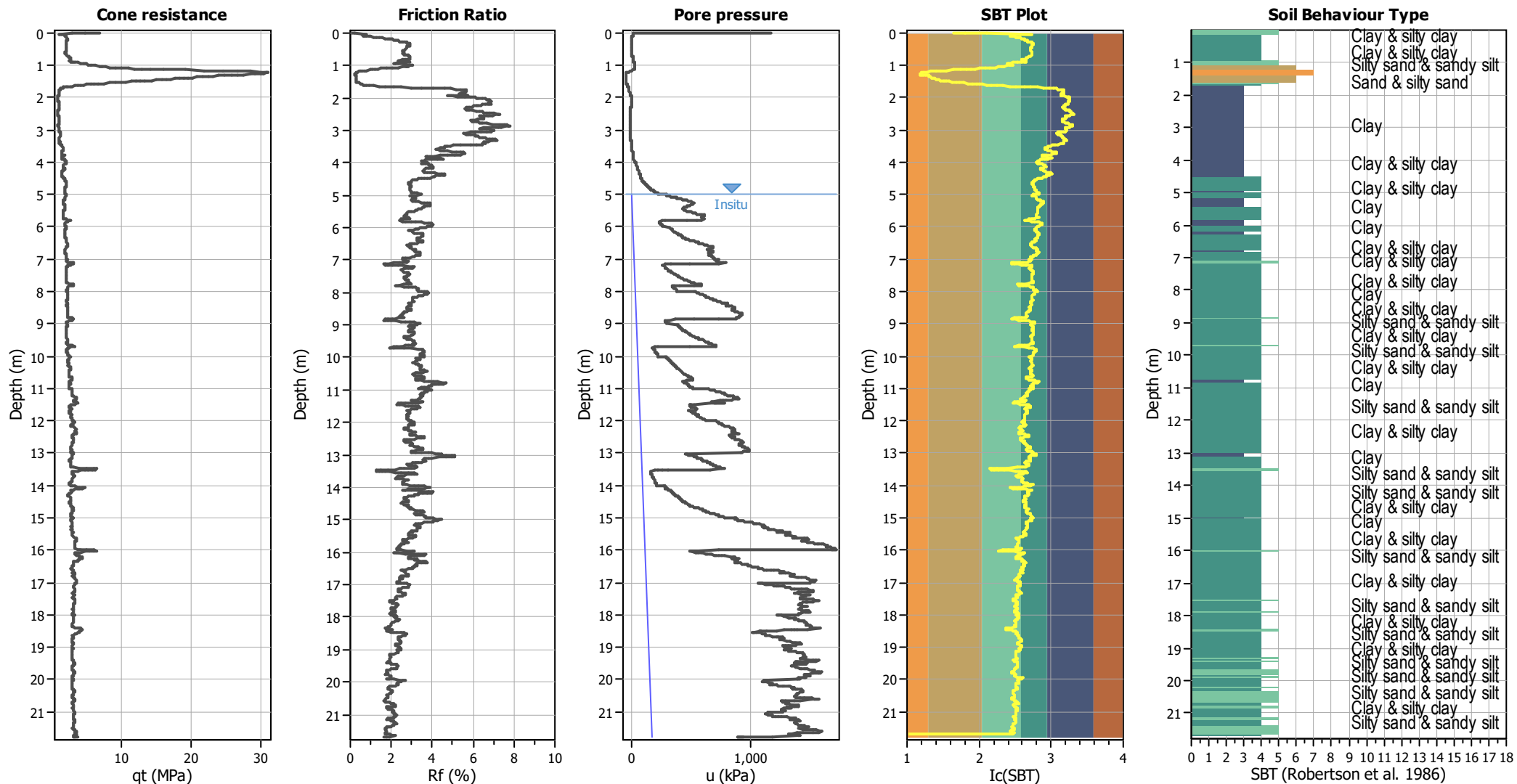
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 m	Excavation:	Yes	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	8.00 m	Excavation depth:	3.00 m	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	54.00 kPa	Limit depth applied:	No
Earthquake magnitude M_w :	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes	MSF method:	Method



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots

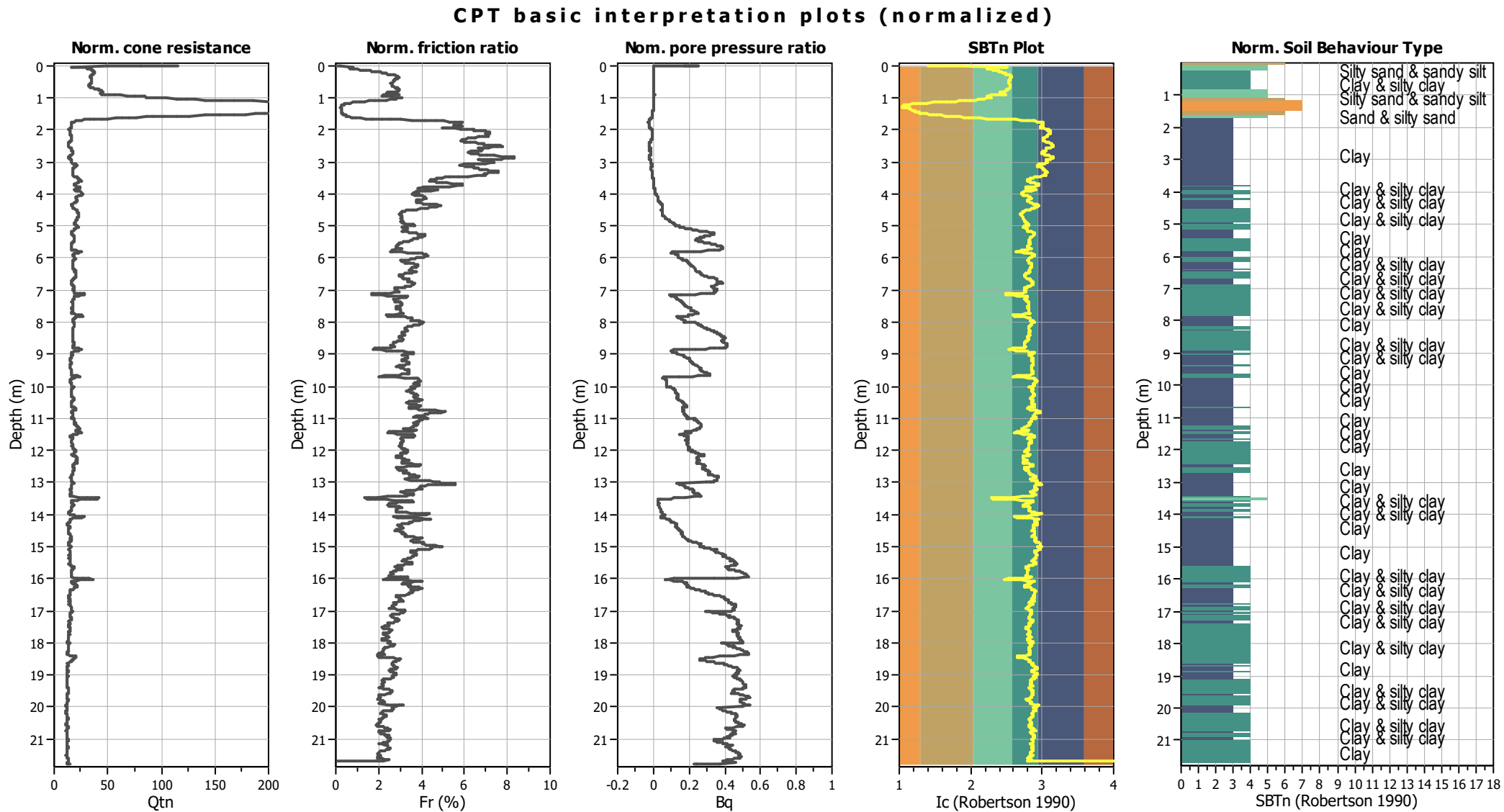


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	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



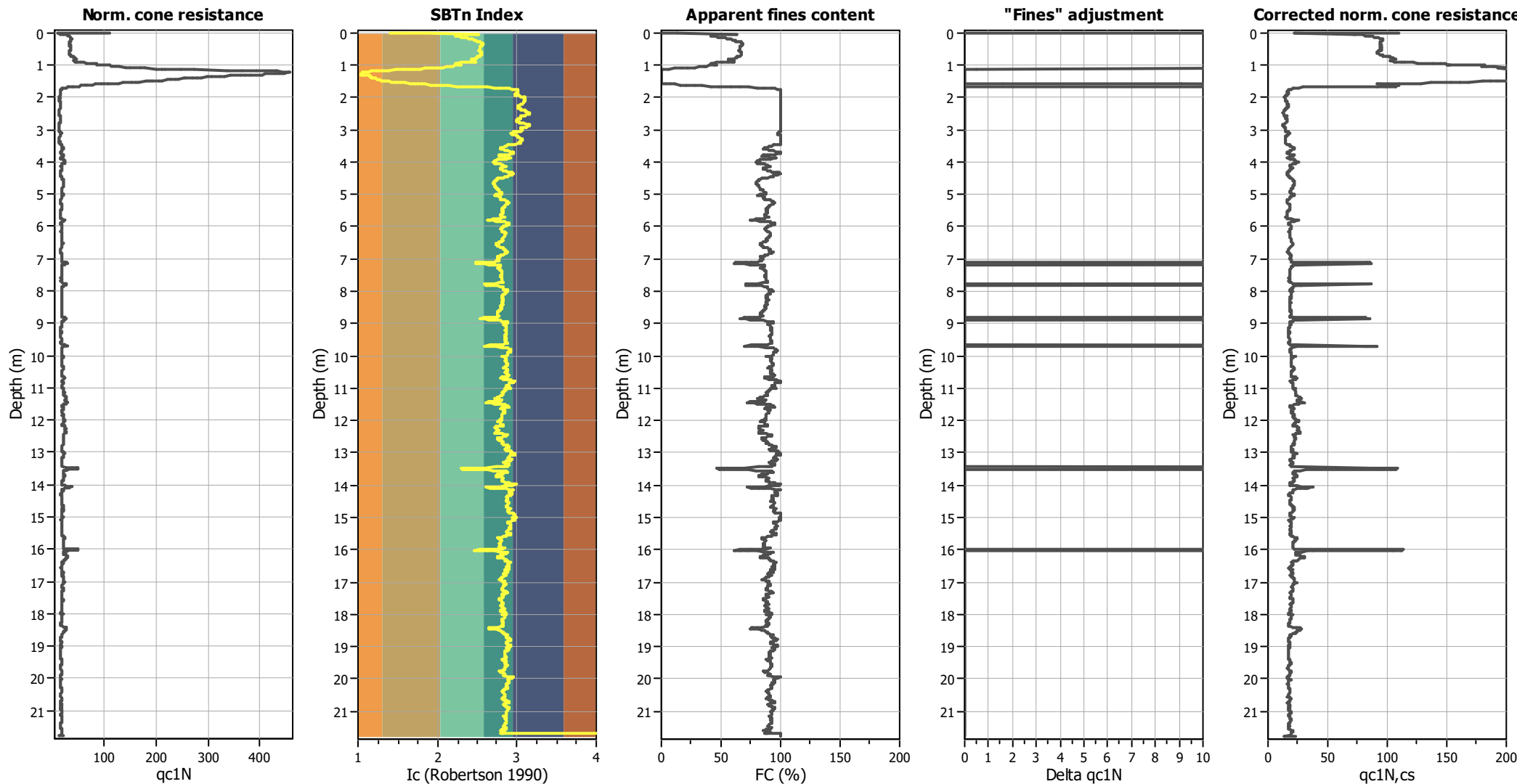
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

