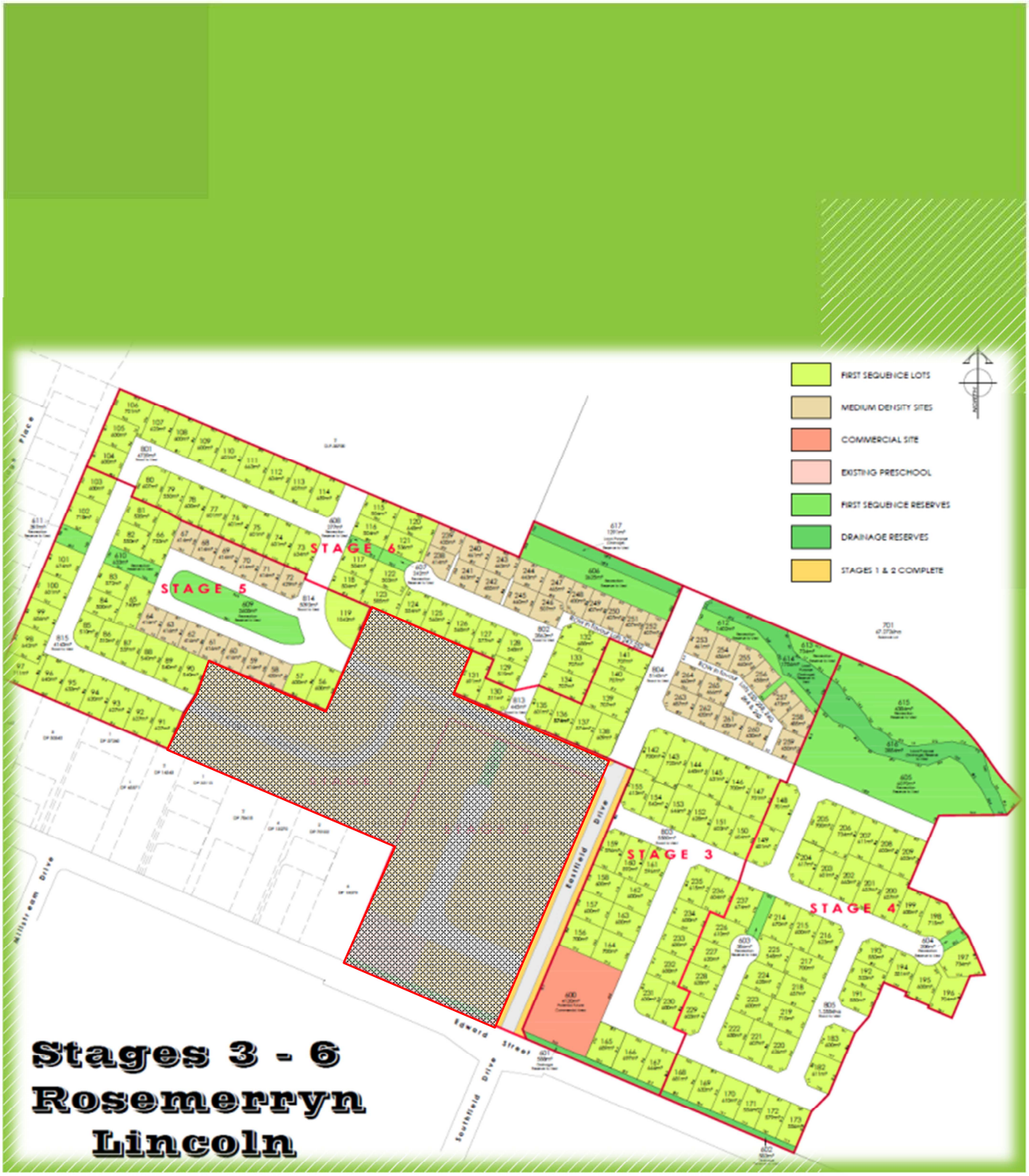

Geotechnical Assessment Report
Rosemerryn Farm
Stages 3 to 6
Fulton Hogan Land Development Limited

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1. Introduction

Fulton Hogan Land Development Limited is proposing to subdivide an area of land, approximately 85ha, off Edward Street on the east side of Lincoln. It is intended to eventually develop approximately 891 residential lots on the greater site. This will be done by developing the subdivision in stages. Stage 1 has been developed and Stage 1A has been submitted for consent. It is proposed to carry out the civil engineering works for the next stage of the subdivision being Stages 3 to 6. These are located immediately off Edwards Street and around the recently completed Stage 1 and 1A (aka Stage 2). This report has been prepared for the purpose of Stages 3 to 6 only but draws on our findings from other stages.

Fulton Hogan Land Development Limited has engaged Aurecon New Zealand Ltd to undertake a geotechnical investigation of the entire Rosemerryn site. Aurecon recently submitted revision 2 of a geotechnical investigation report for Stage 1A, dated 8 March 2012.

The purpose of this geotechnical investigation is to identify any geotechnical issues including addressing any potential liquefaction risk and any remediation options that may be required as part of the residential development.

Our scope of works was as follows:

- A preliminary site walkover and reconnaissance.
- A detailed desk study considering geological and geotechnical information available for this site, including previous geotechnical investigation results.
- Undertake geotechnical investigation including CPT and test pitting. The investigation for Stage 3 to 6 was carried out as part of the investigation for the larger subdivision.
- Carry out machine excavated borehole holes and installation of piezometers.
- Undertake a liquefaction analysis based on the geotechnical investigation information.
- Provide recommendations on potential liquefaction remediation options for the site development, if required.
- Prepare a report detailing the investigation and analysis results, as well as provide development recommendations.

This work excludes the detailed design of any civil engineering which will be dealt with at the detailed design stage of the subdivision development.

This report outlines our geotechnical investigation and presents our assessment of potential liquefaction across Stages 3 to 6 and provides recommendations for liquefaction remediation options as part of the future site development.

Our limitations are attached as Section 9 of this report. This report shall be read as a whole.

2. Executive Summary

Fulton Hogan Land Development Limited is proposing to subdivide an area of land, approximately 85ha, off Edward Street on the east side of Lincoln. It is intended to eventually develop approximately 891 residential lots on the greater site. Previous stages include Stage 1 which has been developed and Stage 1A is currently at consent. It is proposed to carry out the civil engineering works for the next stage of the subdivision being Stages 3 to 6. These stages are located immediately off Edwards Street and around the recently completed Stages 1 and 1A. This report has been prepared for the purpose of Stages 3 to 6 only.

The purpose of the geotechnical investigation was to identify any geotechnical issues with Stages 3 to 6, including potential liquefaction risk, and any potential remediation options should these be required.

Based on the geotechnical test information, the ground conditions consist of predominantly silty sand with minor silt and sand layers, which is underlain by silt with minor silty sand and sand layers. Gravel is present at depths of 4.0m to 7.5m below ground level (bgl).

Groundwater levels were measured at depths of 2.3m to 4.2m bgl. The gravel layers are known to have confined water. Perched groundwater levels are likely to exist within the more permeable sand/silty sand layers in the upper soil profile.

To assess the potential for seismically induced liquefaction, we determined this by analysing the CPT logs using the following levels of ground shaking:

1. Serviceability limit state (SLS) earthquake based on the NZGS Guidelines.
2. Ultimate limit state (ULS) earthquake based on the NZGS Guidelines.

The liquefaction analysis identified the following:

- Under a conservative SLS earthquake case total settlements of up to 70mm can be expected and there is unlikely to be any liquefaction induced ground damage.
- Under a ULS earthquake case total settlements of up to 90mm can be expected. There is the potential for liquefaction induced ground damage in parts of the site. It is however noted that during the ULS design earthquake some building damage is likely at this level of shaking regardless of ground conditions and liquefaction potential.
- Lateral spreading damage was not observed at the site and given that the site has experienced ground accelerations equivalent or more to that of a ULS event, we have assessed the potential for lateral spreading to be low to very low.

For the Christchurch Region the Department of Building and Housing (DBH, 2011) has recently released a new classification system for residential 'Green Zone' land on the flat in regard to the liquefaction susceptibility. **Based on the liquefaction and lateral spreading results we consider Stages 4 and 5 and the southern two thirds of Stage 3 to be classified as Technical Category (TC2)**, **while Stage 6 and the northern one third of Stage 3 currently conforms to Technical Category (TC1).**

For **TC1** areas the DBH has recommended Standard NZS3604:2011 type foundations with tied slabs are suitable.

For **TC2** areas the DBH has recommended types of foundation systems for residential houses in their publication '*Guidance on house repairs and reconstruction following the Canterbury Earthquake',* dated 20 December 2010. As required under the new DBH guidelines for detailed house design, a site

specific geotechnical assessment shall be carried out by suitability qualified chartered engineer with experience in residential house development.

Several foundation options are available for residential houses. These foundation options are house specific and will need to be selected and designed during the building consent stage of the property development. The suitable foundation options fall generally into two categories; shallow foundations, and deep foundations.

It should be noted that this report intends to provide guidance only on residential foundation design and should not be taken as detailed design. The recommendations provided below are for completeness and to present all currently available options. The recommendations provided below are in line with DBH document '*Revised guidelines on repairing and rebuilding houses affected by the Canterbury earthquake sequence',* dated November 2011.

Recommendations are also provided for the infrastructure, although we note that liquefaction induced ground damage under an SLS event is unlikely on Stages 3 to 6. The benefits in building additional seismic resilience into the residential development infrastructure for large earthquake events are discussed in this report. Recommendations are also provided in relation to the proposed subdivision earthworks.

3. Site Conditions

Rosemerryn Subdivision is located towards the north of Edward Street, Lincoln (see Figure 1 in Appendix A). The area of interest are Stages 3 to 6, which span perpendicular to Edward Street, from the western end of the subdivision towards the east (see Figure 2 Appendix A). A geotechnical assessment of Stage 1A was addressed in a previously issued geotechnical report dated 8 March 2012.

This report addresses geotechnical conditions on Stages 3 to 6 only but draws on our findings from past investigations on the greater site and surrounding.

3.1 Site Description

Stage 3 is located along the eastern edge of Eastfield Drive and comprises 53 lots. It is bound to the north by Stages 7 and 8, to the east by Stage 4 and to the south by Edwards Street.

Stage 4 is located towards the east of Eastfield Drive and comprises 46 lots. It is bound to the north by a reserve, to the east by Stages 14 and 15, to the south by Edward Street and the west by Stage 3.

Stage 5 is located towards the south western extent of the subdivision and comprises approximately 42 lots. It is bound to the north by Stage 6, to the east by Stage 1, to the south by residential properties bordering Edward Street and to the west by residential properties bordering Heathridge place.

Stage 6 is located towards the western extent of the subdivision and comprises approximately 51 lots. It is bound to the north by a reserve, to the east by Stage 3 and a reserve, to the south by Stages 1, 2 and 5 and the west by residential properties bordering Heathridge place.

The proposed subdivision plan is presented in Appendix B.

The topography across Stages 3 to 6 is relatively flat with the ground sloping gently by up to 0.8m vertically towards the road.

Stages 3 to 6 are vacant of any structures.

3.2 Site Access

The site access to the various stages is off the existing roads of Eastfield Drive, Temple Avenue and Cassidy Ave. Eastfield Drive is the main subdivision access and comes off Edward Street. Other access tracks on site include the driveway to the existing farm house on the eastern side of the site.

3.3 Vegetation

The site is primarily vegetated with pastoral grass. Mature trees are present forming wind breaks towards the north of Stages 3 to 6.

3.4 Drainage

The following drainage features were present within Stages 3 to 6 and are shown on Figure 2 in Appendix A.

- A shallow stream is located north of the proposed area of the development. It appeared to be for the most part 0.5m deep, 2m to 3m wide and with a minor amount of ponded water. There is no properly defined stream bank and it appears to form more of a large swale drain.

- Along the tree line in the north east corner of the site is a small swale drain. It was noted as being approximately 0.3m in depth and approximately 1m wide.

- Along the southern edge of the development, adjacent to Edwards Street is a drainage channel that appears to have been recently modified with banked sides. It is up to 1.2m in depth and approximately 2.2m wide and at the time of our visit, had approximately 0.2m depth of water. Further along towards the east, the drain is boxed, which is up to 1.3m depth and approximately 0.5m wide, with 0.2m depth of water at the time of the inspection.

- Two stormwater retention ponds are located along the southern boundary of the site, adjacent to Edwards Street. The ponds are approximately 1m in depth with an approximate plan area of 40m by 45m each. We understand that ponds will be filled as part of the site development.

- None of the drainage channels or swales exhibited any form of land damage or lateral spreading as a result of the recent seismic events.

3.5 Regional Geology

The regional geology of the site is described by Forsyth et al. (2008) as *"grey river alluvium beneath plains or low-level terraces (Q1a)"*.

The Institute of Geological and Nuclear Sciences (GNS) Active Fault System database (GNS, 2010a) indicates that the site is located approximately 12km east of the eastern end of the Greendale Fault. It is noted that the movement of the Greendale Fault generated the Magnitude 7.1 Canterbury Earthquake of 4 September 2010. The site is also located approximately 20km south west of the epicentre of the Magnitude 6.3 Christchurch Earthquake on 22 February 2011 and 22km south west of the Magnitude 6.3 aftershock on 13 June 2011 (GNS, 2011b).

4. Geotechnical Site Investigation

4.1 General

The objective of the ground investigation was to investigate the subsoil and groundwater conditions across the site. The investigation for Stages 3 to 6 was carried out as part of the investigation for the larger subdivision. Therefore the geotechnical investigation information used for these stages (Stages 3 to 6) are part of a large group of geotechnical information and only the tests that are relevant to these stages are discussed here. Consideration was given to information and data from outside the Stages 3 to 6 boundaries when assessing geotechnical hazards and issues.

The geotechnical investigation for Stages 3 to 6 comprised the following:

- Site walk over by a senior Engineering Geologist from Aurecon.
- 20 Cone Penetrometer Testing (CPT) undertaken by McMillan Drilling Services and supervised by a Geotechnical Engineer from Aurecon.
- 50 Test pits excavations to confirm soil and groundwater conditions.
- 1 Machine excavated boreholes and the installation of a piezometer.
- A review of the 15 Environment Canterbury GIS database borehole logs.

Overall we achieved an intrusive investigation density of at least one test per four lots. This is in line with the recommendations issued by DBH *Revised guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence*, dated November 2011. Overall our ground investigations indicated a relatively consistent and predictable geology underlying the site that is in line with our past experience in Lincoln.

4.2 Cone Penetrometer Testing

As part of the ground investigations carried out for the larger subdivision over 37 CPT probes were sunk, 20 of those were present within the Stage 3 to 6 boundaries or in very close proximity. The CPT tests were undertaken to effective refusal (tip pressure over 30MPa) of the rig and this generally occurred on thick deposits of dense gravels. The depths achieved were typically between 2.5m and 7.5m below ground level. The locations of the CPT tests are shown in Figure 3 in Appendix A and the logs are presented in Appendix C.

Towards the northern side of the site the ground conditions consist of predominantly silty sand with layers of silt and sand to depths of 2.5m to 3.8m. Below these depths the CPTs refused in dense gravels.

Further to the south the ground conditions consist of predominantly silty sand with layers of silt and sand to depths of 2.5m to 3.5m, which are underlain by interlayered silts, silty sands and sand to depths of 5.8m to 7m. The lower soil profile is predominantly silt to the west but further to the east it is predominantly silty sand and sand. Below these depths the CPTs refused in dense gravels.

The exception is CPT32 where interbedded medium dense to dense gravelly sand and sandy gravel was logged from a depth of 4m to 7.5m. Thin organic peat layers were noted in CPT8, CPT11, CPT30 and CPT37 at depths of 4m to 6m.

Based on the cone tip resistance, the silty sand and sand is typically loose although at depth the sand is medium dense. The silt is firm to very stiff and the gravel is medium dense to very dense.

4.3 Test Pit

Test pits were carried out across the site to confirm the continuity of the soil profile, allow calibration of the CPT logs as well as provide a measurement of indicative groundwater levels. The test pit excavations were undertaken by a 30 ton digger and generally reached a depth of 2.5m to 4m bgl with

a maximum achievable depth of 5m bgl. Test pits were generally terminated when the target depth was reached or due to groundwater being encountered. Of the investigations carried out for the larger subdivision, approximately 50 are present within Stages 3 to 6 or in close proximity. The locations of the test pits are shown in Figure 4 in Appendix A, and the logs are presented in Appendix D.

Towards the northern side of the site the ground conditions consist of predominantly loose to medium dense silt or silty sand and sand with firm to stiff silt layers to depths of 3m to 3.9m. Below these depths medium dense gravel was encountered.

Further to the south the ground conditions consist of predominantly silty sand with layers of silt and sand to depths of 3m to 4m, which are underlain by predominantly firm to stiff clayey silts, silts or sandy silts to the west and by loose to medium dense silty sand and sand to the east.

The exception to this general soil profile is around Test Pits TP4 and TP6, where a shallow gravel layer up to 1.5m thick was logged at a depth of 1m. In addition thin (20mm to 50mm) peat layers and tree branches were logged at depths of 2m to 3m below ground level in a number of the test pits.

The silty sand and sand was typically logged as fine to medium grained and loose, although at depth the sand was medium dense. The silts were typically logged as low plasticity, although the clayey silts appeared to have higher plasticity, with peak shear vane measurements from 40kPa to 100kPa, and therefore the silts are classified as firm to stiff.

The soil profiles logged in the test pits are consistent with the soil profile identified in the CPT logs.

4.4 Borehole Logs

Four boreholes were undertaken as part of the wider subdivision investigation to determine the composition and strength of the deeper subsoils layers. Two boreholes were taken down to 15m bgl to confirm depth to gravels, continuity of the gravel unit and allow installation of piezometers for long term groundwater monitoring within the gravel. Two boreholes were taken down to shallower depths of 3m and 4.5m to allow installation of piezometers for long term groundwater monitoring within the upper layers, and to identify any potentially perched ground water levels. The locations of the boreholes are shown in Figure 5 in Appendix A and the logs are presented in Appendix E.

The boreholes indicate the ground conditions consist of interbedded silt, silty sand and sand overlying gravel. The upper soil layers consist of interbedded silt, sandy silt, silty sand and sand, with a silt layer overlying the gravel.

Borehole BH2, located to the north of Stages 3 to 6, identified sandy gravel at a depth of 3.2m and Borehole BH4, to the south east of the site, identified sandy gravel at 6.8m depth. The gravel was logged as dense, fine to coarse grained and rounded. SPT ‘N’ values in the gravel ranged from 35 to 50. The gravel layer was logged as being relatively consistent to 15m depth.

4.5 Environment Canterbury Borehole Logs

A review of the Environment Canterbury GIS System (ECan, 2011) has been undertaken to identify borehole logs within the direct vicinity of Stages 3 to 6. The borehole logs ranged from 5.2m to 83m bgl in depth. The borehole locations are shown in Figure 6 and the logs are presented in Appendix F.

The deeper ECan borehole logs located to the north and east of the site indicate that the depth to the top of gravel is in the order of 8m to 9m depth. These depths are slightly deeper than that indicated in the boreholes carried out as part of this investigation. While to the south ECan logs indicate the top of the gravels are in the order of 3.7 to 7.5m depth. This indicates that part of the larger subdivision area is underlain by gravel at shallower depth, which then drops off further to the north and east of the site but appears to be at a similar depth to the south of the site.

Borehole M36/7299, to the east of Stages 3 to 6, indicates the top of gravel at 5m bgl. It also indicates that an 'orange pug' layer, 1m thick, is located at 7m bgl. This layer was not identified in the boreholes carried out as part of this investigation and may be a localised seam in this area. The ECan logs generally confirm our borehole and CPT logs, with the gravel layer being consistent once encountered.

A review of the shallower ECan borehole logs indicate that adjacent to Edwards Street the ground conditions consist of interlayered silt/clay to 6m bgl. Further to the north the borehole logs indicate that the ground conditions consist of interbedded silt/clay overlying gravel at depths of 2.8m to 4.2m bgl. These borehole logs are reasonably consistent with the geotechnical testing carried out as part of this investigation.

In summary the past recorded information and geotechnical data correlate well with the current investigations.

4.6 Liquefaction Induced Ground Damage

Based on our site walk over the following was noted:

- A review of high resolution aerial photographs taken on the 24 February 2011 did not identify any apparent surface manifestation of liquefaction on the site.
- Evidence of liquefaction surface ejector (i.e. sand boils) was not apparent during the site walkover carried out as part of this investigation. Even though the site walkover was carried out a significant period of time after the large seismic events, there was no apparent residual evidence, such as degraded sand boils or distinct mounds covered in recent grass growth that would indicate sand boils had been present. Nor was there any evidence of accumulation of sand and silt brought up by liquefaction within the drainage ditches.
- Other evidence of ground damage such as ground cracking or lateral spreading adjacent to the drainage ditches were not apparent on the site.

4.7 Groundwater

The depth to groundwater was measured in the test pits and the CPT holes carried out across the site. The groundwater levels measured in the test locations are presented in Appendix G. The groundwater levels measured in the CPT holes are considered not to be accurate as the CPT probe may have drawn water up the probe hole.

Groundwater seepages and levels were measured in the test pits. To the west and north side of Stages 3 to 6 groundwater levels were measured at depths of 3.5m to 4.0m bgl. Where the gravels were encountered the groundwater rose from the base of the pit indicating confined water table. Groundwater seepages were also noted at shallower depths of 1.7m to 2.5m bgl, however the test pits were carried out during a period of high intensity rainfall and these seepages may represent stormwater runoff through the pit sides or perched groundwater.

To the south and east side of Stages 3 to 6 groundwater levels were measured at depths of 2.5m to 4.2m bgl. Seepages were noted at shallower depths of 0.6m to 2m. However, as noted above, the test pits were carried out during a period of high intensity rainfall and these seepages may represent stormwater runoff through the pit sides or perched groundwater.

The test pit logs indicate that at depth the soil was typically a dark grey colour, which is most likely a result of water logged soil due to seasonally high groundwater levels. The grey soils were logged at depths ranging from 2.3m to 3m bgl at the western end of the site however further to the east the grey soils were in the order of 1.65m to 2.4m bgl.

4.8 Piezometers

Four piezometers were installed in the larger subdivision area. Two piezometers were installed to a depth of 15m to monitor any groundwater levels associated with the underlying gravels and two were installed at shallower depths of 3m and 4.5m bgl to monitor any perched groundwater levels within the upper soil layers.

Results of the monitoring are presented below. We have included the measurements for Boreholes BH1 and BH2 only as these are within the direct vicinity of the site.

Table 1 - Recorded groundwater levels

Borehole	Recorded Depth to Ground Water		
	At time of Drilling	21 September 2011	20 October 2011
BH1	1.10m	1.40m	0.34m
BH2	1.8m	1.39m	1.54m

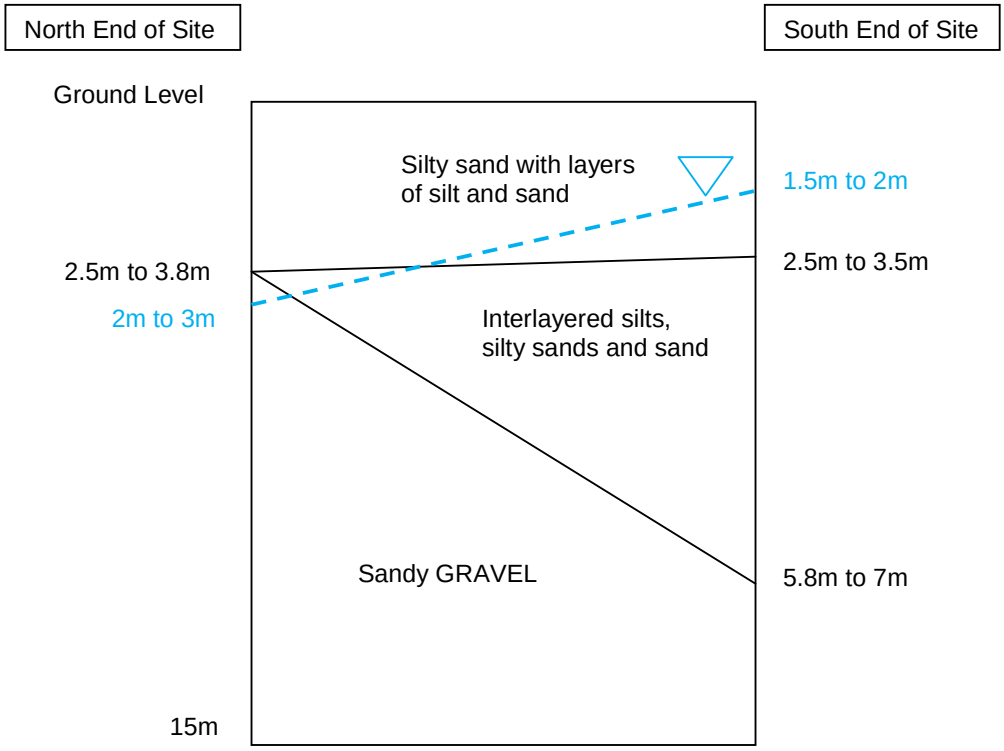
The groundwater levels measured in the piezometers appear to vary. The change in the levels from the time of drilling to the September reading is likely to represent equalisation of the groundwater in the piezometer. The groundwater levels carried out on 20 October 2011 are relatively high. Test pits carried out on 19 to 20 October 2011 did not encounter groundwater levels at these depths. Therefore we consider that the October readings are likely to have been affected by the stormwater runoff rather than reflect an insitu groundwater level, particularly for borehole BH1.

Based on the test logs and piezometer monitoring we consider that a sub-artesian (confined) groundwater level is present within the gravel layer at depth, as groundwater 'bubbled' out of the base of the test pit when the gravels were encountered. The higher groundwater levels measured in Borehole BH2, located to the north of the site, are possibly representative of the head of the pressurised groundwater present in the gravels. The silt layer encountered overlying the gravel may act as a confining layer.

In the upper soil profile there is likely to be a perched groundwater level within the more permeable sand/silty sand layers, as groundwater seeps were noted within these layers and the layers were typically wet. It is possible that the perched groundwater levels are fed by the sub artesian groundwater pressures present in the underlying gravels. However, some of the groundwater seeps encountered are considered to represent stormwater runoff through saturated ground, as a result of the high intensity rainfall at the time of the test pit excavations.

5. Ground Model

Based on the geotechnical investigation the following schematic ground model has been defined for the site.



The testing indicates that the northern part of the site is underlain by medium dense gravels at consistently shallow depths of 3m to 4m. Further to the south the top of the gravel drops off steeply along a line through the middle of the site, refer to Figure 7 in Appendix A. To the south of this line the top of the gravel is relatively consistent at depths of 6m to 7m. Based on our past project work in the Lincoln area and our understanding of the local geology, we infer that the top of the gravel forms a series of terraces beneath the upper soil layers.

The gravel is overlain by predominantly loose to medium dense silty sands in the northern part of the site, while to the south the silty sands overlie a lower soil profile of interbedded firm to stiff clayey silts and silts with loose to medium dense silty sands and sand, which in turn overlie medium dense to dense gravel. The lower soil strata exhibit higher fines contents to the west, while to the east the lower soil strata typically comprise sandy deposits that exhibit lower fines content.

The CPT profiles for these geological areas are present in Figures 8, 9 and 10. Figure 8 is for the northern area, Figure 9 for the western area and Figure 10 for eastern area. With the exception of CPT32, the CPT profiles in each area are reasonably consistent with each other. CPT32 is likely to represent the soil profile along the transition between shallow and deeper gravel areas.

6. Engineering Considerations

6.1 General

Fulton Hogan Land Development Limited is proposing to subdivide an area of land, approximately 85ha off Edward Street, on the east side of Lincoln. It is intended to eventually develop approximately 891 residential lots on the site. Although it is intended to develop the larger subdivision, it is proposed to carry out the civil engineering works for Stages 3 to 6 of the subdivision, located immediately adjacent to the recently completed Stage 1 and recently consented Stage 1A. Due to the required civil engineering work, this report has been prepared for the purpose of Stages 3 to 6 only.

The proposed civil engineering works have not been finalised, however based on the ground conditions encountered during the geotechnical investigations we consider that the following geotechnical aspects need to be considered as part of the subdivision:

- Potential for seismically induced liquefaction
- Recommendations for liquefaction mitigation measures, if required
- Compliance with the intent and definition of NZS3604 for foundation design (Technical Category compliance)
- Implications for building foundations
- Recommendations for infrastructure construction
- Assessment against Resource Management Act (RMA) Section 106 a) to c)

Each of these is discussed in the following sections.

6.2 Seismically Induced Liquefaction

Under cyclic loading during an earthquake cohesionless material (gravels, sands, silty-sands) tends to decrease in volume. This tendency to decrease in volume is much greater in loose than dense soils. When cohesionless soils are saturated and rapid loading occurs under undrained conditions, the tendency is that soil densification causes excess pore water pressure to increase. The increase in pore water pressure results in a loss of soil strength due to a decrease in effective stress and eventually liquefaction when the effective stress drops to zero. Liquefaction of loose sands can lead to large displacements of foundations, ground surface settlement, sand boils, and post-earthquake stability failures.

As part of our geotechnical assessment for the site we have a carried out a liquefaction analysis to determine the liquefaction potential for the site. Although we note that based on our observations and all available information the site did not suffer any seismically induced land damage from the recent series on earthquakes.

6.3 Liquefaction Assessment

For the site development the main factors to be considered for liquefaction are:

- What layers can liquefy?
- What is the likelihood of liquefaction in the future?
- What options are available to limit or prevent liquefaction?

Each of these is considered below.

6.3.1 Liquefaction Potential Assessment

The three primary factors that contribute to liquefaction potential are:

- Loose, uniformly graded soils.
- High groundwater table.
- Sufficiently high, earthquake induced ground acceleration and sustained shaking.

Each of these is considered below together with conclusions on the site liquefaction potential.

Soil Grading and Density

Liquefiable soils generally have a Coefficient of Uniformity of less than 5 and a low proportion of soil finer than 75 microns in size (typically less than 5% to 10%, but up to 30%). However, the test logs indicate Stages 2 to 5 is underlain by interlayered loose sand and silty-sand with silt, within the upper soil profile. Based on the nature of the upper soils, the site can be considered to be potentially liquefiable layers from a grading and density perspective. We note that the entire site is underlain by medium dense to very dense gravel layers that we do not consider to be liquefiable. Hence the liquefaction potential is limited in the vertical extent.

Groundwater

The depth to groundwater has been measured directly from test pits and the piezometers. Groundwater can also be indirectly measured from the test pits where the grey soil layers most likely represent a water logged soil due to seasonally high groundwater levels. Based on the test results, groundwater levels range from 1.5m to 4m below ground level at the south and east side of Stages 2 to 5 and from 2.1m to 4m at the north and west side of Stages 3 to 6. Soils are therefore potentially liquefiable from depths of 1.5m to 4m onward below ground level.

Groundwater levels used in our analysis are based on measurements carried out in Spring and are likely to be relatively high, hence are considered to be conservative. Groundwater levels will vary depending on the time of year, but we infer that we have encountered the likely highest levels.

Earthquake Intensity and Soil Resistance to Liquefaction

The level of ground shaking is one of the key factors in determining whether liquefaction will or will not occur. For this study, we have used two levels of ground shaking, Serviceability Limit State (SLS) and Ultimate Limit State (ULS) design earthquakes, derived using the NZGS (2010) method based on NZS1170:2004. It is generally accepted as a suitable method for liquefaction analysis as it ties into the building structural design criteria.

A back analysis of the 4 September 2010 Darfield earthquake was carried out. The nearest seismogram located to the site is on Lincoln Crop and Food Research site 3km to the northwest of the site and it is considered representative as the ground conditions are known to be similar. Peak ground acceleration (PGA) for the Darfield Earthquake was measured at 0.43g. Based on our current understand of the soil profile and groundwater levels, the site should have experienced liquefaction induced ground damage for a 0.43g and Magnitude 7.1 earthquake. However this is not the case, as we have been advised that no land damage occurred or visible sign were noted on the site following the Darfield Earthquake.

The discrepancy between the analysed results and what was observed is most likely a result of PGA and differences in groundwater levels, as well as the analytical method used for determining the liquefaction susceptibility of the site. A review of the PGA's experienced throughout the region indicates a reasonable variation between the seismograms, even for those with 3km of each other. The PGA for Rolleston on 4 September 2010, near the eastern end of the Greendale Fault, was 0.34g,

while at Templeton the PGA was measured as 0.28g. The variability of the acceleration would depend on a number of factors, such as underlying ground conditions and the shape that the seismic waves propagated from the epicentre and the location of the site in relation to the hypocentre and terminal lobes of the earthquake (spatial and temporal variation). Given the proximity of the seismograms we have considered them in our review and analysis.

Groundwater levels were measured at variable depths across the site and based on the groundwater levels encountered in the test pit logs these exhibited a tendency to fluctuate. This is evident in the Environment Canterbury monitoring well on the south side of Lincoln. The groundwater levels measured in well M36/0512 can vary depending on the time of year. This corresponds well with our observations in other parts of Lincoln.

We note that the current state of the art liquefaction analysis is based on semi-empirical analysis methods, whose accuracy varies depending on many factors and is generally 'calibrated' to provide conservative outcomes. Therefore for some sites the liquefaction analysis may be conservative for reasons not yet captured in current analysis methodologies. This was noted on several sites in the Canterbury area and is currently being reviewed.

Based on the potential variability of spatial and temporal variation from the earthquake centre and uncertainties and conservatisms associated with current analytical tools, it is considered that a back analysis of the Darfield Earthquake may not be accurate or representative. Therefore we have based the liquefaction analysis on Ultimate Limit State (ULS) and Serviceability Limit State (SLS) earthquake events derived using the NZGS method that in turn is based on NZS1170. This approach is generally accepted as a suitable method for liquefaction analysis as it ties into the building structural design criteria.

We are aware that new seismic design guidelines for the Canterbury area are being developed by the Department of Building and House (DBH) and GNS, with the timing of their publication unknown at this stage. According to the '*Requirements for Geotechnical Assessment of Liquefaction for Land Development – Canterbury Region'*, these are likely to supersede the above guidelines for liquefaction analysis. Some indication has been given by the DBH that the SLS case PGA is in the order of 0.15g to 0.2g. However, in the absence of any updated guidelines and timeframes on when these will be published, it is considered appropriate to use the currently available guidelines.

Therefore based on the current guidelines available at the time of our analysis, we have used the following scenarios to assess the potential for liquefaction in a future seismic event:

Serviceability Limit State (SLS) Earthquake

For the site we have assessed the SLS earthquake return period based on the current NZS1170.0:2004 Loading Codes with the increased Z hazard factor of 0.3 (see Appendix G).

NZS1170.0:2004 Table 3.3 indicates that SLS level ground shaking be based on a 1 in 33 year event. However, we consider this value to be too low to be applicable when assessing liquefaction because of its discreet nature of liquefaction (i.e. the site either liquefies or does not and when a site has liquefied there is very little difference in expected deformations for a 'small' earthquake that causes liquefaction relative to a 'large' earthquake that causes liquefaction), and the disproportionate effect seismically induced liquefaction has on a building. We have therefore adopted a more severe (although not unrealistic) earthquake event that has a probabilistic return period of 150 years.

We have adopted the method outlined by the NZ Geotechnical Society for using the New Zealand Loadings Standard to obtain the design earthquake for the liquefaction assessment. A 1 in 150 year return period earthquake in Lincoln area for a Class D site has a Peak Ground Acceleration (PGA) of 0.2g. In accordance with NZGS we have adopted a Magnitude 7.5 earthquake event. We consider this event to be well above the requirements from NZS1170 for SLS criteria, but believe it is realistic.

Ultimate Limit State (ULS) Earthquake

For the site we have assessed the ULS earthquake return period based on the current NZS1170.0:2004 Loading Codes with the increased Z hazard factor of 0.3 (see Appendix G).

A 500 year return period earthquake has been adopted, which is based on the recommendations of NZS1170.0:2004 Tables 3.2 (Importance Level 2 building), and Table 3.3 (50 year design working life). We have adopted the method outlined by the NZ Geotechnical Society for using the New Zealand Loadings Standard to obtain the design earthquake for the liquefaction assessment. A 1 in 500 year return period earthquake in Lincoln area for a Class D soil (Deep Soil Site) has a PGA of 0.34g, and in accordance with NZGS we have adopted a Magnitude 7.5 earthquake event. We note that this level of shaking is lower than the level of shaking experienced in the M7.1 September 2010 Darfield Earthquake, as per the nearest seismogram station.

A summary of the shaking intensities are presented in Table 2.

Table 2 – Summary of ground shaking cases analysed

Earthquake	PGA	Magnitude
Serviceability Limit State – Based on NZS1170	0.20g	7.5
Ultimate Limit State – Based on NZS1170	0.34g	7.5

6.4 Liquefaction Analysis Results

6.4.1 Settlements

The ability of the subsoils to resist the effect of ground shaking associated with the earthquake cases has been assessed from the subsoil information obtained from the CPT logs. The National Centre for Earthquake Engineering Research (NCEER) method as outlined by Youd et. al. (2001) has been used to assess liquefaction potential. Based on recent experience in the Canterbury Region this method appears to give consistent results with liquefaction damage observed elsewhere in region but may possibly be conservative, although it is not considered unrealistic. We note that many other approaches are available but believe that this widely accepted method is representative for this site.

The ability of the subsoils to resist the effect of ground shaking associated with the two design earthquakes has been assessed using the CPT sounding results using Version 5 of the CivilTech Corporation *LiquefyPro* computer programme. The method of Robertson and Wride (1998) for the CPT soundings (the NCEER's recommended method), modified for fines content, was used to calculate the potential for liquefaction and the method of Tokimatsu and Seed (1987) for settlement.

The total settlements due to liquefaction as calculated are presented in Table 3.

Table 3 – Calculated liquefaction induced (total) settlements

Test	Stage	SLS EQ	ULS EQ
CPT5	3	20mm	40mm
CPT8	3	20mm	40mm
CPT10	3	15mm	30mm
CPT38	3	10mm	25mm
CPT40	3	25mm	40mm
CPT11	4	45mm	75mm
CPT12	4	5mm	15mm
CPT14	4	70mm	90mm
CPT15	4	15mm	35mm
CPT34	4	0mm	0mm
CPT35	4	10mm	25mm
CPT36	4	30mm	45mm
CPT2	5	25mm	50mm
CPT4	5	20mm	45mm
CPT30	5	20mm	35mm
CPT37	5	10mm	35mm
CPT39	5	0mm	10mm
CPT1	5	0mm	10mm
CPT3	6	5mm	20mm
CPT6	6	5mm	10mm
CPT9	6	15mm	35mm
CPT32	6	5mm	25mm
CPT33	6	0mm	0mm
Average		**15mm**	**30mm**
Maximum		**70mm**	**90mm**
Minimum		**0mm**	**0mm**
Median		**10mm**	**30mm**

Note: The settlements presented in Table 3 above are to the nearest 5mm and have a likely error of ± 50%

6.4.2 Ground Damage

Published information (after Ishihara, 1985) can be used to assess the potential for surface expression of liquefaction and the likelihood of ground induced damage. Our assessment of liquefaction induced ground damage, such as sand boils and ground cracking, is present in Table 4.

Table 4 – Liquefaction induced ground damage for design earthquakes

Test	SLS EQ	ULS EQ
CPT1	N	N
CPT2	N	N
CPT3	N	N
CPT4	N	N
CPT5	N	Y
CPT6	N	N
CPT8	N	N
CPT9	N	Y
CPT10	N	Y
CPT11	N	Y
CPT12	N	N
CPT14	N	Y
CPT15	N	Y
CPT30	N	N
CPT32	N	N
CPT33	N	N
CPT34	N	N
CPT35	N	Y
CPT36	N	Y
CPT37	N	N
CPT38	N	N
CPT39	N	N
CPT40	N	N

6.4.3 Lateral Spreading

Liquefaction induced lateral spreading or flow failures can occur when the shear stresses required to maintain static equilibrium are greater than the shear strength of the liquefied soil. Structures built on ground that experiences lateral spreading can be expected to sustain significant damage relative to the damage that would be expected from ground shaking alone.

No lateral spreading occurred at the site during the Darfield Earthquake that generated higher ground accelerations than a representative ULS design earthquake.

The watercourse and swales on the site are relatively shallow are unlikely to pose a lateral spreading risk to the development. An assessment was undertaken for the drainage channel along the southern boundary adjacent to Edward Street. We consider that there was no evidence of lateral spreading occurring adjacent to the stream from seismic activity in the last year. The drain is in the order of 1.2m to 1.3m in depth and groundwater measurements in the test pits adjacent to the drain were typically greater than 1.4m.

Therefore based on this evidence we have assessed the potential for lateral spreading to be low to very low. However there may be potential slope instability issue with the drain banks during a significant seismic event, which is discussed further in Section 6.1.

6.5 Discussion

The liquefaction analysis identified the following:

- Following an SLS earthquake liquefaction induced settlements of between 0mm and up to 70mm can be expected and there is unlikely to be any liquefaction induced ground damage.
- Following a ULS earthquake liquefaction induced settlements of up to 90mm can be expected. There is the potential for liquefaction induced ground damage in parts of the site. It is however noted that during the ULS design earthquake some building damage is likely at this level of shaking regardless of ground conditions and liquefaction potential. We also note that ground damage in the form of sand boils and cracking should have manifested following past events but has not been observed which may indicate analytical conservatisms being present.
- Lateral spreading damage was not observed at the site and given that the site has experienced ground accelerations equivalent to a ULS event we have assessed the potential for lateral spreading to be low to very low.

6.6 Land Classification Technical Categories

For the Christchurch Region the Department of Building and Housing (DBH, 2011) has recently released a new classification system for residential 'Green Zone' land on the flat in regard to the liquefaction susceptibility. This new classification system is divided into three technical categories that reflect both the liquefaction experience to date and future performance expectations. The categories and corresponding criteria are summarised as follows:

- **Technical Category 1 (TC1)** – future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances.
- **Technical Category 2 (TC2)** – Minor to moderate land damage from liquefaction is possible in future large earthquakes.
- **Technical Category 3 (TC3)** – Moderate to significant land damage from liquefaction is possible in future large earthquakes.

The DBH has indicated the following liquefaction deformation limits for house foundations as summarised in Table 5 below:

Table 5 – Liquefaction deformation limits and house foundation implications

Technical Category	Liquefaction Deformation Limits				Likely Implication for House Foundations (subject to individual assessment)
	Vertical		Lateral Spread		
	SLS	ULS	SLS	ULS	
TC1	15mm	25mm	Nil	Nil	Standard NZS3604 type foundations with tied slabs
TC2	50mm	100mm	50mm	100mm	DBH enhanced foundation solutions
TC3	>50mm	>100mm	>50mm	>100mm	Site specific foundation solution

Based on results of the liquefaction and lateral spreading results presented in Section 6.4, we consider Stages 4 and 5 and the southern two thirds of Stage 3 can be classified as Technical Category (TC2), while Stage 6 and the northern one third of Stage 3 currently conforms to Technical

Category (TC1). **T**he technical classification has been based partially on a conservative SLS earthquake PGA.

6.7 Foundation Options

The liquefaction assessment indicates that Stages 3 to 6 is classified as **TC1 and TC2.**

For **TC1** areas the DBH has recommended Standard NZS3604:2011 type foundations with tied slabs are suitable.

For **TC2** areas the DBH has recommended types of foundation systems for residential houses in their publication '*Guidance on house repairs and reconstruction following the Canterbury Earthquake',* dated 20 December 2010. Schematics and typical cross sections of these foundation systems are presented in the DBH publication. As required under the new DBH guidelines for detailed house design, a site specific geotechnical assessment shall be carried out by suitability qualified chartered engineer with experience in residential house development. A chartered professional geotechnical engineer is not required for Technical Category 2 type residential lots.

Several foundation options are available for residential houses. These foundation options are house specific and will need to be selected and designed during the building consent stage of the property development. The suitable foundation options fall generally into two categories; shallow foundations, and deep foundations. Each of these is discussed below.

It should be noted that this report intends to provide guidance only on residential foundation design and should not be taken as detailed design. The recommendations provided below are for completeness and to present all currently available options. The recommendations provided below are in line with the DBH document '*Revised guidelines on repairing and rebuilding houses affected by the Canterbury earthquake sequence',* dated November 2011.

Shallow Foundations

A shallow foundation such as a raft is intended to hold the superstructure together and minimise any structural damage if there is any ground movement during or following a future major seismic event. Although a raft foundation is unlikely to prevent settlement of the dwelling it will minimise differential settlement to some extent. If detailed correctly it will also allow the house to be re-levelled if required. Raft foundations are generally suitable for dwellings with concrete floor slabs only. Raft foundation can take several forms, including:

- A gravel raft (either with or without geogrid reinforcement) with a reinforced concrete slab with localised thickening formed on top of the gravel raft.
- A thick, double reinforced concrete raft cast onto the in situ ground.
- An enhanced foundation slab with reinforced ground beam grid cast onto the in situ ground.
- A generic waffle slab (i.e. rib raft) cast onto the insitu ground.

Based on the previous scala penetrometer testing carried out across the site and the recent CPT information ultimate (rupture) bearing capacities of greater than 200kPa should be achievable and hence the raft type foundations above should be suitable.

Deep Foundations

Deep foundations such as piles will transfer structural loads from the structure to deeper and stronger non-liquefiable soil layers. Thereby minimising any structural damage associated with ground liquefaction and settlement during and after a major seismic event. Piled foundations will minimise both total and differential settlement.

Piled foundations for a residential house typically comprise of driven piles and can be either concrete (typically used if a concrete floor system is to be used), or timber (typically used if a timber floor and sub-floor system is to be used). A pile foundation system does not require any special soil preparation, but will require site specific investigation and design. We note that all pile foundations are to be designed to carry the full structural loads and stresses with no reliance on the ground below the slab due to the potential of post-earthquake settlement.

6.7.1 Discussion and Recommendations

For the proposed properties located within the **TC2** categorised area, the DBH has recommended the above types of foundation systems for residential houses built in areas potentially susceptible to seismically induced liquefaction in their publication '*Revised guidelines on repairing and rebuilding houses affected by the Canterbury earthquake sequence',* dated November 2011. Schematics and typical cross sections of these foundation systems are presented in the DBH publication.

The raft foundation options are likely to be cheaper than the piled foundation options. A piled foundation for a residential housing would minimise expected settlement and damage during a large seismic event, however the DBH guidelines indicate that although piles are an option for TC2 sites, this foundation option will require deep geotechnical investigation and design.

If the pile foundation option is adopted, then the floor slab should be sufficiently reinforced to provide continuity across the building floor and foundation elements. The objective will be to provide additional capacity in the floor slab and enhance its ability to redistribute loads, if necessary, during large seismic events. All pile heads need to be adequately tied into the floor slab.

As part of the detailed house foundation design, particular attention should be paid to detailing the connection joints of buried services (water and sewer pipes, power conduits, etc.) between the house foundation and the in situ ground. The design should allow sufficient movement and ductility to account for seismic shaking and liquefaction induced movement, and to allow for their easy reinstatement if they were to be damaged during a future seismic event.

As required under the new DBH guidelines for detailed house design, a site specific geotechnical assessment shall be carried out by a suitability qualified chartered engineer with experience in residential house development. Thereby, allowing site specific geotechnical information to be used in the foundation design.

It should be noted that the above discussion on the foundation options is generic only. The actual foundation option chosen and associated costs will depend upon the specific design of the proposed dwelling and the results of a site specific geotechnical and structural assessments.

6.8 Infrastructure

Our analysis indicates the site is unlikely to be affected by liquefaction induced ground damage in a SLS event but could potentially be affected in a ULS event.

Buried services at the site are still potentially vulnerable to seismically induced liquefaction if inserted into potentially liquefiable soils. If site regrading is to be undertaken only, without further liquefaction mitigation measures being employed, then it is recommended that appropriate liquefaction mitigation measures are incorporated into the design of the council vested infrastructure to further minimise the risk of liquefaction induced damage during a major seismic event.

At this stage it is recommended to design the mitigation measures against the effects of a 1 in 150 year SLS earthquake. For seismic events with a return period greater than 1 in 150 years the system may become progressively less serviceable. This section outlines the possible liquefaction mitigation measures for the infrastructure for stages 3 to 6. Although liquefaction induced ground damage under an SLS event is unlikely there would be benefits in building additional seismic resilience into the residential development infrastructure to withstand large earthquake events.

6.8.1 Buried Structures

All buried services such as manhole risers, pump station chambers, and so forth founded below the groundwater level, should be designed to have neutral buoyancy and accommodate uplift forces associated with liquefied soil, not just hydrostatic groundwater buoyancy forces. This is in order to minimise lifting / floatation of these buried services. Spaces around buried structures should be backfilled with free draining granular non-liquefying fill in order to alleviate pore water pressure build up during a large seismic event thereby reducing the potential for liquefaction in the soils immediately surrounding the buried structure.

As it is unlikely that buried services are able to be founded directly into the underlying dense non-liquefiable sandy gravel material due to the depth, the manhole inverts and pipe entry and exit levels should be designed to accommodate differential settlement post liquefaction event. Based upon differential settlements calculated as part of the geotechnical assessment, the differential settlements are expected to be in the order of 25mm. Essentially the hydraulic design of the pipes coming into and out of the manhole risers should be designed to accommodate both positive (i.e. pipe gradient getting steeper) and negative (i.e. pipe gradient getting shallower) differential settlements of 25mm. The civil engineer will need to assess if this level of settlement will affect the hydraulic design of the pipe and detail the required engineering measures.

Manhole risers should have strap rings to hold the manhole riser sections together in order to reduce lateral displacement of the manhole risers. Additionally, manhole connectors with greater than 90mm sealing lengths should be used to minimise the potential for joint pull-out.

It is recommended that the finalised design of each buried service (manhole riser, pump station, etc.) is confirmed on a case by case basis during construction, as each development stage will require site specific design. This specific design is needed to define the mass concrete for dead weight, tie down anchors, etc. for each buried structure, if required.

6.8.2 Pipes and Service Conduits

Pipes and service conduits should be made from flexible material (i.e. plastic) where practicable. For gravity reticulated sewer lines all pipe joints and intersections with manhole risers should be installed with short slip collars to allow greater capacity of joint movement and increase joint resilience. For pressurised sewer lines, all PE pipes should have end restraints at pump stations. Combined with the PE pipe material well designed end restraints will improve the resilience of the pressure line and help prevent damage.

Hydraulic pipes (sewer, and stormwater and possibly reticulated water), the pipe sizes and gradients should be designed in such a way that it can accommodate post liquefaction differential settlement, both positive (i.e. pipe gradient getting steeper) and negative (i.e. pipe gradient getting shallower). For design, differential settlements of 25mm between manhole risers should be used.

All pipes and conduits should be founded into the non-liquefiable crust material where possible. If the founding depth of the pipes and conduits is in the liquefiable silty sandy material the service trenches should be backfilled with non-liquefiable geotechnically competent fill.

All service trenches located below the water table should be lined with a geosynthetic filter fabric material (i.e. Bidim A19 or similar) to separate potentially liquefiable soils from non-liquefiable granular bedding and backfill material. For shallow service trenches founded above the water table then filter fabric is not required but generally recommended.

By providing a filter fabric and filling the service trenches with non-liquefiable geotechnically competent fill, the trench becomes non-liquefiable and will therefore limit liquefaction induced settlement. Additionally if a pipe was to rupture, by having a filter fabric encasing the bedding material there is less likelihood of sand material infiltrating into and blocking the pipeline.

6.8.3 Pavement

At this stage based on our liquefaction assessment it is inferred that the pavement is unlikely to be significantly affected by seismically induced liquefaction. However, to ensure robustness of the pavement following a liquefaction inducing major earthquake it is recommended that the pavement be designed to accommodate adverse effect of seismically induced liquefaction. The pavement should be designed in such a way that it can bridge any localised voids / settlements that may be caused by seismically induced liquefaction, and prevent liquefiable soil from penetrating into the pavement structure.

If subsoil drains are to be installed as part of the subdivision development for stormwater control, then it is recommended extending the subsoil drainage to below the footprint of the roading network. This will extend the thick non-liquefied crust below the pavement areas as well as the residential sections, thereby minimising the likelihood of liquefaction induced damage.

A geosynthetic filter fabric (i.e. Bidim A19 or similar) should be placed directly onto the in situ sub-grade material prior to the placement of the granular sub-base fill. This filter fabric will act as a barrier to any fines migration from the sub-grade to the sub-base during a liquefaction inducing seismic event. Therefore, the pavements sub-base will not lose strength post the seismic event through fines infiltration and associated loss of effective thickness.

6.9 Slope Instability

There may be a potential slope instability issue with the open drain banks, located adjacent to Edward Street, during an extreme earthquake. We note that the drainage ditch is relatively shallow and based on observations of other drainage ditches within the Canterbury Region, where bank failure has occurred adjacent to these ditches it has typically not extended further than 2m from the edge of the ditch. We recommend to limit any slope stability issues affecting house foundations, the houses should be setback form the crest of the drain by a minimum of 5m.

7. Assessment Against RMA

Section 106 of the Resource Management Act (RMA) states *inter alia*

> *… "a consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that:*
>
> *a) the land in respect of which a consent is sought, or any structure on the land, is or is likely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; or*
>
> *b) any subsequent use that is likely to be made of the land is likely to accelerate, worsen, or result in material damage to the land, other land, or structure by erosion, falling debris, subsidence, slippage, or inundation from any source; or*
>
> *c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision."*

No erosion was observed on the site. However the silty soils that directly underlie parts of the site are inferred to be potentially susceptible to erosion when the site is left without vegetation cover. We infer that the site is not susceptible to falling debris or slippage due to the topographical location. It is noted that issues surround stormwater discharge are being dealt with in the detailed civil engineering design by Davie Lovell-Smith. Therefore any potential "inundation" susceptibility due to stormwater has already been addressed.

Due to the potential for seismically induced liquefaction, we infer that the site is susceptible to subsidence and to a very minor extent to inundation. However, if the appropriate liquefaction mitigation measures, as outlined in this report, are undertaken then the risk of subsidence and inundation is significantly addressed. Therefore, with appropriate liquefaction mitigation measures where required, the site in our opinion will generally be free of "erosion", "falling debris", "subsidence", "slippage", or "inundation". The proposed subdivision development therefore generally complies with the intent of Section 106 (a).

