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Project Number #24496.000.001

Geotechnical Investigation

144 & 170 Main North Road, Kaiapoi, Canterbury

Submitted to:
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Client	Balance Developments Ltd		**Client Contact**	Chris Fowler	
Distribution (PDF)	Chris Fowler				
Date	**Revision**	**Description**	**Author**	**Reviewer**	**WP**
23/02/2024	0	Draft	JM/NN	NC	JT
05/03/2024	1	Issued to Client	NN	NC	JT

1 Introduction and Background

1.1 Introduction

ENGEO Ltd was requested by Saunders and Co on behalf of Balance Developments Ltd to undertake a geotechnical investigation for the site at 144 & 170 Main North Road, Kaiapoi, Canterbury (herein referred to as 'the site'). The purpose of the assessment was to inform the plan change application to rezone the site from rural to medium density residential. This work has been carried out in accordance with our signed agreement dated 16 November 2023 (P24496).

Our scope of works was as follows:

- A review of published geotechnical and geological information relevant to the site.
- Site assessment by an experienced ground engineering professional.
- Completion of eight hand augers with associated Scala penetrometer and shear vane testing as appropriate.
- Organisation and technical supervision of 15 Cone Penetrometer Tests (CPTs) to a target depth of 15 m.
- Analysis of field data and production of a geological site model.
- Production of this geotechnical report based on the findings of our enquiries and ground investigation, including broad indication of concept remediation strategies or foundation solutions to address relevant geohazards.

Our scope of works does not include geotechnical investigations suitable to support resource, subdivision or building consent.

1.2 Site Description and Proposed Development

The site comprises approximately 14 ha of rural land across two legal lots. 144 Main North Road is legally defined as LOT 1 DP19366 BLK XV RANGIORA SD. 170 Main North Road is legally defined as PT RS 37428 RS 38486 39673 SP 17086 BLK BLK XV RANGIORA SD. The site is currently used as agricultural grazing paddocks, with 144 Main North Road containing a dwelling and associated out buildings.

The site is relatively flat and is bound by Kaikainui Stream to the north, Courtenay Stream to the south, Main North Road to the west, and an elevated railway line (Main North Line) to the east. A portion of the site along the south-eastern boundary is lower lying, likely representing a historic river plain / channel. These features are included on the Site Plan in Appendix 1 – Figure 1.

It is proposed to rezone the site from rural to medium density residential. A concept subdivision plan by Davie Lovell-Smith has been provided showing 200-lot residential subdivision of the site with associated infrastructure (roading, stormwater detention basins, etc.).

2 Desktop Review

2.1 Regional Geology

The South Island of New Zealand is located on the northeast-southwest trending boundary between the Pacific and Australian Tectonic Plates. This convergent plate boundary causes the ongoing uplift of the Southern Alps. The rapid uplift leads to high erosion rates with braided river systems supplying large volumes of eroded sediment to the coast. The Canterbury Plains are a result of these rivers depositing sediment in broad overlapping alluvial fans. Variable sedimentation rates and changes in sea level associated with glaciation and tectonic uplift have resulted in a dynamic deposition environment producing the sequence of interbedded terrestrial, estuarine and shallow marine sediment underlying the Canterbury region.

The site has been regionally mapped by GNS to be underlain by dominantly alluvial sand and silt overbank deposits of the Springston Formation, and by Forsyth et al. (2008) as being underlain by river alluvium.

The lower-lying portion of the site, that extends east, is likely a historic brank of the Waimakariri River (Wotherspoon et al. 2012).

2.2 Geohazards

2.2.1 Seismicity

The nearest faults to the site are the Loburn and Ashley faults (part of the Ashley Fault Zone), mapped approximately 16 km north and 17 km northwest respectively. The faults within the Ashley Fault Zone trend roughly east-west, and the fault strands within it are indicated as having equal components of dip-slip and strike-slip movement (Barrell and Van Dissen, 2014). The average recurrence interval of the Ashley Fault Zone is assessed as being between 7,000 and 15,000 years, although it could be as low as 5,000 years. The site is mapped outside of the Ashley Fault Awareness Zone.

The site is not within the Ashley Fault or Springbank Monocline fault awareness areas.

Large regional areas of faulting (GNS, 2015) namely the Porters Pass-Amberley Fault Zone, and the Hope and Alpine Faults, are further afield but present a high seismic hazard to the Christchurch area due to the anticipated size of earthquakes generated. The largest of these faults is the Alpine Fault, which has a return period of 250-300 years and is expected to produce a M8 earthquake. The last rupture on the Alpine Fault is believed to have occurred in 1717 (Pettinga et al., 2001).

2.2.2 Canterbury Earthquake Ground Shaking

Bradley and Hughes (2012) have developed a contour map of the conditional median peak ground accelerations (PGA) interpolated from data measured at various recording stations during the 2010-2011 Canterbury Earthquake Sequence (CES). The PGA contour map was created by combining the prediction from an empirical ground motion model of the fault rupture with the PGA recorded at any adjacent strong motion sites.

Based on the model by Bradley and Hughes (2012), the site experienced the following ground motions from the two largest earthquakes of the CES:

- A PGA of 0.20g in the magnitude 7.1 September 2010 earthquake. This is a similar level of shaking to a design 1 in 100 yr ILS earthquake.
- A PGA of 0.19g in the M6.3 February 2011 earthquake. This is shaking similar to that of a design SLS event (1 in 25 yr).

2.2.3 Liquefaction

The Waimakariri District Natural Hazards map indicates the site as being within an area where ‘Liquefaction damage is possible’ and further assessment is needed.

Aerial photographs of the site taken after the September 2010 earthquake show large quantities of liquefaction ejecta within the southeast lower lying portion of the site, but no obvious signs liquefaction ejecta elsewhere across the site. This photograph is shown in Figure 3 and discussed further in Section 2.3.

2.2.4 Flooding

We have reviewed the Waimakariri District Council GIS database and have presented a snapshot of the flood model map at the site (Figure 1). The mapping indicates that parts of the eastern and southern sides of the site may be subject to a high flood hazard (defined as inundation of extremely high depth and / or water velocity) during a 1 in 200 year flood event. A medium flood hazard (defined as inundation of depth greater than 0.3 m) has been associated with the lower-lying portions of the site extending along the western and eastern sides of the site for the 1 in 200 year flood event. Flood hazard assessment is outside of our scope of work, and we understand this is being addressed by others to support the plan change submission.

Figure 1: Flood Hazard Mapping

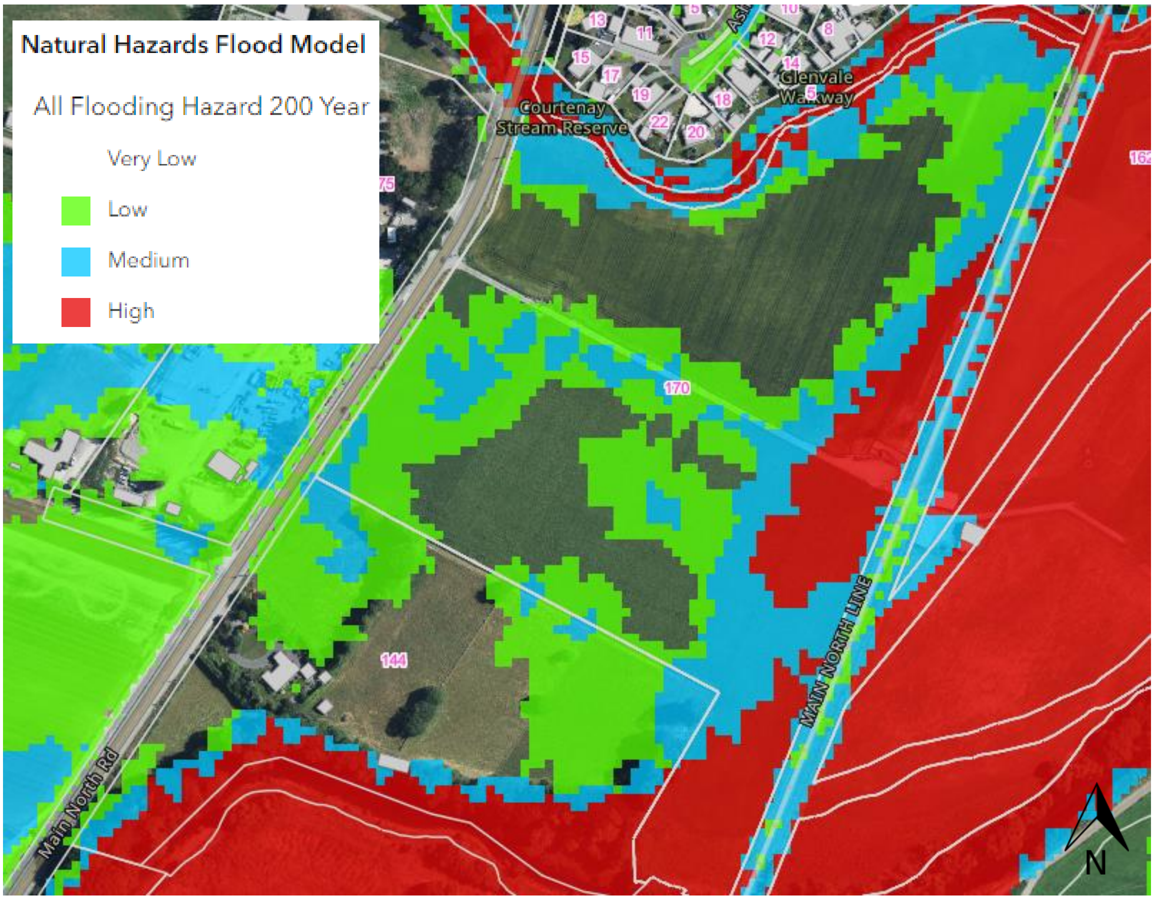


Image sourced from the Waimakariri District council Hazard Maps.

2.2.5 Tsunami

Assessing the risk from tsunami is outside of our scope of work but we have reviewed the Waimakariri District Council GIS database in relation to the tsunami evacuation zones. The site is located within the Orange evacuation zone, which is an area which could be impacted by a 500 year return period tsunami. It includes low-lying coastal areas that are likely to be flooded in a large tsunami that inundates land.

2.3 Historical Aerial Photography Review

We have reviewed historic aerial photographs of the site available through Canterbury Maps (Property Search) dating back to 1940 as outlined below:

- The site appears to have been used as agricultural grazing land since the earliest available photograph in 1940. The dwelling at 144 Main North Road and the railway line was developed prior to the 1955 to 1959 aerial photograph.
- Potential paleochannels (remnants of inactive stream channels or water flow paths) are noted on the western and eastern sides of the site in the 1960-1964 aerial photograph (Figure 2). These are generally orientated northeast to southwest and align with the medium flood level hazard shown in Figure 1.

Figure 2: Historic Aerial 1960-1964

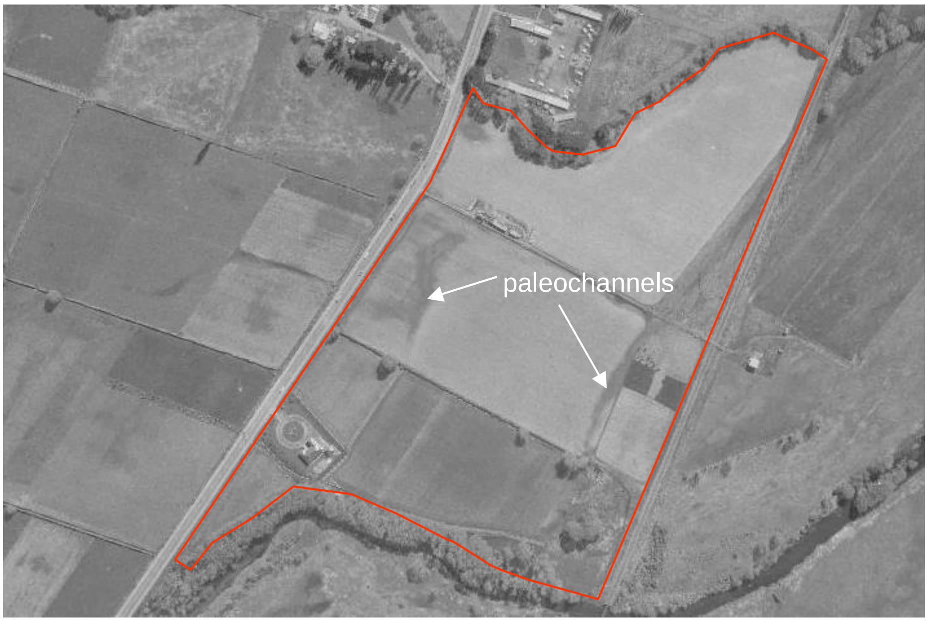


Image sourced from Canterbury maps.

- Aerial photographs following the September 2010 earthquake event (Figure 3) show moderate to severe liquefaction ejecta and extensive lateral spread ground cracks in the lower lying portion of the site that extends east of the site (i.e. the historic branch of the Waimakariri River). Large ground cracks are visible running approximately parallel to the Courtenay River and indicate lateral spreading in this direction.

Figure 3: September 2010 Aerial Photograph

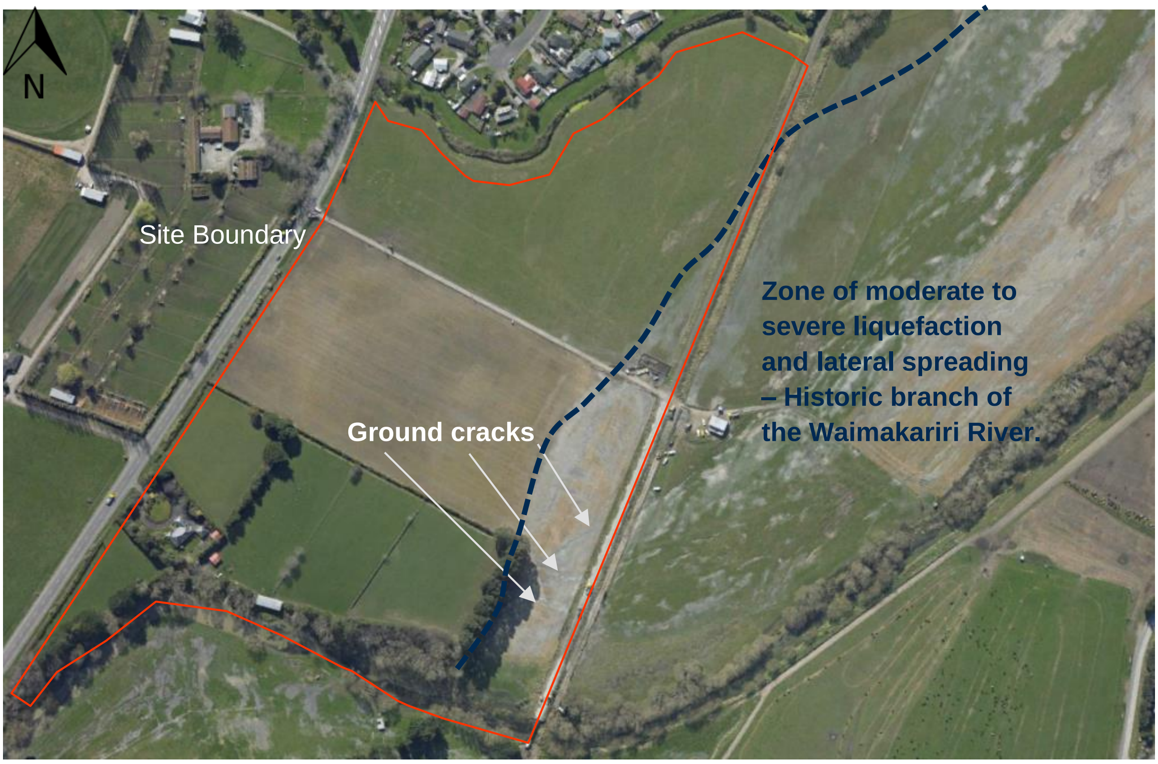


Image sourced from NZGD Canterbury Maps, historic imagery layer.

- Aerial photographs following the February 2011 earthquake event (Figure 4) show minor to moderate liquefaction ejecta and associated ground cracks on the other side of the railway corridor to the east of the site. No clear liquefaction or ground cracks were noted on the site itself.

Figure 4: February 2011 Aerial Photograph

- The Kaikainui and Courtenay Stream channels appear to be relatively consistent with current day across the reviewed historic aerial photographs.

3 Site Investigation

Site Observations

We visited the site on 18 January 2024 and made the following observations:

- The vast majority of the site area is grassed paddocks used for agricultural grazing.
- A residential dwelling was present on 144 Main North Rd with an associated garage and small sleepout building. A garage and barn were present to the east of the dwelling in the paddock area. The remainder of the site was being used for agricultural grazing (sheep).
- The Kaikainui Stream present along the northern boundary line was flowing during the site visit. The banks of this stream are relatively steep and vegetated on either side of the banks. The bank height of the stream is approximately 2.0 m.
- An approximately 1 m deep ditch / drain was observed along the northern boundary line of 144 Main North Road which then presumably went to an underground drain then into a small tributary stream and discharged to the south at Courtenay Stream. There was only a small amount of stagnant water observed in the drain.

- Courtenay Stream present along the southern boundary line was flowing at the time of the site. The stream is relatively wide and has areas of flat sections of bank on the northern side (on the site), and a bank height of approximately 2.5 m to 3 m.
- A railway is present along the eastern / south-eastern boundary line of the site. The railway is built up above the site (approximately 1.5 m to 2.0 m high bank) and runs along the entirety of the site boundary.

Subsurface Investigations

A site-specific geotechnical investigation programme, including eight hand auger boreholes and fifteen Cone Penetration Tests (CPTs), was undertaken by ENGEO in November 2023. A summary of these investigations is included in Table 1, and investigation locations are shown in Appendix 1 - Figure 2. Full logs are presented in Appendix 2 and are written in accordance with the New Zealand Geotechnical Society field classification guidelines (NZGS, 2005). Interpreted findings from these investigations are discussed in Section 4.

Table 1: Summary of Site Investigations

Investigation Type	ID	Depth (m)	Groundwater Measured (m)
Cone Penetration Tests (CPTs)	CPT01	13.68	1.3
	CPT02	6.4	Hole collapse at 1.6 m. GW not encountered.
	CPT03	14.08	2.0
	CPT04	13.77	1.2
	CPT05	14.36	Hole collapse at 1.3 m. GW not encountered.
	CPT06	13.79	0.9
	CPT07	13.36	1.2
	CPT08	14.81	2.3
	CPT09	13.55	1.1
	CPT10	13.3	1.3
	CPT11	13.96	2.3
	CPT12	11.3	0.9
	CPT13	13.13	1.3
	CPT14	13.7	2.5
	CPT15	7.87	0.2 – Likely an error based on nearby hand auger and other measurements across the site.

Investigation Type	ID	Depth (m)	Groundwater Measured (m)
Hand Auger Logs	HA01	3.0	2.6
	HA02	2.0	1.5
	HA03	3.0	2.3
	HA04	1.7	Not encountered
	HA05	2.3	1.3
	HA06	3.0	2.1
	HA07	2.1	Not encountered
	HA08	3.0	Not encountered

4 Engineering Geological Model

The subsurface testing indicates highly variable subsurface conditions across the site. The lower lying portion of the site represents a historic branch of the Waimakariri River and the variability in ground conditions is consistent with the alluvial depositional environment where rivers have avulsed across the landscape over time, creating a layered subsurface profile comprising clay, silt, sand, gravel, and organic deposits.

We have developed an engineering geological model (EGM) using our understanding of the geology and geomorphology of the site and the results of on-site investigations. Our ground model is illustrated by a number of geologic cross sections through the site included in Appendix 3. The various soil units encountered are summarised in Table 2, and a generalised discussion of the distribution of these units across the site is provided below:

Table 2: Summary of Soil Units

Unit ID	Unit Description	Geotechnical Consideration
1	Topsoil: 0.3 to 0.5 m of silt-sand topsoil was encountered in our hand auger investigations.	Potentially compressible
2	Silt-Sand Mixtures: These deposits were generally loose to medium dense and range from silt with some sand to sand. The silt within this unit is generally non plastic to low plasticity and tends toward drained behaviour, more similar to that of fine sand than clay.	Potentially liquefiable below the groundwater table
3	Silt-Clay Mixtures: This unit is typically firm to stiff with inferred low to moderate plasticity with undrained behaviour.	Potentially Compressible
4	Sand: This unit is typically medium dense.	Potentially Liquefiable
5	Sensitive Fine-Grained: This soil type is likely very soft silt-clay mixtures or very soft to soft organic soils such as organic silts-clays or peat.	Potentially Compressible
6	Sand-Gravel Mixtures: Typically dense to very dense.	NA
7	Lower Silt-Clay: This unit comprises firm to stiff silts and clays with inferred low to moderate plasticity, with undrained behaviour.	Potentially compressible but owing to the depth and continuity across the site, low risk of causing damaging differential settlement at the surface.
8	Dense Gravel- All CPT investigations refused at the top of this unit. Based on a brief review of ECan well logs in the general vicinity of the site, this is likely the Riccarton Gravel unit, which extends a significant depth and is laterally extensive across this part of Canterbury.	NA

The upper 2.5 m of the soil profile is somewhat consistent across the site and includes interbedded loose sand-silt mixtures (Unit 2) and clay-silt mixtures (Unit 3). Below this depth ground conditions are complex and highly variable but can be broadly categorised into three ground conditions zones. The locations of these zones across the site are shown in Appendix 1- Figure 2 and described below.

- Zone 1 (shallow gravels - northern end of site - CPT01-06) - Sand-gravel mixtures (Unit 6) extend from the base of the upper deposits to approximately 12.5 m depth.

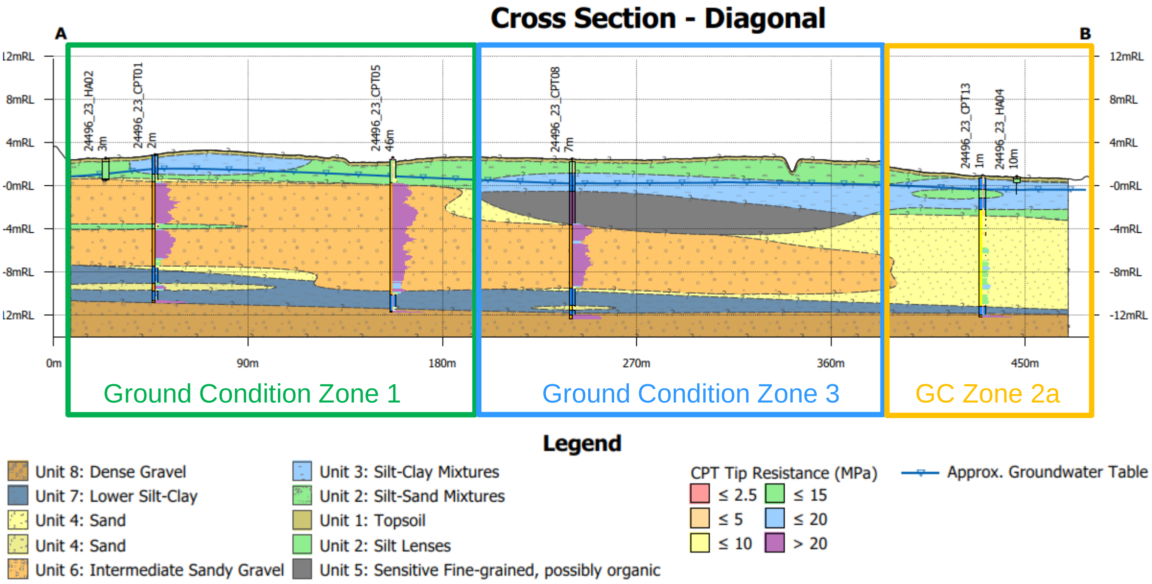
- Zone 2 (sand-silt and sand – eastern and western sides of the site - CPT07, 09, 10, 12, 13 ,15) - Sand and sand-silt mixtures extend to 12 m depth. The portion of Zone 2 (Zone 2a) along the east side of the site, comprises the lower lying area that represents a historic branch of the Waimakariri River.

- Zone 3 (soft soils – southern central portion of site – CPT08, 11, 14) – Clay-silt mixtures (Unit 3) overlie soft, sensitive, fine-grained soils (possibly peat and / or organic silts, Unit 5) from 4 m. The depth of the Unit 5 increases from 6 m depth to 10 m depth toward the south. This is underlain by sand-gravel (Unit 6) to approximately 13 m depth.

From around 12 to 13 m depth, a firm to stiff silt-clay (Unit 7) with occasional lenses of sand extends across the site. Below this, CPT investigations refused on an inferred dense gravel layer (Unit 8) encountered typically between 13 m and 14.8 m.

The cross sections included in Appendix 3 provide a more comprehensive understanding of the distribution of the various soil units across the site than the generalised discussion above. A diagonal cross section through the site captures each of the three zones and is reproduced in Figure 5.

Figure 5: Diagonal Cross Section with Inferred Zones



Groundwater

The depth to groundwater typically varied across the site between 1.0 m and 2.5 m depth. Shallower groundwater was typically present in the lower lying area of the site to the southeast and along the northwest site boundary. Deeper groundwater was encountered in the southwest portion of the site.

Dissipation testing was carried out at the majority of CPT locations within the lower dense gravel layer. However, groundwater levels indicated by the pore pressure readings typically indicated a groundwater table metres lower than the measured groundwater depth from dipping the CPT and hand auger holes. This indicates that the bottom gravel layer is hydraulically disconnected from the upper aquifer by the overlying clayey layers.

At this early stage of geotechnical assessment a design groundwater table of 1.0 m below ground level (bgl) has been adopted for preliminary liquefaction triggering analysis. This should be refined during subdivision consent stage of works.

Assumptions and Uncertainties

- No visual description has been carried out for the soils below the maximum depth of the hand augers. The ground conditions below this have been inferred from the CPT soil behaviour types only. It is recommended that the next phase of ground investigation includes machine boreholes across the site to allow logging of the deeper soils.
- CPT's provide limited understanding soft soils and compressibility potential, as there is no sample recovery with this method. We have therefore had to infer between the silt-clay mixtures and the potentially organic material.
- The high variability in the ground conditions, and relatively low density of investigations means there is a great deal of uncertainty in ground conditions particularly at the boundaries between ground conditions zones. We have made rough approximations of the extent of each zone and the continuity of layers. Additional investigations and refinement of the ground model will be required at further development stages.
- Additional investigation of groundwater levels will be required to better understand the groundwater regime. We recommend wire piezometers are installed during subsequent ground investigation phases to allow continuous monitoring of groundwater levels at multiple locations across the site.

5 Geotechnical Assessment

Based on our review of mapped land damage following the September 2010 earthquake and the ground conditions encountered in our investigations, we consider surface deformation due to liquefaction and consolidation settlement of the soft compressible soils to be the primary geotechnical considerations for the planned development. We have carried out assessments of the liquefaction potential and a preliminary assessment of the long-term consolidation settlement potential of the site using on-site CPT data. Results and analysis are outlined in the following sections.

5.1 Liquefaction Assessment

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soil most susceptible to liquefaction is clean, loose, saturated, uniformly graded fine sand below the groundwater table. Empirical evidence indicates that loose silty sand is also potentially liquefiable. The liquefaction potential of a site depends on the presence of potentially liquefiable soil (sands and silts below the groundwater table), and the intensity of earthquake shaking at the site. Liquefaction can lead to settlement of the ground surface, sand boil formation (ejected liquefied material), ground cracking and lateral displacement of the ground surface, slope instability, and differential and vertical settlement of foundations.

Soils potentially susceptible to liquefaction were encountered in on-site investigations, particularly in Ground Conditions Zone 2 where relatively thick deposits of loose to medium dense sands and silts (Units 2 and 4) were encountered.

Following the September 2010 earthquake, the historic branch of the Waimakariri River lying north of Courtenay Stream suffered extensive lateral spread and liquefaction damage, particularly along the north edge of the historic channel boundary (Wotherspoon, 2012). This lower lying area extends into the site along the southeast edge (Zone 2a). Aerial photos taken following the September 2011 earthquake show extensive lateral spread cracks and liquefaction ejecta within this area along the southeast side of the site.

We have undertaken a liquefaction assessment using the on-site CPT data described in the following sections.

Assessed Earthquake Scenarios

We have assessed the likelihood of liquefaction triggering and post-liquefaction induced vertical settlement occurring at the site for a series of design earthquake scenarios in accordance with NZS 1170.5:2004, Module 1 of MBIE's Geotechnical Engineering Practice Guidance (2021), Waimakariri District Plan liquefaction mitigation design standards (Table 32.3), and Ministry for the Environment (MfE) "Planning and engineering guidance for potentially liquefaction-prone land" (2017). These scenarios are presented in Table 3.

Table 3: Seismic Design Scenarios

Design Case	Seismic Performance Expectations	Assumed Site Class / Importance Level / Design Life	Return Interval	PGA (g)	Magnitude
ULS	Under Ultimate Limit State (ULS) seismic loading the structure should be able to accommodate the potential deformations without structural collapse and protect the safety of the occupants.	Class D / IL2 / 50 years	500 yrs	0.35	7.5
ILS 1	Intermediate Limit State (ILS) - The Waimakariri District Plan liquefaction mitigation design standards (Table 32.3) sets a limit of 100 mm of liquefaction induced vertical settlement and 250 mm of lateral spreading at an intermediate limit state of 1 in 150 year event. This earthquake scenario represents an intensity of shaking that is considered to have a high likelihood of occurring within the land use planning horizon.		150 yrs	0.20	7.5
ILS 2	Intermediate Limit State (ILS) – MfE (2017) indicates the 100-year earthquake scenario for consideration of liquefaction vulnerability.		100 yrs	0.18	7.5
SLS	Under Serviceability Limit State (SLS) design seismic loading, the expectation is that deflections do not result in damage causing loss of function of the structure and that damage is readily repairable.		25 yrs	0.19[2]	6[2]

[1] ILS scaled from the ULS design case using the Return Period Factor for IL2 from Table B1 of the MoE Structural and Geotechnical Guidelines.

[2] As per Issue 7, Update 50 of the clarifications and updates to the 2012 MBIE Guidance. This second SLS case should be assessed when using the B&I liquefaction triggering procedure.

Very recently, updates to the seismic loading standard NZS1170.5 have been issued as draft for public consultation and comment (DZ TS 1170.5:2024). These updates incorporate recent changes to the National Seismic Hazard Model (NSHM, 2022). This document indicates a change in the seismic loading across the assessed earthquake scenarios for Kaiapoi. To understand the implications of these updates, we have undertaken our liquefaction assessment for the updated loading and results are provided and discussed in the following section. We emphasise that NZS 1170.5:2004, and the seismic parameters outlined in Table 3 remain the applicable parameters for assessing liquefaction vulnerability at the time of writing.

Liquefaction Analysis and Results

We completed liquefaction analysis for the earthquake scenarios outlined in Table 3. Liquefaction vulnerability varied across the site as expected owing to the variable ground condition. In general, our analysis indicates that Unit 2 and Unit 4 will liquefy to various degrees in ILS and ULS ground shaking. The highest liquefaction vulnerability is expected within Ground Condition Zone 2 where the thickest deposits of these units were encountered. Details of our liquefaction analysis and full results are provided in Appendix 4, and liquefaction vulnerability maps are included in Figures 3 and 4 in Appendix 1.

We have compared results of our liquefaction analysis against three performance indicators:

- MBIE Technical Categories – Categorisation is based on expected liquefaction in SLS and ULS earthquakes.
- Ministry for the Environment (MfE) Liquefaction Vulnerability Categories (as defined in Table 4.4 of MfE, 2017). Appendix 1 – Figure 3. Categorisation is based on liquefaction in ILS 2 and ULS earthquakes.
- Waimakariri Threshold Displacements. Appendix 1 – Figure 4. These limits are based on liquefaction settlement (limit of 100 mm) and lateral spread (limit of 250 mm) in an ILS 1 earthquake.

Table 4 summarises the assessed categories for each of the ground condition zones outlined in Section 4. Zone 2 is split into two subzones representing the east side of the site (Zone 2a) and the west side of the site (Zone 2b). Further discussion of these areas along with commentary on the confidence in the results is provided in the bullet points below the table.

Table 4: Liquefaction Assessment Summary

Zones	MBIE Technical Categories	MfE Liquefaction Vulnerability Categories Appendix 1 – Figure 3	Waimakariri Threshold Displacements Appendix 1 – Figure 4	Notes
Zone 1	TC2	Medium	Less than 100 mm	Consistent with observed on-site performance where no obvious signs of liquefaction in aerial photos following Sept. 2010 EQ.

Zones	**MBIE Technical Categories**	**MfE Liquefaction Vulnerability Categories** **Appendix 1 – Figure 3**	**Waimakariri Threshold Displacements** **Appendix 1 – Figure 4**	**Notes**
Zone 2a	TC3	High	Greater than 100 mm	Although calculated settlements from CPTs in Zone 2a are less than 100 mm there is high confidence of large settlement / damaging liquefaction based on observed site performance in an earthquake similar to a 1 in 150 yr return period event (Sept. 2010).
Zone 2b	TC3	High	Portion greater than 100 mm	While high liquefaction vulnerability is predicted, based on the lack of observed liquefaction following Sept. 2010 EQ, liquefaction may be overpredicted at some locations and additional investigation and refinement is recommended.
Zone 3	TC2	Medium	Less than 100 mm	Consistent with observed onsite performance where no obvious signs of liquefaction in aerial photos following Sept. 2010 EQ.

- Zones 1 & 3- Medium Liquefaction Vulnerability, Reasonable Confidence:

  These were the locations where shallow dense gravel was encountered or cohesive deposits dominated the upper soil profile. There is reasonable confidence in the vulnerability across this area as analysis results are broadly consistent with site performance in the September 2010 earthquake (no obvious signs of liquefaction), and the lack of significant liquefiable layers present. There is greater uncertainty where this area borders other areas as the investigation density is relatively low.

- Zone 2a – High Liquefaction Vulnerability, High Confidence (CPT09,12,13):

  This area forms the lower-lying southeast portion of the site. Extensive liquefaction and lateral spreading damage is expected within this area in ILS and ULS events based on both site performance in the CES and our analysis. As such there is high confidence in our categorisation of high liquefaction vulnerability.

- Zone 2b – High Liquefaction Vulnerability, High Uncertainty(CPT07, 10, 15):

  In this area analysis results indicate high liquefaction vulnerability, but no obvious signs of liquefaction were observed in September 2010 indicating that our analysis may be overpredicting liquefaction vulnerability. As such there is higher uncertainty in these results. One potential cause for this discrepancy across a portion of the site is the assumption of a 1 m deep groundwater table. Investigations on the south end of this Zone indicated a groundwater depth on the order of 2 to 2.5 m, more consistent with the water levels in the adjacent Courtenay Stream. The adoption of a deeper groundwater table (say 2-2.5 m) would impact the liquefaction results at this location, but additional groundwater investigation is required to support the adoption of a deeper groundwater table for analysis.

As the boundaries of these zones are based on a relatively low density of investigations the uncertainty in category becomes high near the boundary with other categories. Further investigation at subdivision consenting stage is required to delineate and refine these boundaries.

Our liquefaction analysis using seismic loading parameters from the recently released draft DZ TS 1170.5:2024, indicates very similar liquefaction performance across ILS and ULS events. As MfE's Liquefaction Vulnerability Categories, and Waimakariri Displacement Thresholds are based on ILS and ULS earthquakes, the same categorisation as was determined using the draft updated loadings. SLS loading is reduced in DZ TS 1170.5:2024 resulting in low risk of liquefaction occurring (compared to up to minor or moderate liquefaction using the current guidance for loading). If these proposed changes are adopted, they may have implications for design of structures at the site (as SLS is a seismic design scenario for structural design), but we don't expect this will have significant impact at the planning stage where longer return period earthquakes (i.e. ILS and ULS) are used for understanding liquefaction risk over the planning horizon.

Lateral Spread

We have undertaken a preliminary assessment of lateral spread potential toward Kaikainui and Courtenay Stream under an ILS event. It should be noted that lateral spreading mechanisms are complex, are often not adequately captured by the available simplified procedures, and at this site are based on limited data. We emphasise that our analysis is very preliminary, and there is high uncertainty in the indicated offset zones for Zone 1,2b, and 3. More investigation and assessment of lateral spreading is required at subdivision consent stage.

We have run an initial analysis using the methods of Zhang (2004) and Youd (2002). It is our experience that results of lateral spreading analyses using the methods above tend to be conservative when compared with actual site performance, and results are highly sensitive to the depth of the groundwater table. As such we have used "best estimate" groundwater depths. An initial indication of lateral spread potential is provided for each zone below.

- Zones 1 and 3: We anticipate lateral spreading deformations toward Kaikainui Stream and Courtenay Stream may be significant (up to 250 mm of lateral displacement), within around 20 m from the stream channel in an ILS event. These offsets from the stream banks are shown in Figures 3 and 4 in Appendix 1. We emphasise that additional analysis is required and additional investigations are needed to refine this estimate.

- Zone 2a: We anticipate extensive lateral spread damage in a future ILS event across this area based on the performance of this area in the September 2010 earthquake.

- Zone 2b: As a preliminary estimate lateral spreading toward Courtenay Stream may be significant within around 20 m from the stream in an ILS event (similar to Zones 1 and 3), but there is high uncertainty in this estimate as it is based on very limited data. Lateral spread potential is sensitive to the depth of the groundwater table. We have used a "best-estimate" depth of 2.5 m along this portion of Courtenay Stream but additional investigations are required and if shallower groundwater is found, the zone of significant lateral spreading will likely be greater than 20 m.

As discussed earlier in this report, the east side of the site gently slopes toward a lower lying area where extensive liquefaction is expected. Aerial photographs taken following the September 2010 earthquake did not show obvious signs of lateral spreading of the ground at the top of this slope toward the lower lying area, and we consider that the risk of lateral spreading at the top of this this slope is relatively low. However, if the lower lying area is to be further excavated or the slope is to be steepened / heightened during development earthworks, the risk of lateral spreading may increase and this should be assessed.

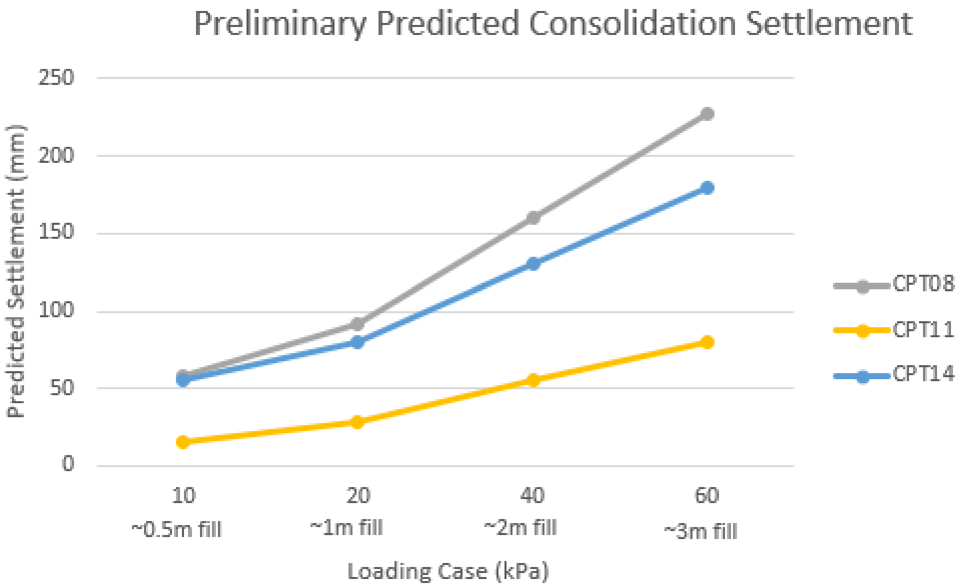
We anticipate that bulk earthworks may form areas of sloped ground such as for stormwater basins. These areas of sloped ground can be subject to lateral spreading and the development design will need to assess and appropriately manage the risk of lateral spread. This could include creation of development offset zones from the slope and / or the need to install retaining walls or inground walls depending on slope steepness and the proximity of buildings and roads. Any services crossing slopes at risk of lateral spread will need to be designed accordingly. Additional lateral spread analysis will be required once the civil/landscaping design of the site-wide landform has been developed.

5.2 Consolidation Settlement

Weak cohesive and possibly organic soils identified in the CPTs within Zone 3 can be susceptible to consolidation settlement over time under new loading from earthworks fill or structure loads. As an initial screening of consolidation potential on this site, we have completed a preliminary settlement calculation using the CPT data over a range of loading representing load from fill placed across the site.

The analysis indicates the soft soils found within the Zone 3 area of the site are susceptible to consolidation settlement and settlement may be significant even under relatively moderate fill loadings (10 kPa – 0.5 m of fill) in this area. Results of our preliminary consolidation analysis are presented in Figure 5. We recommend additional investigation and assessment be undertaken to further define the consolidation risk once fill loads, particularly within Zone 3, are understood. Preliminary settlement estimates in Zones 1 and 2 were generally minor (less than 20 mm) under 20 kPa loading, and these zones are considered to have low risk of consolidation settlement.

Figure 6: Preliminary Consolidation Estimates



6 Conclusions

Based on our findings and analyses outlined above, we consider the primary geohazards to be surface deformation due to liquefaction and long-term consolidation settlement of soft cohesive or organic material across areas of the site (see Appendix 1 for ground conditions zones and hazard maps).

The risks presented by these hazards can be mitigated through earthworks and ground improvement, as outlined in Table 5. In some areas, these works may be extensive, but are relatively standard methods used routinely in the Canterbury Region. We therefore do not consider that these hazards should preclude this site from being rezoned for residential purposes under the proposed Waimakariri District Plan. However, additional work will be required during the subdivision consent phase to refine the geological ground model to more accurately define the boundaries of these areas and further define the options available to remediate them.

Table 5: Preliminary Geohazard Implications / Mitigation Approaches

Geohazard		Applicable Zone	Potential Mitigation / Implications
Liquefaction	Medium Vulnerability	Zone 1 & 3	Structures within these areas may require shallow ground improvement such as a gravel raft, or adoption of rigid foundations capable of tolerating some liquefaction-induced deformations. Gravity services may require greater minimum falls to accommodate anticipated liquefaction settlements.
	High Vulnerability	Zone 2	Development within these areas likely require deep ground improvement to increase the liquefaction resistance of the soils. Appropriate ground improvement depends on the particular site conditions but may include stone columns or vibratory compaction.
Lateral Spreading		Areas adjacent to the streams or sloping ground, in both medium and high liquefaction vulnerability zones	Options for reducing lateral spread risk include: • Improving the ground adjacent to the sloping ground or free face (i.e. stream bank). This is typically achieved by an in-ground palisade wall, or an array of deep ground improvement columns (e.g. soil mixed column or stone columns). • Defining a building exclusion zone along the sloping ground or free face beyond which lateral deformations are tolerable.
Consolidation Settlement		Zone 3	For portions of the site at risk of damaging consolidation settlement, preloading is likely an appropriate option. Preloading involves adding load (usually soil fill) and allowing settlement to occur before removing the load and / or constructing foundations.

7 Recommendations

Further geotechnical assessment works will be required to inform subdivision design and associated bulk earthworks and to support any residential development of the site if the plan change proposal is approved. We anticipate these works may include:

- Additional geotechnical testing across the site to further delineate the boundaries between the ground condition zones, and liquefaction vulnerability categories outlined in Appendix 1. These investigations should include machine boreholes to ground truth the areas with potentially compressible soils and to identify the extent of the gravel deposits encountered in the investigations to date.

- Additional lateral spreading analysis will be required once additional investigations have been carried out and the development / earthworks plan is known. This can be completed during the subdivision consent stage of development.

- Further assessment of consolidation settlement will need to be completed within Zone 3 during subdivision consent stage. The density and extent of testing is dependent on the earthworks and development proposed. However, testing will likely consist of machine boreholes, and consolidation laboratory testing.
- Groundwater monitoring, especially in Zone 2b where this could have a significant impact on the liquefaction potential of this portion of the site. It is recommended that standpipe and / or vibrating wire piezometers are installed during subsequent ground investigation phases to allow continuous monitoring of groundwater levels across the site.

8 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Balance Developments Ltd, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific technical requirements of the client’s brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the Engineering NZ/ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (03) 328 9012 if you require any further information.

Report prepared by

Jacinta Morgan

Engineering Geologist

Naomi Norris

Geotechnical Engineer

Report reviewed by

Neil Charters

Neil Charters, CMEngNZ (CPEng)

Principal Geotechnical Engineer

9 References

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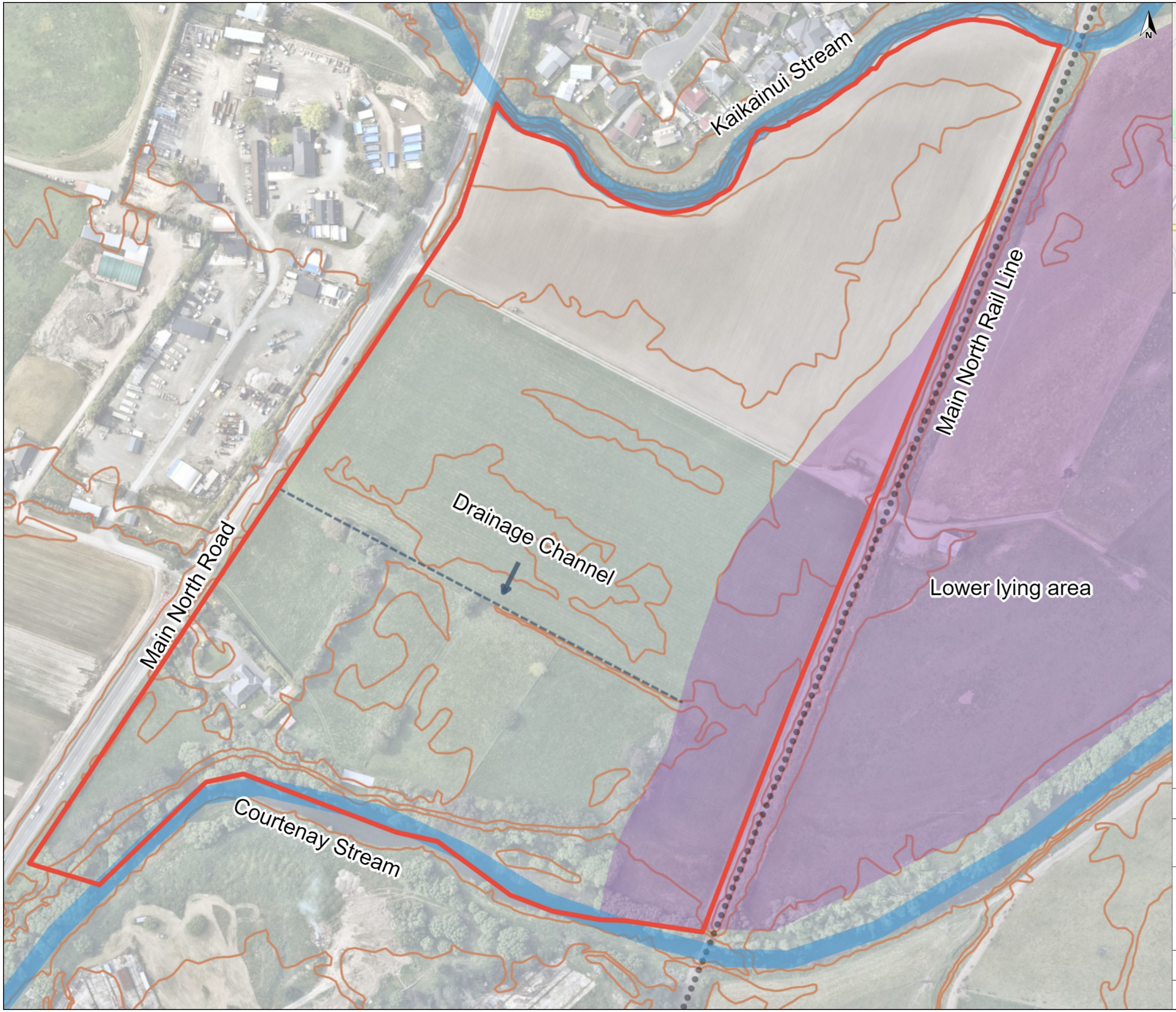
We also acknowledge the New Zealand GeoNet project and its sponsors EQC, GNS Science and LINZ, for providing data used in this report.

APPENDIX 1:

Site Plans and Hazard Maps



Legend

🟥 Site Boundary

⬟ Lower Lying Area

1m ECAN Contours shown in orange

ECAN Contour

0 50 m 100 m

© Nearmap, Canterbury Maps

ENGEO

Produced by **Datanest.earth**

Title: Site Location Plan

Client: Balance Developments Ltd

Size: A4

Project: 144 & 170 Main North Road Kaiapoi

Drawn: NN

Figure No.: 1

Date: 04-03-2024

Checked: NC

Proj No: 24496

Scale: 1:3000

Version: 1.0

Legend

- ▲ ENGEO CPTs 2023
- ⊕ ENGEO Hand Augers 2023
- ⬠ Ground Conditions Zone 1
- ⬠ Ground Conditions Zone 2a
- ⬠ Ground Conditions Zone 2b
- ⬠ Ground Conditions Zone 3

Unmarked areas within the site boundary are areas of high uncertainty in ground conditions due to the low density of investigation.

ENGEO

Produced by **Datanest.earth**

Title:
Site Investigation Plan and Ground Condition Zones

Client: Balance Developments Ltd		Size: A4
Project: 144 & 170 Main North Road Kaiapoi	Drawn: NN	Figure No.: 2
Date: 04-03-2024	Checked: NC	
Proj No: 24496	Scale: 1:3000	Version: 1.0

Legend

▲ CPTs with Calculated Moderate Liquefaction Vulnerability

▲ CPTs with Calculated High Liquefaction Vulnerabilty

⬠ Areas of ~20m offset from stream channels - representing areas of higher risk of damaging lateral spreading.

⬠ Area of Moderate Liquefaction Vulnerability

⬠ Area of High Liquefaction Vulnerability - High uncertainty as results are not consistent with observed performance.

⬠ Area of High Liquefaction Vulnerability

The uncertainty in the vulnerability category becomes high near the boundary with other categories. Further investigation at later development stages is required to refine these boundaries.