SBTn legend

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

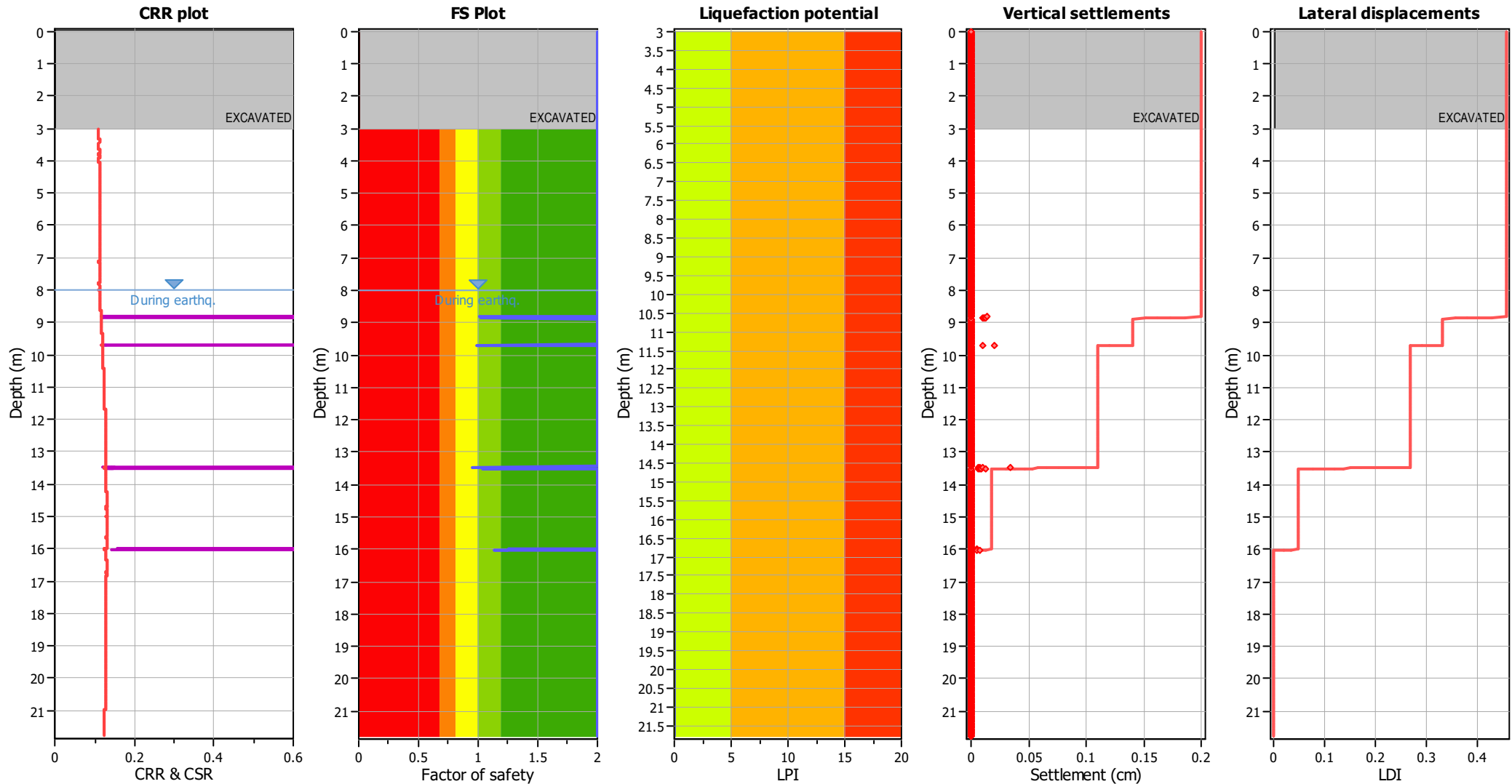
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

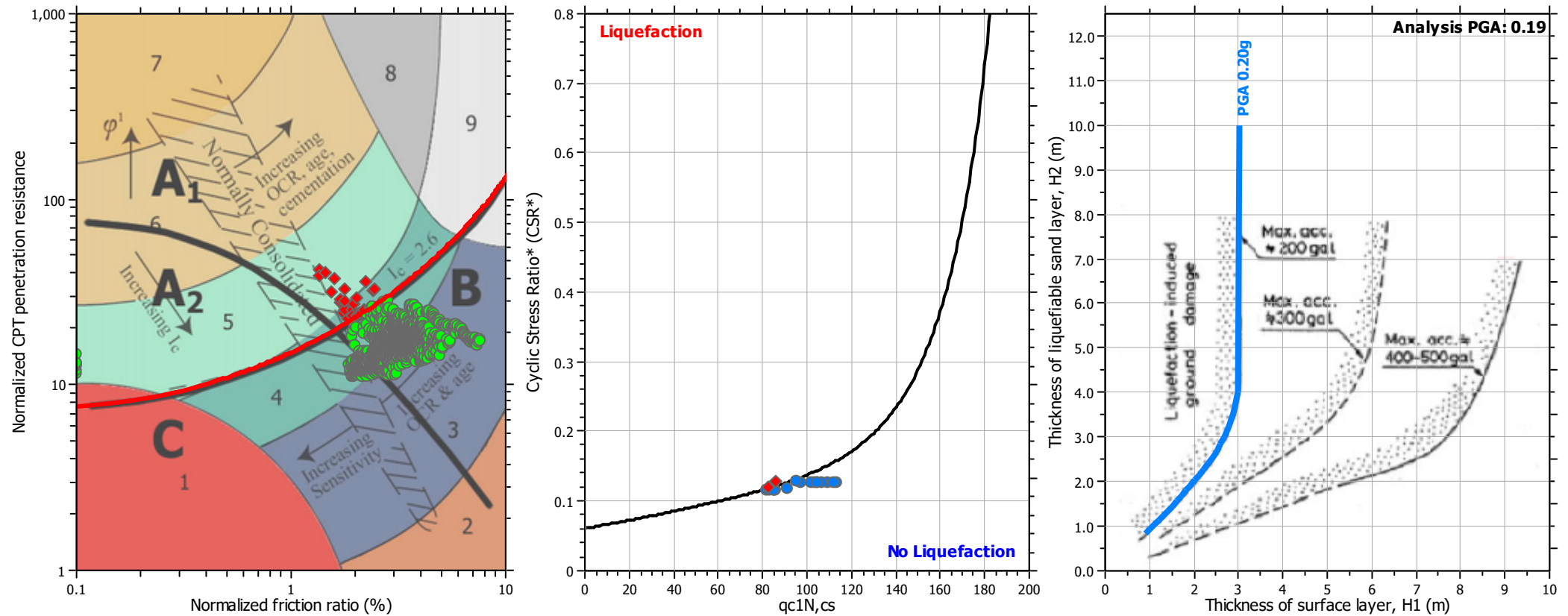
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

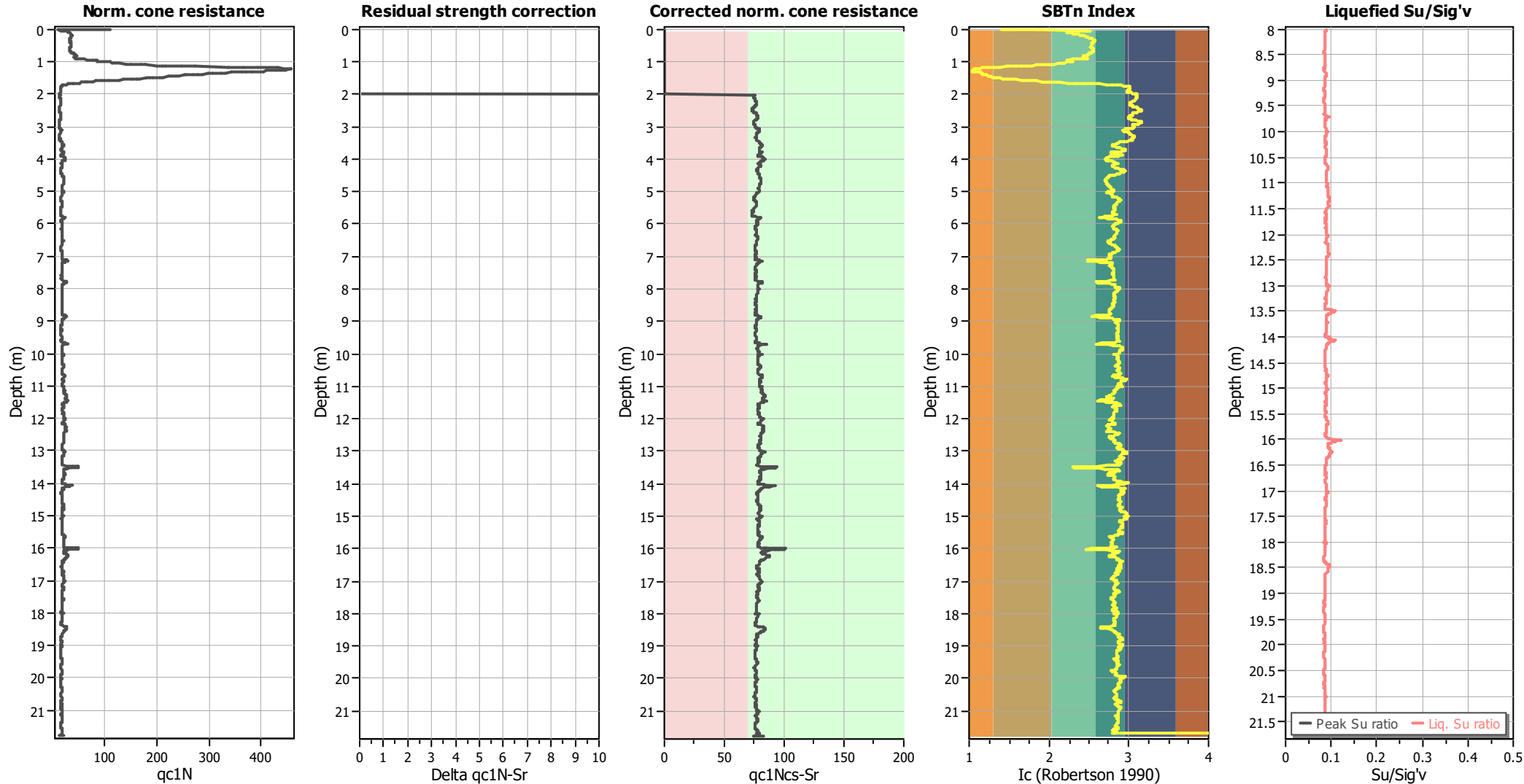
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	8.00 m	Footing load:	54.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	3.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

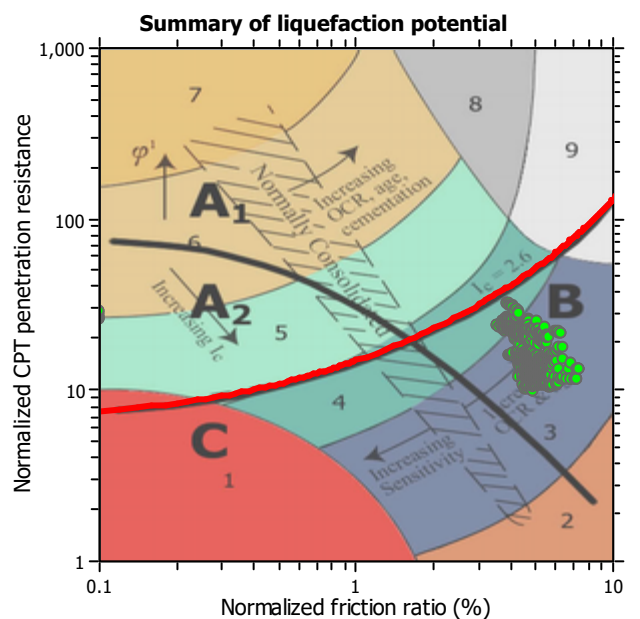
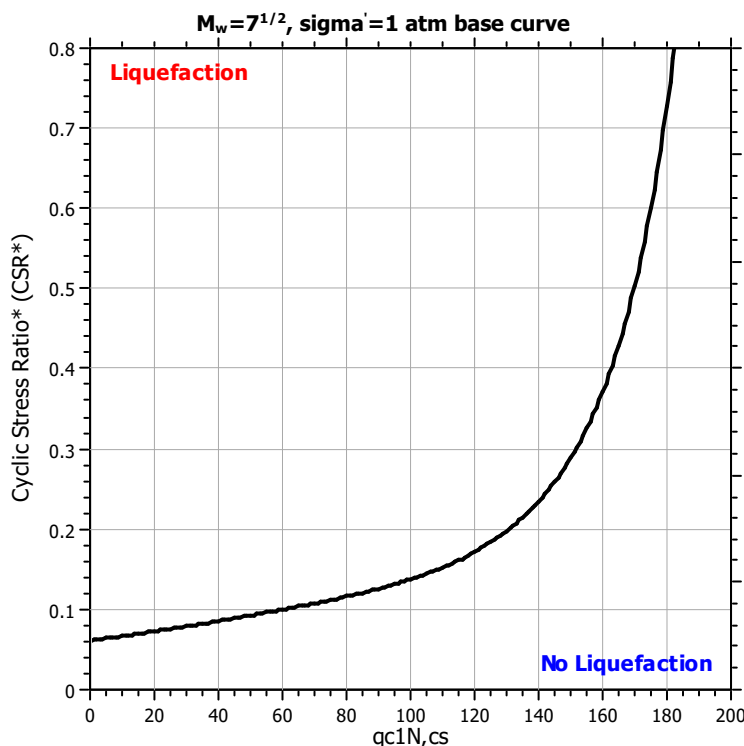
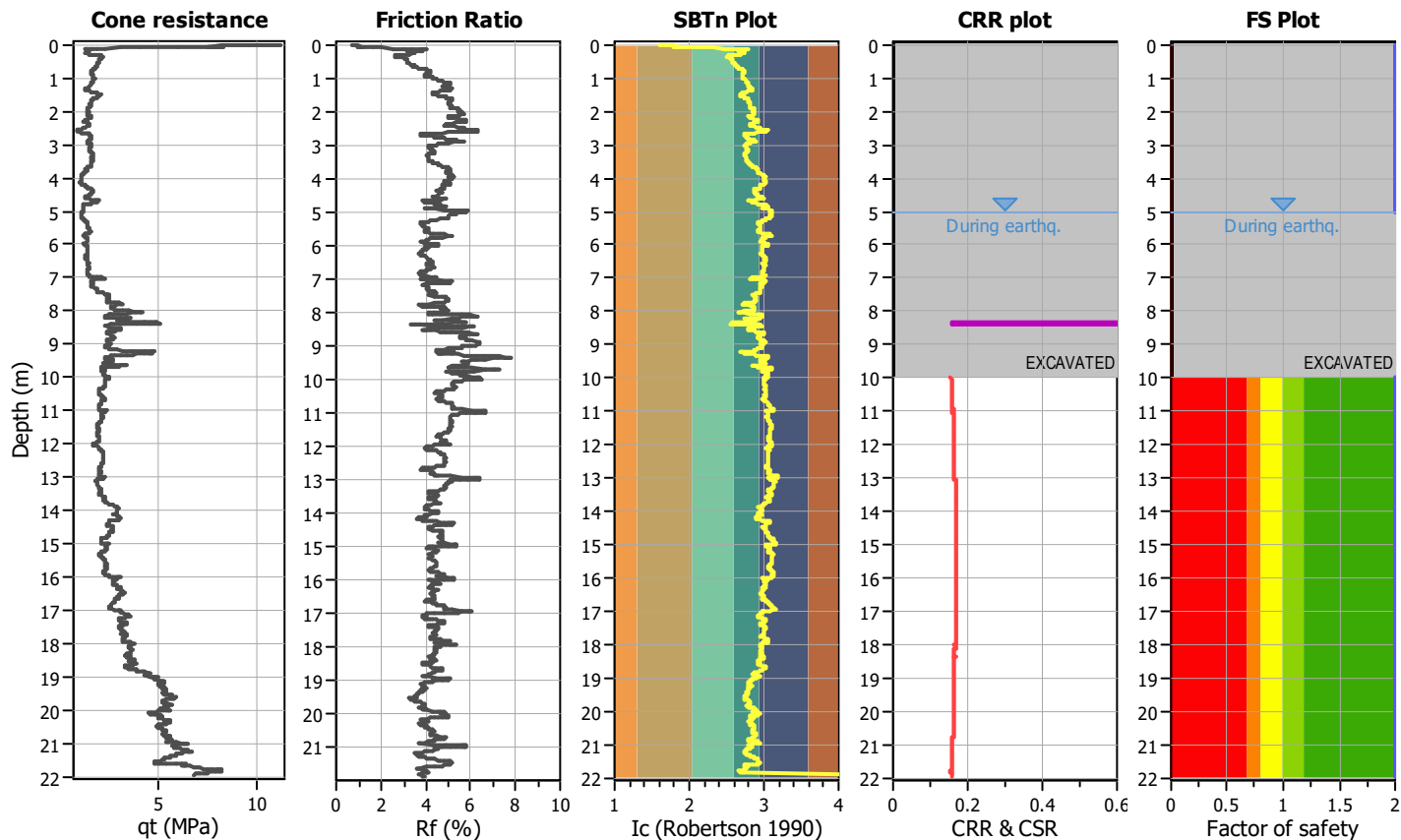
Project title :