Due to the site being partially underlain by fine grained soils, there exists the potential for erosion and rilling of the sandy and silty soils if vegetation cover is removed for prolonged periods of time from both stormwater runoff if it is not discharged in a controlled manner, and from the wind. This susceptibility to erosion of the sandy and silty soils can be minimised with appropriate industry standard design measures undertaken during construction. Revegetation should be carried out as soon as practicable post bulk earthworks.

The site has been identified as being partially susceptible to seismically induced liquefaction and hence has the potential for "subsidence", "and "inundation." Provided that appropriate liquefaction mitigation measures are implemented, as recommended in this report, subsequent use of the land following development is unlikely to accelerate, worsen, or result in material damage to the land, other land, or structures. In our opinion therefore, the development will comply with the intent of Section 106 (b).

Section 106 (c) is not directly relevant to a geotechnical appraisal and therefore has not been considered in detail in this report, although it is noted that the site is accessible from Edwards Street.

Thus in our opinion, under Section 106 of the RMA, there are no geotechnical reasons preventing the development, provided the appropriate engineering measures as recommended in this report are carried out.

8. References

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9. Limitations

We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

The recommendations in this report are based on data collected at specific locations and by using appropriate investigation methods with limited site coverage. Only a finite amount of information has been collected to meet the specific financial and 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 judgment and it must be appreciated that actual conditions could vary from the assumed model.

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.

Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

Appendix A
Figures

Note: Not to scale; boundaries and locations are approximate only

Source: QuickMap (2011)

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Client: Fulton Hogan Land Development Limited	Figure 1 Site Location		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

Note: Not to scale; boundaries and locations are approximate only

Source: LINZ (2011)

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Client: Fulton Hogan Land Development Limited	Figure 2 Site Plan		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

Note: Not to scale; boundaries and locations are approximate only

Source: LINZ (2011)

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Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 3 CPT Location Plan		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

Note: Not to scale; boundaries and locations are approximate only

Source: LINZ (2011)

Aurecon New Zealand Limited
Unit 1, 150 Cavendish Road
Casebrook
PO Box 1061
Christchurch - New Zealand

Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 4 Test Pit Location Plan		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

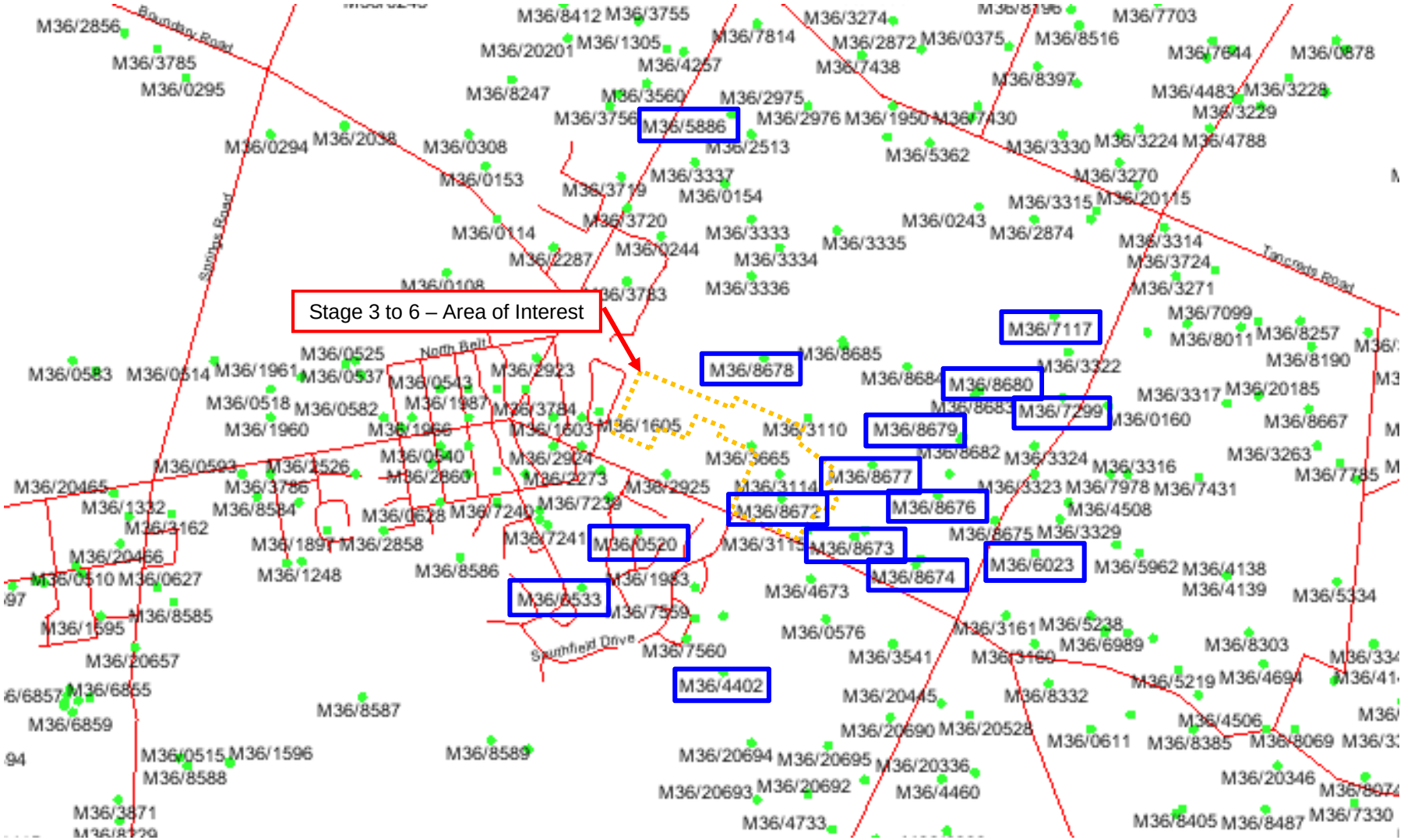
Note: Not to scale; boundaries and locations are approximate only

Source: LINZ (2011)

Aurecon New Zealand Limited
Unit 1, 150 Cavendish Road
Casebrook
PO Box 1061
Christchurch - New Zealand

Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 5 Borehole Location Plan		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	



Note: Not to scale; boundaries and locations are approximate only

Source: ECan (2011)

Aurecon New Zealand Limited
Unit 1, 150 Cavendish Road
Casebrook
PO Box 1061
Christchurch - New Zealand

Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 6 ECan Borehole Location Plan		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

Note: Not to scale; boundaries and locations are approximate only

Source: LINZ (2011)

aurecon

Aurecon New Zealand Limited
Unit 1, 150 Cavendish Road
Casebrook
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Christchurch - New Zealand

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Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 7 Geological Areas		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

Note: Not to scale; boundaries and locations are approximate only

Source: LINZ (2011)

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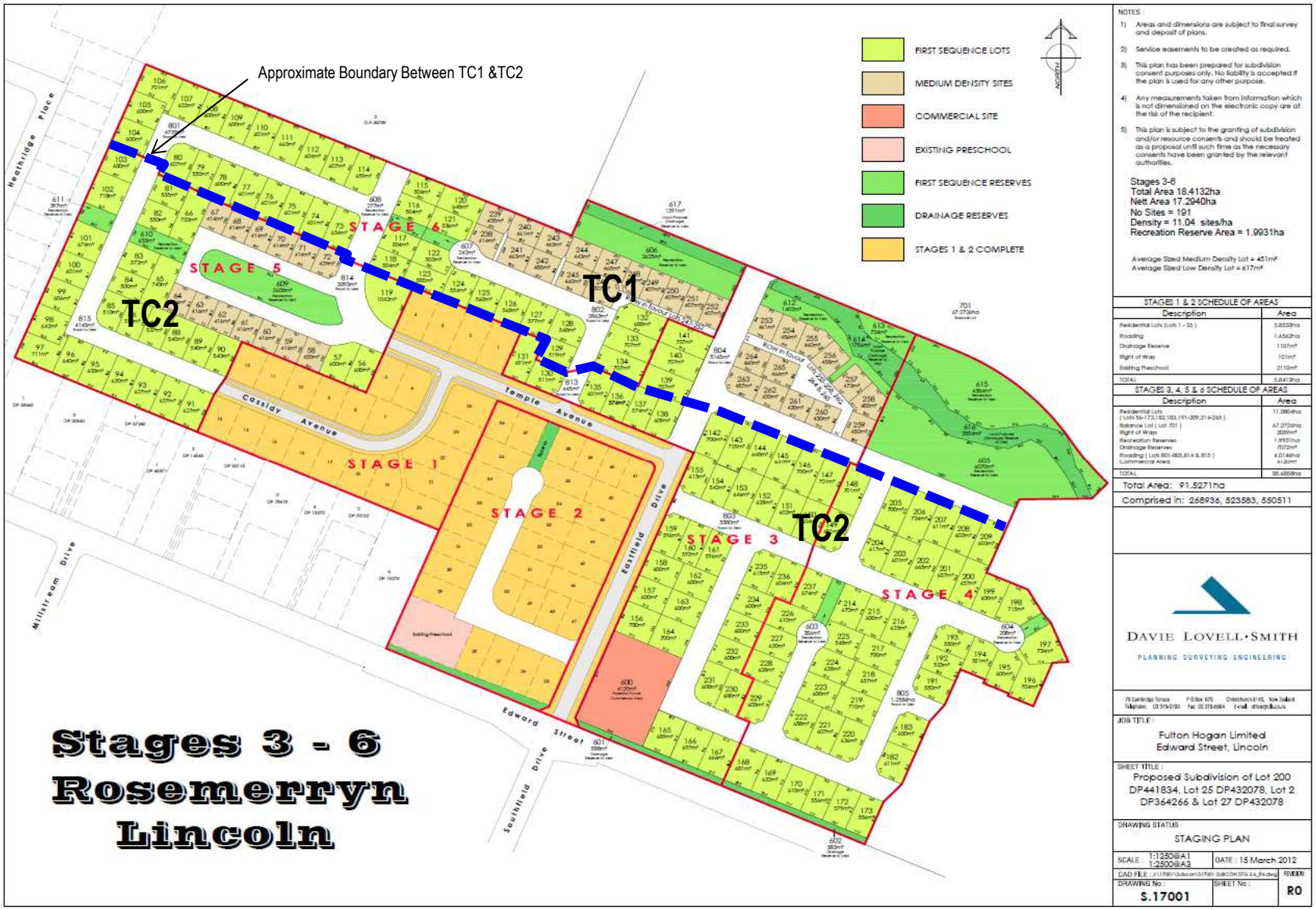
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 8 Technical Category Areas Aerial		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	



Note: Not to scale; boundaries and locations are approximate only

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Aurecon New Zealand Limited
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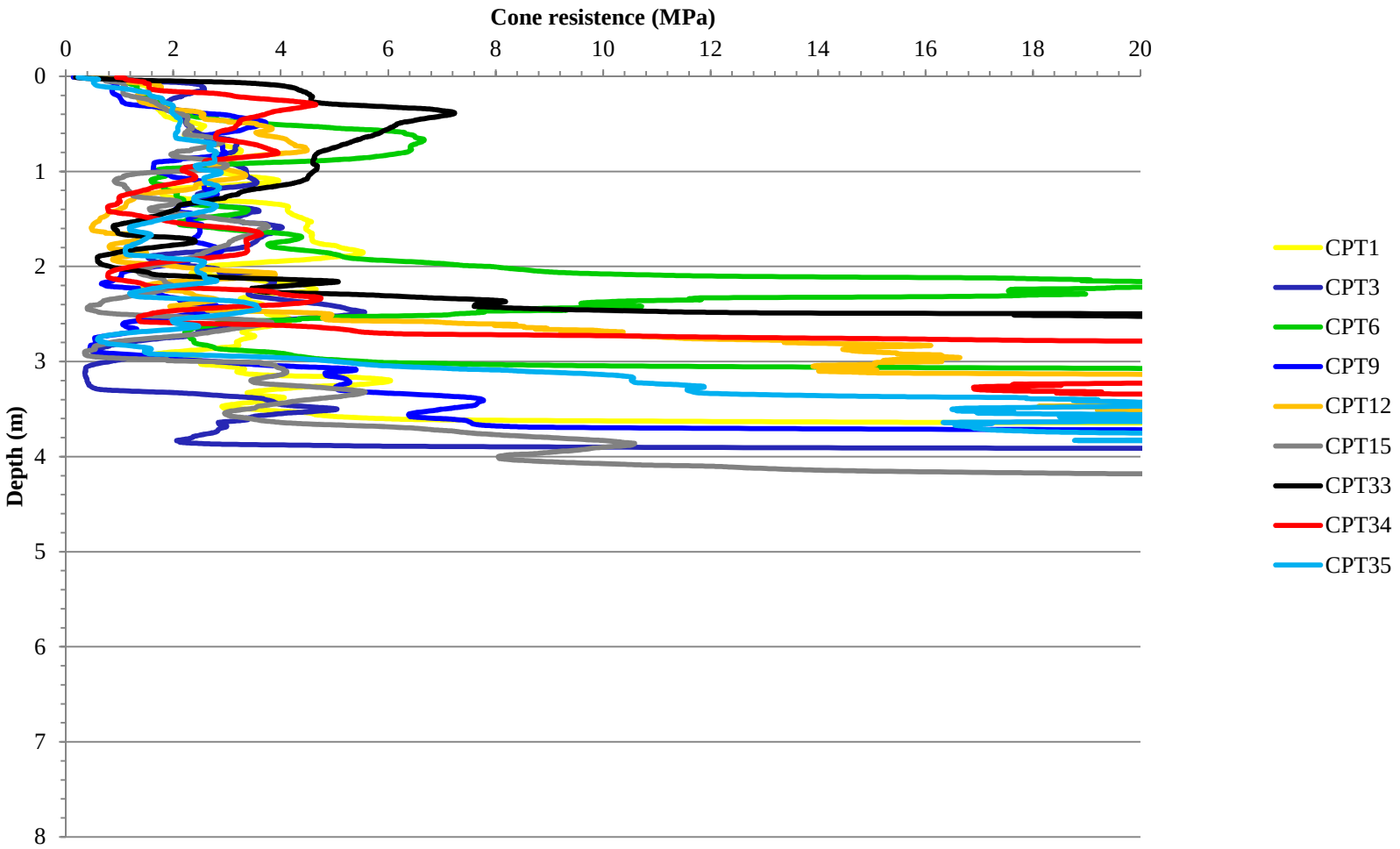
Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 9 Approximate Boundary Between TC1 & TC2 Areas		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

CPT Profile in Northern Area of Site



Note: Not to scale; boundaries and locations are approximate only

Aurecon New Zealand Limited
Unit 1, 150 Cavendish Road
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PO Box 1061
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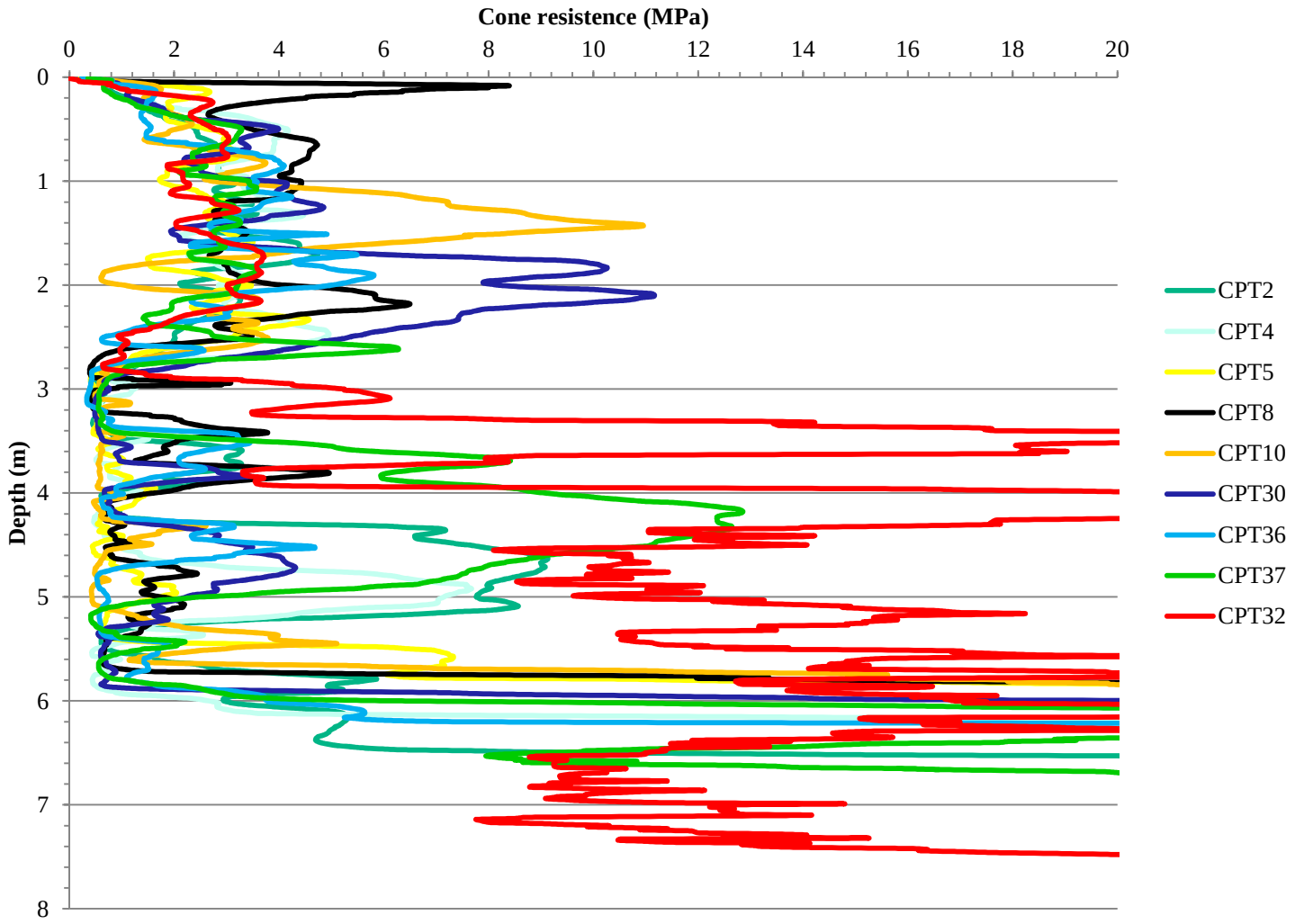
Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 10 CPT Profile in Northern Area of Site		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

CPT Profile in Western Area of Site



Note: Not to scale; boundaries and locations are approximate only

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Unit 1, 150 Cavendish Road
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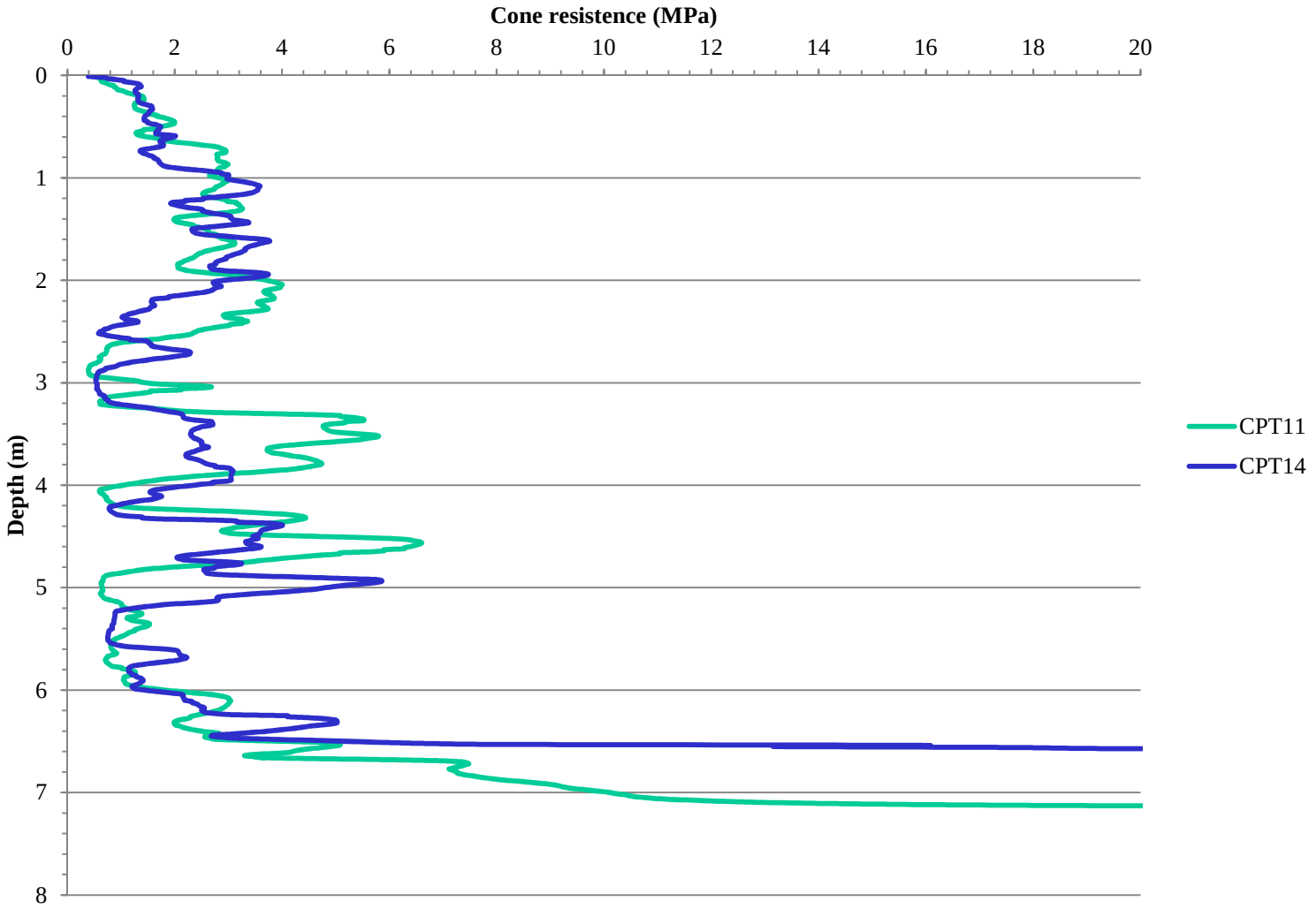
PO Box 1061
Christchurch - New Zealand

Telephone: +64 3 366 0821
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 11 CPT Profile in Western Area of Site		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

CPT Profile in Eastern Area of Site



Note: Not to scale; boundaries and locations are approximate only

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Casebrook
PO Box 1061
Christchurch - New Zealand

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Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com
Website: www.aurecongroup.com

Client: Fulton Hogan Land Development Limited	Figure 12 CPT Profile in Eastern Area of Site		Paper Size: A4
Project: Rosemerryn Farm, Lincoln			Revision: 3
By: RBS	Date: May 2012	Job Number: 224464	

Appendix B
Subdivision Plan

Total Area 91.5546ha
Nett Area 88.8287ha
No sites = 891
Density 10.03 sites/ha

First Sequence
Total Area 53.7090ha
Nett Area 51.8410ha
No Sites = 579
Density = 11.16 sites/ha
Recreation Reserve Area = 3.3308ha

Second Sequence
Total Area 37.8456ha
Nett Area 37.0984ha
No Sites = 334
Density = 9.00 sites/ha
Recreation Reserve Area = 2.0734ha

2
D.P.33700

5
D.P.26021

2
D.P.26632

1
D.P.83562

RS 6016
(BM 73)

NORTH

STAGE 10
STAGE 9
STAGE 7
STAGE 5
STAGE 6
STAGE 8
STAGE 12
STAGE 13
STAGE 11
STAGE 2
STAGE 3
STAGE 4
STAGE 15
STAGE 14

Recreational Reserve 2603m²

Existing Preschool 2110m²

600 Potential Future Commercial Area 4120m²

SECOND SEQUENCE DEVELOPMENT AREA

SECOND SEQUENCE DEVELOPMENT AREA

Eastfield Drive
Northfield Drive
ELLESMERE ROAD
Southfield Drive
EDWARD STREET
LINCOLN TAI TAPU ROAD
HEATHROCE PLACE
MILLSTREAM DRIVE

FIRST SEQUENCE LOTS
MEDIUM DENSITY SITES
COMMERCIAL SITE
EXISTING PRESCHOOL
FIRST SEQUENCE RESERVES
DRAINAGE RESERVES
STAGES 1 & 2 COMPLETE

Rosemerryn Lincoln

NOTES :

1) Areas and dimensions are subject to final survey and deposit of plans.

2) Service easements to be created as required.

3) This plan has been prepared for subdivision consent purposes only. No liability is accepted if the plan is used for any other purpose.

4) Any measurements taken from information which is not dimensioned on the electronic copy are at the risk of the recipient.

5) This plan is subject to the granting of subdivision and/or resource consents and should be treated as a proposal until such time as the necessary consents have been granted by the relevant authorities.

Average Sized Medium Density Lot = 431m²
Average Sized Low Density Lot = 617m²
Average Sized Low Density Lot Excl Stage 1 = 610m²

STAGES 1 & 2 SCHEDULE OF AREAS

Description	Area
Residential Lots (Lots 1 - 55)	3.8533ha
Roading	1.6562ha
Drainage Reserve	1107m²
Right of Way	101m²
Existing Preschool	2110m²
TOTAL	5.8413ha

SCHEDULE OF AREAS

Description	Area
Residential Lots (Lots 56 - 579)	30.5128ha
Balance Lot (Lot 700)	37.0984ha
Right of Ways	2823m²
Recreation Reserves	3.3308ha
Drainage Reserves	1.9922ha
Roading (Lots 801 - 811)	12.0848ha
Commercial Area	4120m²
TOTAL	85.7713ha

Overall Resedential Lots (Net Areas)

Lot Areas	No. of Lots	Total Areas
400m² - 499m²	75	3.2387ha
500m² - 599m²	175	9.4449ha
600m² - 699m²	236	14.7581ha
700m² - 799m²	76	5.4744ha
800m² & Over	17	1.4601ha
TOTALS	579	34.3762ha

Total Area: 91.5546ha

Comprised in: 268936, 523583, 550511

Fulton Hogan

DAVIE LOVELL•SMITH
PLANNING SURVEYING ENGINEERING

79 Cambridge Terrace P O Box 679 Christchurch 8140. New Zealand
Telephone: 03 379-0793 Fax: 03 379-5664 E-mail: office@dls.co.nz

JOB TITLE :
Fulton Hogan Limited
Edward Street, Lincoln

SHEET TITLE :
Proposed Subdivision of Lot 200 DP441834, Lot 25 DP432078, Lot 2 DP364266 & Lot 27 DP432078

DRAWING STATUS
STAGING PLAN

SCALE : 1:2500@A1 1:5000@A3
DATE : 15 March 2012
CAD FILE : J:\17001\S17001 Staging Plan_R7.dwg
REVISION : R7
DRAWING No : S.17001
SHEET No :

Appendix C
Cone Penetrometer Logs

CPT ANALYSIS NOTES

Soil Type

Interpretation using chart of Robertson & Campanella (1983). This is a simple but well proven interpretation using cone tip resistance (q_C) and friction ratio (f_R) only. No normalisation for overburden stress is applied. Cone tip resistance measured with the piezocone is corrected with measured pore pressure (u_C).

- sand (and gravel)
- silt-sand
- silt
- clay-silt
- clay
- peat

Liquefaction Screening

The purpose of the screening is to highlight susceptible soils, that is sand and silt-sand in a relatively loose condition. This is not a full liquefaction risk assessment which requires knowledge of the particular earthquake risk at a site and additional analysis. The screening is based on the chart of Shibata and Teparaksa (1988).

- high susceptibility
- medium susceptibility
- low susceptibility

High susceptibility is here defined as requiring a shear stress ratio of 0.2 to cause liquefaction with D_{50} for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Medium susceptibility is here defined as requiring a shear stress ratio of 0.4 to cause liquefaction with D_{50} for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Low susceptibility is all other cases.

Relative Density (D_R)

Based on the method of Baldi et. al. (1986) from data on normally consolidated sand.

Undrained Shear Strength (S_U)

Derived from the bearing capacity equation using $S_U = (q_C - \sigma_{VO})/15$.

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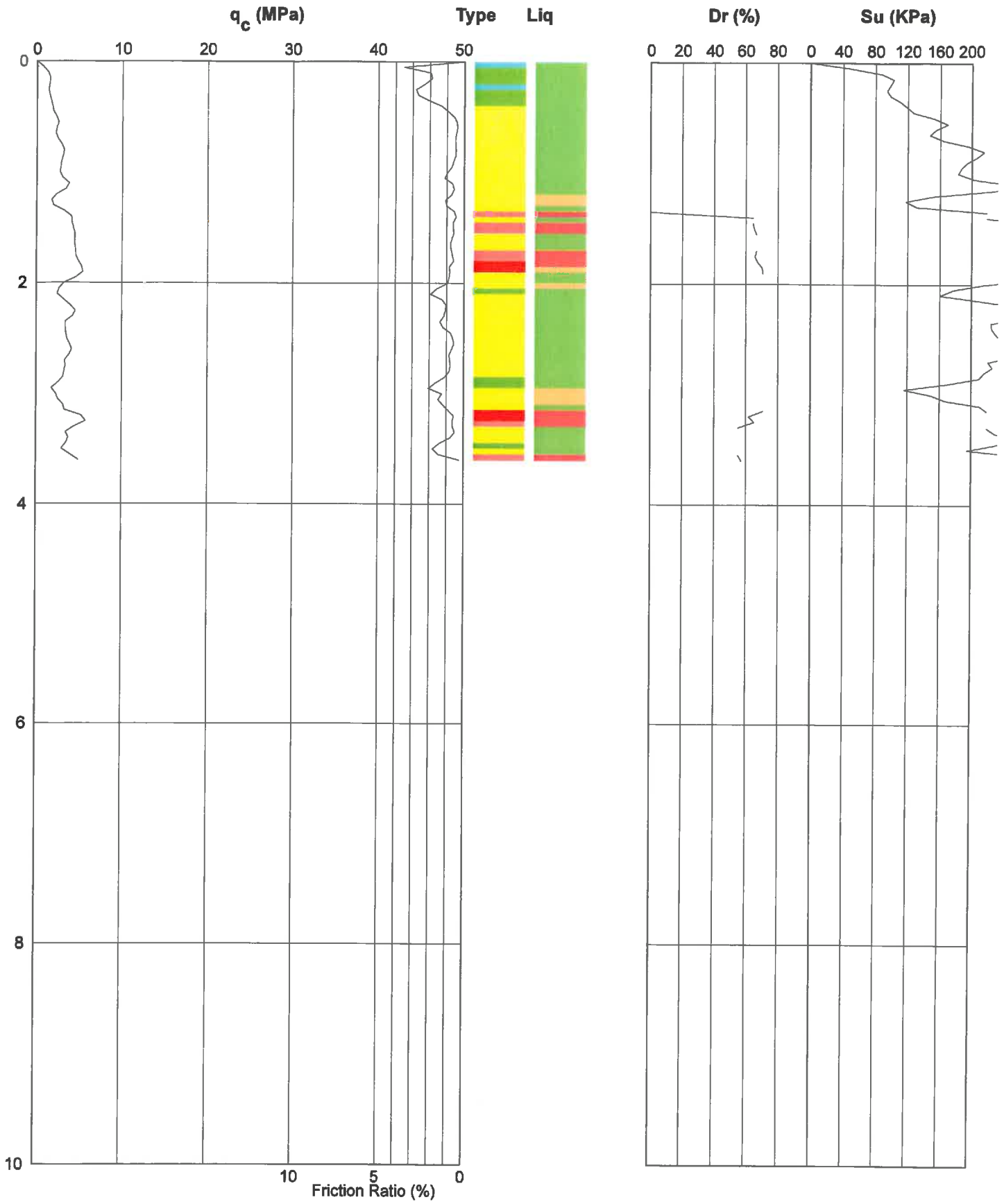
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	27/08/2011
CPT No:	CPTu001	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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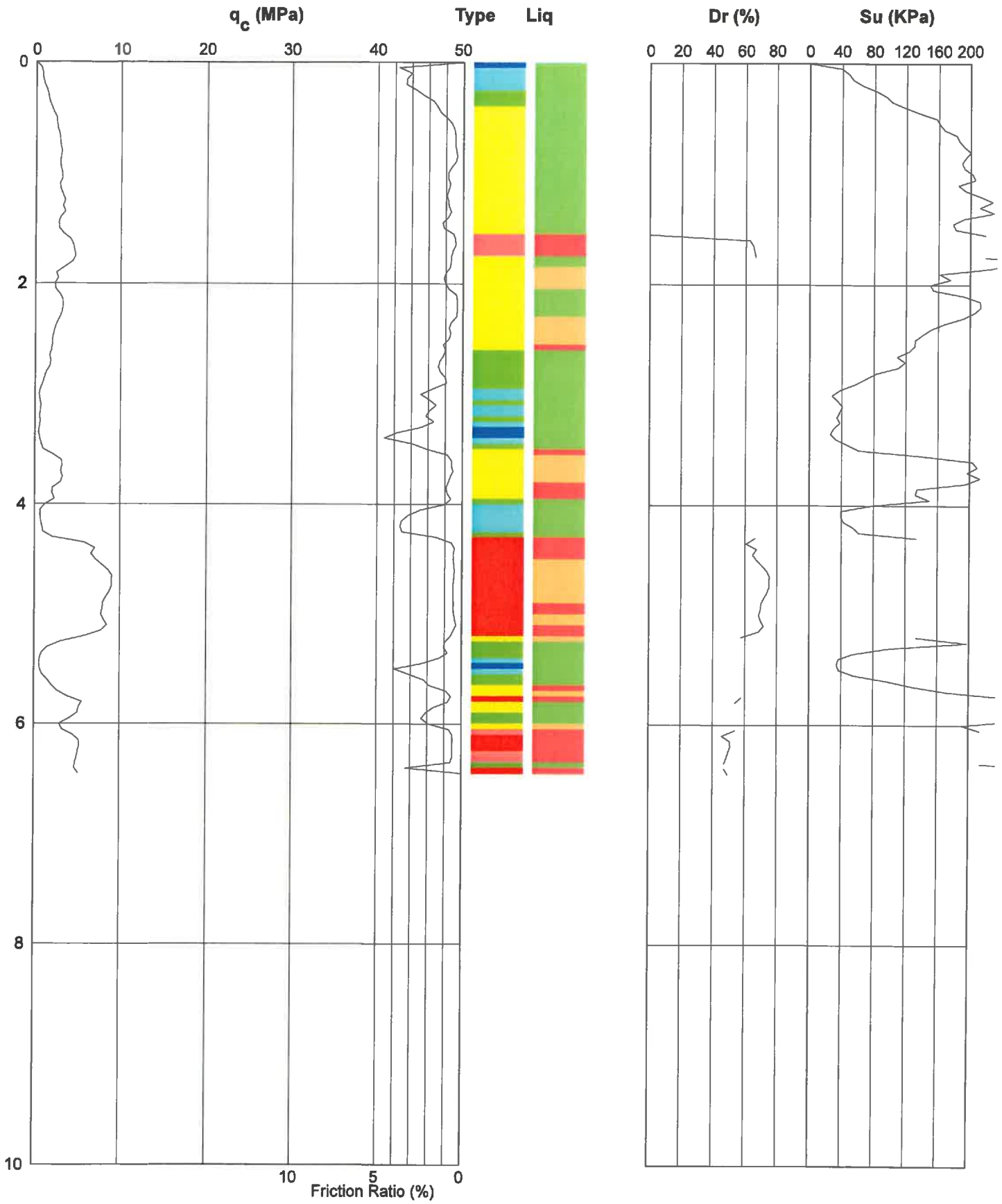
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu002	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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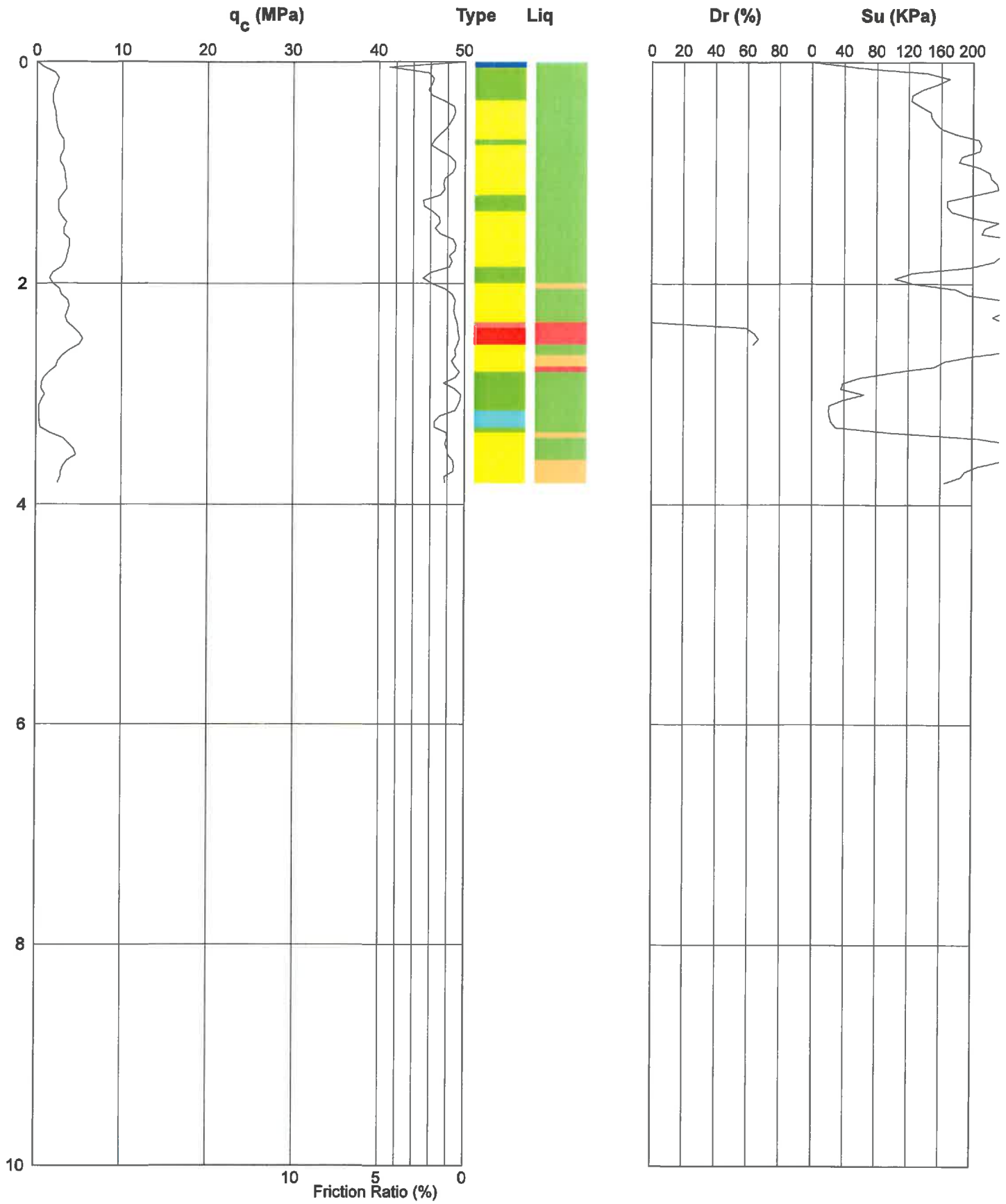