Liquefaction vulnerability estimated through calculated LSNs for 1 in 500yr and 1 in 100yr return period events and Table 4.4 of MfE's "Planning and engineering guidance for potentially liquefaction-prone land" (2017)

0 50 m 100 m

© Nearmap

ENGEO

Produced by **Datanest.earth**

Title: Liquefaction Vulnerability Categories

Client: Balance Developments Ltd		Size: A4
Project: 144 & 170 Main North Road Kaiapoi	Drawn: NN	Figure No.: 3
Date: 04-03-2024	Checked: NC	
Proj No: 24496	Scale: 1:3000	Version: 1.0

Legend

🔺 Calculated Vertical Settlement >= 100mm

▲ Calculated Vertical Settlement < 100mm

⬠ Area of > 100mm of settlement - High Confidence

⬠ Area of estimated >100mm settlement or >250mm of lateral displacement - High Uncertainty

Although calculated settlements from CPTs in the area of high confidence are less than 100mm there is high confidence of large settlement/damaging liquefaction based on observed site performance in an earthquake similar to a 1 in 150 yr return period event (Sept. 2010). The area with high uncertainty is where calculated deformations are higher than the threshold but no obvious signs of liquefaction were can be seen from aerial photos following September 2010 EQ.

In the case of the zones along Kaikainui and Courtenay Streams, the uncertainty stems from the limited investigation data and limitations in analysis methods.

The uncertainty in category becomes high near the boundary with other categories. Further investigation at later development stages is required to refine these boundaries.

0 50 m 100 m
© Nearmap

ENGEO

Produced by **Datanest.earth**

Title:
1 in 150 yr RP Liquefaction Settlements - Waimakariri Threshold Displacements

Client:
Balance Developments Ltd

Size:
A4

Project:
144 & 170 Main North Road Kaiapoi

Drawn:
NN

Figure No.:
4

Date: 04-03-2024

Checked:
NC

Proj No: 24496

Scale:
1:3000

Version:
1.0

APPENDIX 2:

Investigation Logs

ENGEO

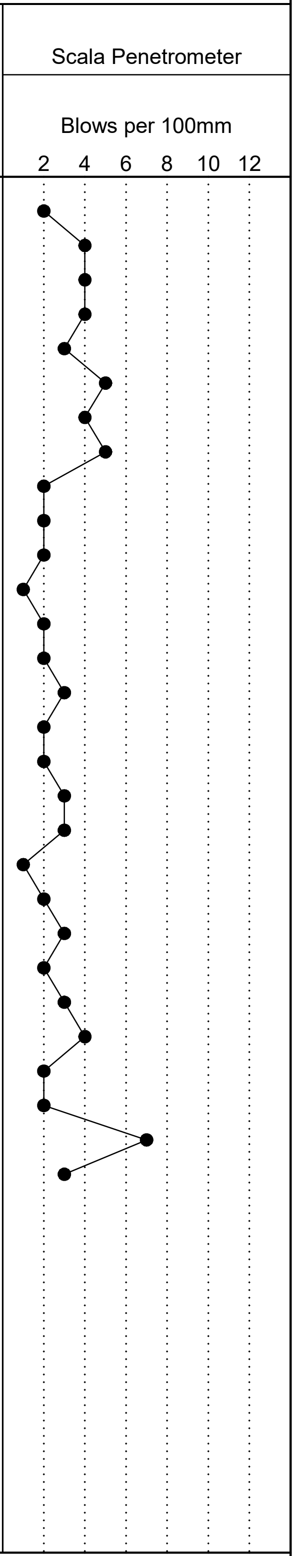
LOG OF AUGER HA01

Geotechnical investigation
144 & 170 main north road
Kaipoi
14496.000.000

Client : Mike greer
Client Ref. : Rezoning Submission WPDP
Date : 24-11-2023
Hole Depth : 3 m
Hole Diameter : 50 mm

Shear Vane No : 1288
Logged By : JXT
Reviewed By : JM
Latitude : -43.3998335
Longitude : 172.6482806

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TOPSOL	ML	[TOPSOIL] Sandy SILT with trace rootlets; brown. Low plasticity. Sand is fine to medium.				D		
0.5	ALLUVIUM	ML	SILT with some sand; light brown with orange streaks. Low plasticity.				D M	F-H	UTP
1.0		ML	SILT with minor sand; grey. Low plasticity. Between 1.1-1.15m - Encountered black organic mottles				M	F-H	200+
1.5		SP	Silty fine to medium SAND; grey. Poorly graded.				W	L	
2.0 2.5		ML	Sandy SILT; grey. Low plasticity. Sand is fine to medium. At 2.2m - Becomes minor sand			▼	W S	VSt	109/63 109/53
		ML	SILT with trace sand; grey. Low plasticity.				S	St	
3.0			End of Hole Depth: 3 m Termination Condition: met target depth						56/39
3.5									
4.0									



Hand Auger met target depth at 3 m depth .
Scala Penetrometer met target depth at 3 m.
Dip test showed standing water at 2.6 m depth.

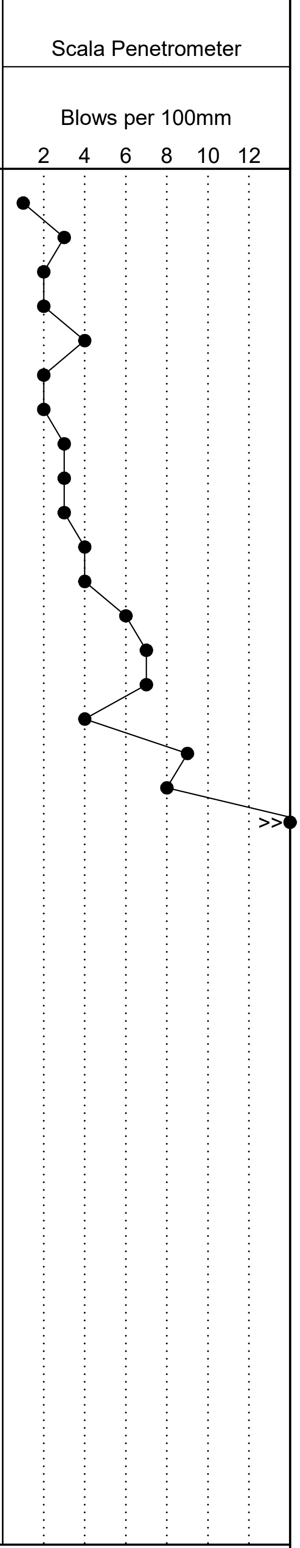
ENGEO

LOG OF AUGER HA02

Geotechnical investigation
144 & 170 main north road
Kaipoi
14496.000.000

Client : Mike greer
Client Ref. : Rezoning Submission WPDP
Date : 24-11-2023
Hole Depth : 2 m
Hole Diameter : 50 mm
Shear Vane No : 1288
Logged By : JXT
Reviewed By : JM
Latitude : -43.3966058
Longitude : 172.6509515

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TS	SM	[TOPSOIL] Silty fine to medium SAND with trace rootlets; light brown. Poorly graded.				D	L	
0.5	ALLUVIUM	SP	Fine to medium SAND with some silt; brown. Poorly graded.				M		153/62
1.0		ML	SILT with some sand; brownish grey. Low plasticity					VSt	109/53
		SP	Silty fine to medium SAND; grey. Poorly graded.				W	MD	
1.5		SP	Fine to medium SAND with trace silt; dark grey. Poorly graded.			▼	S	D	
2.0			End of Hole Depth: 2 m Termination Condition: Practical refusal						
2.5									
3.0									
3.5									
4.0									



TS = TOPSOIL

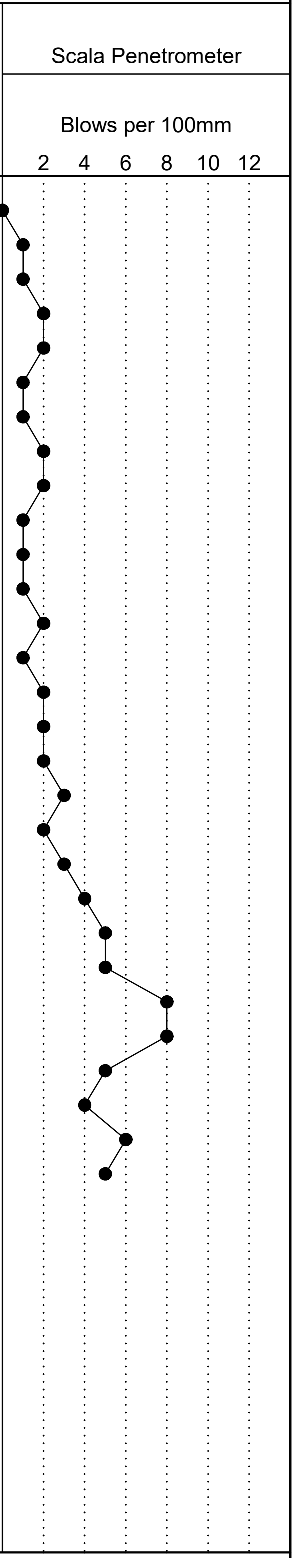
Hand auger met practical refusal at 2 m depth on hard material.
Scala Penetrometer met practical refusal at 1.9 m depth.
Dip test showed standing water at 1.5 m depth.

LOG OF AUGER HA03

Geotechnical Analysis
144 Main North Rd
Kaiapoi
24496.000.001

Client : Mike Greer
Client Ref. : Rezoning Dubmission WPDP
Date : 22/11/23
Hole Depth : 3 m
Hole Diameter : 50 mm
Shear Vane No : 1288
Logged By : AF
Reviewed By : JM
Latitude : -43.396
Longitude : 172.655

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TS	SM	Silty fine to medium SAND with trace rootlets; dark brown. Poorly graded [TOPSOIL].				D	VL-L	
0.5	ALLUVIUM	SP	Silty fine to medium SAND; dark brown. Poorly graded.				M	L	
1.0 1.5 2.0		SP	Fine to medium SAND with some silt; brown. Poorly graded. 1.4 m - Becomes Wet.			▽	M W	L MD	
2.5			Fine to medium SAND with minor to trace silt; grey. Poorly graded. 2.5 m - Becomes Saturated.			▼	W S	MD -D	
3.0 3.5 4.0			End of Hole Depth: 3 m Termination Condition: Target depth						



TS = TOPSOIL

Hand auger met target depth at 3 m.
Scala Penetrometer met target depth at 2.9 m.
Standing groundwater was encountered at

ENGEO

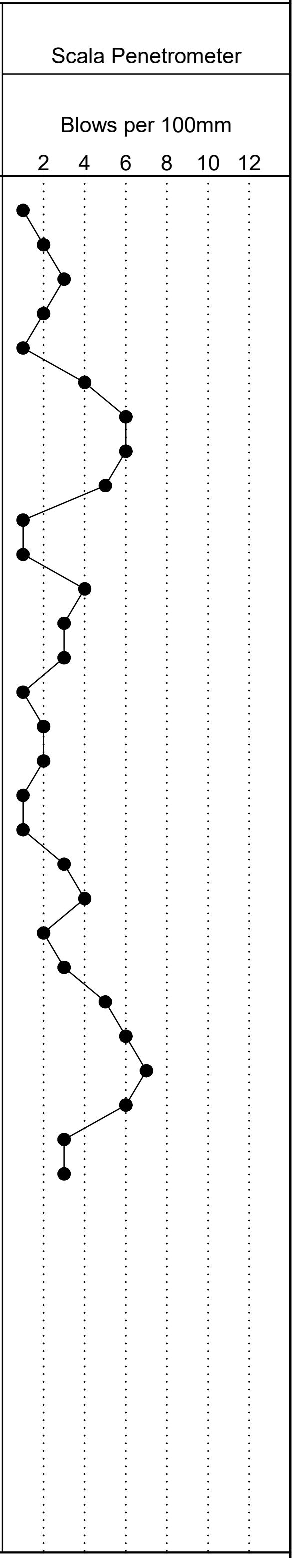
LOG OF AUGER HA04

Geotechnical Analysis
144 Main North Rd
Kaiapoi
24496.000.001

Client : Mike Greer
Client Ref. : Rezoning Dubmission WPDP
Date : 22/11/23
Hole Depth : 1.7 m
Hole Diameter : 50 mm

Shear Vane No : 1288
Logged By : AF
Reviewed By : JM
Latitude : -43.4003
Longitude : 172.6524

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TS	SP	[TOPSOIL] Silty fine to medium SAND; dark brown. Contains minor rootlets. Poorly graded. 0.1 m - Rootlets cease.				M	VL-L	
0.5	ALLUVIUM	ML	Sandy SILT; dark grey. Low plasticity. Sand is fine to medium. 0.5 m - Becomes wet.				M	VSt	123/35
1.0		SP	Fine to medium SAND with minor to trace silt; dark grey. Poorly graded.				W	MD	
1.5								L-MD	
2.0			End of Hole Depth: 1.7 m Termination Condition: Practical refusal						
2.5									
3.0									
3.5									
4.0									



Hand auger met practical refusal at 1.7 m depth due to poor recovery.
Scala Penetrometer met practical refusal at 2.9 m depth.
Standing groundwater was not encountered

TS = TOPSOIL

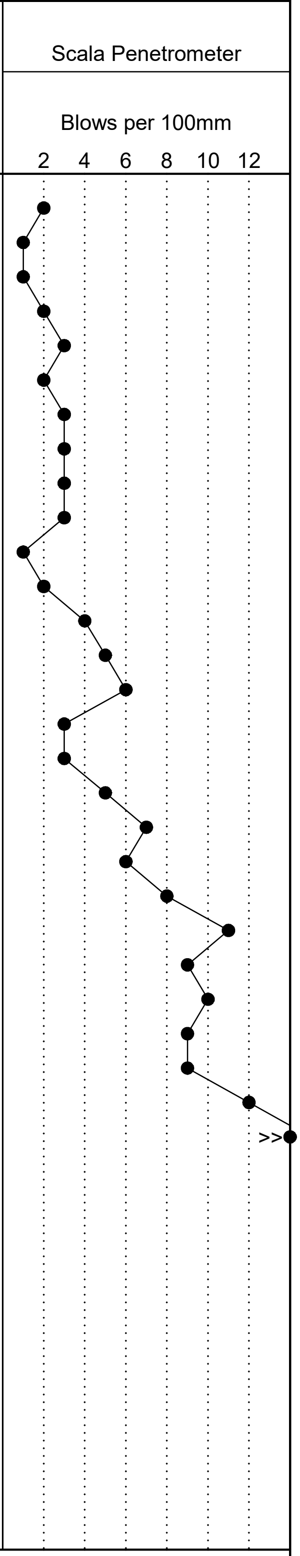
LOG OF AUGER HA05

Geotechnical investigation
144 & 170 main north road
Kaipoi
14496.000.000

Client : Mike greer
Client Ref. : Rezoning Submission WPDP
Date : 22/11/2023
Hole Depth : 2.3 m
Hole Diameter : 50 mm

Shear Vane No : 1288
Logged By : JXT
Reviewed By : JM
Latitude : -43.398215
Longitude : 172.650021

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TS	ML	[TOPSOIL] SILT with some sand and trace rootlets; brown. Low plasticity.				M	VSt-H	
0.5 1.0	ALLUVIUM	ML	SILT with minor sand; grey with orange brown mottles. Low plasticity. At 0.9m - Becomes orange brown with grey mottles At 1.1m - Becomes brown				M W		200+ 162/77
		ML	Sandy SILT with trace roots; grey. Low plasticity. At 1.4m - Roots cease			▼	W S		
1.5 2.0		SP	Fine to medium SAND with trace silt; dark grey. Poorly graded				S	MD D	95/42
2.5 3.0 3.5 4.0			End of Hole Depth: 2.3 m Termination Condition: Practical refusal						



TS = TOPSOIL

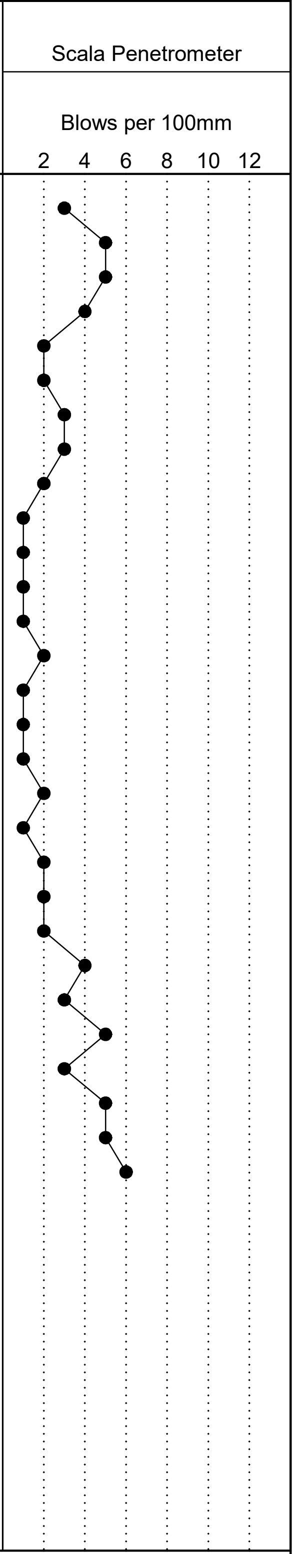
Hand auger met practical refusal at 2.3 m depth due to poor recovery.
Scala Penetrometer met practical refusal at 2.9 m depth.
Dip test showed standing water at 1.3 m depth.

LOG OF AUGER HA06

Geotechnical investigation
144 & 170 main north road
Kaipoi
14496.000.000

Client : Mike greer
Client Ref. : Rezoning Submission WPDP
Date : 24-11-2023
Hole Depth : 3 m
Hole Diameter : 50 mm
Shear Vane No : 1288
Logged By : JXT
Reviewed By : JM
Latitude : -43.3984387
Longitude : 172.6533906

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TOPSOIL	ML	[TOPSOIL] Sandy SILT with trace rootlets; brown. Low plasticity				M	VSt	
0.5 1.0	ALLUVIUM	ML	SILT with some sand; brown with faint orange streaks. Low plasticity.					St	179/77 63/42
1.5 2.0		ML	SILT with minor to trace sand; grey. Low plasticity.			▼	W		76/56 56/56
2.5		SP	Silty fine to medium SAND; grey. Poorly graded. At 2.7m - Becomes fine to course				S	MD	
3.0 3.5 4.0			End of Hole Depth: 3 m Termination Condition: met target depth						



0.1	3
0.2	5
0.3	5
0.4	4
0.5	2
0.6	2
0.7	3
0.8	3
0.9	2
1.0	1
1.1	1
1.2	1
1.3	1
1.4	2
1.5	1
1.6	1
1.7	1
1.8	2
1.9	1
2.0	2
2.1	2
2.2	2
2.3	4
2.4	3
2.5	5
2.6	3
2.7	5
2.8	5
2.9	6

Hand Auger met target depth at 3 m depth .
met target depth
Dip test showed standing water at 2.1 m depth.

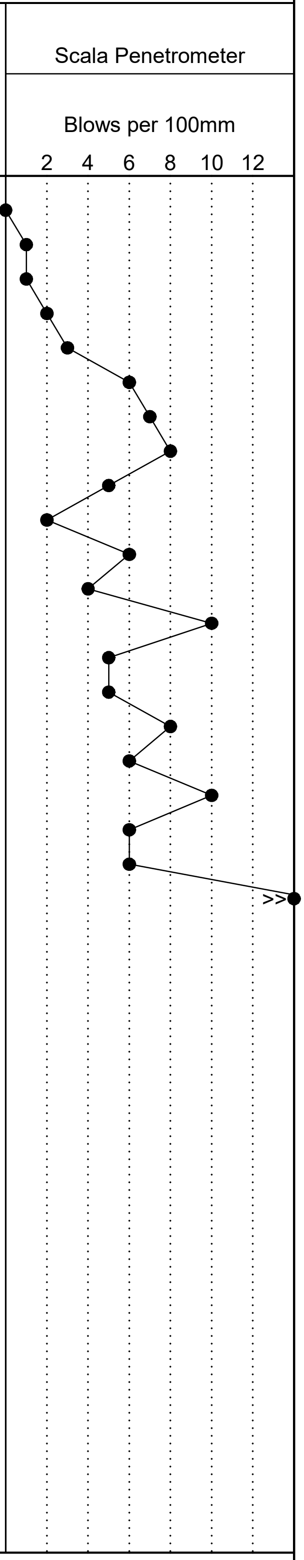
LOG OF AUGER HA07

Geotechnical Analysis
144 Main North Rd
Kaiapoi
24496.000.001

Client : Mike Greer
Client Ref. : Rezoning Dubmission WPDP
Date : 22/11/23
Hole Depth : 2.1 m
Hole Diameter : 50 mm
Shear Vane No : 1288
Logged By : AF
Reviewed By : JM
Latitude : -43.3975
Longitude : 172.6528

Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded
	TS	ML	[TOPSOIL] Sandy SILT; dark brown. Low plasticity, Sand is fine to medium, some rootlets. 0.2 m - Rootlets cease.				D	S	
	ALLUVIUM	SP	Silty fine to medium SAND; dark brown. Poorly graded.				M	L	
1.0								MD	106/67
2.0		SP	Fine to medium SAND with some silt; dark brown with red mottles. Poorly graded.				M	MD-D	

2.1 m - Encountered fine sub rounded gravel.
End of Hole Depth: 2.1 m
Termination Condition: Practical refusal



TS = TOPSOIL

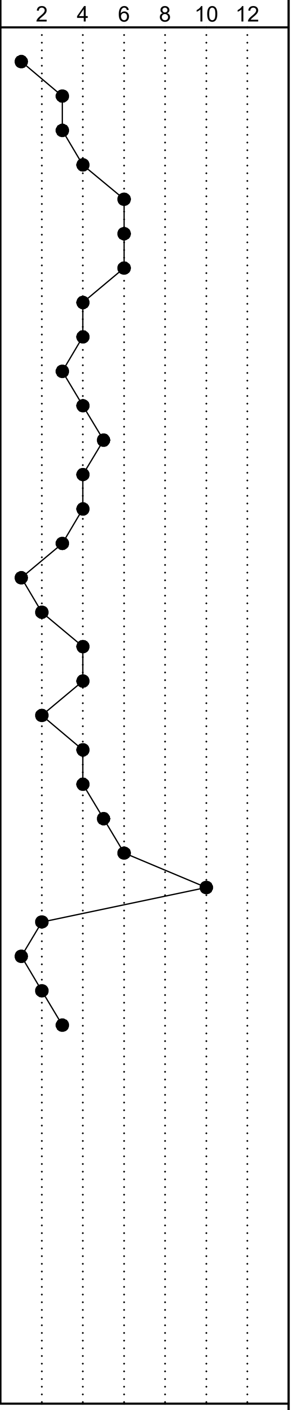
Hand auger met practical refusal at 2.1 m depth on inferred gravel.
Scala Penetrometer met practical refusal at 2.1 m depth.
Standing groundwater was not encountered

LOG OF AUGER HA08

Geotechnical Analysis
144 Main North Rd
Kaiapoi
24496.000.001

Client : Mike Greer
Client Ref. : Rezoning Dubmission WPDP
Date : 24/11/23
Hole Depth : 3 m
Hole Diameter : 50 mm
Shear Vane No : 1288
Logged By : AF
Reviewed By : JM
Latitude : -43.399
Longitude : 172.65

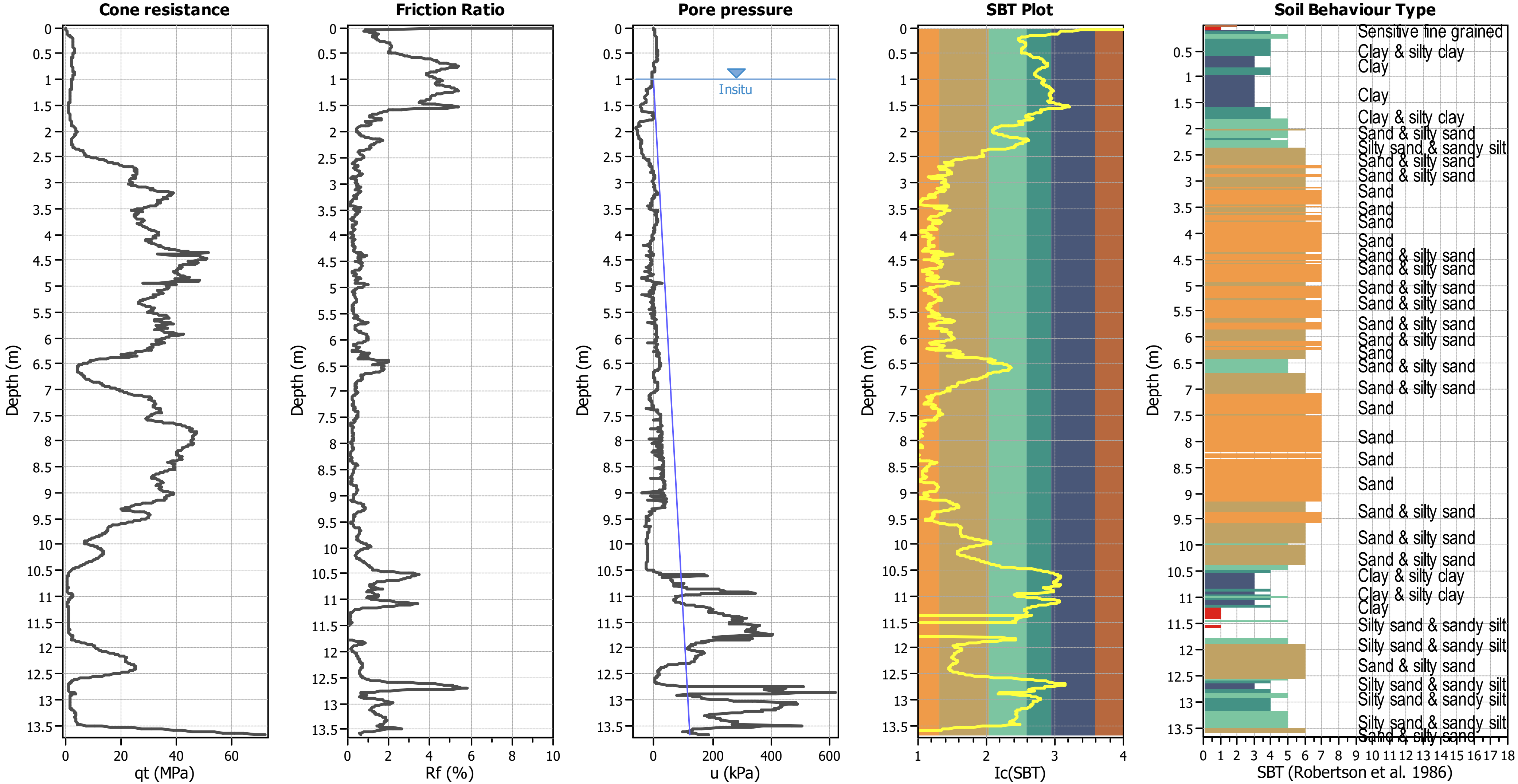
Depth (m BGL)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Elevation (mRL)	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer Blows per 100mm
	TS	OL	[TOPSOIL] Sandy SILT with trace rootlets; dark brown. Low plasticity, sand is fine to medium.				D	VSt*		
0.5	ALLUVIUM	ML	SILT with some sand; brown. Low plasticity, sand is fine to medium.				D	H*	UTP	
1.0 1.5		ML	SILT with minor sand; brown with light brown mottles. Low plasticity.				M	VSt-H	144/46 144/70	
2.0		ML	SILT with minor sand; dark brown with red mottles. Low plasticity.				W		200+	
2.5		ML	SILT with minor to trace sand; dark grey. Low plasticity.				W	F-VSt		
3.0		MH	SILT with minor to some clay; dark grey. High plasticity.				W	F		
3.5 4.0			End of Hole Depth: 3 m Termination Condition: Target depth							



Hand auger met target depth at 3 m.
Scala Penetrometer met target depth at 2.9 m.
Standing groundwater was not encountered
*Inferred from material properties

TS = TOPSOIL

CPT basic interpretation plots



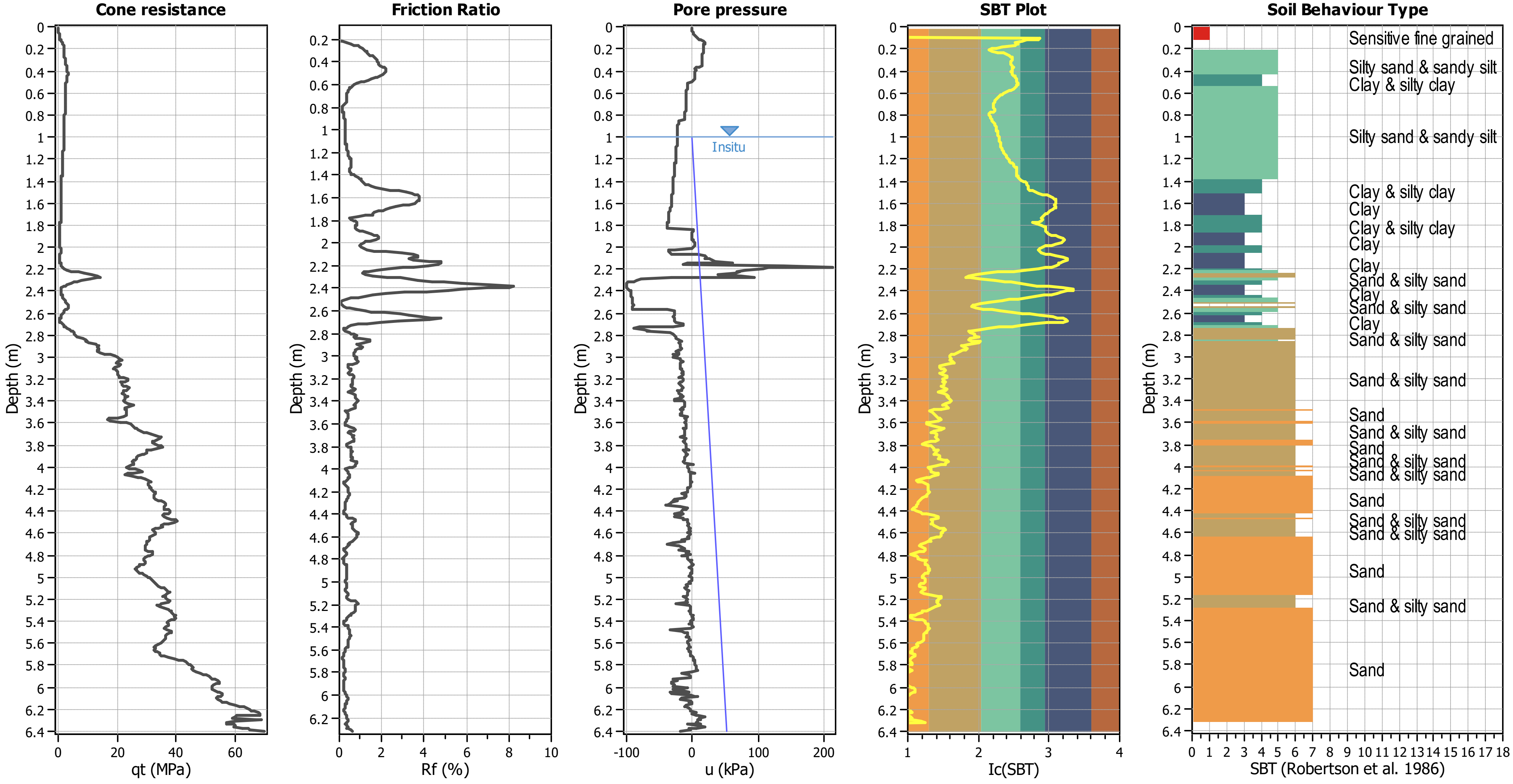
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.35
Depth to water table (insitu): 1.00 m

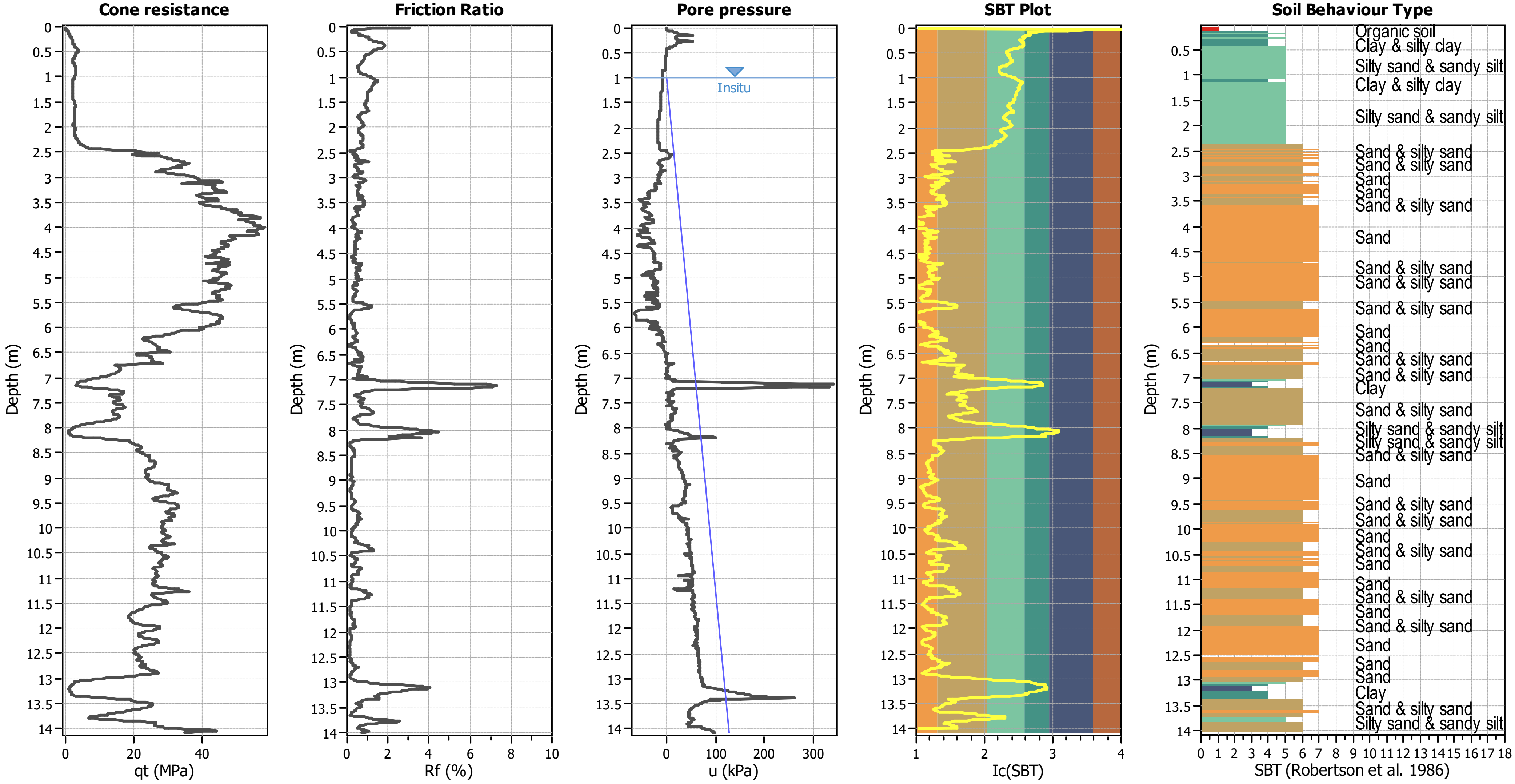
Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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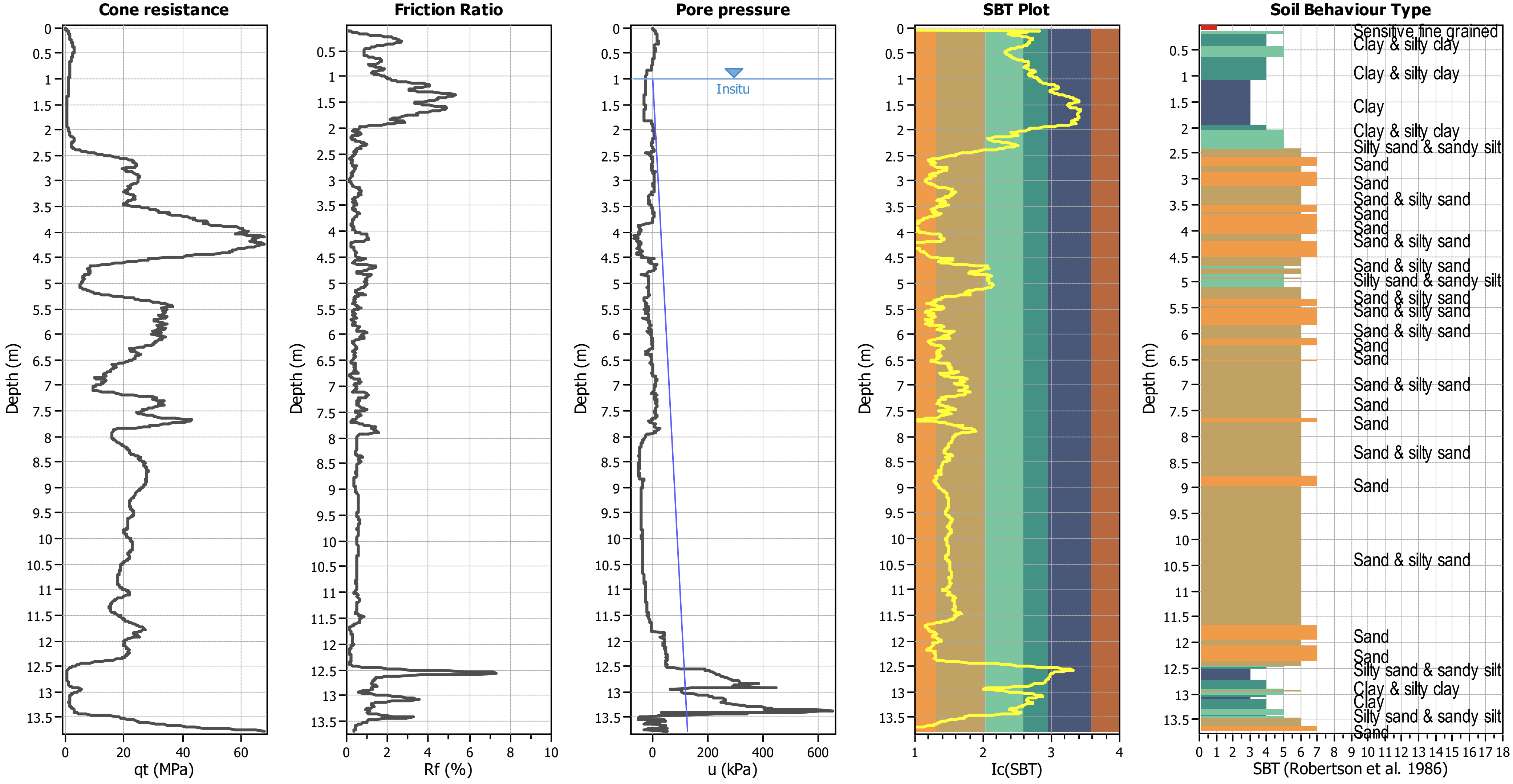
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



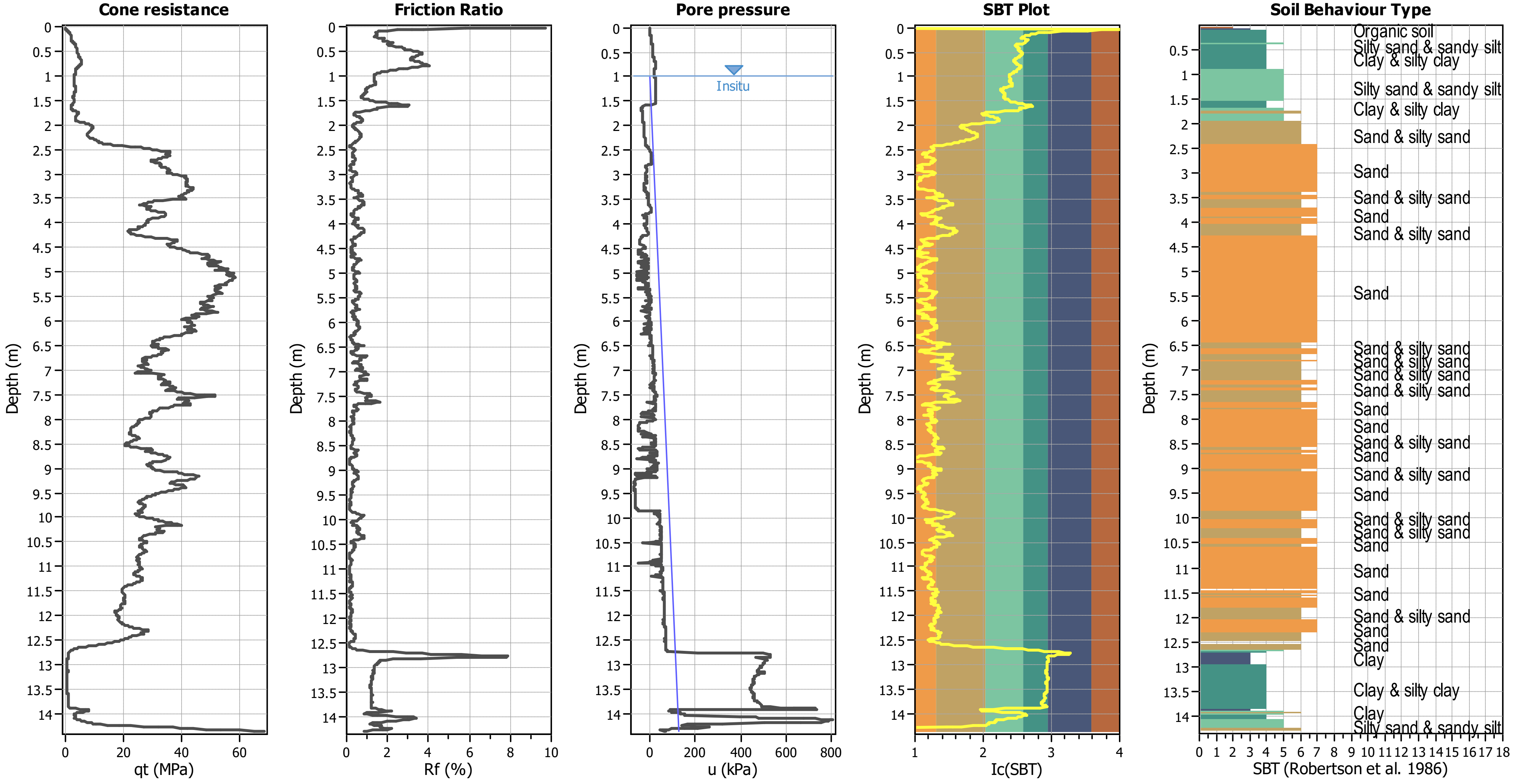
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 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



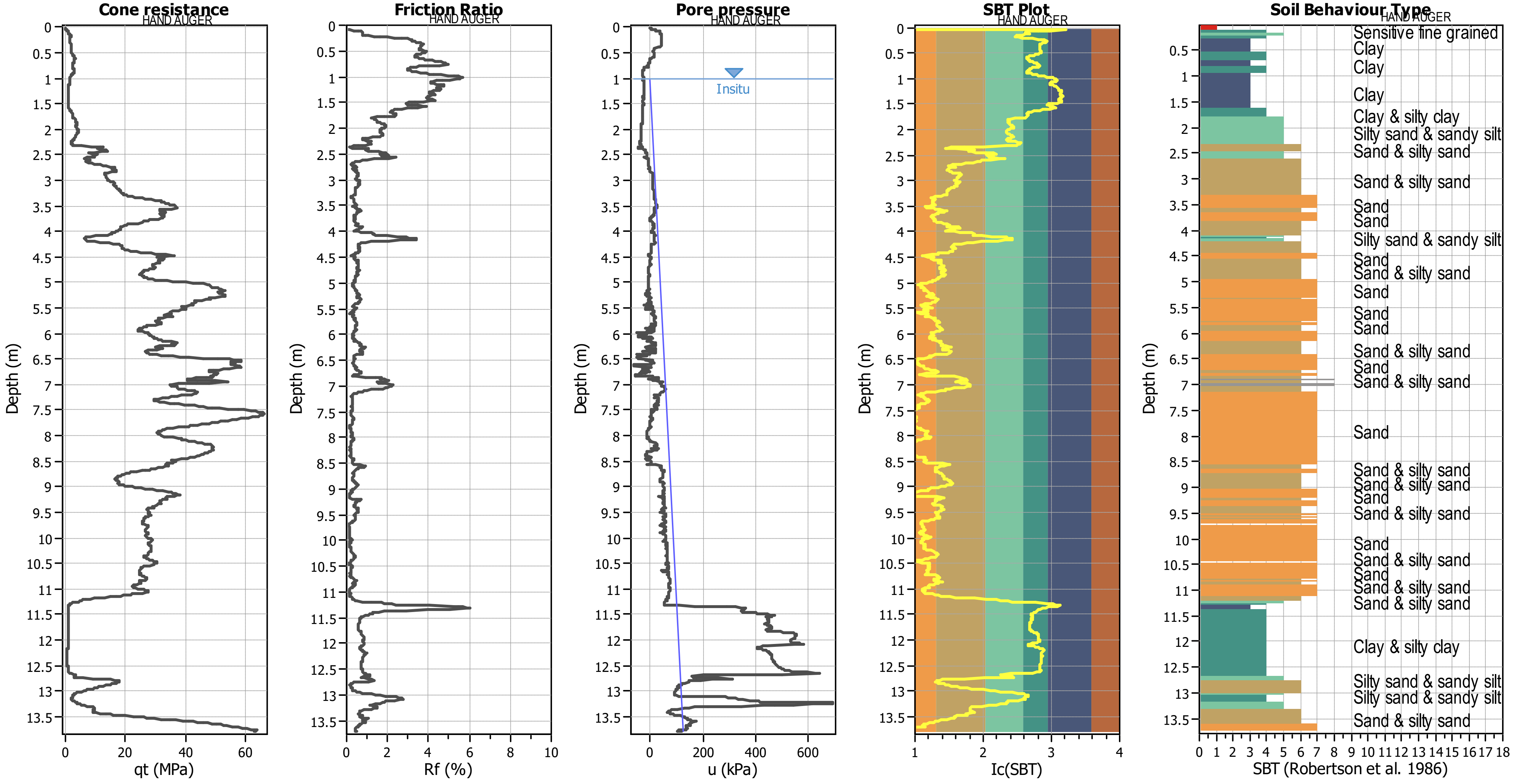
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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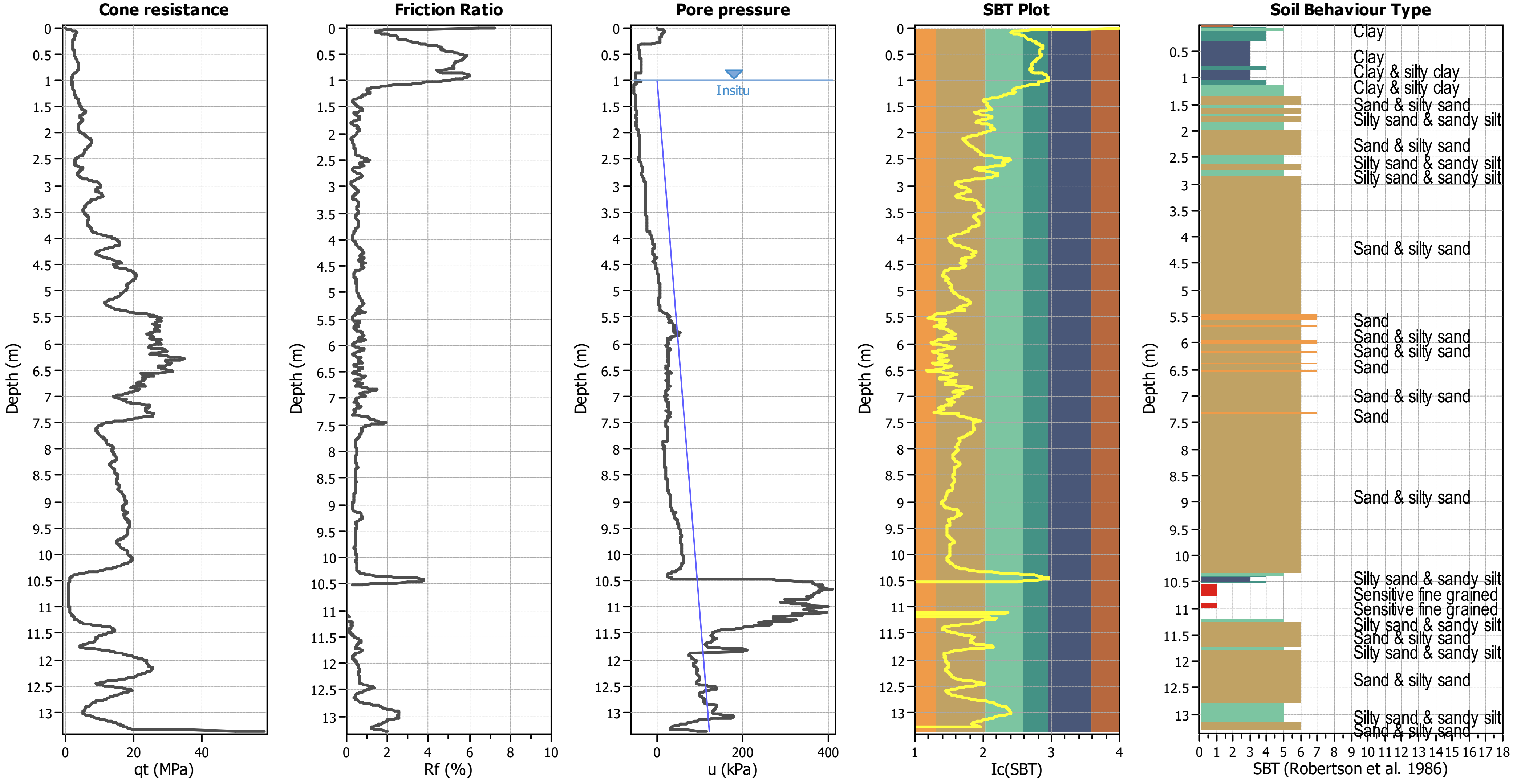
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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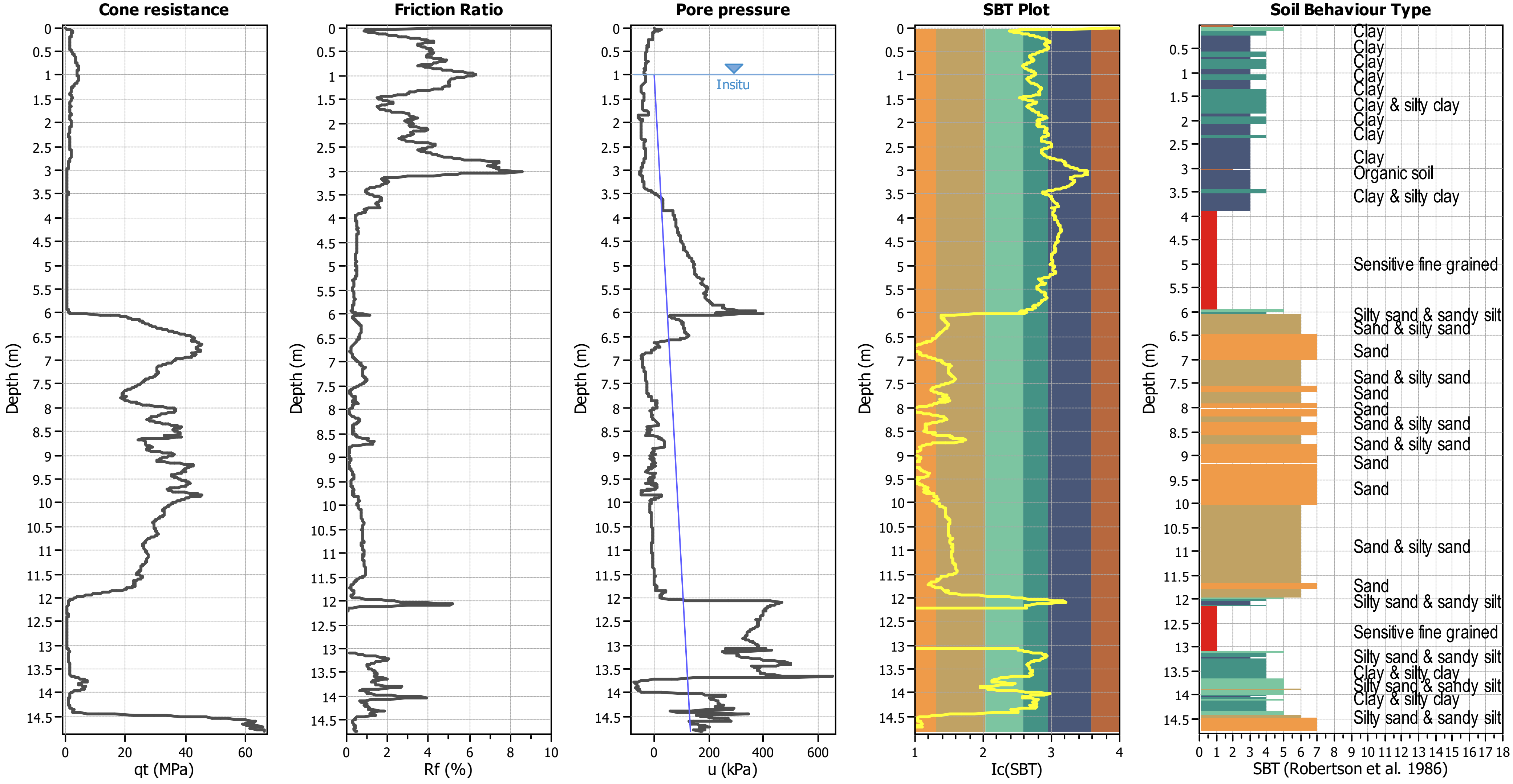
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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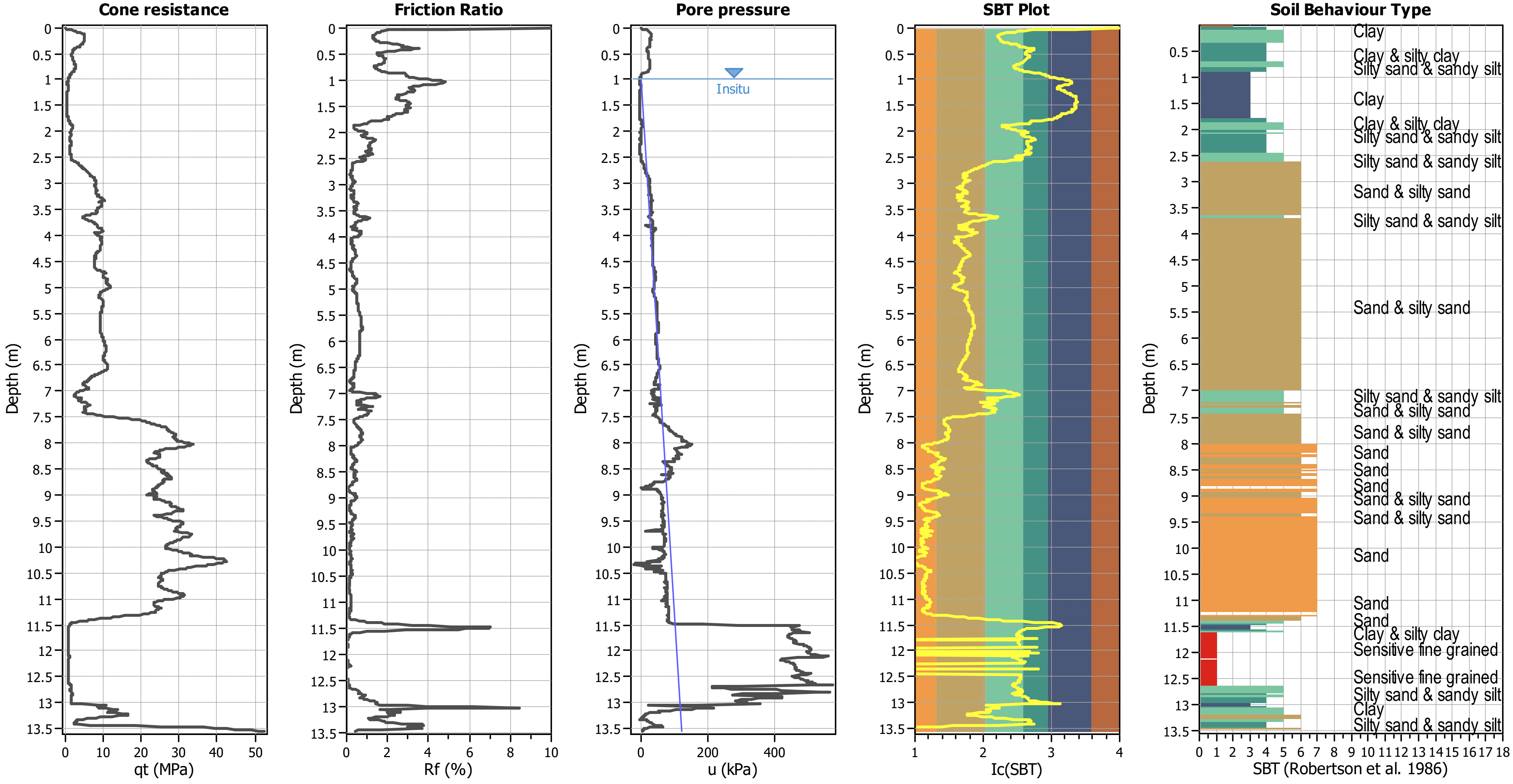
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