Location :

CPT file : CPT-Test CPT04

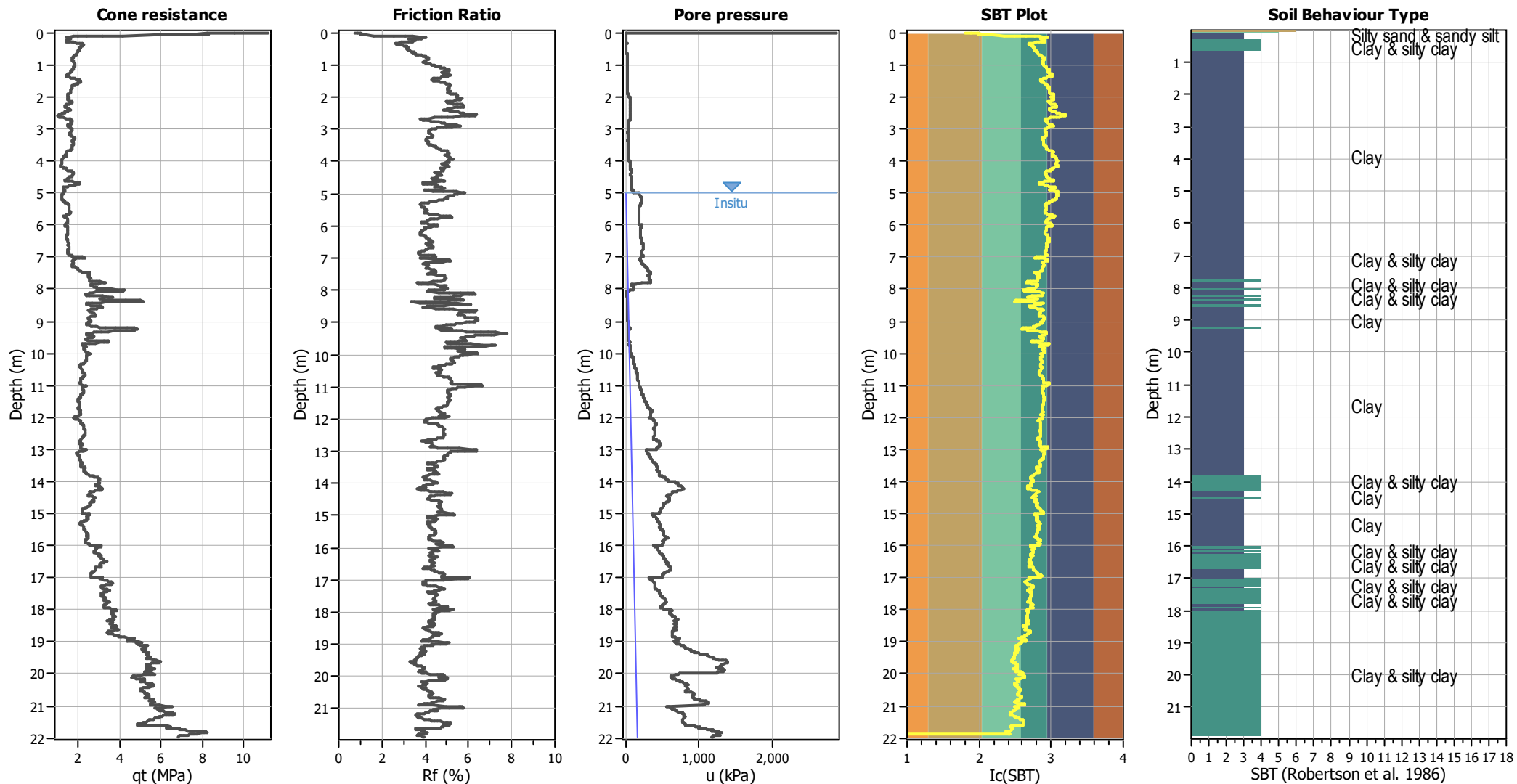
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 m	Excavation:	Yes	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 m	Excavation depth:	10.00 m	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	180.00 kPa	Limit depth applied:	No
Earthquake magnitude M_w :	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes	MSF method:	Method



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

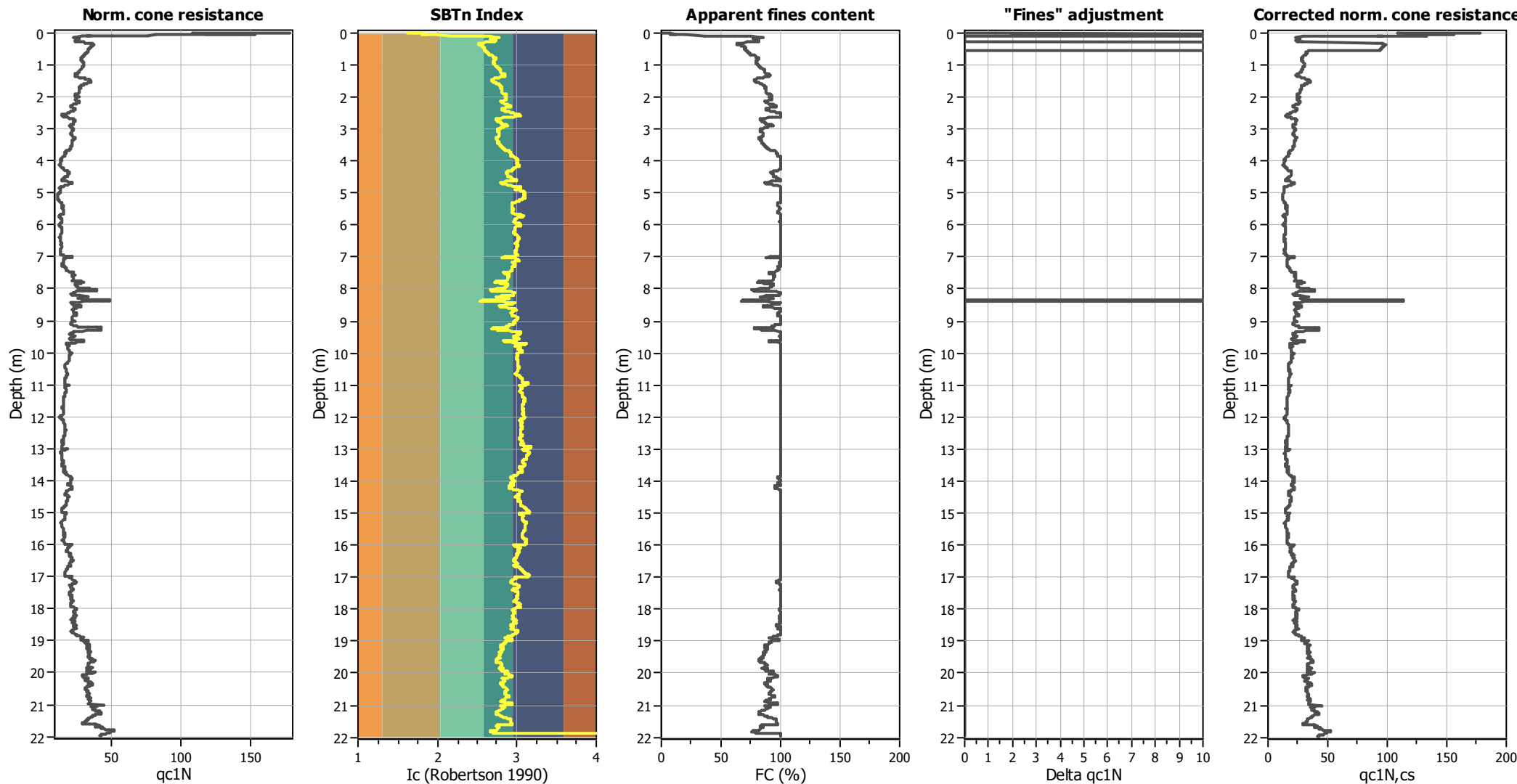
SBT legend

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

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	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 :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

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

Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _σ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