Job No:	9402	Date:	27/08/11
CPT No:	CPTu003	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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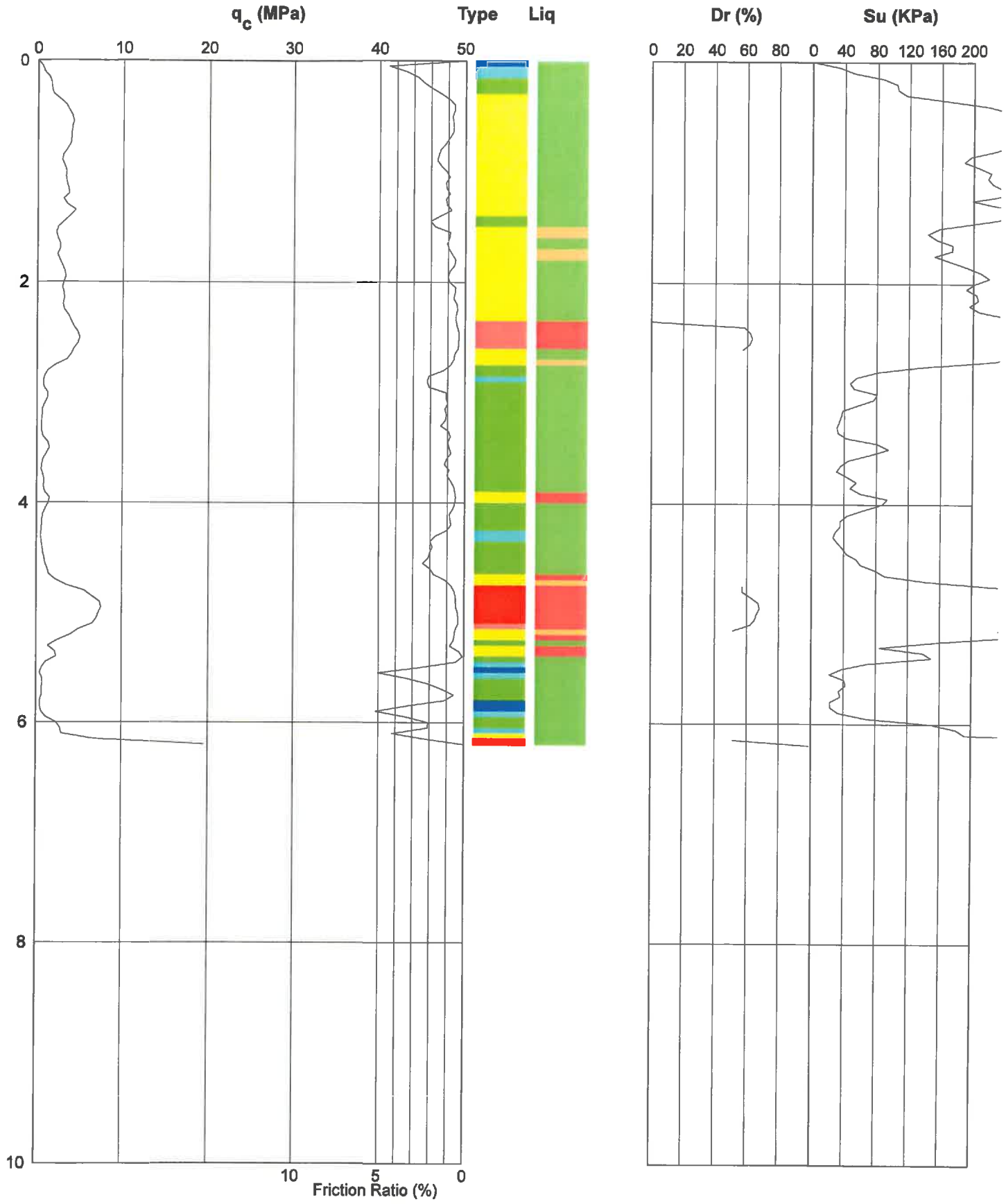
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	27/08/11
CPT No:	CPTu004	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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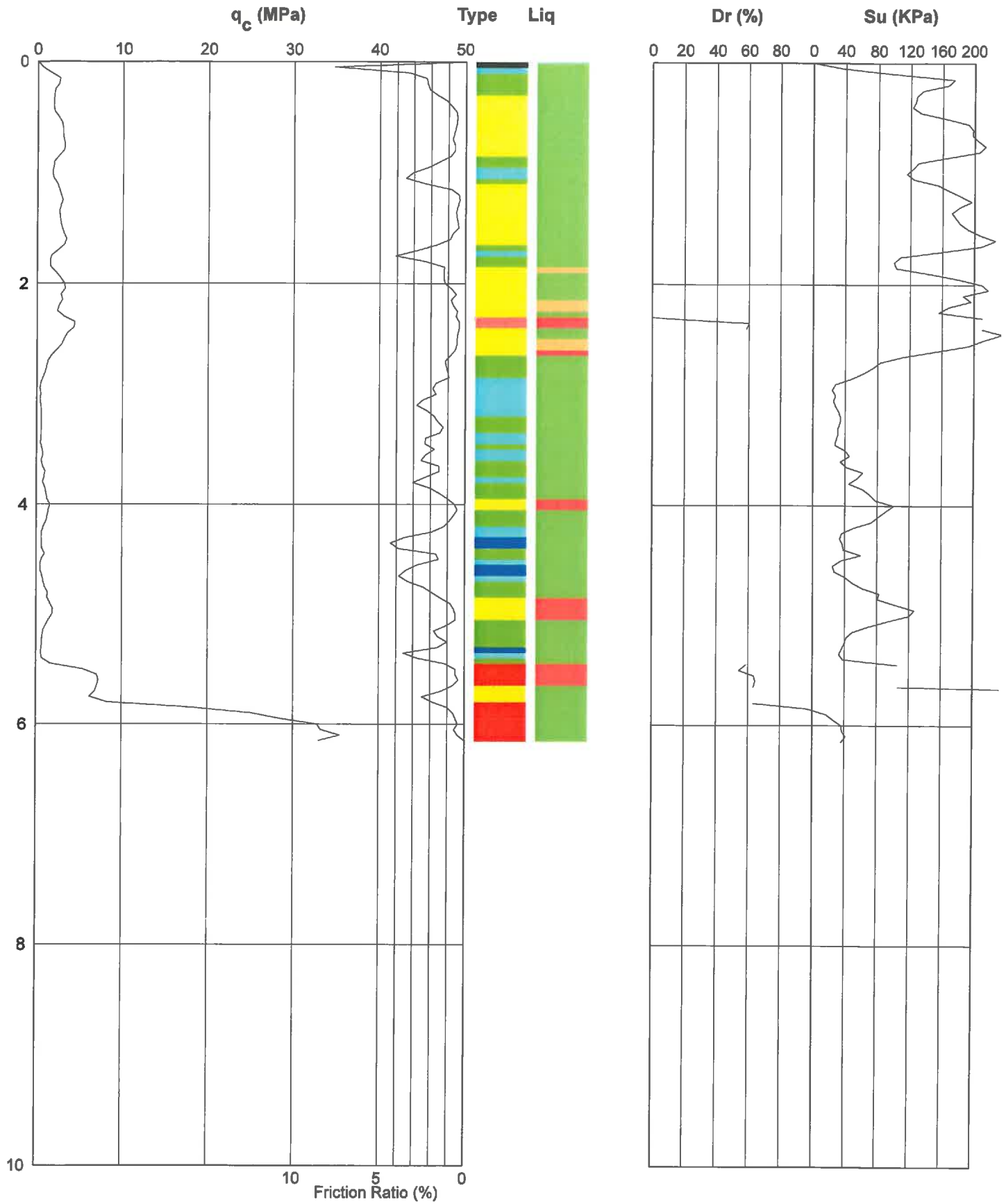
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu005	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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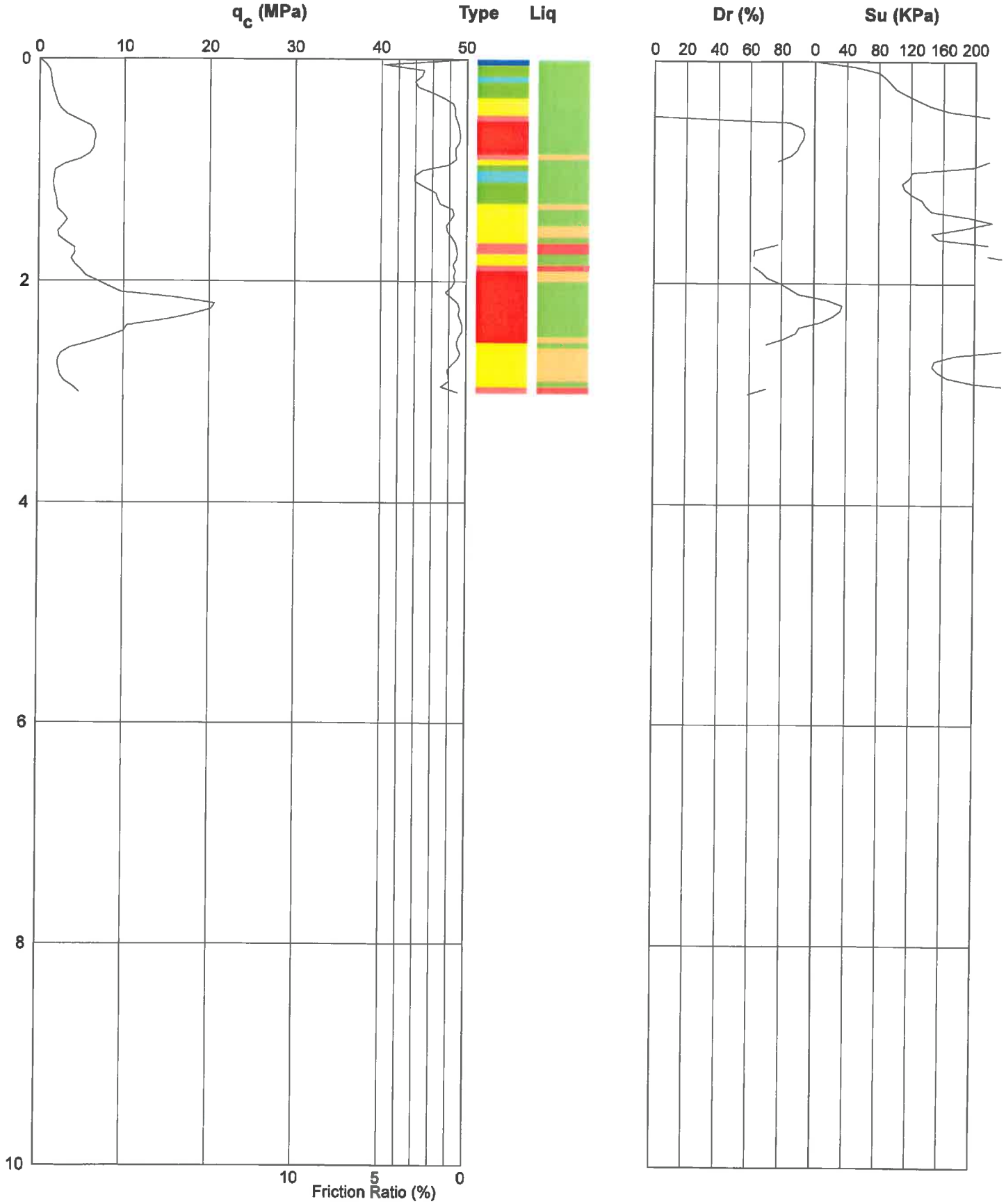
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu006	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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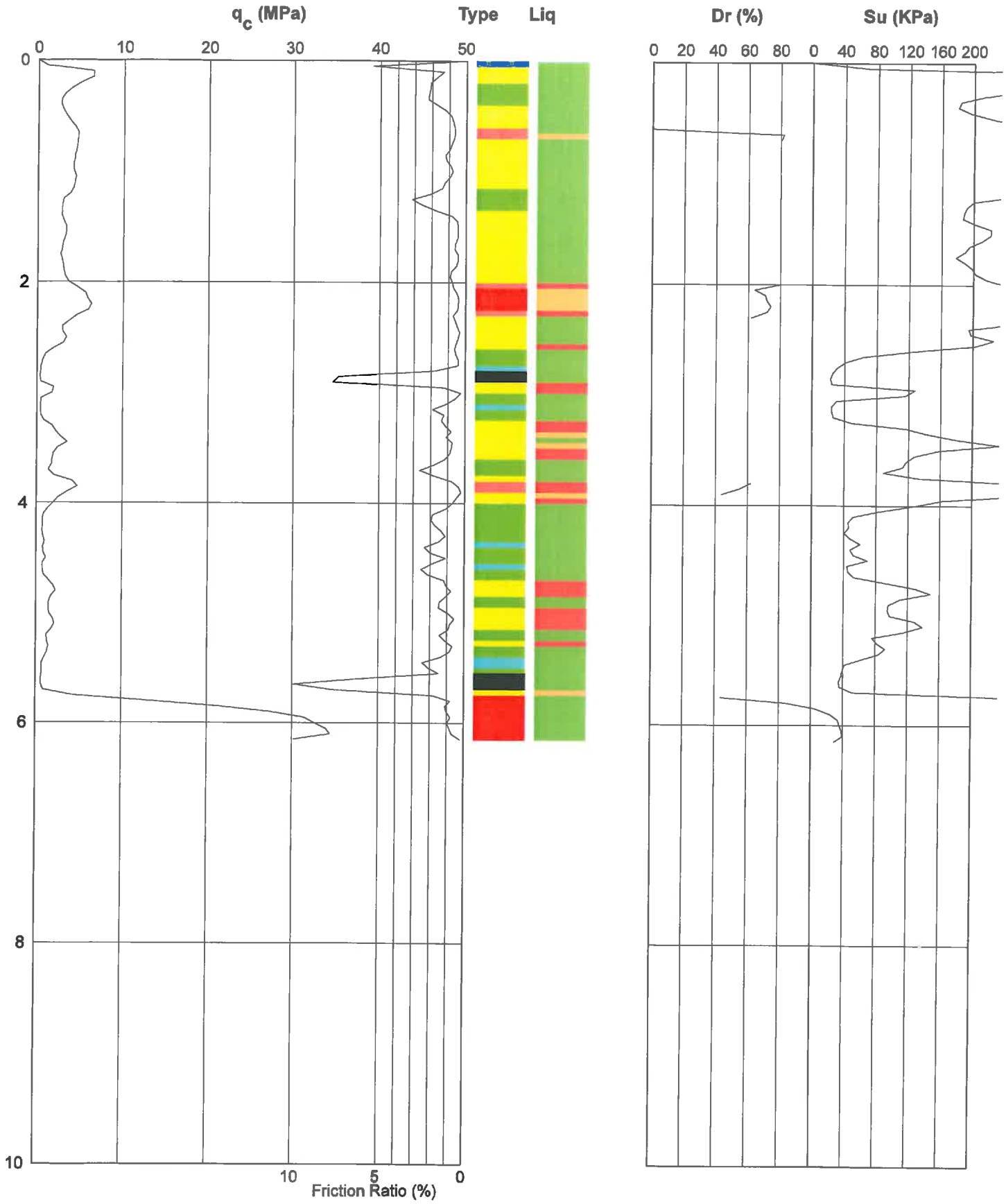
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu008	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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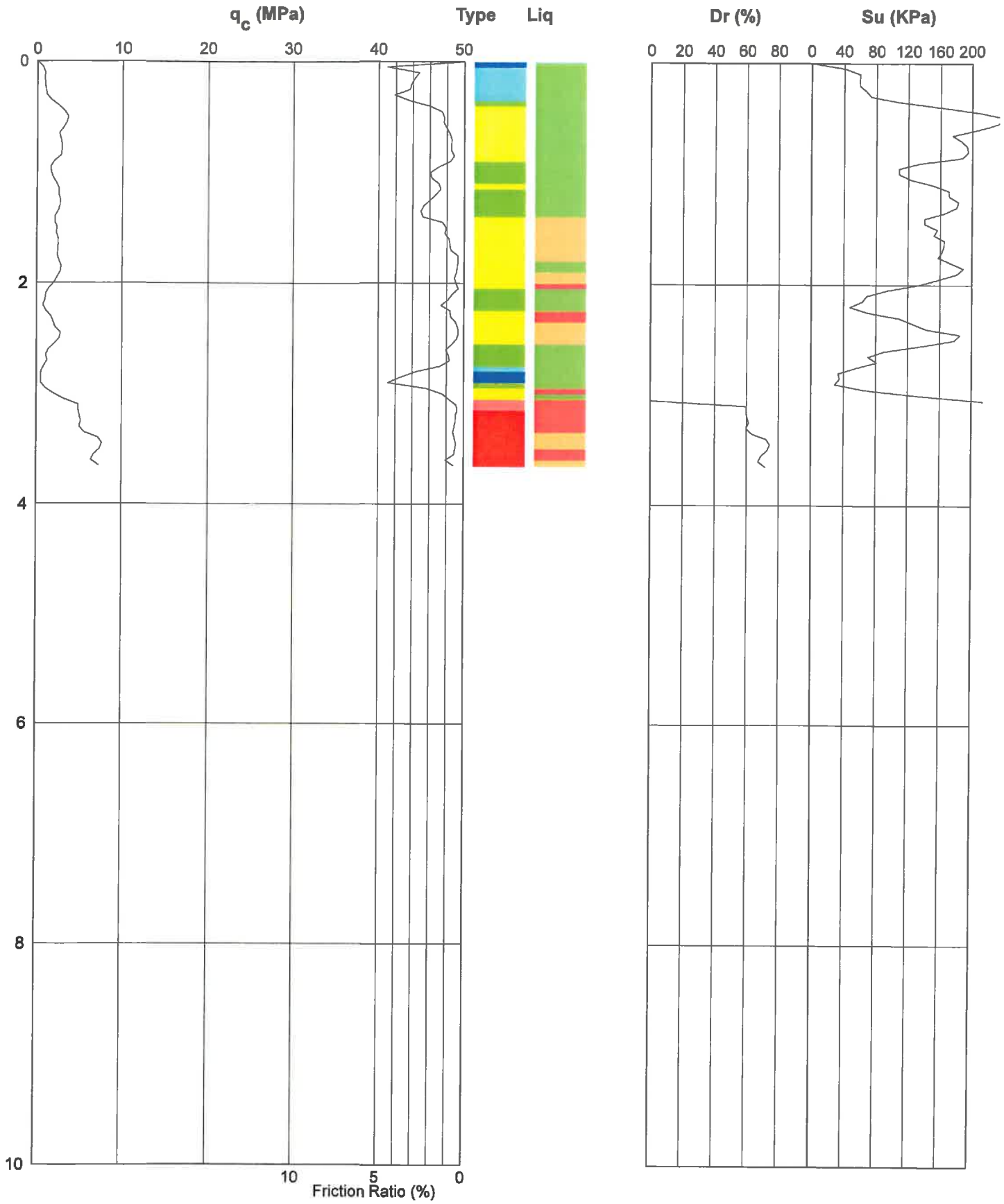
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	27/08/11
CPT No:	CPTu009	Operator:	J. Kendrick
Project:	Job No 9402 - Site Investigations	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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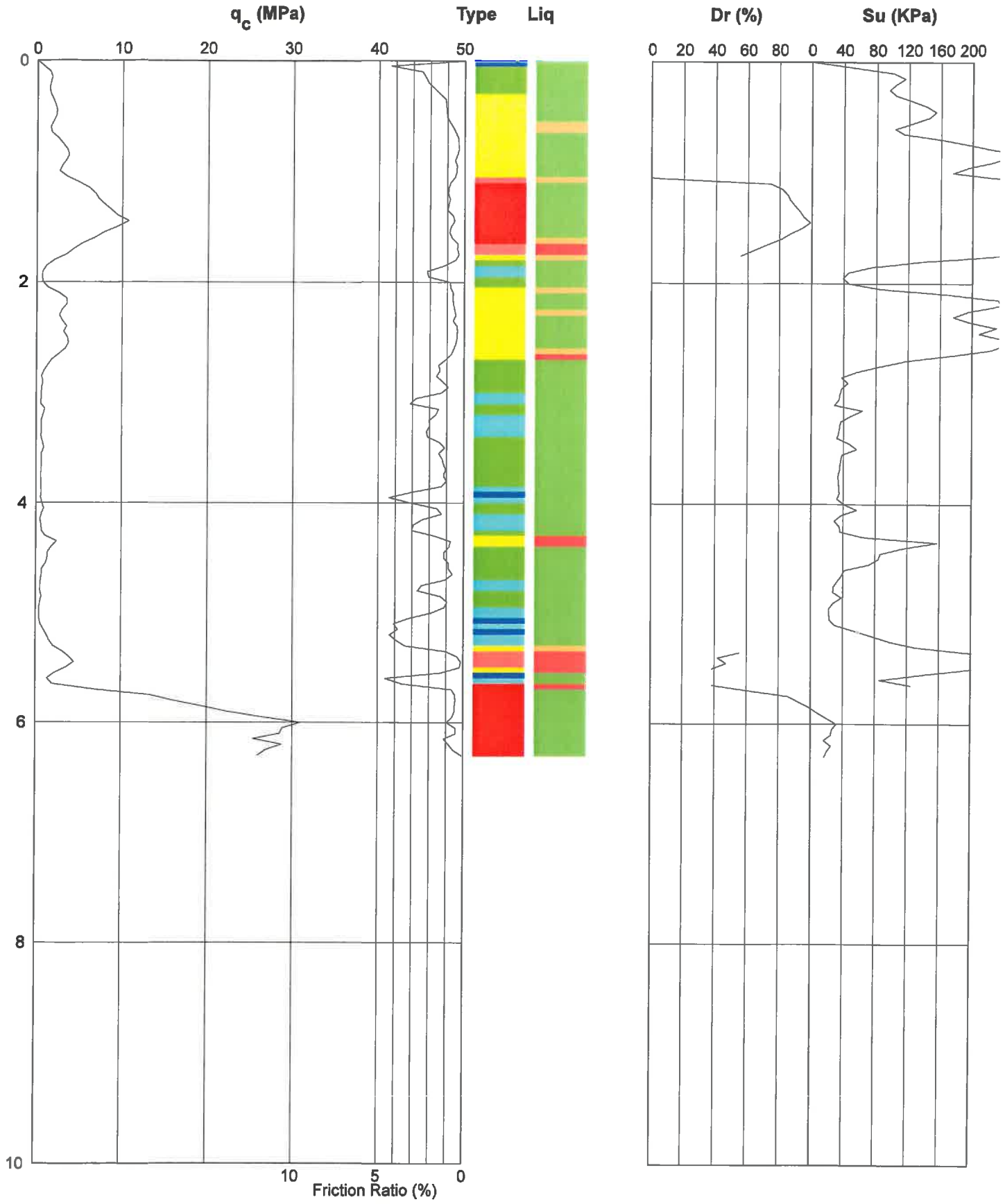
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu010	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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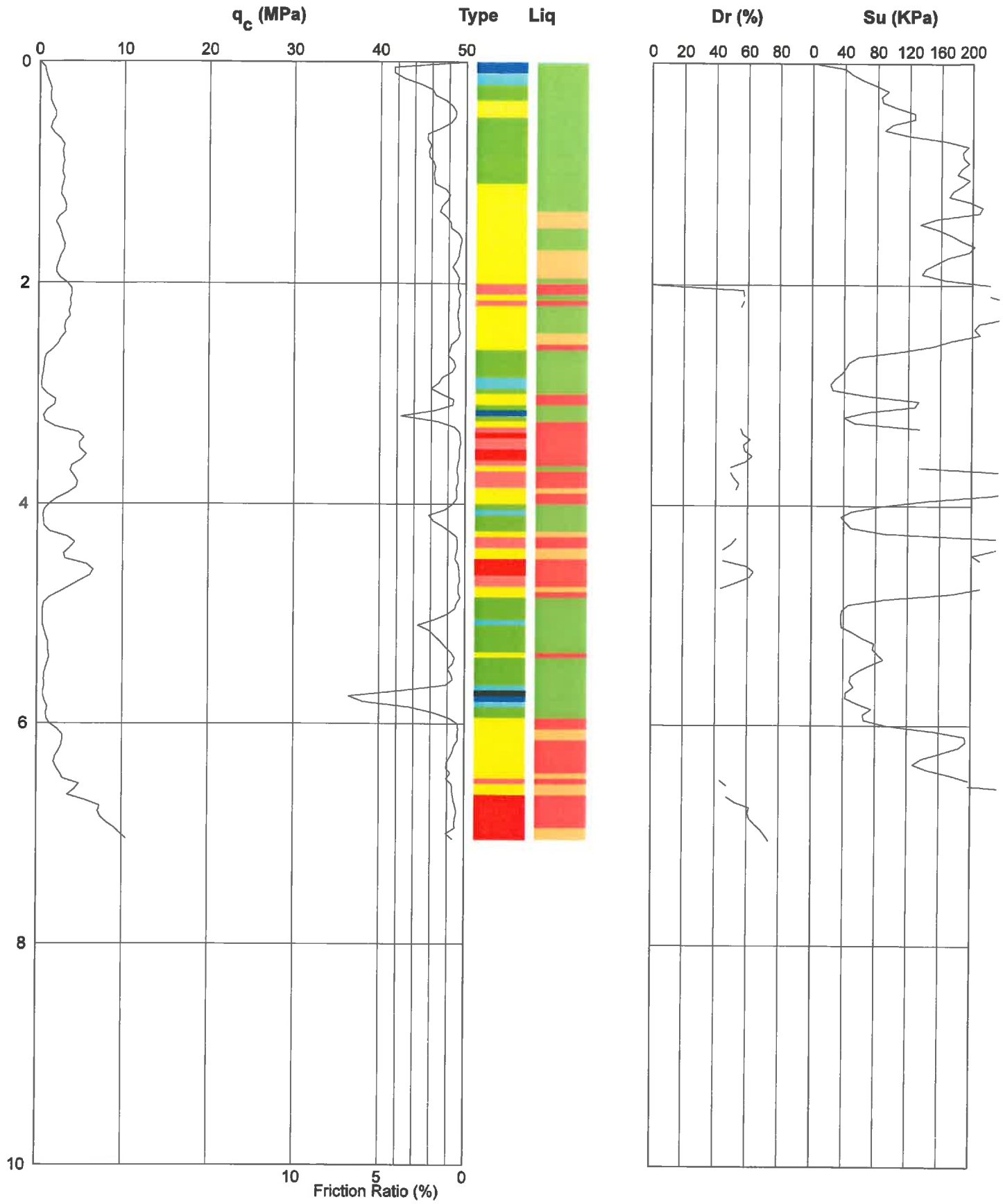
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu011	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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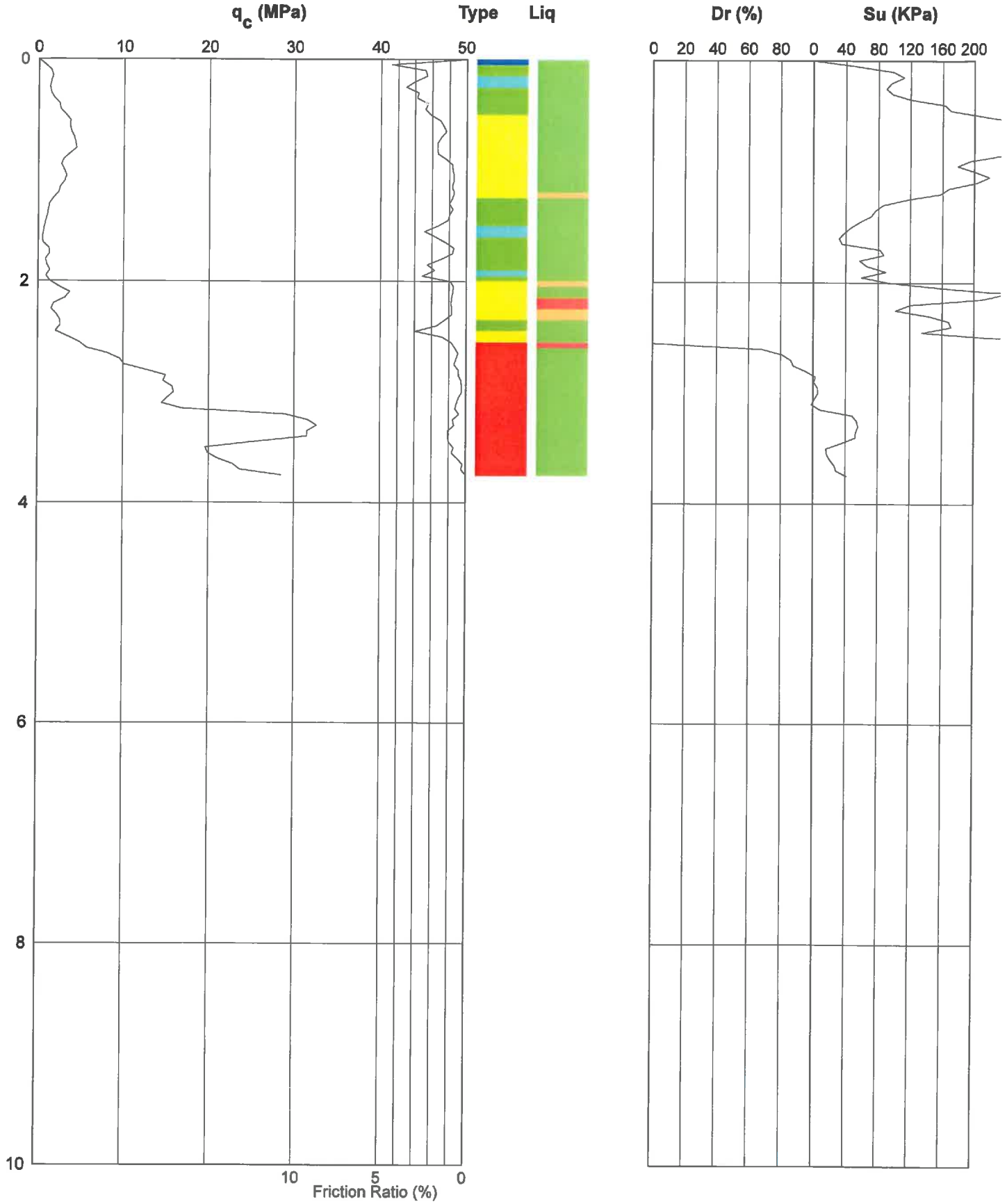

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CPT No:	CPTu012	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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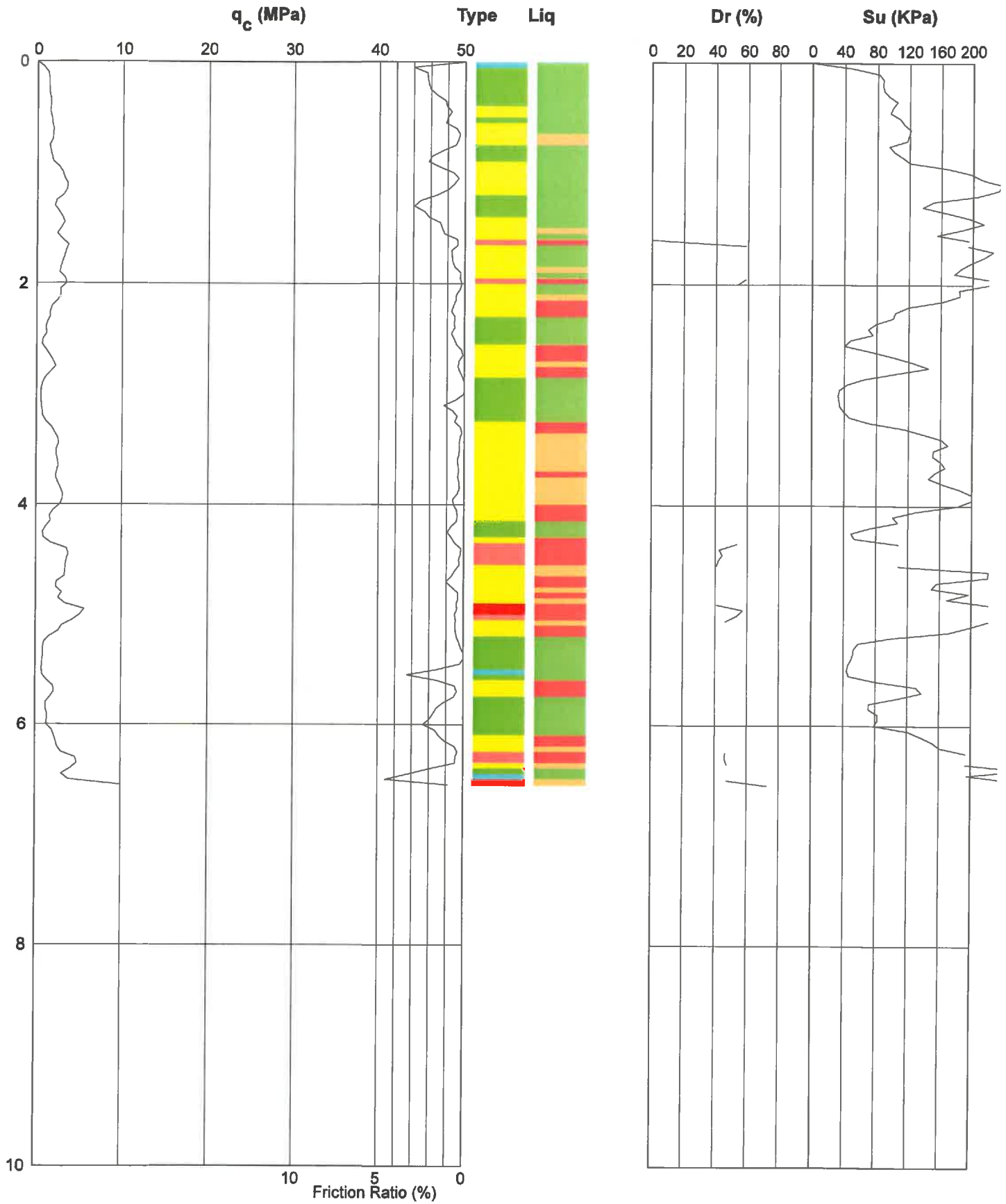

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CPT No:	CPTu014	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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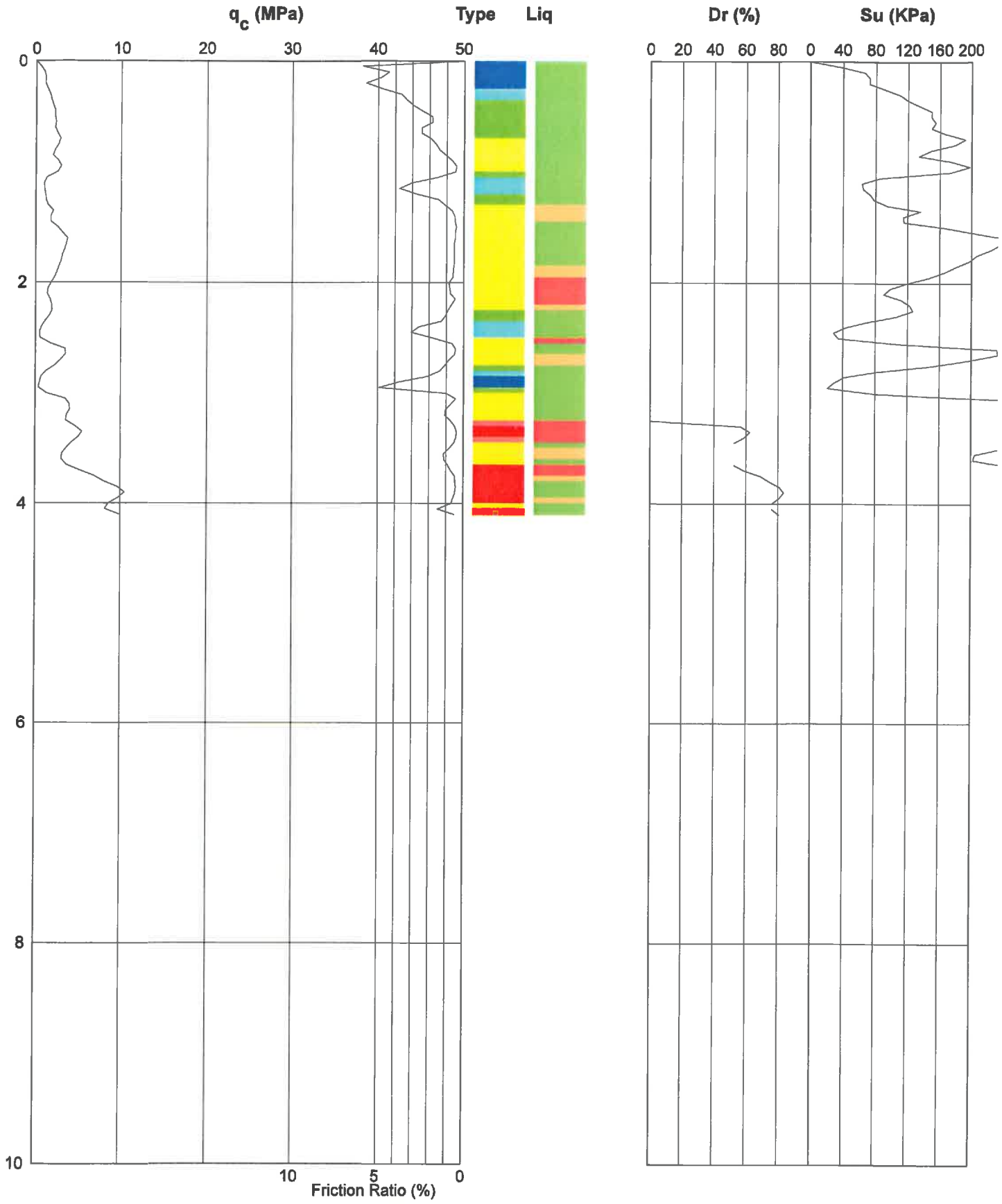
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu015	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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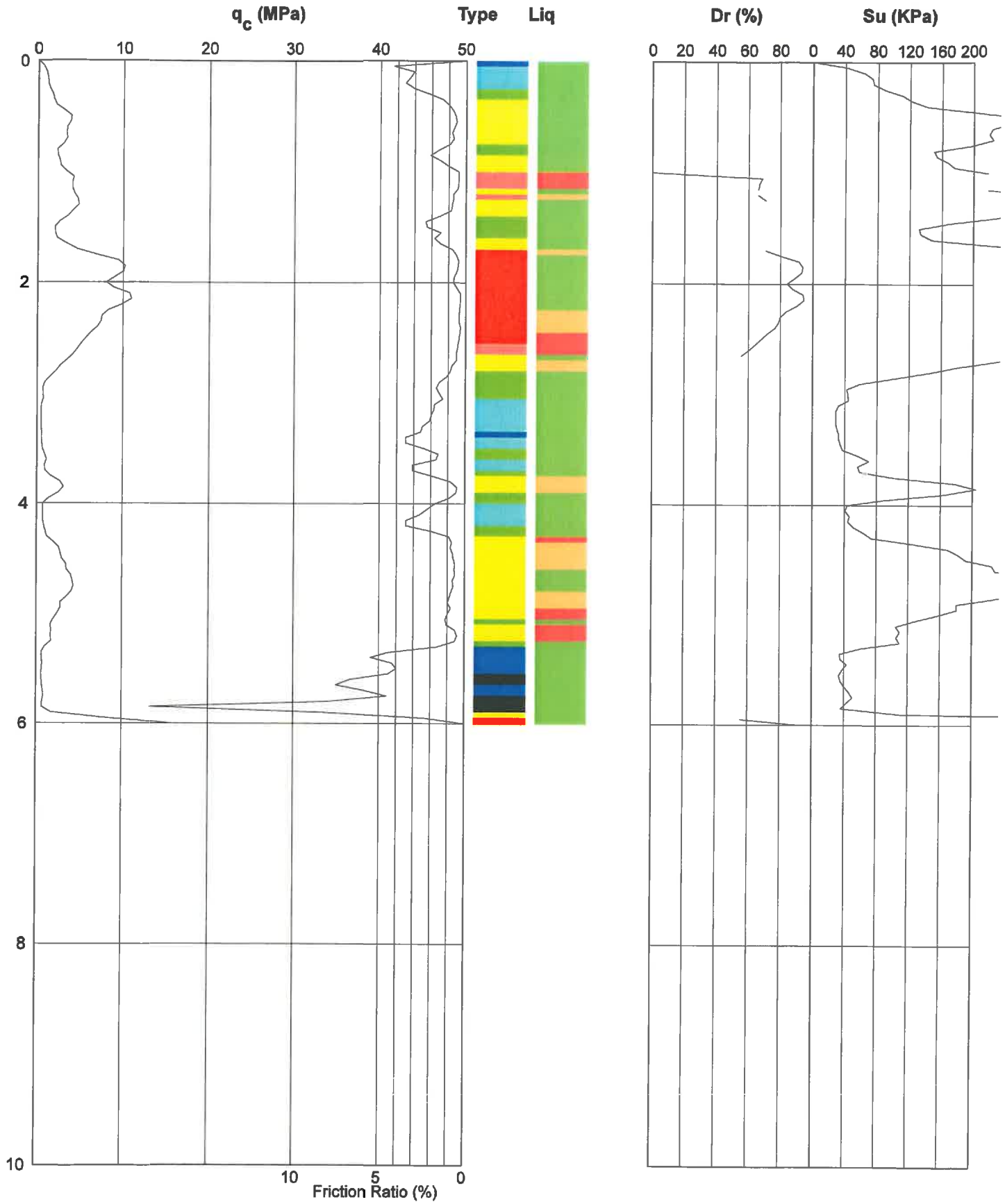

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CPT No:	CPTu030	Operator:	J. Kendrick
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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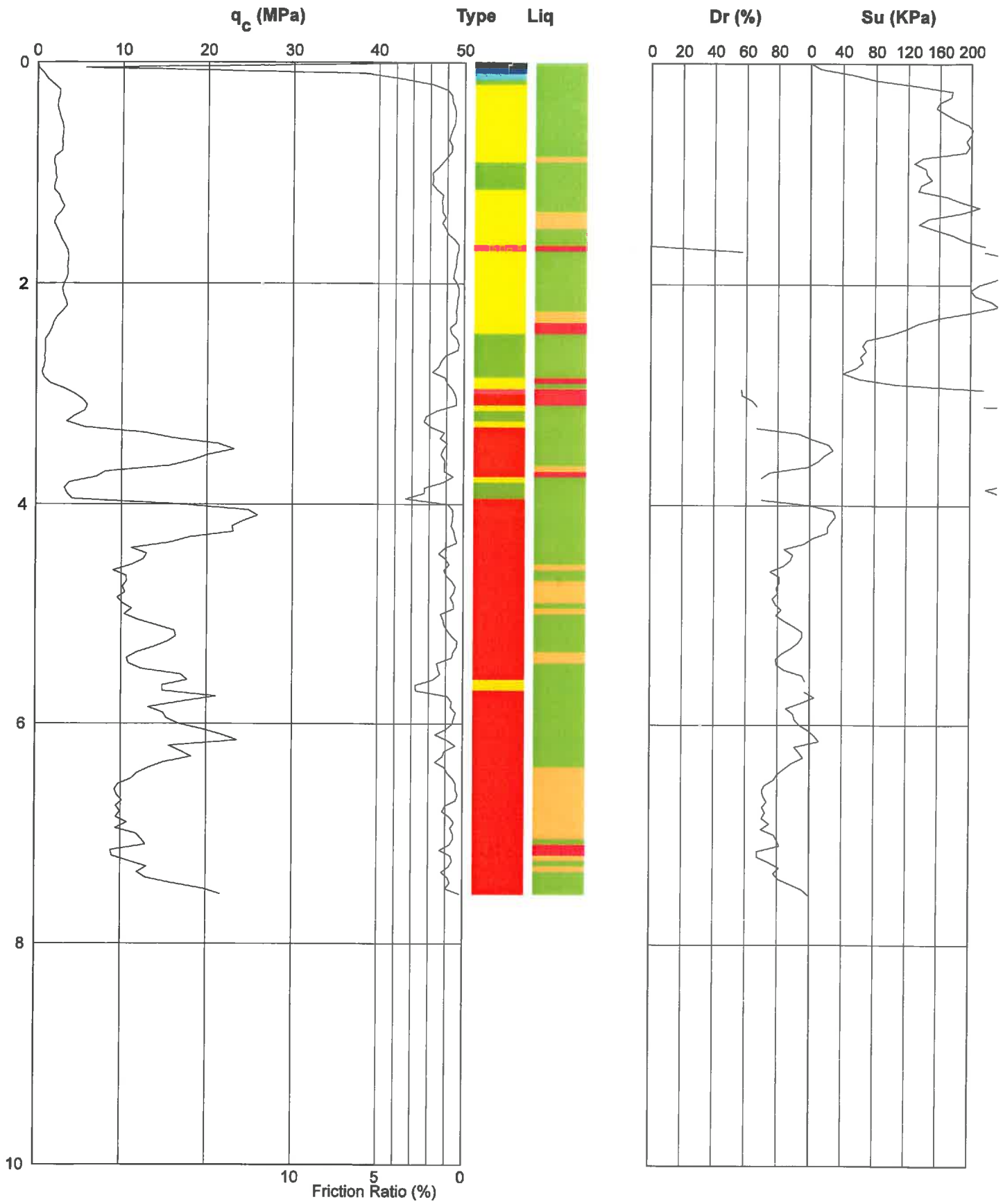

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CPT No:	CPTu032	Operator:	B. Powell
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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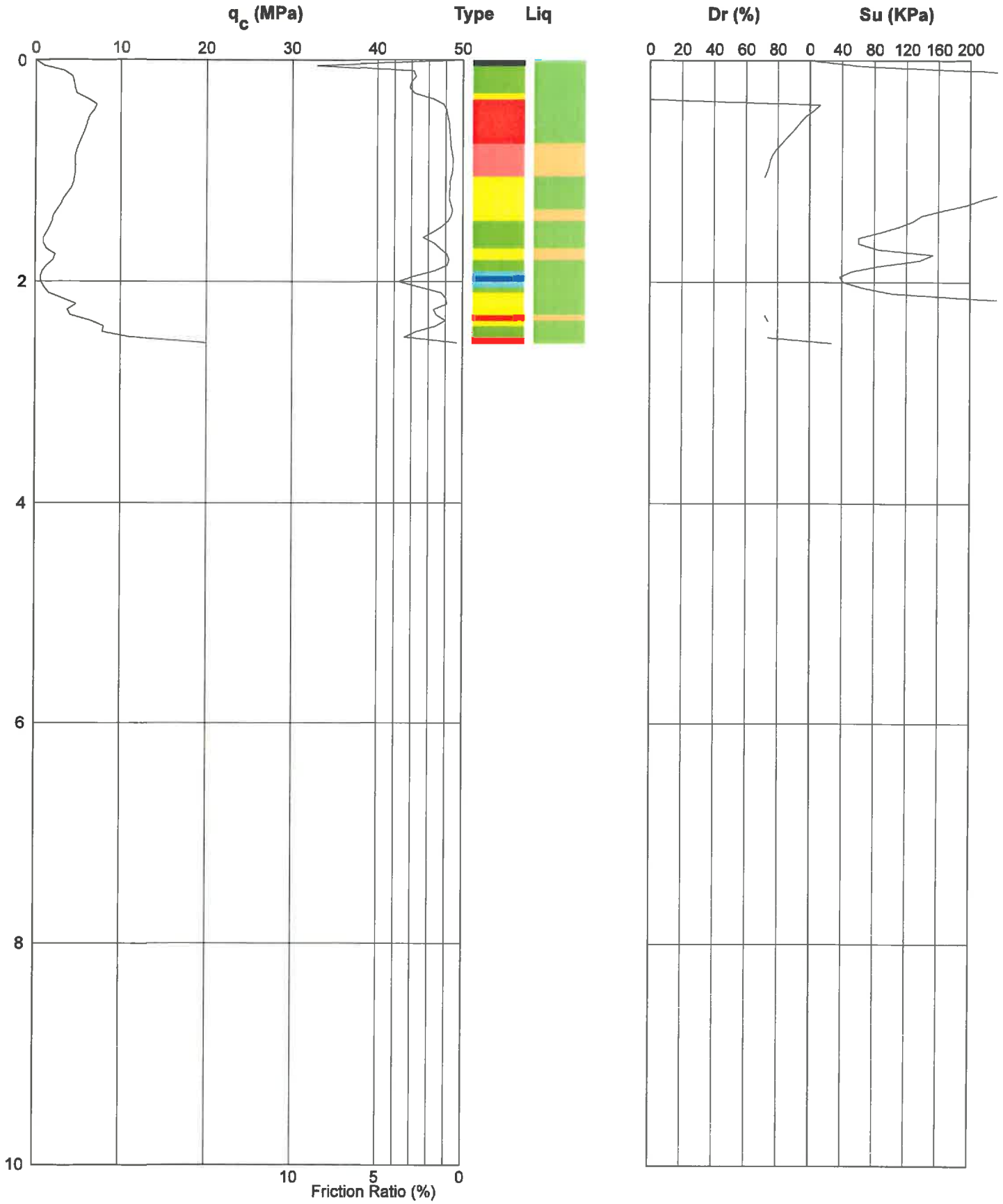
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



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CPT No:	CPTu033	Operator:	B. Powell
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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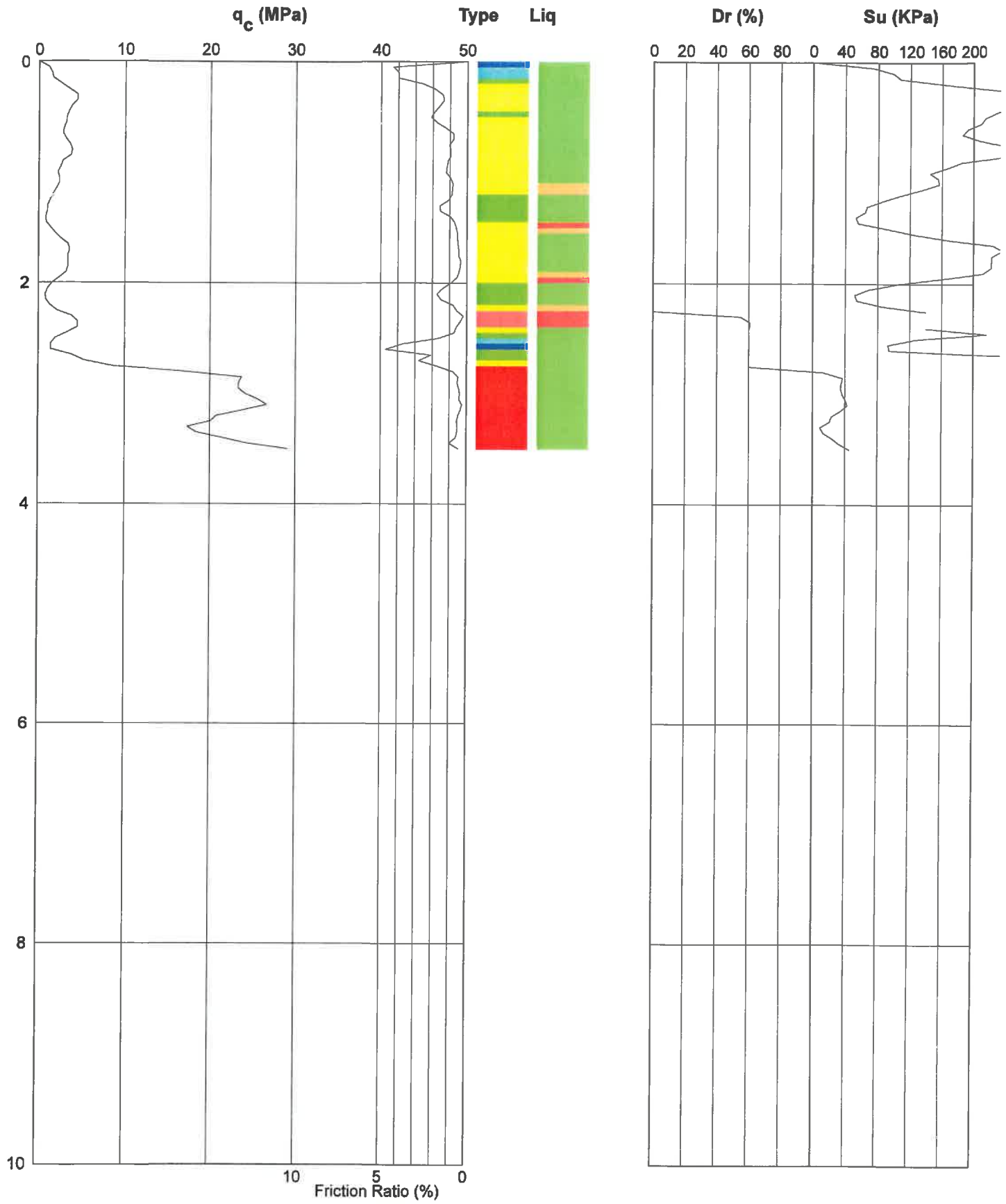

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Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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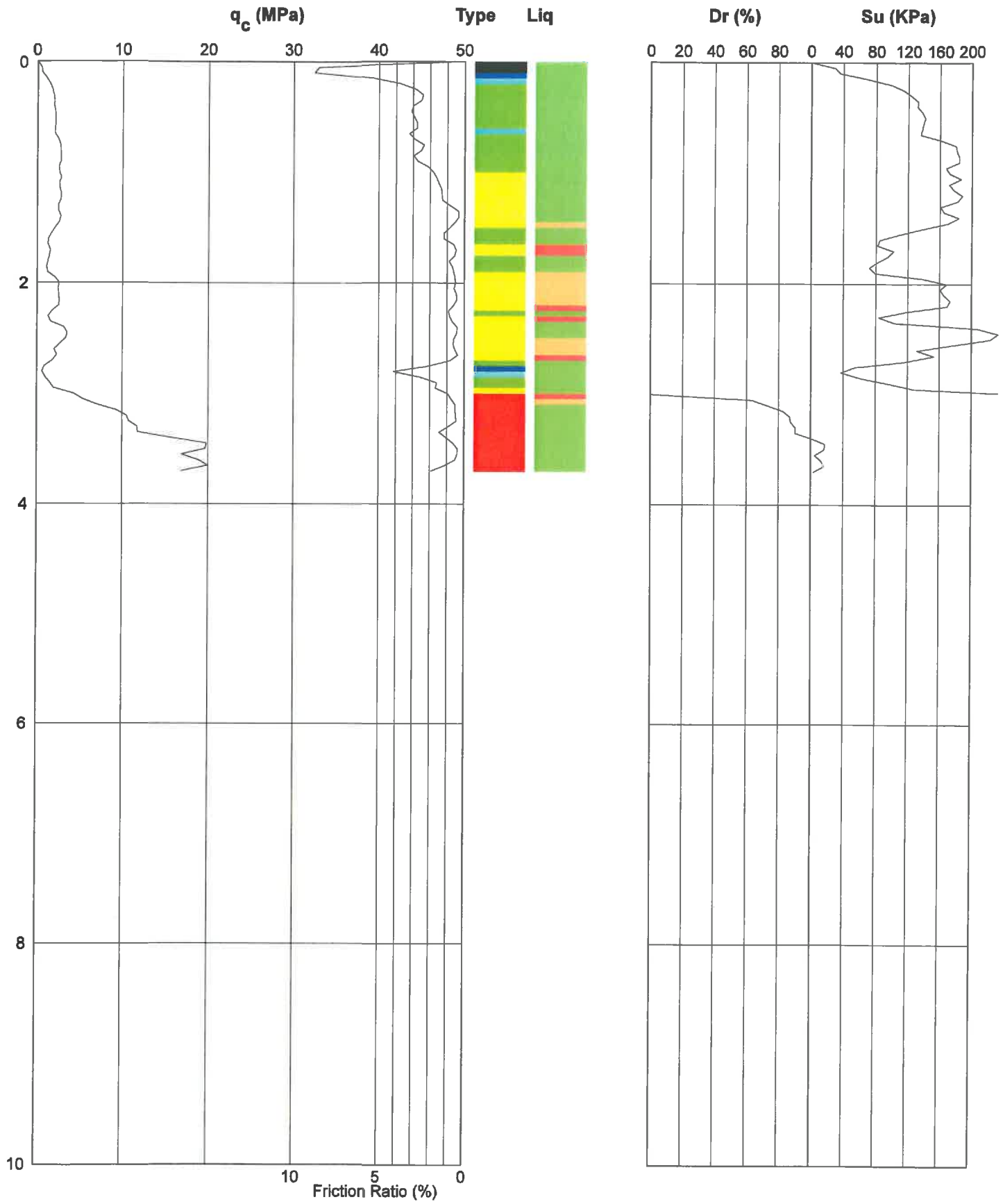
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	20/09/11
CPT No:	CPTu035	Operator:	B. Powell
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

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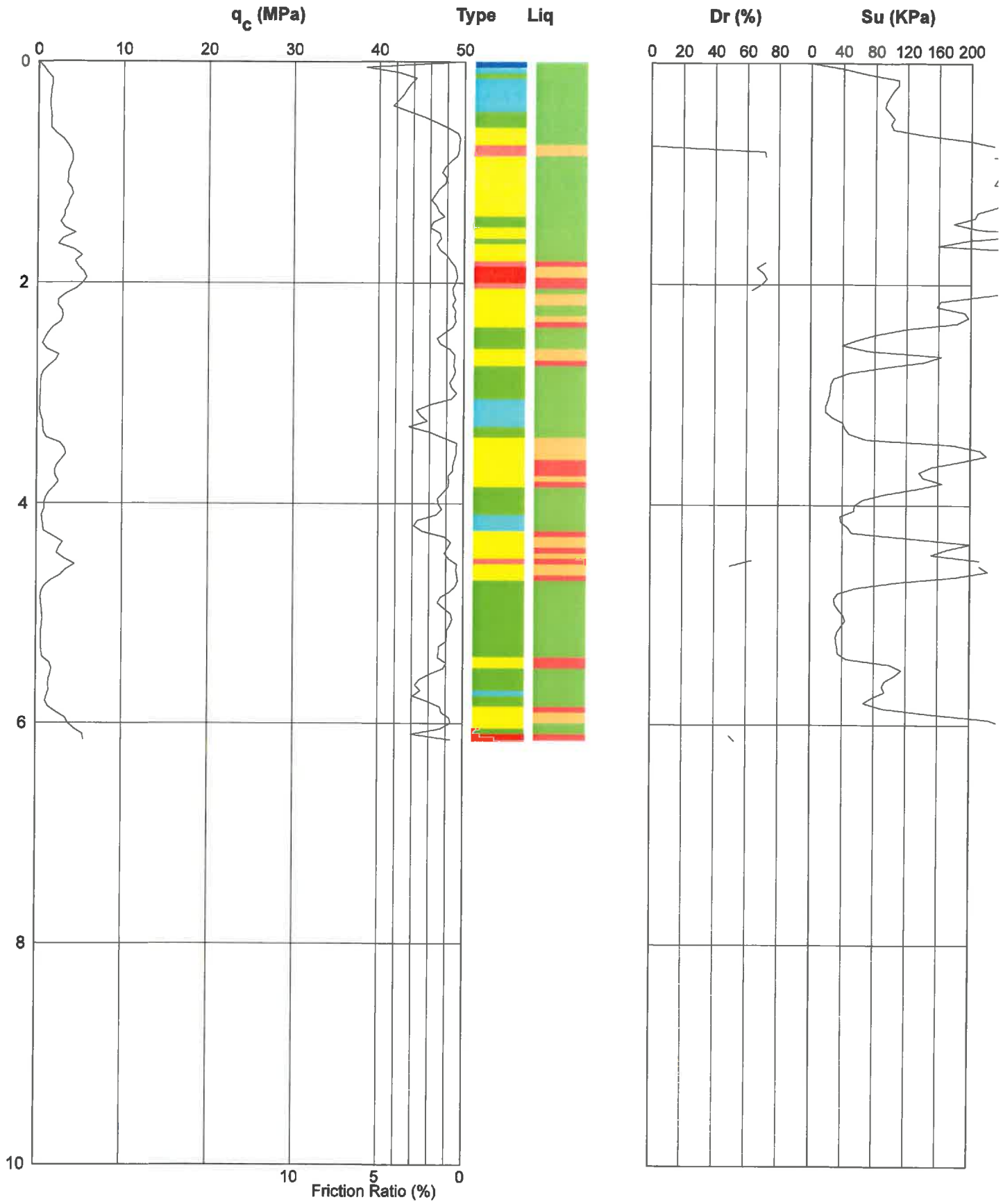
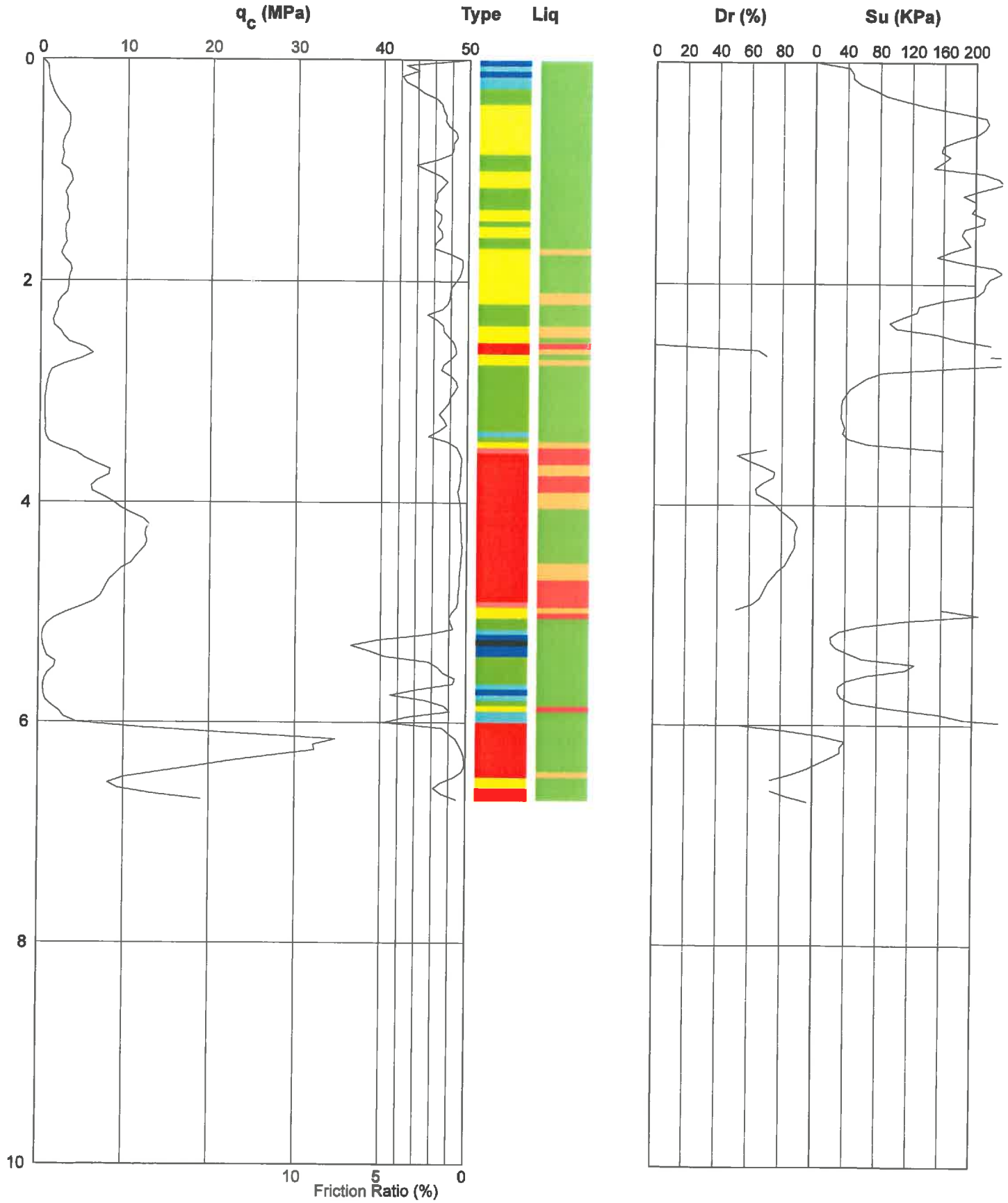
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	20/09/11
CPT No:	CPTu036	Operator:	B. Powell
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

McMILLAN DRILLING SERVICES

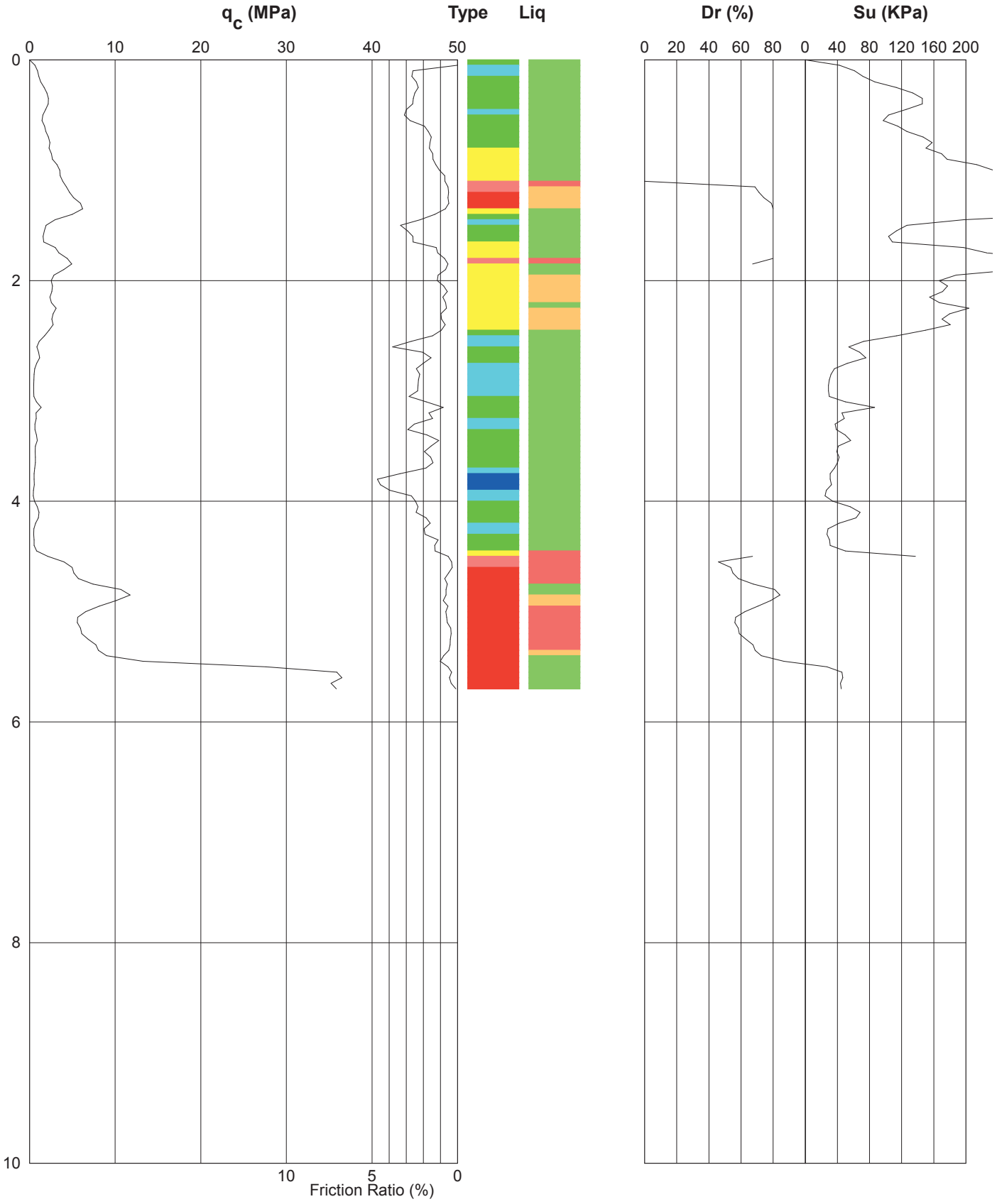
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	20/09/11
CPT No:	CPTu037	Operator:	B. Powell
Project:	FH C/o Aurecon	Remark:	Effective Refusal
Location:	Rosemerryn, Edward St, Lincoln		

McMILLAN DRILLING SERVICES

PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	10/11/2011
CPT No:	CPT038	Operator:	J. Kendrick
Project:	Aurecon	Remark:	Effective Refusal
Location:	Edward Street, Lincoln		