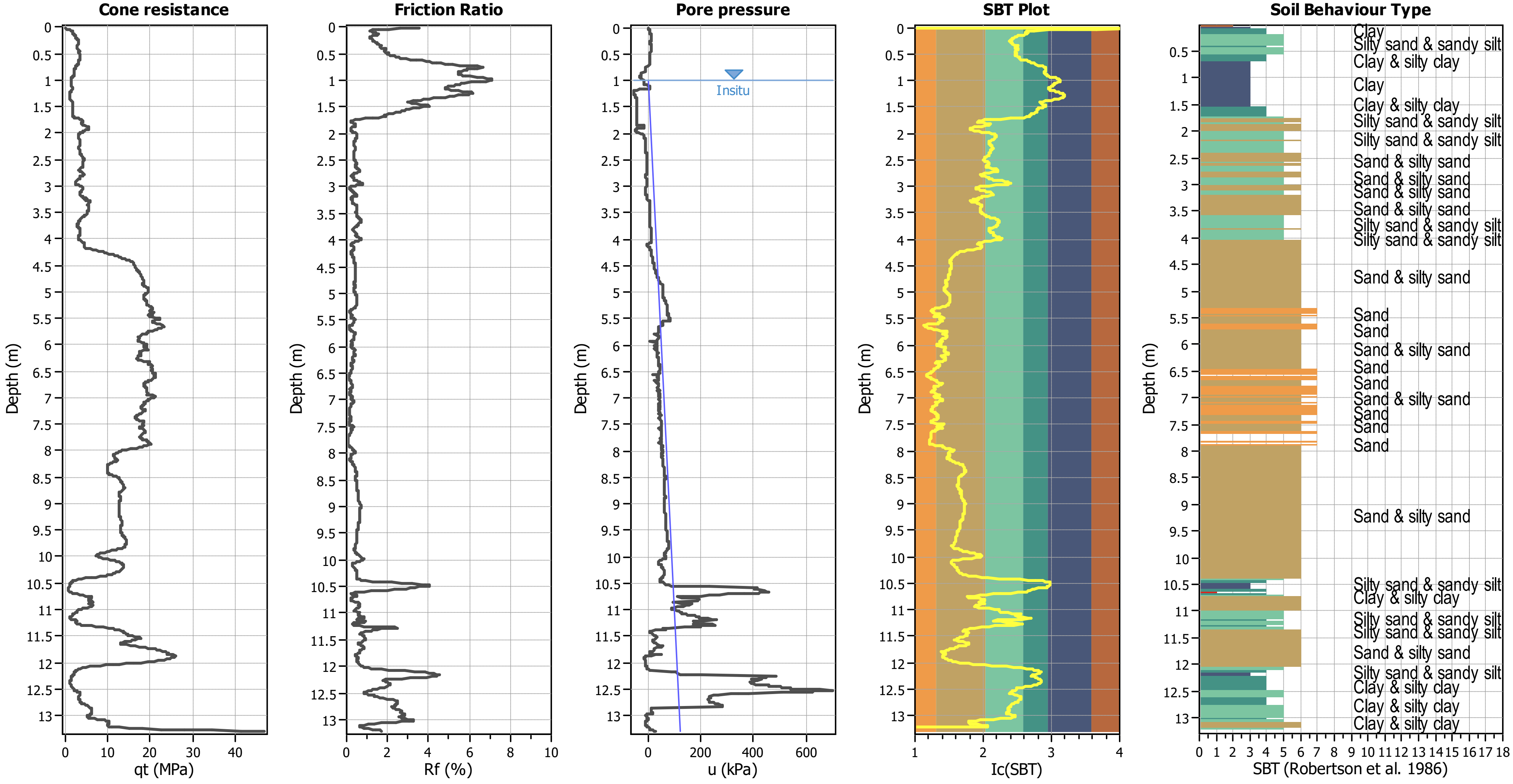
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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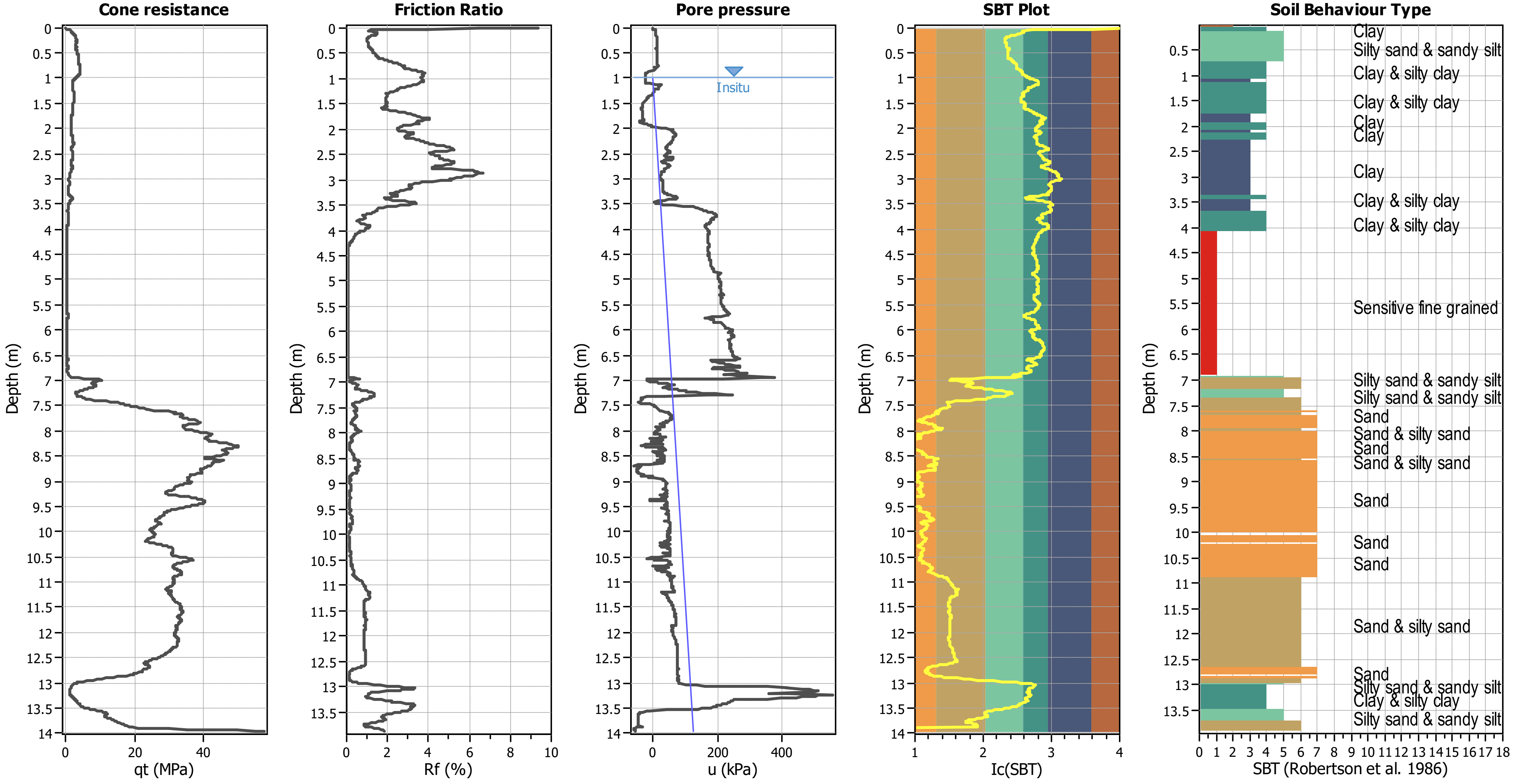
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

CPT basic interpretation plots



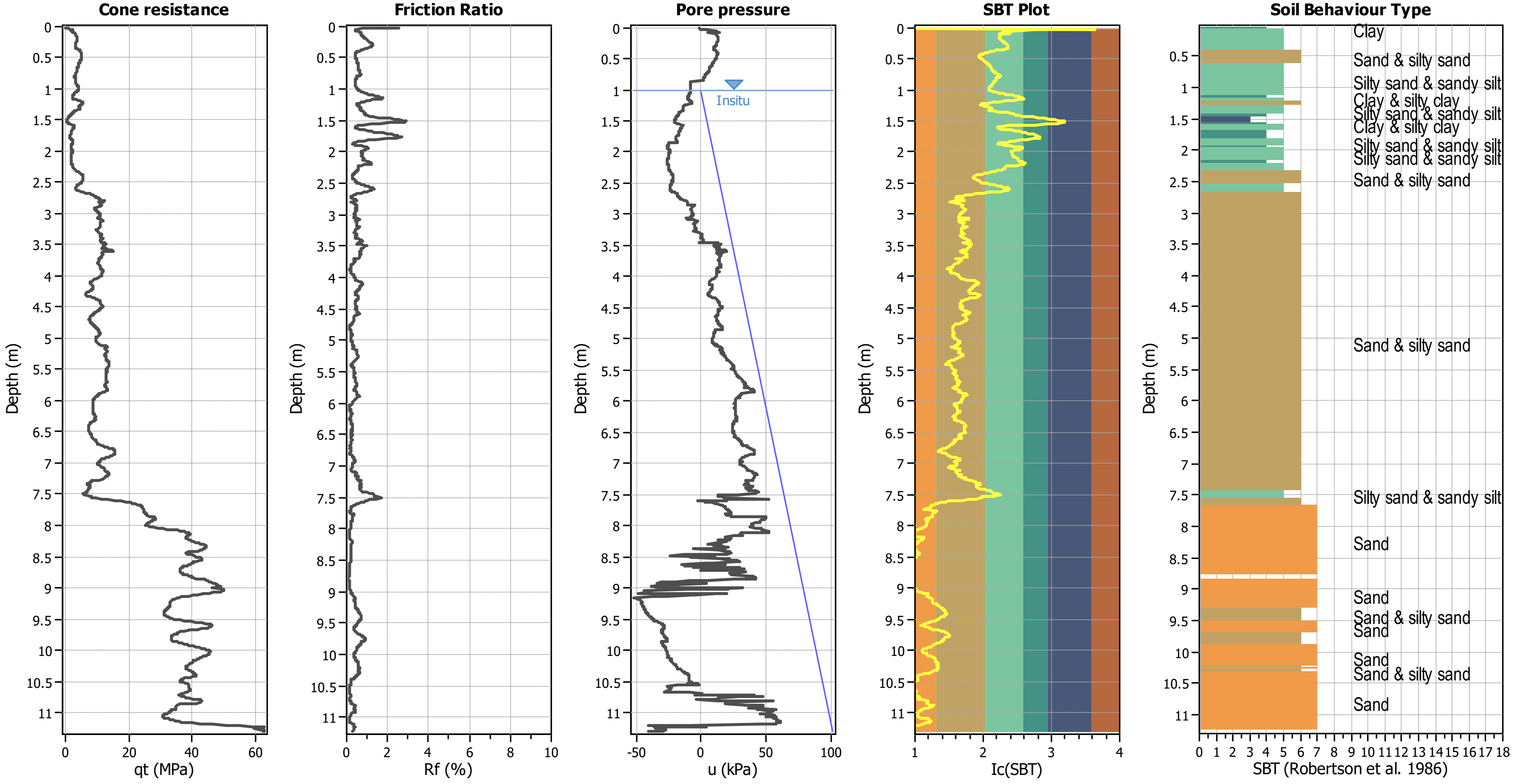
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.35
Depth to water table (insitu): 1.00 m

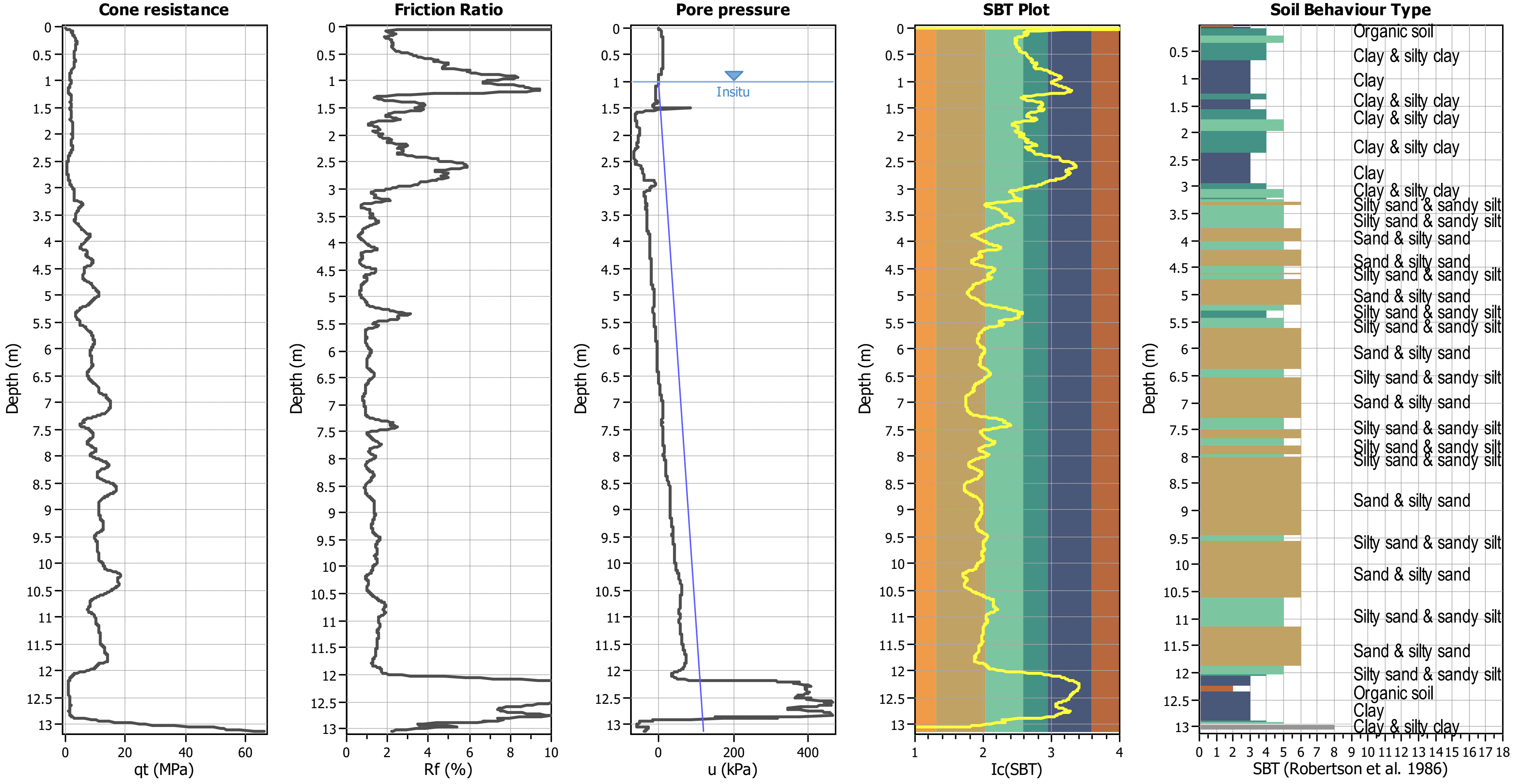
Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
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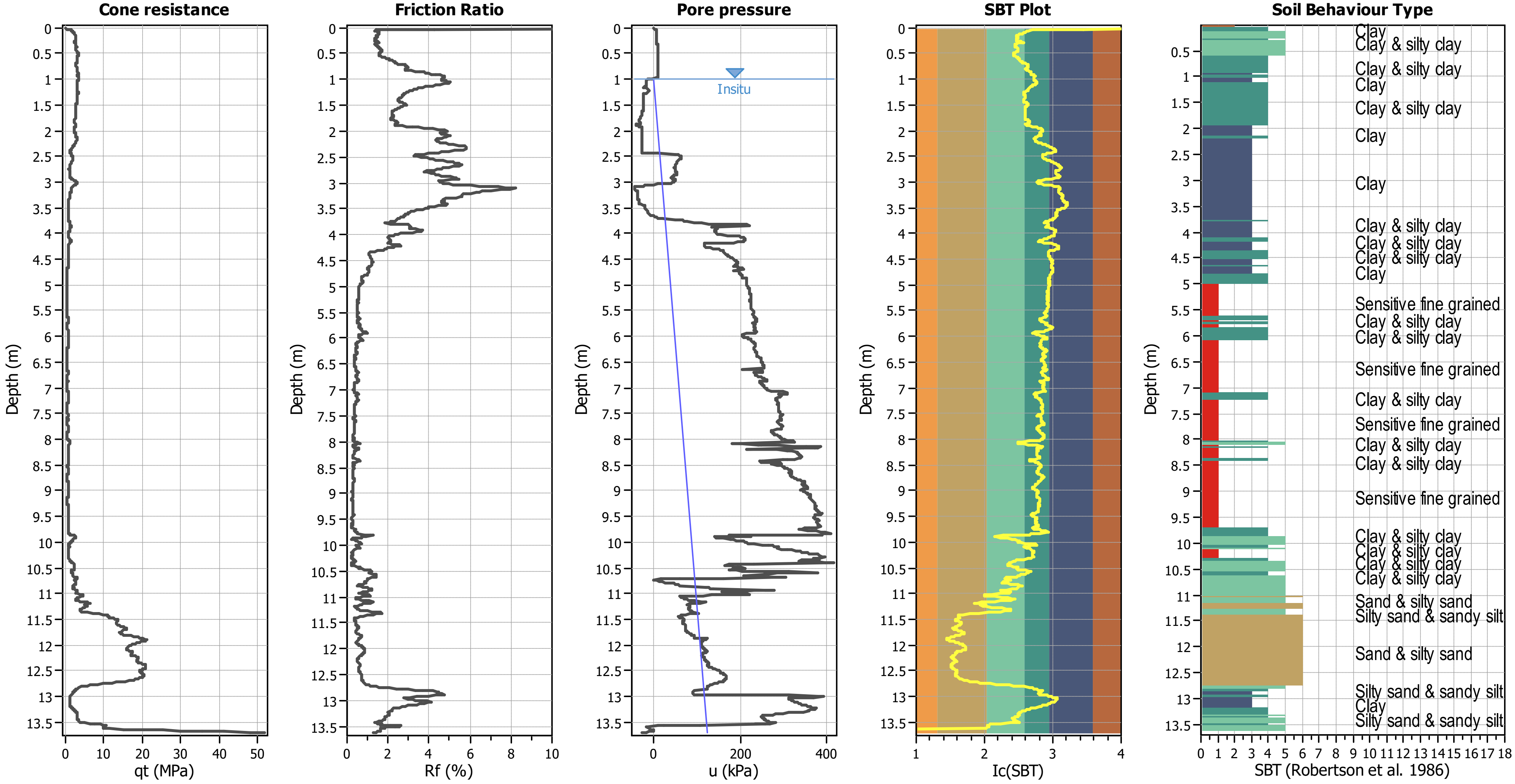
- 🟩 5. Silty sand to sandy silt
- 🟫 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬜ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

CPT basic interpretation plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.35
Depth to water table (insitu): 1.00 m

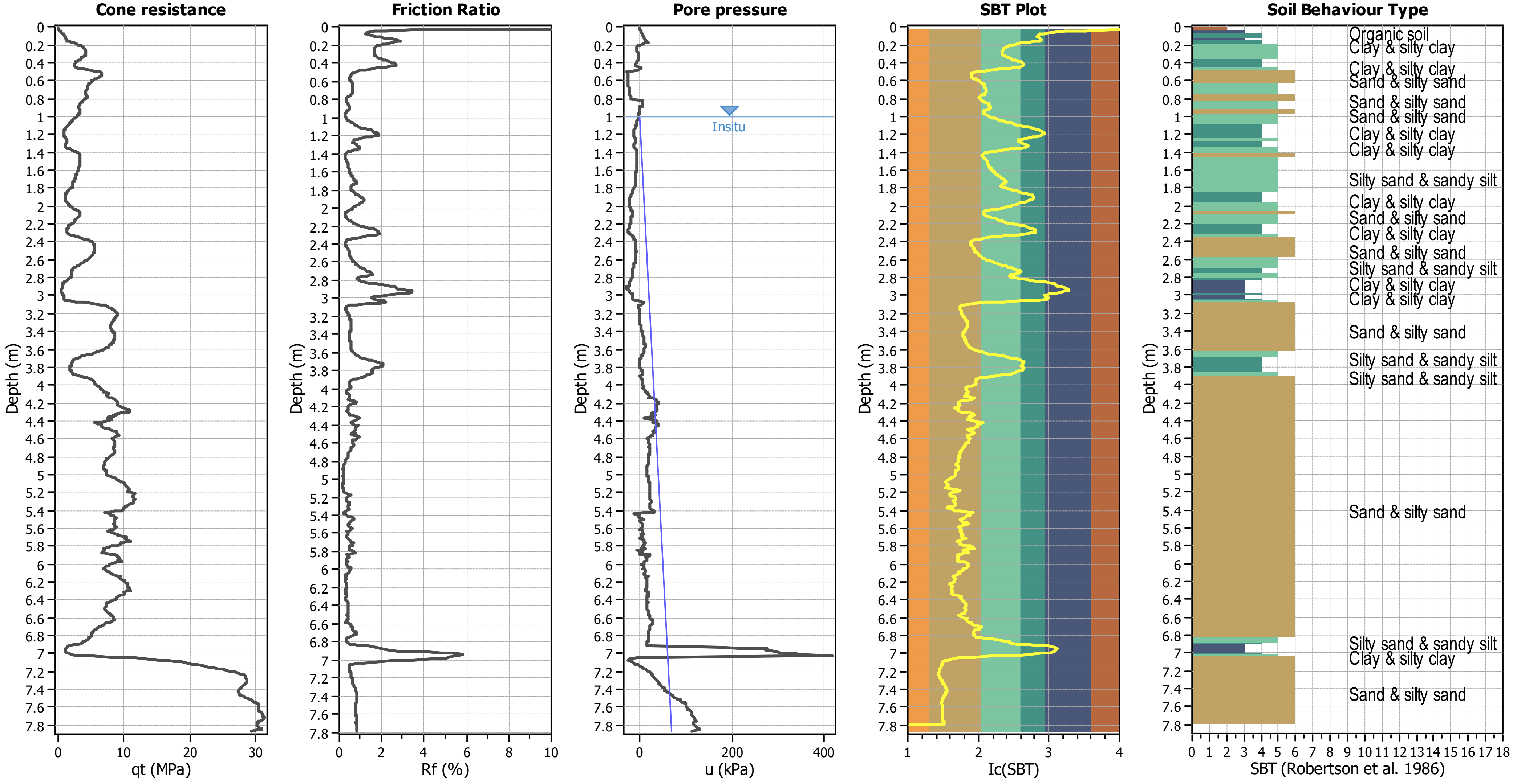
Depth to GWT (erthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: No
K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: No
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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

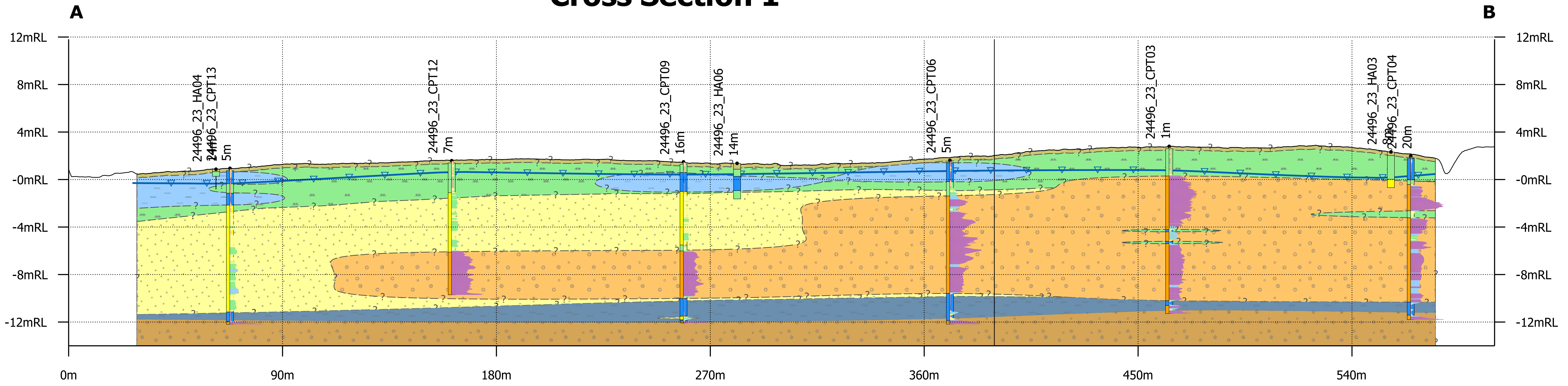
APPENDIX 3:

Ground Model Cross Sections

Plan View

ENGEO Expect Excellence	*Project*	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
	Analysis	Ground Model		
	Drawn By	NN	*Date*	23-Feb-24
	Approved By	NC	*Job Number*	24496

Cross Section 1



Legend

- 🟫 Unit 1: Topsoil
- 🟩 Unit 2: Silt-Sand Mixtures
- 🟩 Unit 8: Silt Lenses
- 🟦 Unit 3: Silt-Clay Mixtures
- 🟨 Unit 4: Sand
- 🟨 Unit 4: Sand
- 🟧 Unit 6: Intermediate Sandy Gravel
- 🟦 Unit 7: Lower Silt-Clay
- 🟫 Unit 8: Dense Gravel

CPT Tip Resistance (MPa)

- 🟥 ≤ 2.5
- 🟧 ≤ 5
- 🟨 ≤ 10
- 🟩 ≤ 15
- 🟦 ≤ 20
- 🟪 > 20

—▽— Approx. Groundwater Table

Scale: 1:1,500

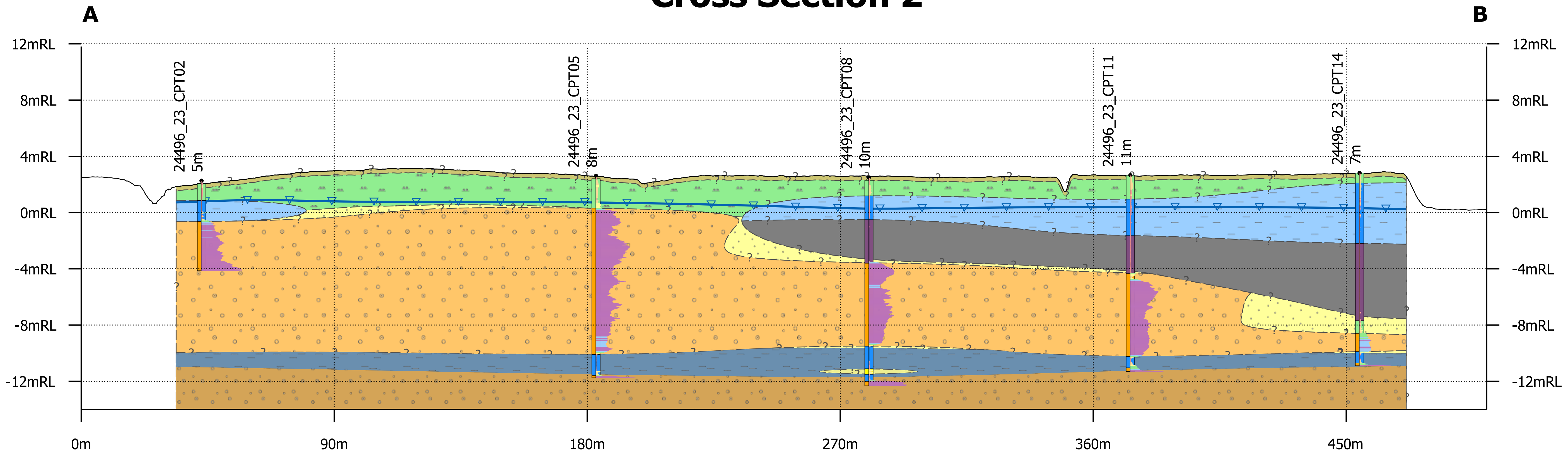
Vertical exaggeration: 5x

0m 50m

ENGEO
Expect Excellence

Project	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
Analysis	Ground Model		
Drawn By	NN	*Date*	23-Feb-24
Approved By	NC	*Job Number*	24496

Cross Section 2



Legend

- 🟨 Unit 1: Topsoil
- 🟩 Unit 2: Silt-Sand Mixtures
- 🟦 Unit 3: Silt-Clay Mixtures
- 🟨 Unit 4: Sand
- 🟨 Unit 4: Sand
- ⬛ Unit 5: Sensitive Fine-grained
- 🟧 Unit 6: Intermediate Sandy Gravel
- 🟦 Unit 7: Lower Silt-Clay
- 🟫 Unit 8: Dense Gravel

CPT Tip Resistance (MPa)

- 🟥 ≤ 2.5
- 🟧 ≤ 5
- 🟨 ≤ 10
- 🟩 ≤ 15
- 🟦 ≤ 20
- 🟪 > 20

Approx. Groundwater Table

Scale: 1:1,500

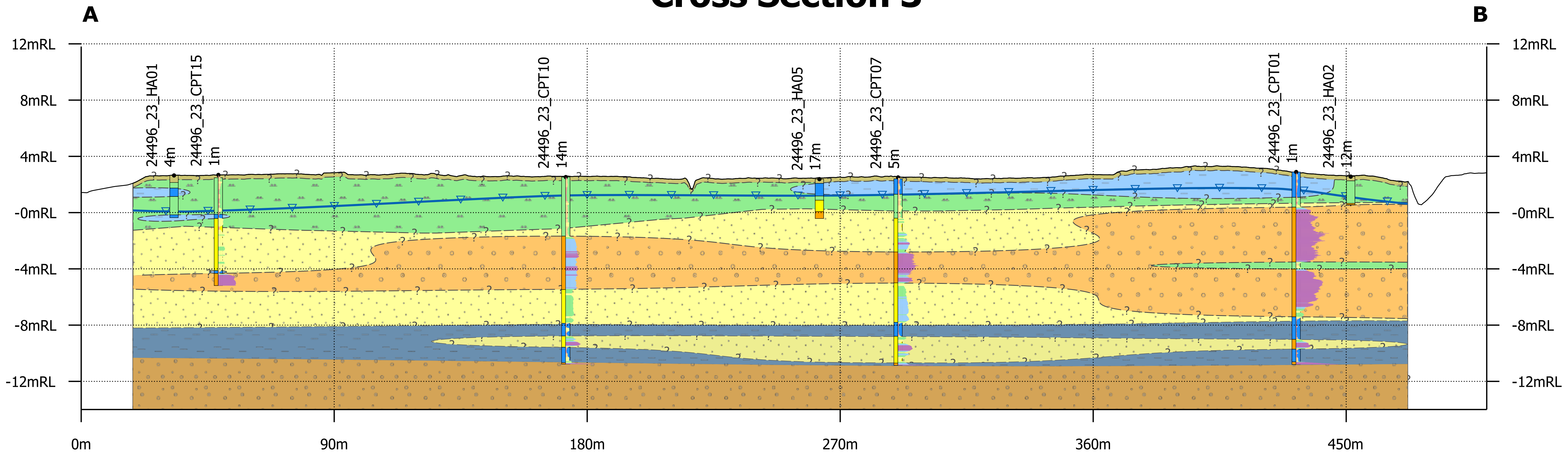
Vertical exaggeration: 5x

0m 50m

ENGEO
Expect Excellence

Project	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
Analysis	Ground Model		
Drawn By	NN	*Date*	23-Feb-24
Approved By	NC	*Job Number*	24496

Cross Section 3



Legend

- 🟫 Unit 1: Topsoil
- 🟩 Unit 2: Silt-Sand Mixtures
- 🟩 Unit 8: Silt Lenses
- 🟦 Unit 3: Silt-Clay Mixtures
- 🟨 Unit 4: Sand
- 🟨 Unit 4: Sand
- 🟧 Unit 6: Intermediate Sandy Gravel
- 🟦 Unit 7: Lower Silt-Clay
- 🟫 Unit 8: Dense Gravel

CPT Tip Resistance (MPa)

🟥 ≤ 2.5	🟩 ≤ 15
🟧 ≤ 5	🟦 ≤ 20
🟨 ≤ 10	🟪 > 20

—▽— Approx. Groundwater Table

Scale: 1:1,500

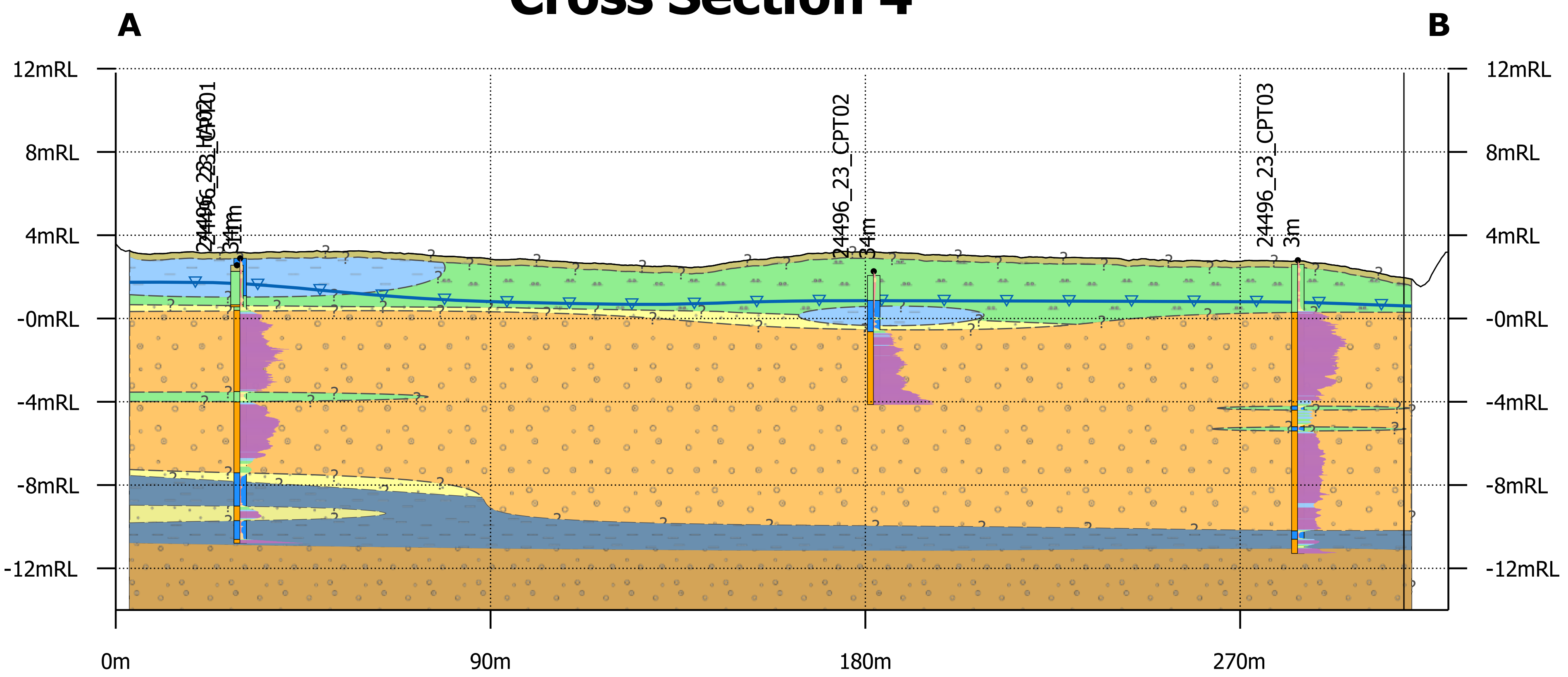
Vertical exaggeration: 5x

0m 50m

ENGEO
Expect Excellence

Project	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
Analysis	Ground Model		
Drawn By	NN	*Date*	23-Feb-24
Approved By	NC	*Job Number*	24496

Cross Section 4



Legend

- 🟨 Unit 1: Topsoil
- 🟩 Unit 2: Silt-Sand Mixtures
- 🟩 Unit 2: Silt Lenses
- 🟦 Unit 3: Silt-Clay Mixtures
- 🟨 Unit 4: Sand
- 🟨 Unit 4: Sand
- 🟧 Unit 6: Intermediate Sandy Gravel
- 🟦 Unit 7: Lower Silt-Clay
- 🟫 Unit 8: Dense Gravel

CPT Tip Resistance (MPa)

🟥 ≤ 2.5	🟨 ≤ 10	🟦 ≤ 20
🟧 ≤ 5	🟩 ≤ 15	🟪 > 20

—▽— Approx. Groundwater Table

Scale: 1:1,500

Vertical exaggeration: 5x

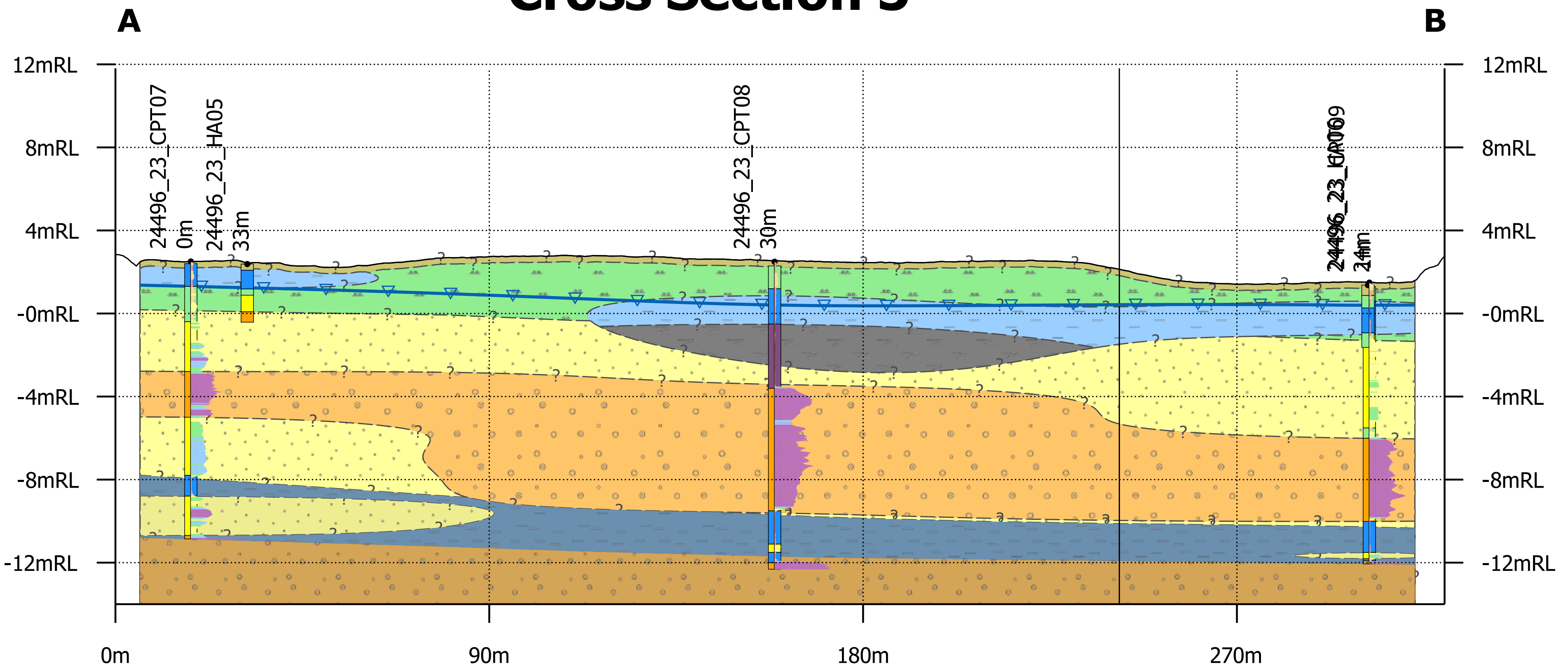
0m 50m

ENGEO

Expect Excellence

Project	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
Analysis	Ground Model		
Drawn By	NN	*Date*	23-Feb-24
Approved By	NC	*Job Number*	24496

Cross Section 5



Legend

- 🟨 Unit 1: Topsoil
- 🟩 Unit 2: Silt-Sand Mixtures
- 🟦 Unit 3: Silt-Clay Mixtures
- 🟨 Unit 4: Sand
- 🟨 Unit 4: Sand
- ⬛ Unit 5: Sensitive Fine-Grained
- 🟧 Unit 6: Intermediate Sandy Gravel
- 🟦 Unit 7: Lower Silt-Clay
- 🟫 Unit 8: Dense Gravel

CPT Tip Resistance (MPa)

🟥 ≤ 2.5	🟨 ≤ 10	🟦 ≤ 20
🟧 ≤ 5	🟩 ≤ 15	🟪 > 20

Approx. Groundwater Table

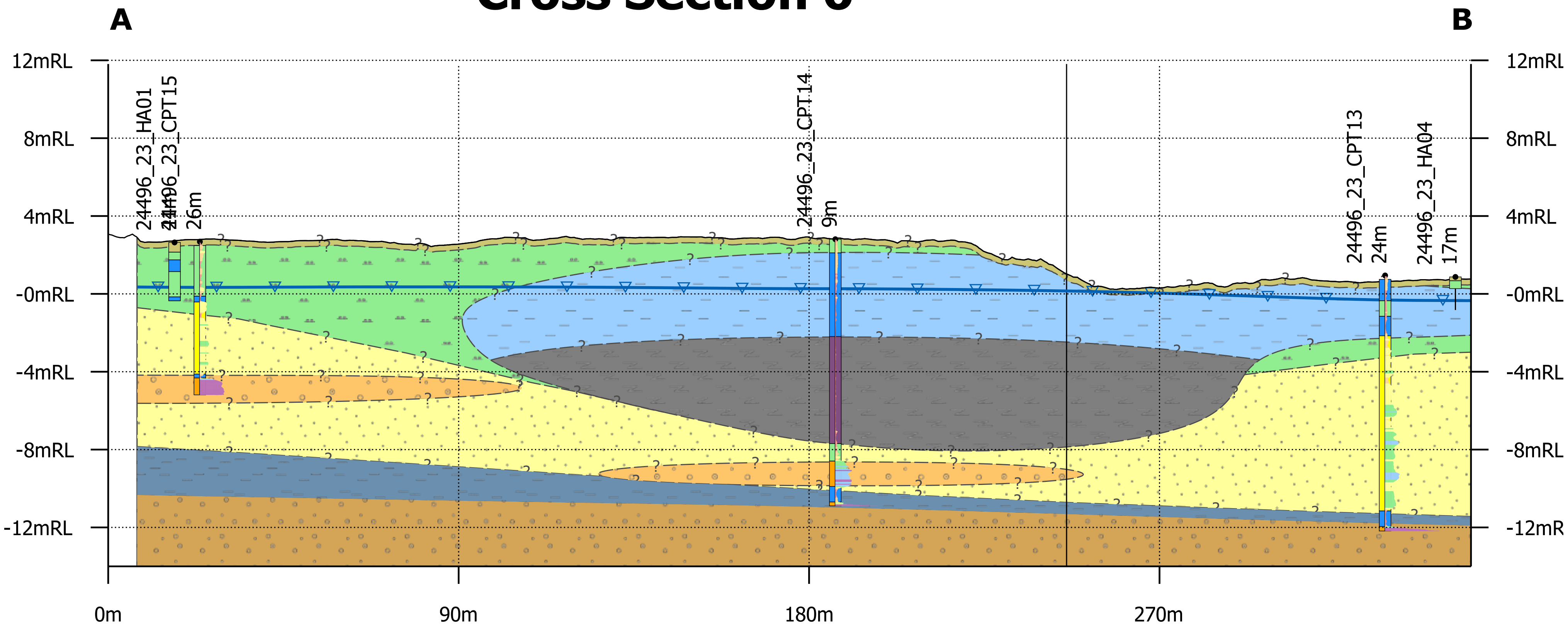
Scale: 1:1,500

Vertical exaggeration: 5x

0m 50m

ENGEO Expect Excellence	*Project*	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
	Analysis	Ground Model		
	Drawn By	NN	*Date*	23-Feb-24
	Approved By	NC	*Job Number*	24496

Cross Section 6



Legend

🟨 Unit 1: Topsoil
🟩 Unit 2: Silt-Sand Mixtures
🟦 Unit 3: Silt-Clay Mixtures
🟨 Unit 4: Sand
⬛ Unit 5: Sensitive Fine-Grained
🟧 Unit 6: Intermediate Sandy Gravel
🟦 Unit 7: Lower Silt-Clay
🟫 Unit 8: Dense Gravel

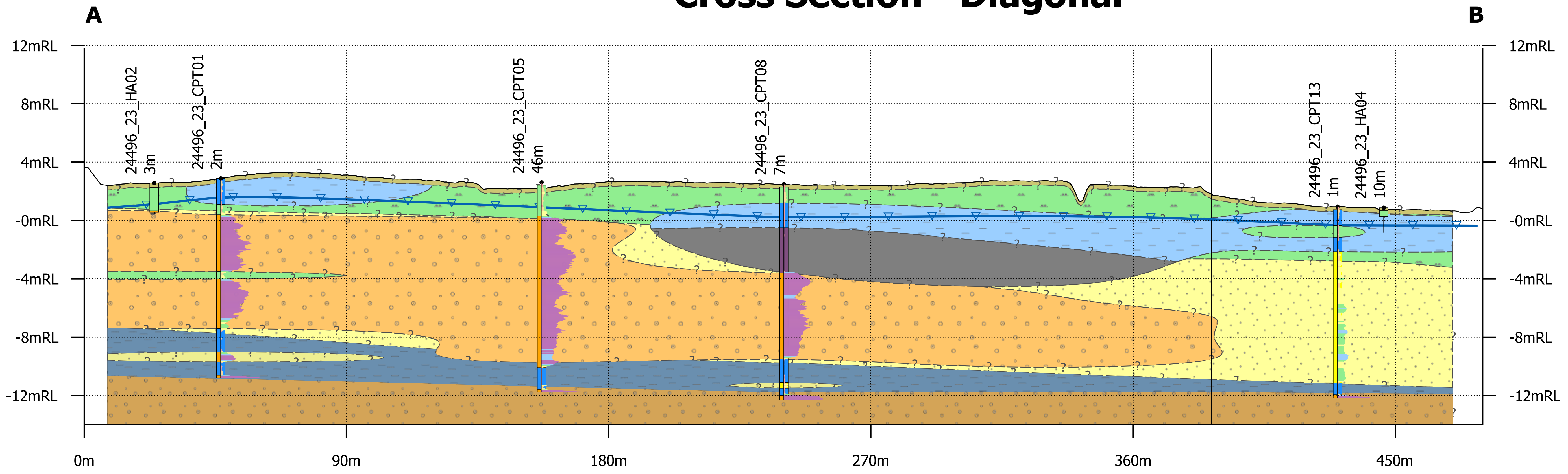
CPT Tip Resistance (MPa)
🟥 ≤ 2.5
🟧 ≤ 5
🟨 ≤ 10
🟩 ≤ 15
🟦 ≤ 20
🟪 > 20

Approx. Groundwater Table

Scale: 1:1,500
Vertical exaggeration: 5x
0m 50m

ENGEO Expect Excellence	*Project*	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
	Analysis	Ground Model		
	Drawn By	NN	*Date*	23-Feb-24
	Approved By	NC	*Job Number*	24496

Cross Section - Diagonal



Legend

- 🟫 Unit 1: Topsoil
- 🟩 Unit 2: Silt-Sand Mixtures
- 🟩 Unit 8: Silt Lenses
- 🟦 Unit 3: Silt-Clay Mixtures
- 🟨 Unit 4: Sand
- 🟨 Unit 4: Sand
- ⬛ Unit 5: Sensitive Fine-grained
- 🟧 Unit 6: Intermediate Sandy Gravel
- 🟦 Unit 7: Lower Silt-Clay
- 🟫 Unit 8: Dense Gravel

CPT Tip Resistance (MPa)

- 🟥 ≤ 2.5
- 🟧 ≤ 5
- 🟨 ≤ 10
- 🟩 ≤ 15
- 🟦 ≤ 20
- 🟪 > 20

Approx. Groundwater Table

Scale: 1:1,500

Vertical exaggeration: 5x

0m 50m

ENGEO Expect Excellence	Project	144 and 170 Main North Road - Geotechnical Investigation for Rezoning Submission		
	Analysis	Ground Model		
	Drawn By	NN	Date	23-Feb-24
	Approved By	NC	Job Number	24496

APPENDIX 4:

Liquefaction Analysis Results

Liquefaction Analysis Results

Analysis Details

Engineer: JM/NN
Date: 8/02/2024
Project Number: 24496
GWT Depth: 1m
Liquefaction Triggering Procedure: Boulanger and Idriss 2014
Volumetric Settlement: Zhang et. al. 2002
Probability of Liquefaction Curve: 16%
Ic cutoff: 2.6
Surface Expression of Liquefaction: Liquefaction Severity Number (LSN)

Ground Conditions Zone Colour Key
Zone 1 and 3
Zone 2a
Zone 2b

Method based on the following:
Boulanger, R.W. and Idriss, I.M. (2014). "CPT and SPT based liquefaction triggering procedures". Department of Civil & Environmental Engineering, College of Engineering, University of California at Davis. April 2014.