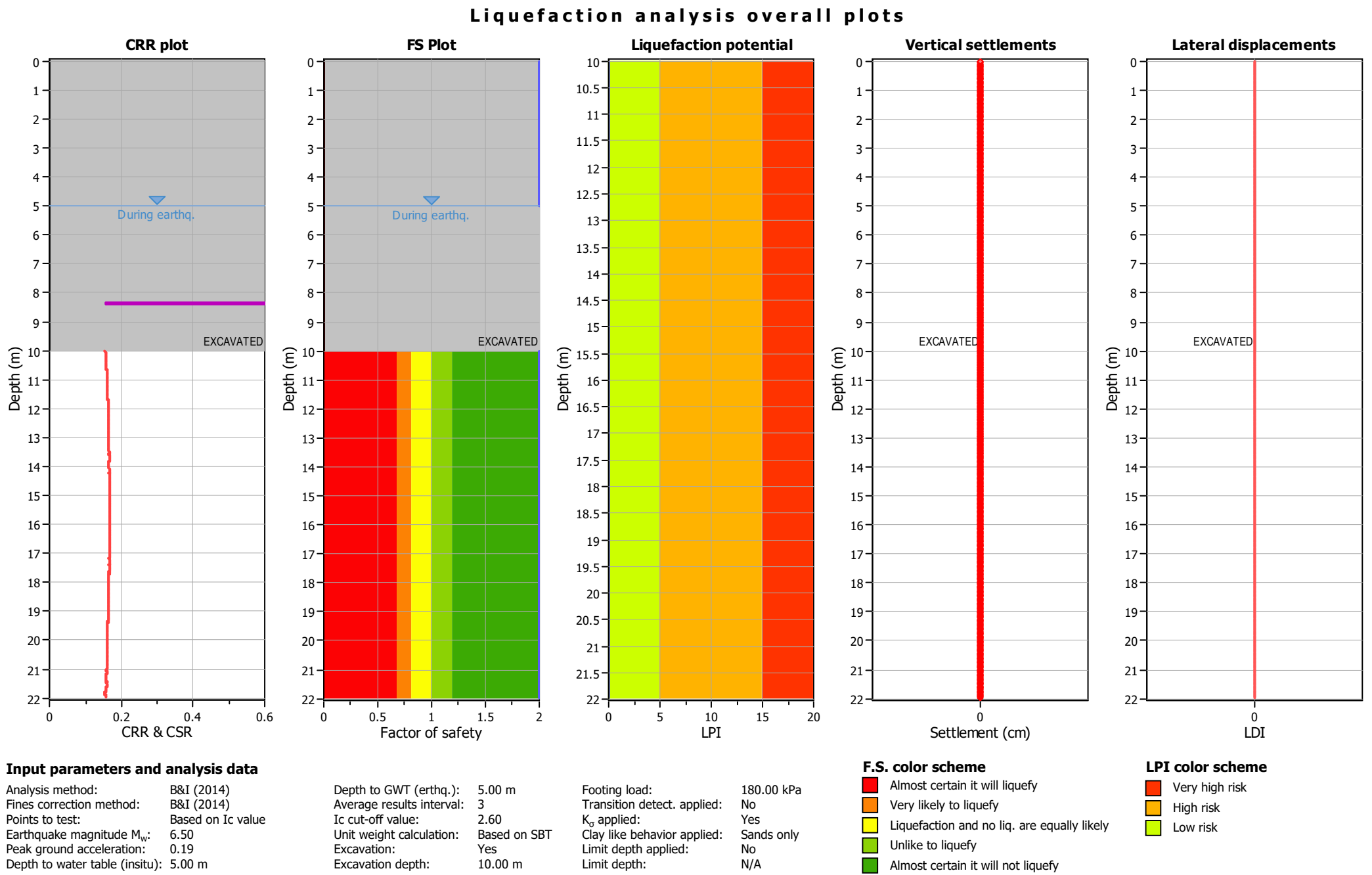
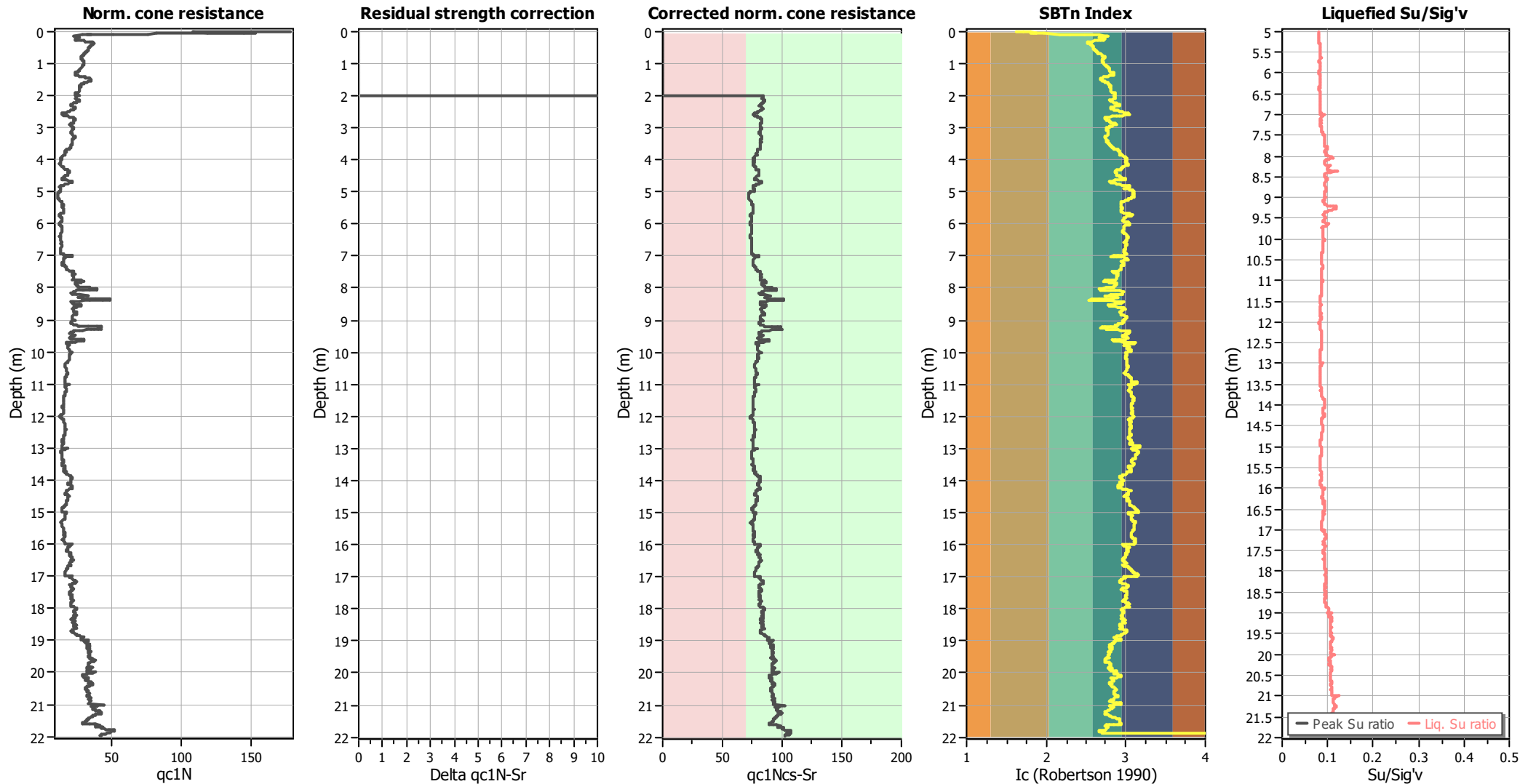


Figure 10 consists of three plots related to soil liquefaction analysis.

- Left Plot:** A log-log plot of Normalized CPT penetration resistance (y-axis, 1 to 1,000) versus Normalized friction ratio (%) (x-axis, 0.1 to 10). The plot is divided into several regions (1-9) and zones (A1, A2, B, C). Arrows indicate trends: ϕ' (increasing), OCR, age, cementation (increasing), $I_c = 2.6$ (increasing), and Sensitivity (increasing).
- Middle Plot:** A log-log plot of Cyclic Stress Ratio* (CSR*) (y-axis, 0 to 0.8) versus $qc_{1N,cs}$ (x-axis, 0 to 200). The plot shows a curve separating the "Liquefaction" region (above) from the "No Liquefaction" region (below).
- Right Plot:** A log-log plot of Thickness of liquefiable sand layer, H_2 (m) (y-axis, 0.0 to 12.0) versus Thickness of surface layer, H_1 (m) (x-axis, 0 to 10). The plot shows a curve separating the "Liquefaction - induced ground damage" region (above) from the "No Liquefaction" region (below). The curve is labeled "PGA 0.20g".

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 m	Footing load:	180.00 kPa
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Excavation:	Yes	Limit depth applied:	No
Depth to water table (insitu):	5.00 m	Excavation depth:	10.00 m	Limit depth:	N/A

LIQUEFACTION ANALYSIS REPORT

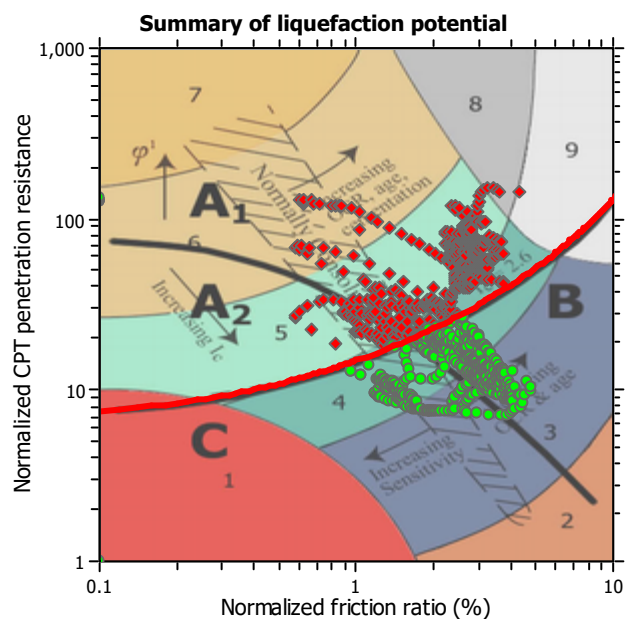
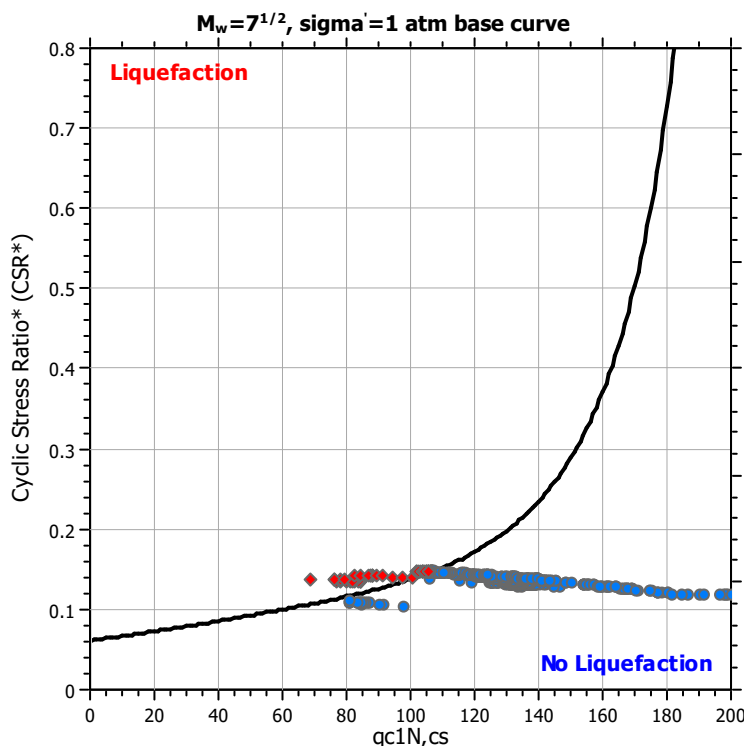
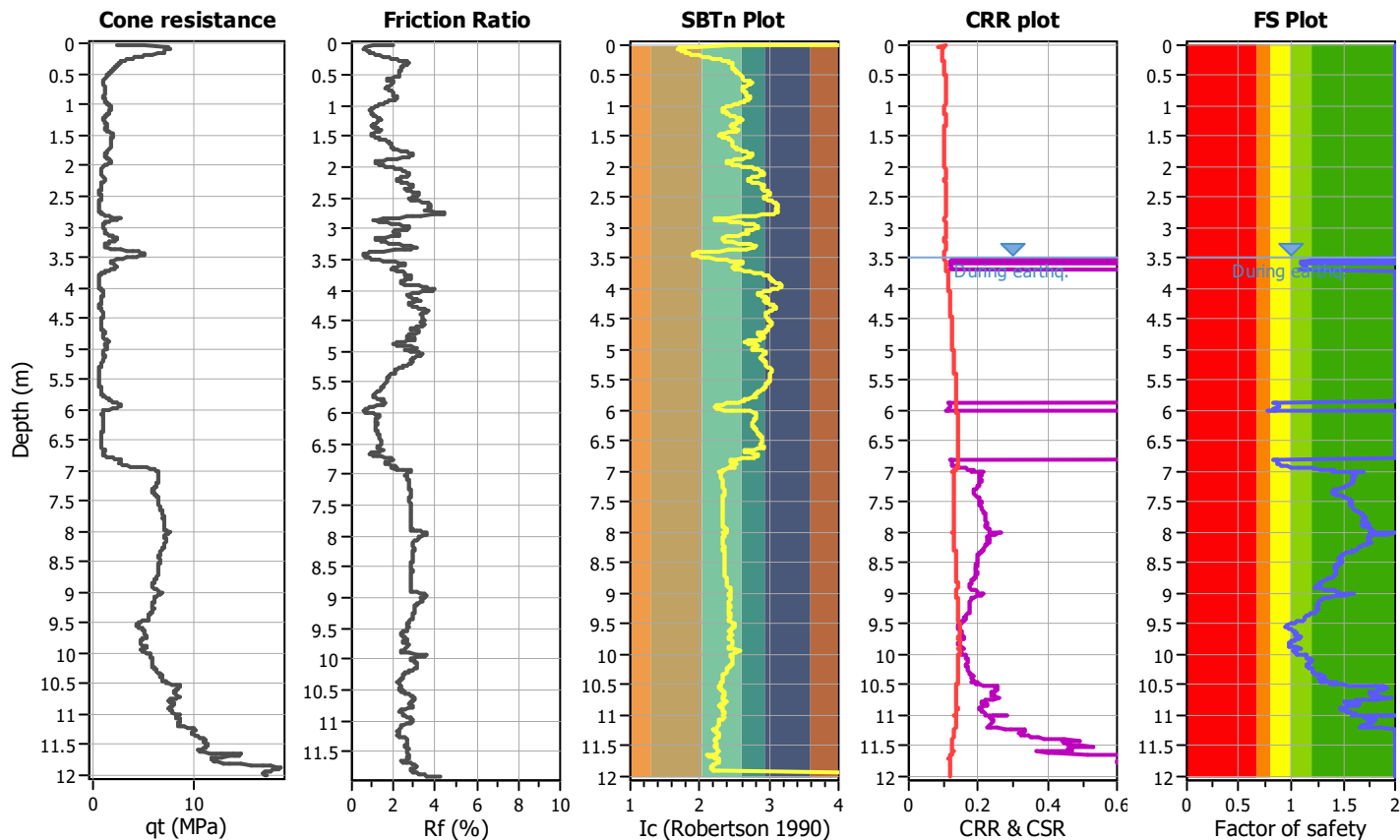
Project title :

Location :