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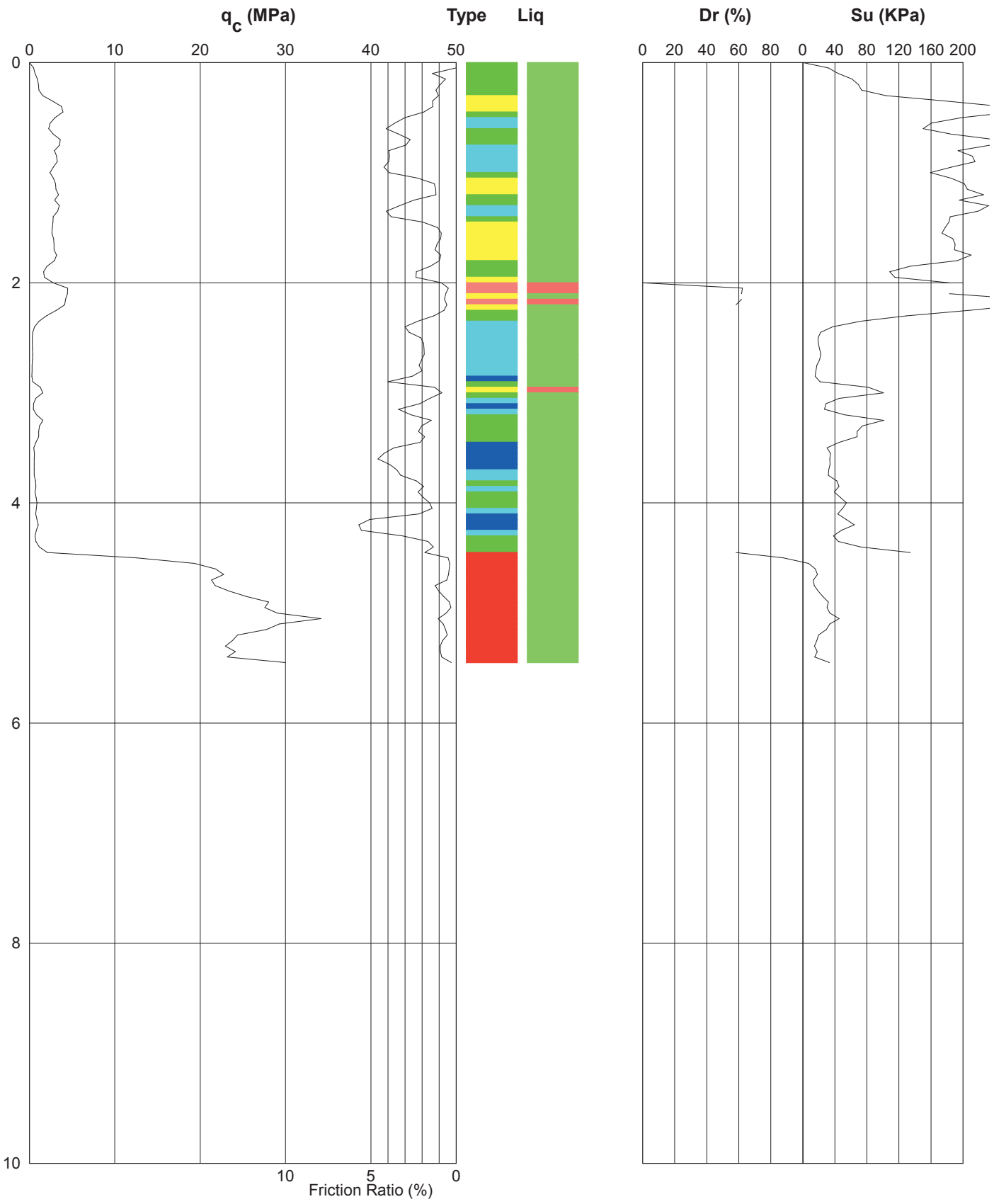
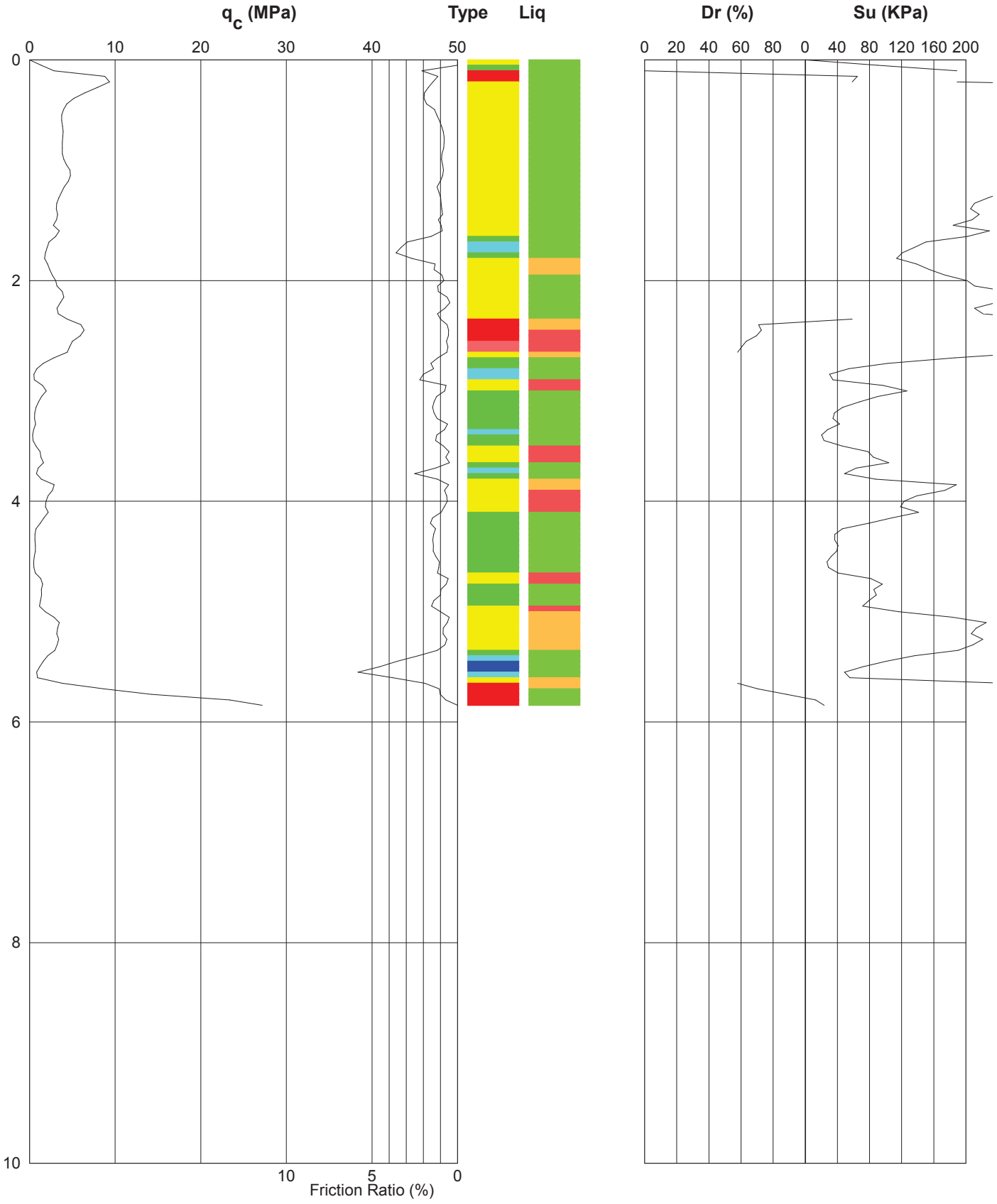
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	10/11/2011
CPT No:	CPT039	Operator:	J. Kendrick
Project:	Aurecon	Remark:	Effective Refusal
Location:	Edward Street, Lincoln		

McMILLAN DRILLING SERVICES

PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	9402	Date:	10/11/2011
CPT No:	CPT040	Operator:	J. Kendrick
Project:	Aurecon	Remark:	Effective Refusal
Location:	Edward Street, Lincoln		

McMILLAN DRILLING SERVICES

Appendix D
Test Pit Logs

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP01

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1558997 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5168035 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.25 Sandy SILT; Grey brown with brown mottles. Low plasticity. Moist. Firm. Sand fine to medium grained.	
0.5				Shear vane at 0.5m: 67/31kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m^2		
1.0				Shear vane at 1m: 61/18kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2		
1.5				Shear vane at 1.5m: 207/0kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2		
2.0				Shear vane at 2m: 44/31kPa /kPa /kPa	Pocket Penetrometer at 2m: kN/m^2	2.00 SAND; Grey brown with brown mottles. Loose. Moist. Sand fine to medium grained.	
						2.20 SAND; Grey brown with brown mottles. Loose to medium dense. Wet. Sand fine to medium grained.	
2.5				Shear vane at 2.5m: 89/38kPa /kPa /kPa	Pocket Penetrometer at 2.5m: kN/m^2	2.40 SILT with minor sand and trace clay; Grey brown with brown mottling. Firm. Moist. Low plasticity. Sand fine to medium grained.	
3.0				Shear vane at 3m: 53/16kPa /kPa /kPa	Pocket Penetrometer at 3m: kN/m^2	3.00 SILT with minor clay and sand; Dark grey. Wet. Low to high plasticity. Sand fine to medium grained.	
3.5				Shear vane at 3.5m: 43/33kPa /kPa /kPa	Pocket Penetrometer at 3.5m: kN/m^2		
4.0		▼				4.00 End of Test Pit at 4m (GW Reached)	
4.5							
5.0							

Remarks:

Groundwater seepage @ 2.3
Groundwater table encountered at 4.0m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP02

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559137 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5168085 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.30 SILT with minor sand; Brown. Firm. Moist. Low plasticity. Sand fine grained.	
0.5				Shear vane at 0.5m: 59/33kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m^2	0.50 Sandy SILT; Brown. Firm. Moist. Low plasticity. Sand fine grained.	
1.0				Shear vane at 1m: 47/24kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2		
1.5				Shear vane at 1.5m: 53/24kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2		
2.0				Shear vane at 2m: 99/27kPa /kPa /kPa	Pocket Penetrometer at 2m: kN/m^2	2.00 Sandy SILT; Grey with orange brown mottling. Stiff. Moist. Low plasticity. Sand fine grained.	
2.5				Shear vane at 2.5m: 38/24kPa /kPa /kPa	Pocket Penetrometer at 2.5m: kN/m^2	2.70 SAND with some silt; Grey with orange brown mottling. Loose to medium dense. Moist. Fine grained.	
3.0						3.00 SAND with some silt and organic inclusions; Dark grey. Loose to medium dense. Moist. Fine grained.	
3.5						3.90	
4.0		▼				4.00 GRAVEL with some sand; Grey and dark orange brown. Dense. Wet to saturated. Gravel fine grained. Rounded to sub-rounded. Sand fine grained. End of Test Pit at 4m (GW Reached)	
4.5							
5.0							

Remarks:

Tree branches @ 3.3m
Tree roots @ 3.5m
Groundwater table encountered at 4.0m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP03

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559200 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167950 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.30 Sandy SILT; Brown. Firm to Stiff. Moist. Low plasticity. Sand fine grained.	
0.5				Shear vane at 0.5m: 160/43kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m^2		
1.0				Shear vane at 1m: 44/24kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	1.20 SAND with minor silt; Grey brown with orange brown mottling. Loose to medium dense. Moist. Sand fine grained.	
						1.40 SILT with some sand; Brown. Firm to Stiff. Moist. Low plasticity. Sand fine grained.	
1.5				Shear vane at 1.5m: 44/21kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2		
2.0				Shear vane at 2m: 36/21kPa /kPa /kPa	Pocket Penetrometer at 2m: kN/m^2		
2.5				Shear vane at 2.5m: 47/33kPa /kPa /kPa	Pocket Penetrometer at 2.5m: kN/m^2	2.60 SAND with minor silt; Grey brown with orange brown mottling. Loose to medium dense. Moist to wet. Sand fine grained.	
3.0				Shear vane at 3m: 50/36kPa /kPa /kPa	Pocket Penetrometer at 3m: kN/m^2	3.00 SILT with some sand; Dark grey. Firm to Stiff. Moist. Low plasticity. Sand fine grained.	
						3.20 SILT with some sand and some clay; Dark grey. Firm to Stiff. Moist. Low plasticity. Sand fine grained.	
3.5				Shear vane at 3.5m: 44/18kPa /kPa /kPa	Pocket Penetrometer at 3.5m: kN/m^2		
4.0						4.00 End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

No groundwater encountered

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP04

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559340 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167999 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
1.0						0.50 SILT; Light grey with orange brown mottling. Firm. Moist. Low plasticity.	
1.5						1.00 GRAVEL with minor cobbles; Grey. Dense. Moist. Gravel medium grained.	
2.0							
2.5						2.50 SILT with minor peat inclusions; Light blue grey. Firm. Wet. Fine grained. Low plasticity.	
3.0						3.20 SAND; Grey brown. Loose to medium dense. Saturated. Sand medium grained.	
3.5							
4.0		▼				4.00 End of Test Pit at 4m (GW Reached)	
4.5							
5.0							

Remarks:

Groundwater seepage @ 2.5m
Tree Branch @ 3.0m
Groundwater tabel reached at 4.0m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP05

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559379 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167849 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.3m: 62/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity. (0.30)	
1.0						Sandy SILT; Light yellow brown with some orange brown mottling. Firm. Moist. Low plasticity. Sand fine to medium grained. (1.30)	
1.5						SAND with minor silt; Light brown grey with orange brown mottling. Medium dense. Wet. Sand fine to medium grained. (2.20)	
2.0						SAND with a trace of gravel; Orange brown with grey mottling. Medium dense. Wet. Sand fine to medium grained. Gravel fine grained. (2.50)	
2.5						SAND; Light grey. Medium dense to dense. Moist to wet. Sand fine to medium grained. (3.00)	
3.0				Shear vane at 3m: 59/30kPa /kPa /kPa	Pocket Penetrometer at 3m: kN/m^2	Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity. (3.80)	
3.5						End of Test Pit at 3.8m (Pit Collapse)	
4.0							
4.5							
5.0							

Remarks:

Groundwater seepage @ 2.2m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP06

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559432 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167960 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.50 SILT; Light grey with orange brown mottling. Firm. Moist. Low plasticity.	
1.0						1.00 GRAVEL with some sand; Grey. Dense. Wet. Gravel coarse grained. Sand medium grained	
1.5							
2.0						2.00 SAND with minor silt; Light blue grey. Medium dense. Saturated. Sand fine grained.	
2.5							
3.0		▼				3.20 End of Test Pit at 3.2m (GW Reached)	
3.5							
4.0							
4.5							
5.0							

Remarks:

Groundwater reached @ 3.2m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP07

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559471 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5168052 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.25 SAND; Brown. Loose. Moist. Sand fine grained.	
1.0				Shear vane at 1m: 59/30kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	1.00 SILT; Grey with orange brown mottling. Very stiff. Moist. Non plastic.	
1.5				Shear vane at 1.5m: 41/30kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2		
2.0						2.20 SAND with minor silt; Light blue grey. Medium dense. Saturated. Sand fine grained.	
2.5							
3.0						3.00 SILT with minor peat inclusions. Light blue grey. Wet. Low plasticity.	
						3.30 SILT; Light blue grey. Stiff. Wet. Low plasticity.	
3.5		▼				3.50 End of Test Pit at 3.5m (GW Reached)	
4.0							
4.5							
5.0							

Remarks:

Groundwater reached @ 3.5m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP09

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559446 m	Date Started: 9/9/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167737 m	Date Completed: 9/9/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.20)	
1.0						SAND; Brown. Loose. Moist. Sand fine to medium grained. (1.00)	
1.5						Silty SAND; Brown with orange mottling. Loose. Moist. Sand fine to medium grained. (1.90)	
2.0						SAND with some silt; Light brown with brown mottling. Loose to medium dense. Wet. Sand fine to medium grained. (3.00)	
2.5						Sandy SILT with tree branches; Light blue grey. Soft. Moist. Low plasticity. Sand fine grained. (3.50)	
3.0		▼				End of Test Pit at 3.5m (Pit Collapse)	
3.5							
4.0							
4.5							
5.0							

Remarks:

Groundwater reached @ 3.5m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP13

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559538 m	Date Started: 9/9/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167698 m	Date Completed: 9/9/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
1.0						0.40 Sandy SILT; Grey with orange brown mottling. Soft. Moist. Low plasticity. Sand fine grained.	
1.5							
2.0						1.80 Silty SAND; Grey. Loose to medium dense. Moist. Sand medium grained.	
2.5							
3.0						3.00 SILT with some sand and tree roots; Blue grey. Stiff. Wet. Low plasticity. Sand fine grained.	
3.5							
4.0						4.00 End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

Tree roots @ 3.0m
Groundwater seepage @ 2.0m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559655 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167974 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.25)	
1.0						SAND; Brown. Medium dense. Moist. Fine grained. (1.00)	
1.5				Shear vane at 1m: 101/24kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	SILT; Light brown. Soft. Moist. Low plasticity. (1.50)	
2.0						SAND; Brown orange. Loose. Wet. Sand fine grained. (2.00)	
2.5						SAND; Grey. Loose. Wet. Sand fine grained. (2.60)	
3.0						Sandy SILT; Blue grey. Firm. Wet. Low plasticity. Sand is fine grained. (3.70)	
3.5		▼				End of Test Pit at 3.7m (GW Reached)	
4.0							
4.5							
5.0							

Remarks:

Tree roots @ 2.4m
Groundwater reached 3.7m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559630 m	Date Started: 9/9/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167659 m	Date Completed: 9/9/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.25 Sandy SILT; Grey brown with brown mottles. Firm. Moist. Low plasticity. Sand fine to medium grained.	
0.5						0.80 Silty SAND; Grey brown with orange brown mottling. Loose to medium dense. Moist. Sand fine to medium grained.	
1.0							
1.5						1.65 SILT; Grey. Firm. Saturated. Low plasticity.	
		▼				1.80 End of Test Pit at 1.8m (GW Reached)	
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

Remarks:

Groundwater reached 1.8m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559669 m	Date Started: 9/9/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167751 m	Date Completed: 9/9/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.5m: 89/15kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m^2	TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.20)	
1.0				Shear vane at 1m: 44/24kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	Sandy SILT; Grey with orange brown mottling. Stiff. Moist. Low plasticity. Sand fine grained.	
1.5				Shear vane at 1.5m: 38/21kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2		
2.0							
2.5						(2.80)	
3.0						Sandy SILT with tree roots; Dark blue grey. Stiff. Wet. Low plasticity. Sand fine grained.	
3.5						(3.80)	
4.0						Sandy GRAVEL; Brown. Dense. Wet. Gravel fine to coarse grained. Sub-rounded. Sand medium grained. (4.00)	
4.5						End of Test Pit at 4m (Pit Collapse)	
5.0							

Remarks:

Tree roots @ 2.2m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

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Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559708 m	Date Started: 9/9/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167843 m	Date Completed: 9/9/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.5m: 95/24kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m^2	TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.20)	
1.0				Shear vane at 1m: 71/15kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	Sandy SILT; Grey with orange brown mottling. Stiff. Moist. Low plasticity. Sand fine grained. (1.50)	
1.5				Shear vane at 1.5m: 30/15kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2	Sandy SILT; Grey with orange brown mottling. Stiff. Saturated. Low plasticity. Sand fine grained. (1.80)	
2.0						SILT with minor sands; Dark blue grey. Soft. Wet. Low plasticity. Sand fine to medium grained. (2.20)	
2.5						SAND with tree roots; Dark blue grey. Loose to medium dense. Moist. Sand medium grained. (2.50)	
3.0						SILT with minor sands; Dark blue grey. Soft. Wet. Low plasticity. Sand fine to medium grained. (2.70)	
3.5						SAND with tree roots; Dark blue grey. Loose to medium dense. Moist. Sand medium grained. (3.80)	
4.0						Sandy GRAVEL; Brown. Dense. Saturated. Gravel fine to coarse grained. Sub-rounded. Sand medium grained. (4.00)	
4.5						End of Test Pit at 4m (GW Reached)	
5.0							

Remarks:

Tree roots @ 2.2m
Groundwater reached 4.0m

Logged by: LFS
Input by: LFS
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Verified by: JK

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Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559747 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167935 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.30 SILT; Light brown. Soft. Moist. Low plasticity.	
0.5						0.80 SAND with minor silt; Light brown. Loose to medium dense. Moist. Sand fine grained.	
1.0						1.00 SILT with minor sand; Grey with brown mottling. Stiff. Moist. Low plasticity. Sand fine to medium grained.	
1.5						1.70 1.80 SILT with some peat inclusions; Light blue grey. Wet. Low plasticity.	
						SAND; Blue. Loose to medium dense. Wet. Fine grained.	
2.0						2.00 SAND; Brown. Loose to medium dense. Wet. Fine grained.	
2.5		▼				2.80	
						End of Test Pit at 2.8m (GW Reached)	
3.0							
3.5							
4.0							
4.5							
5.0							

Remarks:

Tree branch @ 1.8m
Groundwater seepage @ 1.7m
Tree root @ 2.5m
Groundwater table reached at 2.8m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559684 m	Date Started: 9/9/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167528 m	Date Completed: 9/9/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.40 SAND; Dark grey. Loose to medium dense. Moist. Sand fine grained.	
1.0						1.00 Silt with some peat inclusions. Light blue grey. Soft. Wet. Low plasticity.	
1.5						1.50 SAND; Brown. Loose to medium dense. Moist. Sand medium grained.	
						1.70 SAND; Grey. Loose to medium dense. Wet. Sand medium grained.	
2.0						2.00 Silty SAND; Grey. Loose to medium dense. Wet. Sand medium grained.	
2.5						2.70 Silty SAND with tree roots; Light blue grey. Medium dense. Wet. Sand fine grained.	
3.0							
3.5							
4.0						4.00 End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

Tree roots @ 1.0m
Tree roots @ 3.0m
No groundwater encountered

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Location: **SEE PLAN**
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TP24

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559762 m	Date Started: 9/9/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167712 m	Date Completed: 9/9/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.5m: 104/18kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m^2	TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.20)	
1.0				Shear vane at 1m: 44/27kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	Sandy SILT; Grey with orange brown mottling. Stiff. Moist. Low plasticity. Sand fine grained.	
1.5				Shear vane at 1.5m: 30/27kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2		
2.0						(2.00) Sandy SILT with tree roots; Dark blue grey. Stiff. Saturated. Low plasticity. Sand fine grained.	
2.5							
3.0						(3.10) SAND; Brown. Loose to medium dense. Saturated. Sand medium grained.	
3.5		▼				(3.80) End of Test Pit at 3.8m (GW Reached)	
4.0							
4.5							
5.0							

Remarks:

Groundwater encountered @ 3.8m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

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TP25

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559840 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167896 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL with some rootlets and minor silt; Dark brown. Moist. Low plasticity.	
						0.30 SILT; Light brown. Firm. Moist. Low plasticity.	
0.5						0.80 SAND with minor silt; Light brown. Loose to medium dense. Moist. Fine grained.	
1.0							
1.5						1.50 SAND with some silt; Grey with orange brown mottling. Loose to medium dense. Wet. Fine grained.	
2.0						2.00 SILT; Light blue grey. Soft. Wet. Low plasticity.	
2.5		▼				2.50 SAND; Reddish brown. Loose. Wet. Sand medium grained.	
						2.80 End of Test Pit at 2.8m (GW Reached)	
3.0							
3.5							
4.0							
4.5							
5.0							

Remarks:

Groundwater seepage @ 2.2

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

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Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP48

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559333 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167682 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.3m: 37/22kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity. (0.30) Silty SAND; Light yellow brown with orange brown mottling. Loose. Wet. Sand fine to medium grained. (0.70) SAND with traces of gravel; Orange brown. Medium dense. Moist. Sand fine to coarse grained. Gravel fine grained. (1.10) SAND with minor tree matter; Light orange brown with blue mottling. Dense. Moist. Sand fine to medium grained. (2.40)	
2.5				Shear vane at 2.4m: 37/22kPa /kPa /kPa	Pocket Penetrometer at 2.4m: kN/m^2	Clayey SILT with some dark brown fibrous peat inclusions; Light blue grey. Firm. Wet. High plasticity. (3.70) End of Test Pit at 3.7m (Pit Collapse)	

Remarks:

Groundwater seepage @ 2.4m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP49

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559271 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167797 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
0.5							
1.0						1.00 SAND; Light yellow brown. Medium dense. Moist. Sand fine to medium grained.	
				Shear vane at 1.3m: 118/44kPa /kPa /kPa	Pocket Penetrometer at 1.3m: kN/m^2	1.30 SILT; Light grey. Stiff. Moist. Low plasticity.	
1.5							
2.0						1.80 SAND; Light grey. Medium dense. Moist. Sand fine to medium grained.	
2.5							
3.0						2.80 Clayey SILT; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.5							
4.0						3.70 End of Test Pit at 3.7m (Pit Collapse)	
4.5							
5.0							

Remarks:

No groundwater encountered

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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Location: **SEE PLAN**
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TP50

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 30t Excavator	Easting: 1559060 m	Date Started: 9/6/2011	Logged by: LFS
Test Pit Dimensions:	Northing: 5167900 m	Date Completed: 9/6/2011	Input by: LFS
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL silt with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
						0.30 Sandy SILT; Brown. Stiff. Moist. Low plasticity. Sand fine grained.	
0.5				Shear vane at 0.5m: 102/40kPa /kPa /kPa	Pocket Penetrometer at 0.5m: kN/m^2		
1.0				Shear vane at 1m: 121/27kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	1.20 SILT with minor sand; Brown. Firm. Moist. Low plasticity. Sand fine grained.	
1.5				Shear vane at 1.5m: 52/28kPa /kPa /kPa	Pocket Penetrometer at 1.5m: kN/m^2		
2.0						2.00 SAND; Grey with brown mottling. Loose to medium dense. Wet. Fine to medium grained.	
2.5							
3.0				Shear vane at 3m: 75/37kPa /kPa /kPa	Pocket Penetrometer at 3m: kN/m^2	3.00 SILT with minor sand and trace clay and rootlets; Grey with brown mottling. Stiff. Wet. Low plasticity. Sand fine to medium grained.	
3.5				Shear vane at 3.5m: 80/33kPa /kPa /kPa	Pocket Penetrometer at 3.5m: kN/m^2		
4.0						4.00 End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

Groundwater seepage @ 2.1m

Logged by: LFS
Input by: LFS
Checked by: JSM
Verified by: JK

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Location: **SEE PLAN**
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TP51

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES N/A**		
Excavator Type: 12t Excavator	Easting: N/A	Date Started: 9/19/2011	Logged by: JSM
Test Pit Dimensions:	Northing: N/A	Date Completed: 9/19/2011	Input by: JSM
Contractor: Fulton Hogan	Ground Level: N/A		Checked by: JK
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT; Dark brown. Stiff. Moist. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with orange brown mottling. Loose to medium dense. Moist. Sand fine to medium grained.	
0.5						0.55 Sandy SILT; Light yellow brown with orange brown mottling. Stiff. Moist to wet. Low plasticity. Sand fine to medium grained.	
						0.90 Silty SAND; Light yellow brown with orange brown mottling. Loose to medium dense. Wet. Sand fine to medium grained.	
1.0						1.40	
		▼				1.50 SILT; Dark yellow brown with orange brown and grey mottling. Stiff. Moist. Low plasticity.	
1.5						Silty SAND; Dark orange brown. Loose to medium dense. Wet to saturated. Sand fine to medium grained.	
2.0						2.40	
						Sandy SILT; Dark blue grey. Stiff. Moist. Sand fine to medium grained.	
2.5						3.00	
3.0						End of Test Pit at 3m (Maximum Reach)	
3.5							
4.0							
4.5							
5.0							

Remarks:

Groundwater seepage @ 1.5m

Logged by: JSM
Input by: JSM
Checked by: JK
Verified by: JK

Sheet **1** of **1**

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TP52

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559355 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167756 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30	
0.5				Shear vane at 0.3m: 59/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	SILT; Light yellow with some orange brown mottling. Firm. Moist. Low plasticity.	
1.0							
1.5						1.60	
				Shear vane at 1.6m: 74/37kPa /kPa /kPa	Pocket Penetrometer at 1.6m: kN/m^2	SILT; Light grey with some orange brown mottling. Firm. Moist. Low plasticity.	
2.0						2.10	
						SAND with a trace of gravel; Orange brown. Loose to medium dense. Wet. Sand coarse to medium grained. Gravel fine grained.	
						2.40	
2.5						SAND; Grey. Medium dense. Moist to wet. Sand fine to medium grained.	
						2.60	
						SAND; Light blue grey. Dense. Wet. Sand fine to medium grained.	
						2.90	
3.0				Shear vane at 2.9m: 44/30kPa /kPa /kPa	Pocket Penetrometer at 2.9m: kN/m^2	Clayey SILT with some tree matter/roots; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.5						3.80	
						End of Test Pit at 3.8m (Pit Collapse)	
4.0							
4.5							
5.0							

Remarks:

Groundwater seepage @ 2.1m
Groundwater seepage @ 2.9m

Logged by: MHD
Input by: MHD
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TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559085 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167947 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
0.30						Silty SAND; Light yellow brown. Loose. Wet. Sand fine to medium grained	
1.50						SILT; Light yellow brown. Firm. Wet. Low plasticity.	
3.00						Clayey SILT with some tree matter/roots; Light blue grey. Firm to stiff. Wet. High plasticity.	
4.00						End of Test Pit at 4m (GW Reached)	

Remarks:

Groundwater reached @ 3.9m

Logged by: MHD
Input by: MHD
Checked by: JSM
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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559004 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167925 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Sandy SILT; Light yellow brown with orange brown mottling. Soft. Moist. Low plasticity. Sand fine to medium grained.	
1.60						SILT; Light yellow brown with orange brown mottling. Soft. Moist. Low plasticity.	
2.30						Clayey SILT; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.20						SAND; Light blue grey. Dense. Wet. Sand is fine grained.	
5.00						End of Test Pit at 5m (Pit Collapse)	

Remarks:

Groundwater seepage @ 2.3m
Tree trunk @ 2.6m

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Input by: MHD
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TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1558962 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167965 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Sandy SILT. Light yellow brown. Firm. Moist to wet. Low plasticity. Sand fine to medium grained.	
2.80						Clayey SILT; Light blue grey. Firm to stiff. Wet. High Plasticity.	
3.70						Silty SAND; Light blue grey. Dense. Wet. Sand fine grained.	
4.50		▼				End of Test Pit at 4.5m (GW Reached)	

Remarks:

Groundwater seepage @ 2.8m
Groundwater reached @ 4.5m

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TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559066 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5168041 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 SILT; Light yellow brown with orange brown mottling. Firm. Moist to wet. Low plasticity.	
3.20						Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.60						Sitly SAND; Light blue grey. Dense. Wet. Sand fine grained.	
4.50						End of Test Pit at 4.5m (Pit Collapse)	

Remarks:

Groundwater seepage @ 2.6m

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559038 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5168131 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
1.0						0.30 Sandy SILT, Light yellow grey. Firm. Moist to wet. Low plasticity. Sand fine to medium grained.	
1.5						1.20 Silty sandy GRAVEL; Light yellow brown. Medium dense to dense. Wet. Gravel fine to coarse grained. Sub rounded. Sand fine to coarse grained.	
2.0							
2.5							
3.0						3.20 End of Test Pit at 3.2m (Pit Collapse)	
3.5							
4.0							
4.5							
5.0							

Remarks:

No groundwater encountered

Logged by: MHD
Input by: MHD
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TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559187 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5168095 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist to wet. Sand fine to medium grained.	
1.0						0.60 SAND; Light yellow brown with some orange brown mottling. Loose. Moist to wet. Sand fine to medium grained.	
1.5							
2.0							
2.5						2.70 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.0						3.20 Silty SAND; Light blue grey. Dense. Wet. Sand fine grained.	
3.5							
4.0						4.00 End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

Gorundwater seepage @ 2.7m
Tree branches / trunk @ 2.7m

Logged by: MHD
Input by: MHD
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TP59

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559166 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5168014 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.5						2.70 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.0						3.30 Silty SAND; Light blue grey. Dense. Wet. Sand fine to medium grained.	
4.5						4.50 End of Test Pit at 4.5m (Pit Collapse)	

Remarks:

Groundwater seepage @ 2.7m

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Input by: MHD
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Verified by: JK

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TP60

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559133 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167951 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.30						SAND; Orange brown. medium dense. Wet. Sand is fine to coarse grained.	
2.80						Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.60						Silty SAND; Light blue grey. Dense. Wet. Sand fine to medium grained.	
4.50						End of Test Pit at 4.5m (Pit Collapse)	

Remarks:

Tree branches @ 3.6m
No groundwater encountered

Logged by: MHD
Input by: MHD
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TP61

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559266 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167998 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.80						Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.60		▼				Silty sandy GRAVEL; Light yellow brown. Medium dense to dense. Wet. Gravel fine to coarse grained. Sub rounded. Sand fine to coarse grained.	
3.80						End of Test Pit at 3.8m (GW Reached)	

Remarks:

Groundwater seepage @ 2.8m
Groundwater encountered @ 3.8m

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559395 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167934 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.5						2.60 Clayey SILT with some tree matter; Light blue grey. Soft. Wet. High plasticity.	
3.0						3.00 Silty SAND; Light blue grey. Dense. Wet. Sand fine to medium grained.	
3.5		▼				3.60 End of Test Pit at 3.6m (GW Reached)	
4.0							
4.5							
5.0							

Remarks:

Groundwater encountered @ 3.6m

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Input by: MHD
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TP63

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559402 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5168010 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.80						Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.60		▼				Silty Sandy GRAVEL; Light brown. Dense. Saturated. Gravel fine to coarse grained. Sub rounded. Sand fine to coarse grained.	
3.80						End of Test Pit at 3.8m (GW Reached)	

Remarks:

Groundwater seepage @ 2.8m
Groundwater encountered @ 3.8m

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Input by: MHD
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TP64

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559395 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5168079 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
1.0						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.5							
2.0							
2.5						2.20 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.0						2.90 Silty SAND with minor tree matter; Light blue grey. Dense. Wet. Sand fine to medium grained.	
3.5		▼				3.30 Silty Sandy GRAVEL; Light brown. Dense. Saturated. Gravel fine to coarse grained. Sub rounded. Sand fine to coarse grained.	
4.0						3.60 End of Test Pit at 3.6m (GW Reached)	
4.5							
5.0							

Remarks:

Groundwater encountered @ 3.6m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Location: **SEE PLAN**
Project Reference: **224464**

TP65

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559600 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167990 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
1.0						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.5							
2.0						2.20 Clayey SILT with some tree matter; Light blue grey. Firm to Stiff. Wet. High plasticity.	
2.5				Shear vane at 2.2m: 60/30kPa /kPa /kPa	Pocket Penetrometer at 2.2m: kN/m²	2.70 Silty SAND with minor tree matter; Light blue grey. Dense. Wet. Sand fine to medium grained.	
3.0						3.40 Silty Sandy GRAVEL; Light brown. Dense. Saturated. Gravel fine to coarse grained. Sub rounded. Sand fine to coarse grained.	
3.5		▼				3.60 End of Test Pit at 3.6m (GW Reached)	
4.0							
4.5							
5.0							

Remarks:

Groundwater seepage @ 1.7m
Groundwater encountered @ 3.6m

Logged by: MHD
Input by: MHD
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TP66

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559491 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167958 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
1.0						0.40 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.5							
2.0							
2.5				Shear vane at 2.3m: 60/30kPa /kPa /kPa	Pocket Penetrometer at 2.3m: kN/m²	2.30 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.0						3.20 Silty Sandy GRAVEL; Light brown. Dense. Saturated. Gravel fine to coarse grained. Sub rounded. Sand fine to coarse grained.	
3.5		▼				3.50 End of Test Pit at 3.5m (GW Reached)	
4.0							
4.5							
5.0							

Remarks:

Tree branches @ 3.0m
Groundwater encountered @ 3.5m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559454 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167843 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
1.0						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.5							
2.0						2.20 SILT with minor sand; Light yellow brown with orange brown mottling. Firm. Wet. Low plasticity. Sand fine to medium grained	
2.5						2.60 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.0							
3.5						3.30 Silty SAND with minor tree matter; Light blue grey. Dense. Wet. Sand fine to medium grained.	
4.0						4.20 End of Test Pit at 4.2m (Pit Collapse)	
4.5							
5.0							

Remarks:

No groundwater encountered

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559412 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167697 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Wet. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Saturated. Sand fine to medium grained.	
2.80						Clayey SILT with some fibrous dark brown peat; Light blue grey. Firm to stiff. Saturated. High plasticity.	
4.50						End of Test Pit at 4.5m (Pit Collapse)	

Remarks:

Groundwater seepage @ 0.6m

Logged by: MHD
Input by: MHD
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Verified by: JK

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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559467 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167685 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity.	
1.0						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Saturated. Sand fine to medium grained.	
1.5							
2.0						1.80 SAND with trace of silt; Light blue grey. Dense. Saturated. Sand fine to medium grained.	
2.5							
3.0		▼					
3.5						3.30 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Saturated. High plasticity.	
4.0							
4.5						4.50 End of Test Pit at 4.5m (GW Reached)	
5.0							

Remarks:

Groundwater encountered @ 3.3m

Logged by: MHD
Input by: MHD
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TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559470 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167777 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Saturated. Sand fine to medium grained.	
2.10						Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Saturated. High plasticity.	
2.60						Silty SAND with some tree matter; Light blue grey. Dense. Saturated. Sand fine to medium grained.	
3.80		▼				End of Test Pit at 3.8m (GW Reached)	

Remarks:

Groundwater seepage @ 2.1m
Groundwater encountered @ 3.8m

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Input by: MHD
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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559516 m	Date Started: 10/19/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167759 m	Date Completed: 10/19/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity.	
						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.80						SAND with trace of silt; Light blue grey. Medium dense. Moist to wet. Sand fine to medium grained.	
2.00						Clayey SILT with some fibrous dark brown peat; Light blue grey. Firm to stiff. Wet. High plasticity.	
2.50						Silty SAND with some tree matter; Light blue grey. Dense. Wet. Sand fine to medium grained.	
4.00						End of Test Pit at 4m (Pit Collapse)	

Remarks:

Groundwater seepage @ 2.0

Logged by: MHD
Input by: MHD
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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559471 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167648 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity.	
1.0						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.5						1.20 SAND with a trace of gravel; Orange brown with grey mottling. Medium dense. Wet. Sand fine to medium grained. Gravel fine grained.	
2.0				Shear vane at 1.8m: 33/18kPa /kPa /kPa	Pocket Penetrometer at 1.8m: kN/m^2	1.80 Clayey Sandy SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity. Sand fine to medium grained.	
2.5							
3.0							
3.5							
4.0						4.00 End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

Groundwater seepage @ 0.6m
Groundwater seepage @ 1.8m

Logged by: MHD
Input by: MHD
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Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559580 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167562 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.3m: 74/33kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist to wet. Low plasticity.	
						0.30 SILT; Light grey with orange brown mottling. Stiff. Moist to wet. Low plasticity.	
1.0							
1.5							
2.0				Shear vane at 2m: 53/30kPa /kPa /kPa	Pocket Penetrometer at 2m: kN/m^2	2.00 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
2.5							
3.0							
3.5							
4.0		▼				4.20 End of Test Pit at 4.2m (GW Reached)	
4.5							
5.0							

Remarks:

Groundwater seepage @ 1.3m
Groundwater encountered @ 4.2m

Logged by: MHD
Input by: MHD
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TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559572 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167617 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity.	
1.0						0.30 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.5						1.50 SAND with a trace of gravel; Orange brown with grey mottling. Medium dense. Wet. Sand fine to medium grained. Gravel fine grained.	
2.0						1.80 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.5				Shear vane at 2.3m: 44/30kPa /kPa /kPa	Pocket Penetrometer at 2.3m: kN/m²	2.30 Clayey Sandy SILT with some tree matter; Light blue grey. Firm. Wet. High plasticity. Sand fine to medium grained.	
3.0						3.40 End of Test Pit at 3.4m (Pit Collapse)	
3.5							
4.0							
4.5							
5.0							

Remarks:

Groundwater seepage @ 1.5m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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TP75

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559641 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167721 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Saturated. Low plasticity.	
						0.30 SILT; Light yellow brown with orange brown mottling. Firm to stiff. Moist to wet. Low plasticity.	
1.50						Silty SAND; Light grey with some orange brown mottling. Firm. Moist. Sand fine to medium grained.	
2.20						Clayey Sandy SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity. Sand fine to medium grained.	
3.20						SAND with some tree roots and branches; Light blue grey. Dense. Wet. Sand fine to medium grained.	
4.00						End of Test Pit at 4m (Pit Collapse)	

Remarks:

No groundwater encountered.

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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TP76

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559716 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167688 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity.	
						0.30	
0.5				Shear vane at 0.3m: 74/37kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	SILT; Greyish white with some orange brown mottling. Stiff to very stiff. Moist. Low plasticity.	
1.0							
1.5							
2.0						2.00	
						SAND with traces of gravel; Orange brown. Medium dense. Moist to wet. Sand fine to coarse grained. Gravel fine grained.	
						2.40	
2.5				Shear vane at 2.4m: 44/33kPa /kPa /kPa	Pocket Penetrometer at 2.4m: kN/m^2	Clayey Sandy SILT with some tree matter; Light blue grey. Firm to stiff. Saturated. High plasticity. Sand fine to medium grained.	
3.0						3.00	
						SAND with some tree roots and branches; Light blue grey. Dense. Saturated. Sand fine to medium grained.	
3.5							
4.0						4.00	
						End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

Groundwater seepage @ 2.0m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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TP77

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559646 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167588 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.3m: 44/33kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m²	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity. (0.30) Sandy SILT; Light yellow brown with orange brown mottling. Firm. Moist. Friable. Low plasticity. Sand fine to medium grained. (1.30) SAND with a trace of gravel; Orange brown with grey mottling. Medium dense. Wet. Sand fine to medium grained. Gravel fine grained. (1.70) Sandy SILT; Light yellow brown with orange brown mottling. Firm. Moist to wet. Low plasticity. Sand fine to medium grained. (2.10) SAND with some tree roots and branches; Light blue grey. Dense. Wet. Sand fine to medium grained. (3.00) Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. Cohesive. High plasticity. (4.00) End of Test Pit at 4m (Pit Collapse)	
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

Remarks:

Groundwater seepage @ 1.3m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN RESIDENTIAL SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

TP78

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559697 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167558 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.3m: 98/33kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m²	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity. (0.30) SILT with trace of gravel; Greyish white with some orange brown mottling. Stiff to very stiff. Moist. Low plasticity. Gravel fine grained	
1.0						(1.10) SAND with a trace of gravel; Orange brown with grey mottling. Medium dense. Wet. Sand fine to medium grained. Gravel fine grained. (1.30)	
1.5						SAND; Light brown grey. Dense. Wet. Sand fine to medium grained. (1.70)	
2.0						SAND with some tree roots and branches; Light blue grey. Dense. Wet. Sand fine to medium grained. (2.40)	
2.5						Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.0							
3.5							
4.0						(4.00) End of Test Pit at 4m (Pit Collapse)	
4.5							
5.0							

Remarks:

Groundwater seepage @ 1.1m
Groundwater seepage @ 2.4m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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TP79

Sheet **1** of **1**

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559753 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167717 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0				Shear vane at 0.3m: 163/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity.	
						0.30 SILT; Light yellow with some orange brown mottling. Very stiff. Moist. Low plasticity.	
1.0						1.20 Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
2.0						2.00 SAND with some tree roots and branches; Light blue grey. Dense. Wet. Sand fine to medium grained.	
3.0		▼				2.70 Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
4.0						3.50 End of Test Pit at 3.5m (GW Reached)	
5.0							

Remarks:

Groundwater seepage @ 2.7m
Groundwater encountered @ 3.5m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

Sheet **1** of **1**

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Location: **SEE PLAN**
Project Reference: **224464**

TP80

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559645 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167785 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5				Shear vane at 0.3m: 100/44kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity. 0.30	
1.0						SILT; Light yellow with some orange brown mottling. Very stiff. Moist. Low plasticity. 1.20	
1.5						Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained. 2.00	
2.0						SAND with some tree roots and branches; Light blue grey. Dense. Wet. Sand fine to medium grained. 2.90	
2.5						Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity. 3.60	
3.0						End of Test Pit at 3.6m (GW Reached)	
3.5		▼					
4.0							
4.5							
5.0							

Remarks:

Groundwater encountered at 3.6m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

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TP81

TEST PIT INFORMATION	**CO-ORDINATES NZTM**		
Excavator Type: 25t Excavator	Easting: 1559316 m	Date Started: 10/20/2011	Logged by: MHD
Test Pit Dimensions:	Northing: 5167821 m	Date Completed: 10/20/2011	Input by: MHD
Contractor: Texco	Ground Level: N/A		Checked by: JSM
			Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.0						TOPSOIL SILT with some rootlets; Dark Brown. Soft. Moist. Low plasticity.	
						0.30	
0.5				Shear vane at 0.3m: 44/30kPa /kPa /kPa	Pocket Penetrometer at 0.3m: kN/m^2	Silty SAND; Light yellow brown with some orange brown mottling. Loose. Moist. Sand fine to medium grained.	
1.0				Shear vane at 1m: 89/30kPa /kPa /kPa	Pocket Penetrometer at 1m: kN/m^2	1.00 SILT; Light yellow brown with orange brown mottling. Stiff. Moist to wet. Low plasticity.	
1.5							
2.0						2.00 SAND; Grey. Medium dense. Wet. Sand fine to medium grained.	
2.5						2.70	
3.0				Shear vane at 2.7m: 41/18kPa /kPa /kPa	Pocket Penetrometer at 2.7m: kN/m^2	Clayey SILT with some tree matter; Light blue grey. Firm to stiff. Wet. High plasticity.	
3.5							
4.0						4.10	
4.5						End of Test Pit at 4.1m (Pit Collapse)	
5.0							

Remarks:

Groundwater seepage @ 2.0m
Groundwater seepage @ 3.3m

Logged by: MHD
Input by: MHD
Checked by: JSM
Verified by: JK

Appendix E
Borehole Logs

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Location: **SEE PLAN**
Project Reference: **224464**

BH01

BOREHOLE INFORMATION
Drilling Method: CAT 312 Track Rig
Diameter Core: 100mm
Contractor: McMillan Drilling

CO-ORDINATES N/A
Easting: N/A
Northing: N/A
Ground Level: N/A

Date Started: 19/09/2011
Date Completed: 19/09/2011
Inclination: 90
Orientation:

Logged by: JSM
Input by: JSM
Checked by: JSM
Verified by: JK

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
WASH			▼		0		TOPSOIL SILT with trace sand and occaisional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.30)	OL									
					1		SILT with minor sand; Yellow brown. Low plasticity. Firm. Moist. Sand fine to medium grained. (1.10)	ML									
					1		Silty SAND; Yellow brown with orange brown mottles. Loose. Moist to wet. Sand fine to medium grained. (1.80)	SM									
					2		Silty SAND; Dark blue grey. Loose. Moist to wet. Sand fine to medium grained. (3.00)	SM			D						
					3		SILT with some sand; Dark blue grey. Low plasticity. Stiff. Moist. (4.50)	ML				SPT at 3m N = 5 1, 1/1, 1, 1, 2 450mm (SC)					
					4		Borehole Terminated at 4.5m (Target Depth)						NO LABORATORY TESTING				
					5												
					6												
					7												
					8												
					9												

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
GW Well Graded GRAVEL
MH Inorganic SILT high plasticity
ML Inorganic SILT low plasticity
OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
▽ at end of excavation
▽ at time of excavation
▽ at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weight

Moisture
D dry
M moist
W wet
S saturated

Graphic Log
Topsoil
SILT
Silty SAND

Backfill
Cement Seal: 1 pipe group, 1 pipe
Bentonite Seal: 1 pipe group, 1 pipe
Slough Backfill: 1 pipe group, 1 pipe
Filter Pack: 1 pipe group, 1 pipe
Slotted Pipe: 1 pipe group, 1 pipe

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Location: **SEE PLAN**
Project Reference: **224464**

BH02

BOREHOLE INFORMATION	CO-ORDINATES N/A		
Drilling Method: CAT 312 Track Rig	Easting: N/A	Date Started: 16/09/2011	Logged by: JSM
Diameter Core: 100mm	Northing: N/A	Date Completed: 19/09/2011	Input by: JSM
Contractor: McMillan Drilling	Ground Level: N/A	Inclination: 90	Checked by: JSM
		Orientation:	Verified by: JK

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
WASH			▼		0 1 2 3 4 5 6 7 8 9		TOPSOIL SILT with trace sand and occaisional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.40) SAND; Grey brown with orange brown mottles. Loose. Moist. Sand fine grained. (1.00) SILT; Dark blue grey. Low plasticity. Stiff. Moist. (3.20) Sandy GRAVEL: Dark grey with orange brown mottling. Dense. Wet to saturated. Gravel fine to coarse grained and rounded. Sand fine to medium grained.	OL SP ML GW			B	SPT at 3m N = 35 6, 9/9, 9, 9, 8 450mm (SC)	NO LABORATORY TESTING			

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
GW Well Graded GRAVEL
MH Inorganic SILT high plasticity
ML Inorganic SILT low plasticity
OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
▼ at end of excavation
▼ at time of excavation
▼ at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weigh

Moisture
D dry
M moist
W wet
S saturated

Graphic Log
Topsoil
SAND
SILT
Sandy GRAVEL

Backfill
Cement Seal: 1 pipe group, 1 pipe
Bentonite Seal: 1 pipe group, 1 pipe
Slough Backfill: 1 pipe group, 1 pipe
Slotted Pipe: 1 pipe group, 1 pipe

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Location: **SEE PLAN**
Project Reference: **224464**

BH02

BOREHOLE INFORMATION	CO-ORDINATES N/A		
Drilling Method: CAT 312 Track Rig	Easting: N/A	Date Started: 16/09/2011	Logged by: JSM
Diameter Core: 100mm	Northing: N/A	Date Completed: 19/09/2011	Input by: JSM
Contractor: McMillan Drilling	Ground Level: N/A	Inclination: 90	Checked by: JSM
		Orientation:	Verified by: JK

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
WASH					11 12 13 14 15		Sandy GRAVEL: Dark grey with orange brown mottling. Dense. Wet to saturated. Gravel fine to coarse grained and rounded. Sand fine to medium grained. *(Layer Continued from previous page)*	GW				SPT at 10m N = 50 5, 7/12, 14, 13, 11 450mm (SC)	NO LABORATORY TESTING			
					15 16 17 18 19		Borehole Terminated at 15m (Target Depth)									

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
GW Well Graded GRAVEL
MH Inorganic SILT high plasticity
ML Inorganic SILT low plasticity
OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
at end of excavation
at time of excavation
at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weight

Moisture
D dry
M moist
W wet
S saturated

Graphic Log
Topsoil
SAND
SILT
Sandy GRAVEL

Backfill
Cement Seal: 1 pipe group, 1 pipe
Bentonite Seal: 1 pipe group, 1 pipe
Slough Backfill: 1 pipe group, 1 pipe
Slotted Pipe: 1 pipe group, 1 pipe

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Location: **SEE PLAN**
Project Reference: **224464**

BH03

Sheet 1 of 1

BOREHOLE INFORMATION	CO-ORDINATES N/A		
Drilling Method: CAT 312 Track Rig	Easting: N/A	Date Started: 16/09/2011	Logged by: JSM
Diameter Core: 100mm	Northing: N/A	Date Completed: 16/09/2011	Input by: JSM
Contractor: McMillan Drilling	Ground Level: N/A	Inclination: 90	Checked by: JSM
		Orientation:	Verified by: JK

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
WASH			▼		0 1 2 3		TOPSOIL SILT with trace sand and occaisional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.30) Sandy SILT; Yellow brown. Low plasticity. Firm. Moist. (1.00) Sandy SILT; Dark grey. Low plasticity. Firm. Moist. Borehole Terminated at 3m (Target Depth) (3.00)	OL ML ML				SPT at 1.5m N = 7 1, 1/1, 1, 2, 3 450mm (SC)	NO LABORATORY TESTING			

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
GW Well Graded GRAVEL
MH Inorganic SILT high plasticity
ML Inorganic SILT low plasticity
OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
▽ at end of excavation
▽ at time of excavation
▽ at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weight

Moisture
D dry
M moist
W wet
S saturated

Graphic Log
Topsoil
Sandy SILT

Backfill
Cement Seal: 1 pipe group, 1 pipe
Bentonite Seal: 1 pipe group, 1 pipe
Filter Pack: 1 pipe group, 1 pipe
Slotted Pipe: 1 pipe group, 1 pipe

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Project Name: **ROSEMERRYN FARM SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

BH04

BOREHOLE INFORMATION	CO-ORDINATES N/A		
Drilling Method: CAT 312 Track Rig	Easting: N/A	Date Started: 15/09/2011	Logged by: JSM
Diameter Core: 100mm	Northing: N/A	Date Completed: 15/09/2011	Input by: JSM
Contractor: McMillan Drilling	Ground Level: N/A	Inclination: 90	Checked by: JSM
		Orientation:	Verified by: JK

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
WASH			▼		0 1 2 3 4 5 6 7 8 9		TOPSOIL SILT with trace sand and occaisional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. (0.40) SILT with minor sand; Yellow brown. Low plasticity. Firm. Moist. Sand fine to medium grained. (1.40) Silty SAND; Dark blue grey. Loose to medium dense. Moist to wet. Sand fine to medium grained. (4.20) SILT: Dark blue grey. Low plasticity. Firm to stiff, Moist. (6.80) Sandy GRAVEL: Dark grey with orange brown mottling. Dense. Wet to saturated. Gravel fine to coarse grained and rounded. Sand fine to medium grained.	OL ML SM ML GW				SPT at 3m N = 12 2, 2/3, 3, 3, 3 450mm (SC)	NO LABORATORY TESTING			

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
GW Well Graded GRAVEL
MH Inorganic SILT high plasticity
ML Inorganic SILT low plasticity
OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
▼ at end of excavation
▼ at time of excavation
▼ at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weigh

Moisture
D dry
M moist
W wet
S saturated

Graphic Log
Topsoil
SILT
Silty SAND
Sandy GRAVEL

Backfill
Cement Seal: 1 pipe group, 1 pipe
Bentonite Seal: 1 pipe group, 1 pipe
Slough Backfill: 1 pipe group, 1 pipe
Slotted Pipe: 1 pipe group, 1 pipe

Last Generated: 19/10/2011 12:50:53 p.m.

Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY MARCH 2011.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 19/10/2011.

aurecon
Aurecon (New Zealand) Limited
Unit 1, 150 Cavendish Road
PO BOX 1061
Christchurch 8140
New Zealand
Telephone: +64 3 366 0821
www.aurecongroup.com
Facsimile: +64 3 379 6955
Email: christchurch@ap.aurecongroup.com

Client: **FULTON HOGAN LAND DEVELOPMENT**
Project Name: **ROSEMERRYN FARM SUBDIVISION**
Location: **SEE PLAN**
Project Reference: **224464**

BH04

BOREHOLE INFORMATION
Drilling Method: CAT 312 Track Rig
Diameter Core: 100mm
Contractor: McMillan Drilling

CO-ORDINATES N/A
Easting: N/A
Northing: N/A
Ground Level: N/A

Date Started: 15/09/2011
Date Completed: 15/09/2011
Inclination: 90
Orientation:

Logged by: JSM
Input by: JSM
Checked by: JSM
Verified by: JK

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
WASH					11		Sandy GRAVEL: Dark grey with orange brown mottling. Dense. Wet to saturated. Gravel fine to coarse grained and rounded. Sand fine to medium grained. *(Layer Continued from previous page)*	GW				SPT at 10m N = 49 3, 6/10, 15, 9, 15 450mm (SC)				
					12											
					13											
					14											
					15		15.00 Borehole Terminated at 15m (Target Depth)						NO LABORATORY TESTING			
					16											
					17											
					18											
					19											

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
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MH Inorganic SILT high plasticity
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OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
▽ at end of excavation
▽ at time of excavation
▽ at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weight

Moisture
D dry
M moist
W wet
S saturated

Graphic Log
Topsoil
SILT
Silty SAND
Sandy GRAVEL

Backfill
Cement Seal: 1 pipe group, 1 pipe
Bentonite Seal: 1 pipe group, 1 pipe
Slough Backfill: 1 pipe group, 1 pipe
Slotted Pipe: 1 pipe group, 1 pipe

Last Generated: 19/10/2011 12:50:53 p.m.

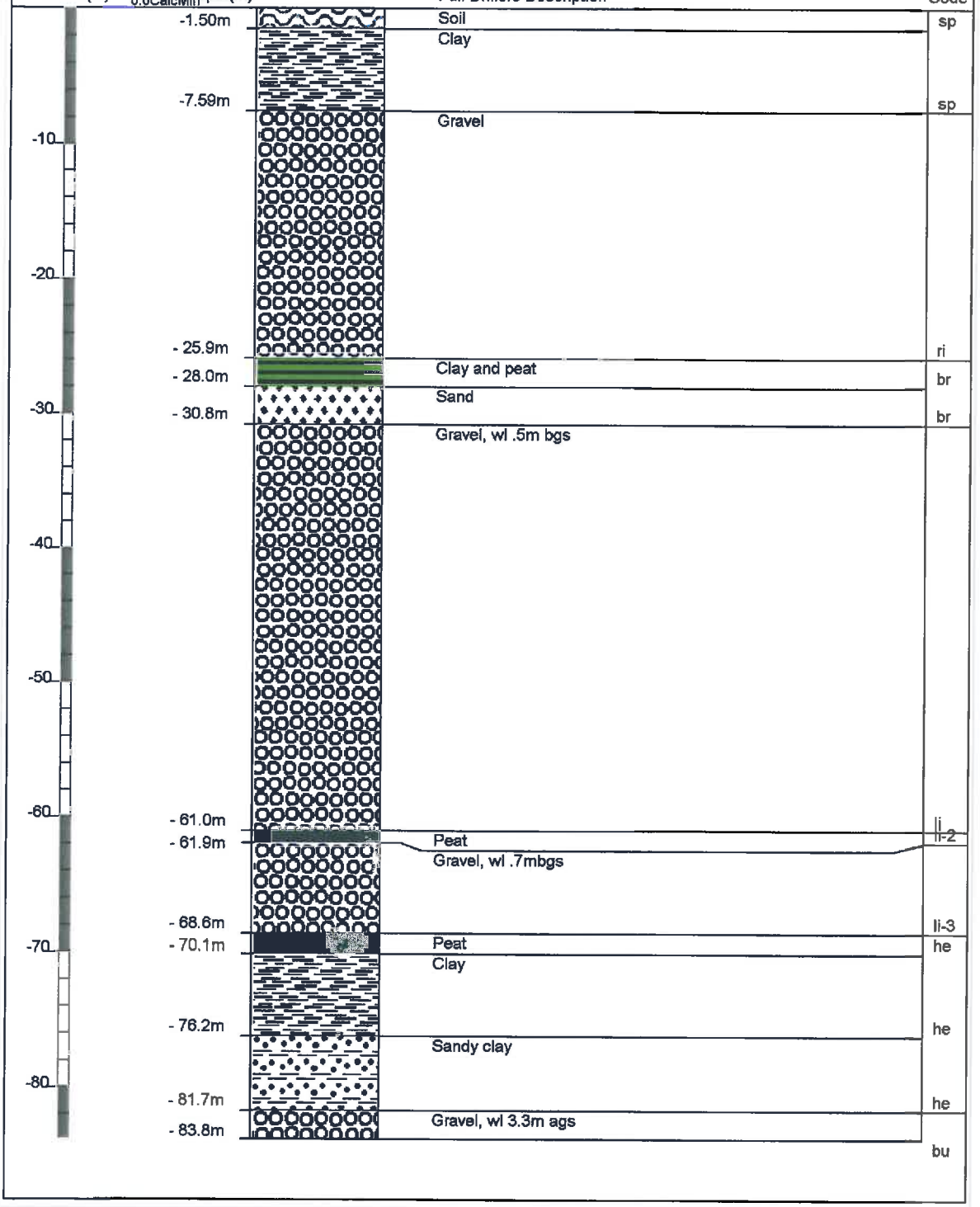
Database File: TEST PITS.GPJ, Library: COPY OF CHCH LIBRARY MARCH 2011.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT, Last Generated: 19/10/2011.

Appendix F
Environment Canterbury Borehole Log

Borelog for well M36/0533

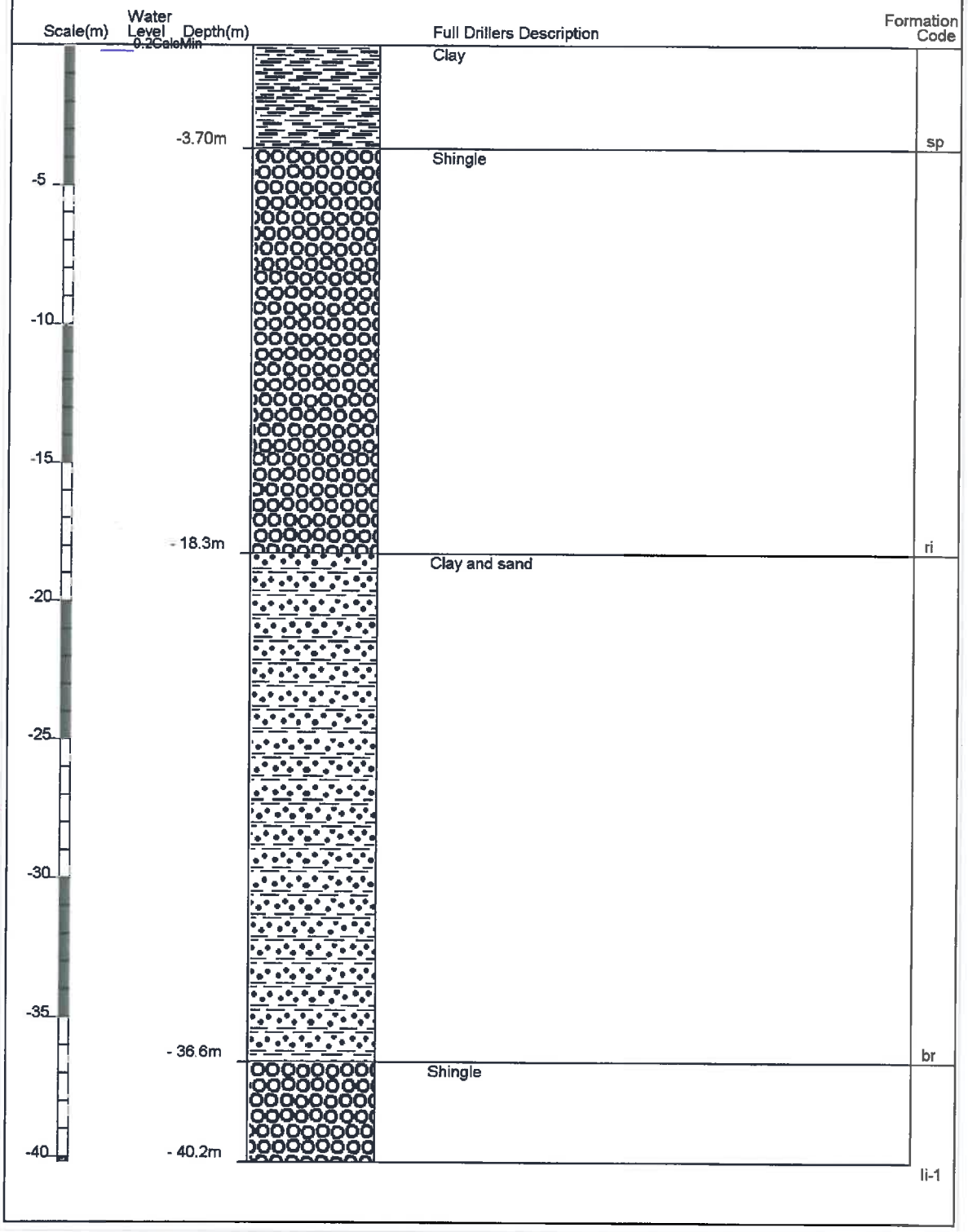
Gridref: M36:688-290 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 10 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -83.8m Drill Date :

Environment Canterbury
Your regional council



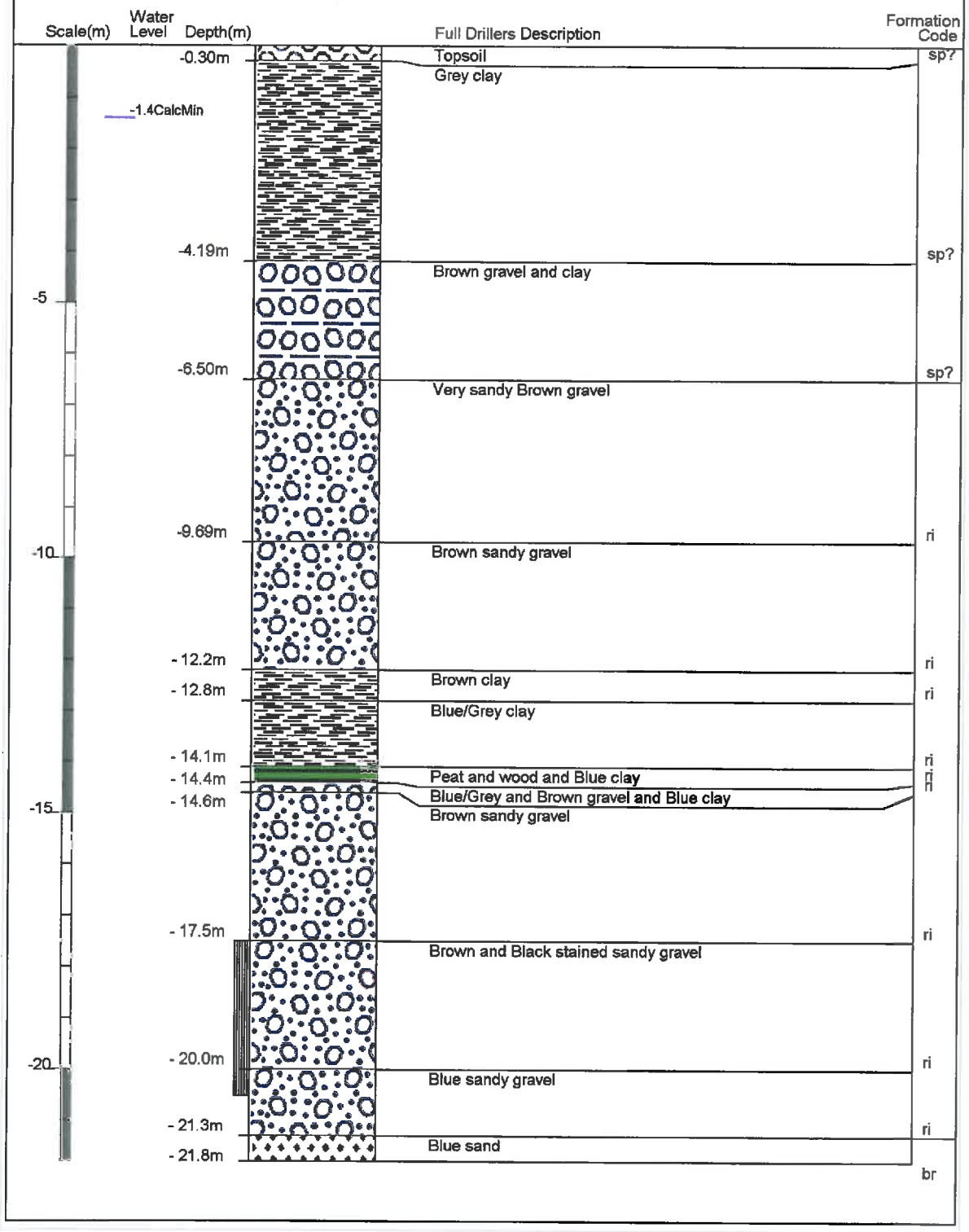
Borelog for well M36/0520

Gridref: M36:690-292 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 7.5 +MSD
Driller : Miller F
Drill Method : Driven Pipe
Drill Depth : -40.2m Drill Date : 1/07/1898



Borelog for well M36/4402

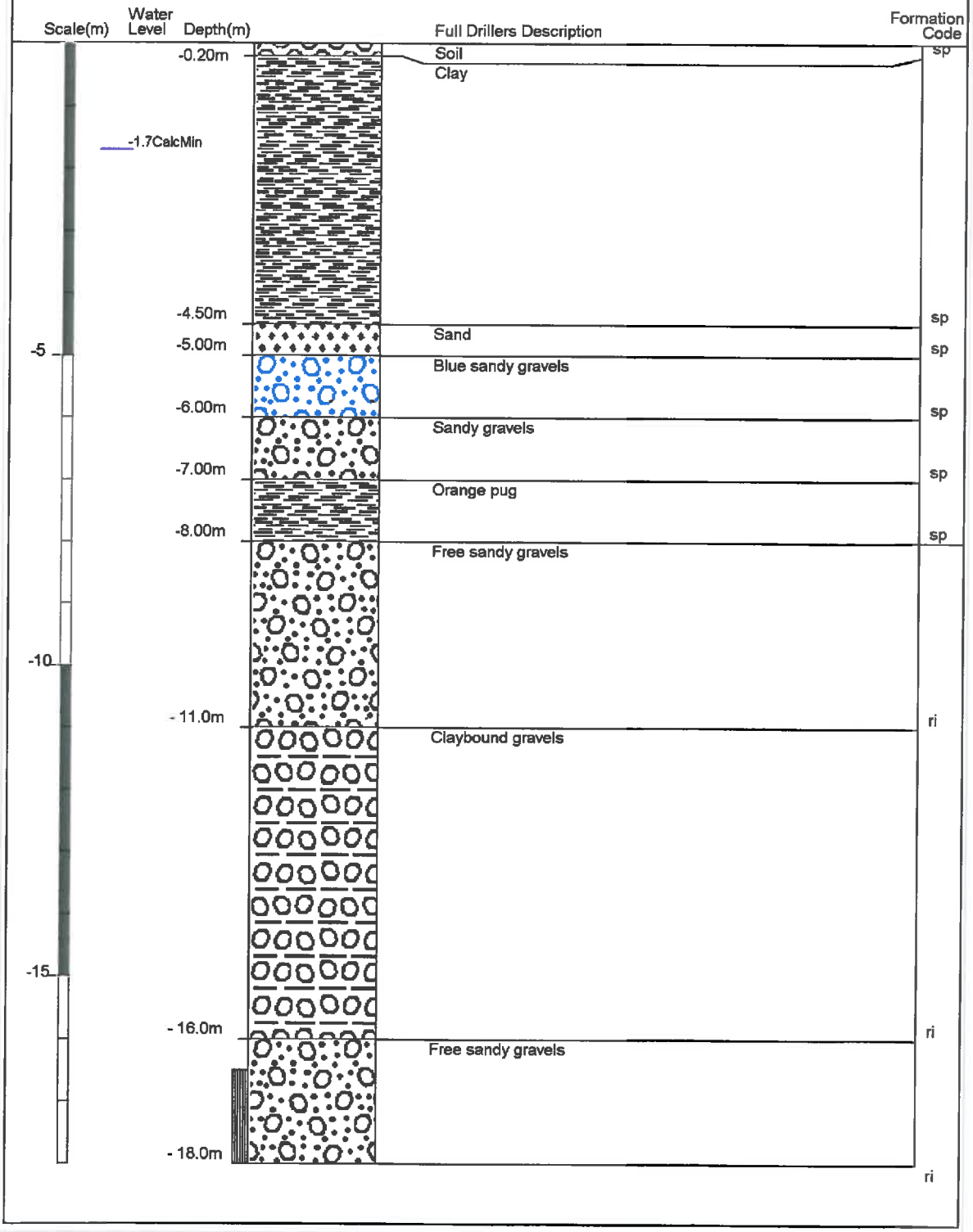
Gridref: M36:693-287 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 8.2 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Cable Tool
Drill Depth : -21.79m Drill Date : 26/09/1991



Borelog for well M36/7299

Gridref: M36:7050-2967 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 8.7 +MSD
Driller : Smiths Welldrilling
Drill Method : Rotary Rig
Drill Depth : -18m Drill Date : 20/11/2002

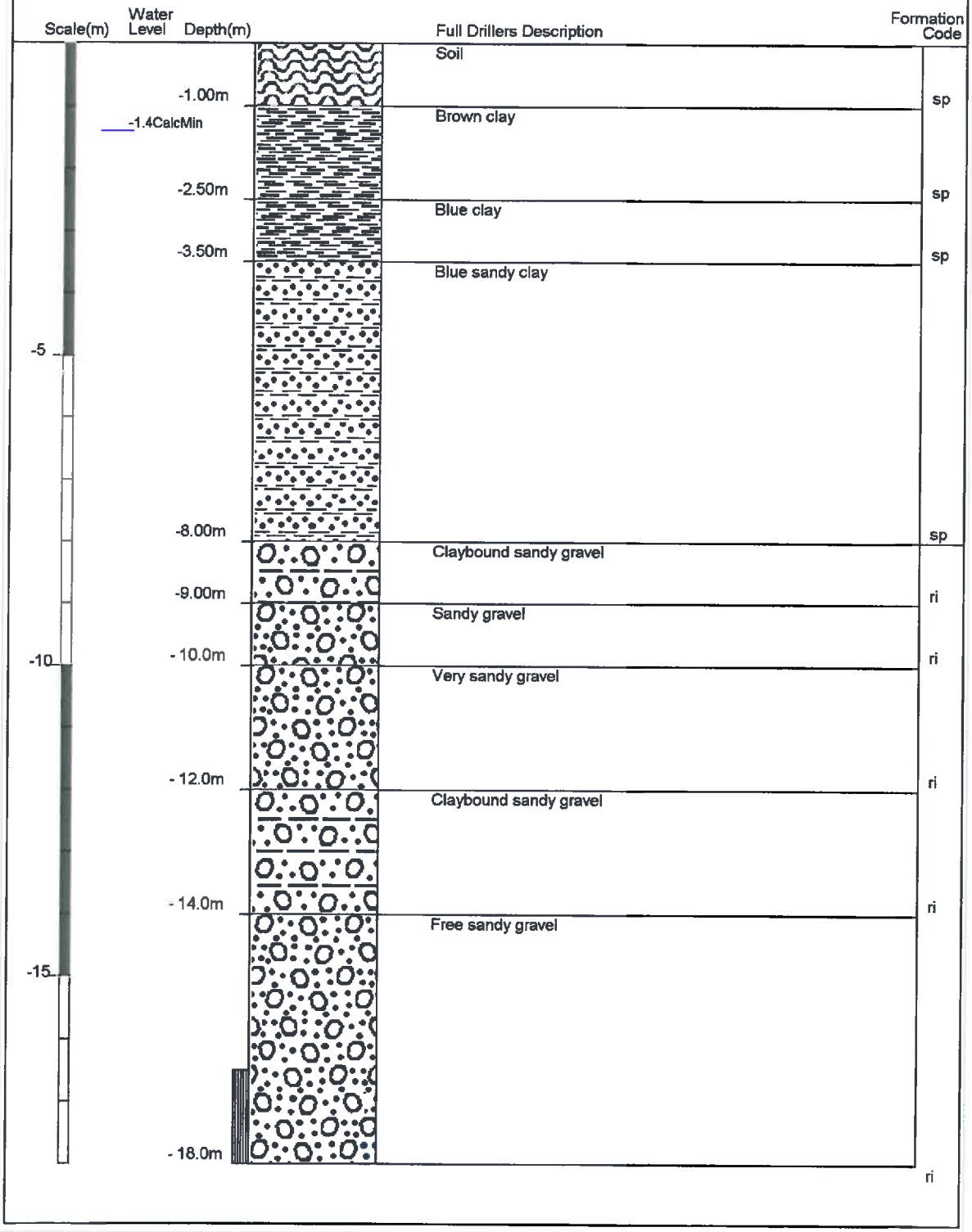
Environment Canterbury



Borelog for well M36/6023

Gridref: M36:70402-29122 Accuracy : 2 (1=best, 4=worst)
Ground Level Altitude : 8 +MSD
Driller : Smiths Welldrilling
Drill Method : Rotary/Percussion
Drill Depth : -18m Drill Date : 27/04/2000

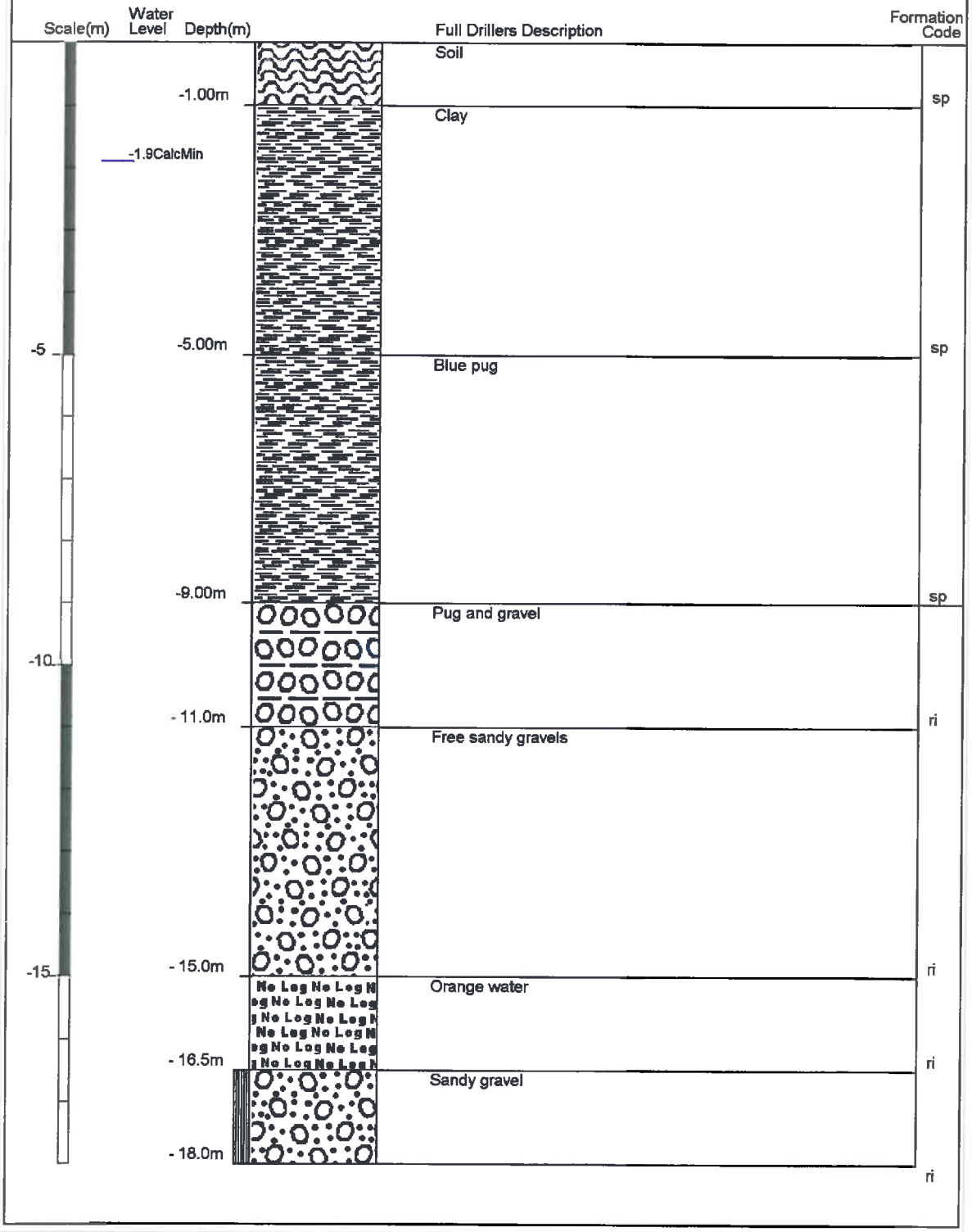
Environment Canterbury
Your regional council



Borelog for well M36/7117

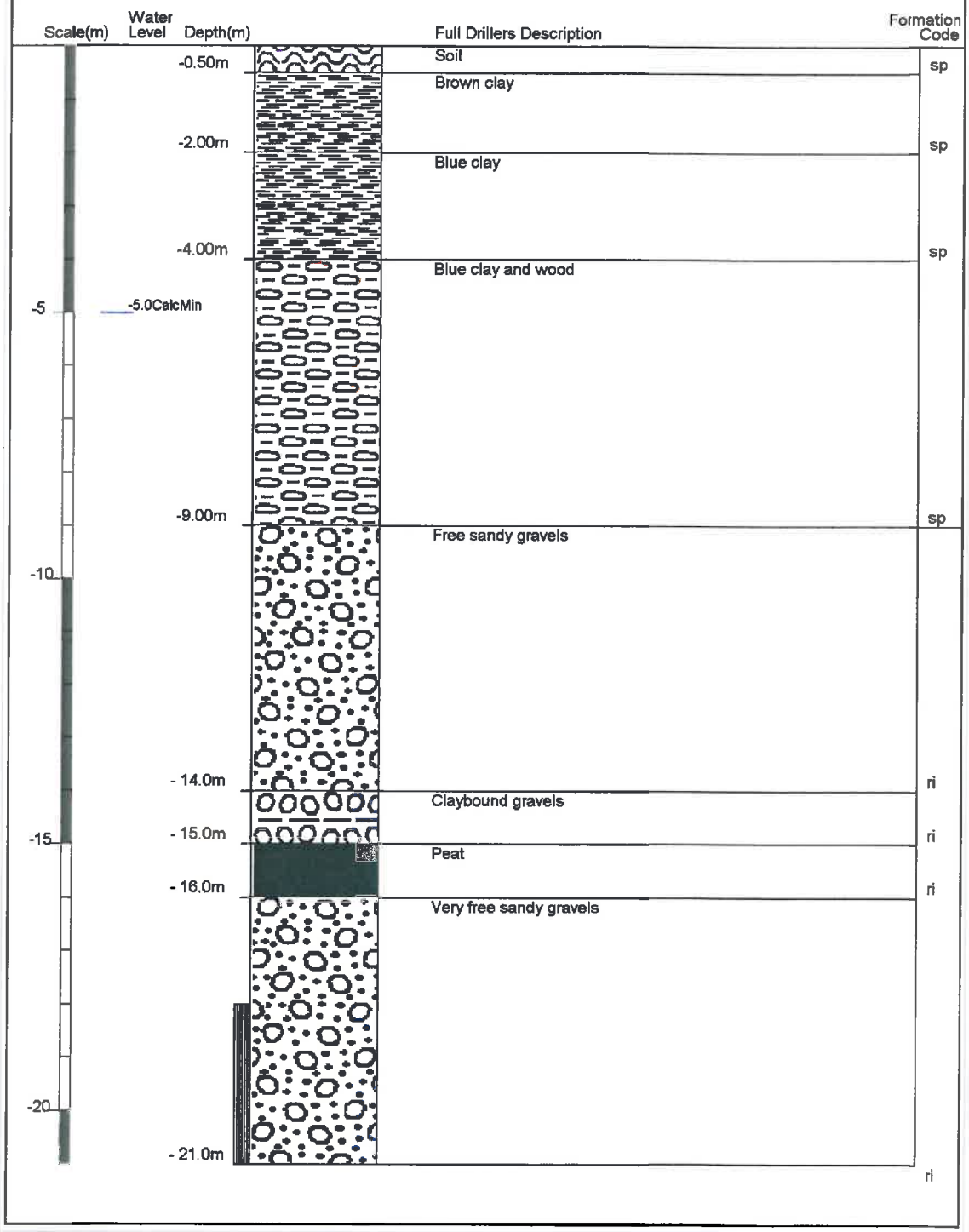
Gridref: M36:7047-2996 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 8.7 +MSD
Driller : Smiths Welldrilling
Drill Method : Rotary Rig
Drill Depth : -18m Drill Date : 28/01/2002

Environment Canterbury
Your regional council



Borelog for well M36/5886

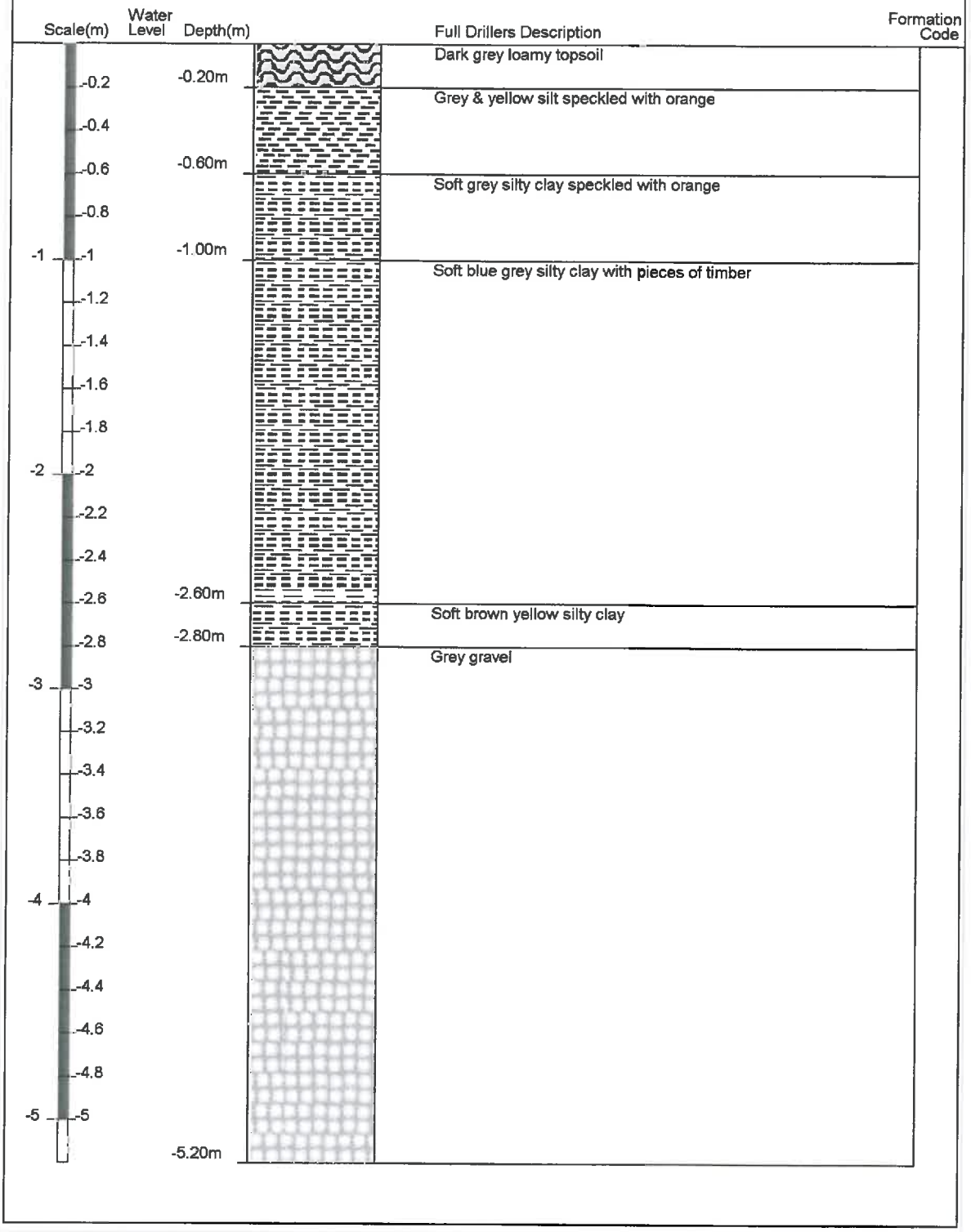
Gridref: M36:6933-3067 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 13 +MSD
Driller : Smiths Welldrilling
Drill Method : Rotary Rig
Drill Depth : -21m Drill Date : 17/10/2001



Borelog for well M36/8677

Gridref: M36:69828-29433 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 8.67 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -5.2m Drill Date : 9/10/2008

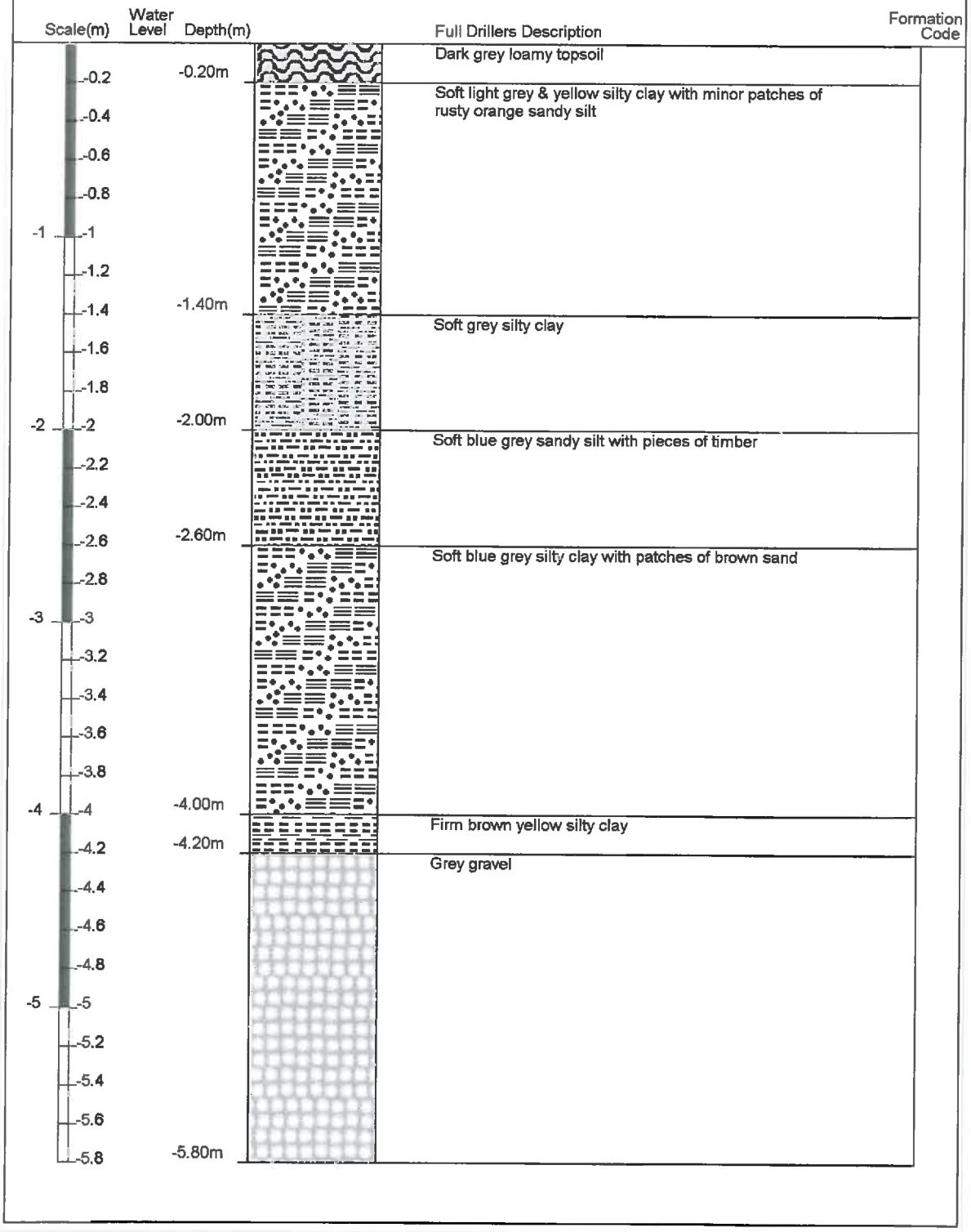
Environment Canterbury



Borelog for well M36/8679

Gridref: M36:70146-29530 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 10.14 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -5.8m Drill Date : 9/10/2008

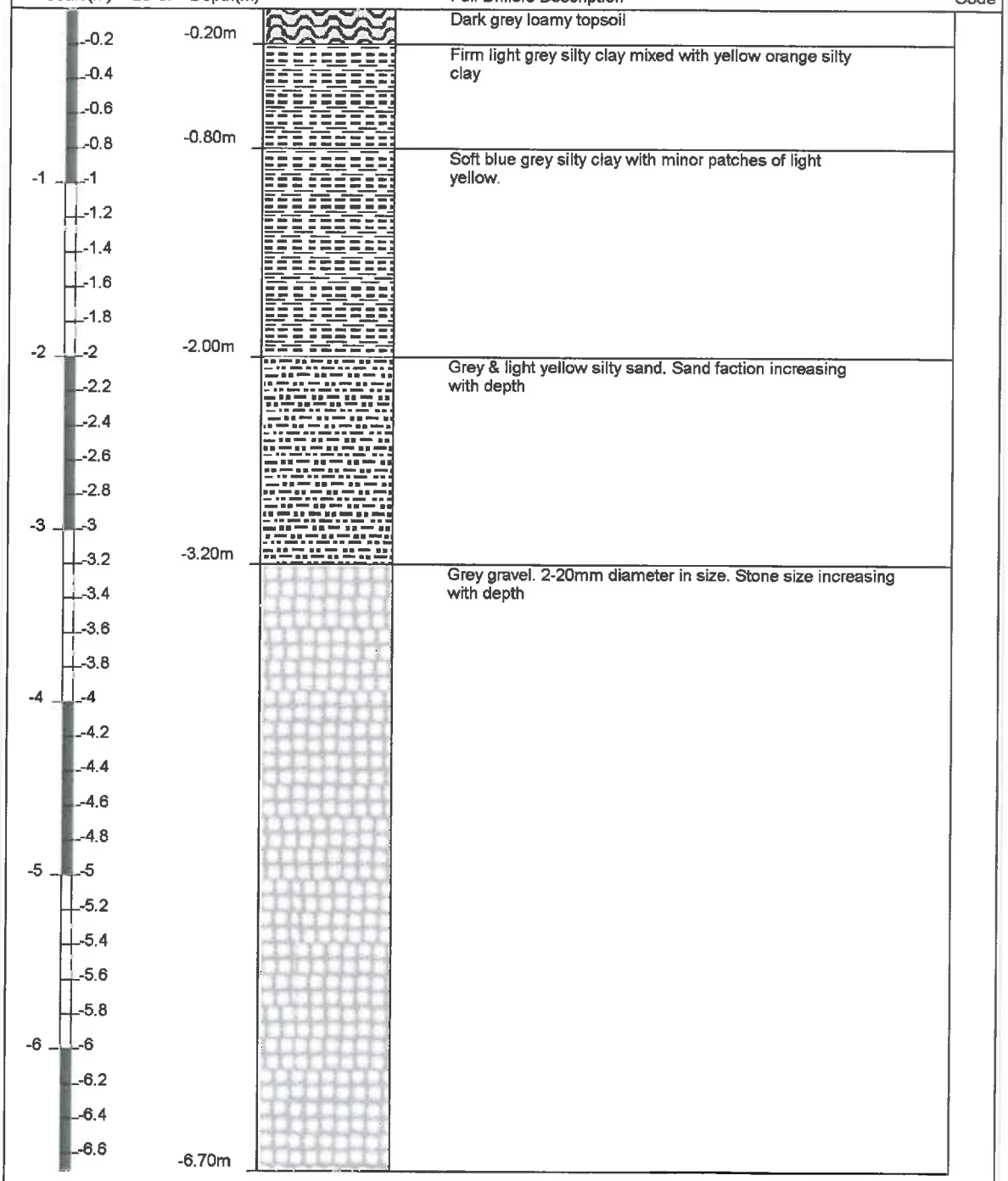
Environment Canterbury



Borelog for well M36/8680

Gridref: M36:70207-29692 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 10.14 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -6.7m Drill Date : 9/10/2008

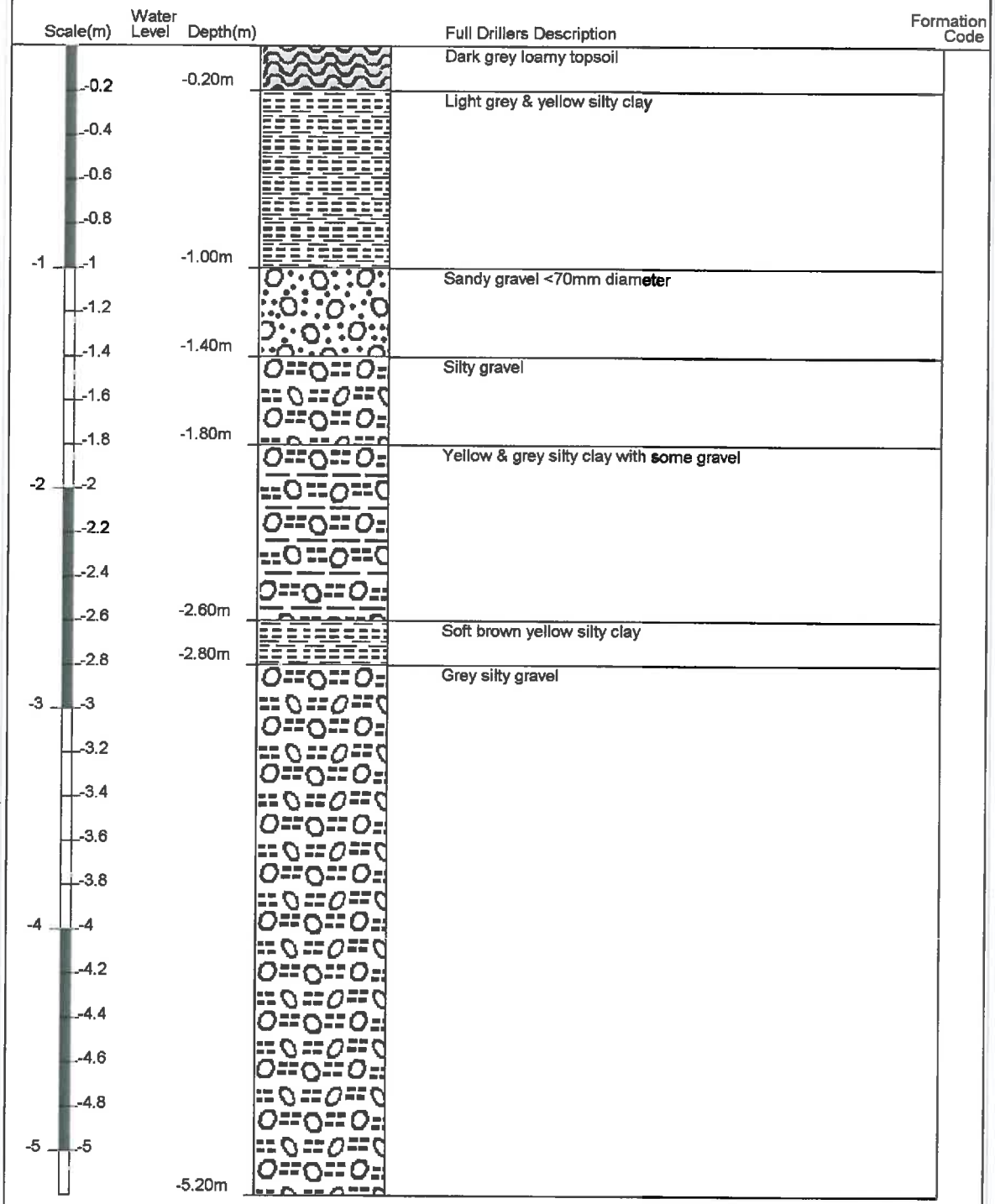
Environment Canterbury



Borelog for well M36/8678

Gridref: M36:69444-29810 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 10.14 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -5.2m Drill Date : 9/10/2008

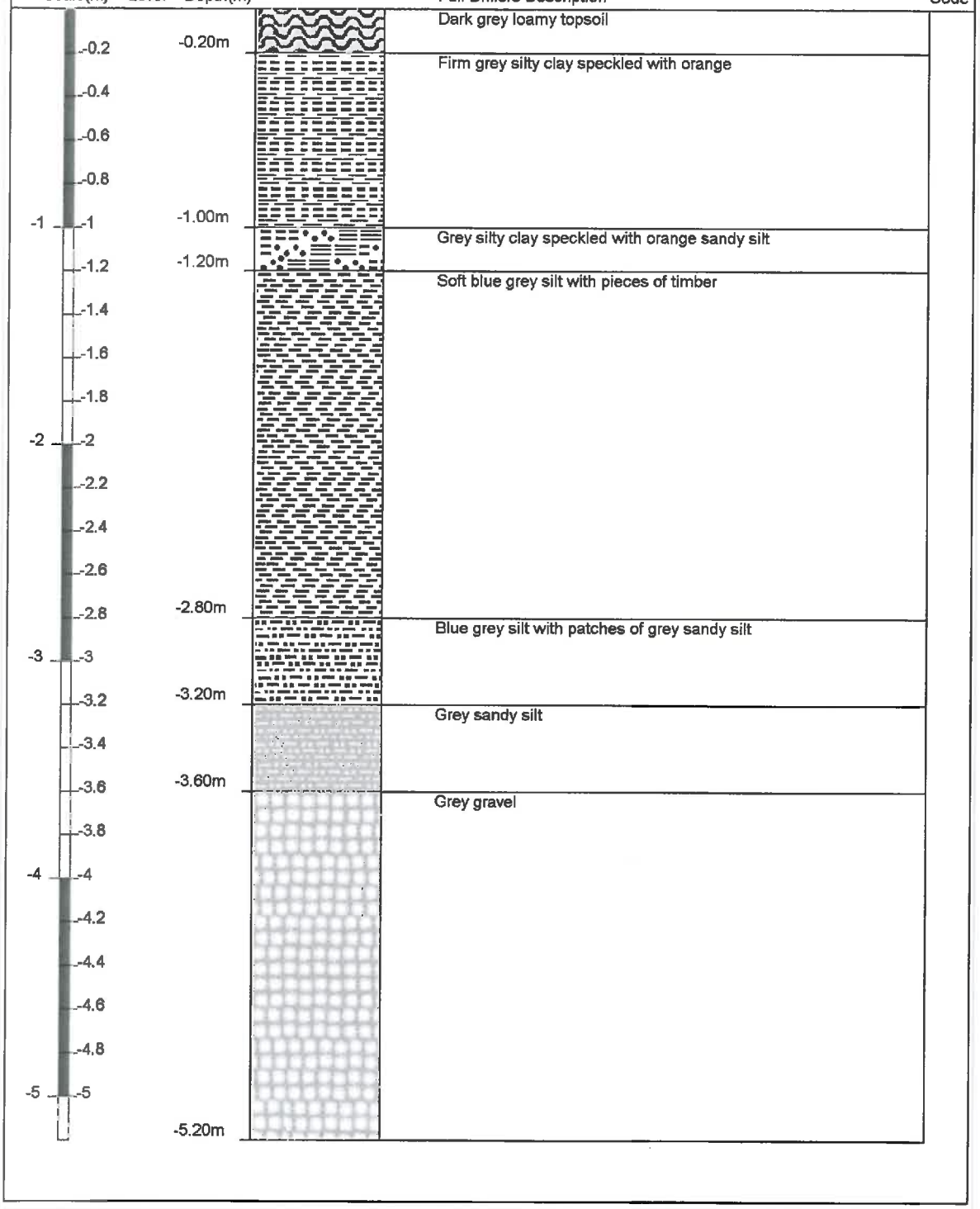
Environment Canterbury



Borelog for well M36/8676

Gridref: M36:70058-29327 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 9.27 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -5.2m Drill Date : 9/10/2008

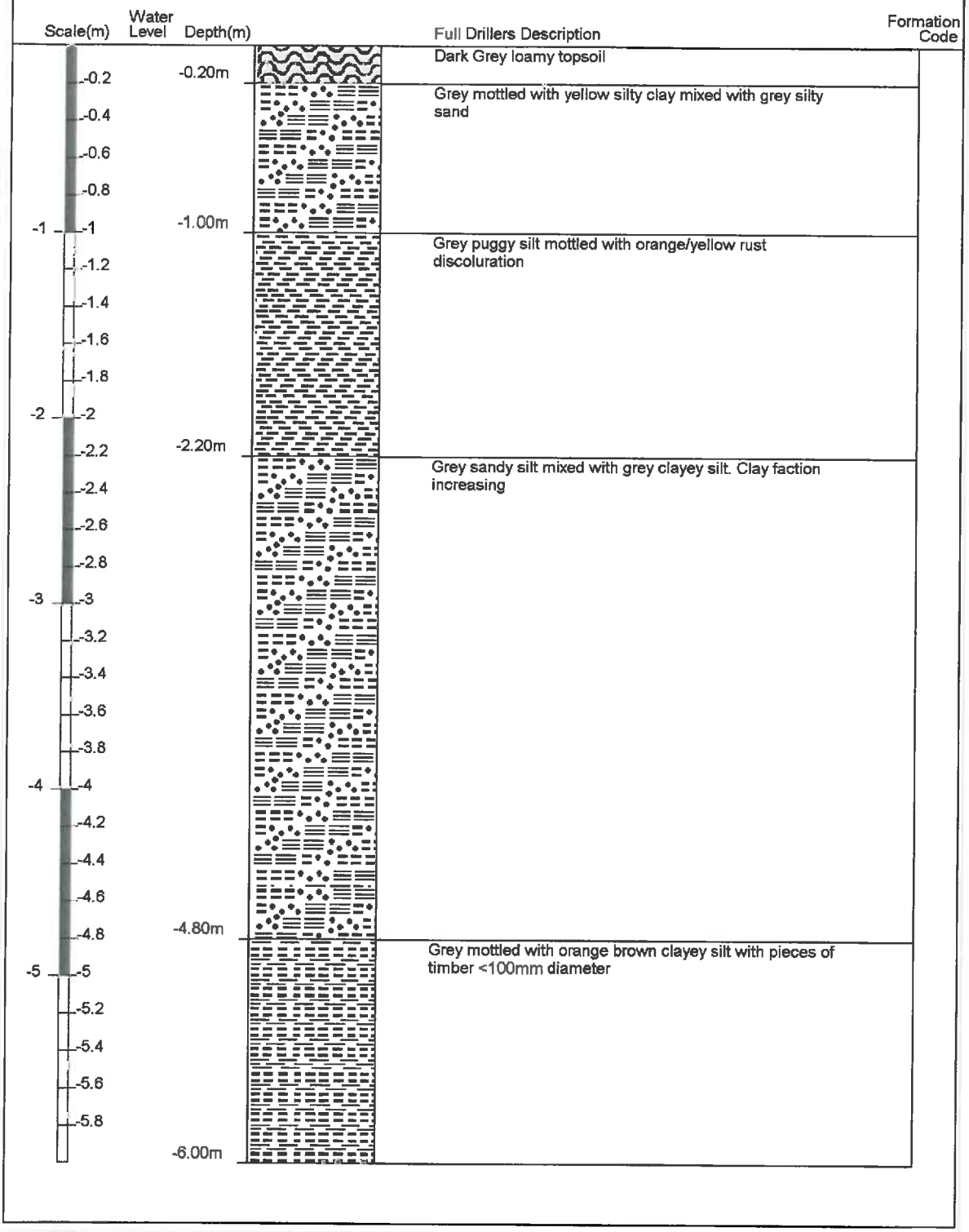
Environment Canterbury



Borelog for well M36/8672

Gridref: M36:69507-29314 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 9.45 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -6m Drill Date : 9/10/2008