Zhang, G., Robertson, P. K., & Brachman, R. (2002). Estimating Liquefaction Induced Ground Settlements from the CPT. 39, 1168-1180.

Analysis using Seismic Parameters from MBIE Geotechnical Earthquake Guidance - Module 1 (2021)

		Liquefaction Analysis Results															Performance Categories					
CPT ID	Ground Conditions Zone	ULS - 1 in 500 yr Return Period, M7.5, PGA=0.35g			SLS - 1 in 25 yr Return Period, M6, PGA=0.19g			ILS 1 - 1 in 100 yr Return Period, M7.5, PGA=0.18g			ILS 2 - 1 in 150 yr Return Period, M7.5, PGA=0.2g.			September 2010 EQ - Similar to a 1/150 yr RP EQ, M7.2, PGA=0.21g			MBIE Technical Category (TC)		MfE Planning Guidance Category - ILS is 1 in 100 yr RP			Waimakariri District Council Rule - ILS is 1 in 150 yr RP
		LSN	Expression of Liq. from LSN	Vert. Settlement	LSN	Expression of Liq. from LSN	Vert. Settlement	LSN	Expression of Liq. from LSN	Vert. Settlement	LSN	Expression of Liq. from LSN	Vert. Settlement	September LSN	Expression of Liq. from LSN	Estimated Performance From Aerial Photo Review	MBIE Technical Category (TC)	TC on basis of LSN	ULS Performance	ILS Performance	Planning Guidance Category	Volumetric Vertical Settlement
24496_23_CPT01	Zone 1	13	Minor	71	8	Little to none	42	10	Minor	55	11	Minor	61	10	Minor	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	None to Minor	None to Minor	Medium	Less than 100mm
24496_23_CPT02	Zone 1	15	Minor	24	9	Little to none	16	12	Minor	19	14	Minor	22	12	Minor	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	Minor to Moderate	None to Minor	Medium	Less than 100mm
24496_23_CPT03	Zone 1	23	Moderate	53	8	Little to none	18	12	Minor	27	16	Minor	36	12	Minor	No obvious signs of liquefaction ejecta	TC2	TC2	Minor to Moderate	None to Minor	Medium	Less than 100mm
24496_23_CPT04	Zone 1	9	Little to none	42	7	Little to none	23	8	Little to none	29	8	Little to none	32	7	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	None to Minor	None to Minor	Medium	Less than 100mm
24496_23_CPT05	Zone 1	17	Minor	35	3	Little to none	10	5	Little to none	15	8	Little to none	19	6	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	Minor to Moderate	None to Minor	Medium	Less than 100mm
24496_23_CPT06	Zone 1	9	Little to none	35	2	Little to none	14	3	Little to none	21	5	Little to none	24	4	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1	None to Minor	None to Minor	Medium	Less than 100mm
24496_23_CPT07	Zone 2b	33	Moderate to Severe	122	14	Minor	50	19	Minor	71	23	Moderate	84	20	Moderate	No obvious signs of liquefaction ejecta	TC3	TC3	Moderate to Severe	Minor to Moderate	High	Less than 100mm
24496_23_CPT08	Zone 3	7	Little to none	27	2	Little to none	16	4	Little to none	21	6	Little to none	24	4	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1	None to Minor	None to Minor	Medium	Less than 100mm
24496_23_CPT09	Zone 2a	31	Moderate to Severe	129	17	Minor	61	21	Moderate	81	23	Moderate	92	21	Moderate	Major Liquefaction	TC3	TC3	Moderate to Severe	Minor to Moderate	High	Less than 100mm
24496_23_CPT10	Zone 2b	31	Moderate to Severe	157	24	Moderate	99	27	Moderate	121	29	Moderate	130	32	Moderate to Severe	No obvious signs of liquefaction ejecta	TC3	TC3	Moderate to Severe	Minor to Moderate	High	Greater than 100mm
24496_23_CPT11	Zone 3	20	Moderate	76	11	Minor	55	12	Minor	61	15	Minor	65	20	Moderate	No obvious signs of liquefaction ejecta	TC3	TC2	Minor to Moderate	None to Minor	Medium	Less than 100mm
24496_23_CPT12	Zone 2a	33	Moderate to Severe	96	14	Minor	39	19	Minor	56	23	Moderate	66	20	Moderate	Major Liquefaction	TC2	TC3	Moderate to Severe	Minor to Moderate	High	Less than 100mm
24496_23_CPT13	Zone 2a	33	Moderate to Severe	155	9	Little to none	28	17	Minor	61	22	Moderate	83	17	Minor	Major Liquefaction	TC3	TC3	Moderate to Severe	Minor to Moderate	High	Less than 100mm
24496_23_CPT14	Zone 3	15	Minor	75	2	Little to none	47	4	Little to none	52	6	Little to none	57	7	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	Minor to Moderate	None to Minor	Medium	Less than 100mm
24496_23_CPT15	Zone 2b	43	Major	127	26	Moderate	73	32	Moderate to Severe	95	37	Moderate to Severe	106	33	Moderate to Severe	No obvious signs of liquefaction ejecta	TC3	TC3	Moderate to Severe	Moderate to Severe	High	Greater than 100mm

Analysis using seismic parameters from DZ TS 1170.5:2024

		Liquefaction Analysis Results															Performance Categories					
CPT ID	Ground Conditions Zone	ULS - 1 in 500 yr Return Period, M6.8, PGA=0.39g			SLS - 1 in 25 yr Return Period, M6.4, PGA=0.09g			ILS 1 - 1 in 100 yr Return Period, M6.6, PGA=0.2g			ILS 2 - 1 in 150 yr Return Period, Ground Motions Not Available for This Return Period			September 2010 EQ - Similar to a 1/150 yr RP EQ, M7.2, PGA=0.21g			MBIE Technical Category (TC)		MfE Planning Guidance Liquefaction Vulnerability Category - ILS is 1 in 100 yr RP			Waimakariri District Council Rule - ILS is 1 in 150 yr RP
		LSN	Expression of Liq. from LSN	Vert. Settlement	LSN	Expression of Liq. from LSN	Vert. Settlement	LSN	Expression of Liq. from LSN	Vert. Settlement	LSN	Expression of Liq. from LSN	Vert. Settlement	September LSN	Expression of Liq. from LSN	Estimated Performance From Aerial Photo Review	MBIE Technical Category (TC)	TC on basis of LSN	ULS Performance	ILS Performance	Planning Guidance Category	Volumetric Vertical Settlement > 100mm?
24496_23_CPT01	Zone 1	13	Minor	70	0	Little to none	0	11	Minor	54	Ground Motions not provided in DZ TS 1170.5:2024 for this return interval			10	Minor	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	None to Minor	None to Minor	Medium	Not calculated as seismic loadsing for a 1 in 150 RP are not provided. Based on results from 1 in 100 yr earthquake, expect similar results to current recommended seismic loading.
24496_23_CPT02	Zone 1	16	Minor	24	0	Little to none	0	13	Minor	21				12	Minor	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	Minor to Moderate	None to Minor	Medium	
24496_23_CPT03	Zone 1	23	Moderate	52	0	Little to none	0	13	Minor	28				12	Minor	No obvious signs of liquefaction ejecta	TC2	TC2	Minor to Moderate	None to Minor	Medium	
24496_23_CPT04	Zone 1	9	Little to none	40	0	Little to none	0	8	Little to none	28				7	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1	None to Minor	None to Minor	Medium	
24496_23_CPT05	Zone 1	17	Minor	35	0	Little to none	0	6	Little to none	15				6	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	Minor to Moderate	None to Minor	Medium	
24496_23_CPT06	Zone 1	9	Little to none	35	0	Little to none	0	4	Little to none	20				4	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1	None to Minor	None to Minor	Medium	
24496_23_CPT07	Zone 2b	33	Moderate to Severe	118	0	Little to none	0	20	Moderate	70				20	Moderate	No obvious signs of liquefaction ejecta	TC3	TC3	Moderate to Severe	Minor to Moderate	High	
24496_23_CPT08	Zone 3	7	Little to none	27	0	Little to none	0	4	Little to none	21				4	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1	None to Minor	None to Minor	Medium	
24496_23_CPT09	Zone 2a	31	Moderate to Severe	128	0	Little to none	0	20	Moderate	76				21	Moderate	Major Liquefaction	TC3	TC3	Moderate to Severe	Minor to Moderate	High	
24496_23_CPT10	Zone 2b	31	Moderate to Severe	155	0	Little to none	0	27	Moderate	115				32	Moderate to Severe	No obvious signs of liquefaction ejecta	TC3	TC3	Moderate to Severe	Minor to Moderate	High	
24496_23_CPT11	Zone 3	21	Moderate	76	2	Little to none	11	13	Minor	61				20	Moderate	No obvious signs of liquefaction ejecta	TC2	TC2	Minor to Moderate	None to Minor	Medium	
24496_23_CPT12	Zone 2a	32	Moderate to Severe	93	0	Little to none	0	19	Minor	54				20	Moderate	Major Liquefaction	TC2	TC3	Moderate to Severe	Minor to Moderate	High	
24496_23_CPT13	Zone 2a	32	Moderate to Severe	146	0	Little to none	0	17	Minor	56				17	Minor	Major Liquefaction	TC3	TC3	Moderate to Severe	Minor to Moderate	High	
24496_23_CPT14	Zone 3	15	Minor	75	0	Little to none	8	14	Minor	52				7	Little to none	No obvious signs of liquefaction ejecta	TC2	TC1/TC2	Minor to Moderate	None to Minor	Medium	
24496_23_CPT15	Zone 2b	43	Major	127	0	Little to none	0	33	Moderate to Severe	92				33	Moderate to Severe	No obvious signs of liquefaction ejecta	TC3	TC3	Moderate to Severe	Moderate to Severe	High	

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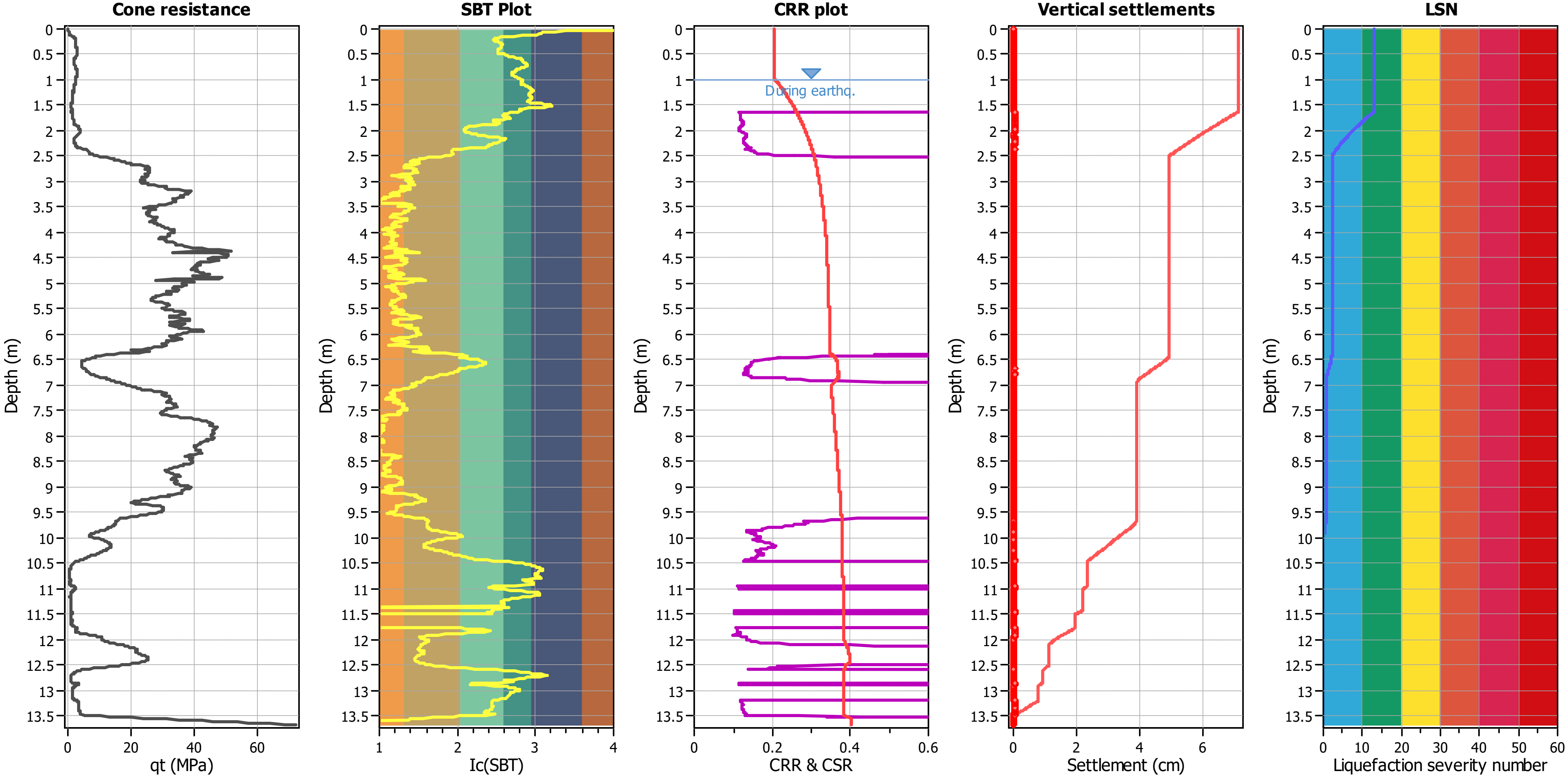
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT01
Total depth: 13.68 m



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Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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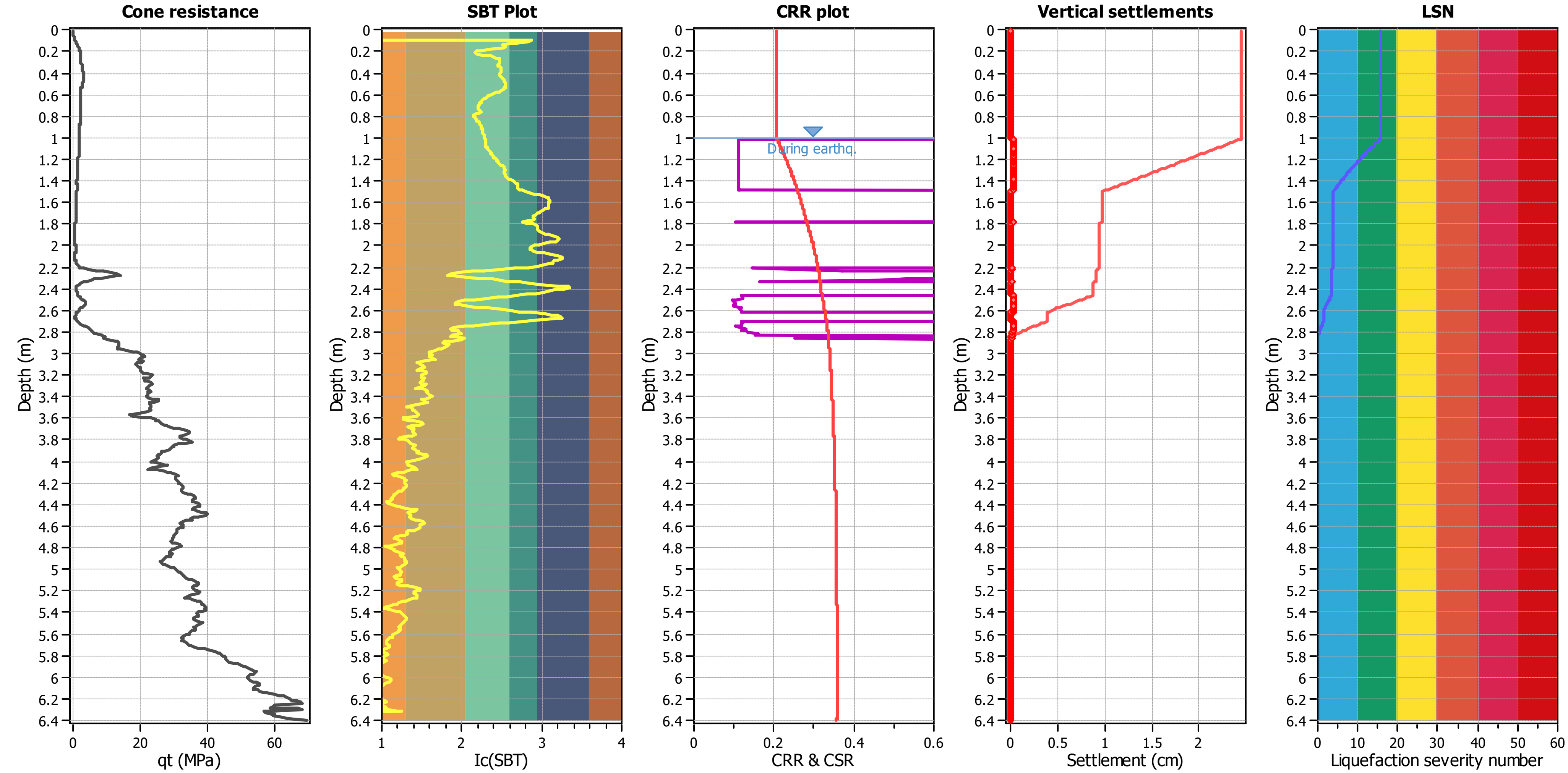
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT02
Total depth: 6.40 m



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Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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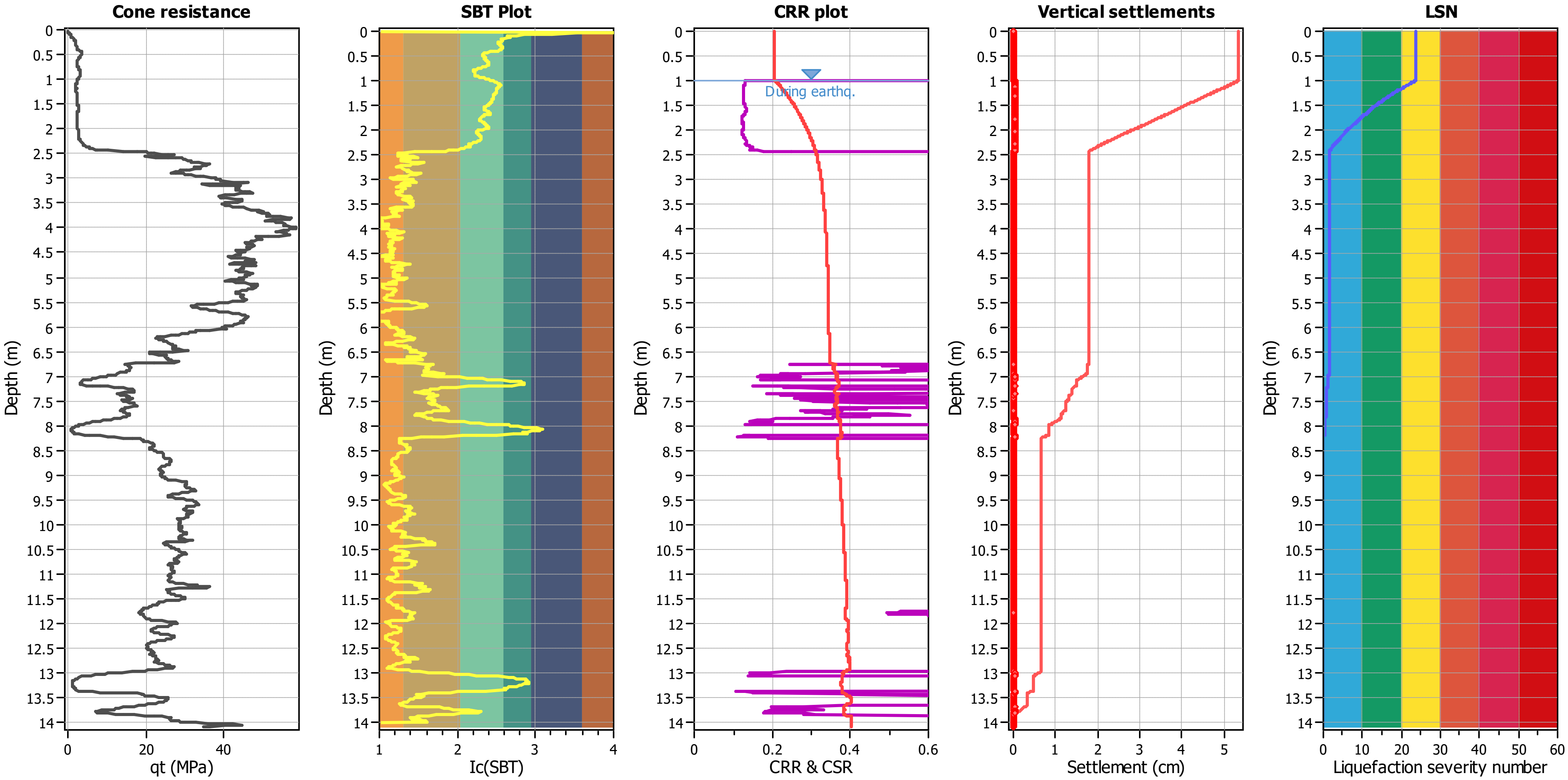
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT03
Total depth: 14.08 m



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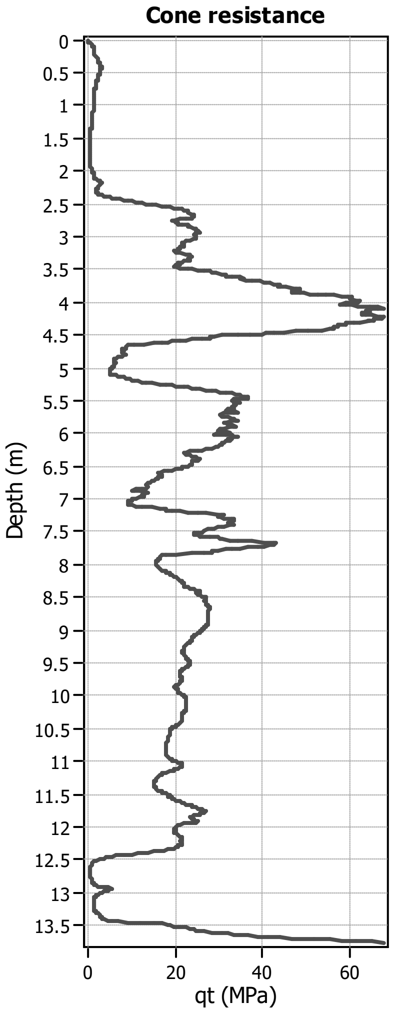
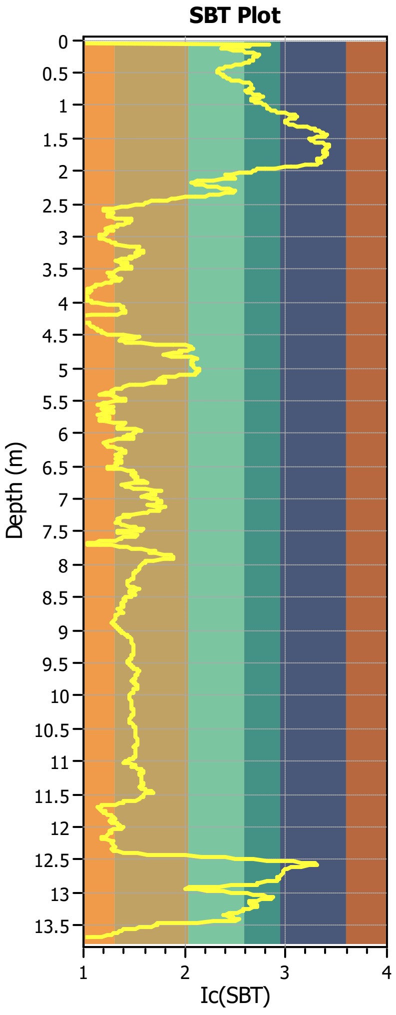
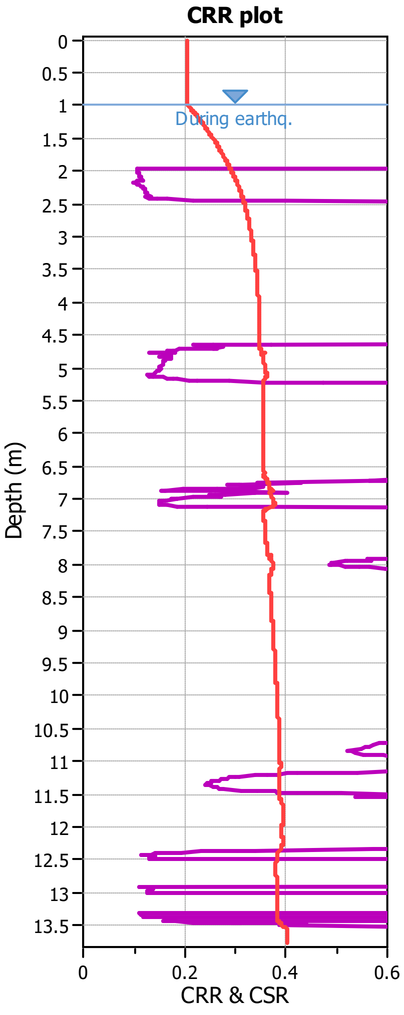
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

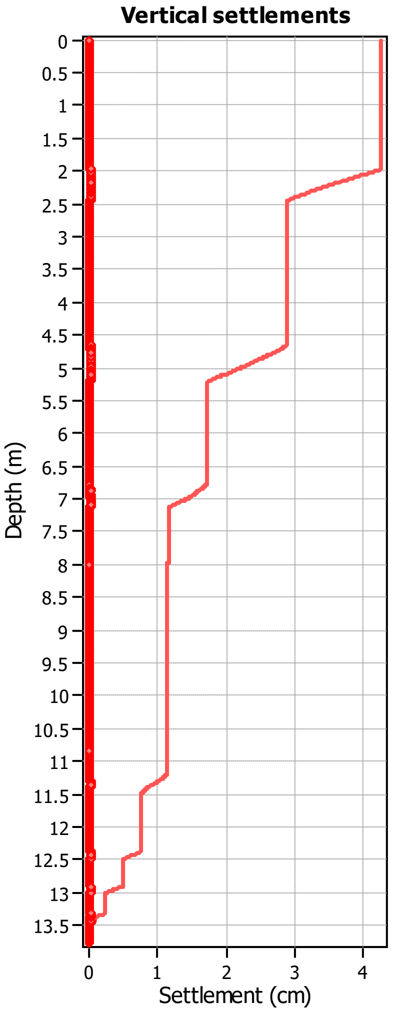
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

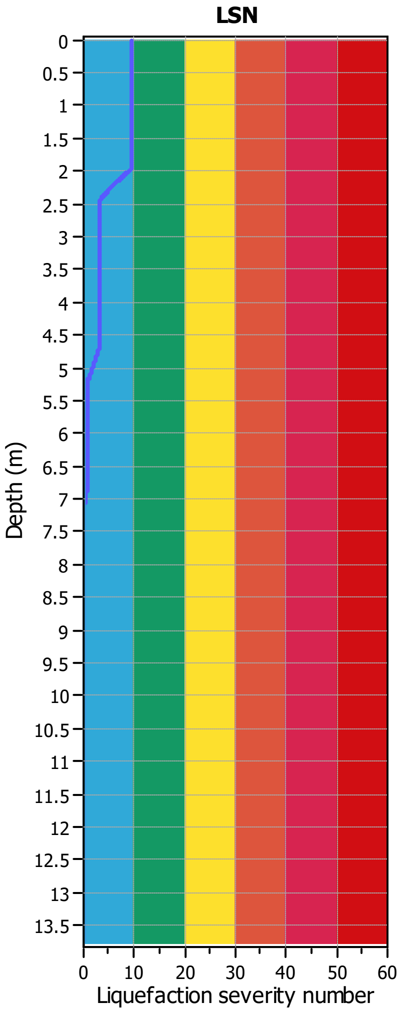
CPT: CPT04
Total depth: 13.77 m


Cone resistance


SBT Plot


CRR plot

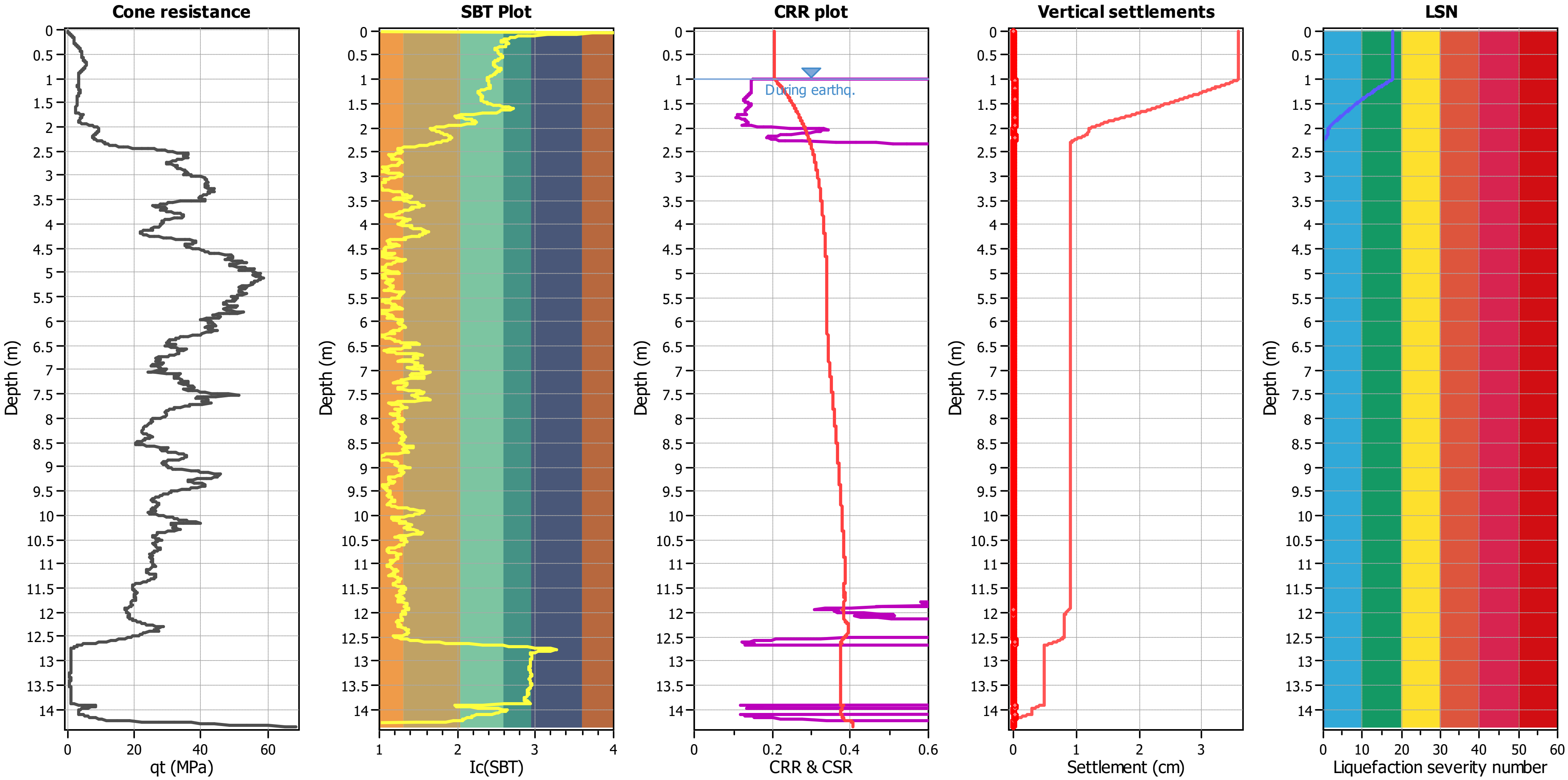

Vertical settlements


LSN

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT05
Total depth: 14.36 m



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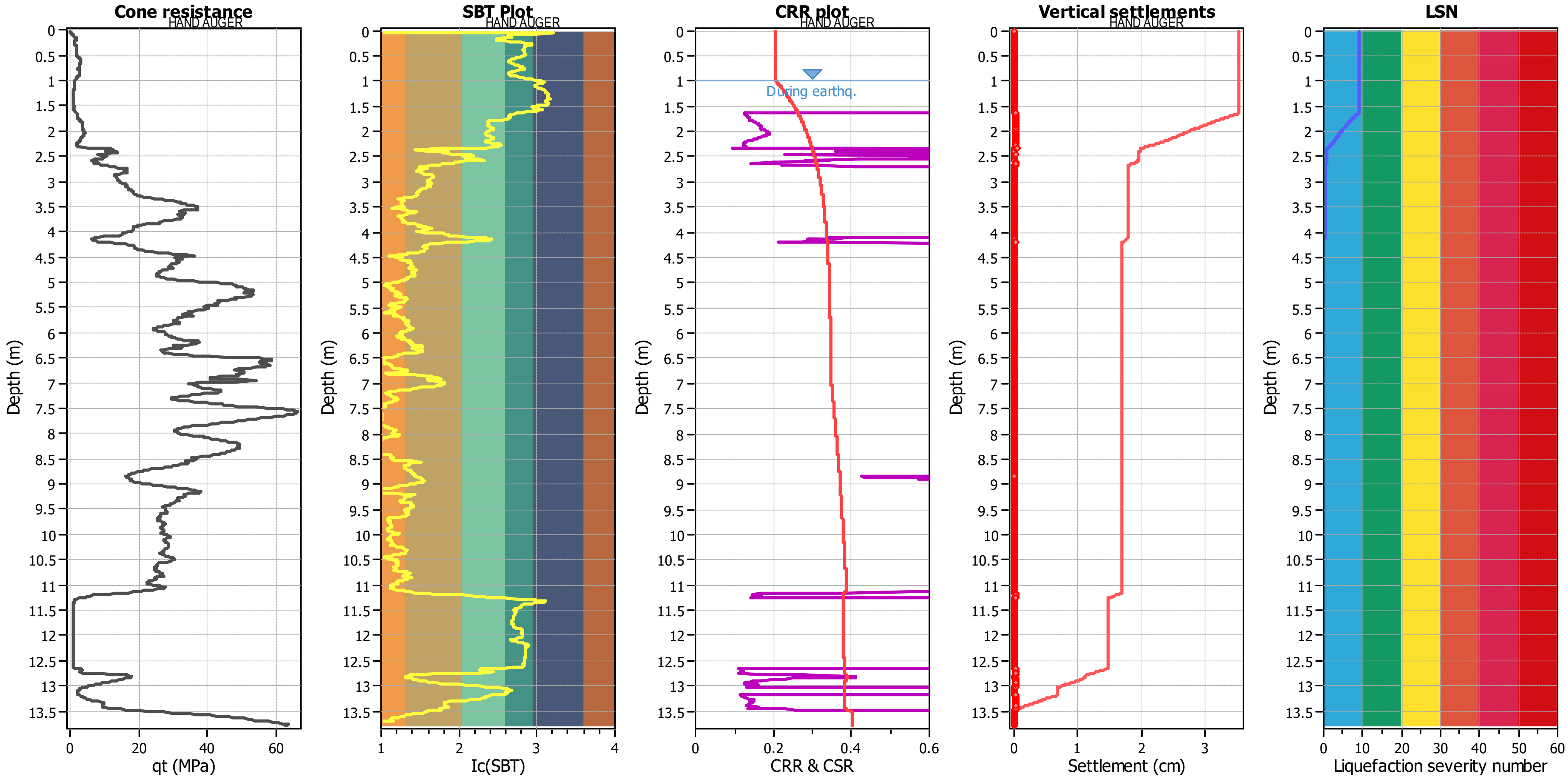
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT06
Total depth: 13.79 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.35

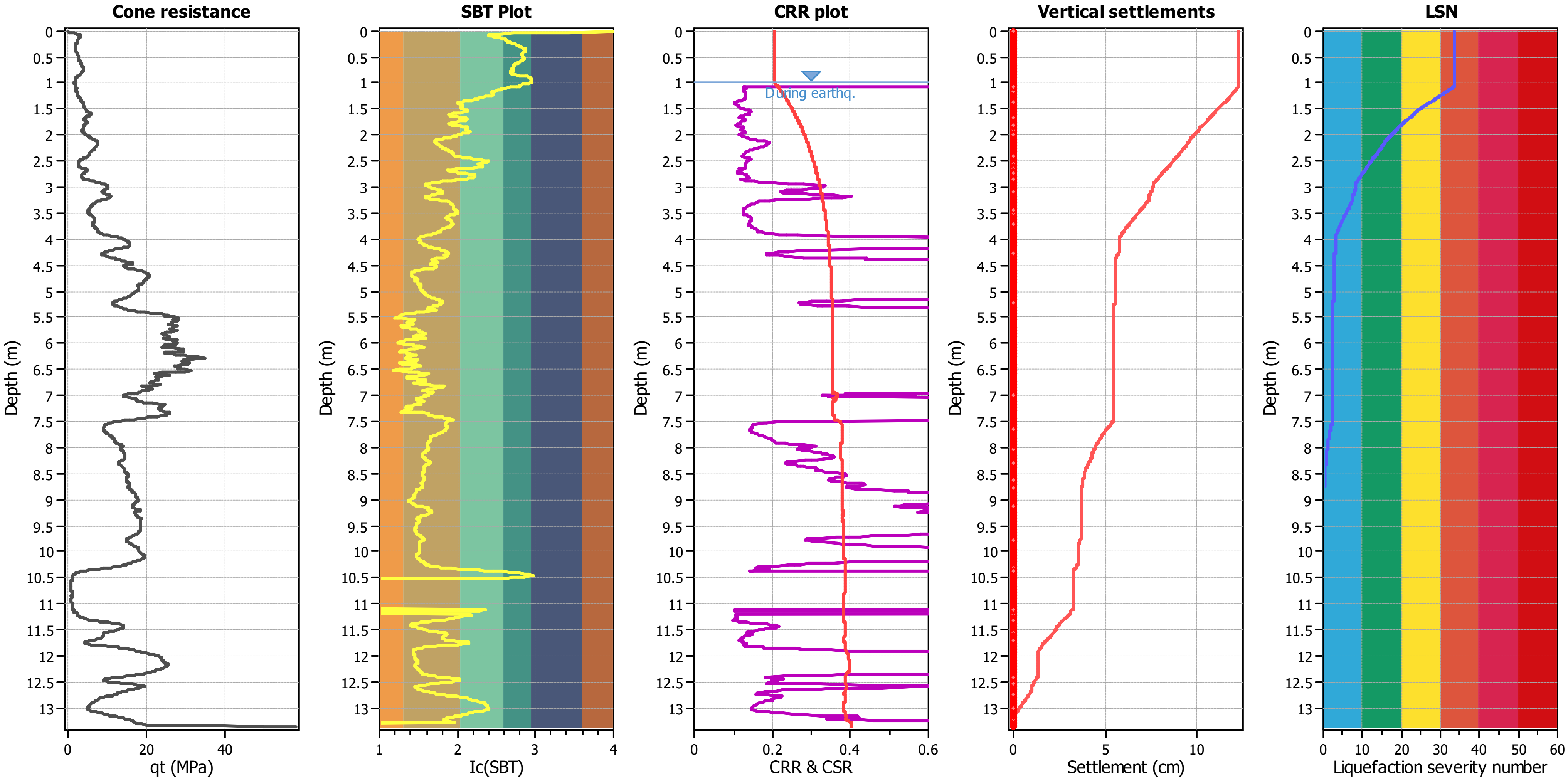
G.W.T. (in-situ): 1.00 m
G.W.T. (earthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT07
Total depth: 13.36 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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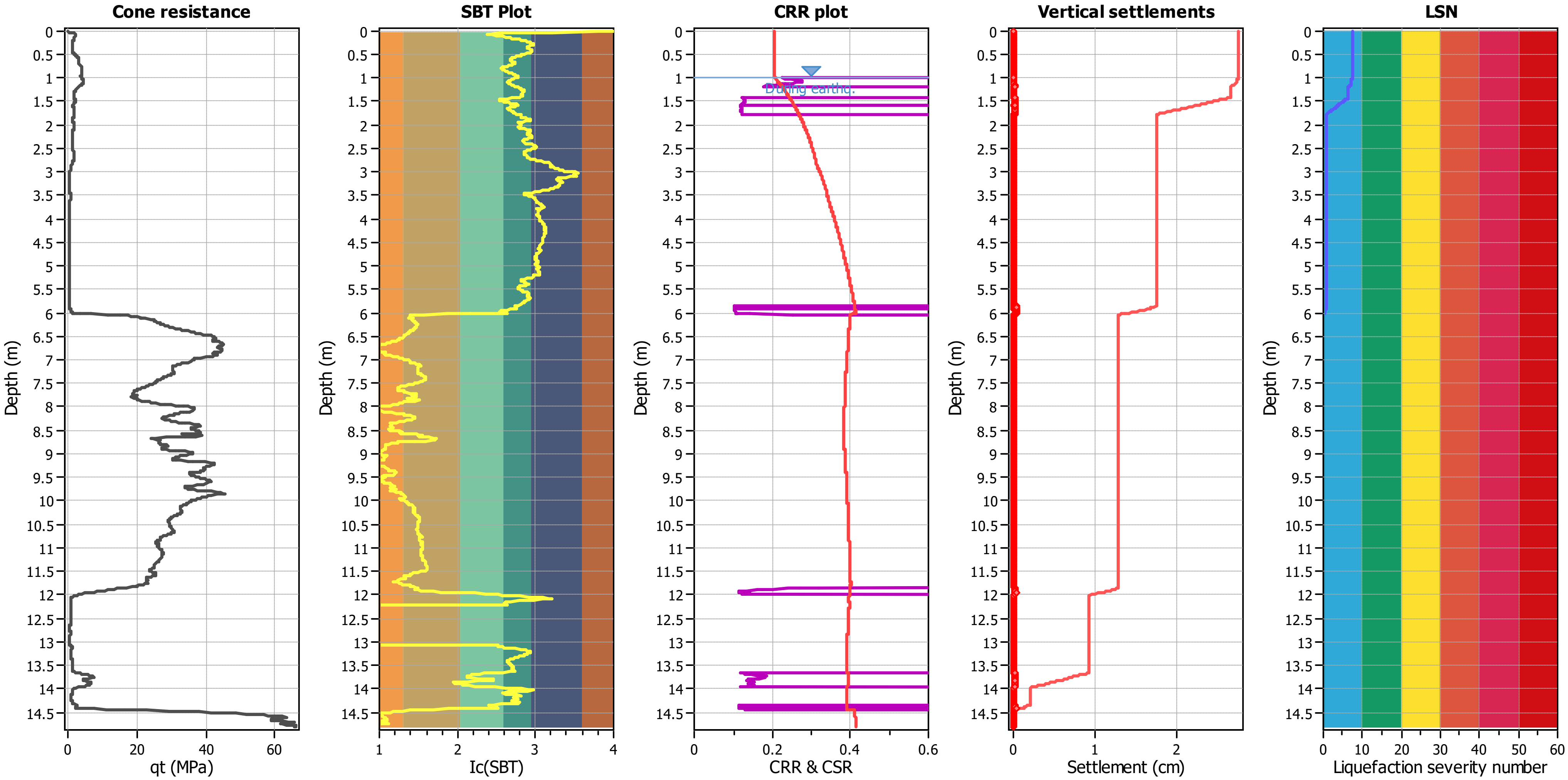
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT08
Total depth: 14.81 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.35

