

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT40_32SutherlandsRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

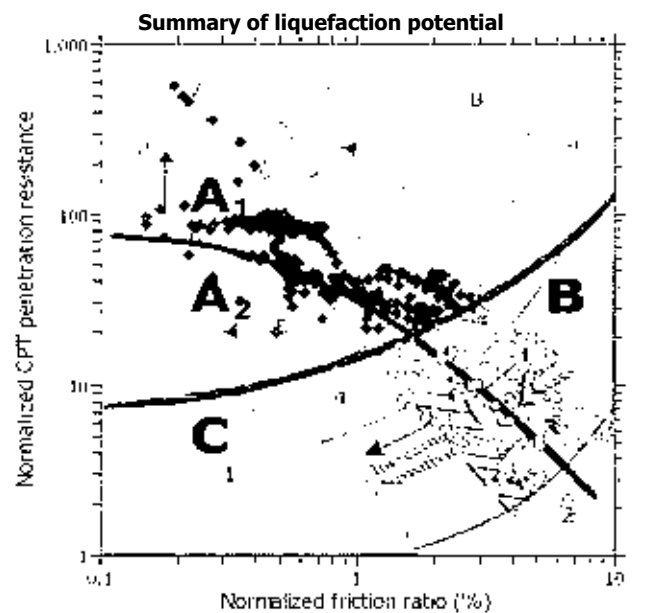
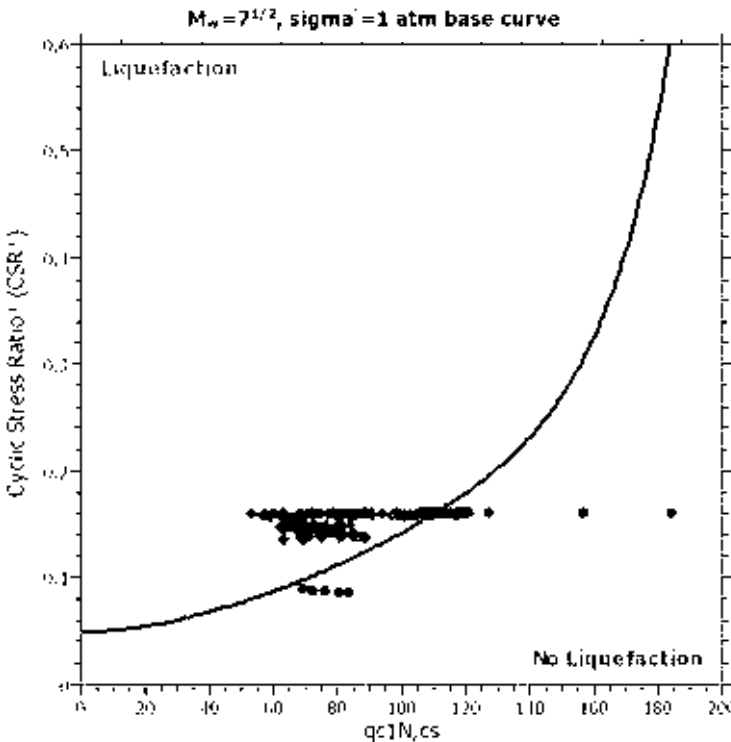
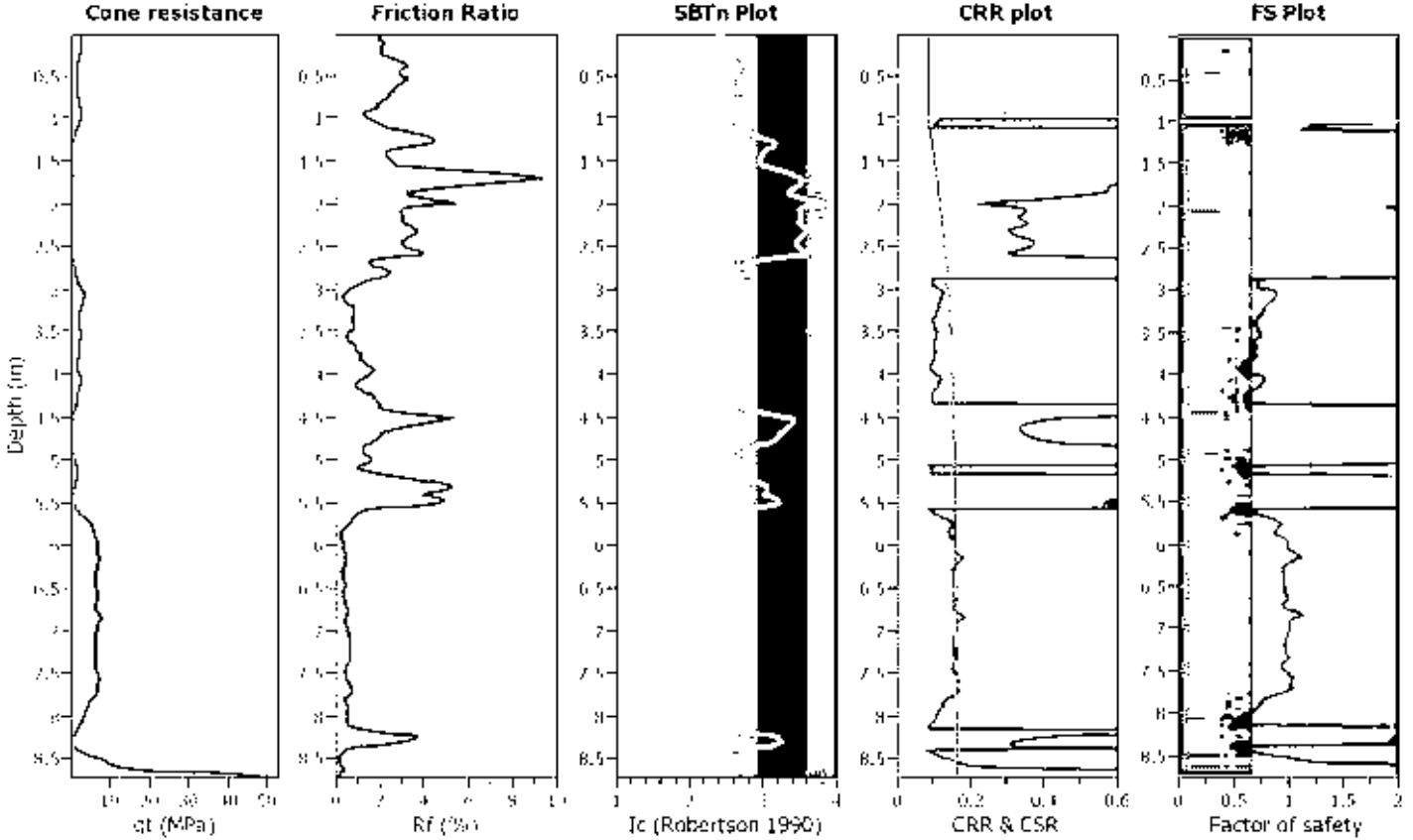
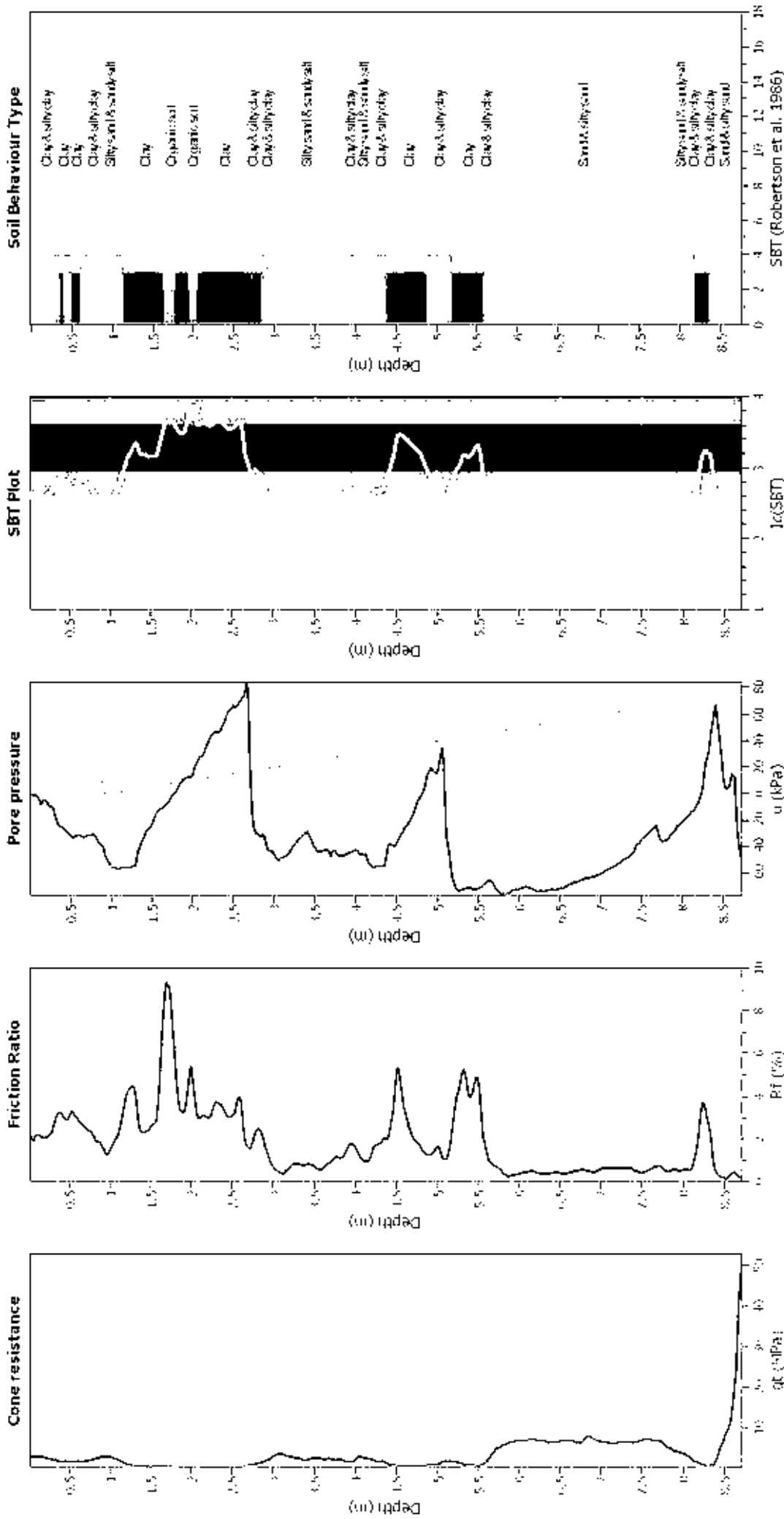


Figure 4: Summary of liquefaction potential assessment plot and data points of cyclic test. Zone A1: Fully liquefied, Zone A2: Partially liquefied, Zone B: No liquefaction, Zone C1: No liquefaction. The liquefaction boundary is shown as a dashed line. The plot is divided into zones A1, A2, B, and C1. A 'Liquefaction boundary' is indicated.

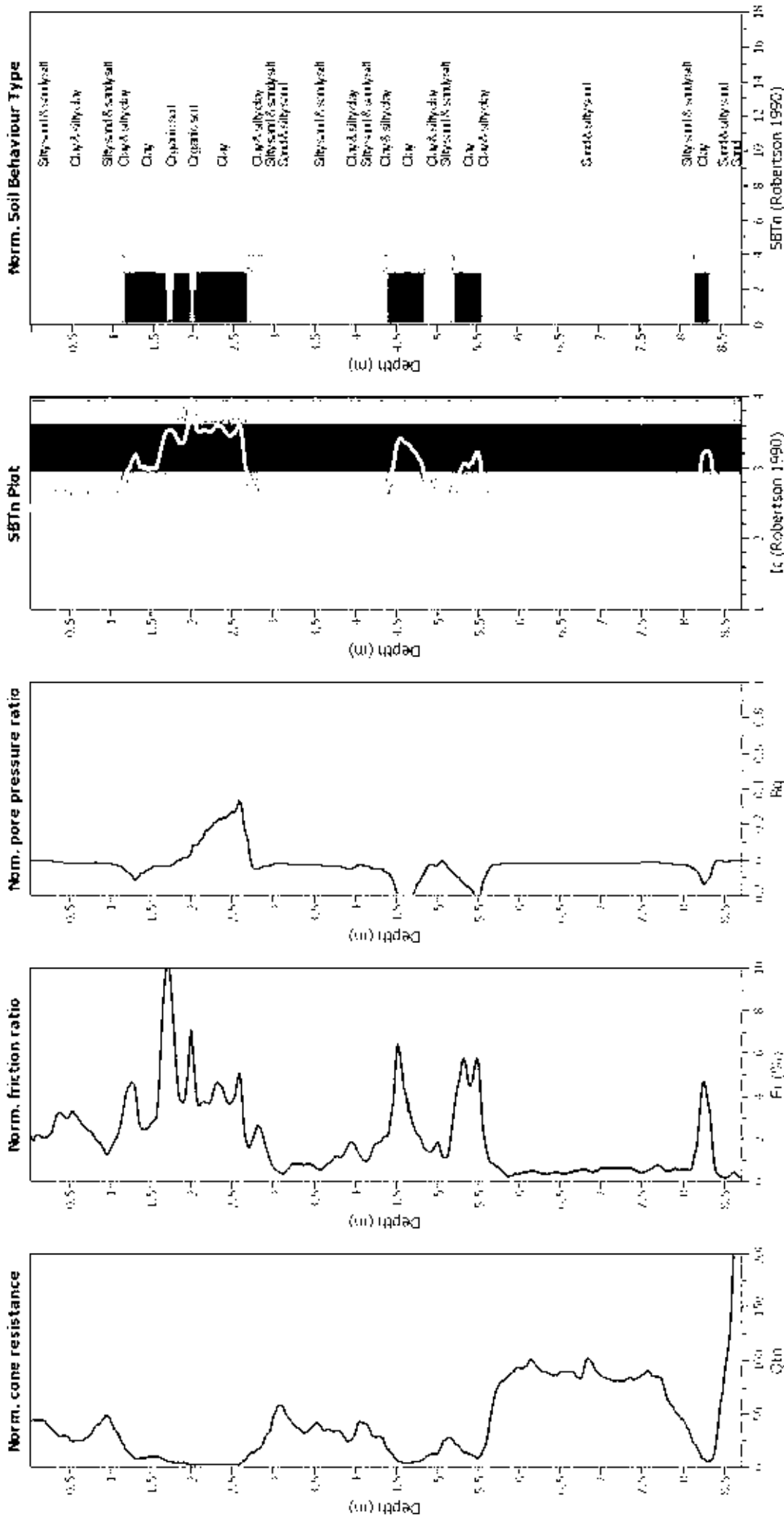
CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A	SBT legend	<input type="checkbox"/> 1. Sensitive fine grained	<input type="checkbox"/> 7. Gravely sand to sand
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay	<input type="checkbox"/> 4. Clayey silt to silty	<input type="checkbox"/> 8. Very stiff sand to	
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes	<input type="checkbox"/> 5. Silty sand to sandy silt	<input type="checkbox"/> 9. Very stiff fine grained	
Earthquake magnitude (M _w):	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No	<input type="checkbox"/> 6. Clean sand to silty sand		
Peak ground acceleration:	0.13	Use fill:	No	Unit depth:	N/A			
Depth to water table (m):	1.00 m	Fill height:	N/A					

CPT basic interpretation plots (normalized)



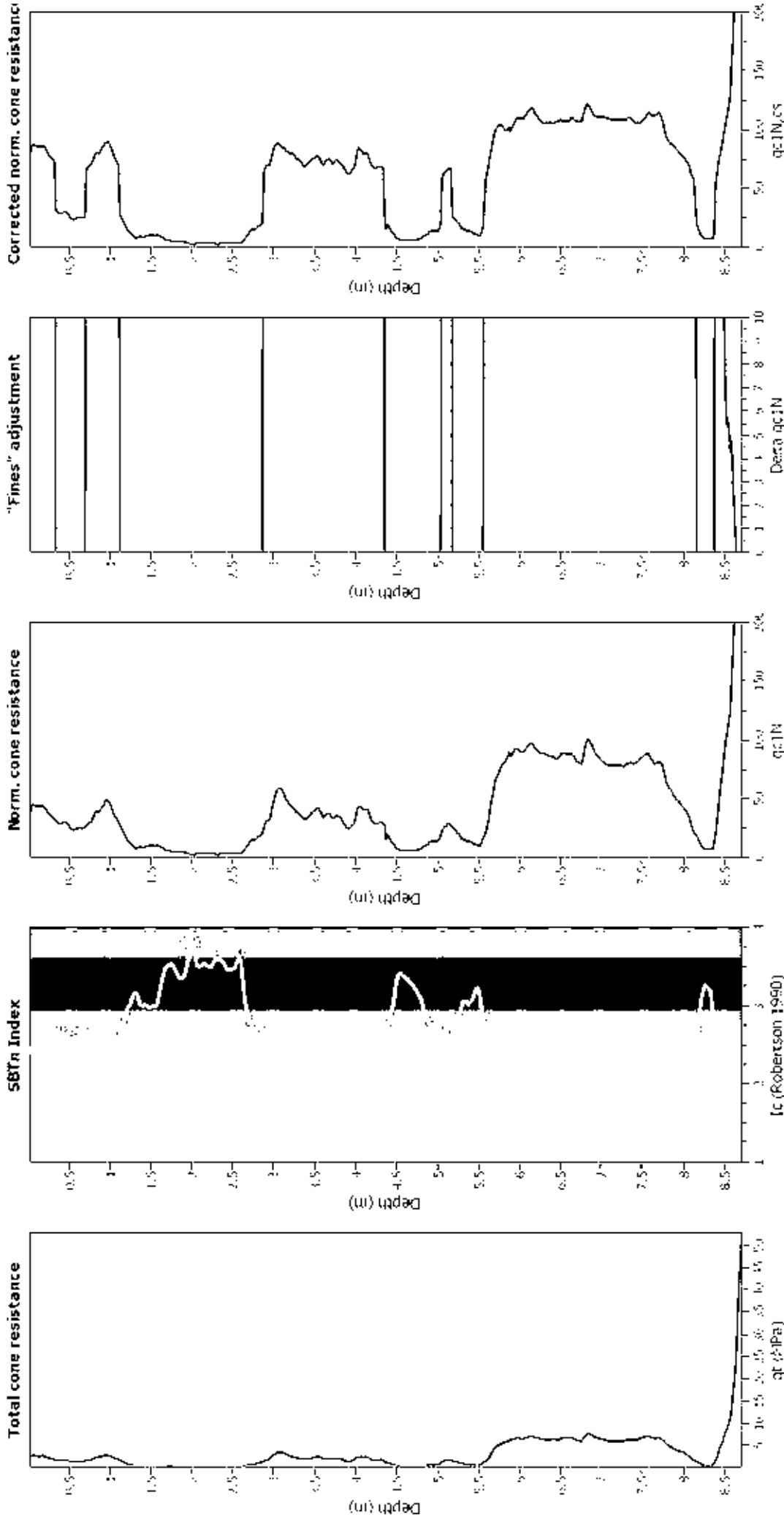
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (erthq.):	1.00 m	Fill height:	N/A	Unit 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

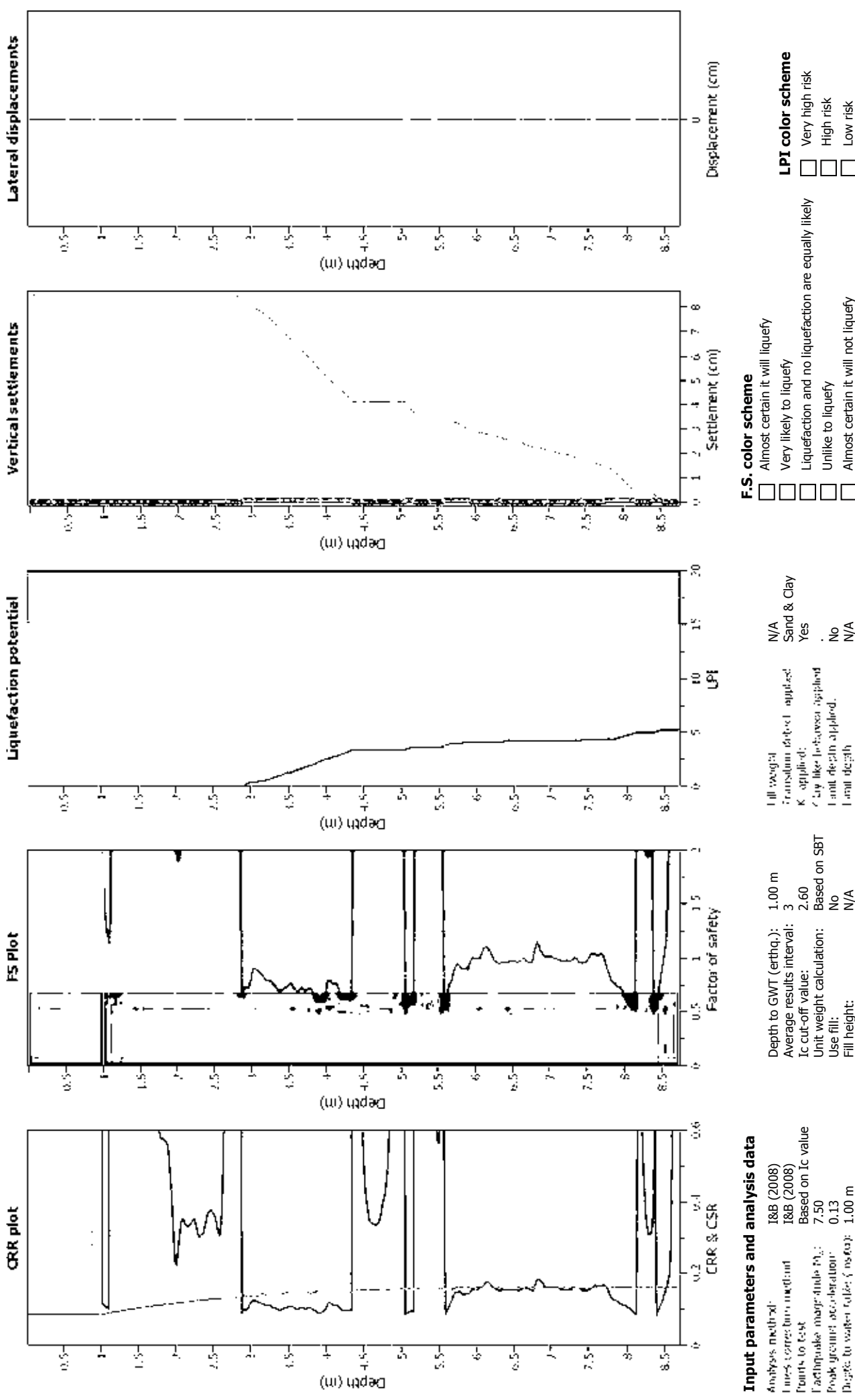
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

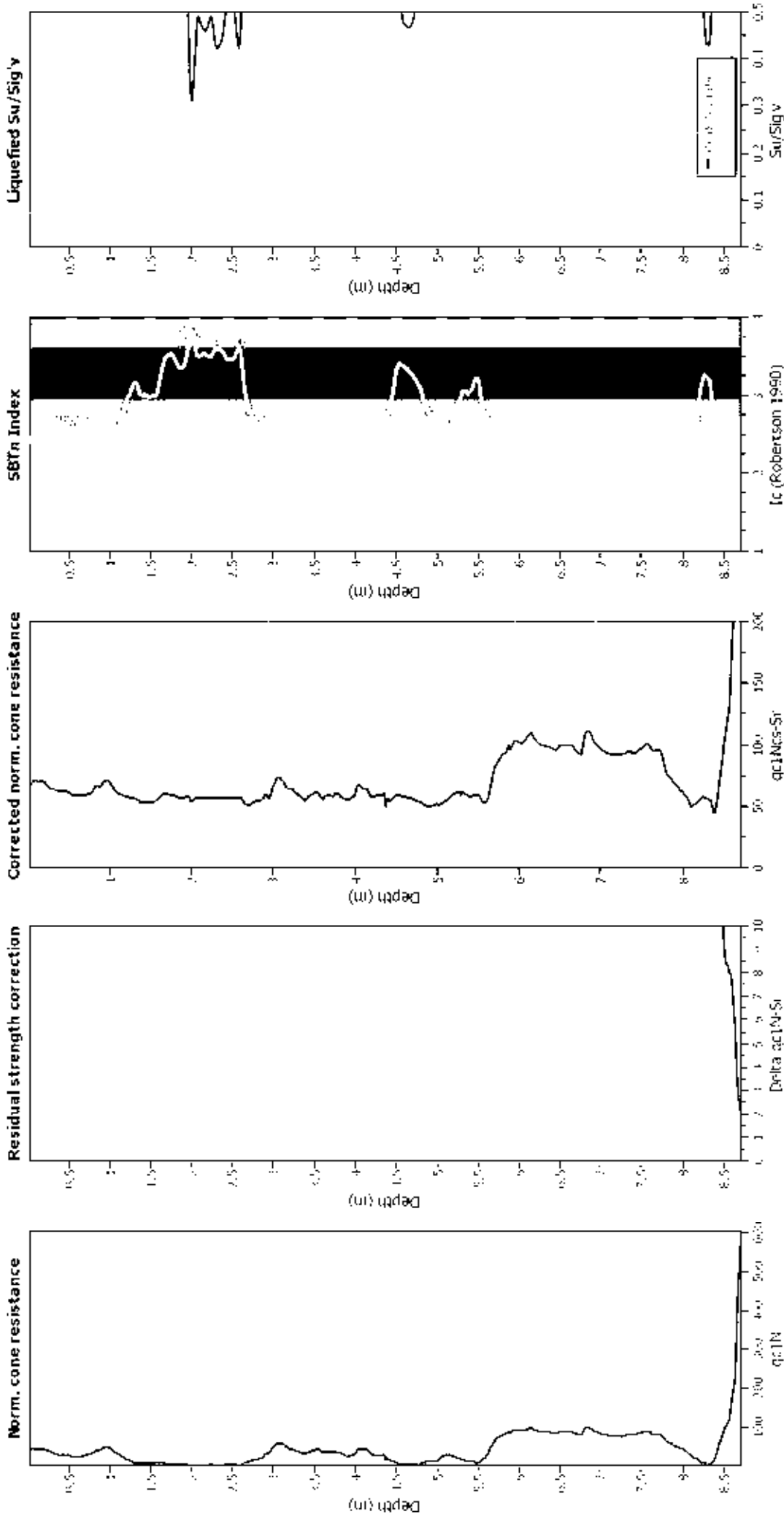
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: I88 (2008)
 Liquefaction correction method: I88 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.00 m
 Depth to GWL (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A
 Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

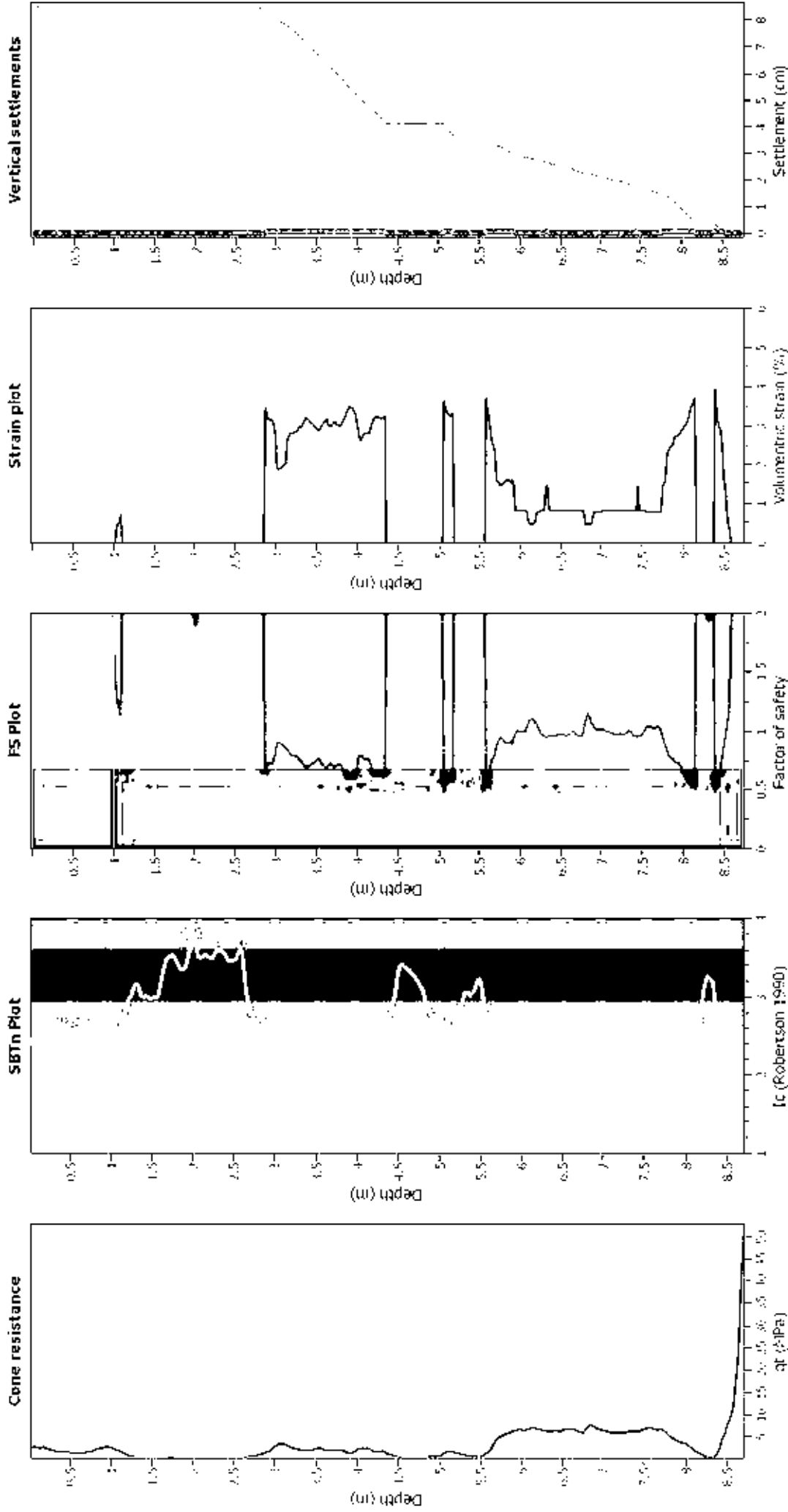
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition detect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lamé depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Lamé depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- q_t: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT41_678CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

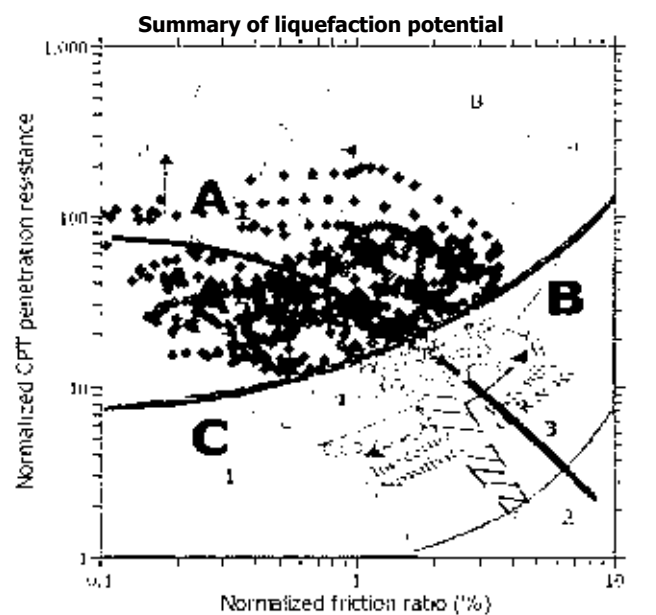
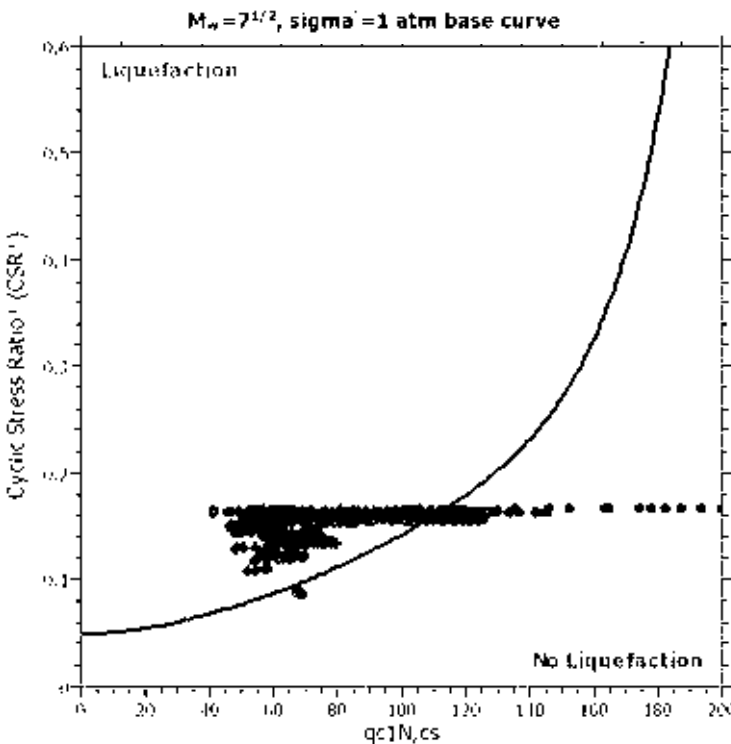
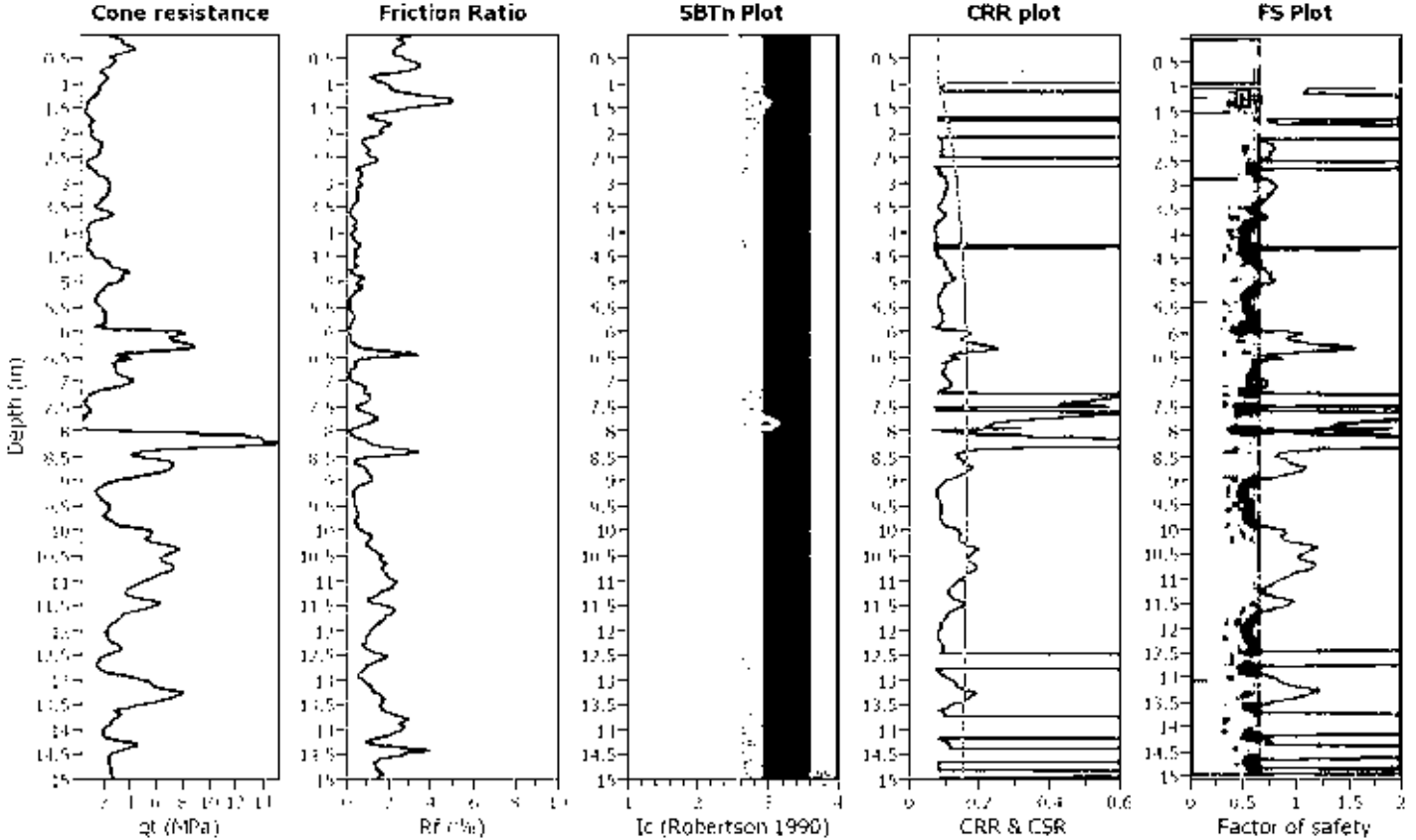
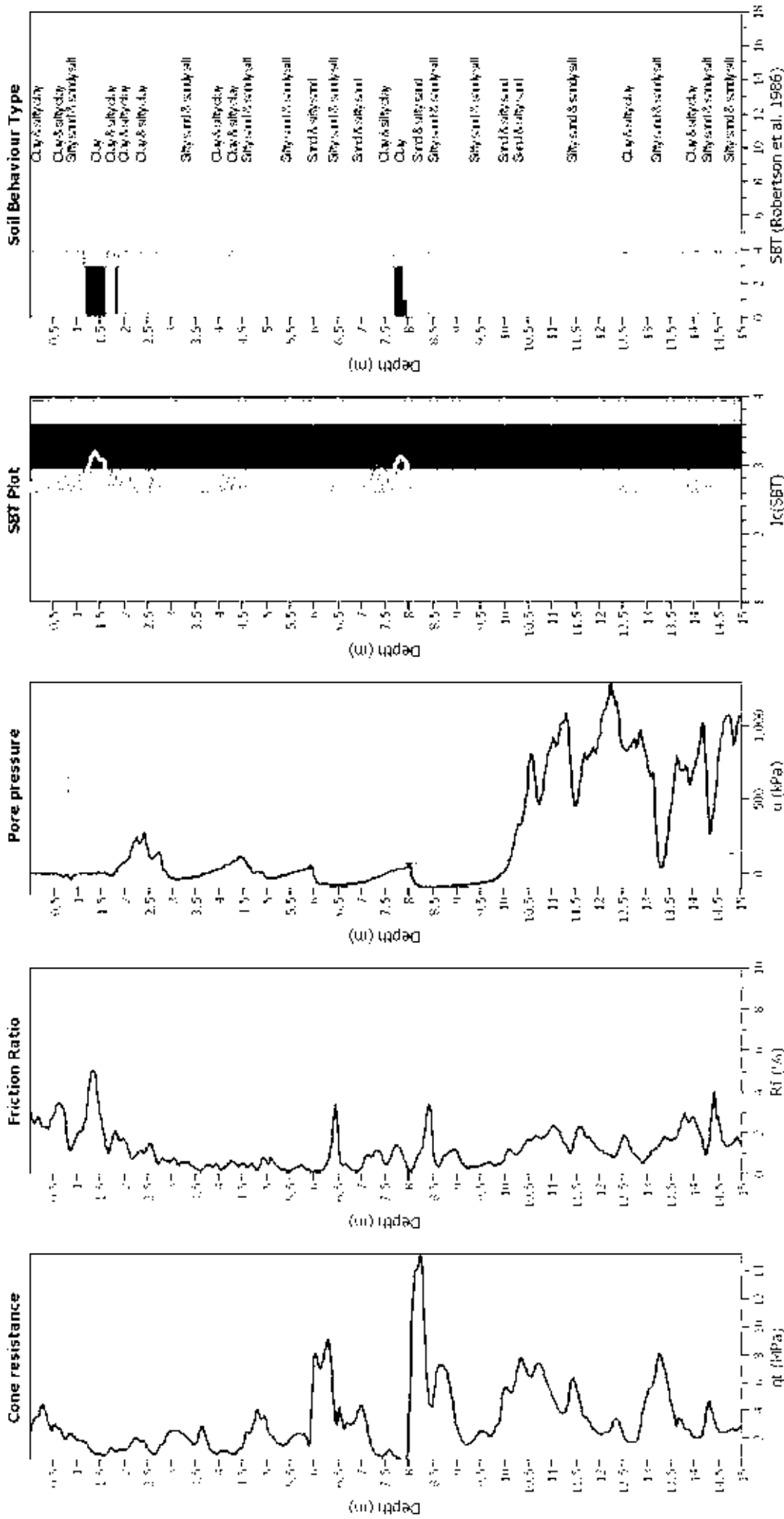


Figure 4: Summary of liquefaction potential assessment and classification of the test data. Zone A: Fully liquefiable soils; Zone B: Partially liquefiable soils; Zone C: Non-liquefiable soils. The liquefaction potential is assessed based on the normalized CPT penetration resistance and normalized friction ratio. The liquefaction potential is assessed based on the normalized CPT penetration resistance and normalized friction ratio.

CPT basic interpretation plots



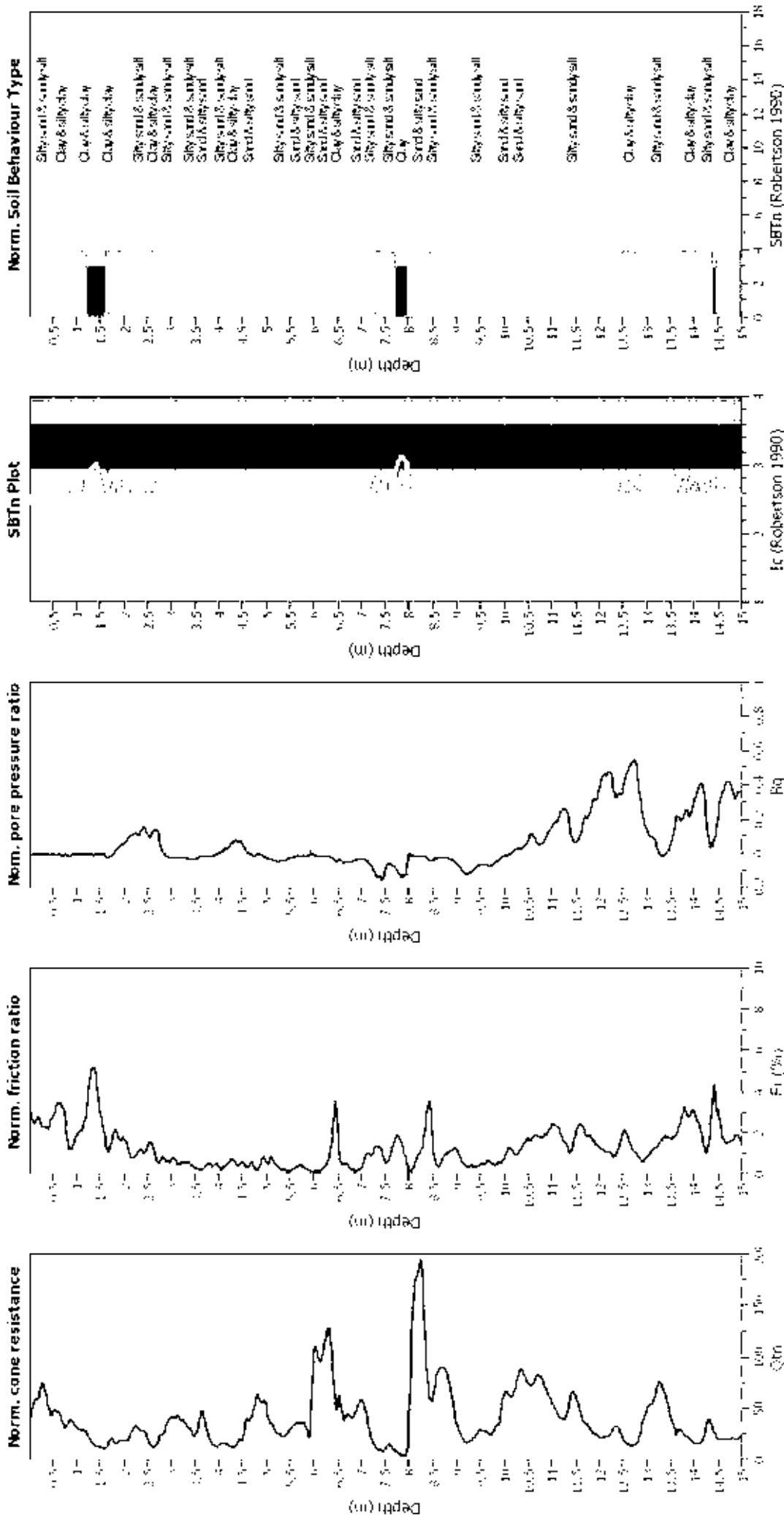
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K. applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GW (m):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



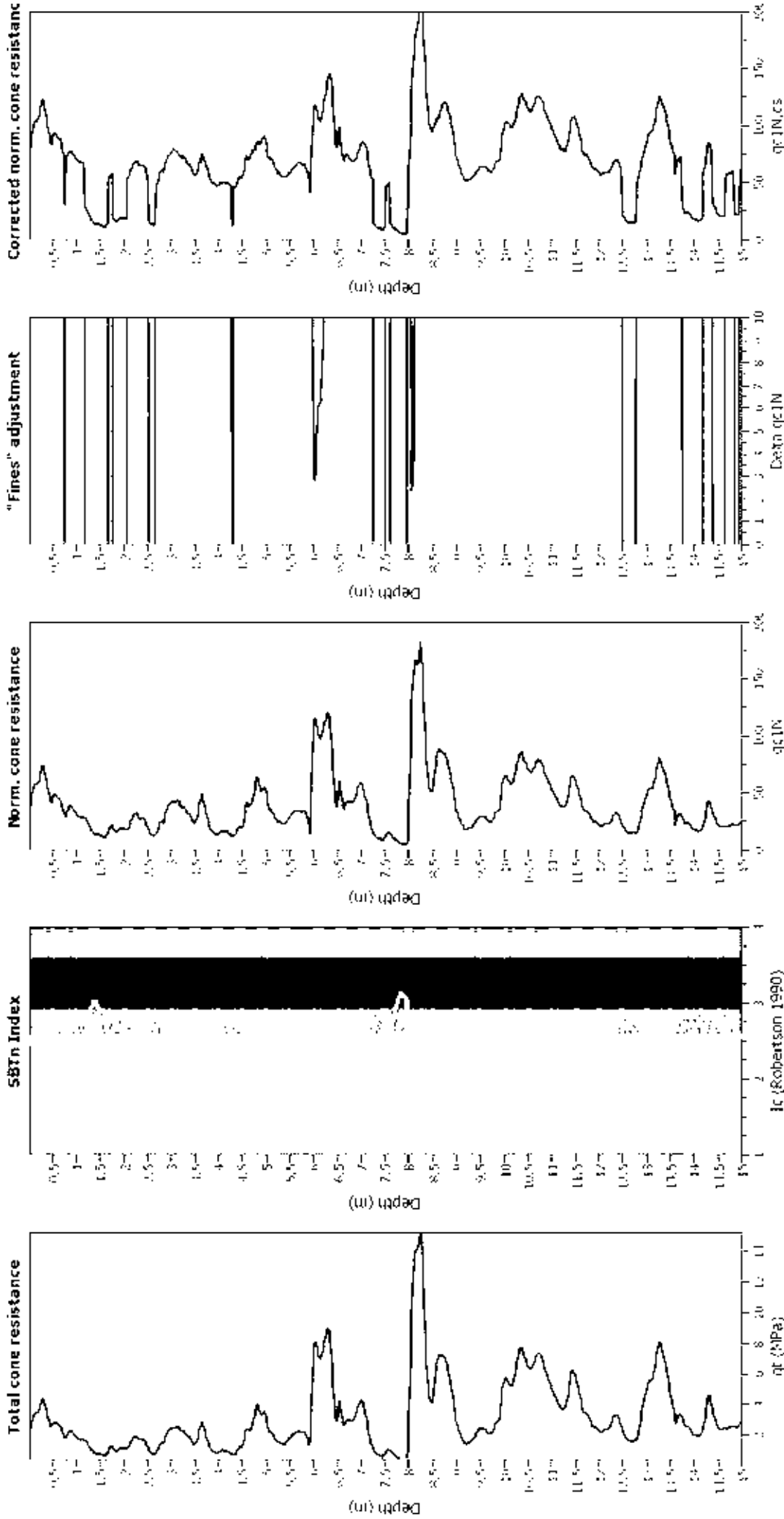
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

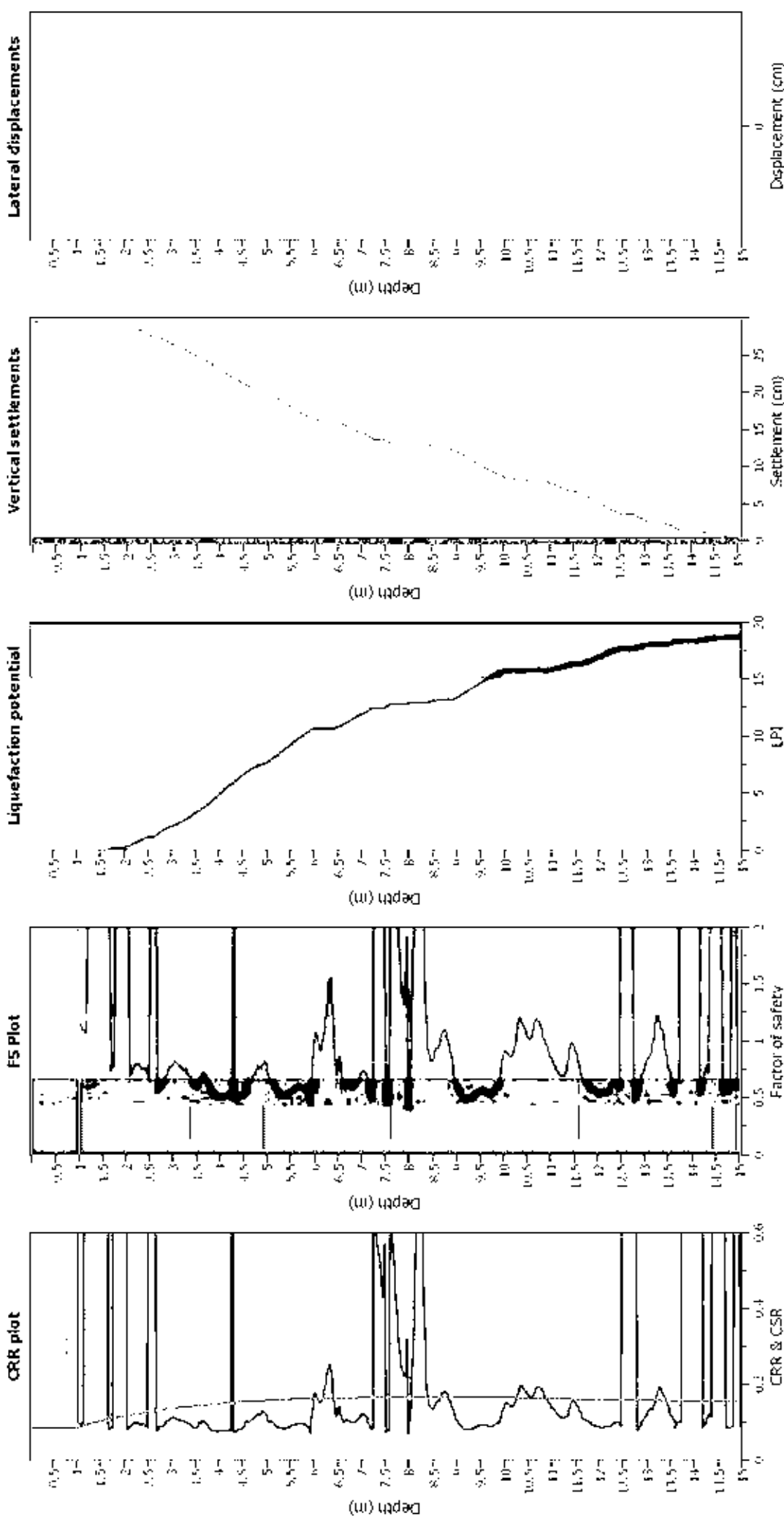
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition method applied: N/A
 Sand & Clay: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

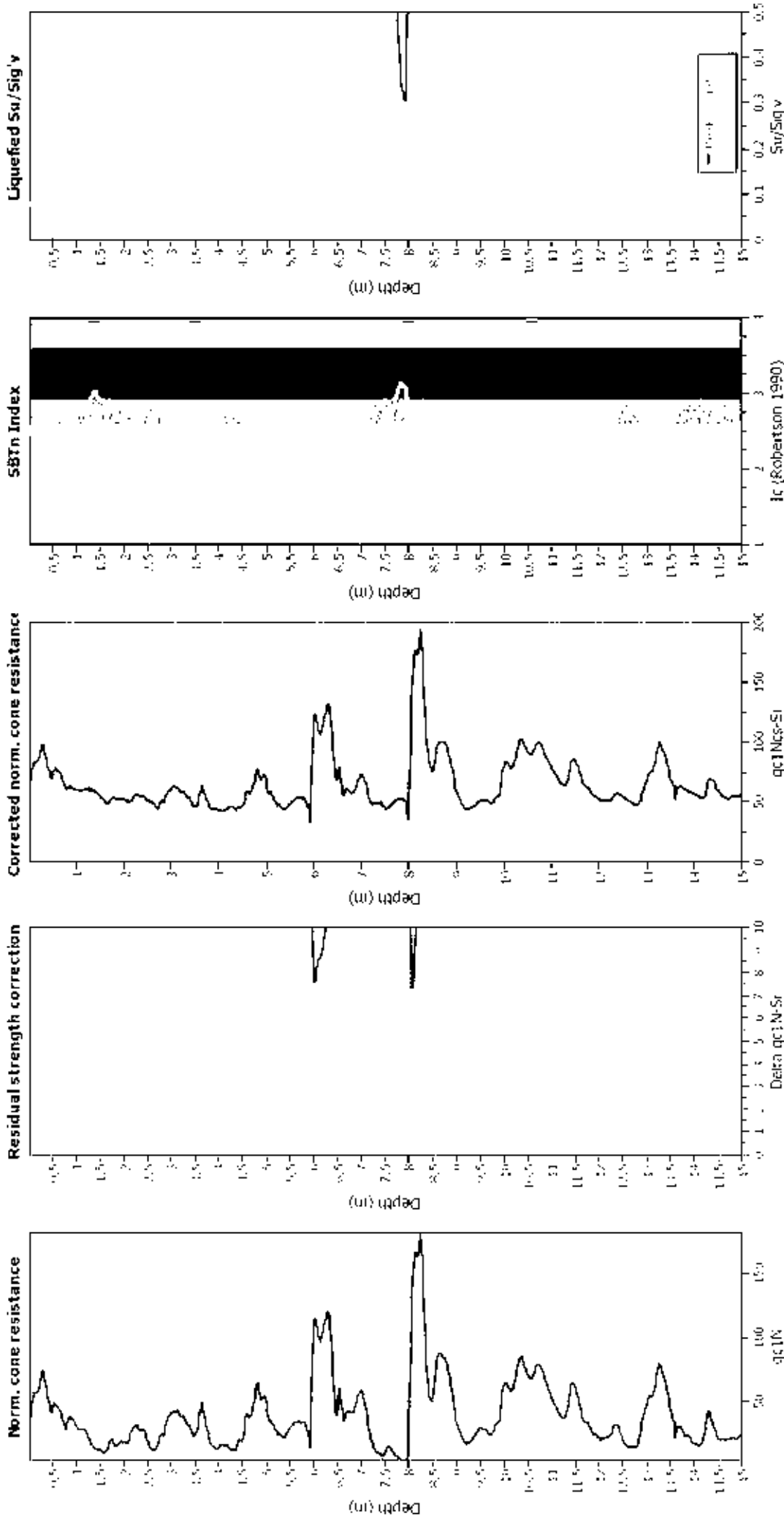
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

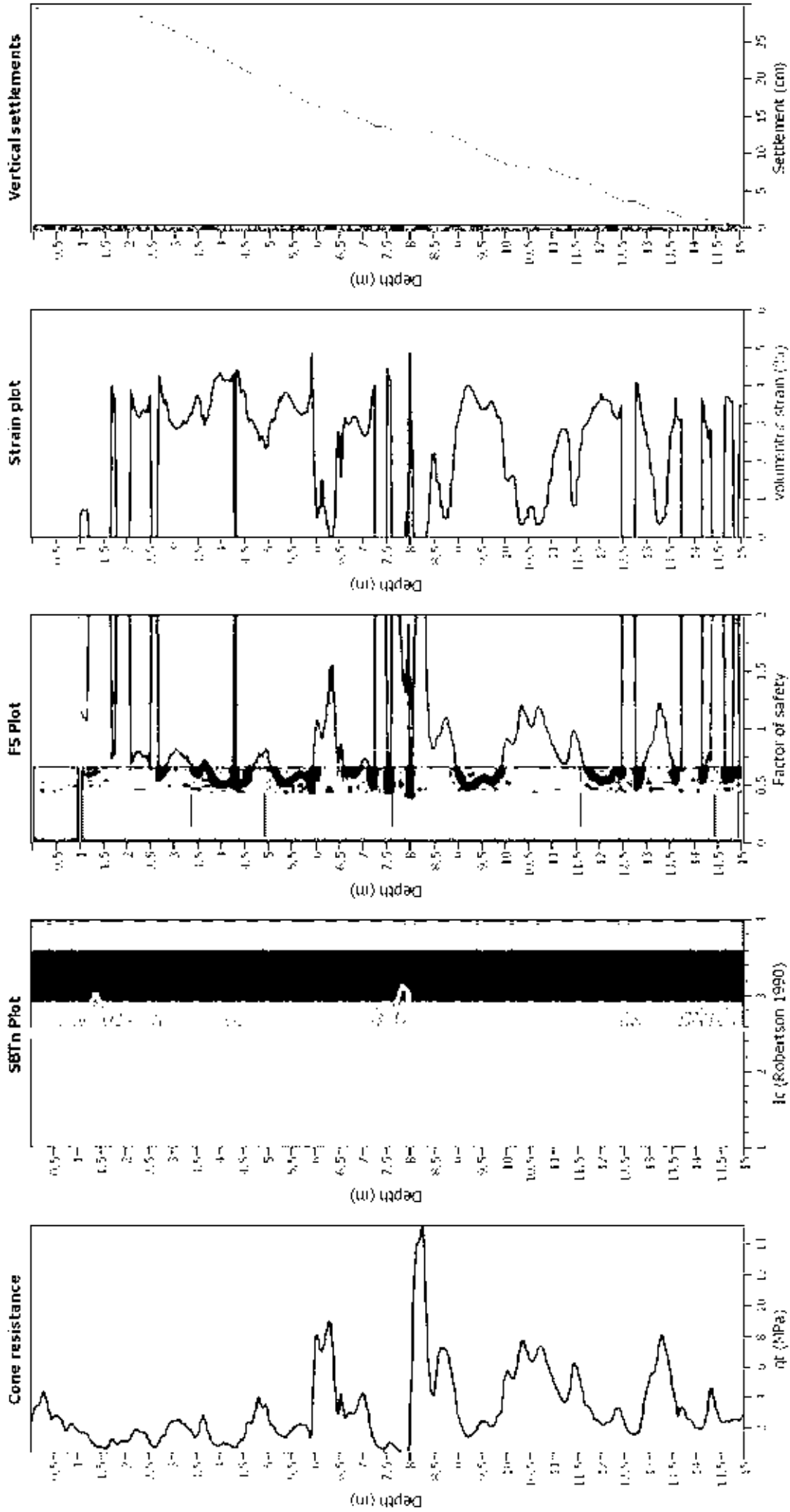
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude (M _w):	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
- q_s: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT42_564CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

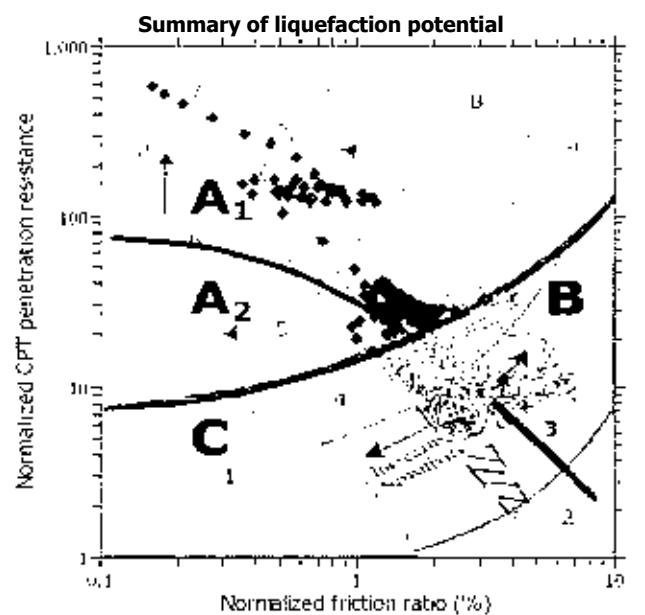
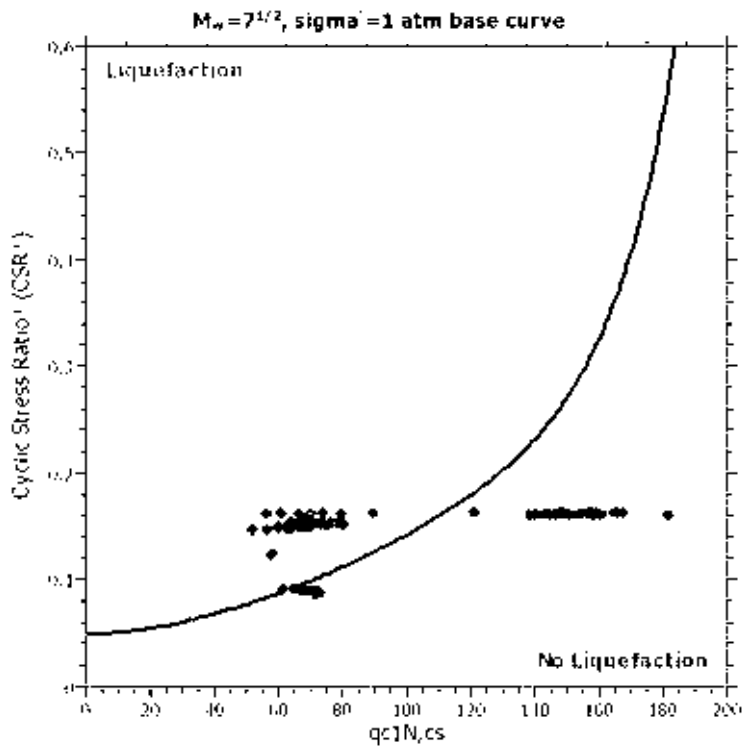
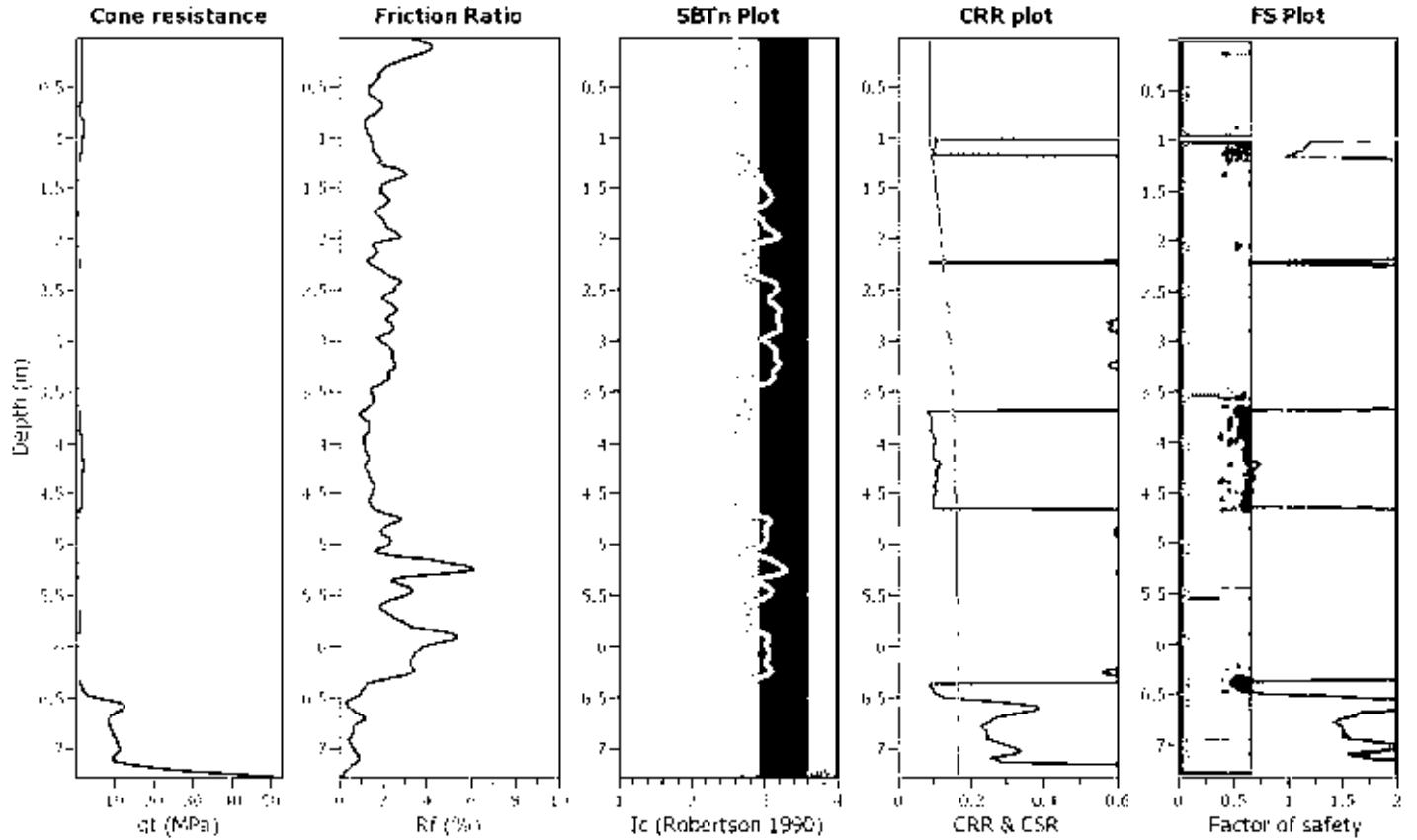
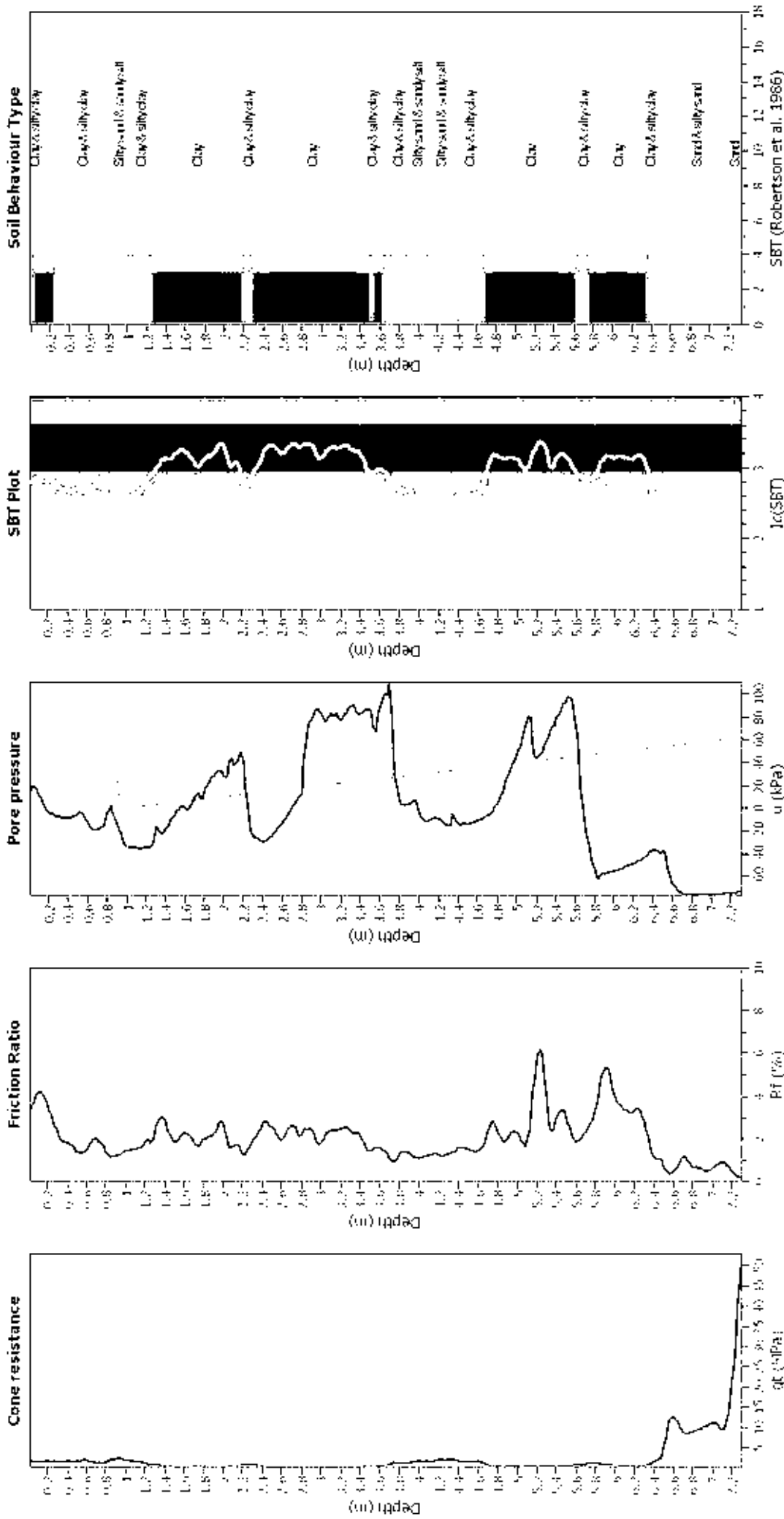


Figure 4: Summary of liquefaction potential plot and normalized cyclic stress ratio plot. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The plot is divided into zones A1, A2, B, and C. Arrows indicate the direction of increasing resistance and friction ratio.

CPT basic interpretation plots



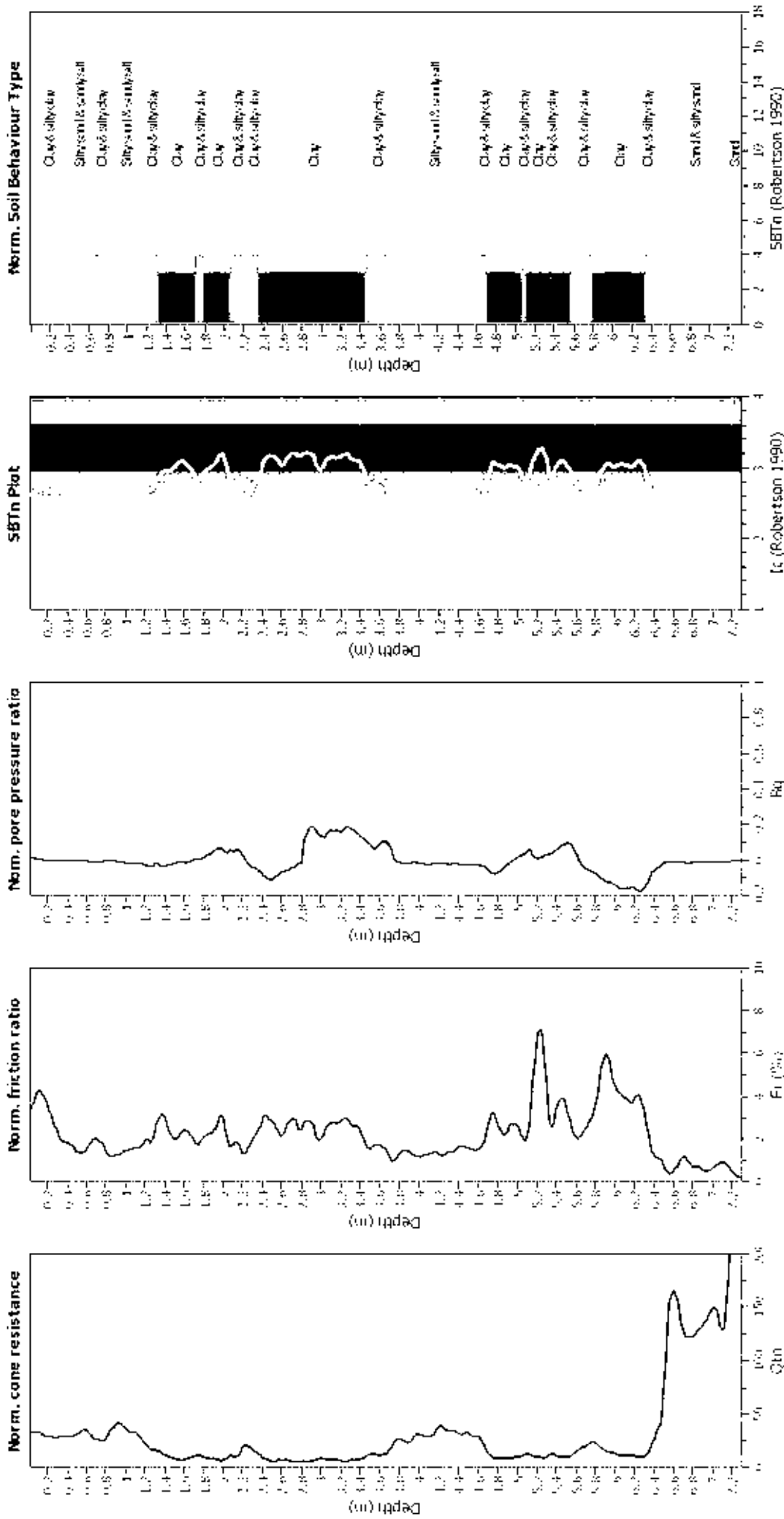
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K_s applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Lamé depth applied:	N/A
Depth to water table (m):	1.00 m		
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



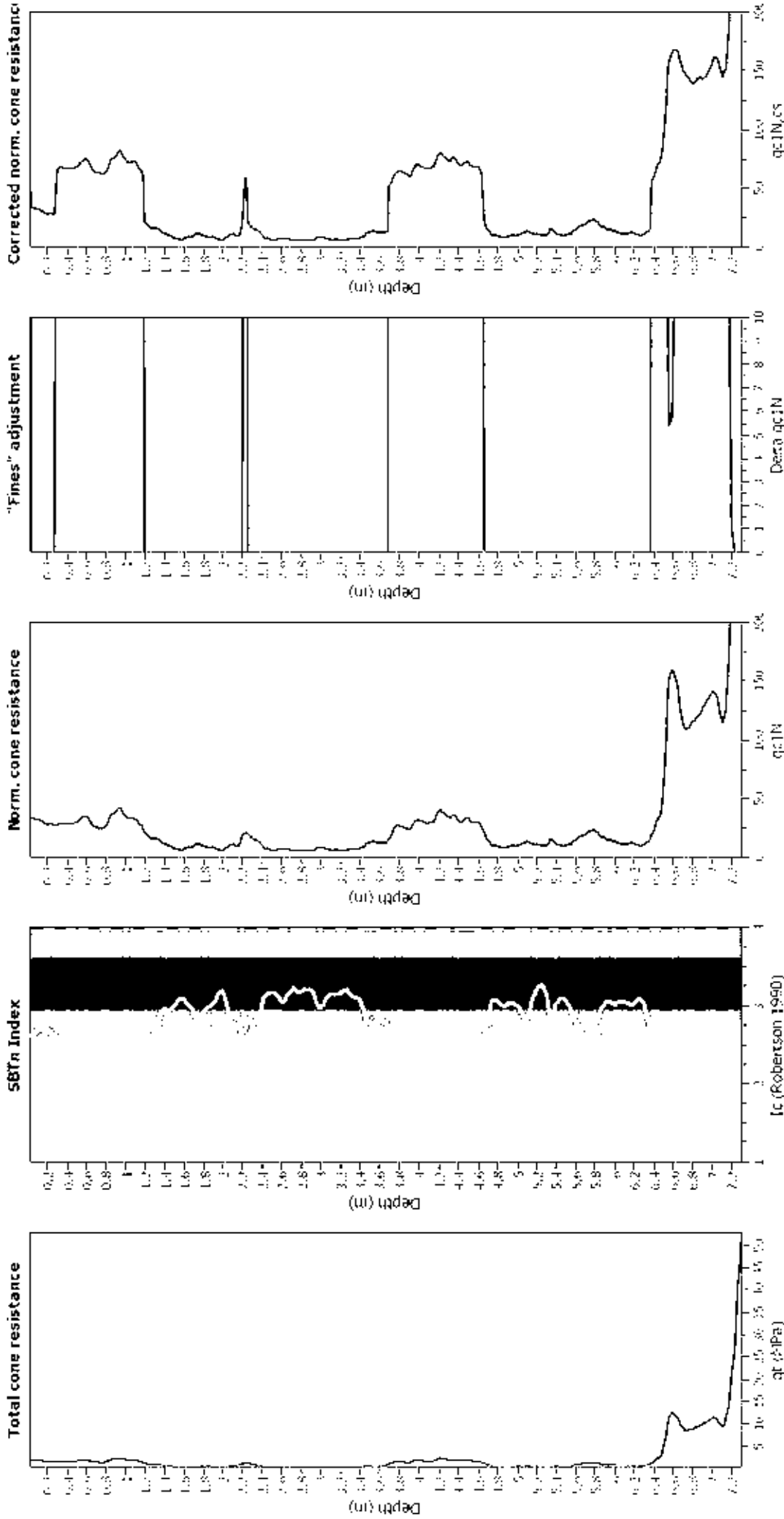
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

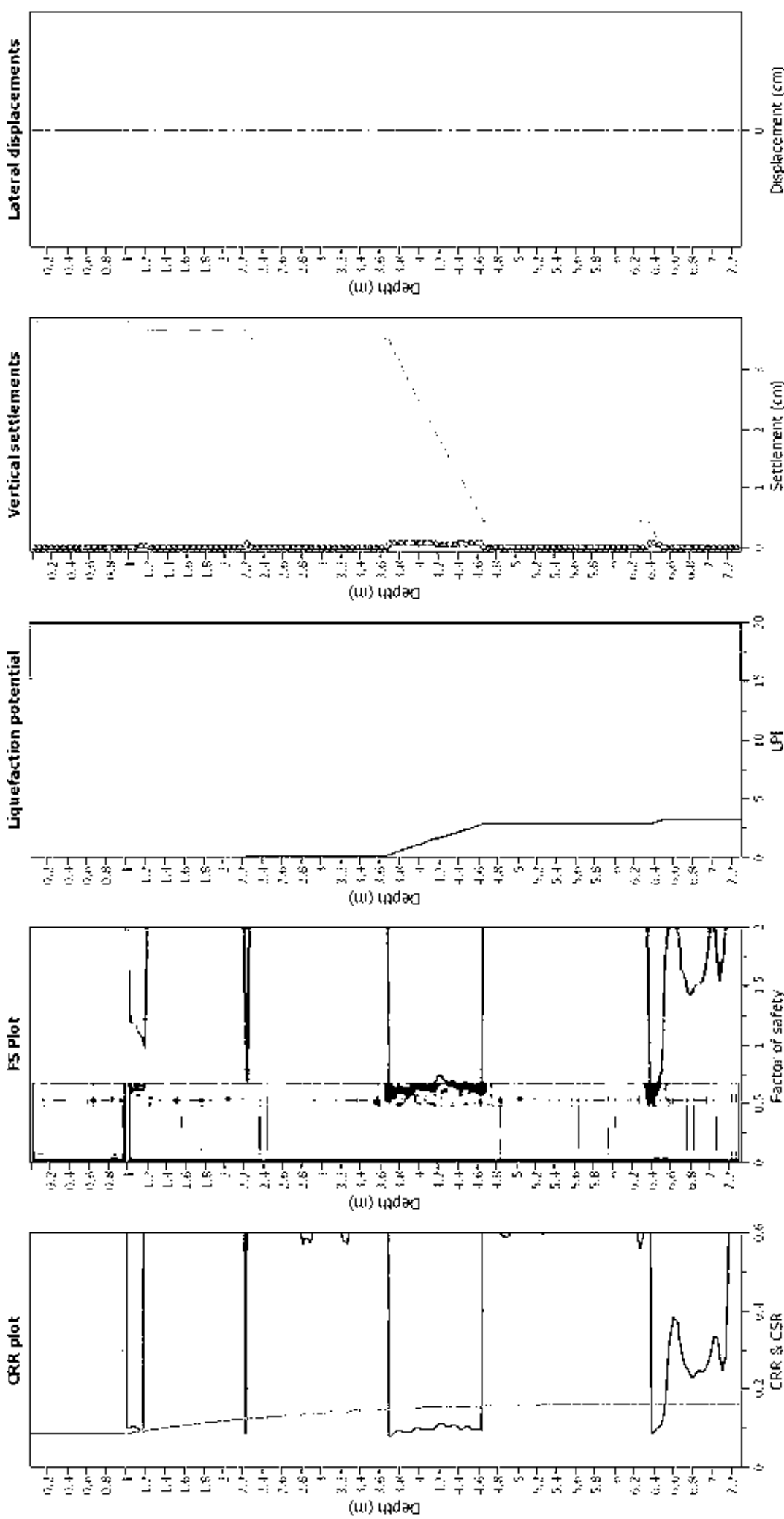
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

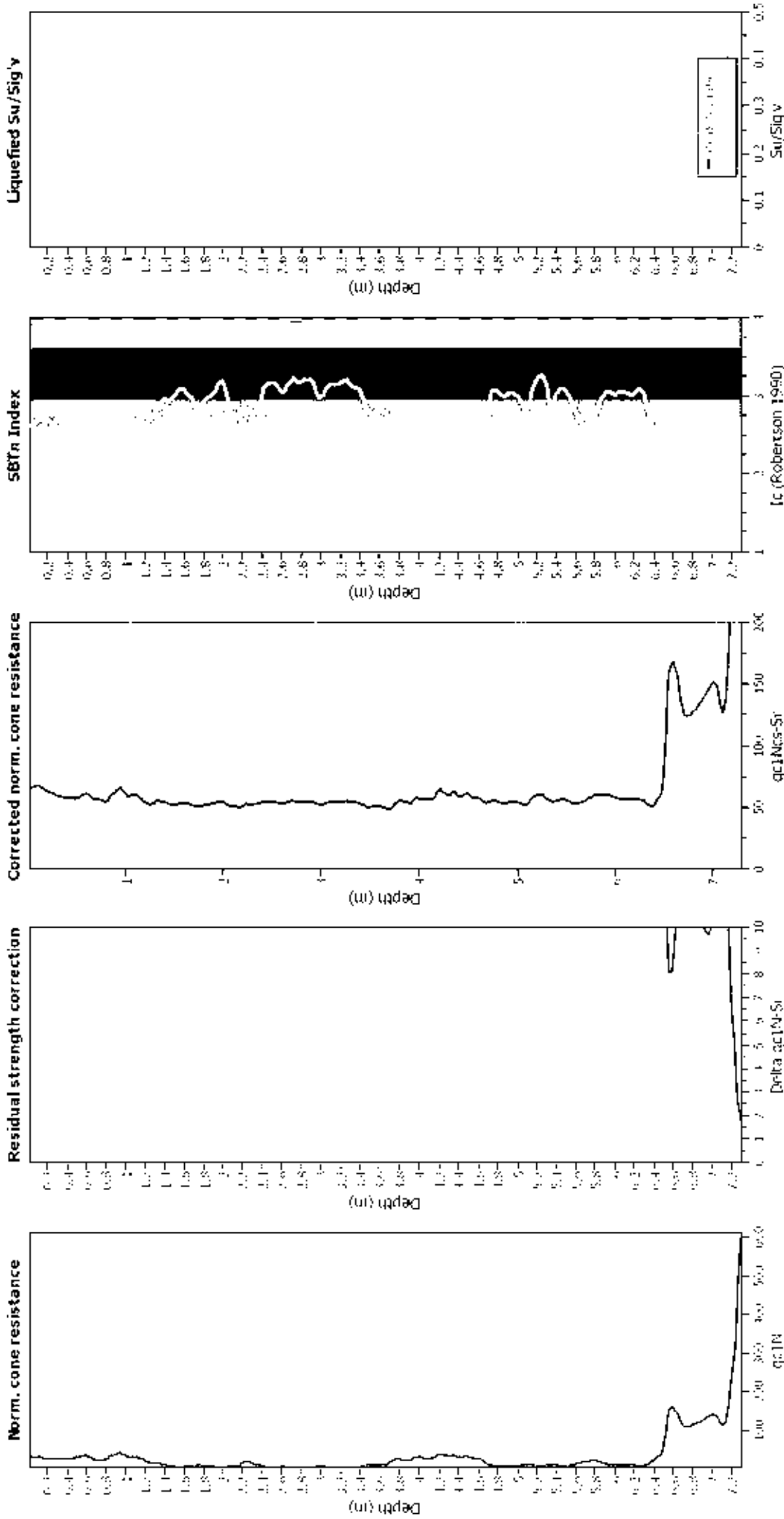
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

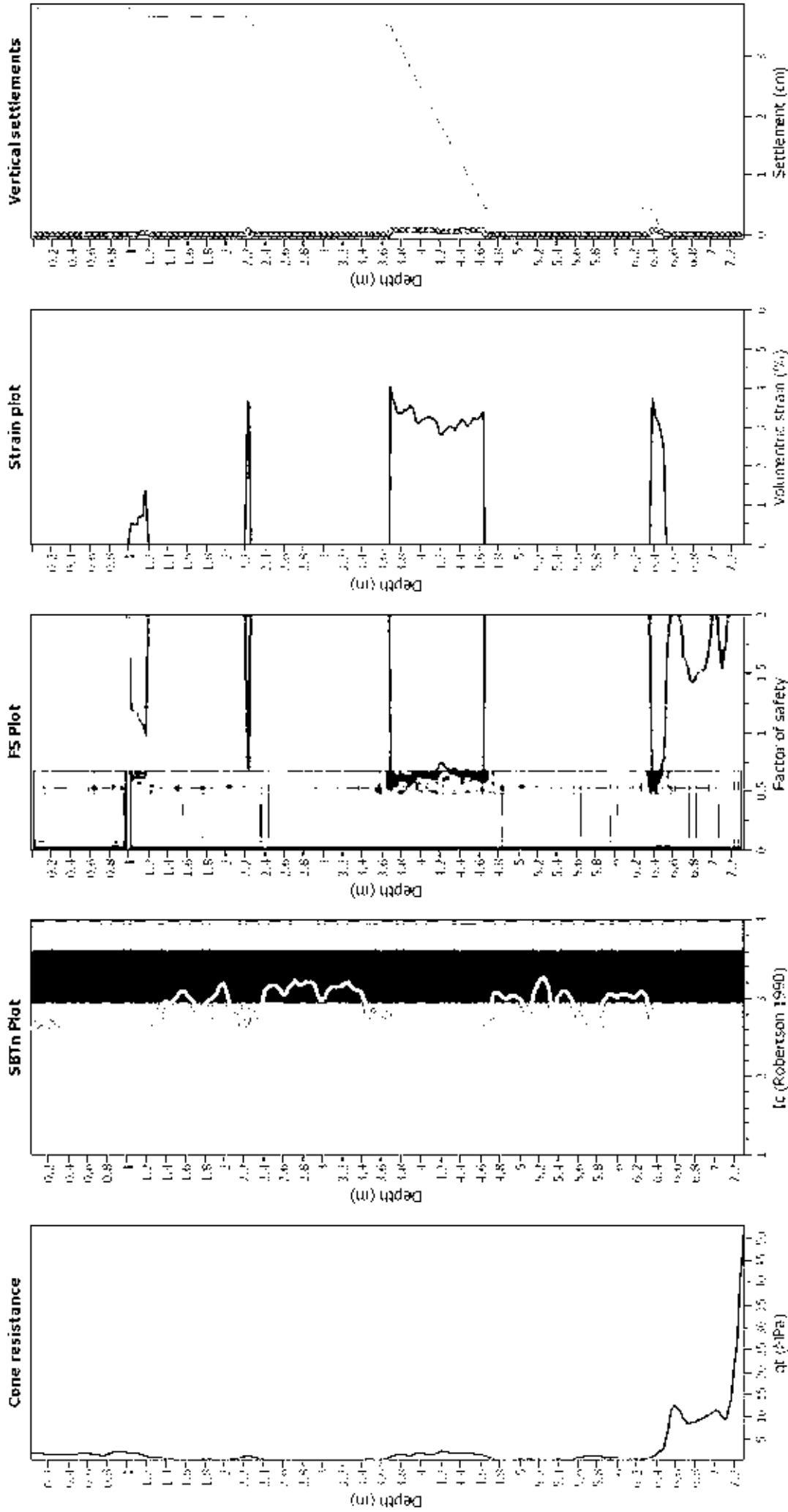
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT43_484CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

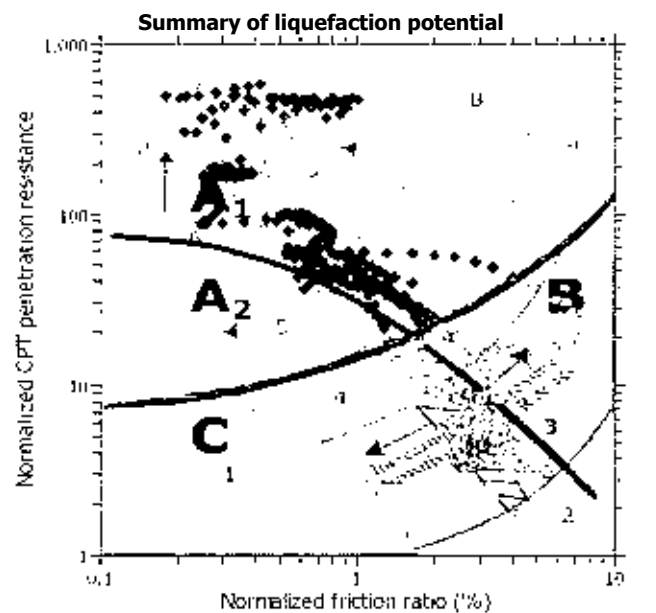
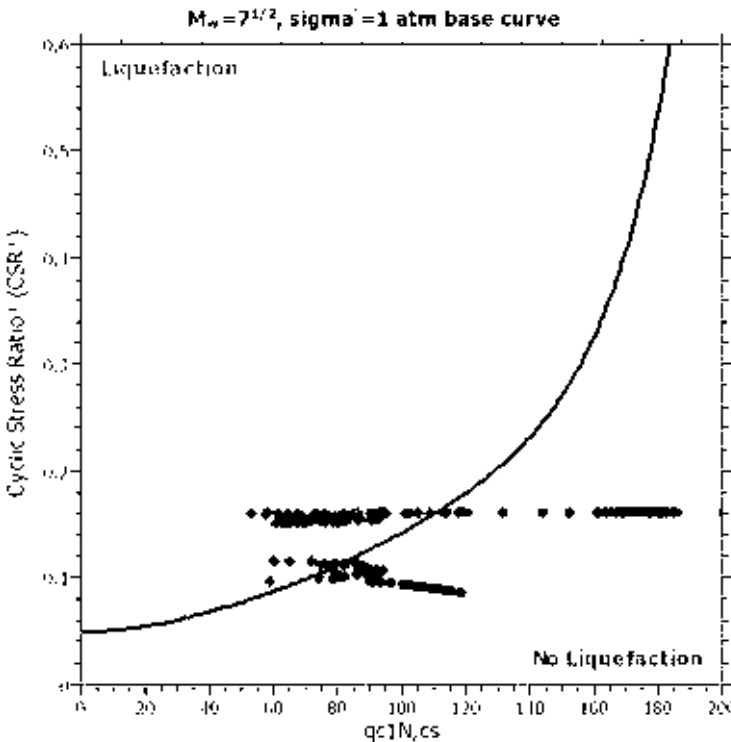
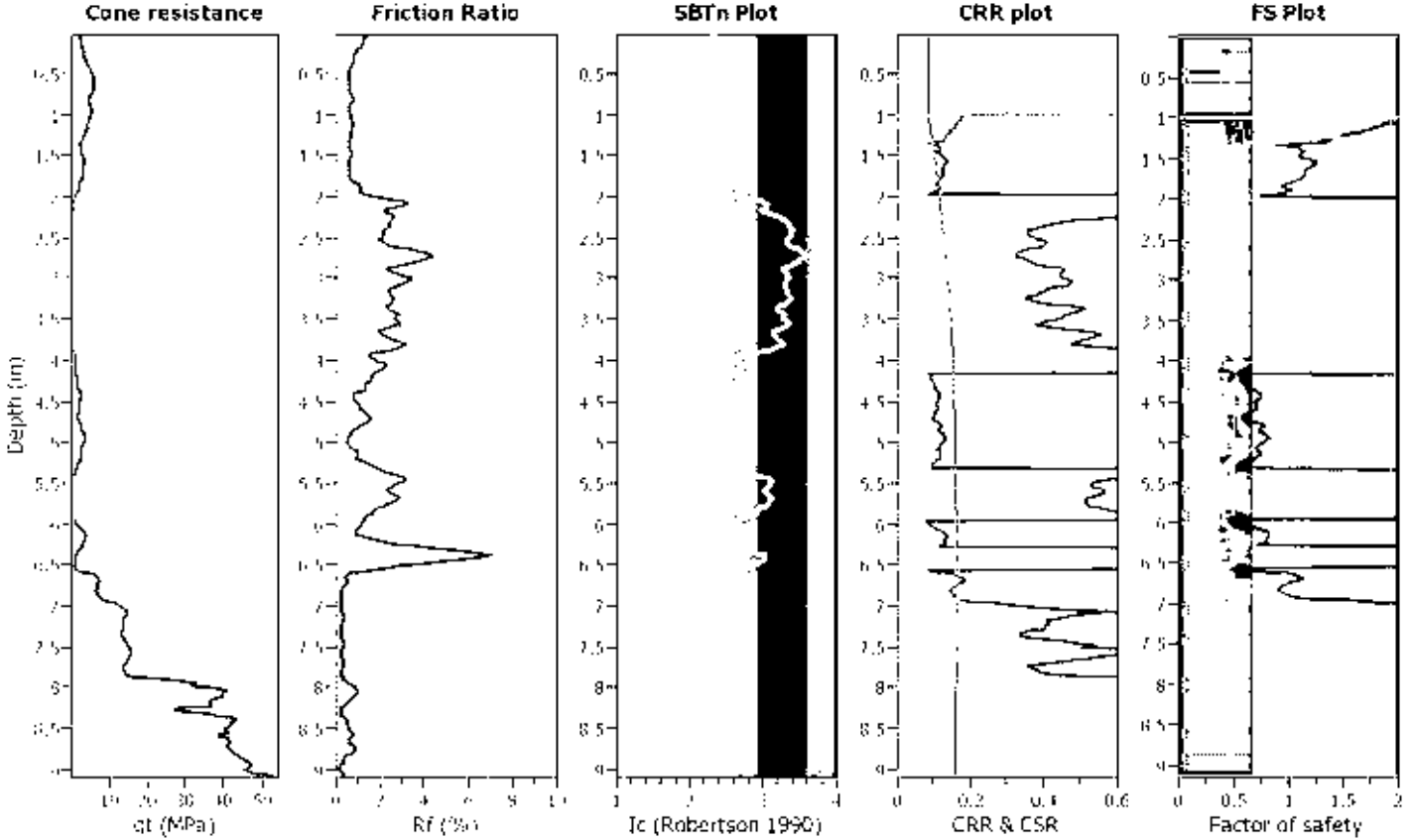
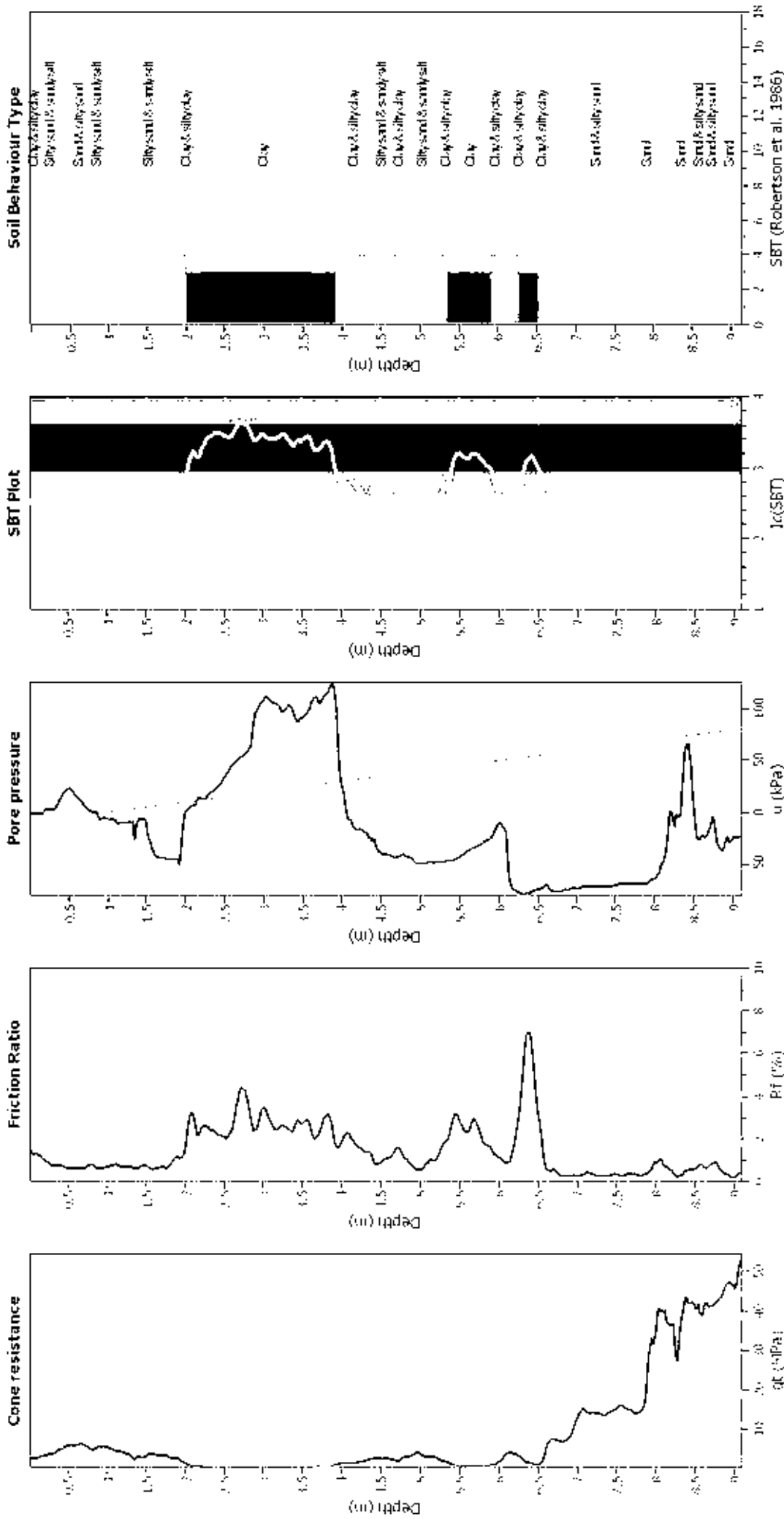


Figure 4: Summary of liquefaction potential plot and data points for test 13. Zone A1: Fully liquefied zone, Zone A2: Partially liquefied zone, Zone B: No liquefaction, Zone C: Fully liquefied zone. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with data points indicating the liquefaction potential for each test point.

CPT basic interpretation plots



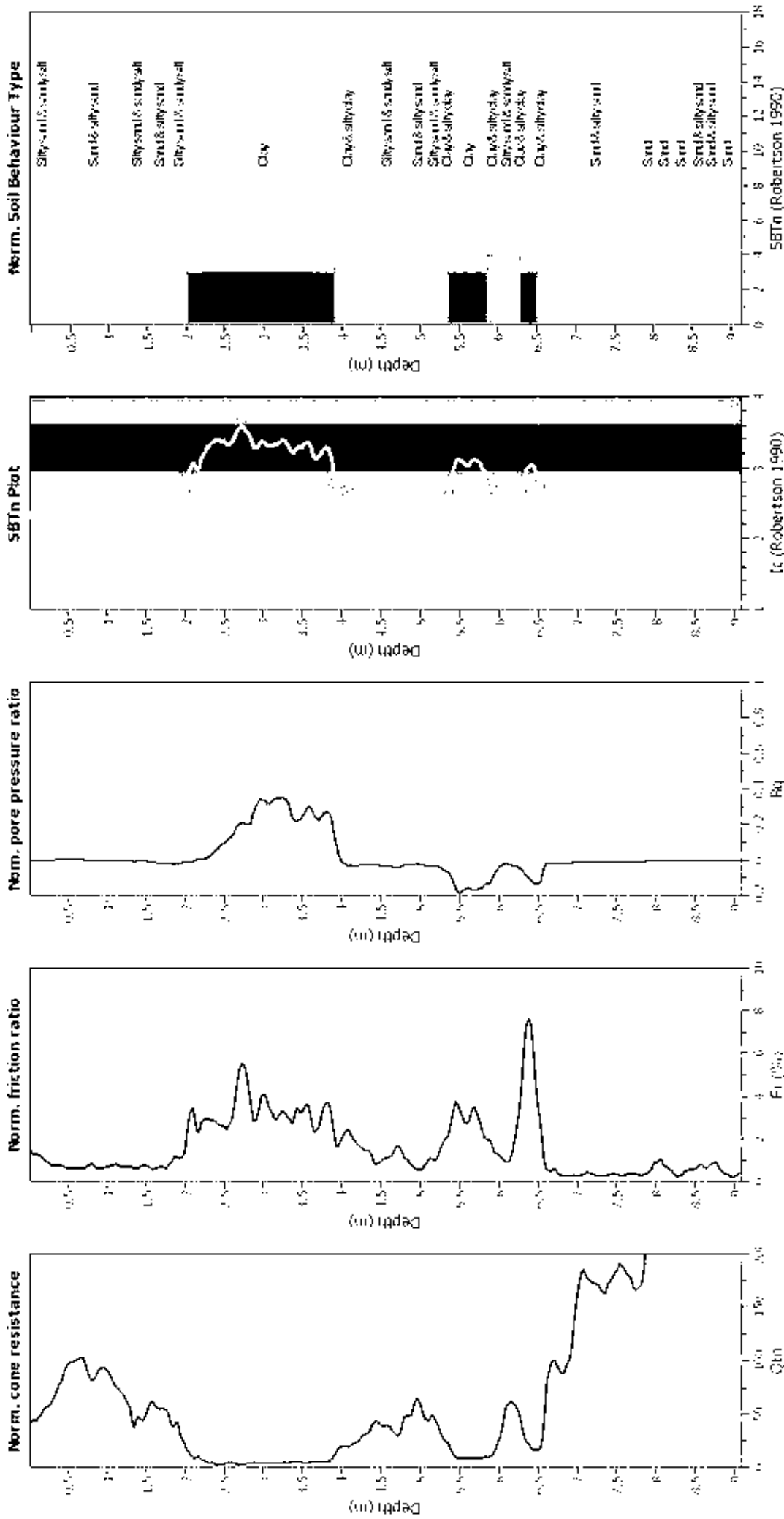
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude (M _w):	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



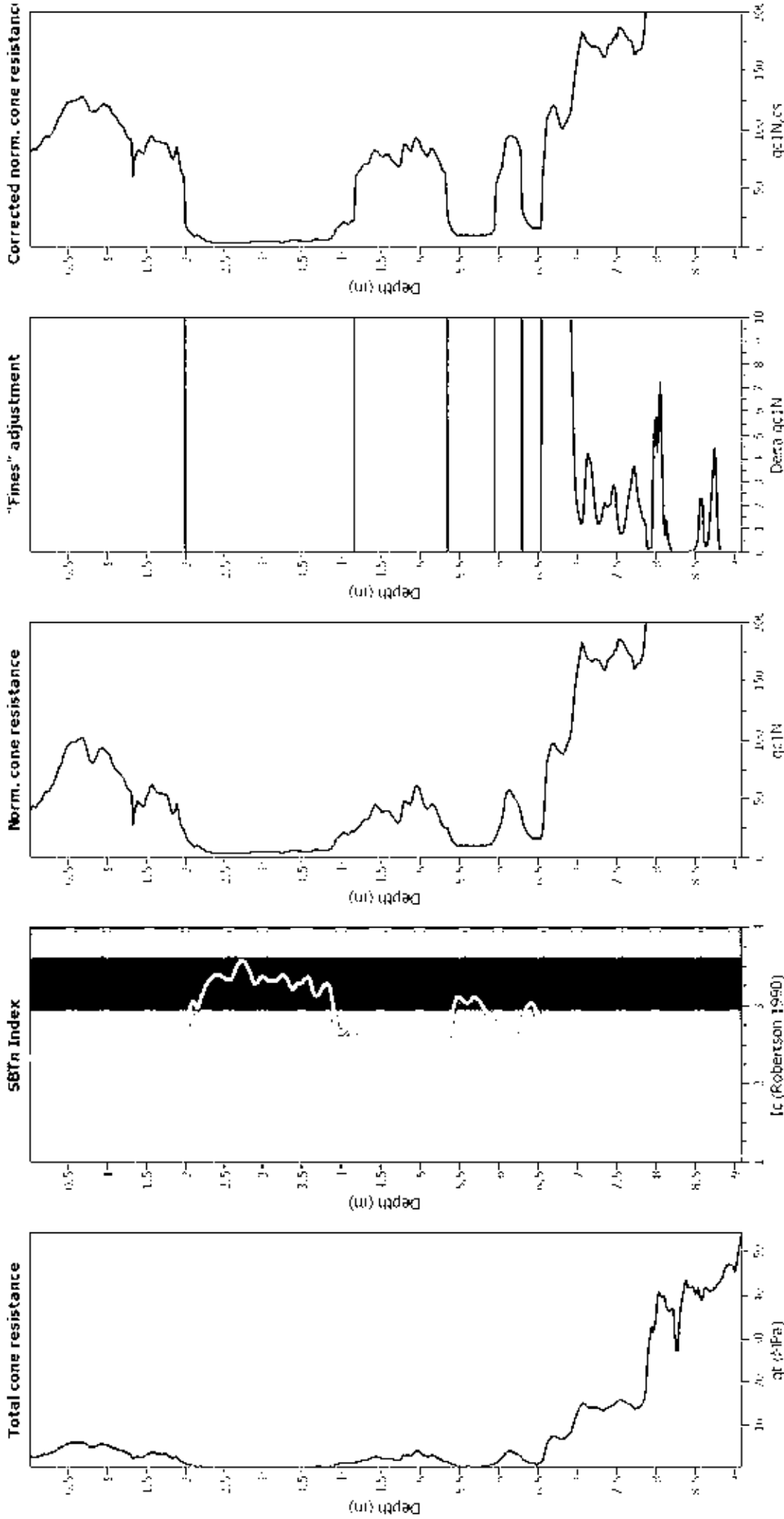
Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GWL (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A		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

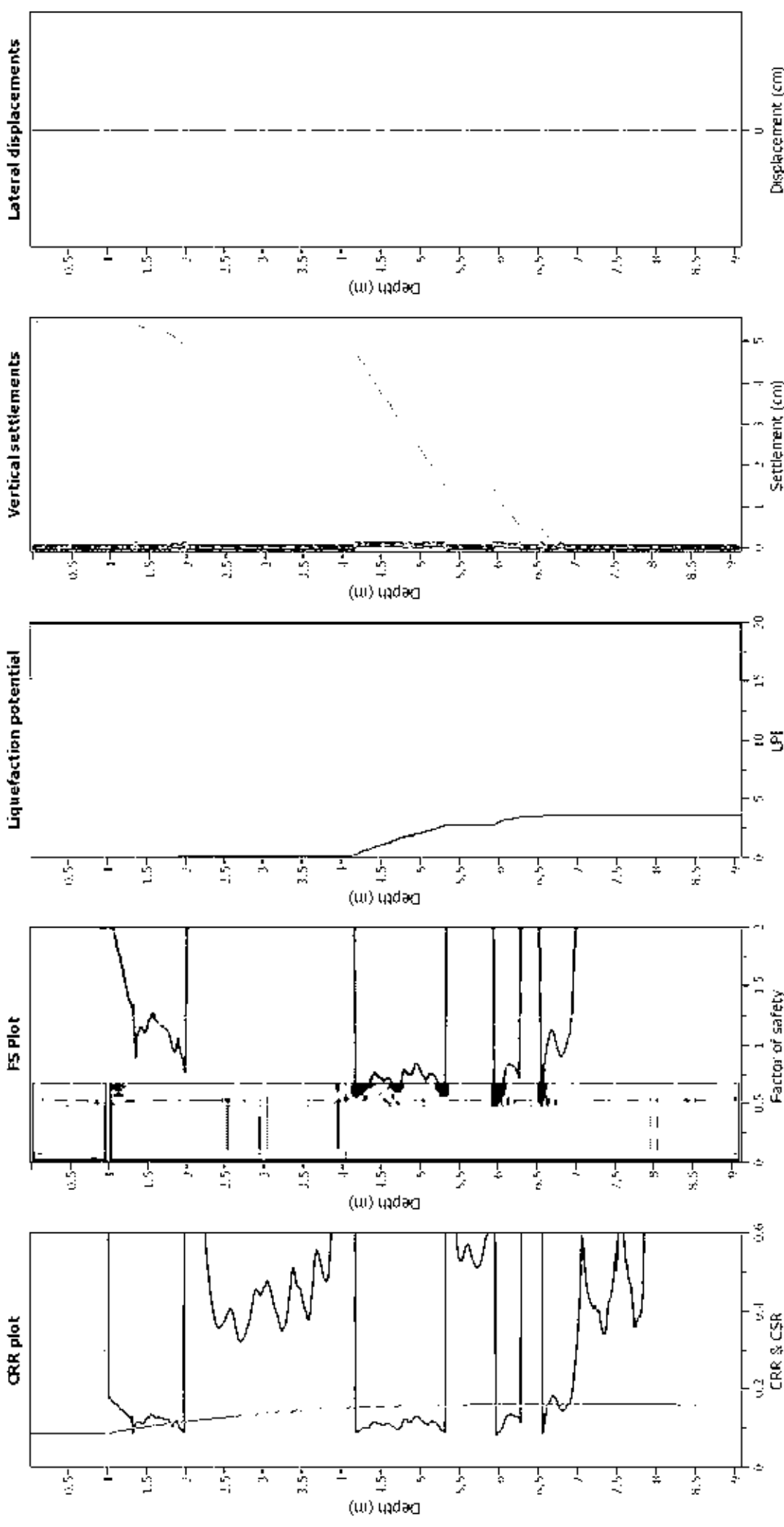
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Liquefaction correction method: 18B (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.5
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

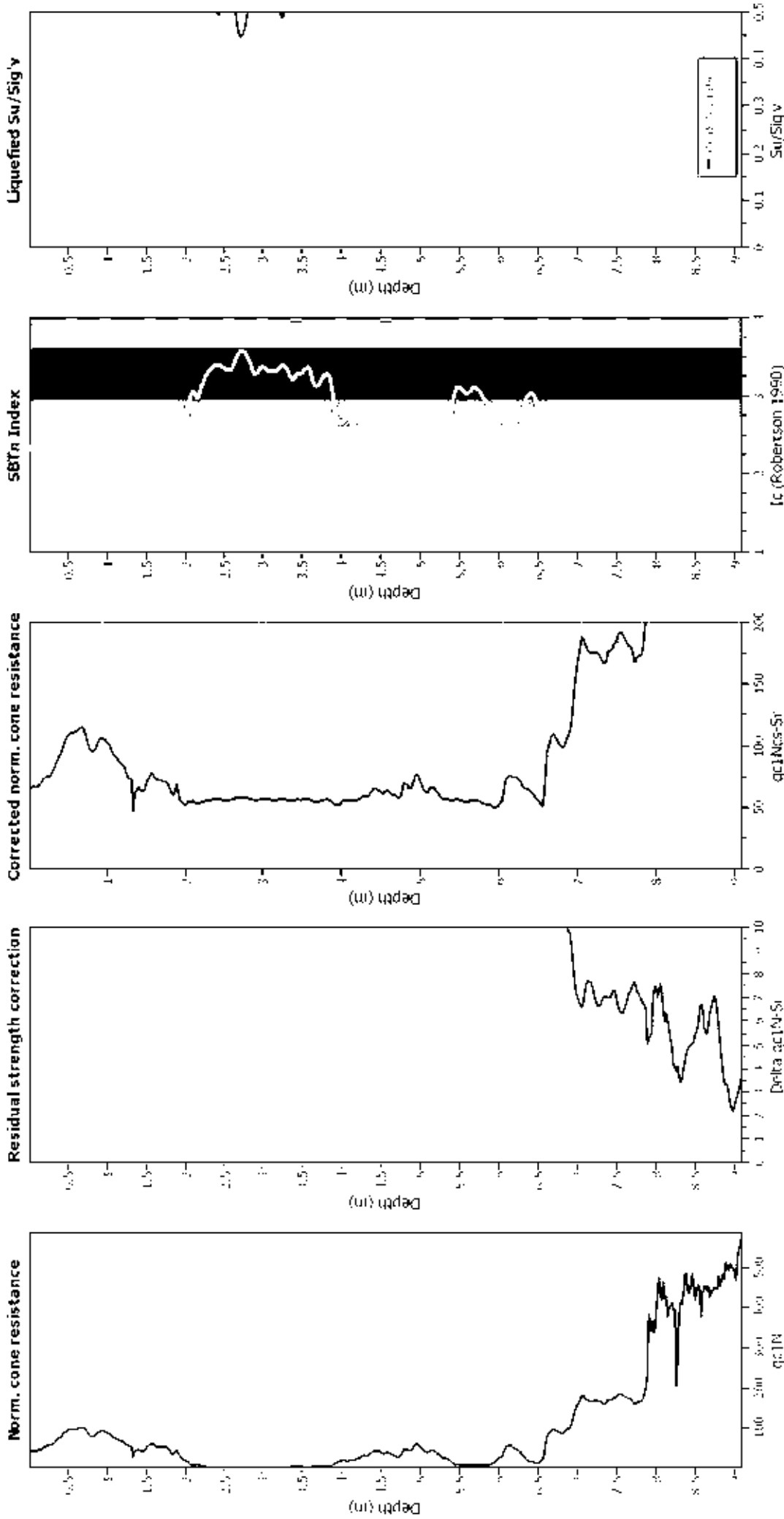
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

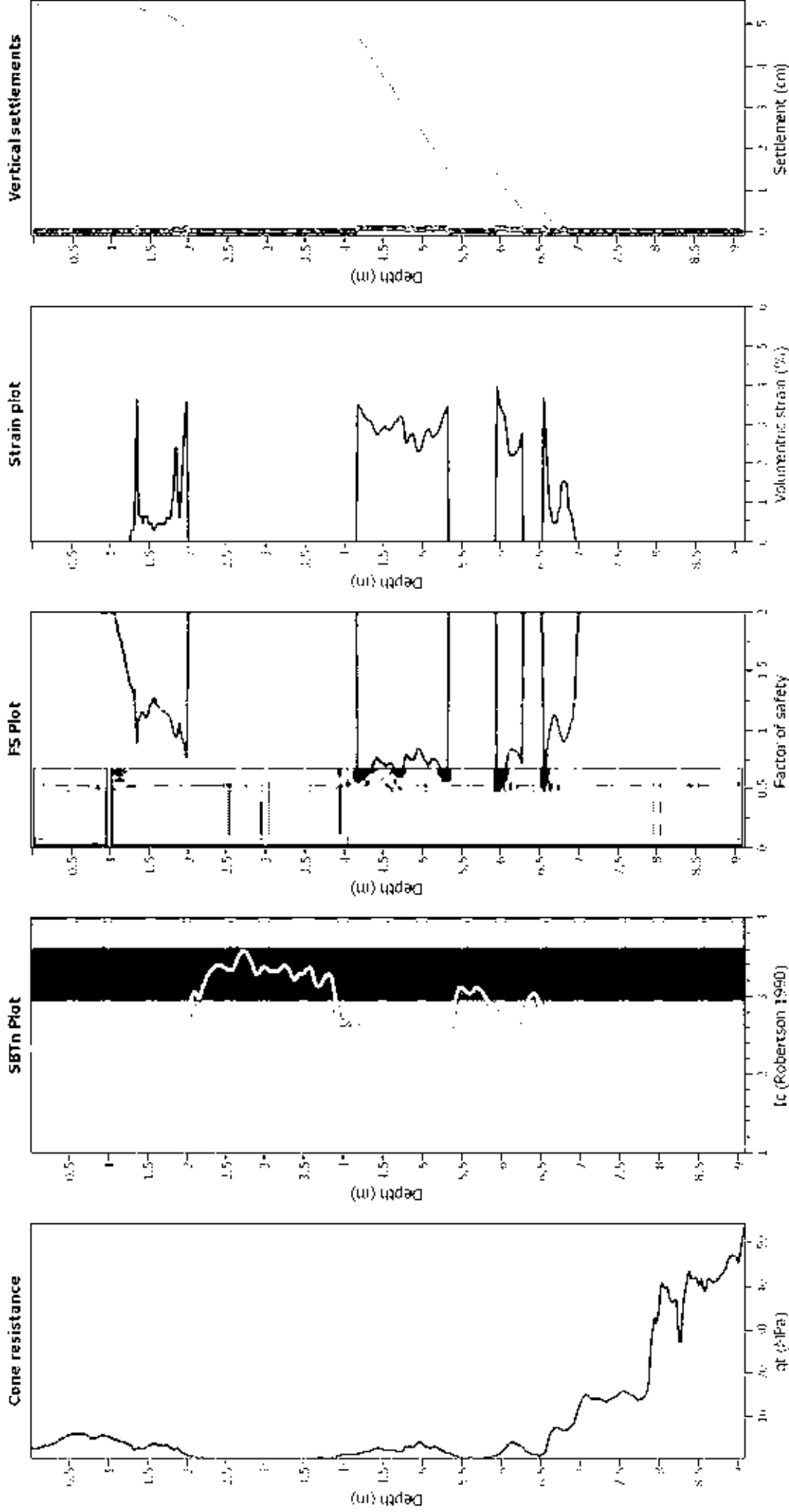
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial earthquake magnitude Ms:	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- q_t: Total cone resistance (cone resistance q corrected for pore water effects)
- I_c: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT44_564CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

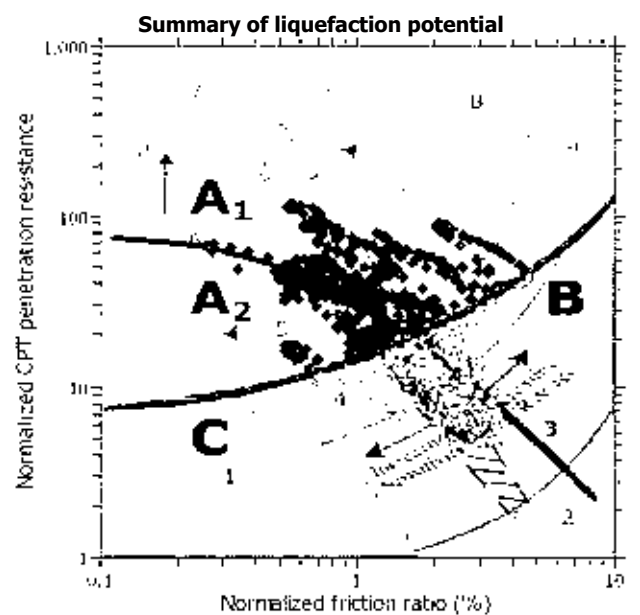
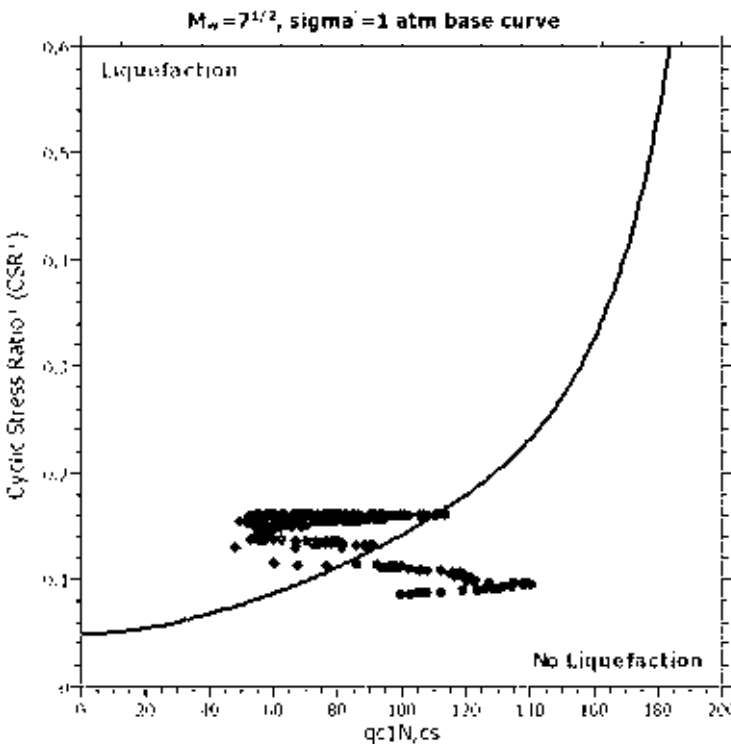
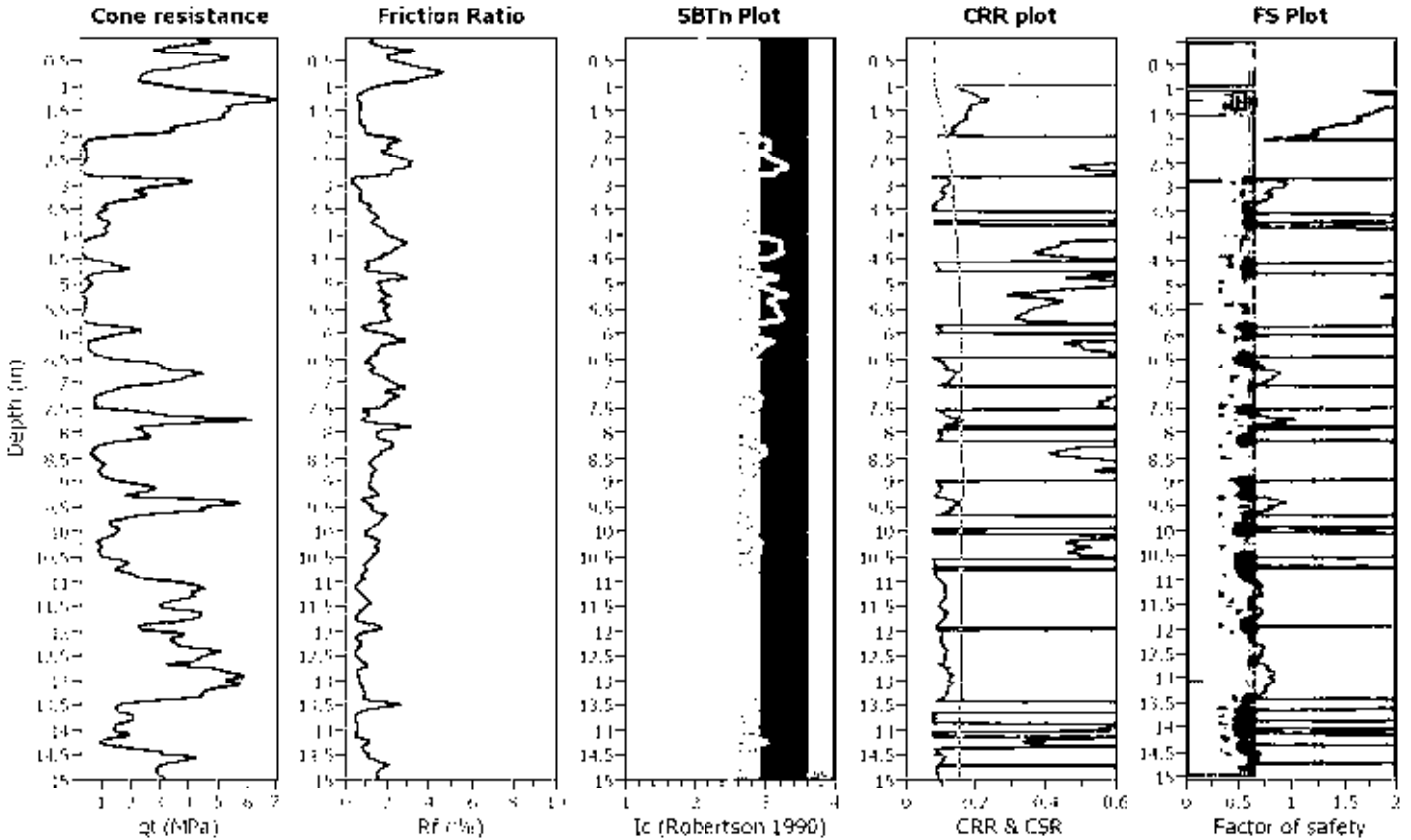
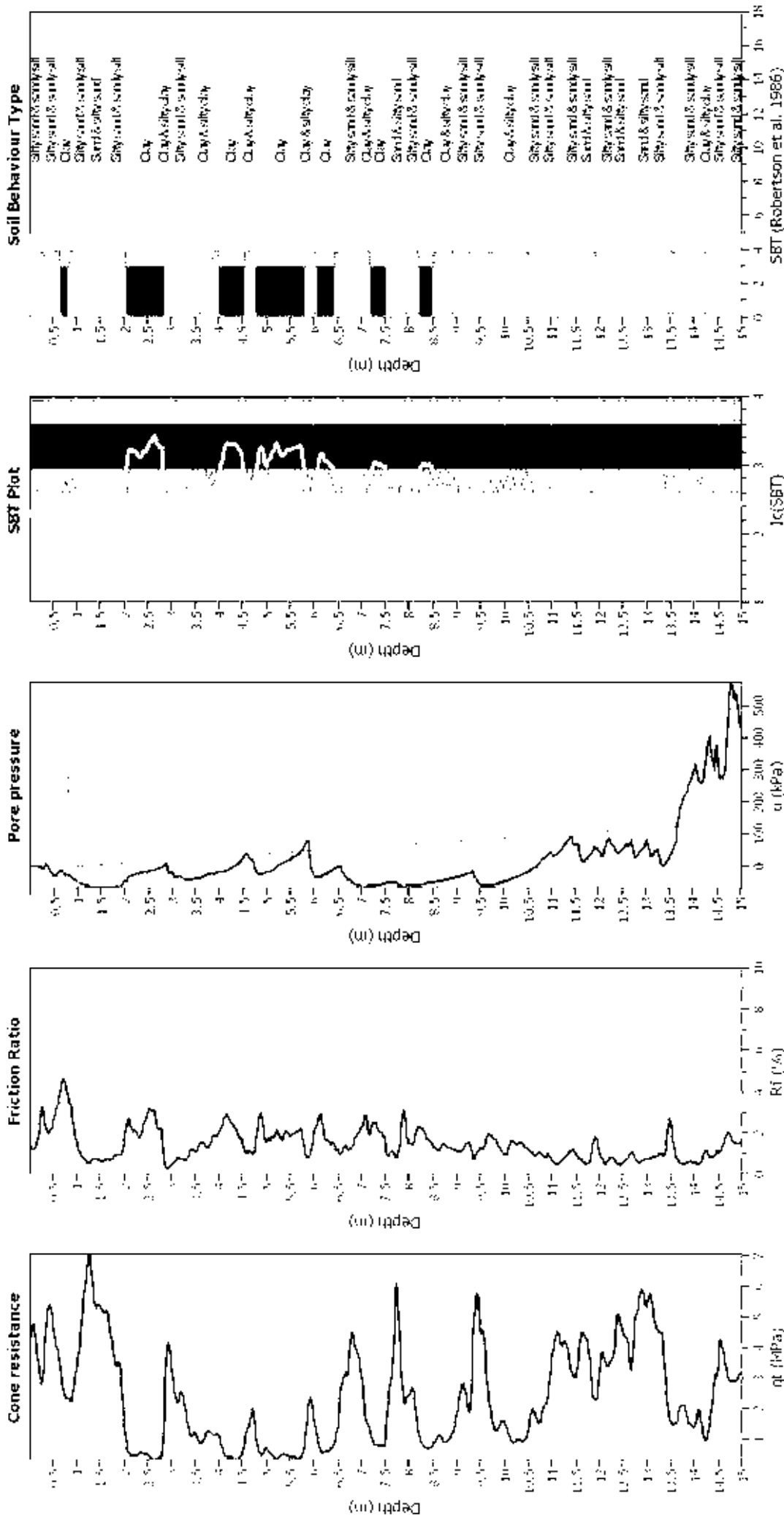


Figure 4: Summary of liquefaction potential plot and data points for test CPT44_564. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The liquefaction boundary is indicated by a dashed line. The plot is divided into zones A1, A2, B, and C. The liquefaction potential is high in zones A1 and A2, and low in zones B and C.