CPT file : CPT-Test CPT05

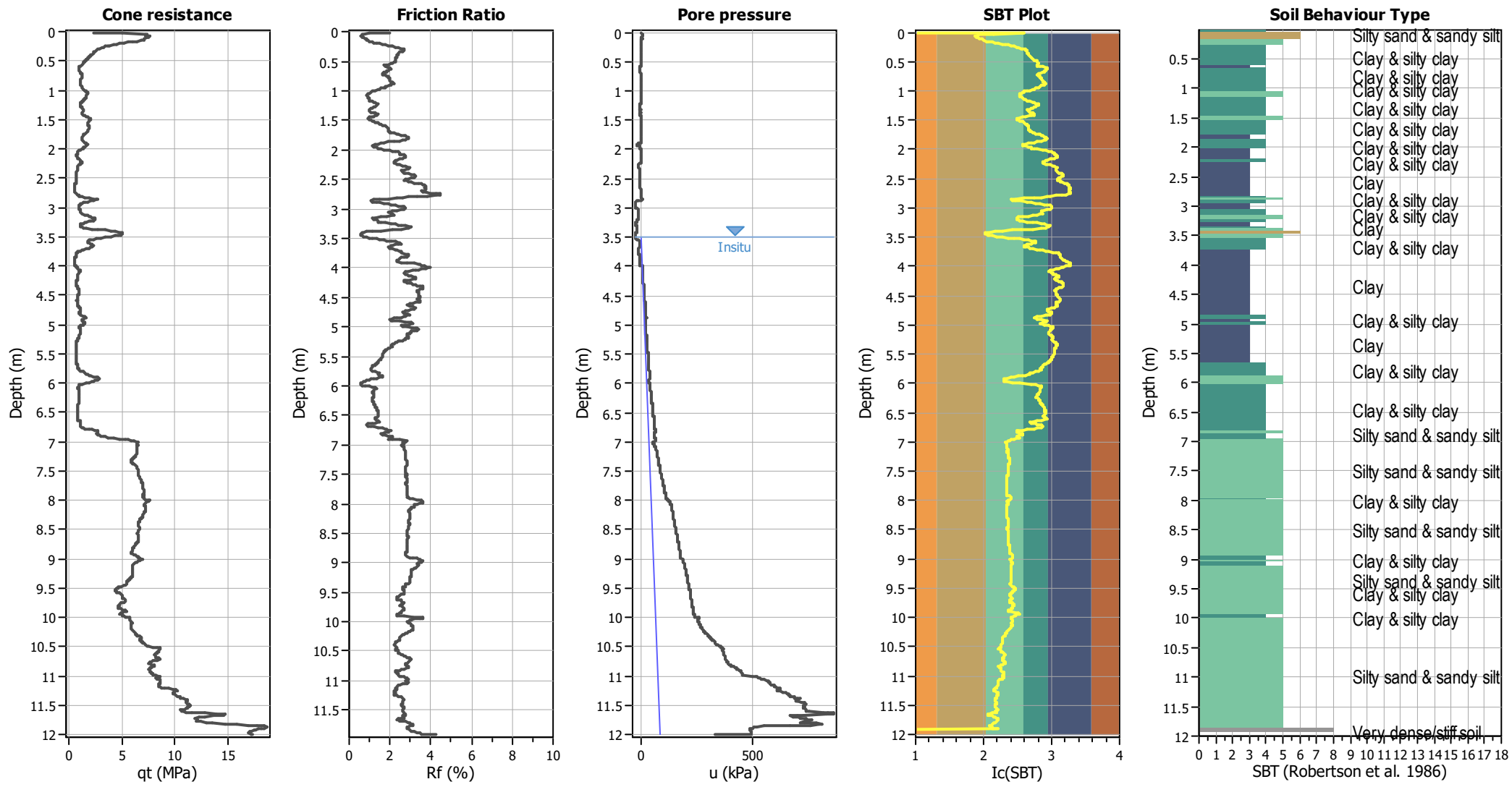
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	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 :	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_g applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

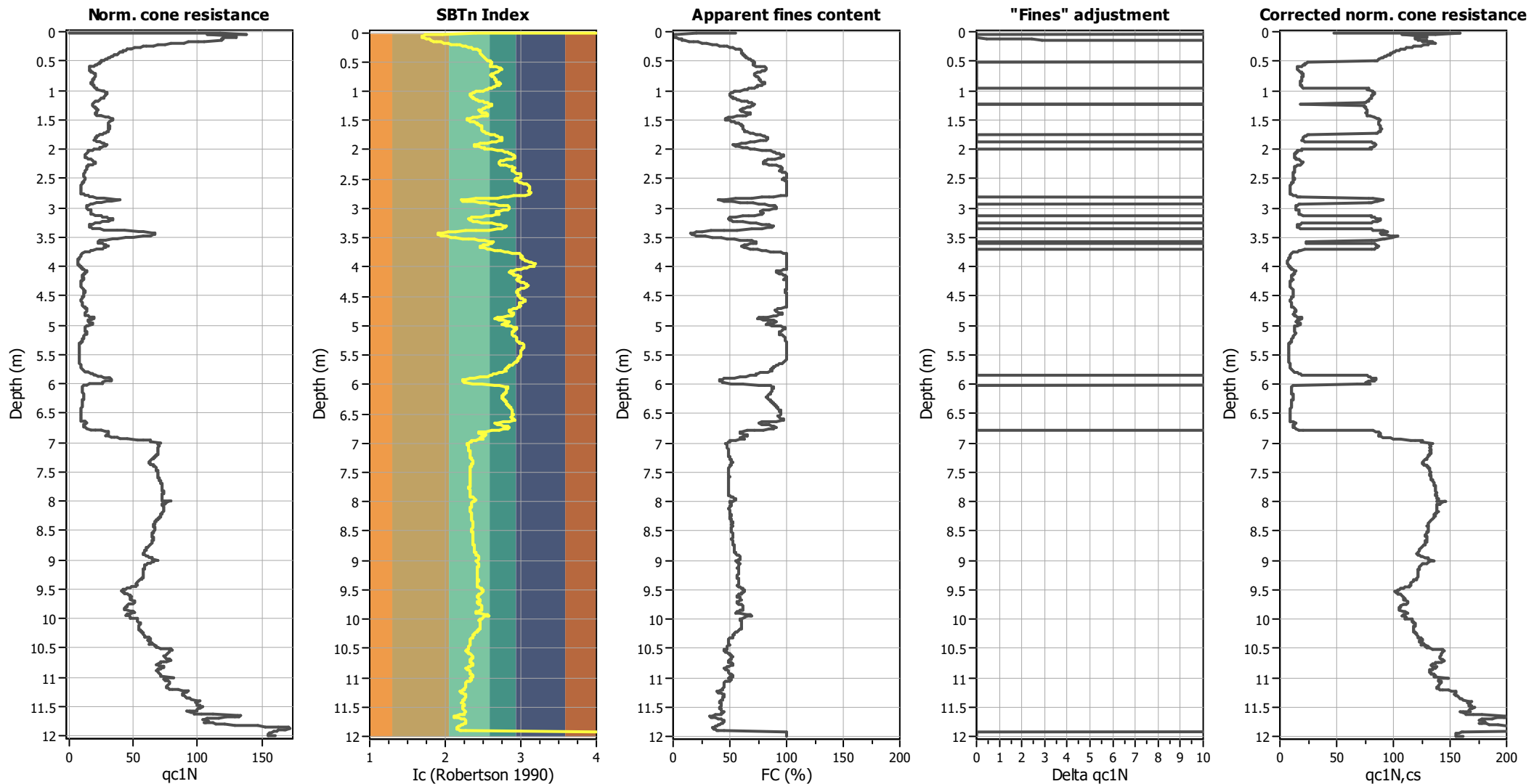
SBT legend

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

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	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 :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

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

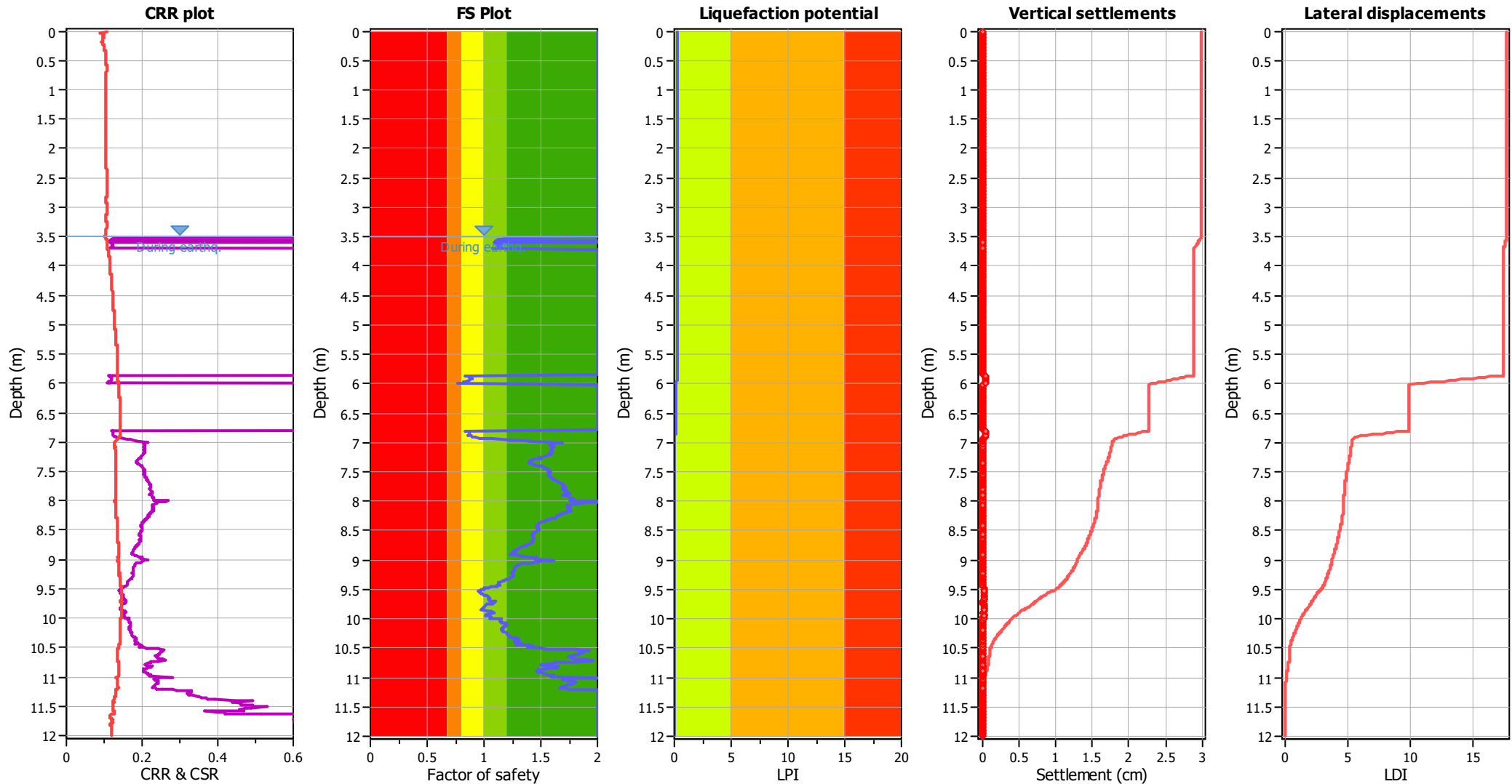
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _q applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