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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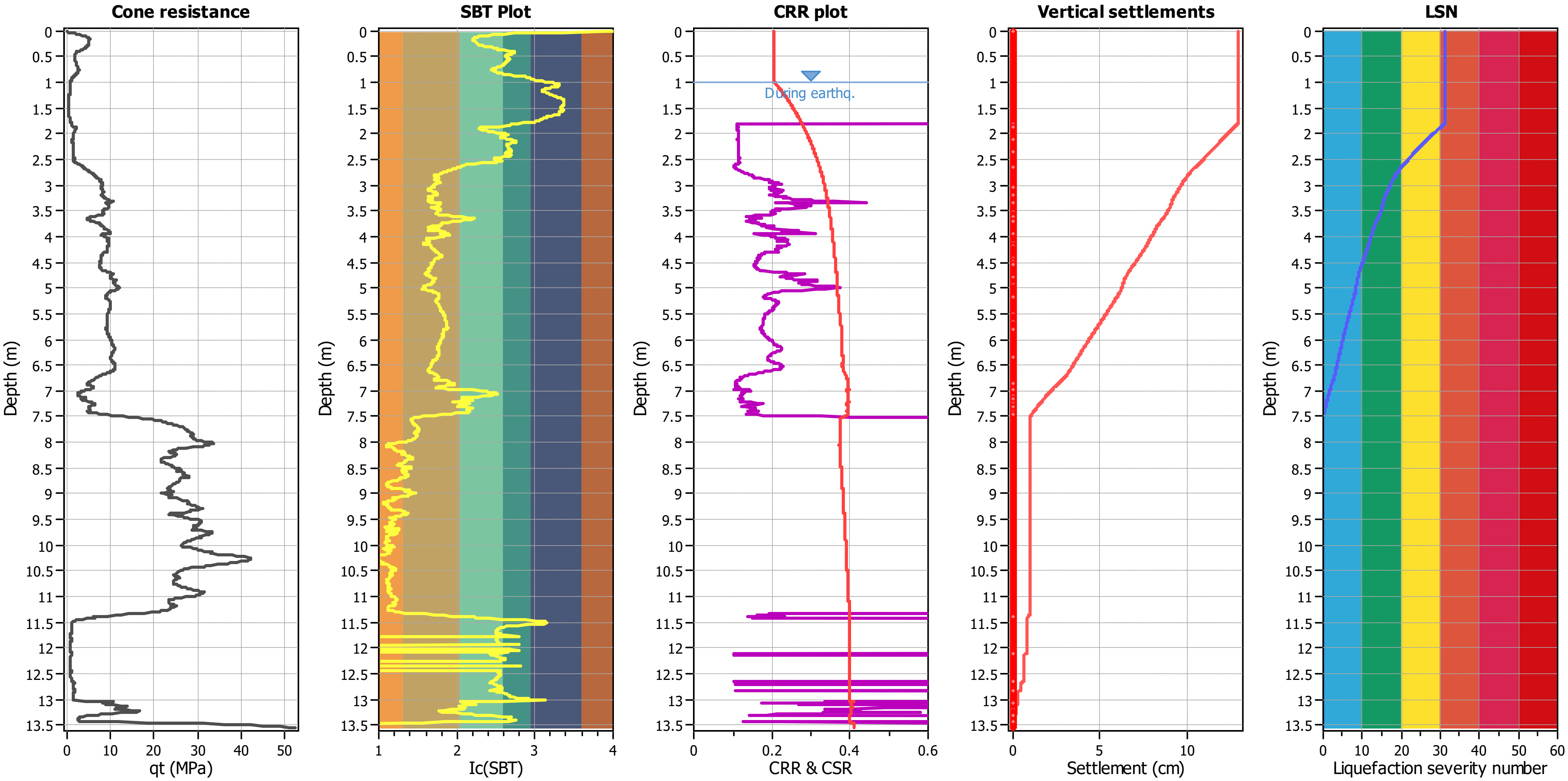
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT09
Total depth: 13.55 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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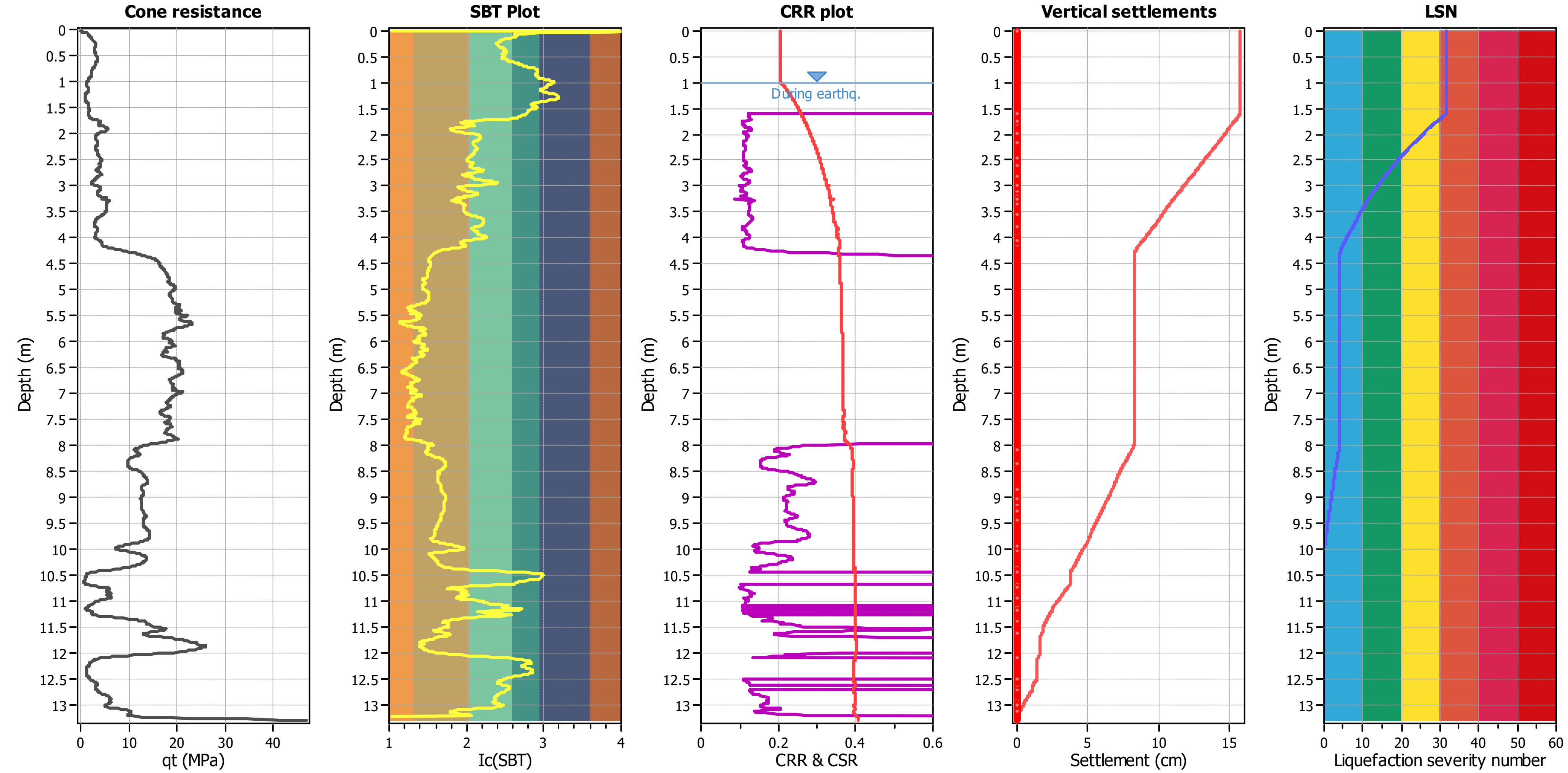
Project: **144 & 170 Main North Road**
Location: **Kaipoi**

CPT: CPT10
Total depth: 13.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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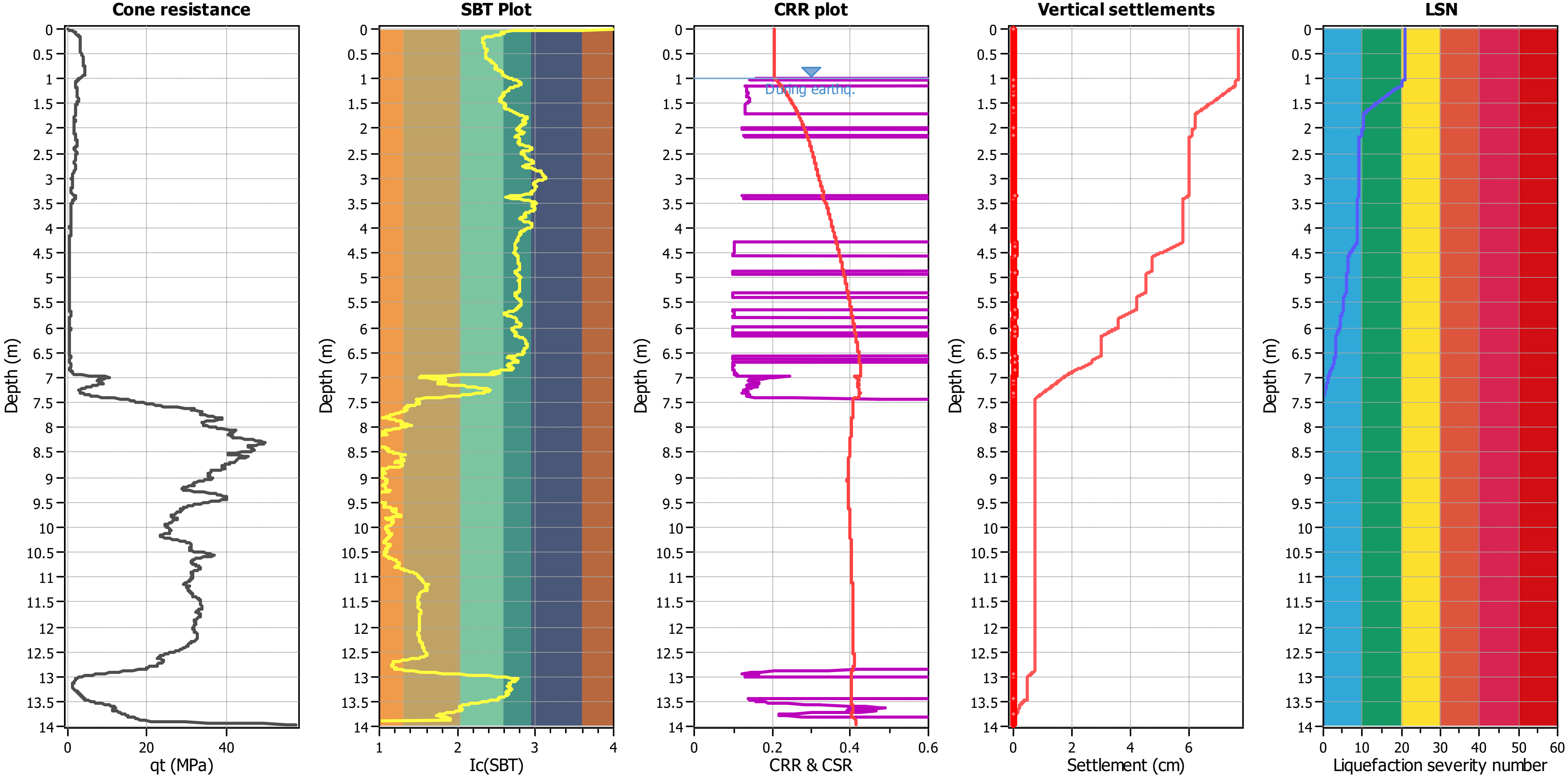
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT11
Total depth: 13.96 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.		
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A		
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based		
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes				

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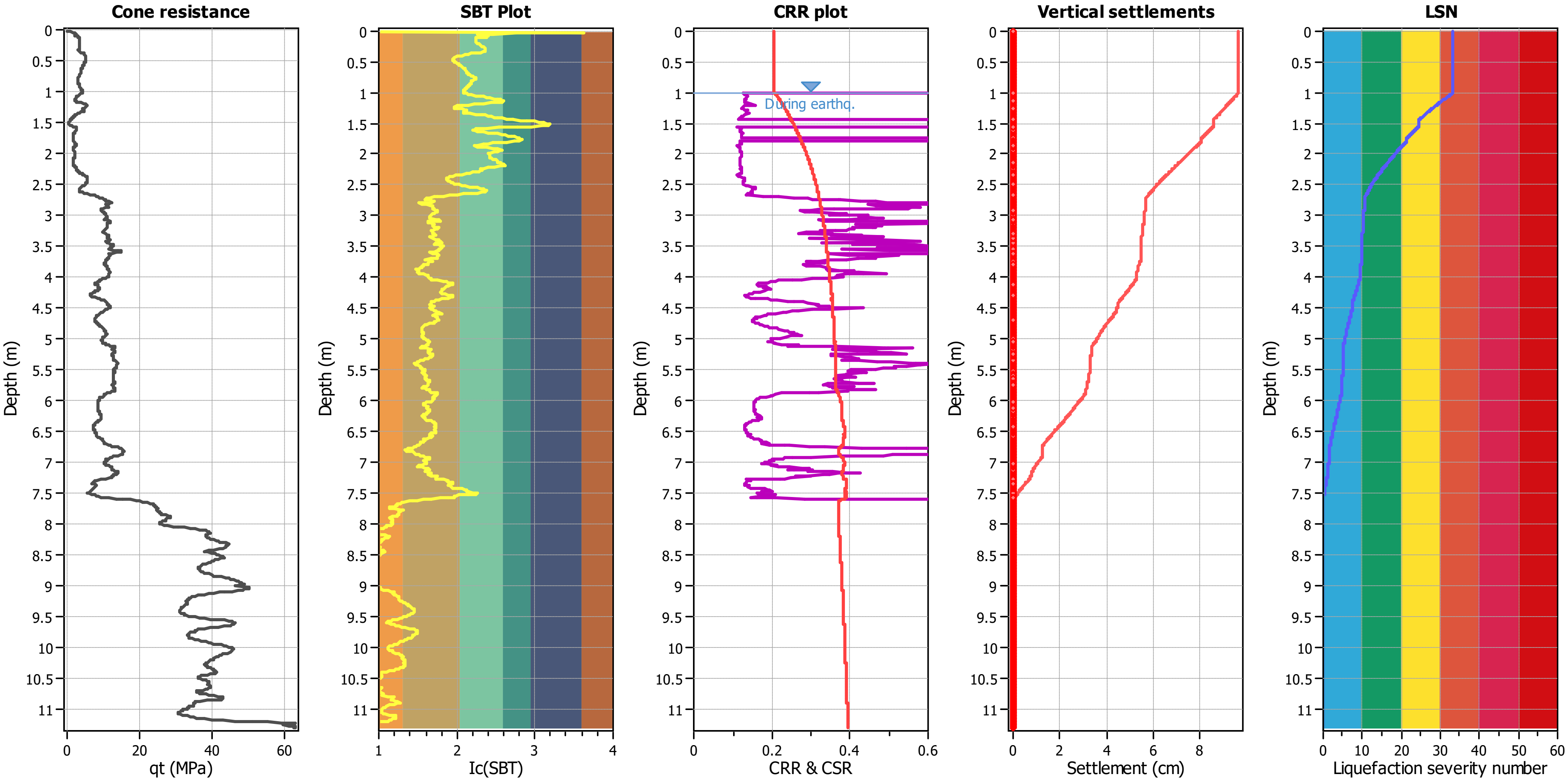
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT12
Total depth: 11.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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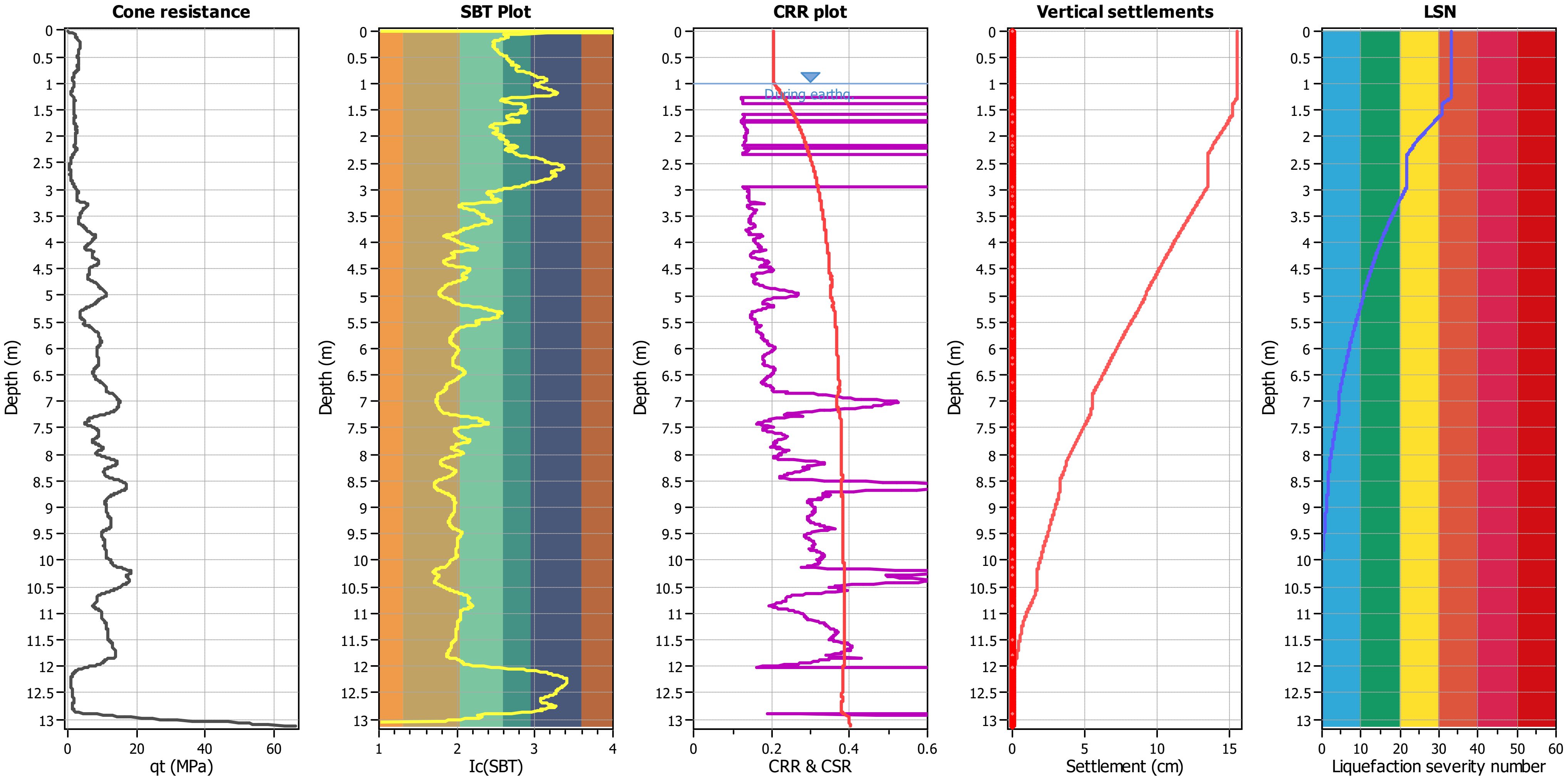
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

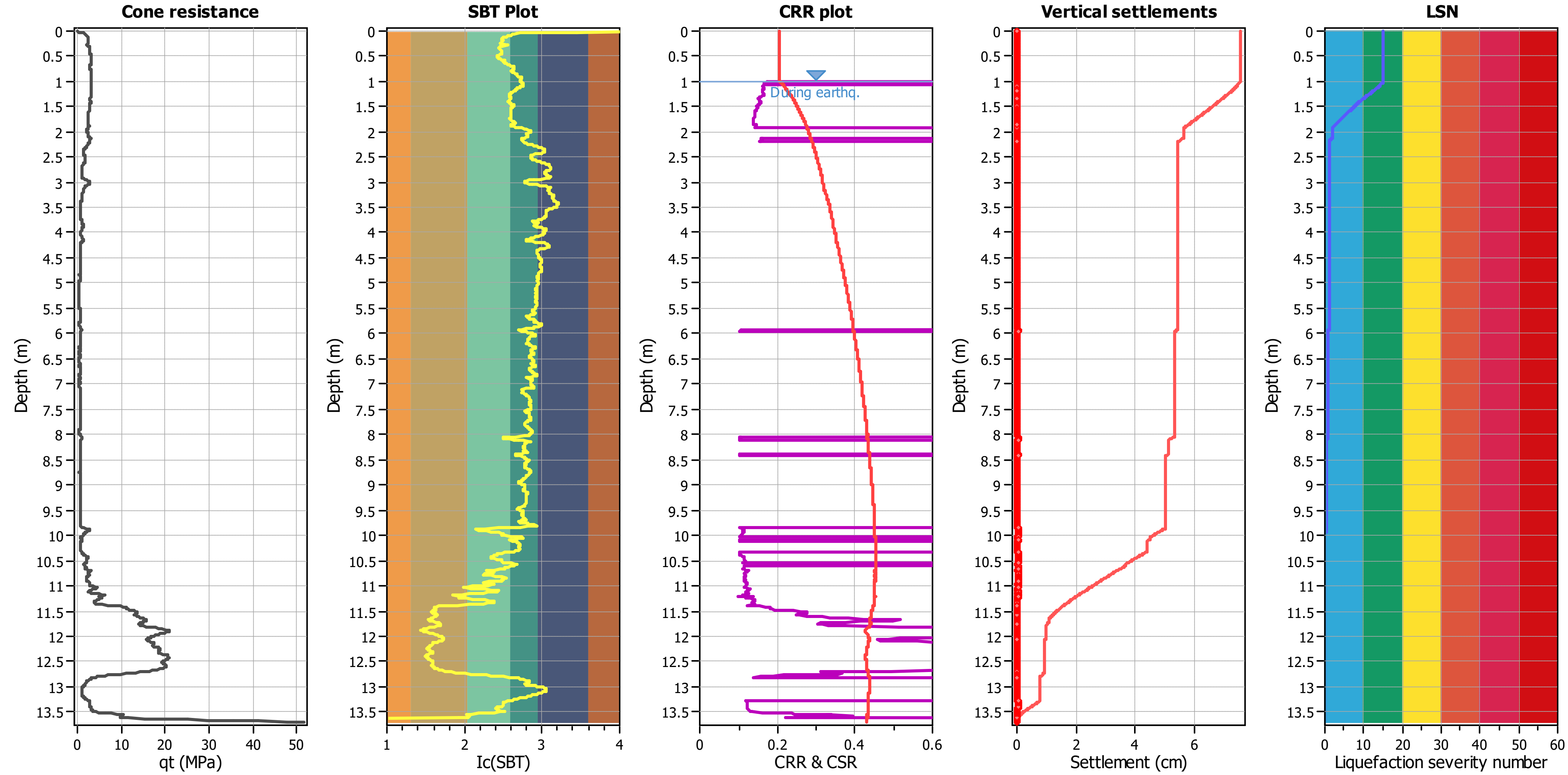
CPT: CPT13
Total depth: 13.13 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT14
Total depth: 13.70 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
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_σ applied:	Yes	MSF method:	Method based

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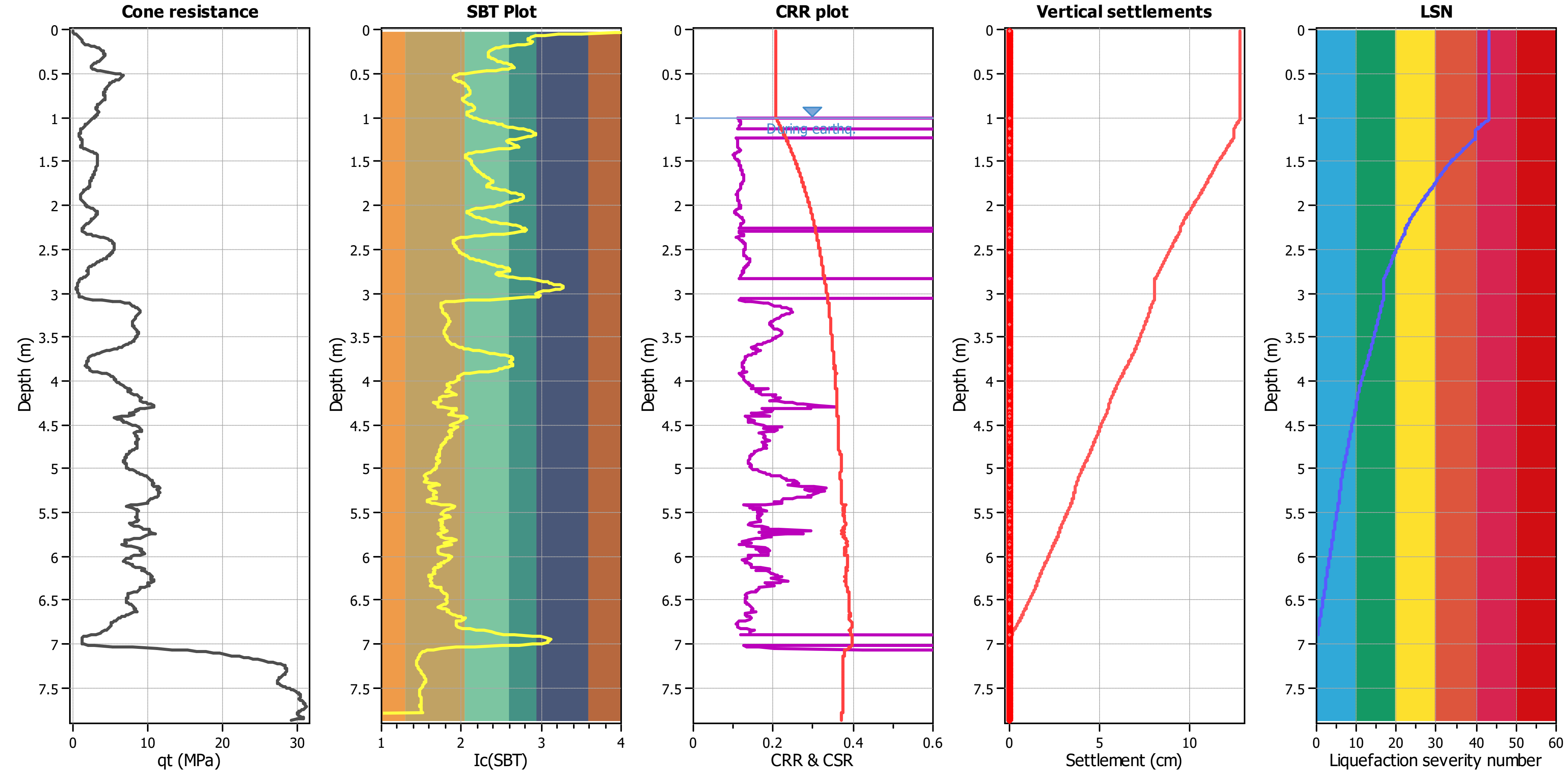
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT15
Total depth: 7.87 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
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_σ applied:	Yes	MSF method:	Method based

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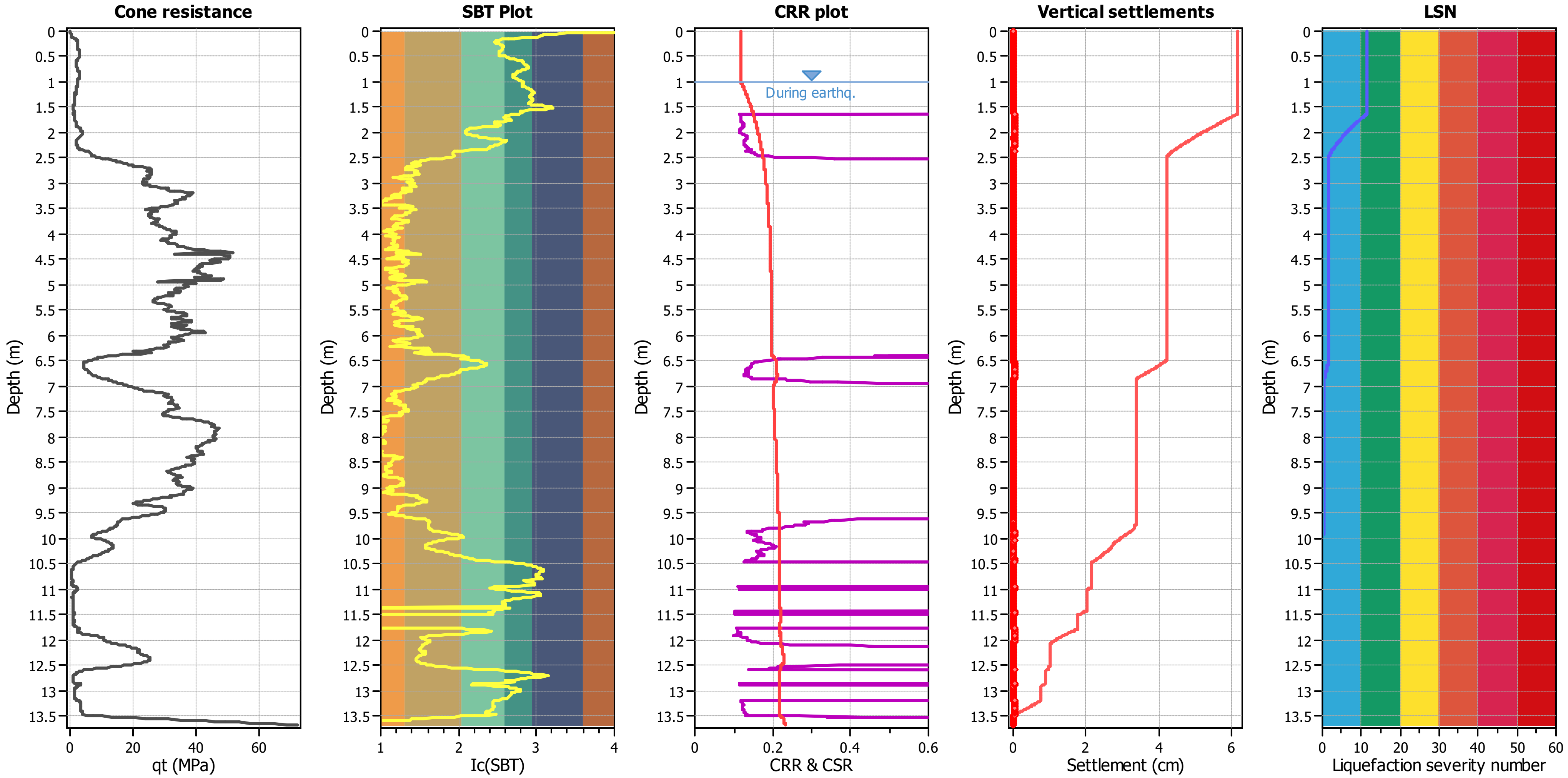
Project: **144 & 170 Main North Road**

Location: **Kaiapoi**

CPT: CPT01

Total depth: 13.68 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.20

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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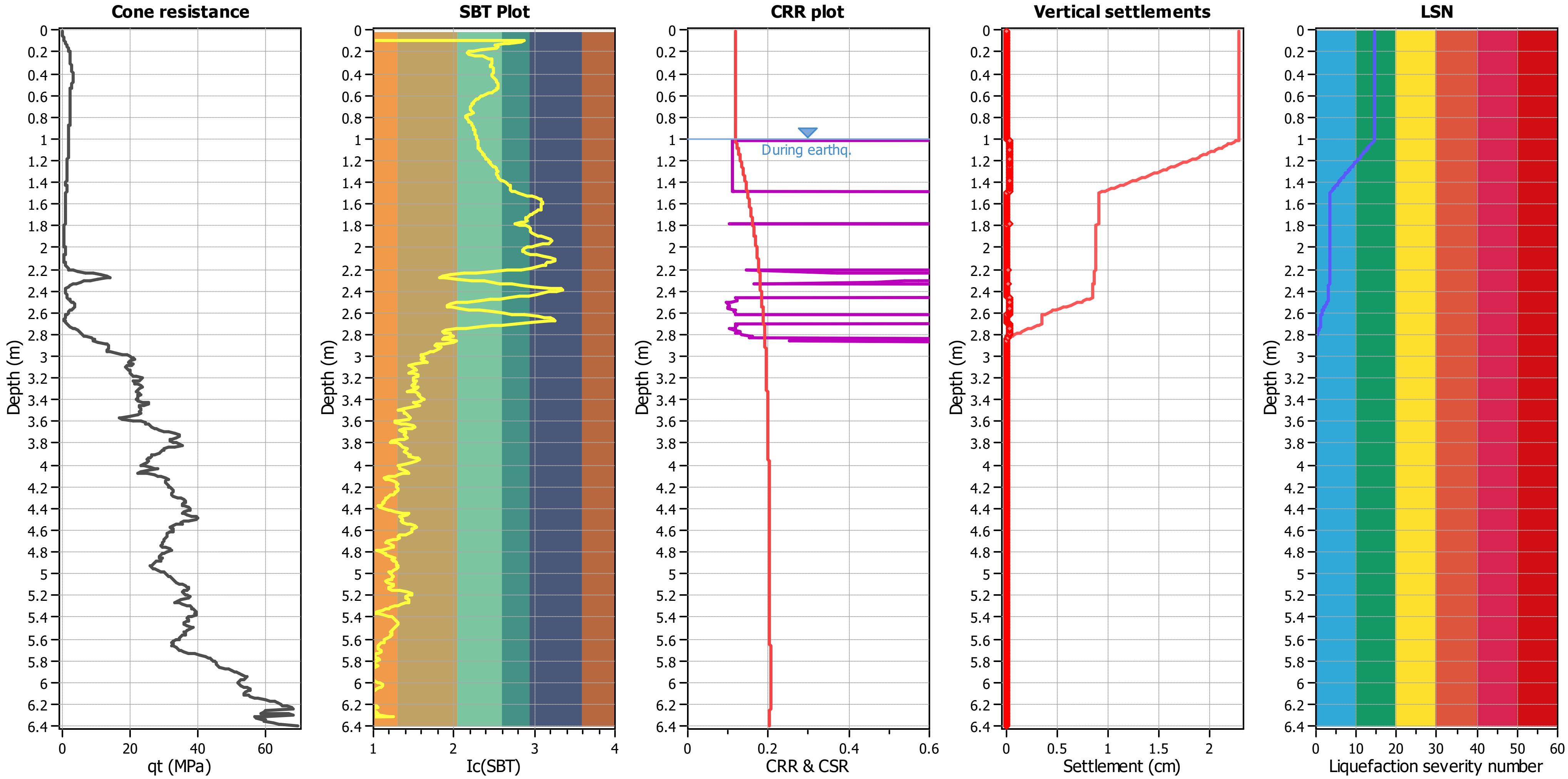
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT02
Total depth: 6.40 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.20

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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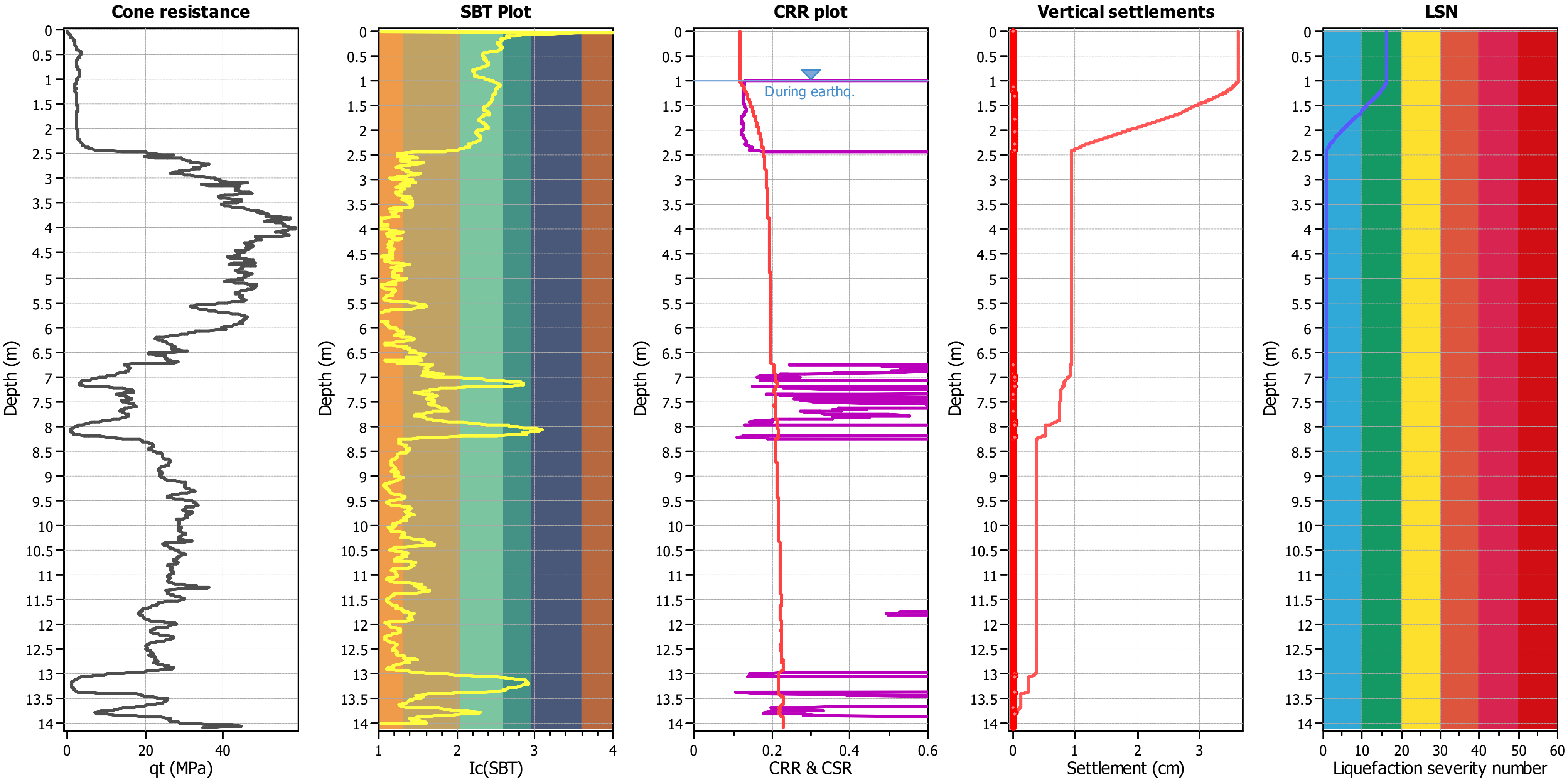
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT03
Total depth: 14.08 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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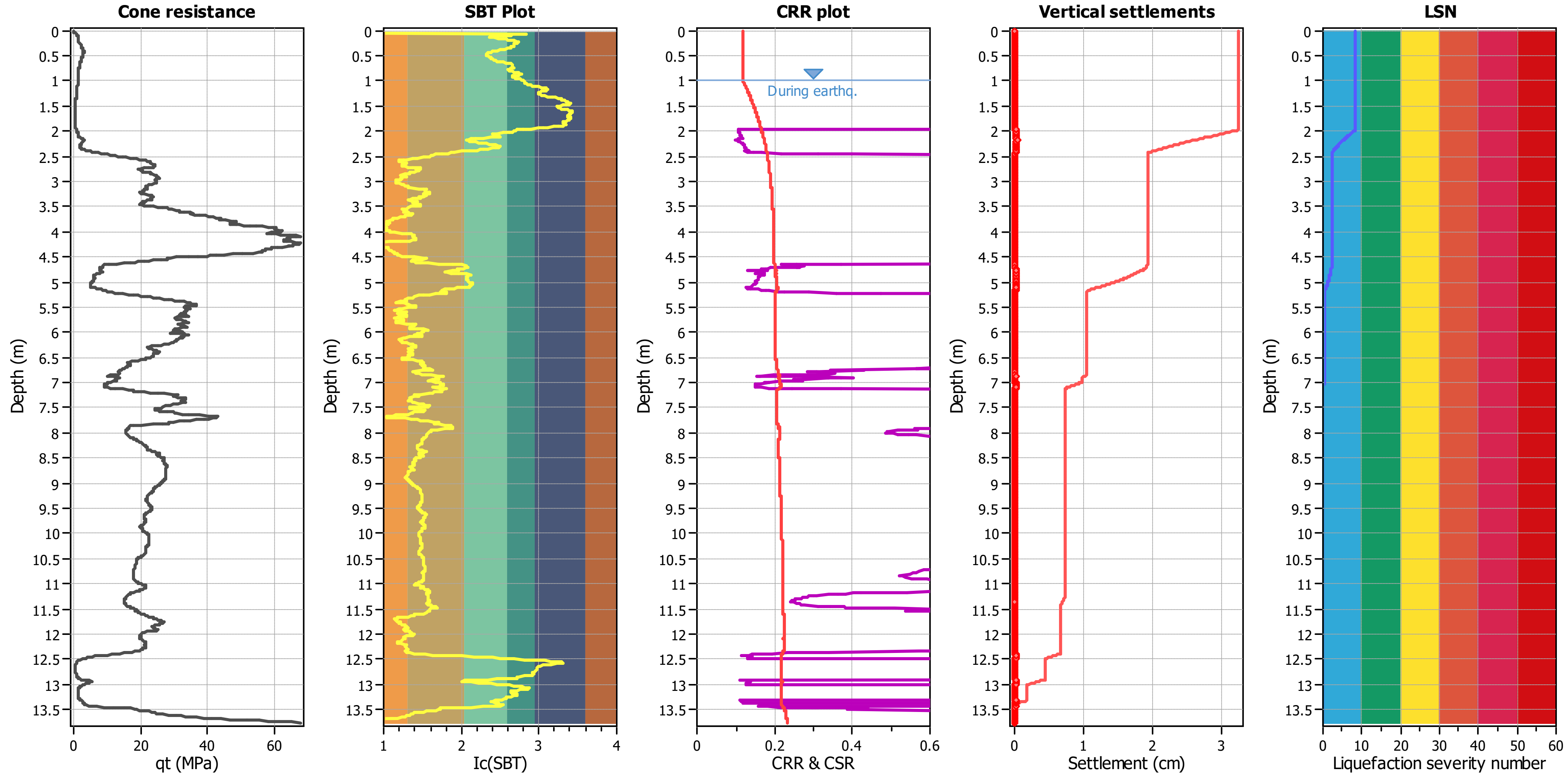
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT04
Total depth: 13.77 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.20

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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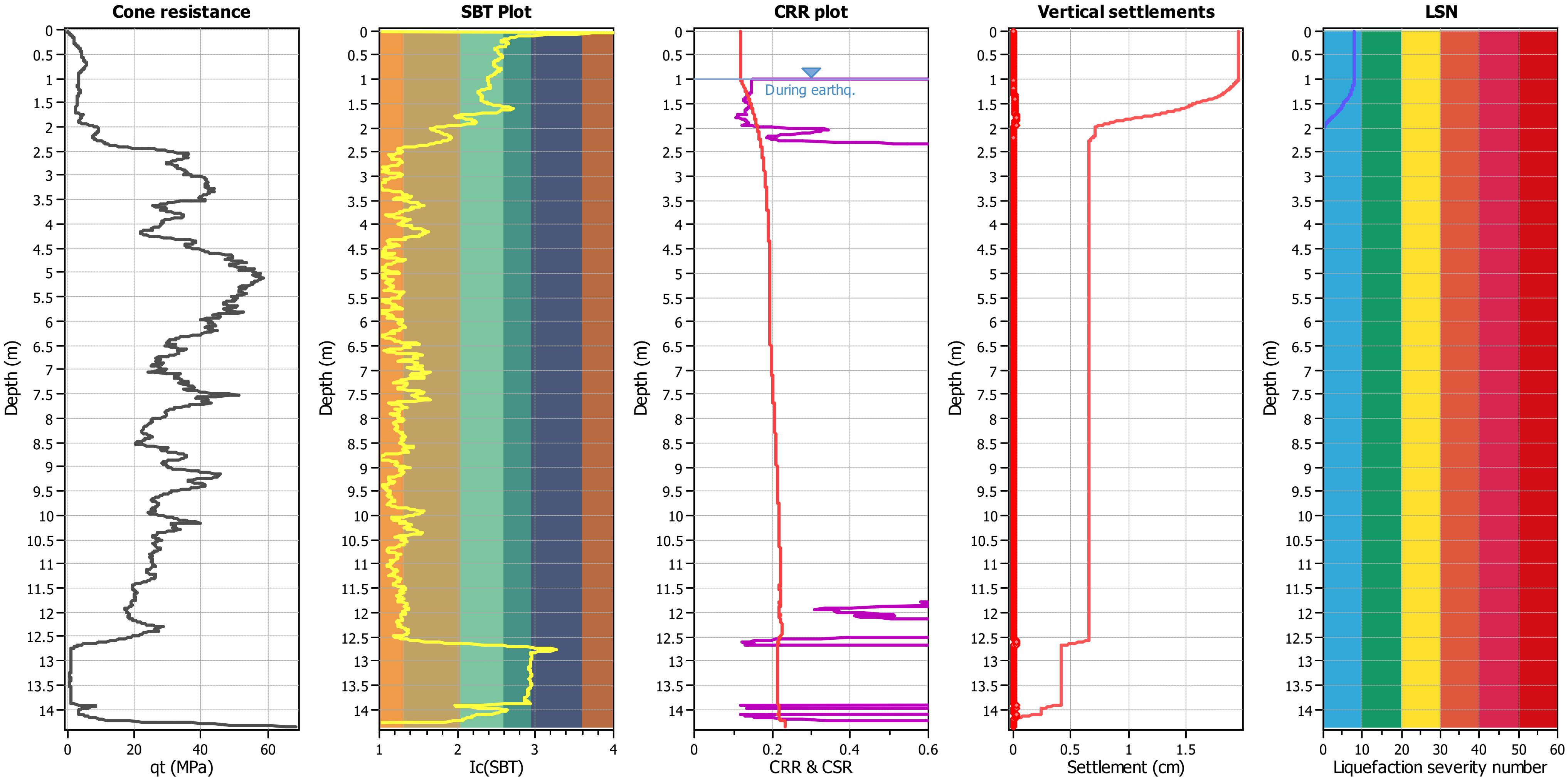
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT05
Total depth: 14.36 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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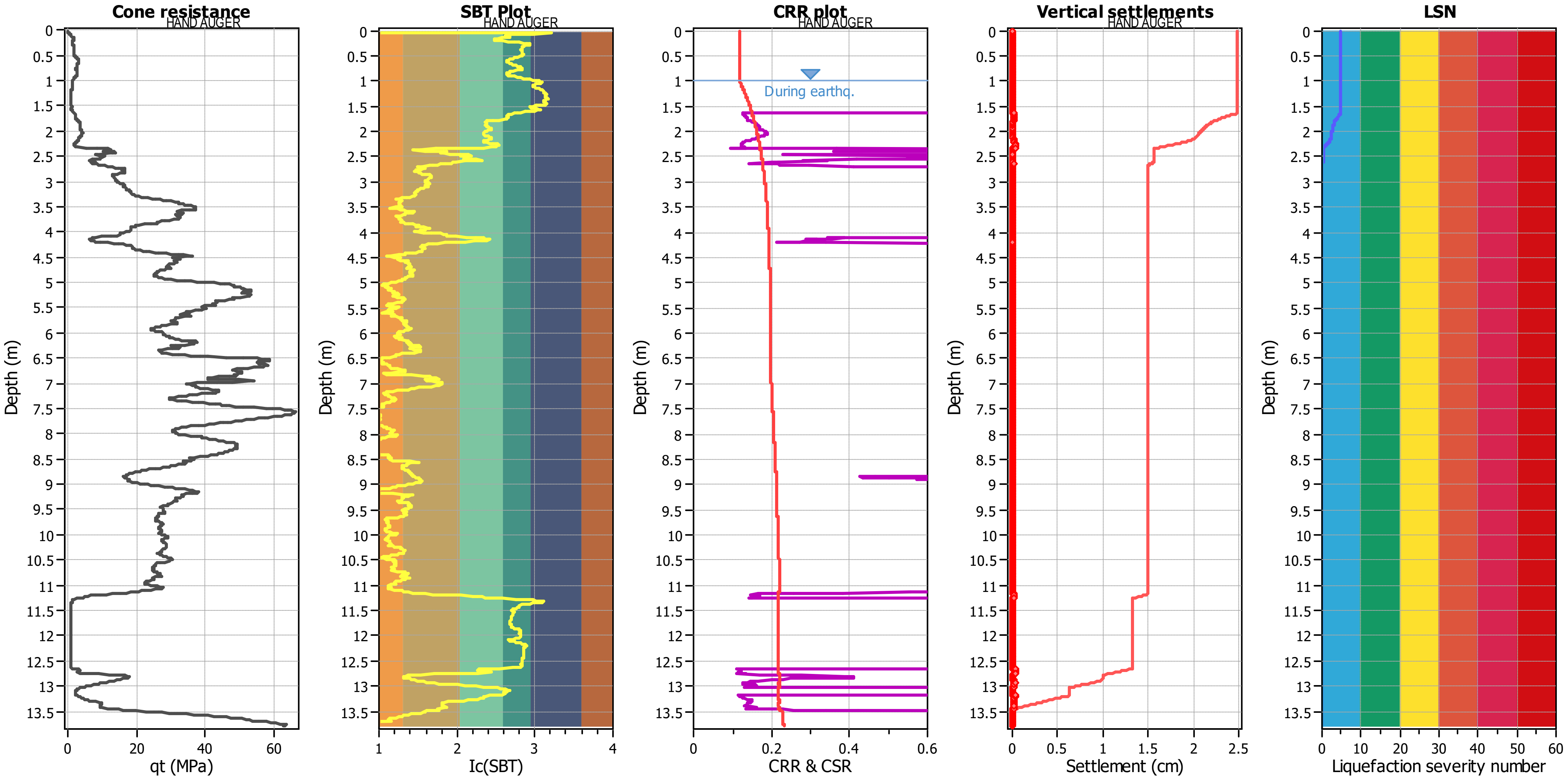
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT06
Total depth: 13.79 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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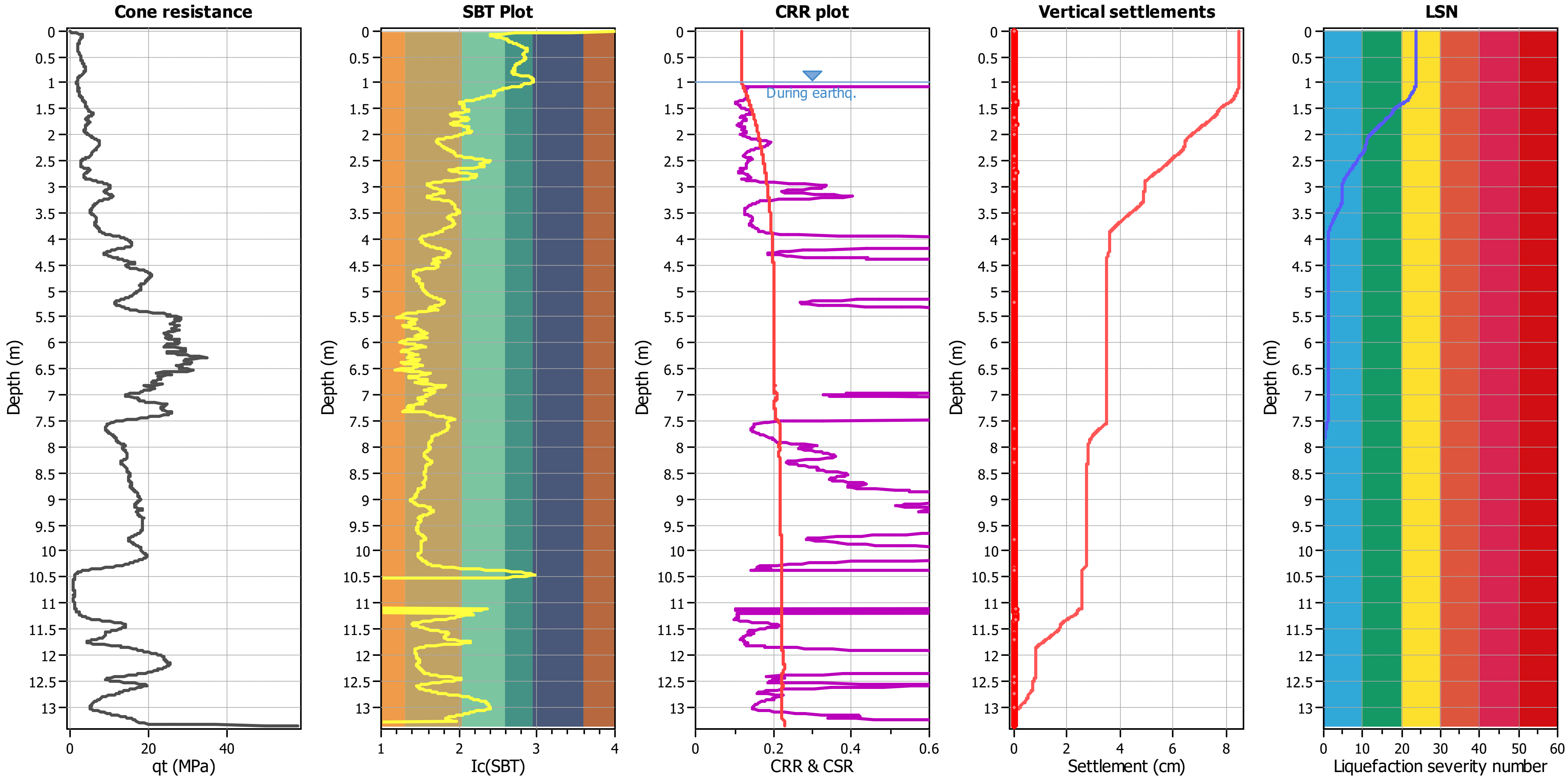
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT07
Total depth: 13.36 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.20