CPT basic interpretation plots



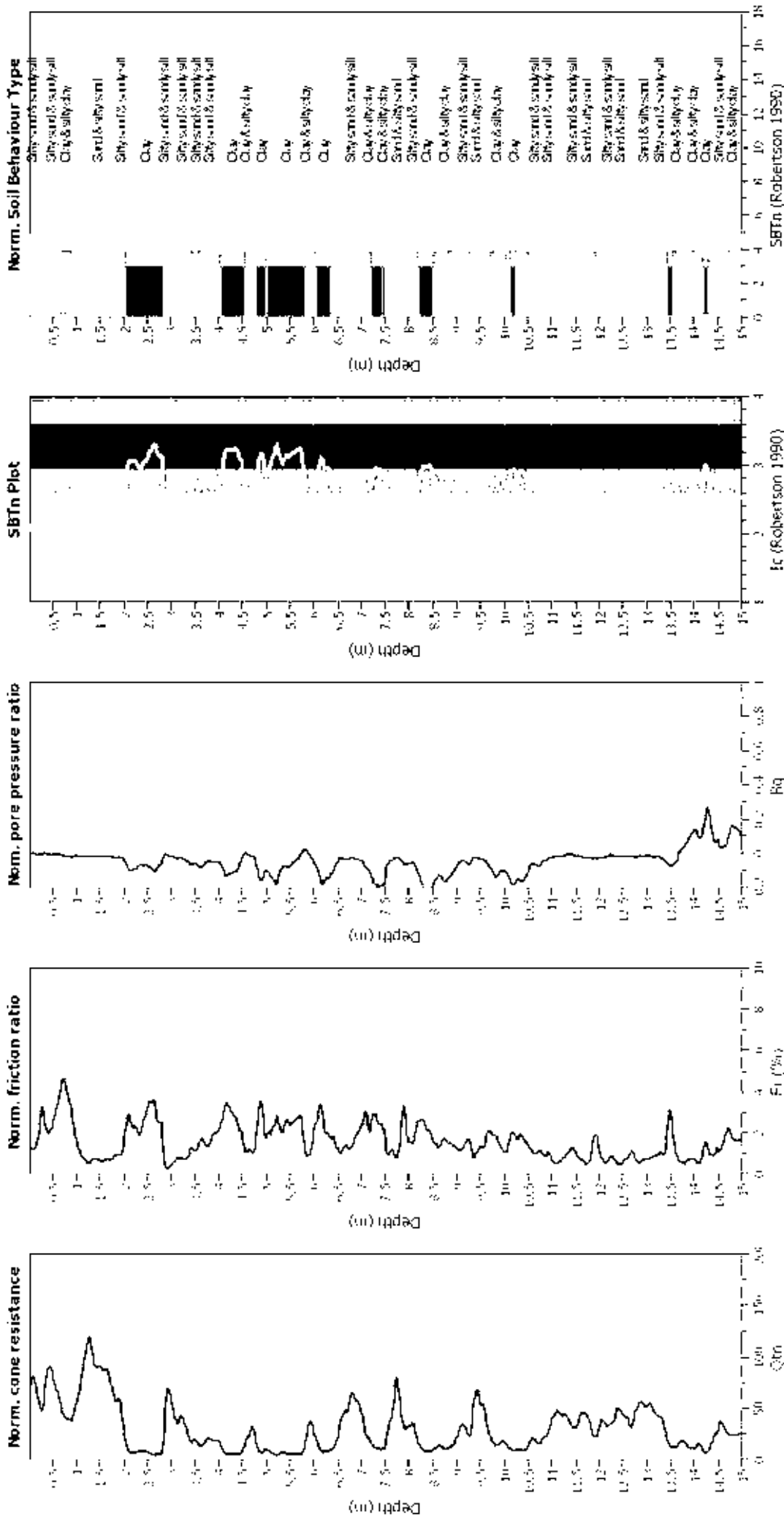
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial analysis magnitude:	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



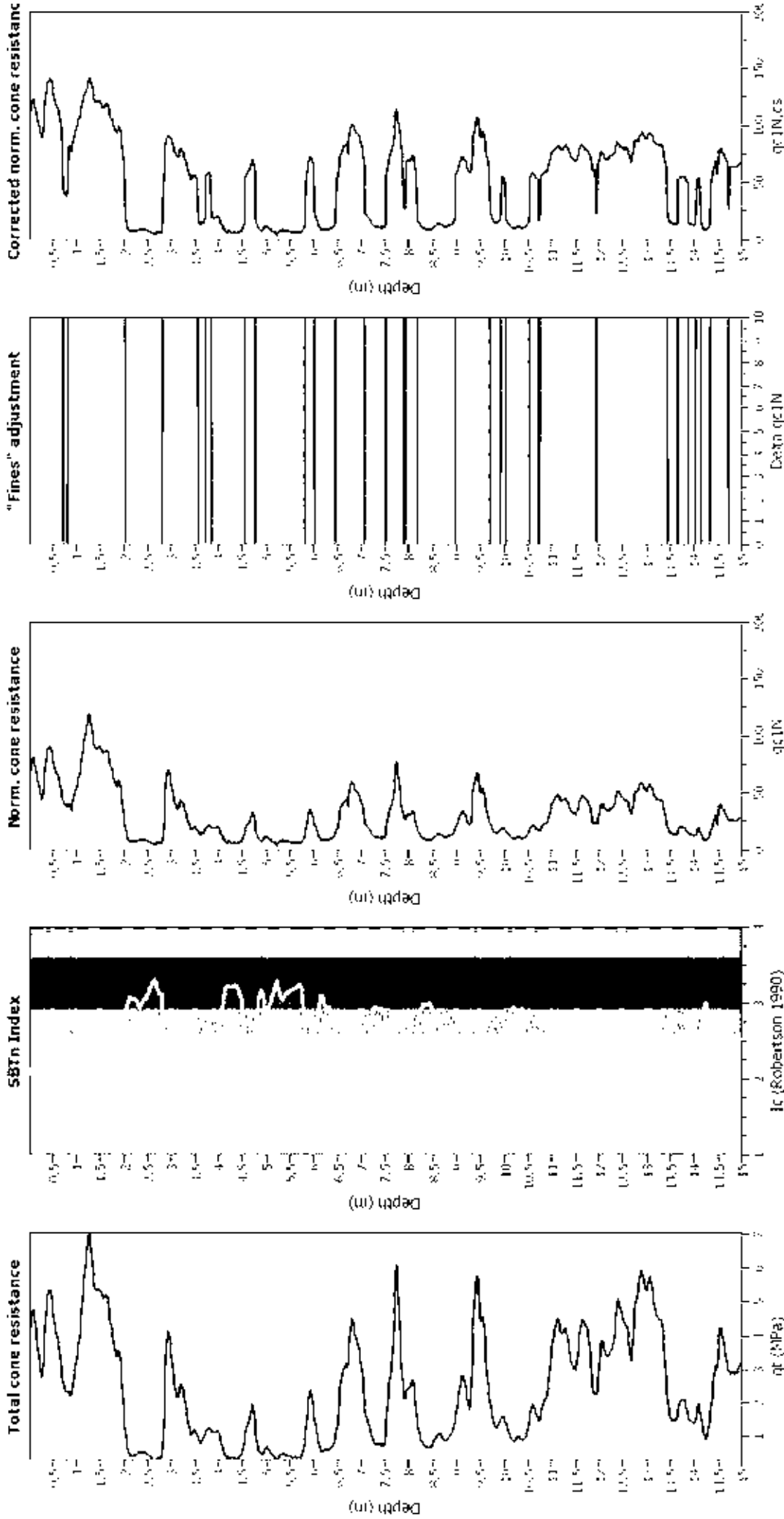
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	N/A
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

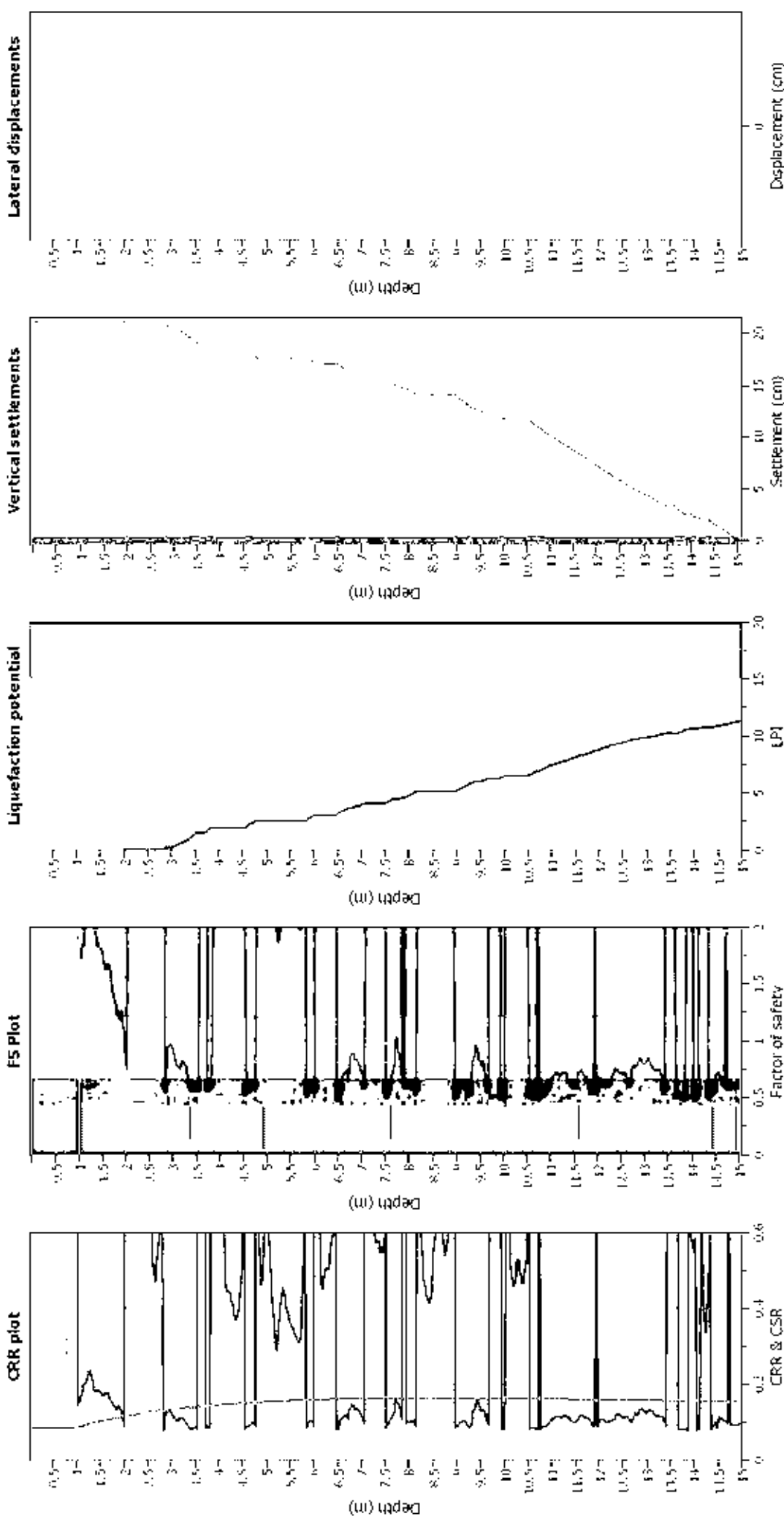
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude M_w : 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition method applied: N/A
 K applied: Sand & Clay
 Clay like behavior applied: Yes
 Limit depth applied: No
 Limit depth: N/A

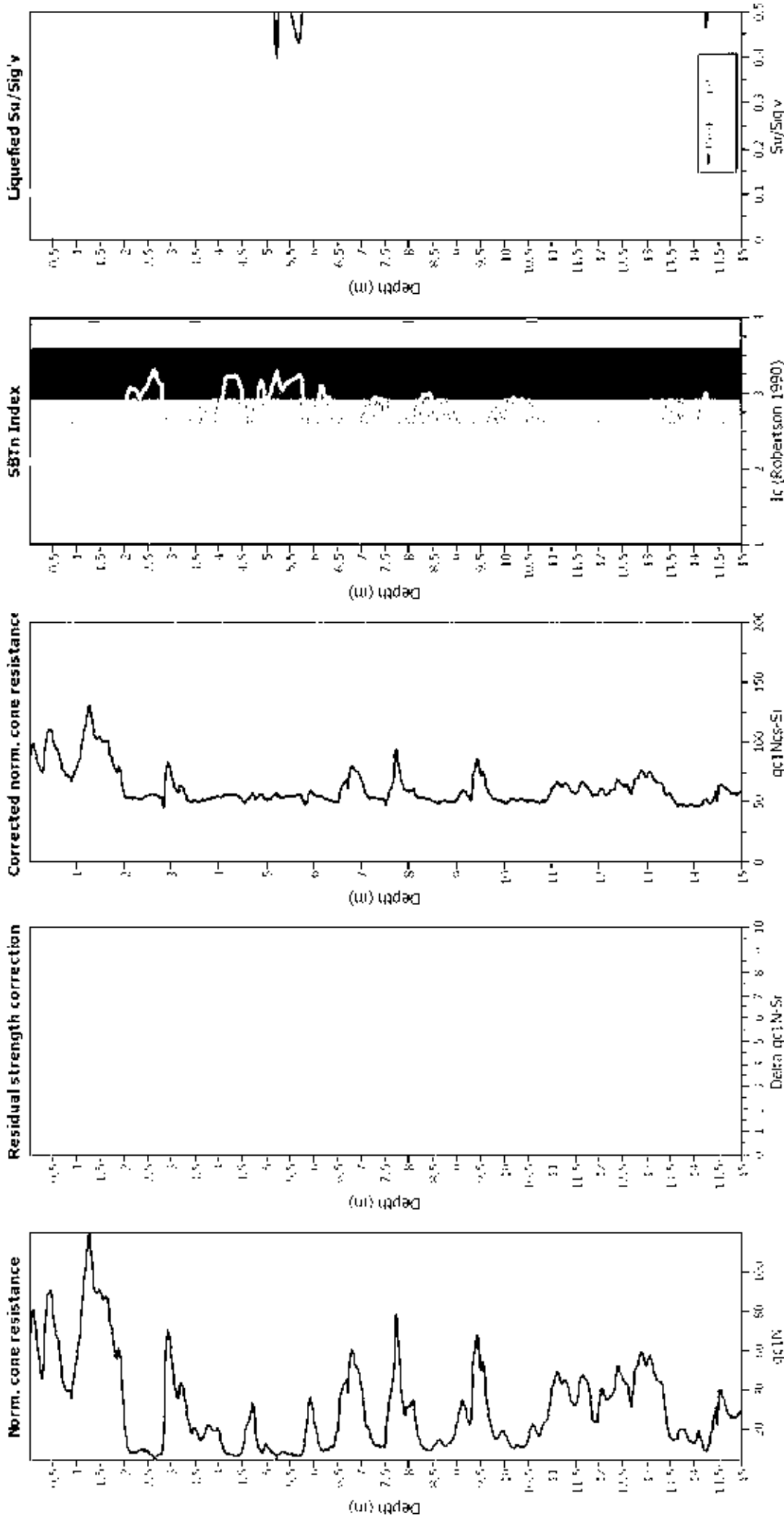
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

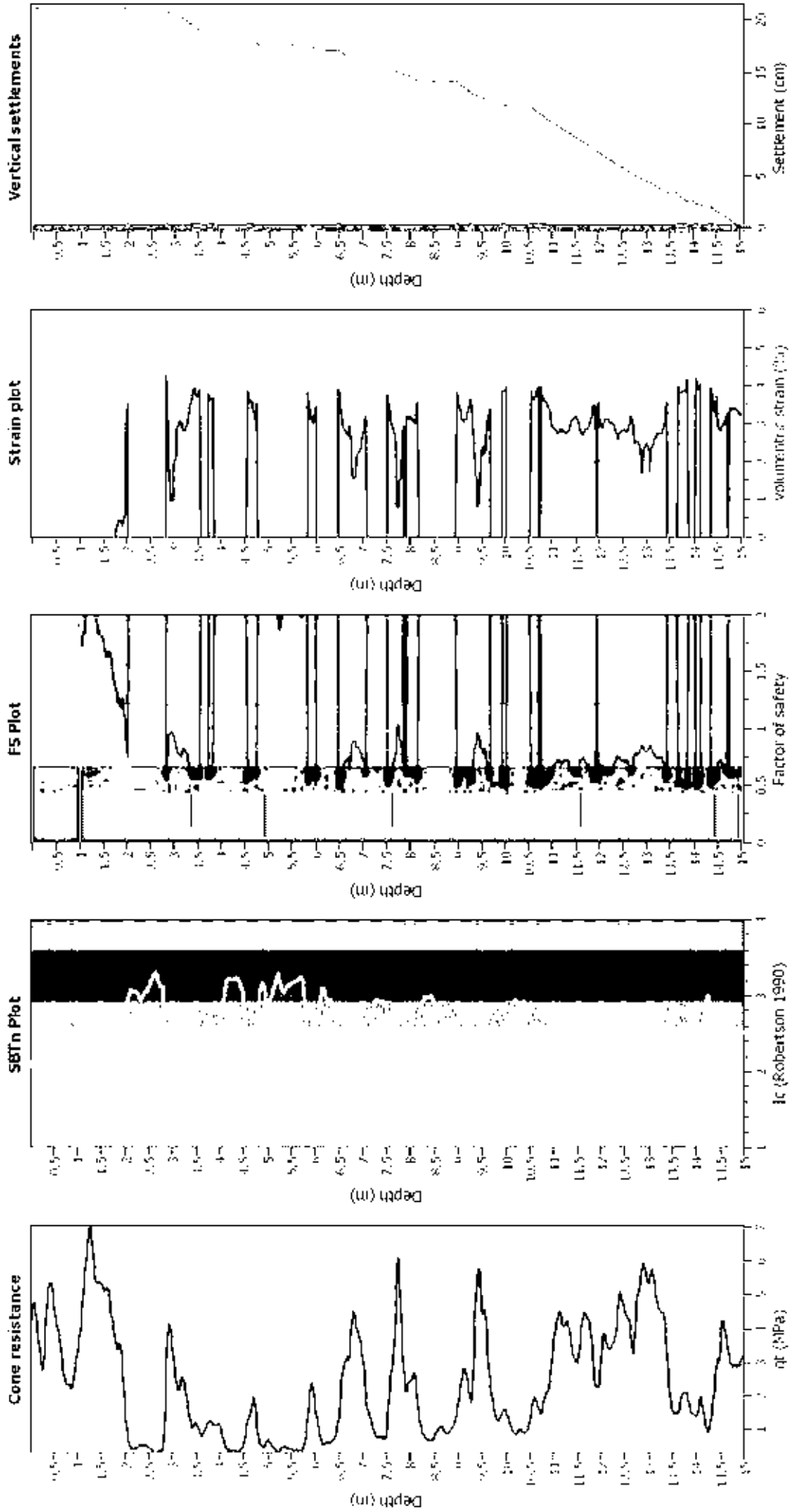
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- FS: Total cone resistance (cone resistance q_c corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT45_428cashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

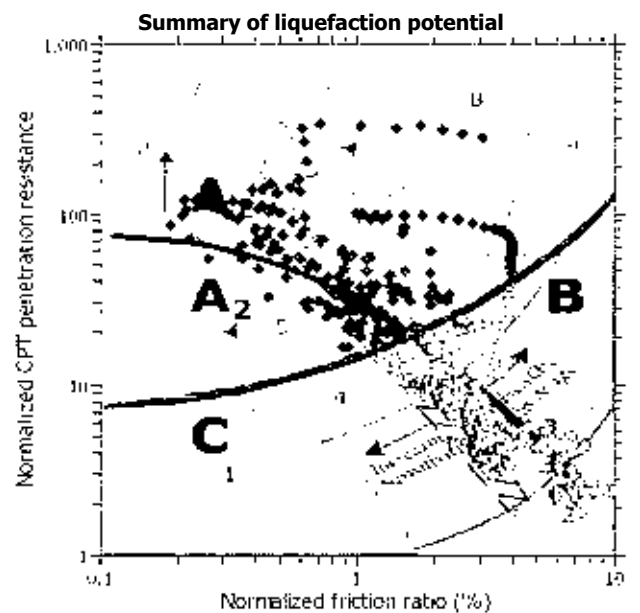
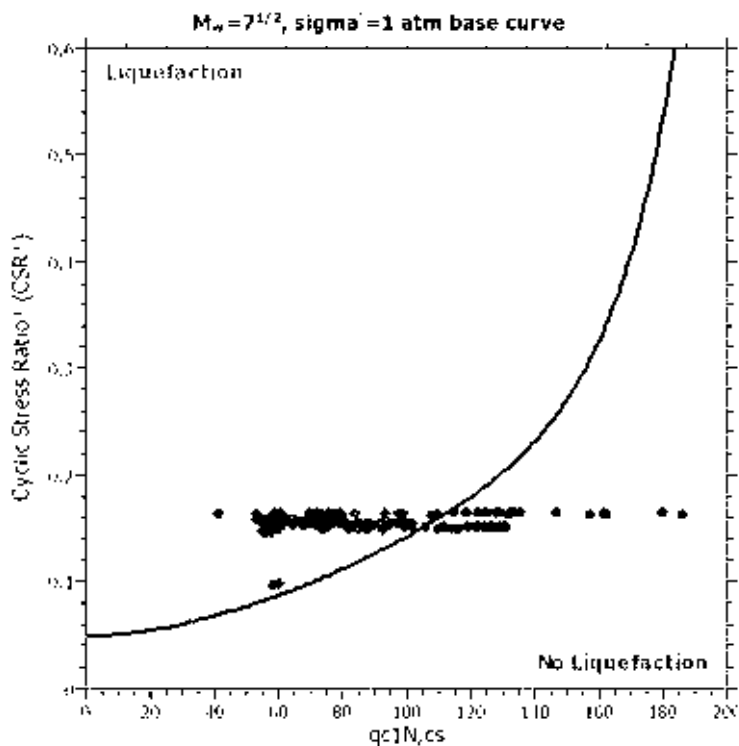
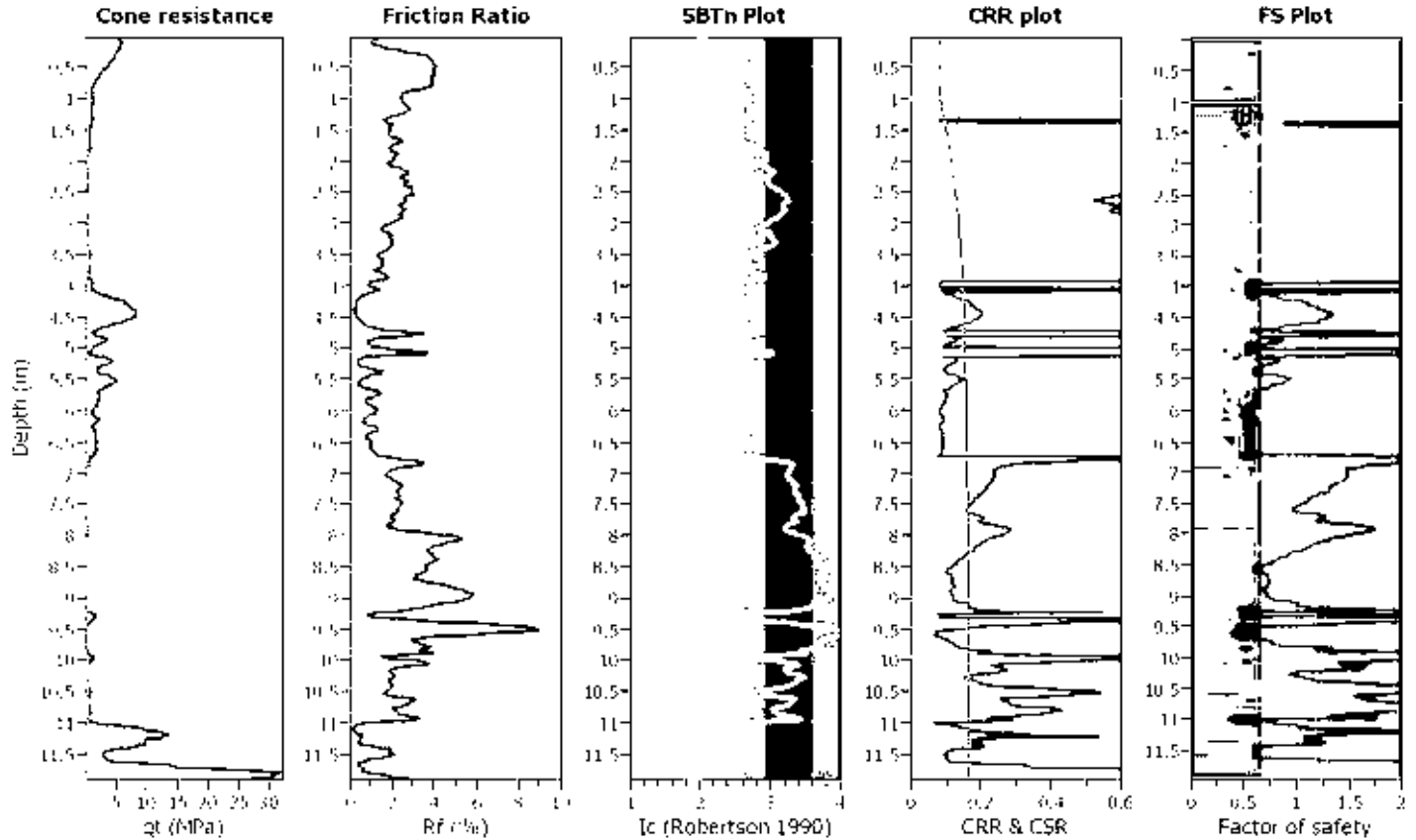
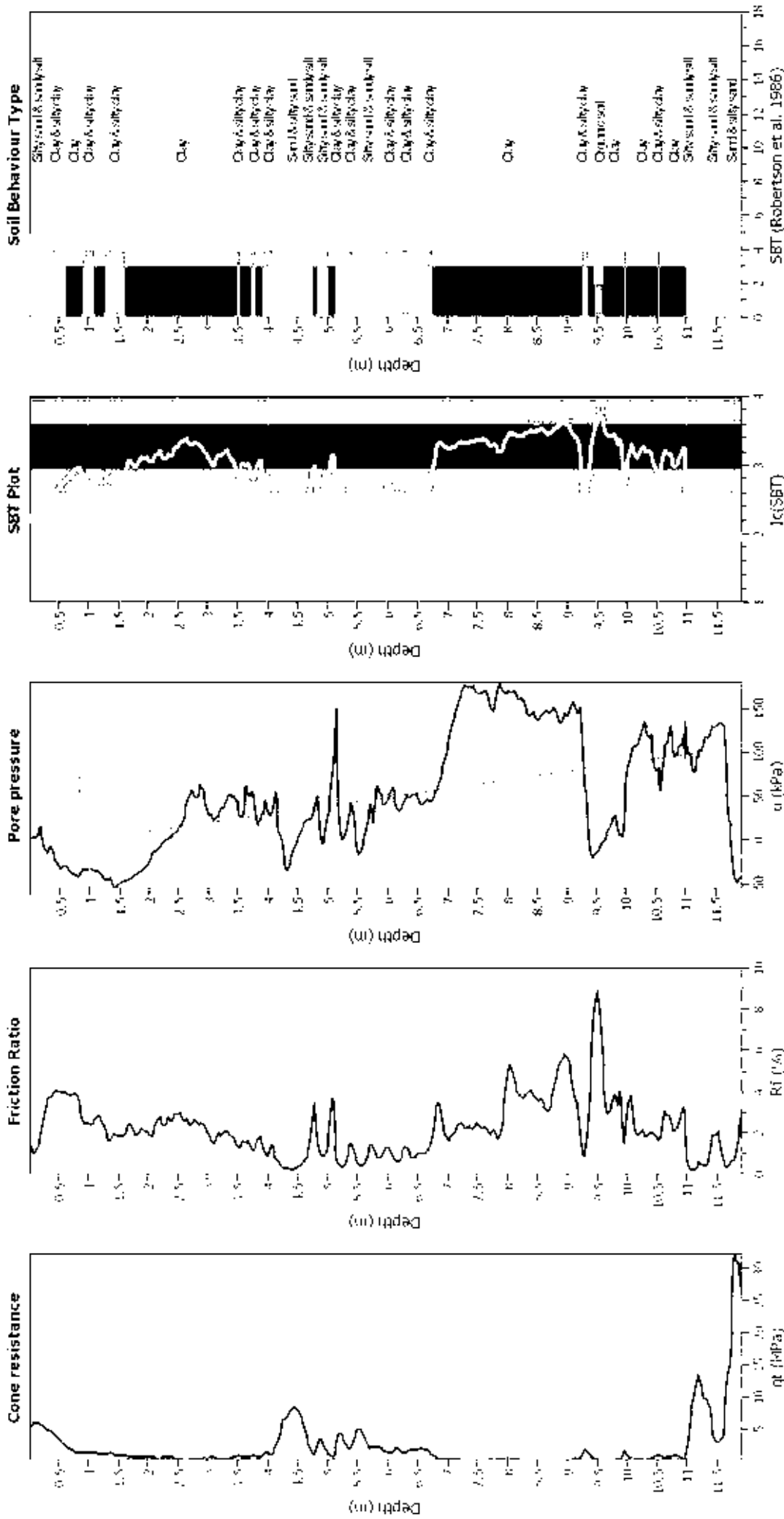


Figure 4: Summary of liquefaction potential assessment and classification of the test data. Zone A1: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction unlikely; Zone C: No liquefaction. The dashed line indicates the liquefaction boundary. The shaded area represents the liquefaction potential assessment. The data points are classified into zones A1, A2, B, and C based on the liquefaction potential assessment.

CPT basic interpretation plots



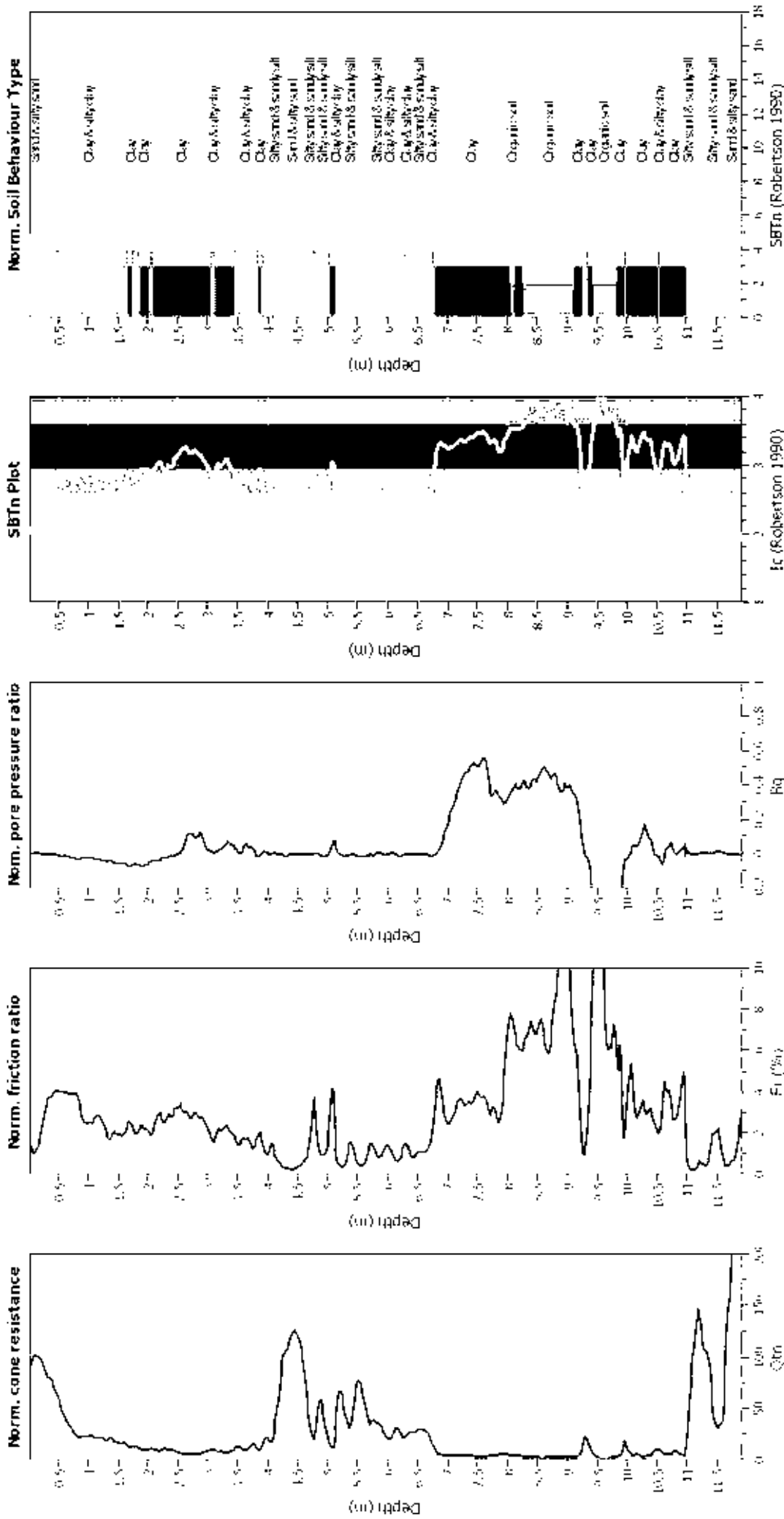
Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



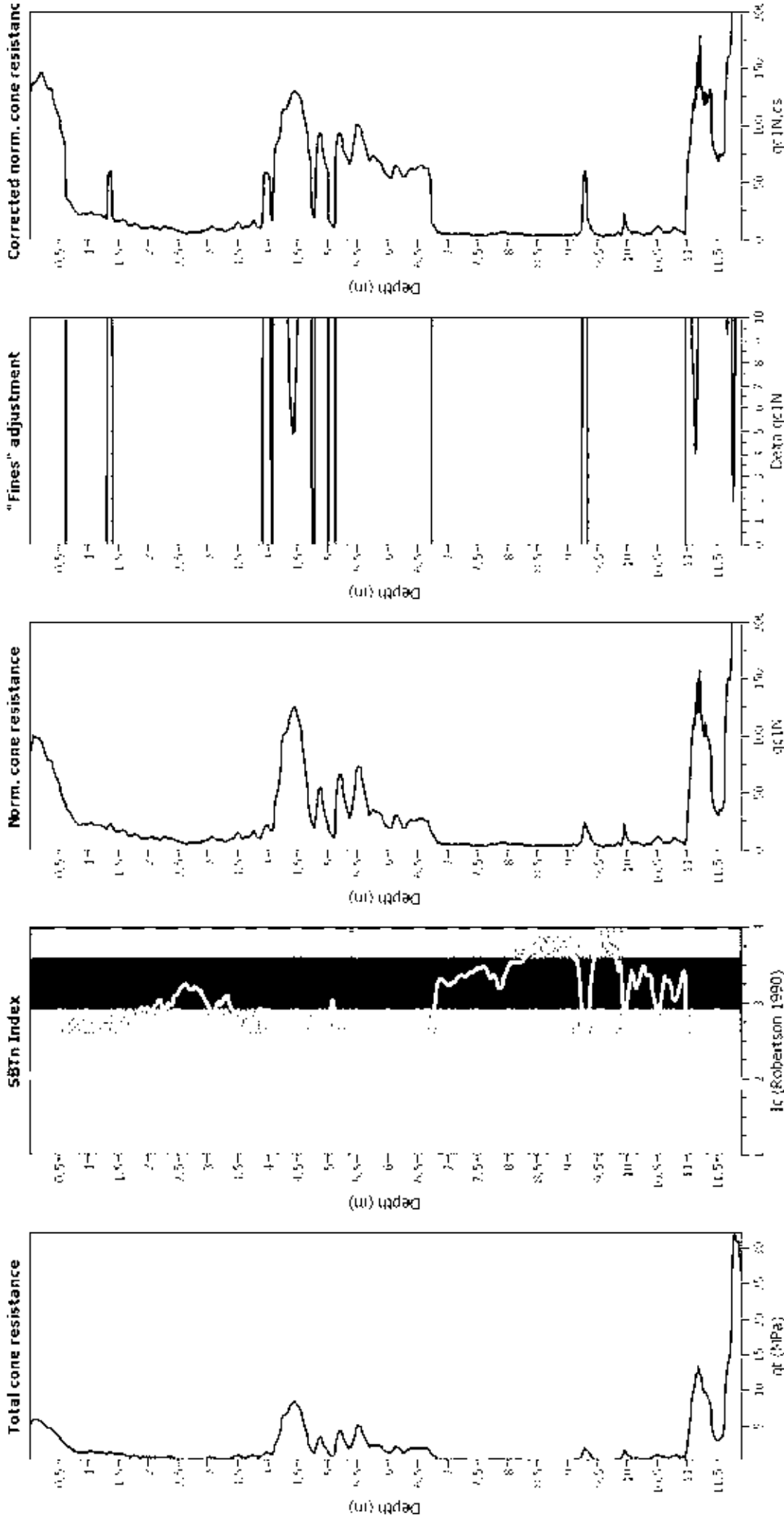
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

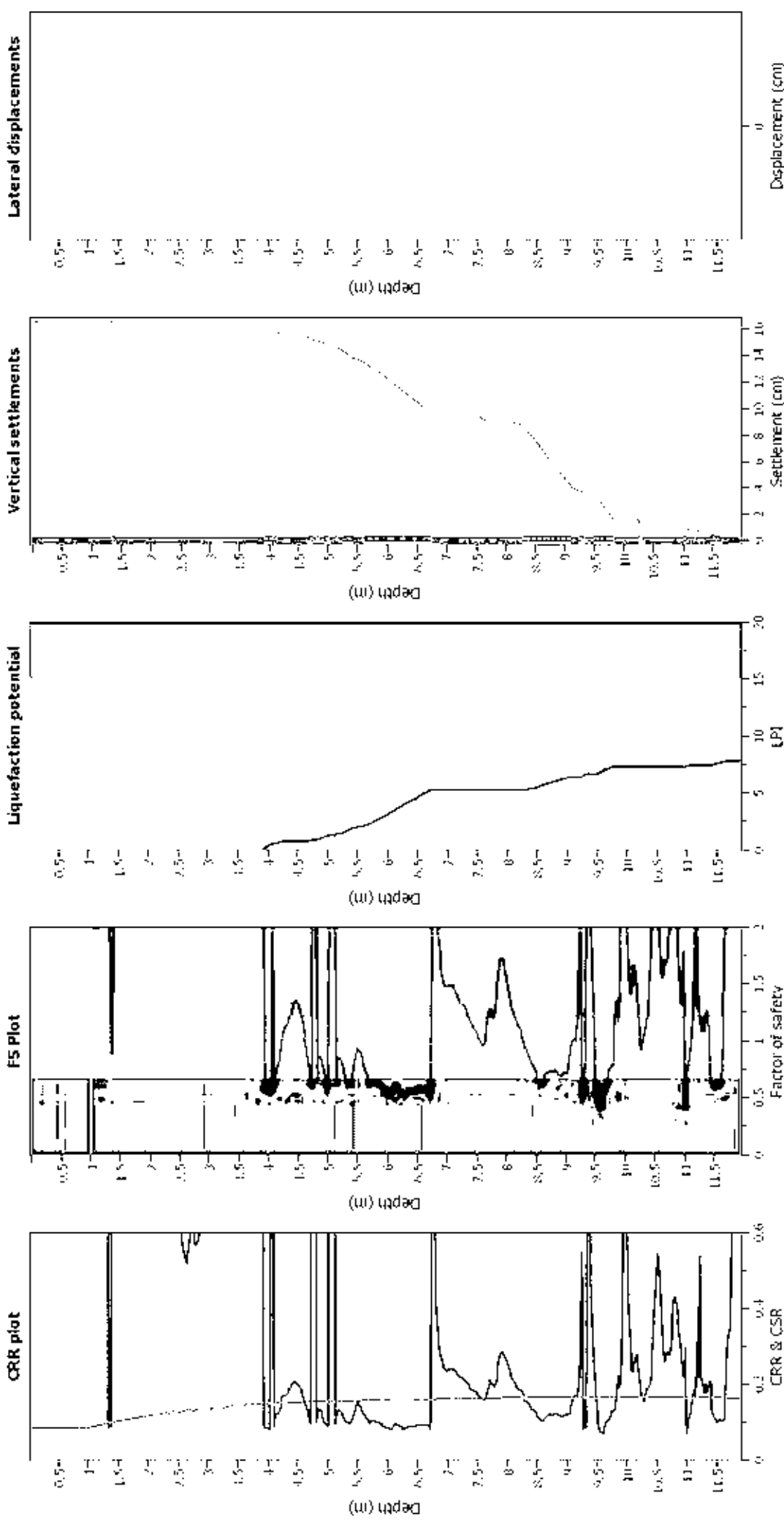
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make mag. angle β_s :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Liquefaction method: 18B (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude: 7.5
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

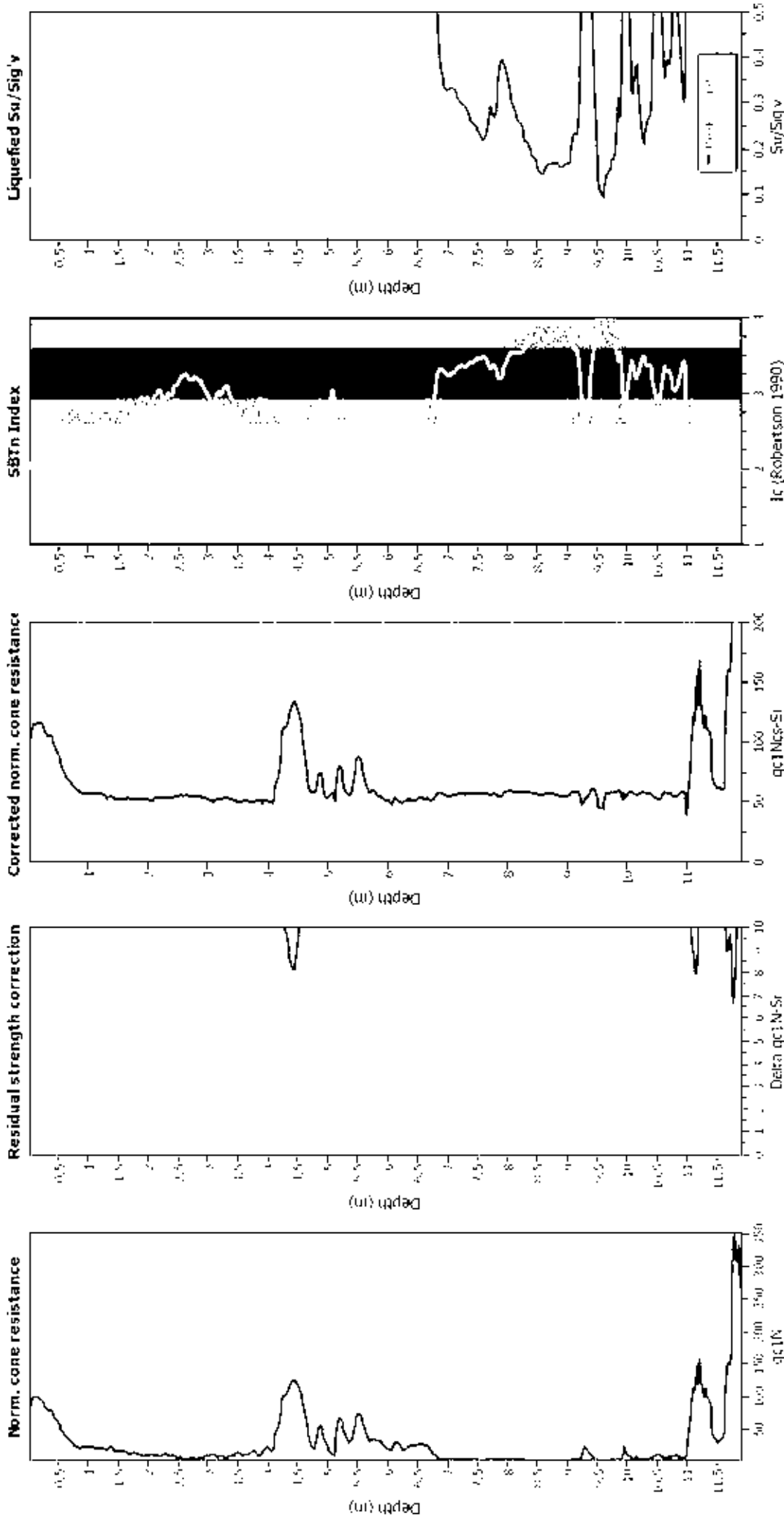
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

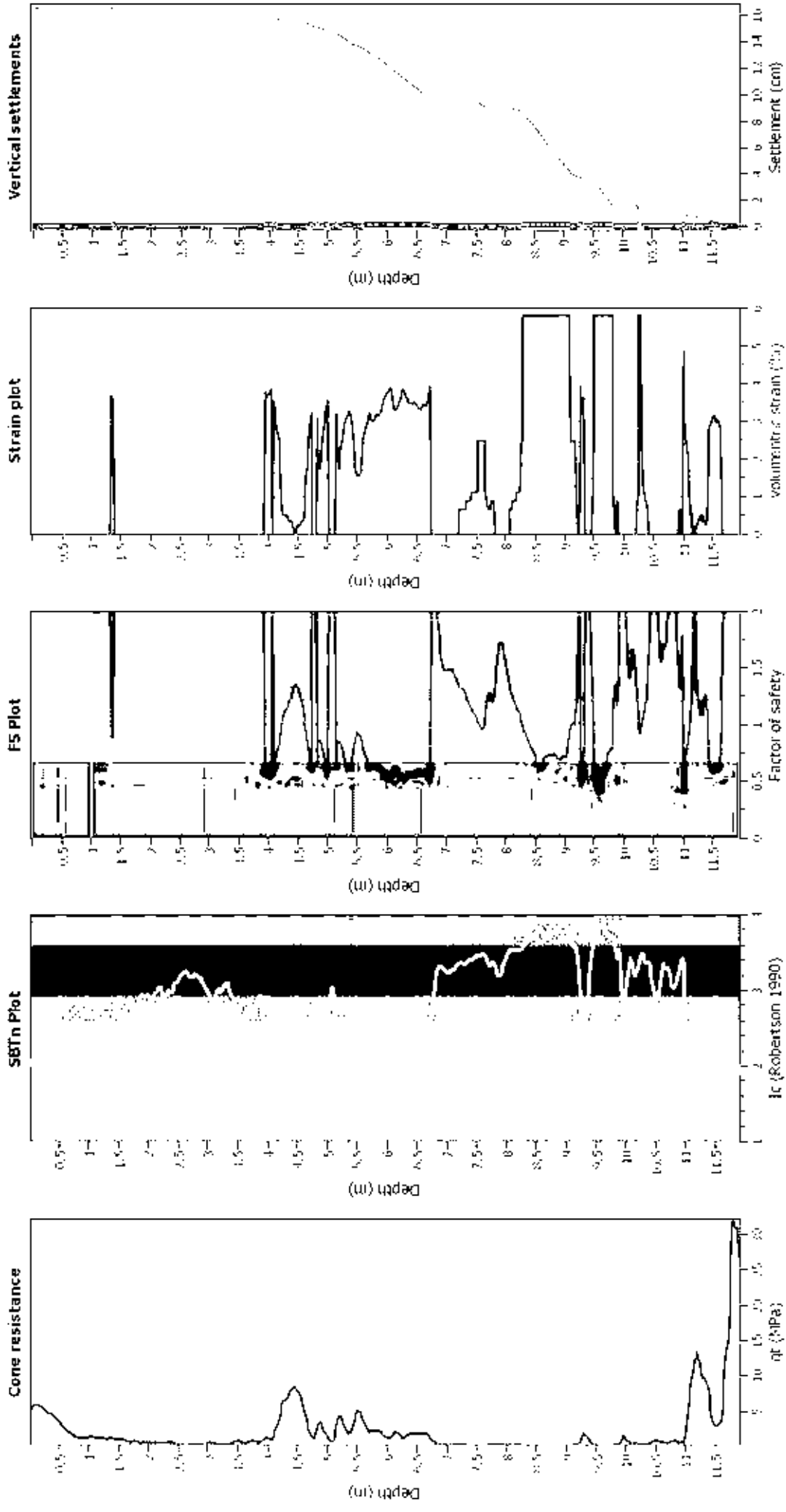
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

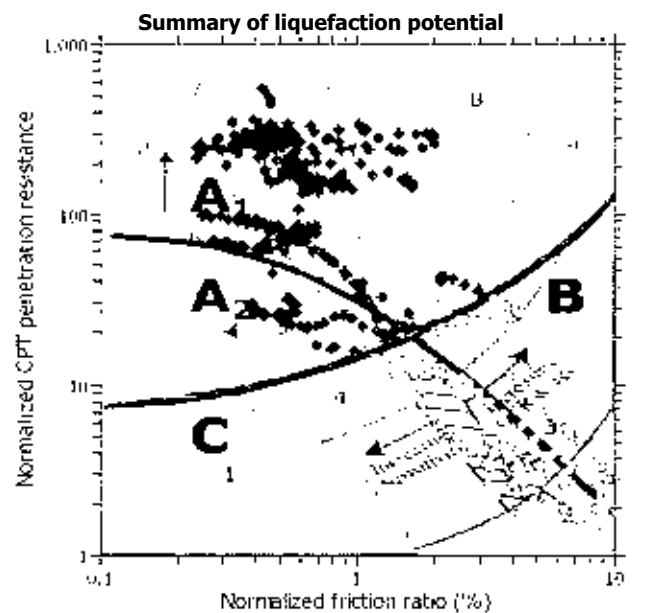
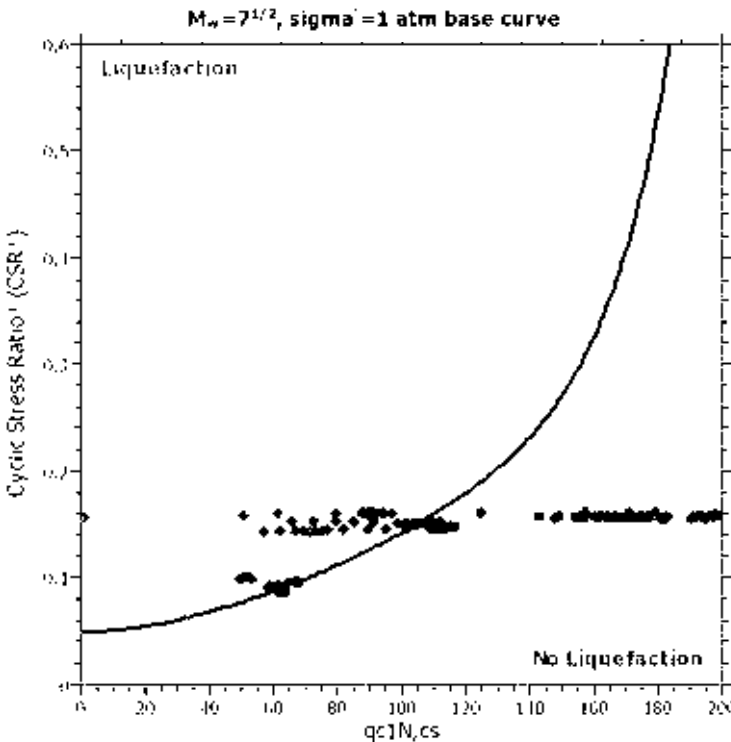
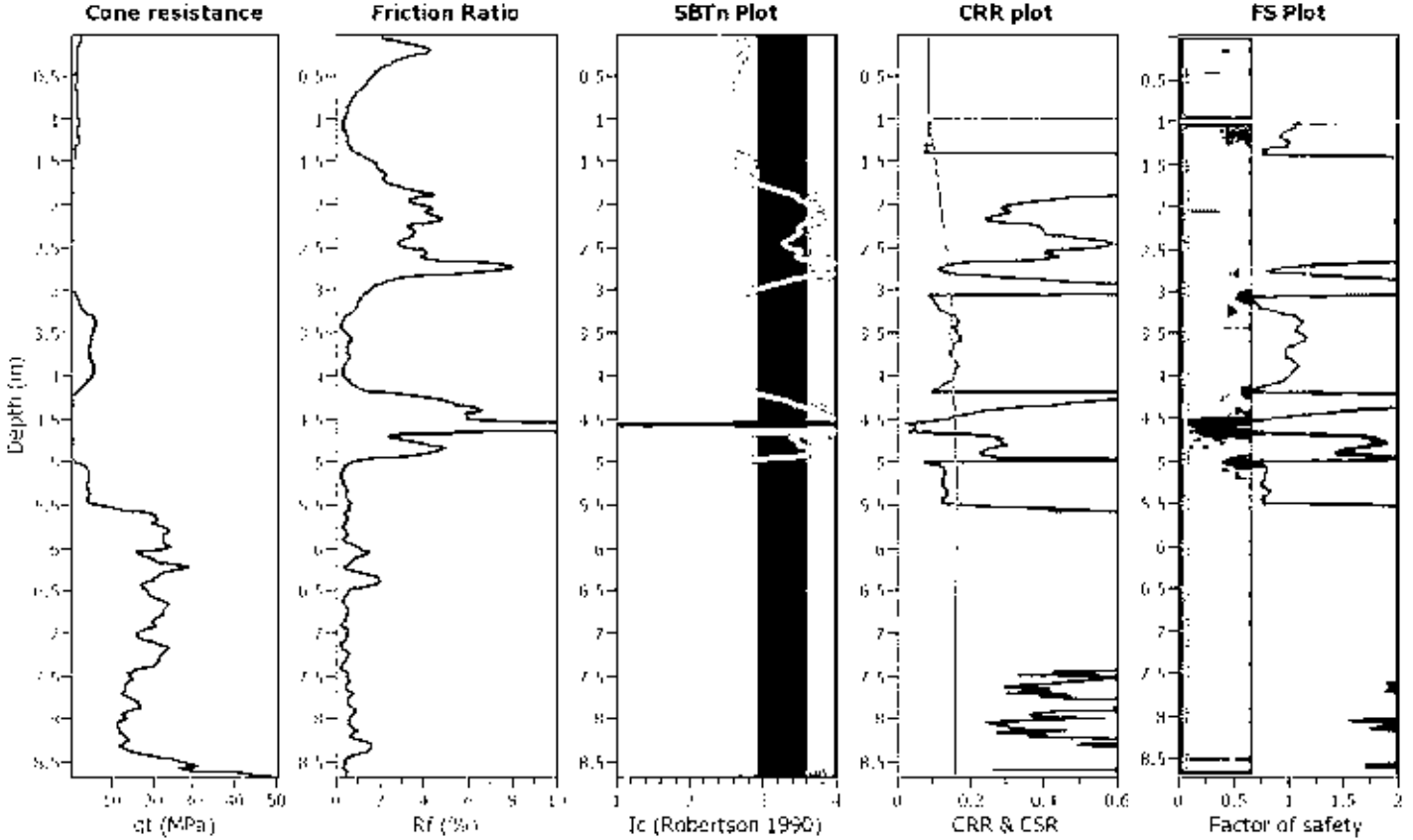
- qc: Total cone resistance (cone resistance q_c corrected for pore water effects)
- SBTn: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT46_428cashmereRd

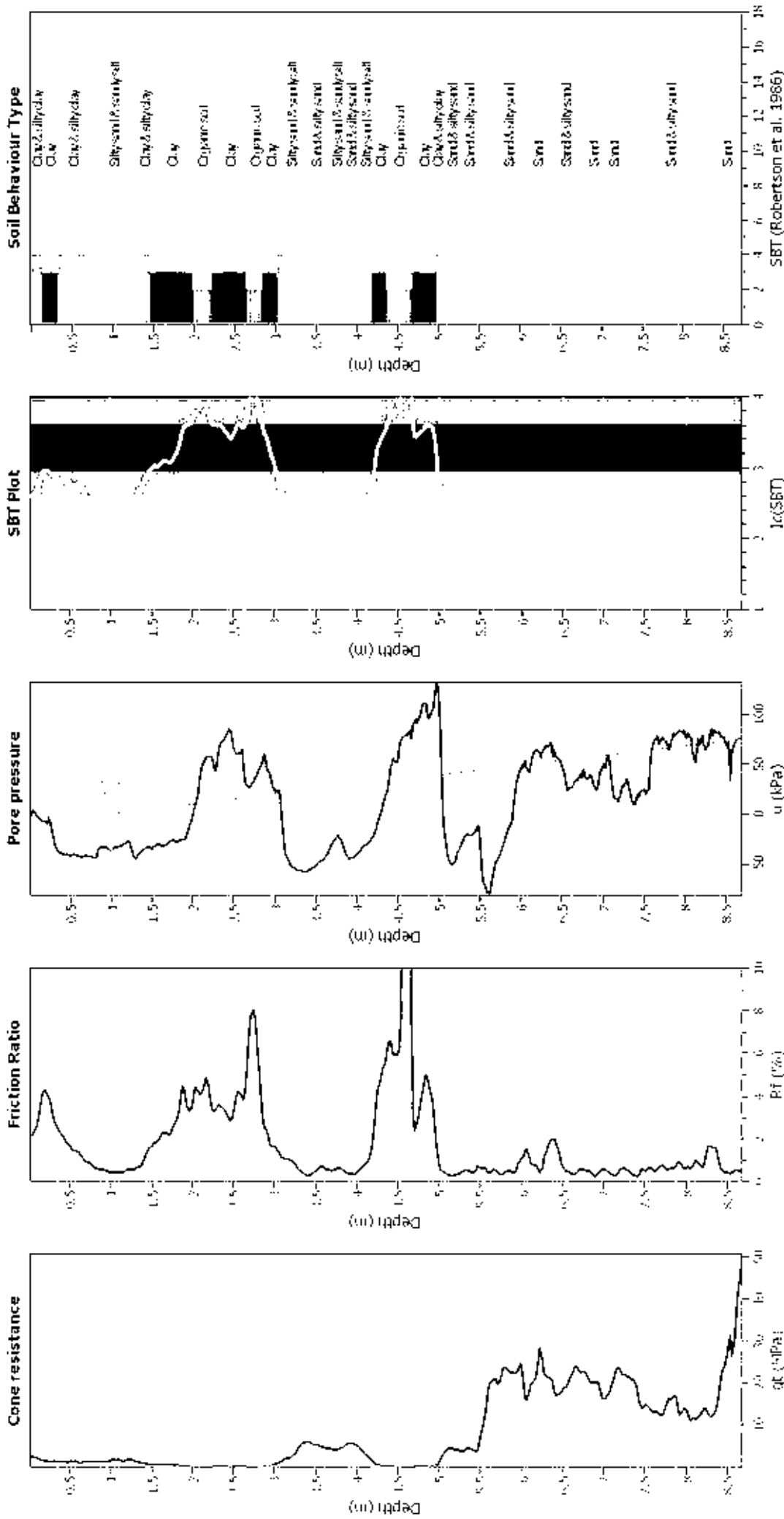
Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		



Zone A: High liquefaction potential. Zone B: Moderate liquefaction potential. Zone C: Low liquefaction potential. The liquefaction boundary is defined by the relationship between normalized CPT penetration resistance and normalized friction ratio.

CPT basic interpretation plots



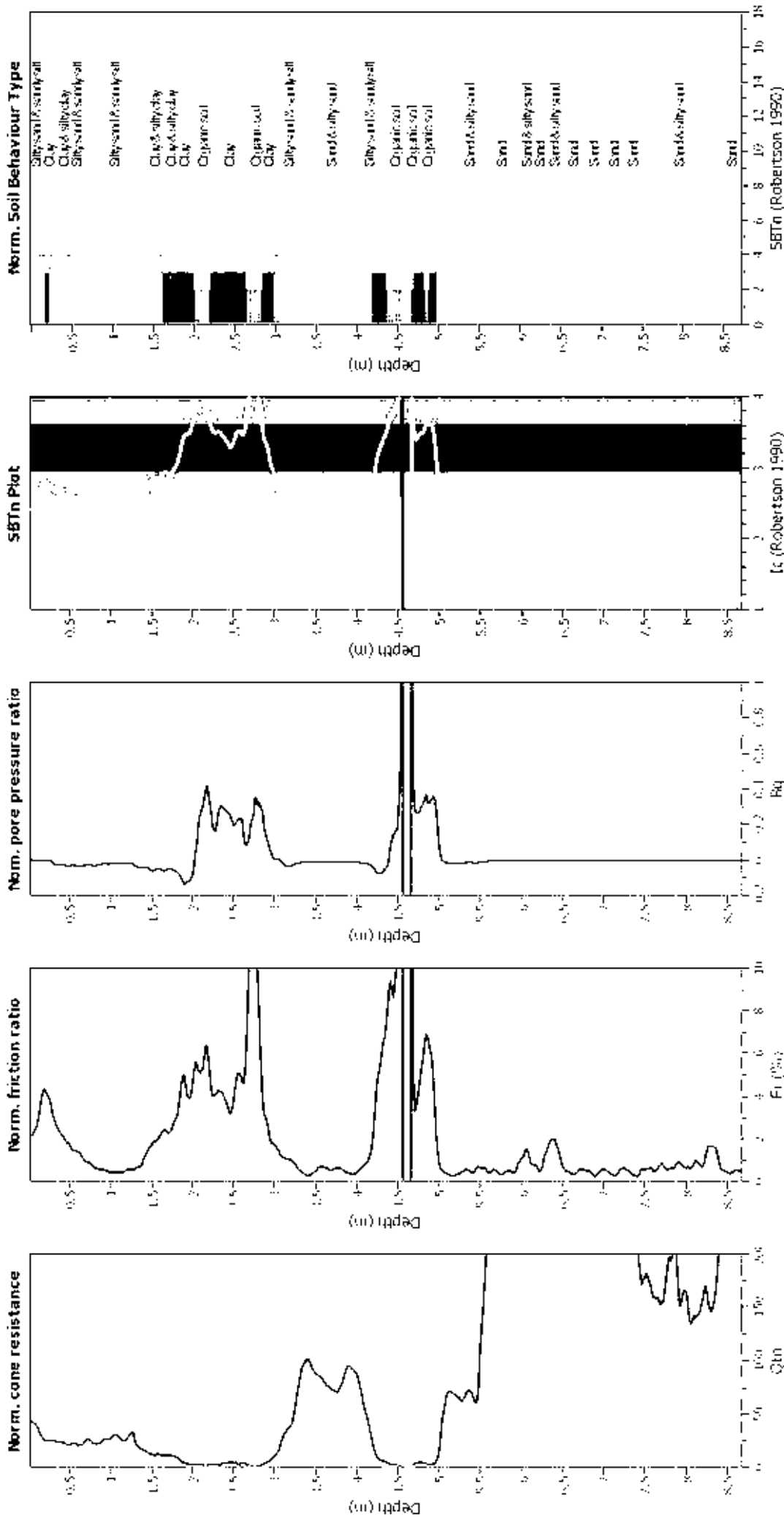
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



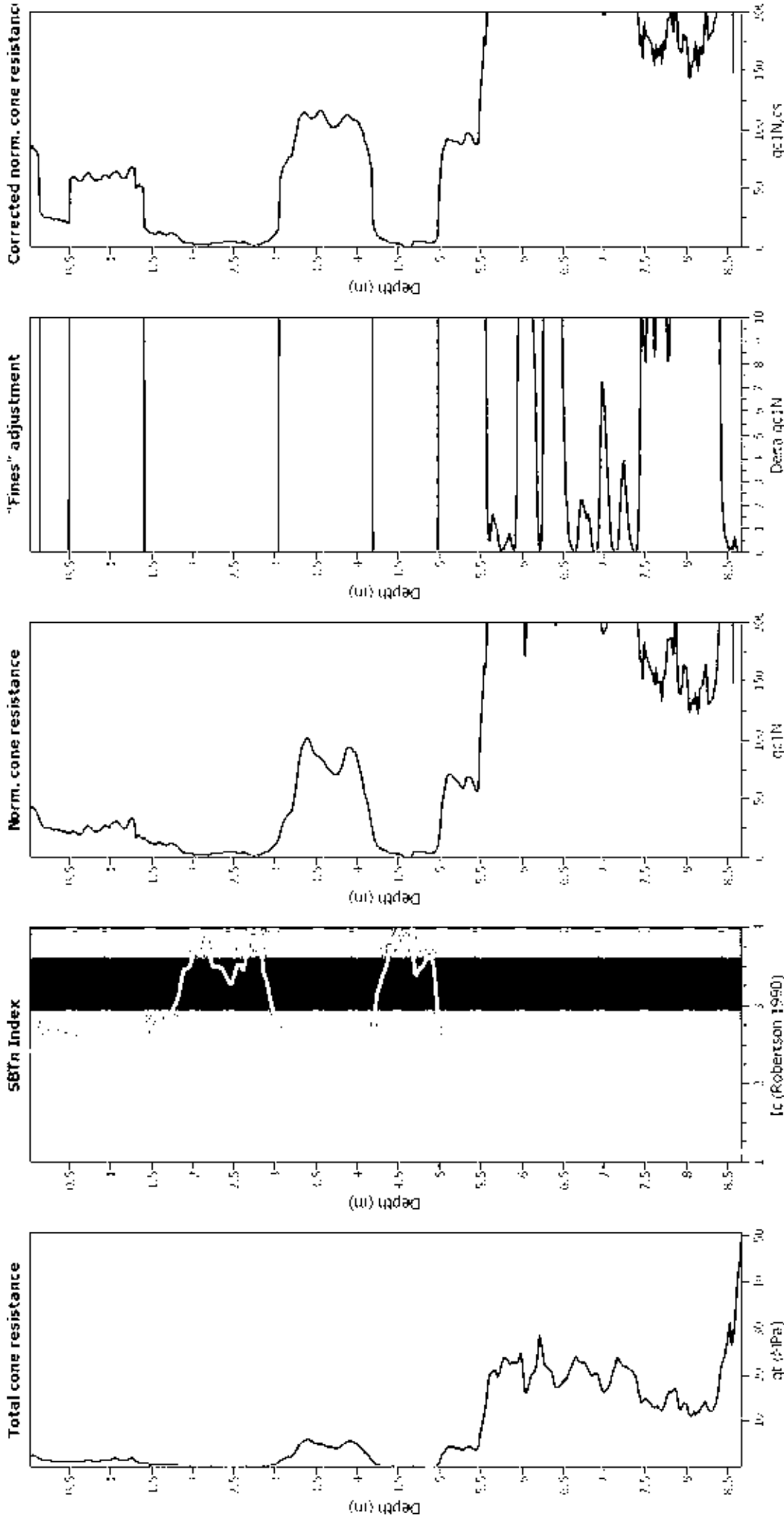
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A		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

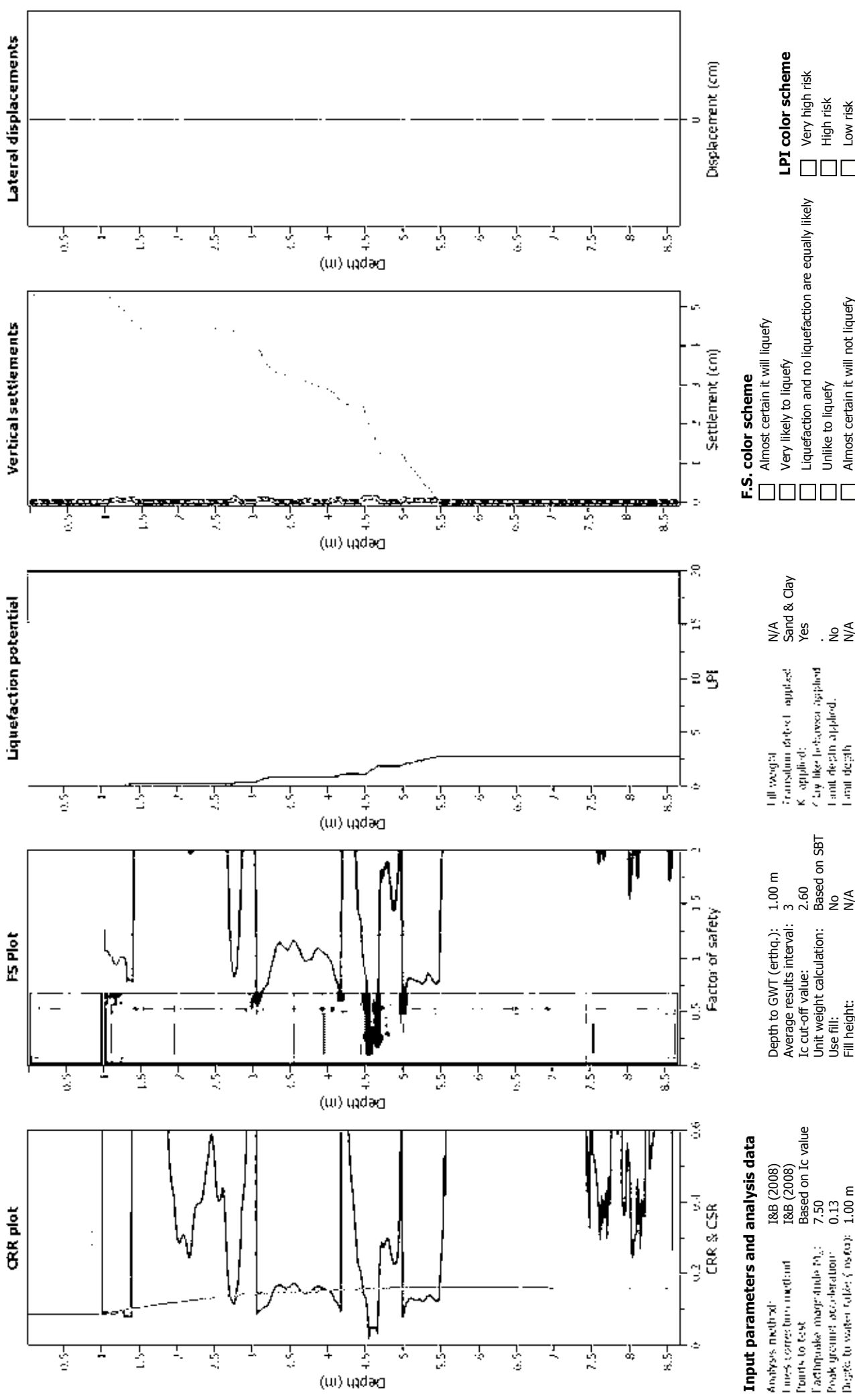
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (z_{wt}):	1.00 m	Limit depth:	N/A
Depth to GW (erthq.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: I&B (2008)
 Liquefaction correction method: I&B (2008)
 Points to test: Based on Ic value
 Earthquake magnitude: 7.5
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.00 m

F.S. color scheme

Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlikely to liquefy
 Almost certain it will not liquefy

LPI color scheme

All weight
 Transition depth applied
 Clay like behavior applied
 Limit depth applied
 Limit depth

Input parameters and analysis data

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

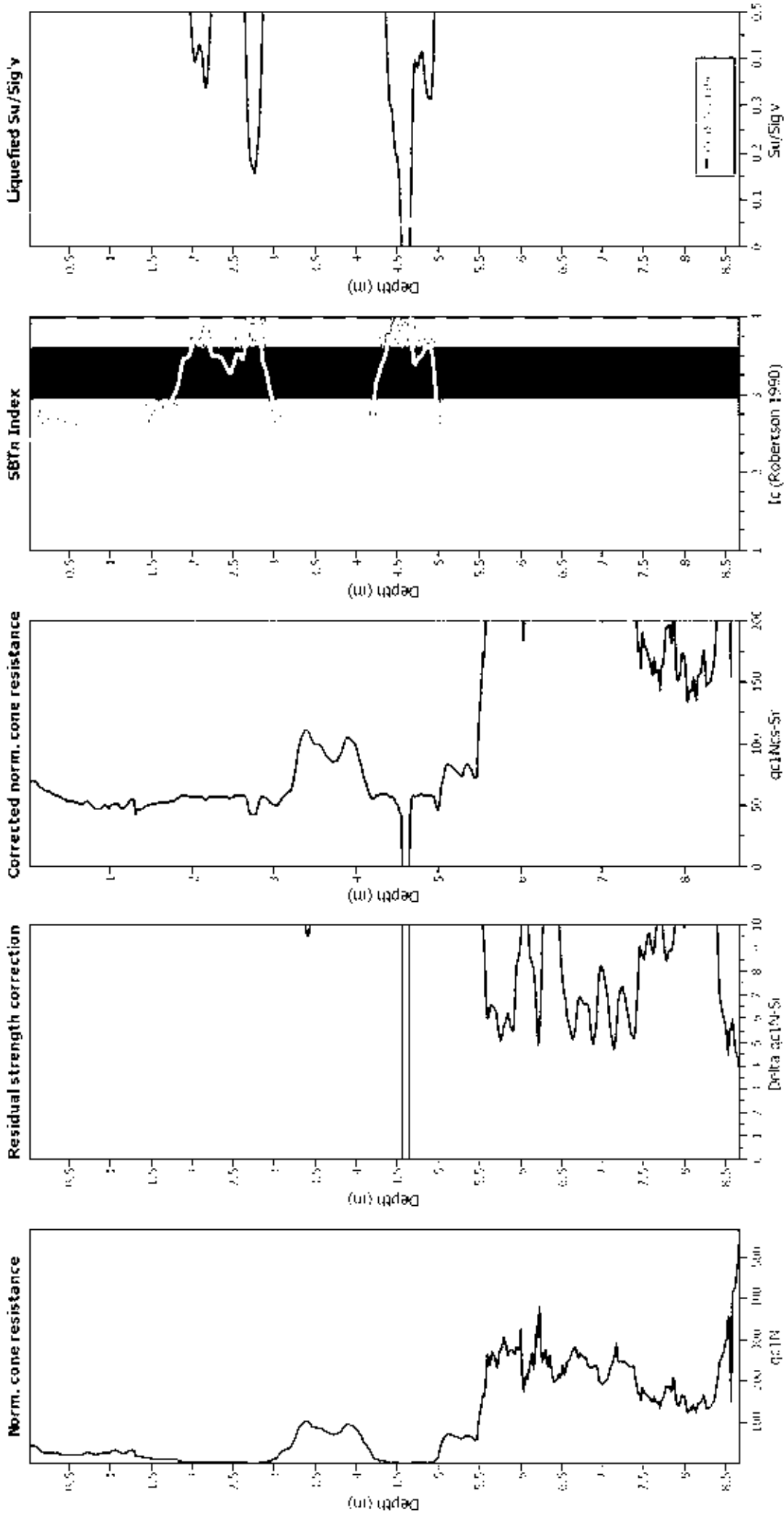
F.S. color scheme

Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlikely to liquefy
 Almost certain it will not liquefy

LPI color scheme

Very high risk
 High risk
 Low risk

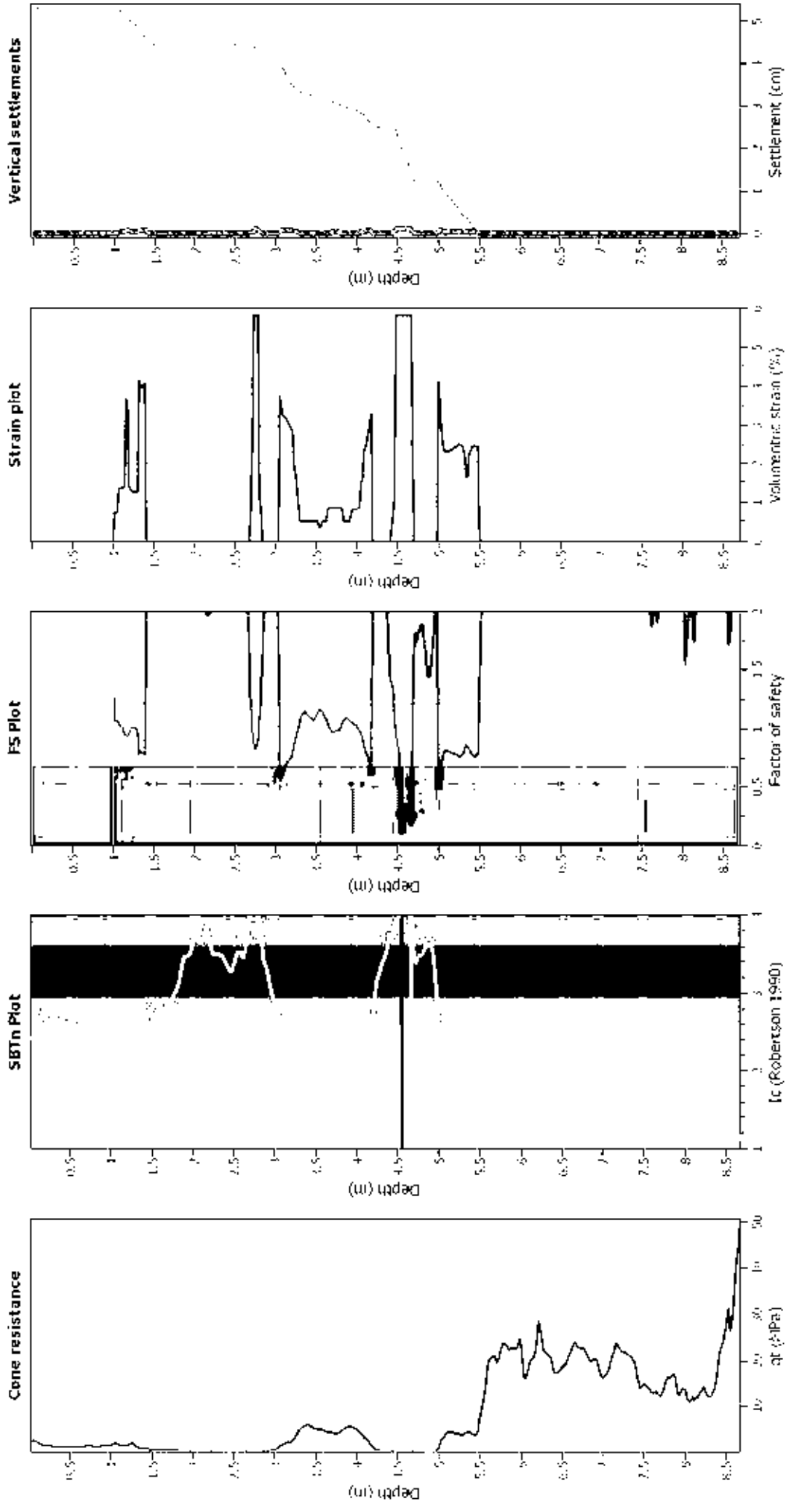
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- q_t: Total cone resistance (cone resistance q corrected for pore water effects)
- I_c: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT47_334SparksRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

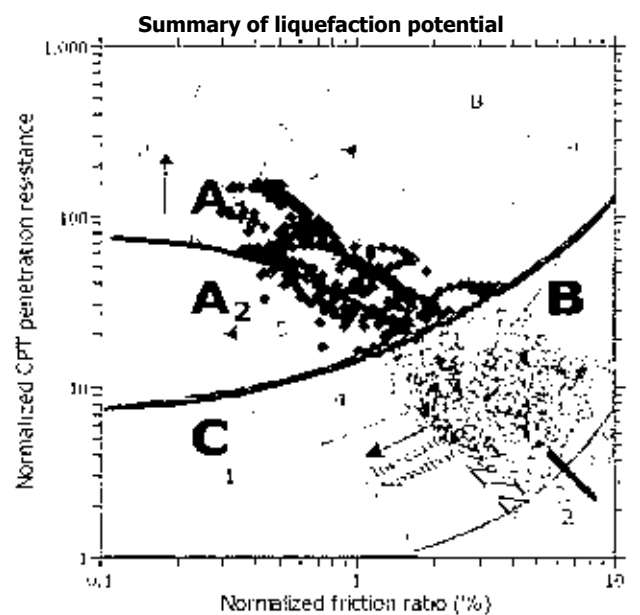
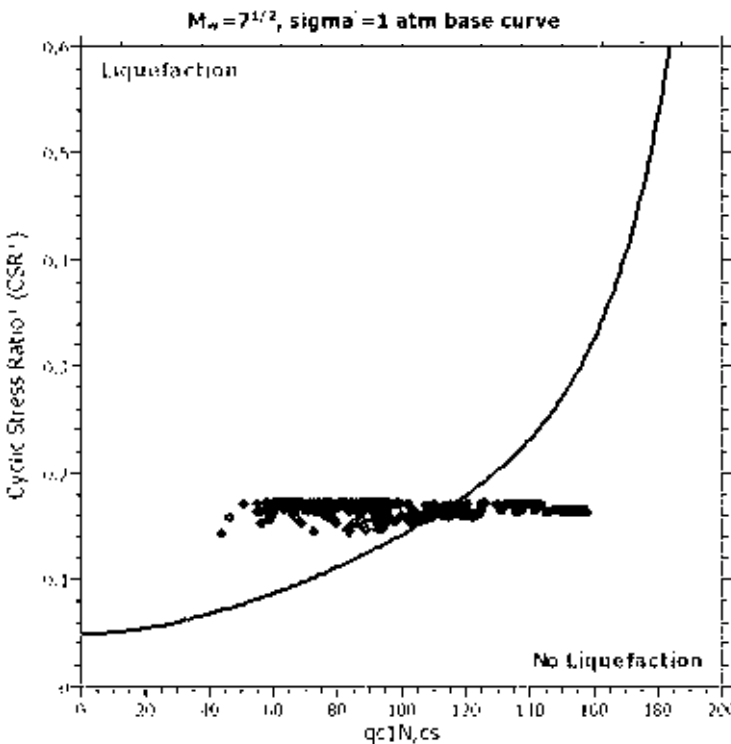
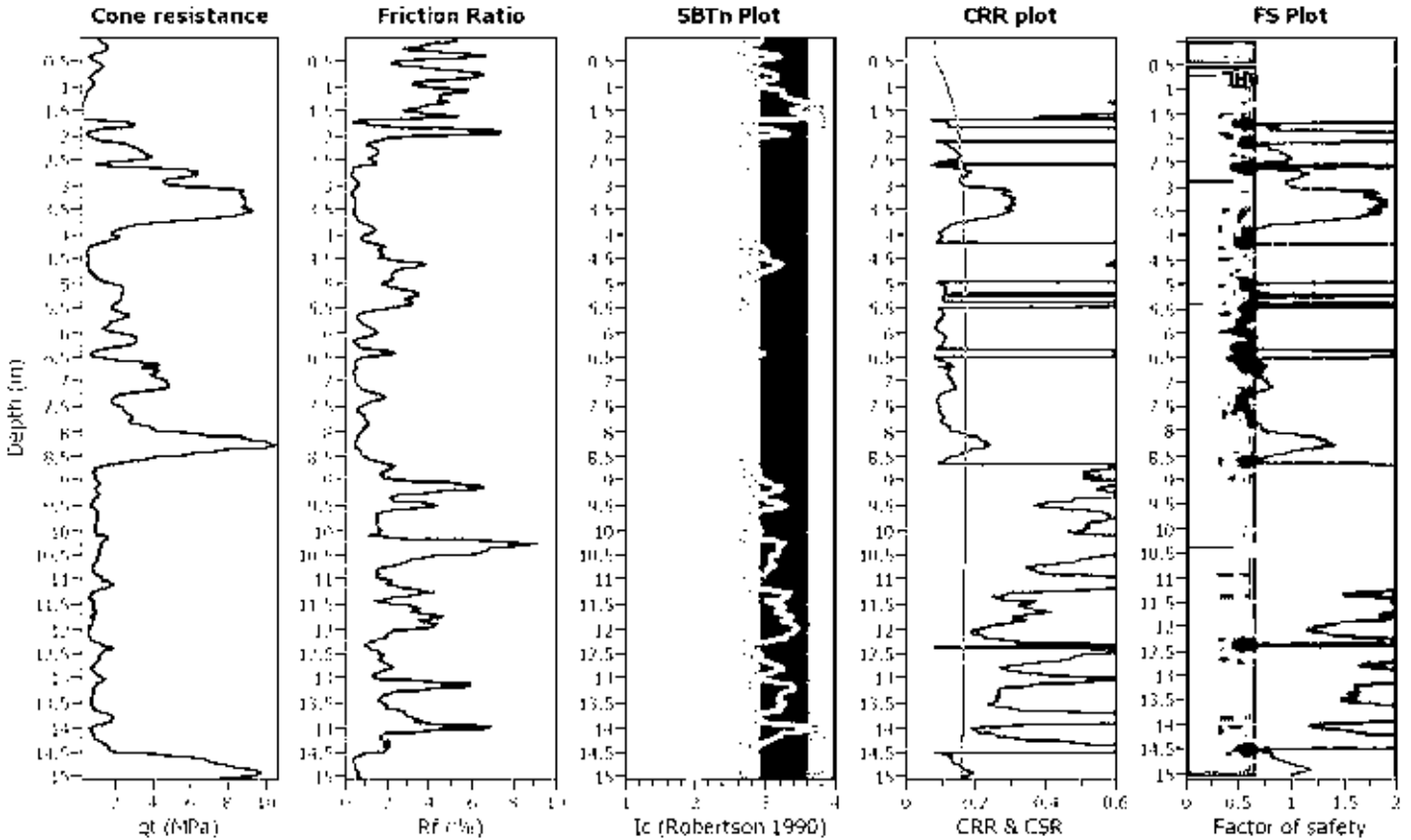
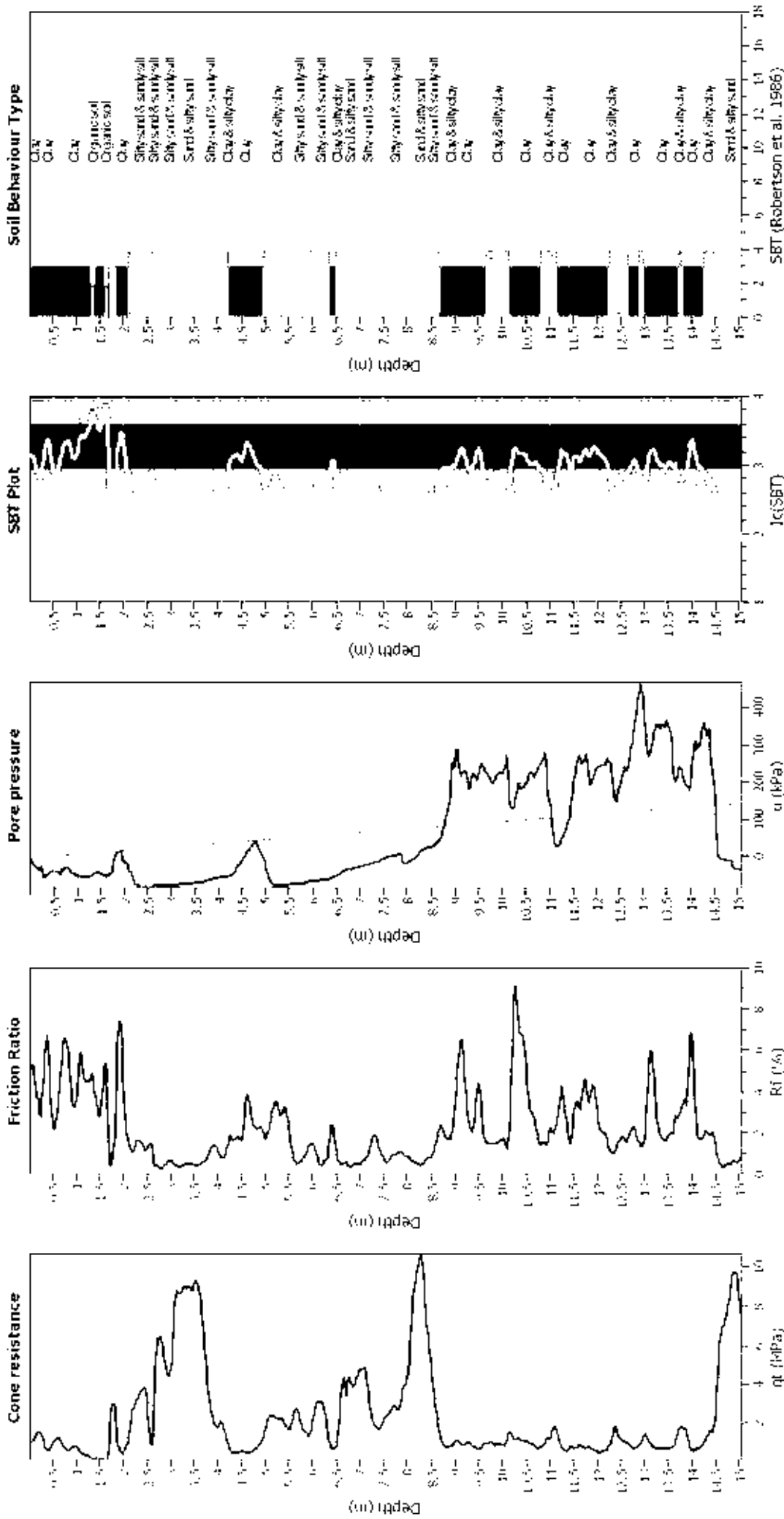


Figure 4: Summary of liquefaction potential assessment and classification of the test data. Zone A: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction potential; Zone C: No liquefaction. The dashed line indicates the liquefaction boundary. The shaded area represents the liquefaction potential assessment results.