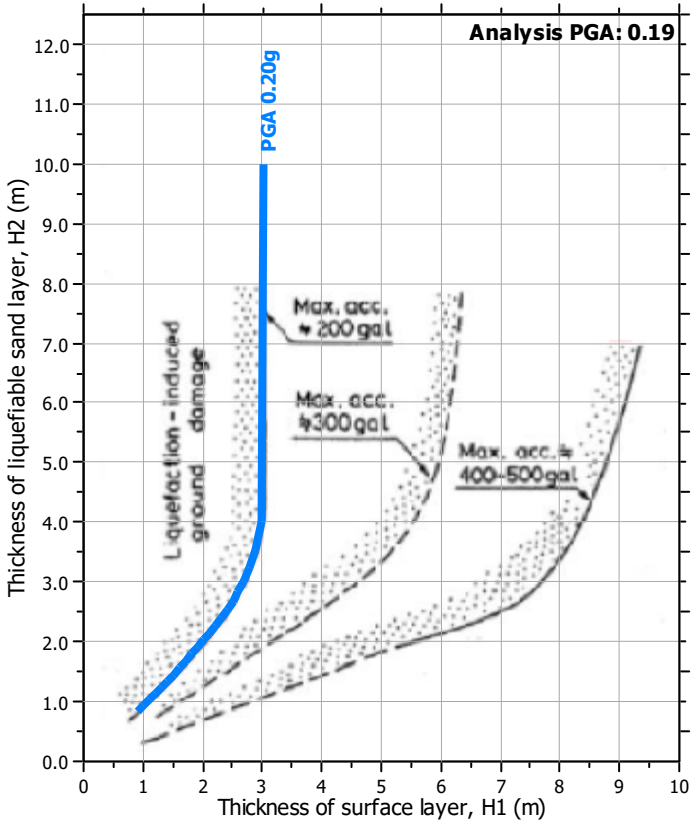
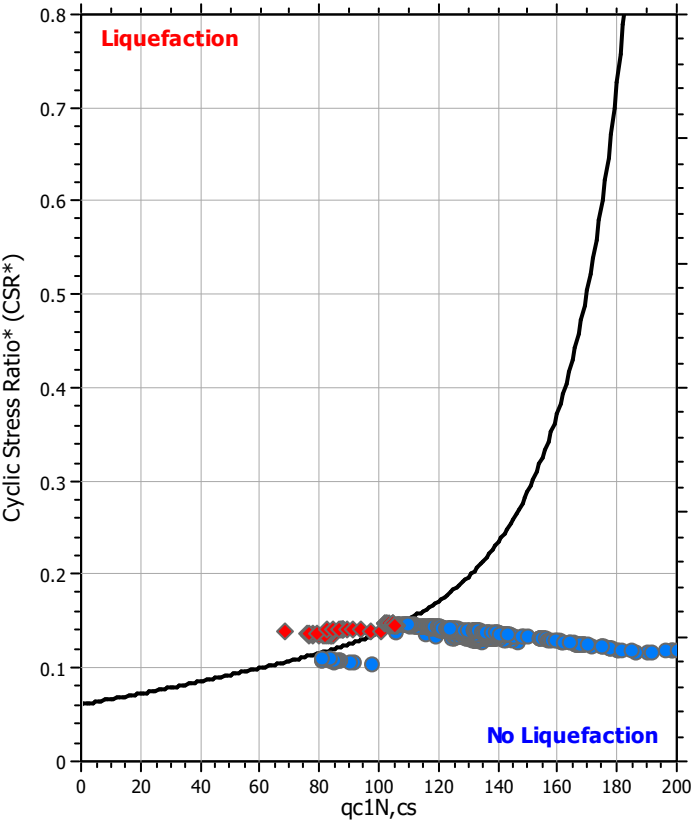
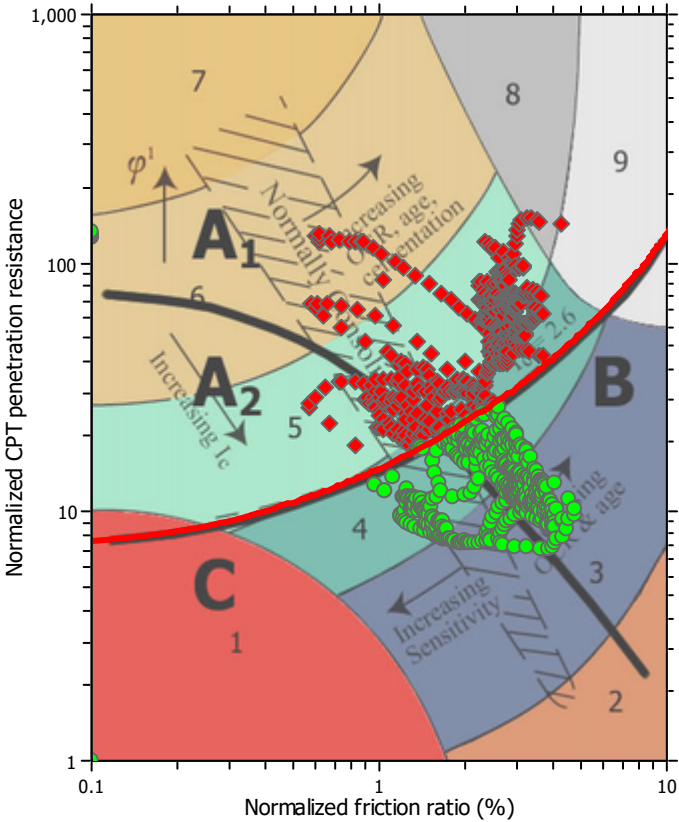
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

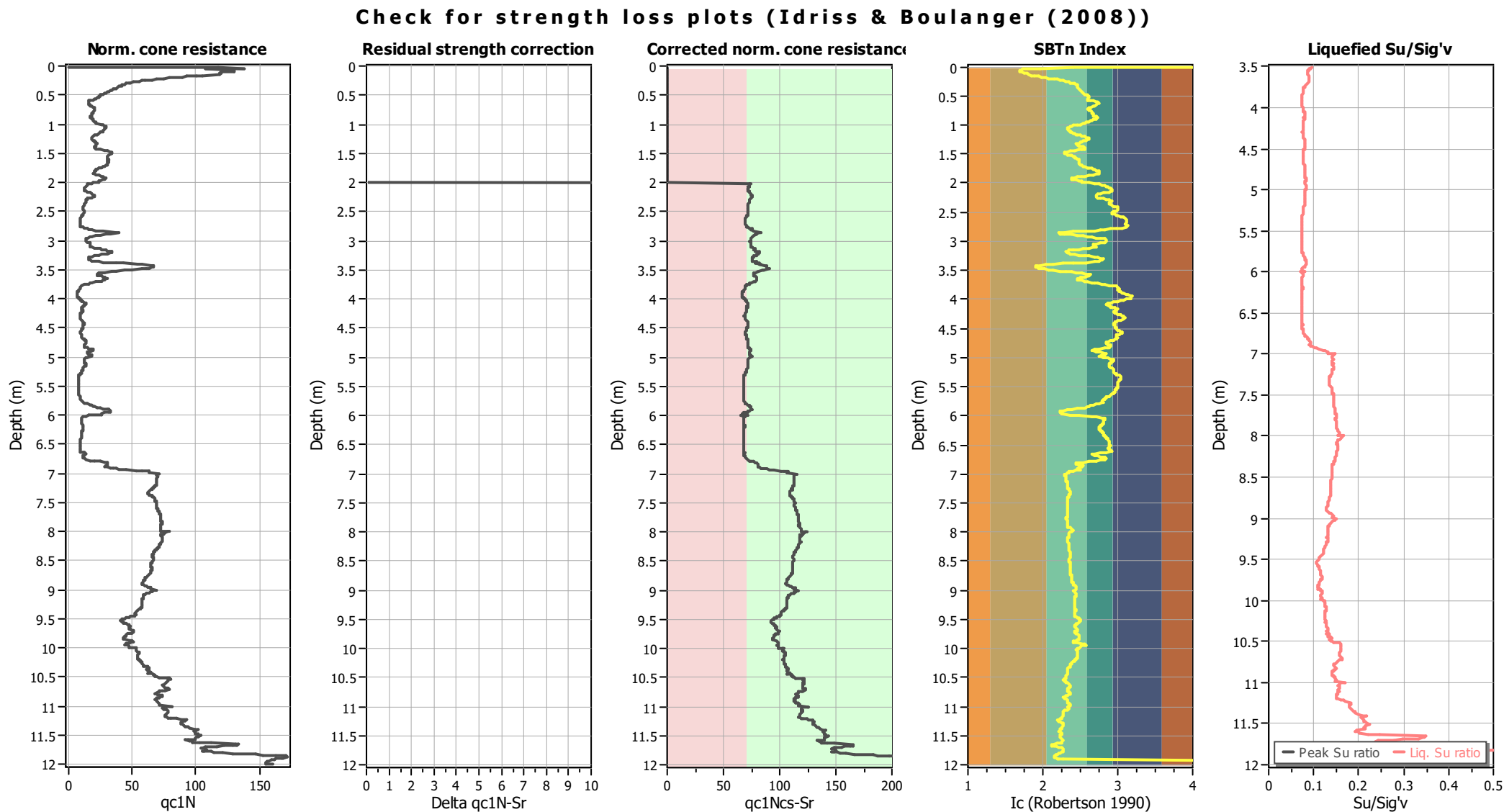
Red	Very high risk
Orange	High risk
Yellow	Low risk

Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_g applied:	Yes
Earthquake magnitude M_w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