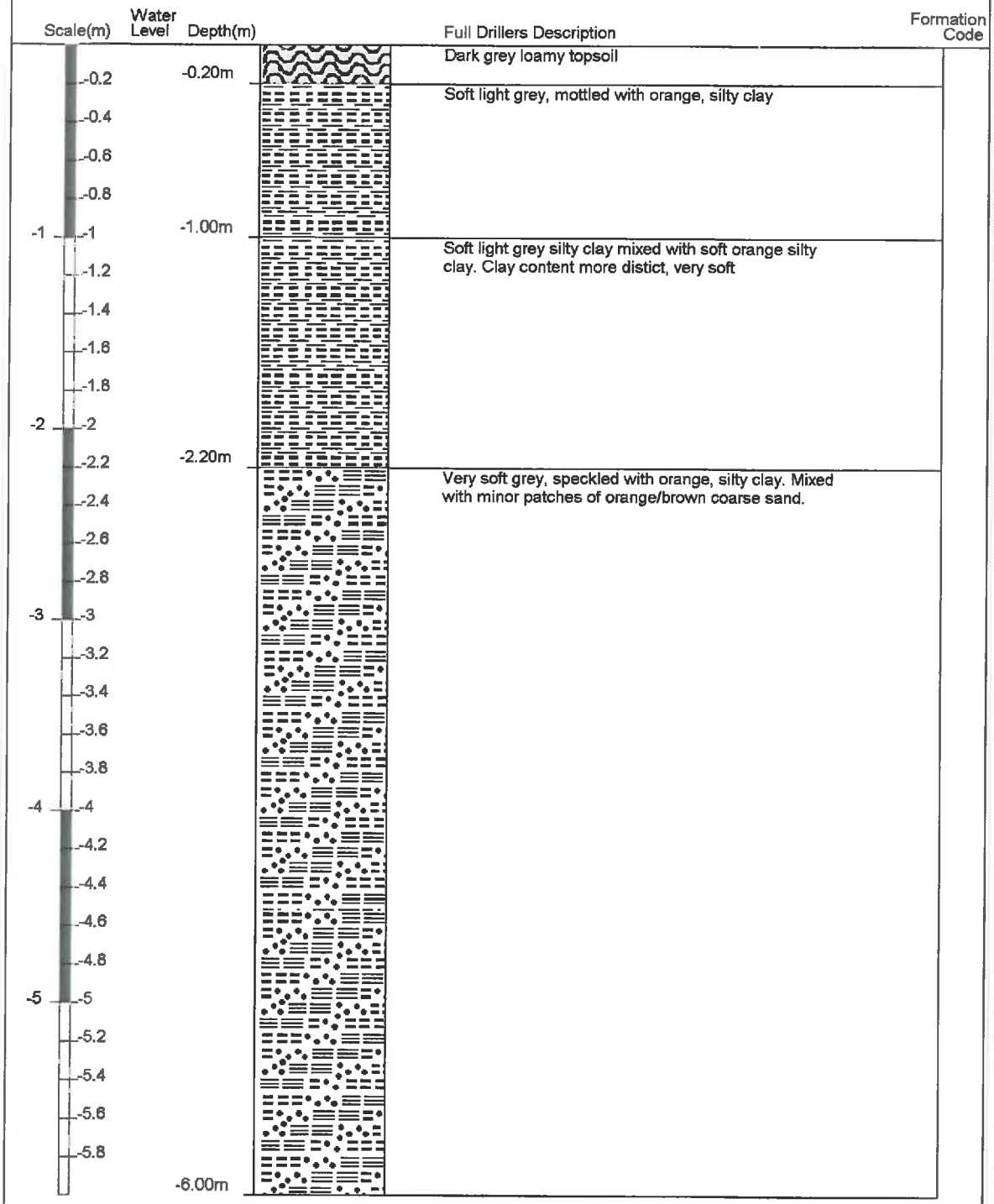
Environment Canterbury



Borelog for well M36/8673

Gridref: M36:69764-29180 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 8.67 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -6m Drill Date : 9/10/2008

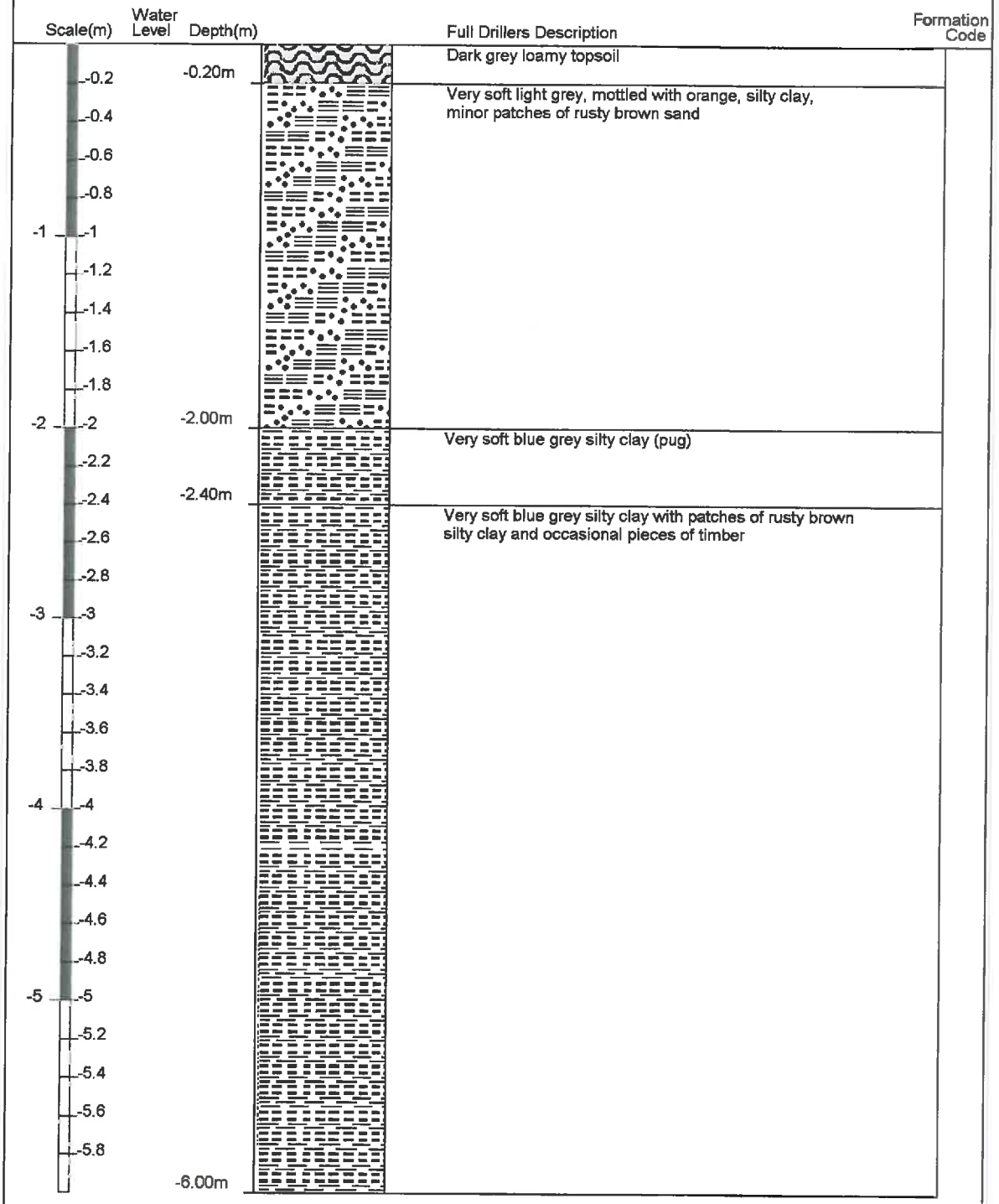
Environment Canterbury



Borelog for well M36/8674

Gridref: M36:69981-29081 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 8.51 +MSD
Driller : not known
Drill Method : Rotary/Percussion
Drill Depth : -6m Drill Date : 9/10/2008

Environment Canterbury



Appendix G
Groundwater Levels

Project Rosemerryn Farm Subdivision
Project Number 224464
Title Groundwater Levels

Test Location	Recorded Depth to Ground Water	Groundwater Seepages	Comments
CPT1	3.0m		Measured down CPT hole
CPT2	Not Recorded		
CPT3	Not Recorded		
CPT4	2.0m		Measured down CPT hole
CPT5	Not Recorded		
CPT6	1.9m		Measured down CPT hole
CPT7	Not Recorded		
CPT8	Not Recorded		
CPT9	1.5m		Measured down CPT hole
CPT10	Not Recorded		Measured down CPT hole
CPT11	Not Recorded		
CPT12	1.5m		Measured down CPT hole
CPT13	Not Recorded		
CPT14	Not Recorded		Measured down CPT hole
CPT15	Not Recorded		
CPT16	Not Recorded		
CPT17	Not Recorded		
CPT18	Not Recorded		
CPT19	1.0m		Measured down CPT hole
CPT20	Not Recorded		
CPT21	1.5m		Measured down CPT hole
CPT22	0.9m		Measured down CPT hole
CPT23	1.4m		Measured down CPT hole
CPT24	Not Recorded		
CPT25	1.0m		Measured down CPT hole
CPT26	Not Recorded		
CPT27	Not Recorded		
CPT28	Not Recorded		
CPT29	0.9m		Measured down CPT hole
CPT30	1.5m		Measured down CPT hole
CPT31	Not Recorded		
CPT32	Not Recorded		
CPT33	Not Recorded		
CPT34	Not Recorded		
CPT35	Not Recorded		
CPT36	Not Recorded		
CPT37	Not Recorded		
TP1	4.0m	2.3m	Dark grey soil from 3m
TP2	4.0m		
TP3	Not Recorded		Dark grey soil from 3m
TP4	4.0m	2.5m	Dark grey soil from 2.5m
TP5		2.2m	Grey soil from 2.5m *
TP6	3.2m		Dark grey soil from 2m

TP7	3.5m		Dark grey soil from 3m	
TP9	3.5m		Dark grey soil from 3m	
TP10	3.3m		Dark grey soil from 2.3m	
TP13	2.0m		Dark grey soil from 3m	
TP14	3.7m		Dark grey soil from 2m	
TP16	1.8m		Dark grey soil from 1.65m	
TP17			Dark grey soil from 2.8m	
TP18	4.0m		Dark grey soil from 1.8m	
TP19	2.8m	1.7m	Dark grey soil from 1.8m	
TP23	Not Recorded		Dark grey soil from 1.7m	
TP24	3.8m		Dark grey soil from 2m	
TP25	2.8m		Dark grey soil from 2m	
TP48		0.7m & 2.4m	Grey soil from 1.1m	*
TP49			Grey soil from 1.3m	*
TP50	Not Recorded	2.1m		*
TP52		2.1m & 2.9m	Grey soil from 2.4m	*
TP53	3.9m		Grey soil from 3m	*
TP54		2.3m	Grey soil from 2.3m	*
TP55	4.5m	2.8m	Grey soil from 2.8m	*
TP56		2.6m	Grey soil from 3.2m	*
TP57				*
TP58		2.7m	Grey soil from 2.7m	*
TP59		2.7m	Grey soil from 2.7m	*
TP60			Grey soil from 2.8m	*
TP61	3.8m	2.8m	Grey soil from 2.8m	*
TP62	3.6m		Grey soil from 2.6m	*
TP63	3.8m	2.8m	Grey soil from 2.8m	*
TP64	3.6m		Grey soil from 2.2m	*
TP65	3.6m	1.7m	Grey soil from 2.2m	*
TP66	3.5m		Grey soil from 2.3m	*
TP67			Grey soil from 2.6m	*
TP68		0.6m	Grey soil from 2.8m	*
TP69	3.3m		Grey soil from 1.8m	*
TP70	3.8m	2.1m	Grey soil from 2.1m	*
TP71		2m	Grey soil from 1.8m	*
TP72		0.6m & 1.8m	Grey soil from 1.8m	*
TP73	4.2m	1.3m	Grey soil from 2m	*
TP74		1.5m	Grey soil from 2.3m	*
TP75			Grey soil from 2.2m	*
TP76		2m	Grey soil from 2.4m	*
TP77		1.3m	Grey soil from 2.1m	*
TP78		1.1m & 2.4m	Grey soil from 1.7m	*
TP79	3.5m	2.7m	Grey soil from 2m	*
TP80	3.6m		Grey soil from 2m	*
TP81		2m	Grey soil from 2m	*

* - Test pitting carried out in intense rainfall event. Therefore seepages from stormwater runoff were evident in the test pits and the soil samples were typically logged as wet.

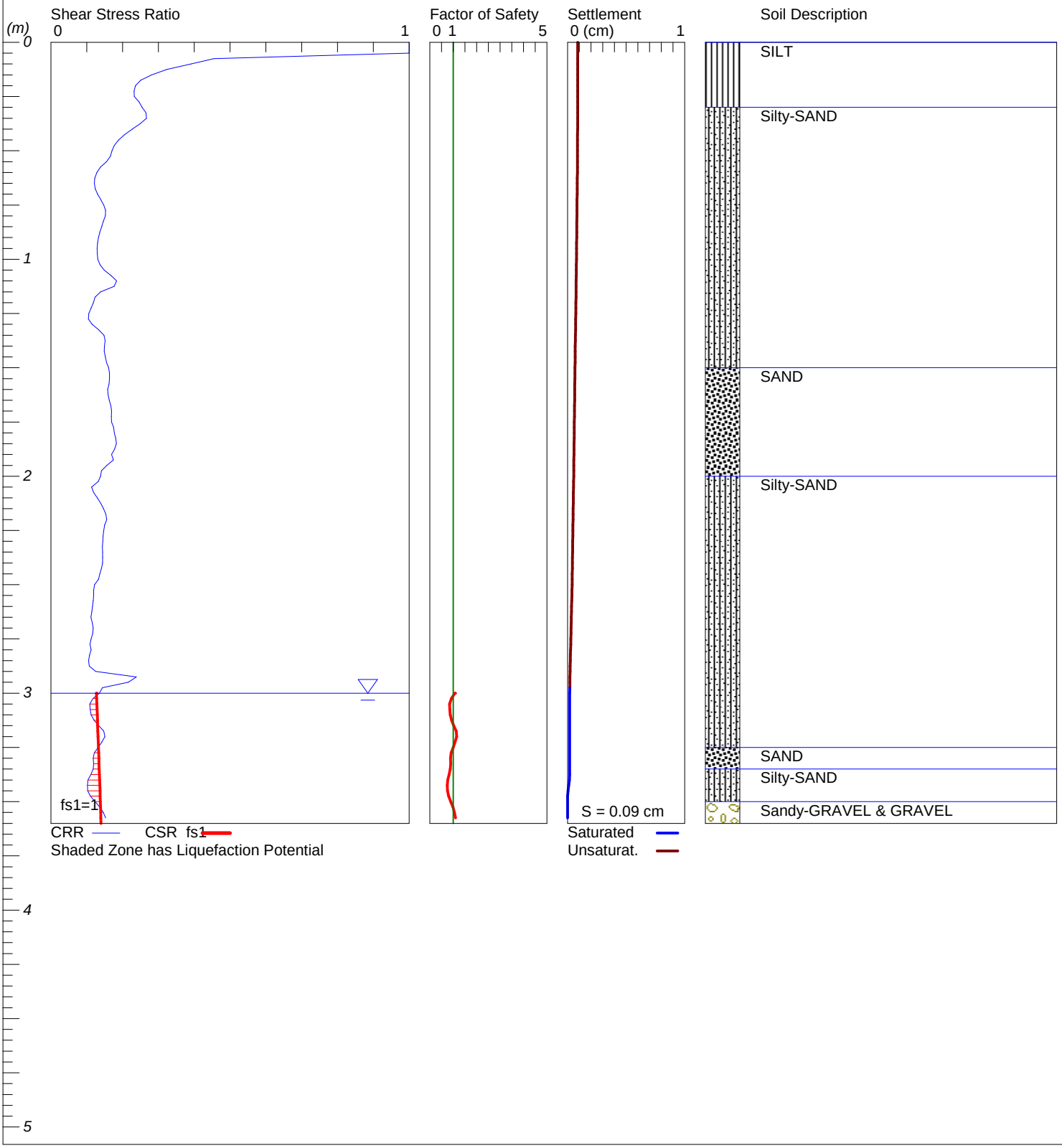
Appendix H
LiquifyPro Results

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT1 Water Depth=3 m

Magnitude=7.5
Acceleration=0.2g



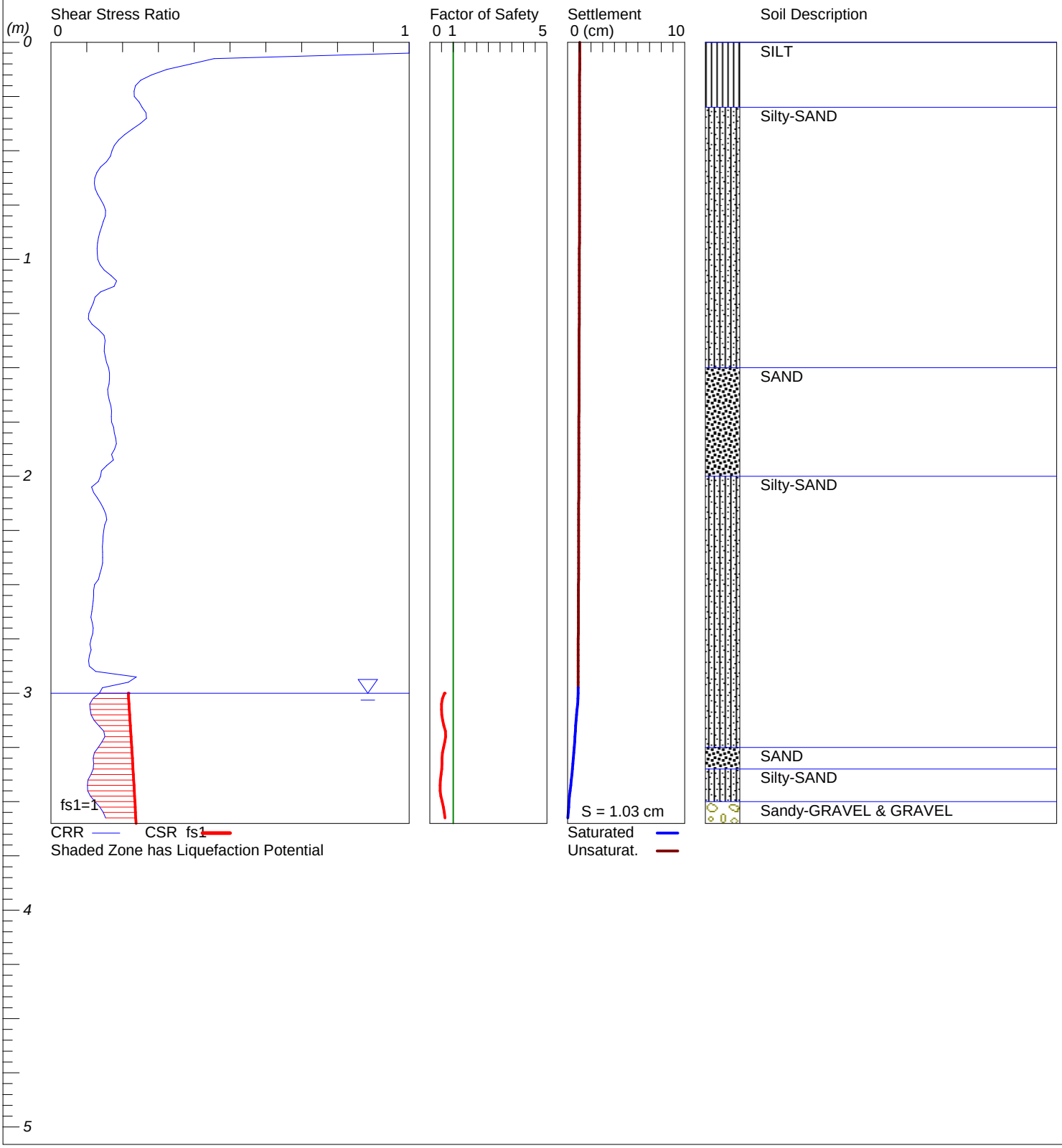
SLS Event **CPT1**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT1 Water Depth=3 m

Magnitude=7.5
Acceleration=0.34g



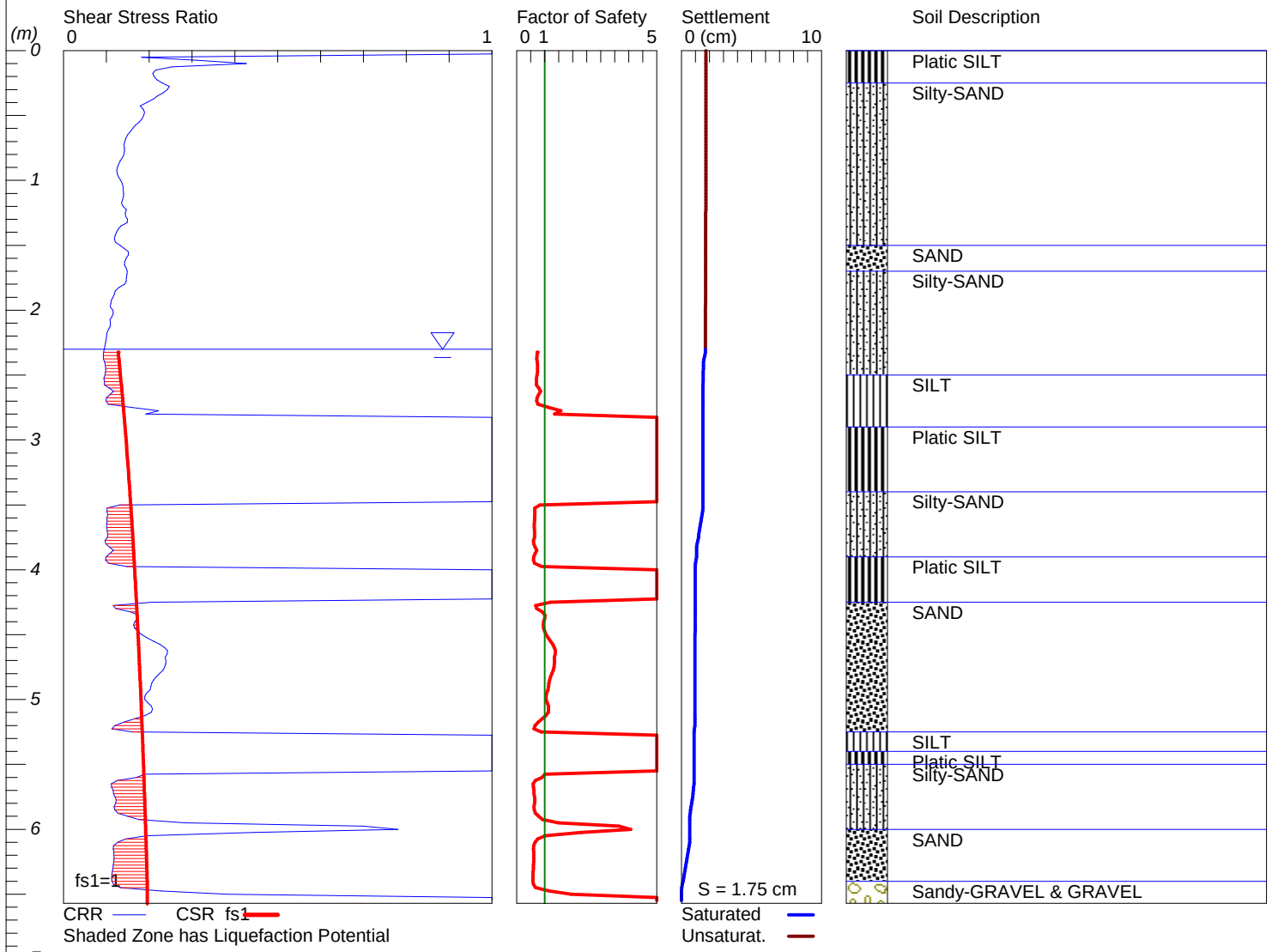
ULS Event **CPT1**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT2 Water Depth=2.3 m

Magnitude=7.5
Acceleration=0.2g



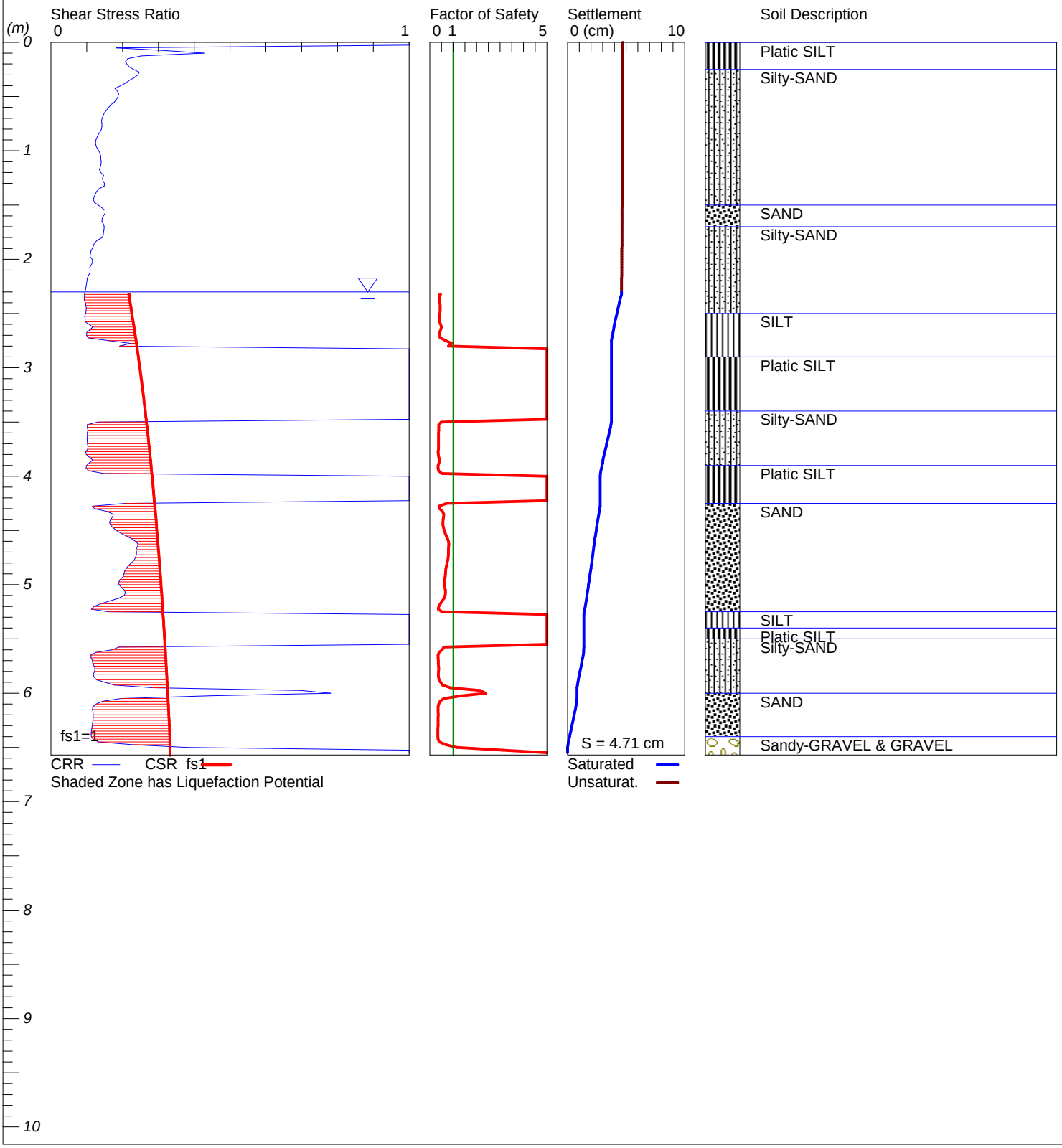
SLS Event **CPT2**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT2 Water Depth=2.3 m

Magnitude=7.5
Acceleration=0.34g

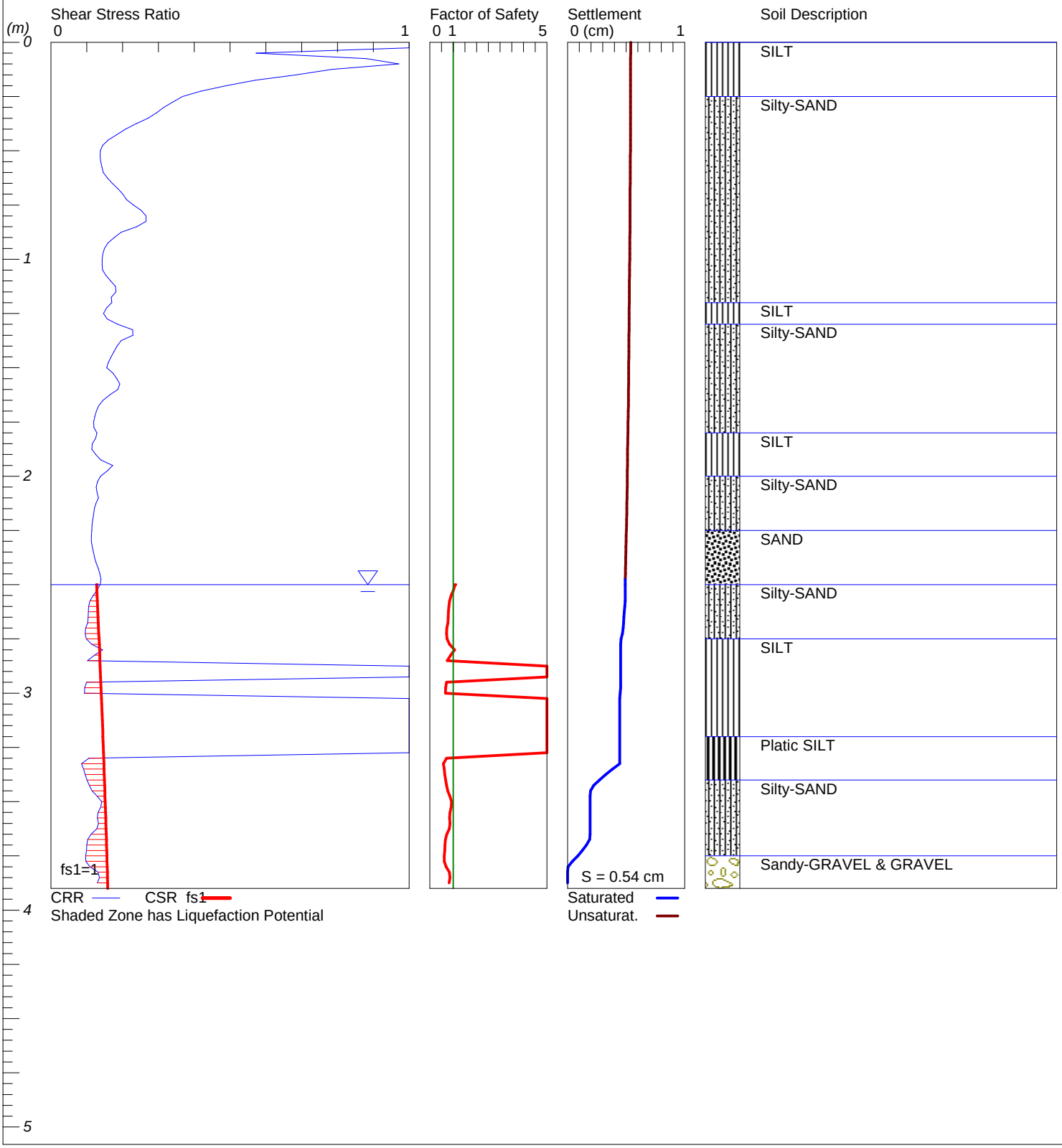


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT3 Water Depth=2.5 m

Magnitude=7.5
Acceleration=0.2g



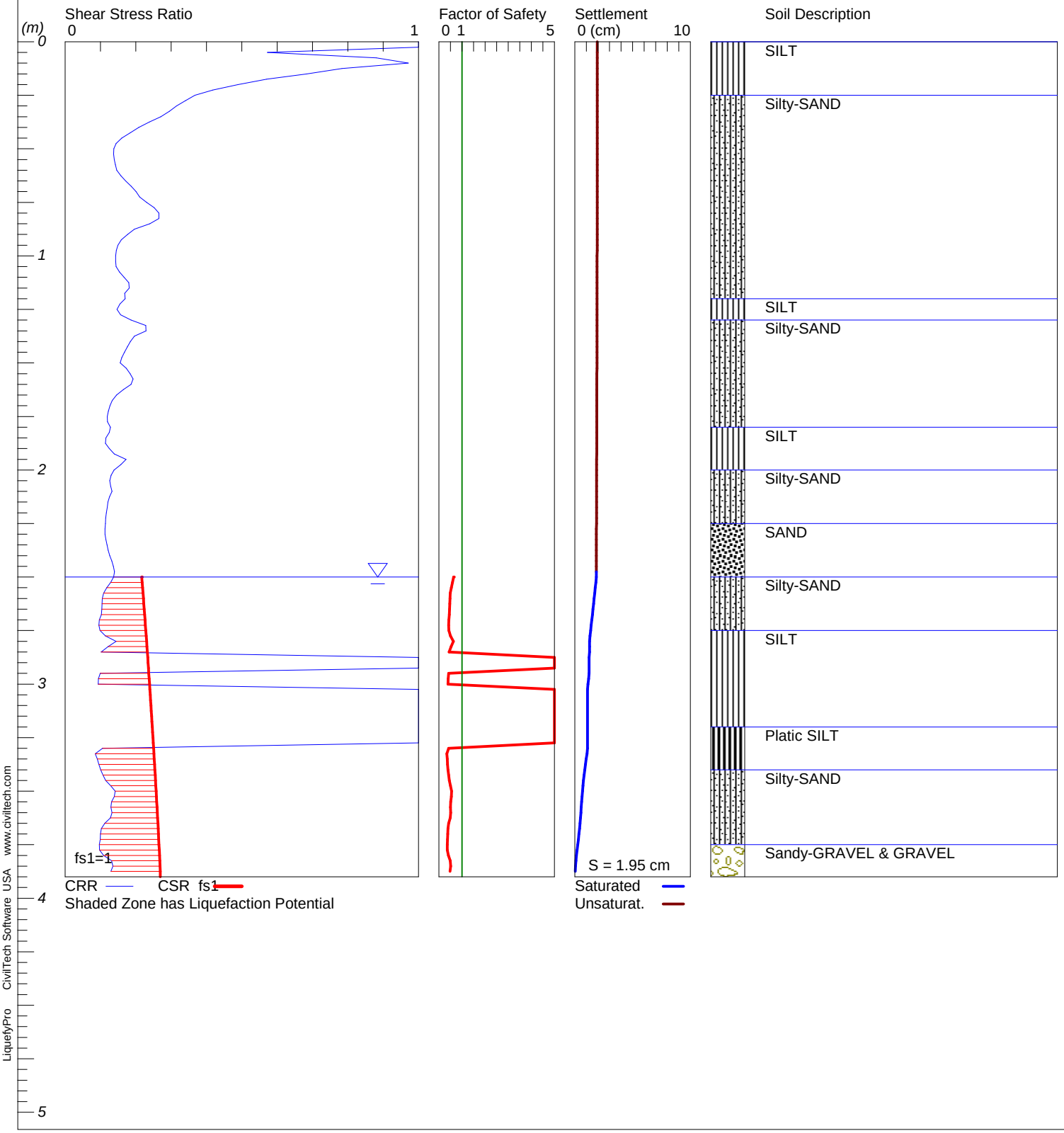
SLS Event **CPT3**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT3 Water Depth=2.5 m

Magnitude=7.5
Acceleration=0.34g

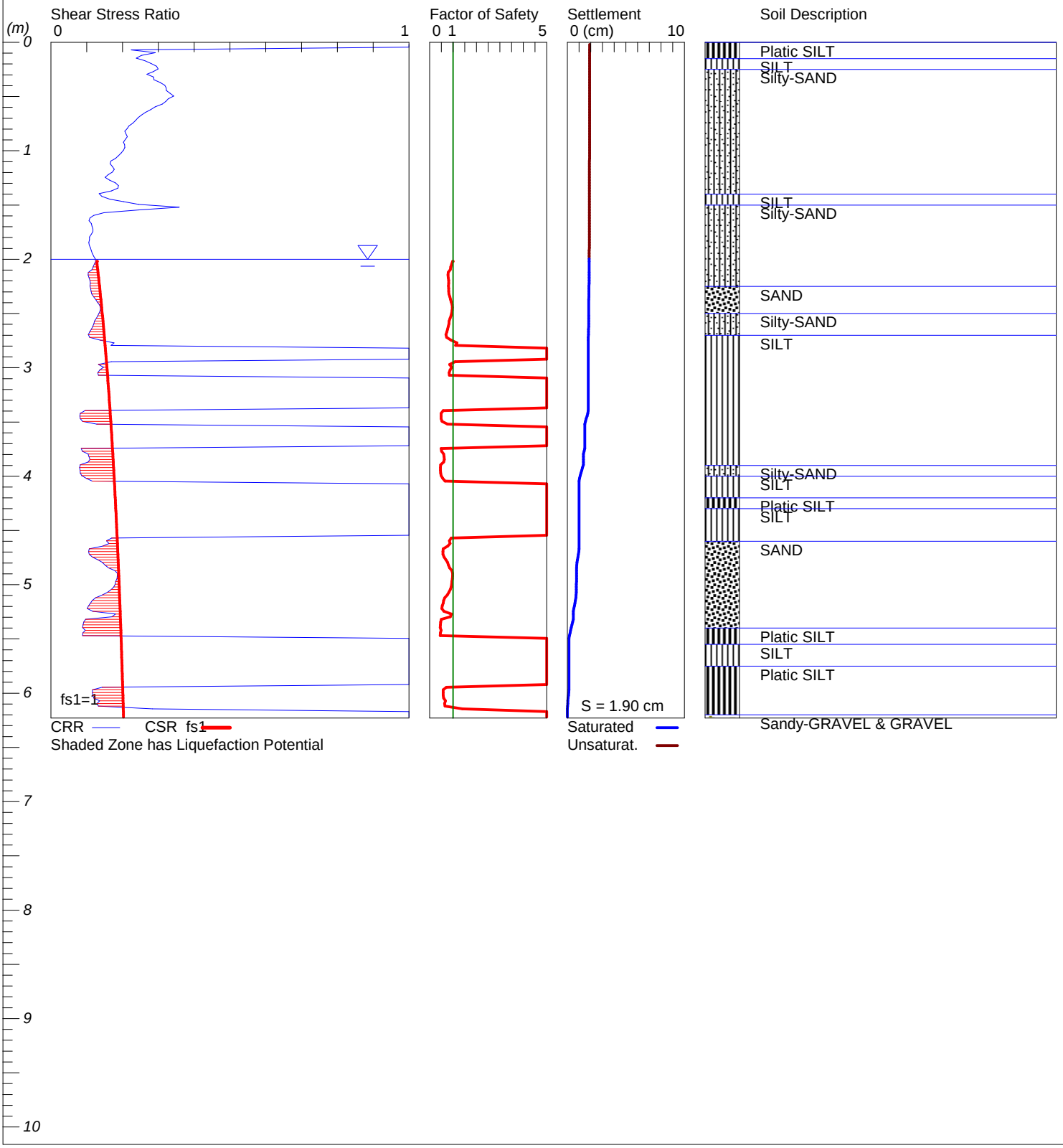


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT4 ***Water Depth=2 m***

Magnitude=7.5
Acceleration=0.2g



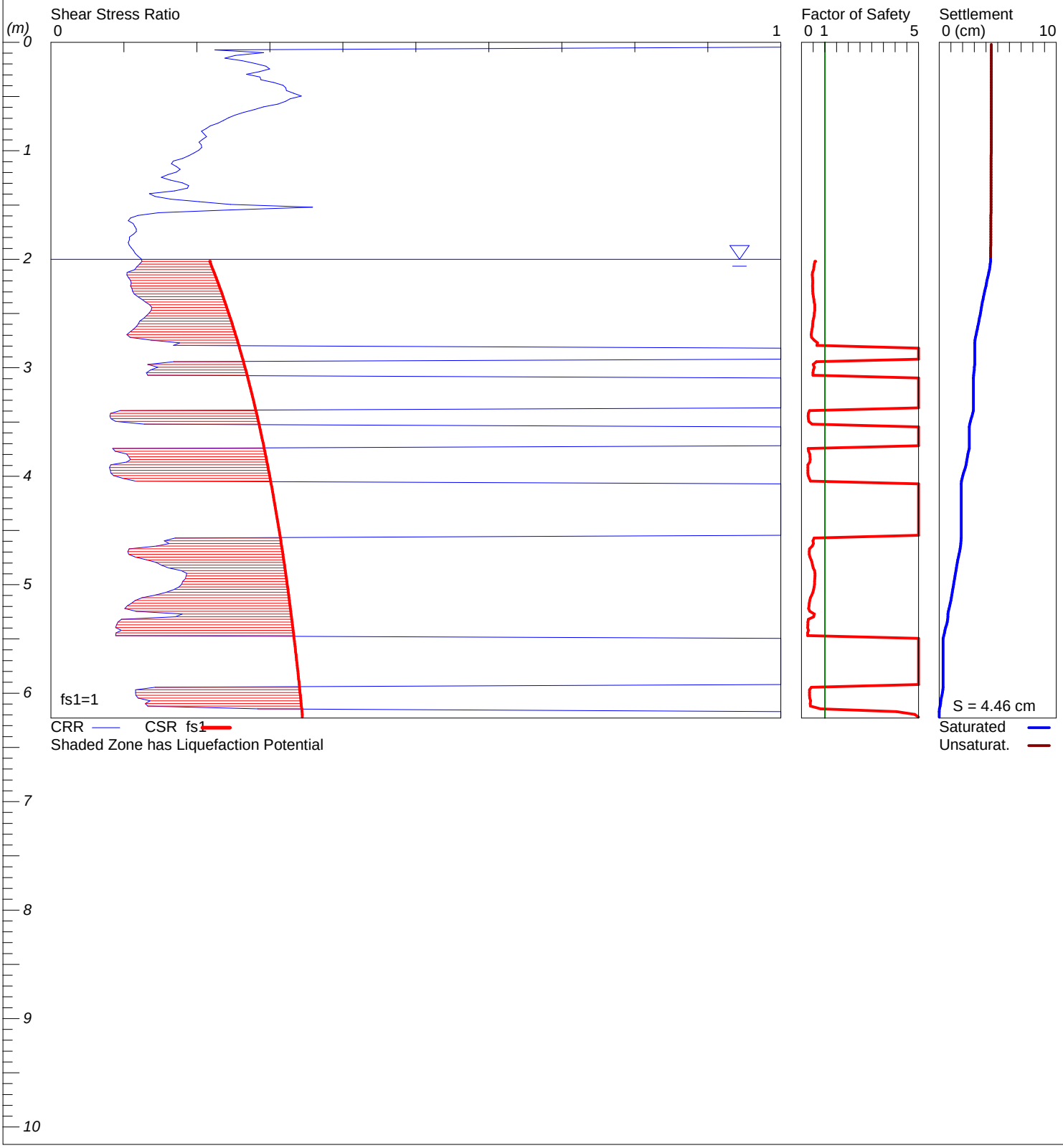
SLS Event **CPT4**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT4 Water Depth=2 m

Magnitude=7.5
Acceleration=0.34g



ULS Event

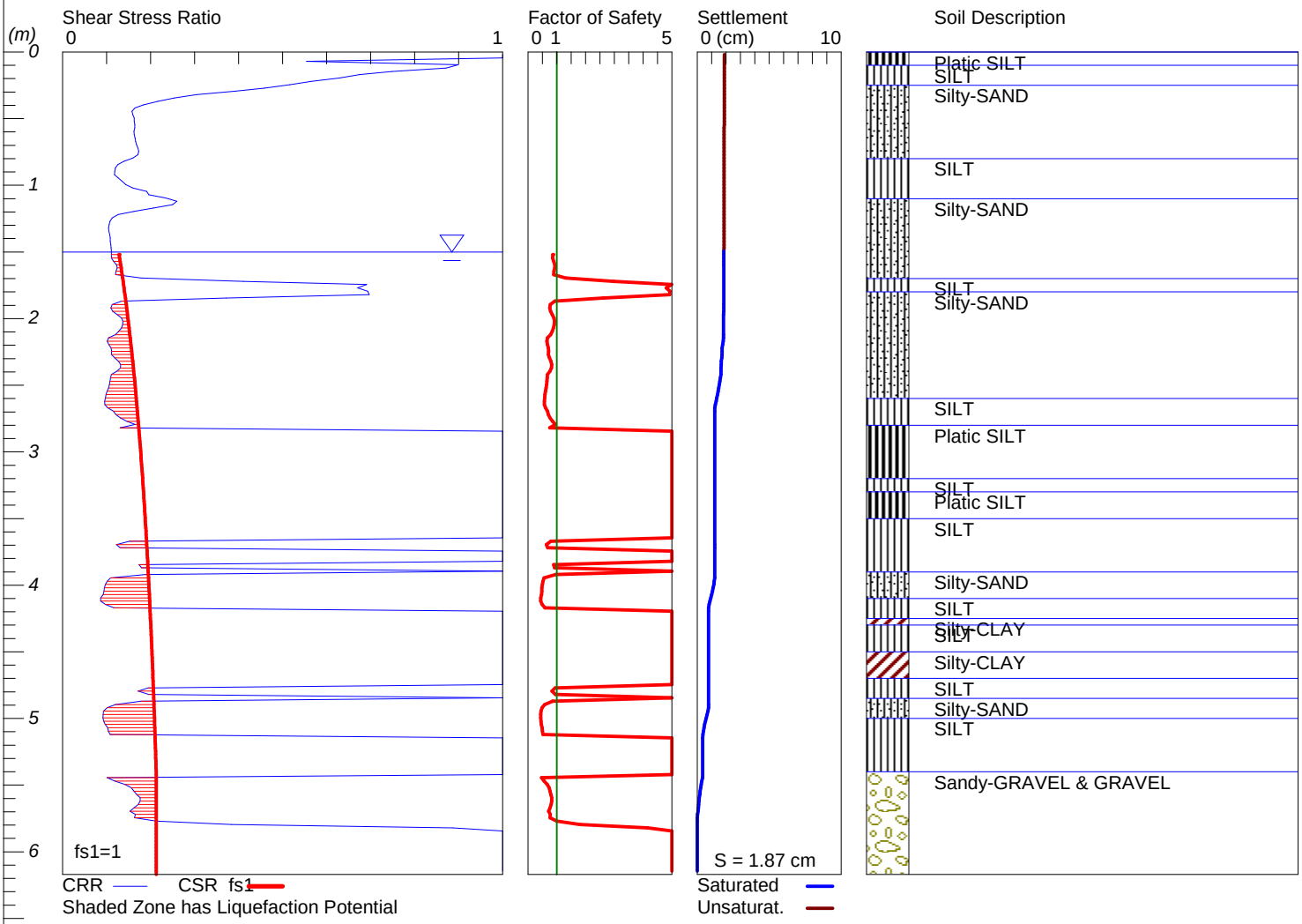
CPT4

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT5 Water Depth=1.5 m

Magnitude=7.5
Acceleration=0.2g



SLS Event

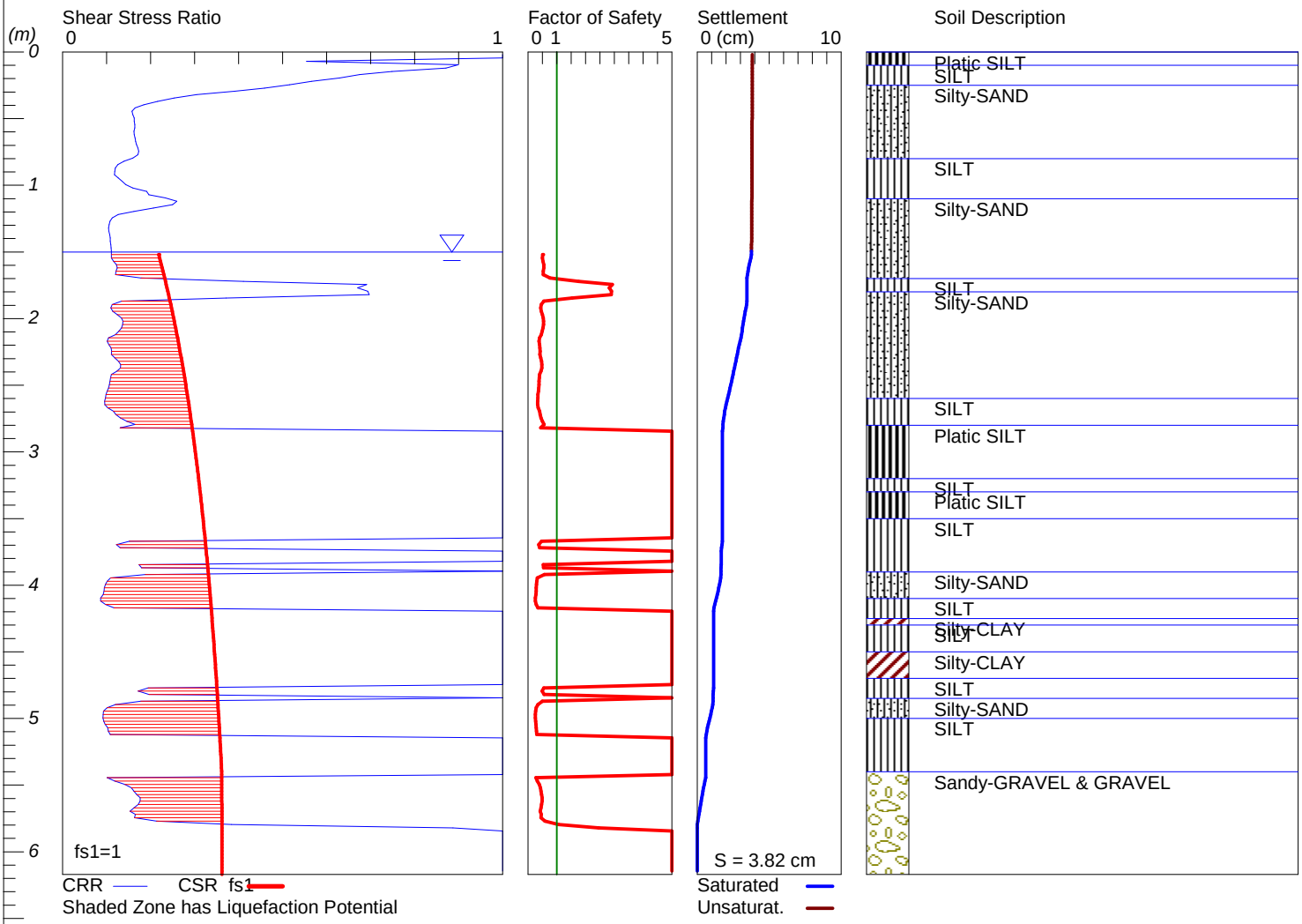
CPT5

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT5 Water Depth=1.5 m

Magnitude=7.5
Acceleration=0.34g



ULS Event

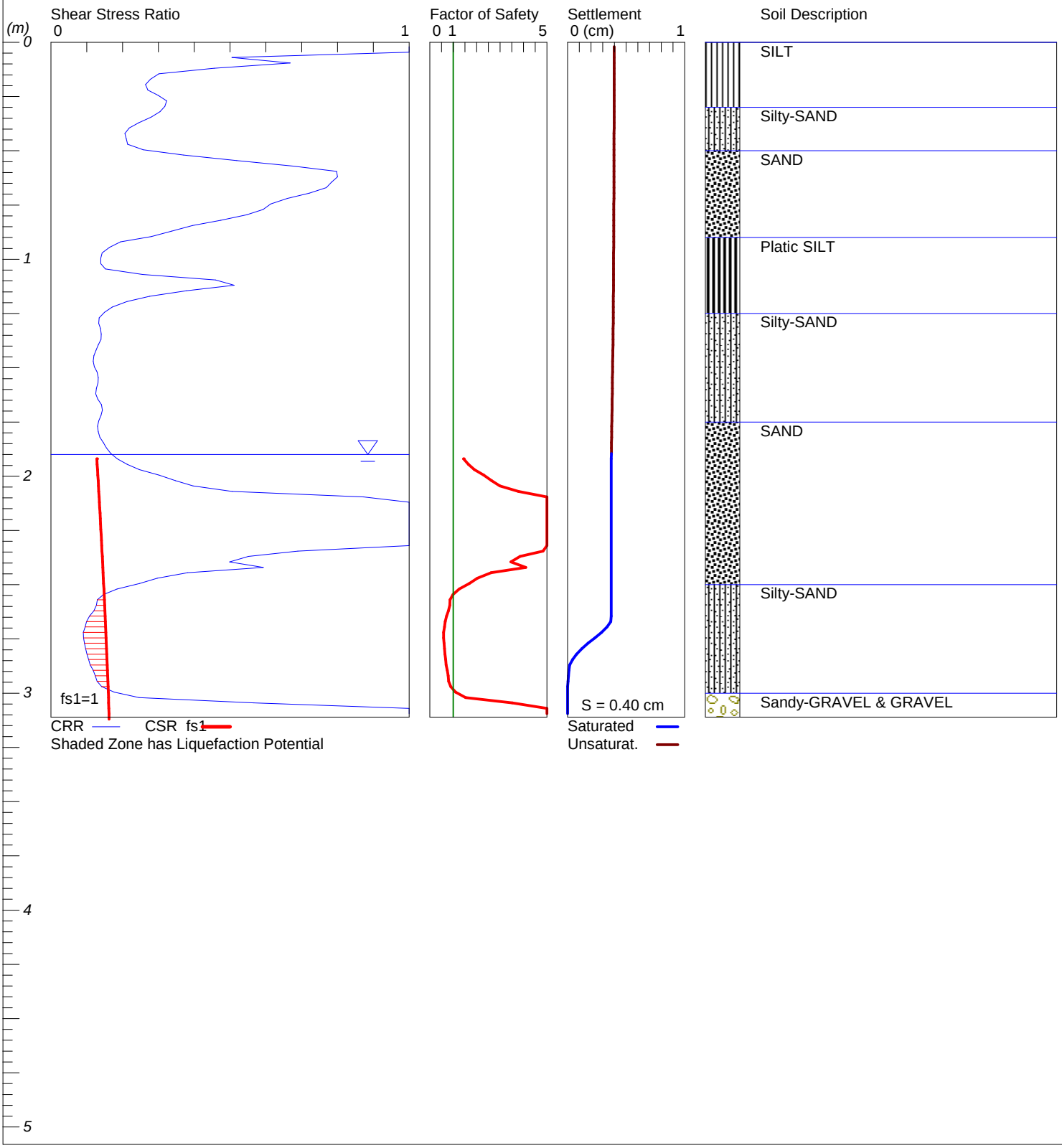
CPT5

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT6 Water Depth=1.9 m

Magnitude=7.5
Acceleration=0.2g



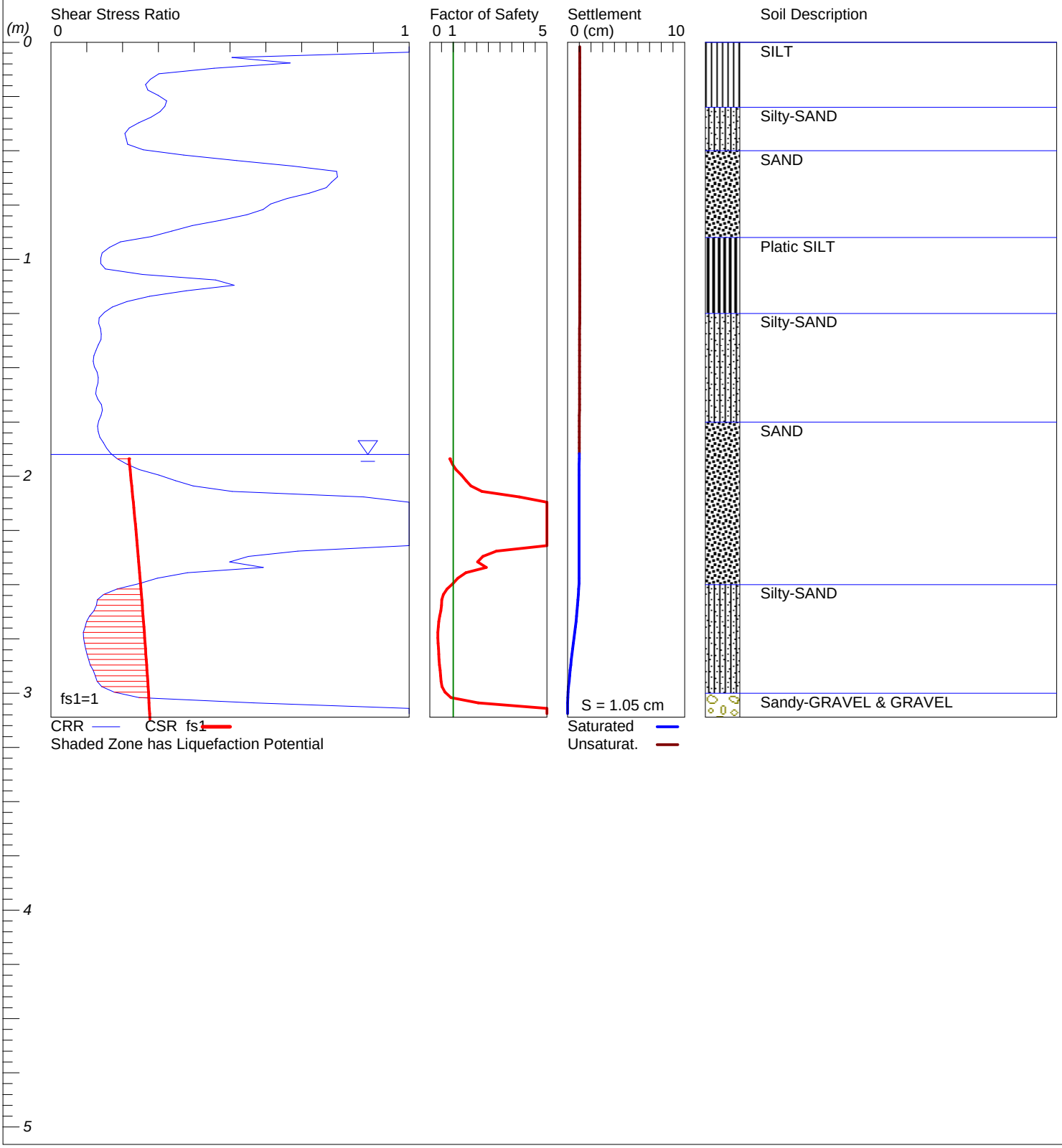
SLS Event **CPT6**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT6 Water Depth=1.9 m