CPT basic interpretation plots



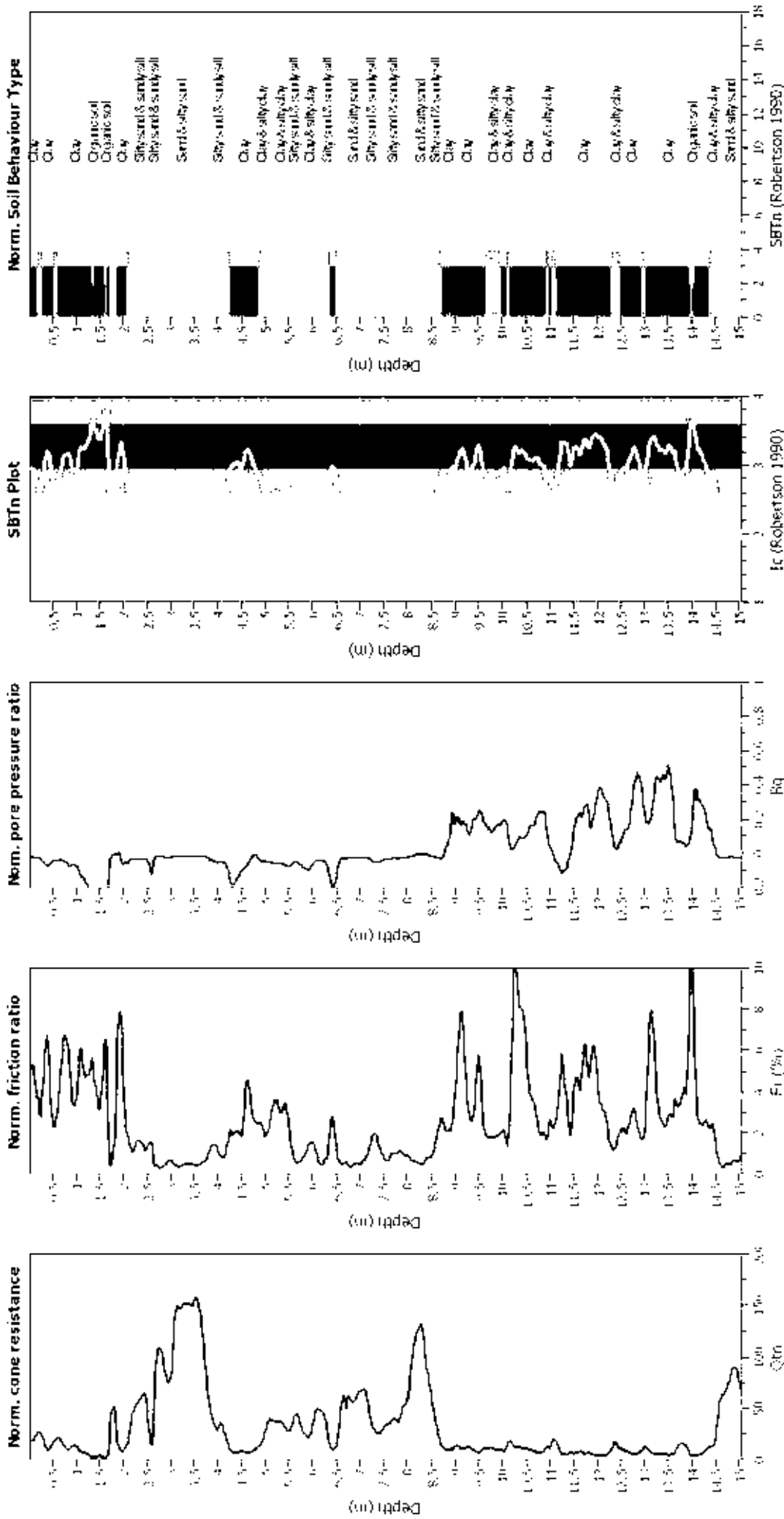
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial magnitude M_v :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	0.50 m	Unit depth:	N/A
Depth to GWL (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



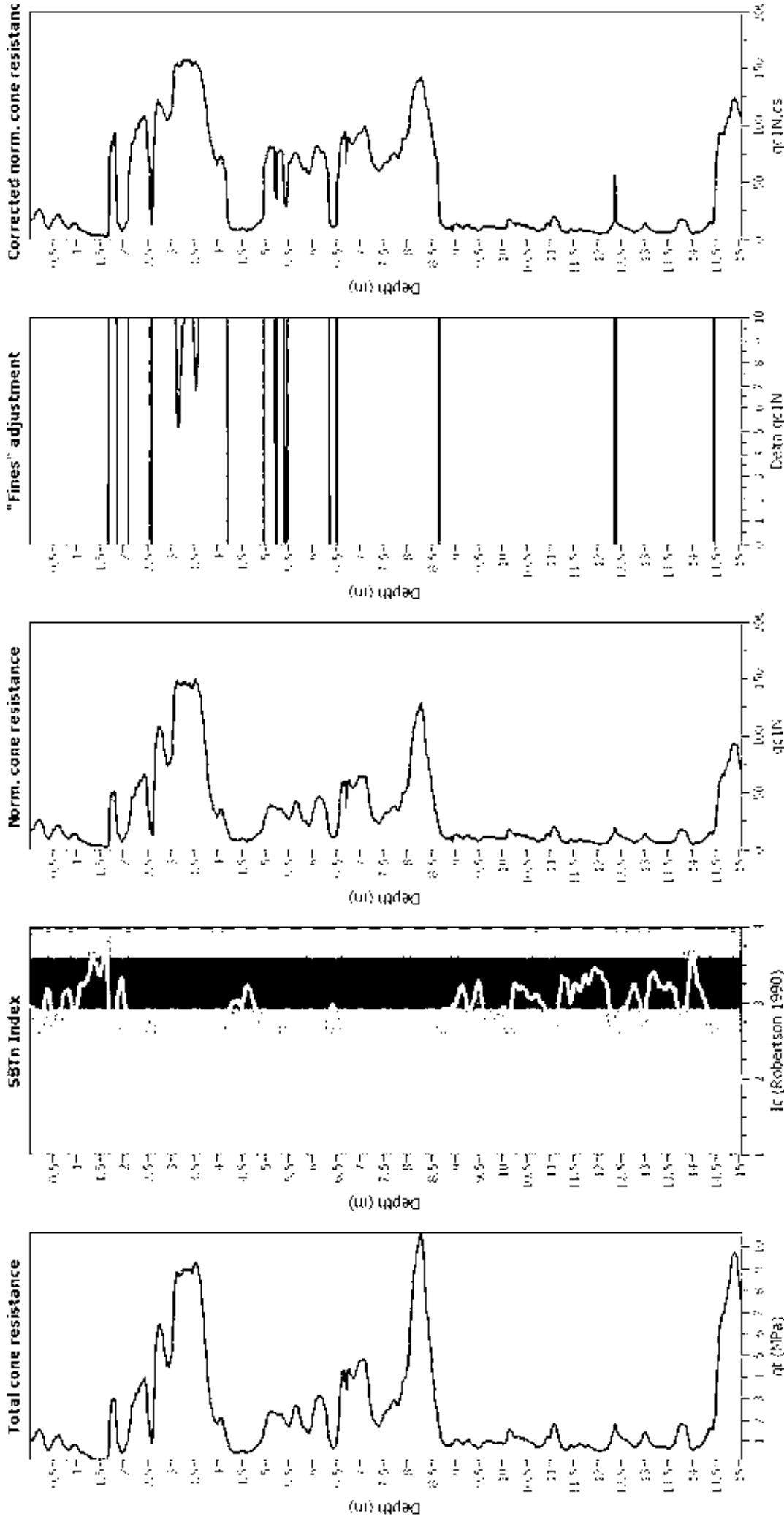
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	0.50 m	Unit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

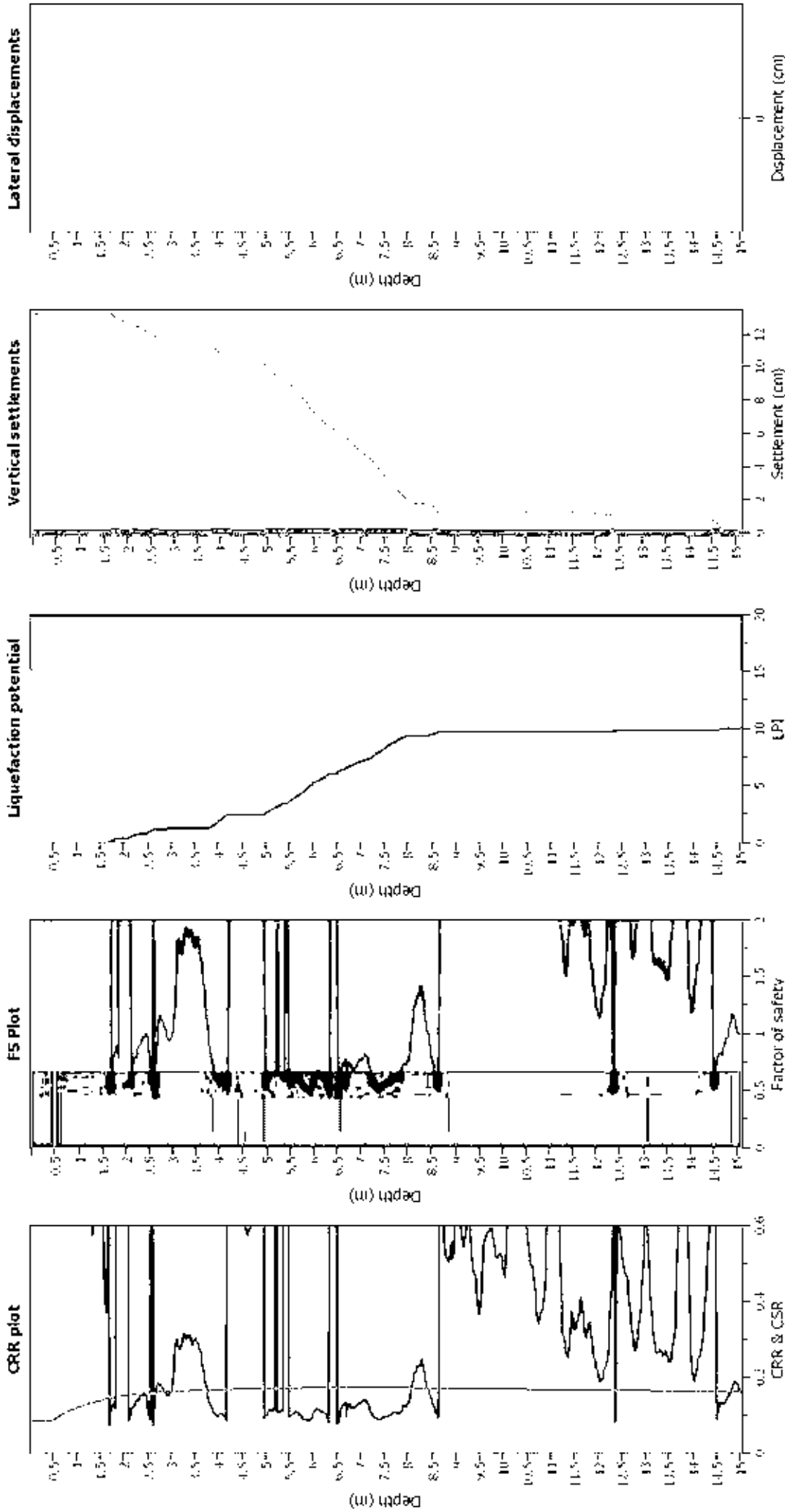
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Input correction method: 18B (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 0.50 m

Depth to GW (earthq.): 0.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition depth applied: N/A
 Sand & Clay: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

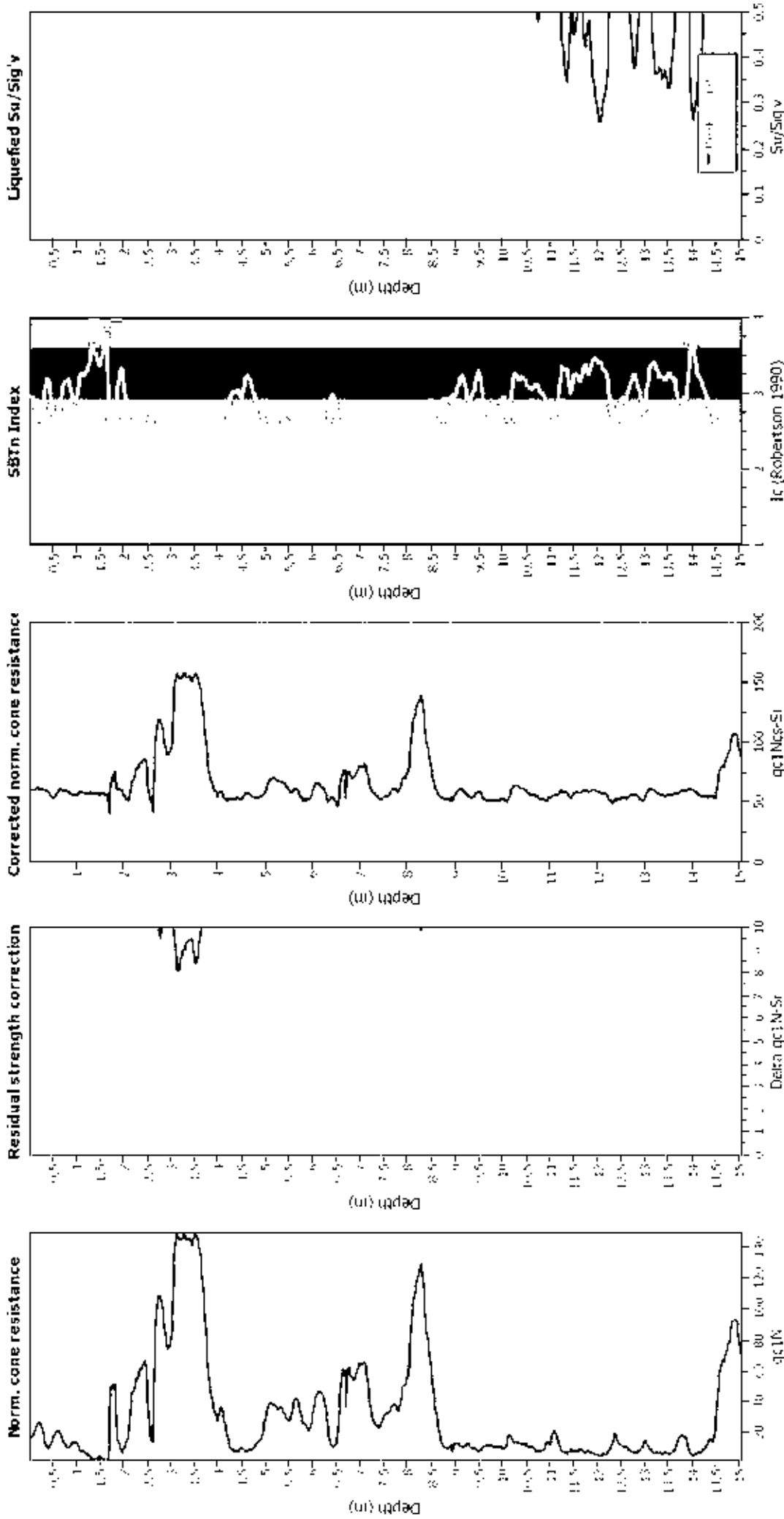
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

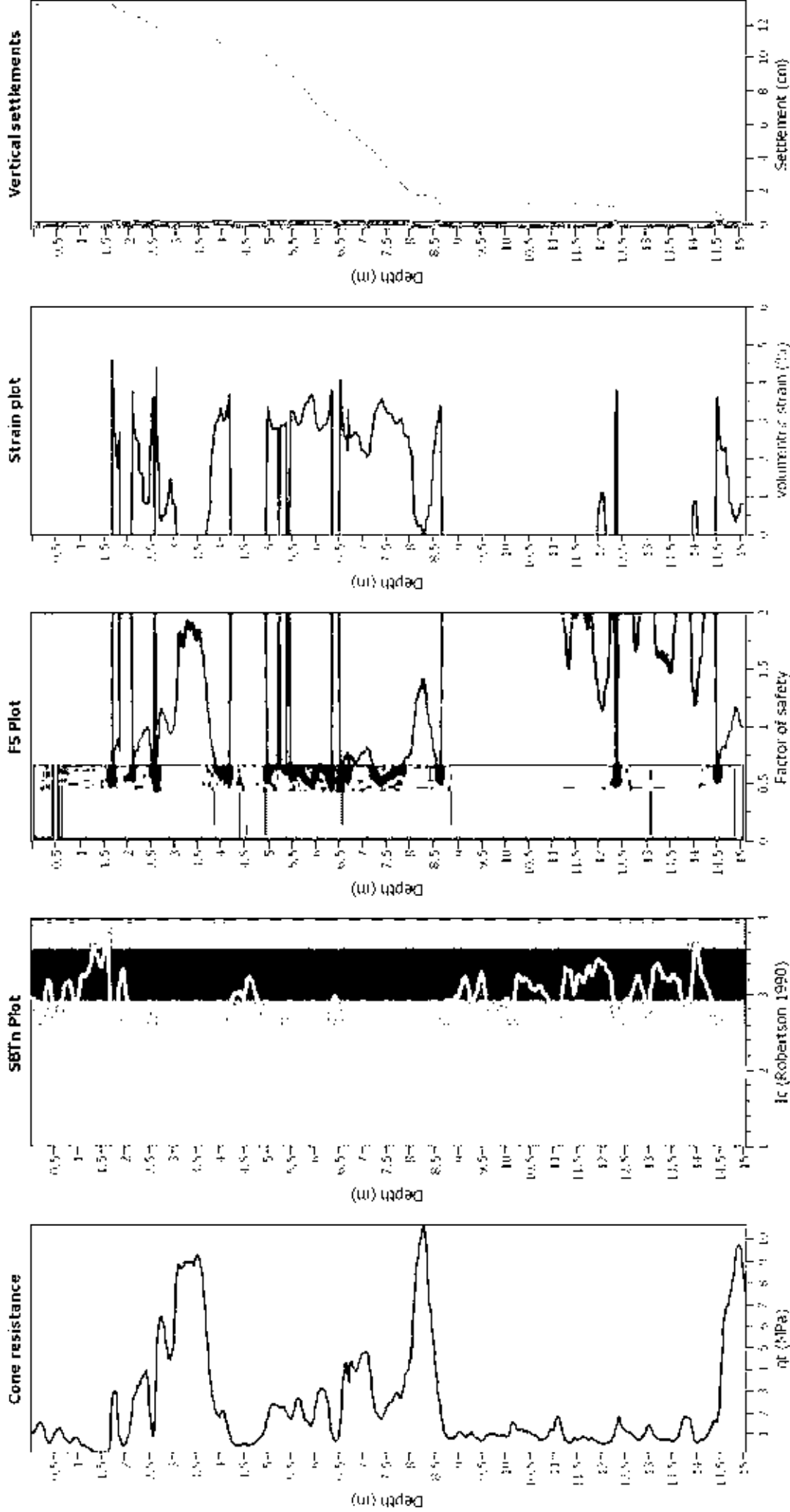
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- RS: Total cone resistance (cone resistance q_c corrected for pore water effects)
- BT: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT48_334SparksRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

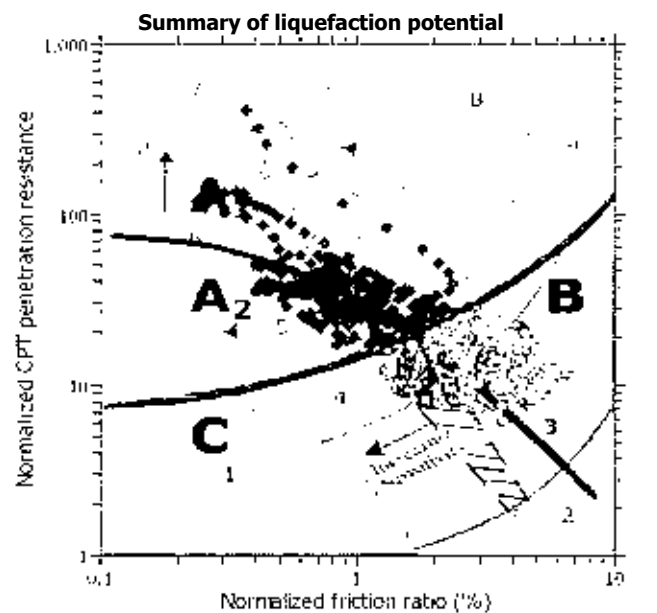
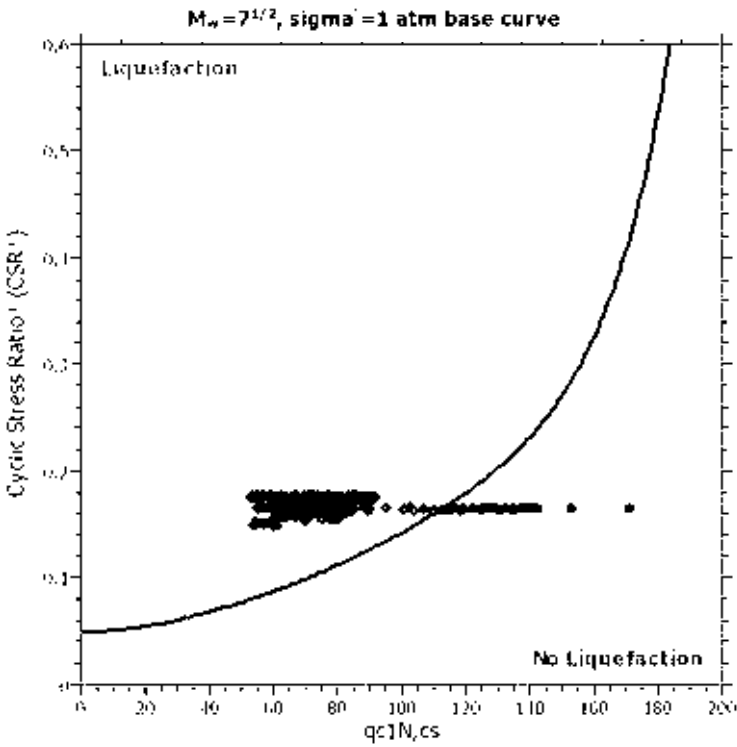
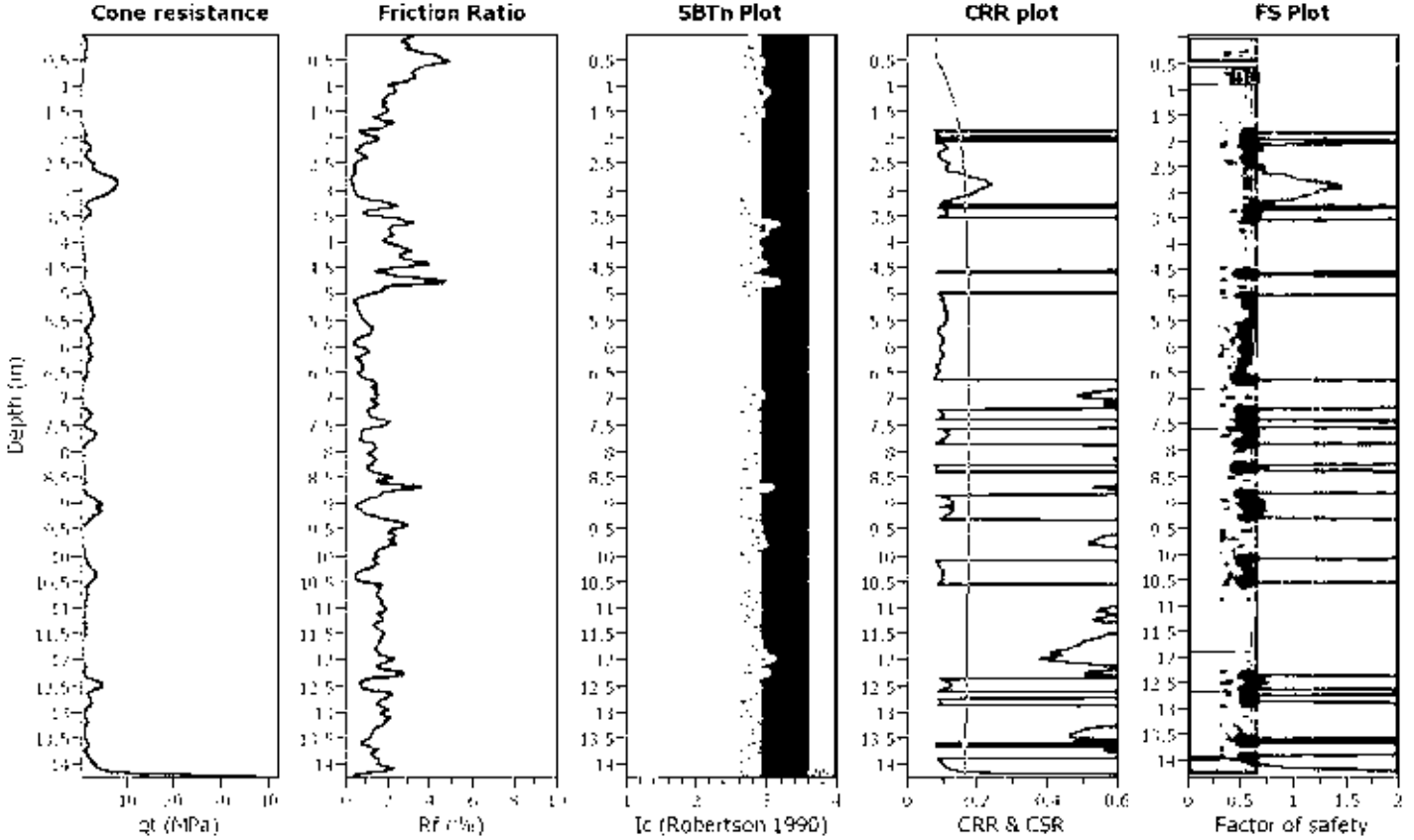
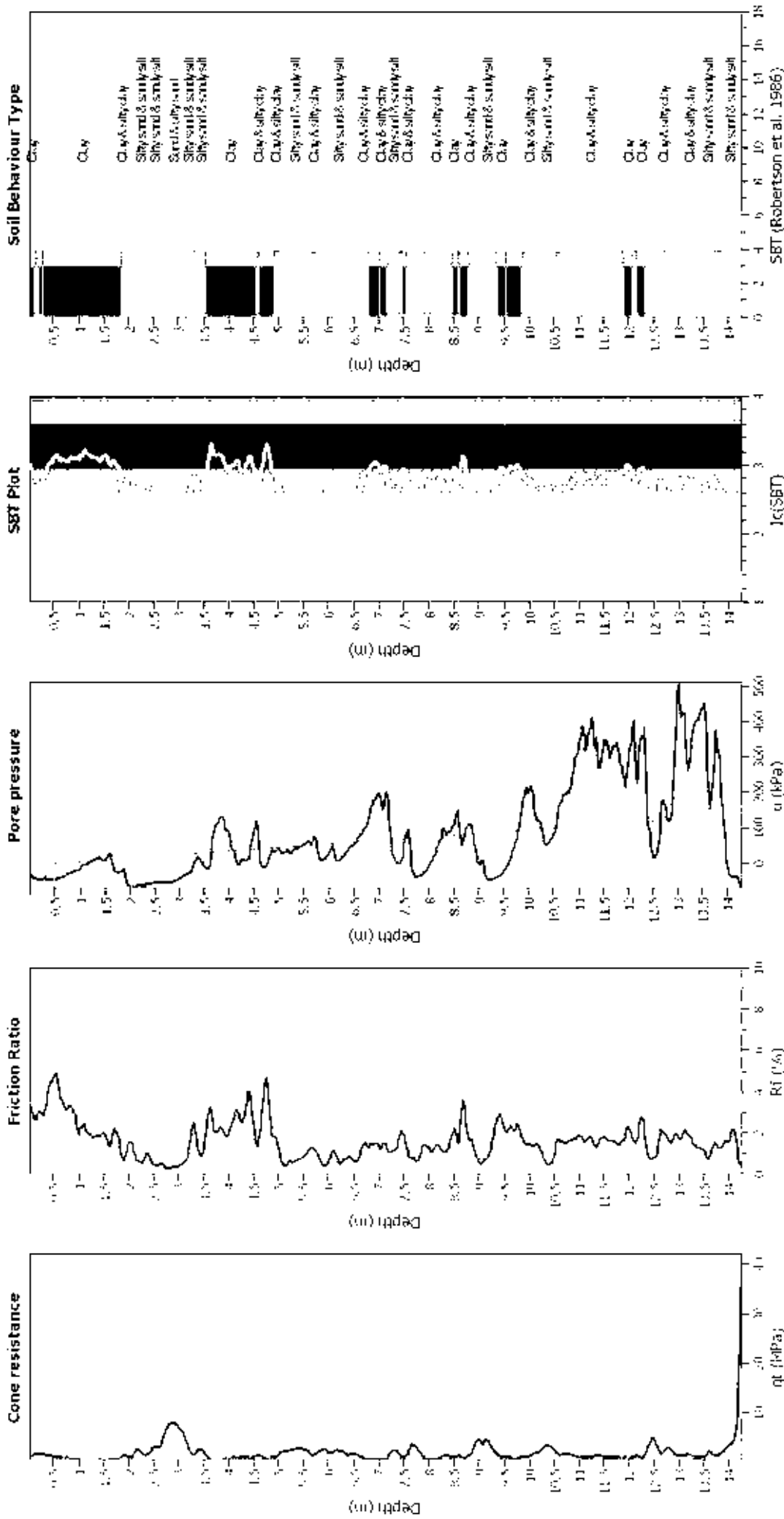


Figure 4: Summary of liquefaction potential assessment and classification of test results. Zone A1: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction unlikely; Zone C: No liquefaction. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with data points clustered in the 'No Liquefaction' region.

CPT basic interpretation plots



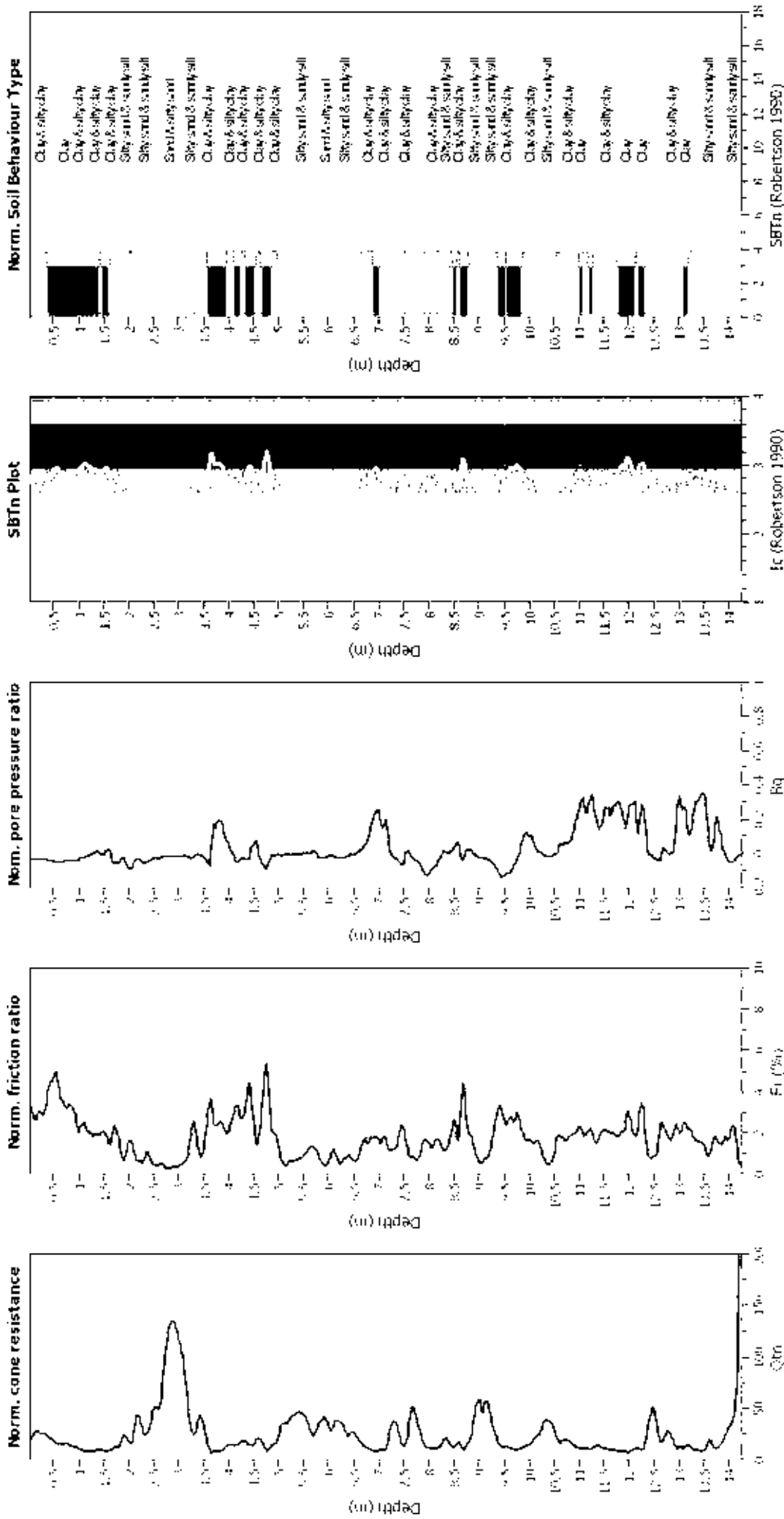
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial magnitude M_v :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.13	Unit depth applied:	No
Depth to water table (m):	0.50 m	Unit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



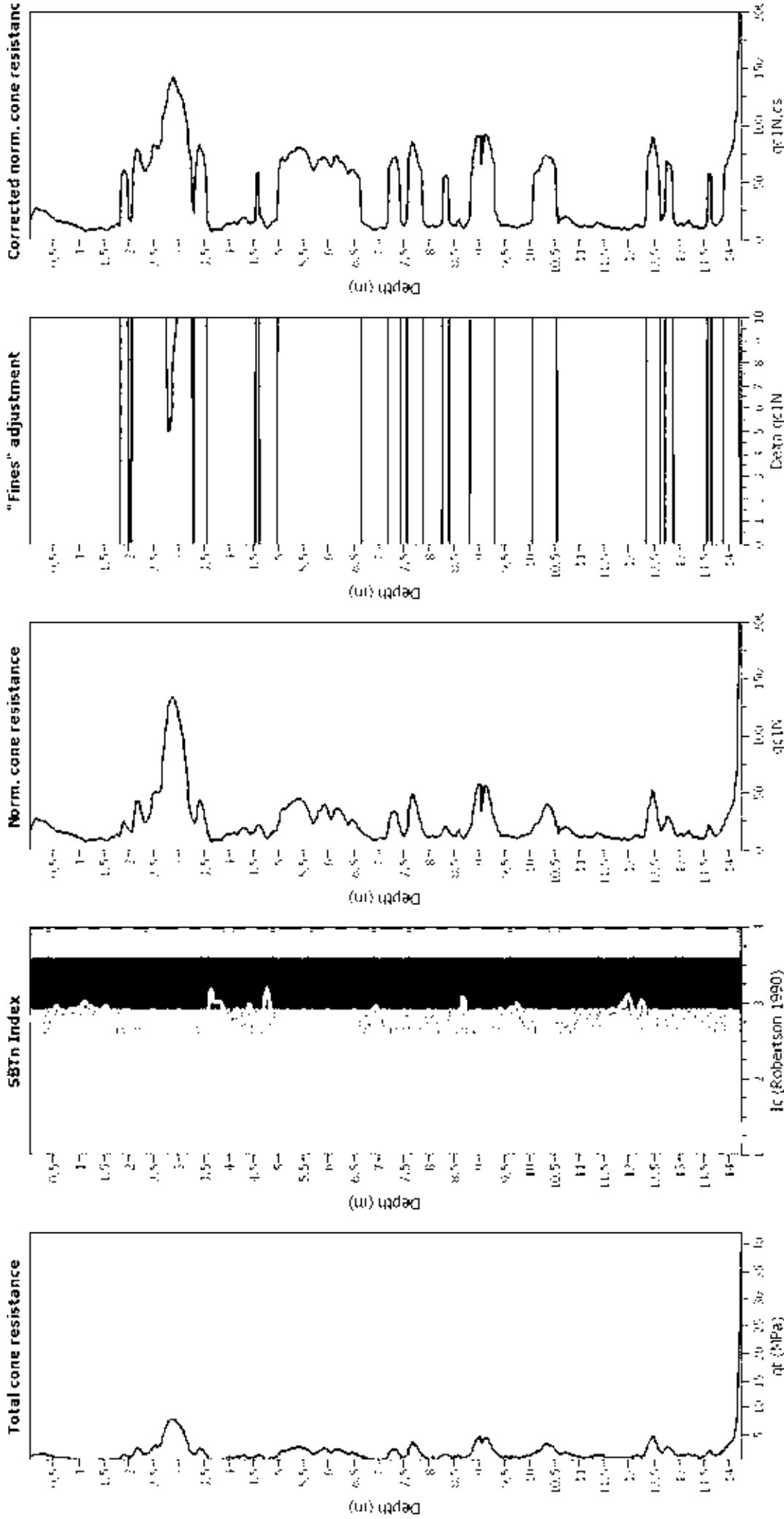
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	0.50 m	Fill weight:	N/A	Sand & Clay	
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Clay like behavior applied		
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Unit depth applied:	No		
Peak ground acceleration:	0.13	Use fill:	No	Unit depth:	N/A		
Depth to water table (m):	0.50 m	Fill height:	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

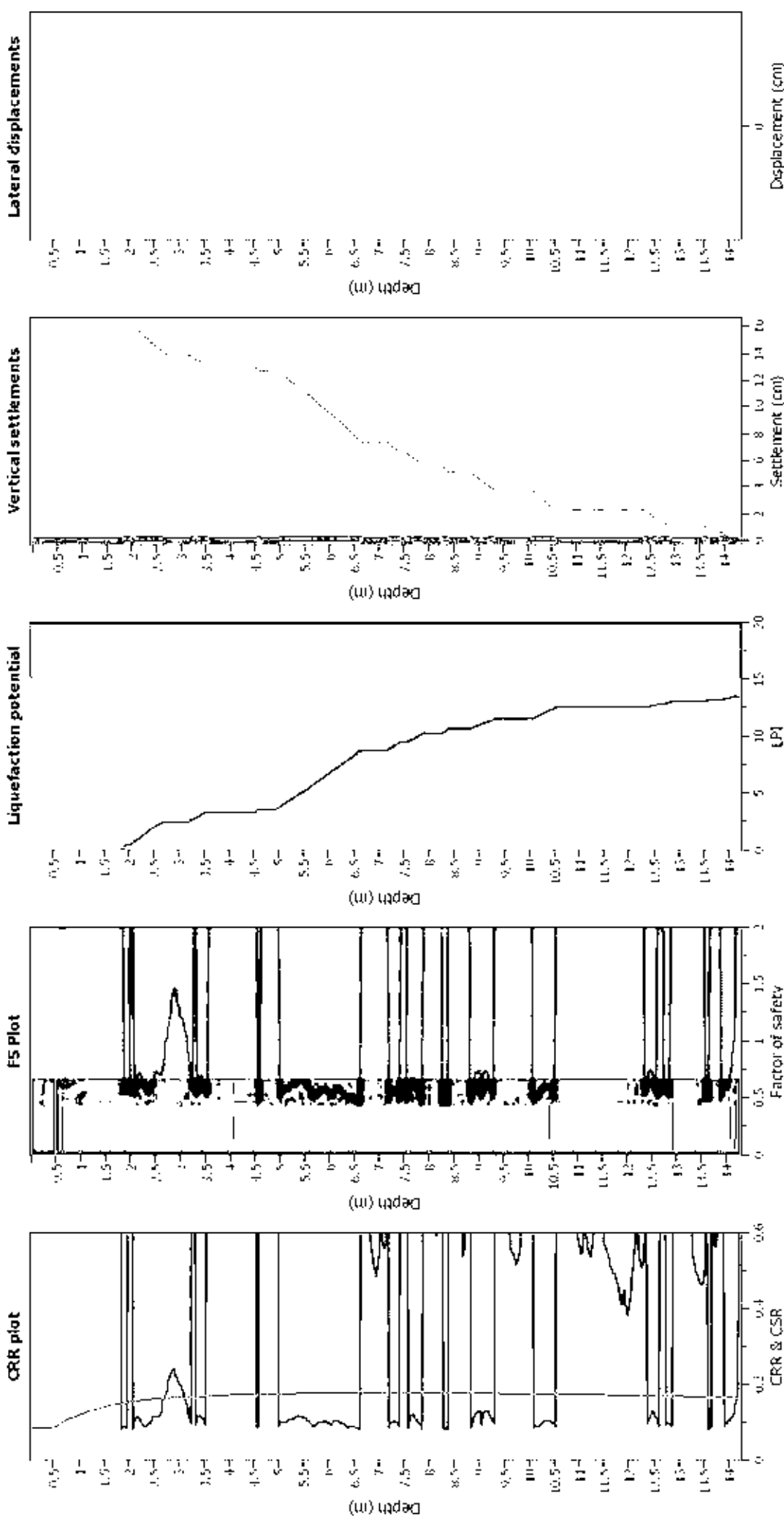
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make mag. angle β_s :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m _{wt}):	0.50 m	Limit depth:	N/A
Depth to GW (erthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude M_w : 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 0.50 m

Depth to GW (earthq.): 0.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

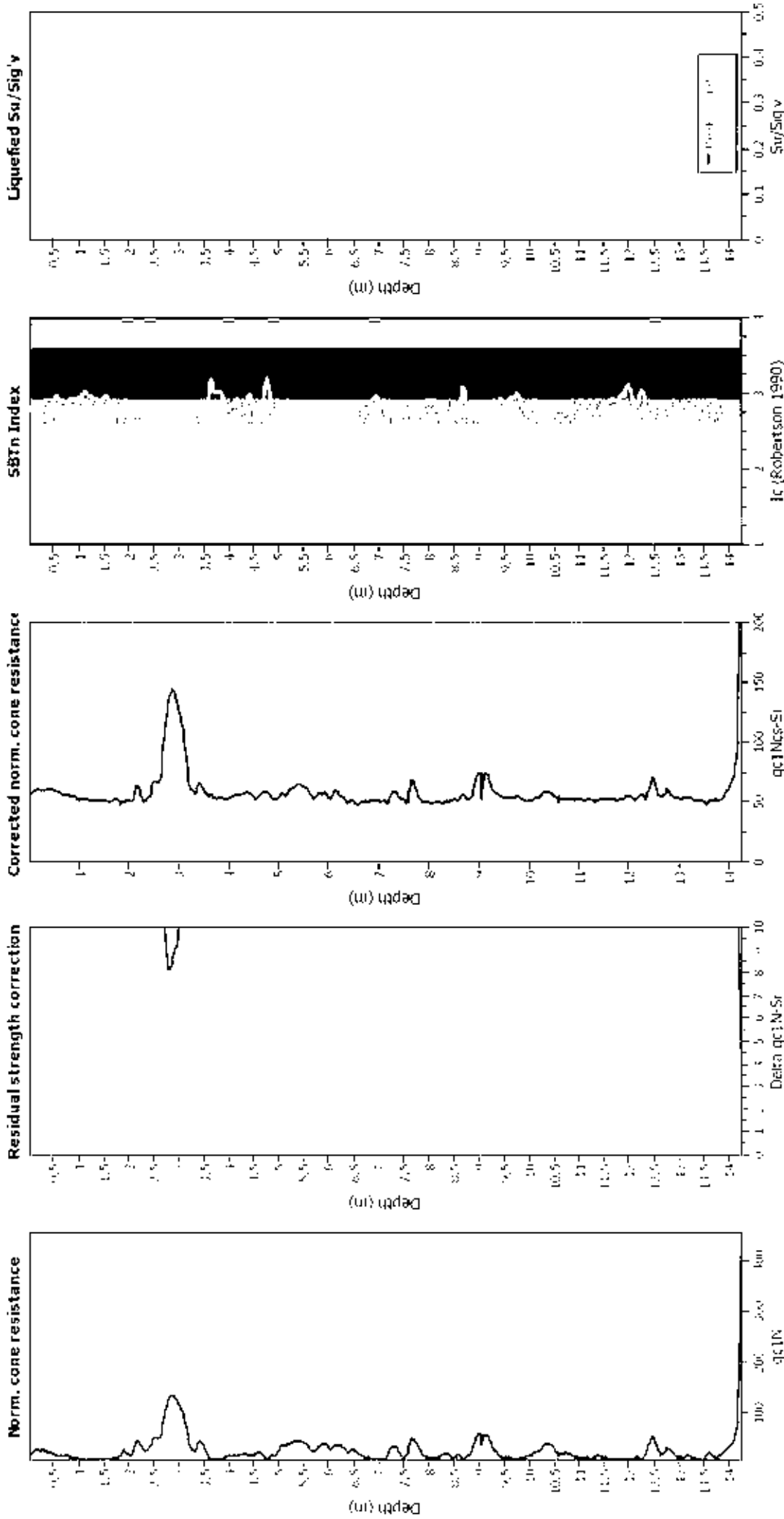
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

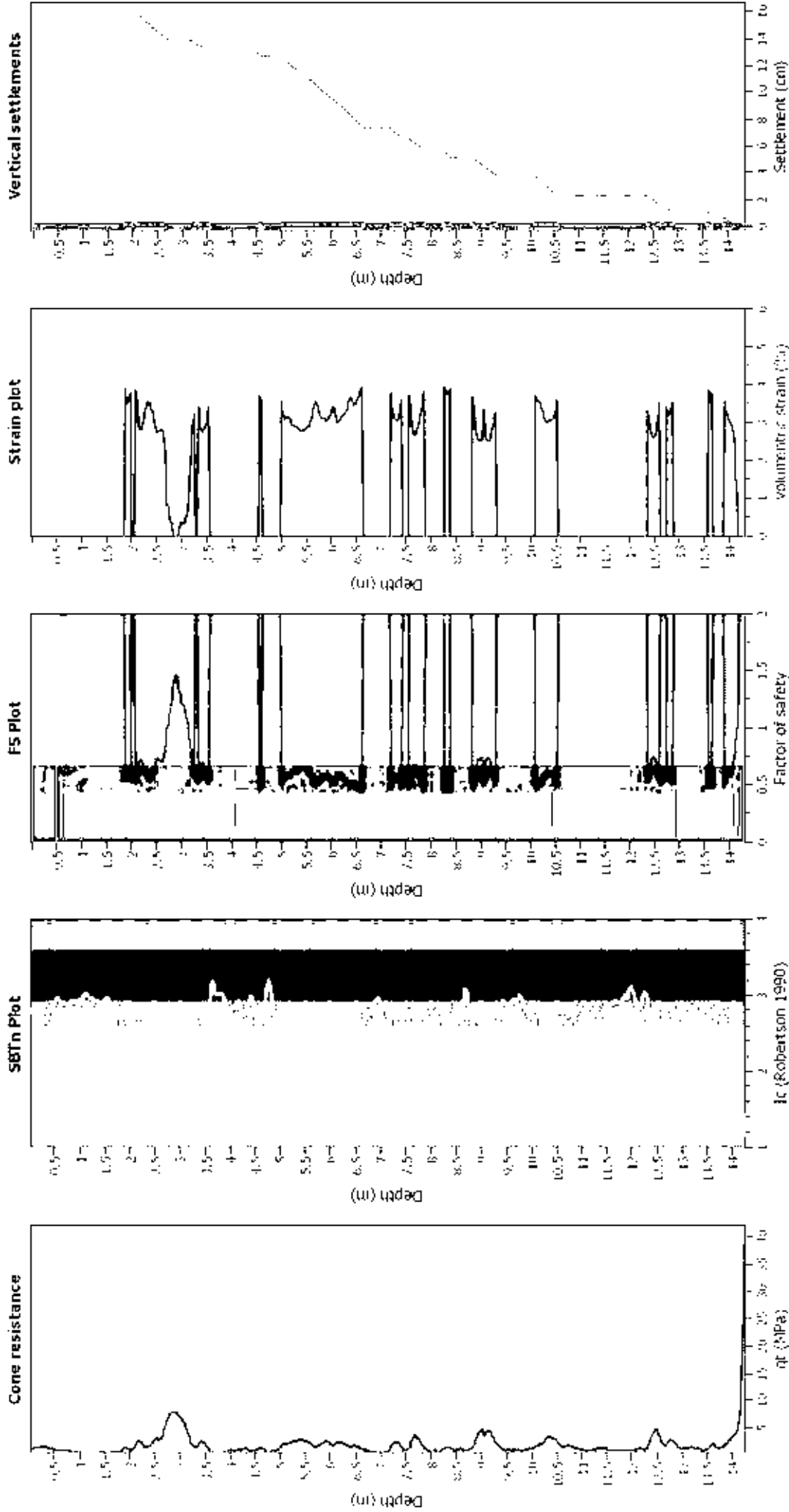
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial mags. angle θ_c :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

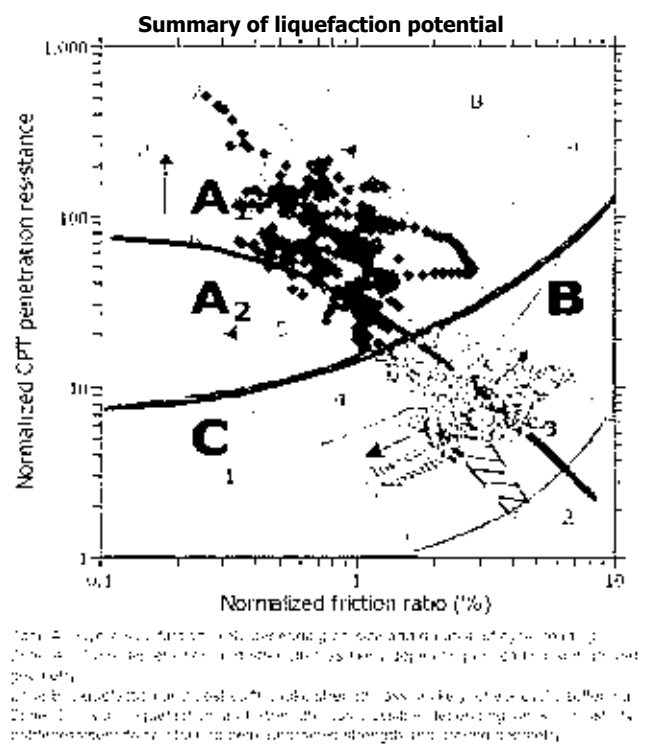
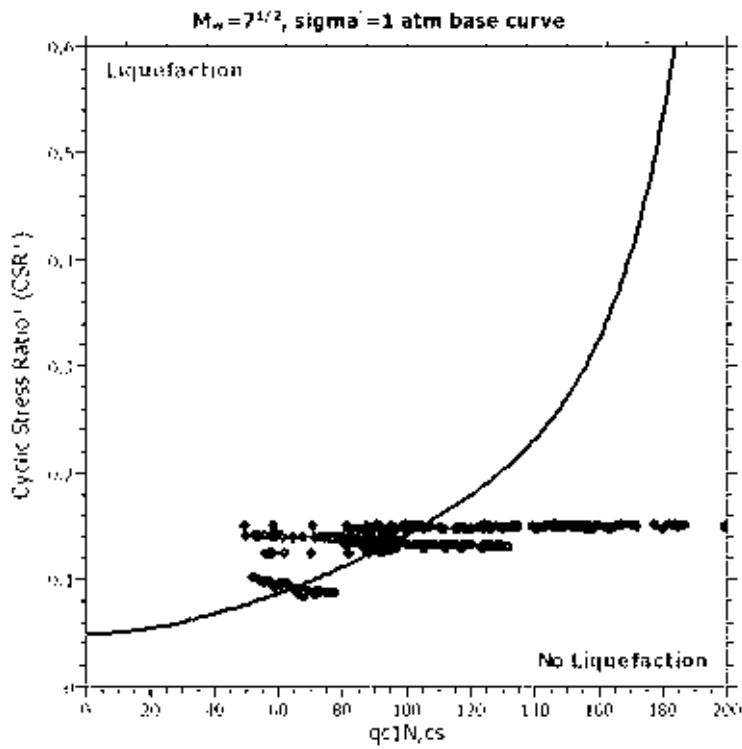
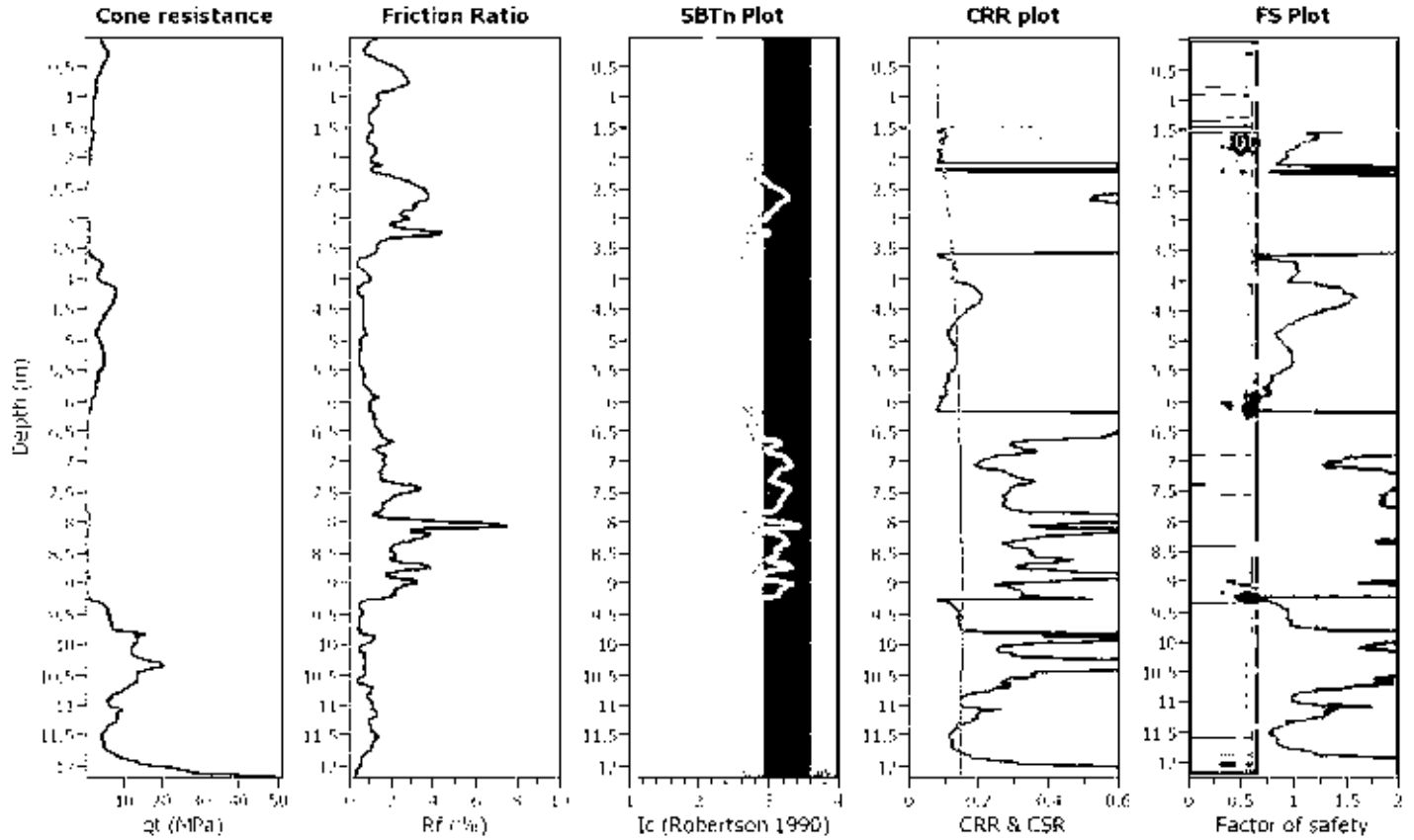
- TC Total cone resistance (cone resistance q_c corrected for pore water effects)
- SB Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

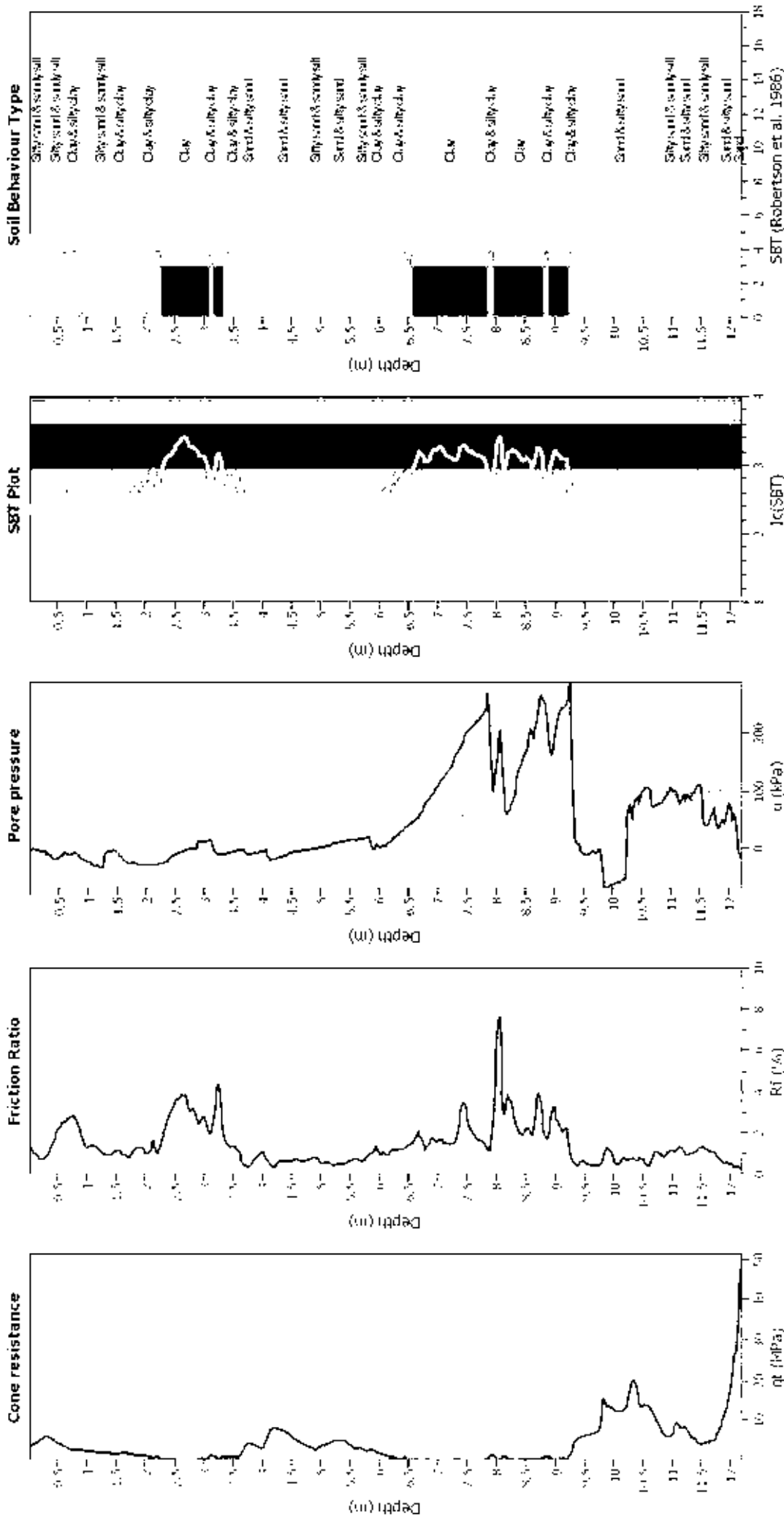
CPT file : CPT49_200CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _o applied:	Yes		



CPT basic interpretation plots



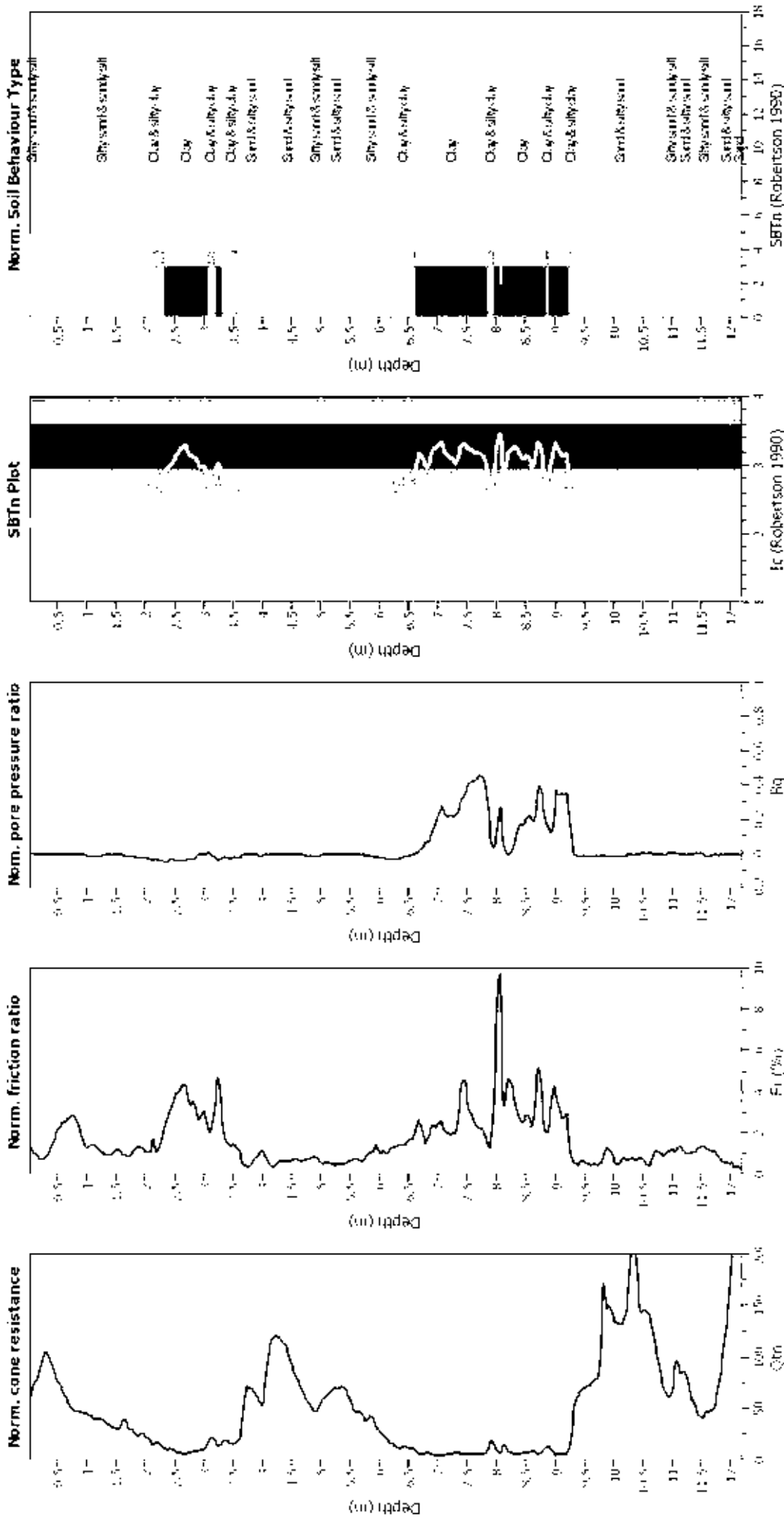
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m _{wt}):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



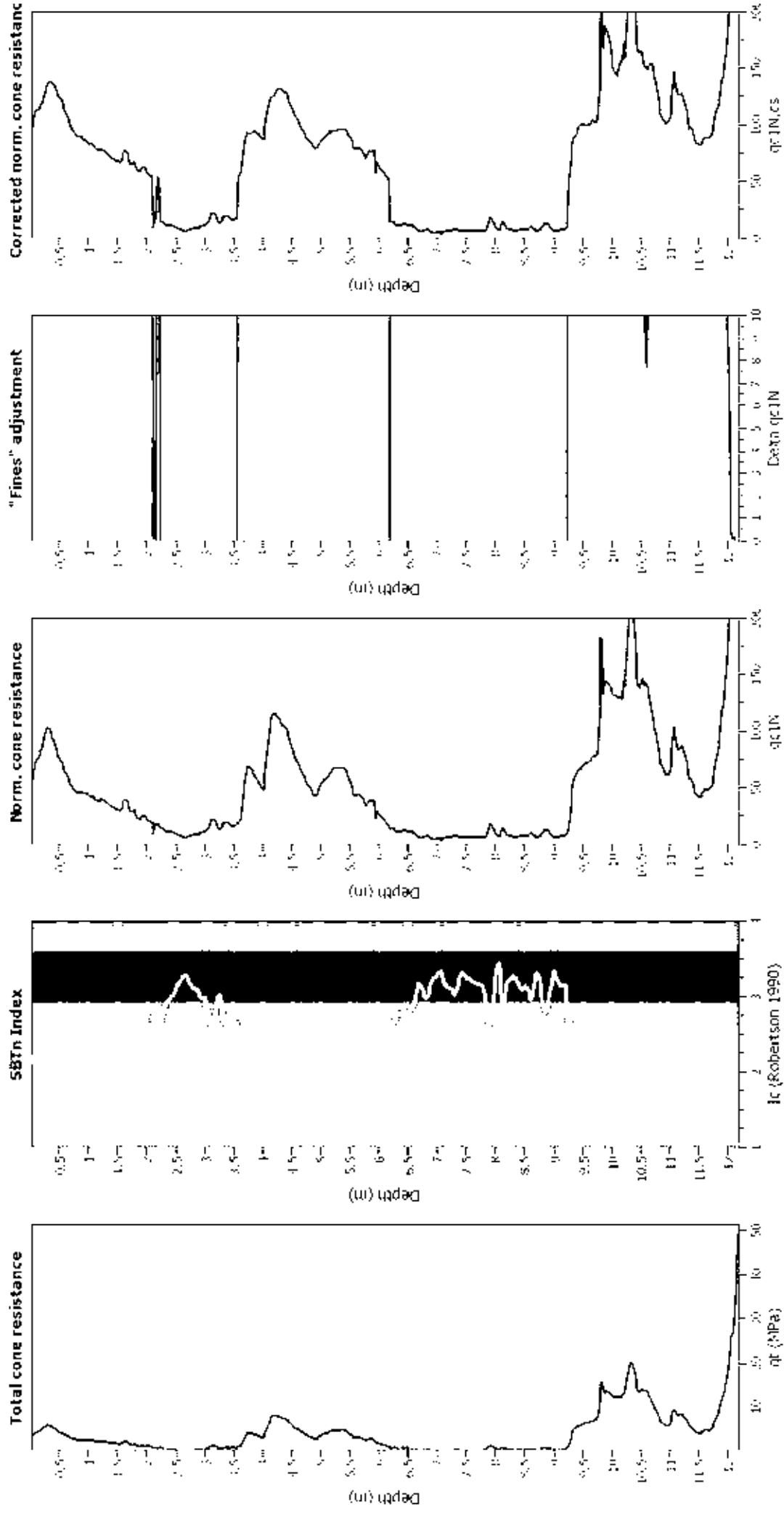
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.5	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

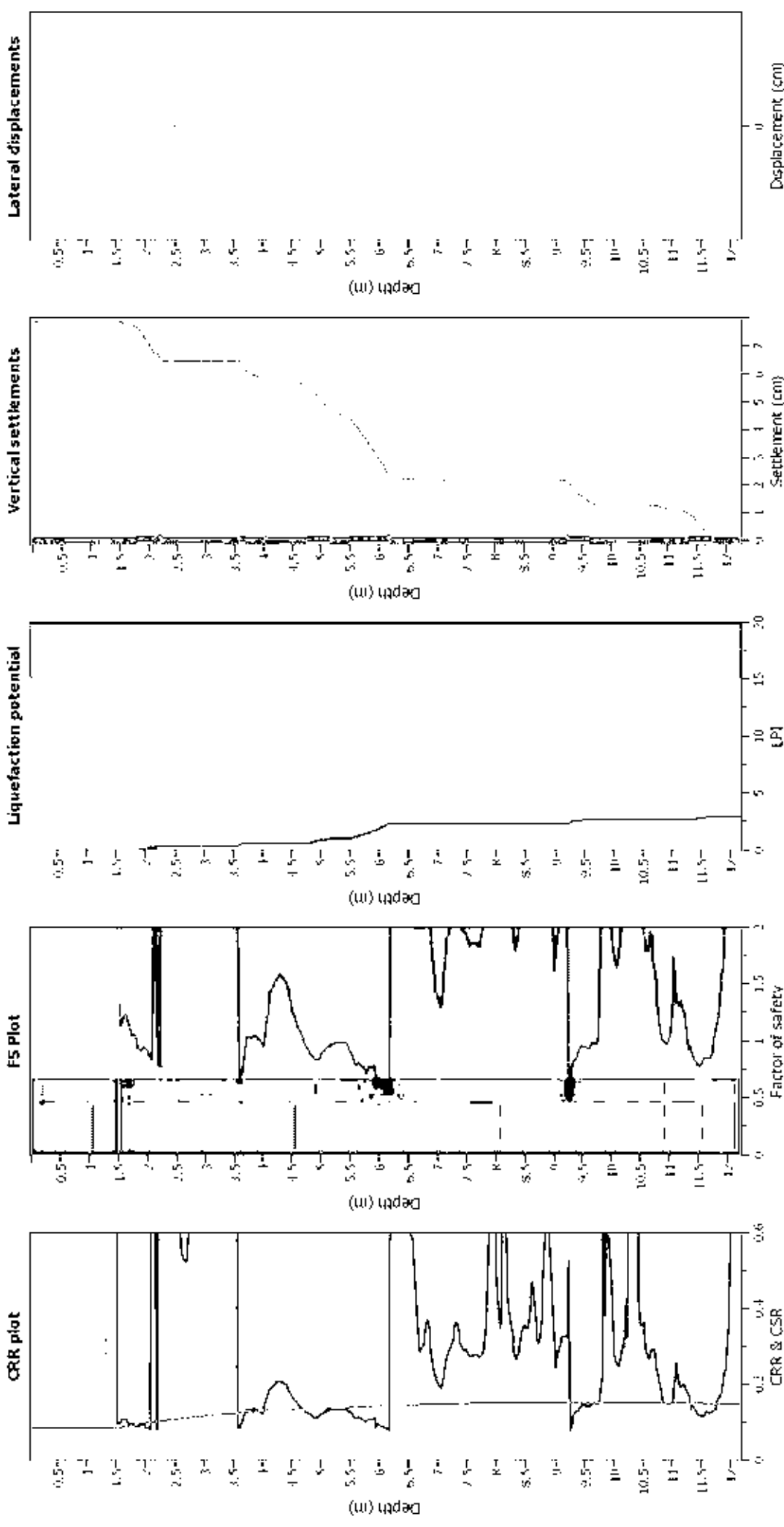
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorquake mag. single M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m _{wt}):	1.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Input correction method: 18B (2008)
 Points to test: Based on Ic value
 Earthquake magnitude: 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition depth applied: N/A
 K applied: Sand & Clay
 Clay like behavior applied: Yes
 Limit depth applied: No
 Limit depth: N/A

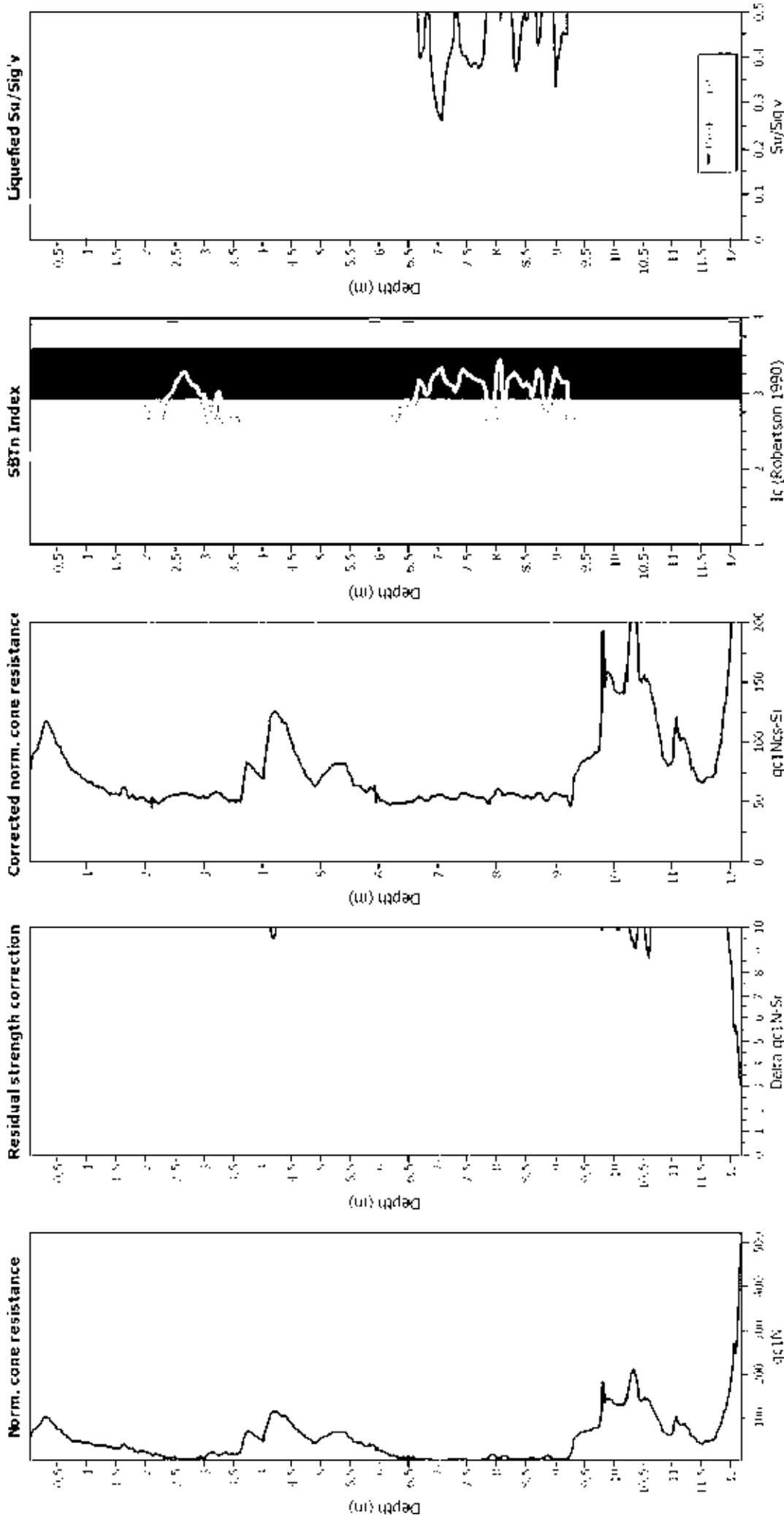
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

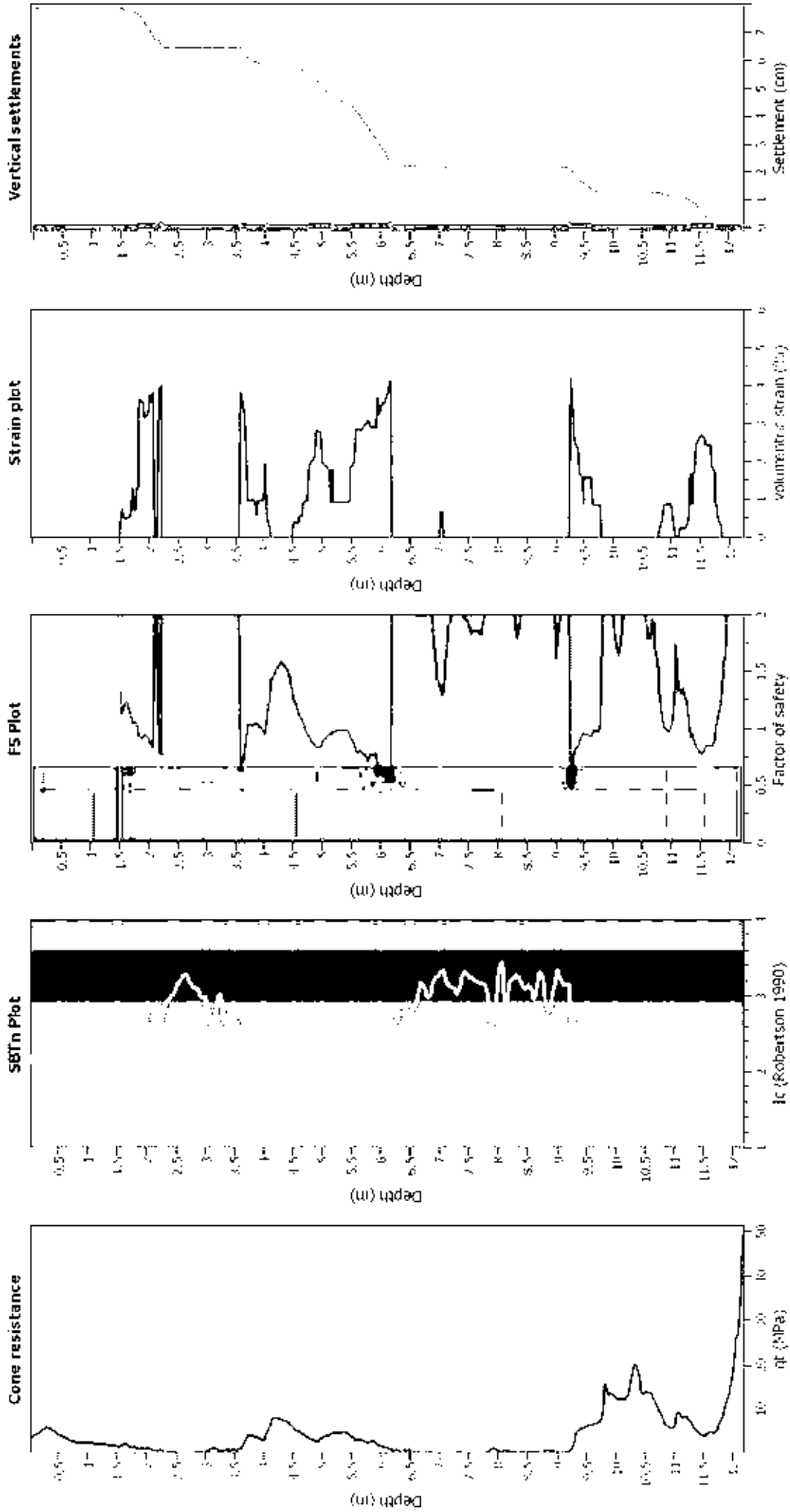
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Factorial mag. angle β_s :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Lam. depth applied:	No
Depth to water table (m):	1.50 m	Lam. depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- qc: Soil Behaviour Type index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT50_334SparksRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.13	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

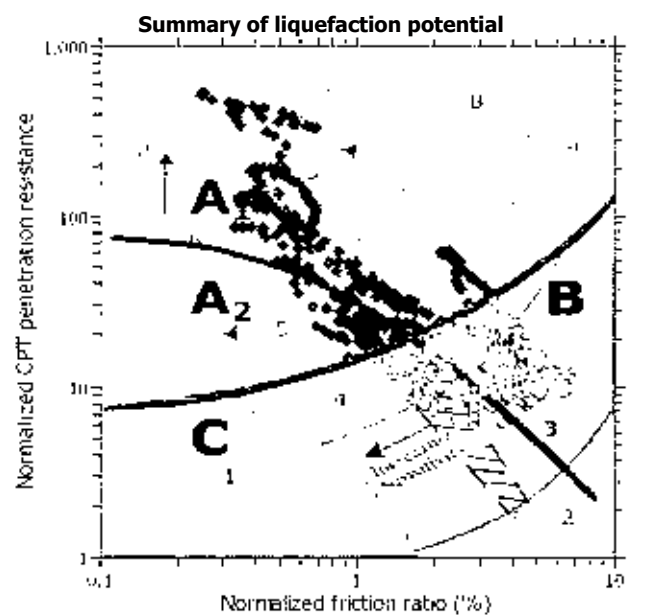
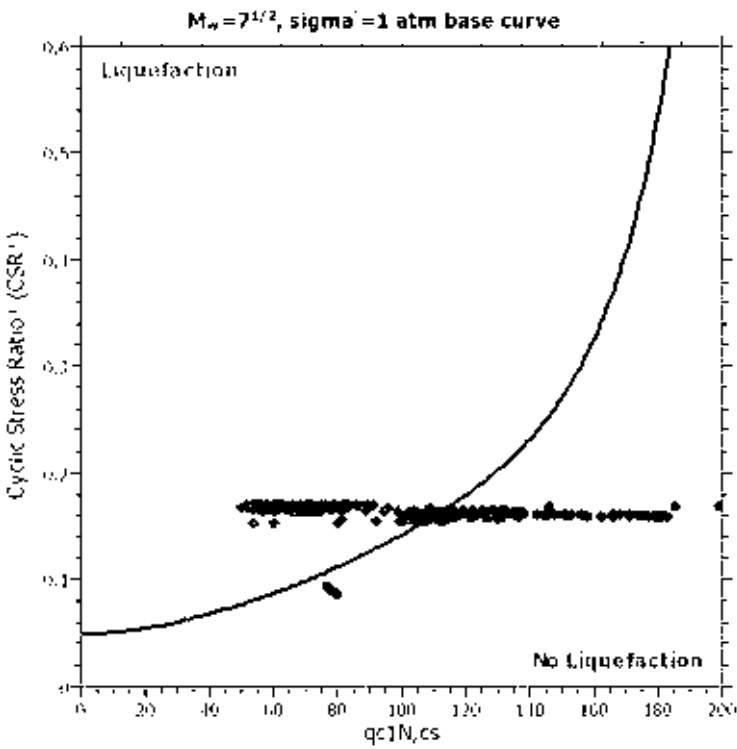
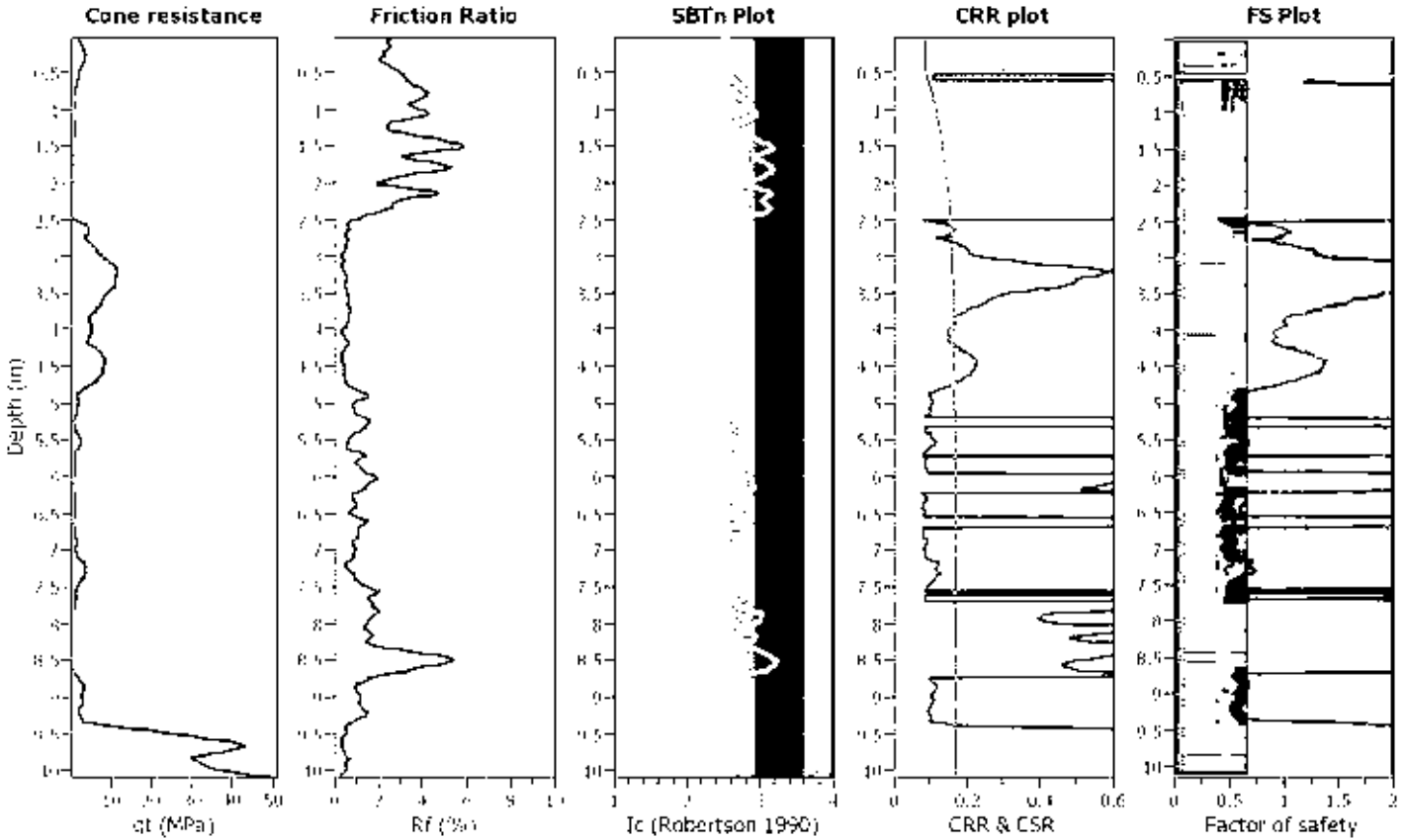
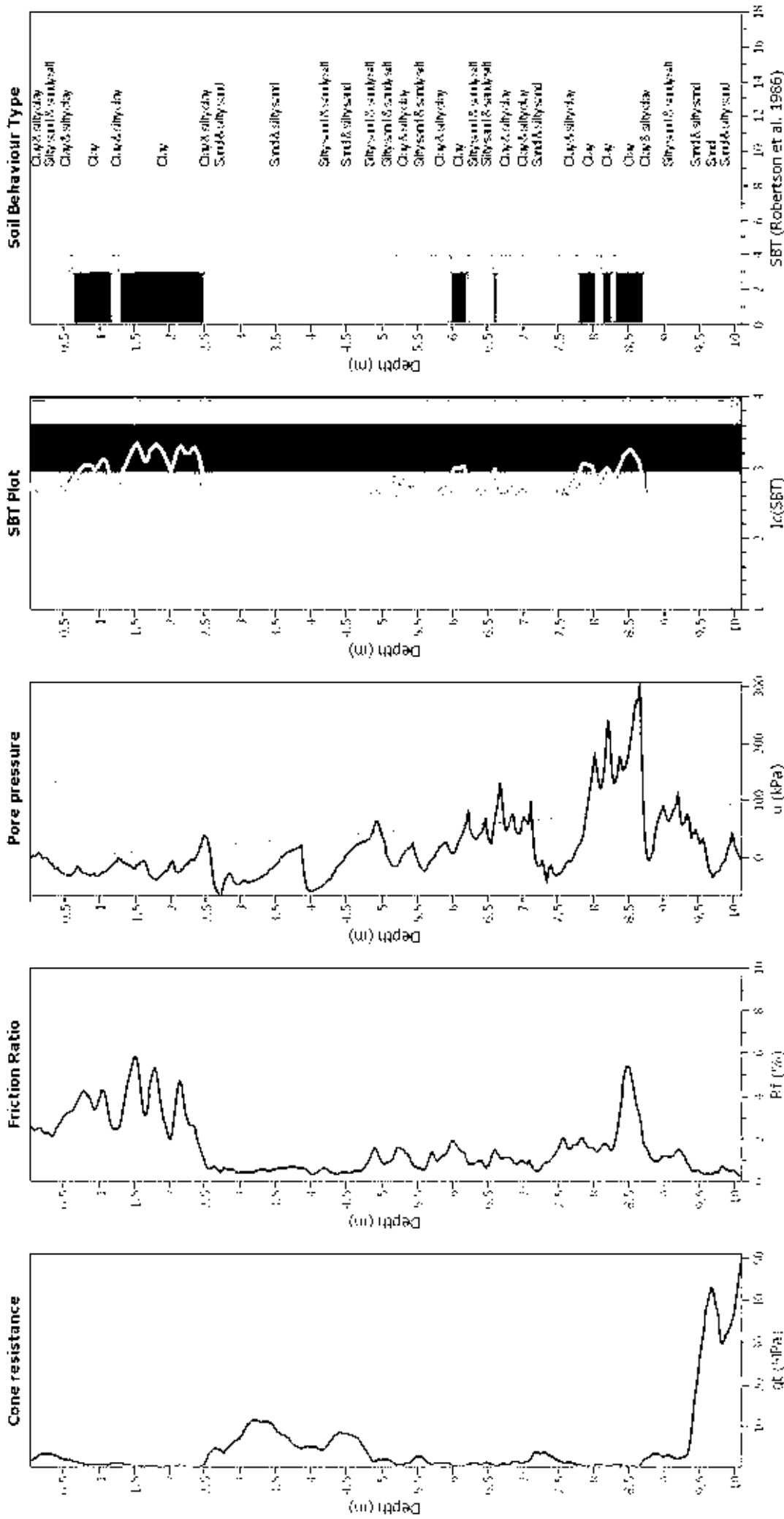


Figure 4: Summary of liquefaction potential assessment and data for the test. Zone A1: Normalized CPT penetration resistance > 100 and normalized friction ratio < 10%. Zone A2: Normalized CPT penetration resistance > 100 and normalized friction ratio > 10%. Zone B: Normalized CPT penetration resistance > 100 and normalized friction ratio > 10%. Zone C: Normalized CPT penetration resistance < 100 and normalized friction ratio > 10%. The liquefaction boundary is shown as a dashed line.

CPT basic interpretation plots



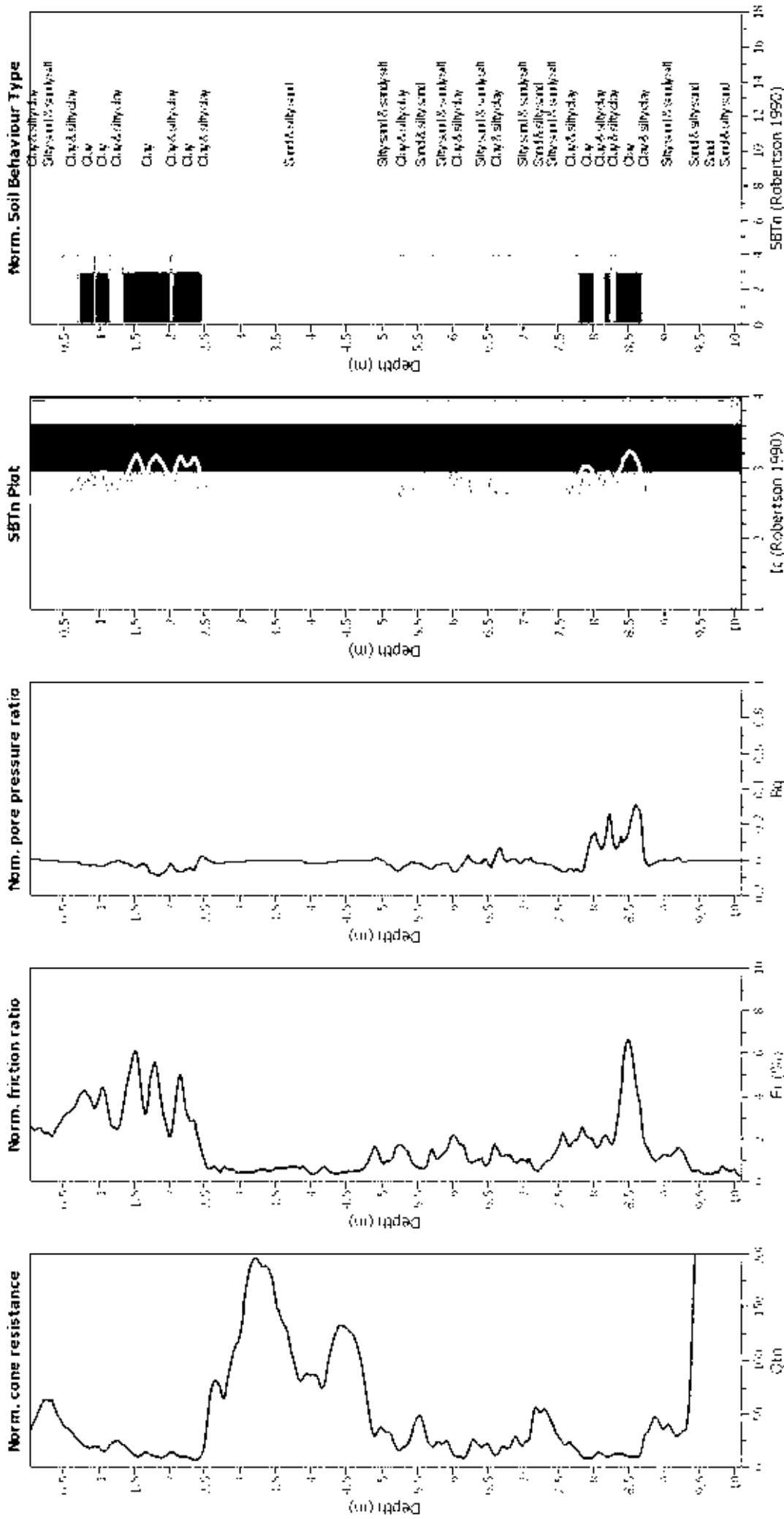
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	0.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	0.50 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



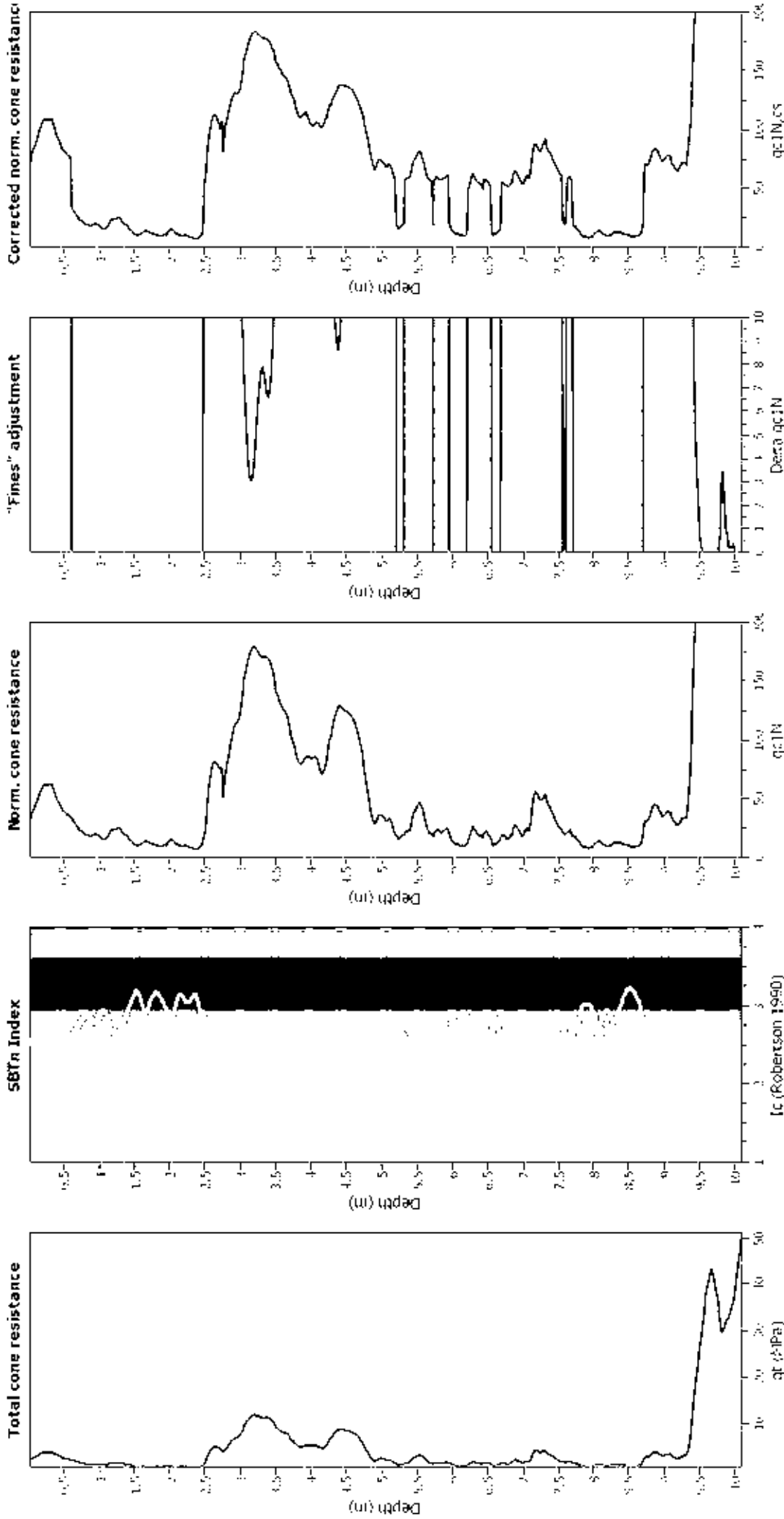
Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	N/A
Depth to water table (m):	0.50 m	Unit weight:	
		Fill height:	
		Average results interval:	0.50 m
		Ic cut-off value:	2.60
		Unit weight calculation:	Based on SBT
		Use fill:	No
		Fill height:	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

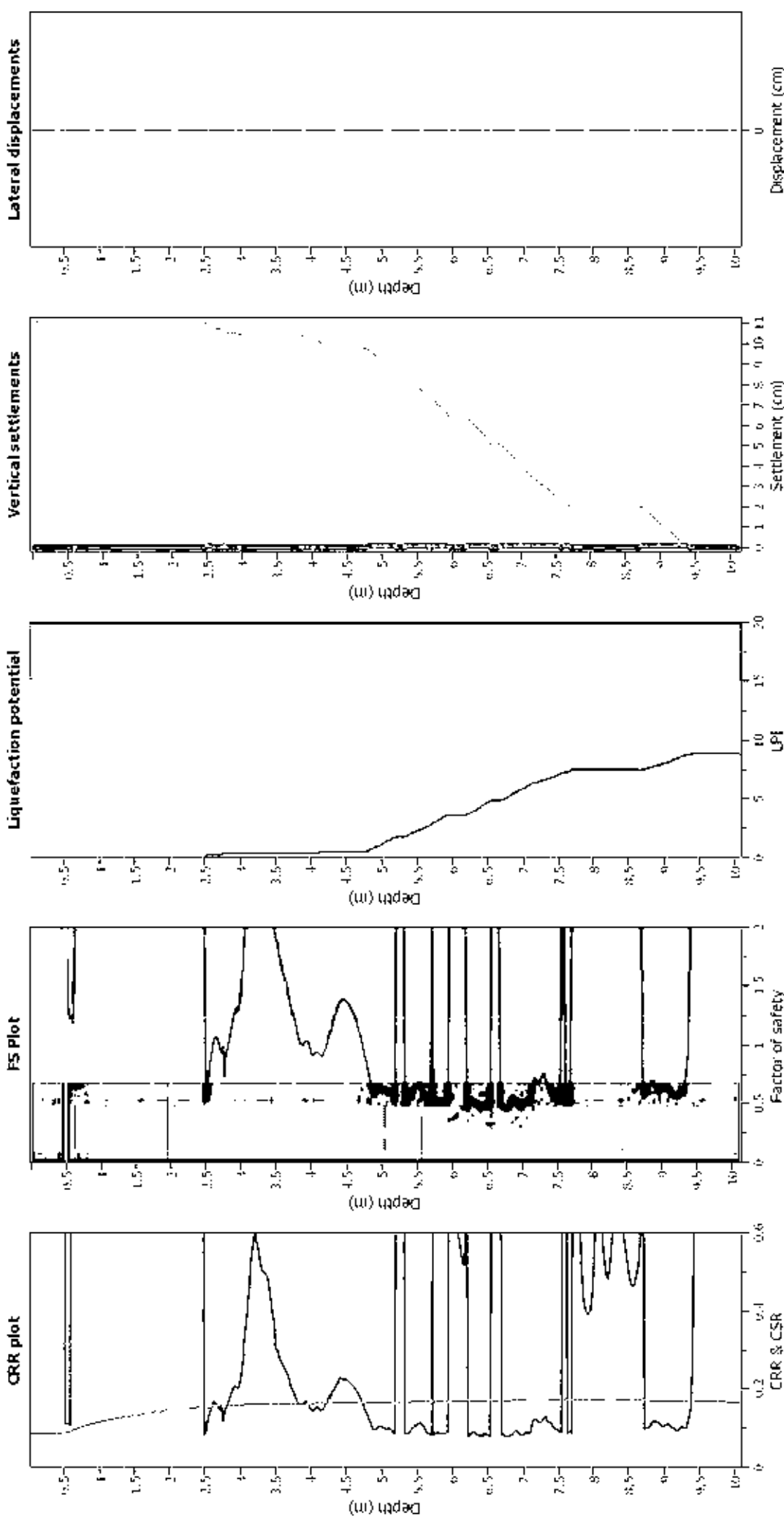
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.13
 Depth to water table (m): 0.50 m

Depth to GW (earthq.): 0.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

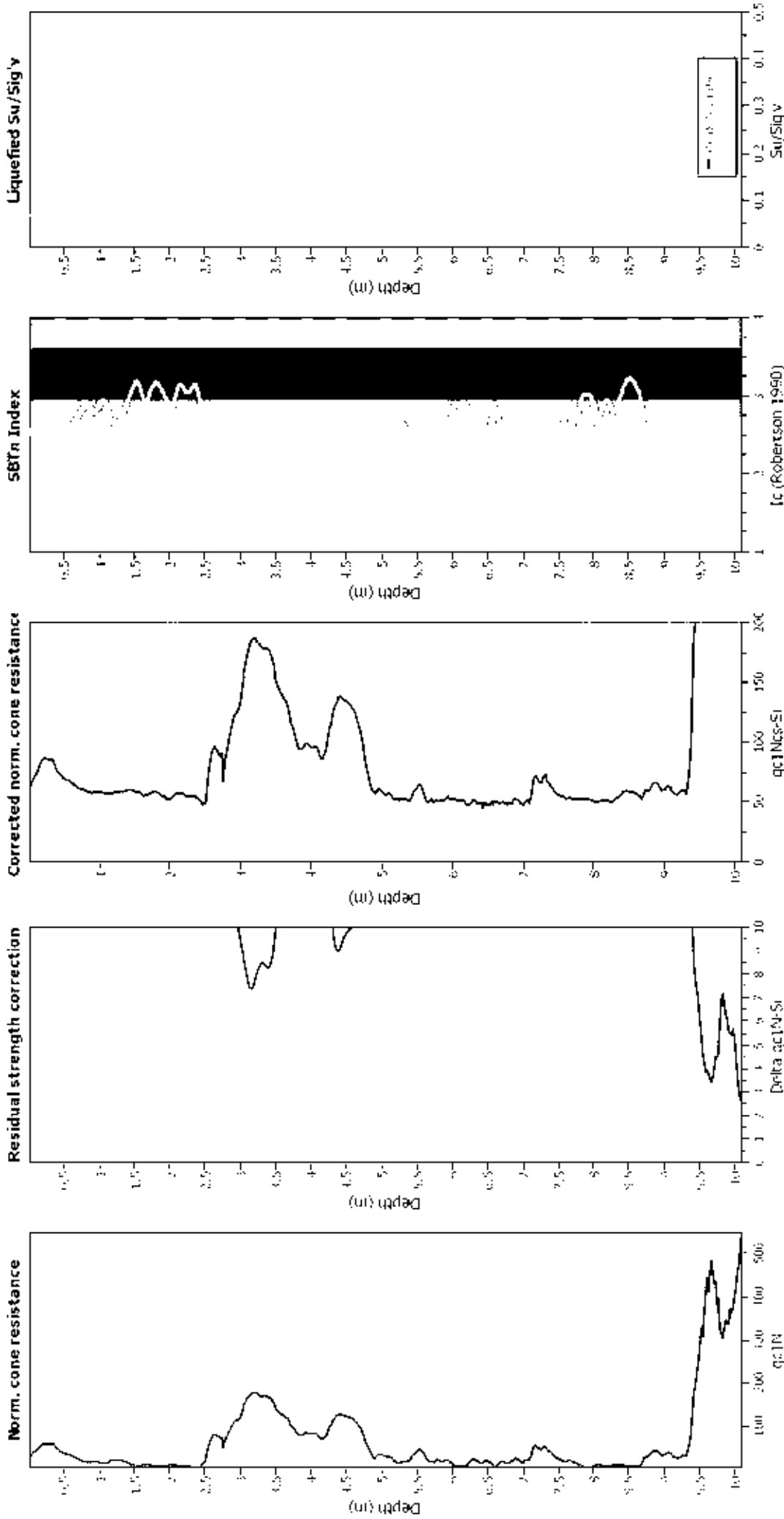
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

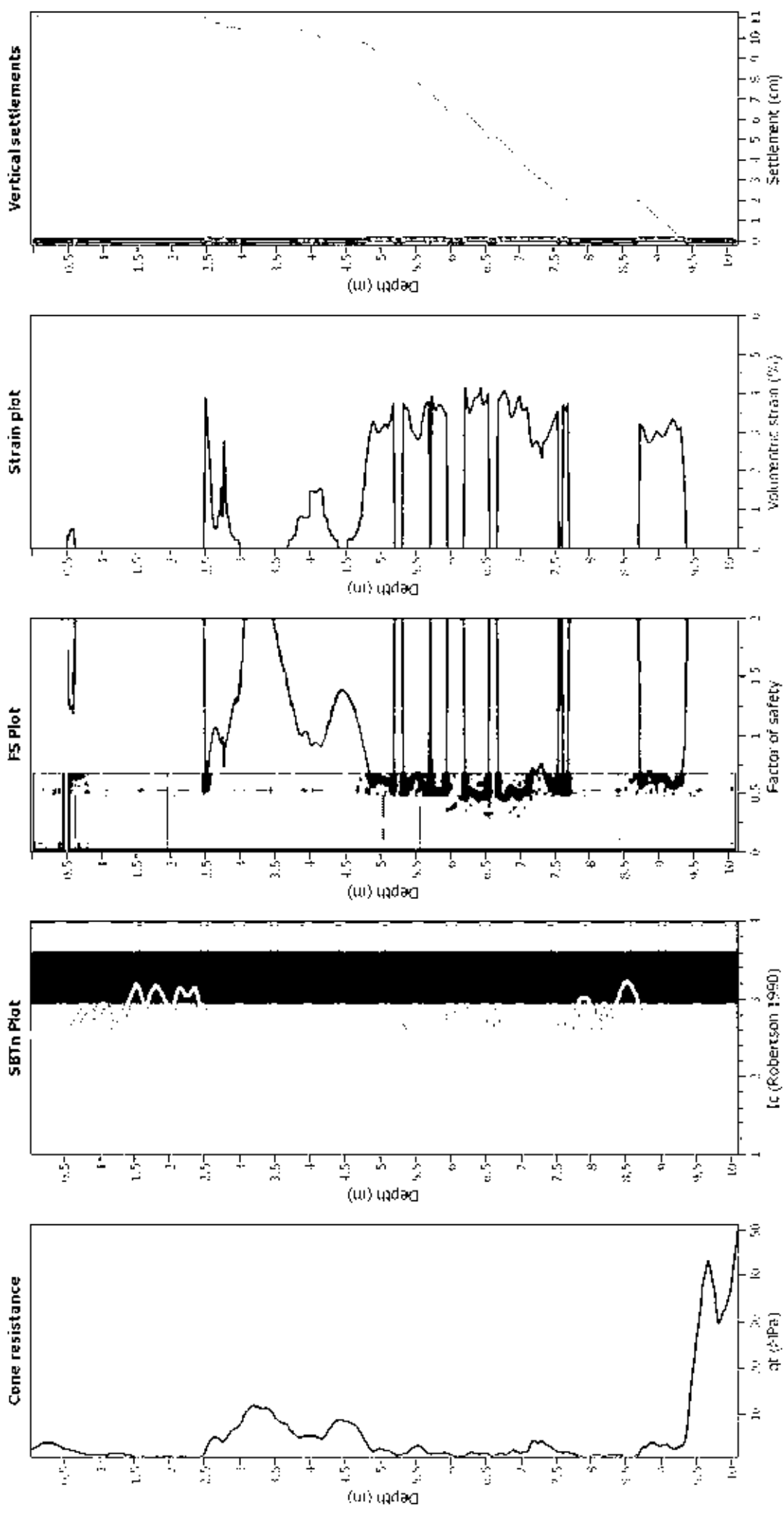
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition detect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.13	Limit depth applied:	No
Depth to water table (m _{wt}):	0.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT34_396SparksRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

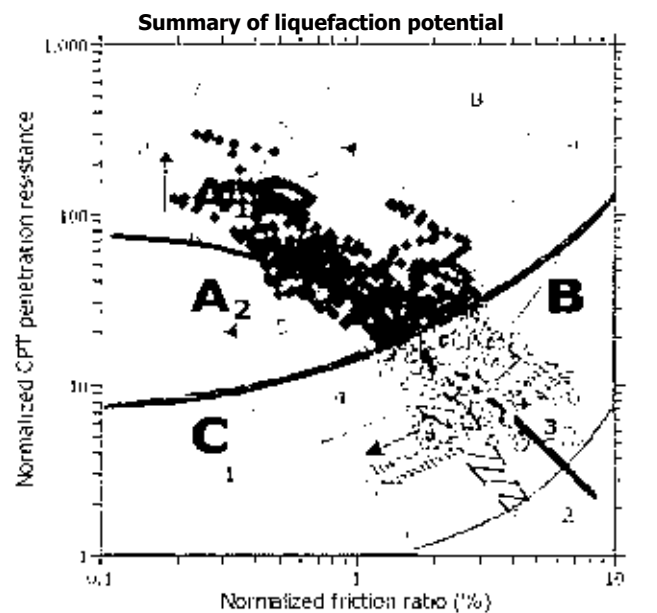
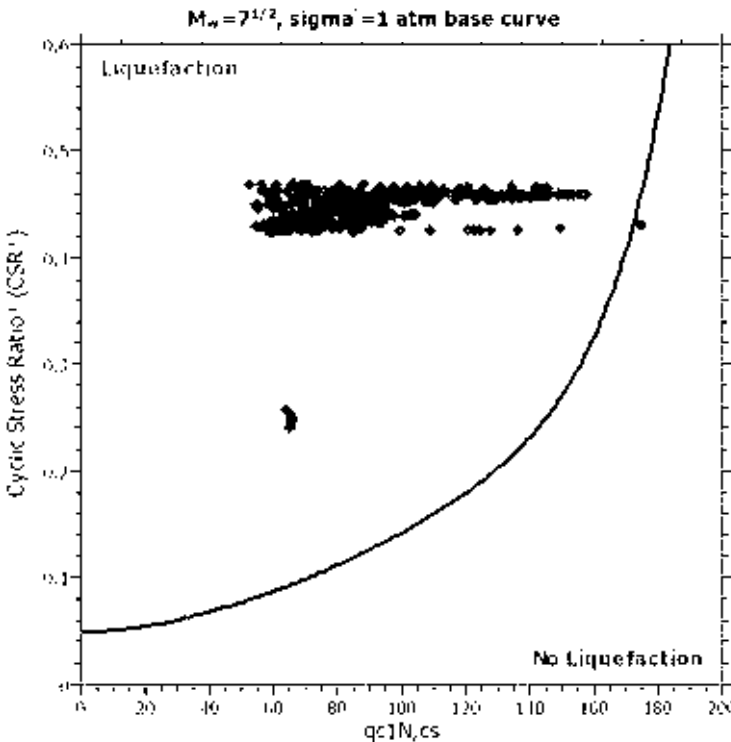
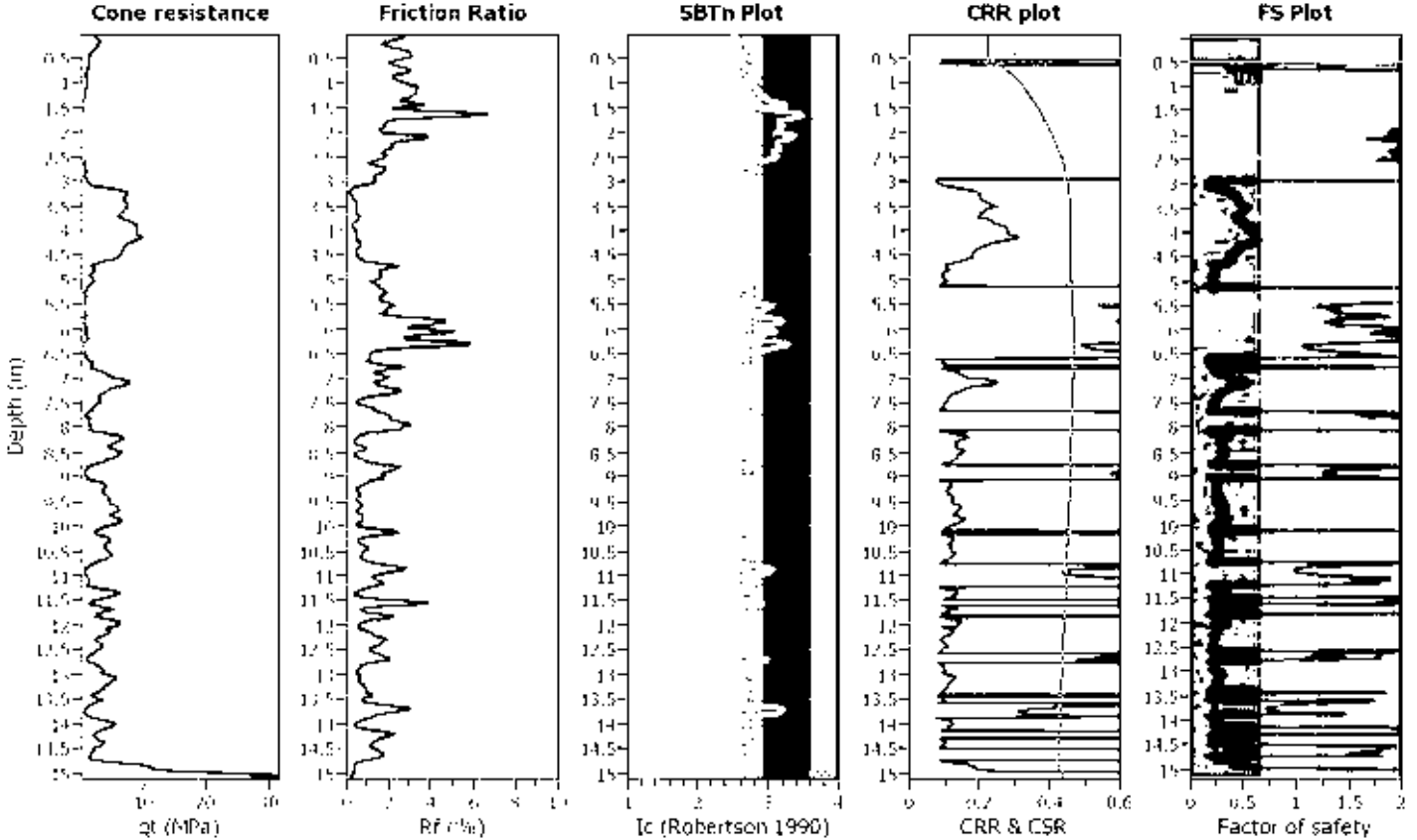
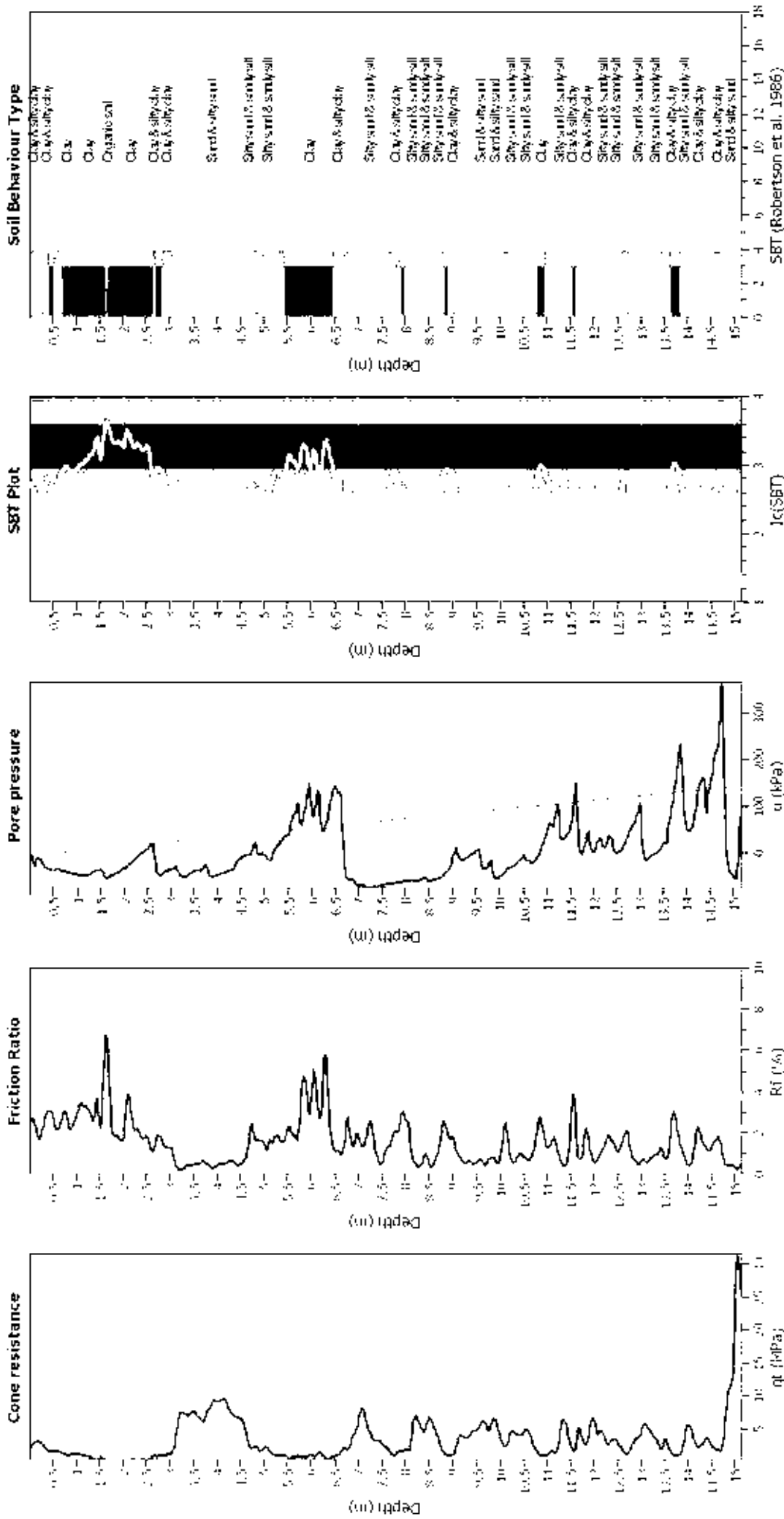


Figure 4: Summary of liquefaction potential plot and curve of cyclic stress ratio. Zone A1: Fully liquefied (CSR > 1.0) and Zone A2: Partially liquefied (0.5 < CSR < 1.0). Zone B: Liquefaction potential (0.1 < CSR < 0.5) and Zone C: No liquefaction (CSR < 0.1). The chart is divided into zones A1, A2, B, and C. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with a curve indicating the boundary between liquefaction and no liquefaction.