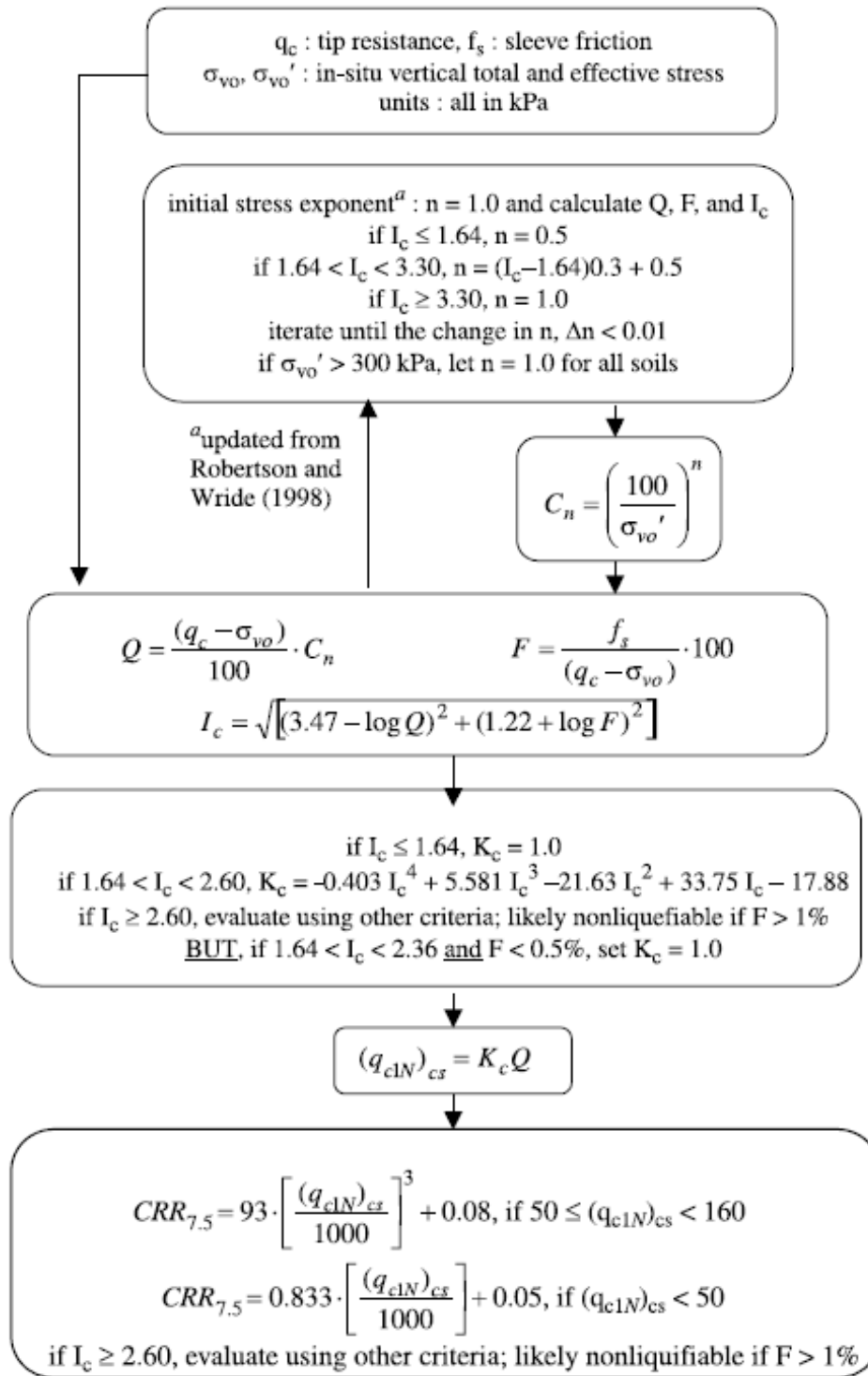


Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

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

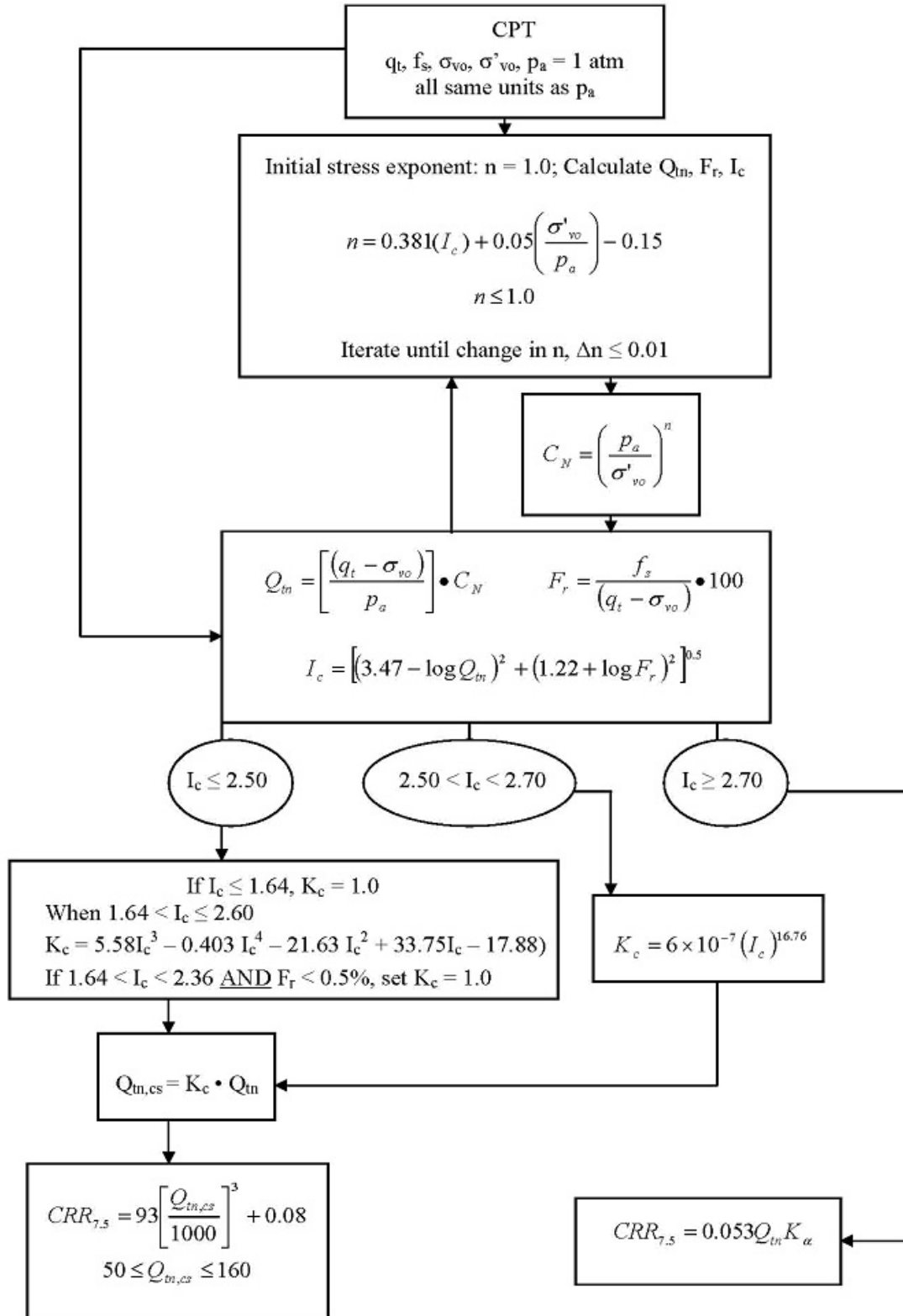
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of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

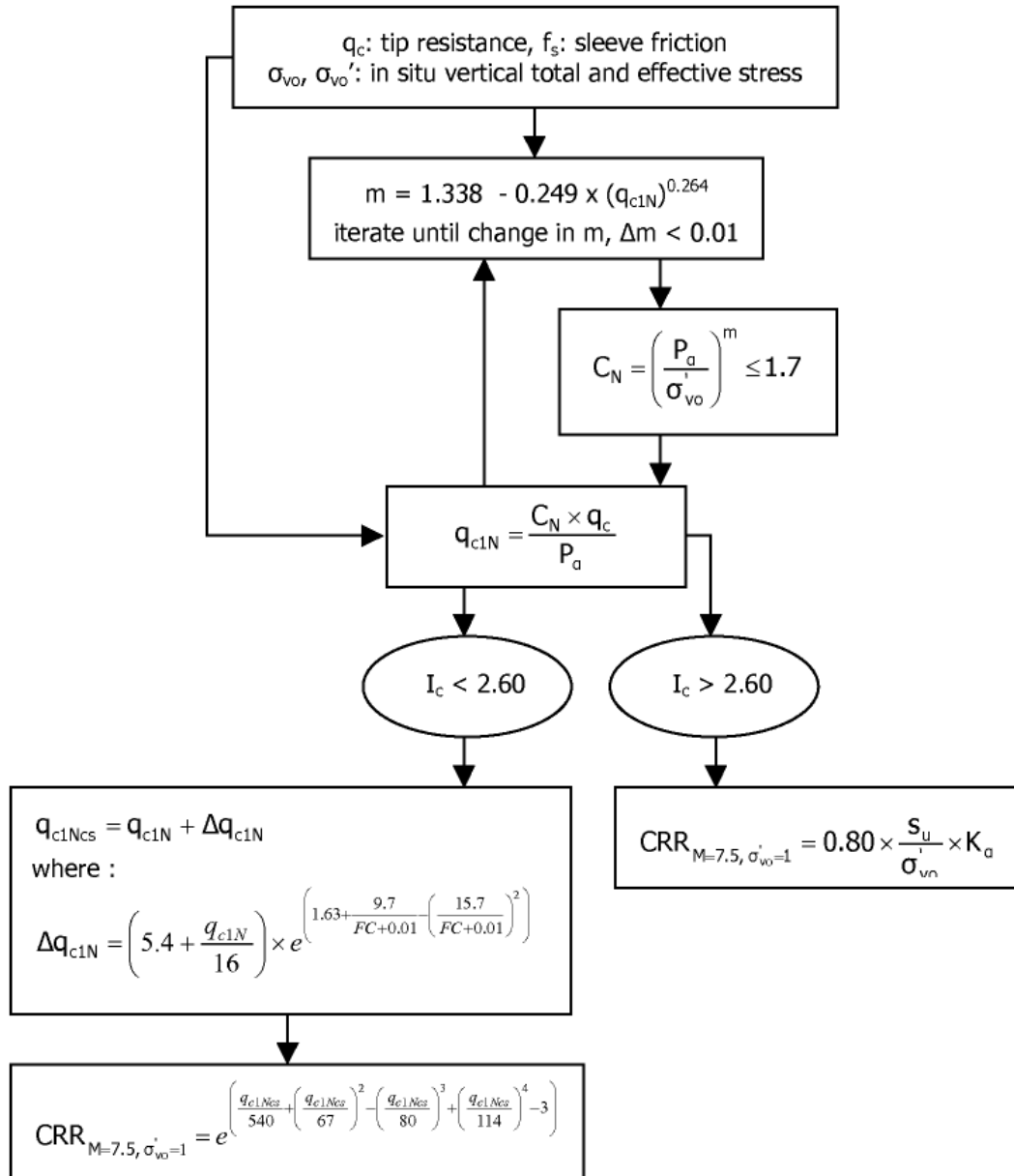
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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

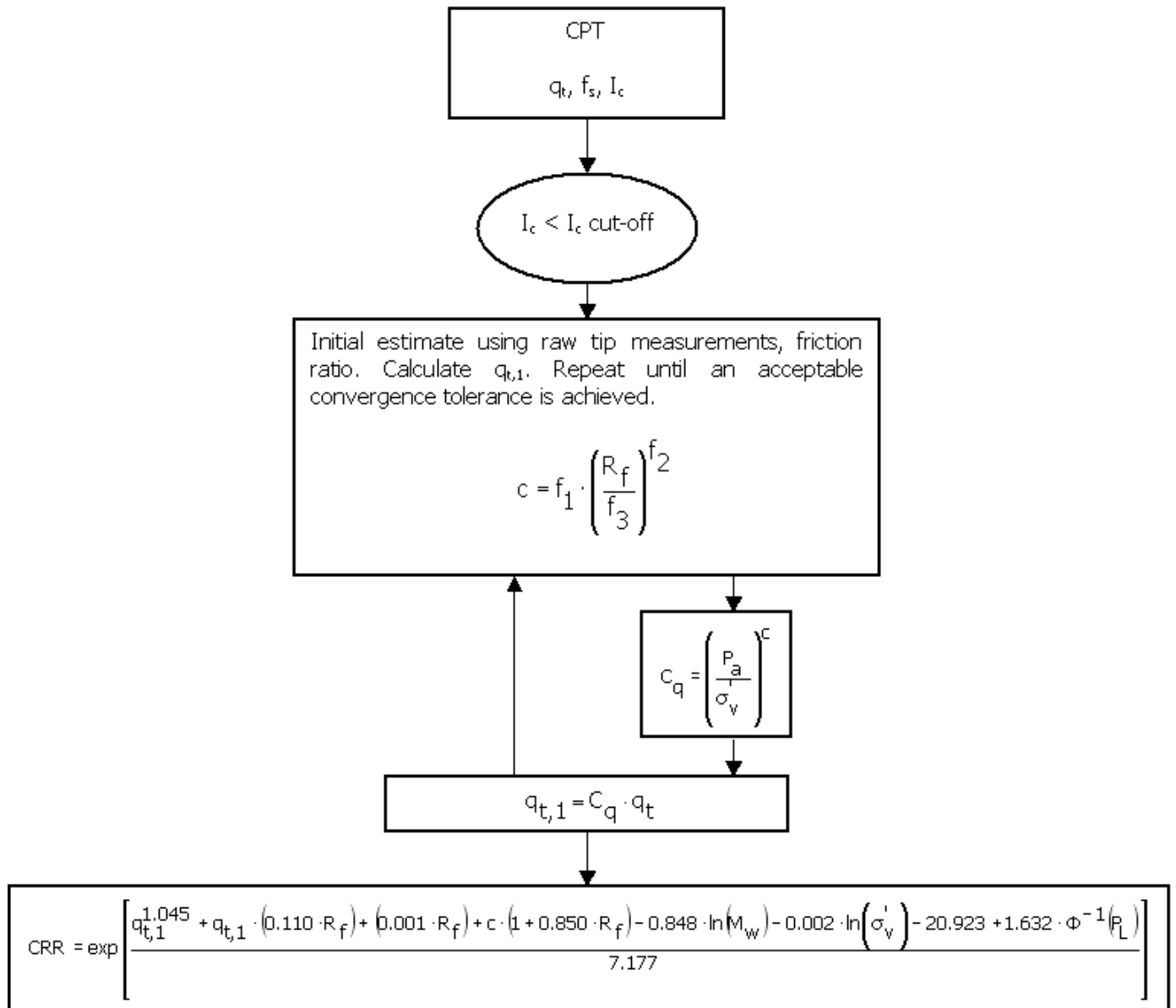


¹ P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

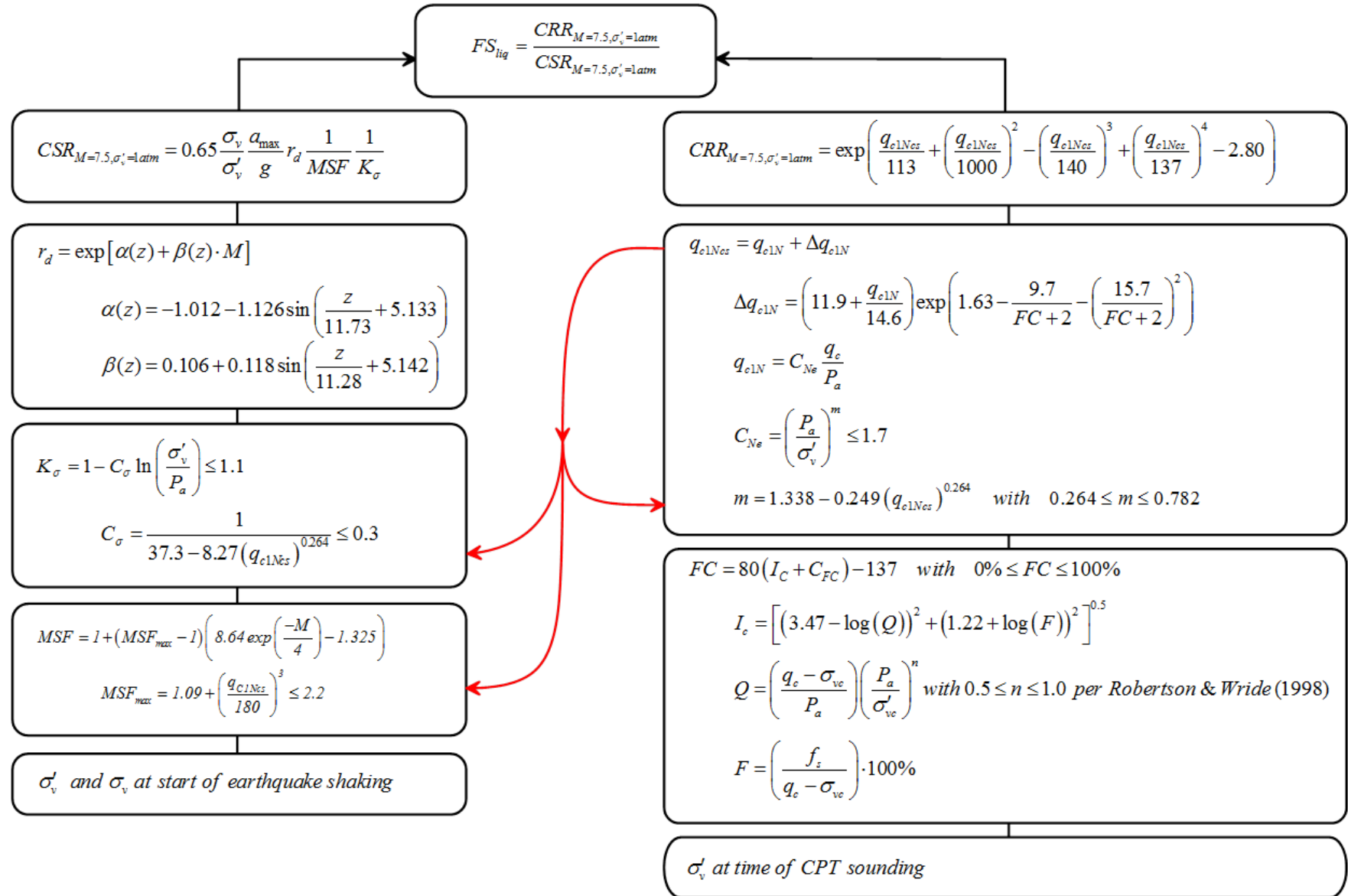
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