Magnitude=7.5
Acceleration=0.34g



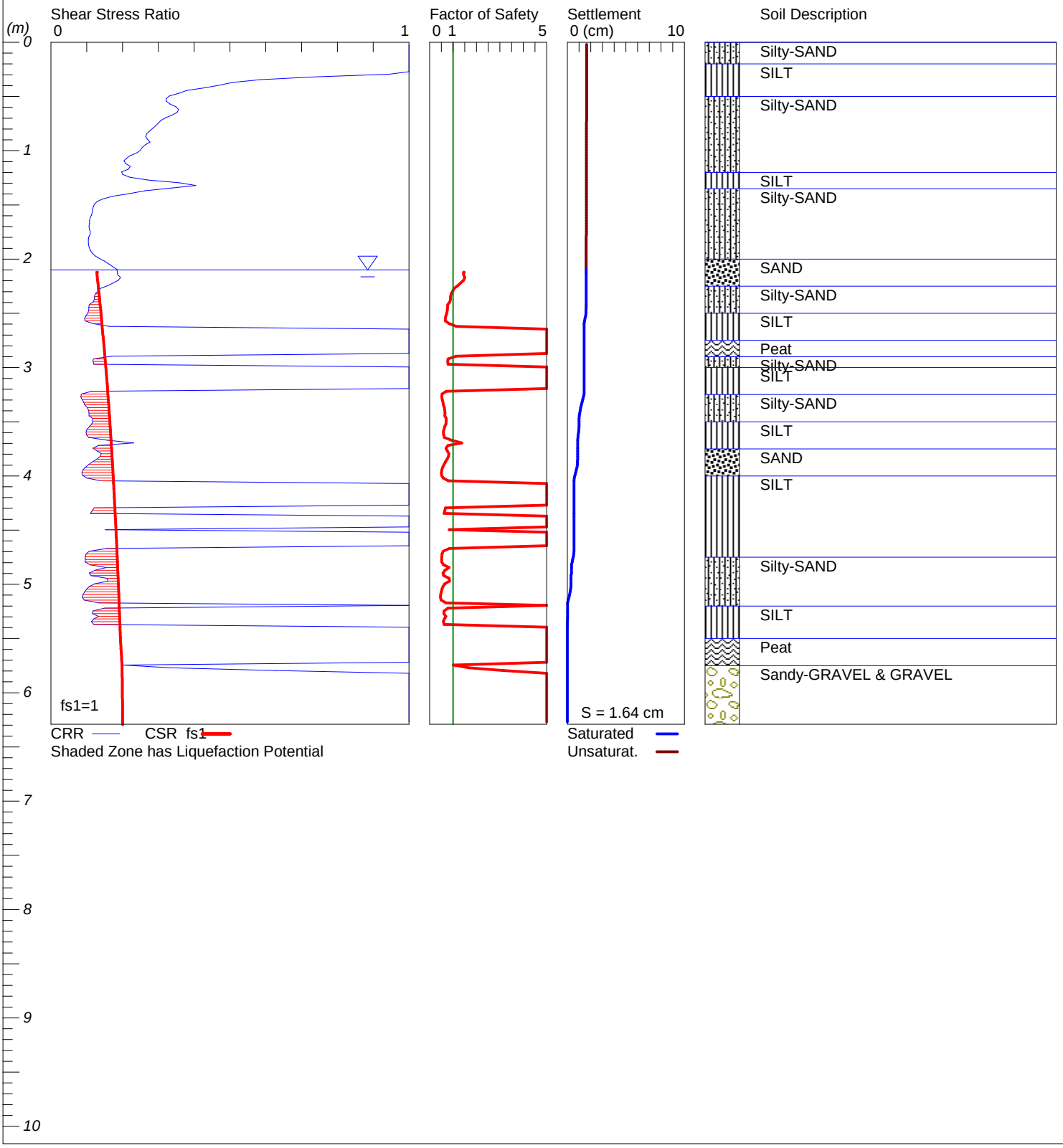
ULS Event **CPT6**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT8 Water Depth=2.1 m

Magnitude=7.5
Acceleration=0.2g



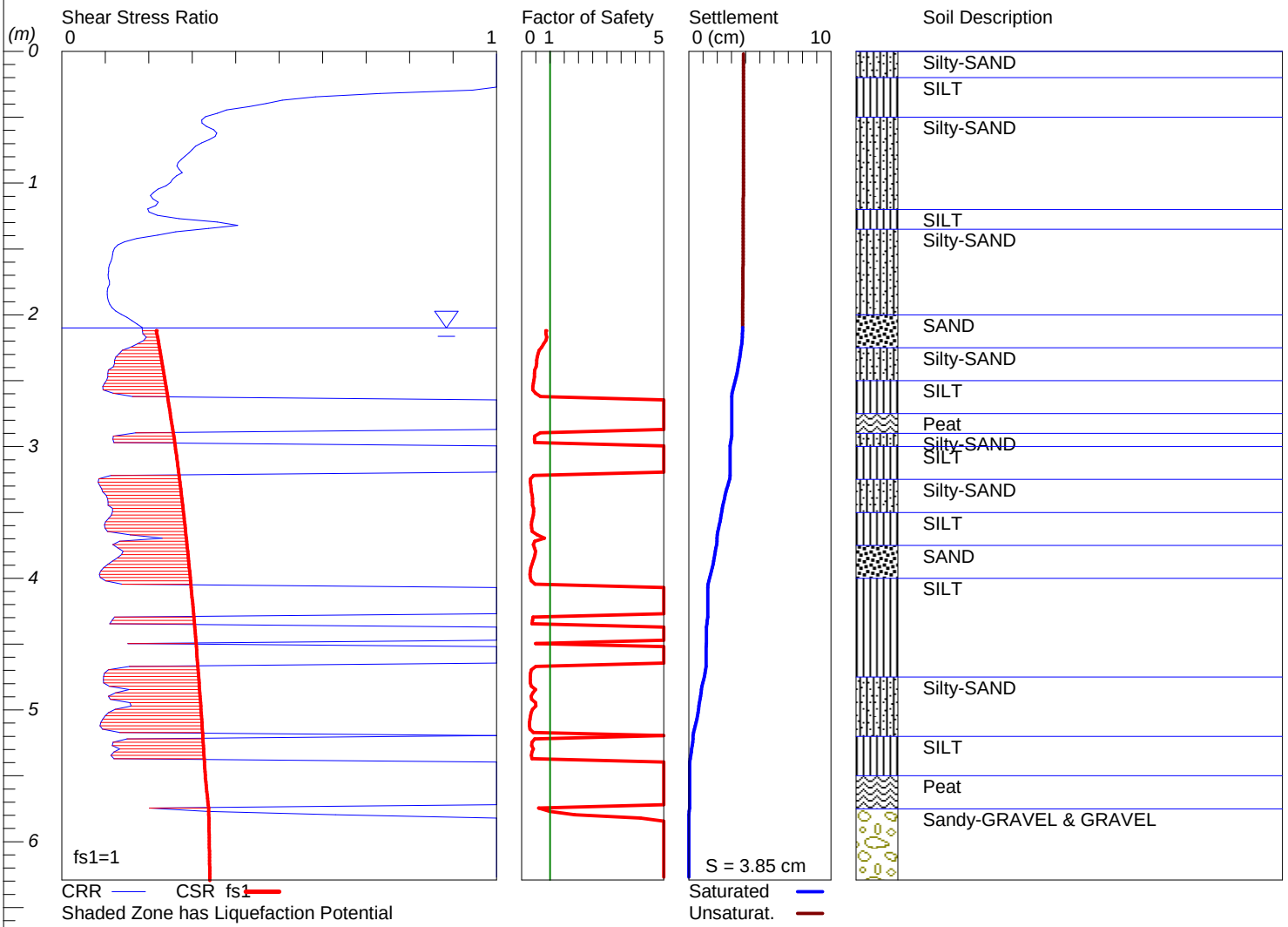
SLS Event **CPT8**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT8 Water Depth=2.1 m

Magnitude=7.5
Acceleration=0.34g



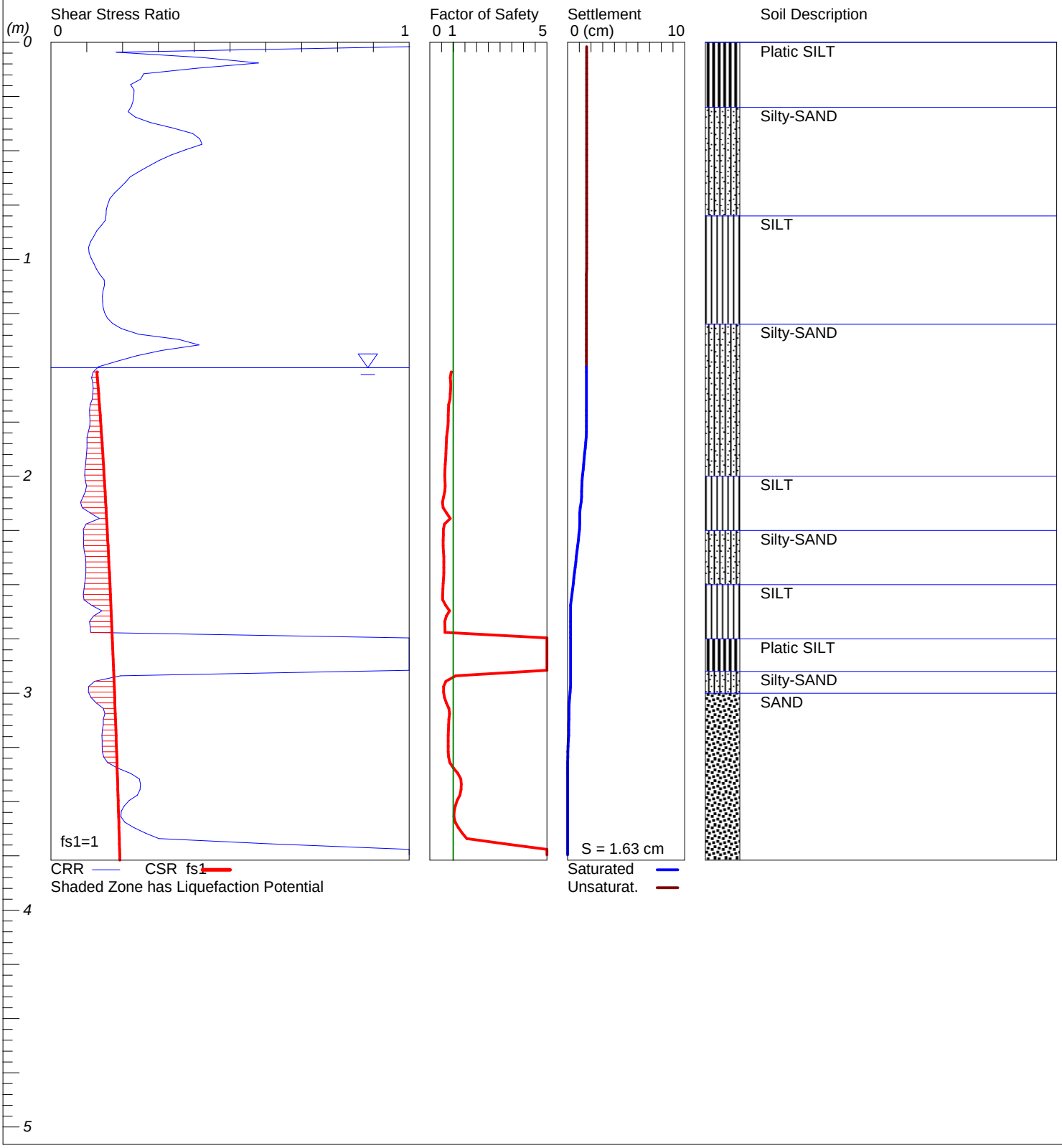
ULS Event **CPT8**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT9 Water Depth=1.5 m

Magnitude=7.5
Acceleration=0.2g



SLS Event

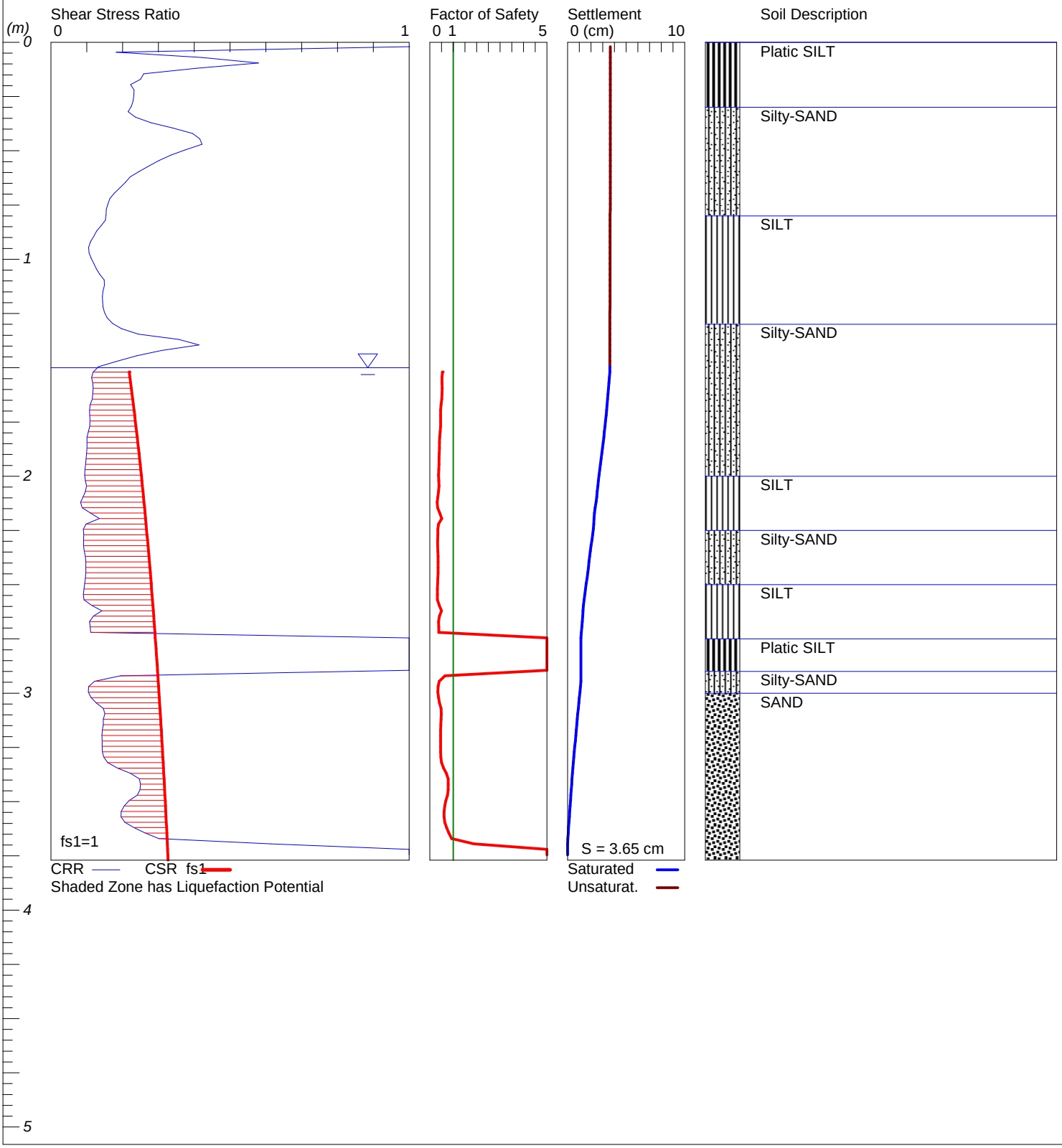
CPT9

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT9 Water Depth=1.5 m

Magnitude=7.5
Acceleration=0.34g



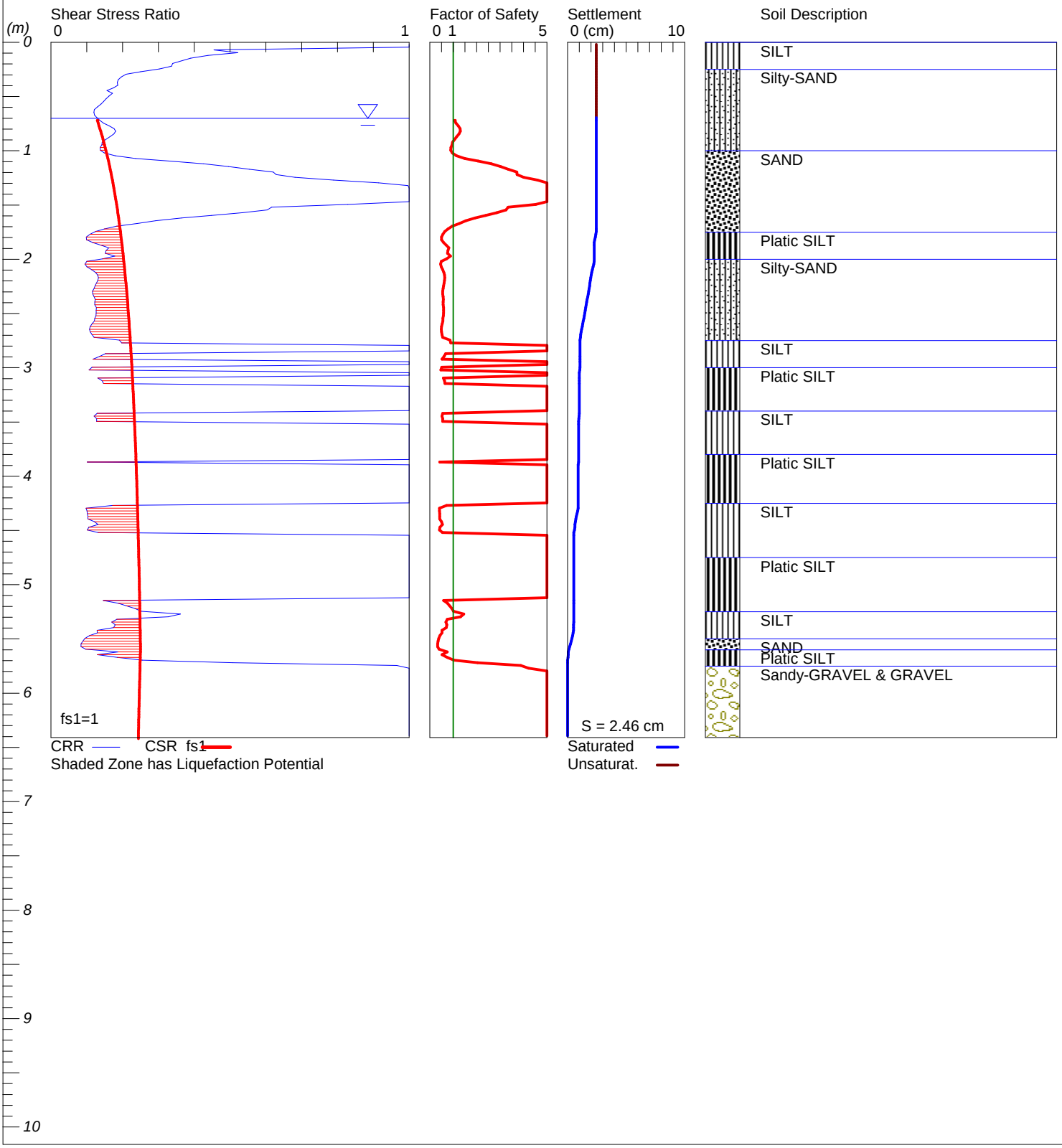
ULS Event **CPT9**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT10 Water Depth=0.7 m

Magnitude=7.5
Acceleration=0.2g

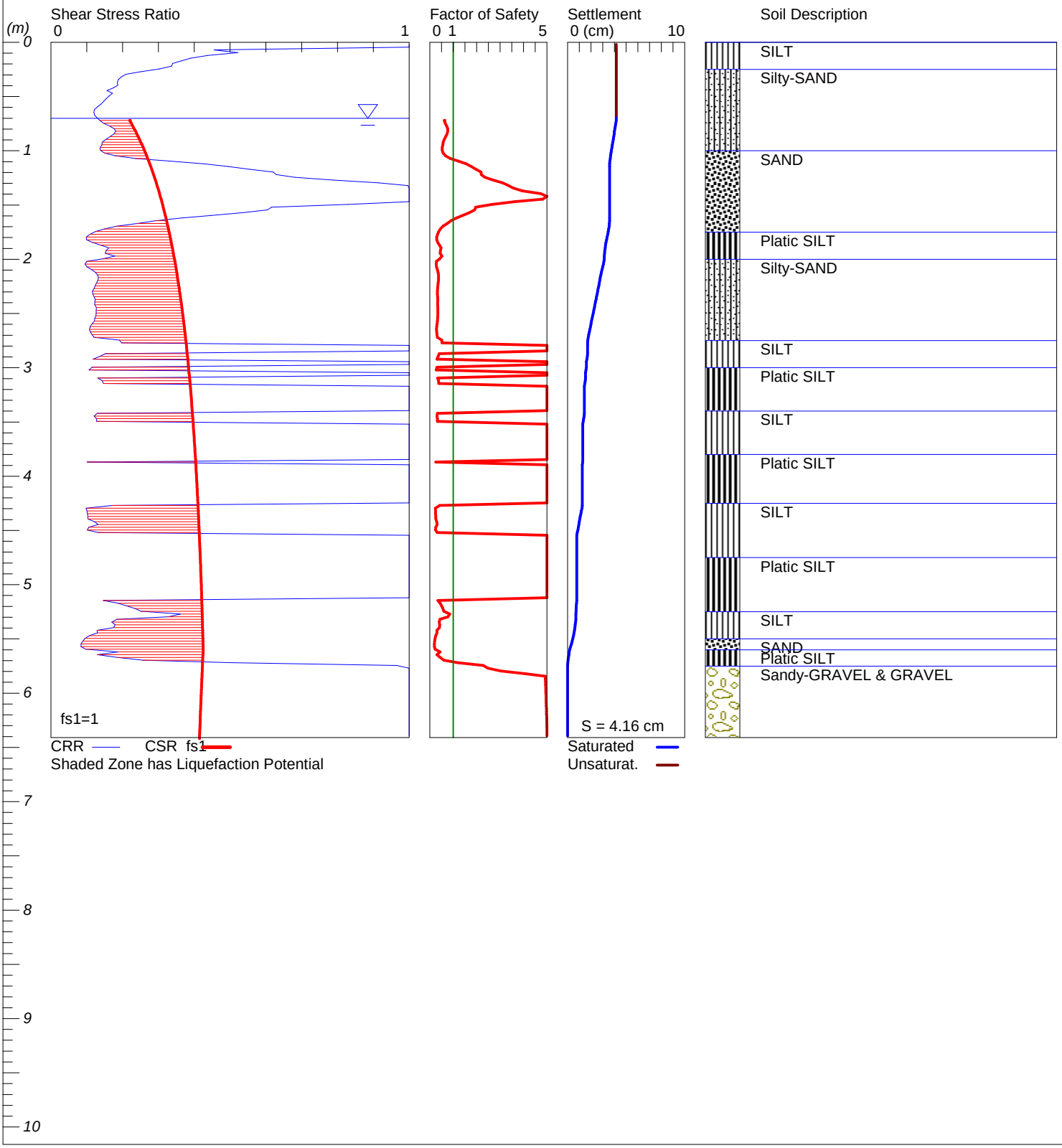


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT10 Water Depth=0.7 m

Magnitude=7.5
Acceleration=0.34g

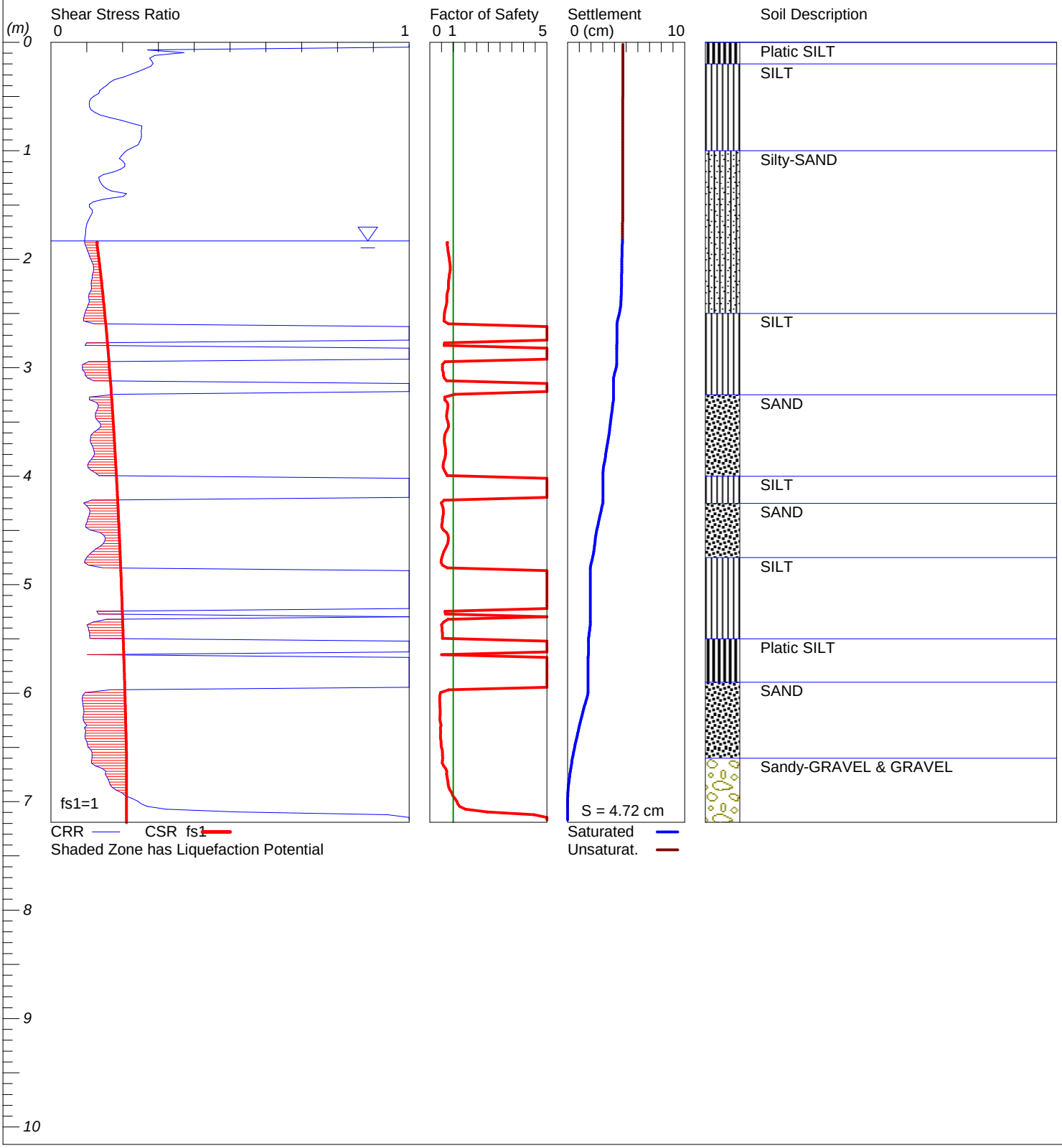


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT11 Water Depth=1.83 m

Magnitude=7.5
Acceleration=0.2g



SLS Event

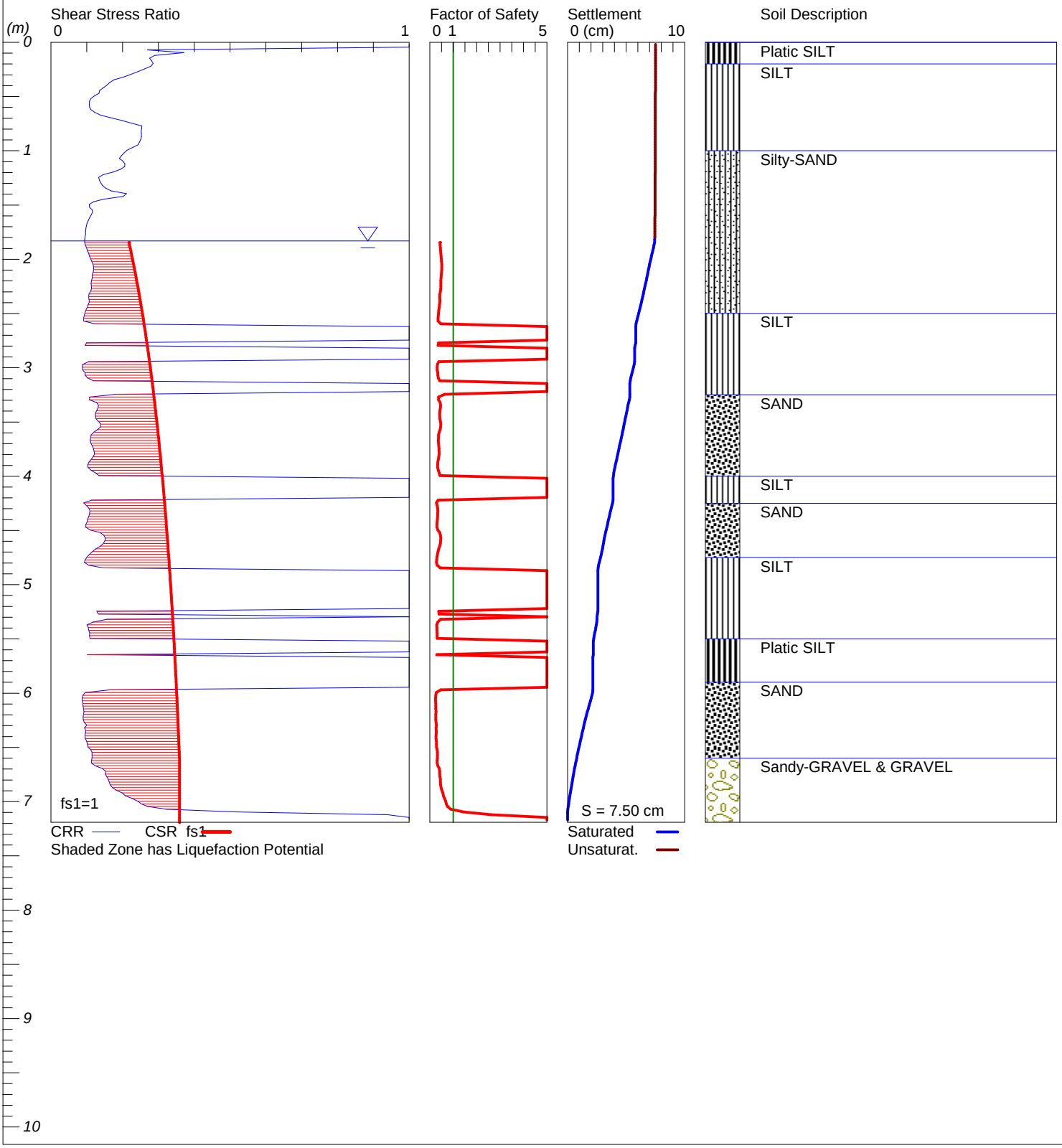
CPT10

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT11 Water Depth=1.83 m

Magnitude=7.5
Acceleration=0.34g



ULS Event

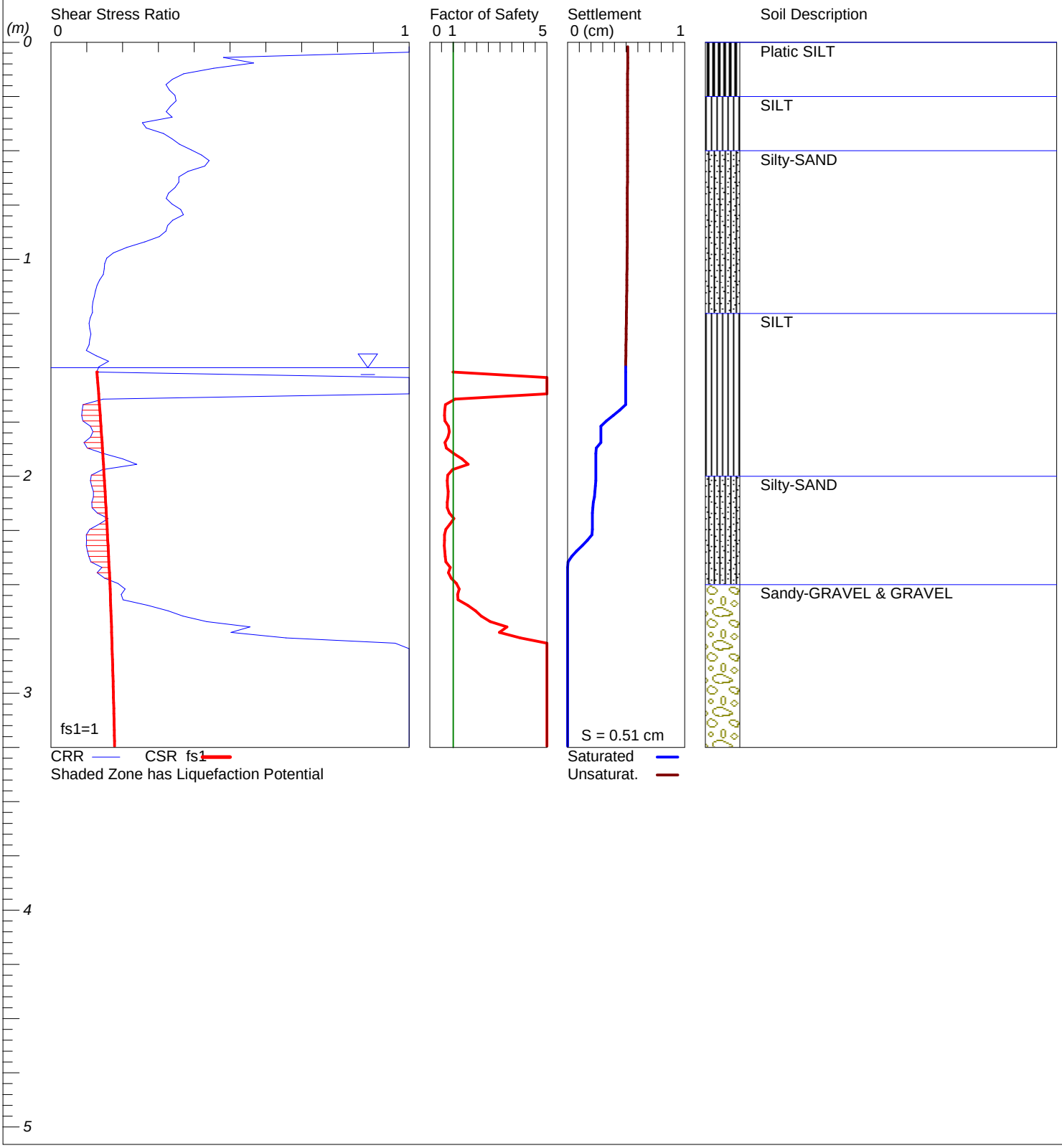
CPT10

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT12 ***Water Depth=1.5 m***

Magnitude=7.5
Acceleration=0.2g

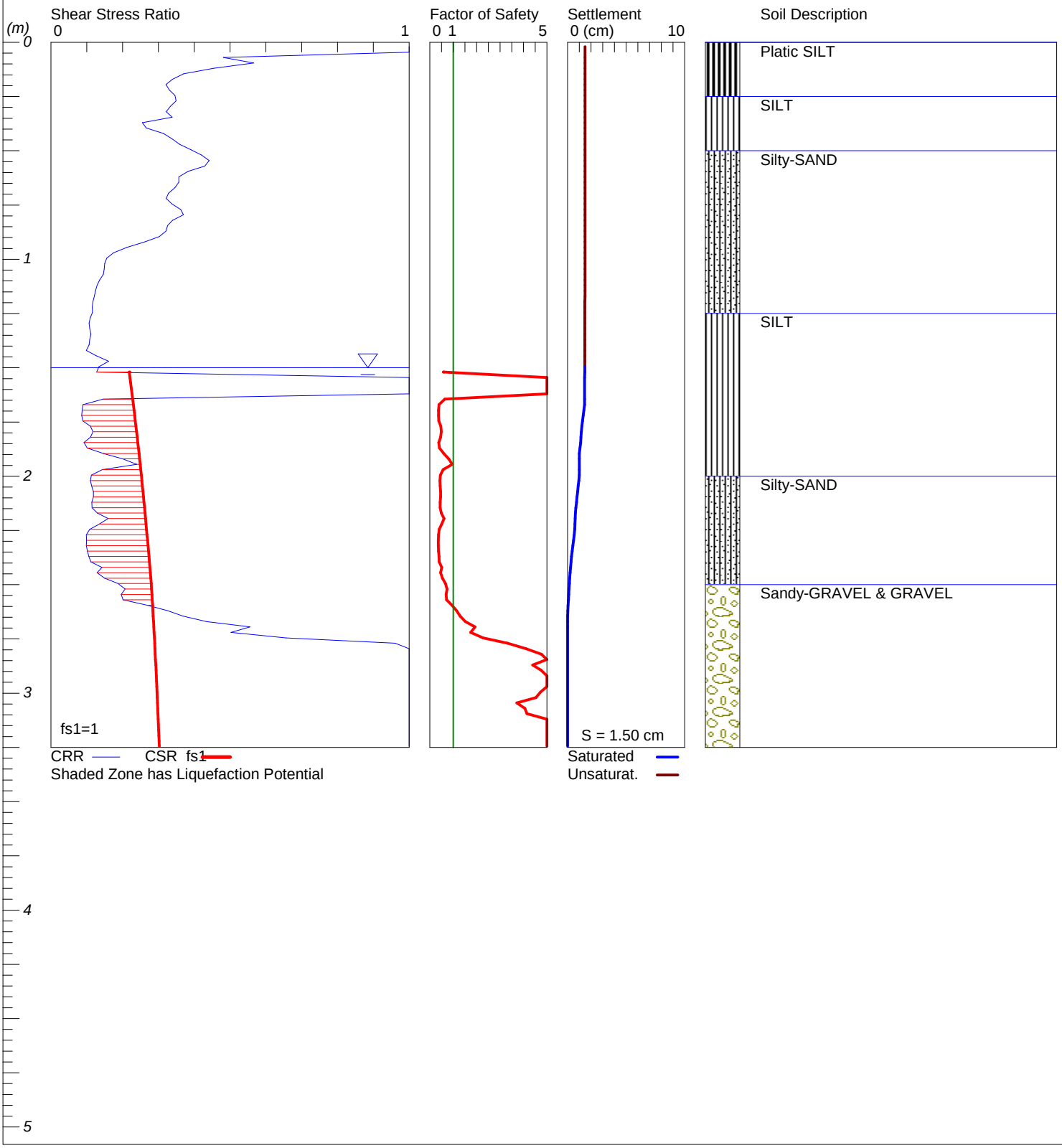


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT12 Water Depth=1.5 m

Magnitude=7.5
Acceleration=0.34g

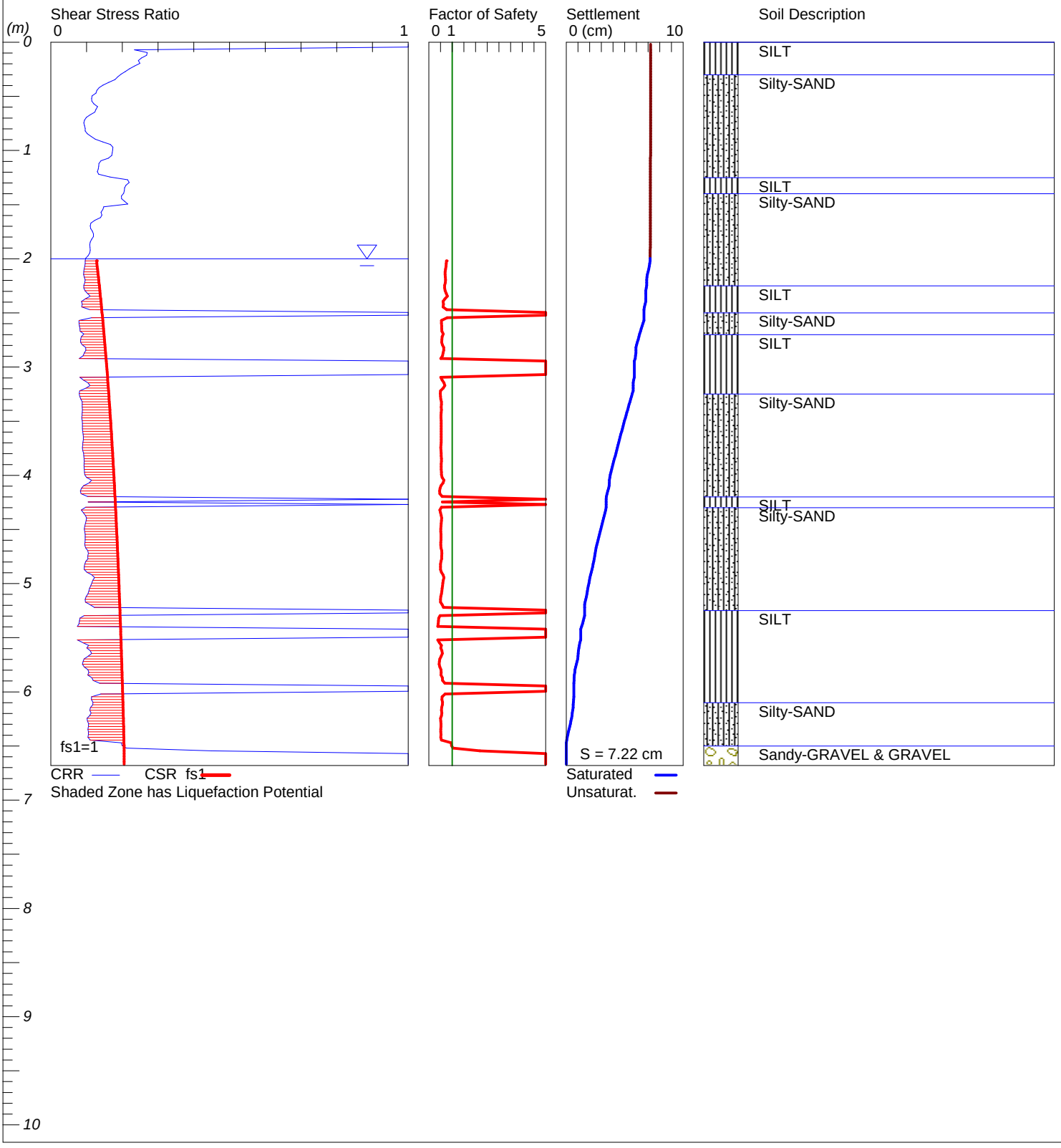


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT14 ***Water Depth=2 m***

Magnitude=7.5
Acceleration=0.2g



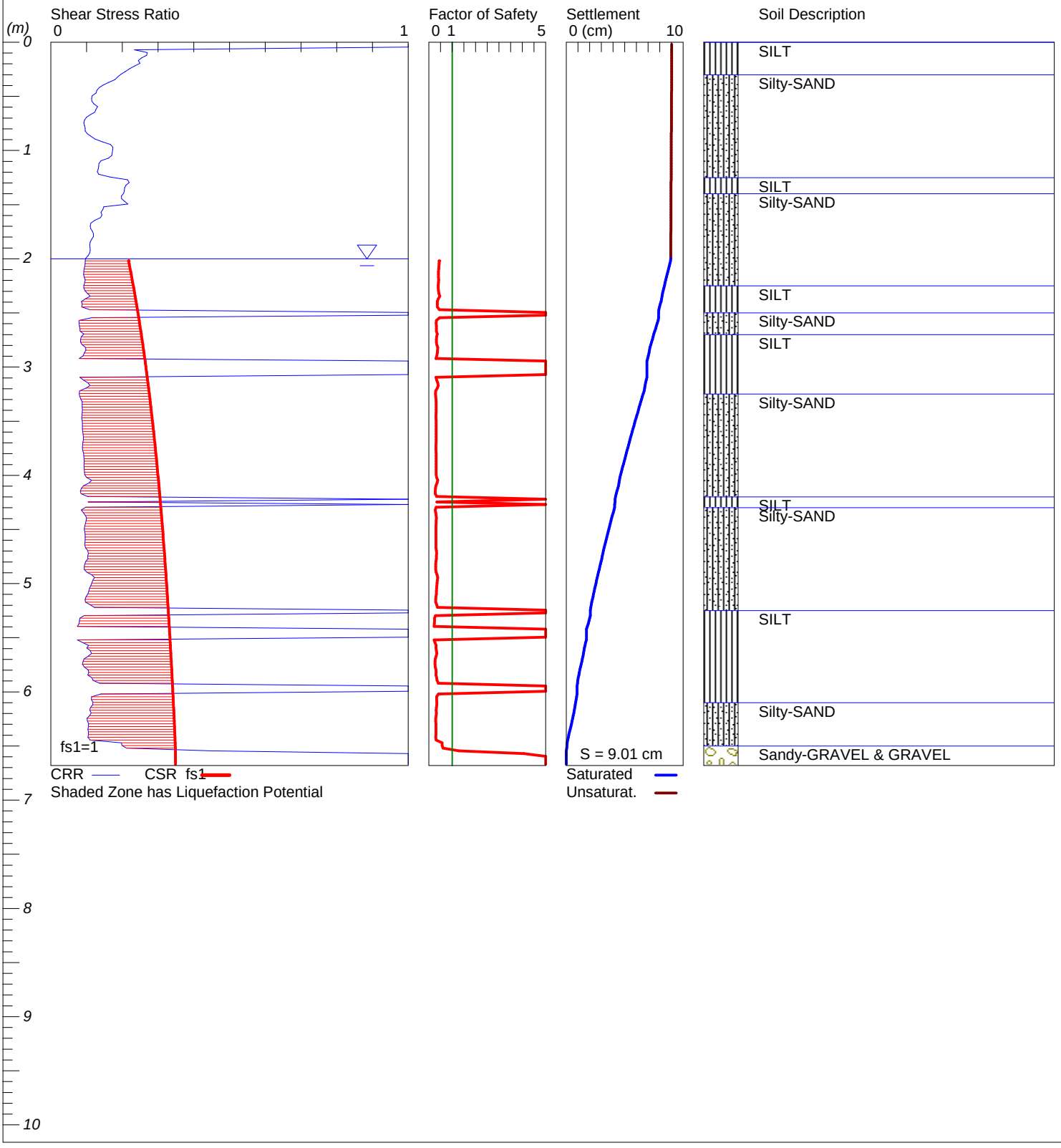
SLS Event **CPT14**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT14 ***Water Depth=2 m***

Magnitude=7.5
Acceleration=0.34g



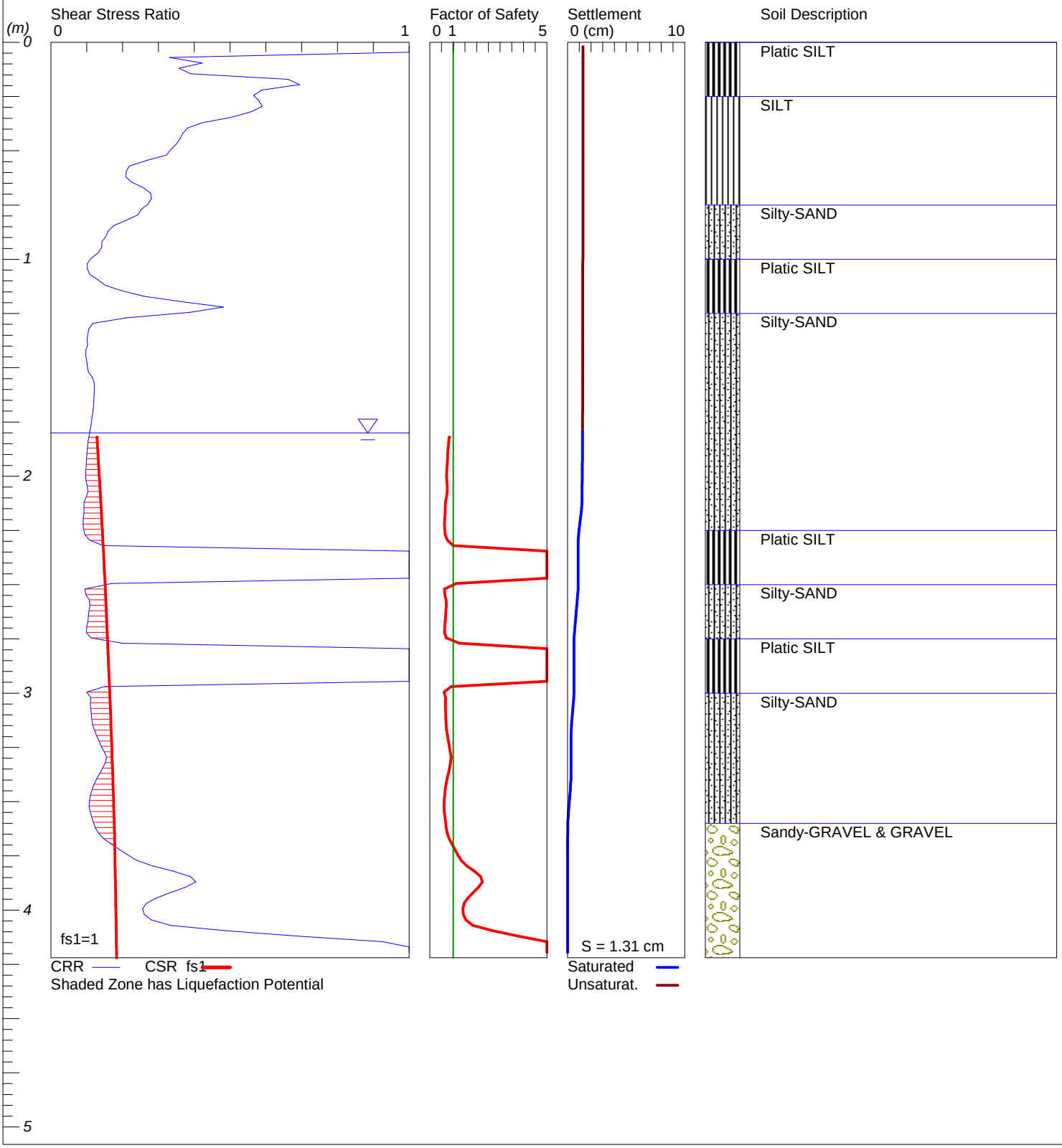
ULS Event **CPT14**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT15 Water Depth=1.8 m