CPT basic interpretation plots



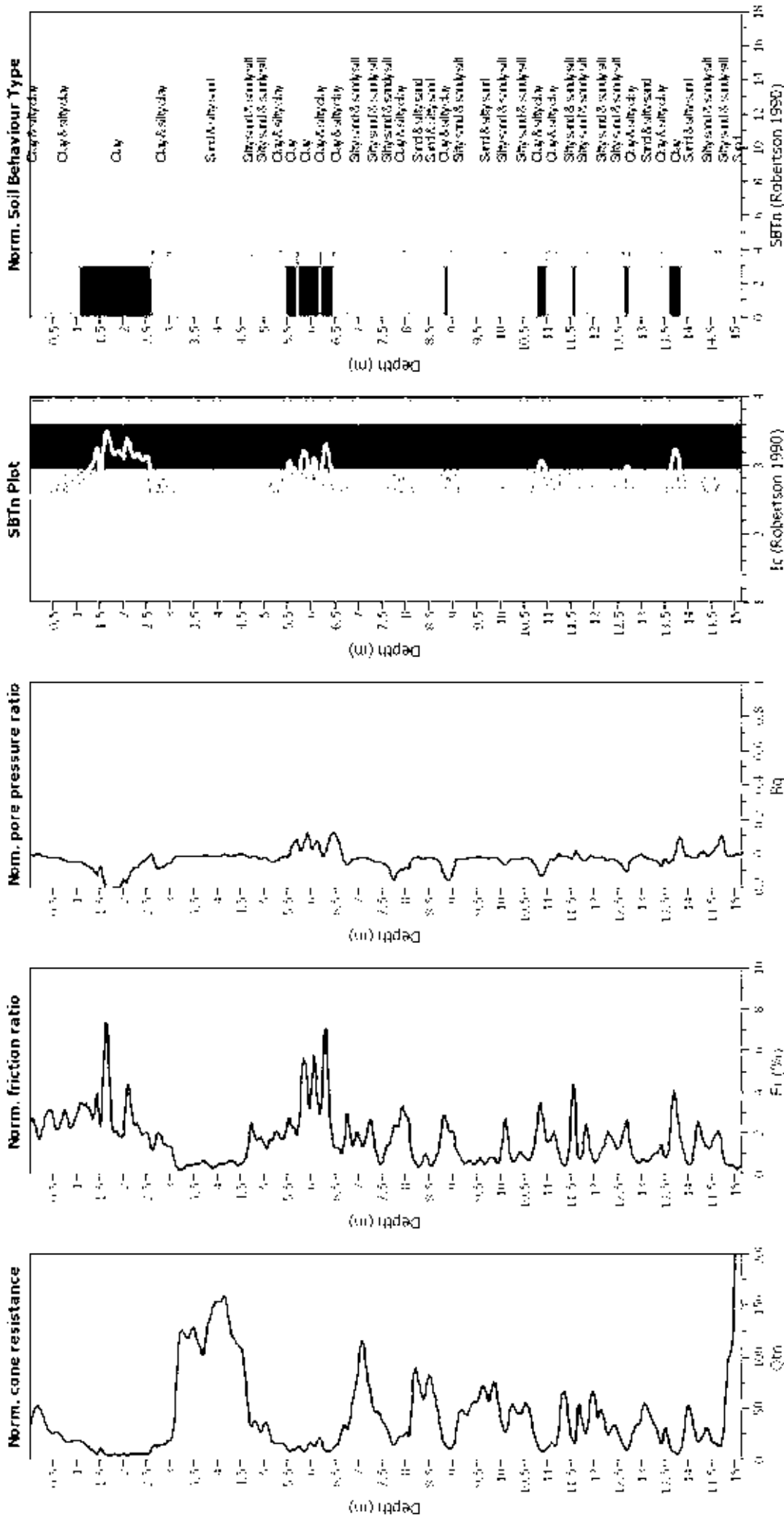
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	0.50 m	Unit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



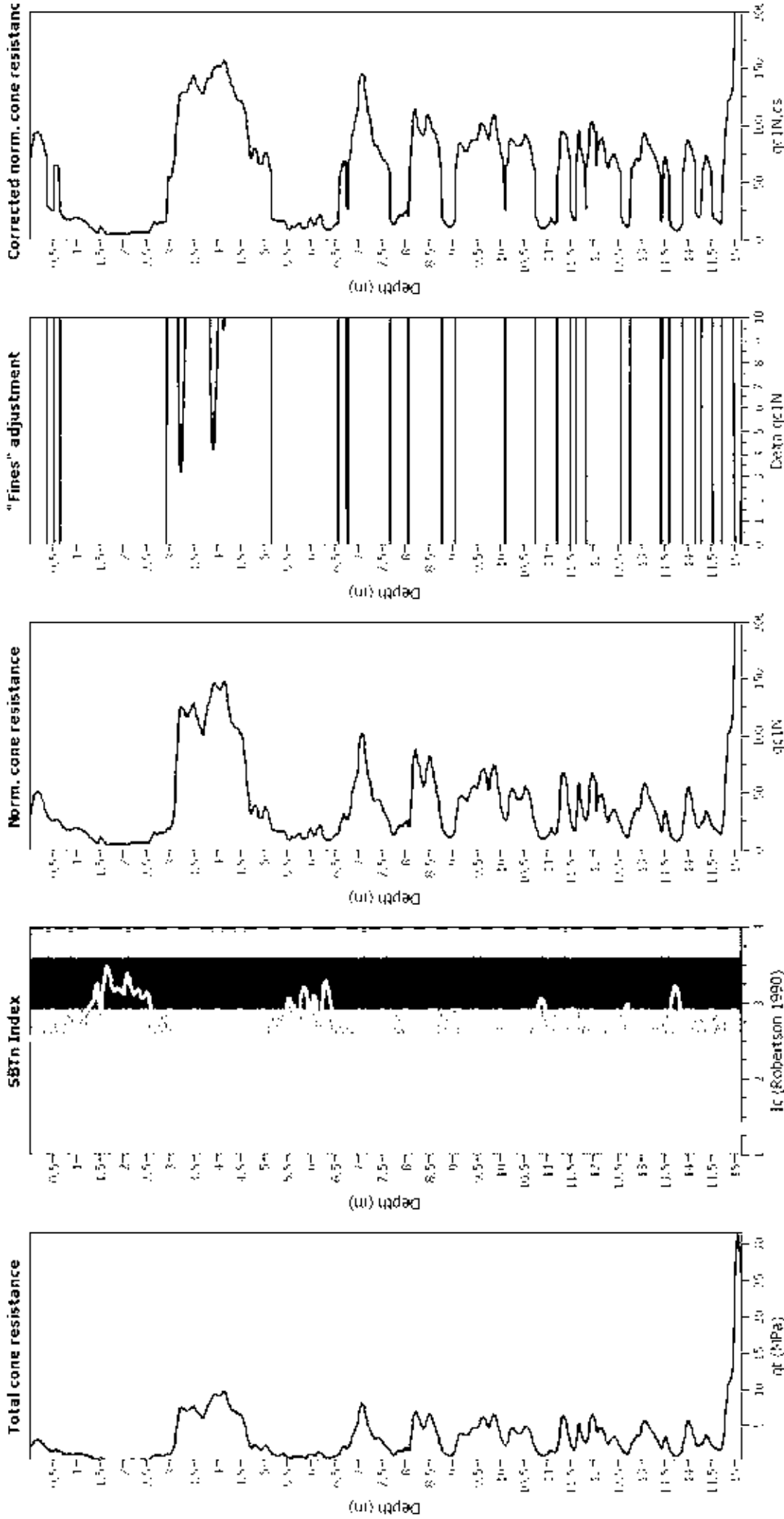
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	0.50 m	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Average results interval:	3	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (erthq.):	0.50 m	Fill height:	N/A		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

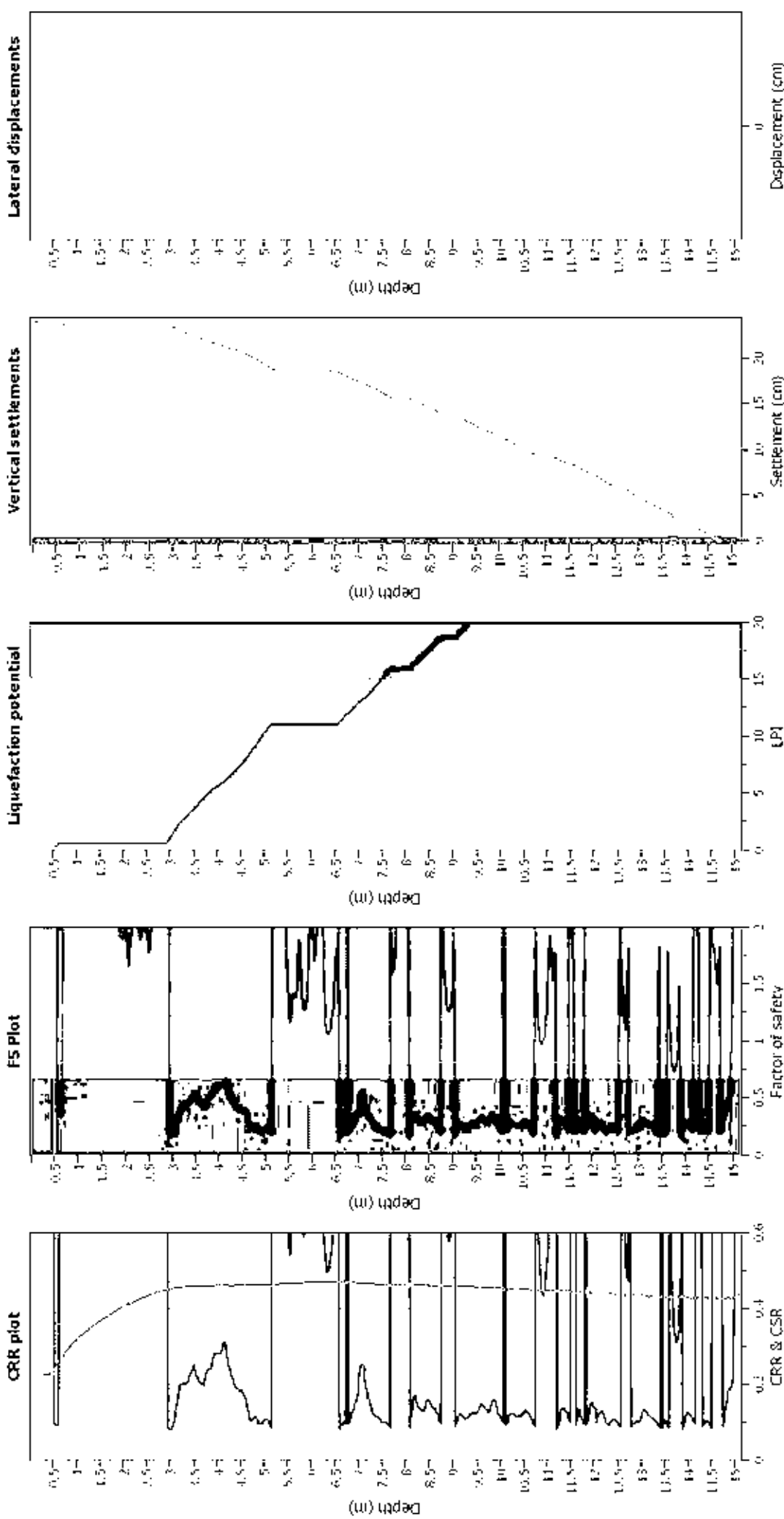
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make magnitude M_v :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Lines correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.5
 Peak ground acceleration: 0.35
 Depth to water table (m): 0.50 m

Depth to GW (earthq.): 0.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

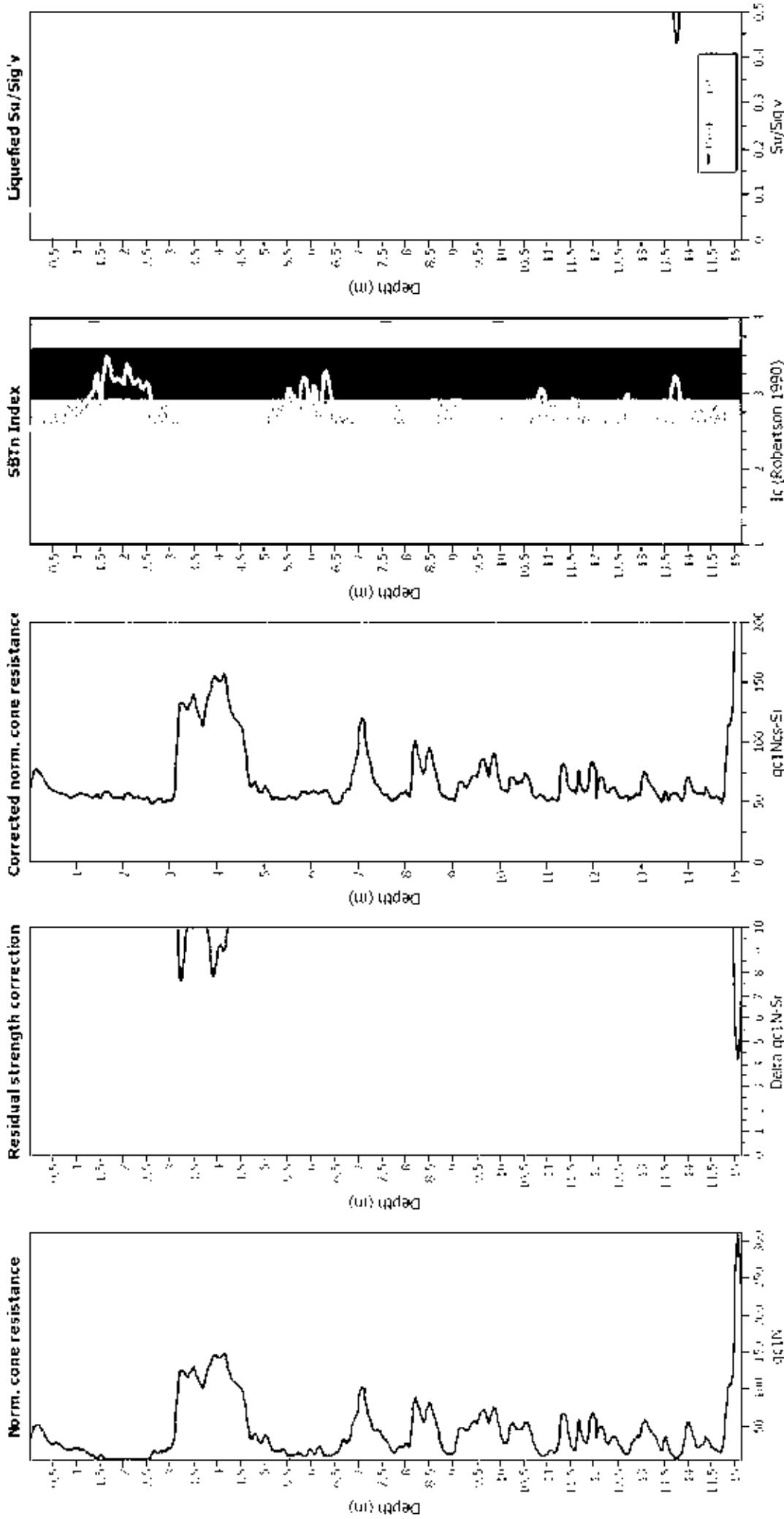
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

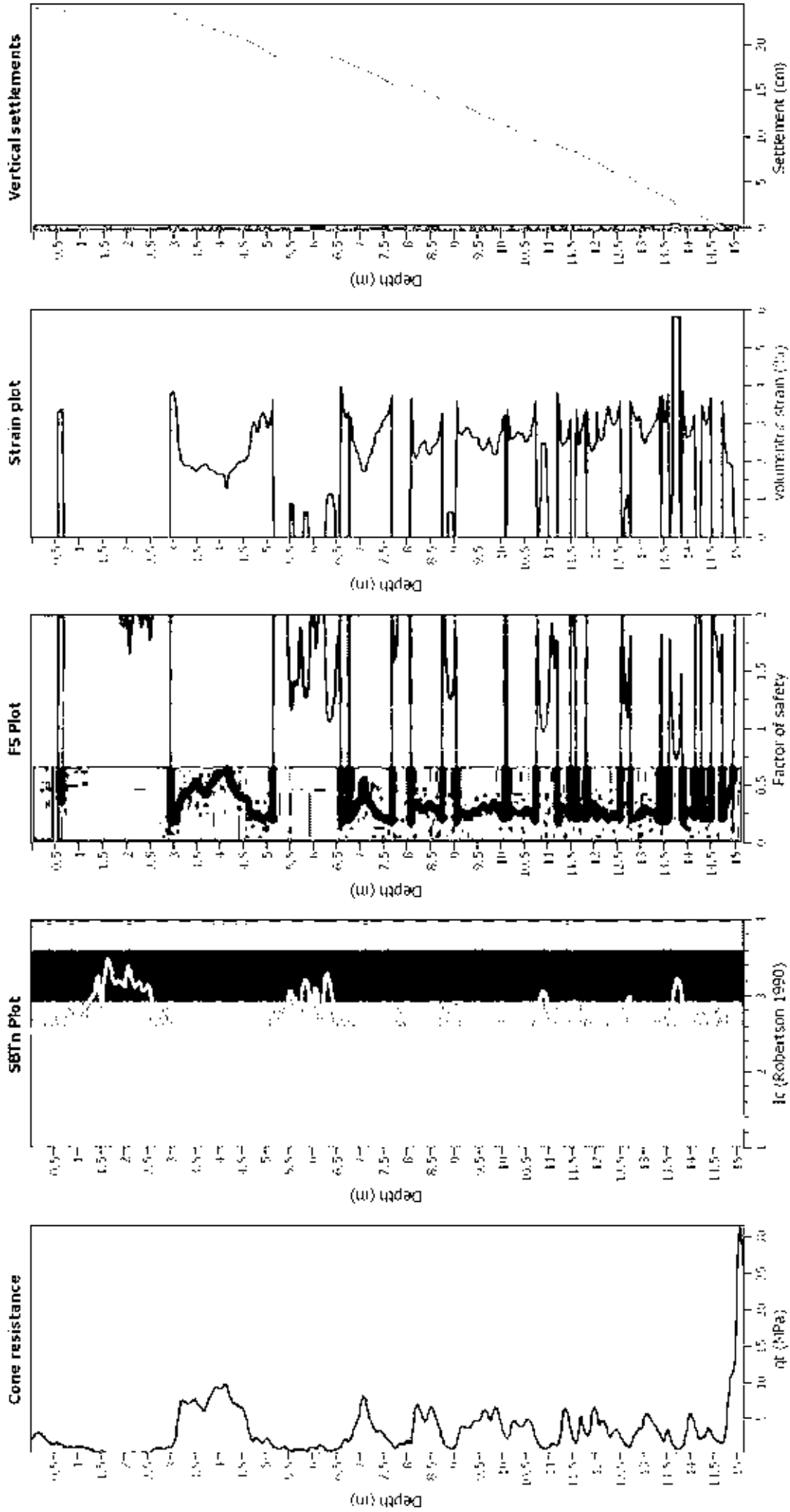
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Factorial mag. angle β_s :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table ($z_{w,eq}$):	0.50 m	Limit depth:	N/A
Depth to GW (erthq.):	0.50 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT35_32SutherlandsRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

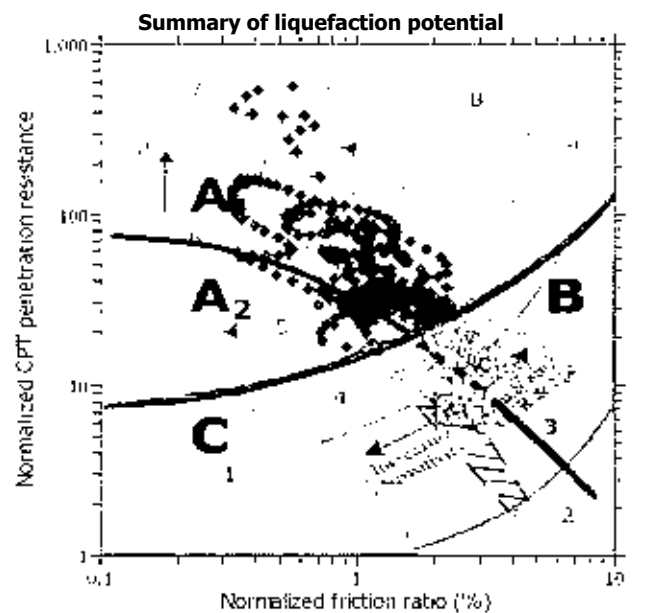
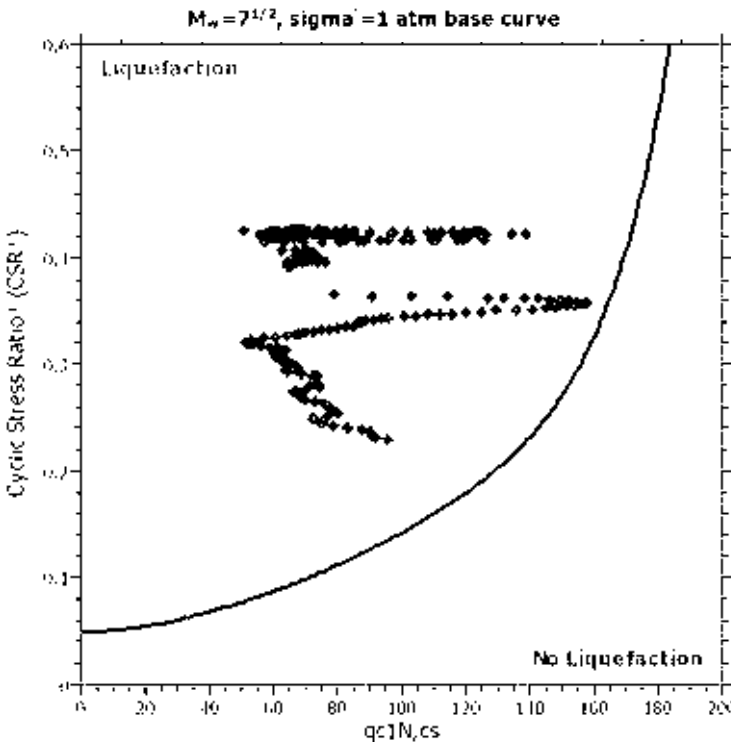
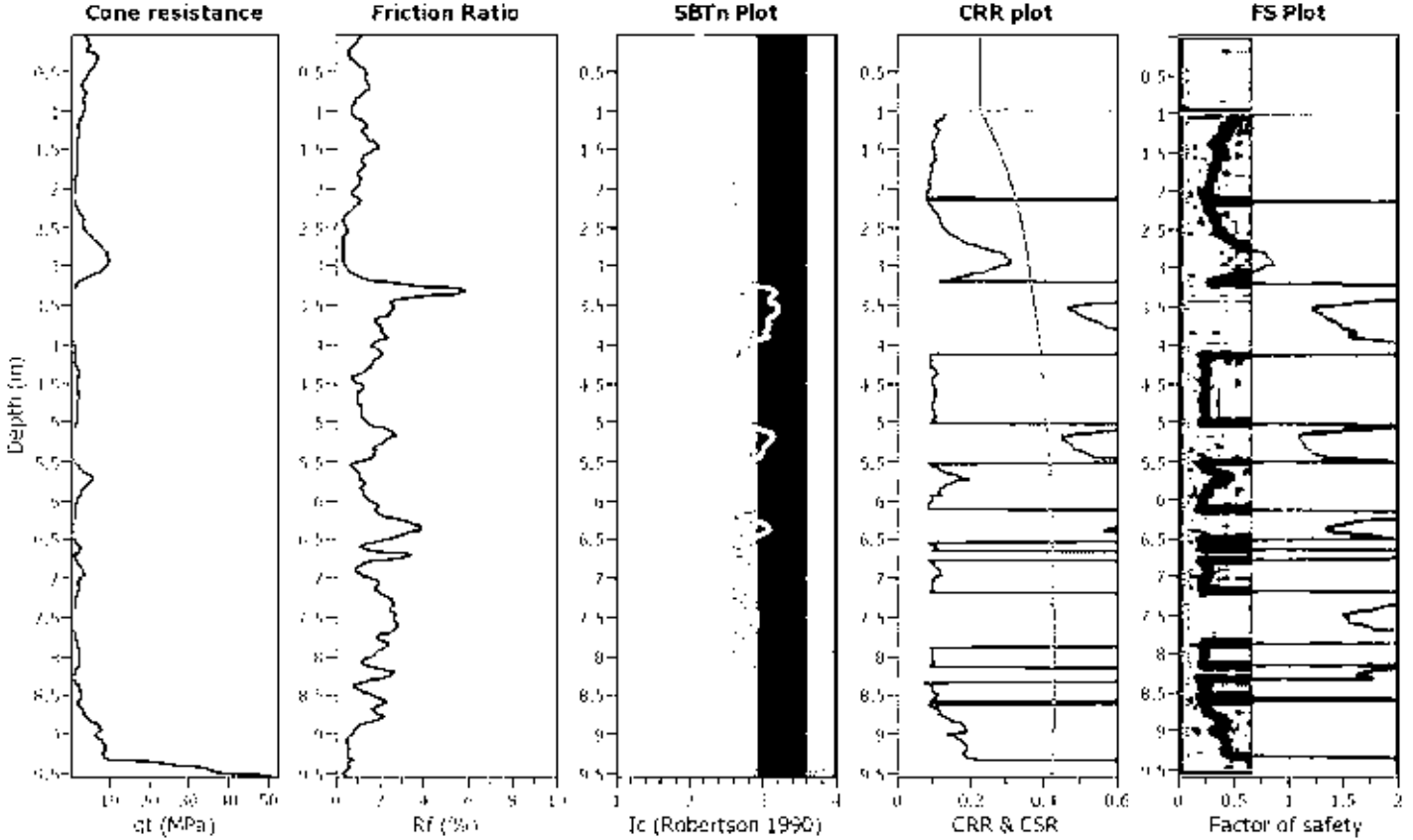
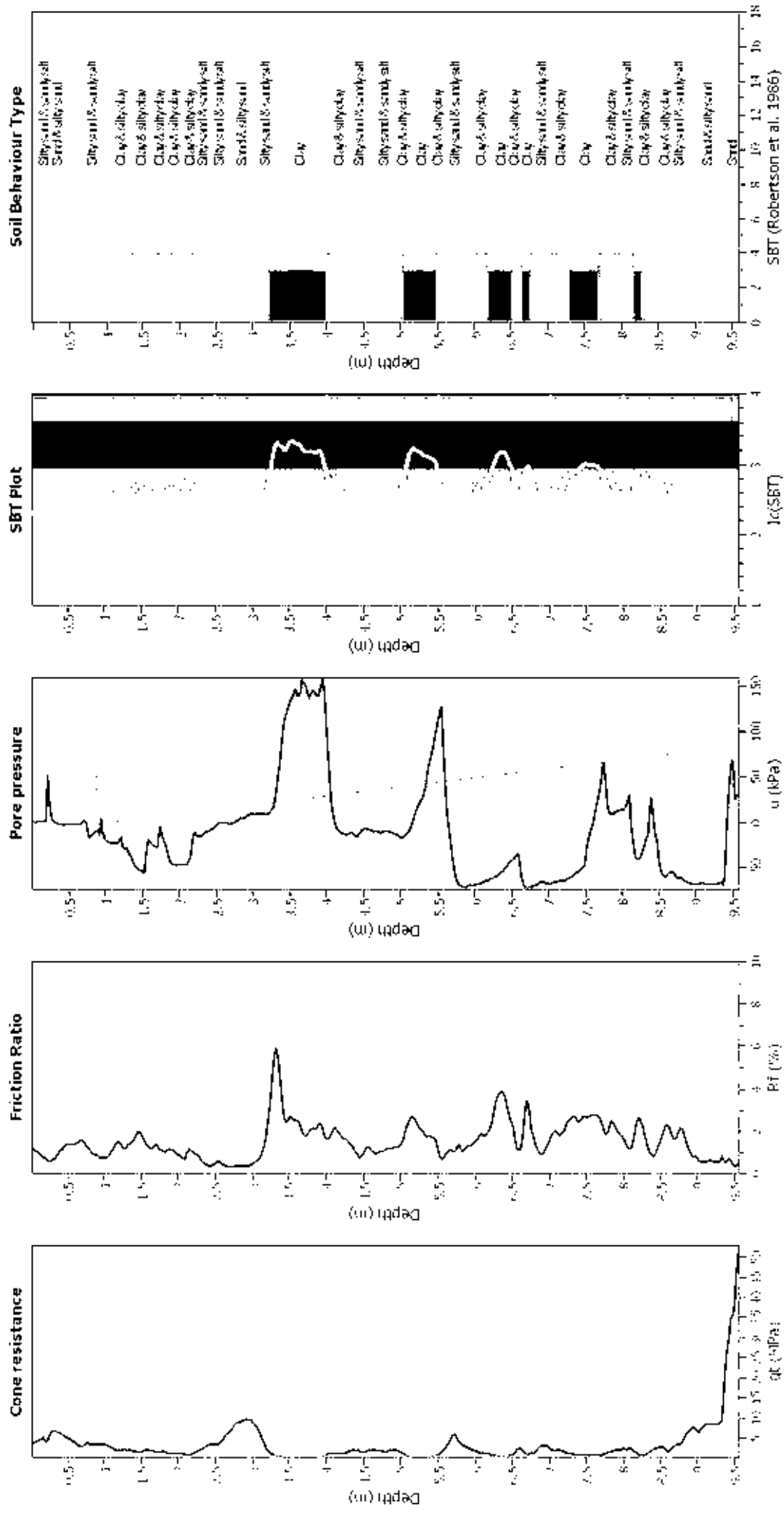


Figure 4: Summary of liquefaction potential plot and curve of cyclic stress ratio. Zone A1: Fully liquefied (CSR > 1.0), Zone A2: Partially liquefied (0.5 < CSR < 1.0), Zone B: Liquefaction potential (0.2 < CSR < 0.5), Zone C: No liquefaction (CSR < 0.2). The liquefaction boundary is shown as a dashed line.

CPT basic interpretation plots



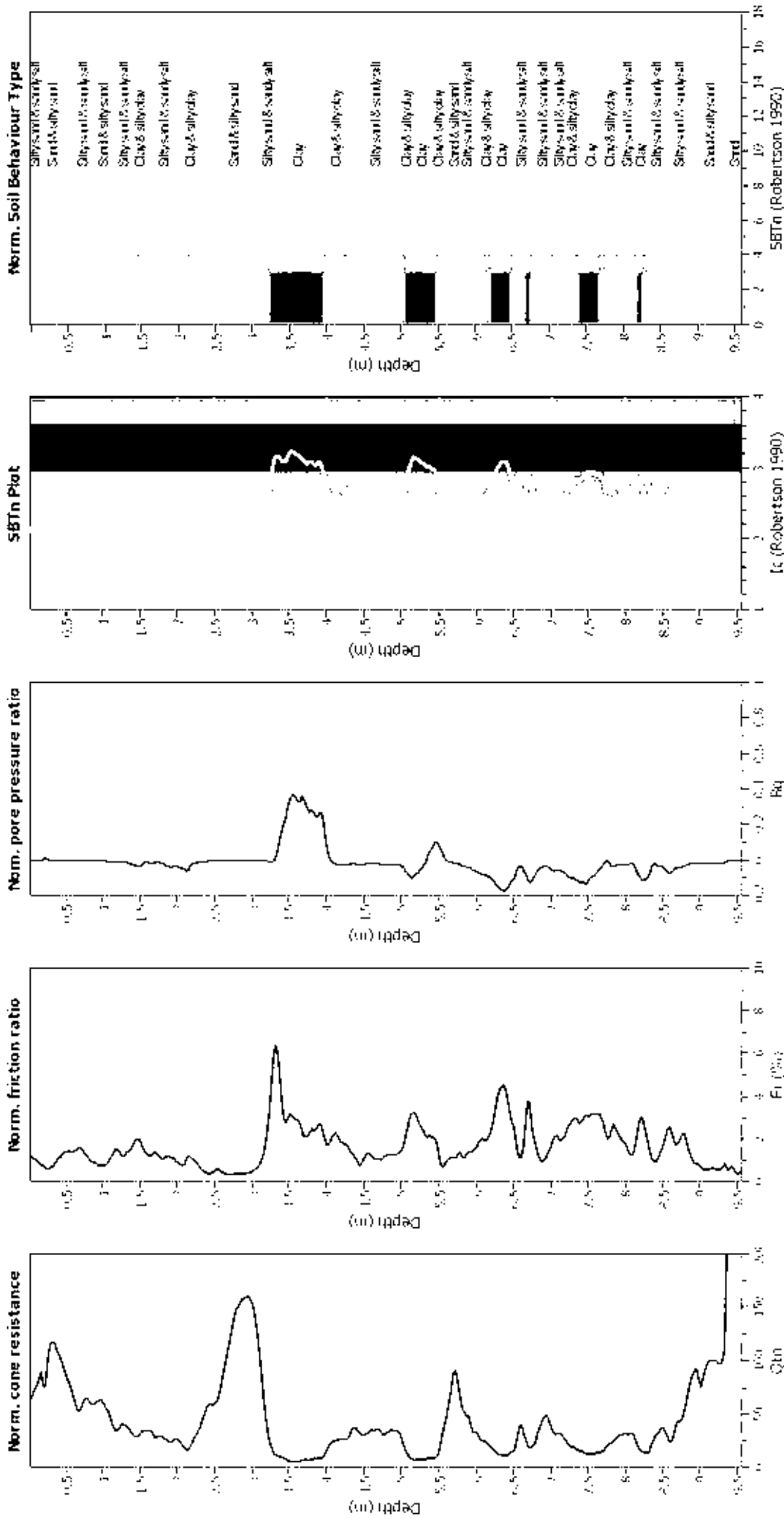
Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	N/A
Depth to water table (z_{wt}):	1.00 m	Unit depth:	N/A
Depth to GW (erthq.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



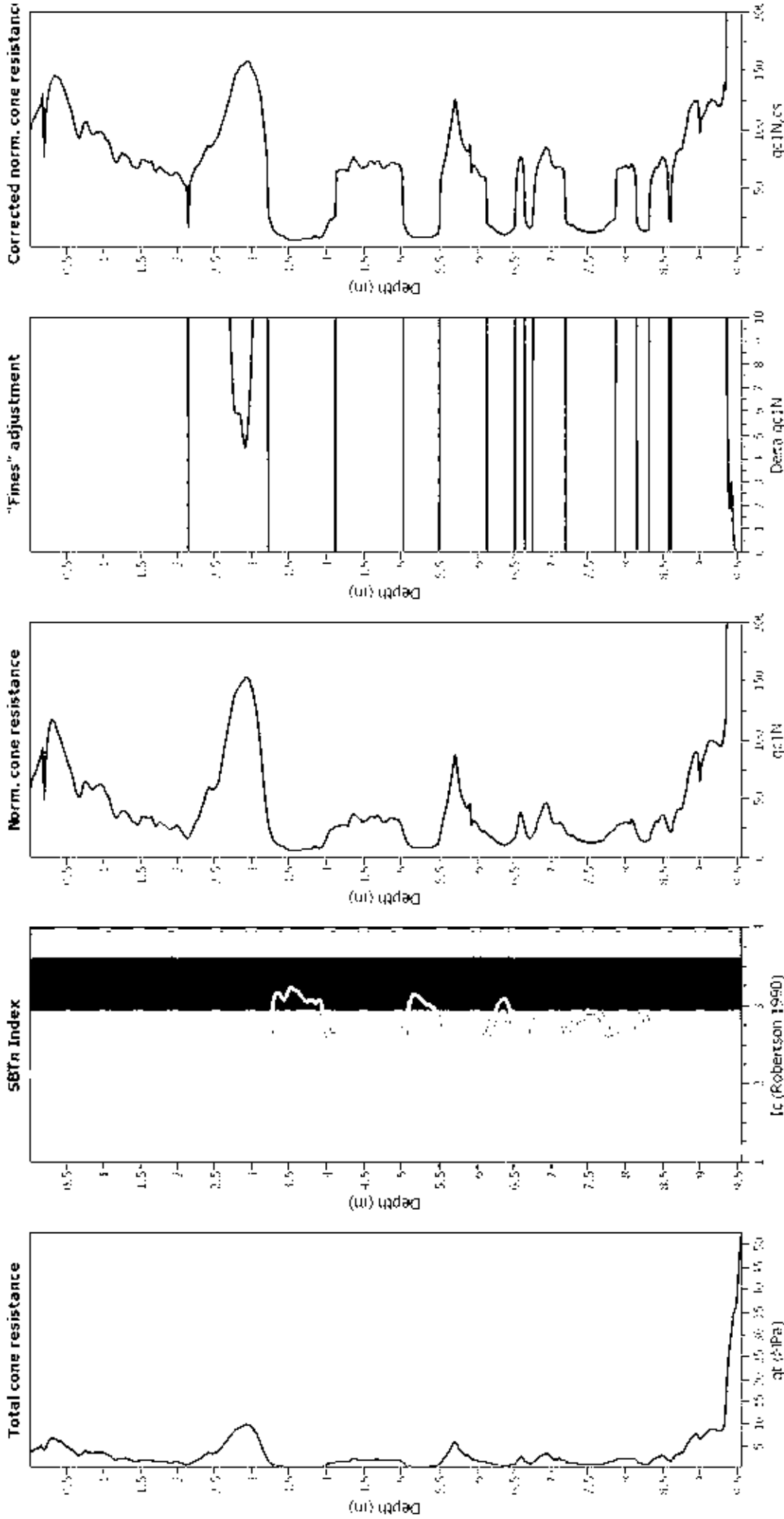
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

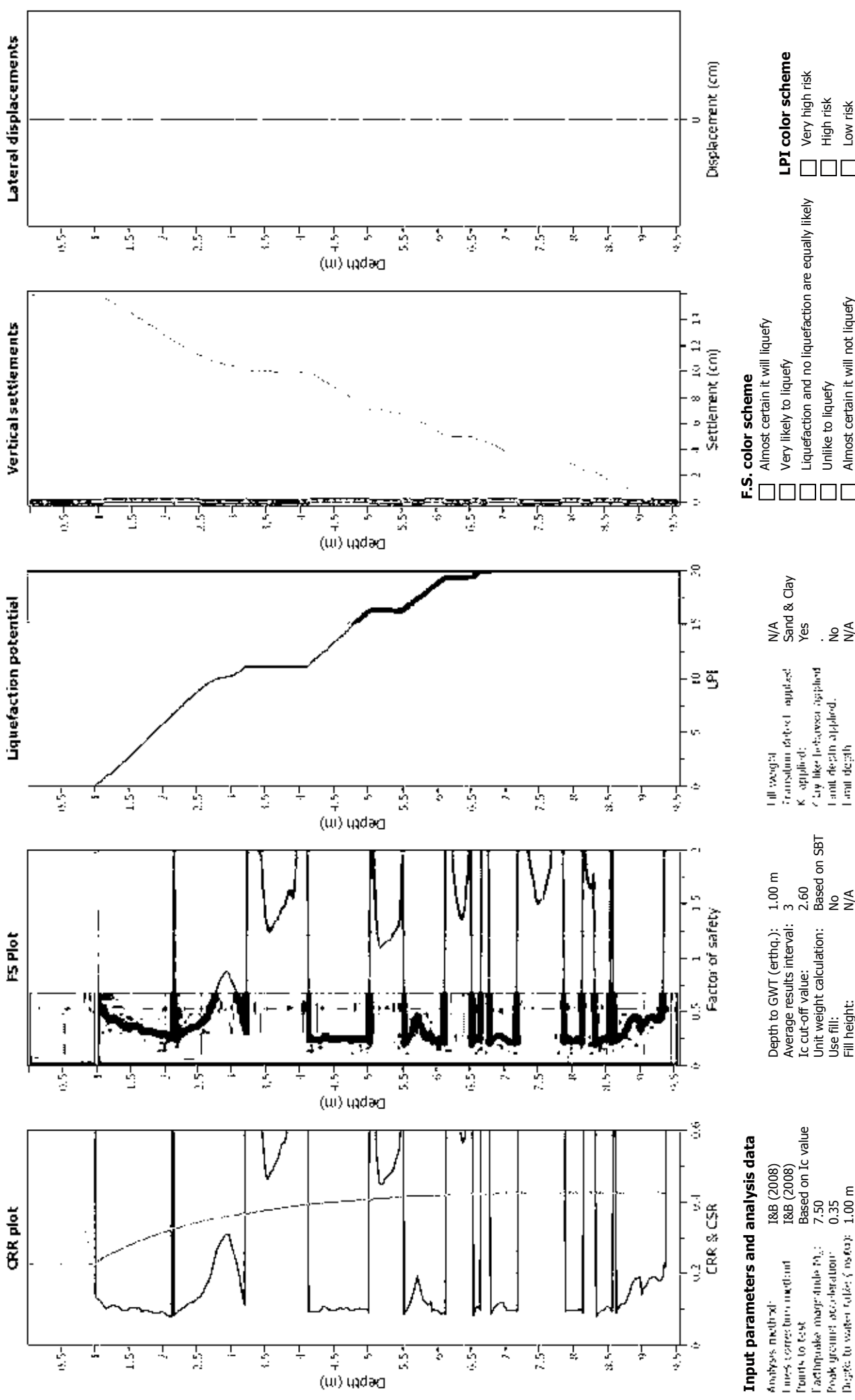
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Lam. depth applied:	No
Depth to water table (m):	1.00 m	Lam. depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Liquefaction correction method: 18B (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude M_L : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

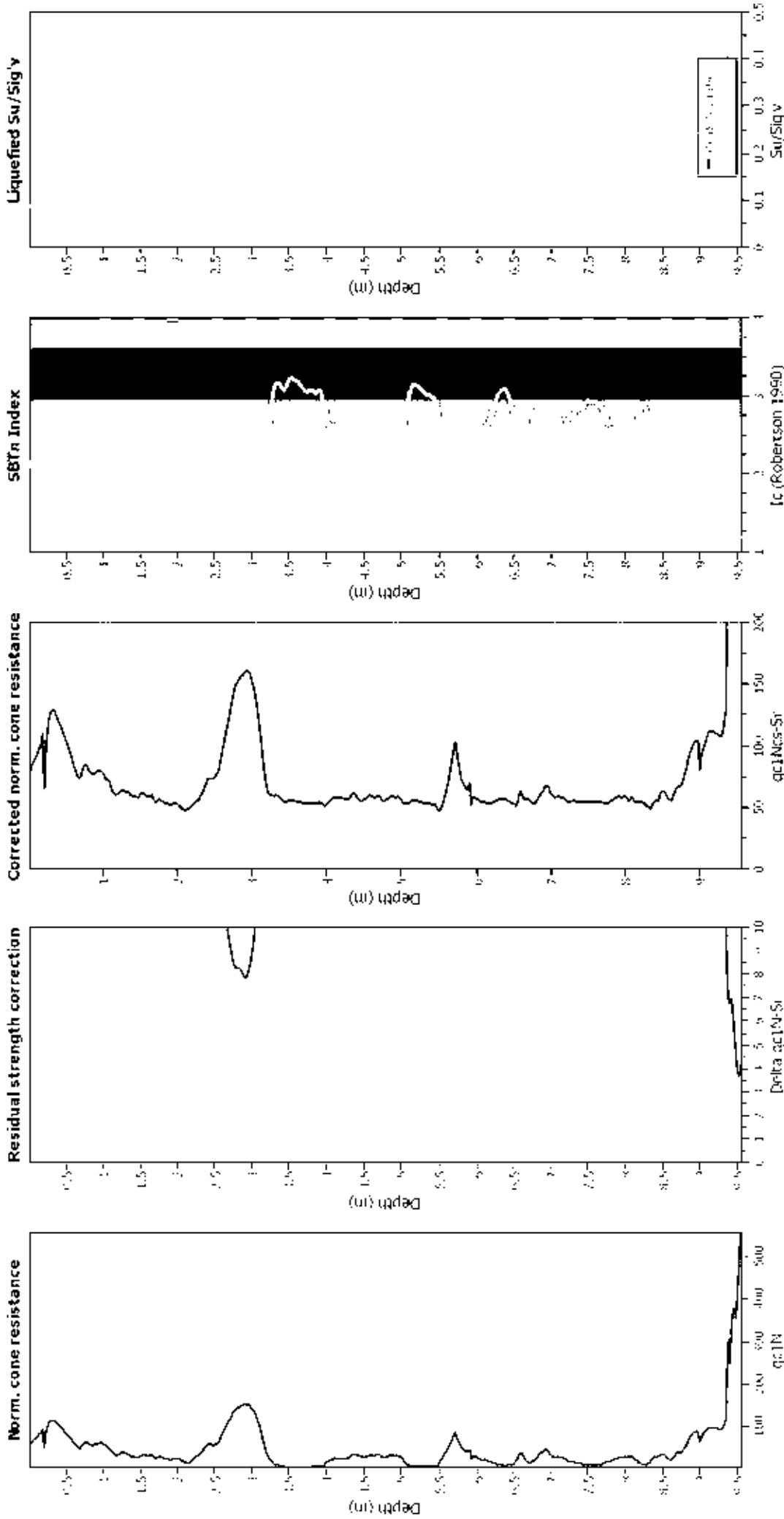
F.S. color scheme

Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlike to liquefy
 Almost certain it will not liquefy

LPI color scheme

Very high risk
 High risk
 Low risk

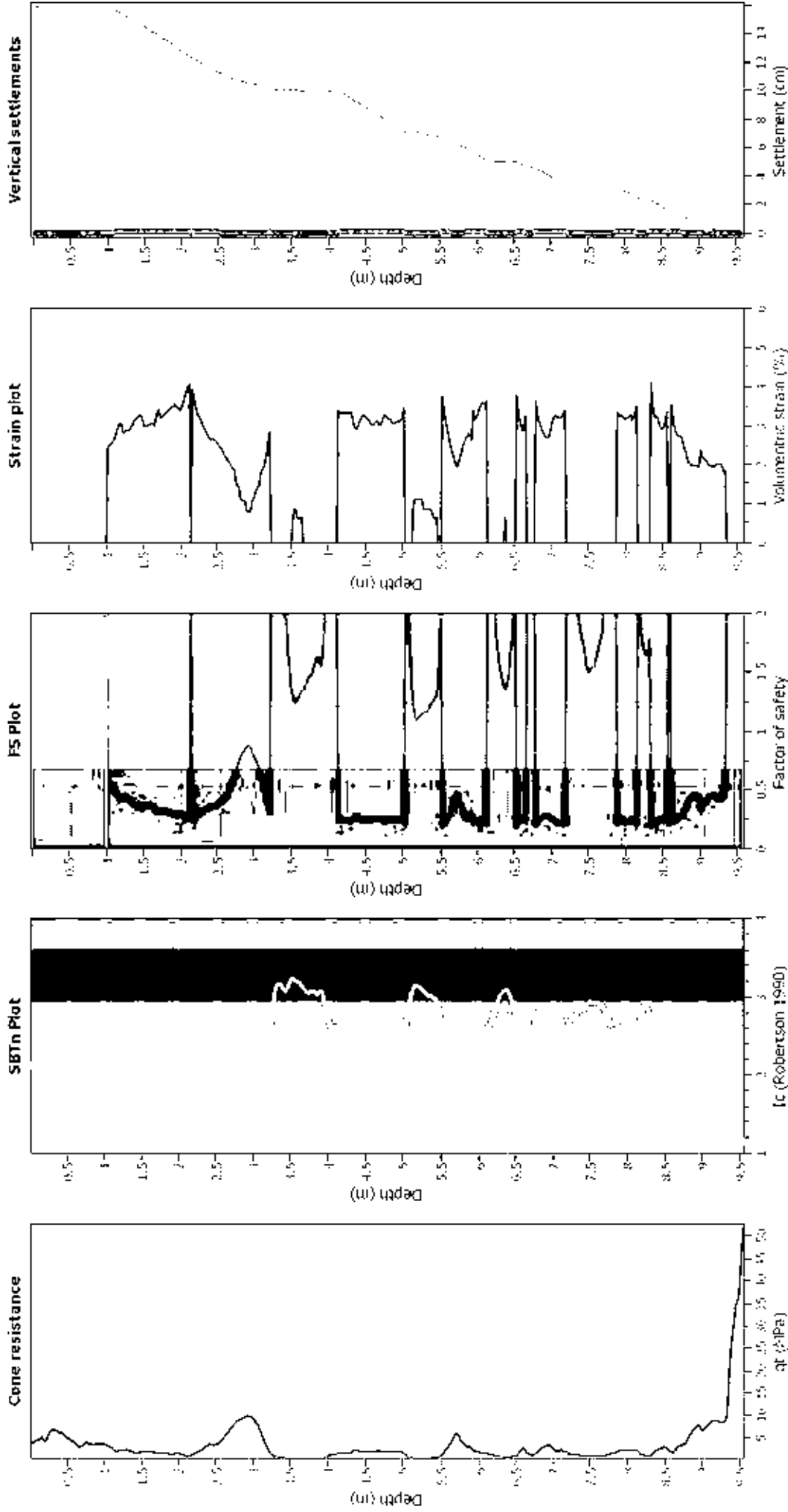
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Lamé depth applied:	No
Depth to water table (m):	1.00 m	Lamé depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

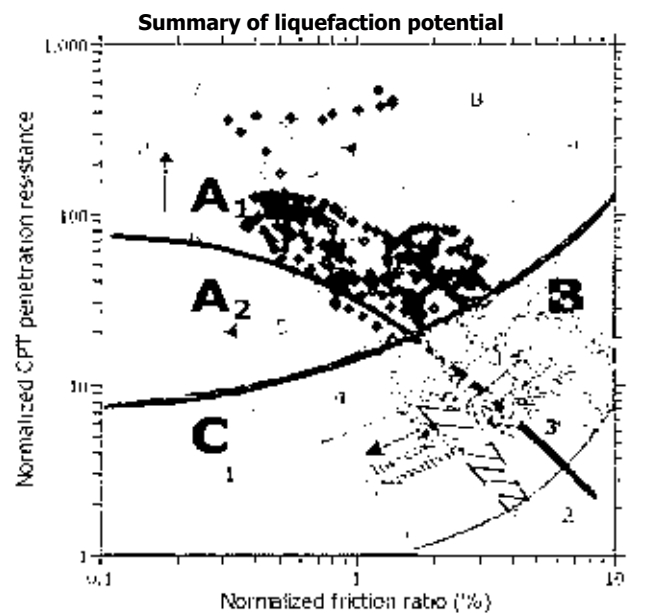
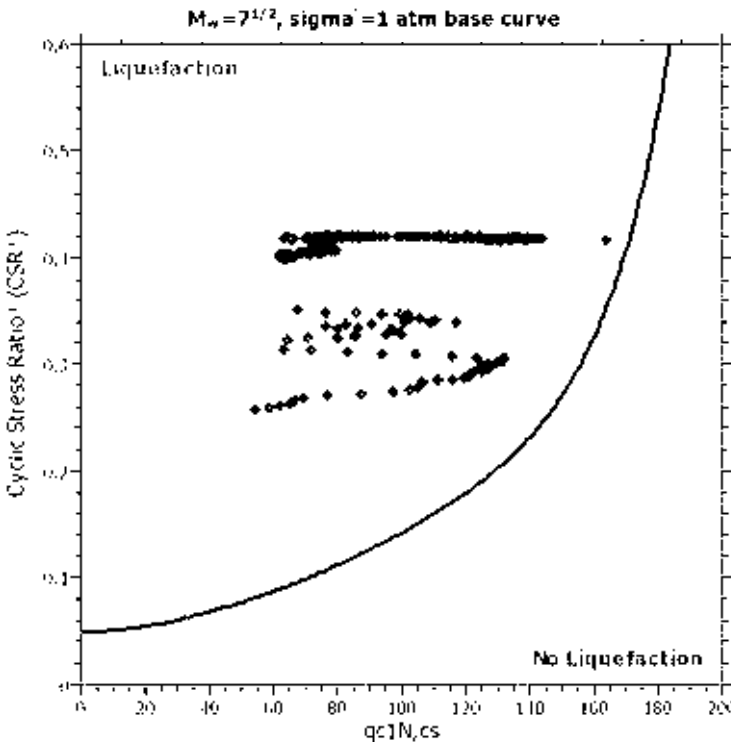
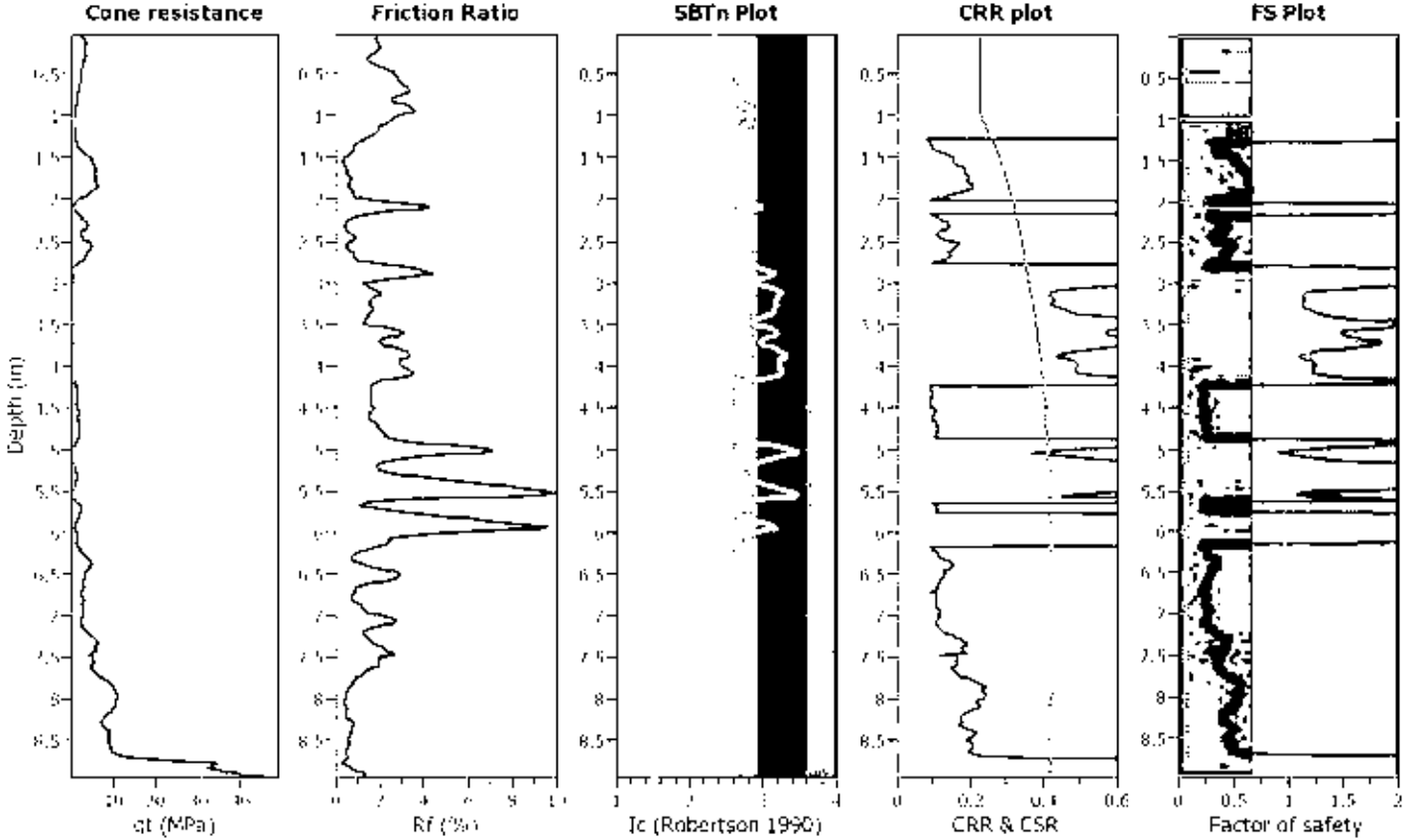
- q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT36_32SutherlandsRd

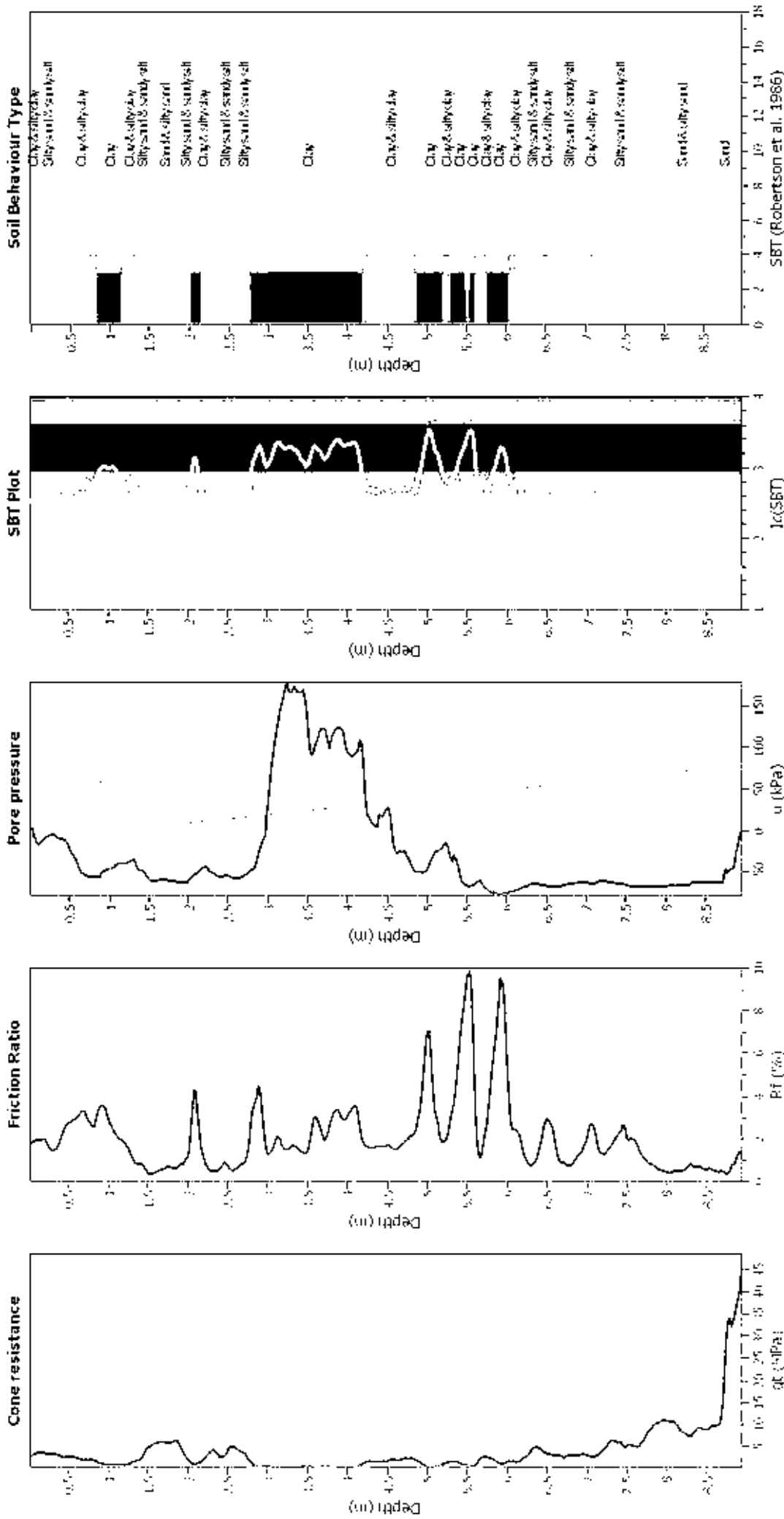
Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		



Zone A₁ is highly susceptible to cyclic loading and pore water pressure build-up. Zone A₂ is susceptible to cyclic loading and pore water pressure build-up, but is less susceptible to pore water pressure build-up. Zone B is susceptible to cyclic loading and pore water pressure build-up, but is less susceptible to pore water pressure build-up. Zone C is not susceptible to cyclic loading and pore water pressure build-up.

CPT basic interpretation plots



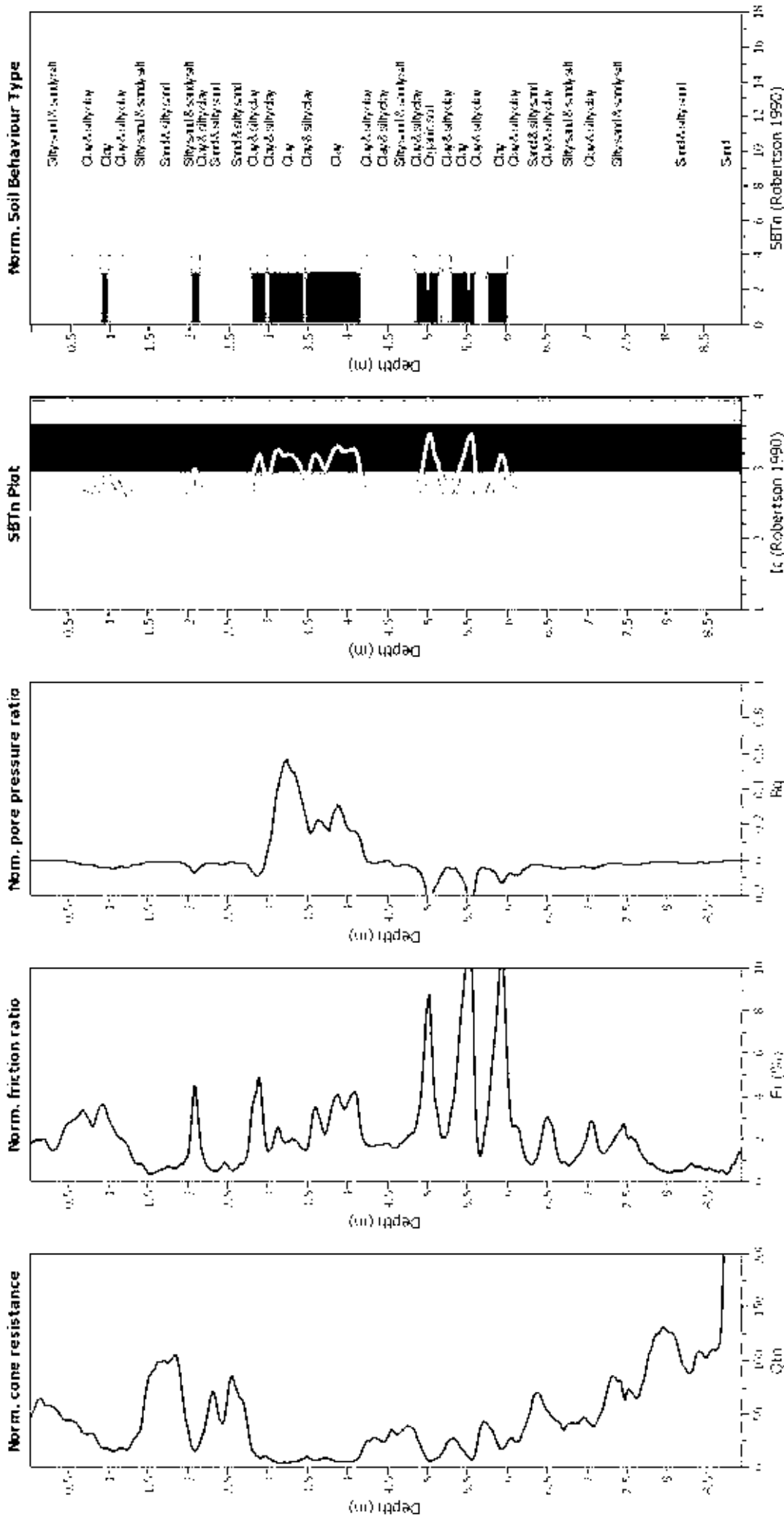
Input parameters and analysis data

Analysis method:	18B (2008)	Full weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	N/A
Depth to water table (m):	1.00 m		
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



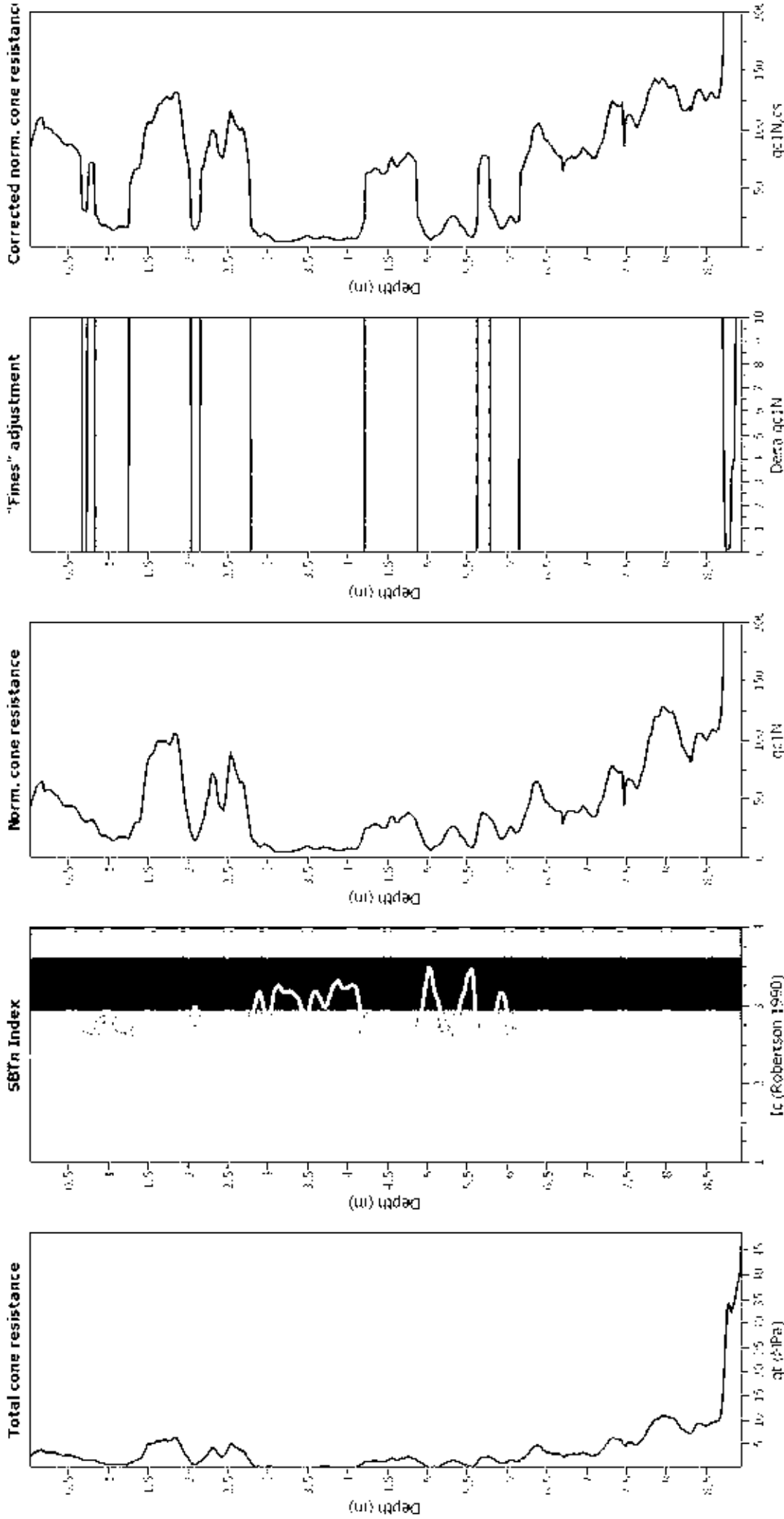
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude (M _w):	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	N/A
Depth to water table (m):	1.00 m	Unit weight:	N/A
		Fill height:	N/A
		Depth to GW (earthq.):	1.00 m
		Average results interval:	3
		Ic cut-off value:	2.60
		Unit weight calculation:	Based on SBT
		Use fill:	No

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

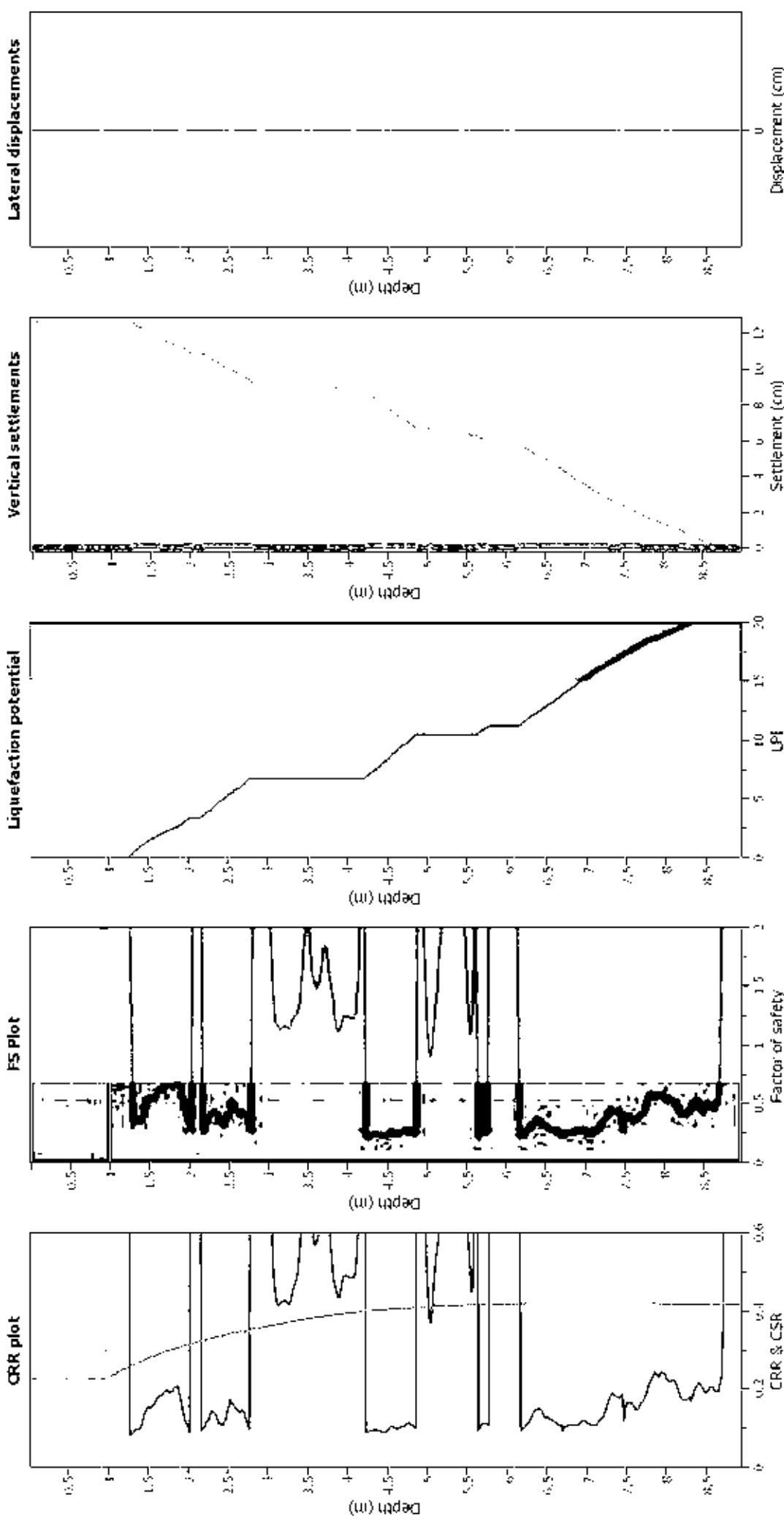
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Lines corre. func. method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Liquefaction correction method: 18B (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

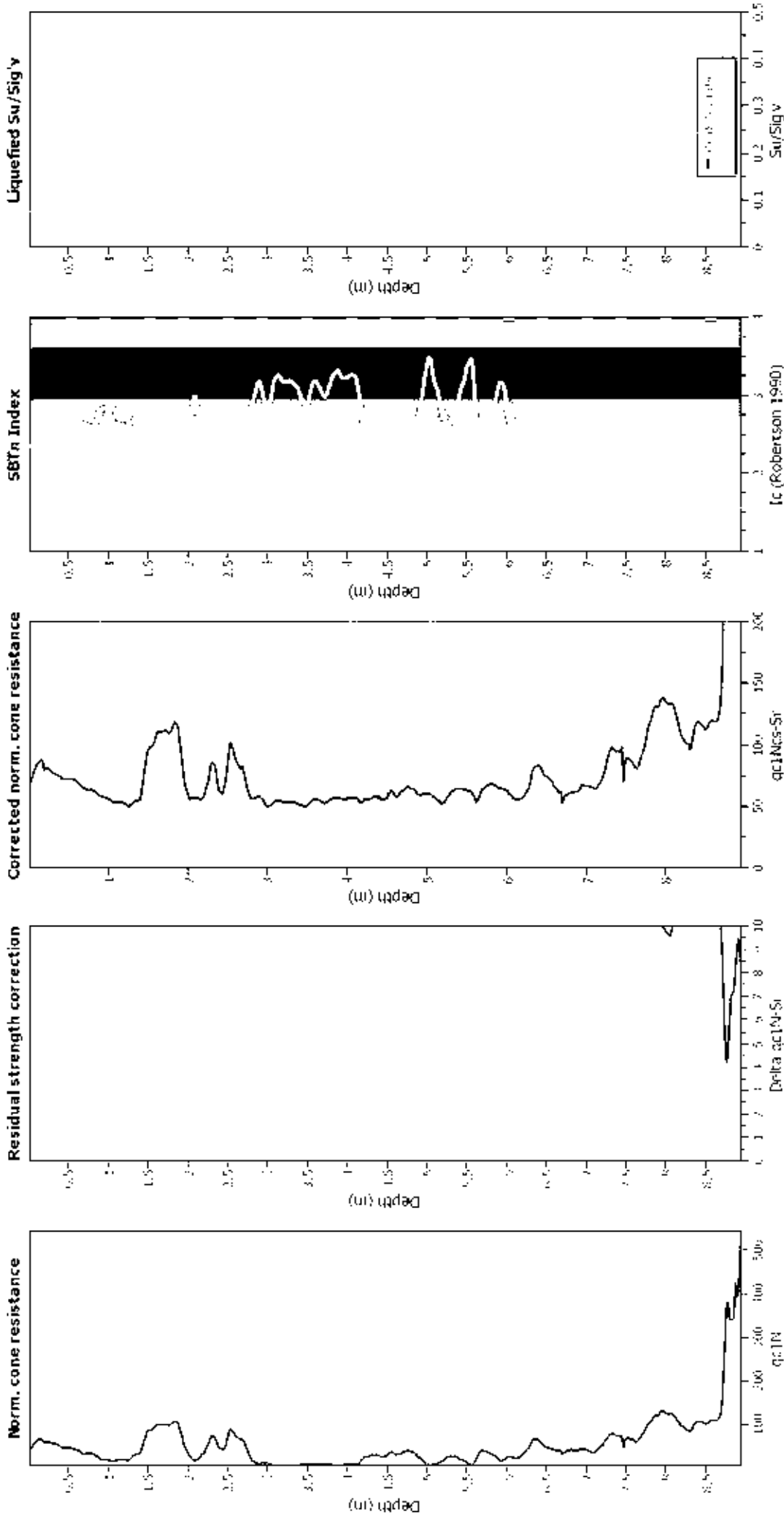
F.S. color scheme

Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlikely to liquefy
 Almost certain it will not liquefy

LPI color scheme

Very high risk
 High risk
 Low risk

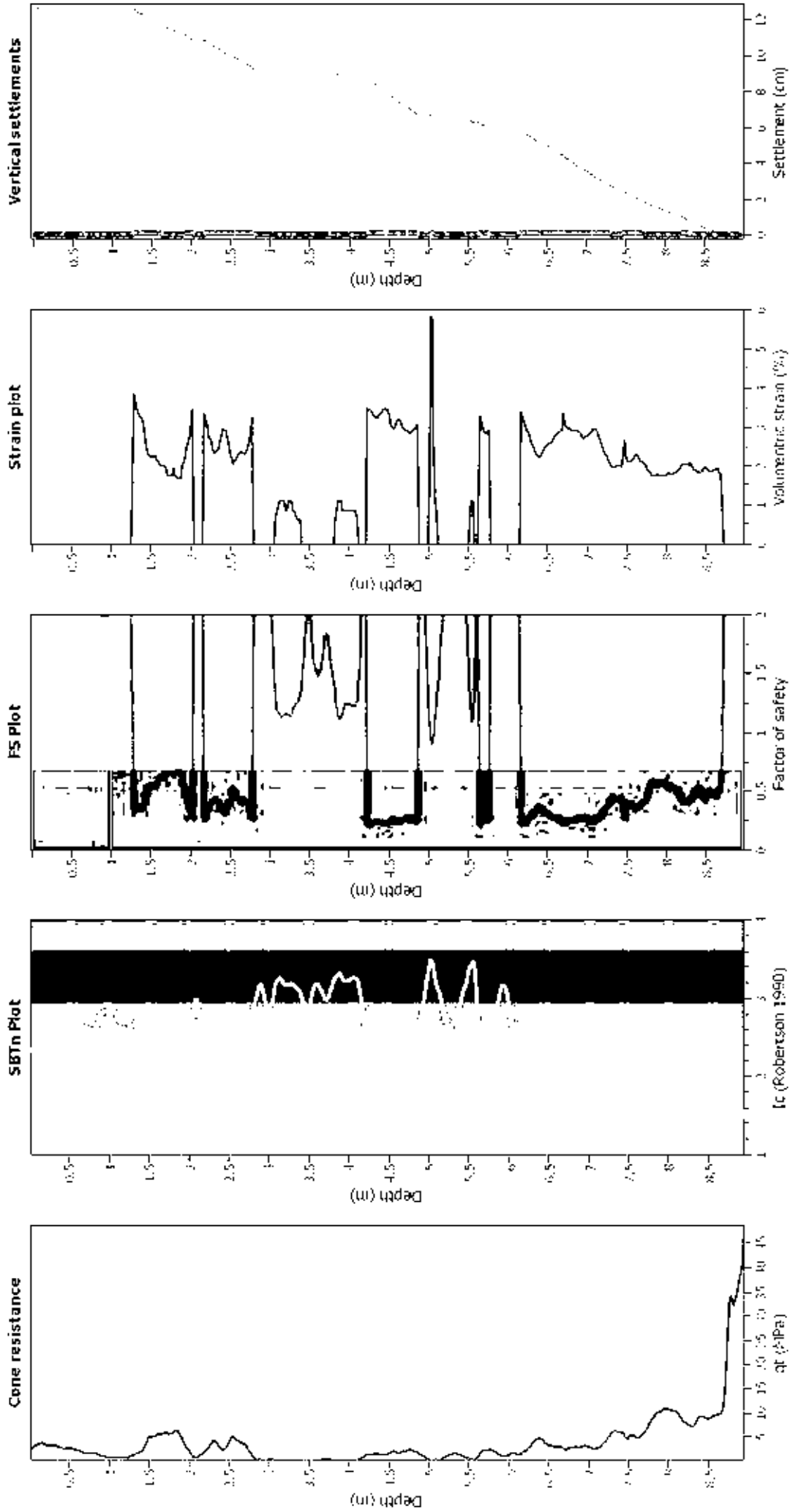
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Lamit depth applied:	No
Depth to water table (m):	1.00 m	Lamit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- q_t: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT37_32SutherlandsRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

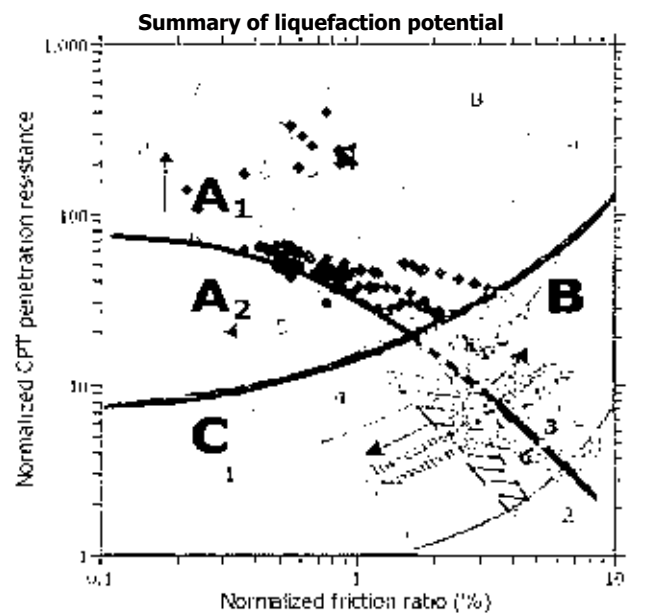
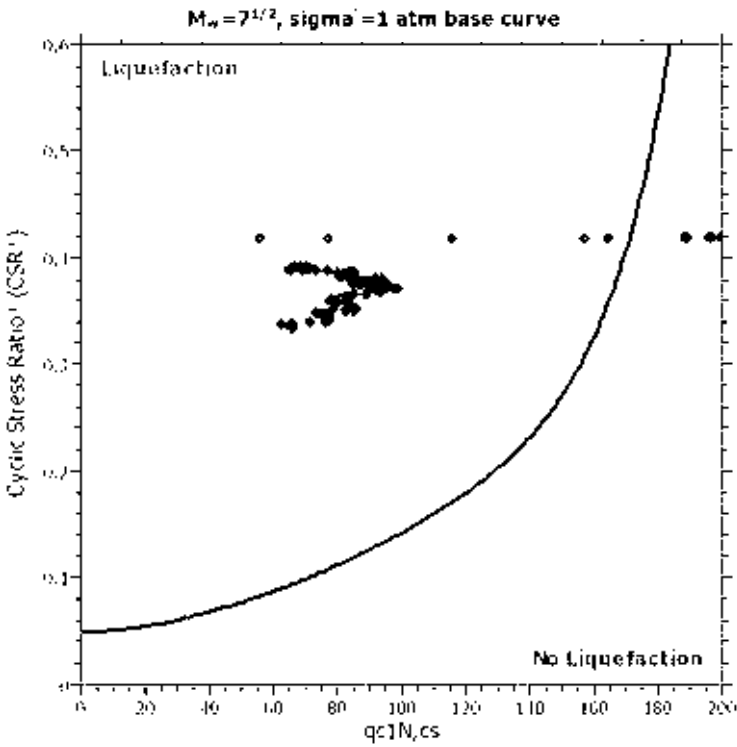
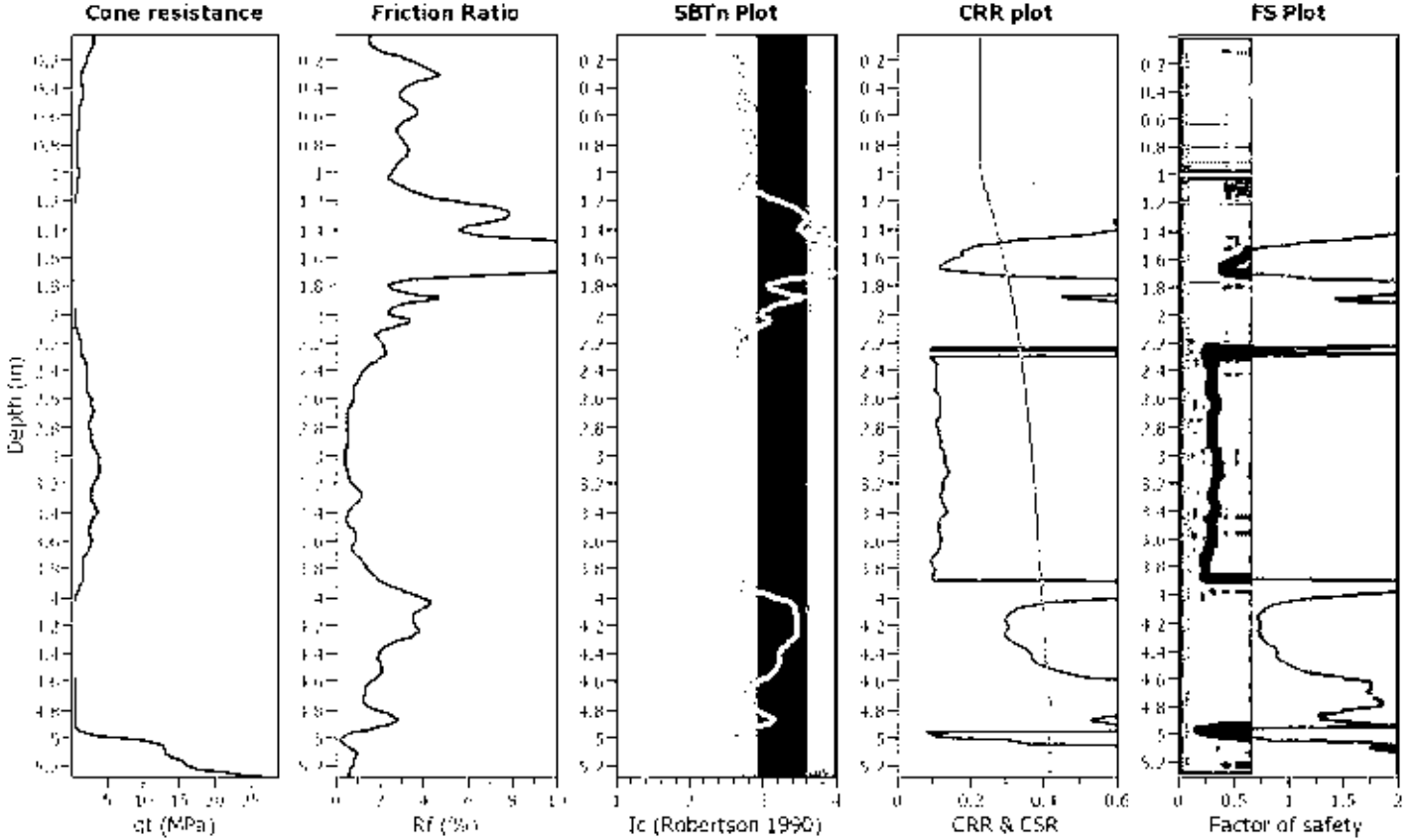
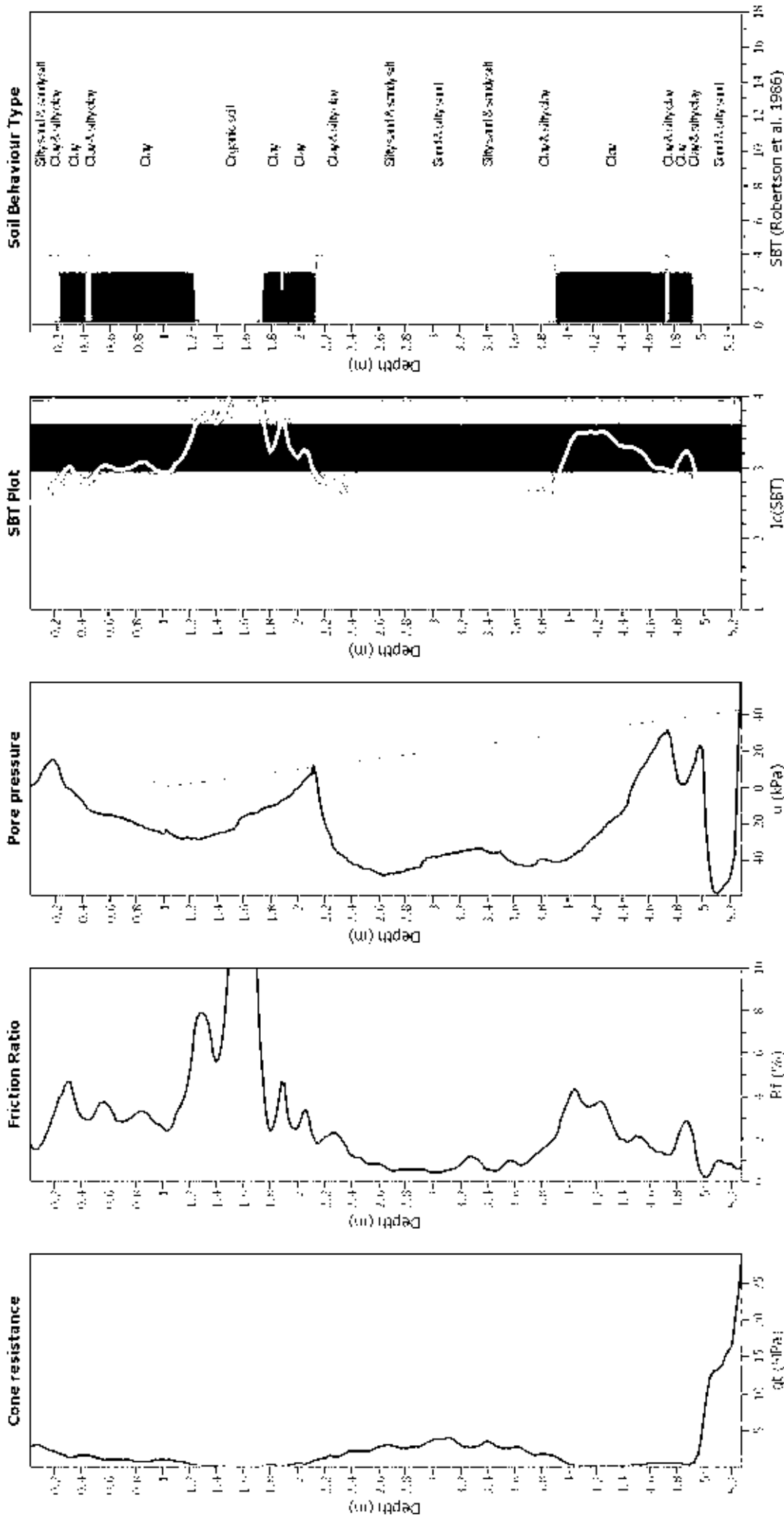


Figure 4: Summary of liquefaction potential plot and normalized cyclic stress ratio plot. The liquefaction potential plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The liquefaction boundary is shown as a dashed line. The cyclic stress ratio plot shows the relationship between cyclic stress ratio and normalized friction ratio. The liquefaction boundary is shown as a solid line.

CPT basic interpretation plots



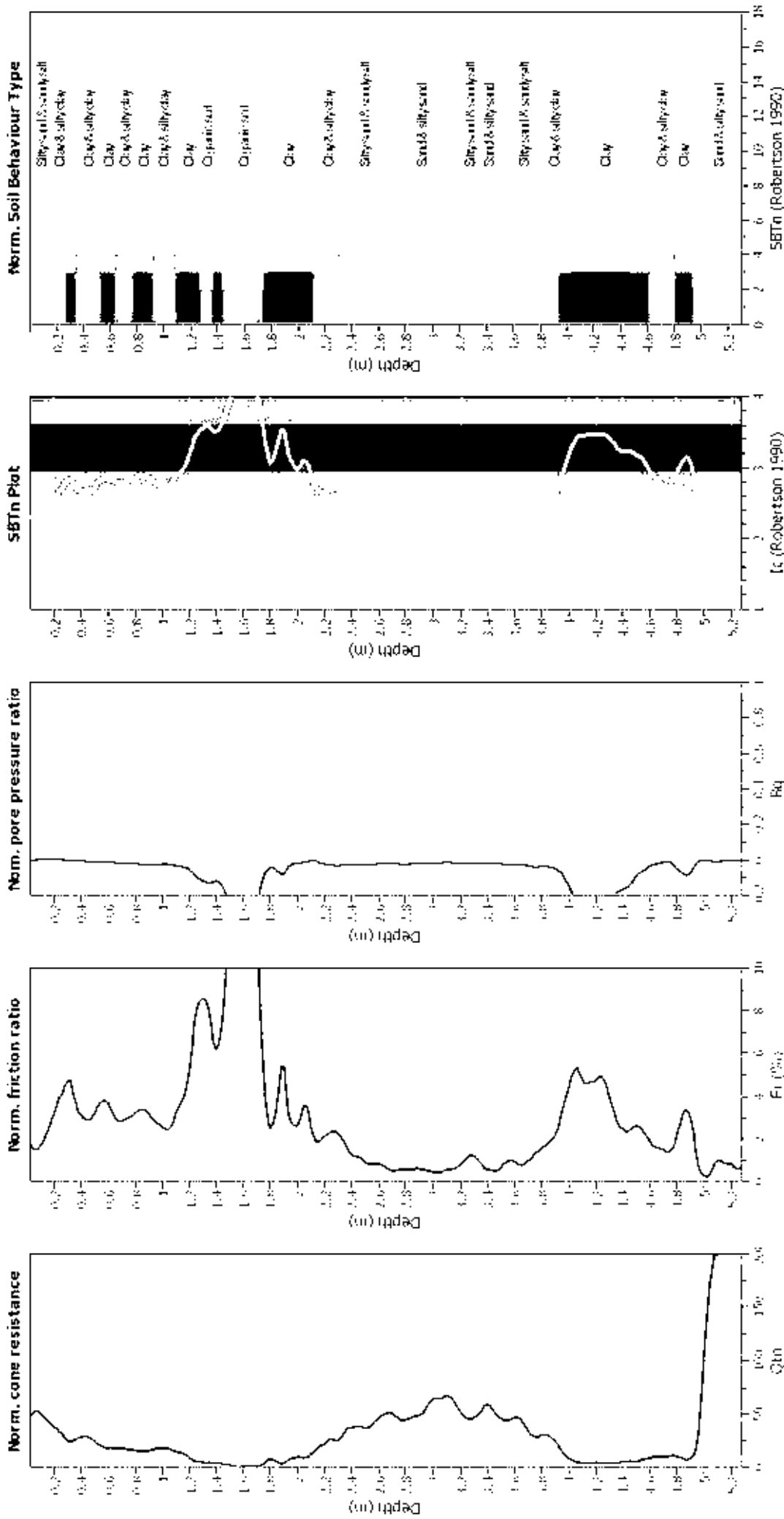
Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (earthq.):	1.00 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



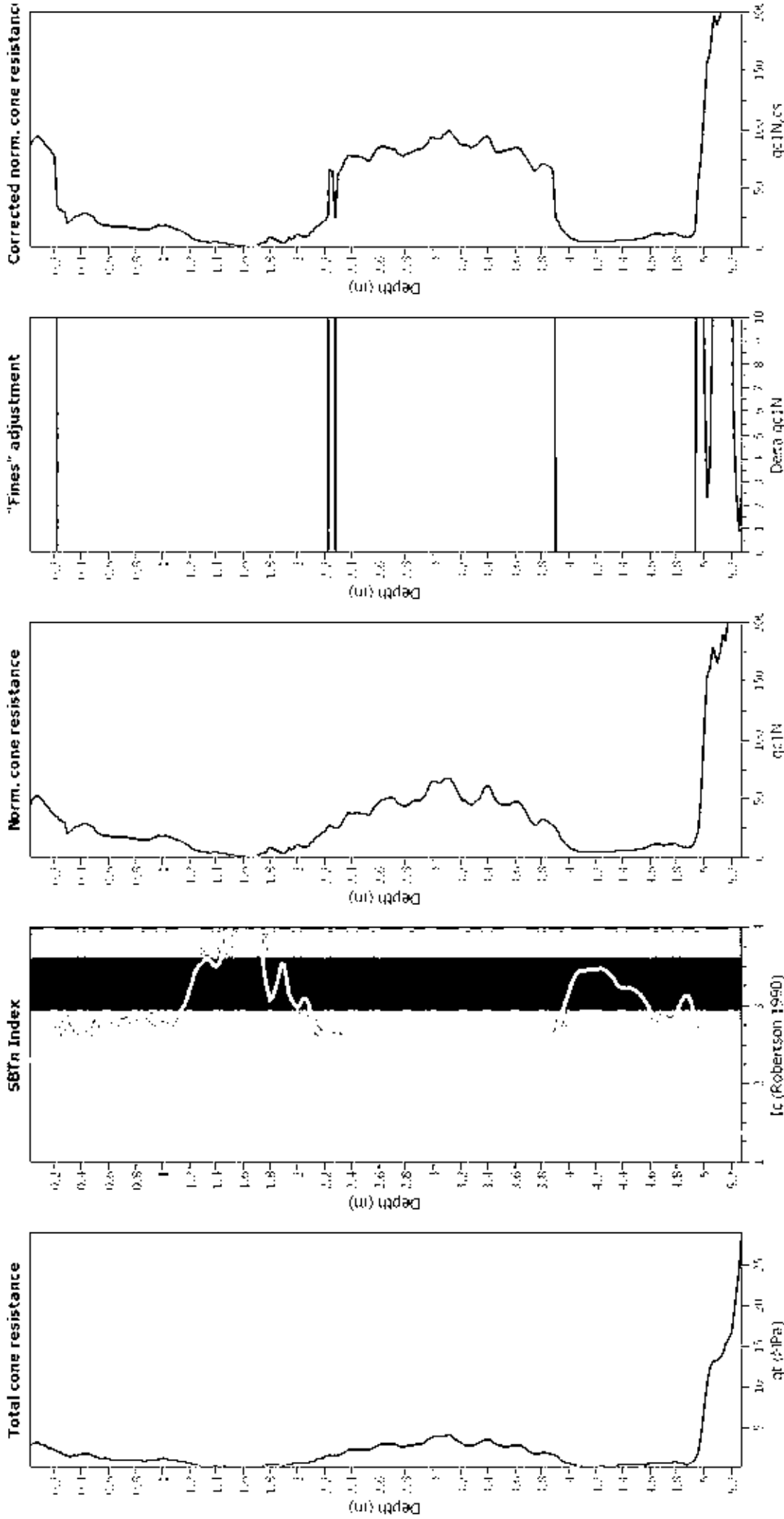
Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

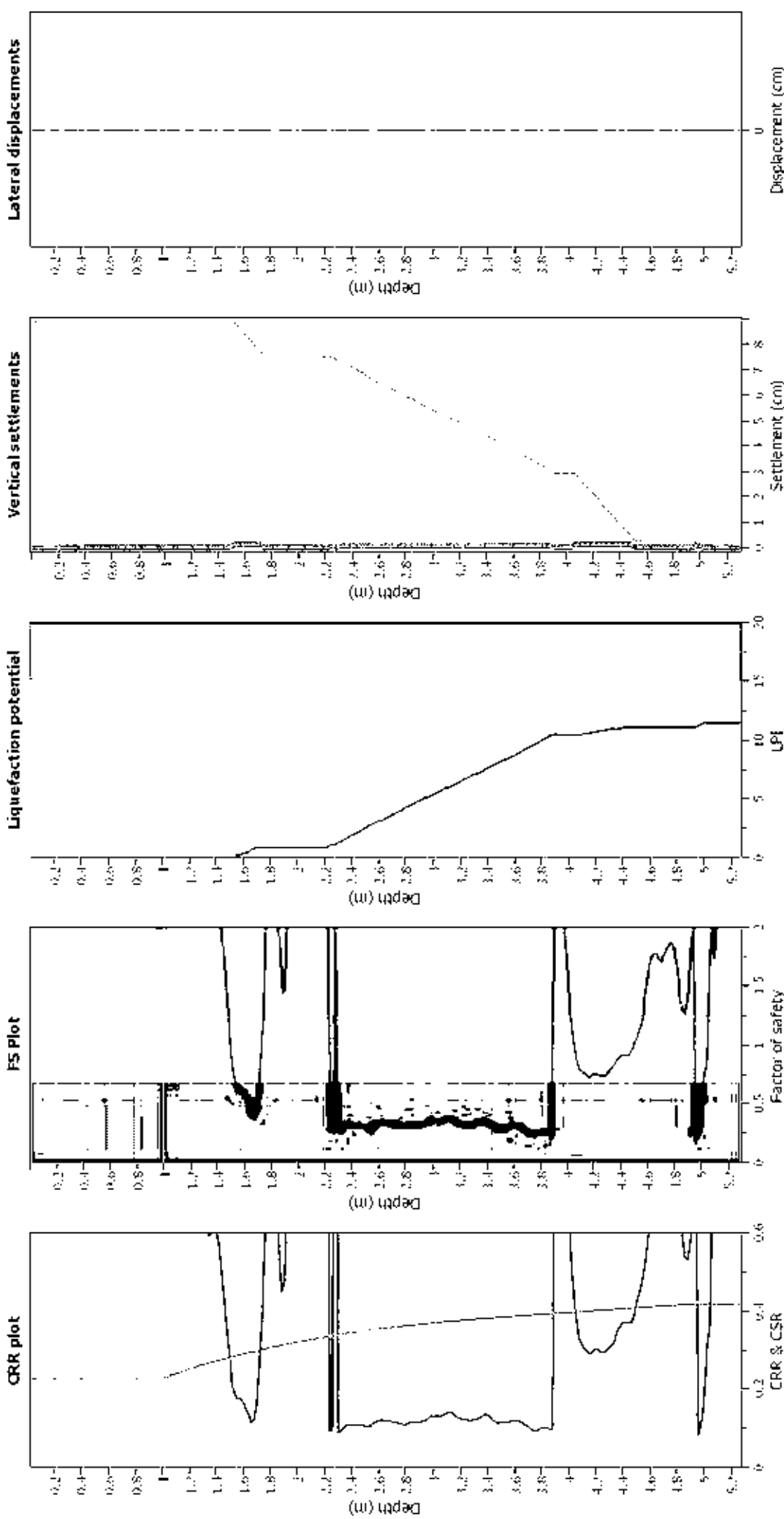
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

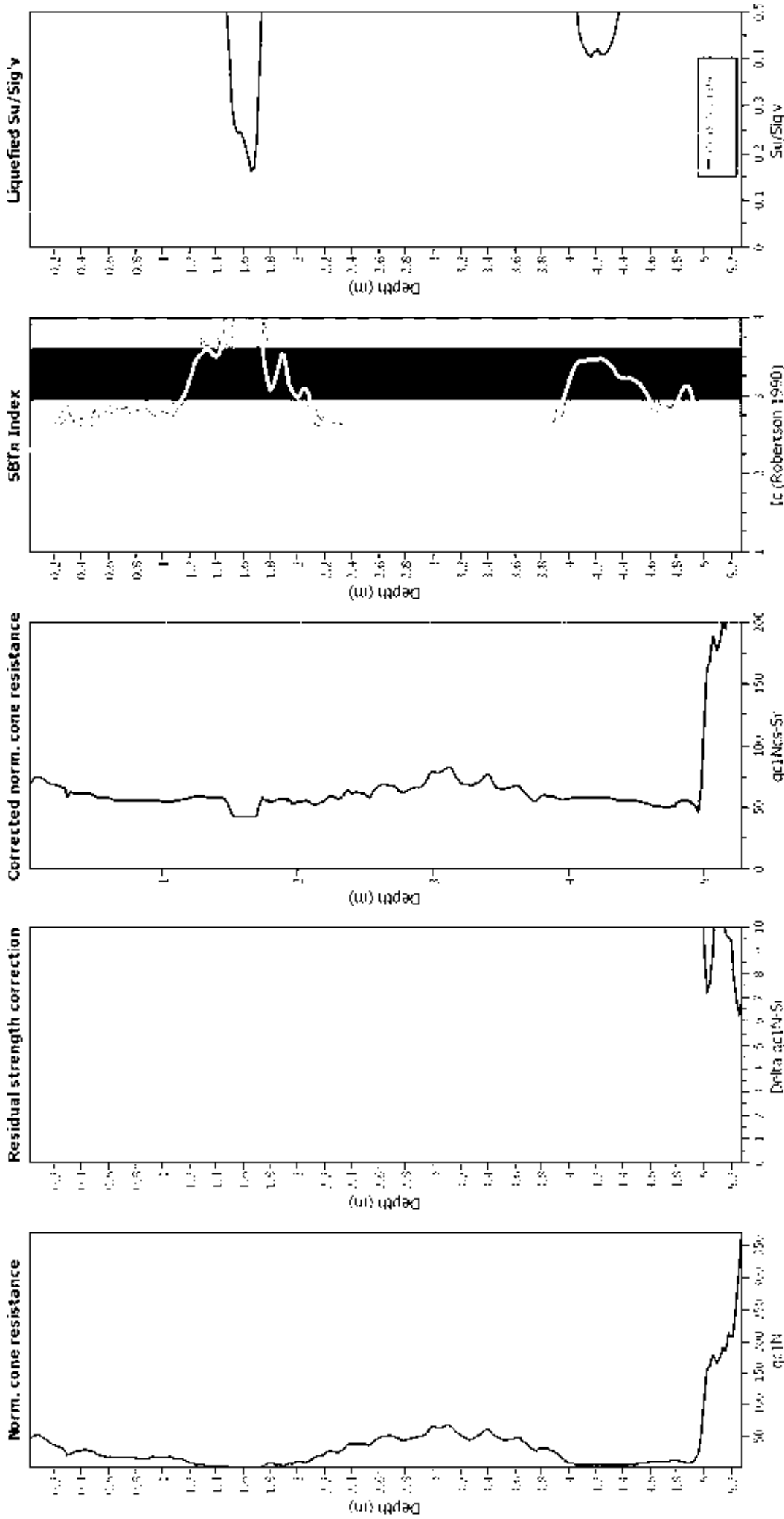
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

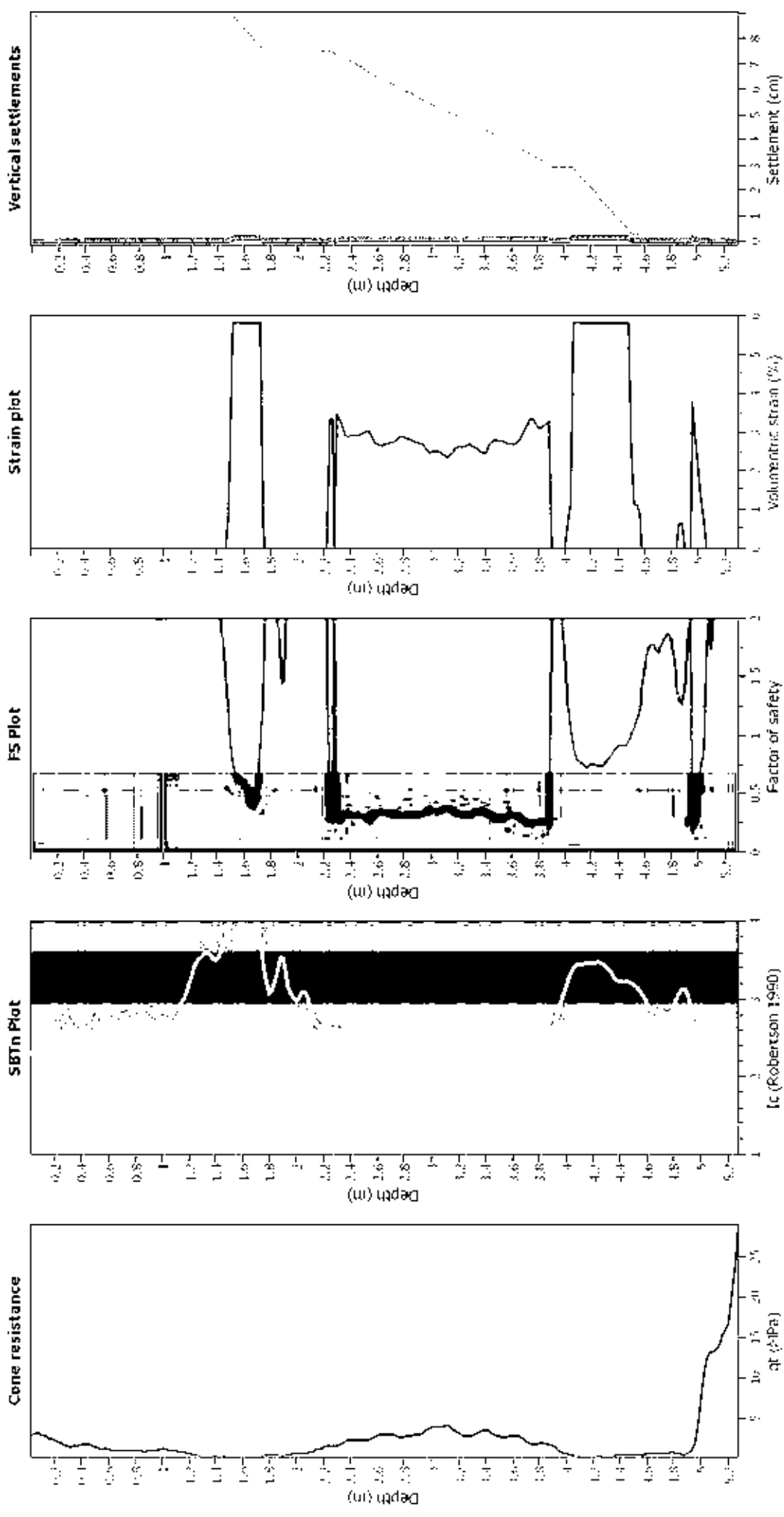
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c: Soil Behaviour Type index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT38_32SutherlandsRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.25 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.25 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

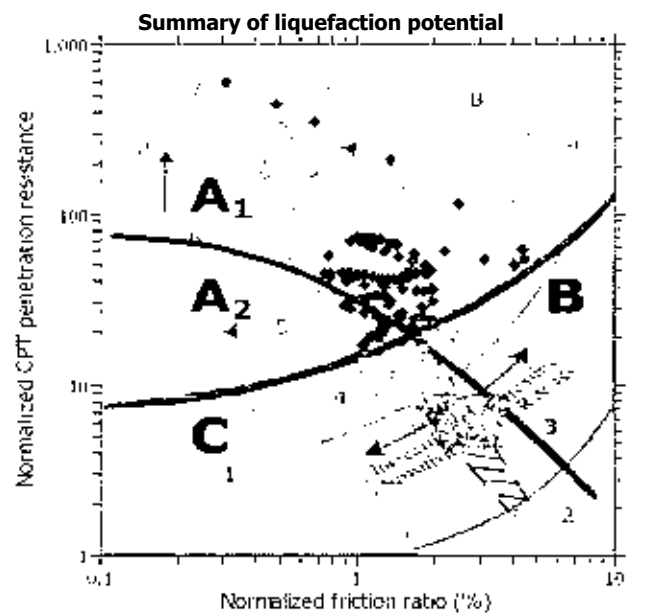
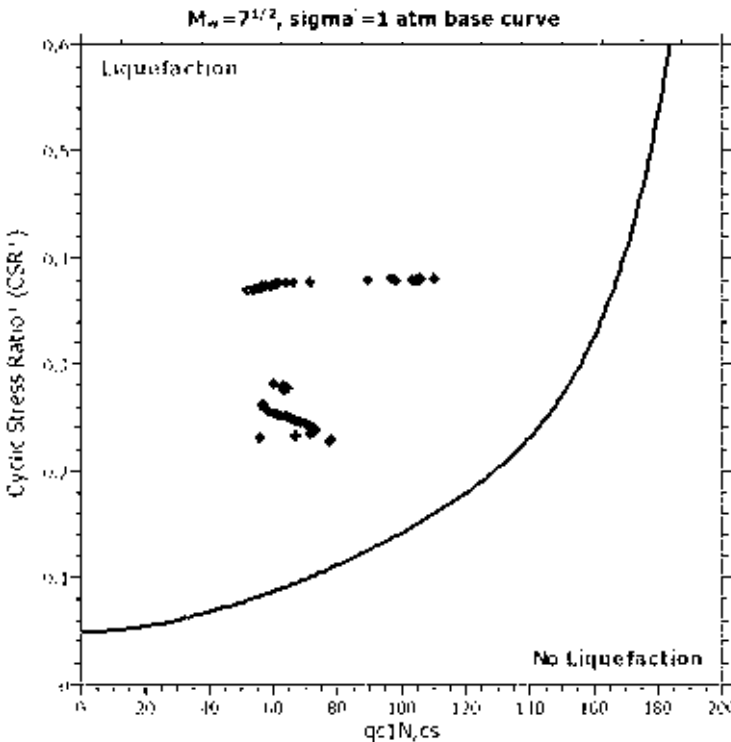
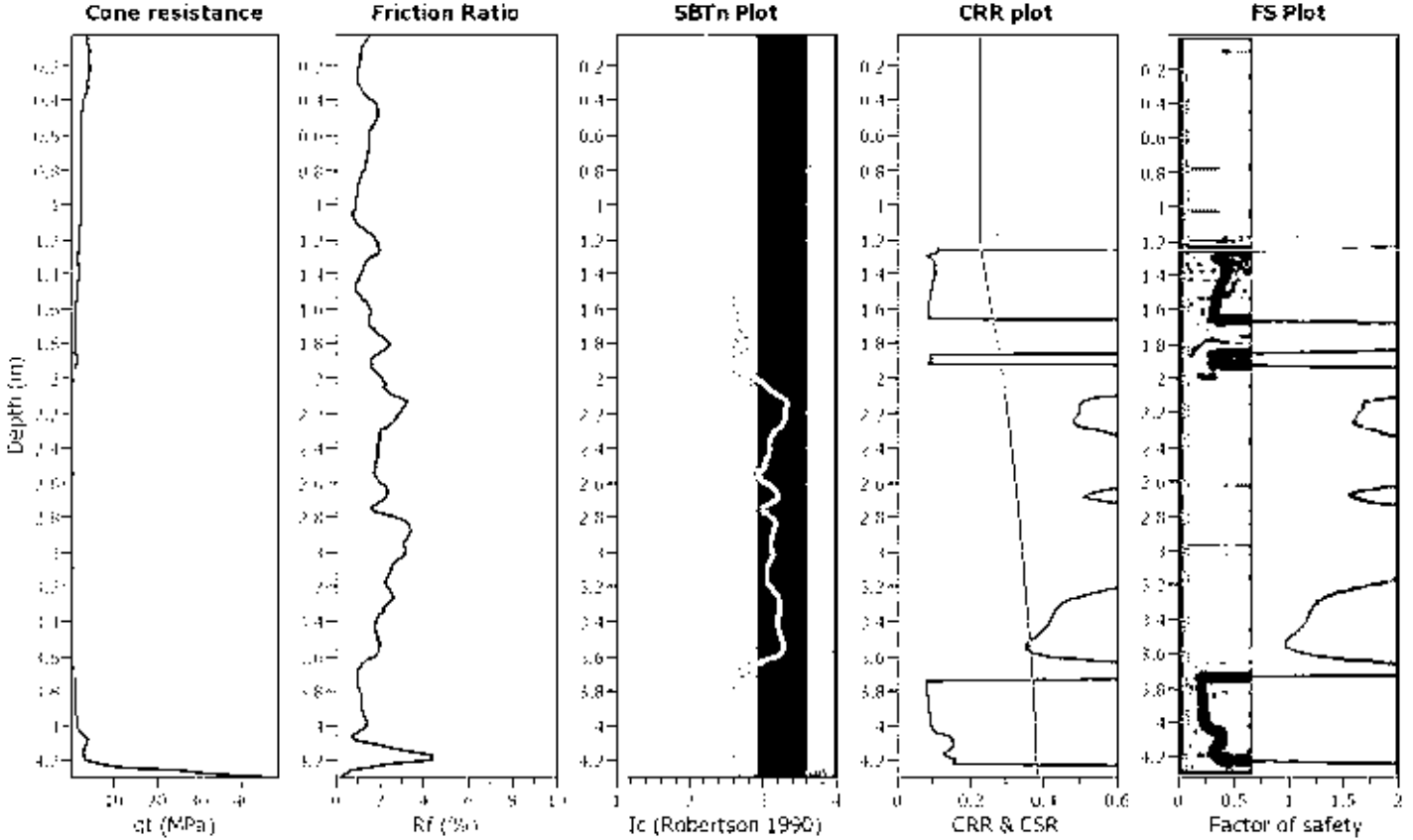
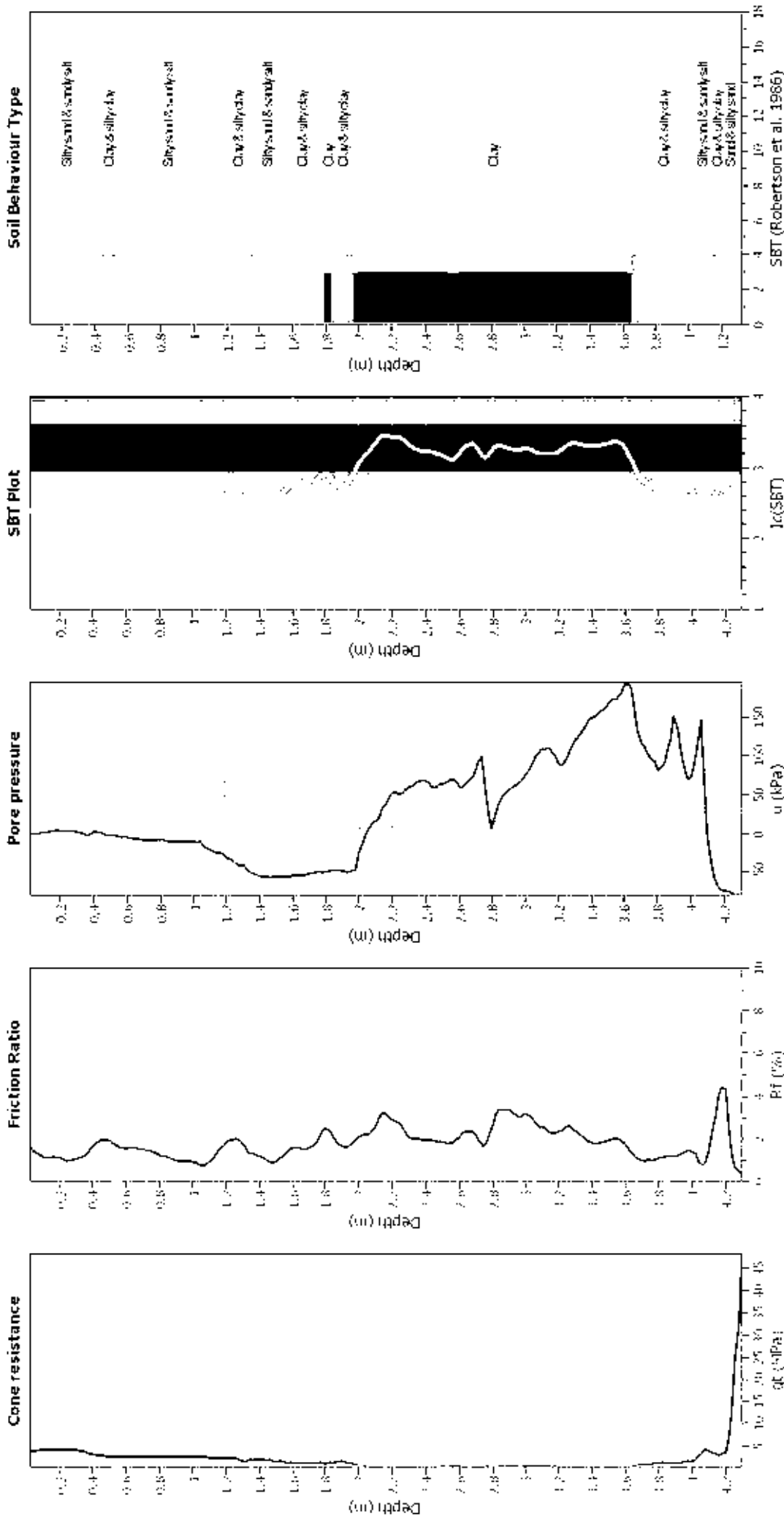


Figure 4: Summary of liquefaction potential assessment and data for the test. Zone A1: Normalized CPT penetration resistance greater than 100 and normalized friction ratio less than 10%. Zone A2: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 10% and 20%. Zone B: Normalized CPT penetration resistance greater than 100 and normalized friction ratio between 20% and 30%. Zone C: Normalized CPT penetration resistance less than 100 and normalized friction ratio between 20% and 30%. The liquefaction potential is assessed based on the normalized CPT penetration resistance and normalized friction ratio. The liquefaction potential is assessed based on the normalized CPT penetration resistance and normalized friction ratio.