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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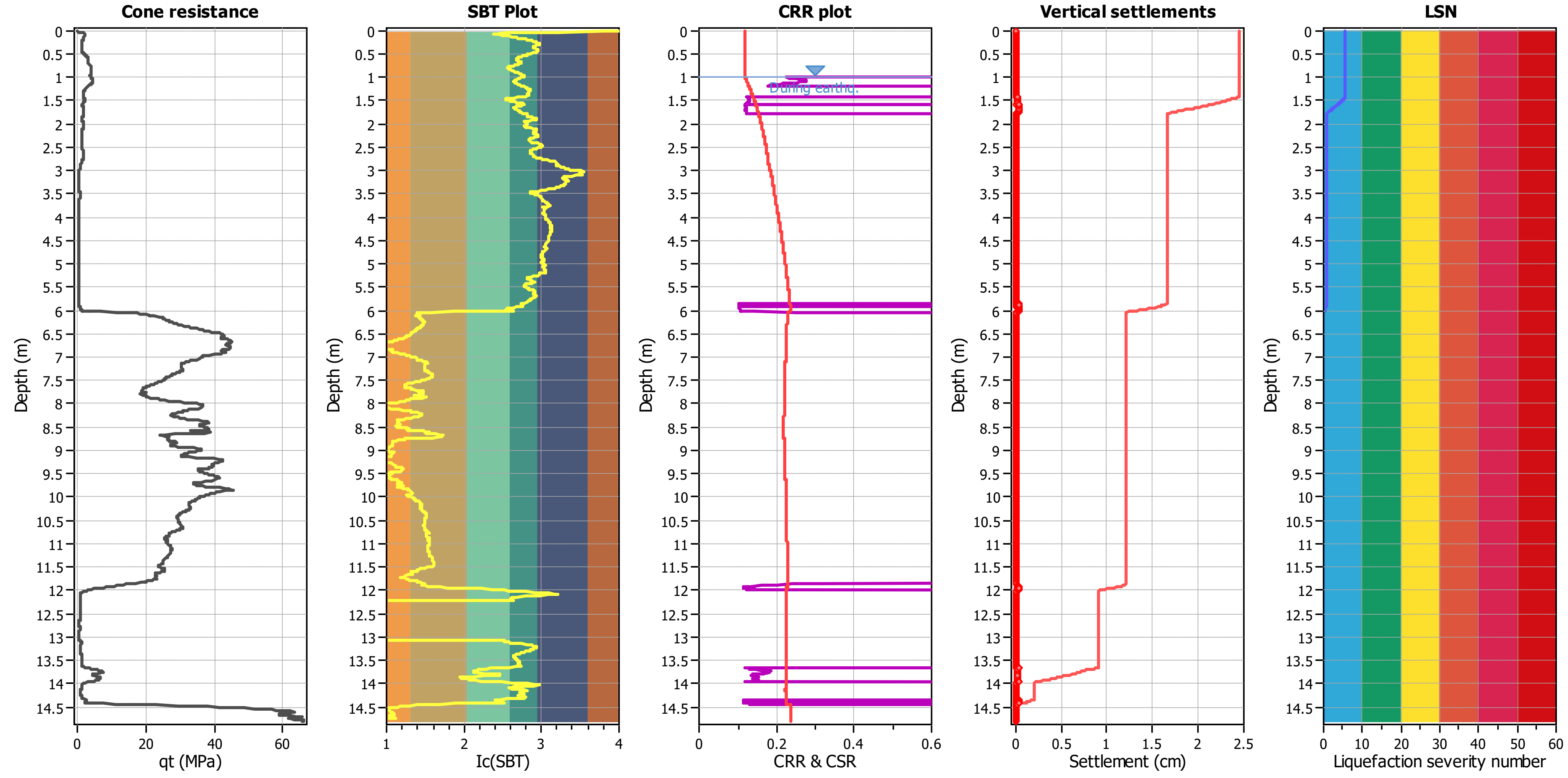
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT08
Total depth: 14.81 m



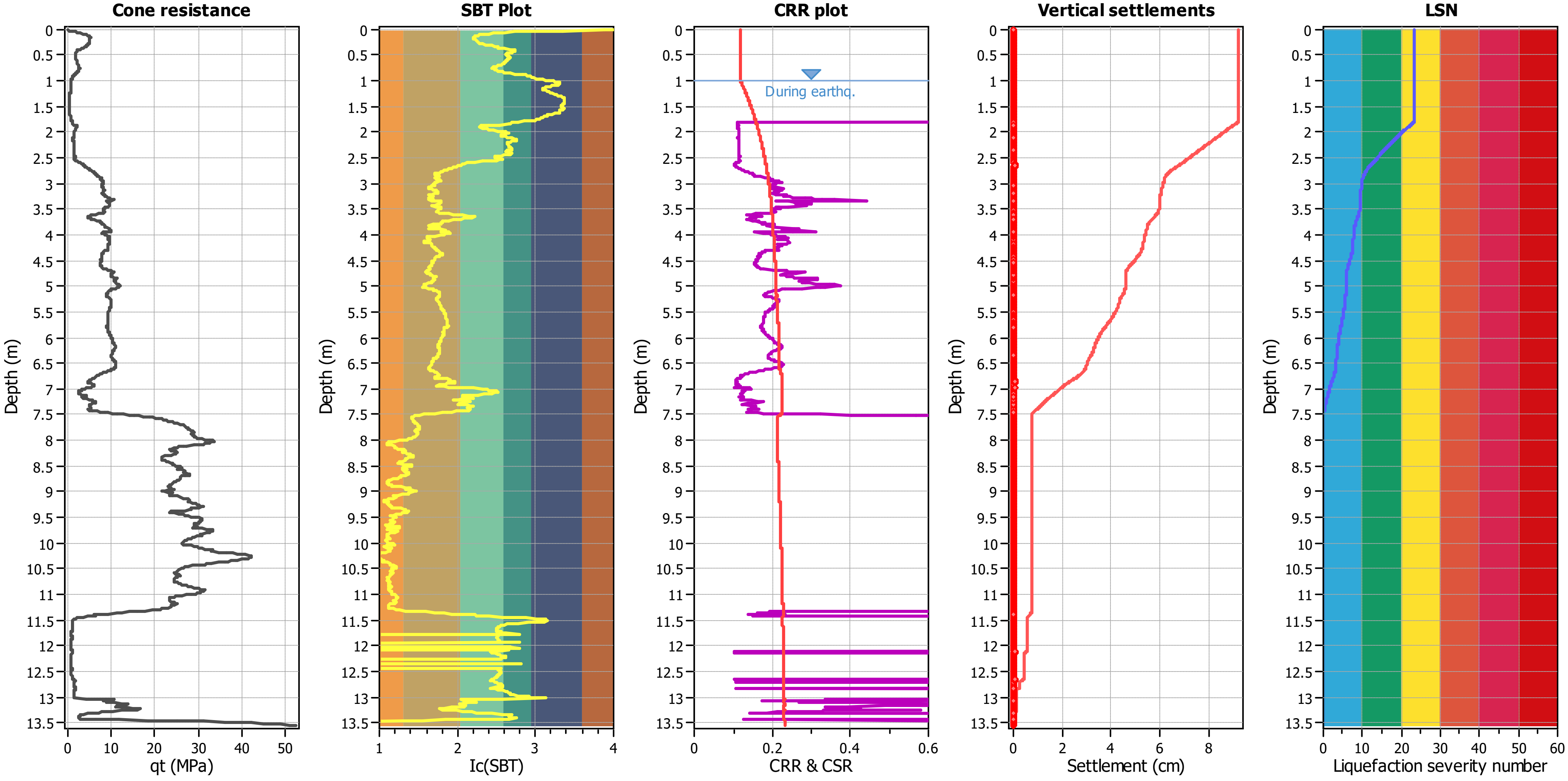
Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	. No
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**

Location: **Kaiapoi**

CPT: CPT09

Total depth: 13.55 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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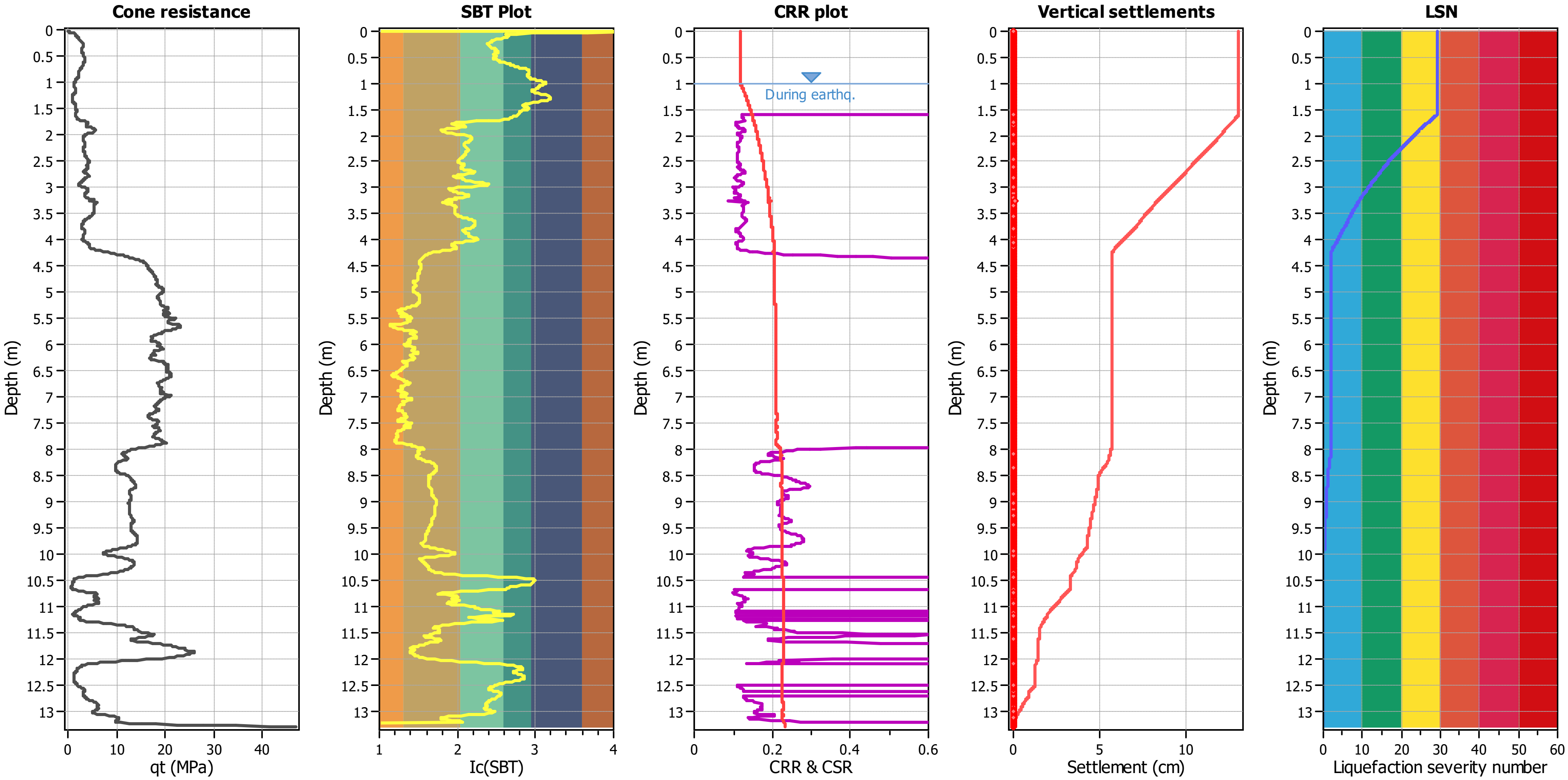
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT10
Total depth: 13.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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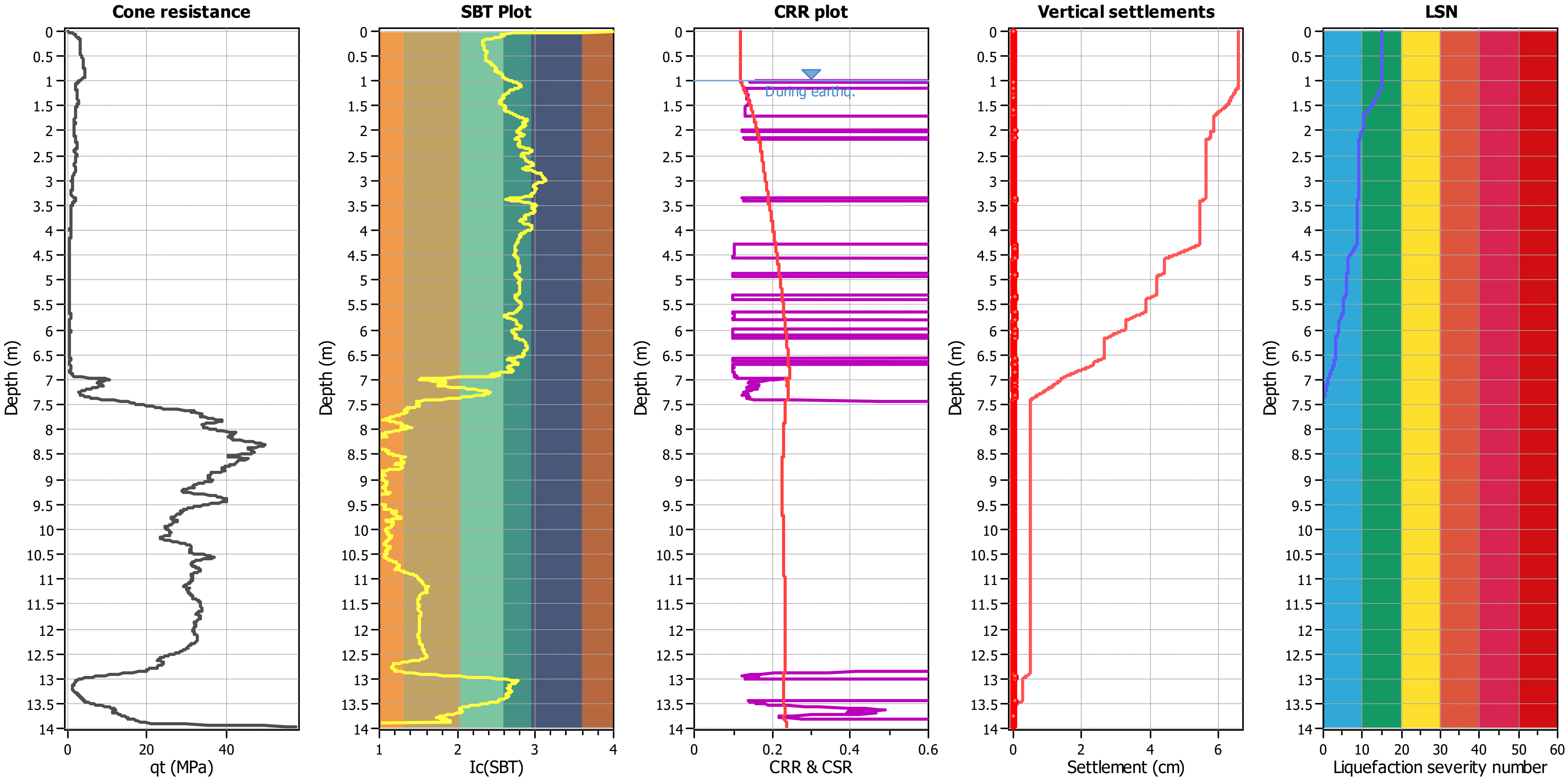
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT11
Total depth: 13.96 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.20

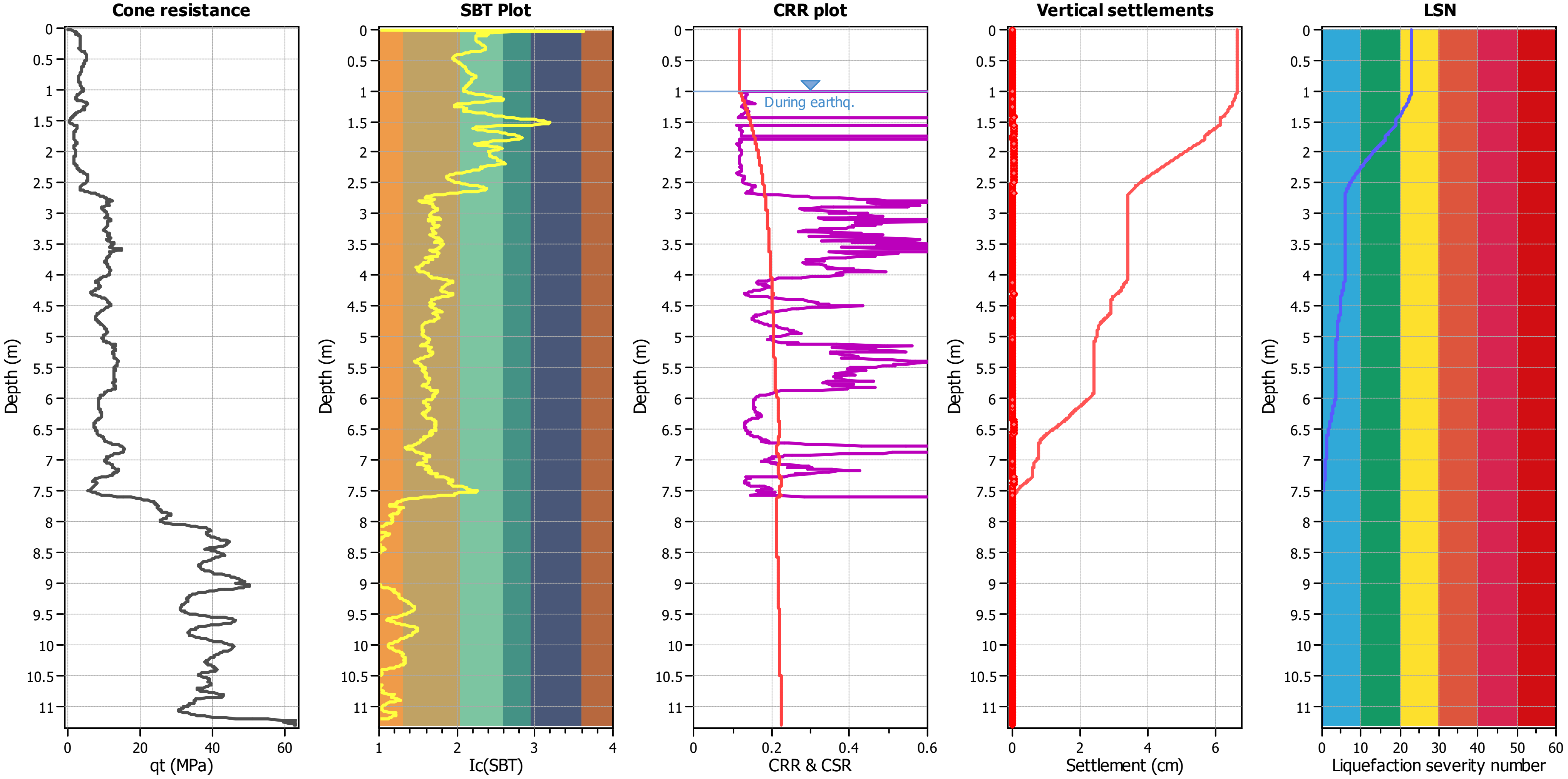
G.W.T. (in-situ): 1.00 m
G.W.T. (earthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

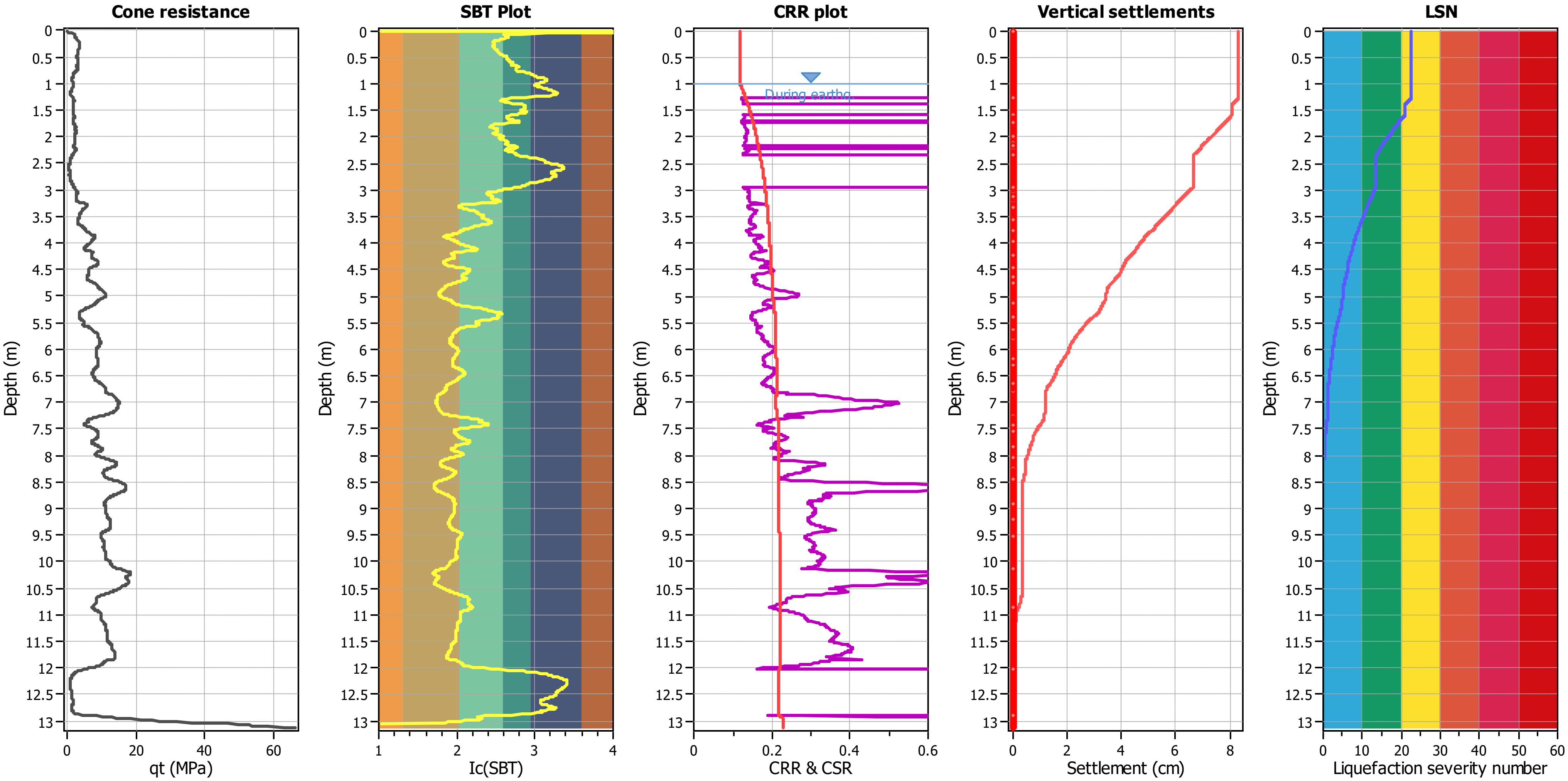
CPT: CPT12
Total depth: 11.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

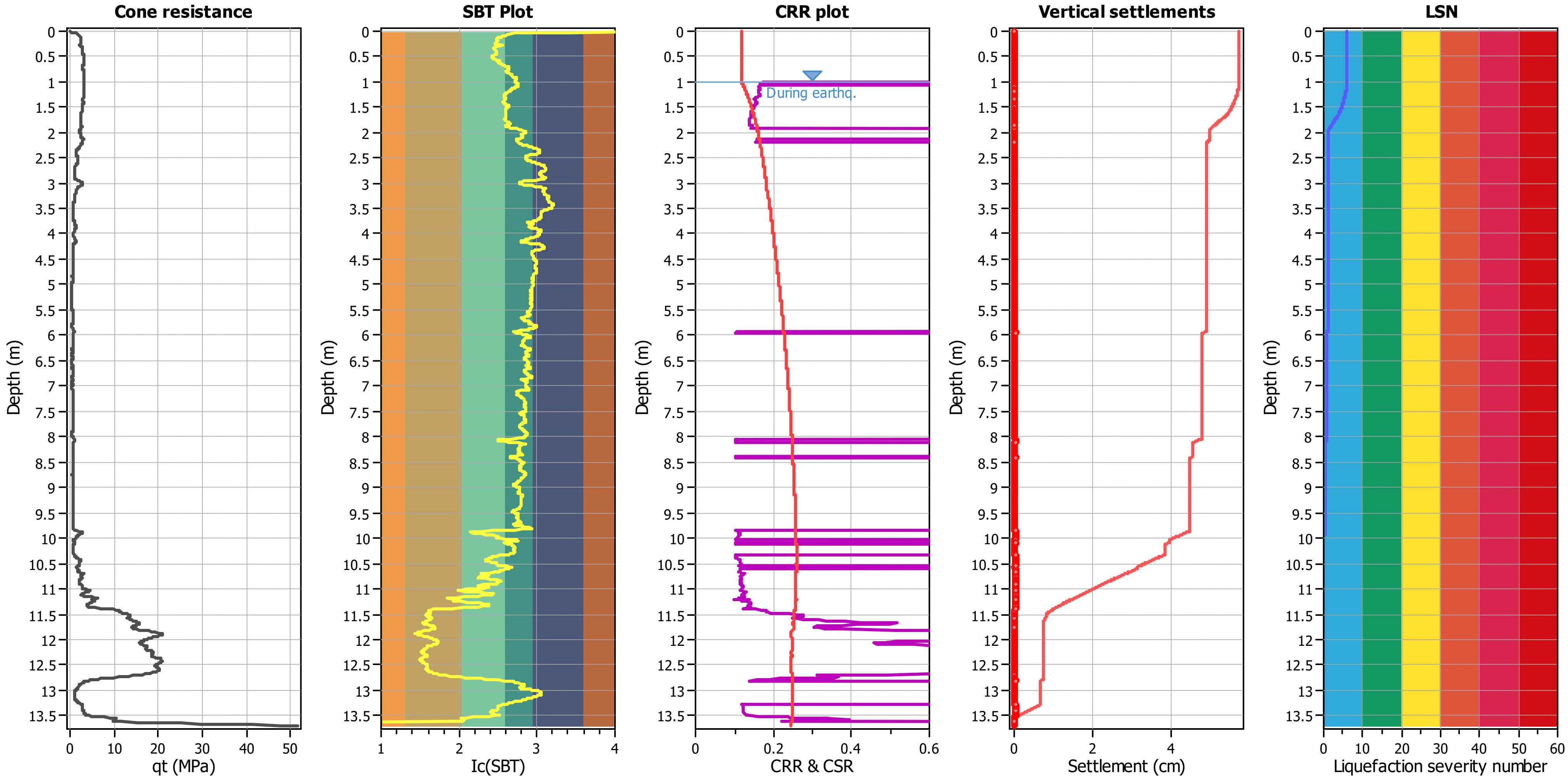
CPT: CPT13
Total depth: 13.13 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT14
Total depth: 13.70 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.20

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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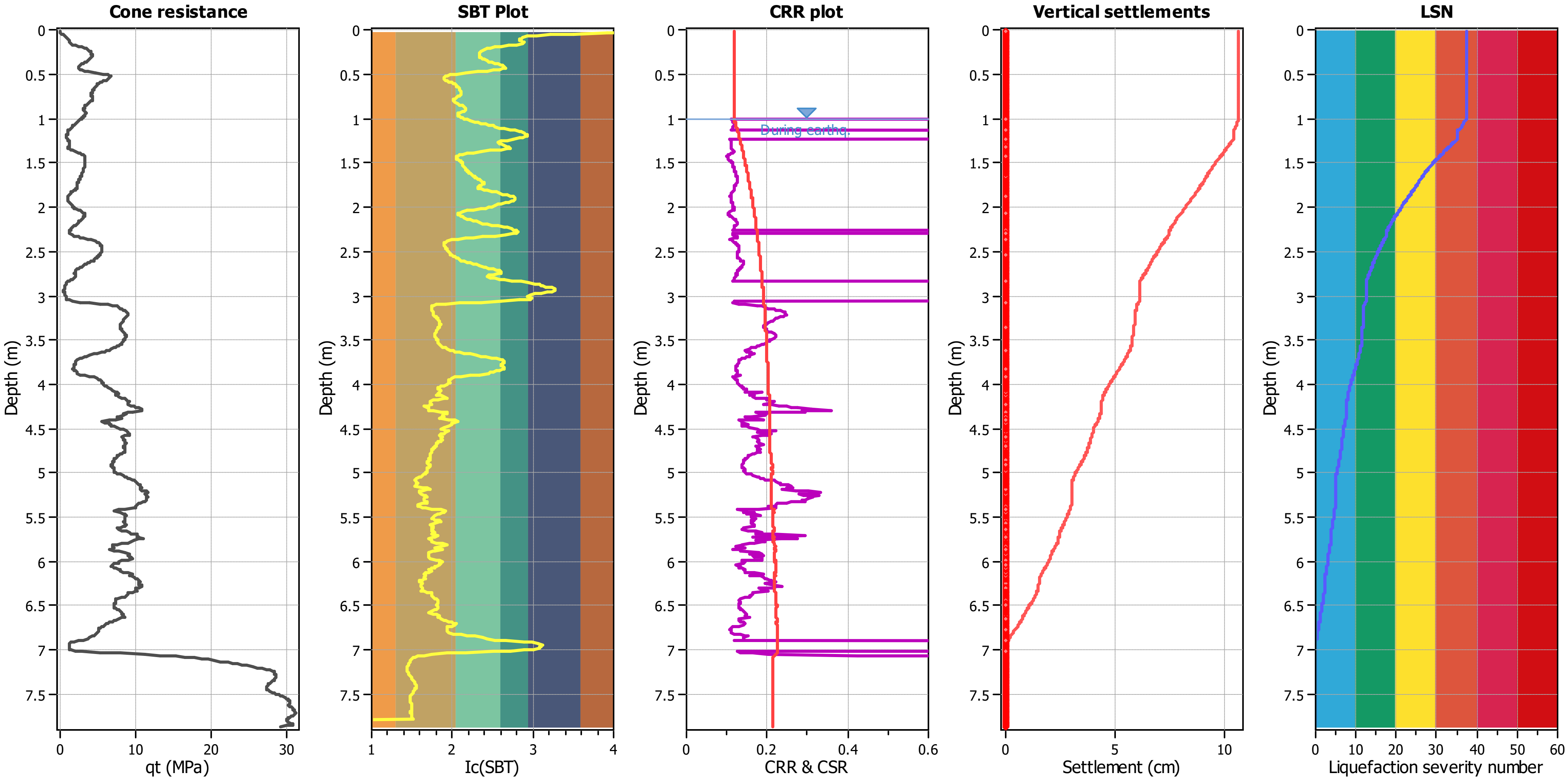
Project: **144 & 170 Main North Road**

Location: **Kaiapoi**

CPT: CPT15

Total depth: 7.87 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.20

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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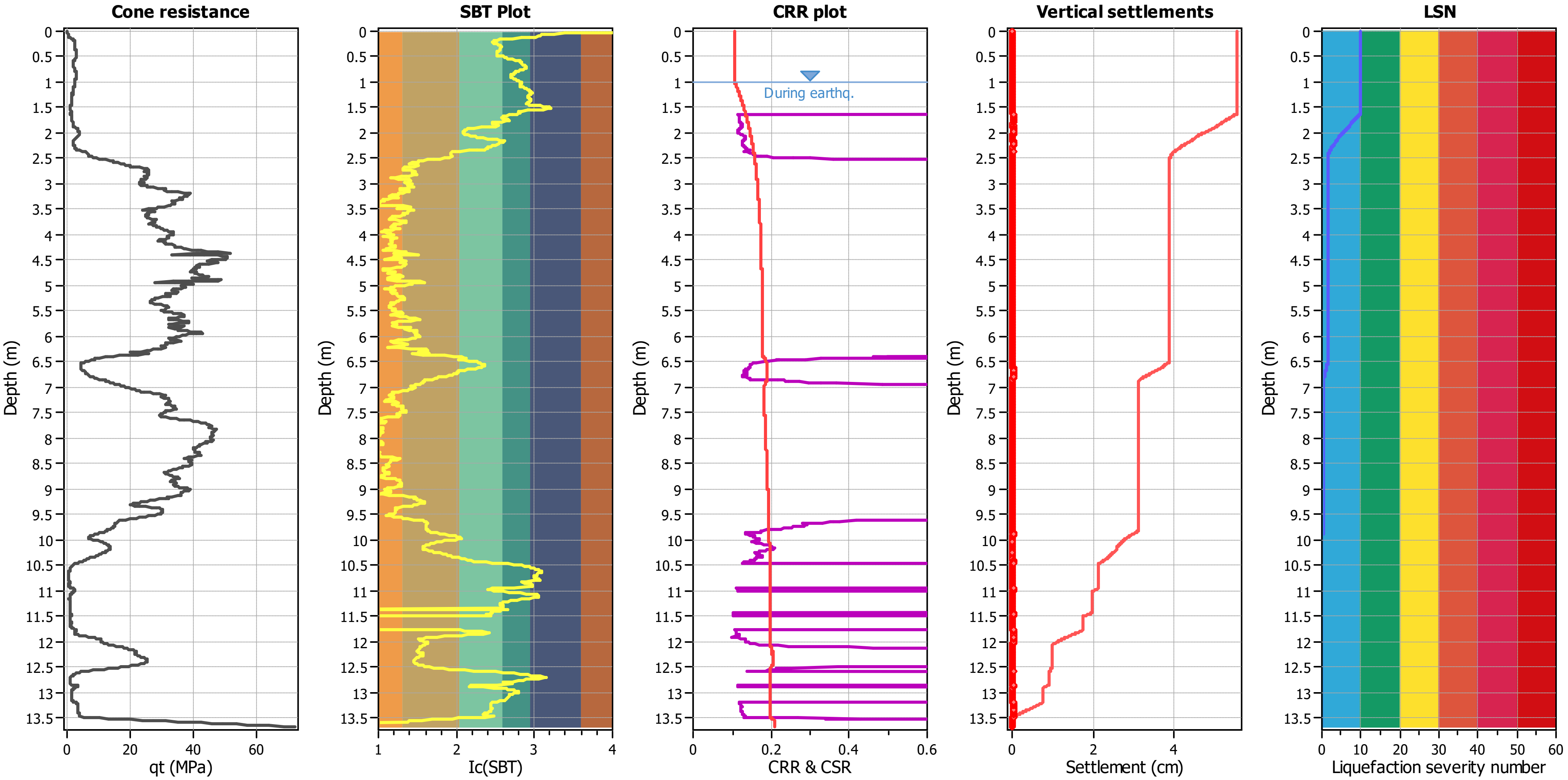
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT01
Total depth: 13.68 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.18

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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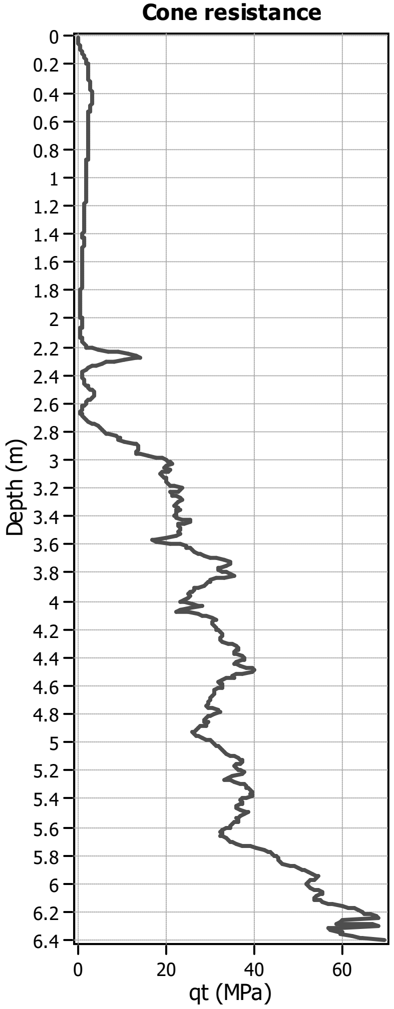
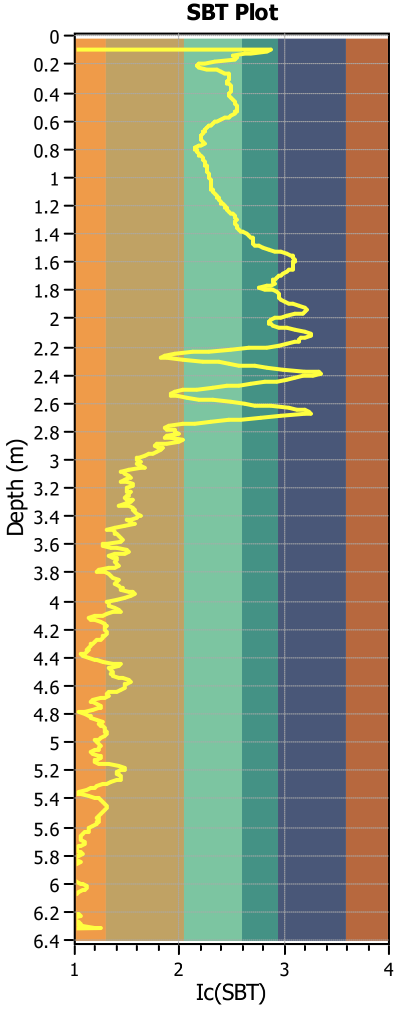
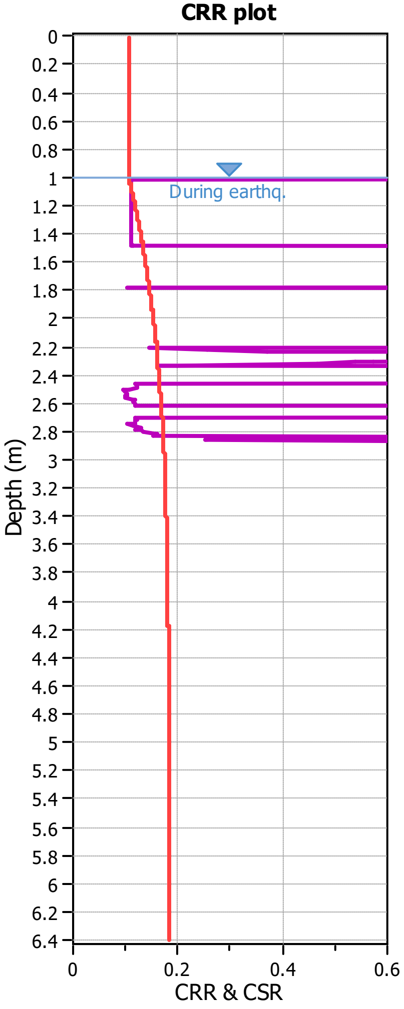
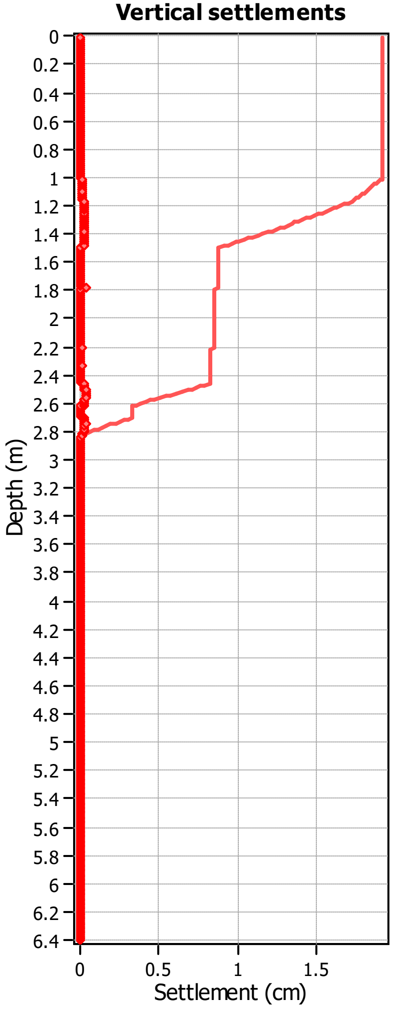
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

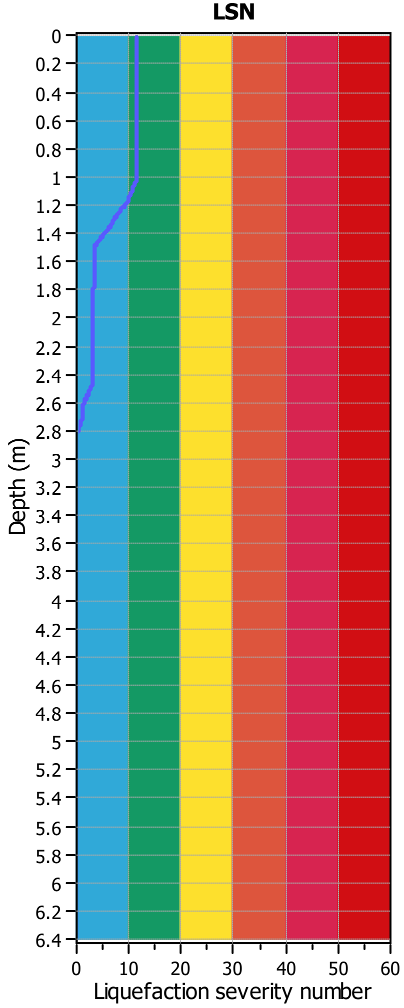
CPT: CPT02
Total depth: 6.40 m











Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
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:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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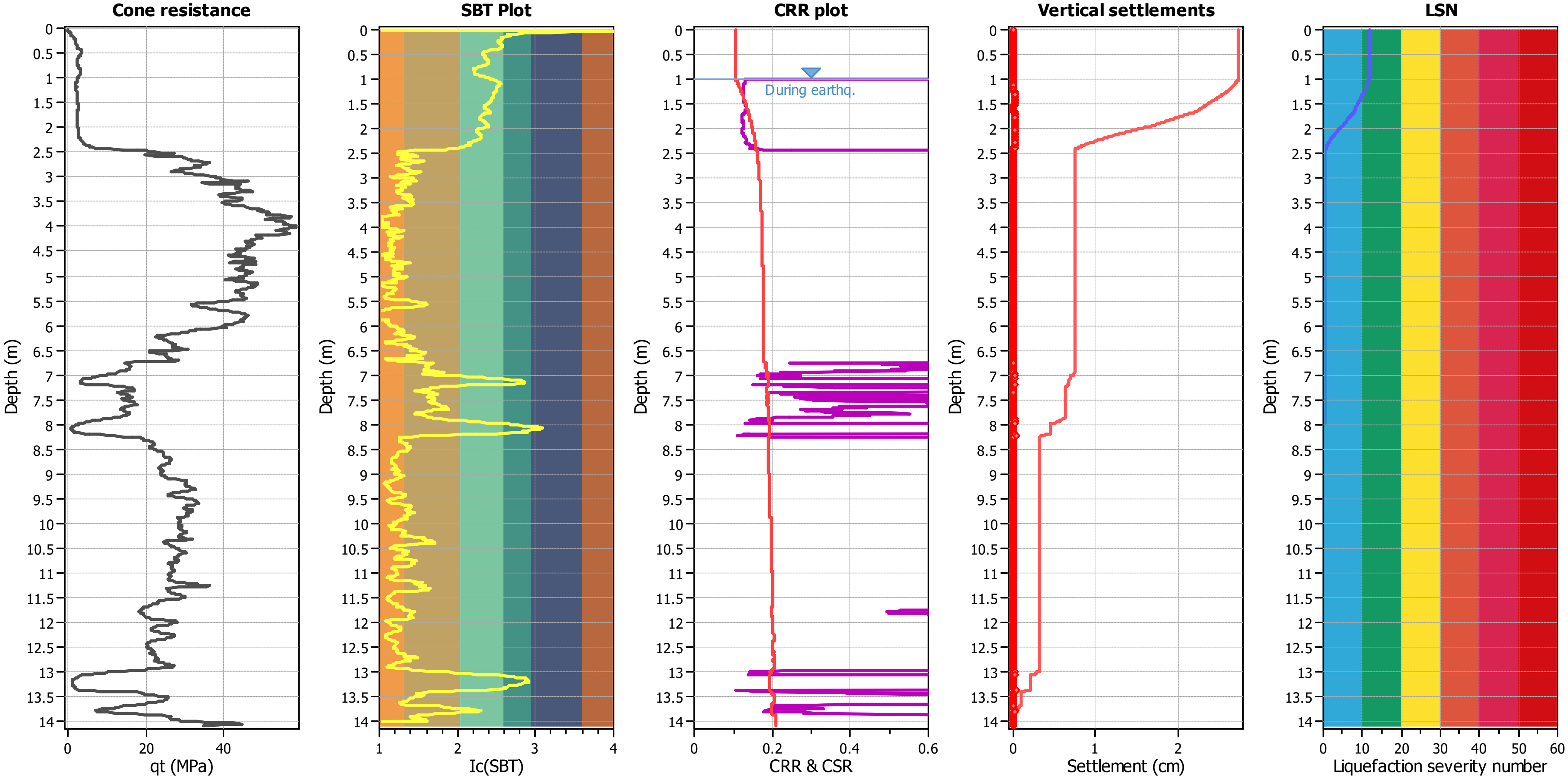
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT03
Total depth: 14.08 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
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:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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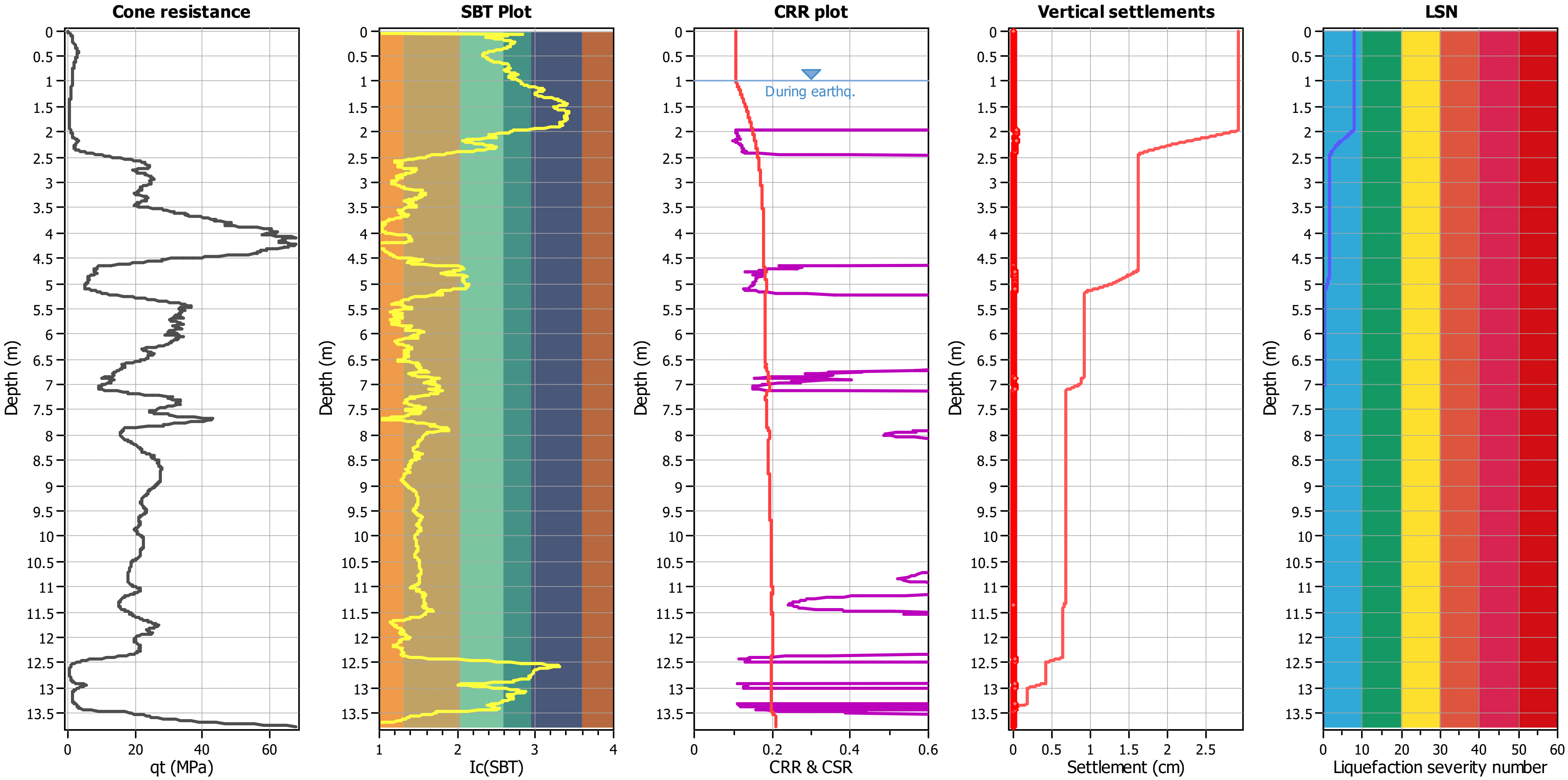
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT04
Total depth: 13.77 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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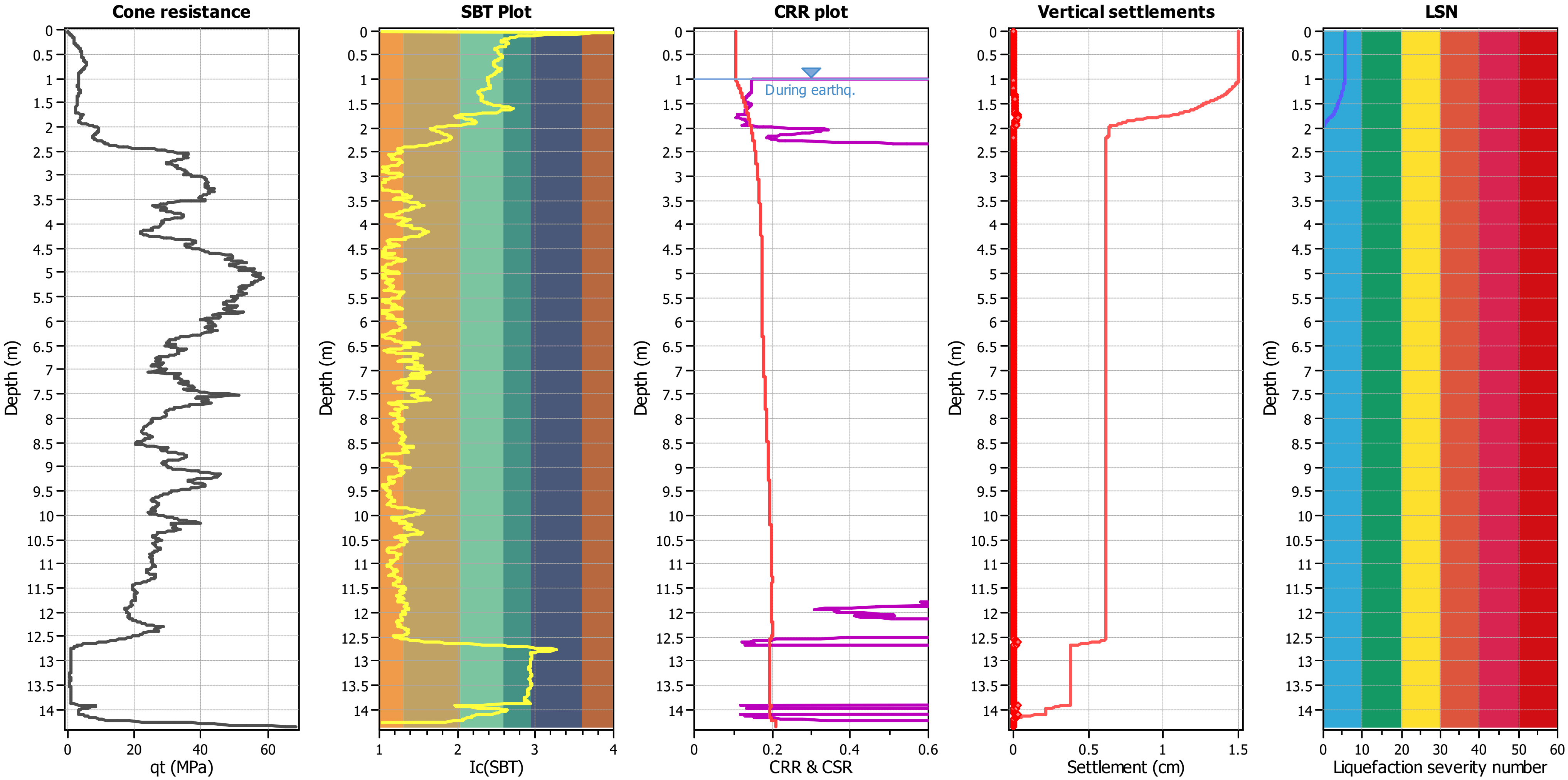
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