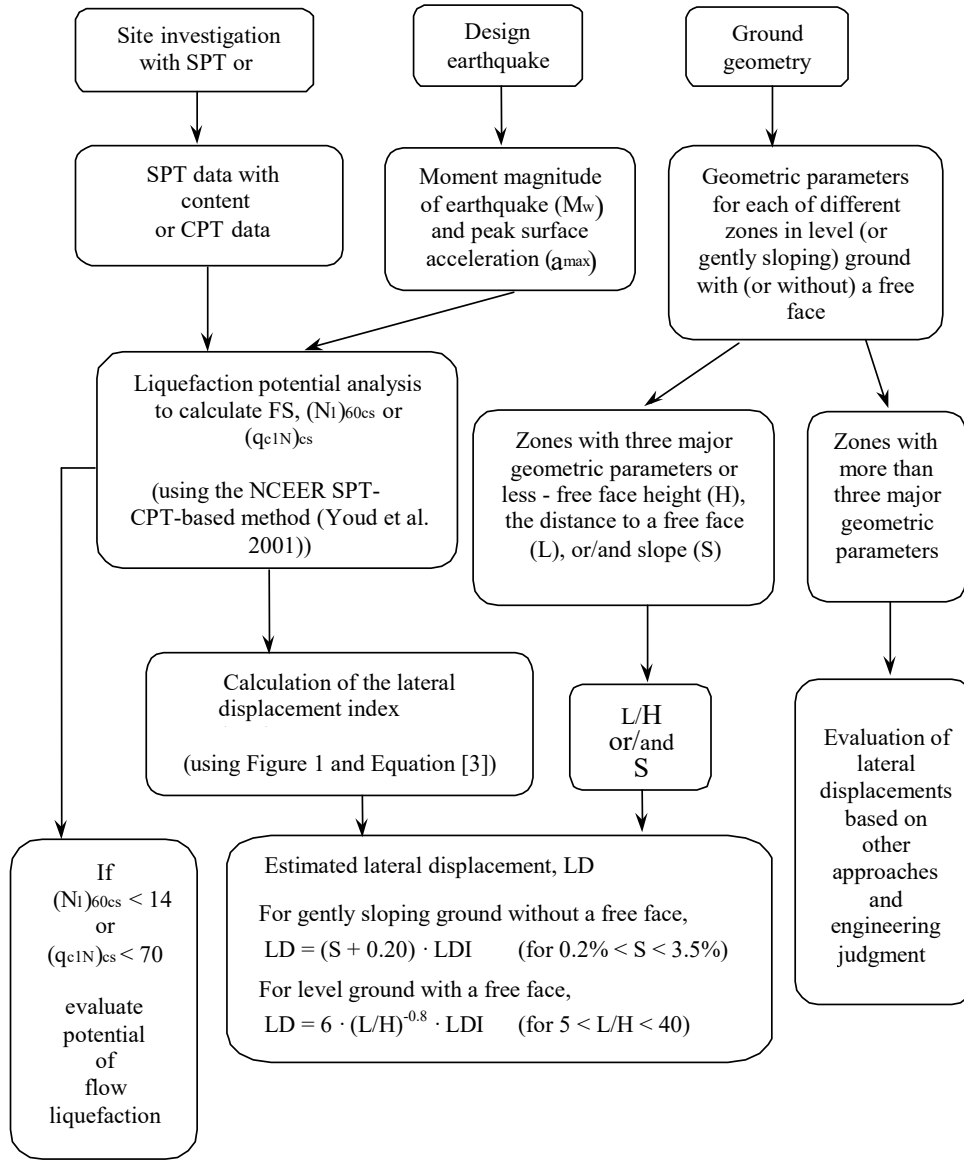
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



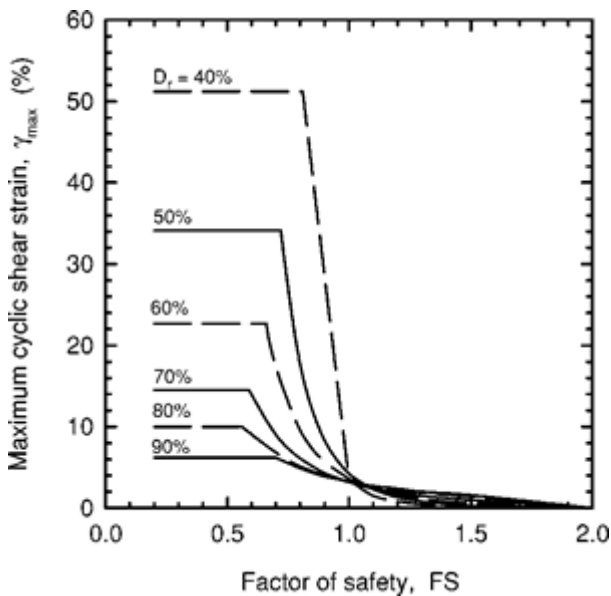
Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)



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



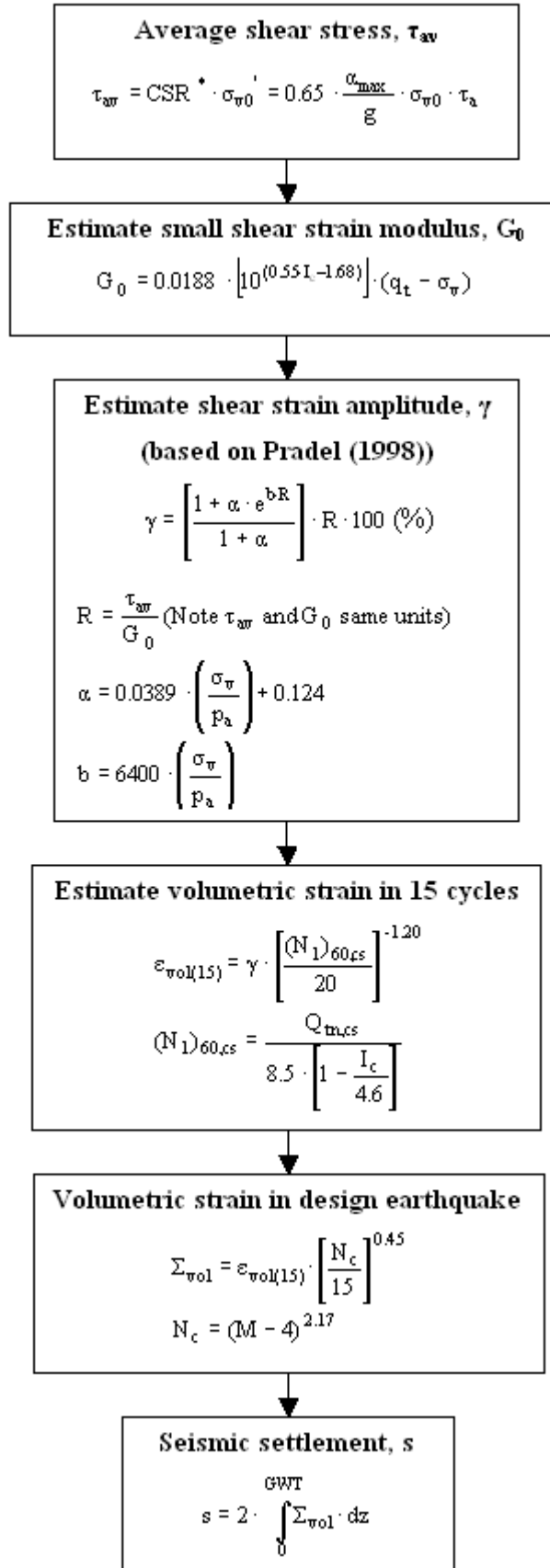
¹ Figure 1

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

¹ Equation [3]

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

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

where:

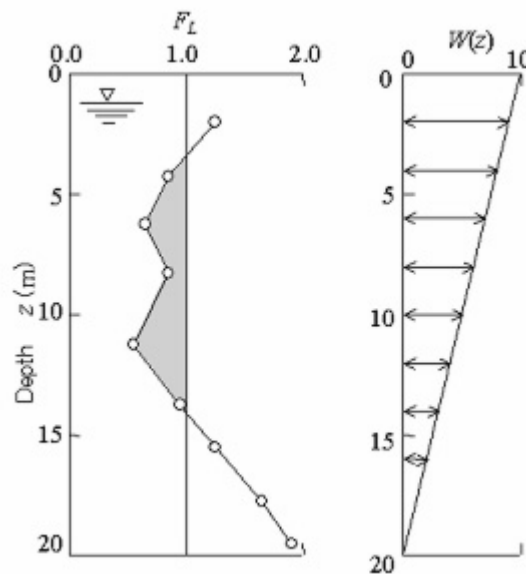
$F_L = 1 - F.S.$ when F.S. less than 1

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

z depth of 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

Shear-Induced Building Settlement (Ds) calculation procedure

The shear-induced building settlement (Ds) due to liquefaction below the building can be estimated using the relationship developed by Bray and Macedo (2017):

$$\begin{aligned} \ln(D_s) = & c_1 + c_2 * LBS + 0.58 * \ln\left(\tanh\left(\frac{HL}{6}\right)\right) + \\ & 4.59 * \ln(Q) - 0.42 * \ln(Q)^2 - 0.02 * B + \\ & 0.84 * \ln(CAV_{dp}) + 0.41 * \ln(Sa_1) + \varepsilon \end{aligned}$$

where Ds is in the units of mm, c1= -8.35 and c2= 0.072 for LBS ≤ 16, and c1= -7.48 and c2= 0.014 otherwise. Q is the building contact pressure in units of kPa, HL is the cumulative thickness of the liquefiable layers in the units of m, B is the building width in the units of m, CAVdp is a standardized version of the cumulative absolute velocity in the units of g-s, Sa1 is 5%-damped pseudo-acceleration response spectral value at a period of 1 s in the units of g, and ε is a normal random variable with zero mean and 0.50 standard deviation in Ln units. The liquefaction-induced building settlement index (LBS) is:

$$LBS = \sum W * \frac{\varepsilon_{shear}}{z} dz$$

where z (m) is the depth measured from the ground surface > 0, W is a foundation-weighting factor wherein W = 0.0 for z less than Df, which is the embedment depth of the foundation, and W = 1.0 otherwise. The shear strain parameter (ε_{shear}) is the liquefaction-induced free-field shear strain (in %) estimated using Zhang et al. (2004). It is calculated based on the estimated Dr of the liquefied soil layer and the calculated safety factor against liquefaction triggering (FSL).

References

- Lunne, T., Robertson, P.K., and Powell, J.J.M 1997. Cone penetration testing in geotechnical practice, E & FN Spon Routledge, 352 p, ISBN 0-7514-0393-8.
- Boulanger, R.W. and Idriss, I. M., 2007. Evaluation of Cyclic Softening in Silts and Clays. ASCE Journal of Geotechnical and Geoenvironmental Engineering June, Vol. 133, No. 6 pp 641-652
- Boulanger, R.W. and Idriss, I. M., 2014. CPT AND SPT BASED LIQUEFACTION TRIGGERING PROCEDURES. DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA AT DAVIS
- Robertson, P.K. and Cabal, K.L., 2007, Guide to Cone Penetration Testing for Geotechnical Engineering. Available at no cost at <http://www.geologismiki.gr/>
- Robertson, P.K. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27 (1), 151-8.
- Robertson, P.K. and Wride, C.E., 1998. Cyclic Liquefaction and its Evaluation based on the CPT Canadian Geotechnical Journal, 1998, Vol. 35, August.
- Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833
- Zhang, G., Robertson. P.K., Brachman, R., 2002, Estimating Liquefaction Induced Ground Settlements from the CPT, Canadian Geotechnical Journal, 39: pp 1168-1180
- Zhang, G., Robertson. P.K., Brachman, R., 2004, Estimating Liquefaction Induced Lateral Displacements using the SPT and CPT, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 130, No. 8, 861-871
- Pradel, D., 1998, Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 124, No. 4, 364-368
- Iwasaki, T., 1986, Soil liquefaction studies in Japan: state-of-the-art, Soil Dynamics and Earthquake Engineering, Vol. 5, No. 1, 2-70
- Papathanassiou G., 2008, LPI-based approach for calibrating the severity of liquefaction-induced failures and for assessing the probability of liquefaction surface evidence, Eng. Geol. 96:94–104
- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355
- P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering - from case history to practice, IS-Tokyo, June 2009
- Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, *Symposium in honor of professor I. M. Idriss*, SAN diego, CA
- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006
- I. M. Idriss and R. W. Boulanger, 2008. Soil liquefaction during earthquakes, Earthquake Engineering Research Institute MNO-12
- Jonathan D. Bray & Jorge Macedo, Department of Civil & Environmental Engineering, Univ. of California, Berkeley, CA, USA, Simplified procedure for estimating liquefaction-induced building settlement, *Proceedings of the 19th International Conference on Soil Mechanics and Geotechnical Engineering, Seoul 201*