CPT basic interpretation plots



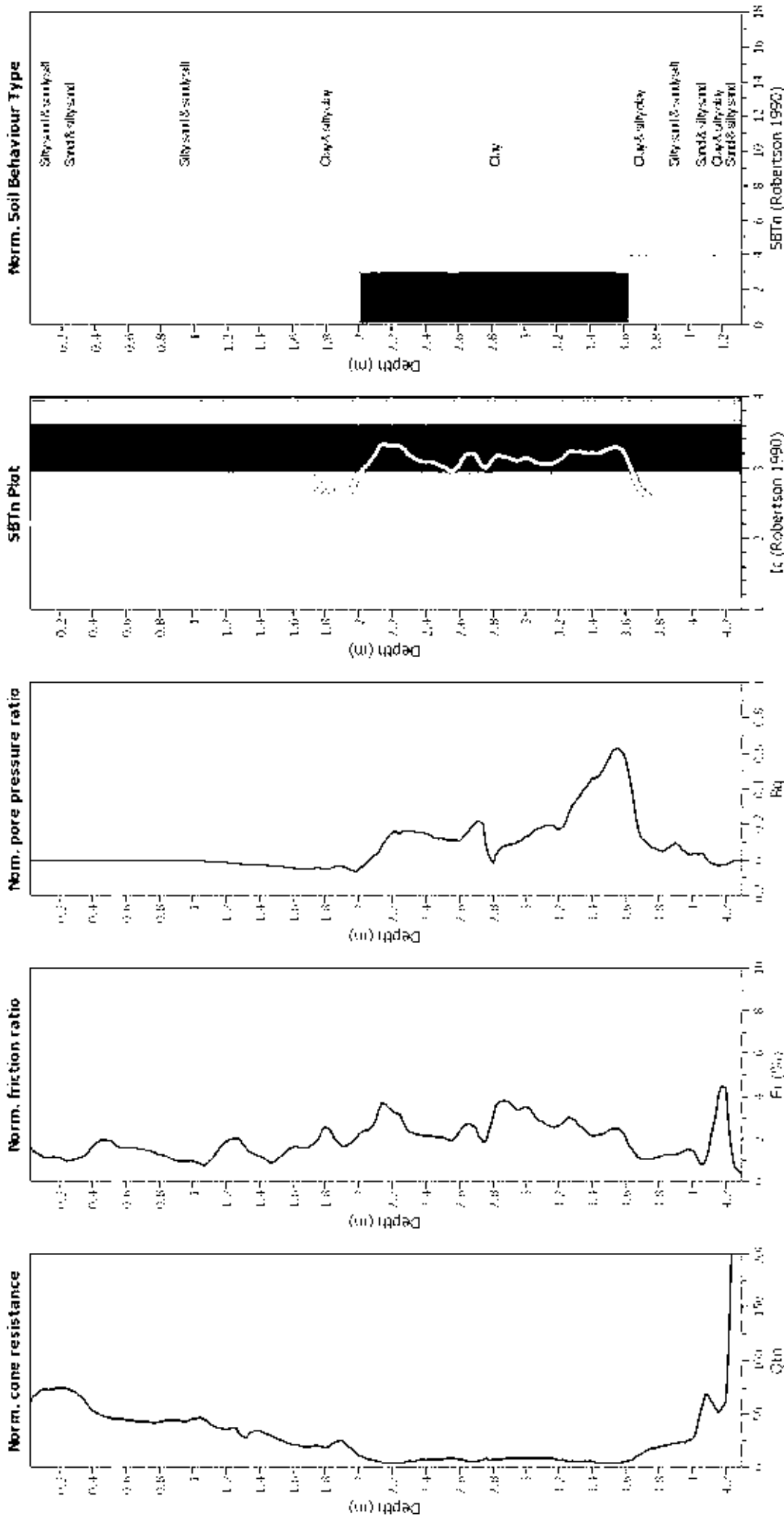
Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	1.25 m	Unit depth:	N/A
Depth to GW (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



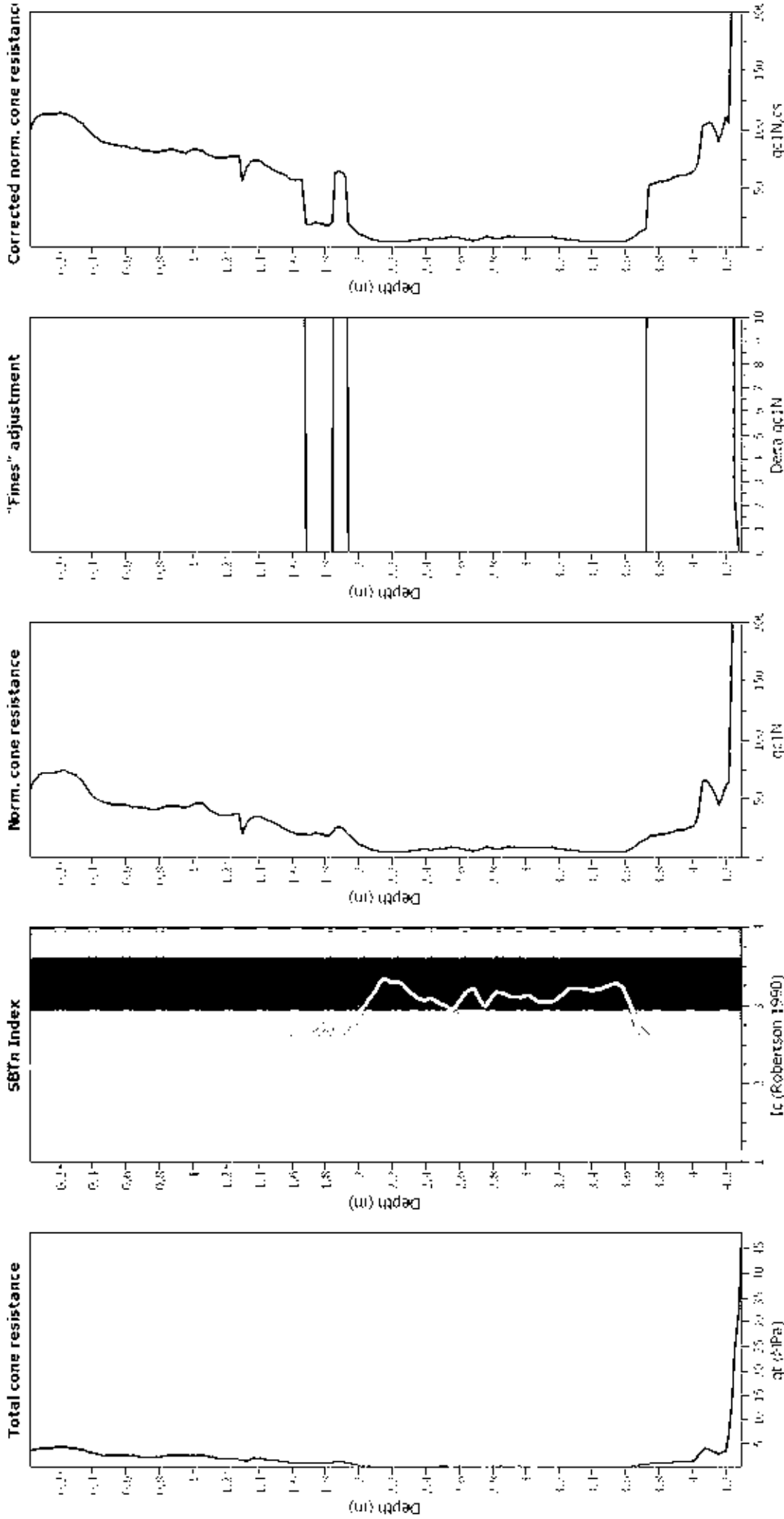
Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (erthq.):	1.25 m	Fill weight:	N/A	Sand & Clay	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes		
Factorial/make magnitude M_v :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No		
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No		
Depth to water table (m):	1.25 m	Fill height:	N/A	Unit 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

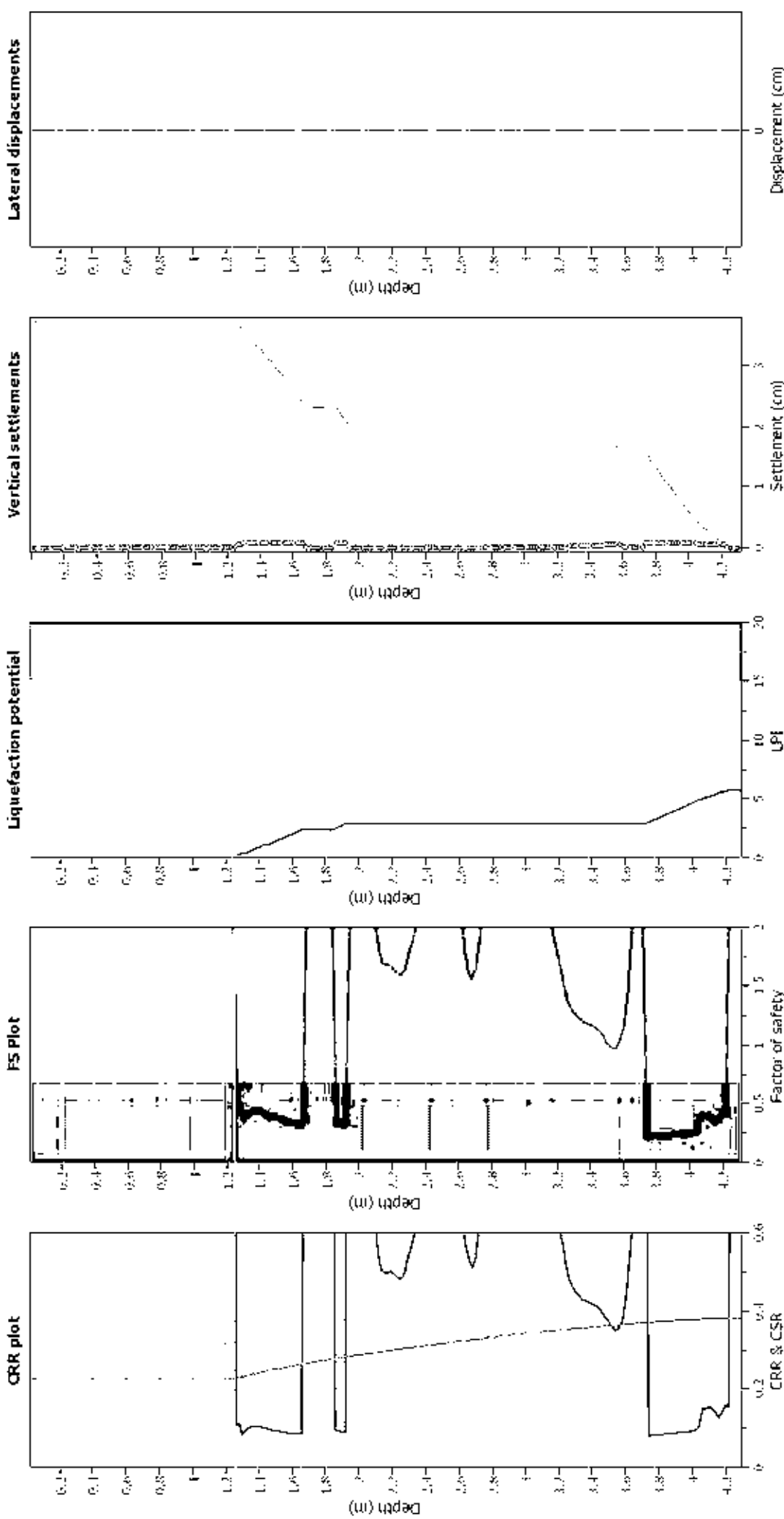
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make magnitude M_v :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.25 m	Limit depth:	N/A
Depth to GW (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.25 m

Depth to GW (earthq.): 1.25 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

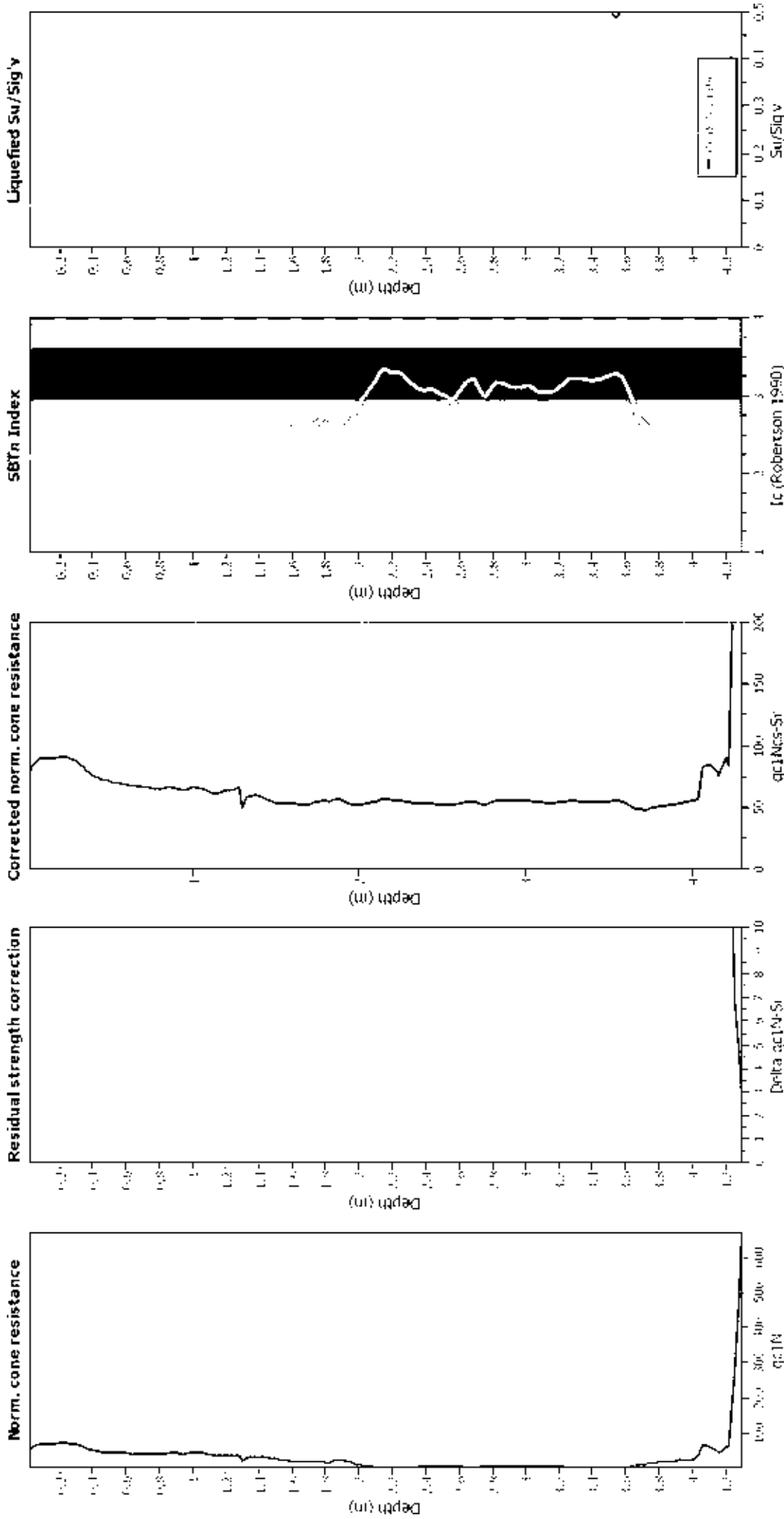
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

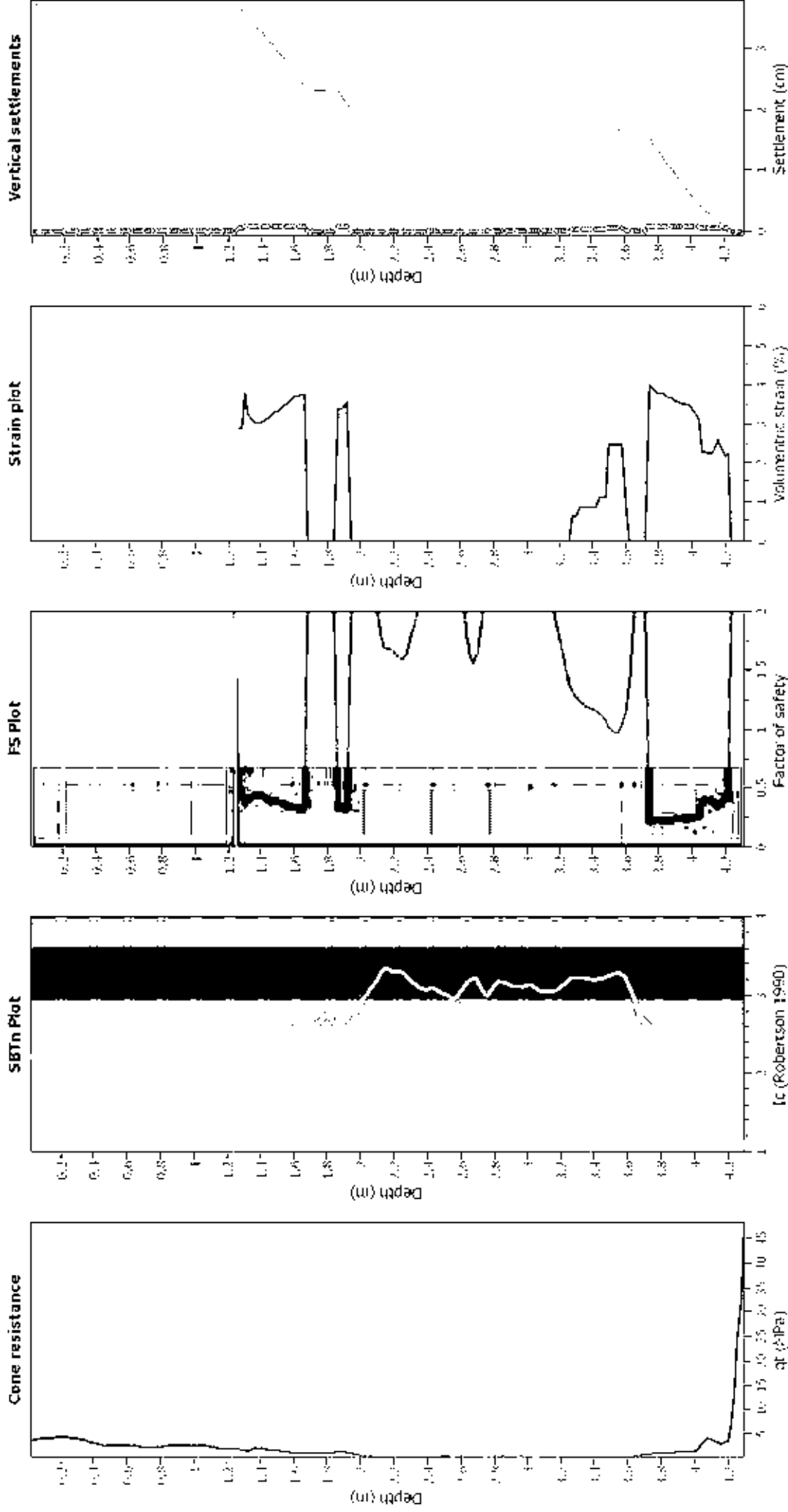
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.25	Limit depth:	N/A
Depth to GW (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT39_32SutherlandsRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.25 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.25 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

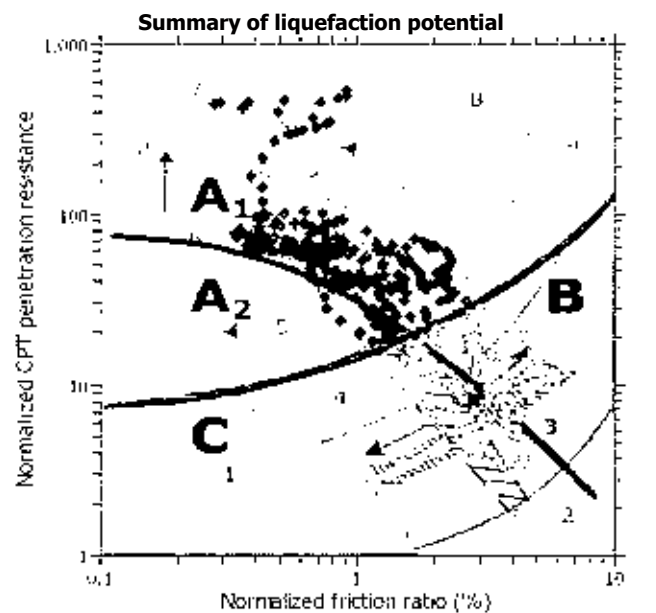
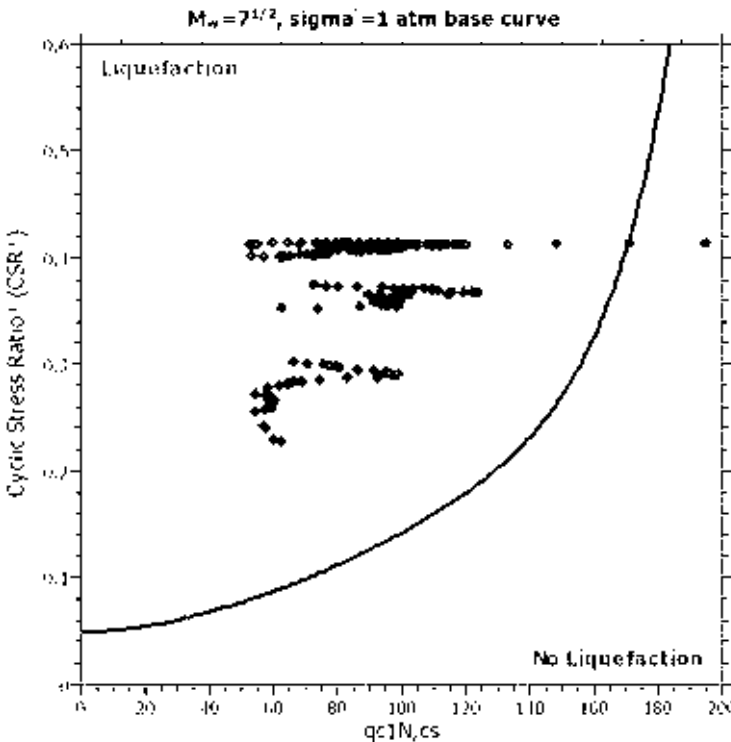
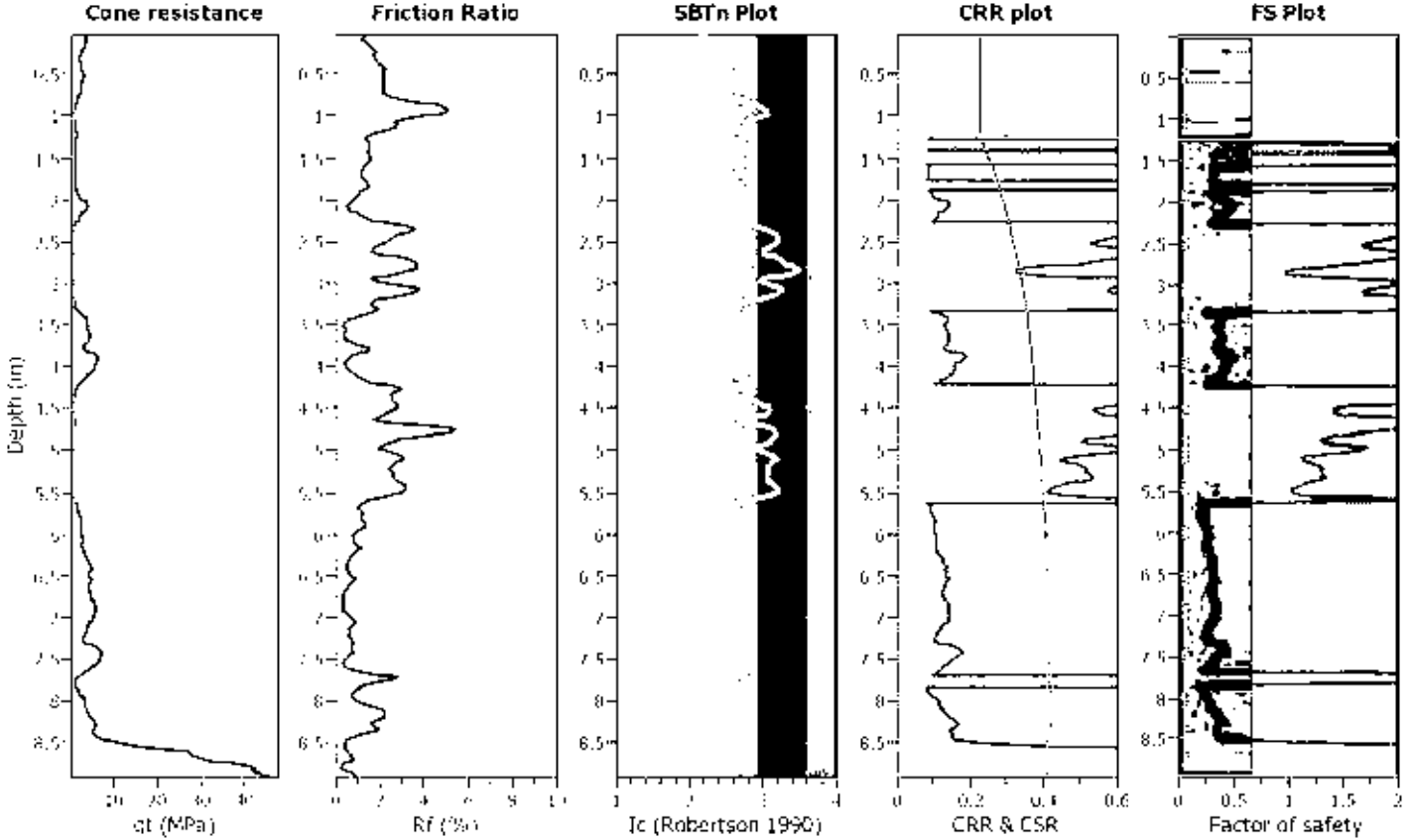
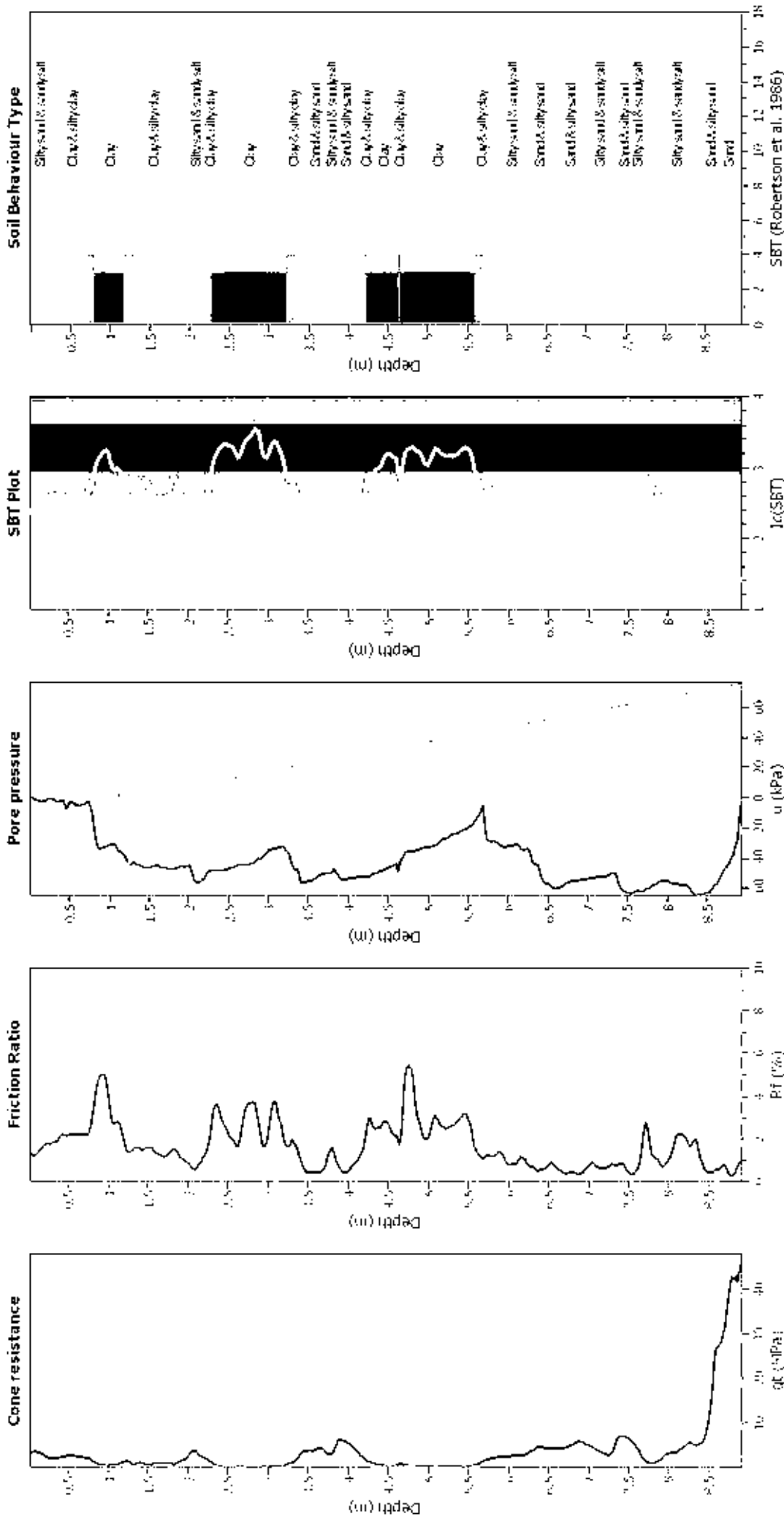


Figure 4: Summary of liquefaction potential based on cone and friction ratio data.
 Zone A1: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f > 10\%$)
 Zone A2: Partially liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)
 Zone B: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f > 10\%$)
 Zone C: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f < 10\%$)
 Zone D: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)
 Zone E: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f > 10\%$)
 Zone F: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)
 Zone G: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f < 10\%$)
 Zone H: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f > 10\%$)
 Zone I: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f > 10\%$)
 Zone J: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)
 Zone K: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f < 10\%$)
 Zone L: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f > 10\%$)
 Zone M: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f > 10\%$)
 Zone N: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)
 Zone O: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f < 10\%$)
 Zone P: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f > 10\%$)
 Zone Q: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f > 10\%$)
 Zone R: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)
 Zone S: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f < 10\%$)
 Zone T: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f > 10\%$)
 Zone U: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f > 10\%$)
 Zone V: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)
 Zone W: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f < 10\%$)
 Zone X: Fully liquefiable (CSR > 0.15, $q_c > 100$ N/cm², $r_f > 10\%$)
 Zone Y: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f > 10\%$)
 Zone Z: Fully liquefiable (CSR > 0.15, $q_c < 100$ N/cm², $r_f < 10\%$)

CPT basic interpretation plots



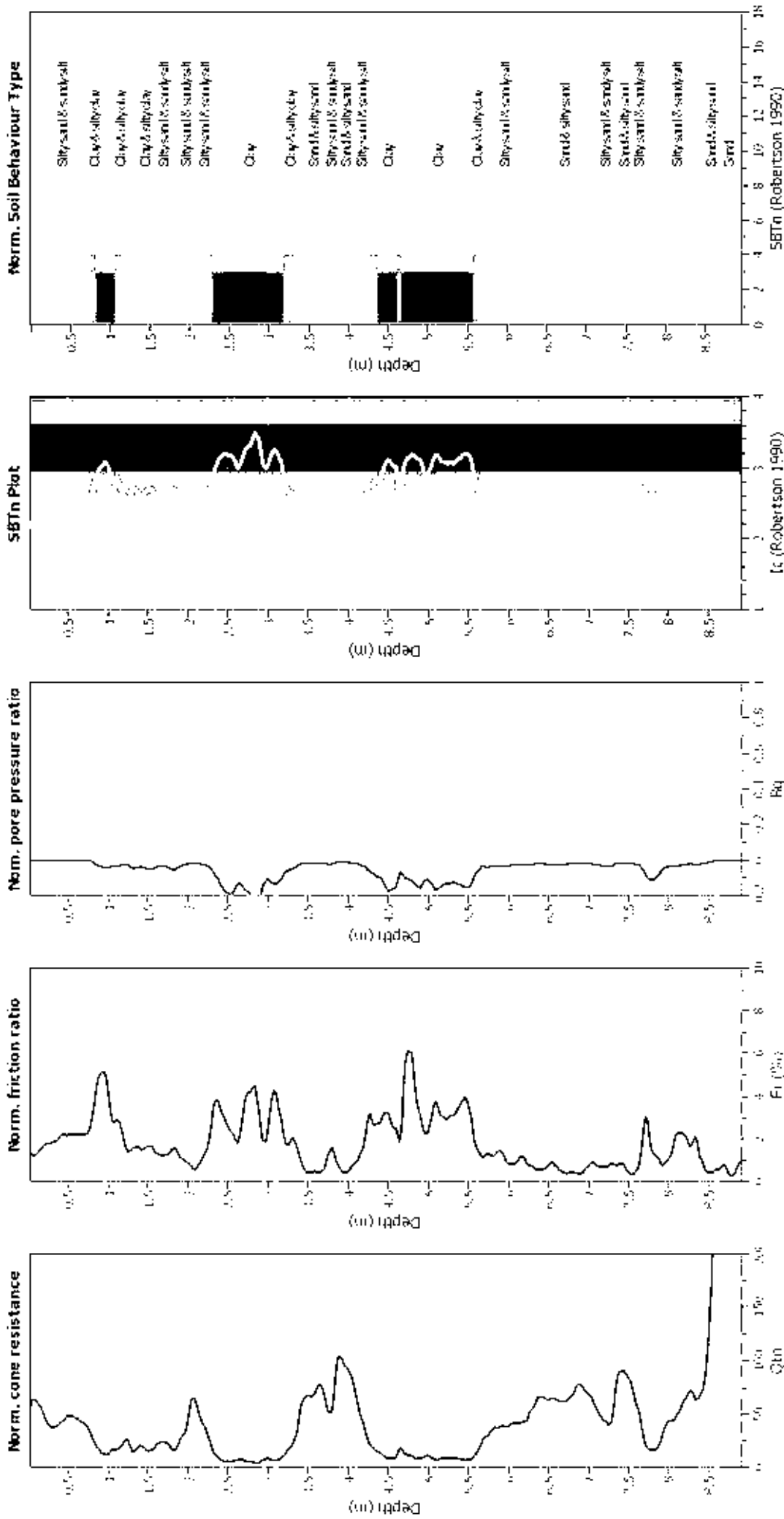
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.25 m	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.25 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



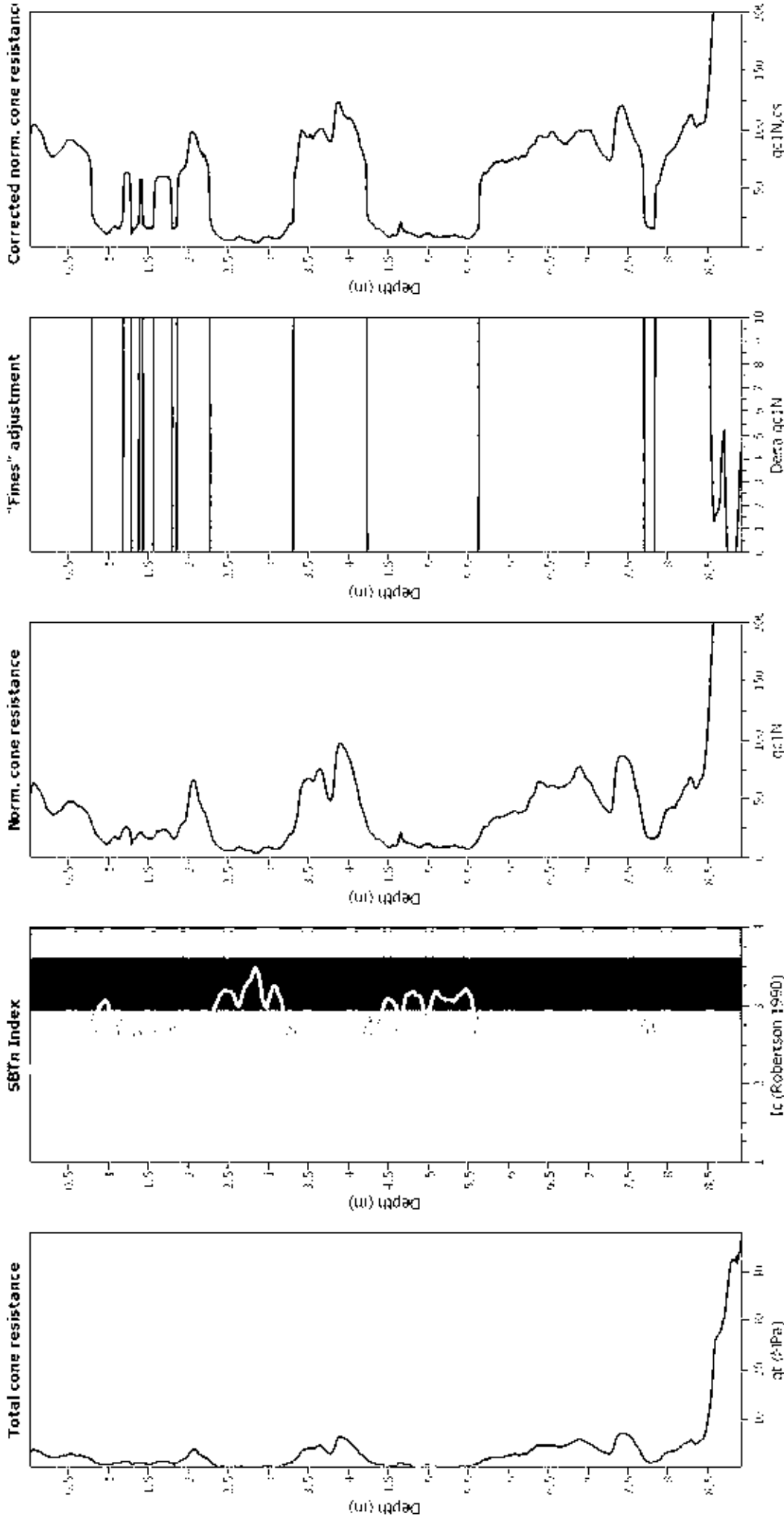
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.25 m	Fill weight:	N/A	Sand & Clay	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes		
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No		
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No		
Depth to water table (m):	1.25 m	Fill height:	N/A		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

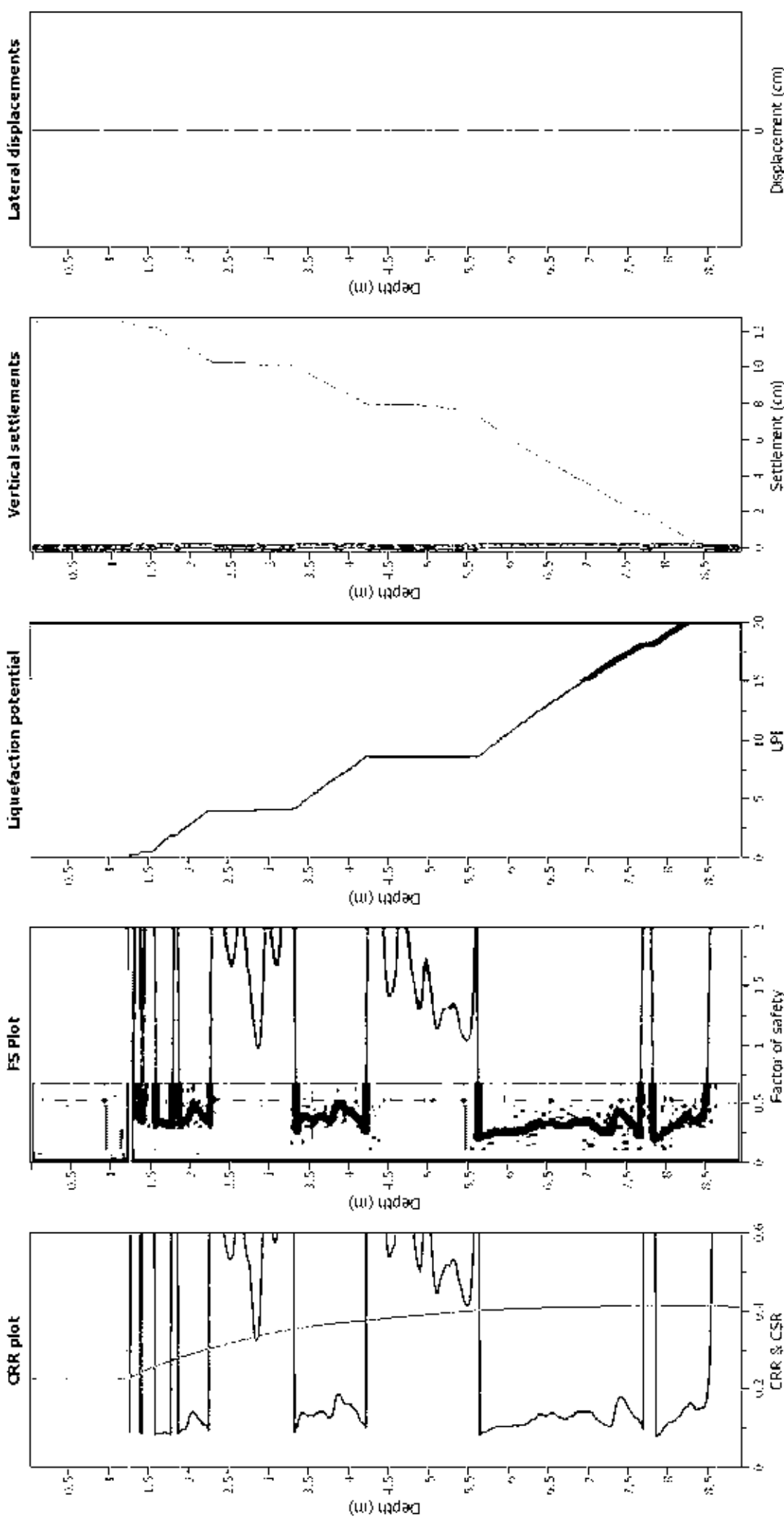
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.25 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.25 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Lines correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.25 m

Depth to GW (earthq.): 1.25 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

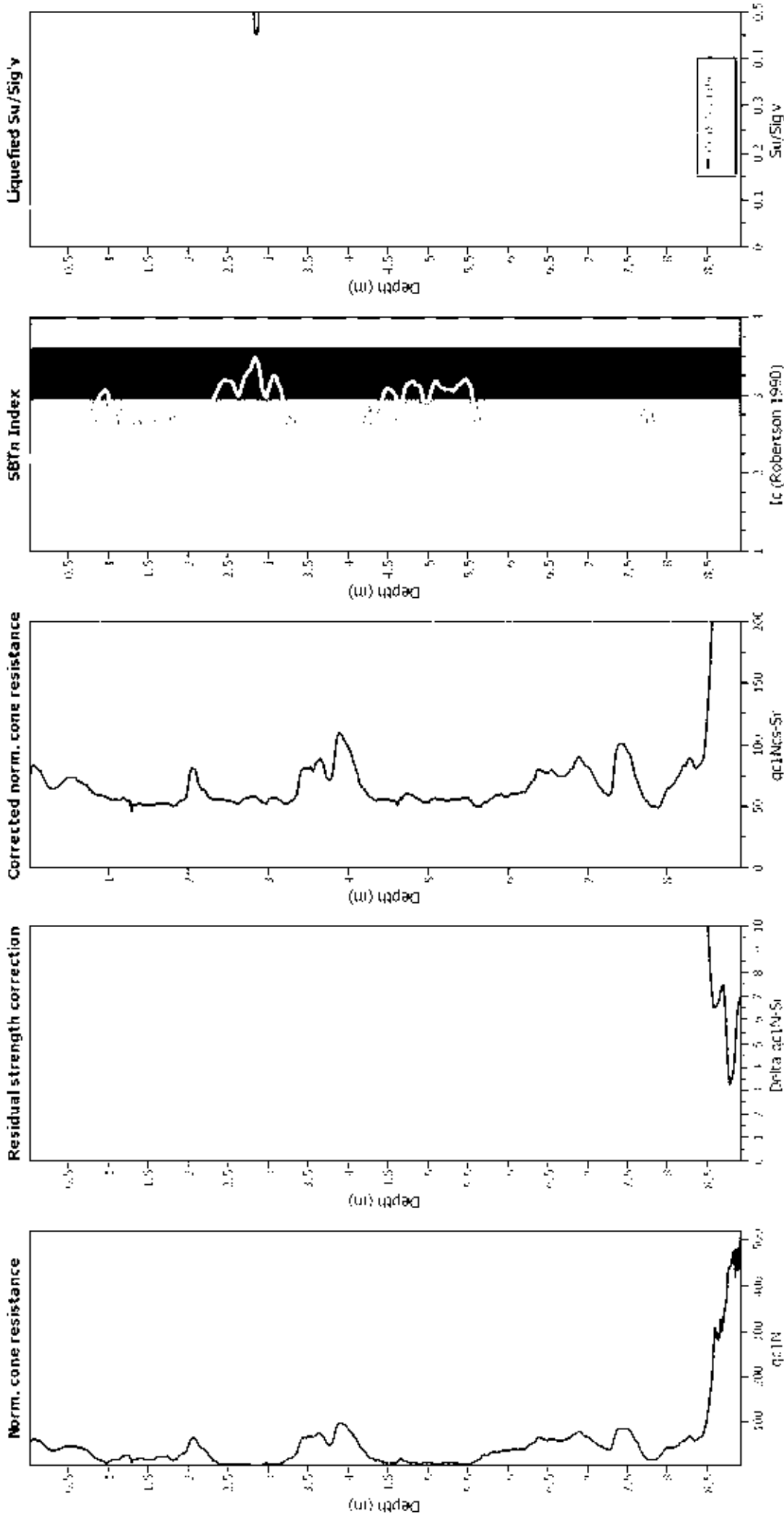
F.S. color scheme

Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlike to liquefy
 Almost certain it will not liquefy

LPI color scheme

Very high risk
 High risk
 Low risk

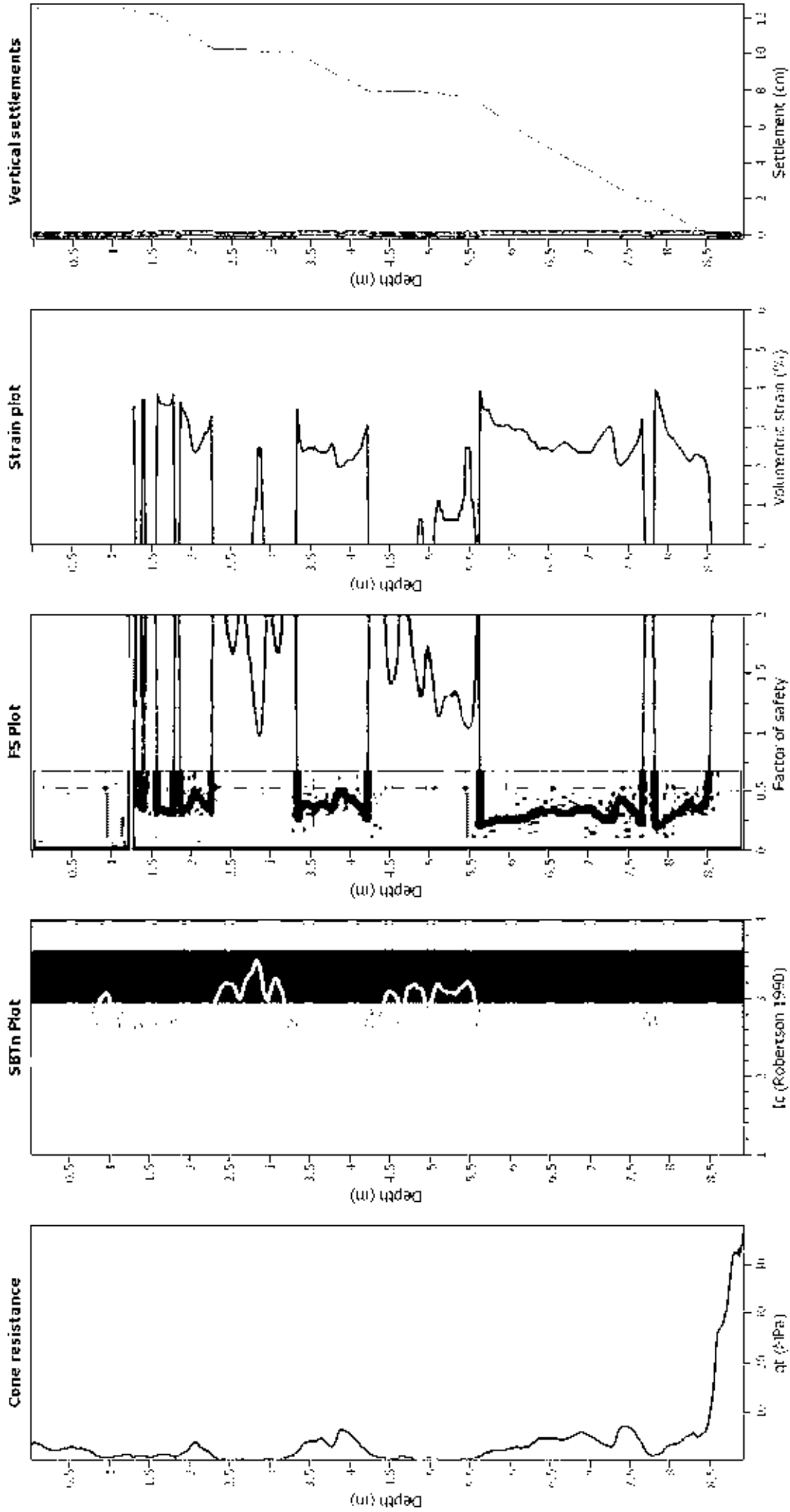
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.25 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.25 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT40_32SutherlandsRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to Test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

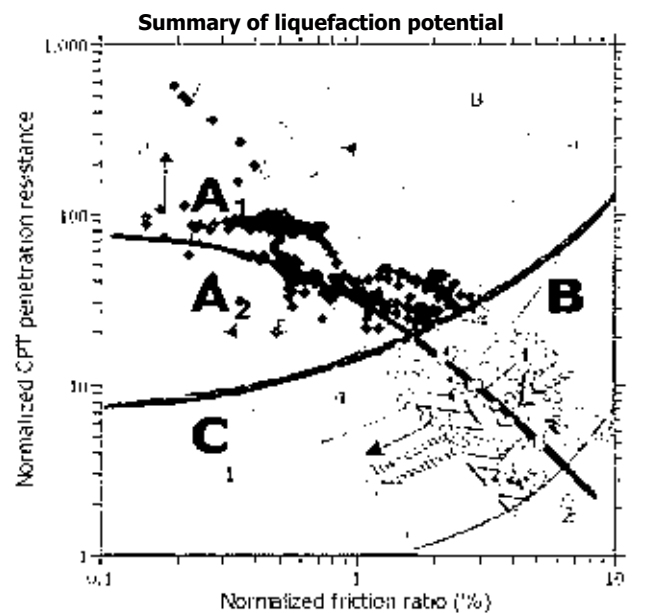
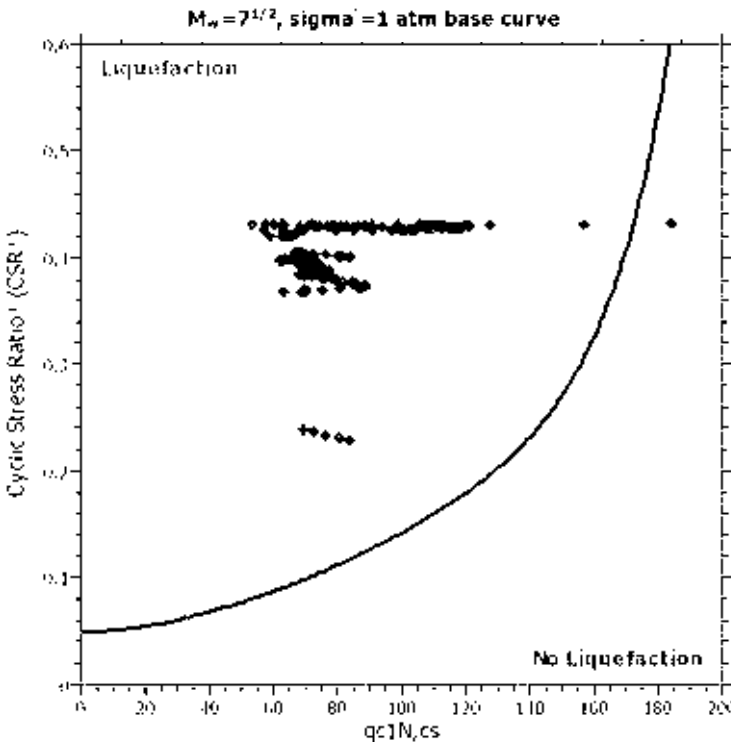
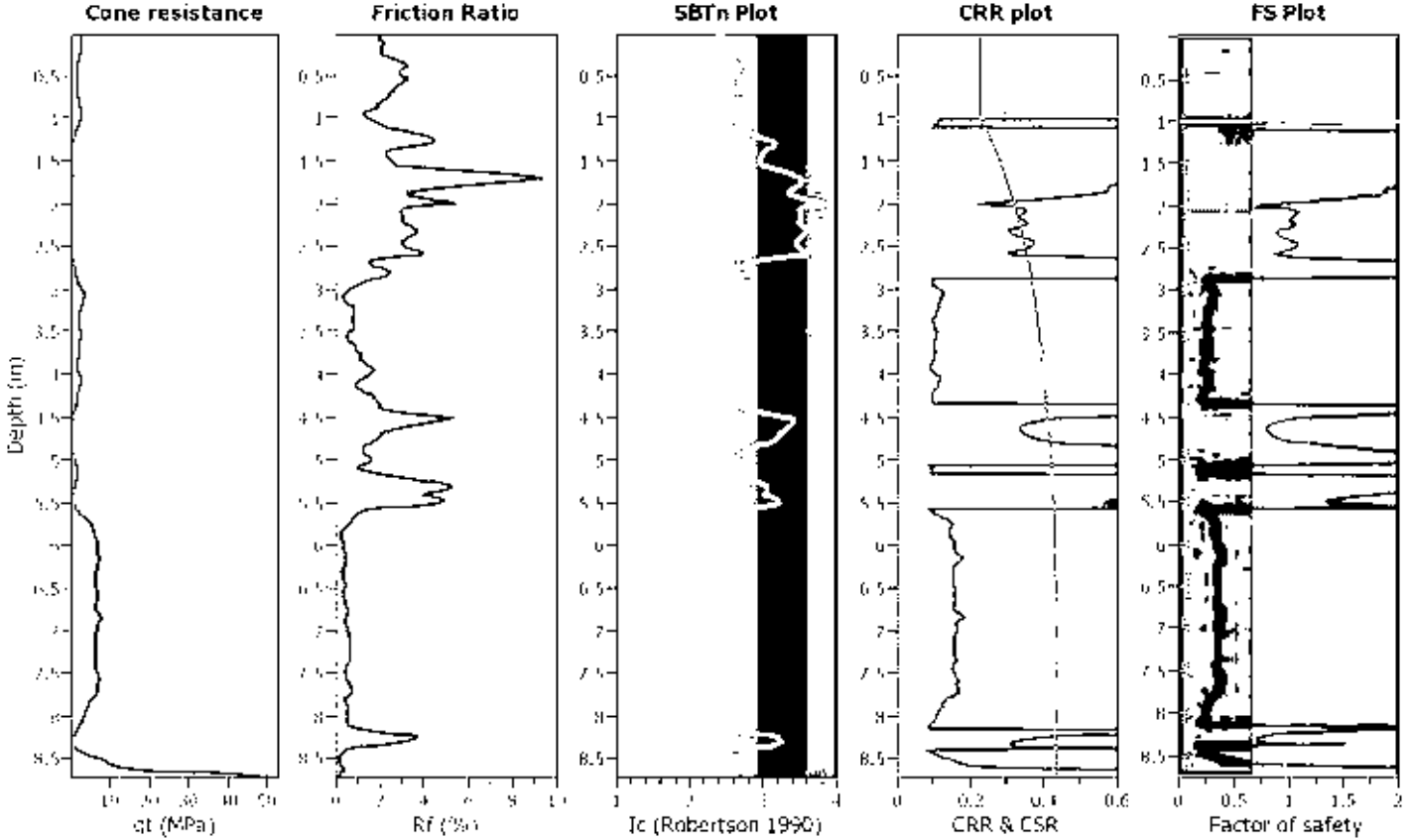
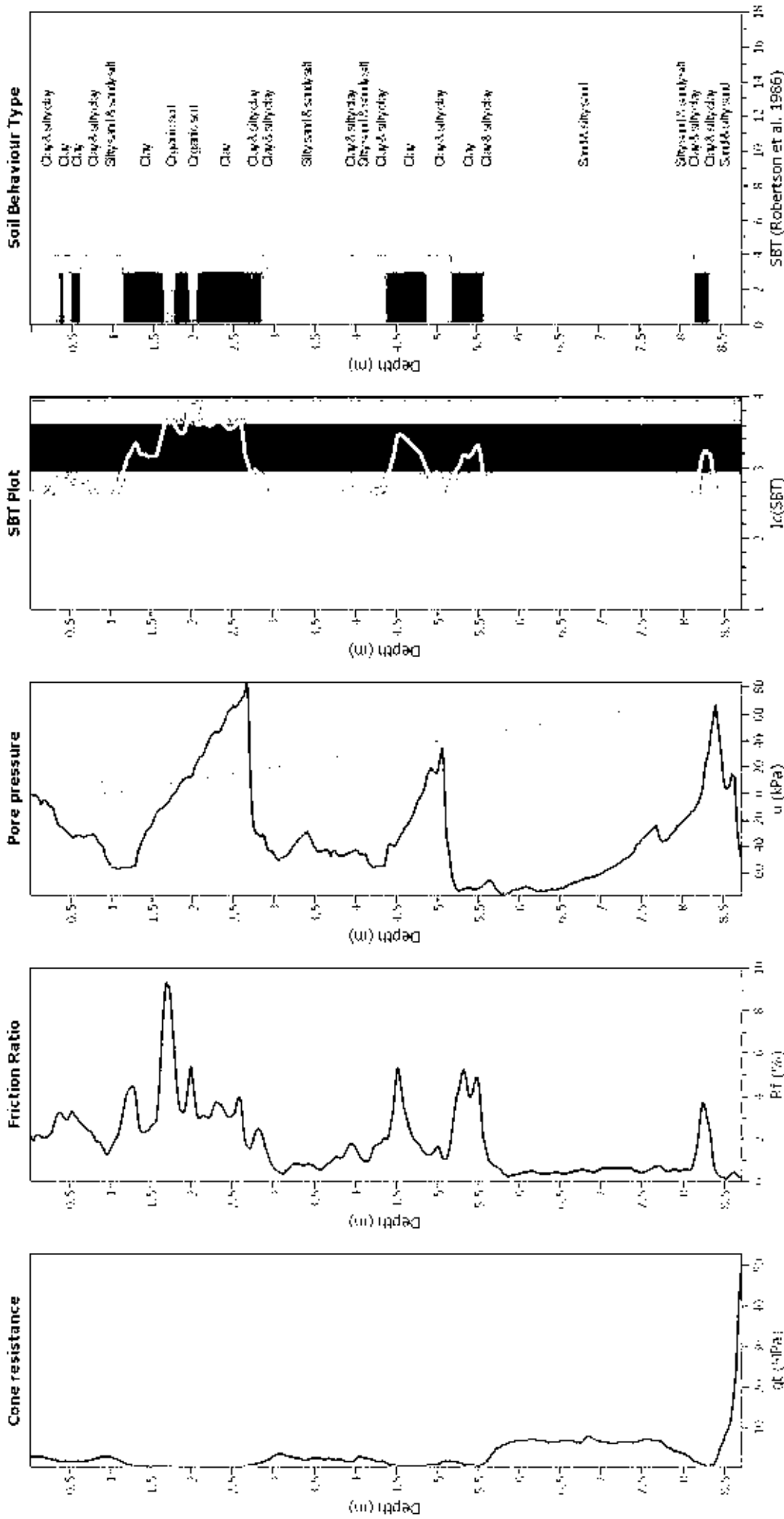


Figure 4: Summary of liquefaction potential based on penetration resistance and cyclic stress ratio. The chart shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with regions A1, A2, B, and C defined. A shaded area indicates the liquefaction potential. The chart is based on the input parameters and analysis data provided in the report.

CPT basic interpretation plots



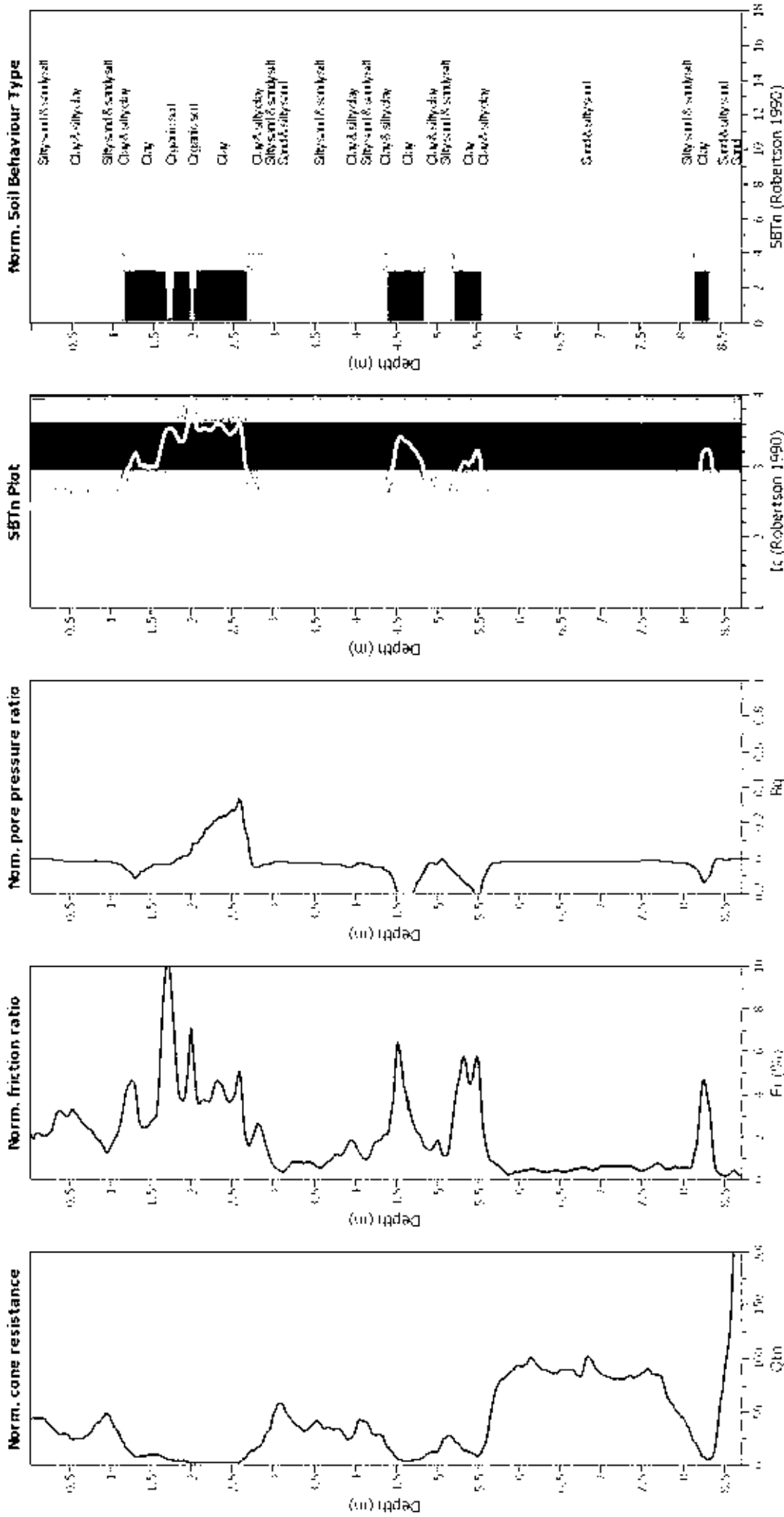
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude (M _w):	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



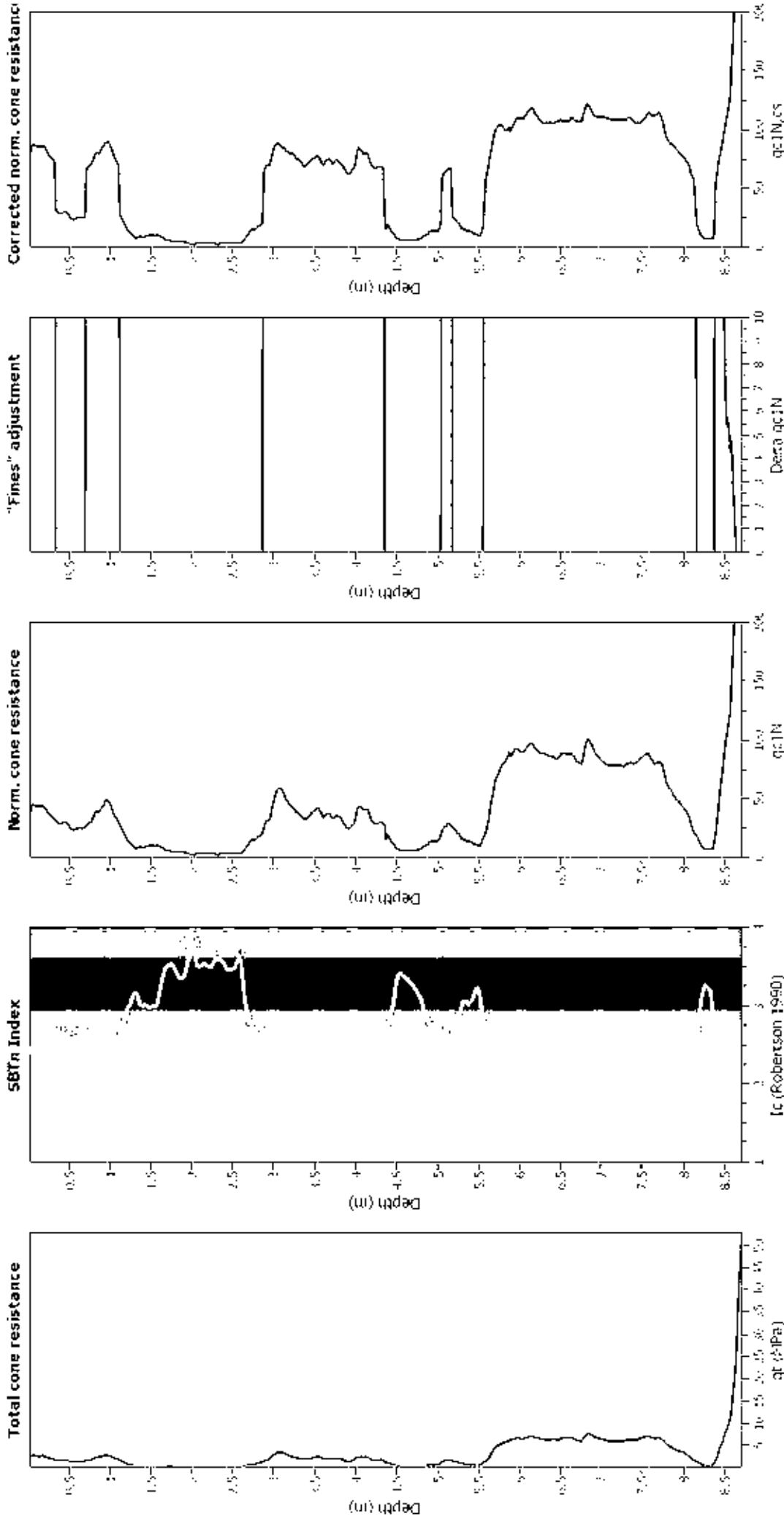
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A	Sand & Clay:	N/A
Units corre: (m, m, ft, mm)	18B (2008)	Average results interval:	3	Transition depth: applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K: applied:	Clay like behavior: applied		
Earthquake magnitude (M _s):	7.50	Unit weight calculation:	Based on SBT	Unit depth:	No		
Peak ground acceleration:	0.35	Use fill:	No	Unit depth:	N/A		
Depth to water table (m, ft):	1.00 m	Fill height:	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

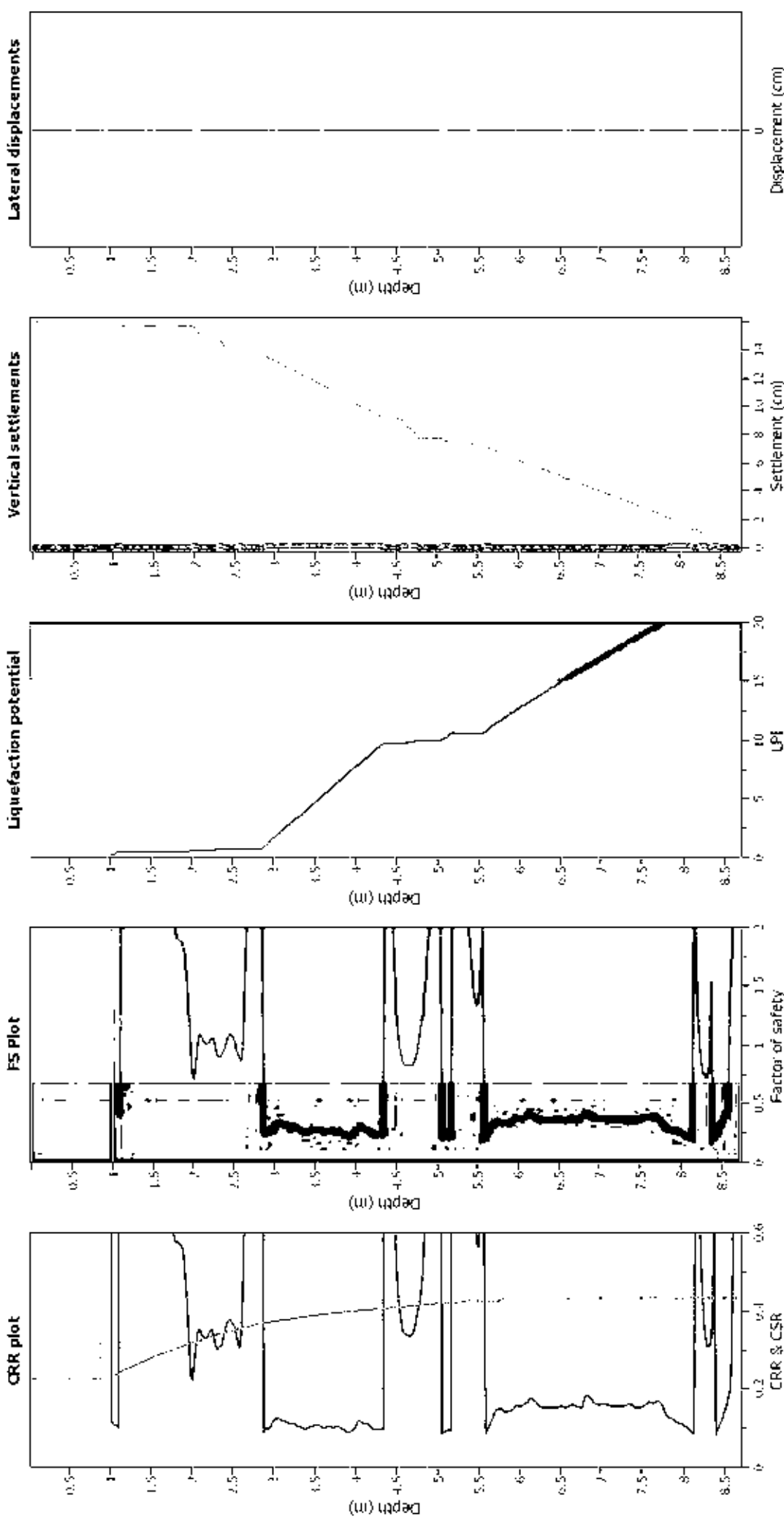
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Liquefaction correction method: 18B (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

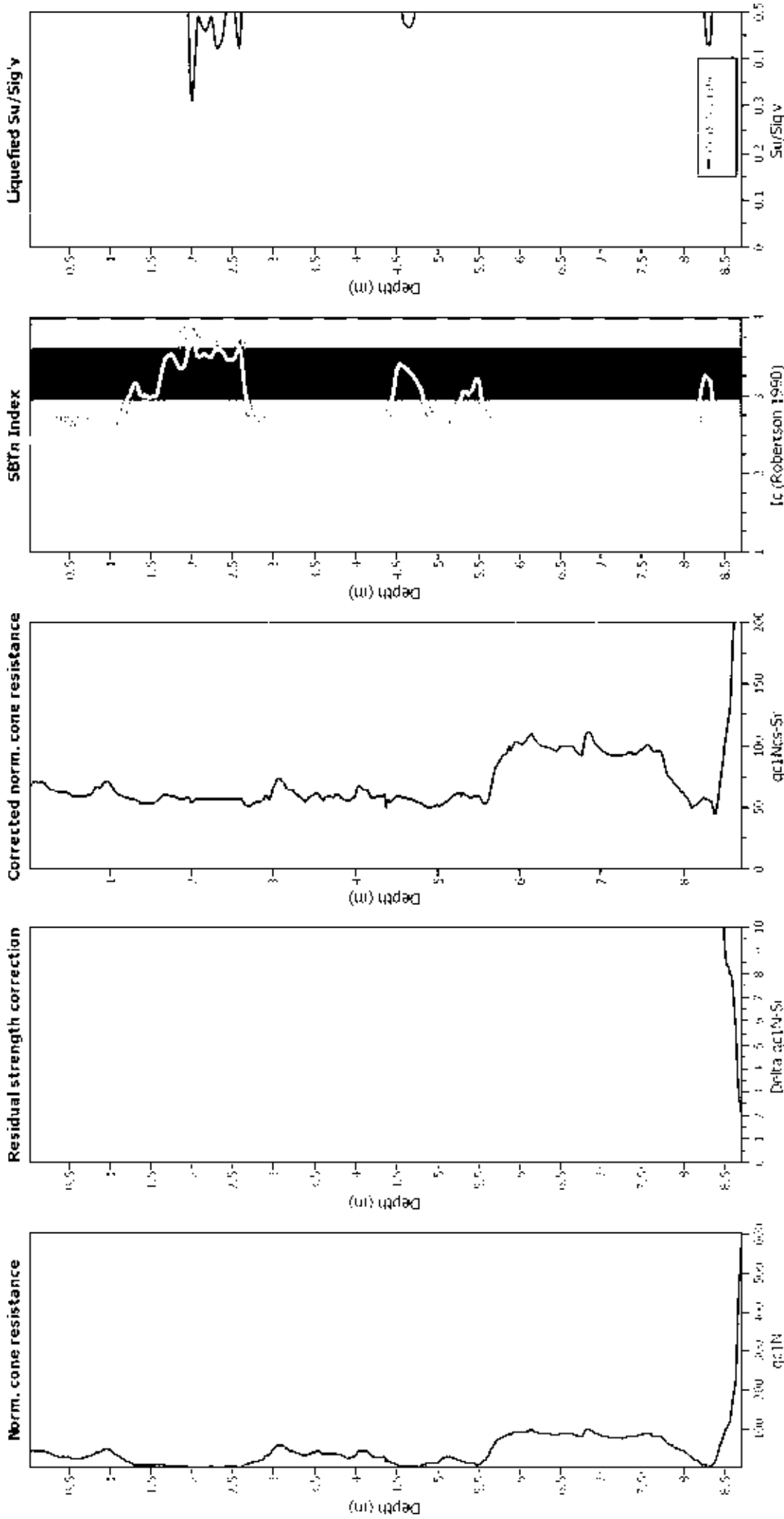
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

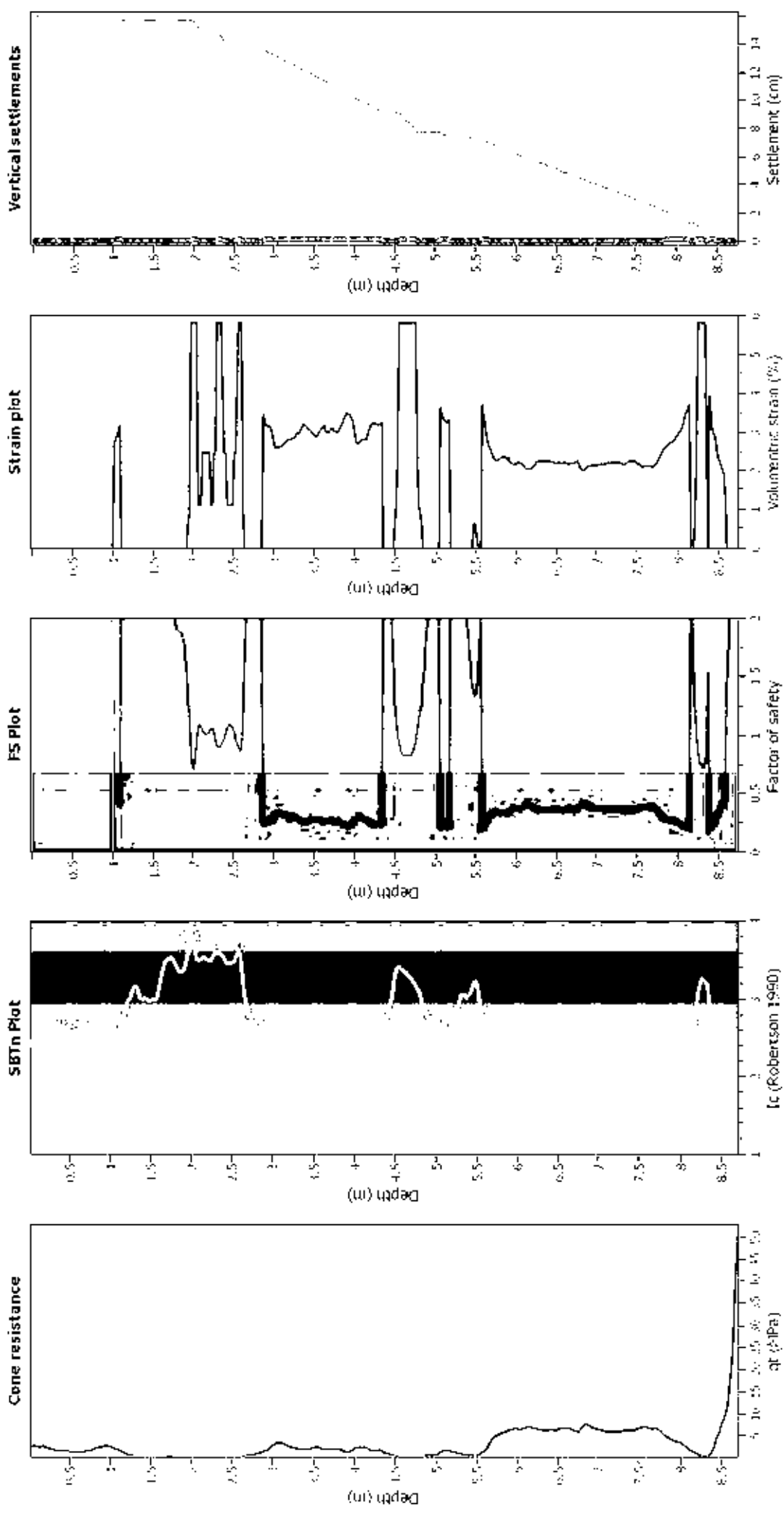
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

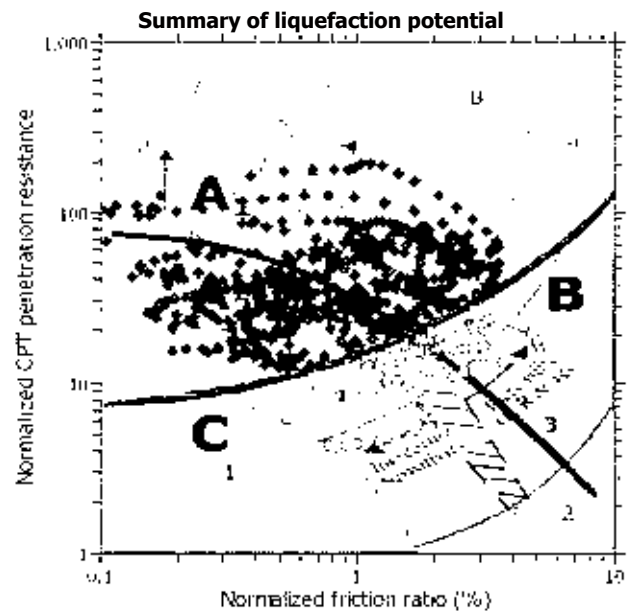
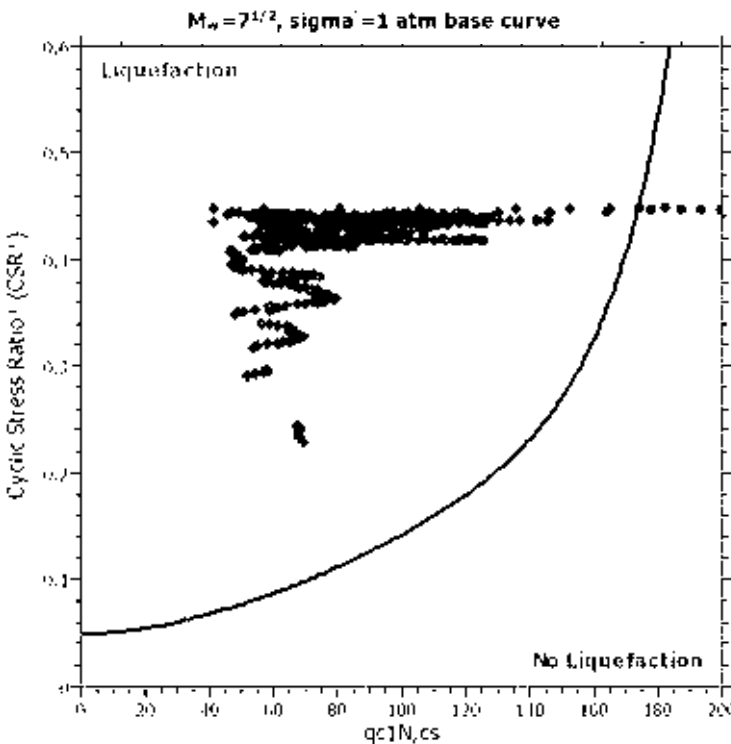
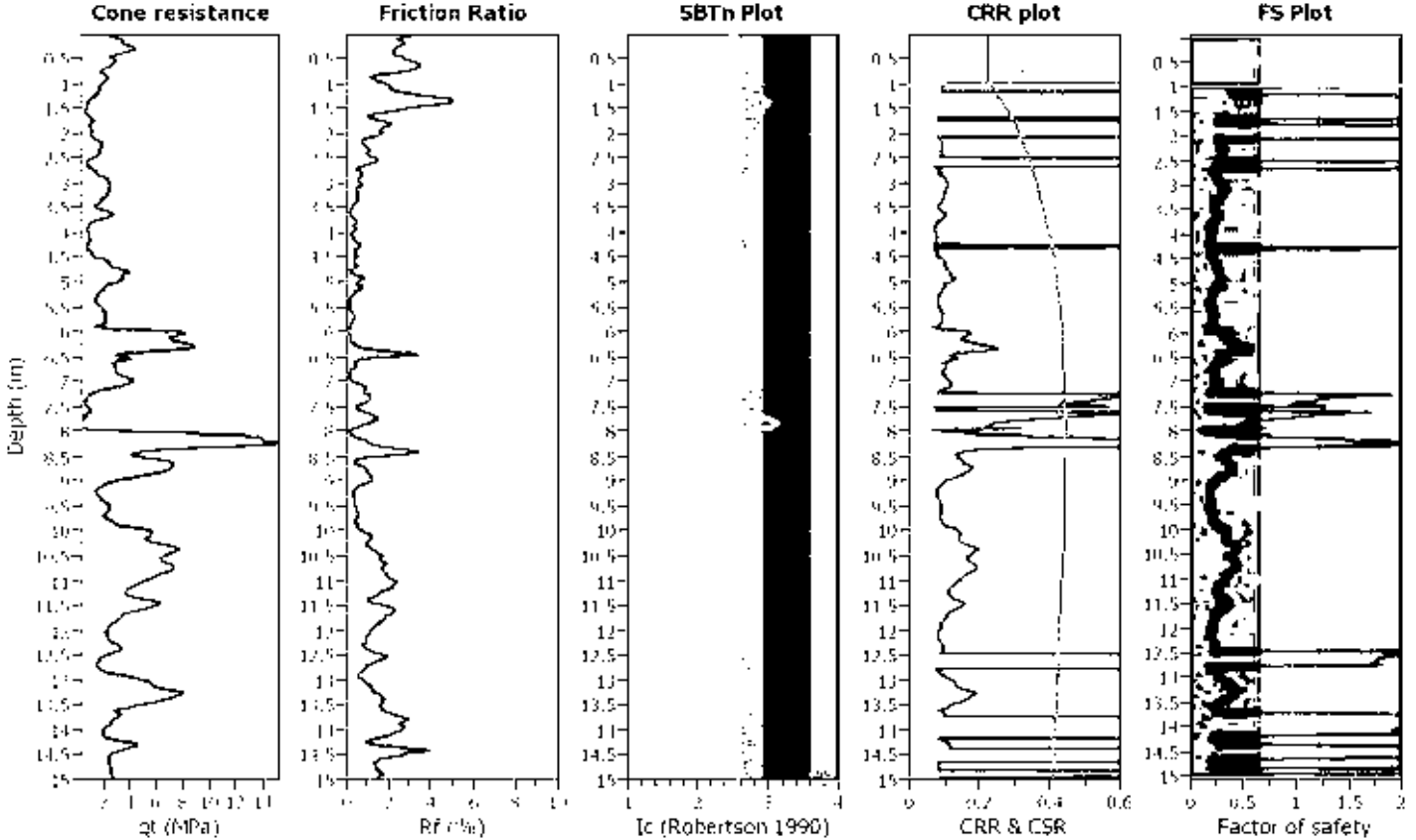
- q_t: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT41_678CashmereRd

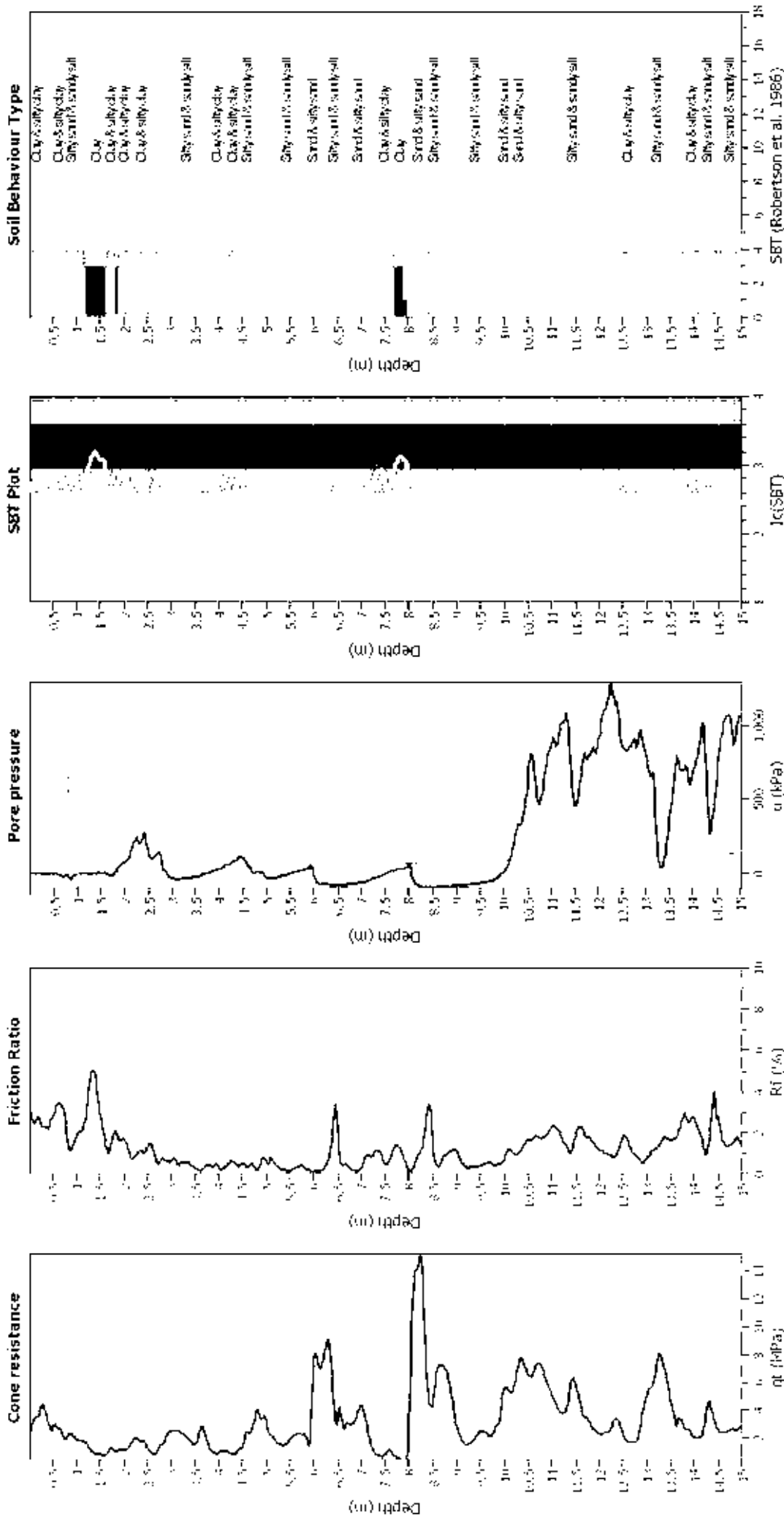
Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		



Zone A: High cyclic stress ratio, low penetration resistance and low cyclic stress ratio.
 Zone B: High cyclic stress ratio, high penetration resistance and high cyclic stress ratio.
 Zone C: Low cyclic stress ratio, low penetration resistance and low cyclic stress ratio.
 Zone D: Low cyclic stress ratio, high penetration resistance and high cyclic stress ratio.
 Zone E: High cyclic stress ratio, low penetration resistance and high cyclic stress ratio.
 Zone F: High cyclic stress ratio, high penetration resistance and low cyclic stress ratio.
 Zone G: Low cyclic stress ratio, low penetration resistance and high cyclic stress ratio.
 Zone H: Low cyclic stress ratio, high penetration resistance and low cyclic stress ratio.

CPT basic interpretation plots



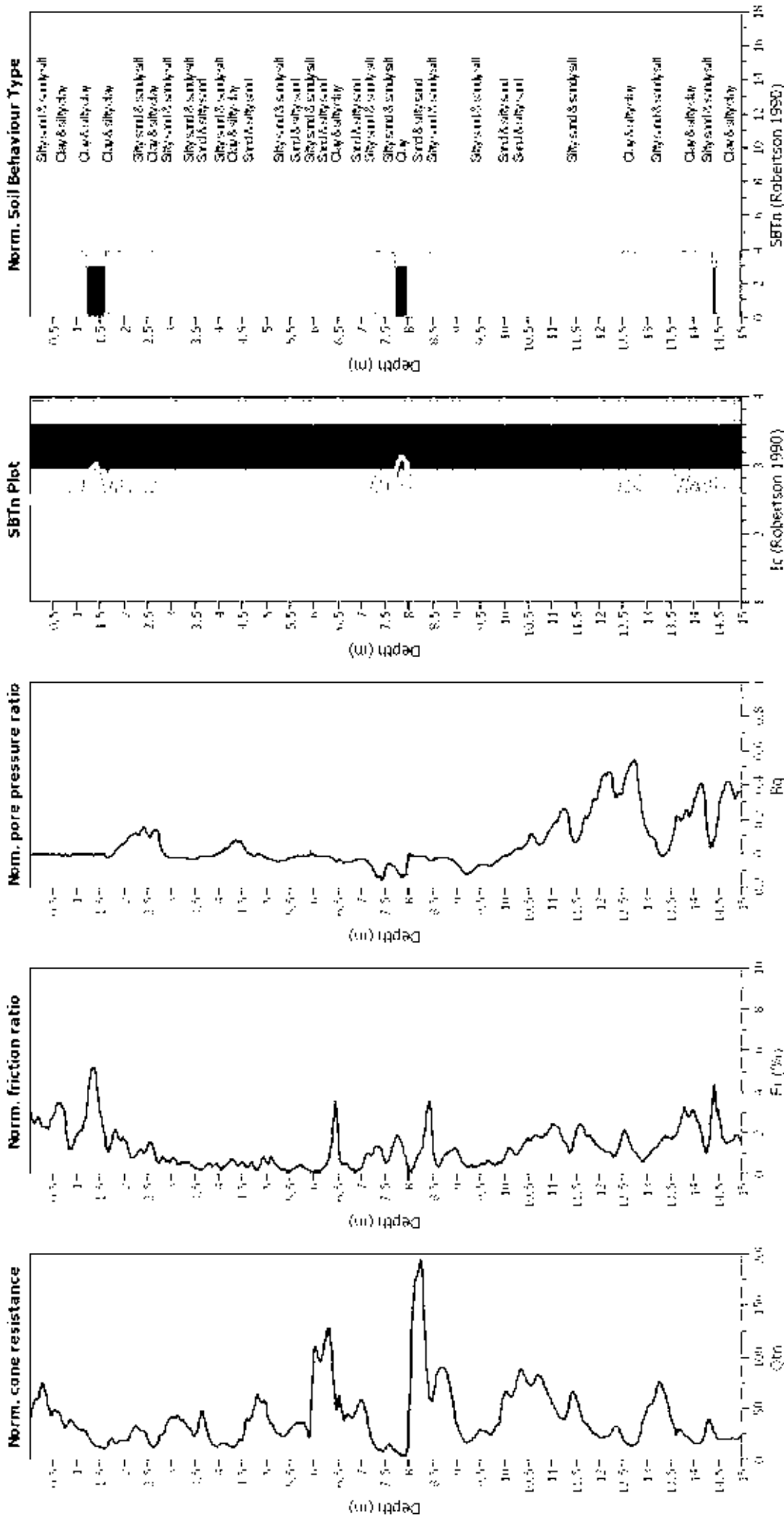
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



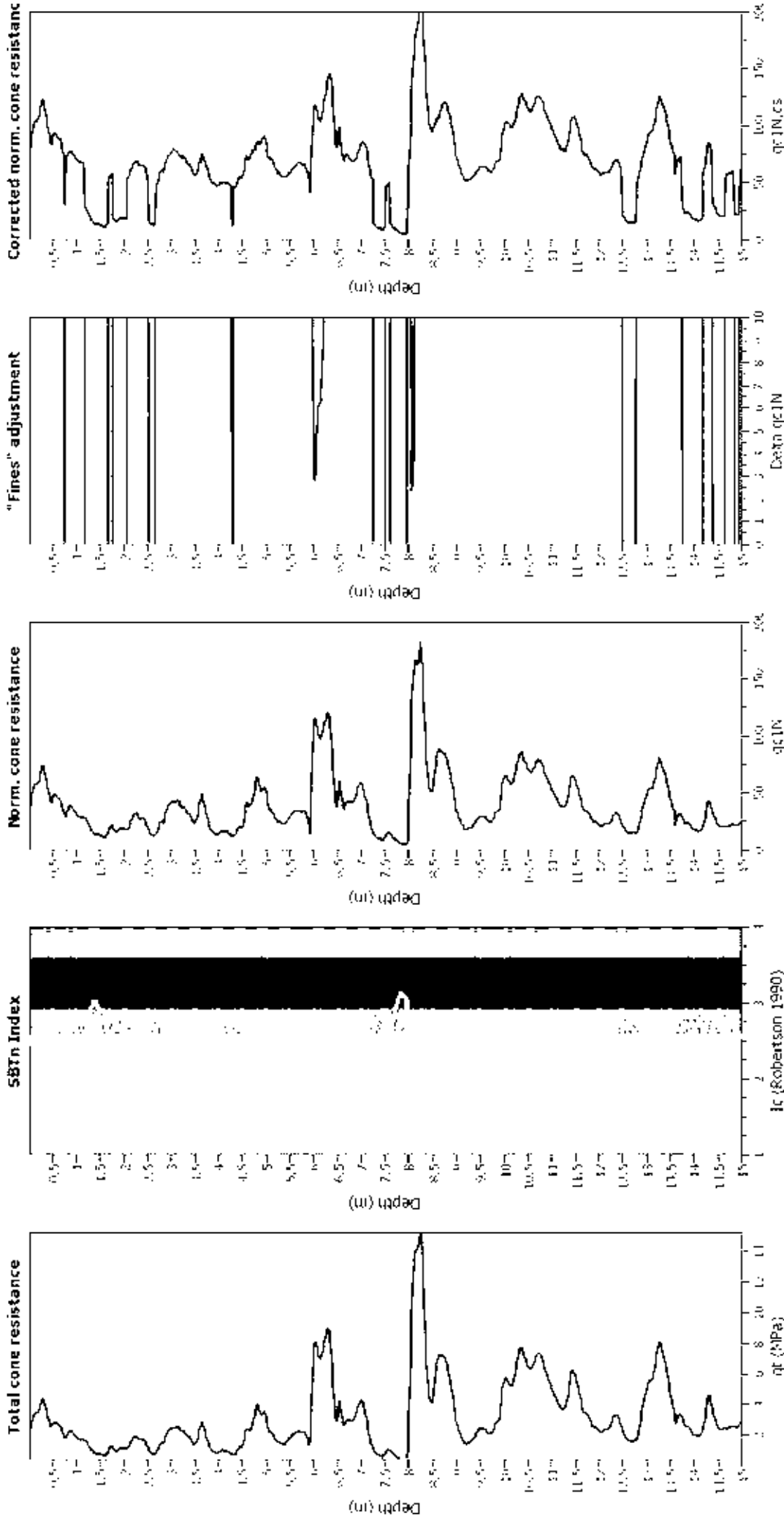
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A		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

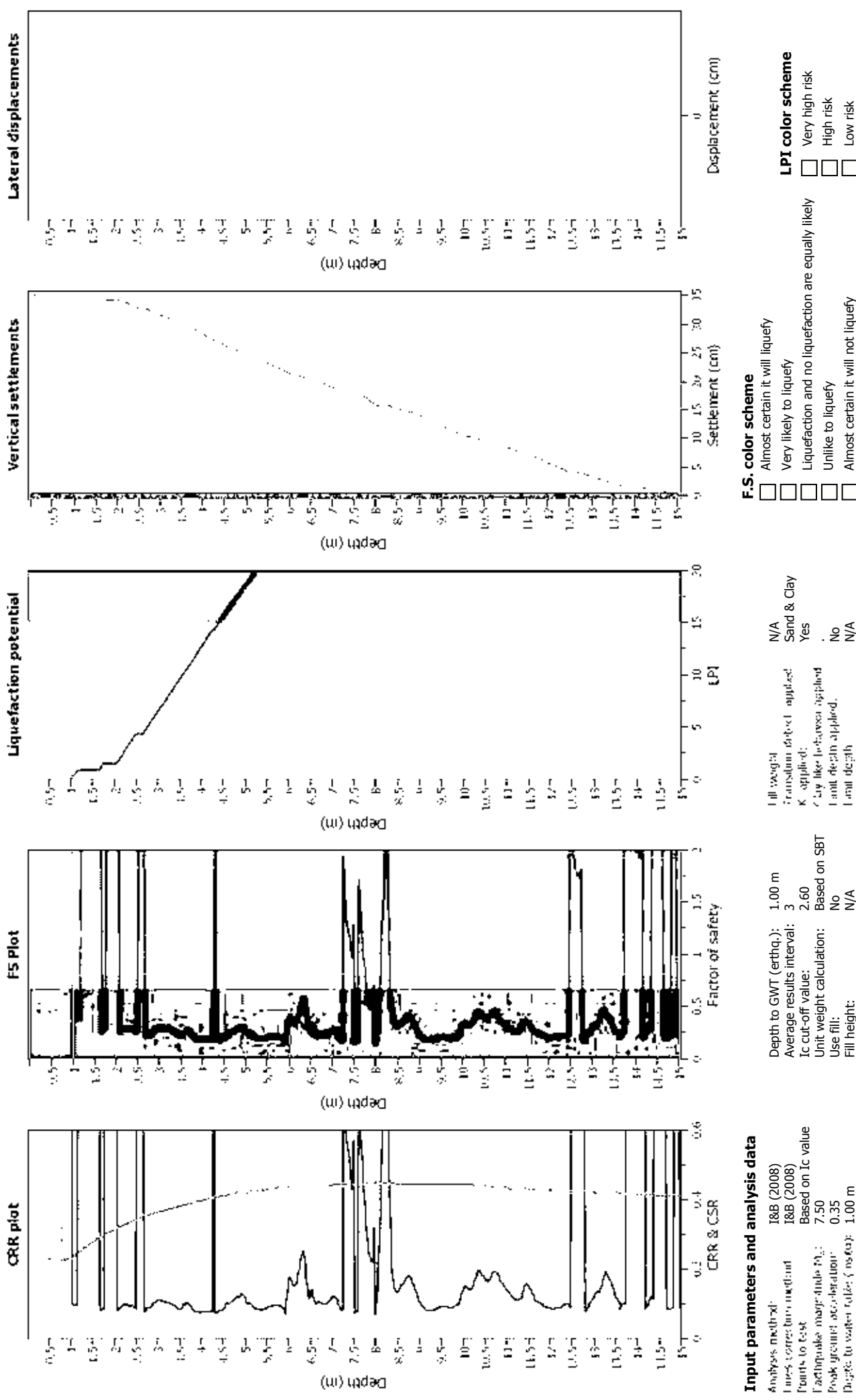
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.5	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Input correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.5
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m
 Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

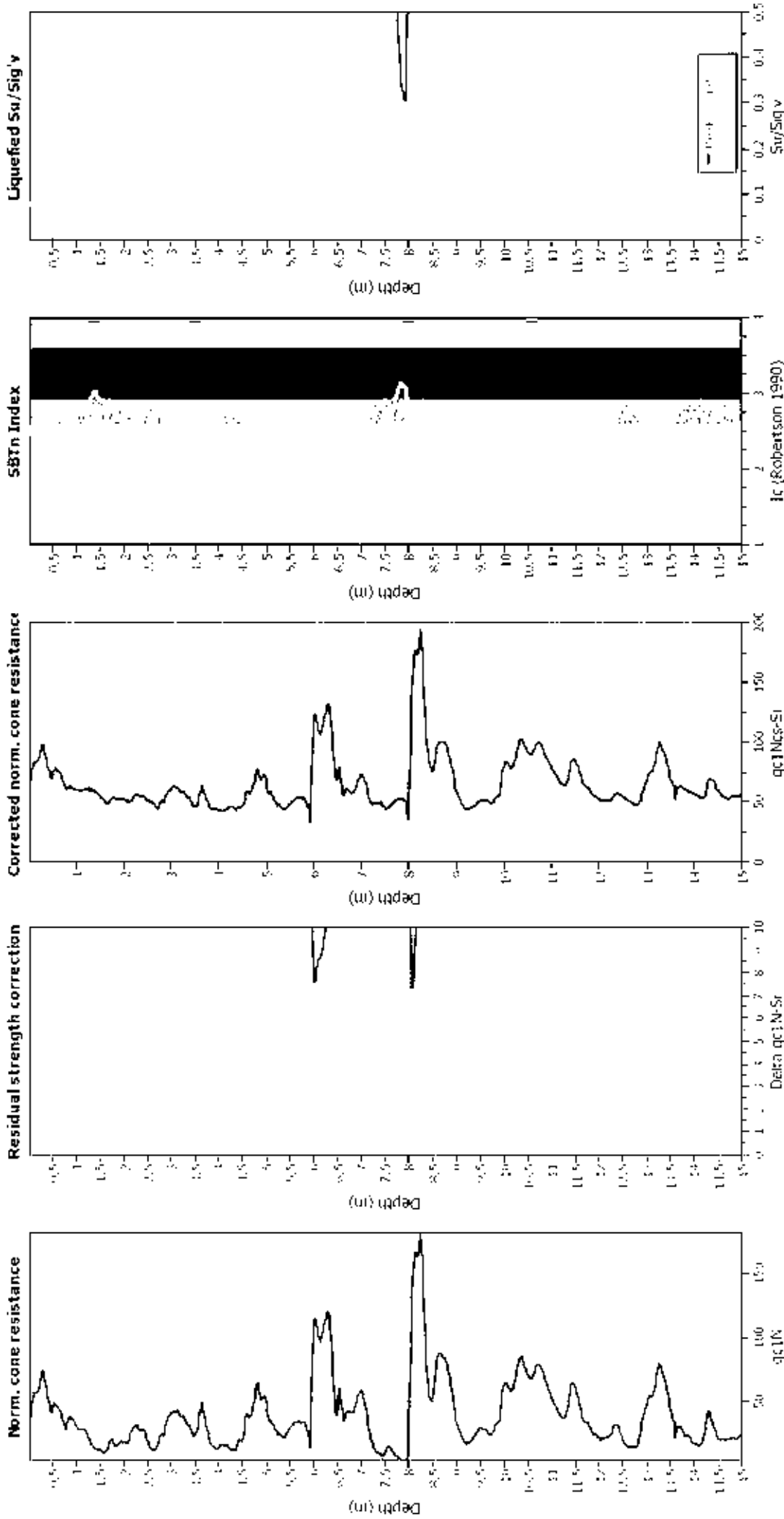
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

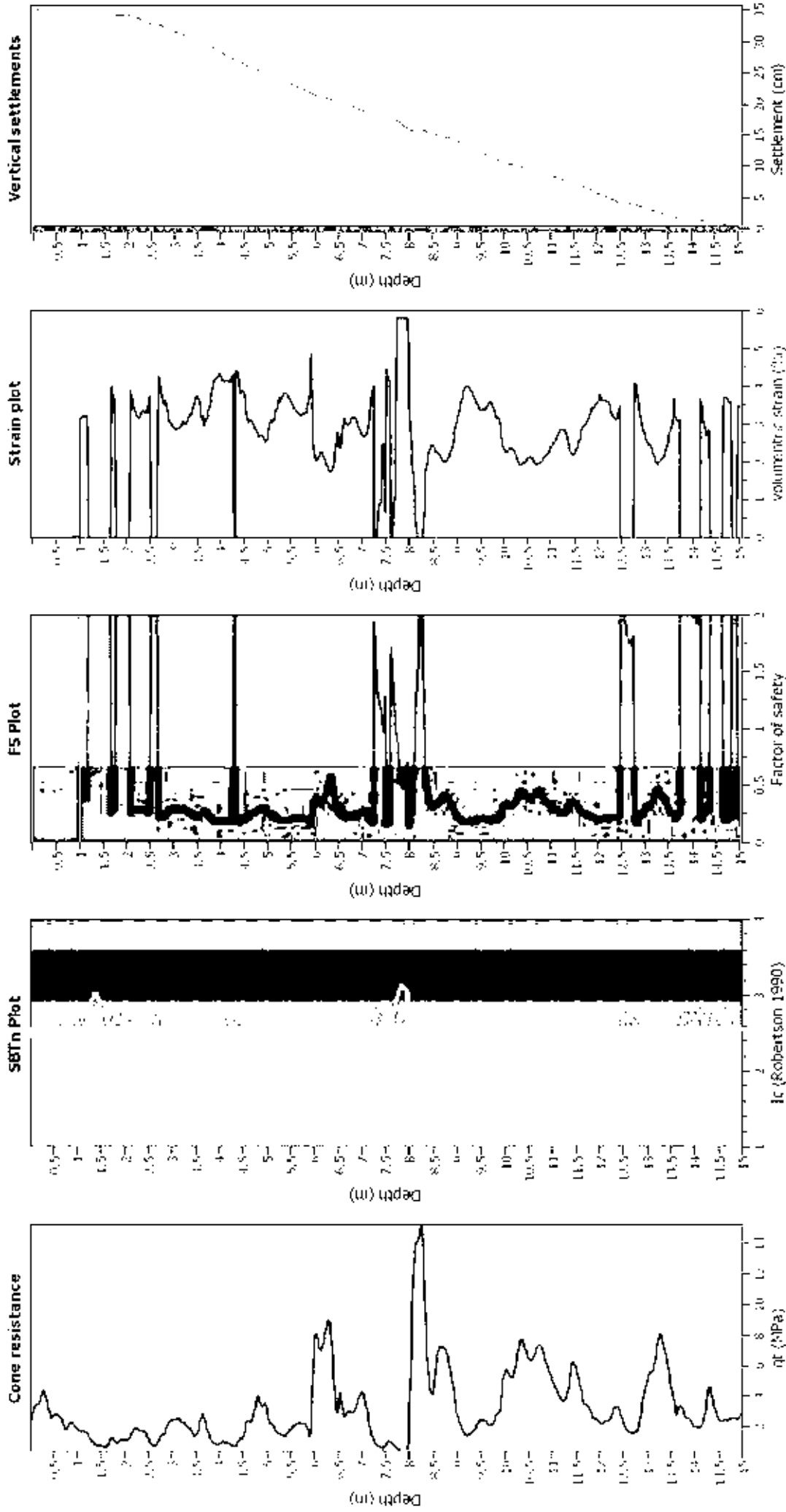
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- RC: Total cone resistance (cone resistance q_c corrected for pore water effects)
- SB: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT42_564CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

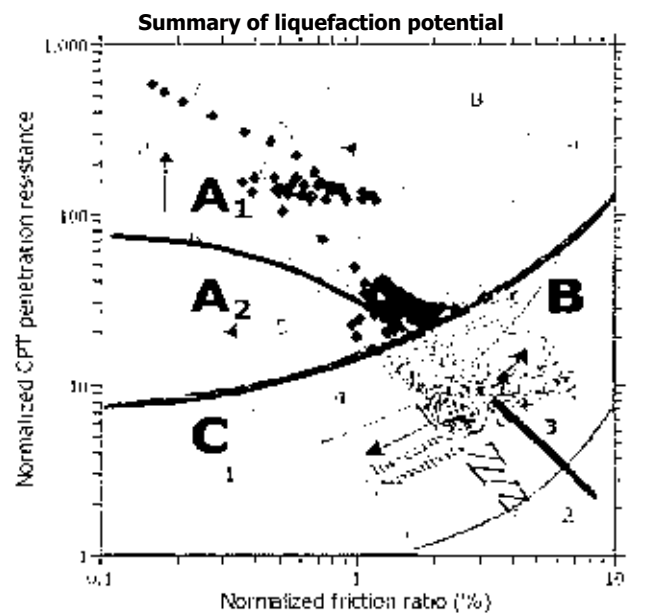
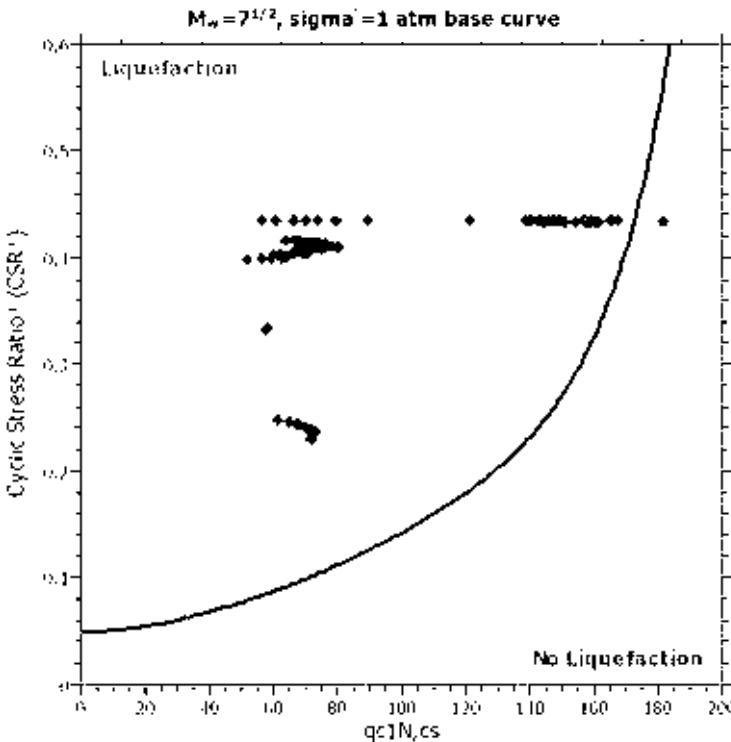
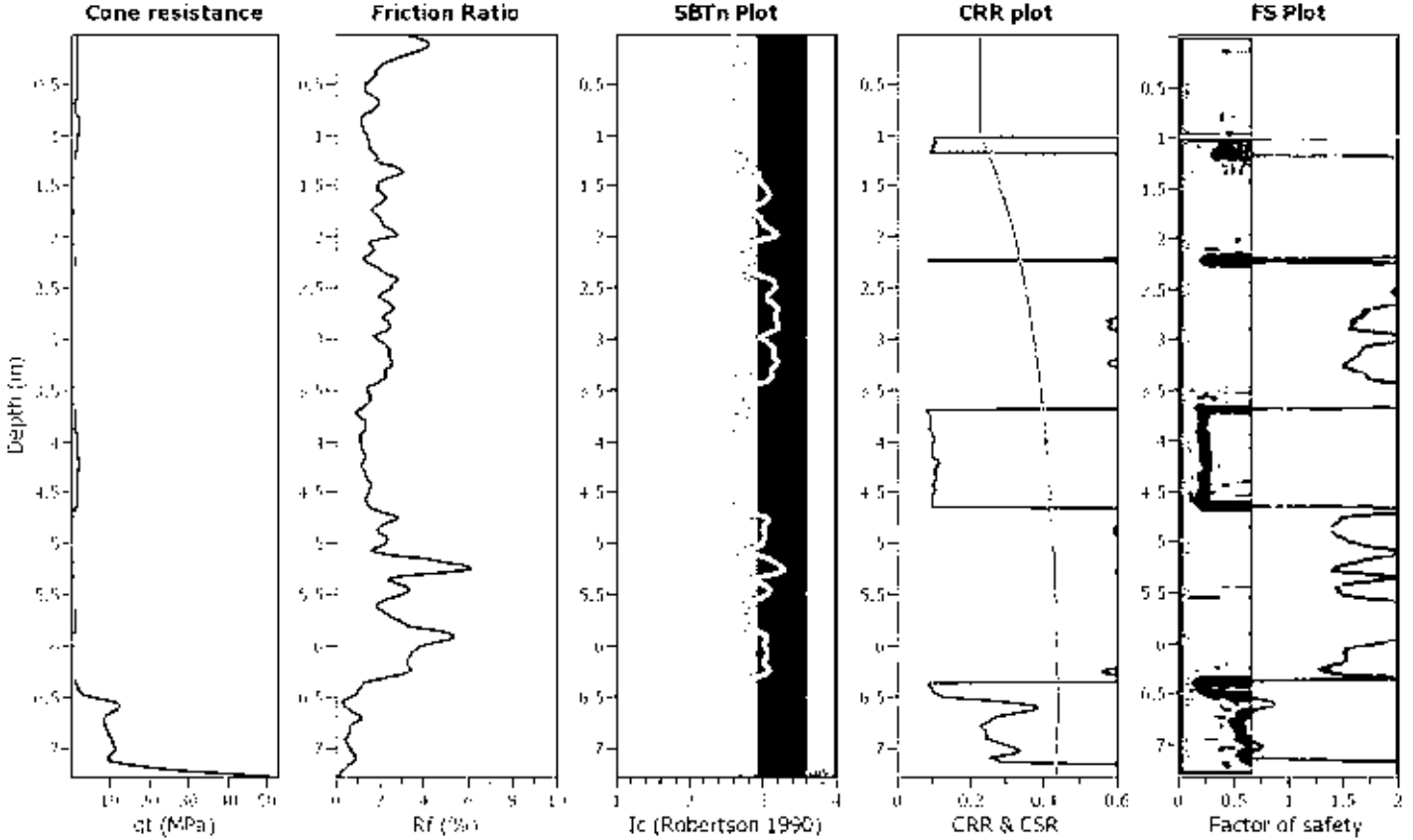
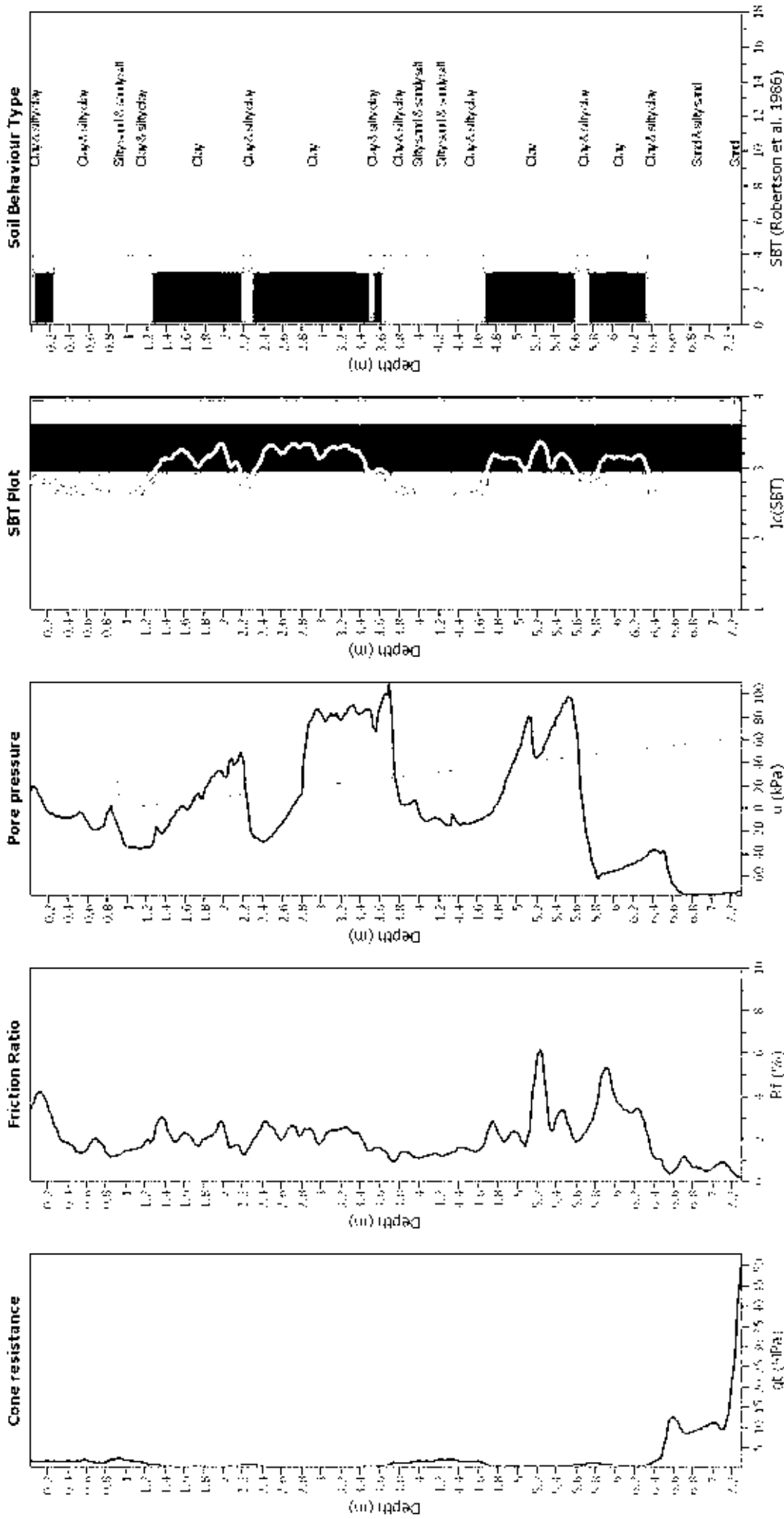


Figure 4: Summary of liquefaction potential assessment plot and data points of cyclic test. Zone A1: Fully liquefied, Zone A2: Partially liquefied, Zone B: Fully liquefied, Zone C: No liquefaction. The liquefaction potential is assessed based on the cyclic stress ratio (CSR) and the normalized friction ratio (Rf). The liquefaction potential is assessed based on the cyclic stress ratio (CSR) and the normalized friction ratio (Rf). The liquefaction potential is assessed based on the cyclic stress ratio (CSR) and the normalized friction ratio (Rf).