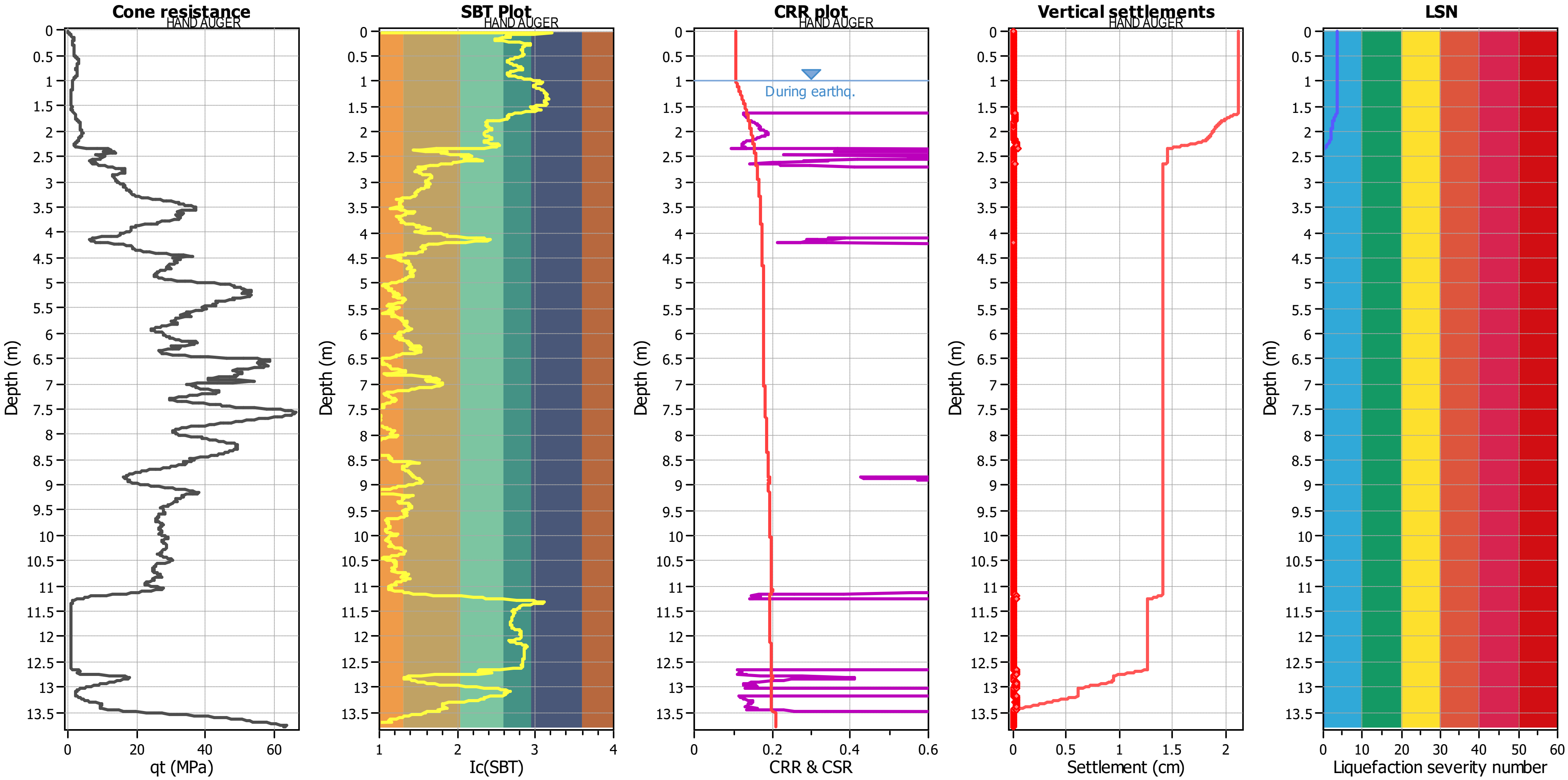
CPT: CPT05
Total depth: 14.36 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
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:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT06
Total depth: 13.79 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.18

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

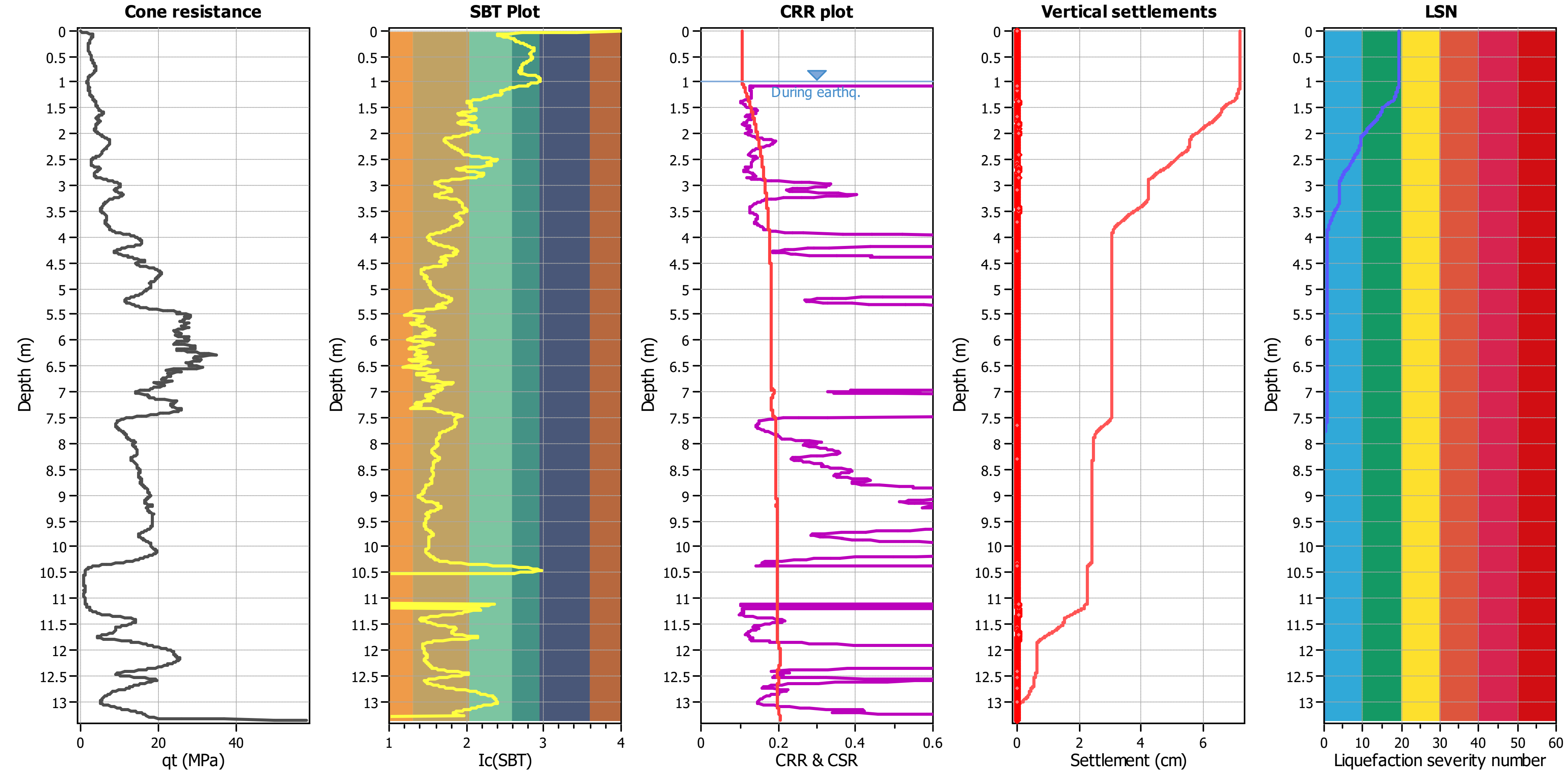
Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

Project: **144 & 170 Main North Road**

Location: **Kaiapoi**

CPT: CPT07

Total depth: 13.36 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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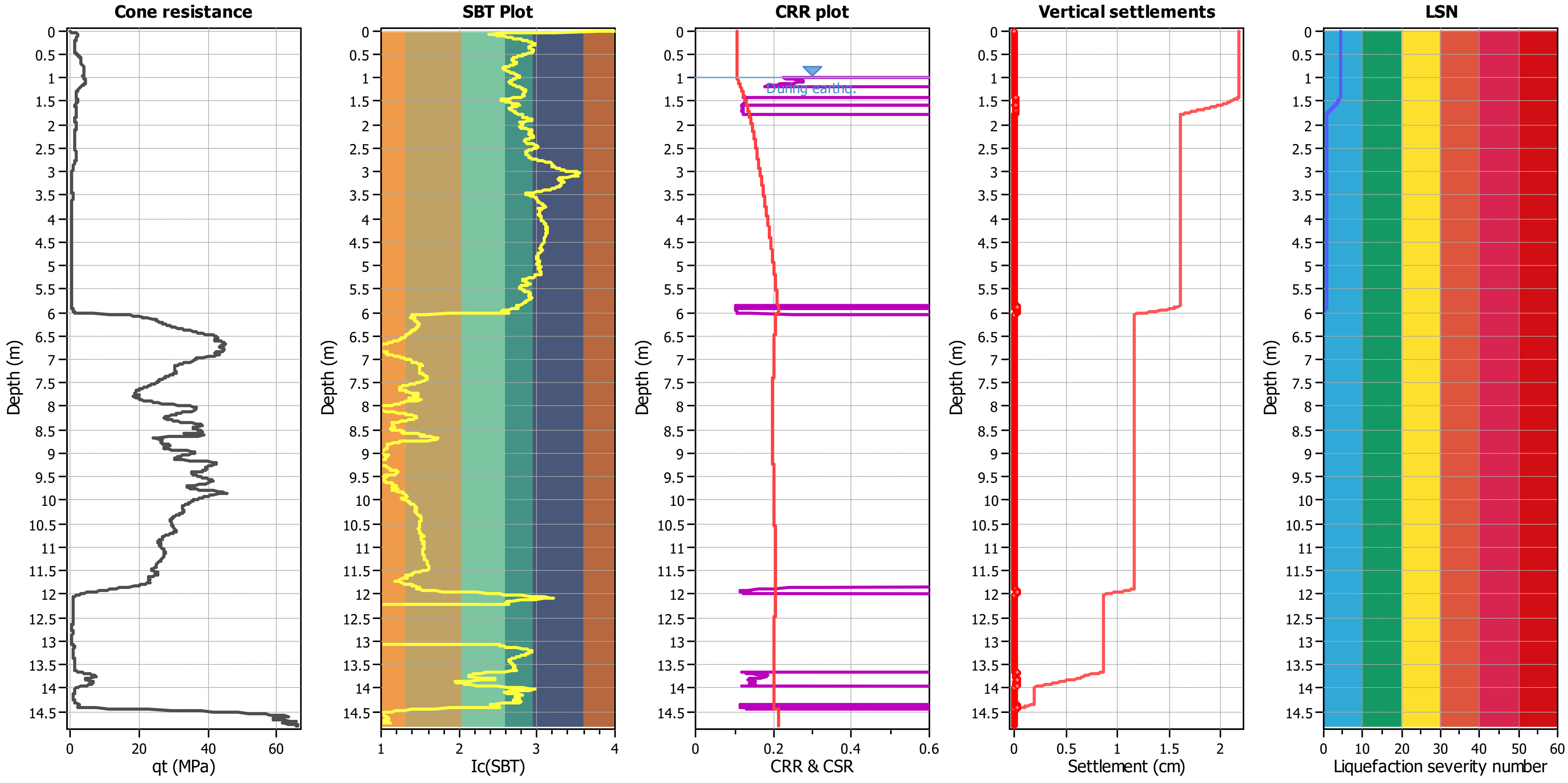
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT08
Total depth: 14.81 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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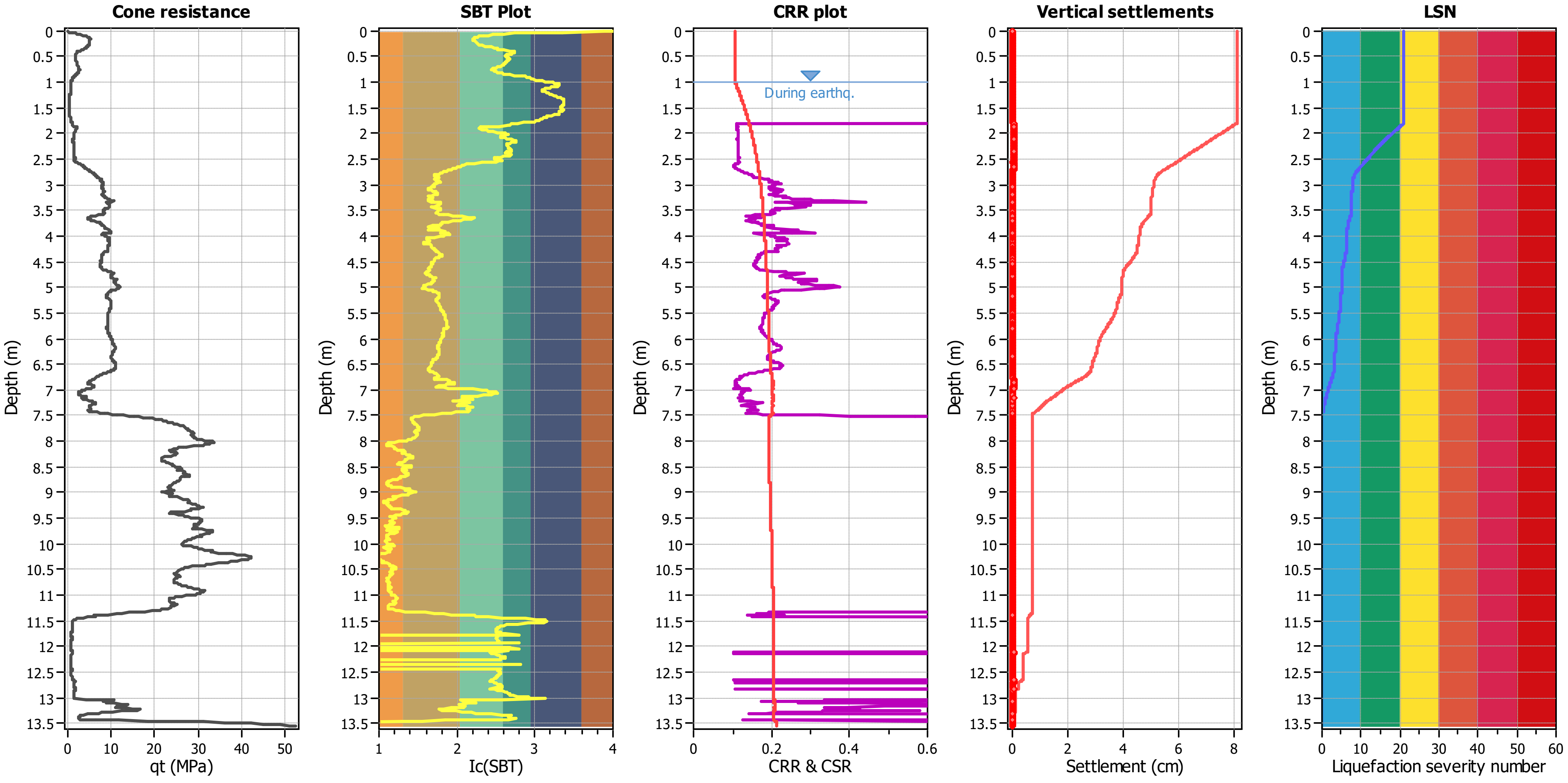
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

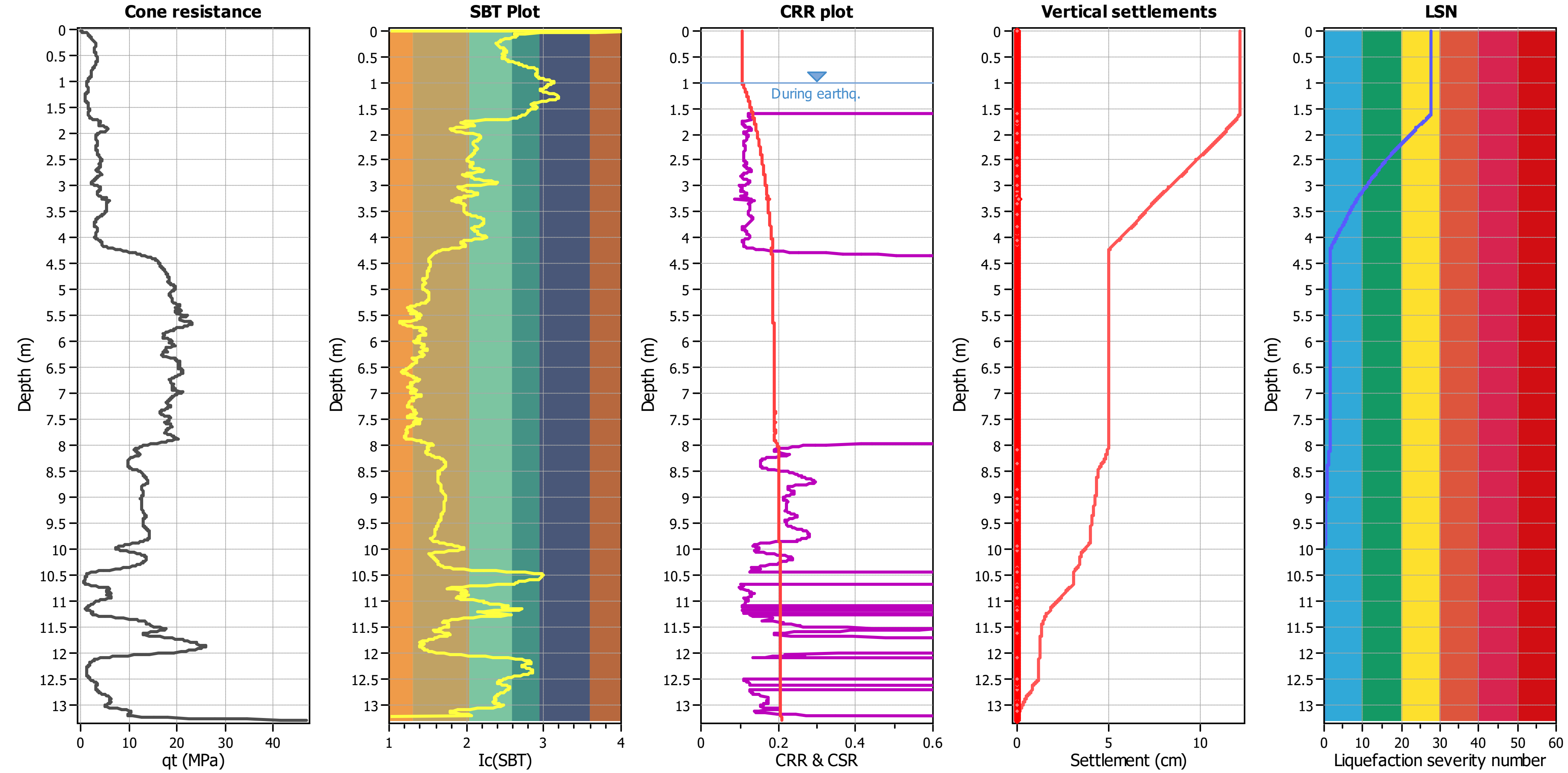
CPT: CPT09
Total depth: 13.55 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT10
Total depth: 13.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
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:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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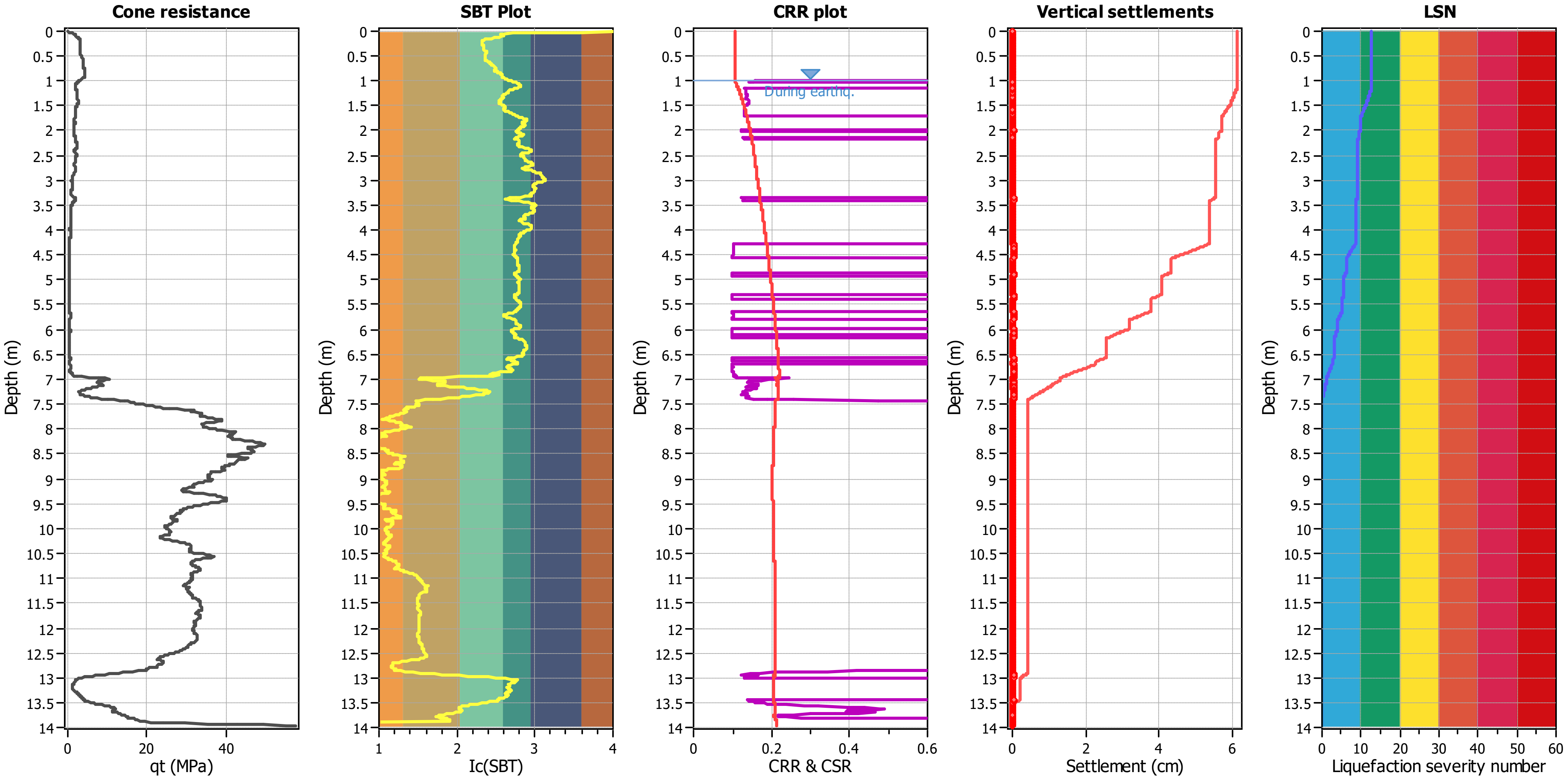
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT11
Total depth: 13.96 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
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:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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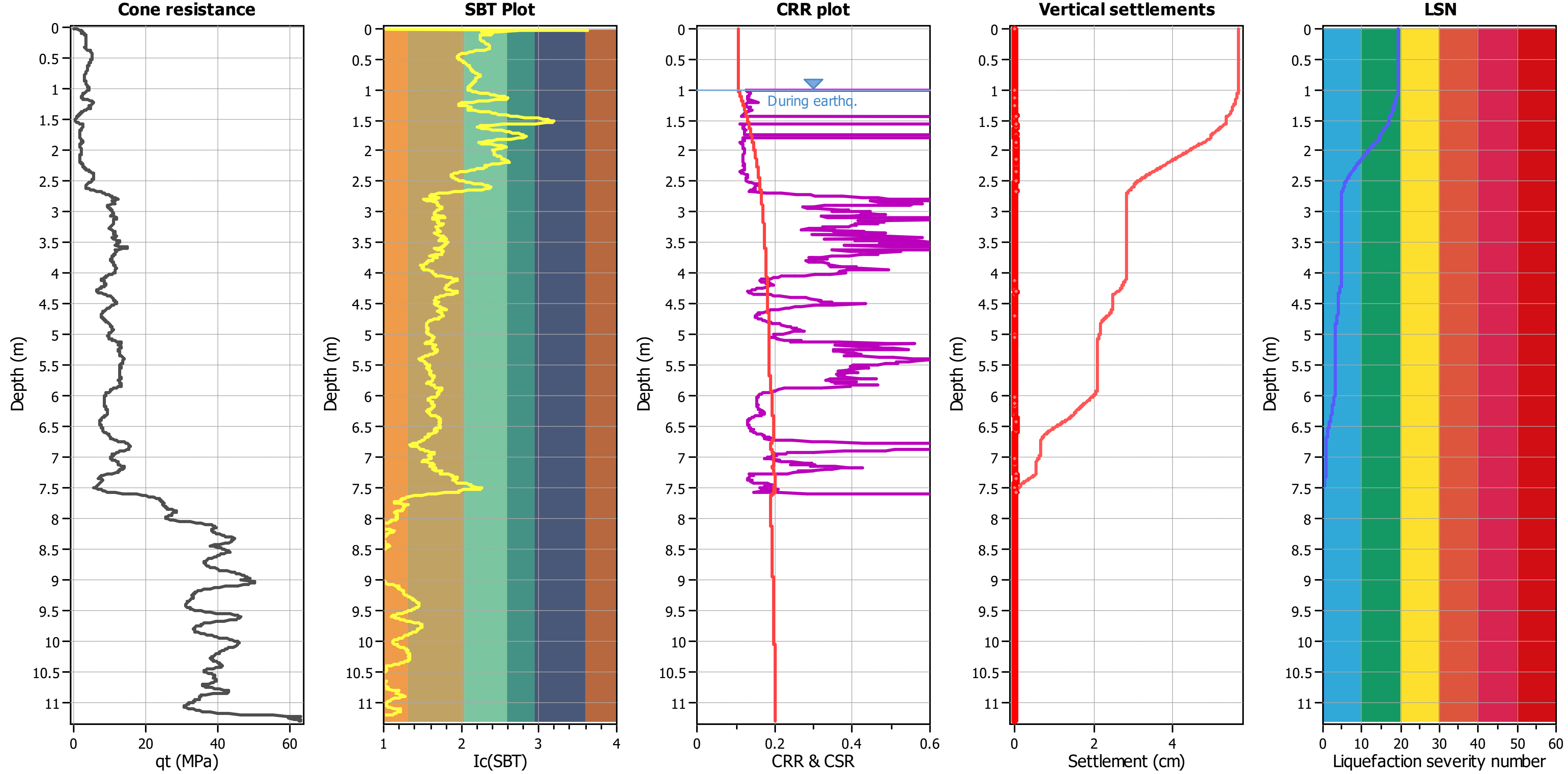
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT12
Total depth: 11.30 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.50
Peak ground acceleration: 0.18

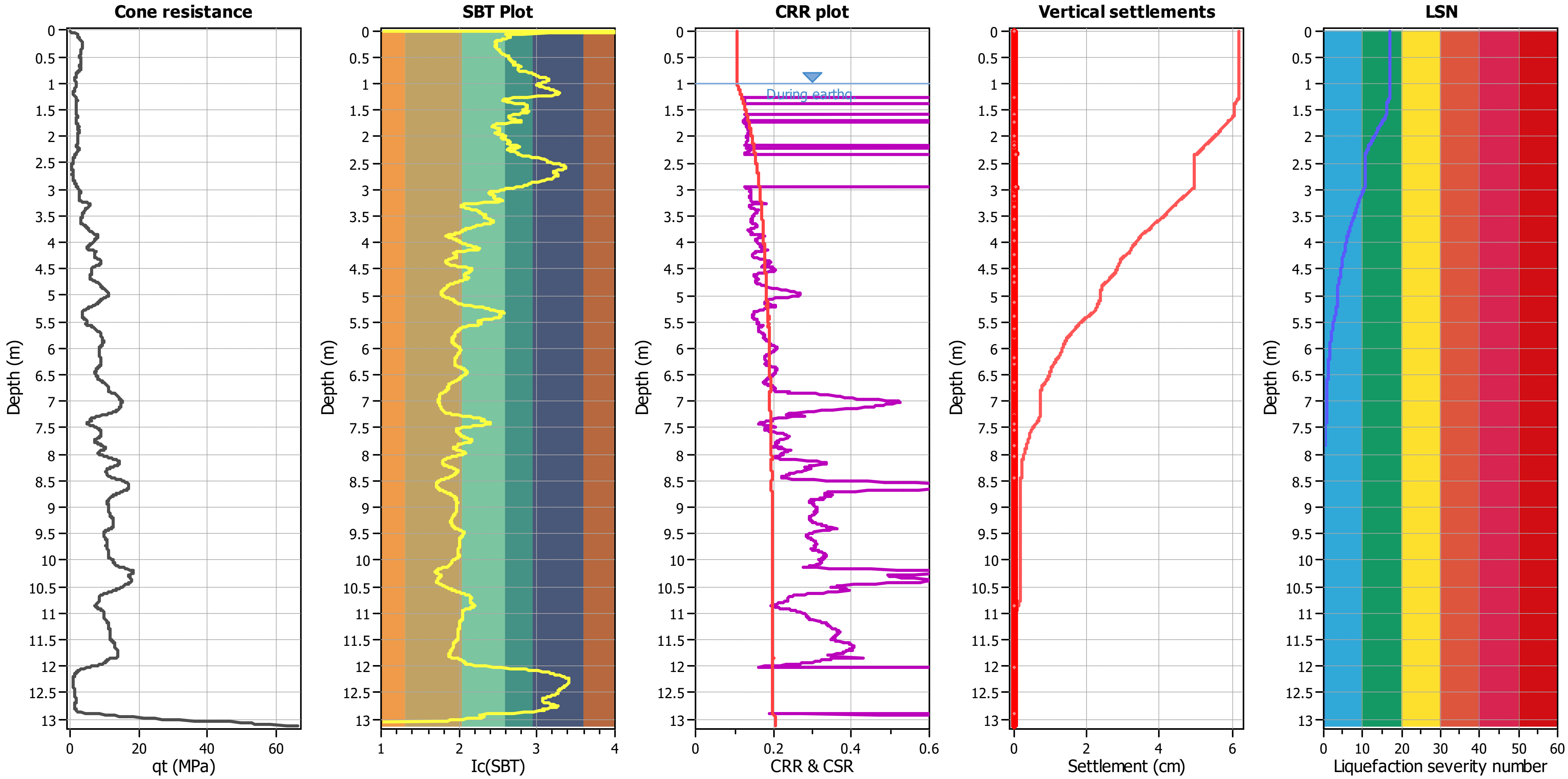
G.W.T. (in-situ): 1.00 m
G.W.T. (earthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT13
Total depth: 13.13 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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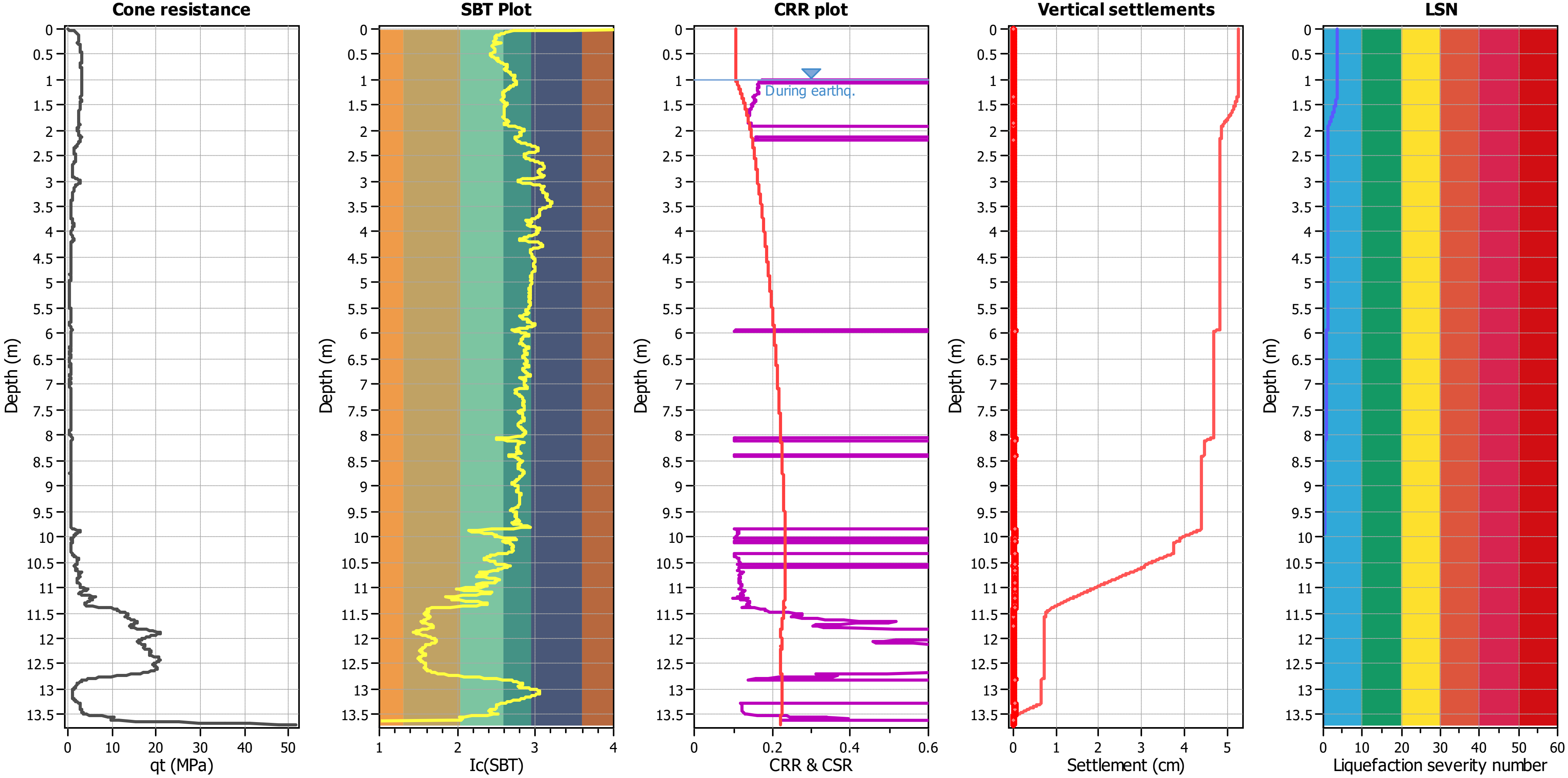
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

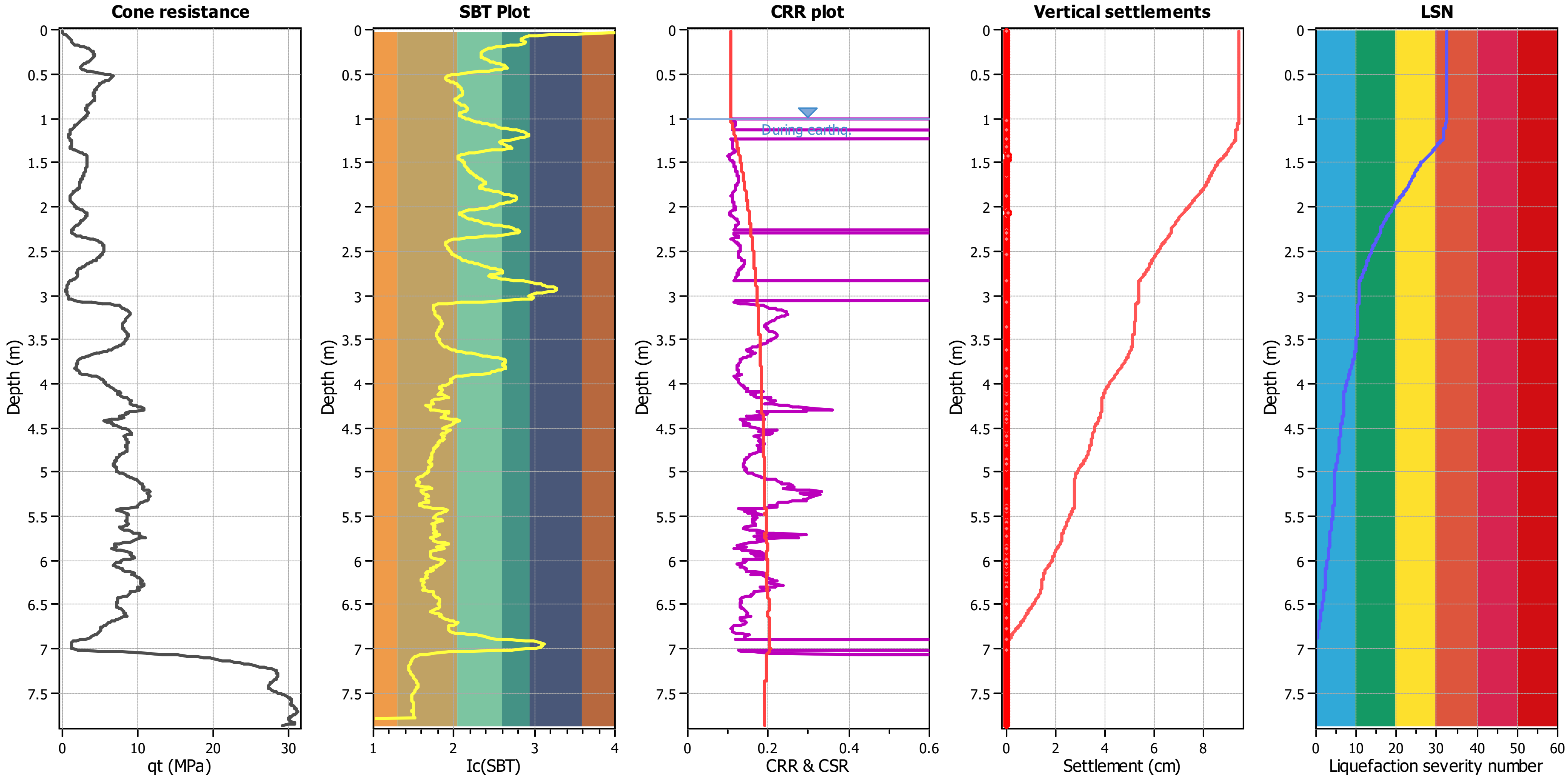
CPT: CPT14
Total depth: 13.70 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.		
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A		
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based		
Peak ground acceleration:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes				

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT15
Total depth: 7.87 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.18	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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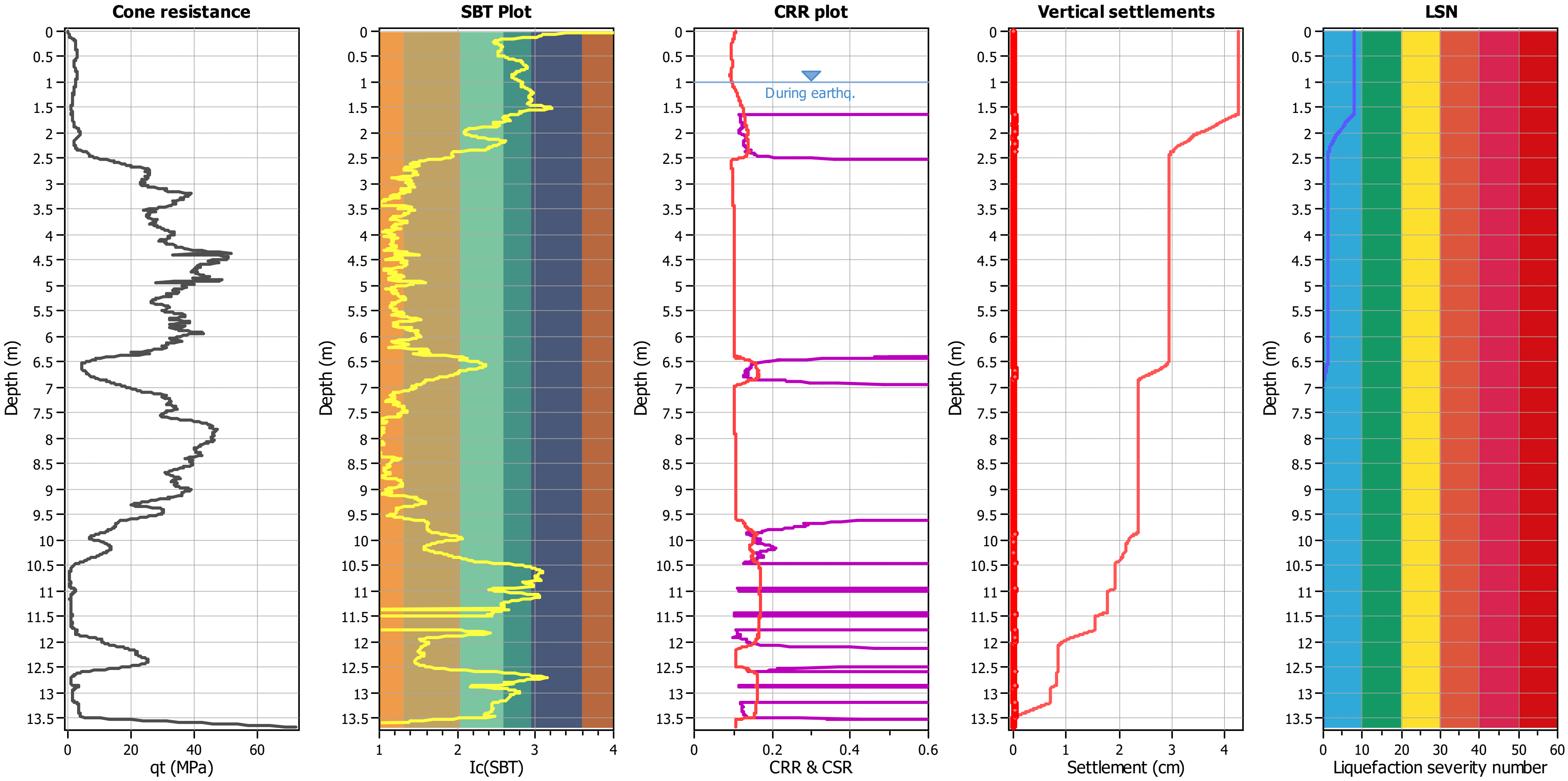
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

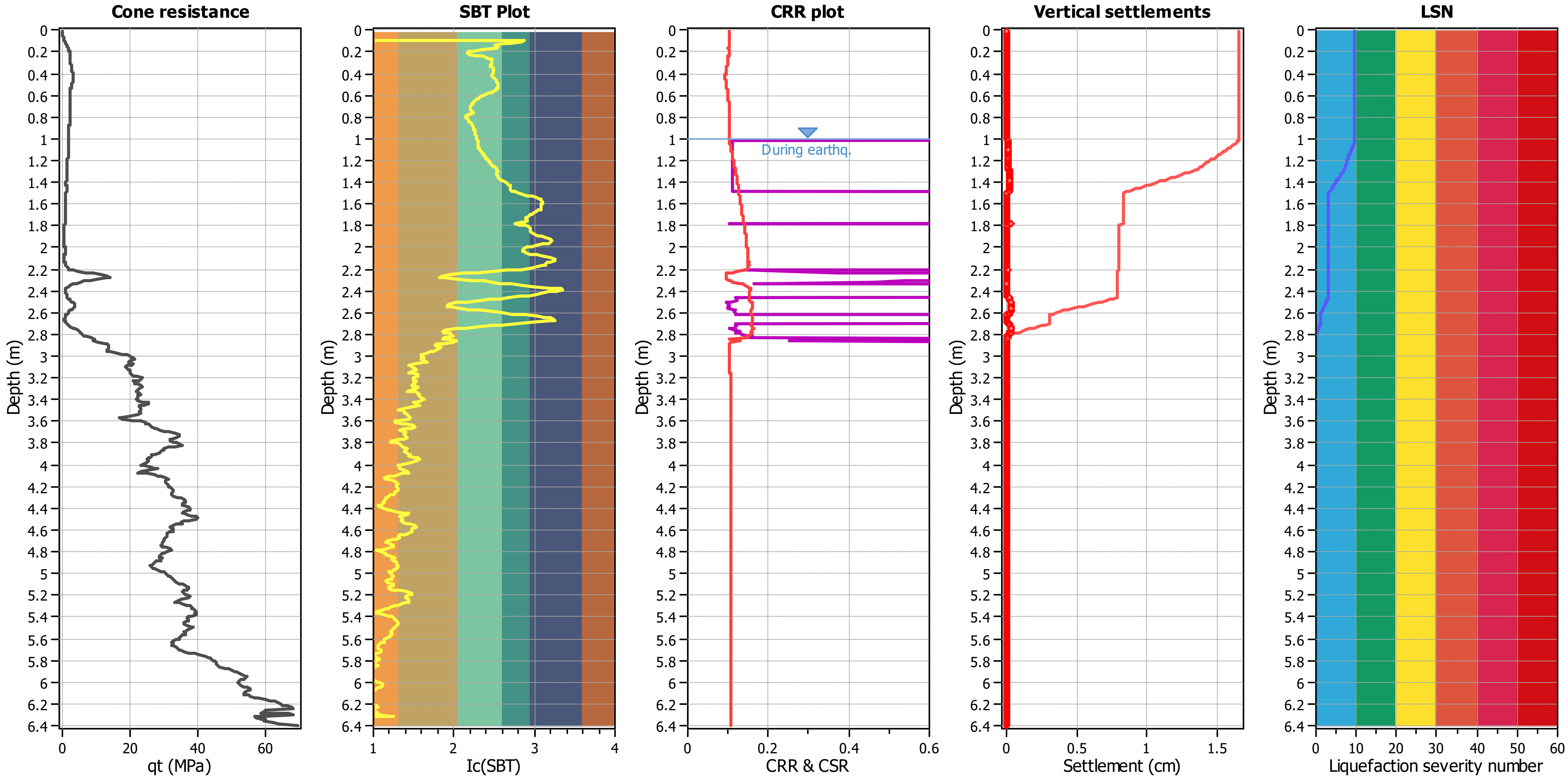
CPT: CPT01
Total depth: 13.68 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT02
Total depth: 6.40 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.00
Peak ground acceleration: 0.19