CPT basic interpretation plots



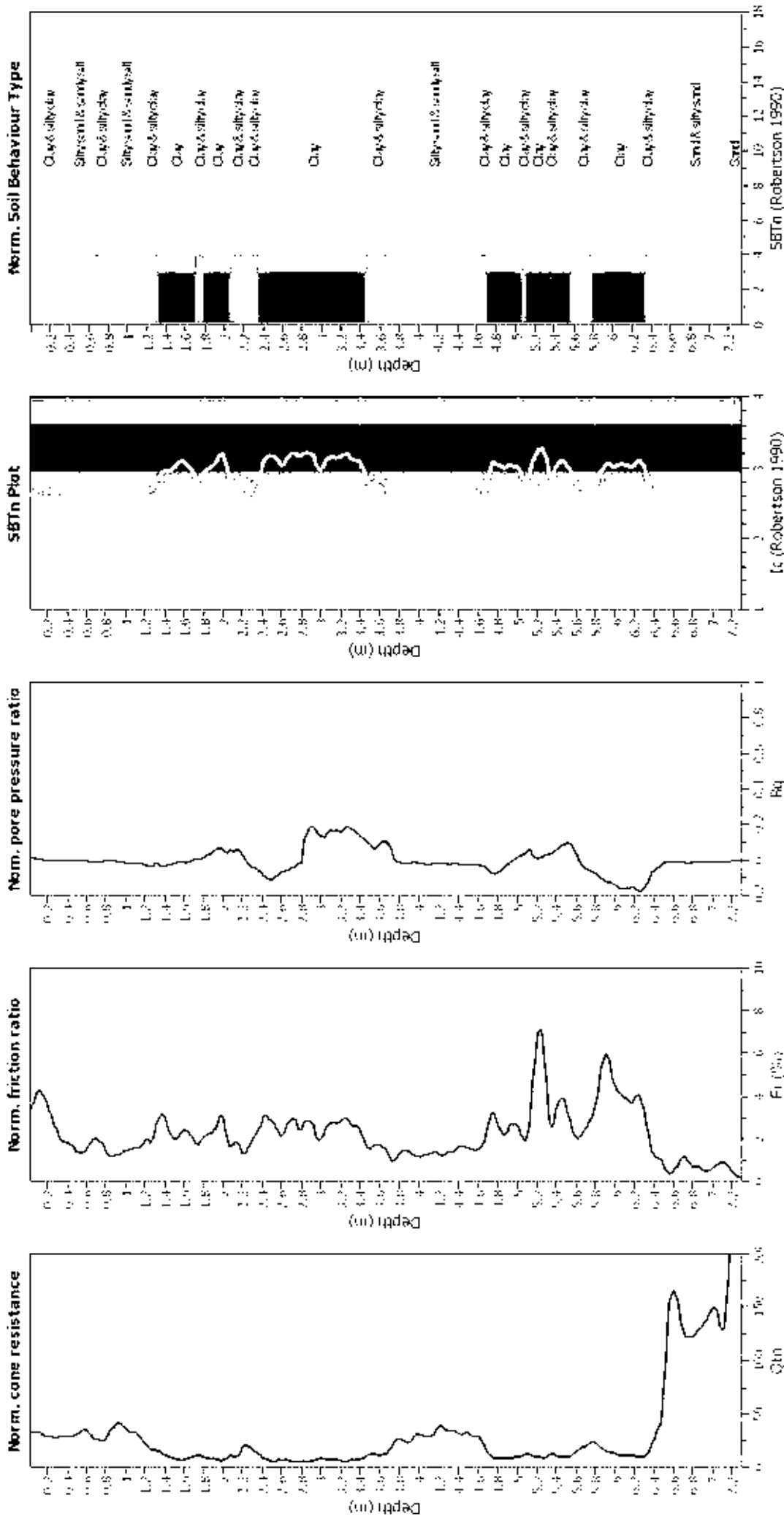
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Lamé depth applied:	No
Depth to water table (m):	1.00 m	Lamé depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



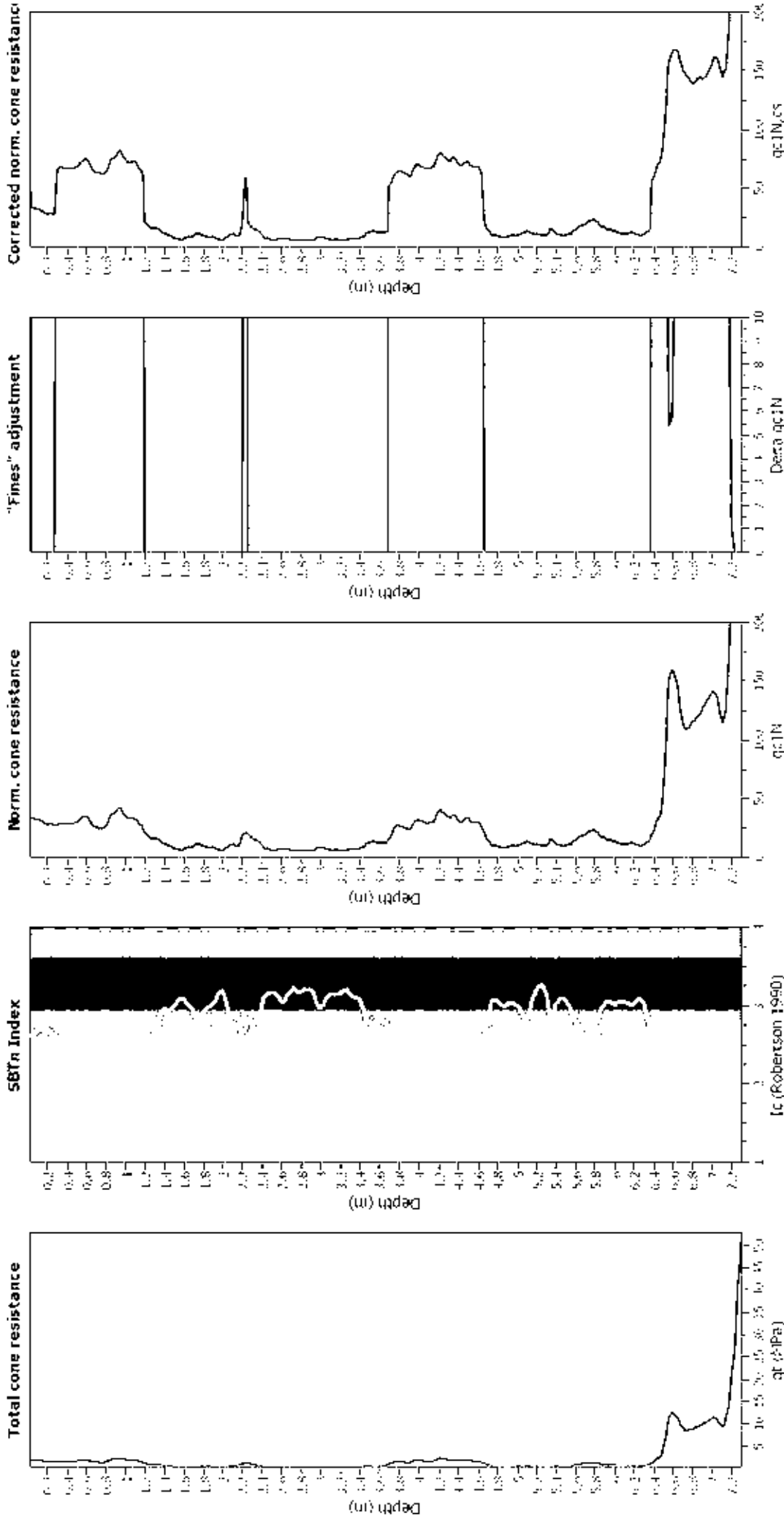
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.00 m	Fill weight:	N/A	Sand & Clay:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Clay like behavior applied		
Factorial analysis method:	Based on SBT	Unit weight calculation:	No	Unit depth applied:	No		
Peak ground acceleration:	0.35	Use fill:	N/A	Unit depth:	N/A		
Depth to water table (m):	1.00 m	Fill height:	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

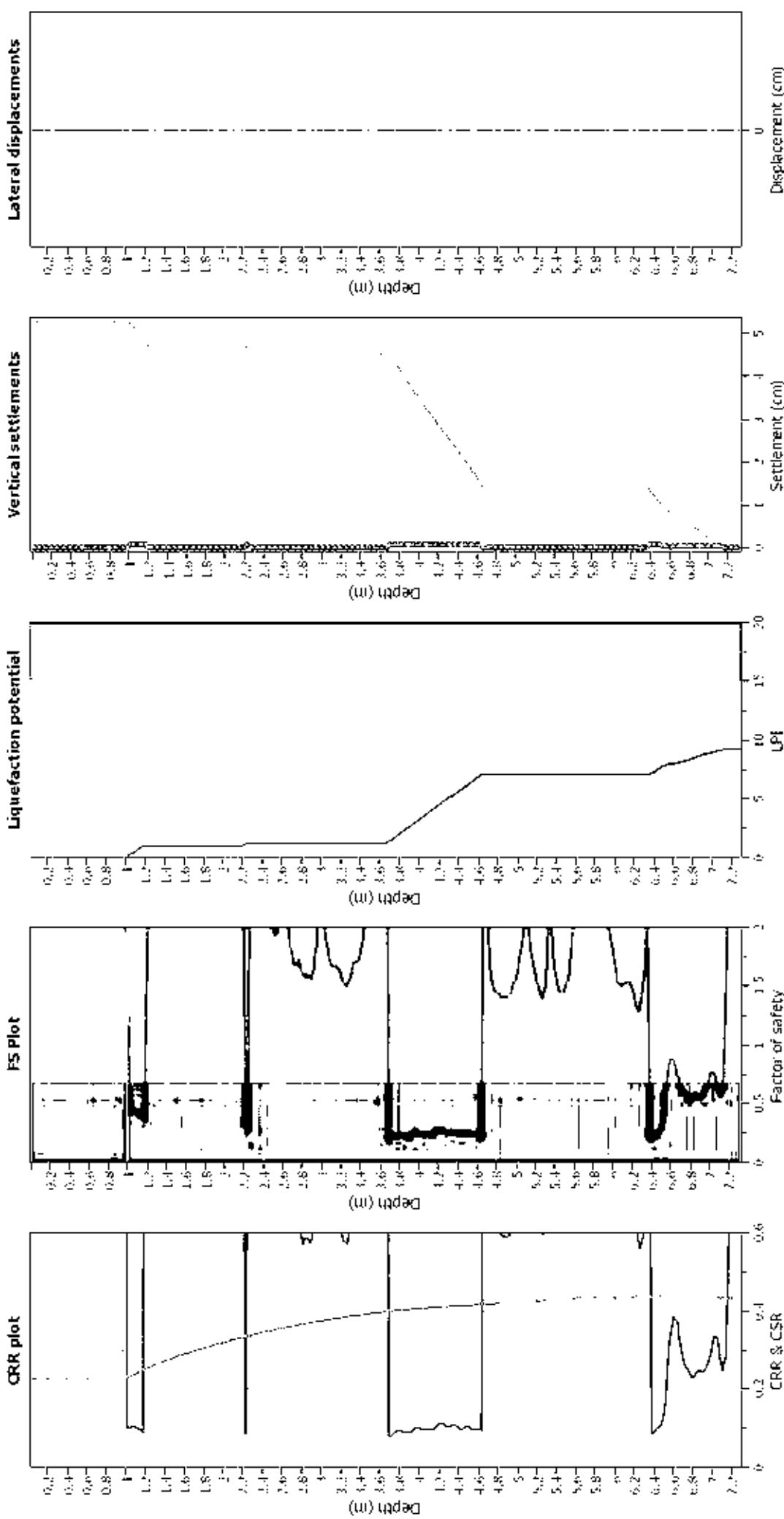
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m
 Depth to GWL (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

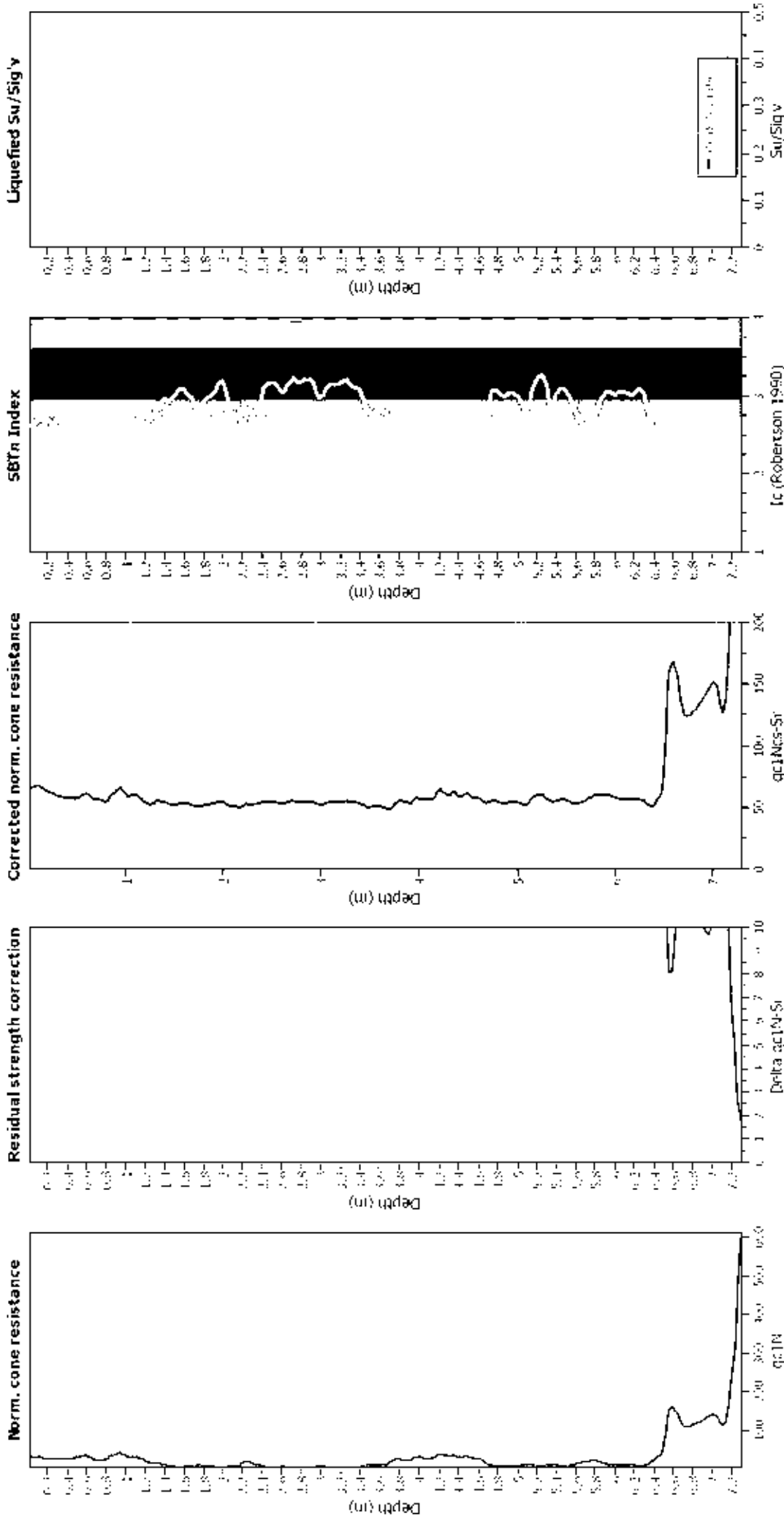
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

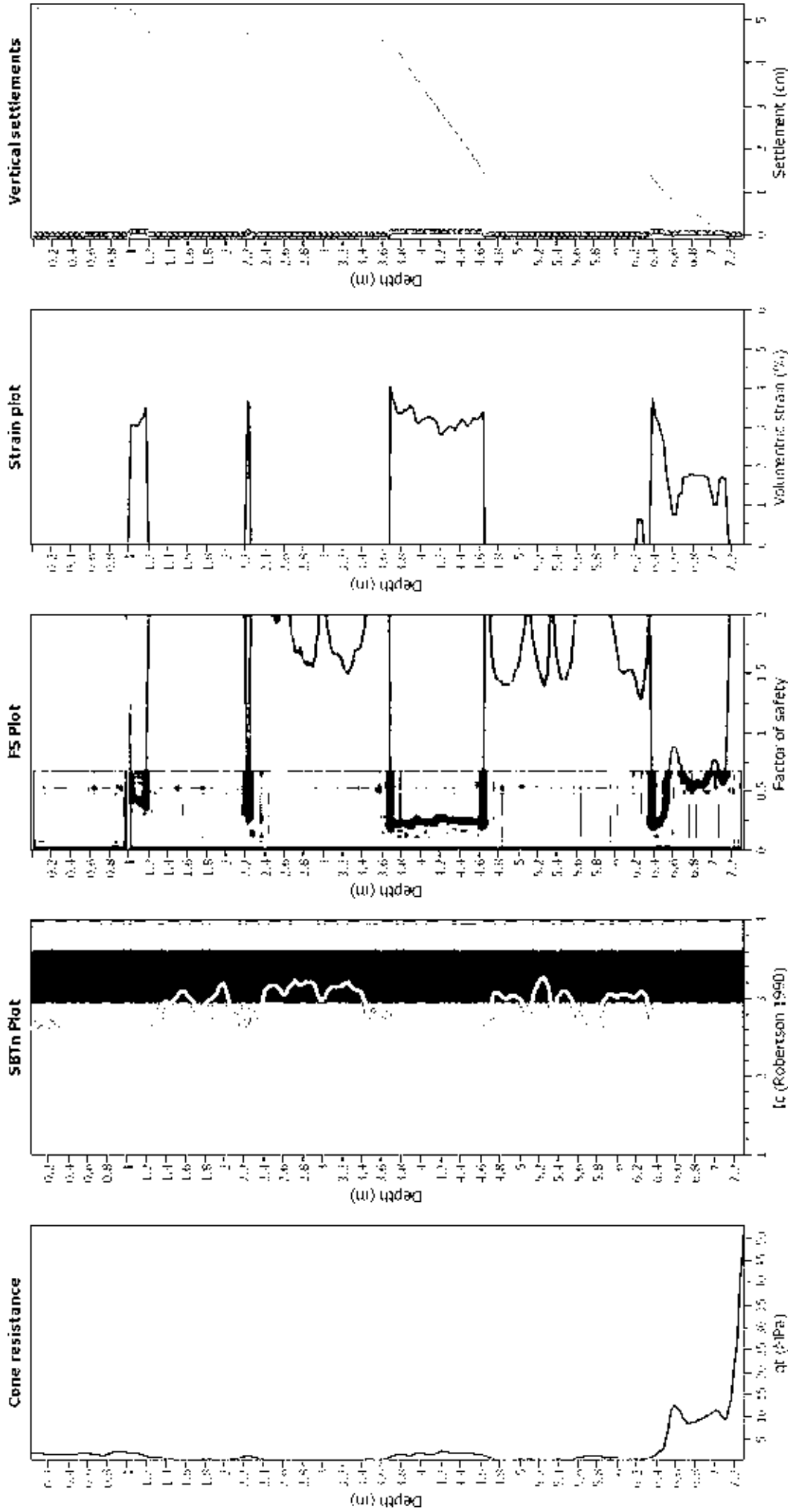
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition detect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GWT (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT43_484CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

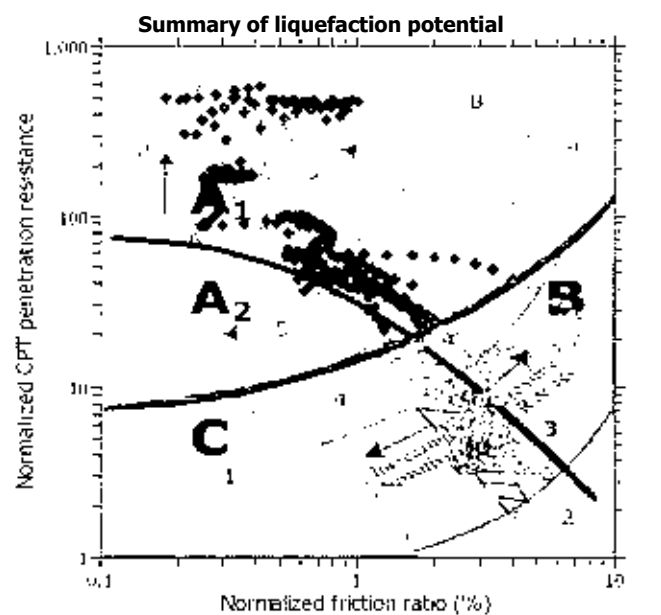
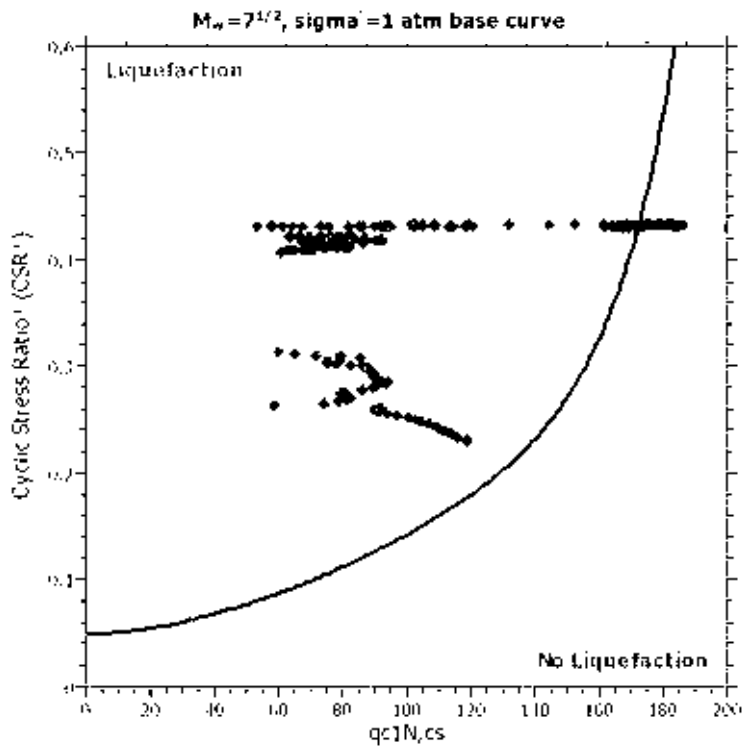
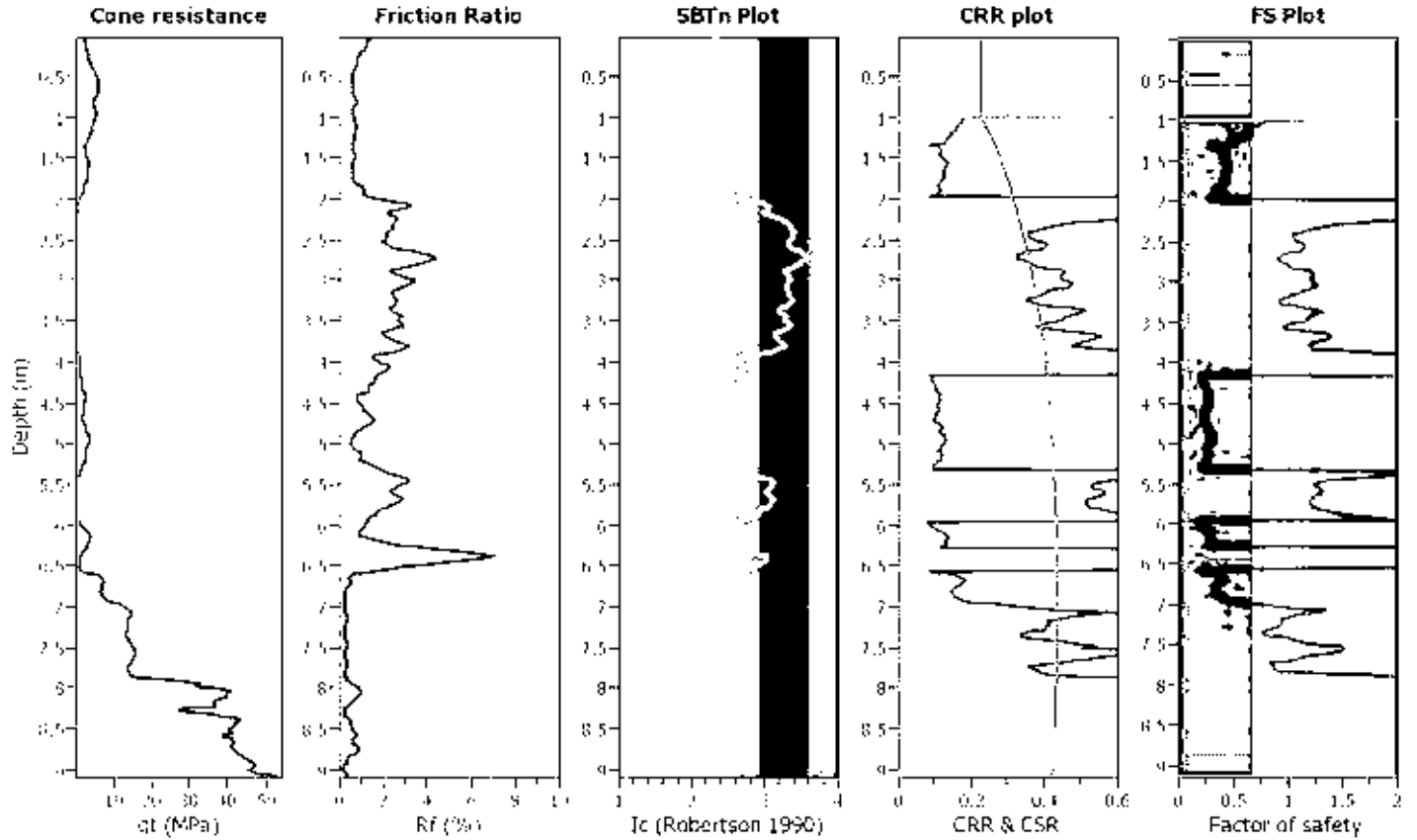
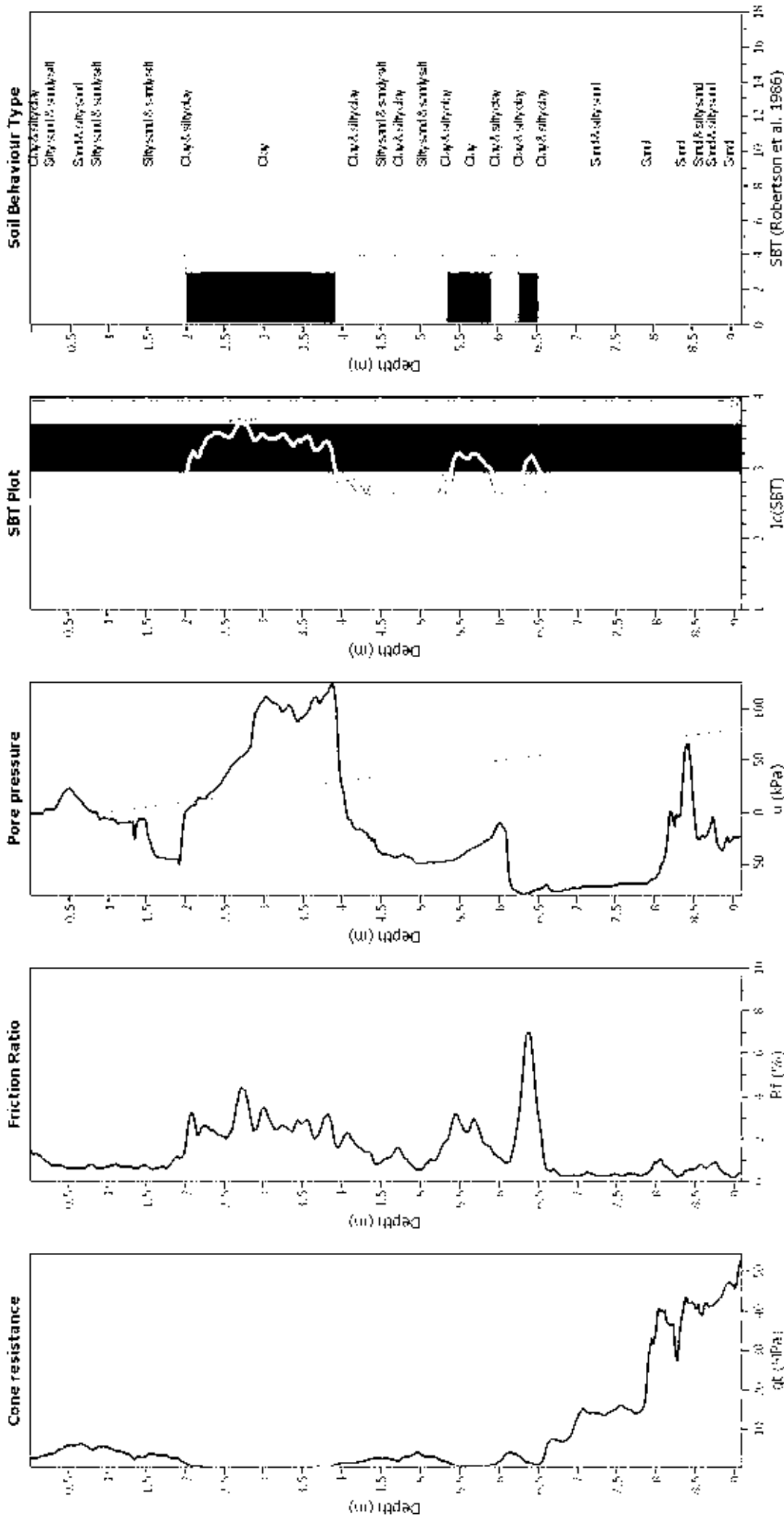


Figure 4: Summary of liquefaction potential plot and data points of cyclic test. Zone A1: Fully liquefied zone, Zone A2: Partially liquefied zone, Zone B: No liquefaction zone, Zone C: No liquefaction zone. The liquefaction potential plot is based on the cyclic stress ratio (CSR) and the normalized friction ratio (Rf). The liquefaction potential plot is based on the cyclic stress ratio (CSR) and the normalized friction ratio (Rf). The liquefaction potential plot is based on the cyclic stress ratio (CSR) and the normalized friction ratio (Rf).

CPT basic interpretation plots



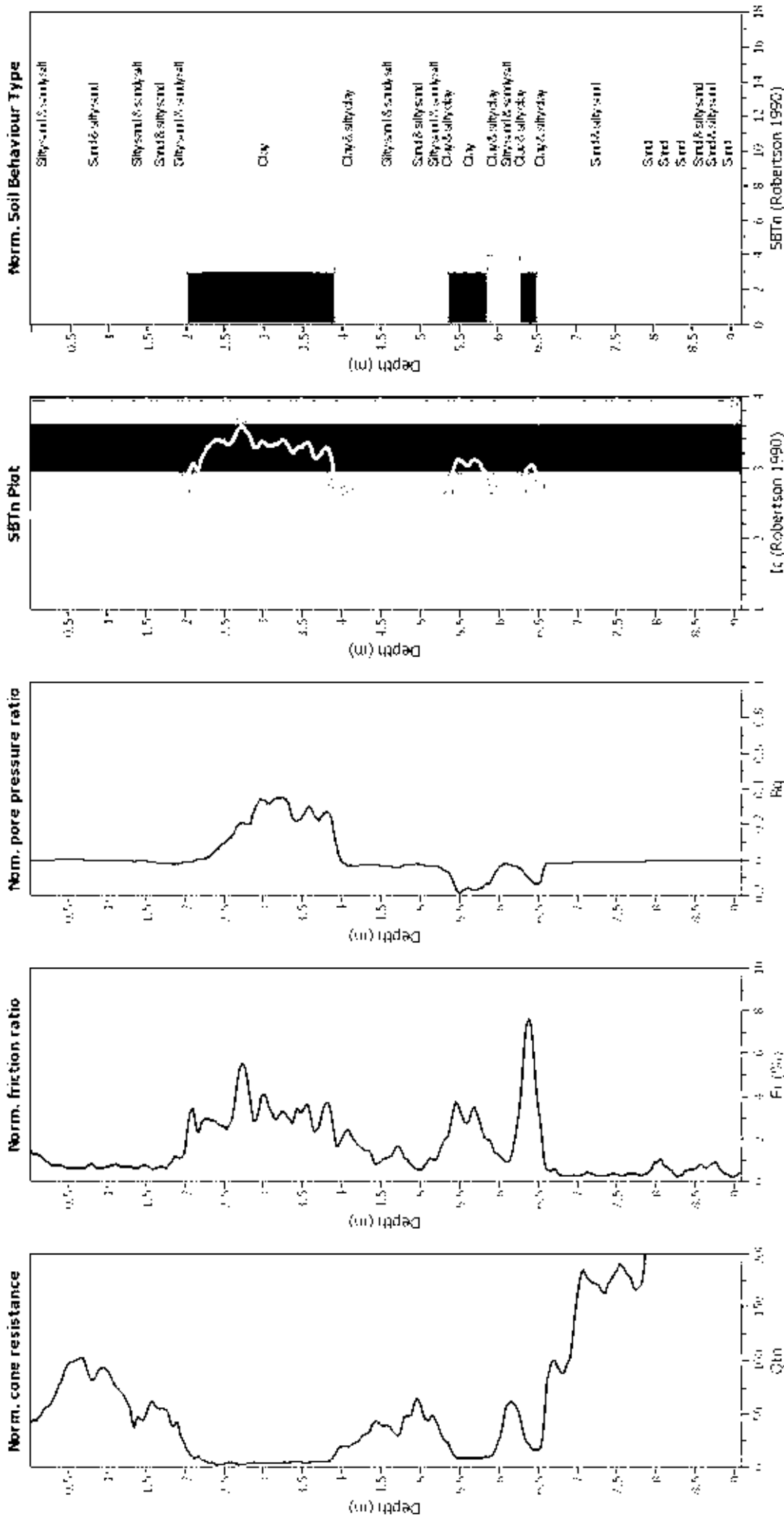
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Factorial magnitude M_v :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



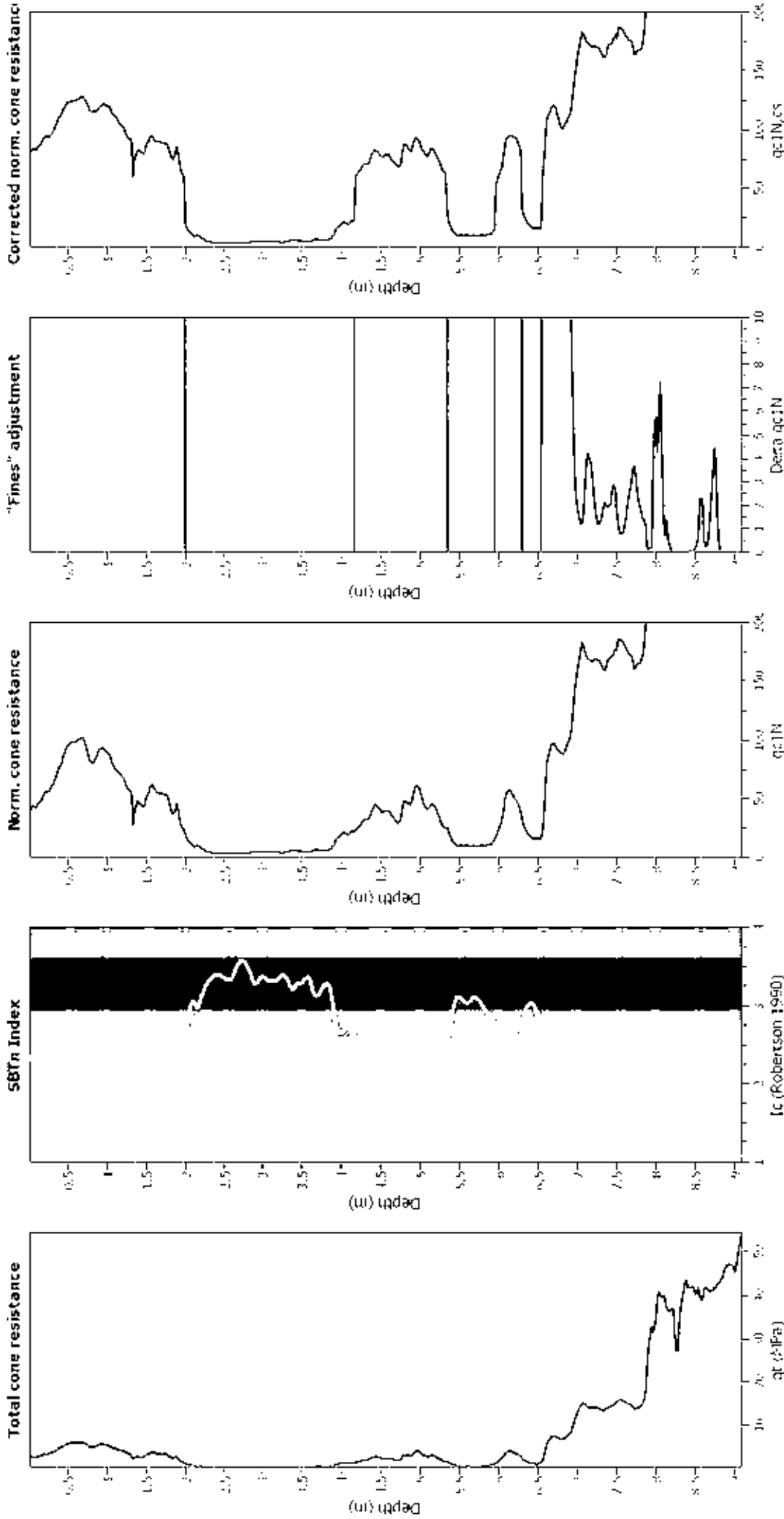
Input parameters and analysis data

Analysis method:	188 (2008)	Depth to GW (earthq.):	1.00 m	Fill weight:	N/A
Units correction method:	188 (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	Unit weight calculation:	Based on SBT	K applied:	Yes
Earthquake magnitude M_w :	7.50	Use fill:	No	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Fill height:	N/A	Unit depth:	N/A
Depth to water table (m):	1.00 m				

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

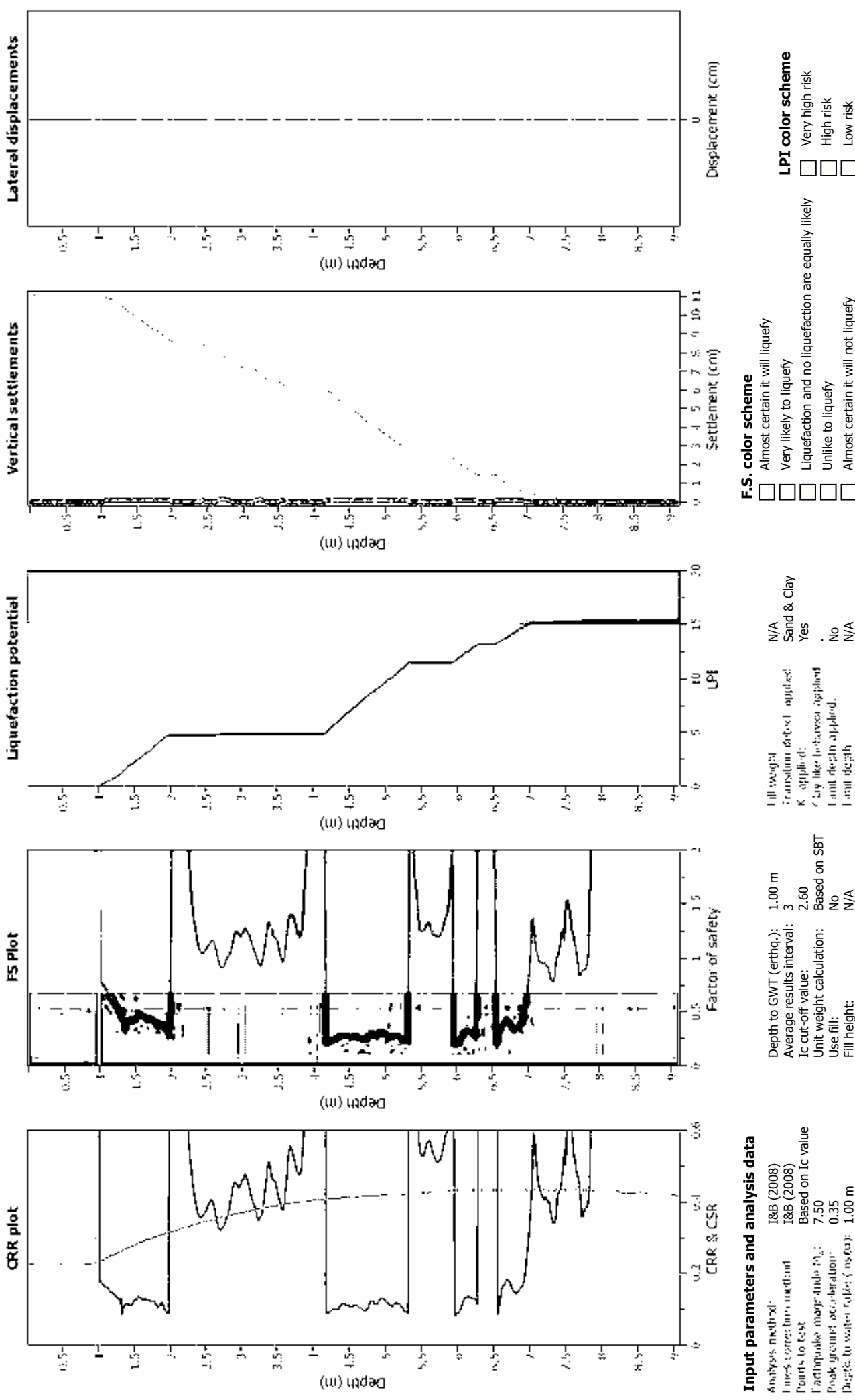
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

F.S. color scheme

Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlikely to liquefy
 Almost certain it will not liquefy

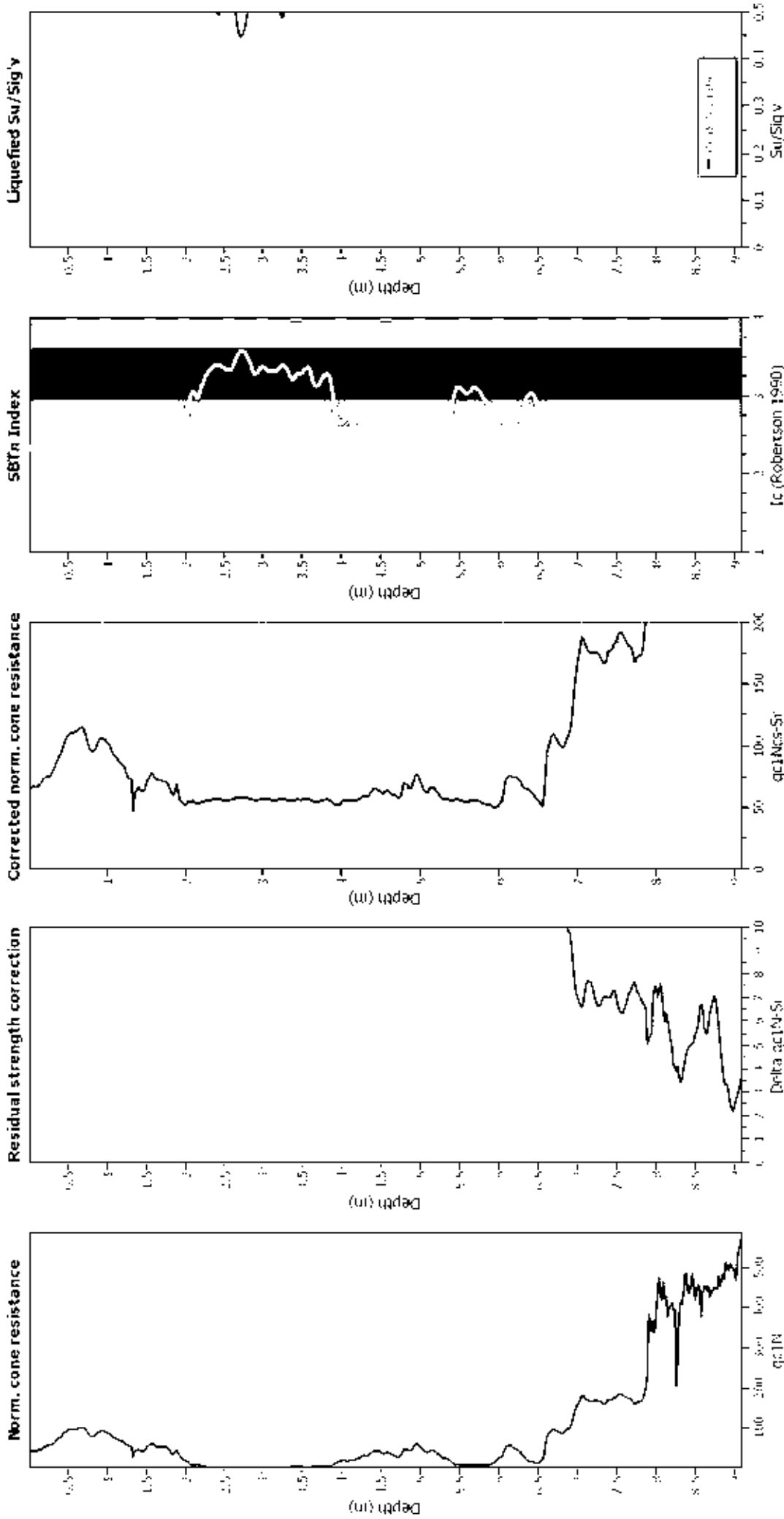
F.S. color scheme

All weight transition method applied
 K applied
 Clay like behavior applied
 Limit depth applied

LPI color scheme

Very high risk
 High risk
 Low risk

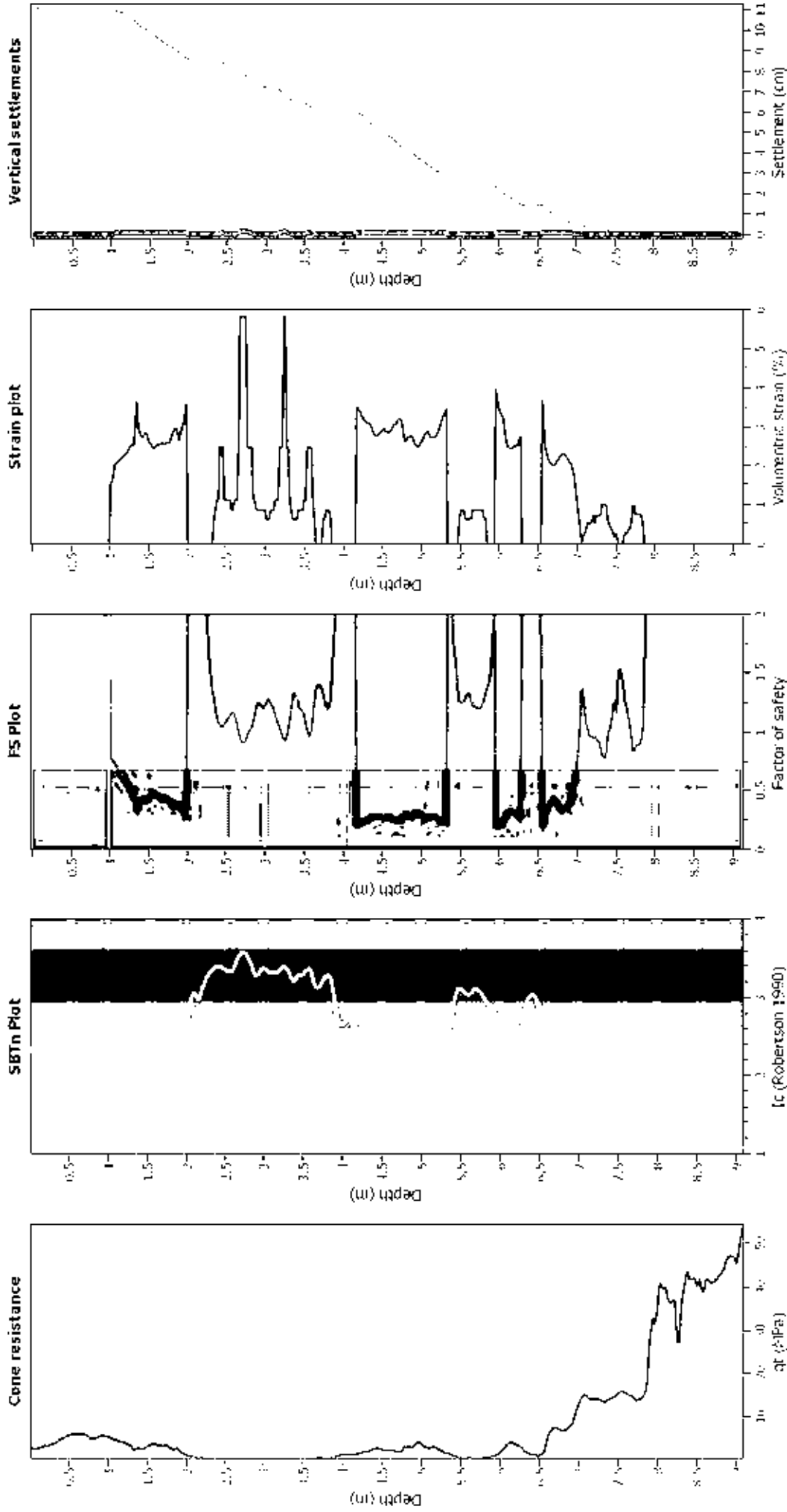
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- sbtn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT44_564CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M _w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

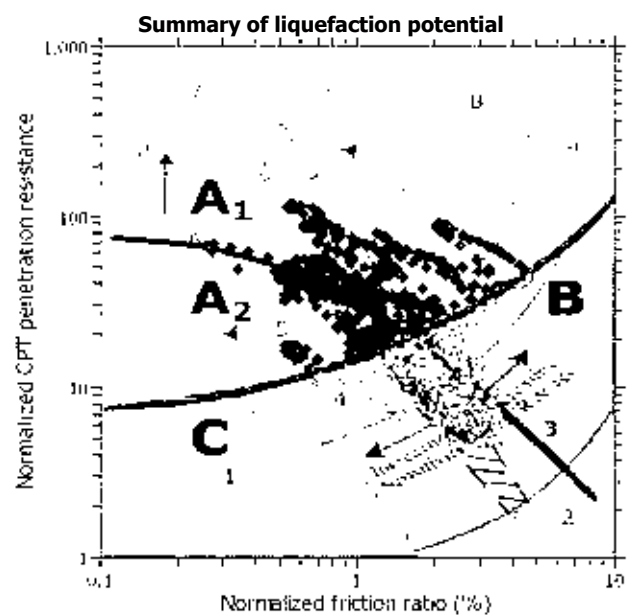
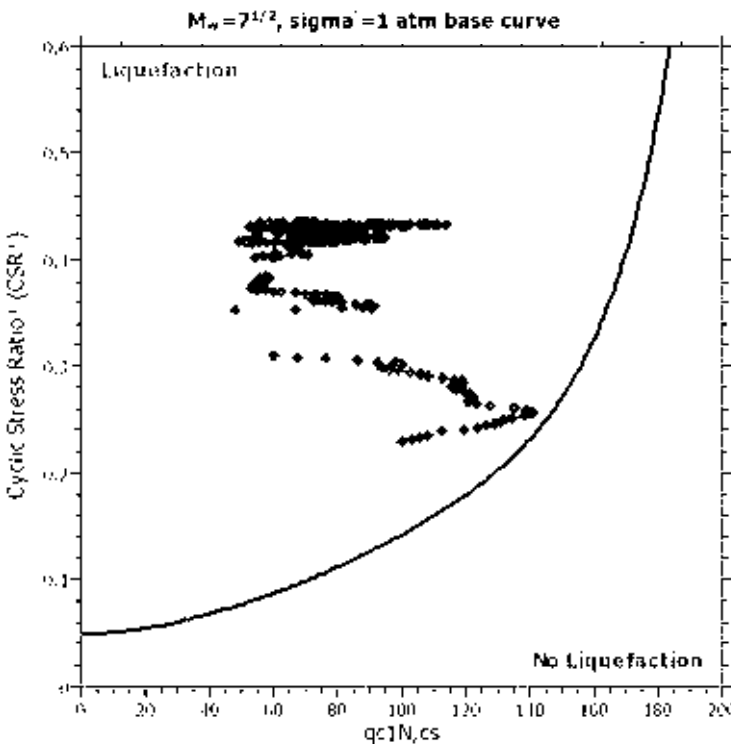
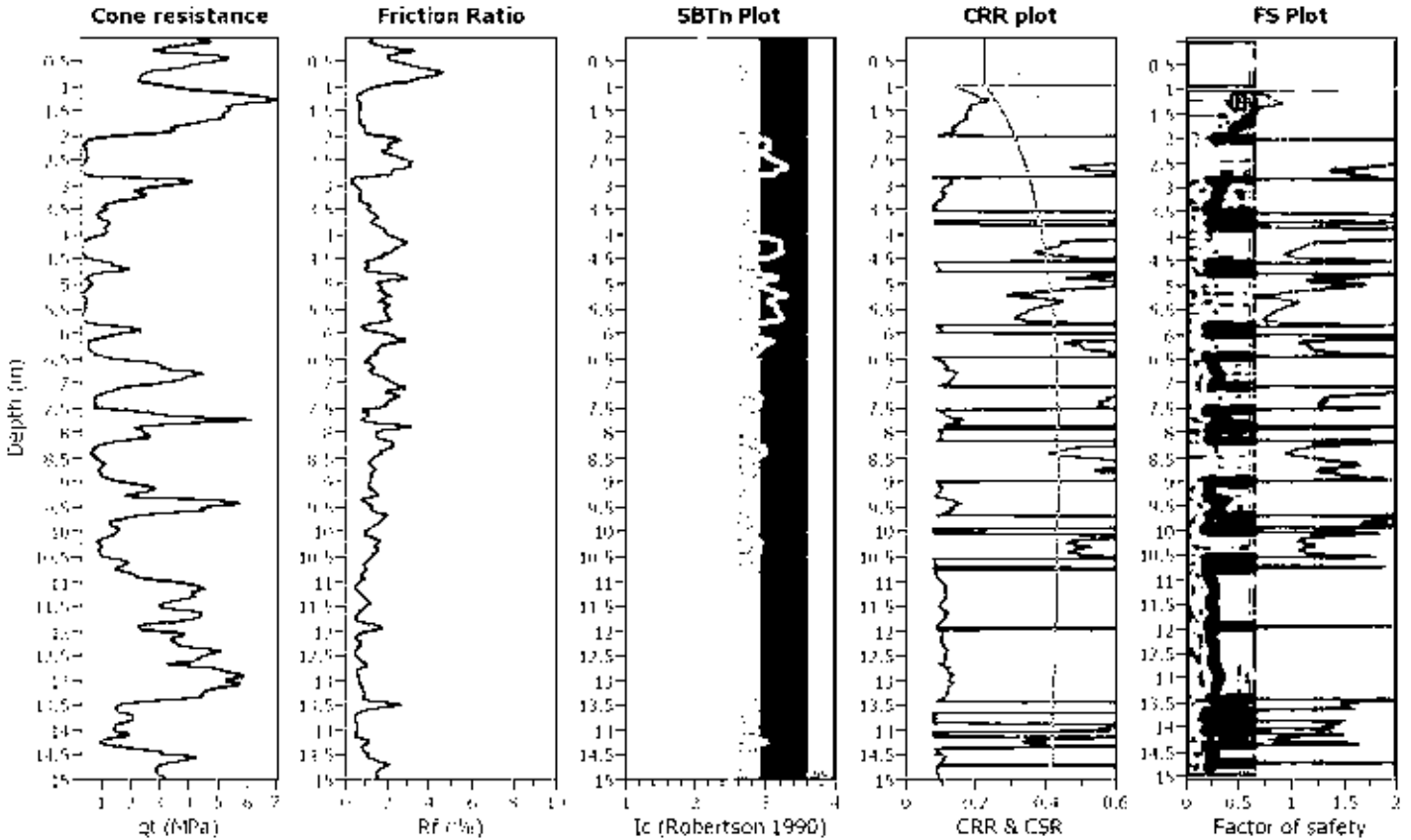
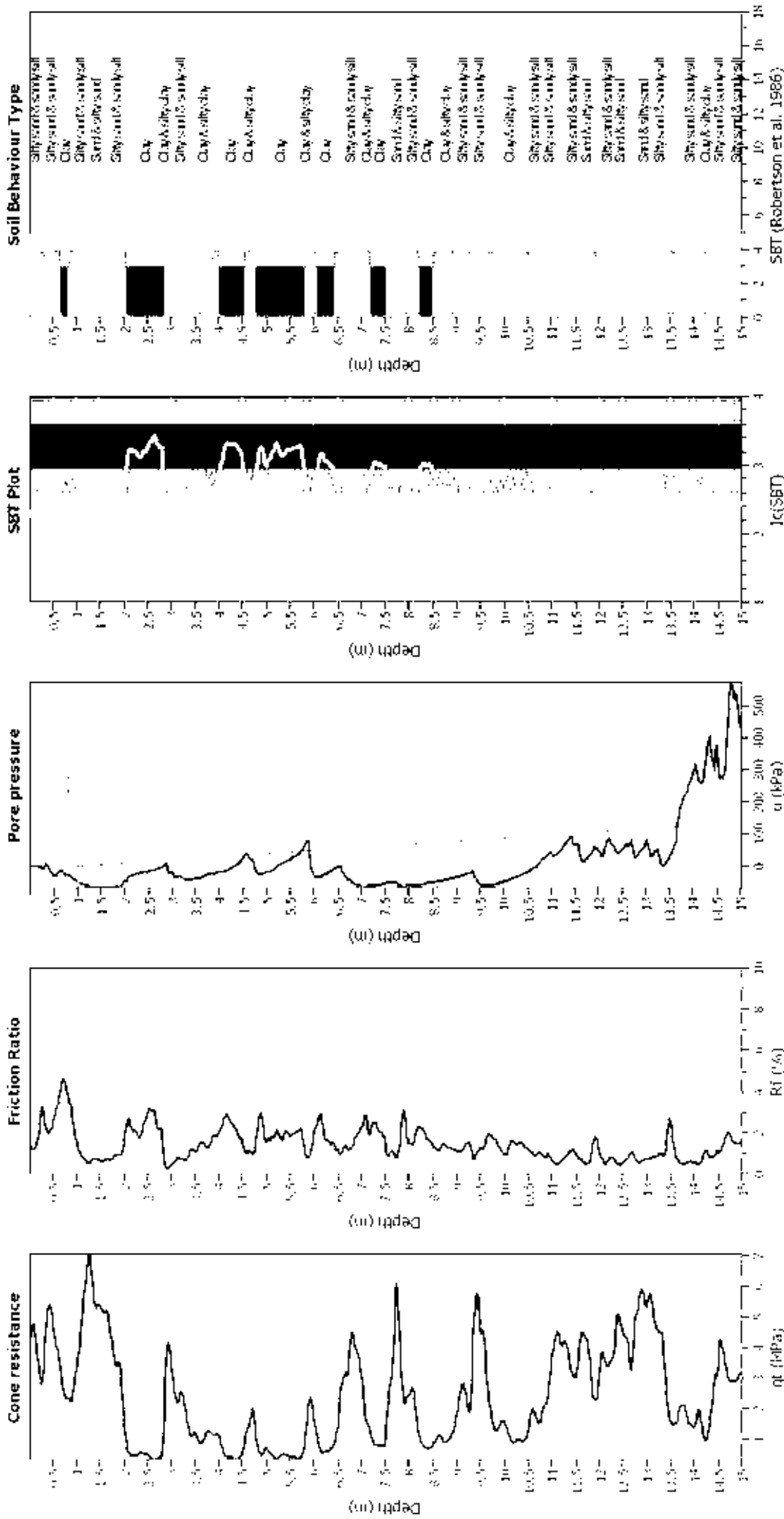


Figure 4: Summary of liquefaction potential based on cone and friction ratio data. Zone A1: Fully liquefiable soils, Zone A2: Partially liquefiable soils, Zone B: Non-liquefiable soils, Zone C: Fully liquefiable soils. The dashed line indicates the liquefaction boundary.

CPT basic interpretation plots



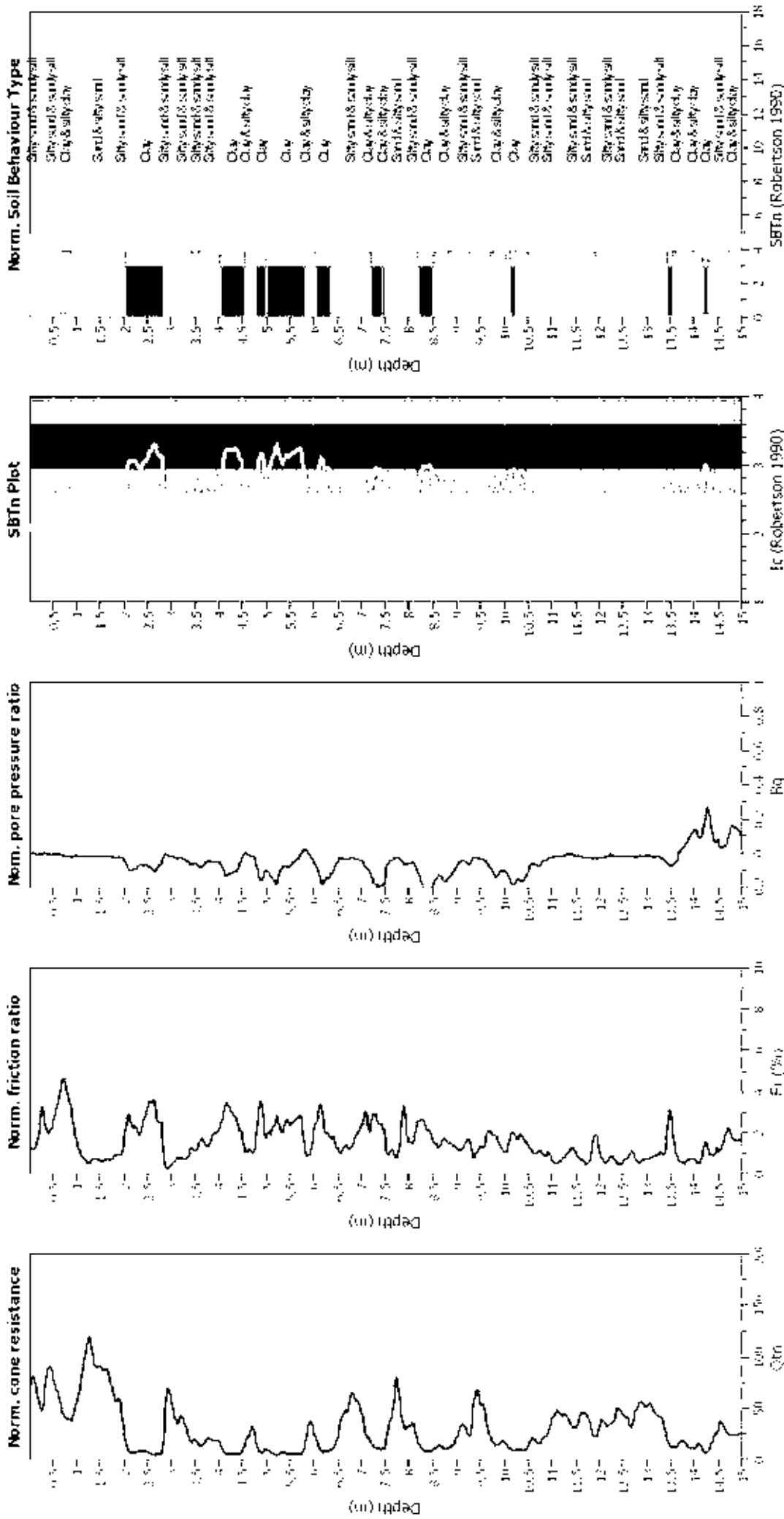
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre: (b), (c), (d), (e)	18B (2008)	Transition depth:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Factor: (a) mag: (b) M_v :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth:	N/A
Depth to water table: (c) (d):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m	Unit weight:	N/A
Average results interval:	3	Transition depth applied:	Yes
I_c cut-off value:	2.60	K applied:	Yes
Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Use fill:	No	Unit depth:	N/A
Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



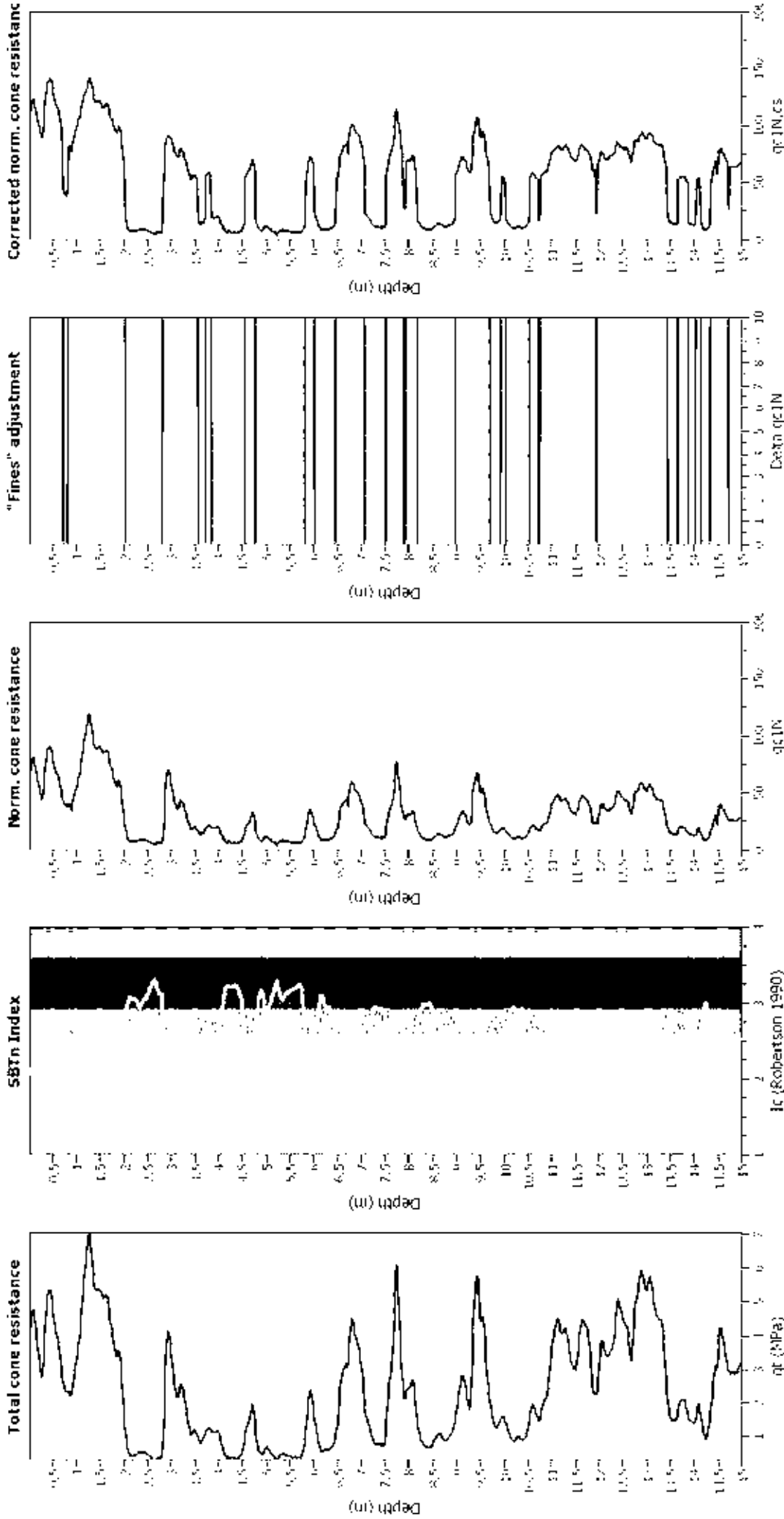
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines core: true method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.5	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	N/A
Depth to water table ($z_{w,eq}$):	1.00 m	Unit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

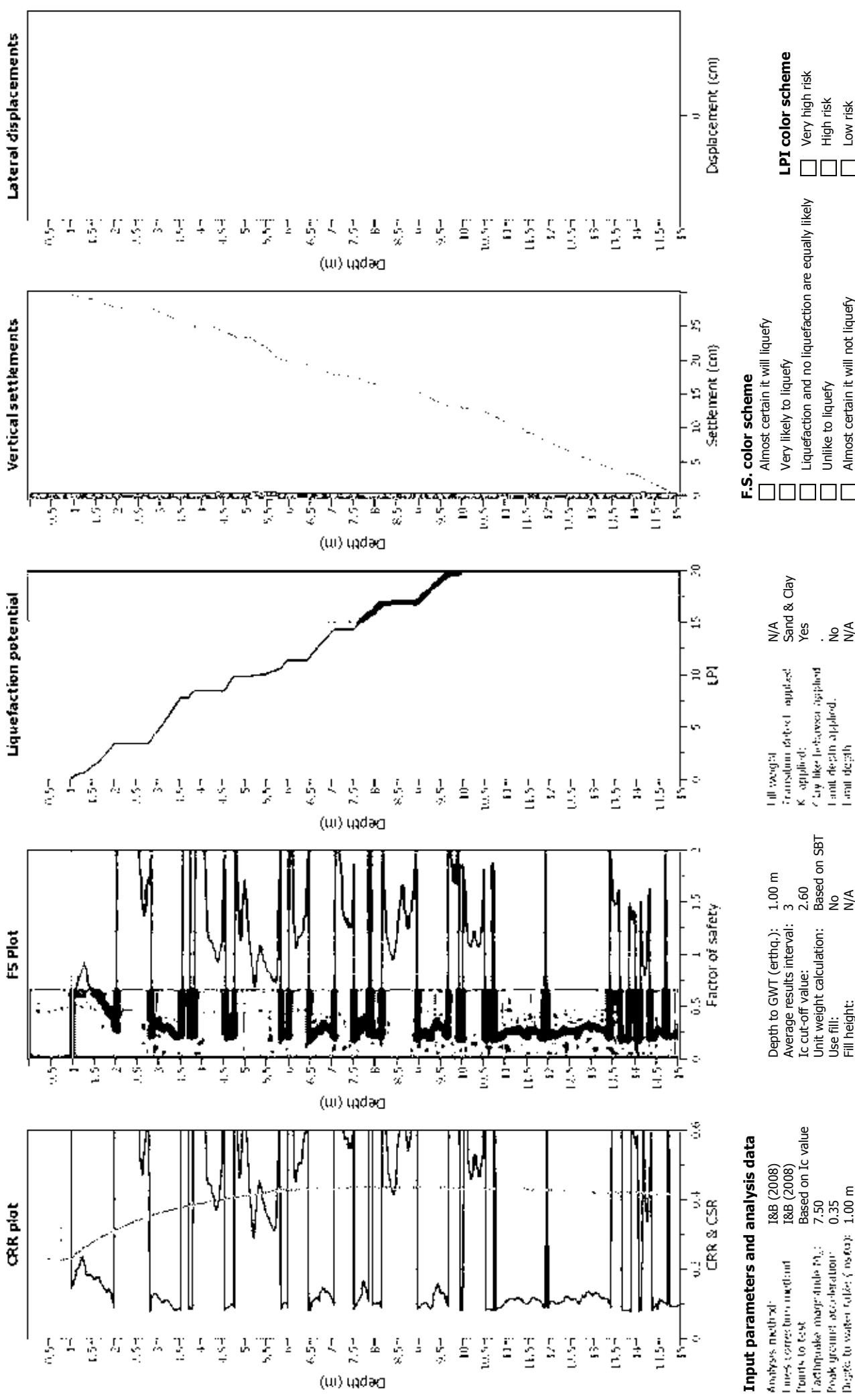
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

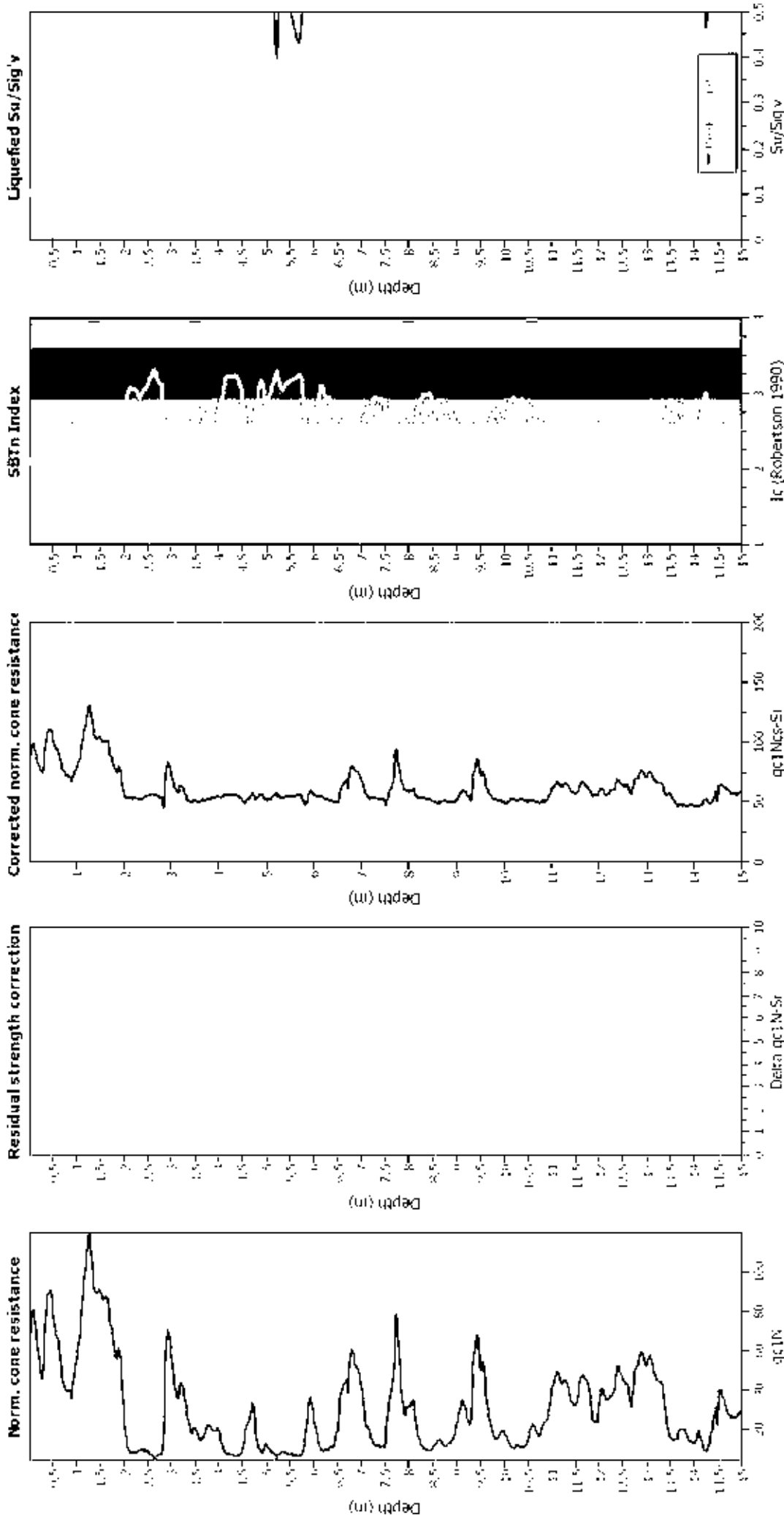
Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition depth applied: N/A
 Sand & Clay: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: No
 Limit depth: N/A

F.S. color scheme
 Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlike to liquefy
 Almost certain it will not liquefy

LPI color scheme
 Very high risk
 High risk
 Low risk

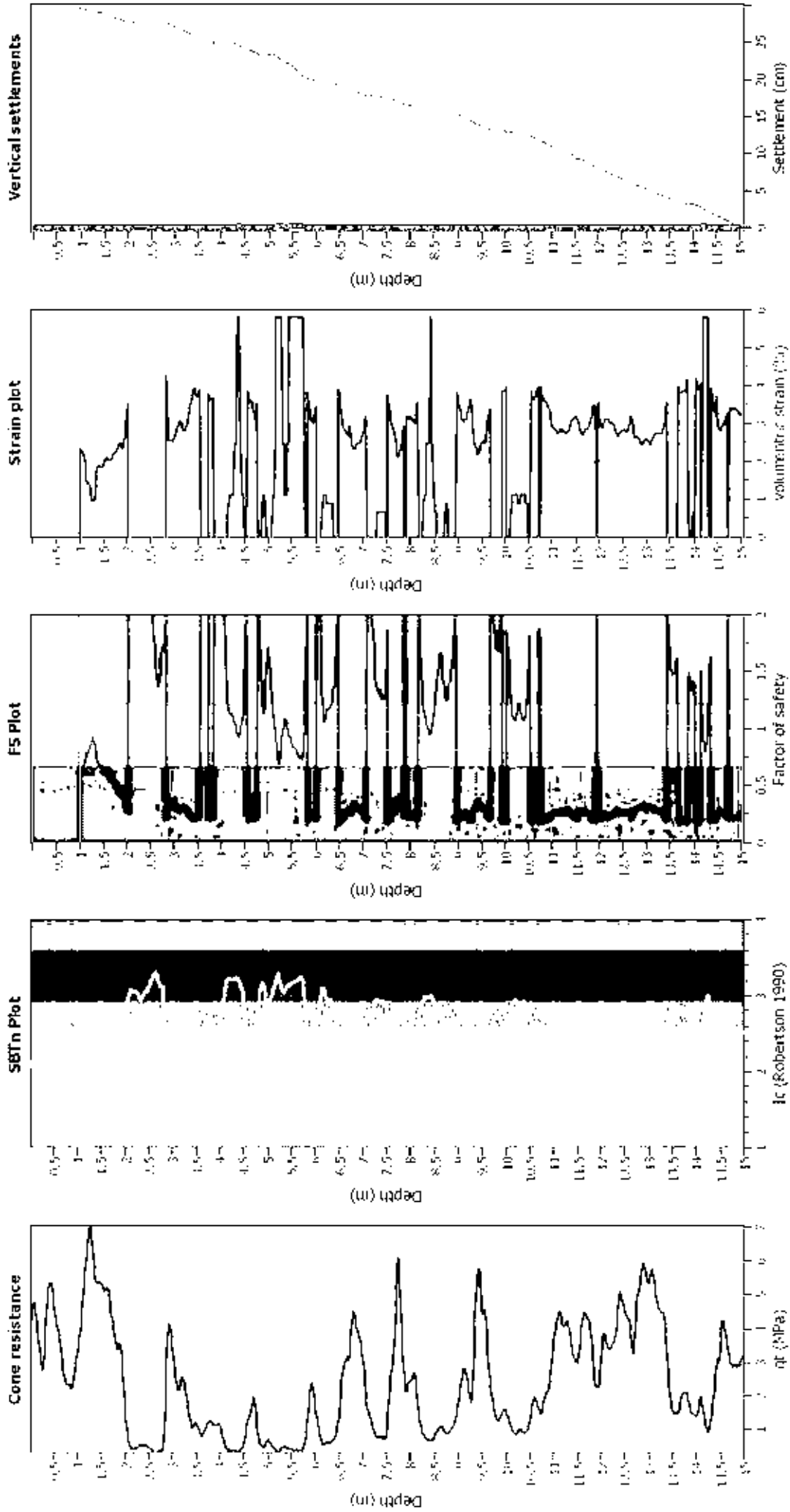
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Average results interval:	3	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Lamé depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A	Lamé depth:	N/A

Estimation of post-earthquake settlements



Abbreviations

- RS: Total cone resistance (cone resistance q_c corrected for pore water effects)
- SB: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT45_428cashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

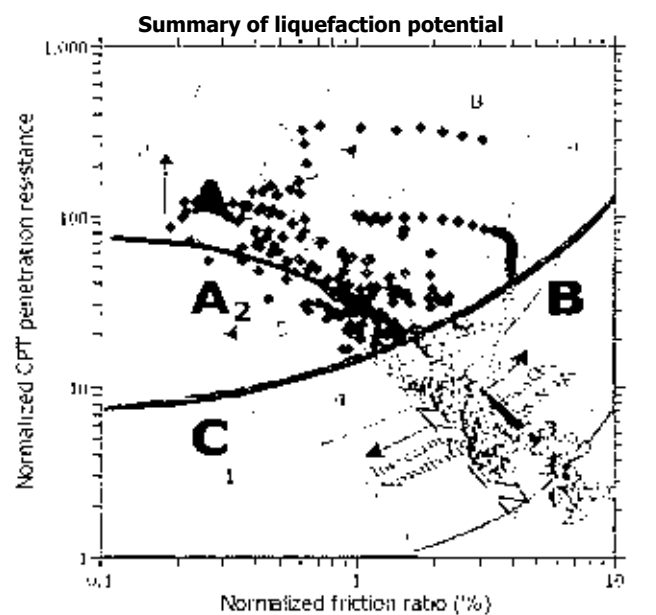
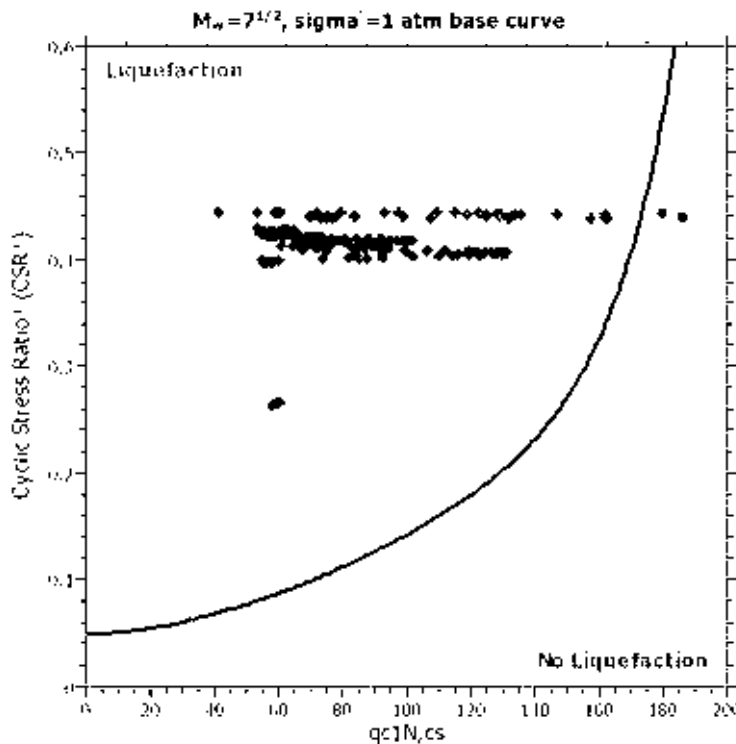
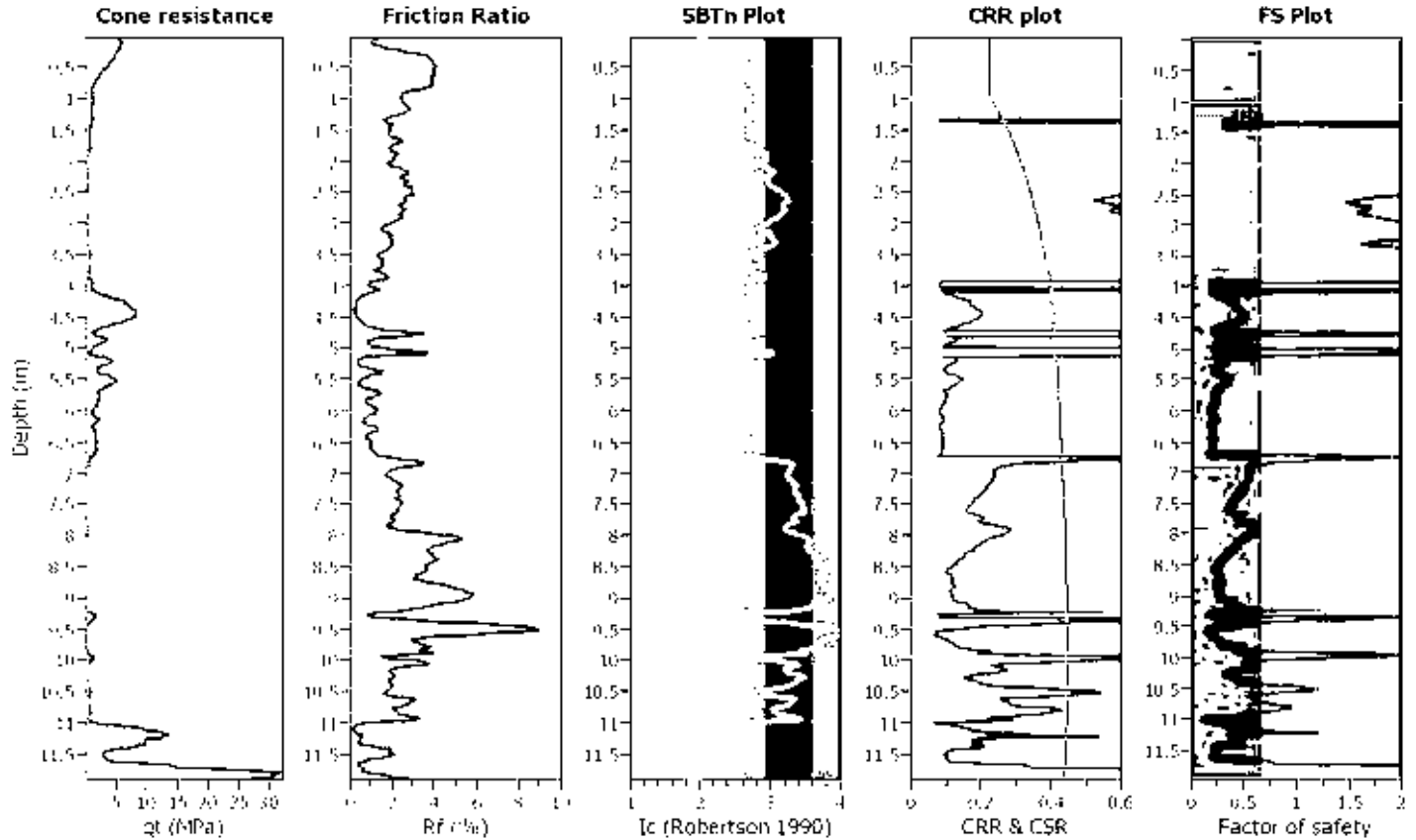
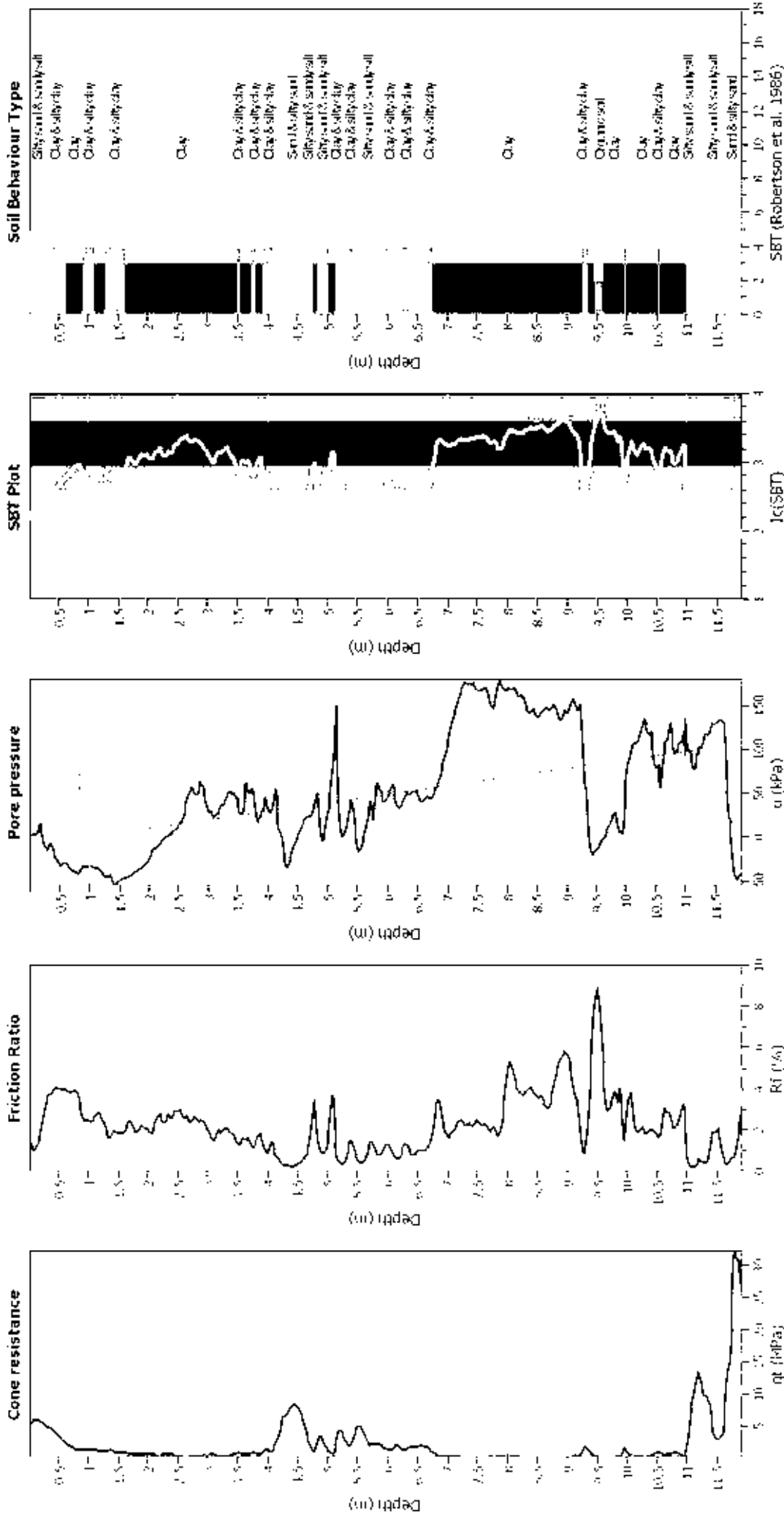


Figure 4: Summary of liquefaction potential assessment and classification of test results. Zone A1: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction unlikely; Zone C: No liquefaction. The dashed line indicates the liquefaction boundary.

CPT basic interpretation plots



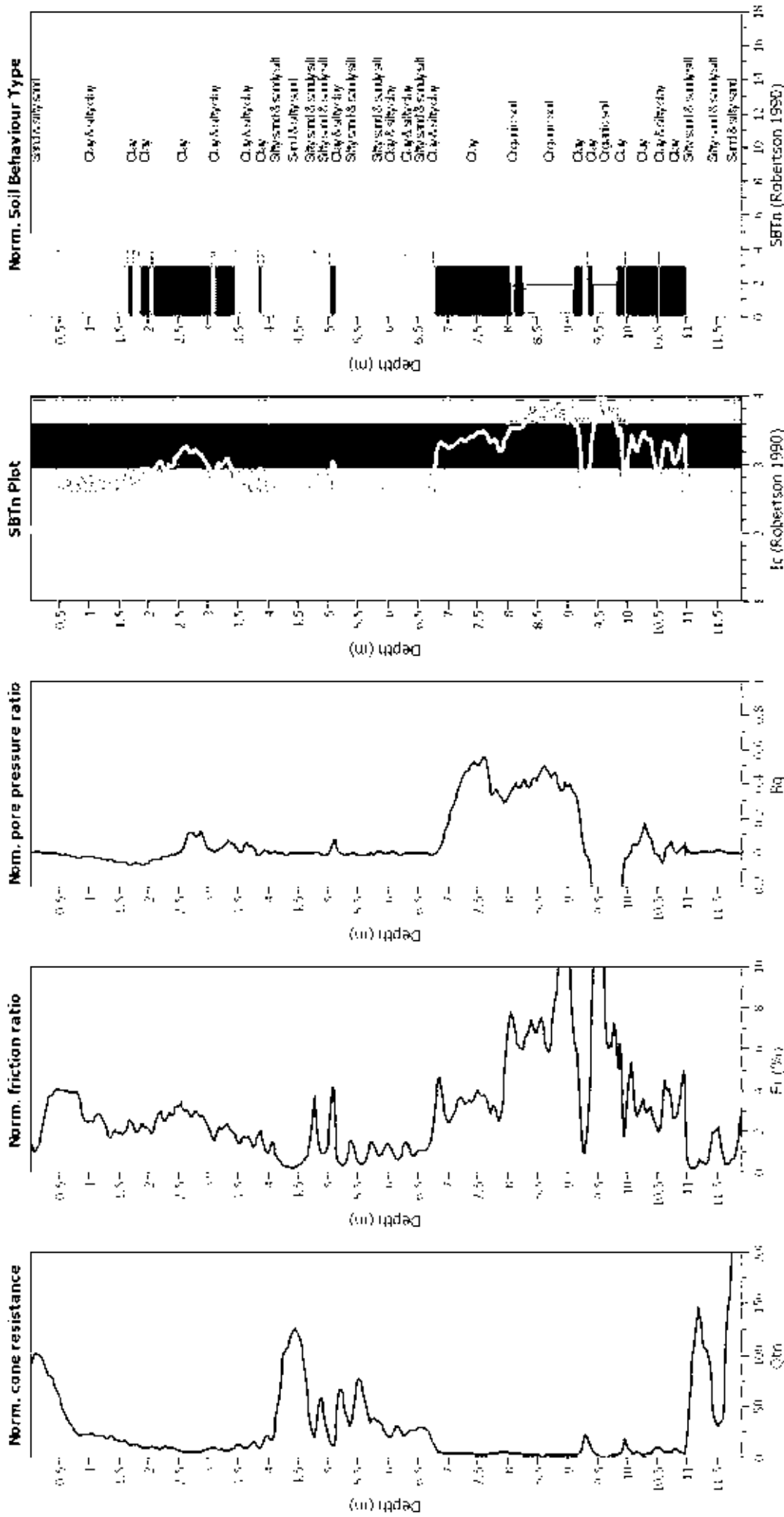
Input parameters and analysis data

Analysis method:	188 (2008)	Fill weight:	N/A
Units correction method:	188 (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	N/A
Depth to water table (m):	1.00 m		
Depth to GWL (ortho.):	1.00 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



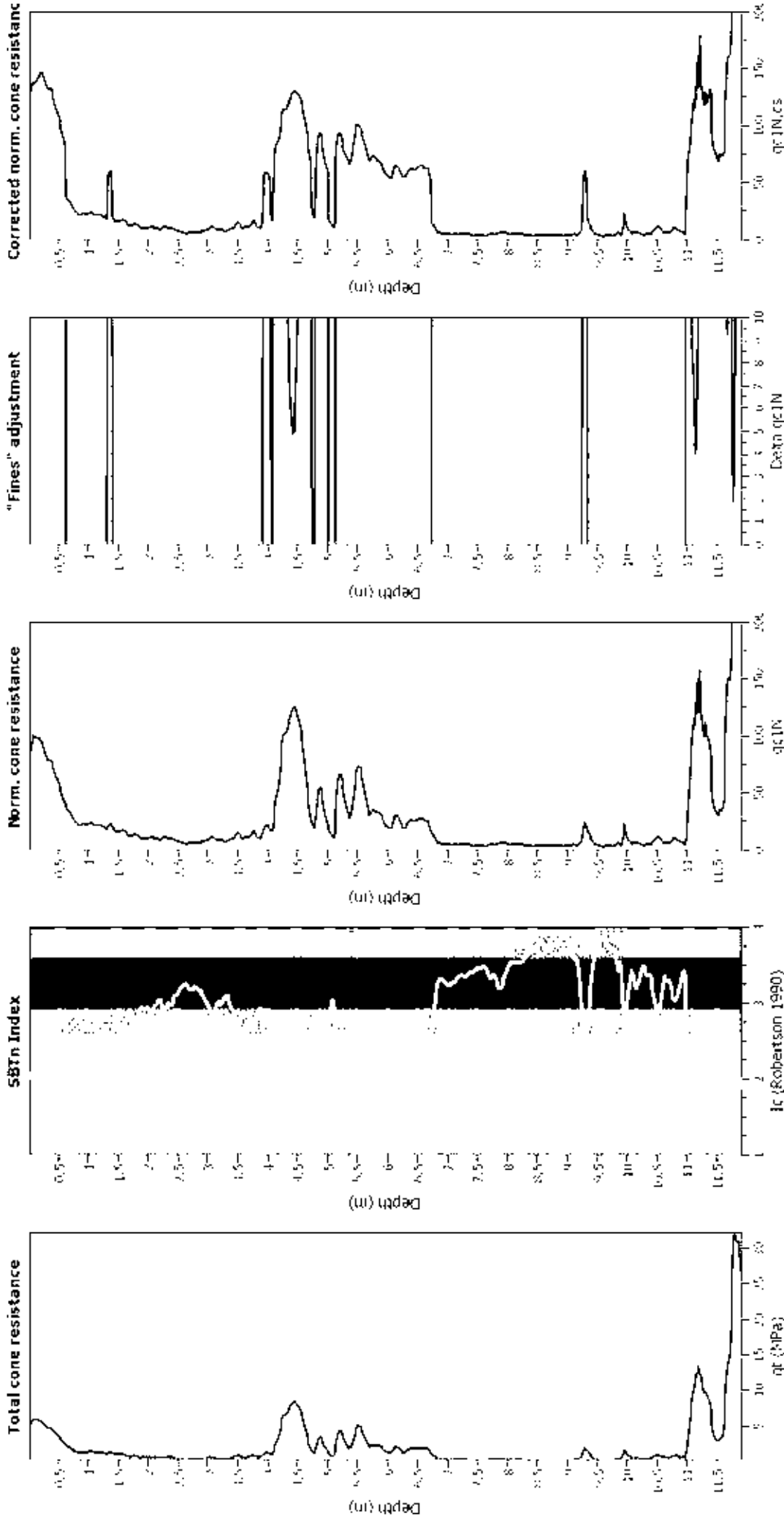
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Input correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	N/A
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

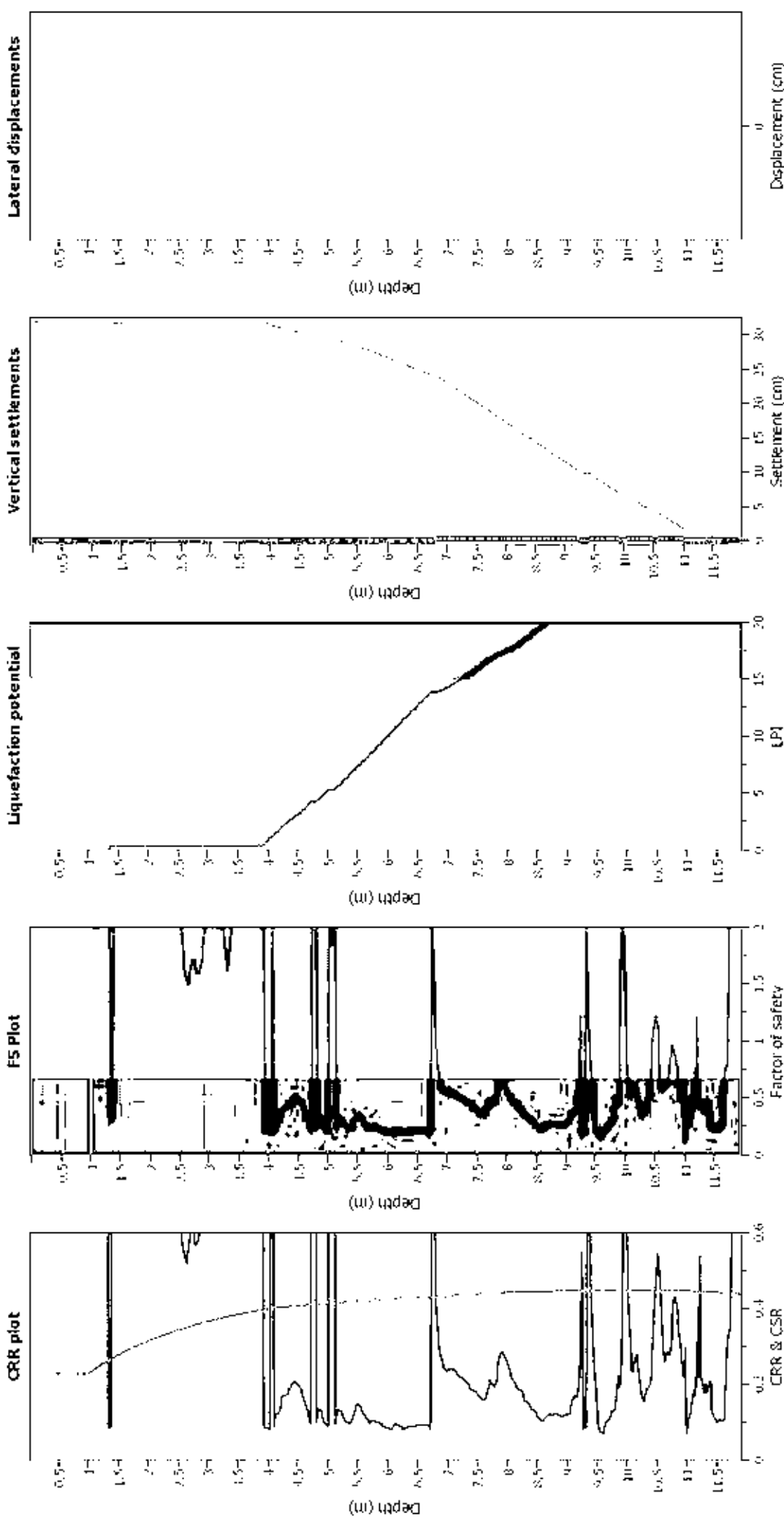
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial mag. angle θ_s :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 18B (2008)
 Liquefaction correction method: 18B (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

F.S. color scheme

Almost certain it will liquefy
 Very likely to liquefy
 Liquefaction and no liquefaction are equally likely
 Unlike to liquefy
 Almost certain it will not liquefy

LPI color scheme

Very high risk
 High risk
 Low risk

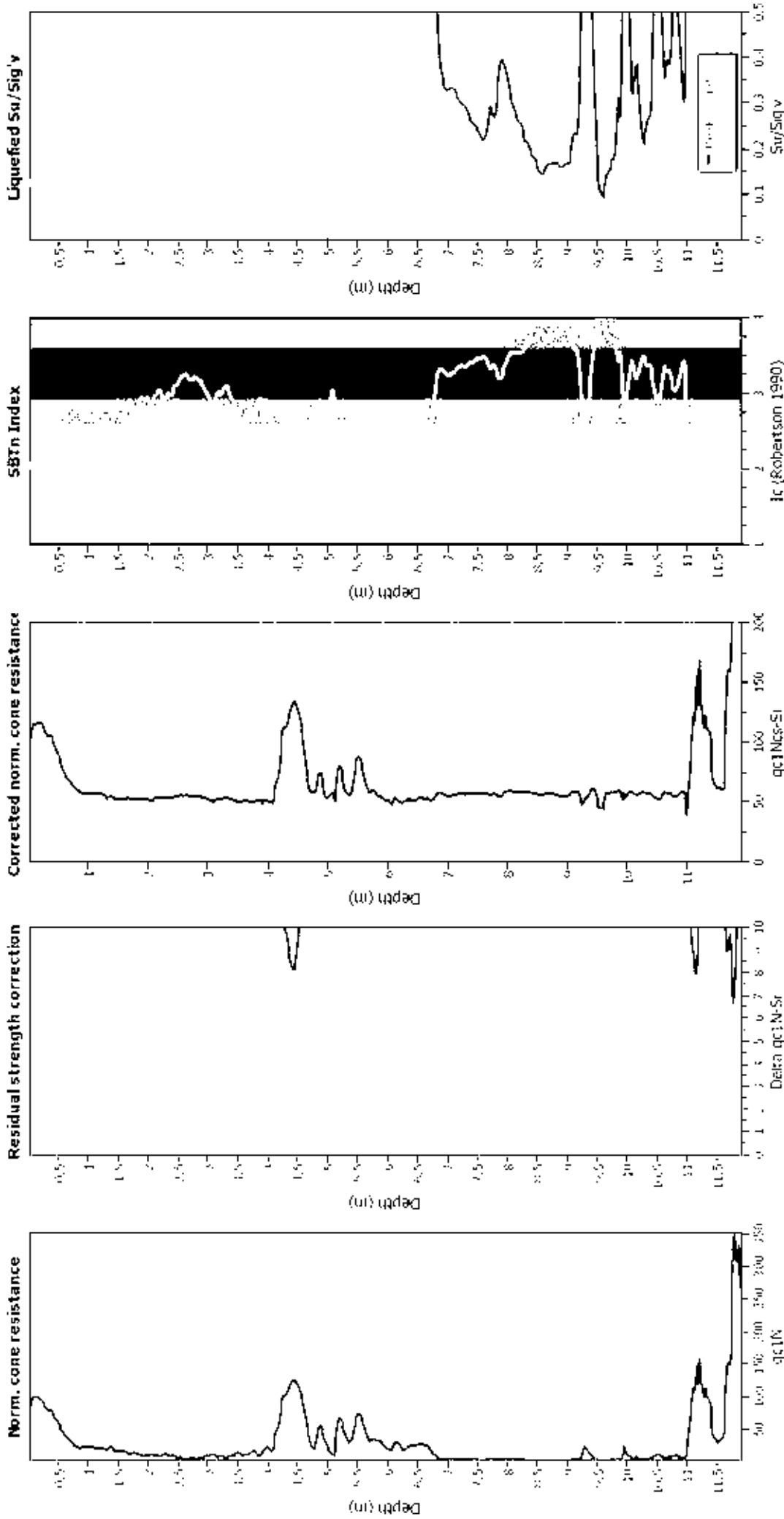
Parameters and analysis data

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Soil parameters

Full weight: N/A
 Transition depth: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A
 Limit depth: N/A

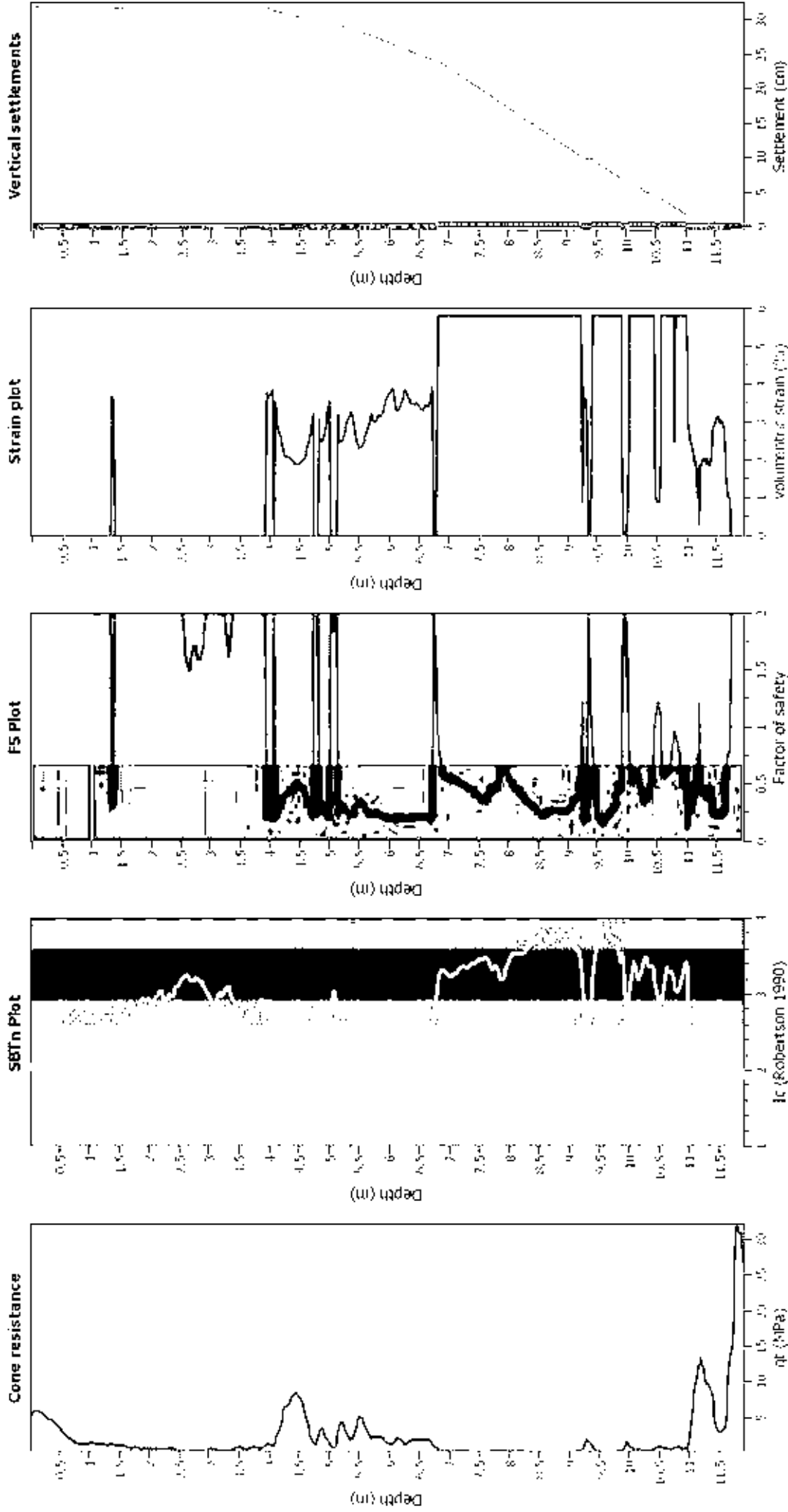
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GWT (erthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

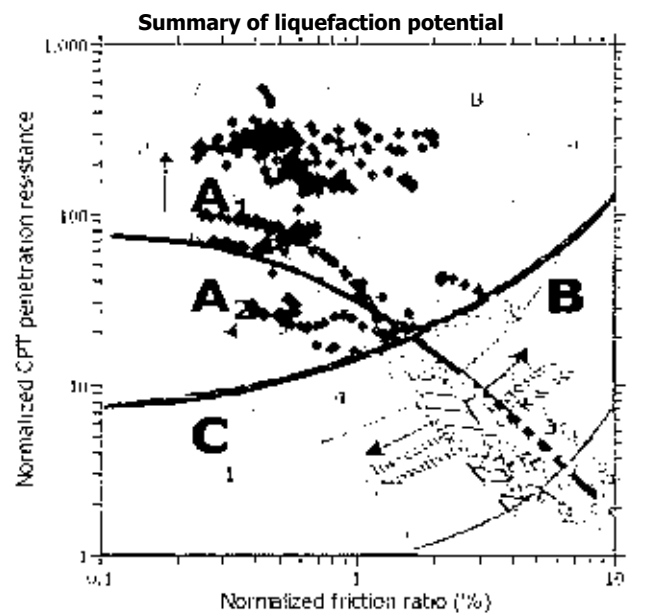
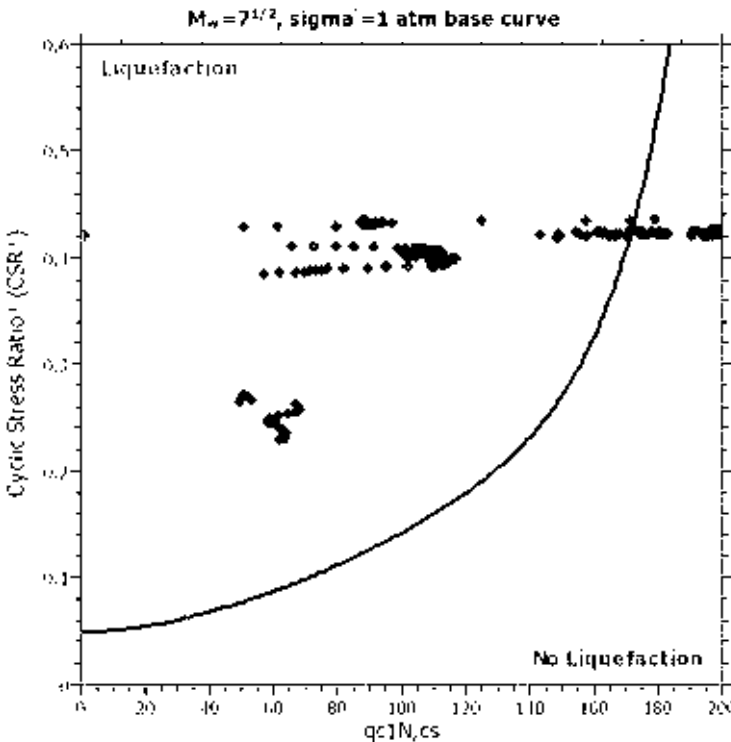
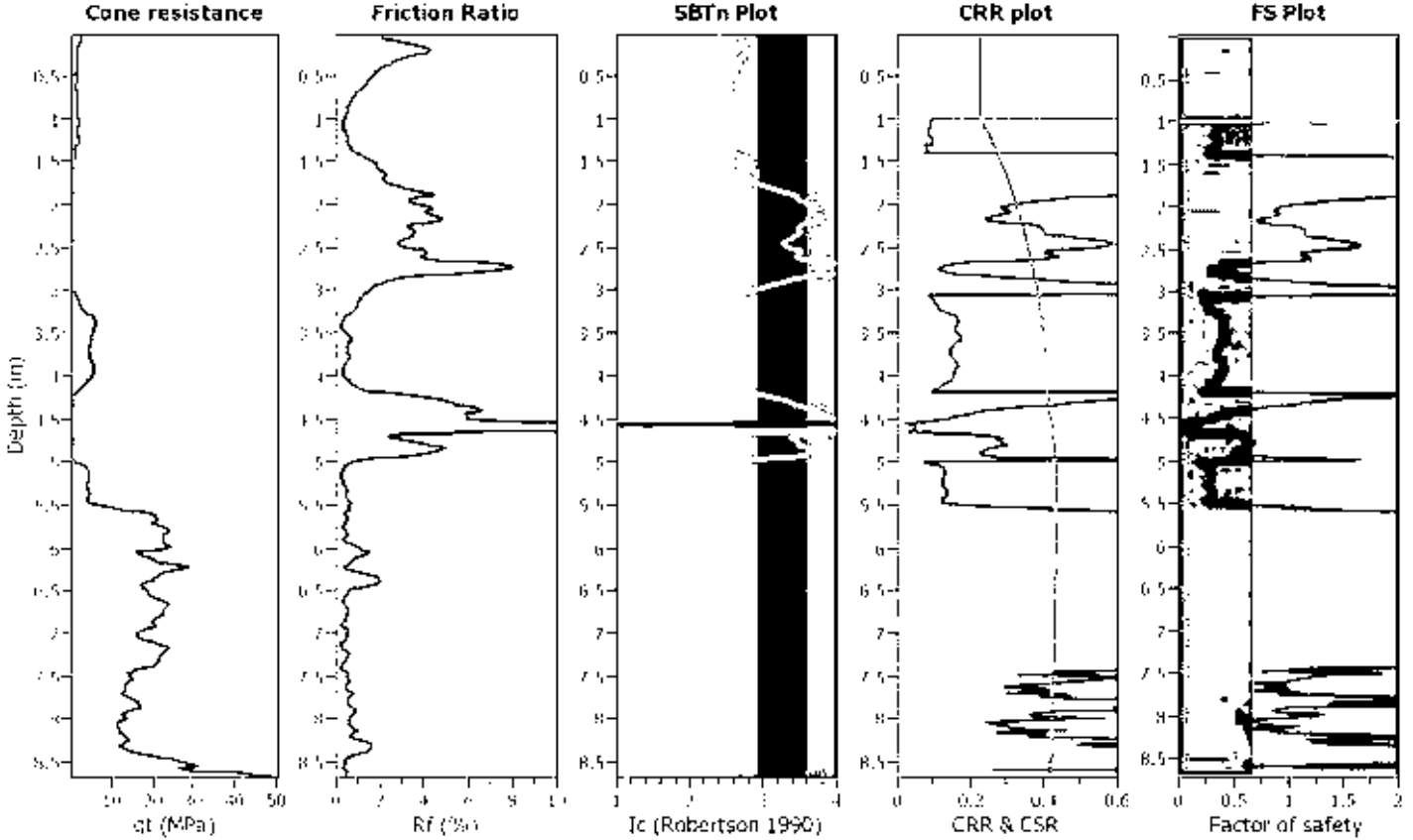
- FS: Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn: Soil Behaviour Type Index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT46_428cashmereRd

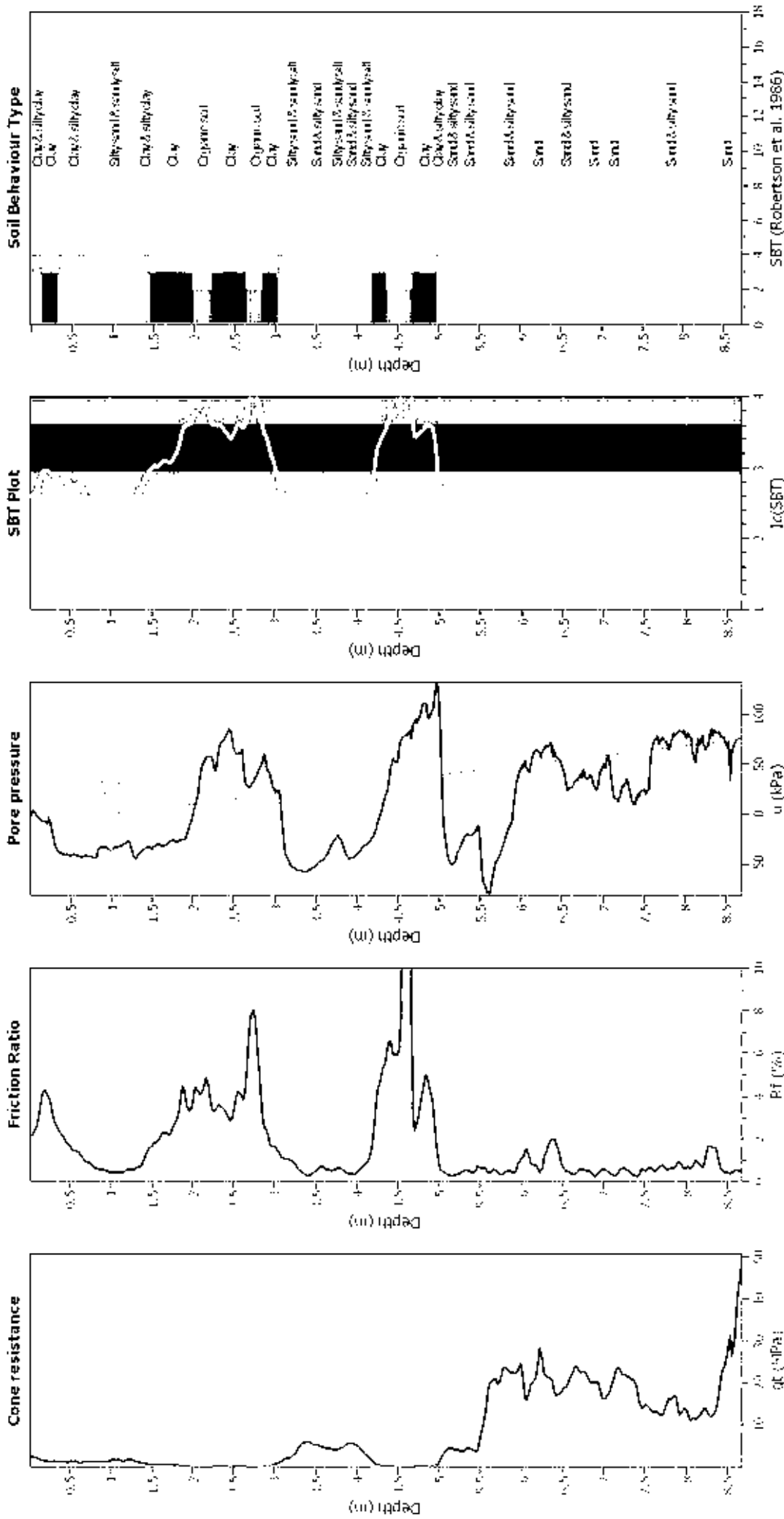
Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.00 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.00 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		



Zone A: High liquefaction potential. Normalized penetration resistance and normalized friction ratio are both high. Zone B: Moderate liquefaction potential. Normalized penetration resistance is high, but normalized friction ratio is low. Zone C: Low liquefaction potential. Normalized penetration resistance is low, but normalized friction ratio is high. Zone D: Very low liquefaction potential. Both normalized penetration resistance and normalized friction ratio are low.