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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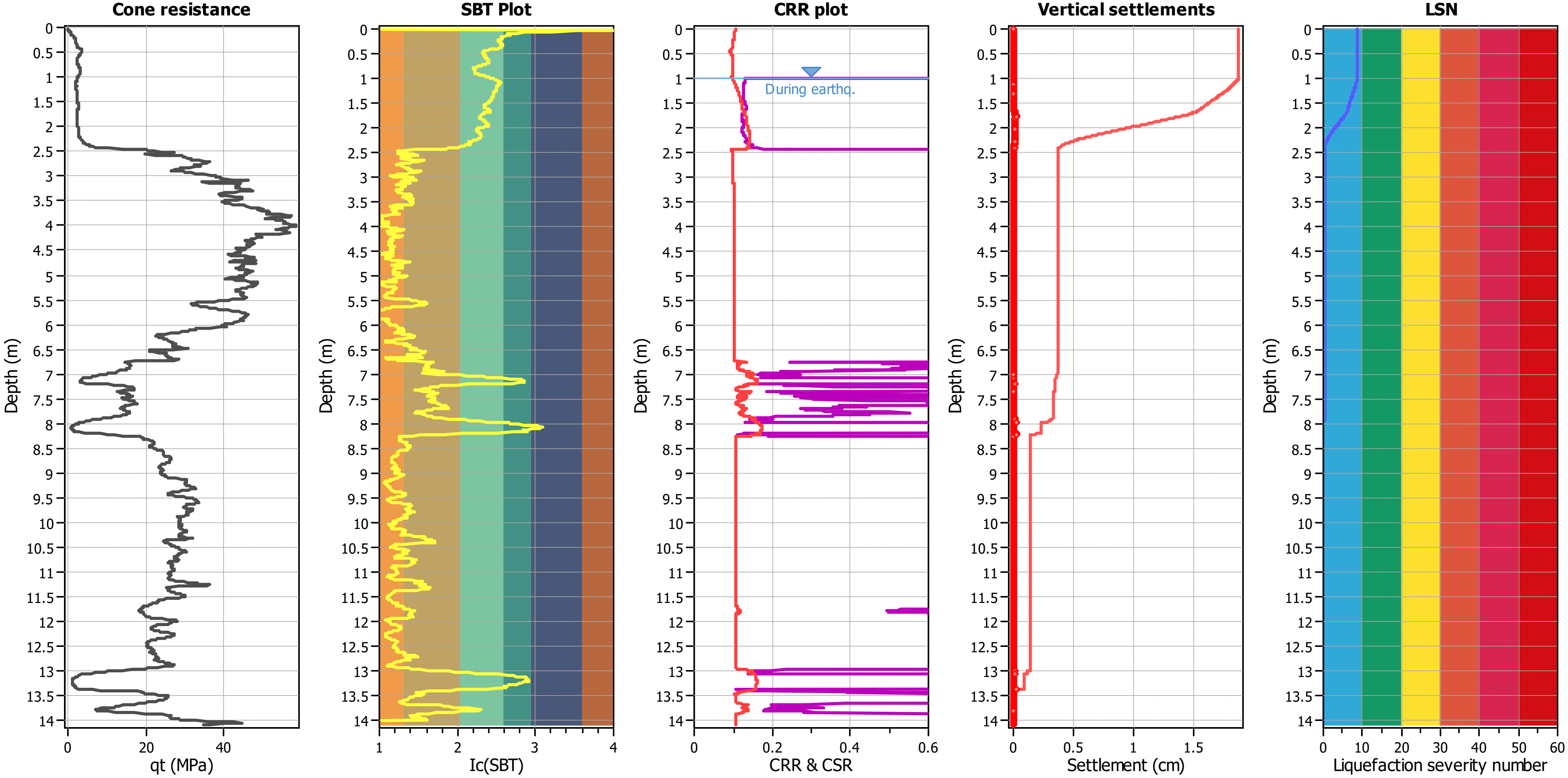
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT03
Total depth: 14.08 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.00
Peak ground acceleration: 0.19

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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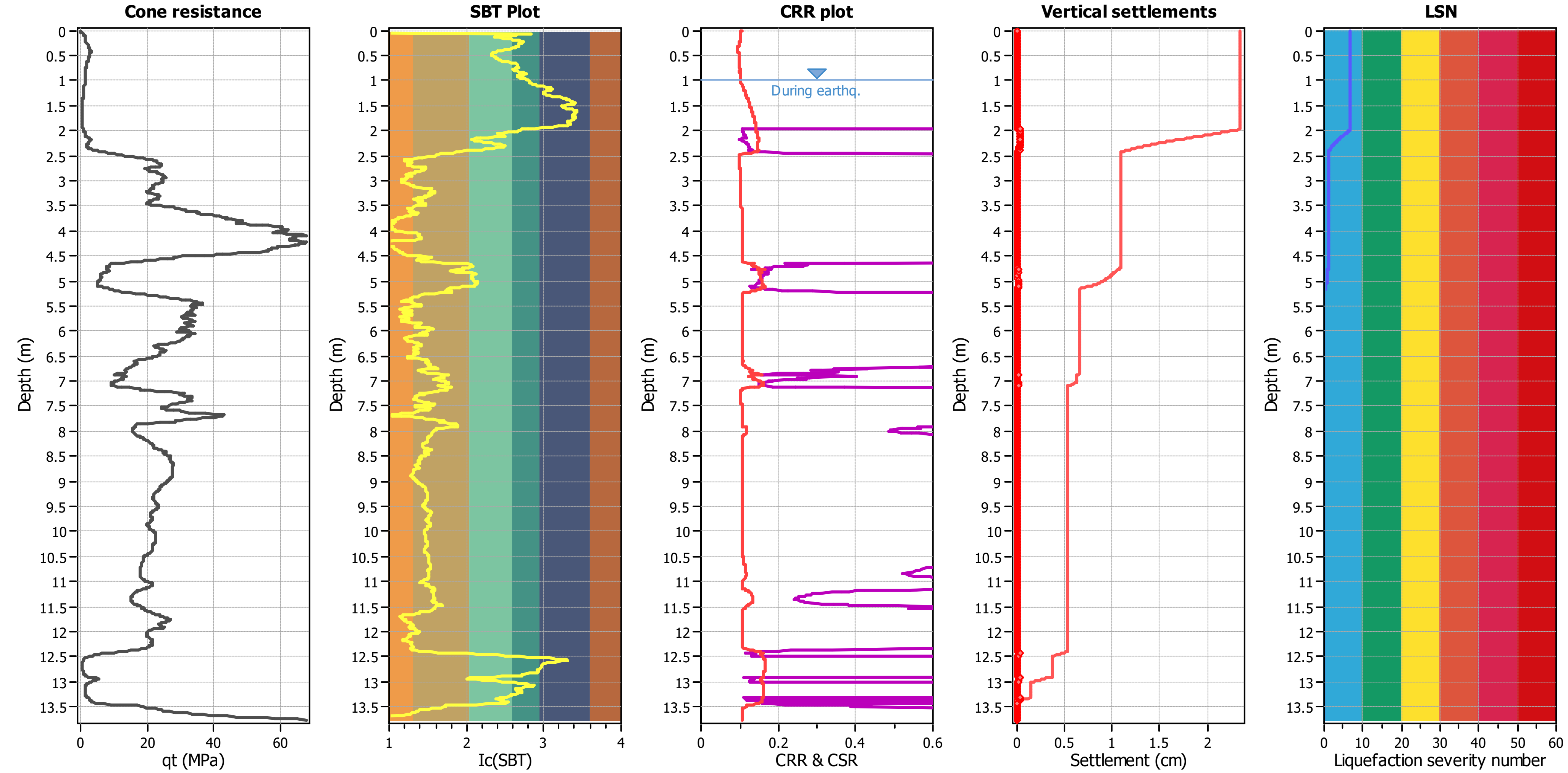
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT04
Total depth: 13.77 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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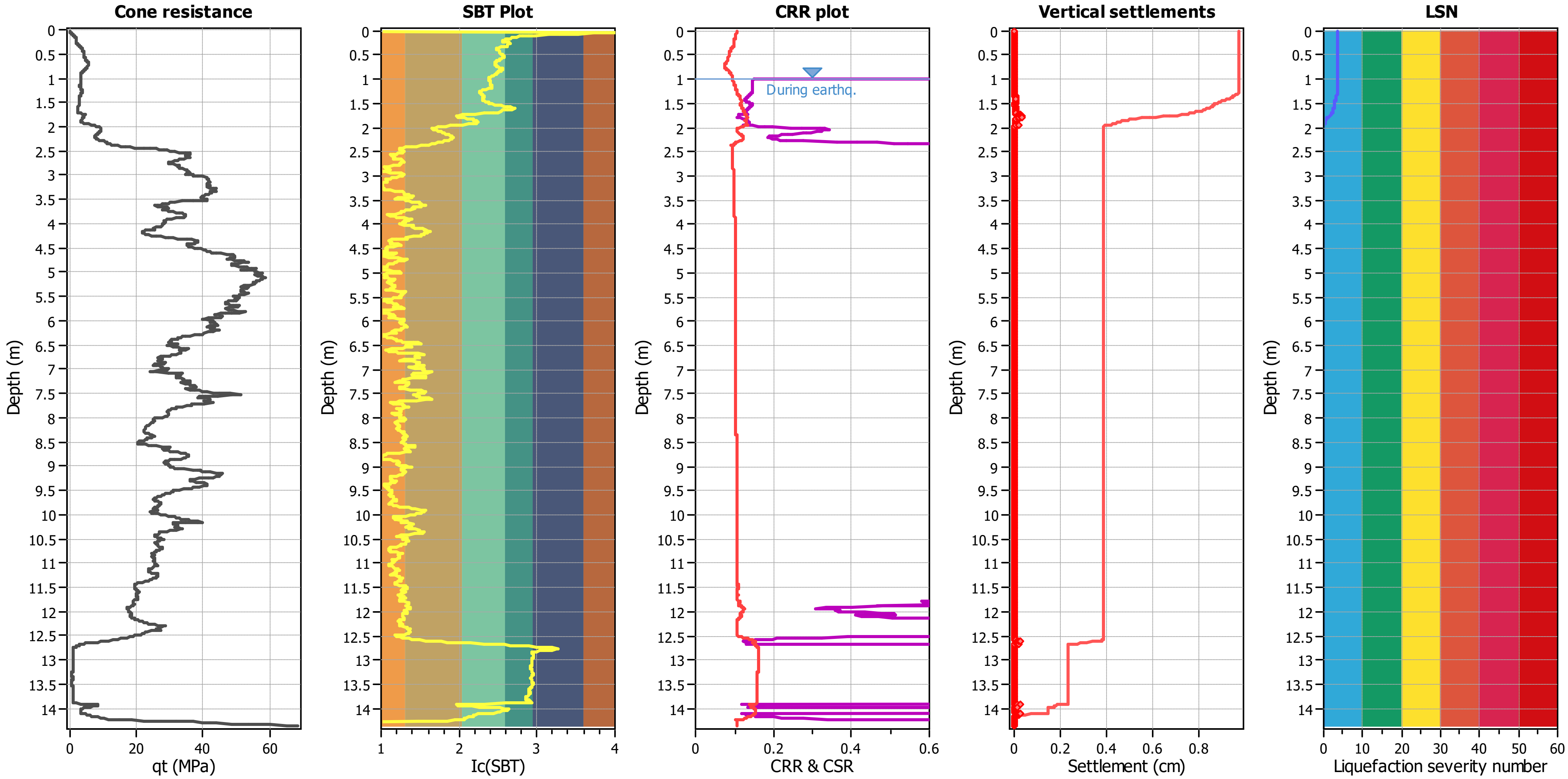
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

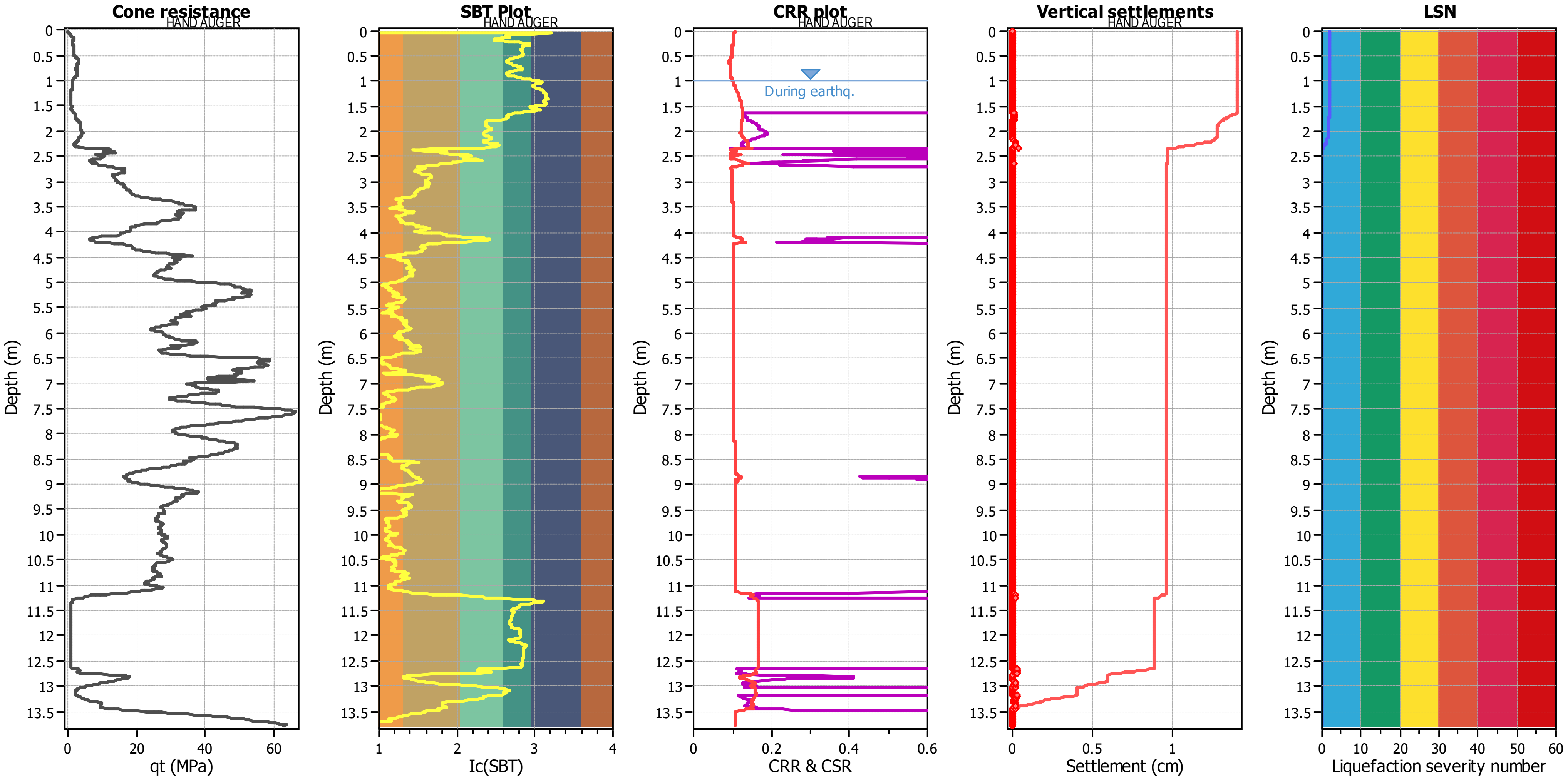
CPT: CPT05
Total depth: 14.36 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

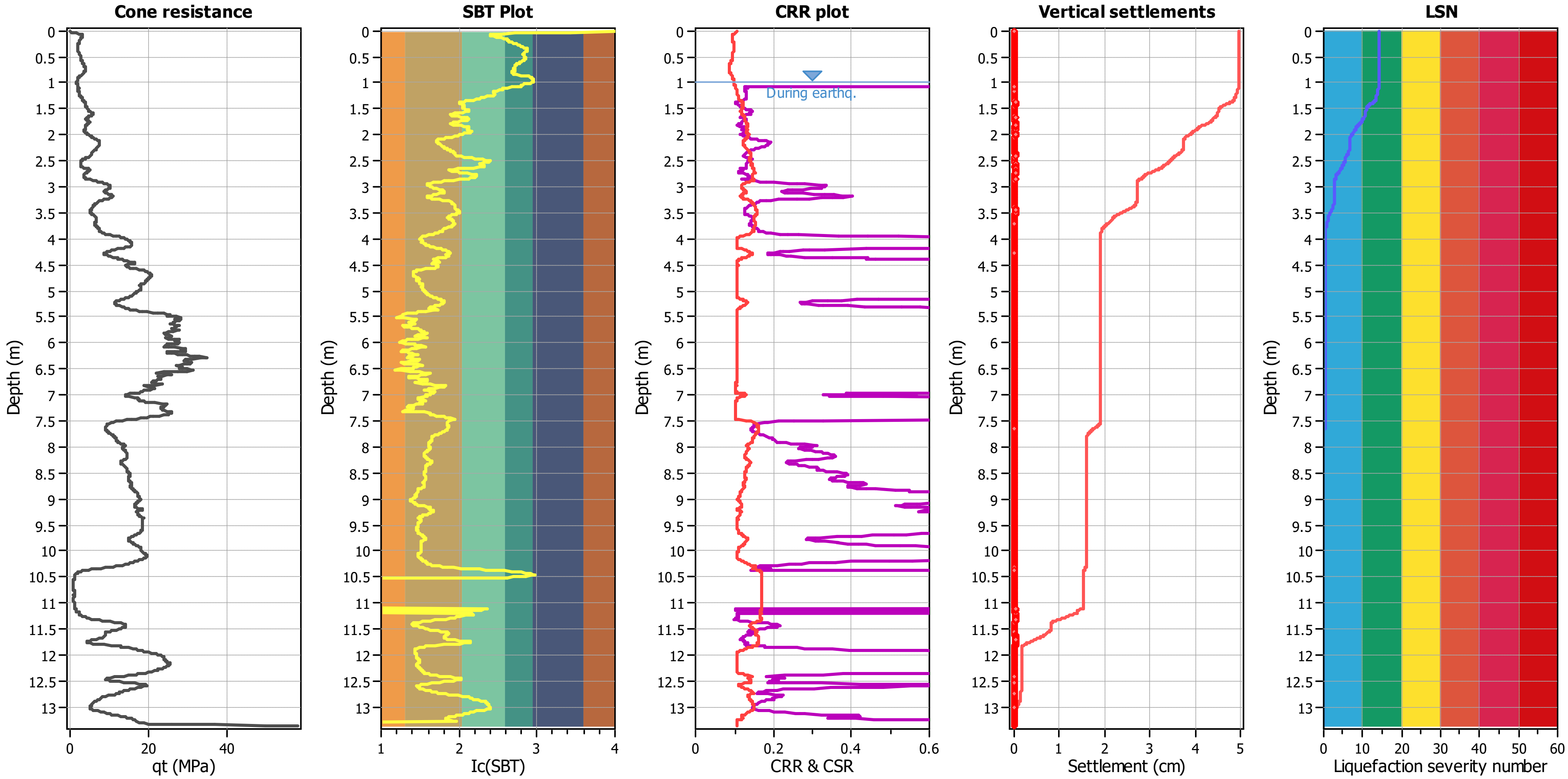
CPT: CPT06
Total depth: 13.79 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT07
Total depth: 13.36 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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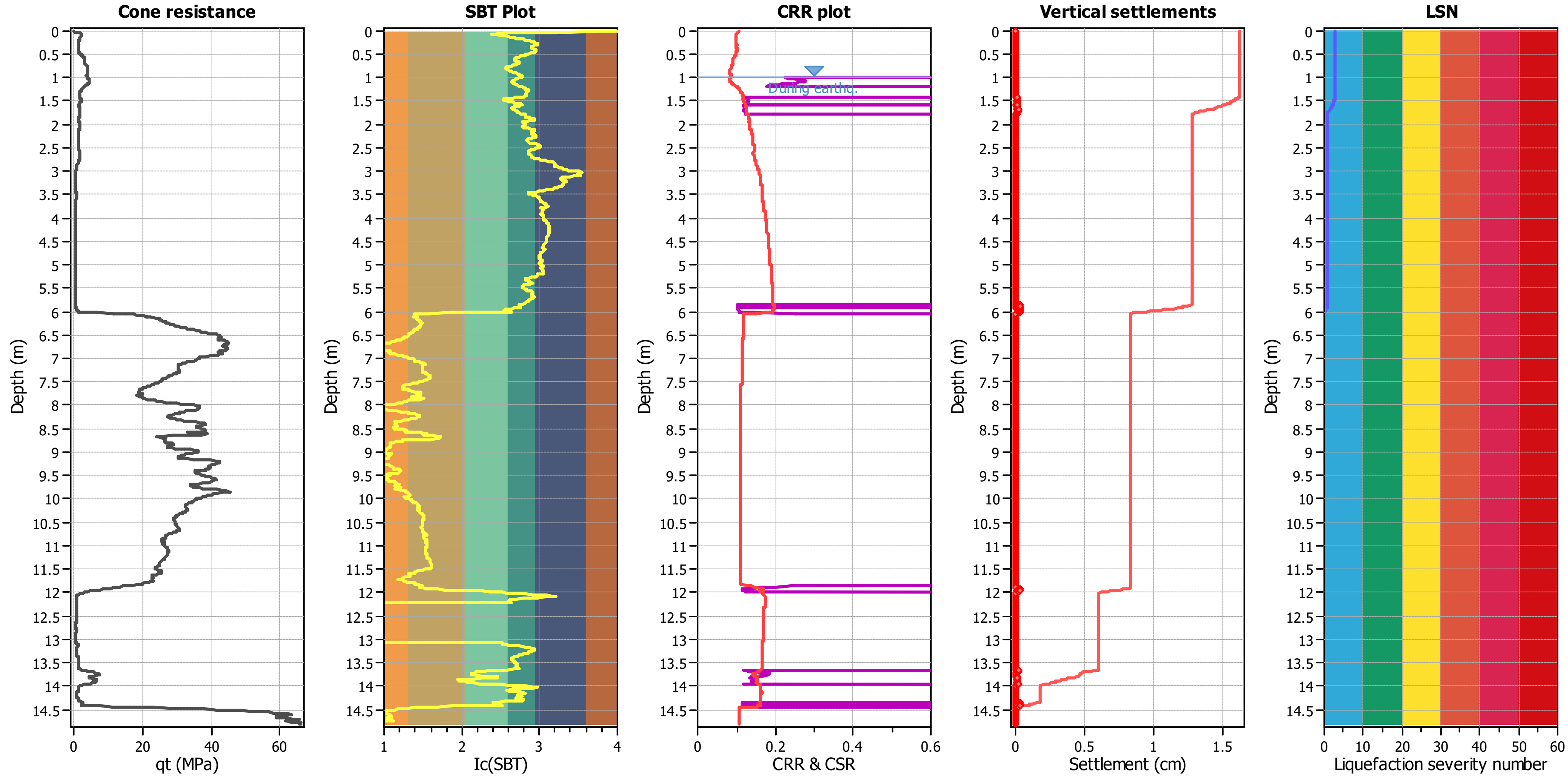
Project: **144 & 170 Main North Road**

Location: **Kaiapoi**

CPT: CPT08

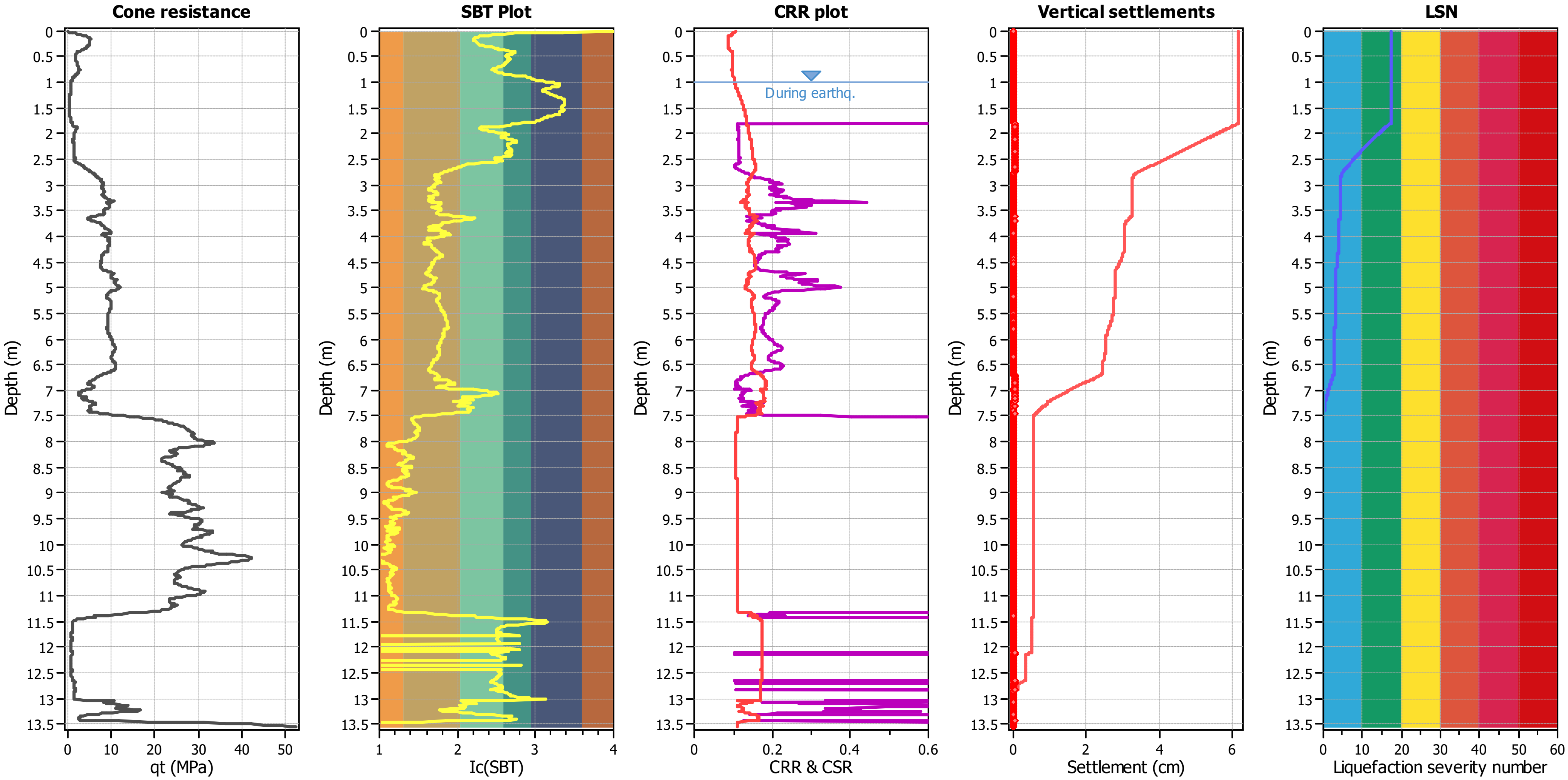
Total depth: 14.81 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT09
Total depth: 13.55 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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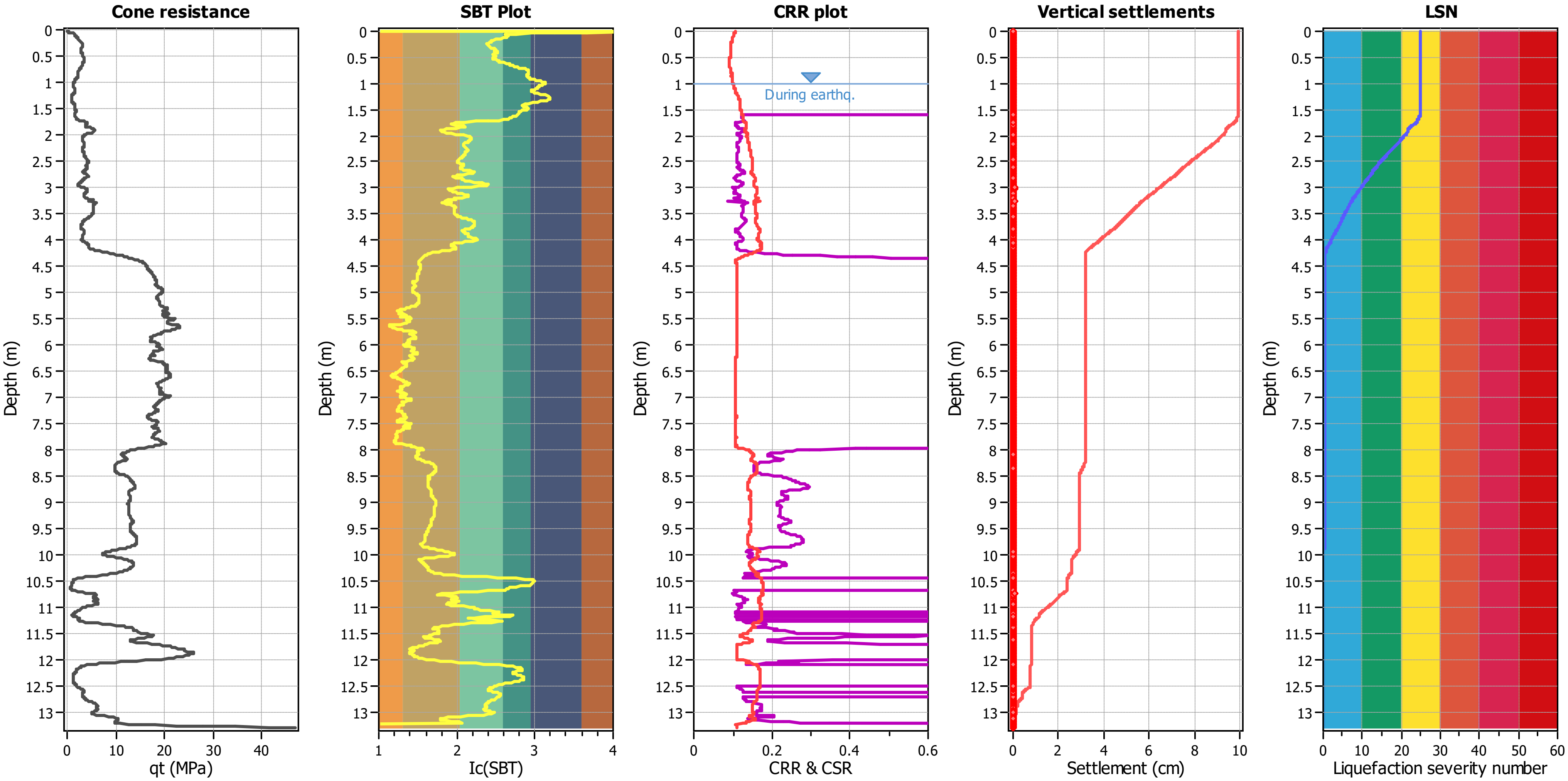
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT10
Total depth: 13.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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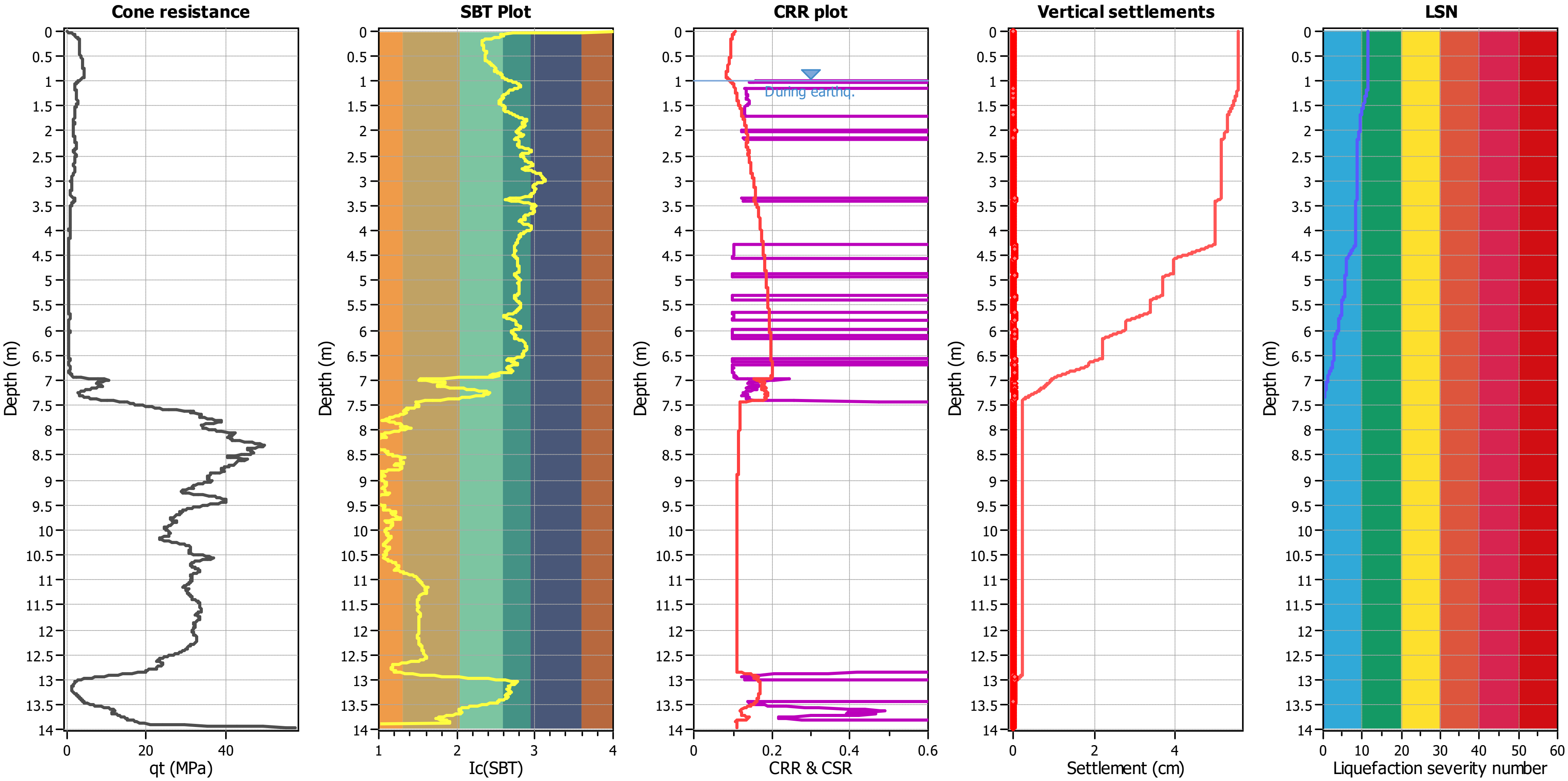
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT11
Total depth: 13.96 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.00
Peak ground acceleration: 0.19

G.W.T. (in-situ): 1.00 m
G.W.T. (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
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

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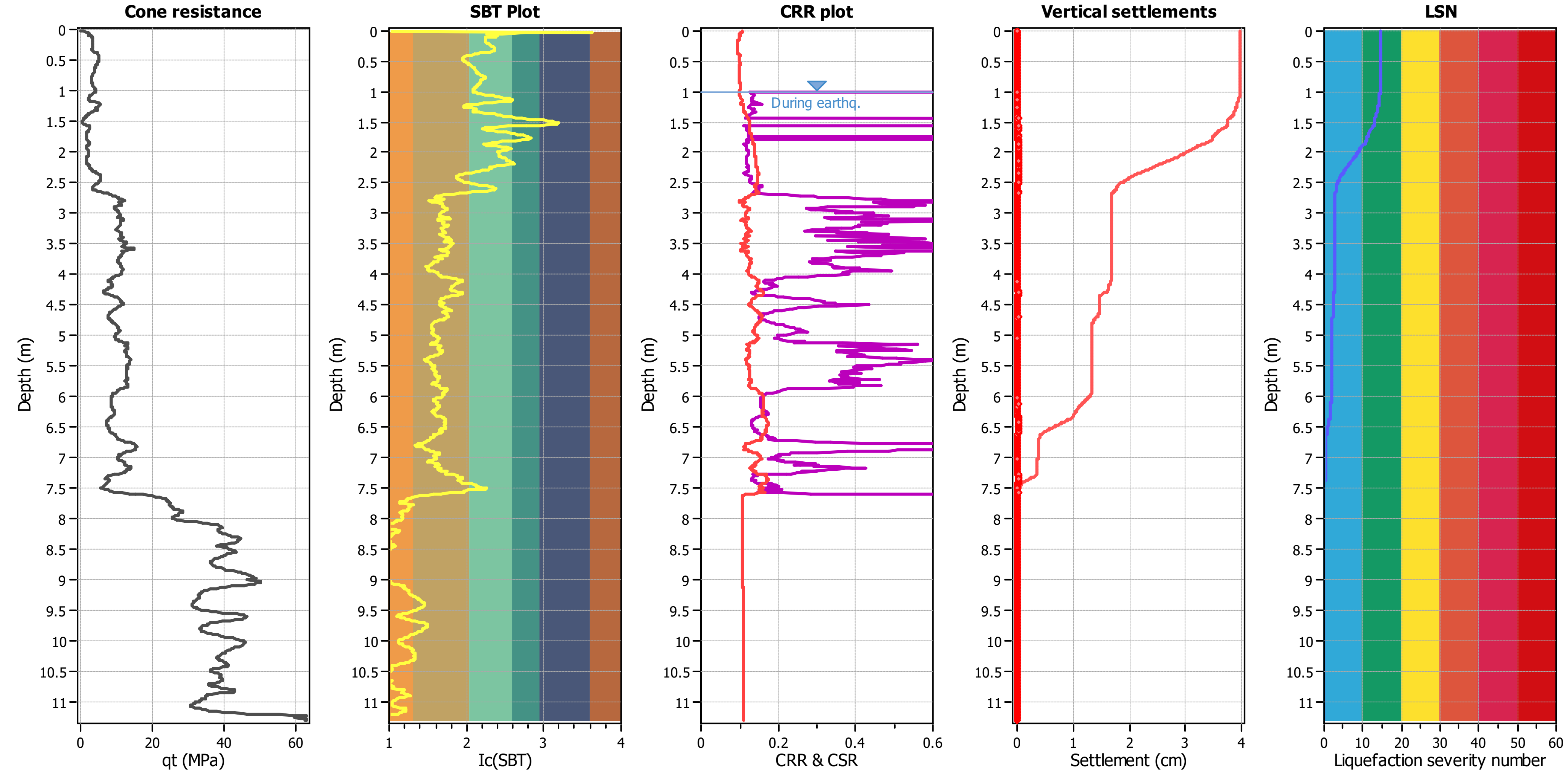
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT12
Total depth: 11.30 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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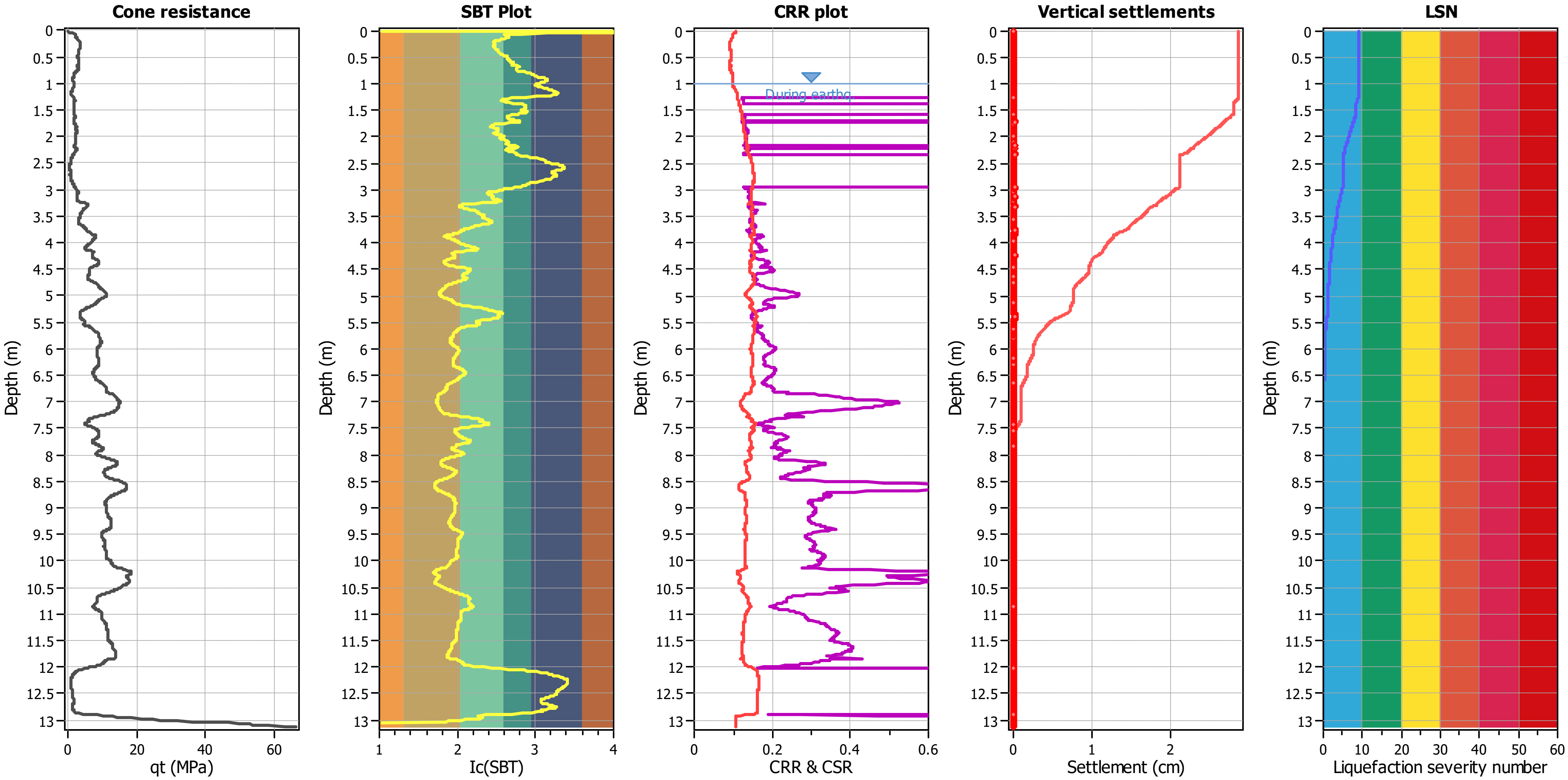
Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

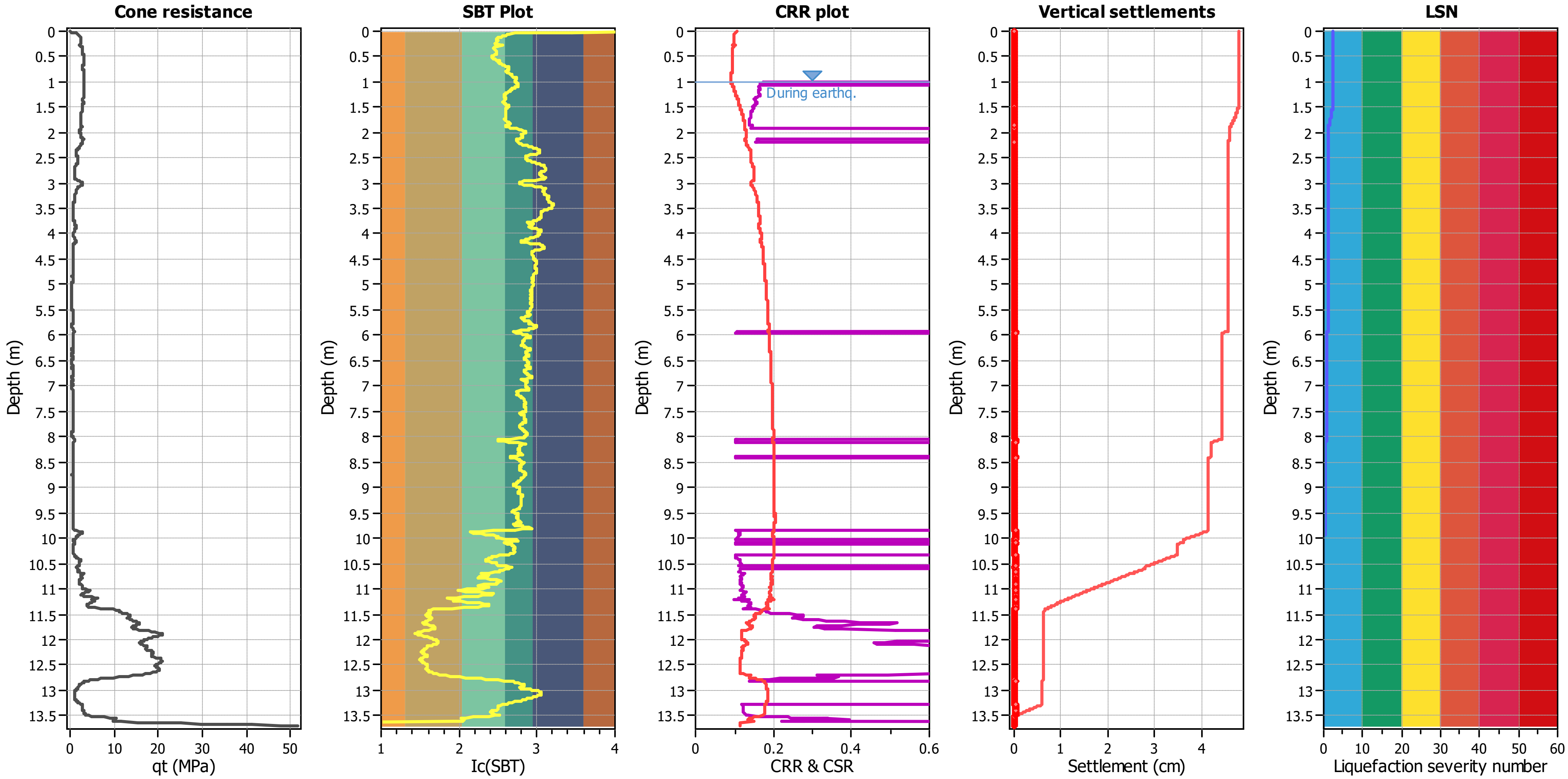
CPT: CPT13
Total depth: 13.13 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT14
Total depth: 13.70 m



Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.00
Peak ground acceleration: 0.19

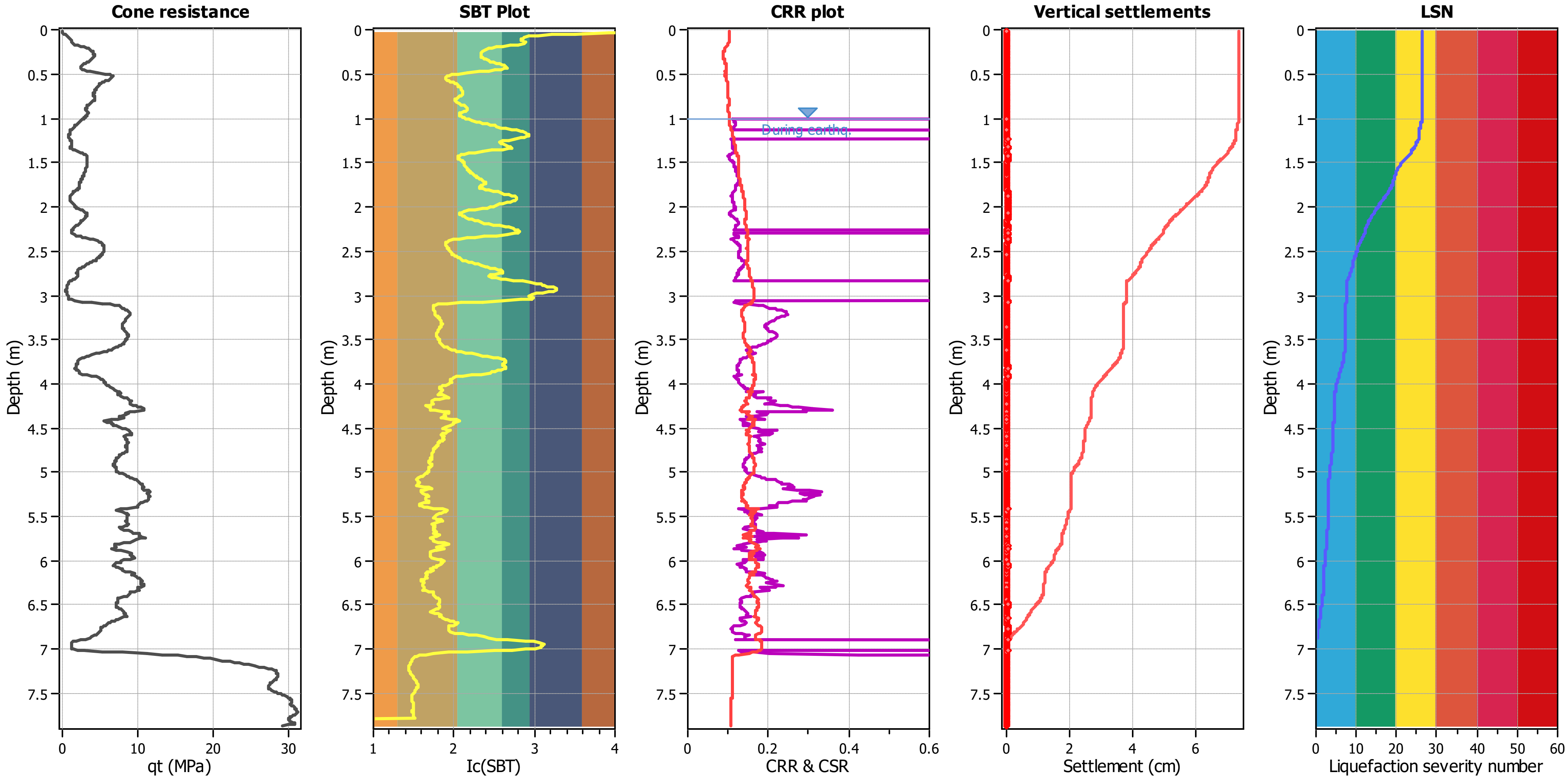
G.W.T. (in-situ): 1.00 m
G.W.T. (earthq.): 1.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT

Use fill: No
Fill height: N/A
Fill weight: N/A
Trans. detect. applied: No
K_σ applied: Yes

Clay like behavior applied: .
Limit depth applied: No
Limit depth: N/A
MSF method: Method based

Project: **144 & 170 Main North Road**
Location: **Kaiapoi**

CPT: CPT15
Total depth: 7.87 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		