CPT basic interpretation plots



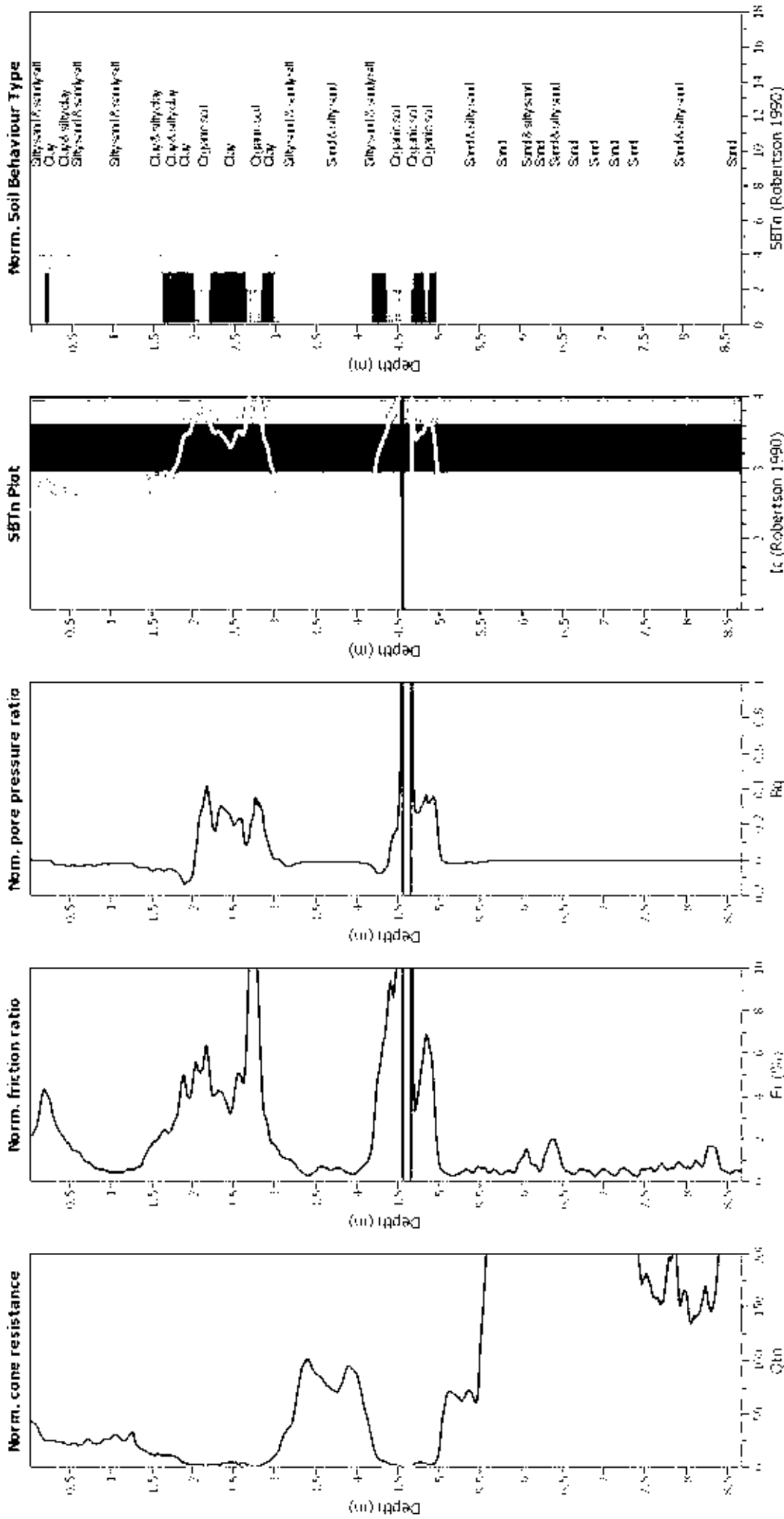
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (earthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



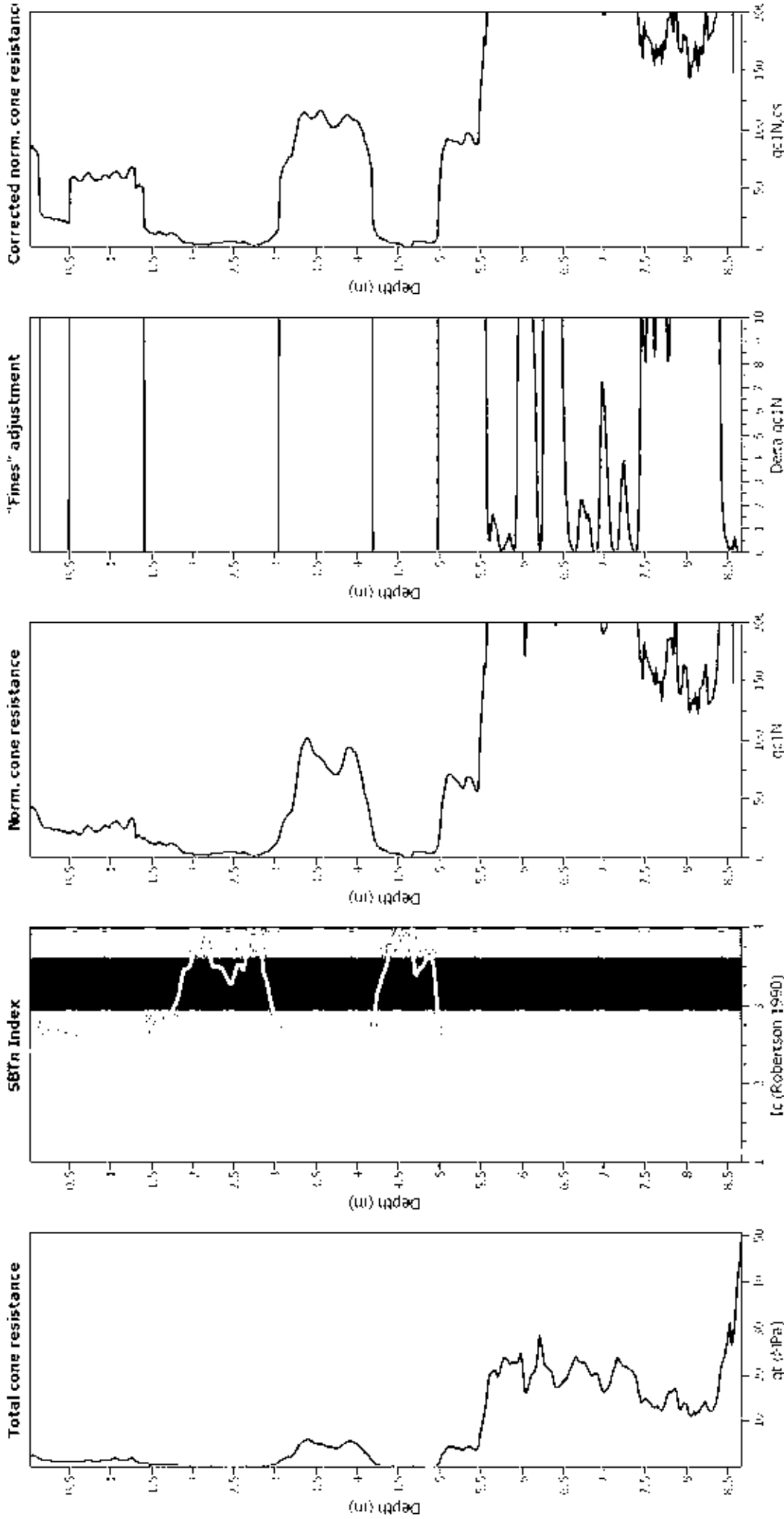
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.00 m	Fill height:	N/A		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

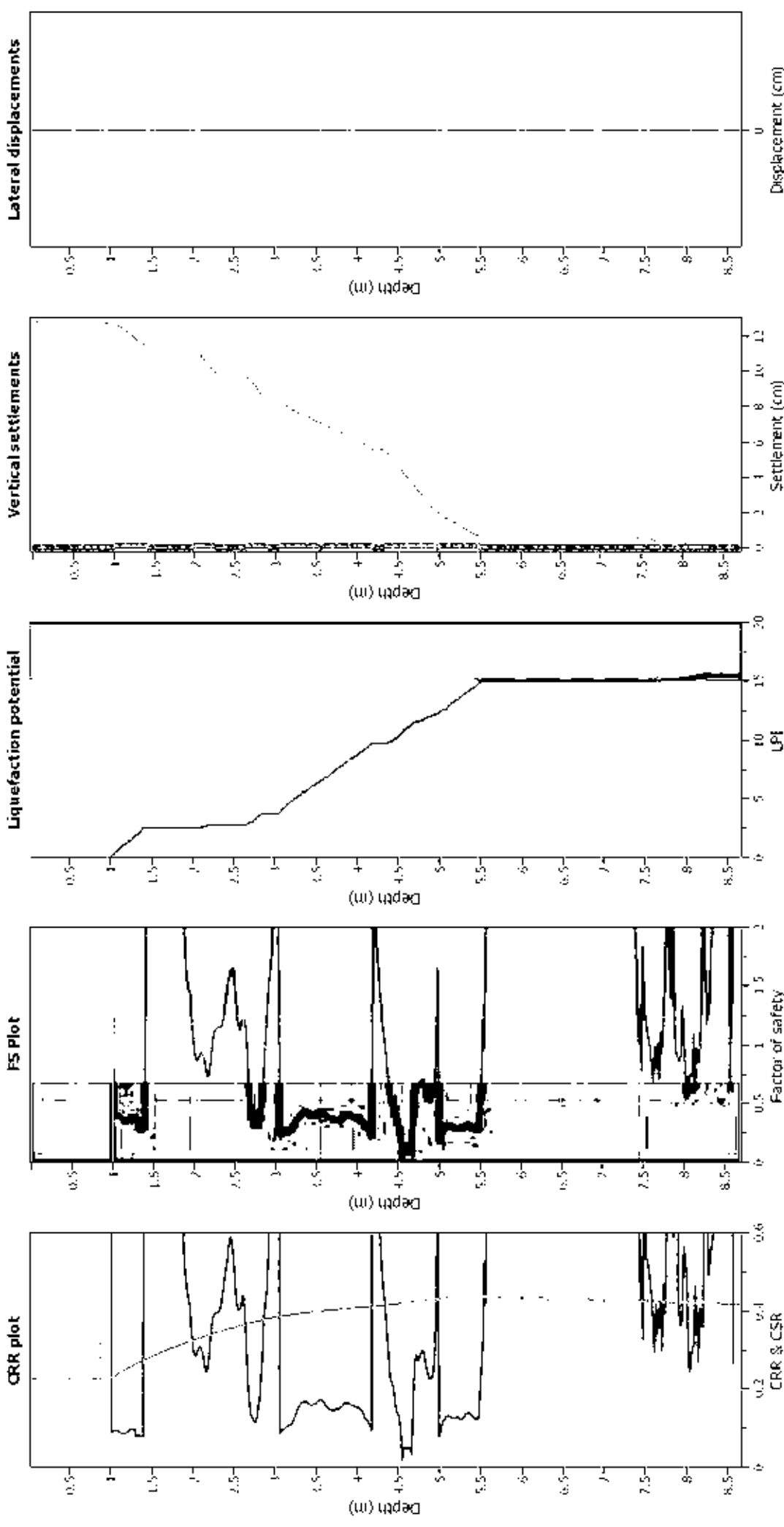
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	1.00 m	Limit depth:	N/A
Depth to GW (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude: 7.5
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.00 m

Depth to GW (earthq.): 1.00 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Fill weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

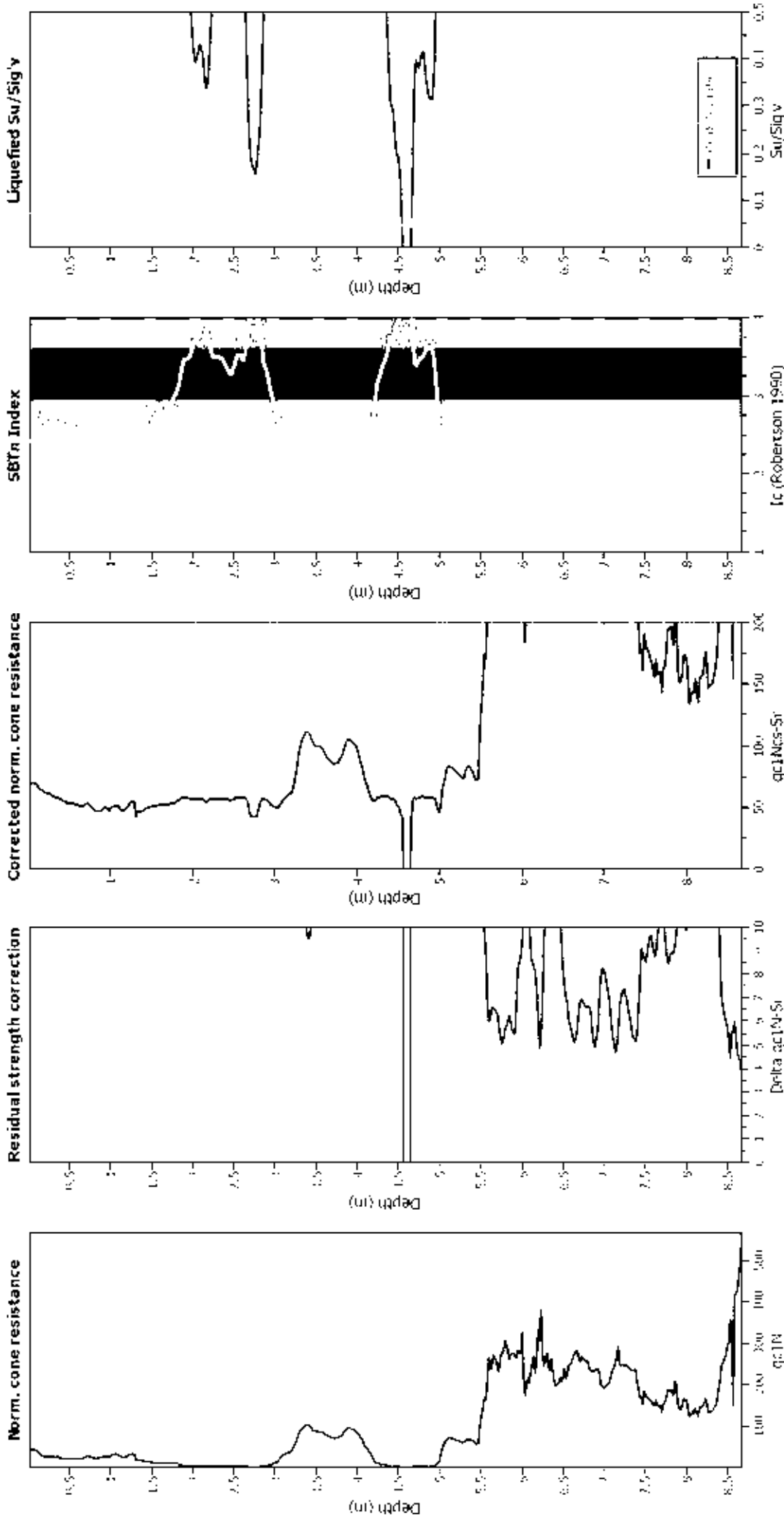
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

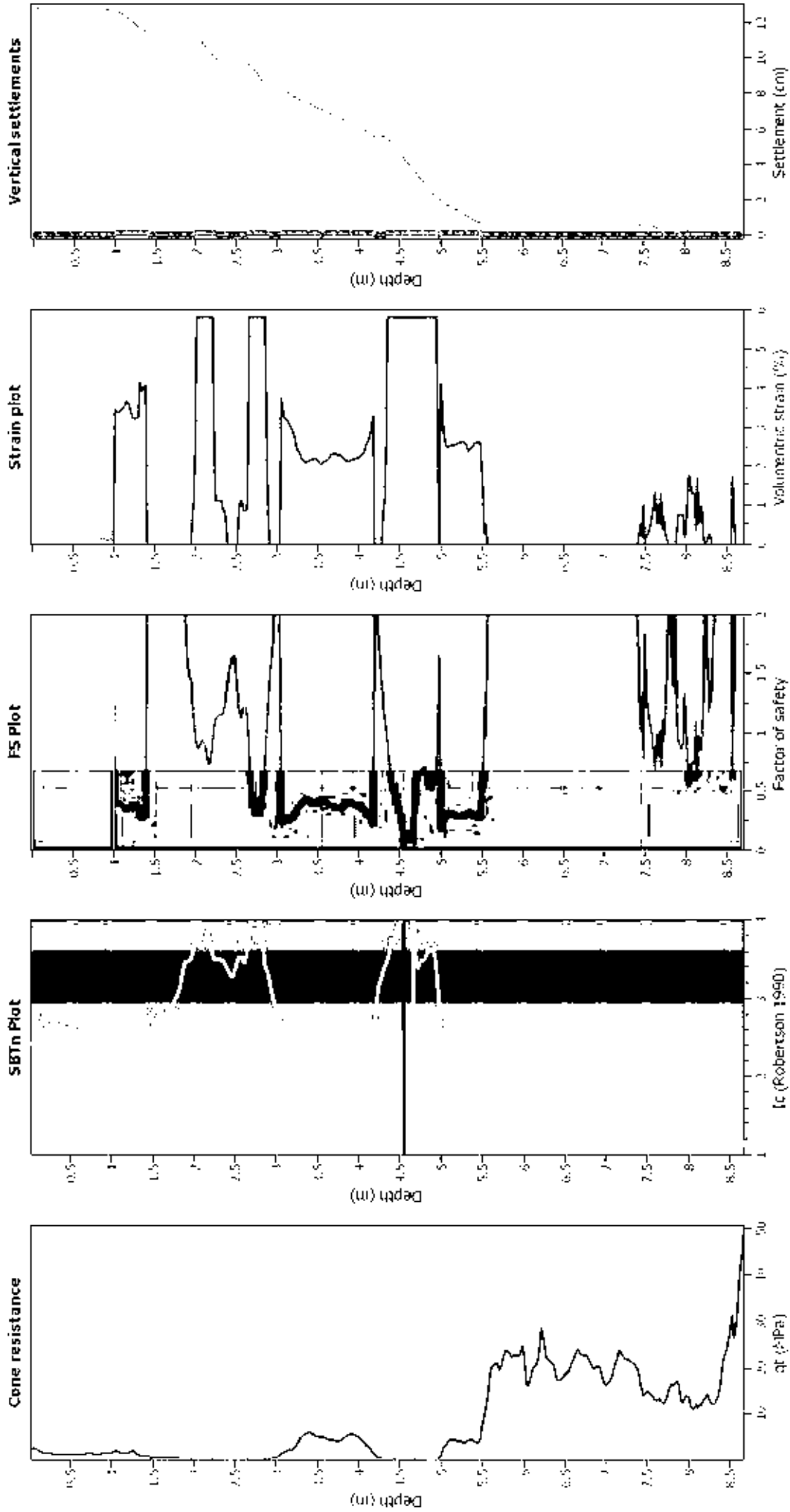
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M _w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m _{wt}):	1.00 m	Limit depth:	N/A
Depth to GWL (earthq.):	1.00 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qt: Total cone resistance (cone resistance q_c corrected for pore water effects)
- Ic: Soil Behaviour Type index
- FS: Calculated Factor of Safety against Liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT47_334SparksRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Limit correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

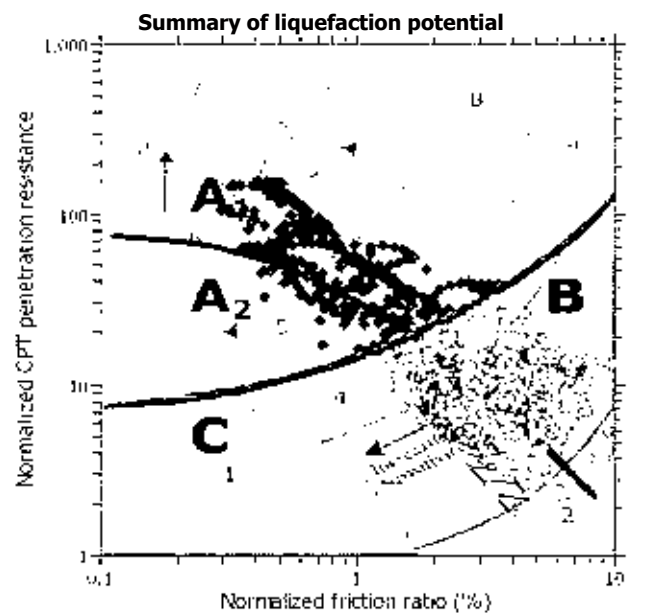
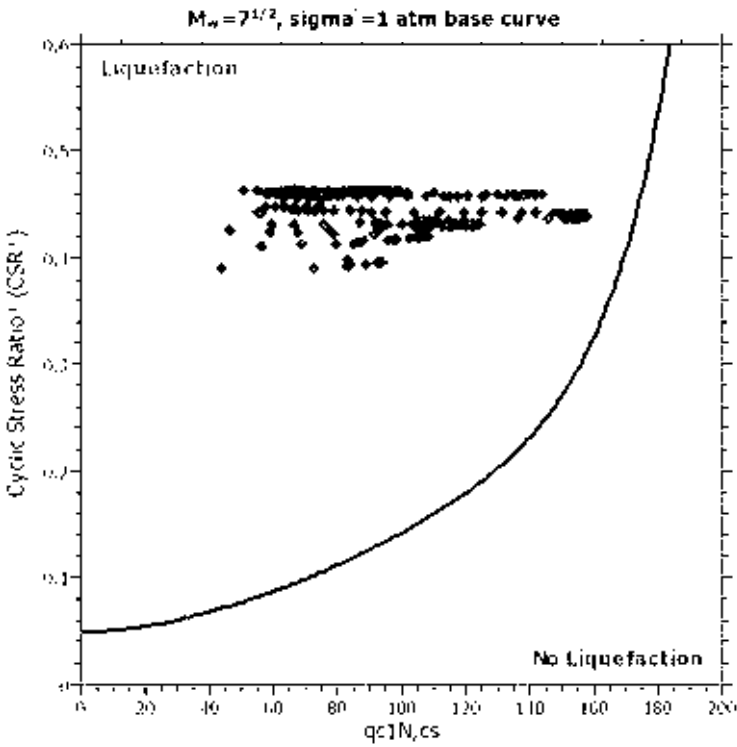
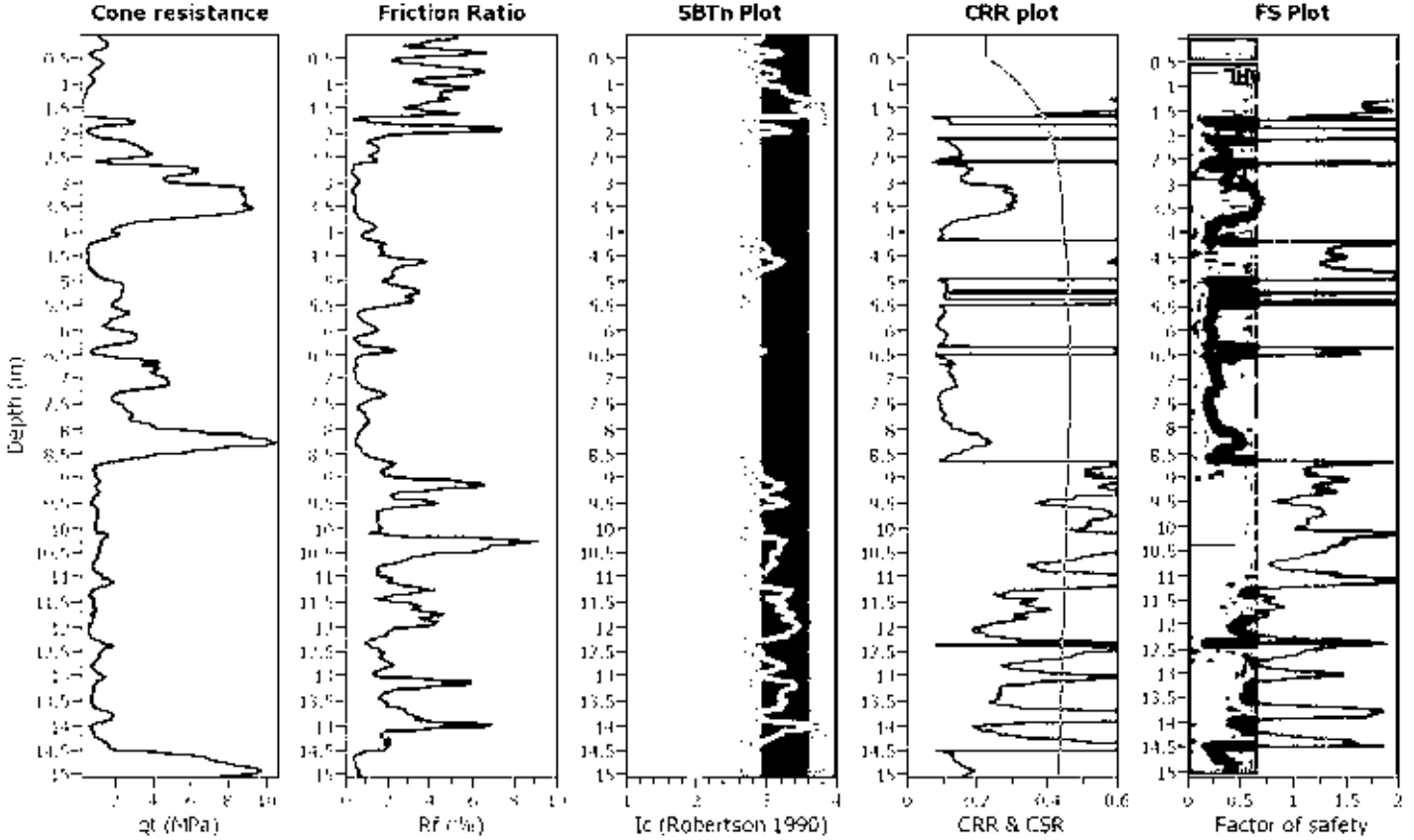
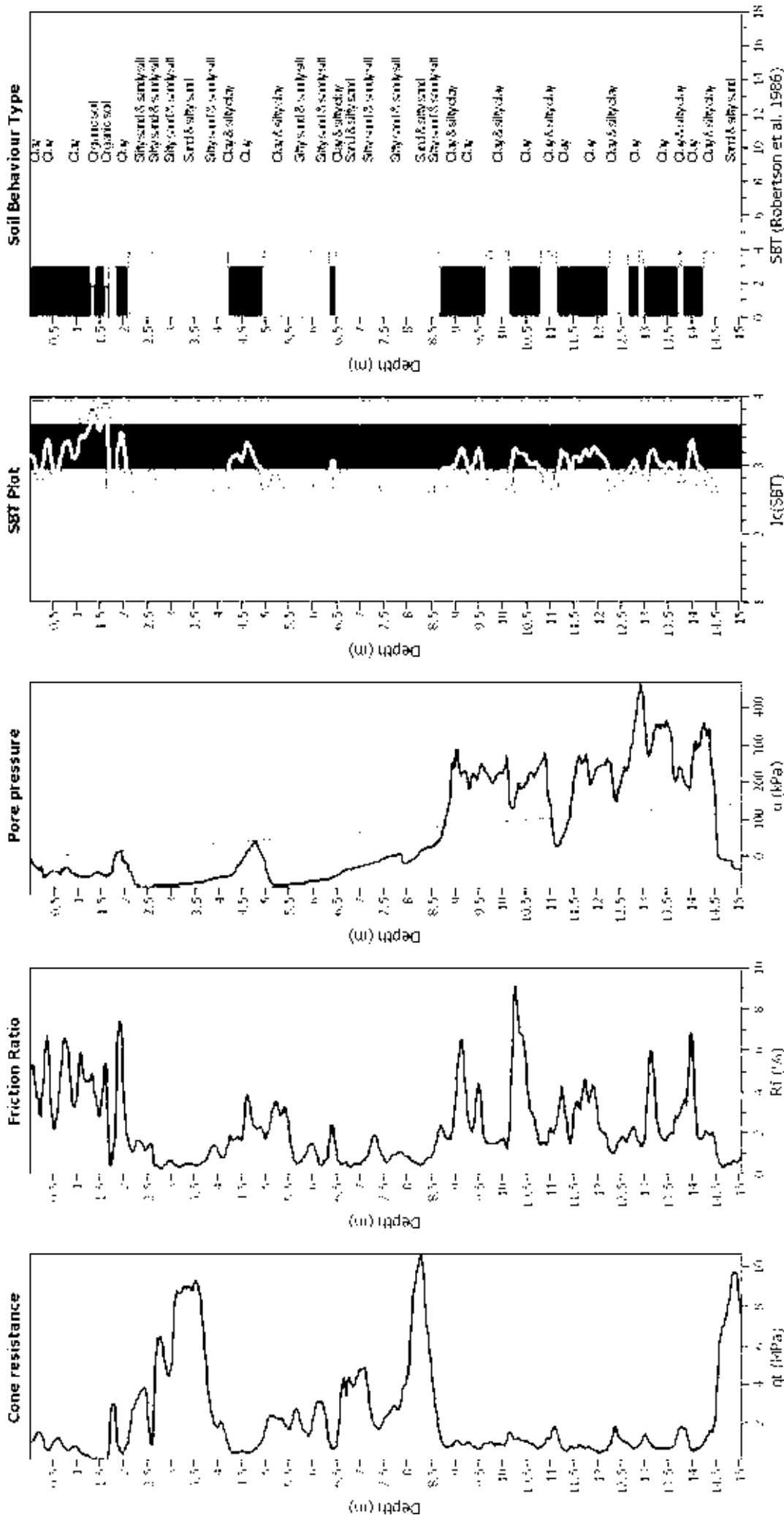


Figure 4: Summary of liquefaction potential plot and data points for test CPT47_334SparksRd. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio. The liquefaction boundary is indicated by a dashed line. The plot is divided into zones A1, A2, B, and C. The liquefaction potential is high in zones A1 and A2, and low in zones B and C.

CPT basic interpretation plots



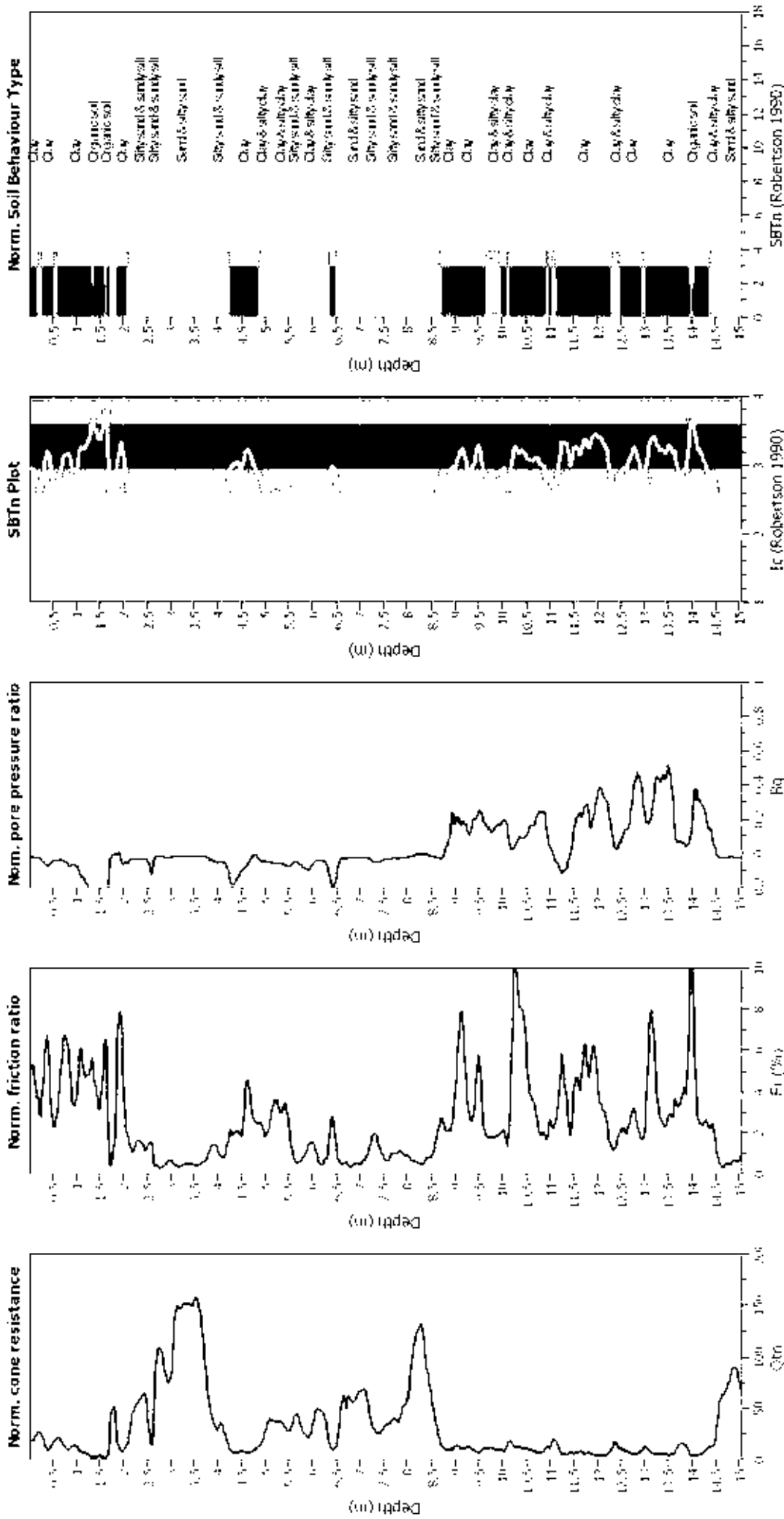
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factorial analysis magnitude (M _a):	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m _{wt}):	0.50 m	Unit depth:	N/A
Depth to GWL (erthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



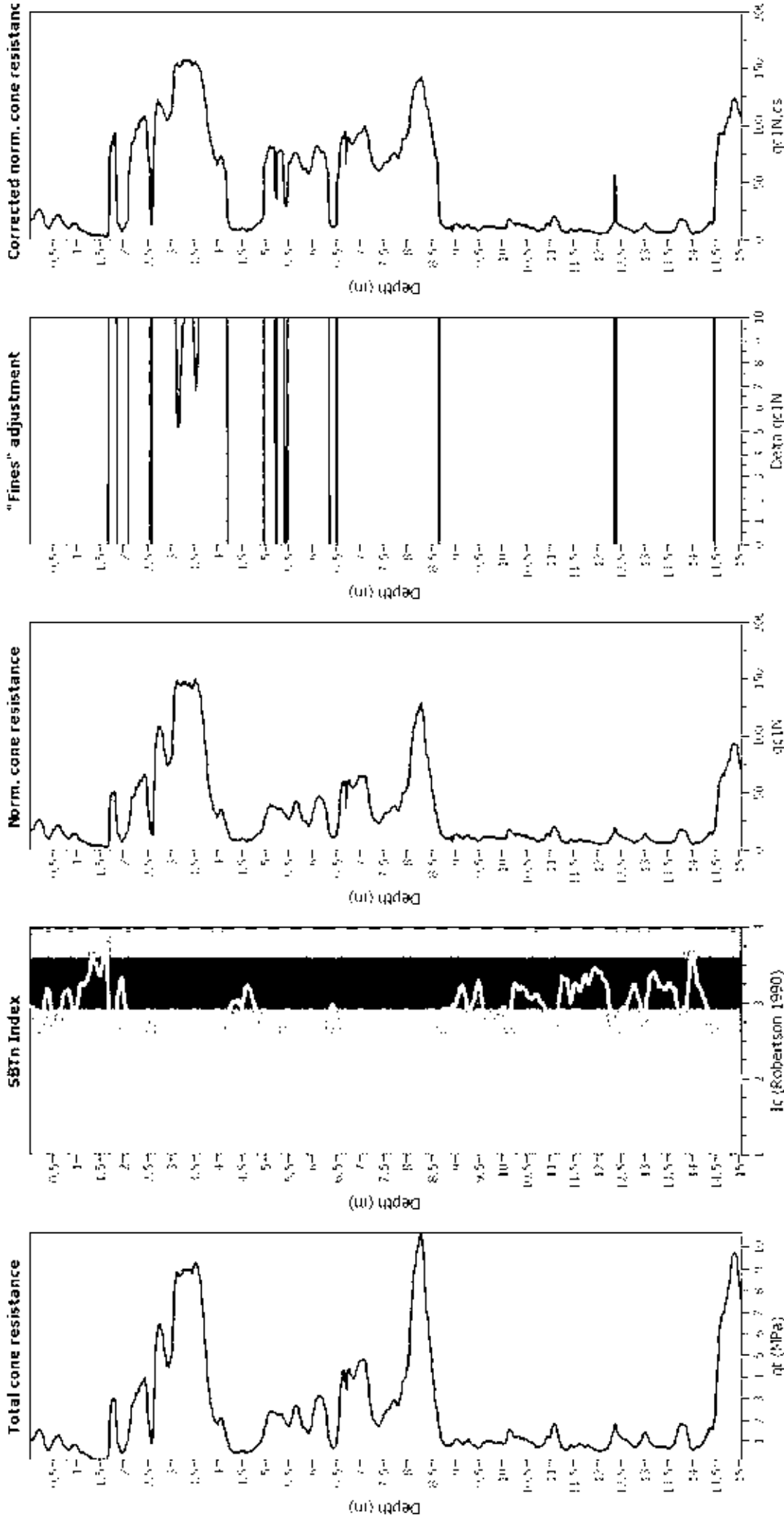
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	0.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	0.50 m	Fill height:	N/A	Unit 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

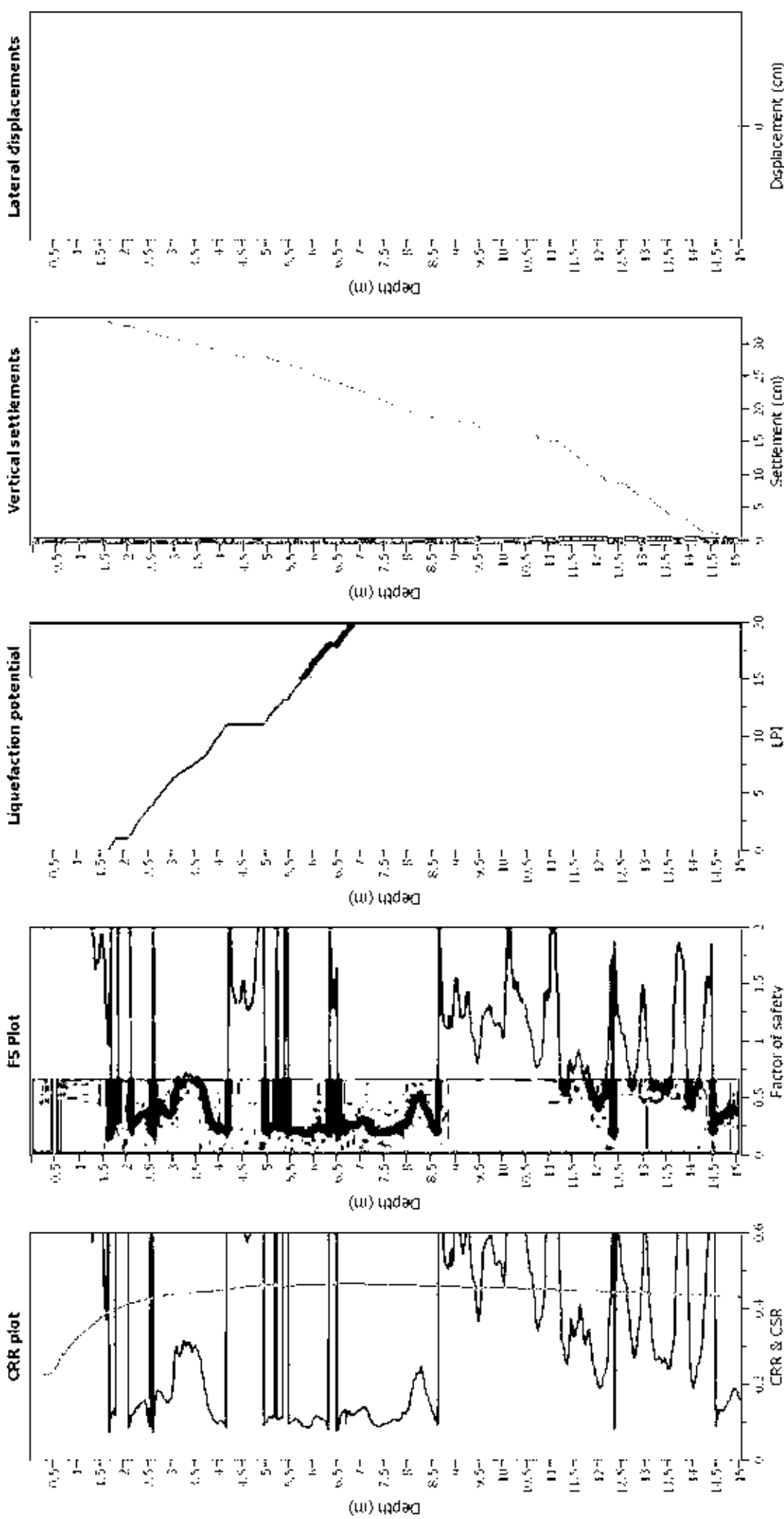
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make magnitude (M):	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m _{wt}):	0.50 m	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 0.50 m

Depth to GW (earthq.): 0.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition method applied: N/A
 Sand & Clay: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

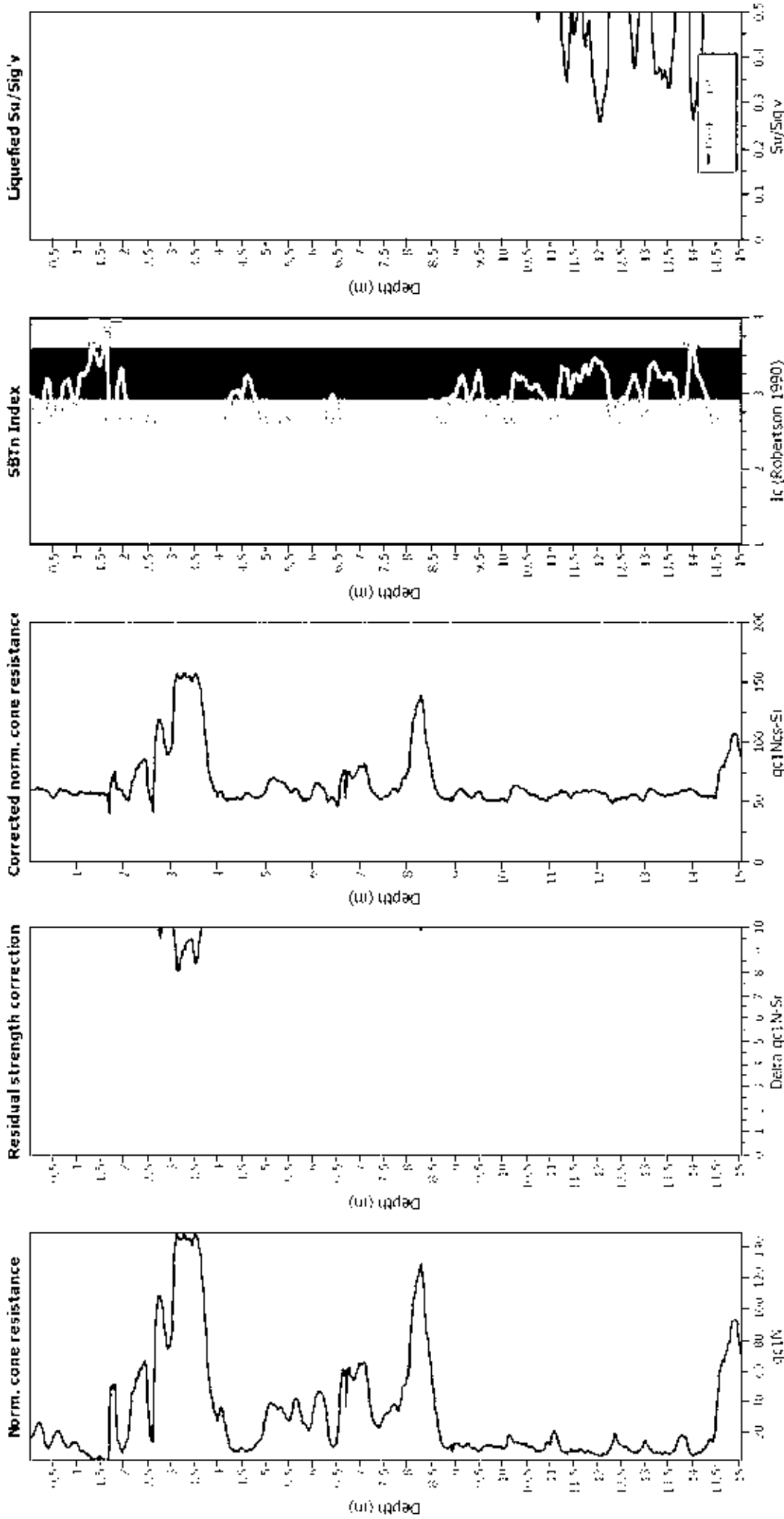
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

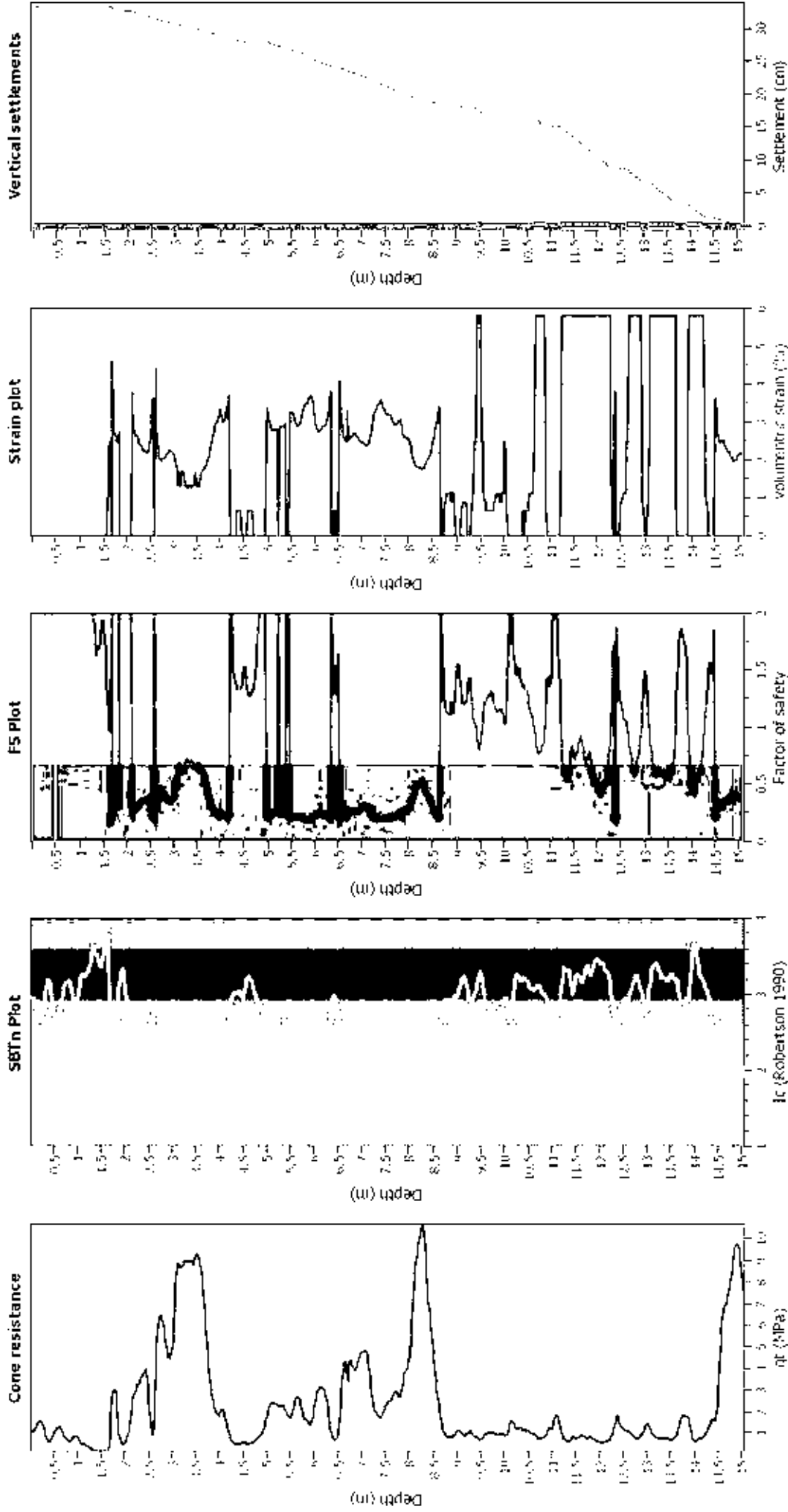
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- TC: Total cone resistance (cone resistance q_c corrected for pore water effects)
- SB: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT48_334SparksRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

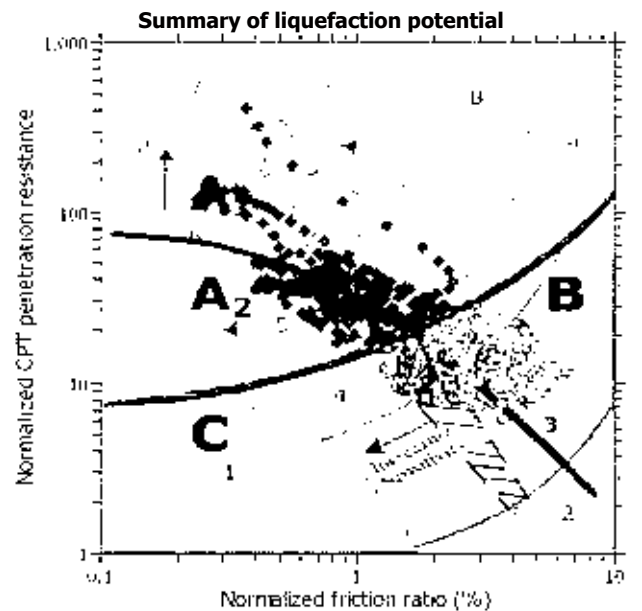
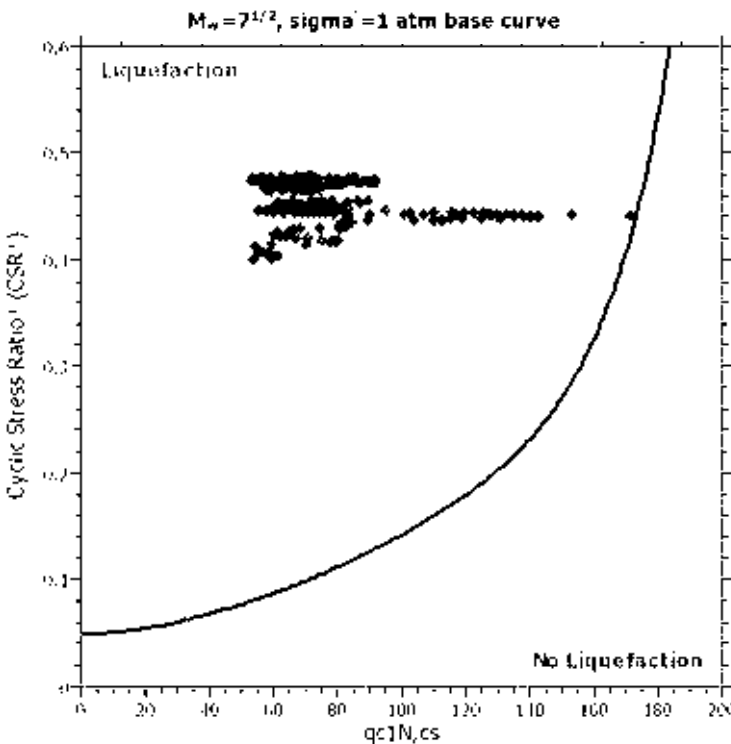
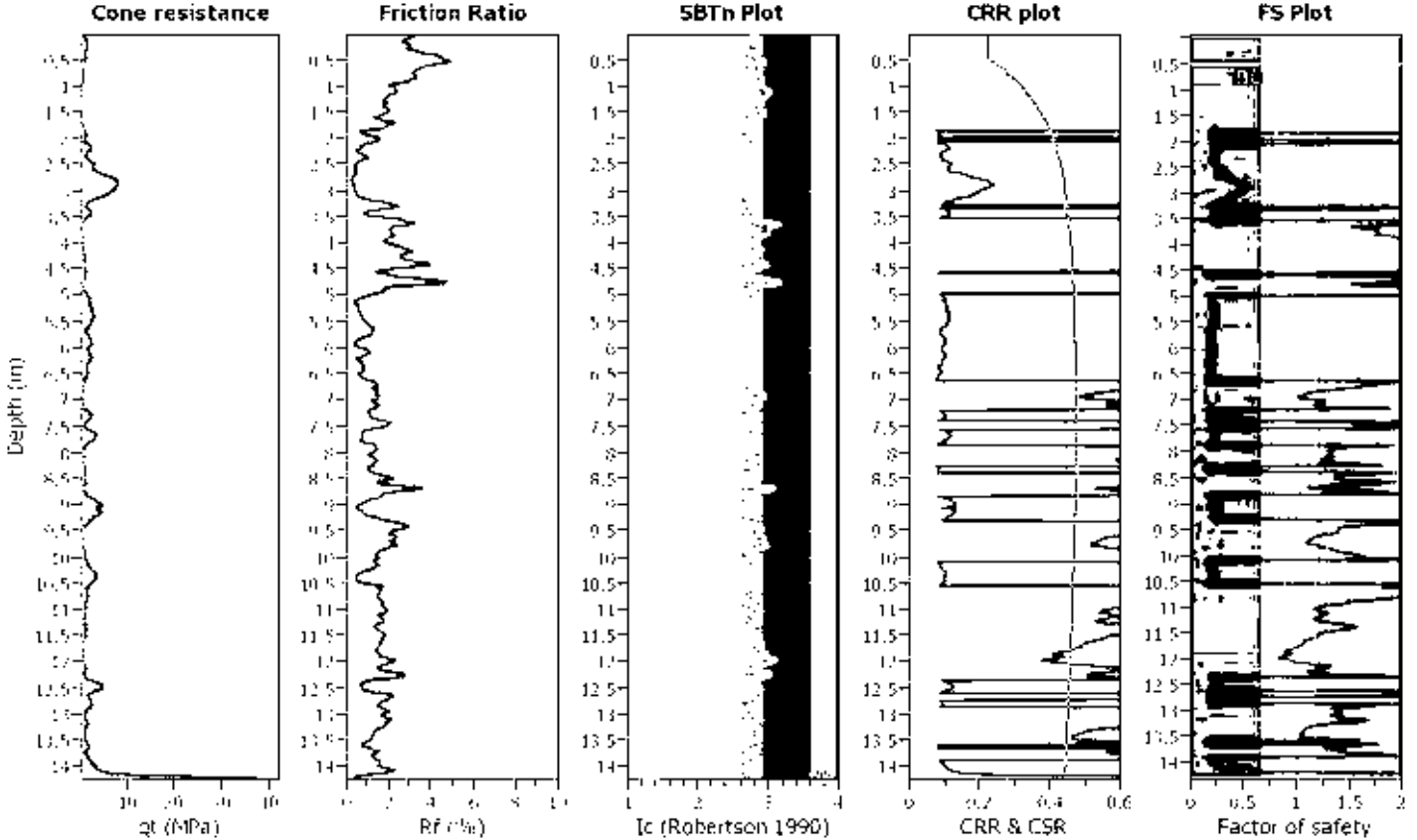
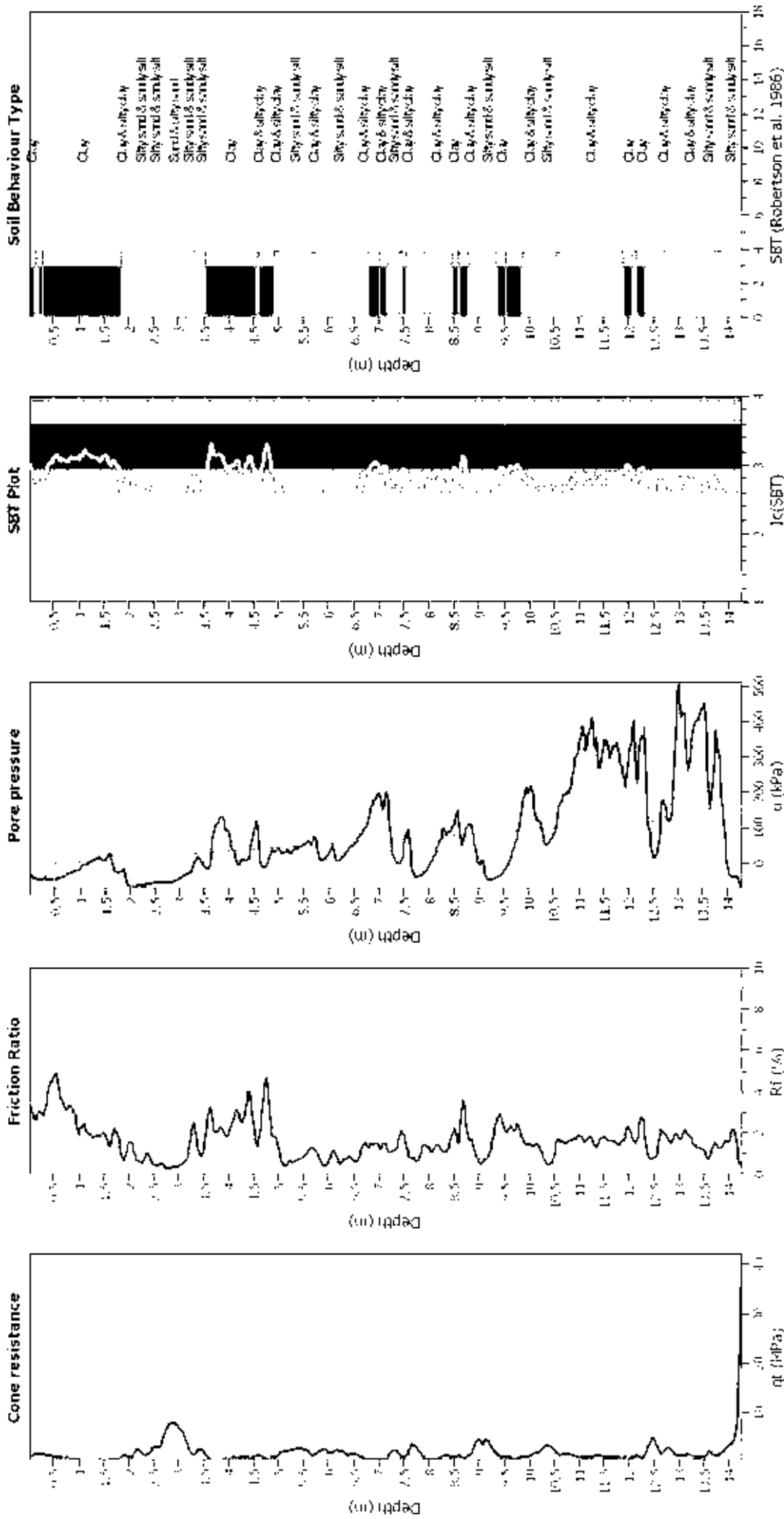


Figure 4: Summary of liquefaction potential assessment and classification of test results. Zone A1: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction unlikely; Zone C: No liquefaction. The dashed line indicates the liquefaction boundary. The arrows indicate the direction of increasing normalized friction ratio and increasing normalized CPT penetration resistance.

CPT basic interpretation plots



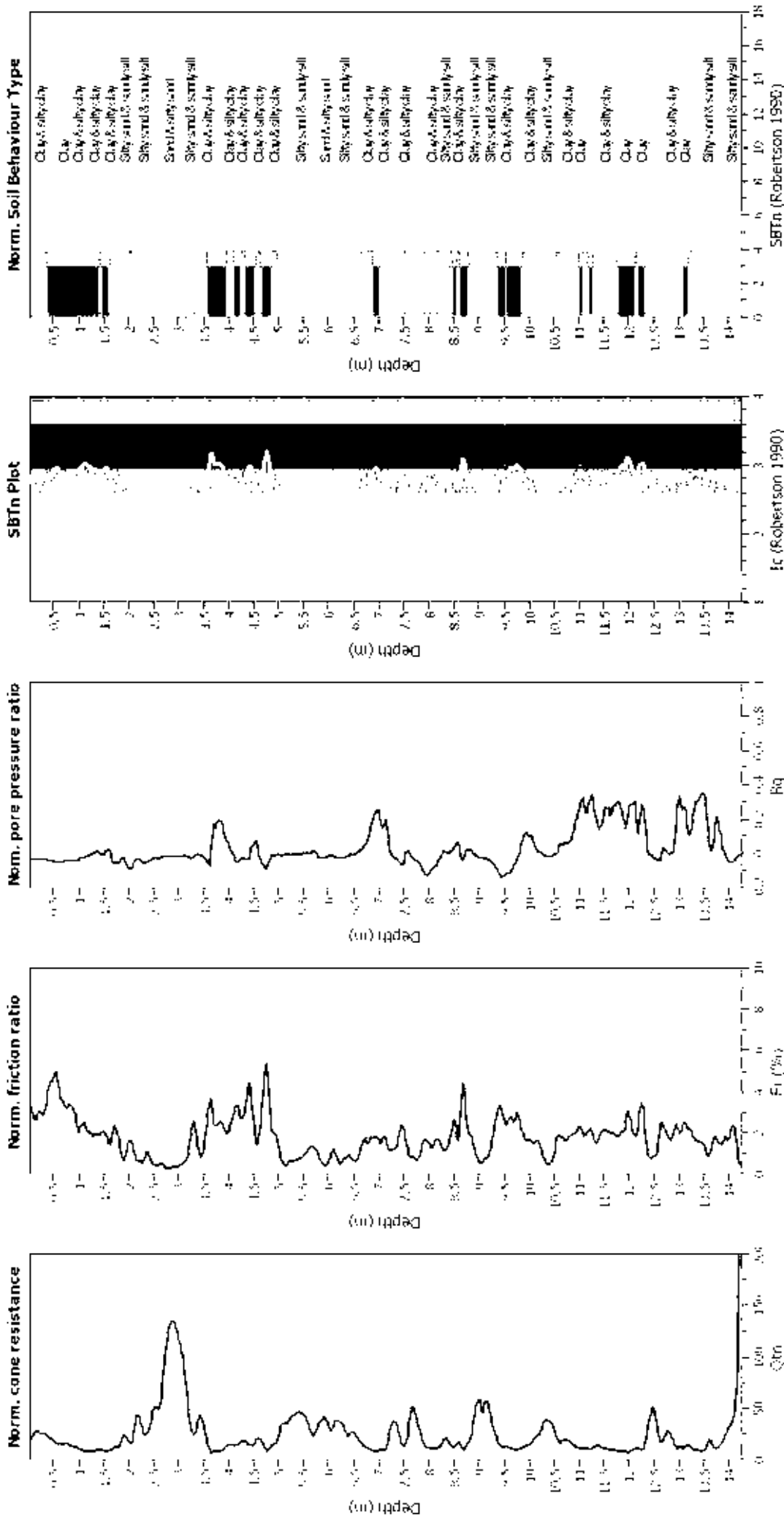
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behaviour applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	0.50 m	Unit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



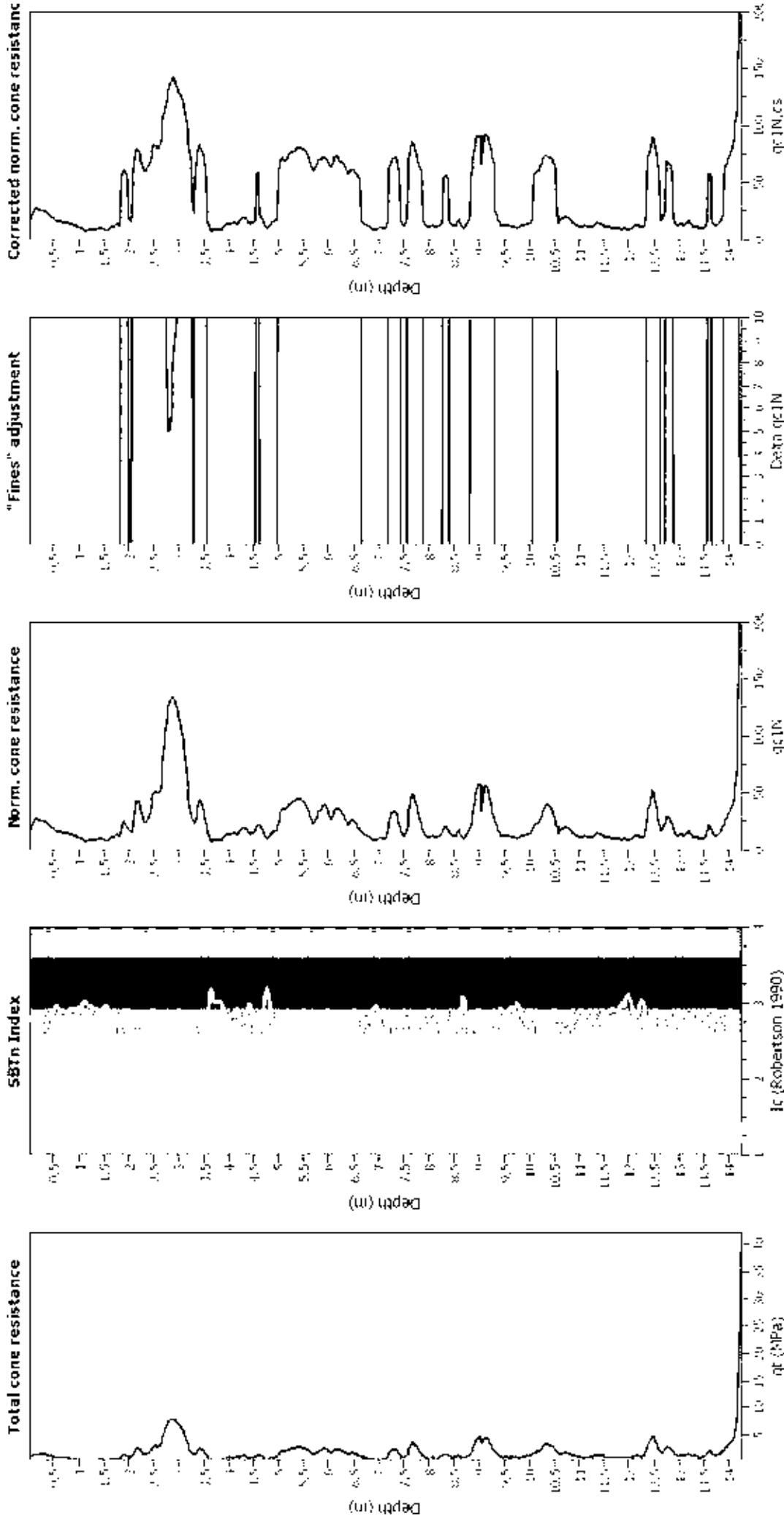
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Unit depth applied:	No
Depth to water table (m):	0.50 m	Unit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	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

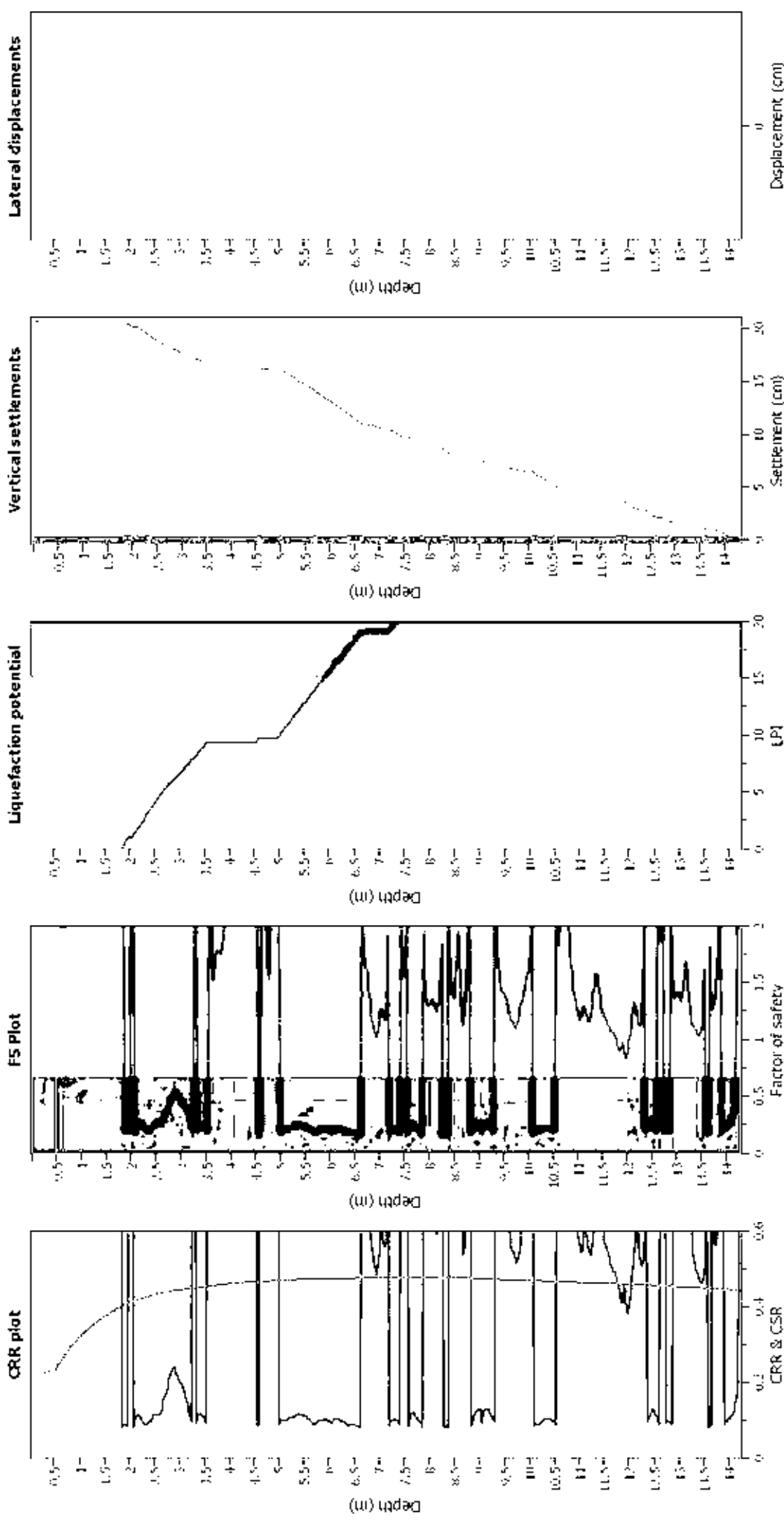
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Factor/make mag. angle β_s :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m): $z_{w(t)}$:	0.50 m	Limit depth:	N/A
Depth to GW (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Lines correction method: 188 (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude M_L : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 0.50 m

Depth to GW (earthq.): 0.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition depth applied: N/A
 K applied: Sand & Clay
 Clay like behavior applied: Yes
 Limit depth applied: No
 Limit depth: N/A

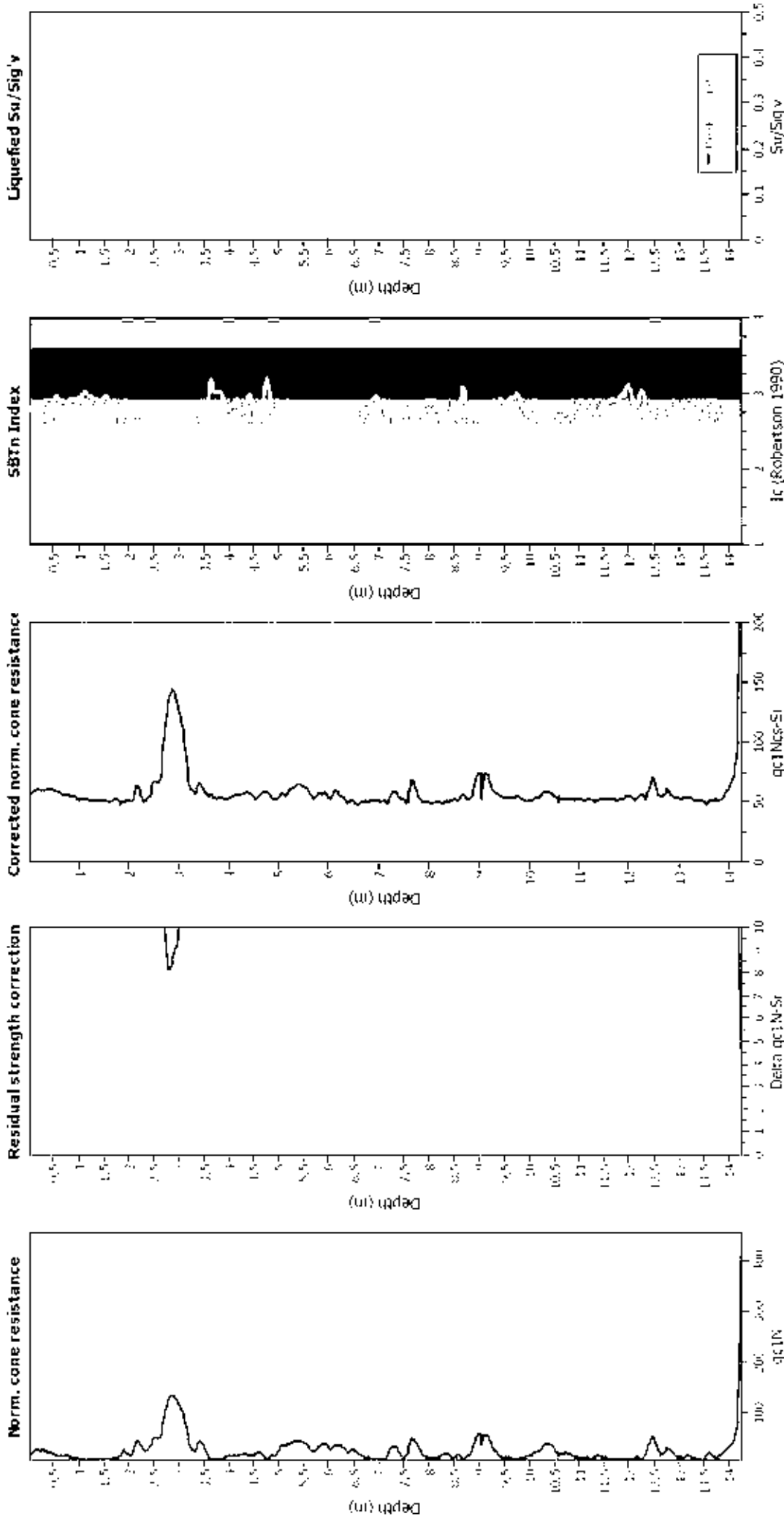
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

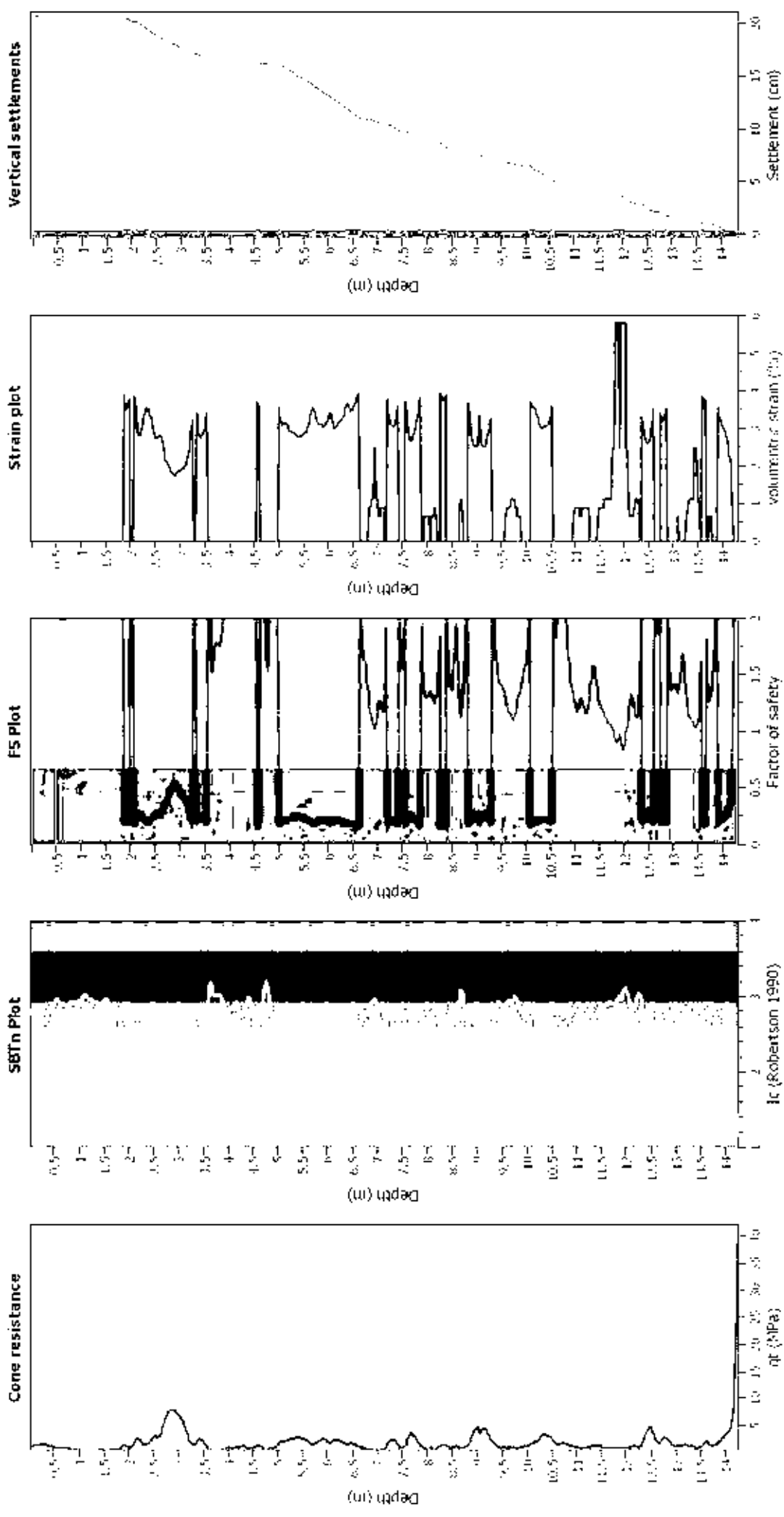
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition detect. applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GWT (earthq.):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- TC: Total cone resistance (cone resistance q_c corrected for pore water effects)
- SB: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT49_200CashmereRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	1.50 m	Use fill	No	Clay like behavior	
Time correction method	I&B (2008)	G.W.T. (earthq.):	1.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

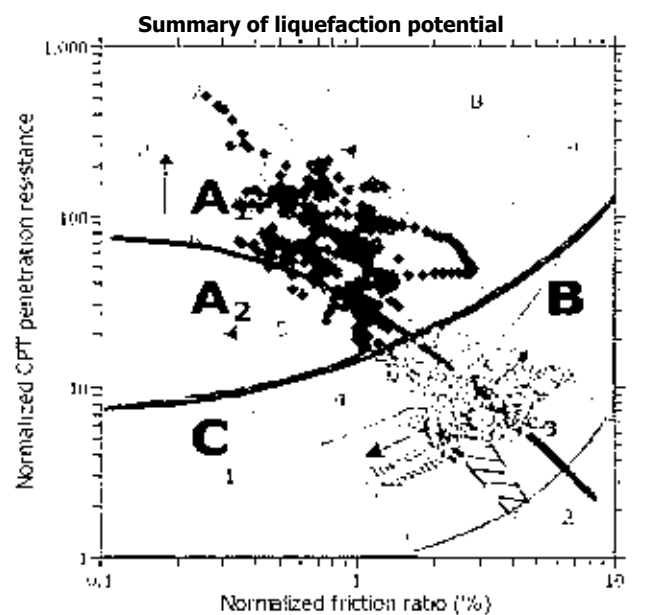
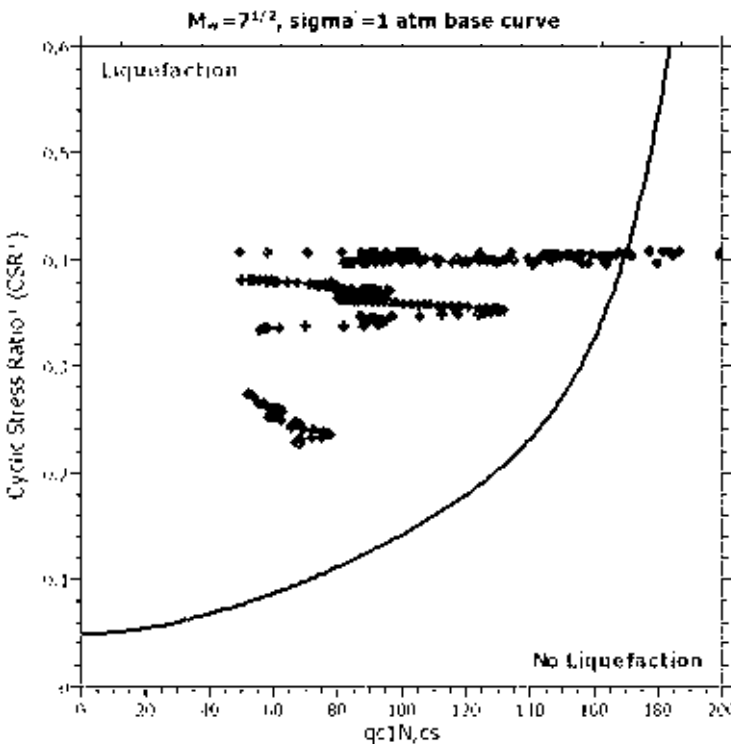
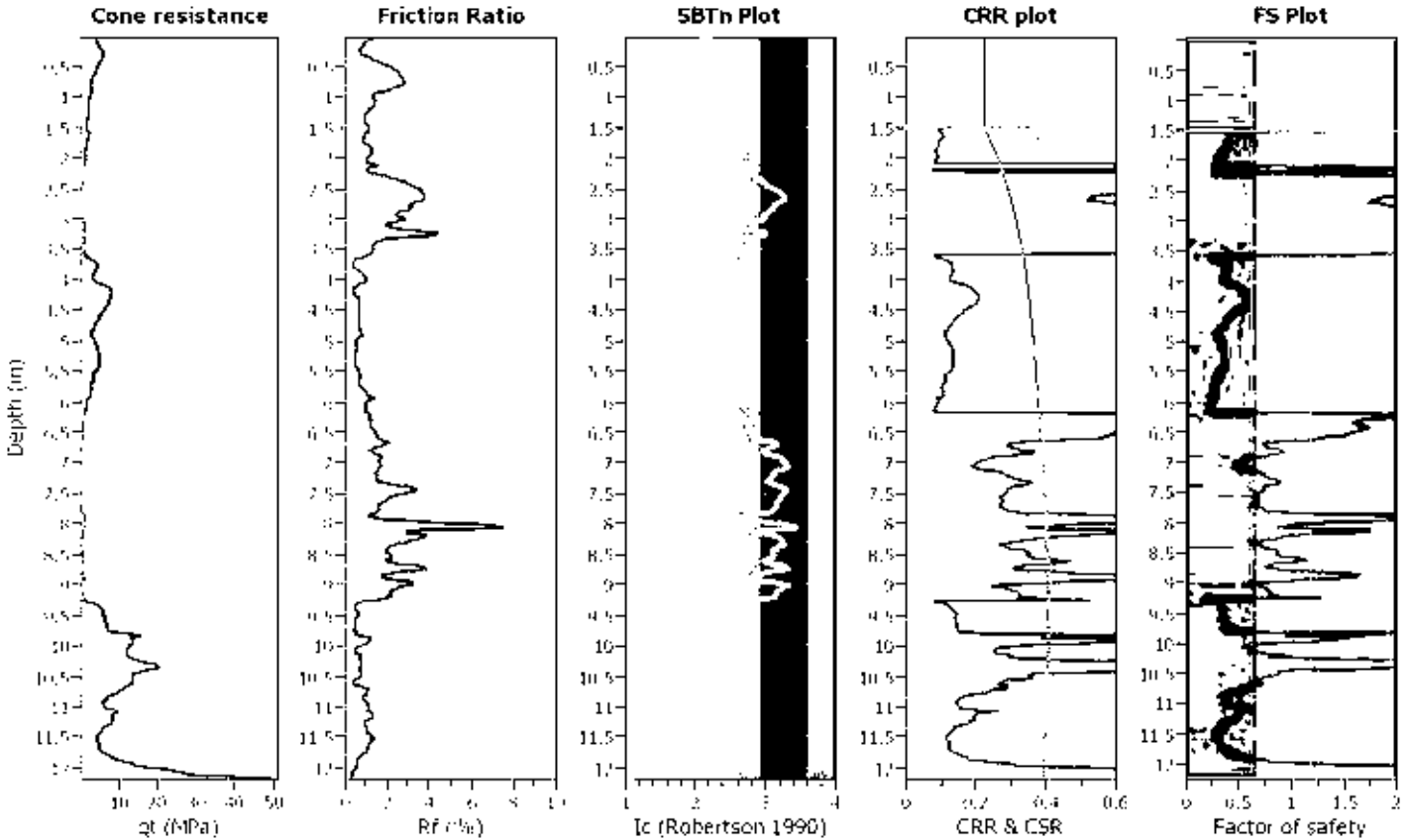
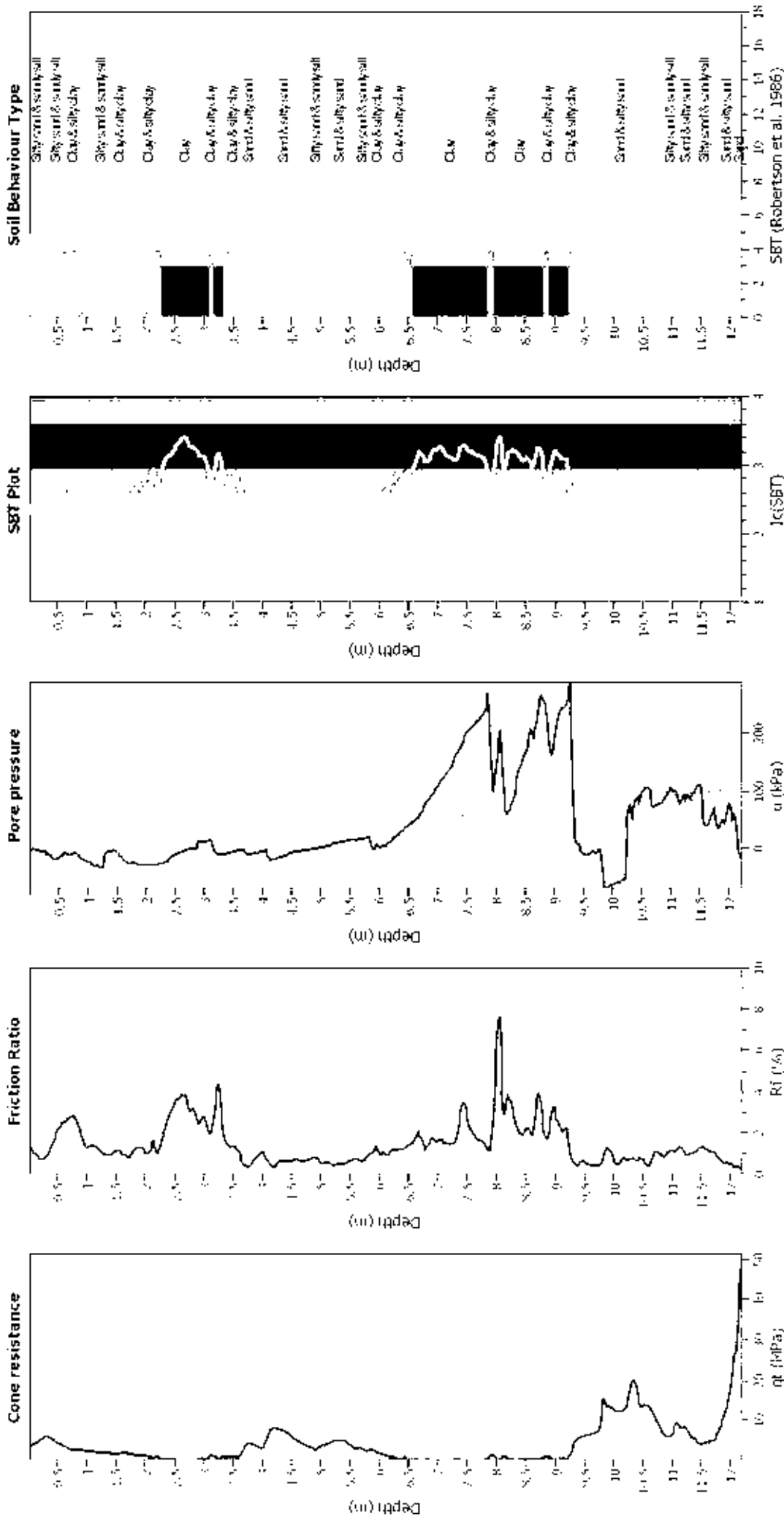


Figure 4: Summary of liquefaction potential and penetration resistance and cyclic stress ratio. Zone A: Fully liquefiable; Zone A2: Partially liquefiable; Zone B: Liquefaction potential; Zone C: No liquefaction. The plot shows the relationship between normalized CPT penetration resistance and normalized friction ratio, with arrows indicating liquefaction potential and liquefaction resistance.

CPT basic interpretation plots



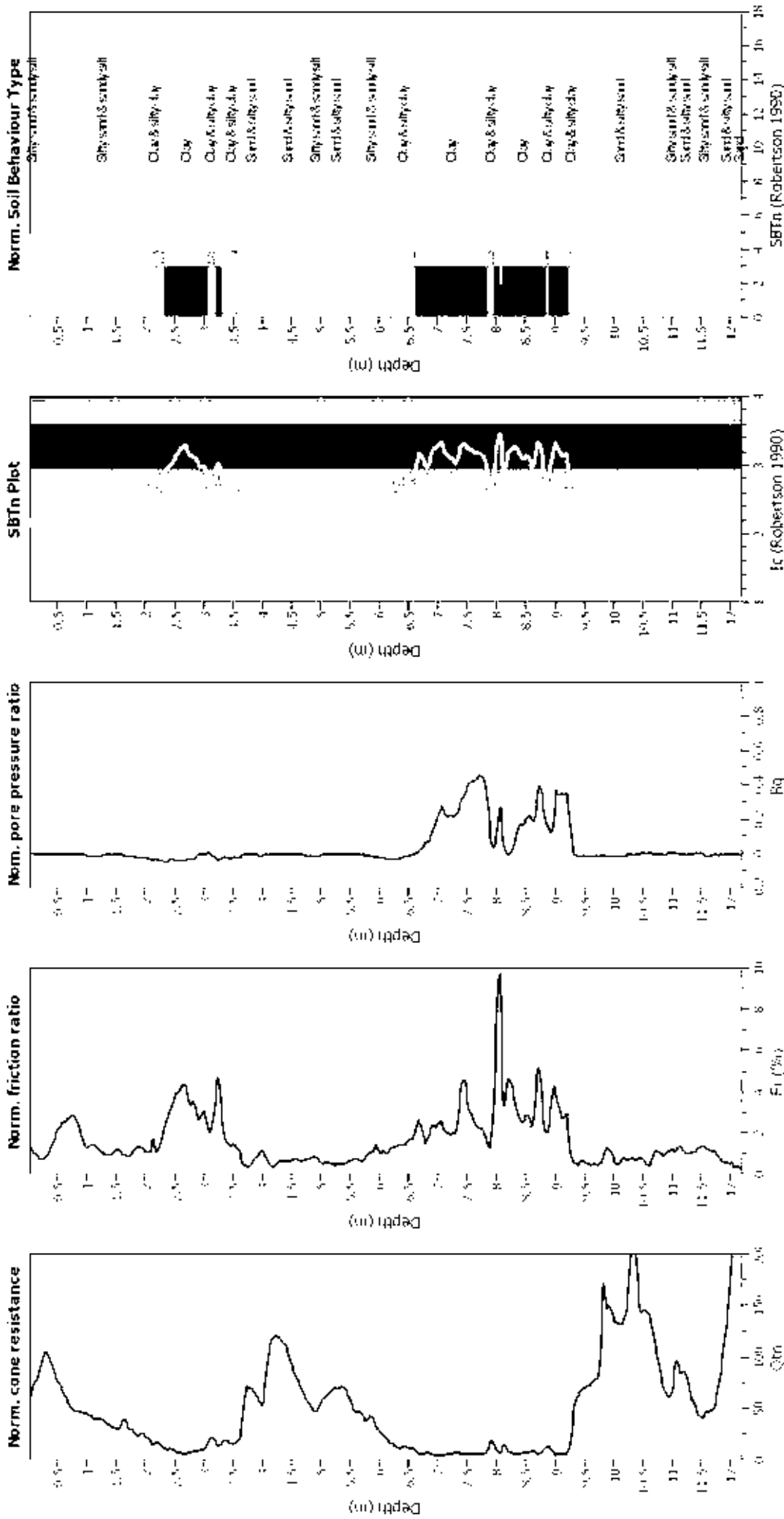
Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Units correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	N/A
Depth to water table (m):	1.50 m	Limit depth:	N/A
Depth to GW (earthq.):	1.50 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

SBT legend

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

CPT basic interpretation plots (normalized)



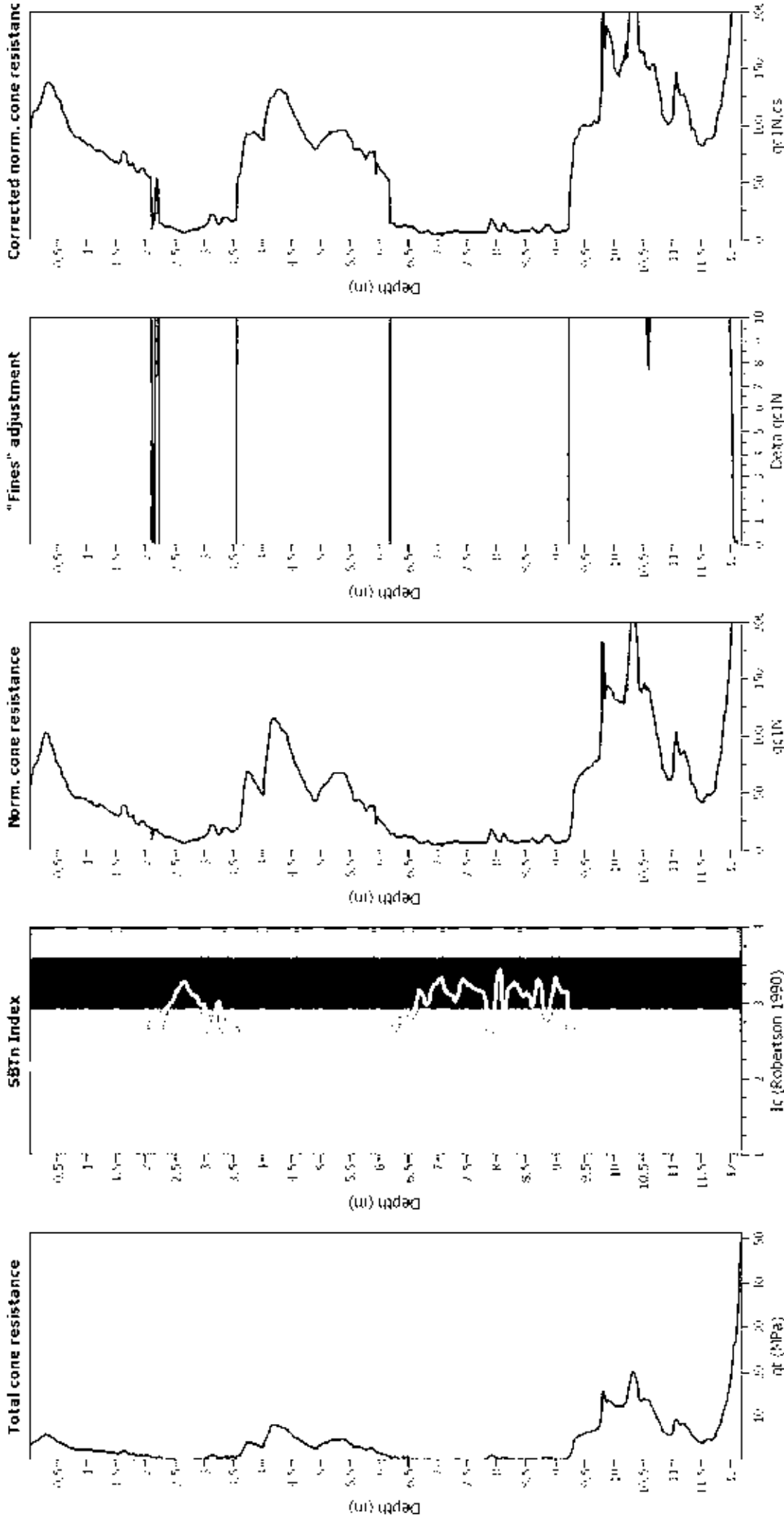
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	1.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (m):	1.50 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

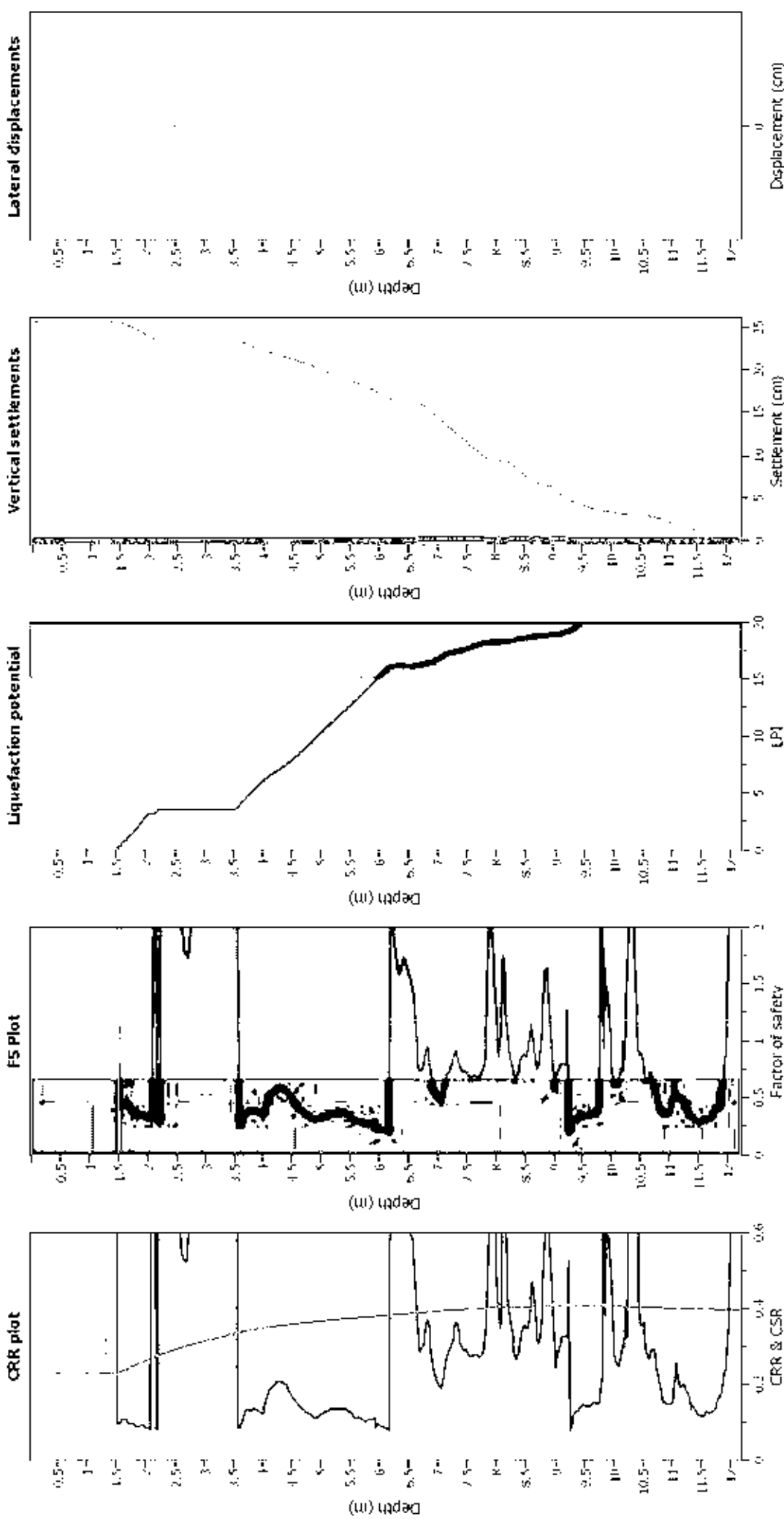
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. func. method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Factorial mag. angle M_2 :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table ($z_{w,eq}$):	1.50 m	Limit depth:	N/A
Depth to GWL (erthq.):	1.50 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Liquefaction magnitude M_w : 7.50
 Peak ground acceleration: 0.35
 Depth to water table (m): 1.50 m

Depth to GW (earthq.): 1.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight transition depth applied: N/A
 Sand & Clay: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: No
 Limit depth: N/A

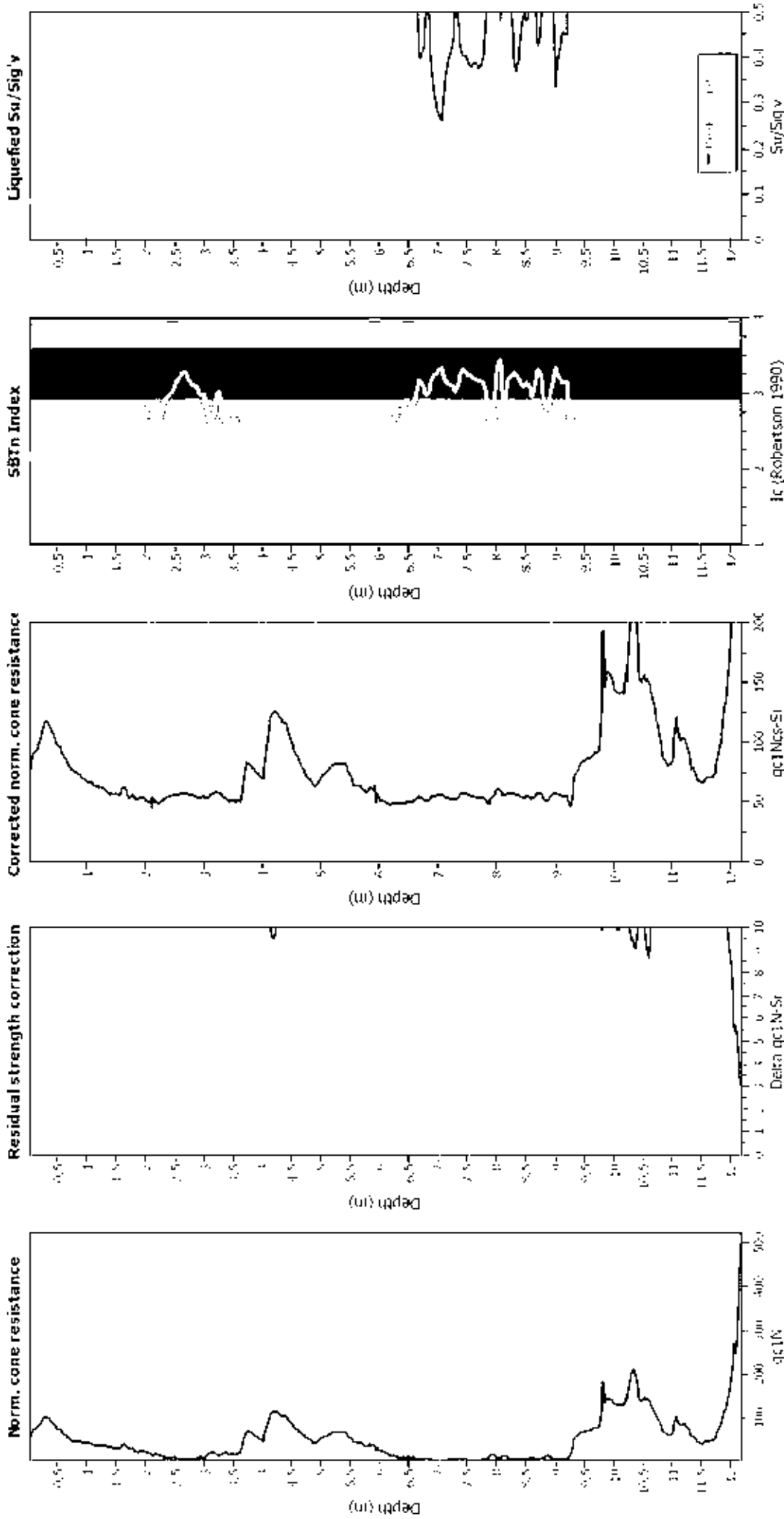
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

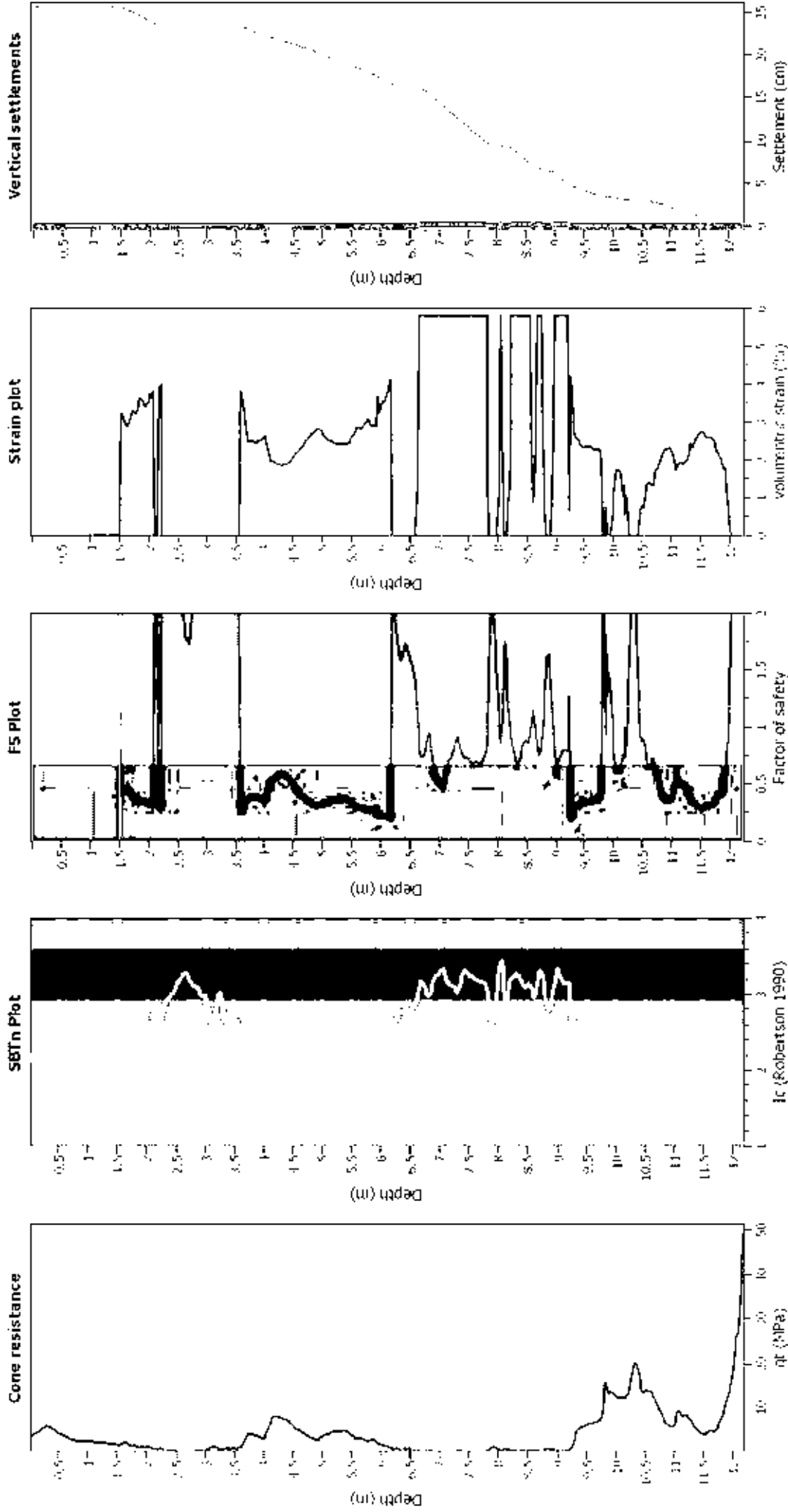
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition defect applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Factorial mag. angle β_s :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Lam. depth applied:	No
Depth to water table (m):	1.50 m	Lam. depth:	N/A
Depth to GWT (earthq.):	1.50 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements



Abbreviations

- qc: Total cone resistance (cone resistance q_c corrected for pore water effects)
- SBTn: Soil Behaviour Type index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain

Project title : CCC Halswell ODP Geotechnical Investigation Location : Halswell, Christchurch

CPT file : CPT50_334SparksRd

Input parameters and analysis data

Analysis method	I&B (2008)	G.W.T. (in-situ):	0.50 m	Use fill	No	Clay like behavior	
Line correction method	I&B (2008)	G.W.T. (earthq.):	0.50 m	Full height:	N/A	applied:	Sand & Clay
Points to test	Based on Ic value	Average results interval:	3	Full weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration	0.35	Unit weight calculation:	Based on SBT	K _v applied:	Yes		

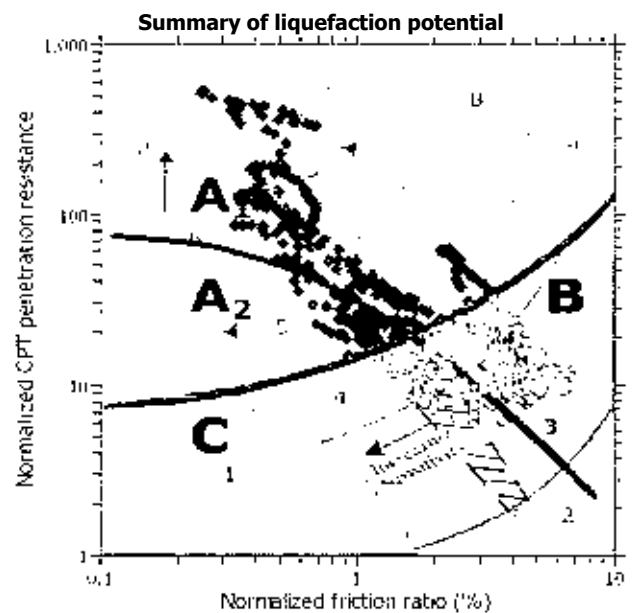
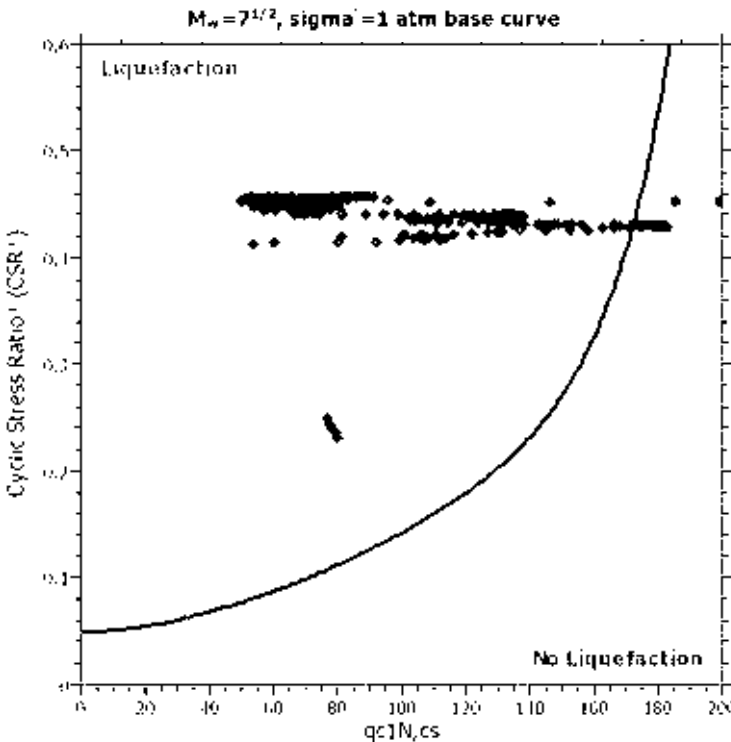
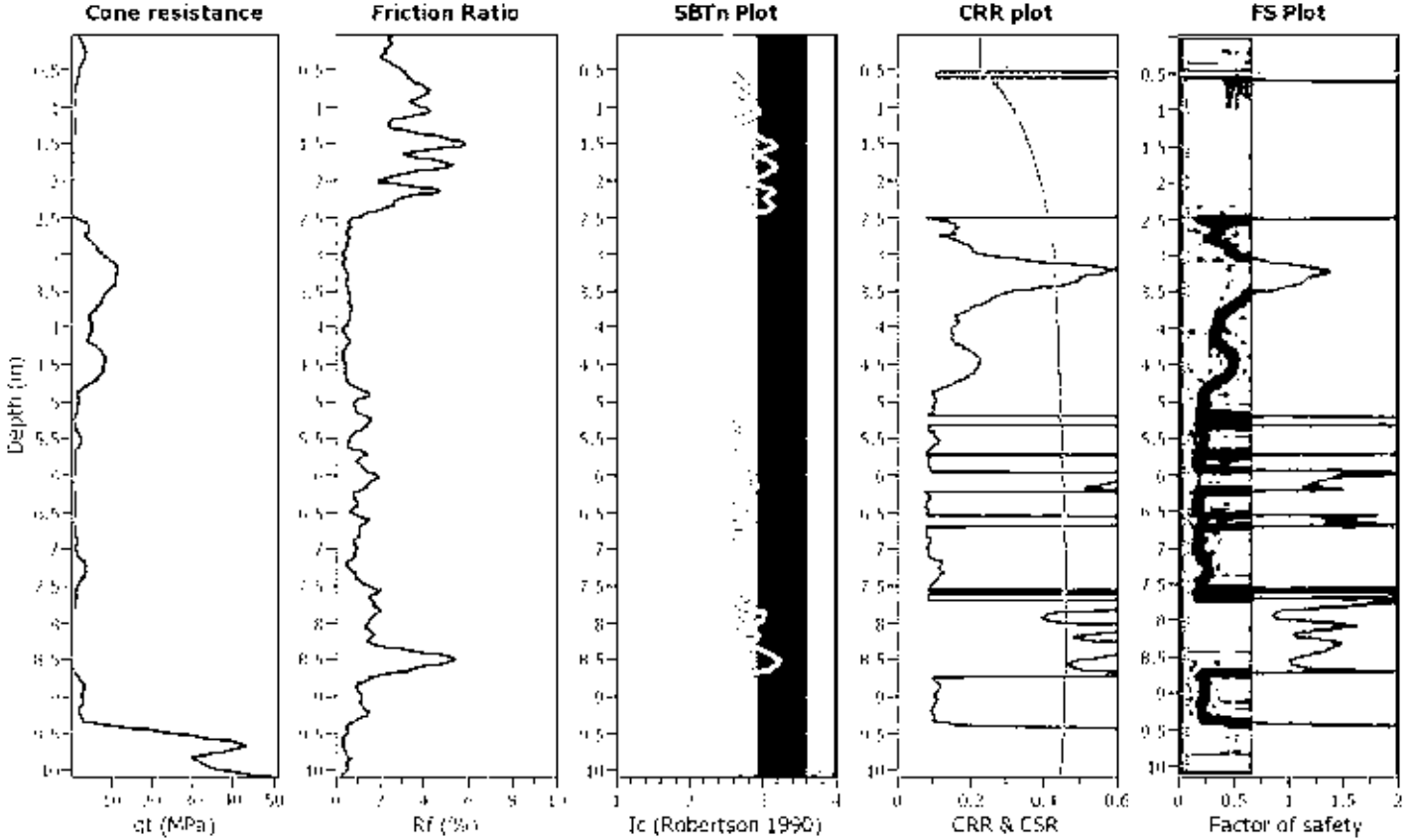
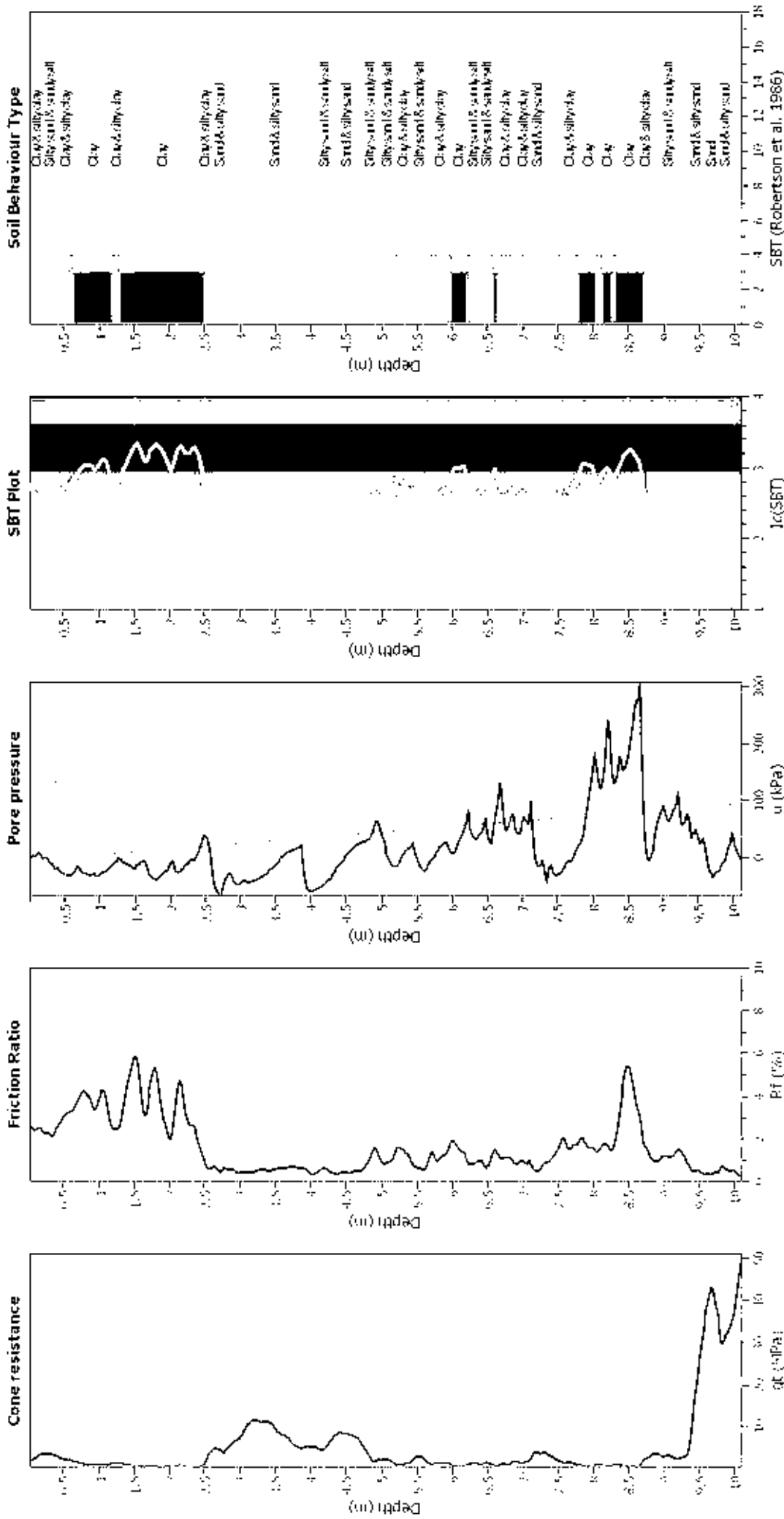


Figure 4: Summary of liquefaction potential assessment and data for the test. Zone A: Fully liquefied; Zone A2: Partially liquefied; Zone B: No liquefaction; Zone C: No liquefaction. The liquefaction boundary is shown as a dashed line. The liquefaction boundary is shown as a dashed line.

CPT basic interpretation plots



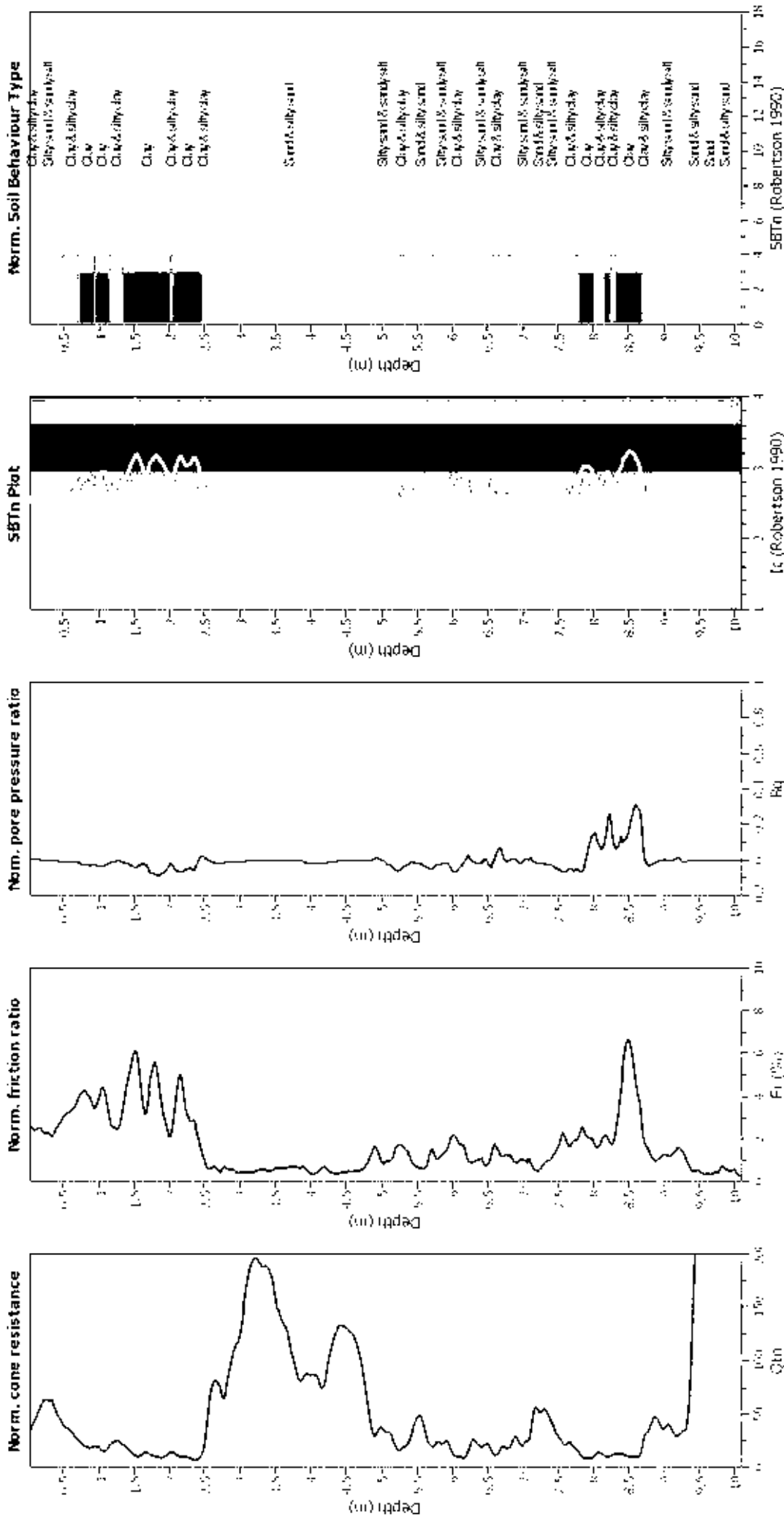
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GW (erthq.):	0.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (m):	0.50 m	Fill height:	N/A	Unit depth:	N/A

SBT legend

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

CPT basic interpretation plots (normalized)



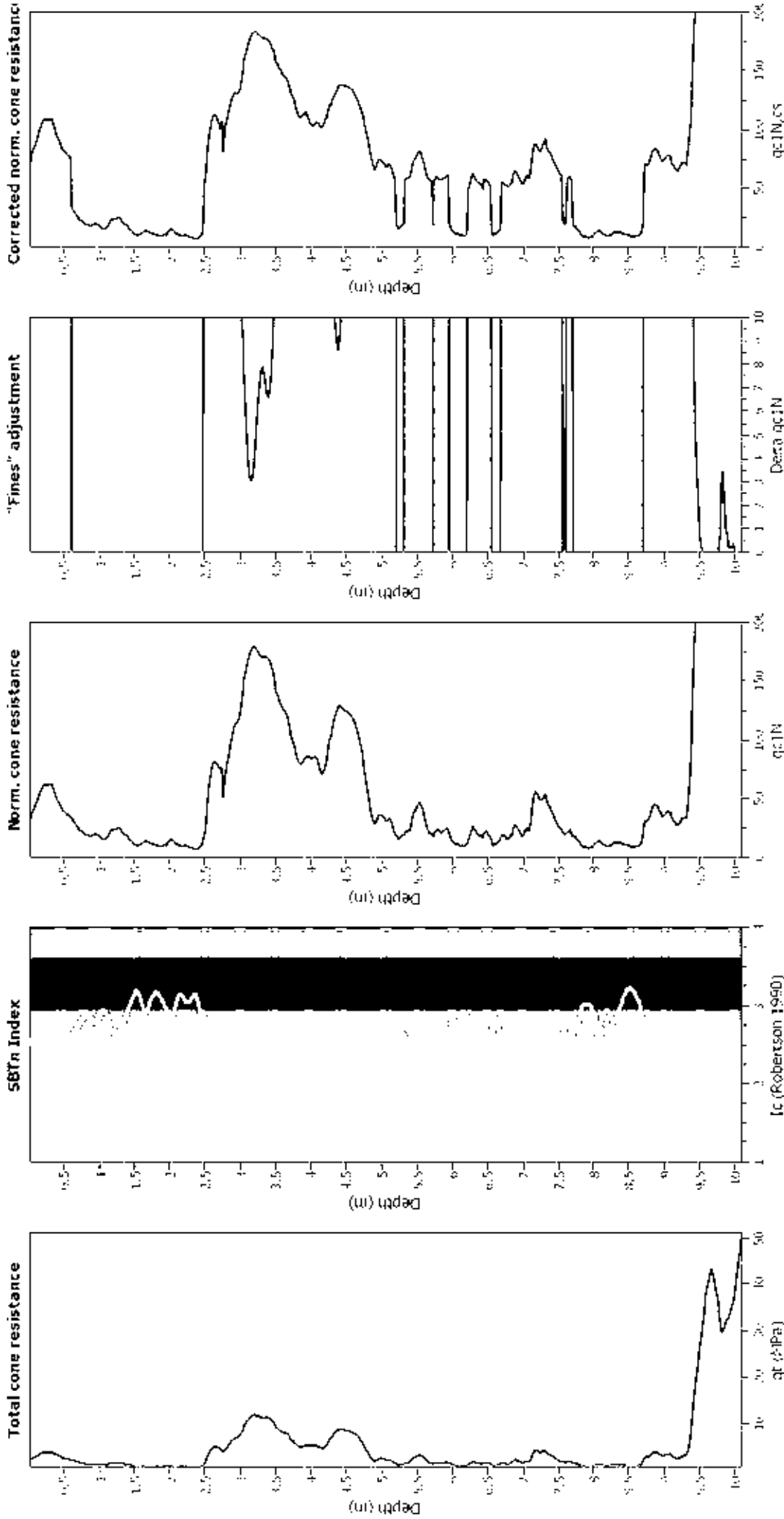
Input parameters and analysis data

Analysis method:	18B (2008)	Depth to GWL (erthq.):	0.50 m	Fill weight:	N/A
Units correction method:	18B (2008)	Average results interval:	3	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Use fill:	No	Unit depth applied:	No
Depth to water table (erthq.):	0.50 m	Fill height:	N/A		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

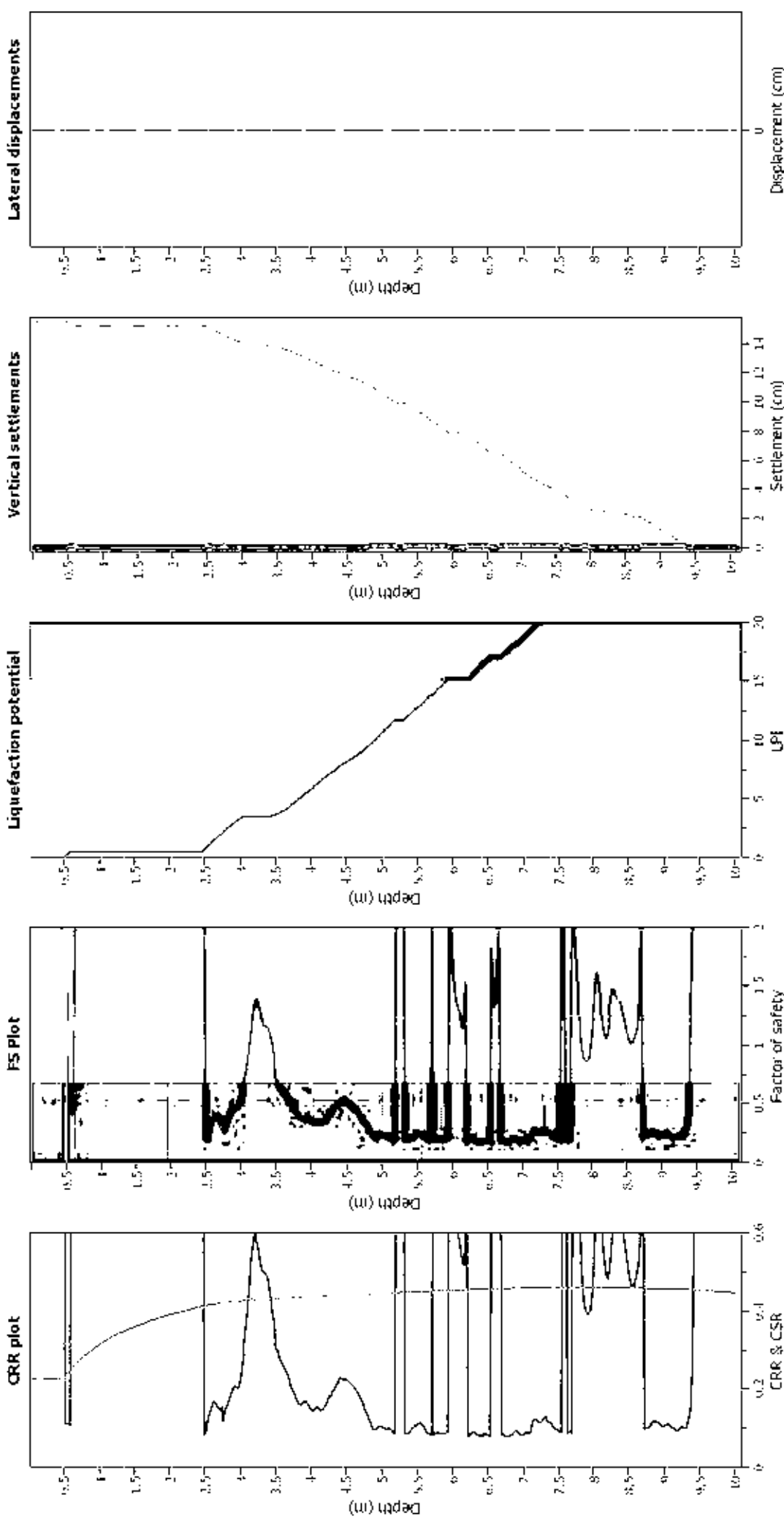
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Fines correction method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on Ic value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	No
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GW (ortho):	0.50 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: 188 (2008)
 Liquefaction correction method: 188 (2008)
 Points to test: Based on Ic value
 Earthquake magnitude M_w : 7.5
 Peak ground acceleration: 0.35
 Depth to water table (m): 0.50 m

Depth to GW (earthq.): 0.50 m
 Average results interval: 3
 Ic cut-off value: 2.60
 Unit weight calculation: Based on SBT
 Use fill: No
 Fill height: N/A

Full weight: N/A
 Transition depth applied: Sand & Clay
 K applied: Yes
 Clay like behavior applied: No
 Limit depth applied: N/A

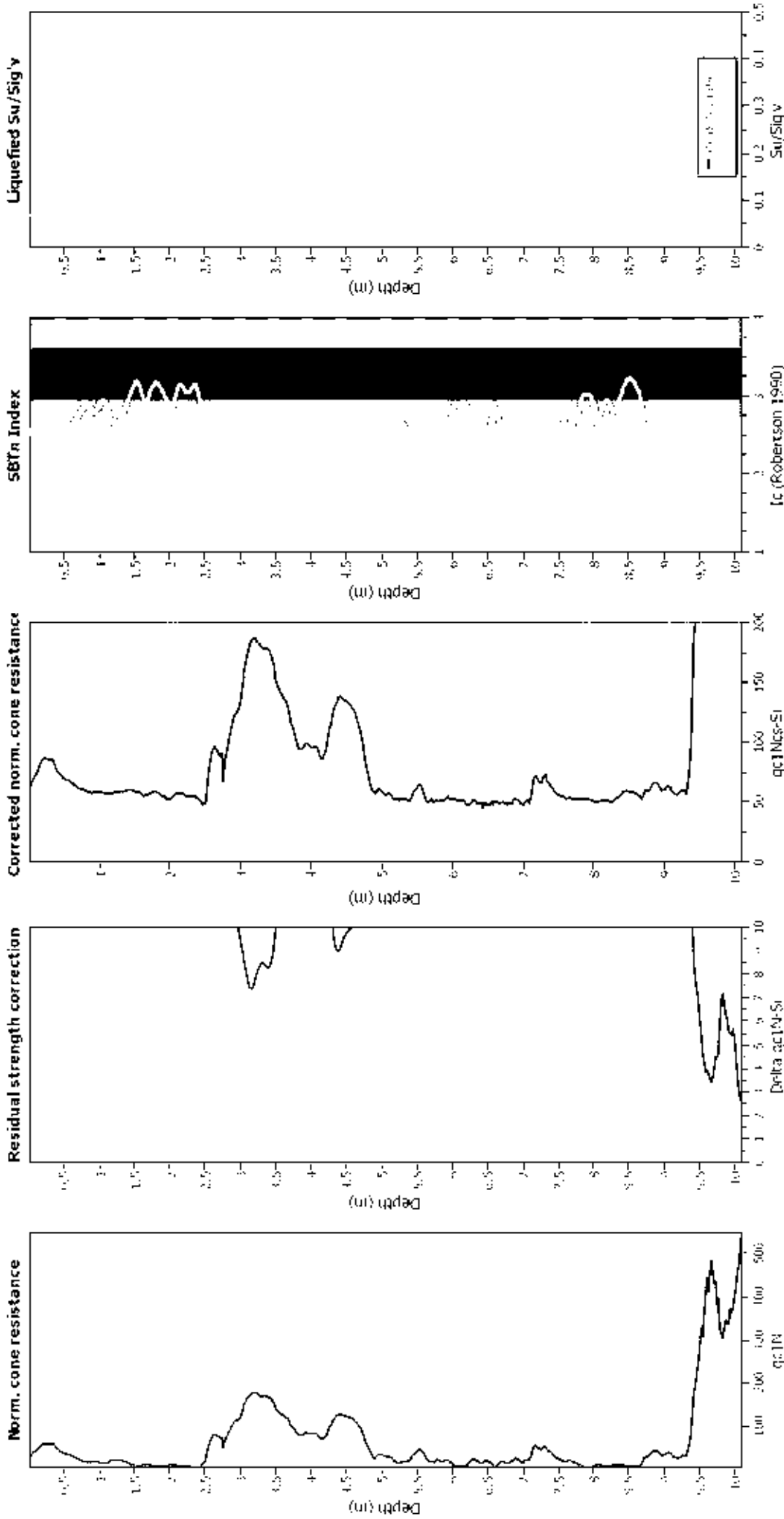
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

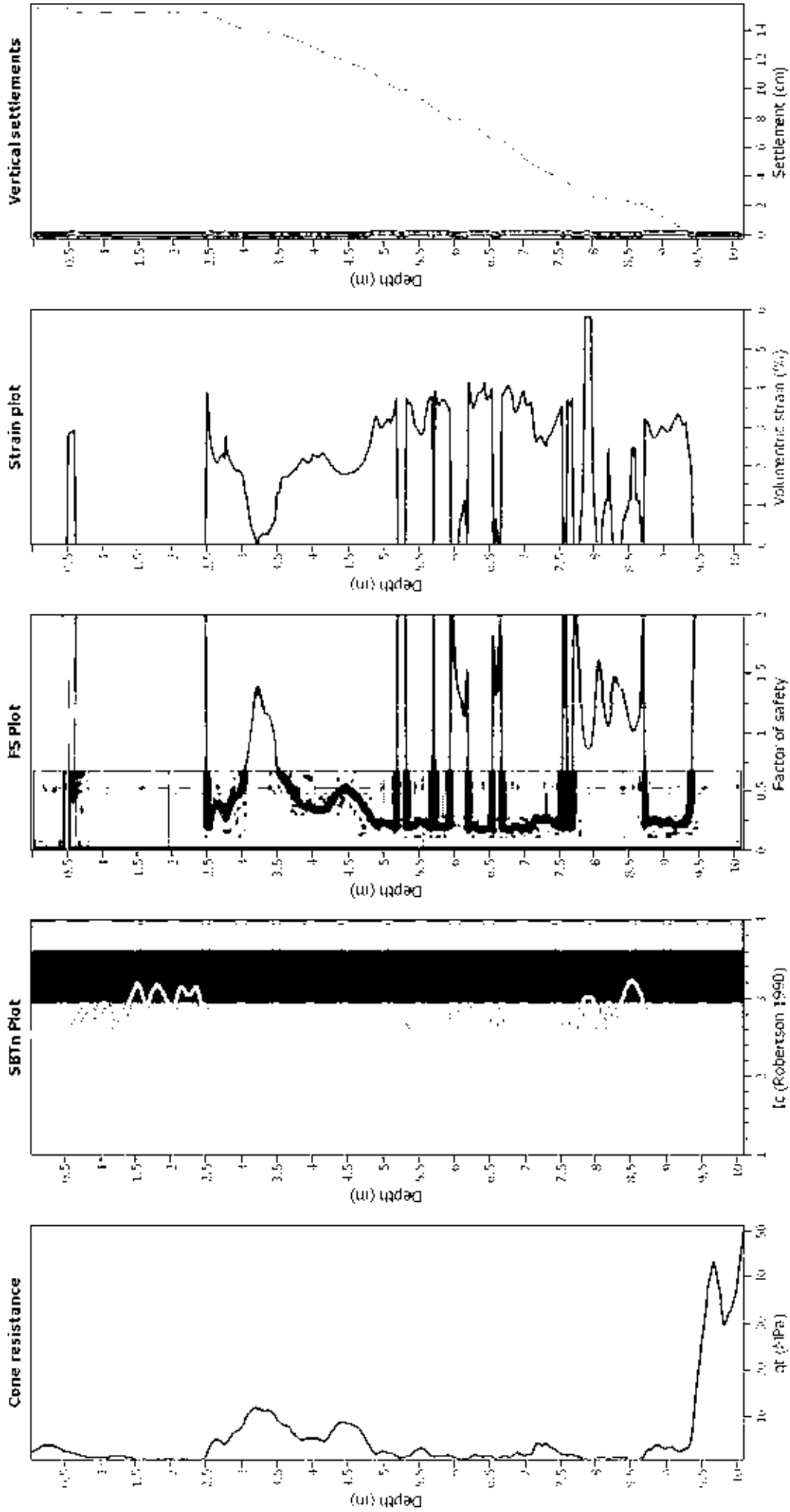
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	18B (2008)	Fill weight:	N/A
Lines corre. for method:	18B (2008)	Transition depth applied:	Sand & Clay
Points to test:	Based on I_c value	K applied:	Yes
Earthquake magnitude M_w :	7.50	Clay like behavior applied:	.
Peak ground acceleration:	0.35	Limit depth applied:	No
Depth to water table (m):	0.50 m	Limit depth:	N/A
Depth to GWL (earthq.):	0.50 m		
Average results interval:	3		
I_c cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

Estimation of post-earthquake settlements

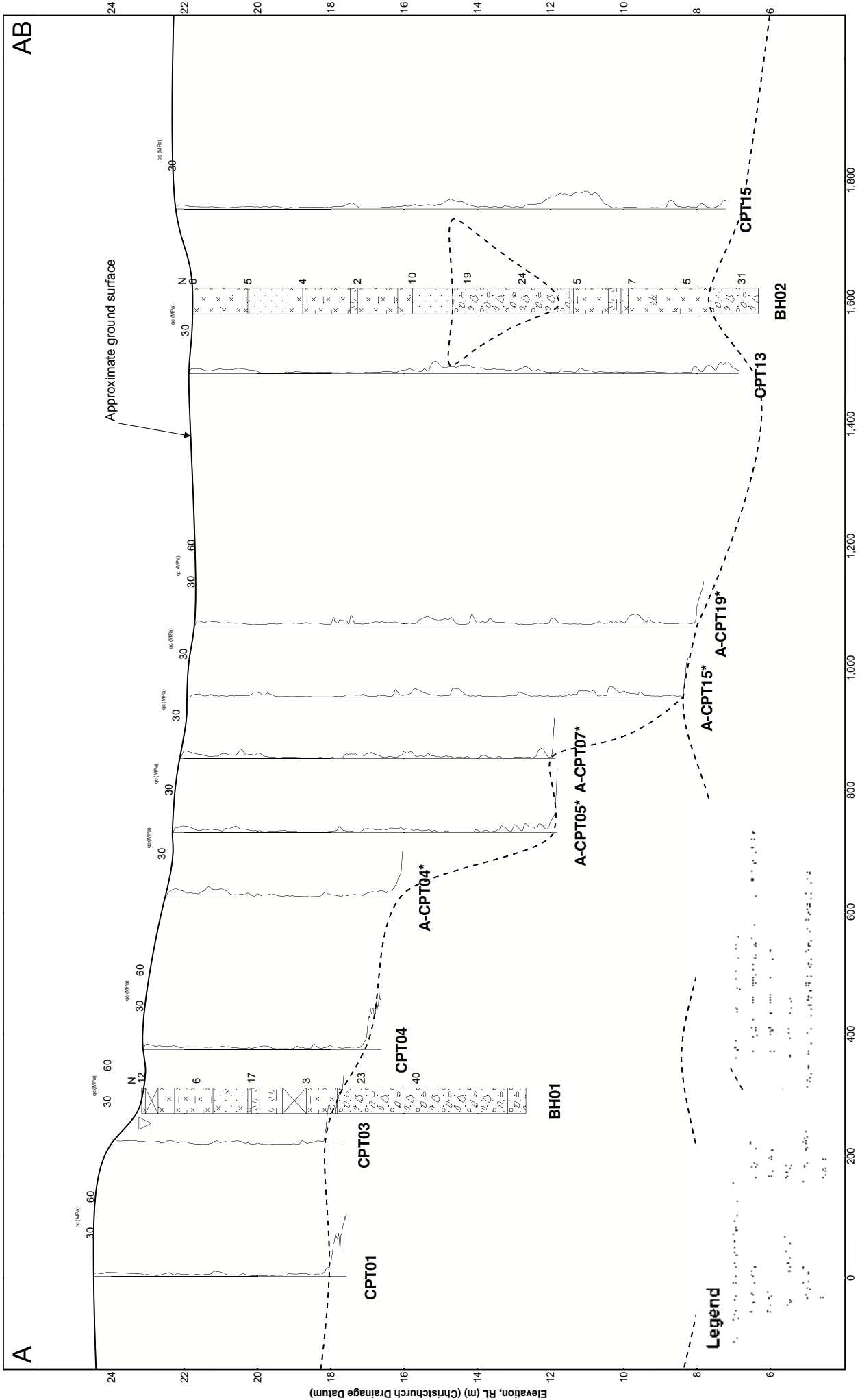


Abbreviations

- qt Total cone resistance (cone resistance q corrected for pore water effects)
- SBTn Soil Behaviour Type Index
- FS Calculated Factor of Safety against Liquefaction
- Volumetric strain Post liquefaction volumetric strain

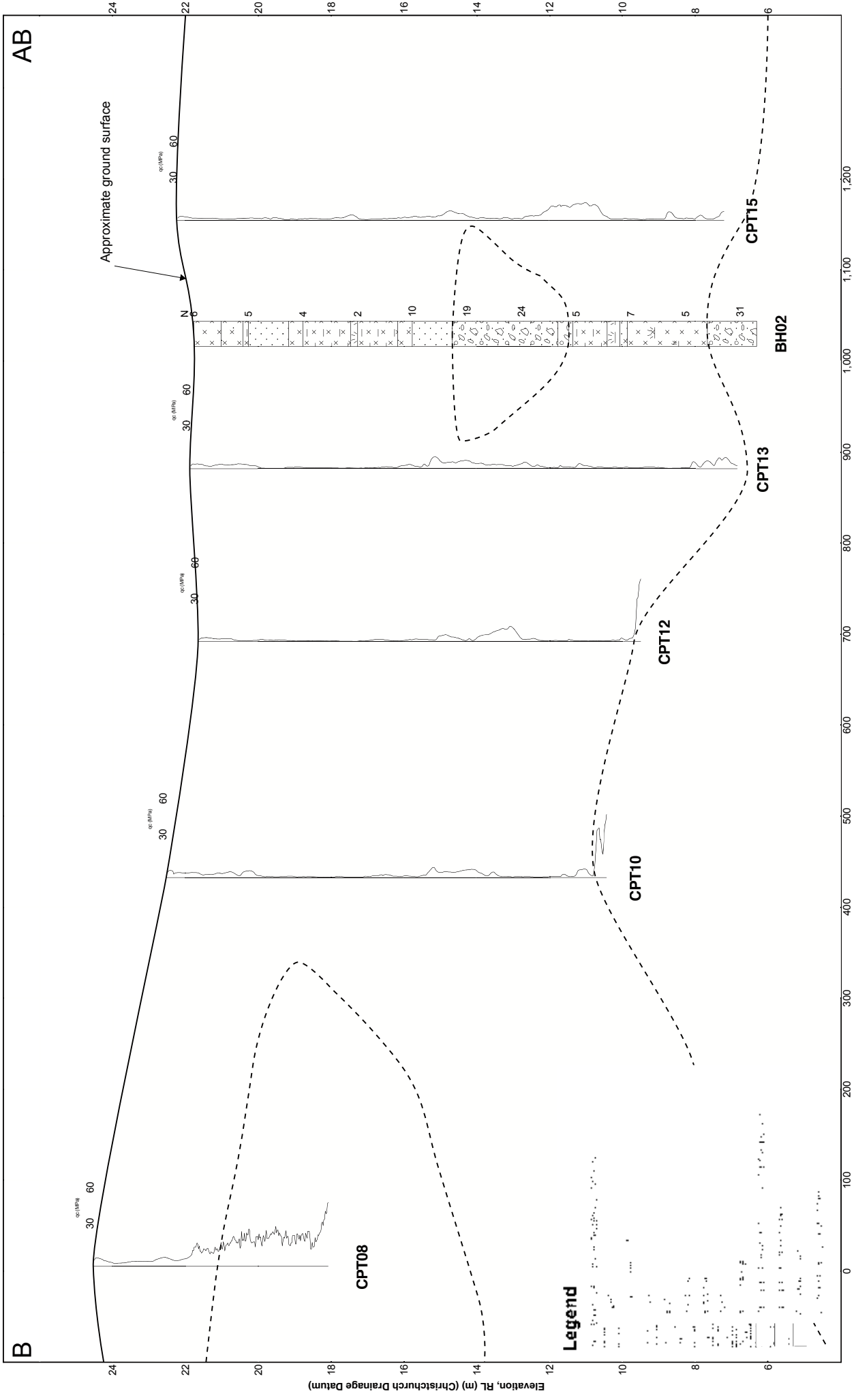


Geological Cross Sections



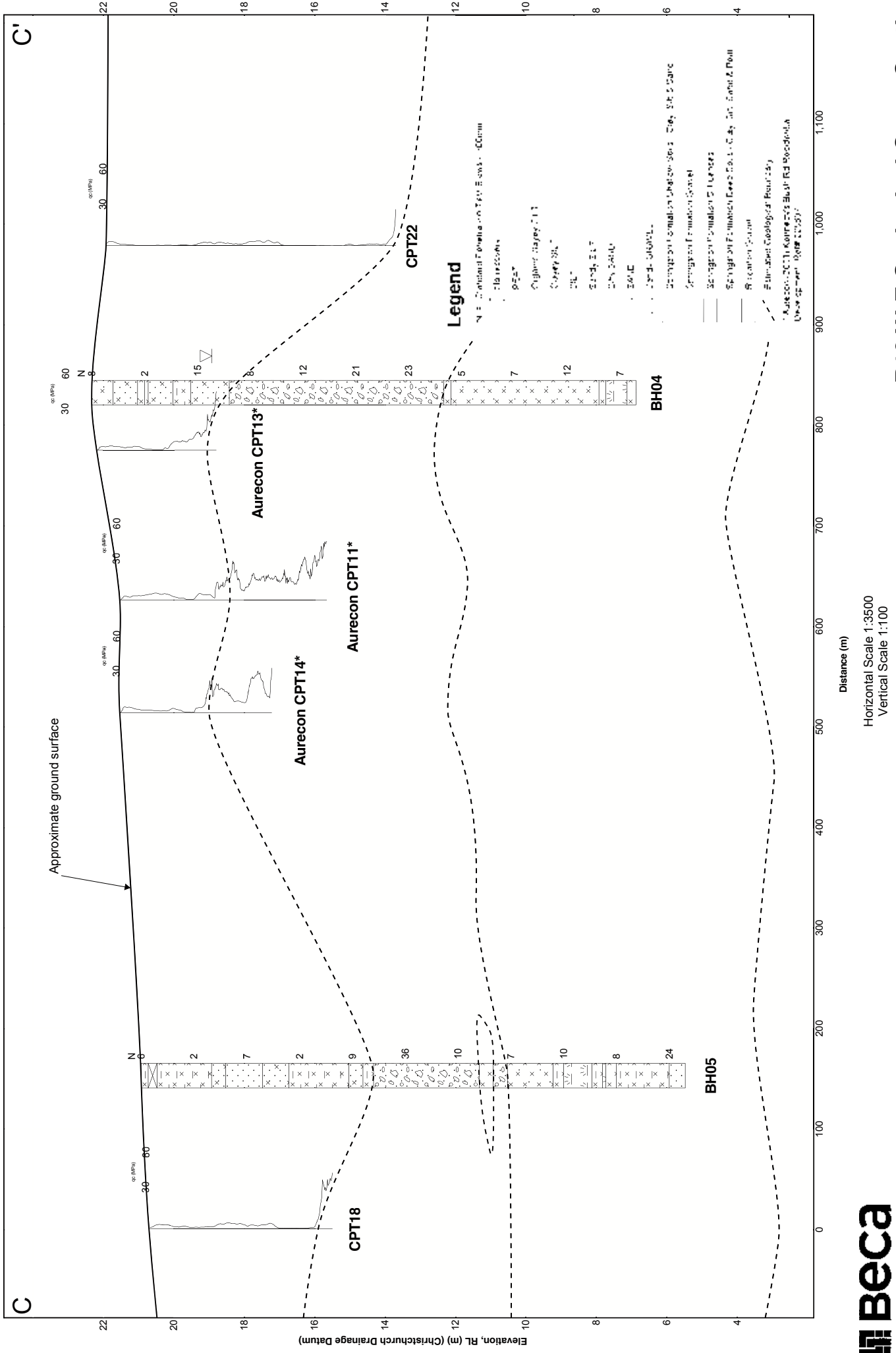
R15 NW-SE Geological Cross-Section SECTION A-AB





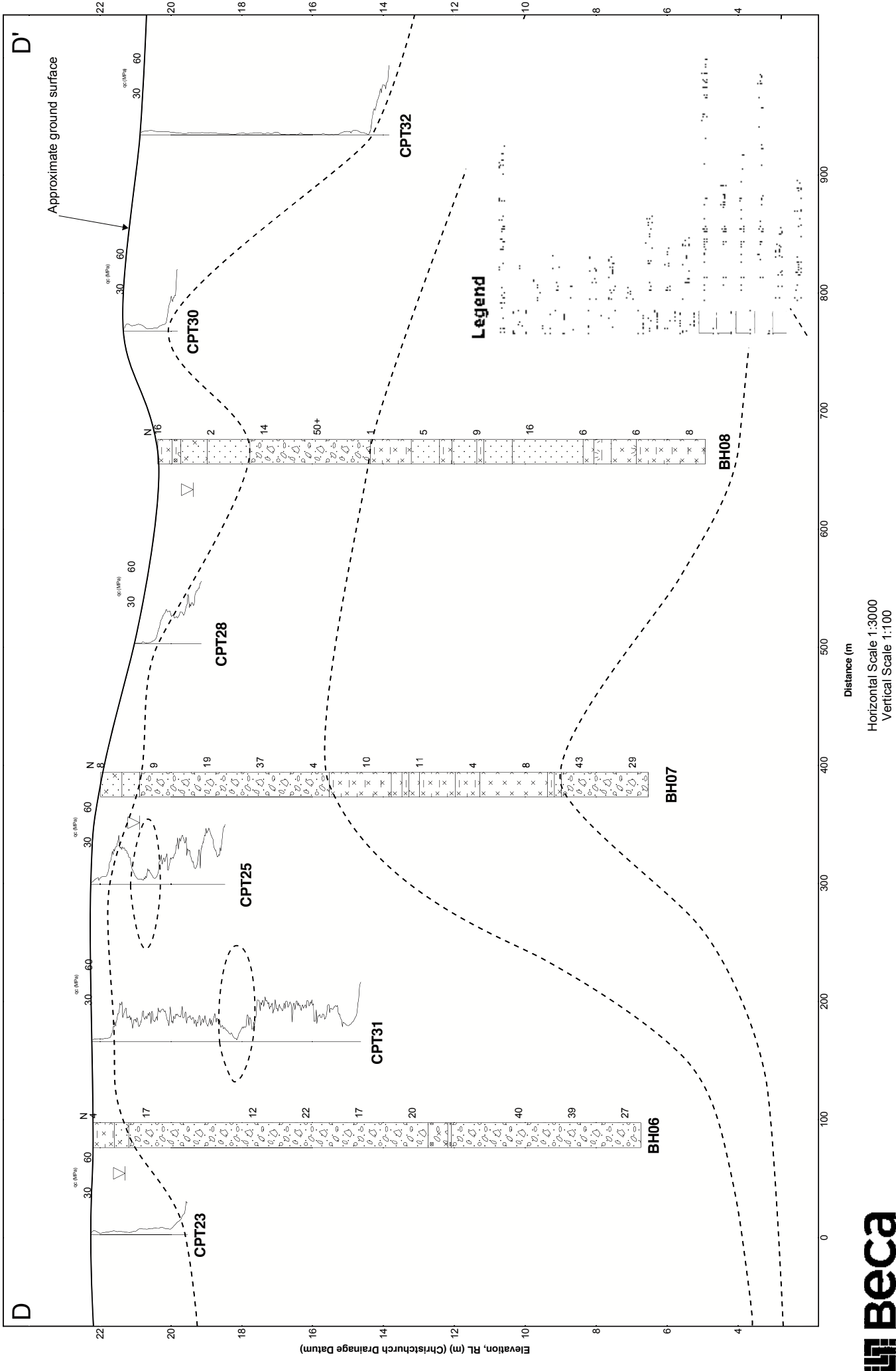
**R15 N-S Geological Cross-Section
SECTION B-A-B**





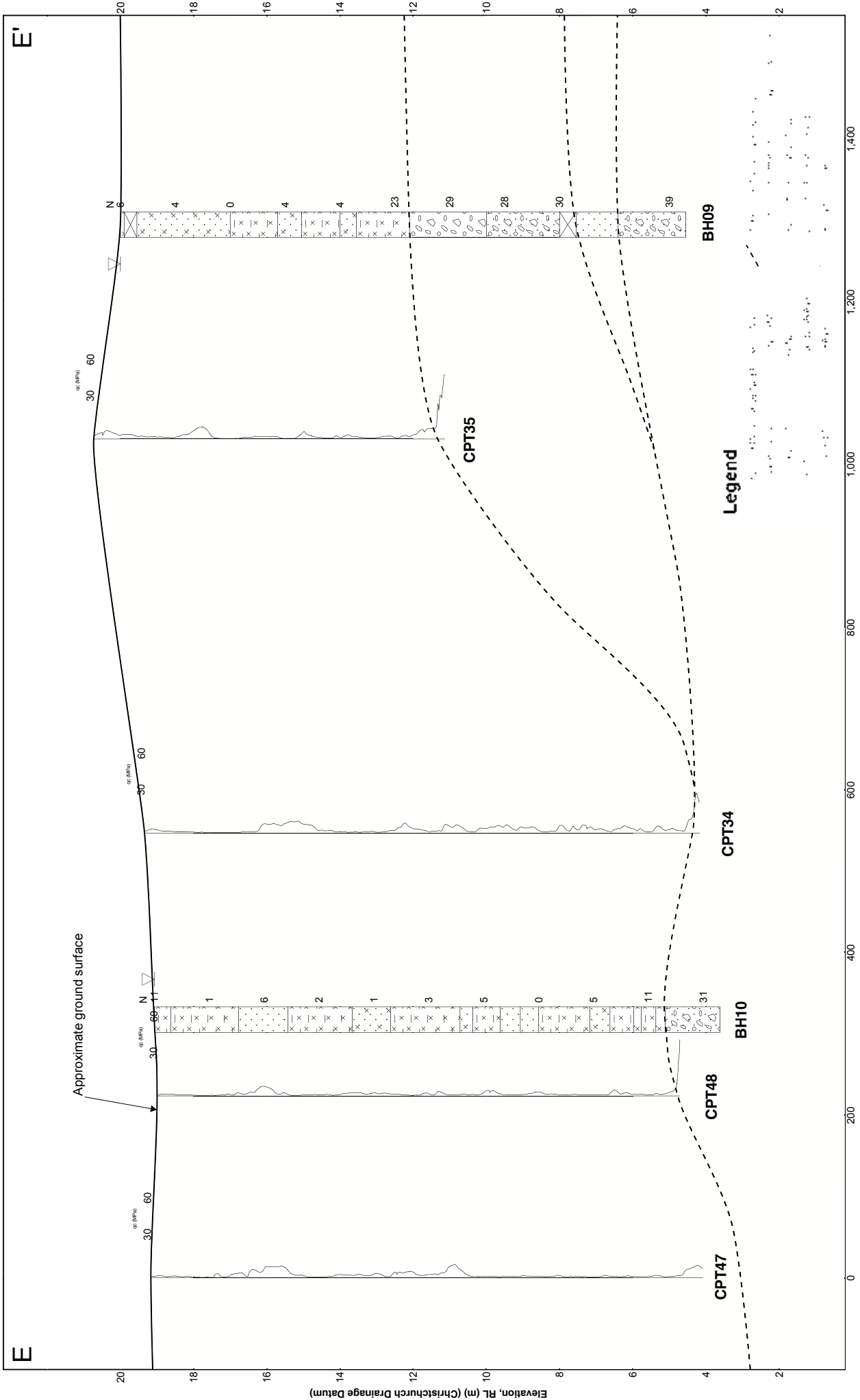
R16 W-E Geological Cross-Section
SECTION C-C'



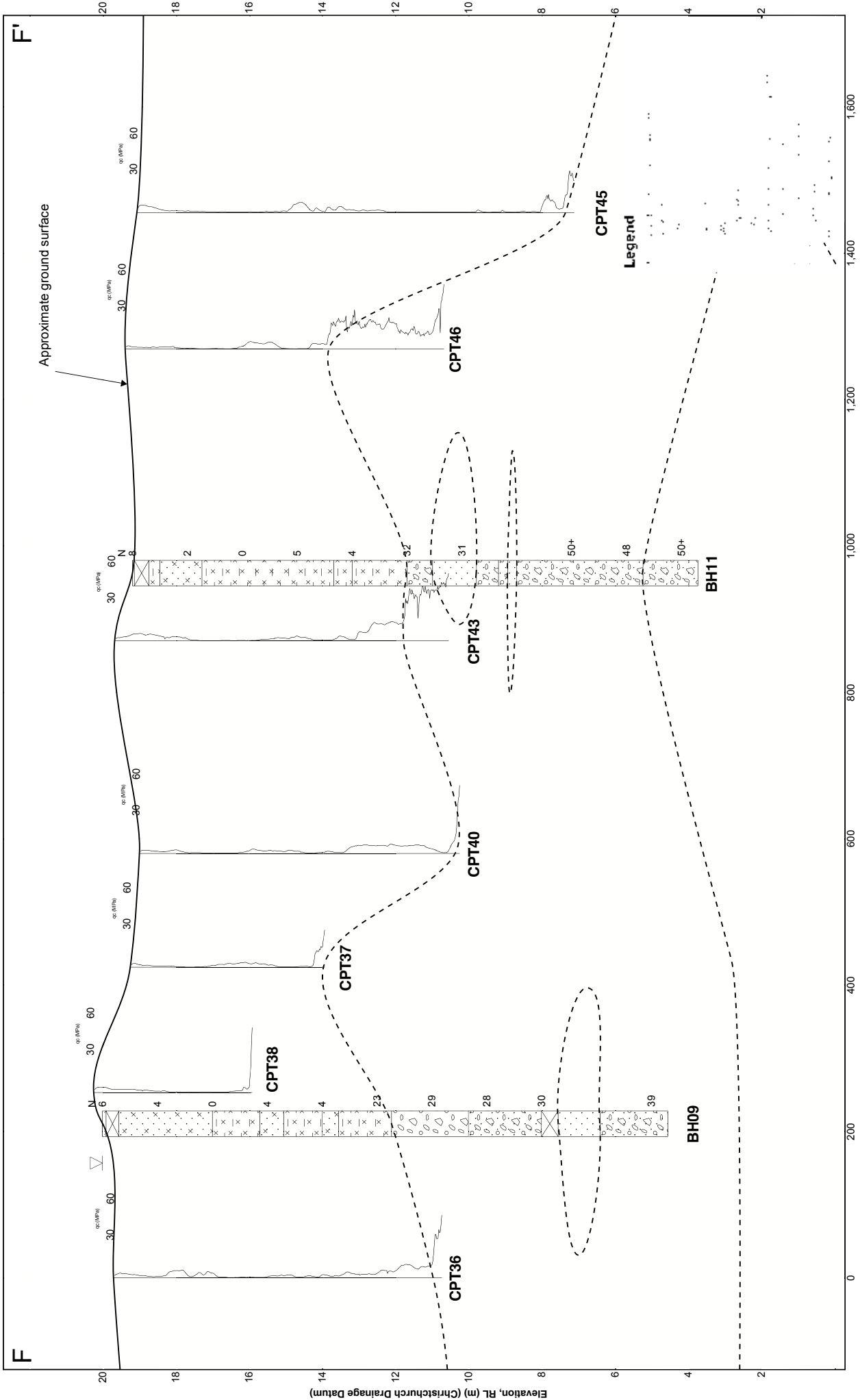


R17 N-S Geological Cross-Section
SECTION D-D'





R18 N-S Geological Cross-Section
SECTION E-E'



**R18 SW-NE Geological Cross-Section
SECTION F-F'**

Geotechnical Summary Sheets



Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	A10 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH12	15.45
CPT49	12.2

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	8.9 - 12	Very soft - stiff / very loose - loose
Sandy GRAVEL & GRAVEL	8.9 - 12	>3	Medium dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT49	2	50	260	80

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	B7 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	0.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
No ground investigations conducted	

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	>15	Unknown

* The soil profile is derived from one CPT (CPT47) located outside of Grid B7.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance	Design Life (Years)	Settlement values	
	Level		1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
No ground investigations conducted				

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	B9 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
No ground investigations conducted	

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded clayey SILT, organic clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	8.9 - 12	Very soft-stiff / loose
Sandy GRAVEL & GRAVEL	8.9 - 12	>3	Medium dense

* The soil profile is derived from one borehole (BH12) located outside of Grid B9 & CGD data.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance	Design Life (Years)	Settlement values	
	Level		1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
No ground investigations conducted				

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	C1 (R15)

Technical Category	TC3 & TC2/3
Groundwater Depth (m) (Source)	0.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH1	10.5
CPT01	6.88
CPT02	5.44

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY clayey SILT & sandy SILT; silty SAND & SAND	0	5 - 6.5	Very soft-stiff / loose
Sandy GRAVEL	5 - 6.5	>4	Medium dense - dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance		Settlement values	
	Level	Design Life (Years)	1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT01	2	50	120	100
CPT02	2	50	80	50

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	C2 (R15)

Technical Category (Description)	TC3 & TC2/3
Groundwater Depth (m) (Source)	1.0 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT03	6.34
CPT04	6.48

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Cohesion/Density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	6 - 8	Very soft - firm / very loose - loose
Sandy GRAVEL & GRAVEL	6 - 8	>7	Medium dense - very dense

* The soil profile is derived from a combination of Beca investigations, Beca interpretations of Aurecon (2012) investigations & CGD data.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT03	2	50	90	60
CPT04	2	50	90	70

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	C6 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	0.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH10	15.45
CPT34	15.14
CPT47	15.06
CPT48	14.26

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT; silty SAND & SAND with occasional lenses of PEAT	0	14 - 15+	Very soft - stiff / loose
Sandy GRAVEL	14 - 15+	>1	Dense

* The gravel layer first occurs between 14-15m across most of the grid. In the northeast of the grid (CPT47) there is no indication of the gravel layer before the CPT was terminated at 15m.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT34	2	50	240	180
CPT47	2	50	330	130
CPT48	2	50	210	160

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	C7 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	0.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT50	10.1

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	8.5 - 15+	Very soft - firm / loose
Sandy GRAVEL	8.5 - 15+	Unknown	Medium dense - dense

* Soil profile is derived from CPT46 & CPT47 located outside Grid C7 combined with CPT50. The gravel layer depth is shallowest (approximately 9.0 m bgl) at the eastern end of the grid and was not encountered in the northwest corner of the grid.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance		Settlement values	
	Level	Design Life (Years)	1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT50	2	50	160	110

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	C8 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.0 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT45	11.92
CPT46	8.68

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	8.5 - 12	Very soft - firm / loose
Sandy GRAVEL	8.5 - 12	Unknown	Medium dense - dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT45	2	50	320	170
CPT46	2	50	130	50

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	D1 (R15)

Technical Category (Description)	TC3 & TC2/3
Groundwater Depth (m) (Source)	0.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT05	6.22
CPT06	4.98

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, sandy SILT, silty SAND & SAND	0	5 - 14	Unknown
Sandy GRAVEL	5 - 14	Unknown	Medium dense - very dense

* The soil profile is derived from Beca investigations & Beca interpretations of Soil & Rock (2013) investigations.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance		Settlement values	
	Level	Design Life (Years)	1/500 (JLS, 0.35g)	1/25 (SLS, 0.13g)
CPT05	2	50	100	40
CPT06	2	50	60	50

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	D2 (R15)

Technical Category (Description)	TC3 & TC2/3
Groundwater Depth (m) (Source)	0.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT07	11.18

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	6.5 - 14.5	Soft - firm / very loose - medium dense
Sandy GRAVEL & GRAVEL	6.5 - 14.5	>1	Medium dense - very dense

* The soil profile is derived from a combination of Beca investigations & Beca interpretations of Aurecon (2012) investigations. Gravel layer was observed at shallower depths in the north of the grid.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT07	2	50	180	110

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	D3 (R15)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT08	6.42
CPT10	12.06

North Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT & silty SAND	0	2 - 4	Very soft - stiff / loose
Sandy GRAVEL	2 - 4	>2	Medium dense - dense

South & East Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	11 - 13.5	Very soft - stiff / loose
Sandy GRAVEL	11 - 13.5	Unknown	Medium dense - very dense

* The soil profile is derived from a combination of Beca investigations, Beca interpretations of Aurecon (2012) investigations & CGD data.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT08	2	50	20	0
CPT10	2	50	210	80

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	D5 (R17)

Technical Category (Description)	TC2
Groundwater Depth (m) (Source)	1.5 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH6	15.45
CPT23	2.7
CPT24	4.34
CPT31	7.56

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, sandy SILT, silty SAND & SAND	0	1 - 3	Soft - firm / loose
Sandy GRAVEL & silty GRAVEL with occasional lenses of SAND	1 - 3	>14*	Medium dense - dense

* Thickness of gravel determined from borehole. The maximum refusal of CPTs was 7.56m. Gravel should not be assumed to occur to 15m across the entire grid.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance	Design Life (Years)	Settlement values	
	Level		1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT23	2	50	20	0
CPT24	2	50	0	0
CPT31	2	50	10	5

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	D6 (R17 & R18)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.0 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT26	3.38
CPT35	9.56

West Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, sandy SILT & silty SAND	0	1.5	Very soft - firm / loose
Sandy GRAVEL	1.5	>2	Medium dense - dense

East Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	9.5 - 15	Very soft - firm / loose
Sandy GRAVEL	9.5 - 15	Unknown	Medium dense - dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT26	2	50	0	0
CPT35	2	50	160	120

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	D7 (R18)

Technical Category (Description)	TC3 and TC2/3
Groundwater Depth (m) (Source)	1.0 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH11	15.45
CPT37	5.28
CPT40	8.72
CPT43	9.1

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded organic clayey SILT, clayey SILT, SILT, sandy SILT & silty SAND with occasional lenses of PEAT	0	5 - 8.5	Very soft - firm / loose
Sandy GRAVEL with occasional layers of SAND	5 - 8.5	>6	Dense - very dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT37	2	50	90	40
CPT40	2	50	160	90
CPT43	2	50	110	60

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	D8 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.0 (GNS Median Depth to Water Table)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT42	7.3
CPT44	15

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT & sandy SILT with occasional layers of silty SAND & SAND	0	7 - 15+	Very soft-firm / loose
Sandy GRAVEL with occasional layers of SAND	7 - 15+	Unknown	Medium dense - very dense

* The gravel layer is shallowest (approximately 7m bgl) in the east of the grid and was not encountered in the west of the grid.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT42	2	50	50	40
CPT44	2	50	300	210

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	E2 (R15)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT11	14.74
CPT14	14.32

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT.	0	14.0 - 14.5	Unknown
GRAVEL	14.0 - 14.5	Unknown	Unknown

* The soil profile is derived from a combination of Beca investigations & Beca interpretations of Aurecon (2012) investigations.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (JLS, 0.35g)	1/25 (SLS, 0.13g)
CPT11	2	50	240	60
CPT14	2	50	350	90

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	E3 (R15)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT12	12.12
CPT13	15

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT.	0	12 - 15+	Firm / very loose - medium dense
Sandy GRAVEL	12 - 15+	>3.5	Dense - very dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT12	2	50	220	90
CPT13	2	50	260	150

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	E5 (R17)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH7	15.45
BH8	15.45
CPT25	3.76
CPT27	6
CPT28	1.86

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of peat.	0	1 - 5	Soft - stiff / very loose - loose
Sandy GRAVEL with occasional lenses of gravelly SAND*	1 - 5	1.5 - 5.5	Medium dense - very dense
Interbedded clayey SILT, SILT, sandy SILT, silty SAND, SAND & PEAT	6.5	6.5 - 8.5+	Very soft - stiff / loose - medium dense
Sandy GRAVEL	13 - 15+	>2.5	Medium dense - dense

* The shallow gravel layer is absent in a small area along the western boundary of the grid.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT25	2	50	5	0
CPT27	2	50	50	5
CPT28	2	50	0	0

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	E6 (R17 & R18)

Technical Category (Description)	TC3, TC2 & TC2/3
Groundwater Depth (m) (Source)	1.0 (Beca CPT)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH9	15.45
CPT29	4.16
CPT36	8.94

West Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, sandy SILT & silty SAND	0	0.5 - 2	Very soft - firm / loose
Sandy GRAVEL with occasional lenses of sand	1.5	3.5+	Medium dense - dense

East Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded clayey SILT, SILT & silty SAND	0	8 - 8.5	Very soft - firm / loose
Sandy GRAVEL	8 - 8.5	4	Medium dense
SAND	12	1.5	Medium dense
Sandy GRAVEL	13.5	>2	Dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance		Settlement values	
	Level	Design Life (Years)	1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT29	2	50	0	0
CPT36	2	50	130	70

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	E7 (R18)

Technical Category (Description)	TC3 & TC2/3
Groundwater Depth (m) (Source)	1.25 (Beca CPT)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT38	4.3
CPT39	8.92

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT & silty SAND	0	4.5 - 8.5	Very soft - firm / loose
Sandy GRAVEL with occasional layers of SAND	4.5 - 8.5	Unknown	Medium dense - dense

* Shallow gravel layer encountered at the western side of the grid at a depth of 4m . The extent of the layer is unknown, although depth of gravel is observed as 8m (BH09) less than 100m west in Grid E6.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT38	2	50	40	20
CPT39	2	50	130	90

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	E8 (R18)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.0 (Beca CPT)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT41	15

Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	15+	Very soft - stiff / loose - medium dense

* The soil profile model is derived from a single CPT (CPT41).

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT41	2	50	350	300

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	F3 (R15)

Technical Category (Description)	TC3
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH2	15.45
CPT15	15
CPT16	15

Northwest Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Cohesion/Density
Interbedded clayey SILT, SILT, sandy SILT; silty SAND, SAND and PEAT	0	7	Soft - firm / loose
Sandy GRAVEL	7	3.5	Medium dense
Interbedded layers of clayey SILT, organic clayey SILT; Silty SAND, SAND and PEAT.	10.5	3.5	Firm / loose
Sandy GRAVEL	14	1+	Dense

Central Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	10	Very soft - firm / loose
SAND	10	2	Loose - medium dense
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND	12	4	Unknown
GRAVEL	16	Unknown	Dense

* The soil profile is derived from Beca investigations & CGD CPT data.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT15	2	50	270	180
CPT16	2	50	220	90

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	F3 (R16)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT17	9.26

Central Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	10	Very soft - firm / loose
SAND	10	2	Loose - medium dense
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND	12	4	Unknown
GRAVEL	16	Unknown	Dense

* The soil profile is derived from Beca investigations combined with CGD CPT data.

Southeast Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Cohesion/Density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND, SAND & occasional lenses of PEAT	0	7	Very soft - firm / loose
SAND (potential GRAVEL)	7	>2.5	Medium dense - dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT17	2	50	90	60

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	F4 (R16)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
No ground investigations conducted	

West Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT silty SAND & SAND with occasional lenses of PEAT	0	15+	Soft - stiff / loose - medium dense
SAND & silty SAND	10	2	Loose - medium dense

* The soil profile is derived from Beca interpretations of Aurecon (2011) investigations.

East Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	2 - 5	Soft - stiff / loose
Interbedded GRAVEL, sandy GRAVEL, silty sandy GRAVEL & gravelly SAND	2 - 5	>1.7	Medium dense - very dense

* The soil profile is derived from Beca interpretations of Aurecon (2011) investigations.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (JLS, 0.35g)	1/25 (SLS, 0.13g)
No ground investigations conducted				

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	F5 (R16)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH4	15.45
CPT22	8.2

West Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	4	Soft - firm / very loose - medium dense
Sandy GRAVEL & GRAVEL	4	10	Loose - medium dense
Interbedded organic clayey SILT, SILT, sandy SILT & PEAT	10	5+	Firm - stiff / loose - medium dense

East Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND & PEAT	0	8	Very soft - firm / very loose - loose
GRAVEL	8	Unknown	Medium dense - dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance		Settlement values	
	Level	Design Life (Years)	1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT22	2	50	170	120

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	F5 (R17)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT30	1.5
CPT33	10.24

North Generalised Soil Profile			
Ground Materials*	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	1.2 - 2.6	Very soft - firm / very loose - loose
Sandy GRAVEL	1.2 - 2.6	3.4	Medium dense - very dense
Interbedded organic clayey SILT, clayey SILT, SILT, SAND & PEAT	6	9+	Very soft - stiff / loose - medium dense

* The soil profile is derived from Beca investigations & Beca interpretations of Aurecon (2010) investigations.

Southeast Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, SILT, sandy SILT, silty SAND, SAND & PEAT	0	10	Very soft - firm / very loose - loose
GRAVEL	10	Unknown	Dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance		Settlement values	
	Level	Design Life (Years)	1/500 (JLS, 0.35g)	1/25 (SLS, 0.13g)
CPT30	2	50	0	0
CPT33	2	50	200	130

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	F6 (R17 & R18)

Technical Category (Description)	TC3, TC2 & TC2/3
Groundwater Depth (m) (Source)	1.5 (closest grids)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
CPT32	7

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded SILT, sandy SILT & clayey SILT; silty SAND	0	7	Very soft - firm / loose
Sandy GRAVEL	7	>0.5	Medium dense - dense

* The soil profile is derived from a single CPT (CPT32) located inside grid F6.

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance	Design Life (Years)	Settlement values	
	Level		1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT32	2	50	100	70

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	G3 (R16)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH5	15.45
CPT18	5.18
CPT19	4.62
CPT20	6.94

Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded clayey SILT, SILT, sandy SILT, silty SAND & SAND with occasional lenses of PEAT	0	4 - 7	Soft - stiff / loose
Sandy GRAVEL	4 - 7	>1	Medium dense - dense
Interbedded organic SILT, clayey SILT, sandy SILT, silty SAND, SAND & PEAT	10	5+	Firm - stiff / loose - medium dense

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance Level	Design Life (Years)	Settlement values	
			1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT18	2	50	70	20
CPT19	2	50	50	20
CPT20	2	50	70	20

Job Name	CCC Halswell ODP Geotechnical Investigation
Date	7/03/2014
Grid Reference (Area)	G4 (R16)

Technical Category (Description)	TC3 & TC2
Groundwater Depth (m) (Source)	1.5 (ECan Wells)

Summary of Investigations	
Reference ID	Depth of Investigation (m)
BH3	15.45
CPT21	1.1

West Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded CLAY, silty CLAY, clayey SILT, sandy SILT, SILT, silty SAND, SAND & gravelly SAND with occasional PEAT layers	0	1.1 - 6	Soft - stiff / loose
Sandy GRAVEL & silty sandy GRAVEL	1.1 - 6	>1.4	Loose - dense

East Generalised Soil Profile			
Ground Materials	Approximate Depth to Top of Unit (m)	Thickness (m)	Consistency/ Relative density
Interbedded clayey SILT, SILT, sandy SILT, silty SAND & SAND	0	7 - 10	Very soft - firm / loose
Sandy GRAVEL with occasional lenses of SAND	7 - 10	3 - 6	Dense
Clayey SILT, SILT, sandy SILT, silty SAND, SAND & Peat	14	1+	Very soft - soft / loose

Summary of Estimated Liquefaction Induced Settlements				
ID	Importance		Settlement values	
	Level	Design Life (Years)	1/500 (ULS, 0.35g)	1/25 (SLS, 0.13g)
CPT21	2	50	0	0



Technical Categories Maps



Legend

□ LURP Zones

DBH Equivalent Technical Categories

- TC2 Minor to moderate land damage from liquefaction is possible in future significant earthquakes
- TC3 Moderate to significant land damage from liquefaction is possible in future significant earthquakes
- TC2/3 As above

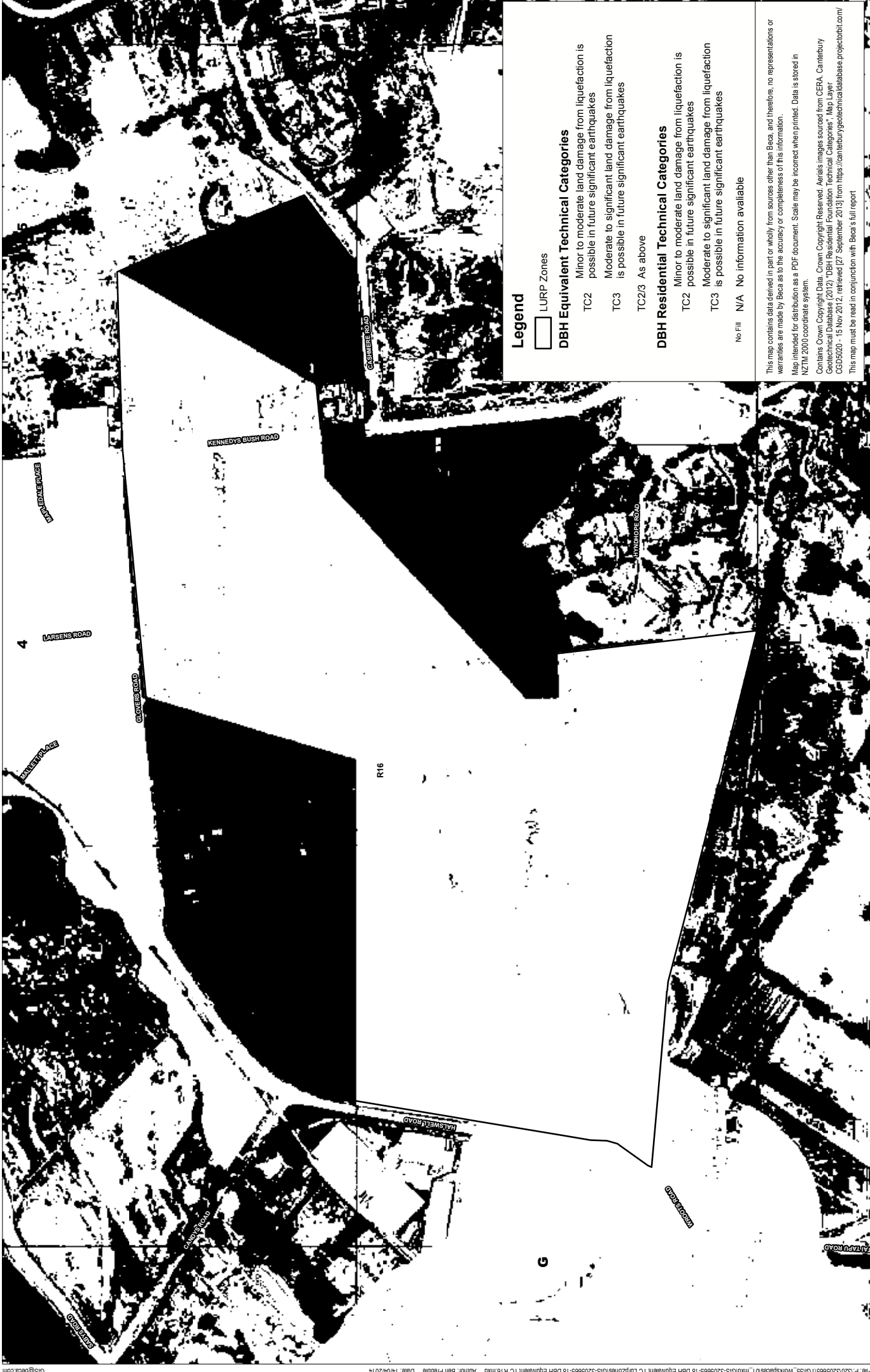
DBH Residential Technical Categories

- TC2 Minor to moderate land damage from liquefaction is possible in future significant earthquakes
- TC3 Moderate to significant land damage from liquefaction is possible in future significant earthquakes

No Fill N/A No information available

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 This map must be read in conjunction with Beca's full report

	Client: Christchurch City Council Project: CCC Halswell ODP Geotechnical Investigations	Discipline: GIS Drawing No: GIS-3205665-18
	LURP Zones with DBH Equivalent Technical Category CCC Halswell ODP R15 Zone Map	
	Title:	Date:
Map Scale @ A3: 1:6,000 	Author:	Date:
Revision:	Written:	Approved:
T	RL BAP	SVJ
14/04/2014	14/04/2014	14/04/2014



Legend

□ LURP Zones

DBH Equivalent Technical Categories

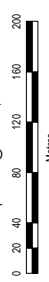
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Map Scale @ A3: 1:3,000



Revision	Author	Writer	Approved	Date
1	RL	BAP	SCV	30/03/14

Title:
LURP Zones with DBH Equivalent Technical Category
CCC Halswell ODP
R16 Zone Map

Client:
 Christchurch City Council

Project:
 CCC Halswell ODP
 Geotechnical Investigations



Discipline:
 GIS

Drawing No.:
 GIS-3205665-18



Legend

LURP Zones

DBH Equivalent Technical Categories

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- TC3 Moderate to significant land damage from liquefaction is possible in future significant earthquakes
- TC2/3 As above

Port Hills Zones DBH Technical Category does not apply

DBH Residential Technical Categories

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		Discipline: GIS											
		Drawing No: GIS-3205665-18											
LURP Zones with DBH Equivalent Technical Category CCC Halswell ODP R17 Zone Map		Client: Christchurch City Council	Project: CCC Halswell ODP Geotechnical Investigations										
		Title:											
Map Scale @ A3: 1:4,000													
0 25 50 100 150 200 250 Metres		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Revision</th> <th>Author</th> <th>Writer</th> <th>Approved</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>RL</td> <td>BAP</td> <td>SVJ</td> <td>09/02/14</td> </tr> </tbody> </table>		Revision	Author	Writer	Approved	Date	1	RL	BAP	SVJ	09/02/14
Revision	Author	Writer	Approved	Date									
1	RL	BAP	SVJ	09/02/14									



Legend

□ LURP Zones

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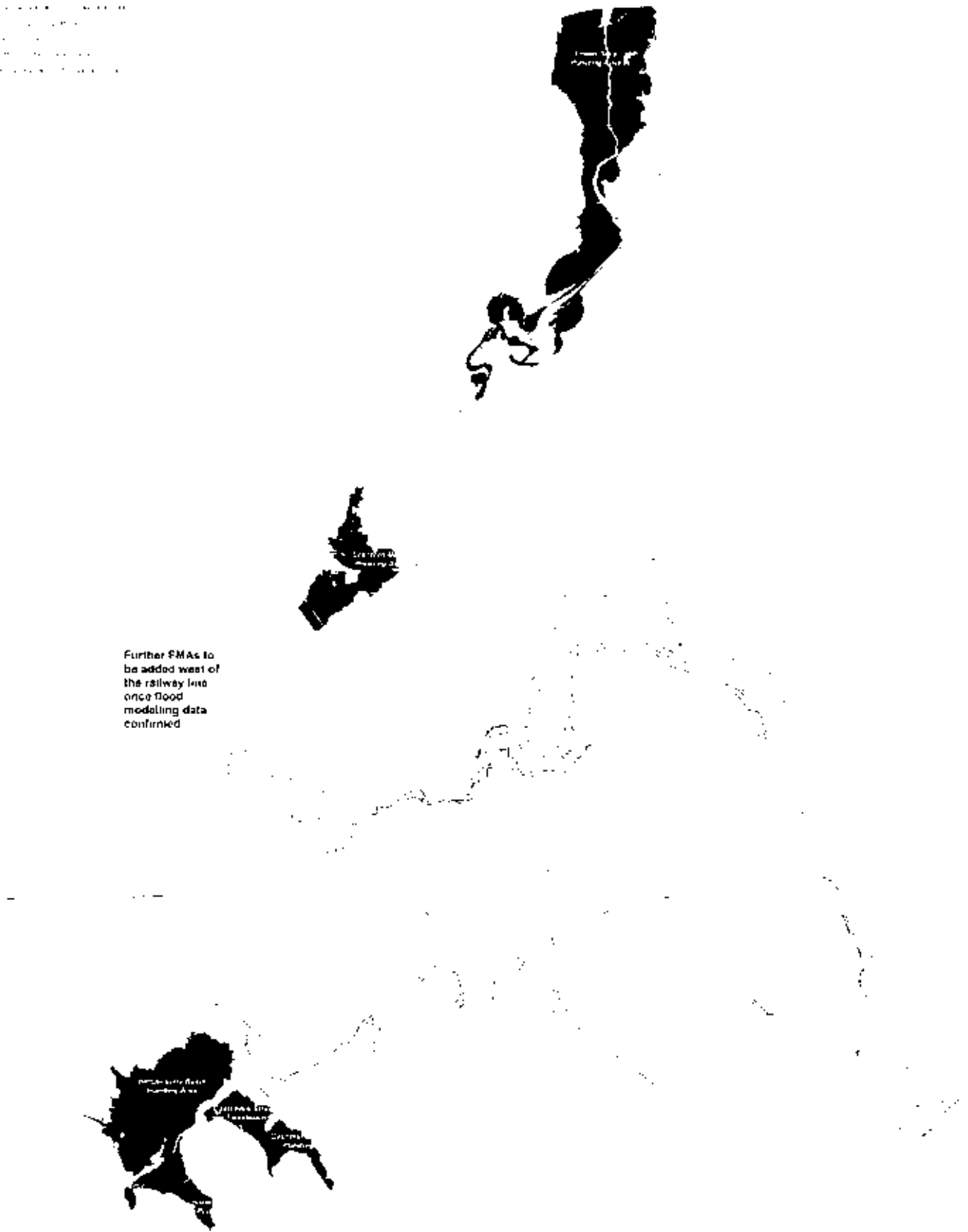
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	<p>Map Scale @ A3: 1:8,000</p> <p style="text-align: right;">Metres</p>	<p>+</p>	<p>Title:</p> <p>LURP Zones with DBH Equivalent Technical Category CCC Halswell ODP R18 Zone Map</p>	<p>Client:</p> <p>Christchurch City Council</p>	<p>Discipline:</p> <p>GIS</p>
	<p>Project:</p> <p>CCC Halswell ODP Geotechnical Investigations</p>	<p>Drawing No.:</p> <p>GIS-3205665-18</p>			

Flood Risk

Figure 10

- Legend
- Existing FMA
- Proposed FMA
- Proposed FMA to be added west of the railway line once flood modeling data confirmed
- Water
- Land
- Urban
- Road
- Railway
- Watercourse
- Boundary
- Other





Legend

Existing Flood Management Area (FMA)



Zone Number

- R15
- R16
- R17
- R18

Watercourses (CCC)

Official

Unofficial

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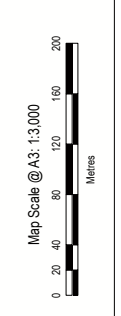
Discipline: GIS
 Drawing No: GIS-3205665-19



Client: Christchurch City Council
 Project: CCC Halswell ODP
 Geotechnical Investigations

**Existing Flood Management Area
 CCC Halswell ODP
 R16 Zone Map**

Revision	Author	Writer	Approved	Date	Title:
1	RL	BAP	MMP	09/02/14	





Legend

Existing Flood Management Area (FMA)

Zone Number

R15
R16
R17
R18

Watercourses (CCC)

Official
Unofficial

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Existing Flood Management Area
CCC Halswell ODP
R17 Zone Map

Title:

Revision	Author	Writer	Approved	Date
1	RL	BAP	MMP	09/02/14

Client: Christchurch City Council
Project: CCC Halswell ODP Geotechnical Investigations

Discipline: GIS
Drawing No.: GIS-3205665-19

Map Scale @ A3: 1:4,000

Metres

Becca



Legend

Existing Flood Management Area (FMA)

Zone Number

- R15
- R16
- R17
- R18

Watercourses (CCC)

- Official
- Unofficial

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Existing Flood Management Area
CCC Halswell ODP
R18 Zone Map

Client: Christchurch City Council

Project: CCC Halswell ODP
Geotechnical Investigations

Revision

Revision	Author	Written	Approved	Date
1	RL	BAP	MMP	09/02/14

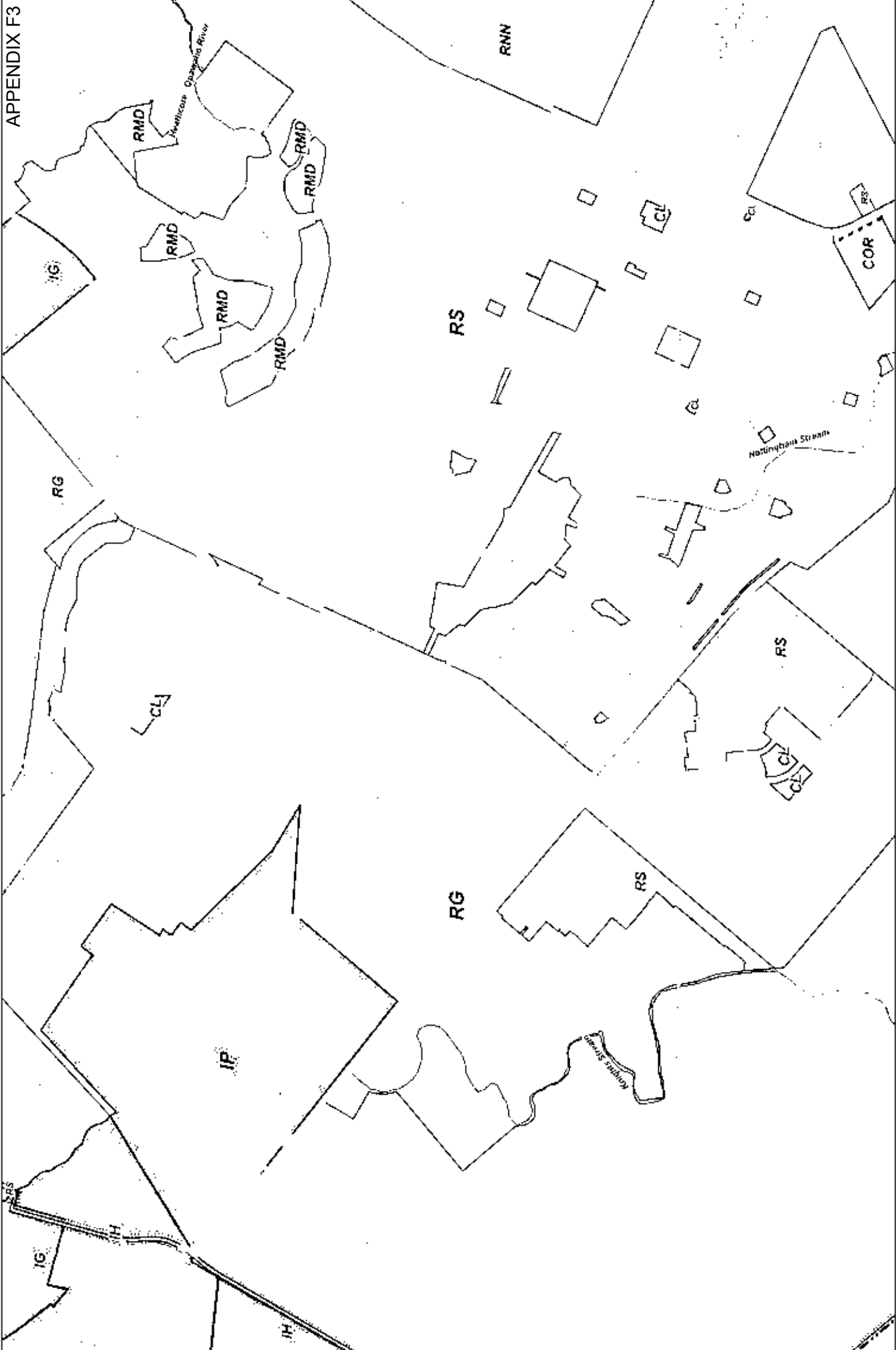
Title:

Map Scale @ A3: 1:8,000

Metres

Discipline: GIS

Drawing No.: GIS-3205665-19



Draft Map 44

PLANNING ZONES

CBP	Commercial Banks Peninsula
COR	Commercial Core
CF	Commercial Fringe
CL	Commercial Local
CRP	Commercial Rural Park
TG	Industrial General
PH	Industrial Heavy
IPX	Industrial Park
RBP	Residential Banks Peninsula
RC	Residential Conservation
RG	Residential Greenfield
RG*	Residential Guest Accommodation
RMD	Residential Medium Density
RNN	Residential New Neighbourhood
RS	Residential Suburban

OTHER NOTATIONS

	Easting Rural Humlet
	Medium Density Higher Height Limit and Side Density
	Office Park Policy Overlay
	Park Ground Condition Constraint
	Precinct Road Overlay
	Residential Suburban Density Overlay
	Residential Suburban Redwood
	Stormwater Capacity Constraint
	Urban Function Assessment Area 1
	Urban Function Assessment Area 2
	Cliff Hazard Management Area
	Rockfall Hazard Management Area 1
	Rockfall Hazard Management Area 2
	Mass Movement Hazard Management Area 1 (subject to ongoing investigation report due in May 2014 to relevant authorities)
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	Mass Movement Hazard Management Area 3
	Remainder of Pot Holes and Bumps Pursuing Slope Instability Management Area
	Flood Management Area (FMA)
	Free Minimum Floor Level Overlay
	Flood Ponding

	Wairakau River Floodplain High Hazard
	Wairakau River Stopbank Floodplain
	Wairakau River Stopbank Setback
	Key Pedestrian Frontage
	Commercial Housing Redevelopment Mooring
	Lidleton Port Influences Overlay Area
	Air Noise Corridor (SDBA Limit) approved through the Land Use Recovery Plan

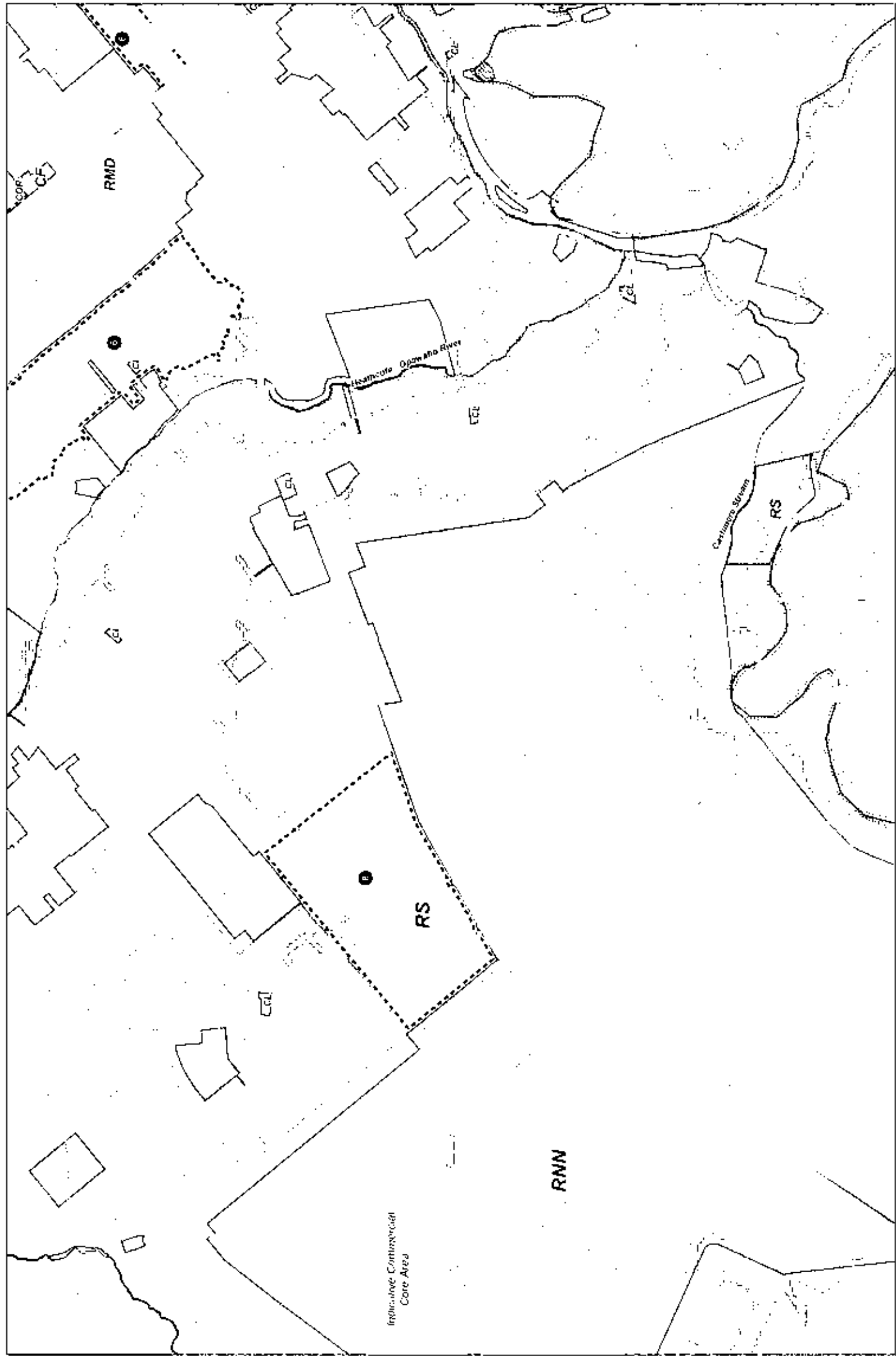
INFORMATION ONLY

	Christchurch District Boundary
	Area Outside Christchurch District Boundary
	CERA Residential Red Zone (October 2011) not being reviewed in this round of notification
	Phase 1a1 Review Area
	Railway
	Hazard Line 1 (Coastal)
	Major Arterial Road
	Minor Arterial Road
	Proposed Major Arterial Road
	River

The cadastral and coastline shown on the planning maps is not part of the information in the District Plan. It has been provided on the planning maps as an additional function to enhance navigability and search capability. The cadastral was based on the most recent information held by the Council at the date the map was produced.

Establishing compliance or otherwise with the plan may require a formal survey.

CCC planning maps and data are designed to be viewed at a scale of 1:10000. The accuracy of any layer cannot be guaranteed at large scale.



PLANNING ZONES

[CBP]	Commercial Banks Peninsula
[COR]	Commercial Core
[CF]	Commercial Fringe
[CL]	Commercial Local
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[IG]	Industrial General
[IH]	Industrial Heavy
[IPX]	Industrial Park
[RBP]	Residential Banks Peninsula
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[RG]	Residential Greenfield
[RGA]	Residential Guest Accommodation
[RMD]	Residential Medium Density
[RNN]	Residential New Neighbourhood
[RS]	Residential Suburban

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[1]	Easting Rural Humlet
[2]	Medium Density Higher Height Limit and Side Density
[3]	Office Park Policy Overlay
[4]	Park Ground Condition Constraint
[5]	Precinct Road Overlay
[6]	Residential Suburban Density Overlay
[7]	Residential Suburban Redwood
[8]	Stormwater Capacity Constraint
[9]	Urban Function Assessment Area 1
[10]	Urban Function Assessment Area 2
[11]	Cliff Hazard Management Area
[12]	Rockfall Hazard Management Area 1
[13]	Rockfall Hazard Management Area 2
[14]	Mass Movement Hazard Management Area 1 (subject to ongoing review/policy report due in May 2014 to review boundaries)
[15]	Mass Movement Hazard Management Area 2
[16]	Mass Movement Hazard Management Area 3
[17]	Remainder of Pot Holes and Bumps Pursuing Slope Instability Management Area
[18]	Flood Management Area F15A1
[19]	Free Minimum Floor Level Overlay
[20]	Flood Ponding

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	Wairakauri River Stopbank Floodplain
	Wairakauri River Stopbank Setback
	Key Pedestrian Frontage
	Coastal Housing Redevelopment Mooring
	Lidleton Port Influences Overlay Area
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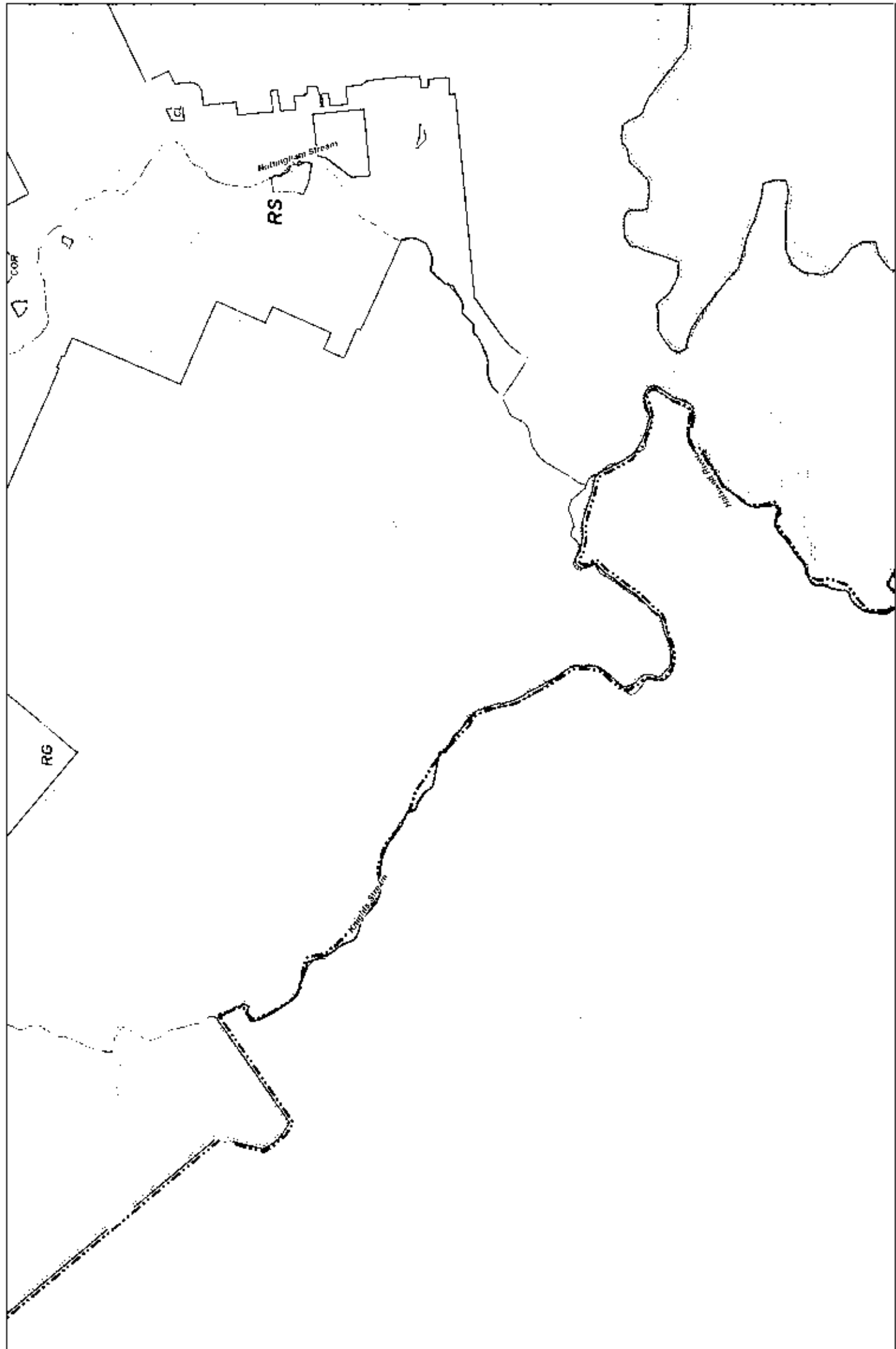
INFORMATION ONLY

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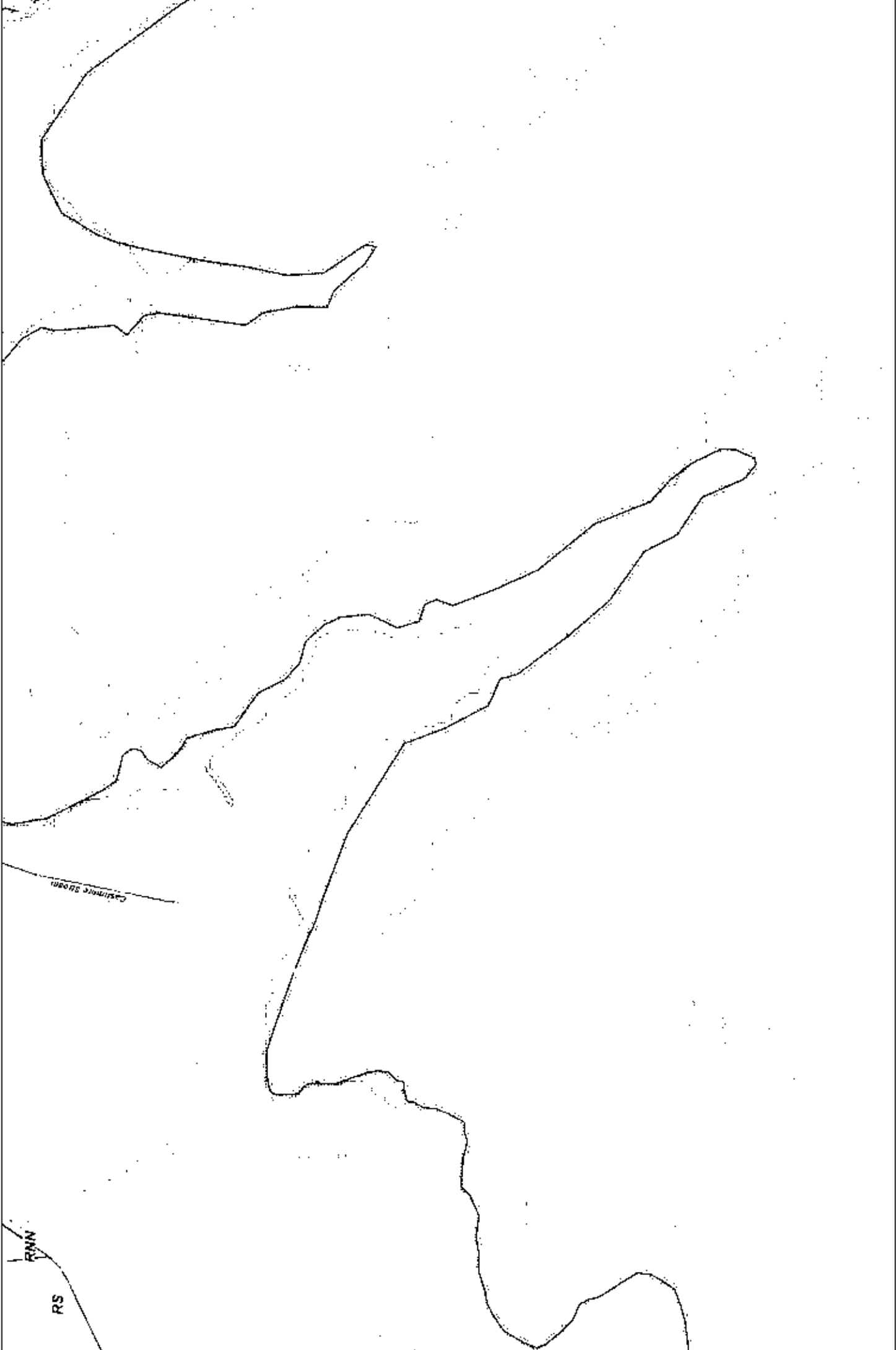
INFORMATION ONLY

	Christchurch District Boundary
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	Railway
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	Main Arterial Road
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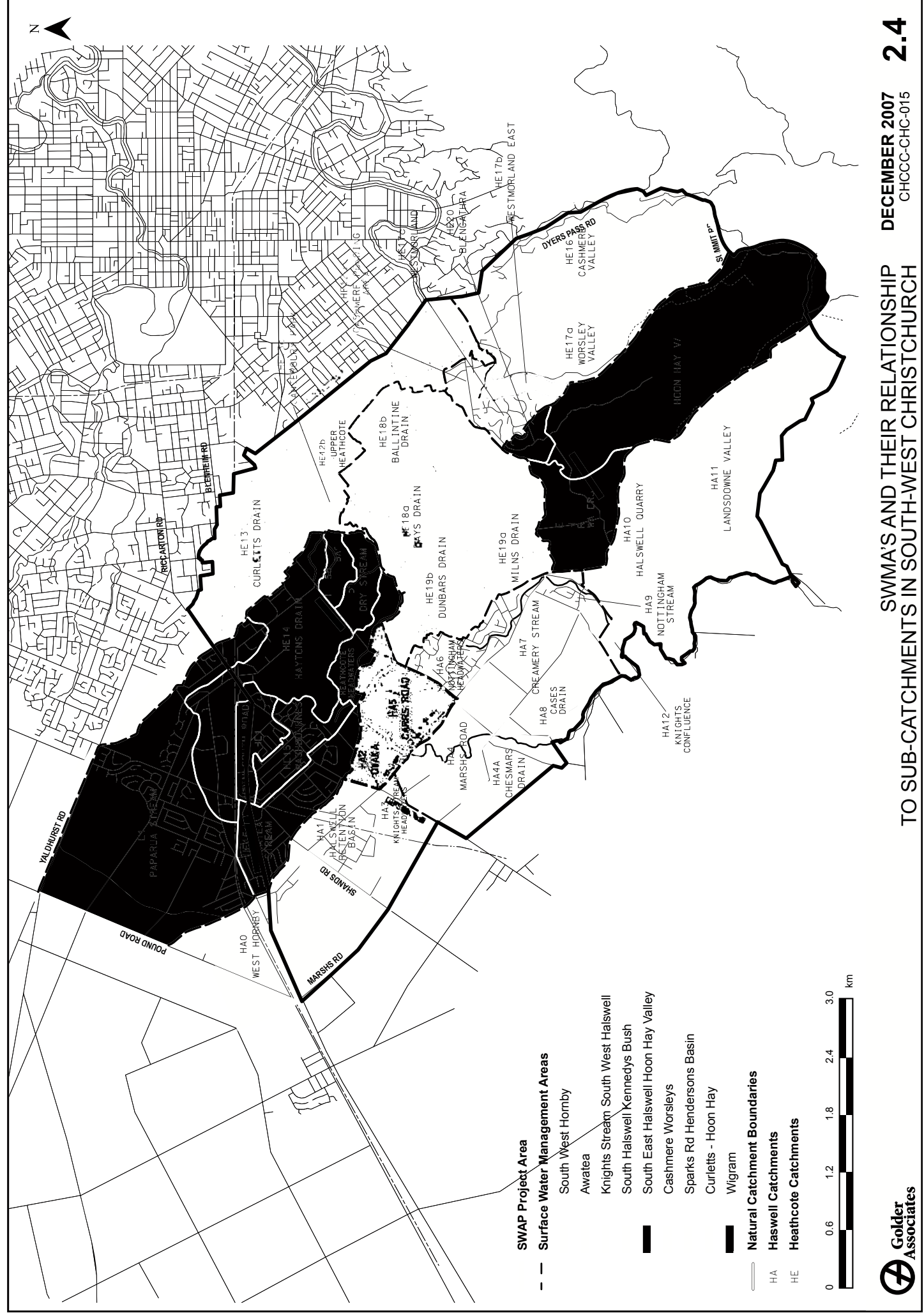
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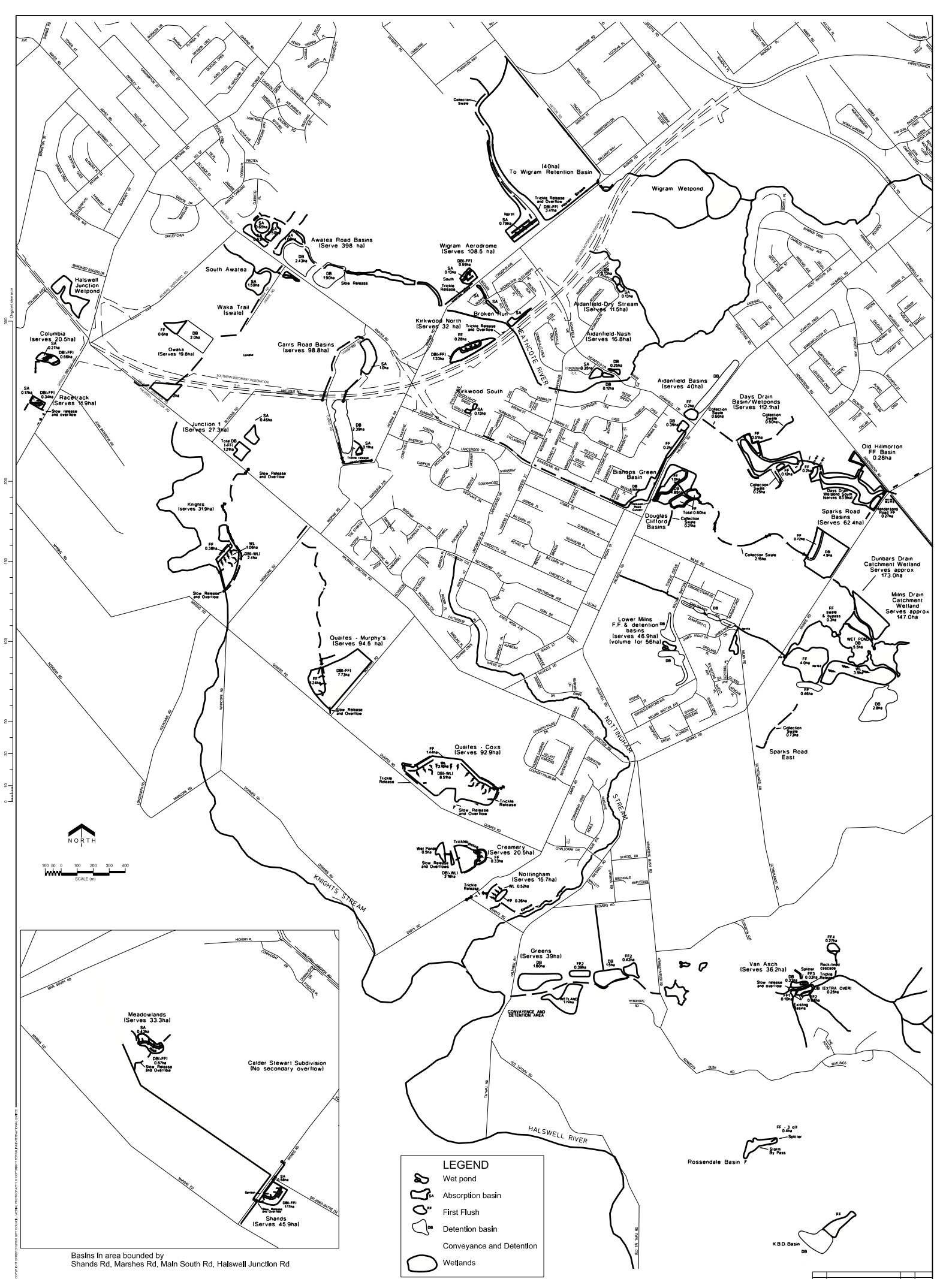
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Basins in area bounded by Shands Rd, Marshes Rd, Main South Rd, Halswell Junction Rd

LEGEND

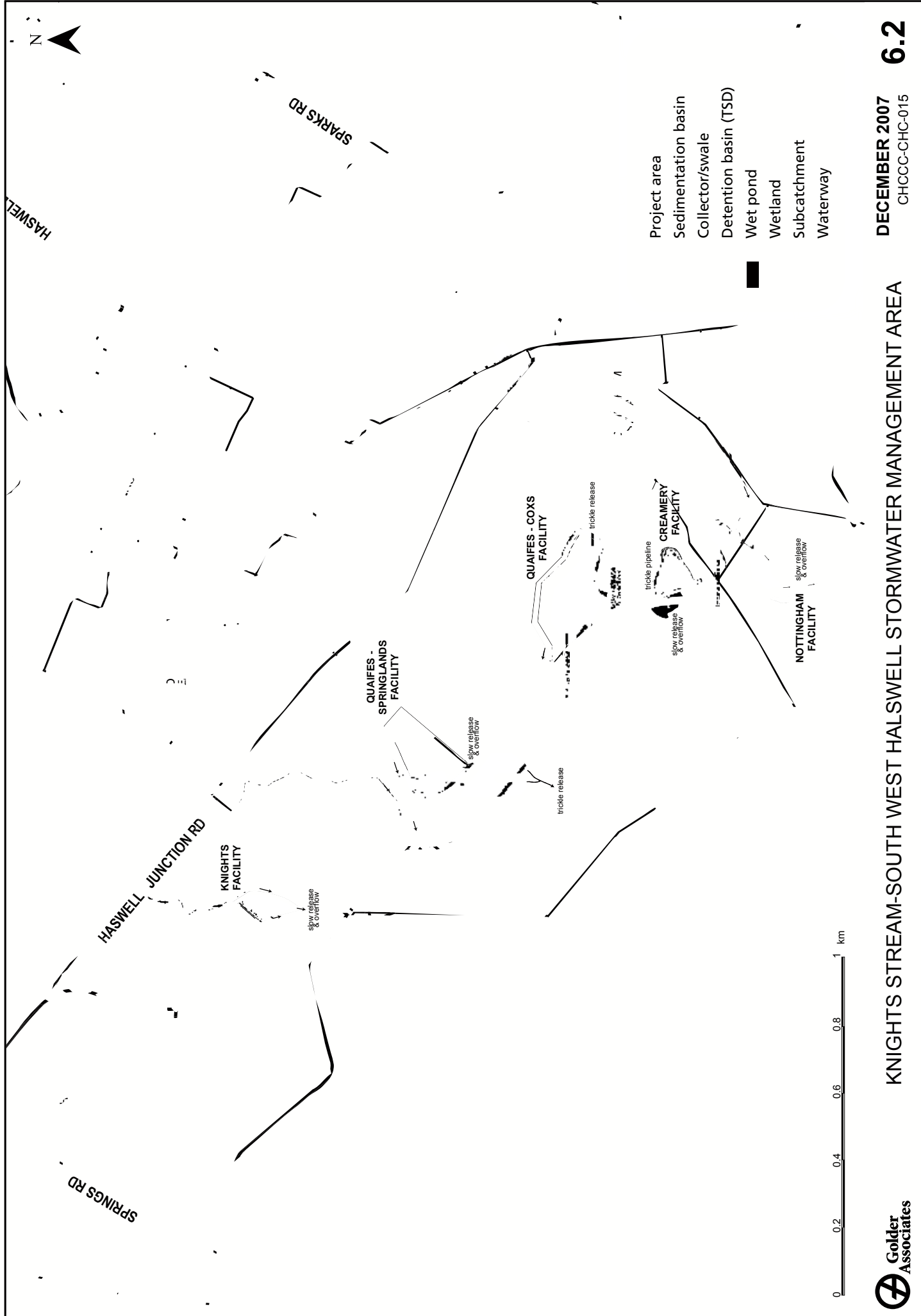
- Wet pond
- Absorption basin
- First Flush
- Detention basin
- Conveyance and Detention
- Wetlands

NO.	CODE	NAME	DATE	APPROVED FOR
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2	DCR/2014/11	REVISION 2	11/10/2014	DATE SERVED
3	DCR/2014/12	REVISION 3	12/10/2014	FOR CONSTRUCTION
4	DCR/2014/13	REVISION 4	13/10/2014	DATE SERVED
5	DCR/2014/14	REVISION 5	14/10/2014	FOR CONSTRUCTION
6	DCR/2014/15	REVISION 6	15/10/2014	DATE SERVED
7	DCR/2014/16	REVISION 7	16/10/2014	FOR CONSTRUCTION
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66	DCR/2014/75	REVISION 66	31/10/2014	DATE SERVED
67	DCR/2014/76	REVISION 67	31/10/2014	FOR CONSTRUCTION
68	DCR/2014/77	REVISION 68	31/10/2014	DATE SERVED
69	DCR/2014/78	REVISION 69	31/10/2014	FOR CONSTRUCTION
70	DCR/2014/79	REVISION 70	31/10/2014	DATE SERVED
71	DCR/2014/80	REVISION 71	31/10/2014	FOR CONSTRUCTION
72	DCR/2014/81	REVISION 72	31/10/2014	DATE SERVED
73	DCR/2014/82	REVISION 73	31/10/2014	FOR CONSTRUCTION
74	DCR/2014/83	REVISION 74	31/10/2014	DATE SERVED
75	DCR/2014/84	REVISION 75	31/10/2014	FOR CONSTRUCTION
76	DCR/2014/85	REVISION 76	31/10/2014	DATE SERVED
77	DCR/2014/86	REVISION 77	31/10/2014	FOR CONSTRUCTION
78	DCR/2014/87	REVISION 78	31/10/2014	DATE SERVED
79	DCR/2014/88	REVISION 79	31/10/2014	FOR CONSTRUCTION
80	DCR/2014/89	REVISION 80	31/10/2014	DATE SERVED
81	DCR/2014/90	REVISION 81	31/10/2014	FOR CONSTRUCTION
82	DCR/2014/91	REVISION 82	31/10/2014	DATE SERVED
83	DCR/2014/92	REVISION 83	31/10/2014	FOR CONSTRUCTION
84	DCR/2014/93	REVISION 84	31/10/2014	DATE SERVED
85	DCR/2014/94	REVISION 85	31/10/2014	FOR CONSTRUCTION
86	DCR/2014/95	REVISION 86	31/10/2014	DATE SERVED
87	DCR/2014/96	REVISION 87	31/10/2014	FOR CONSTRUCTION
88	DCR/2014/97	REVISION 88	31/10/2014	DATE SERVED
89	DCR/2014/98	REVISION 89	31/10/2014	FOR CONSTRUCTION
90	DCR/2014/99	REVISION 90	31/10/2014	DATE SERVED
91	DCR/2014/100	REVISION 91	31/10/2014	FOR CONSTRUCTION

SOUTH WEST AREA

PROPOSED BASIN AND STORMWATER SYSTEM

PROJECT NO.	SCALE	DATE
DC1019101	A1	A1 1:10,000 A3 1:20,000
CP500000	1	1 OF 1



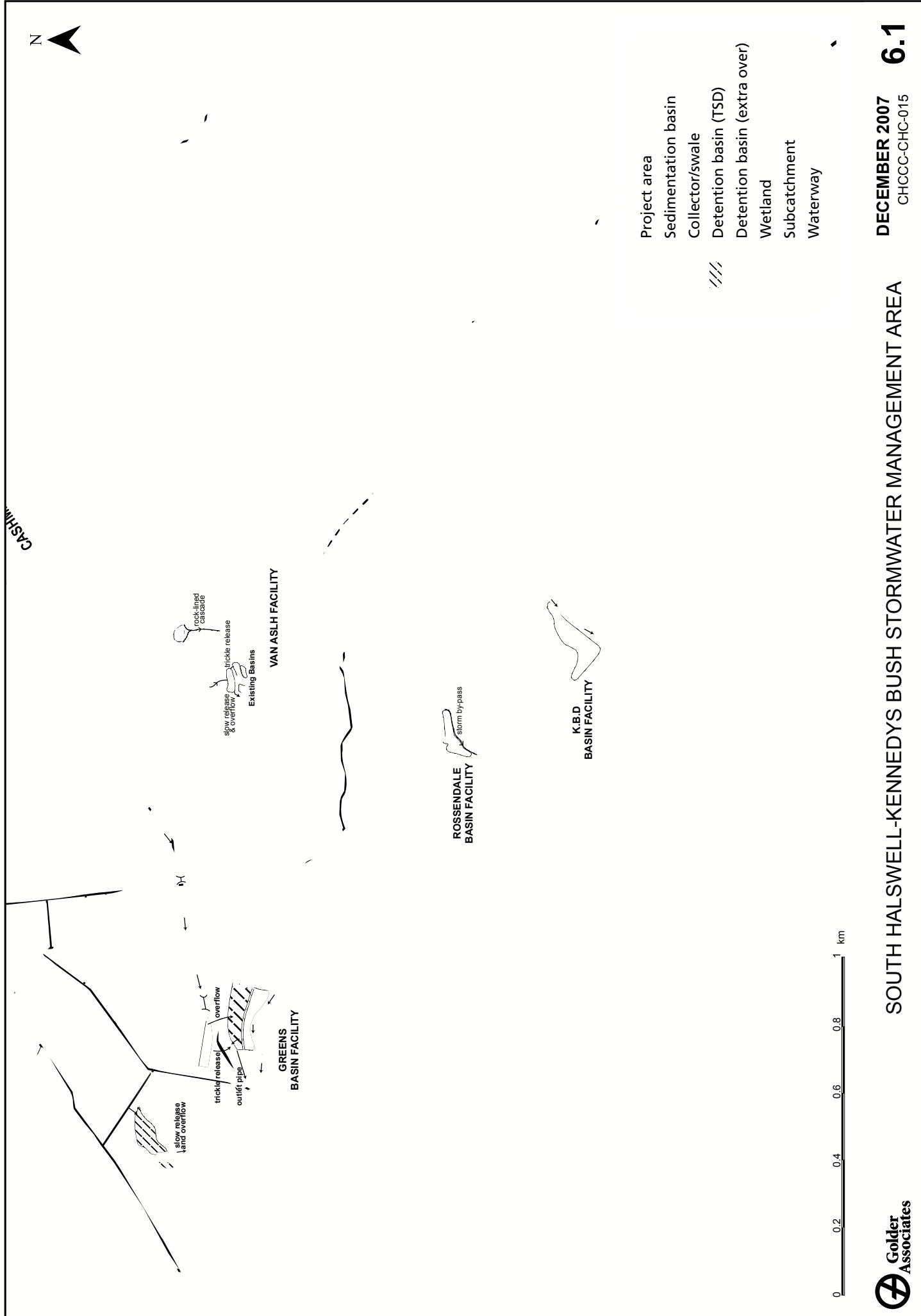
- Project area
- Sedimentation basin
- Collector/swale
- Detention basin (TSD)
- Wet pond
- Wetland
- Subcatchment
- Waterway



KNIGHTS STREAM-SOUTH WEST HALSWELL STORMWATER MANAGEMENT AREA

DECEMBER 2007
CHCCC-CHC-015

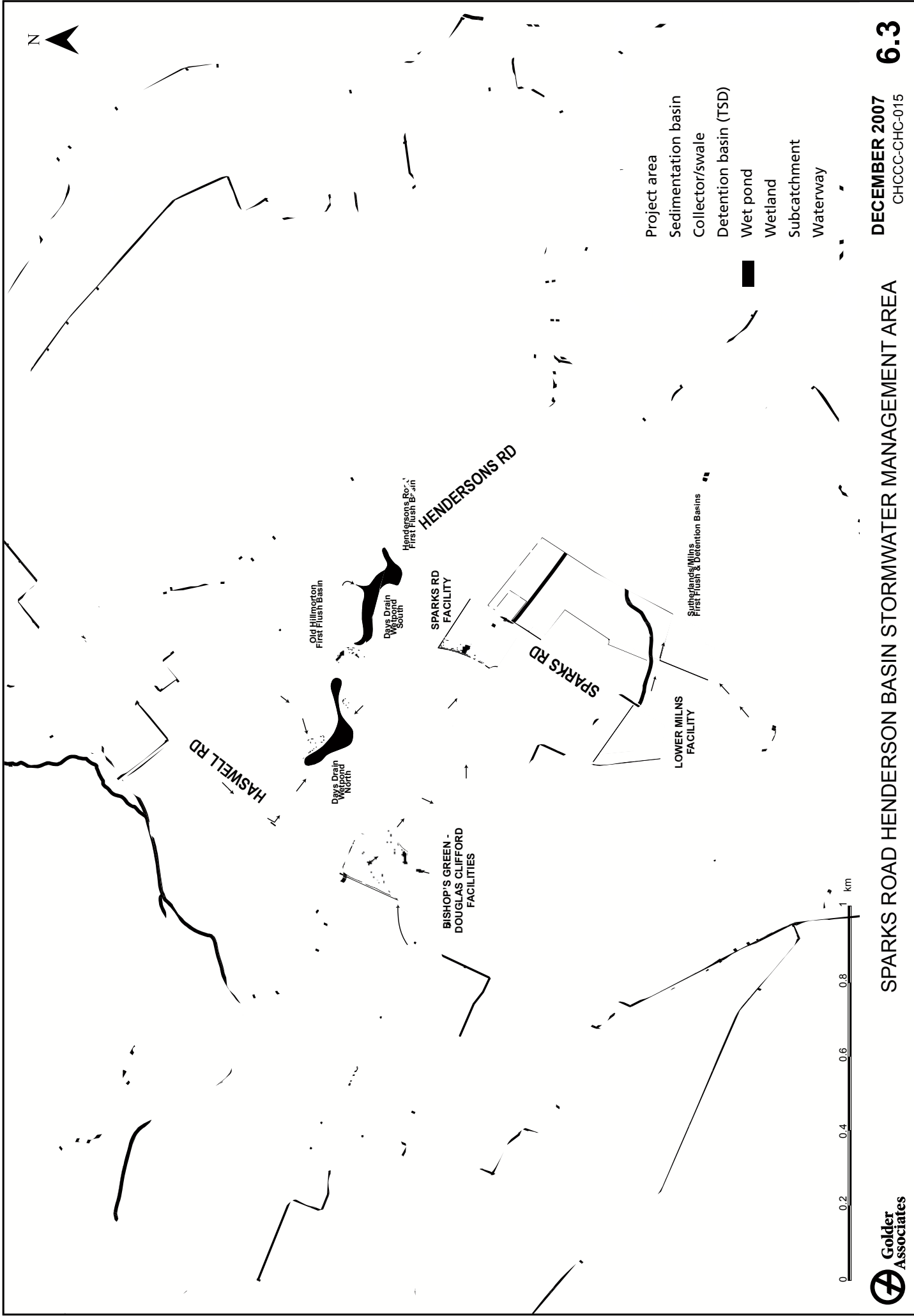
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- Project area
- Sedimentation basin
 - Collector/swale
 - Detention basin (TSD)
 - Detention basin (extra over)
 - Wetland
 - Subcatchment
 - Waterway



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- Project area
- Sedimentation basin
- Collector/swale
- Detention basin (TSD)
- Wet pond
- Wetland
- Subcatchment
- Waterway



SPARKS ROAD HENDERSON BASIN STORMWATER MANAGEMENT AREA

DECEMBER 2007
CHCCC-CHC-015

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