Magnitude=7.5
Acceleration=0.2g



SLS Event

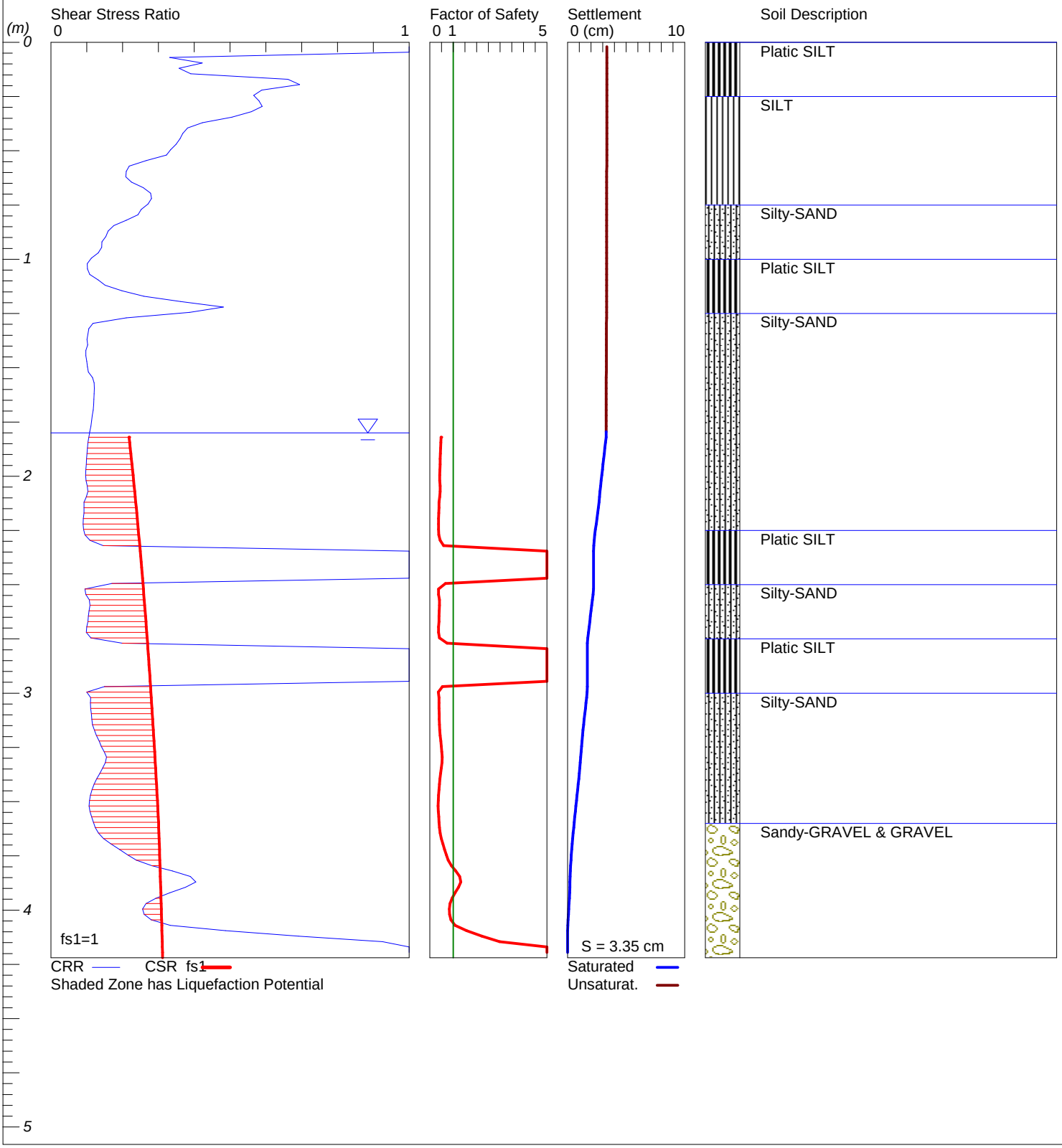
CPT15

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT15 Water Depth=1.8 m

Magnitude=7.5
Acceleration=0.34g



ULS Event

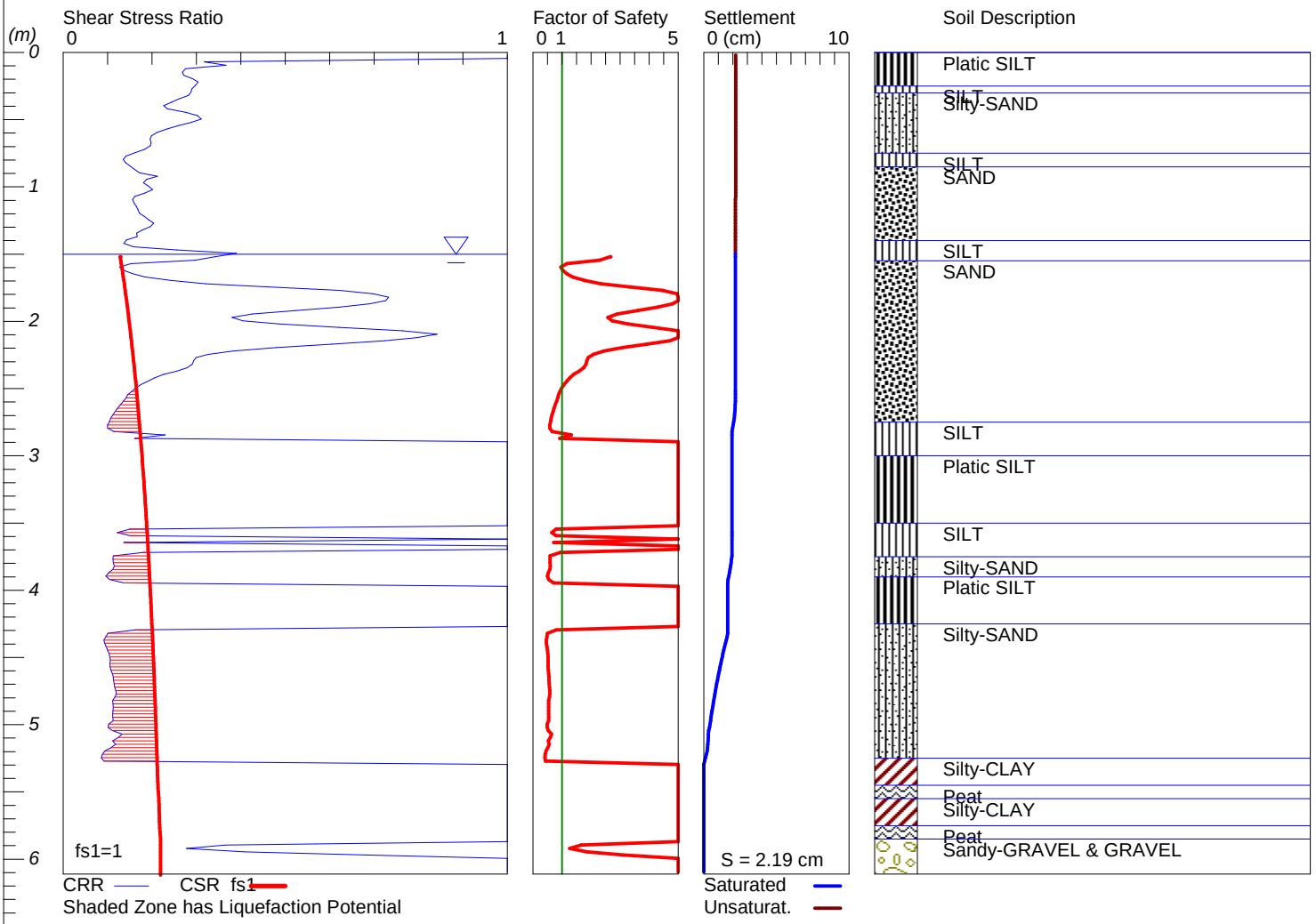
CPT15

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT30 Water Depth=1.5 m

Magnitude=7.5
Acceleration=0.2g



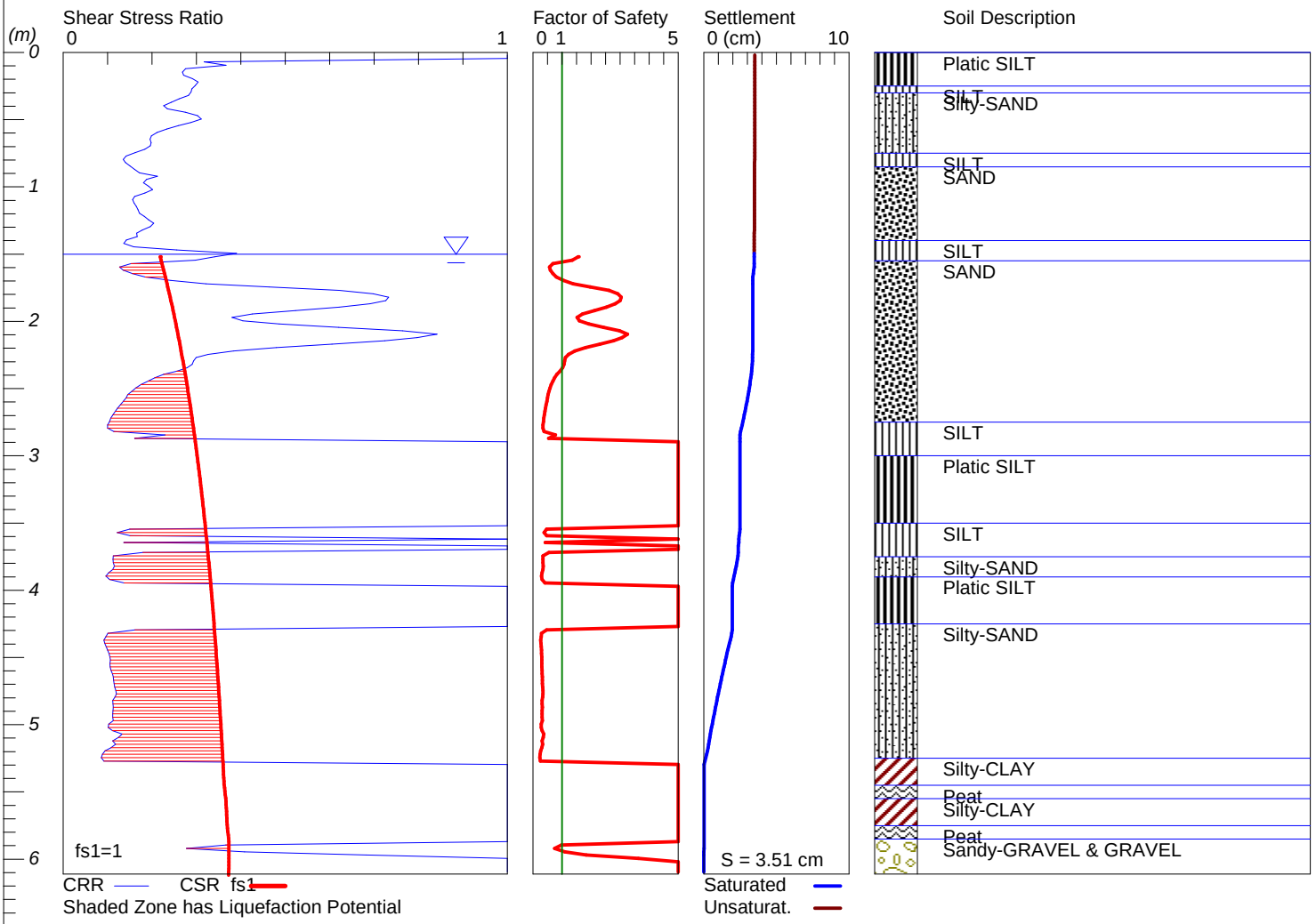
SLS Event **CPT30**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT30 ***Water Depth=1.5 m***

Magnitude=7.5
Acceleration=0.34g

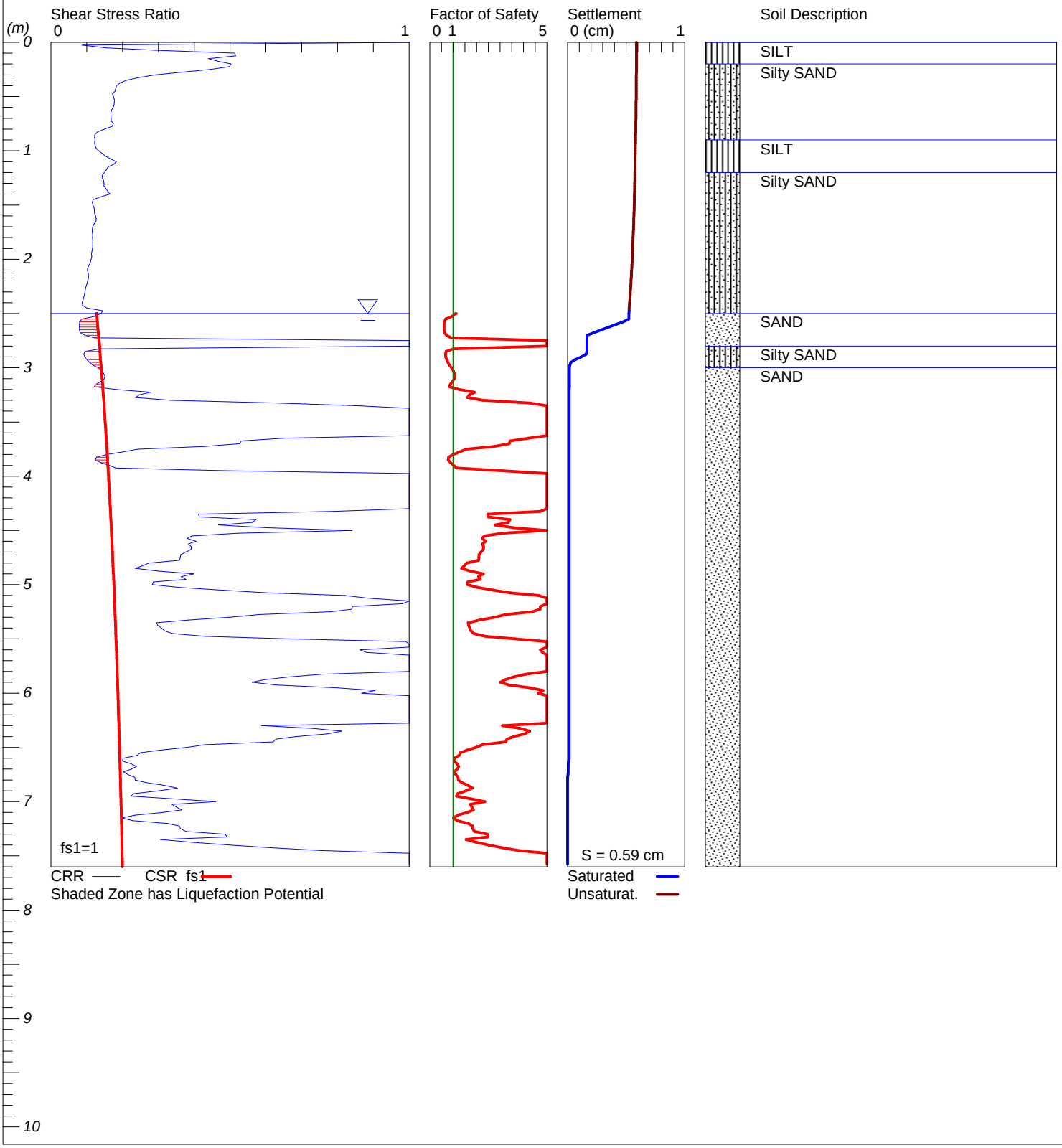


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT32 ***Water Depth=2.5 m***

Magnitude=7.5
Acceleration=0.2g



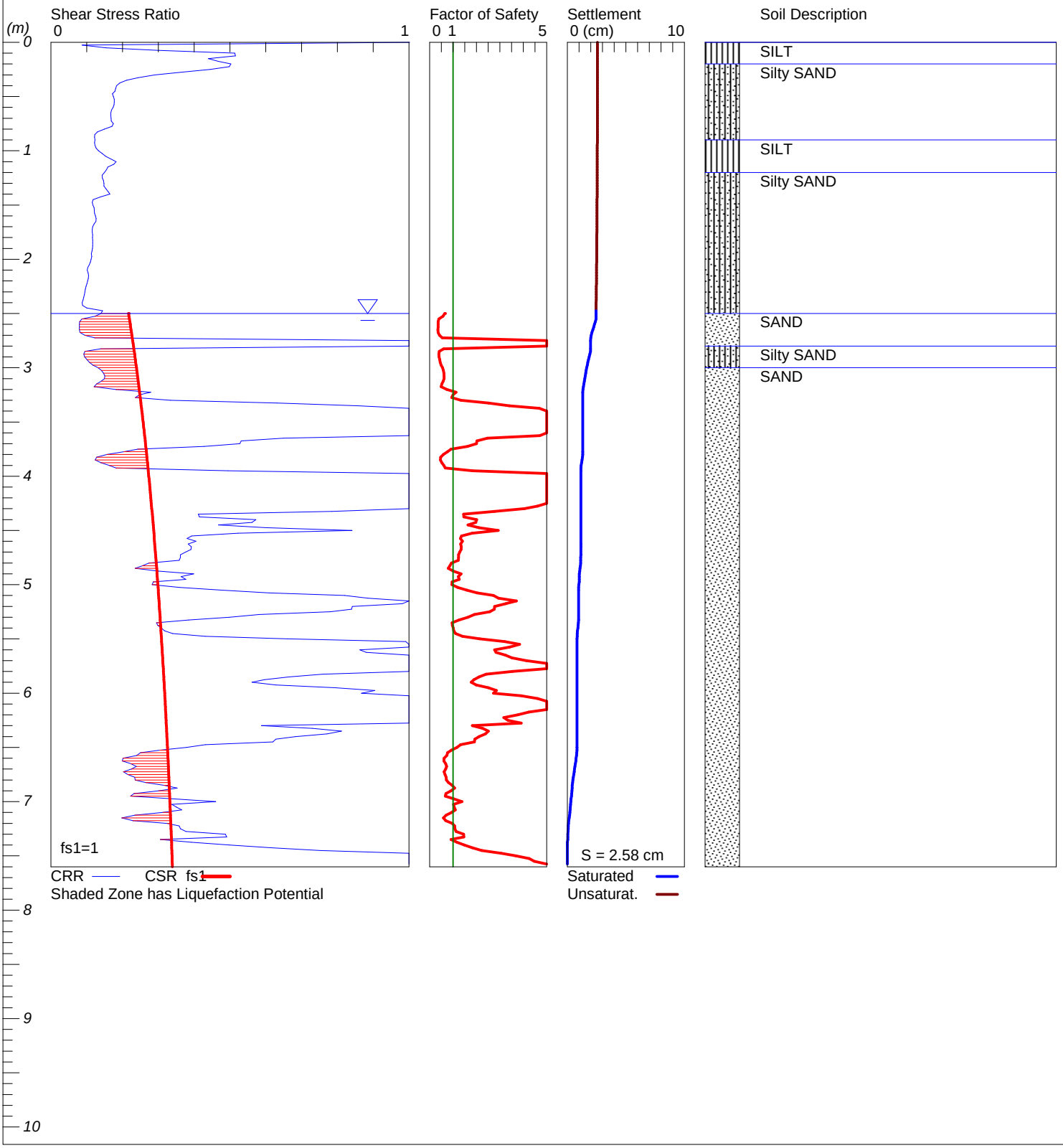
SLS Event **CPT32**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT32 ***Water Depth=2.5 m***

Magnitude=7.5
Acceleration=0.34g



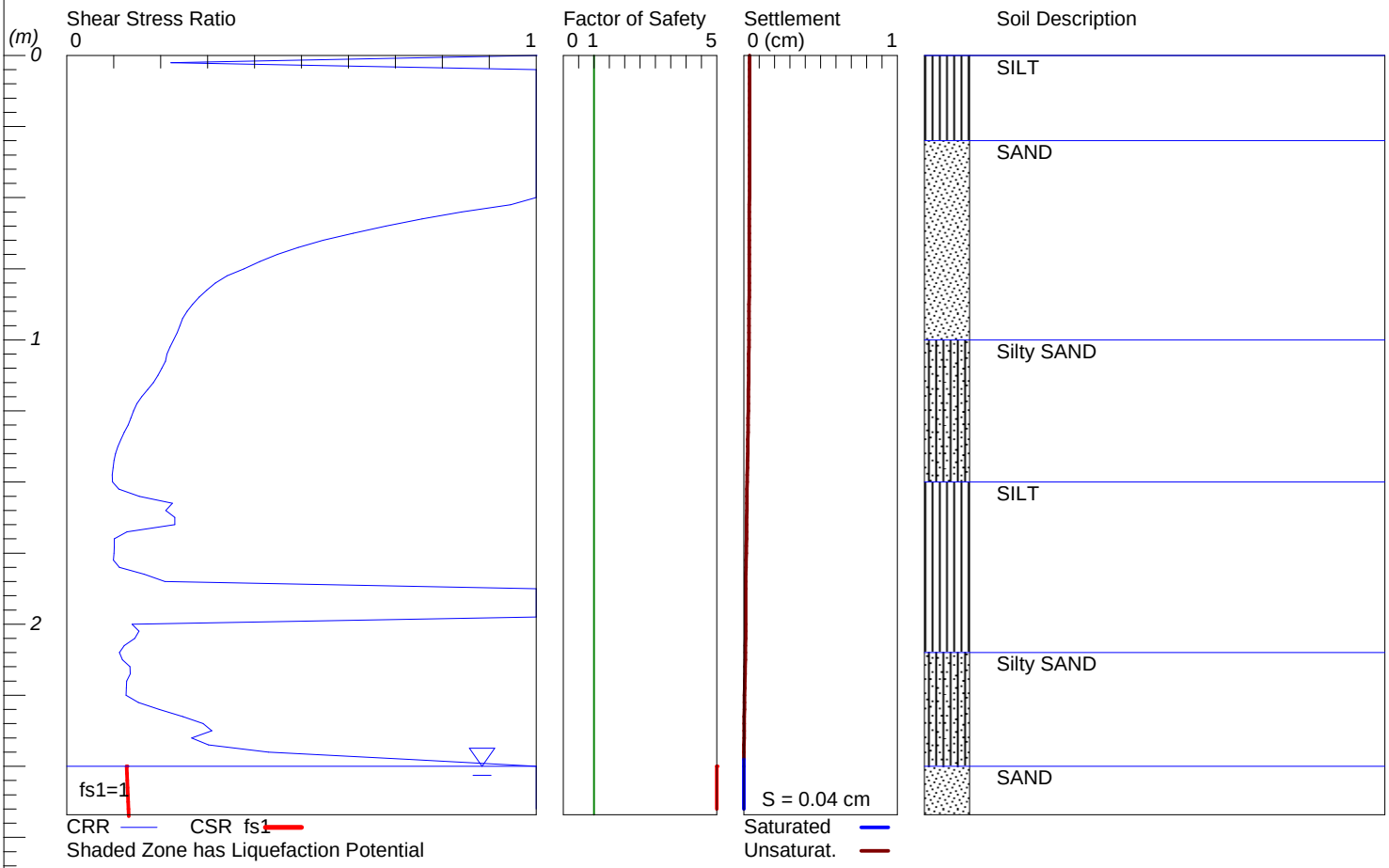
ULS Event **CPT32**

LIQUEFACTION ANALYSIS

Roemerryn Residental Development

Hole No.=CPT33 Water Depth=2.5 m

Magnitude=7.5
Acceleration=0.2g



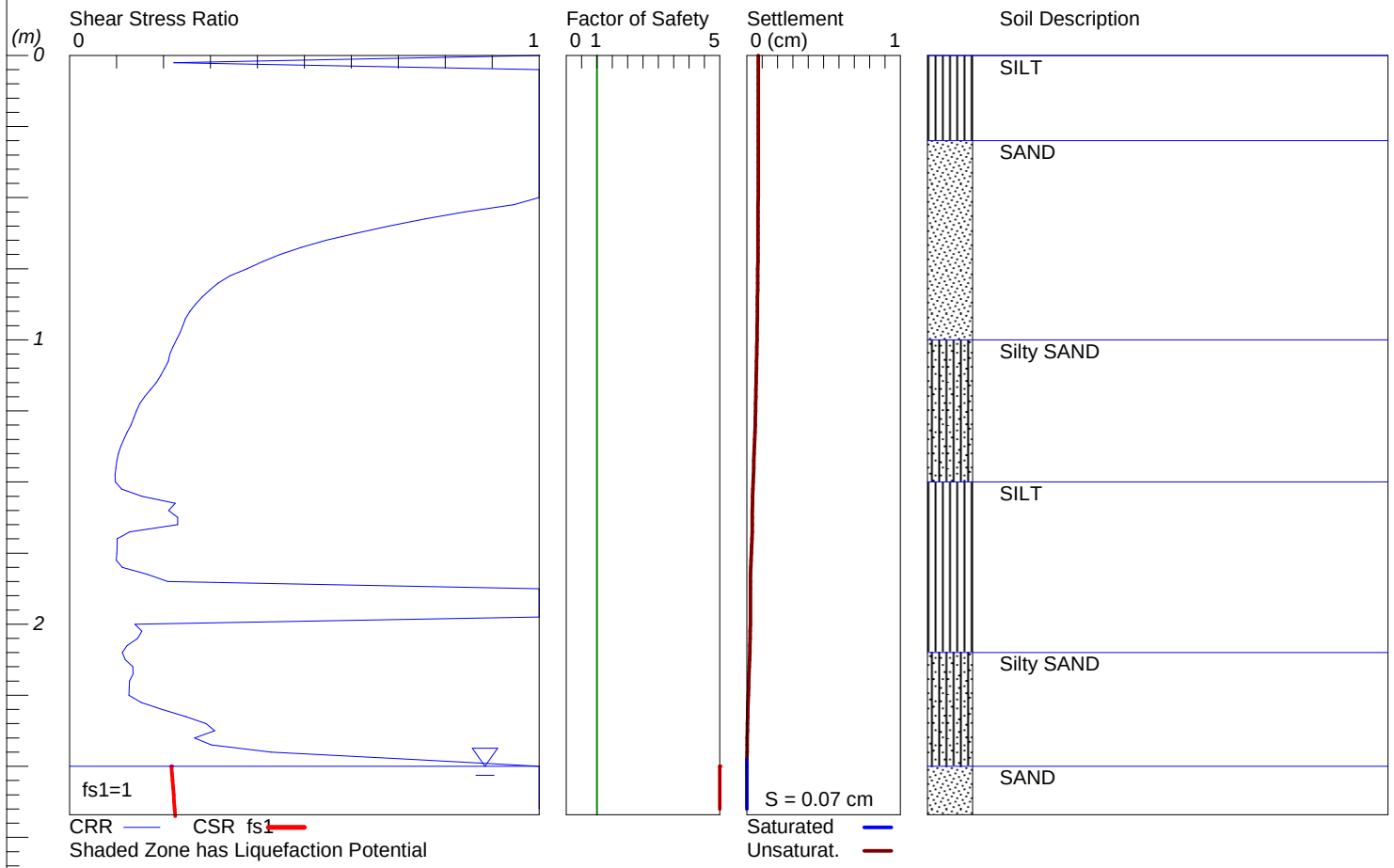
SLS Event **CPT33**

LIQUEFACTION ANALYSIS

Roemerryn Residental Development

Hole No.=CPT33 Water Depth=2.5 m

Magnitude=7.5
Acceleration=0.34g



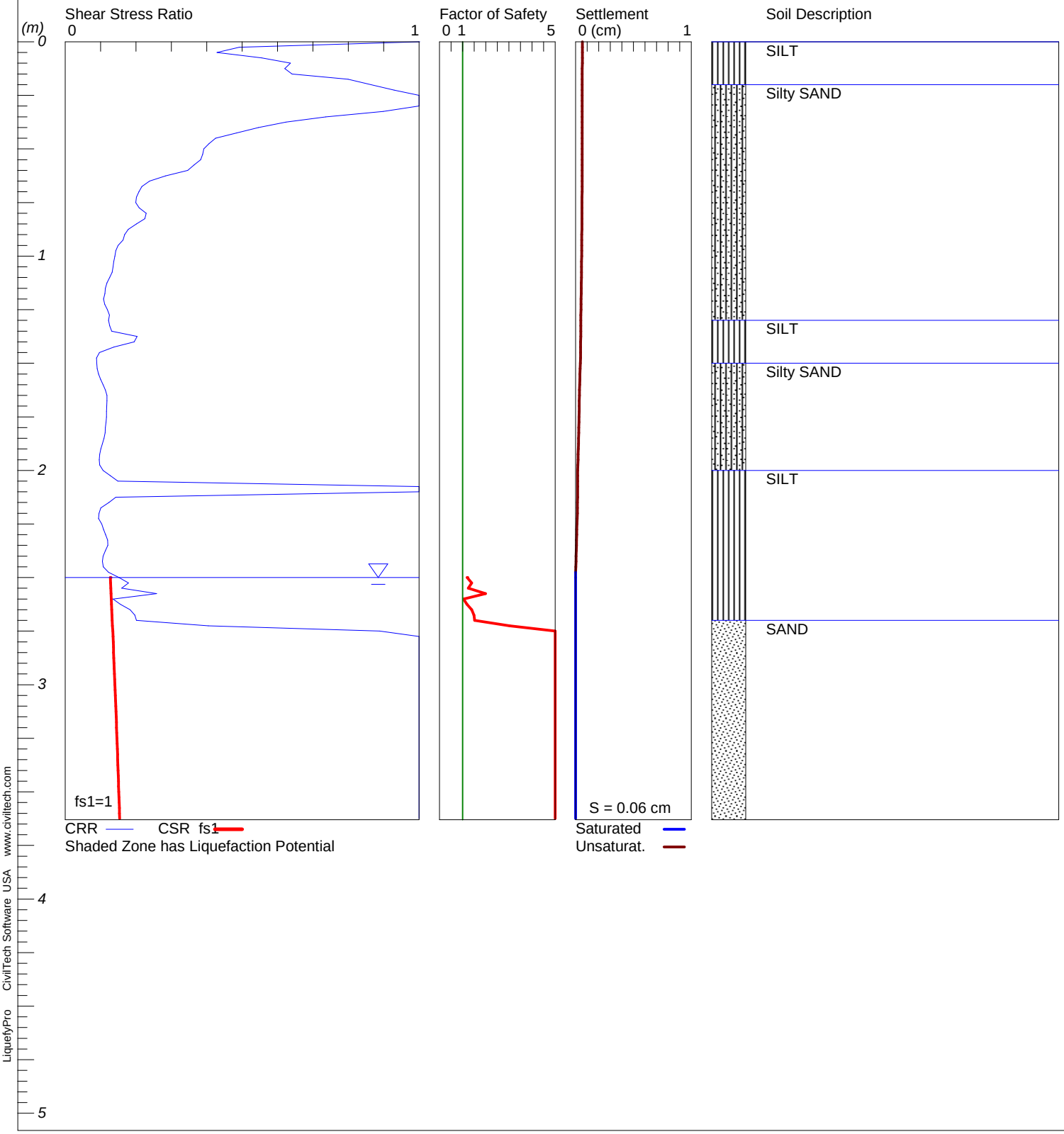
ULS Event **CPT33**

LIQUEFACTION ANALYSIS

Rosemerryn Residental Delvelopment

Hole No.=CPT34 ***Water Depth=2.5 m***

Magnitude=7.5
Acceleration=0.2g



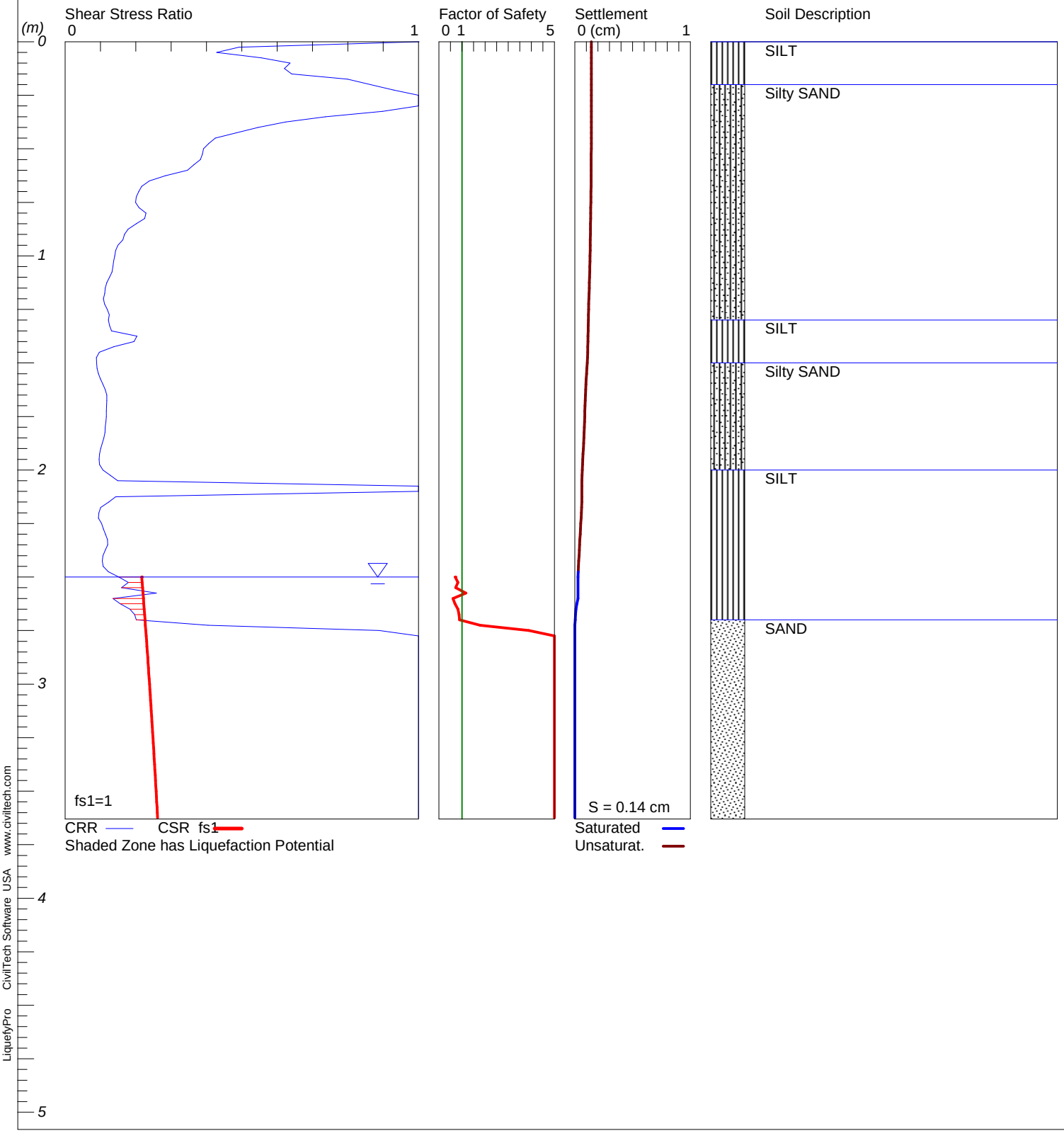
SLS Event **CPT34**

LIQUEFACTION ANALYSIS

Rosemerryn Residental Delvelopment

Hole No.=CPT34 ***Water Depth=2.5 m***

Magnitude=7.5
Acceleration=0.34g



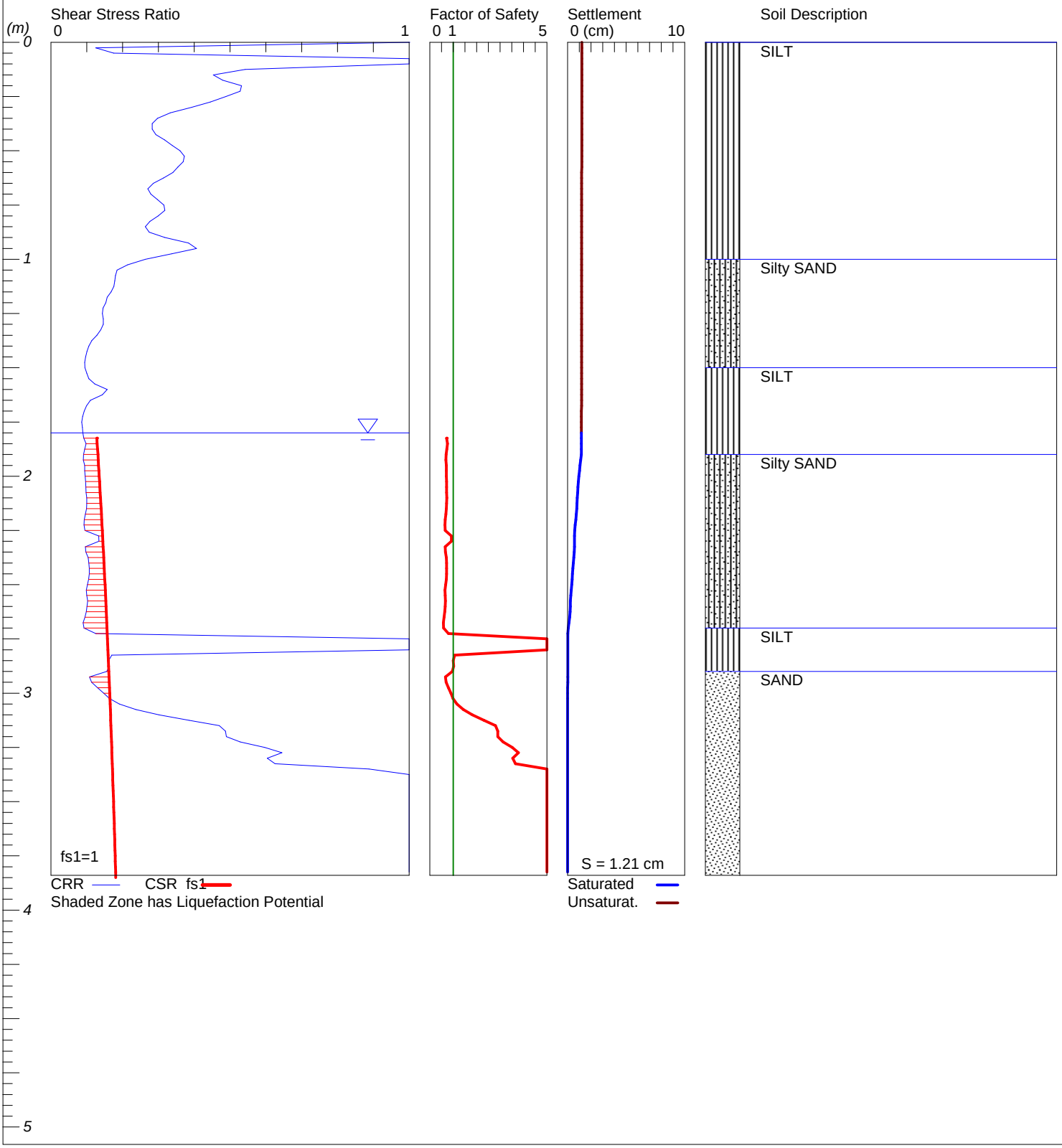
ULS Event **CPT34**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT35 ***Water Depth=1.8 m***

Magnitude=7.5
Acceleration=0.2g



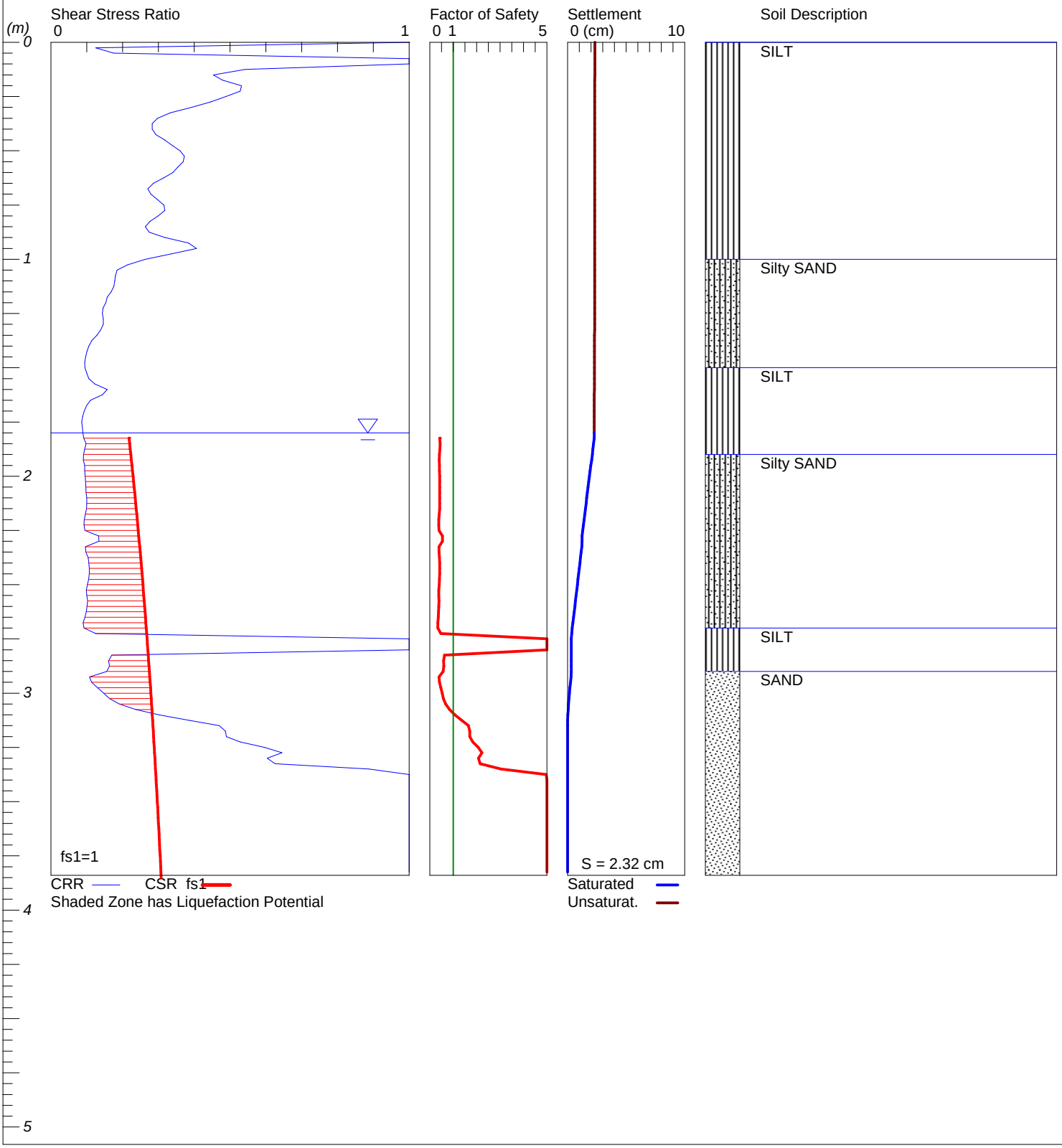
SLS Event **CPT35**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT35 Water Depth=1.8 m

Magnitude=7.5
Acceleration=0.34g



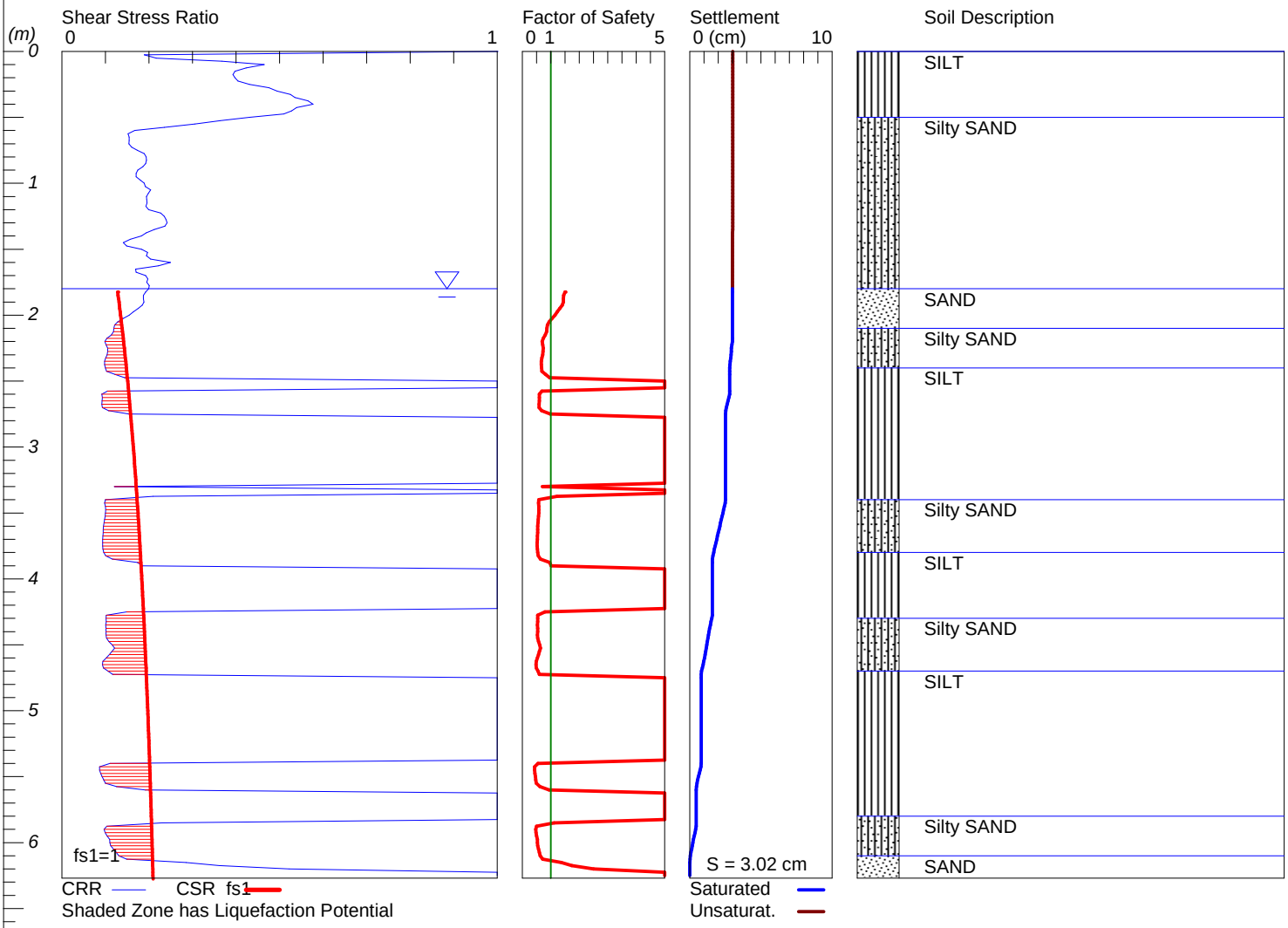
ULS Event **CPT35**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT36 Water Depth=1.8 m

Magnitude=7.5
Acceleration=0.2g



SLS Event

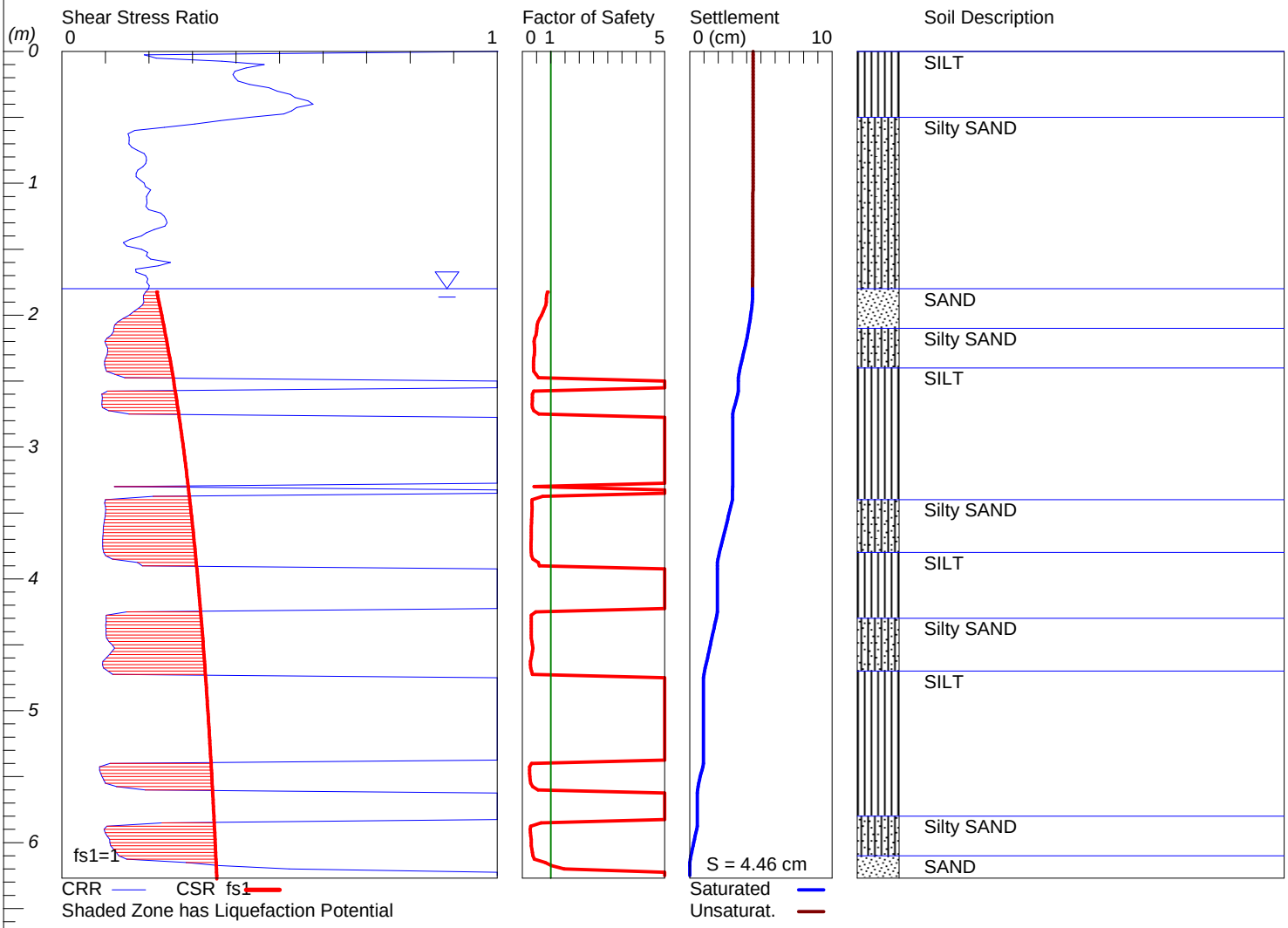
CPT36

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT36 Water Depth=1.8 m

Magnitude=7.5
Acceleration=0.34g

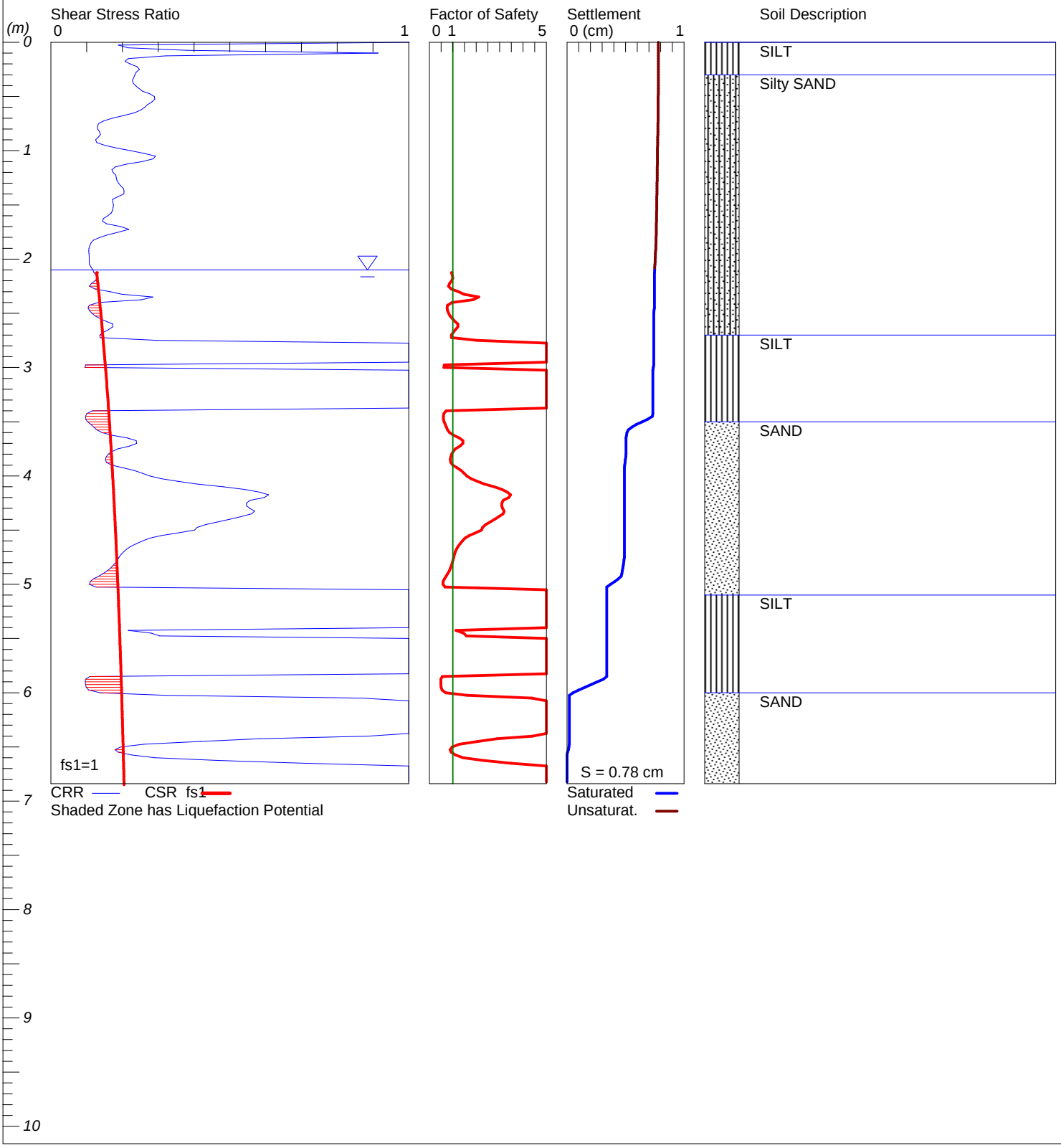


LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT37 ***Water Depth=2.1 m***

Magnitude=7.5
Acceleration=0.2g



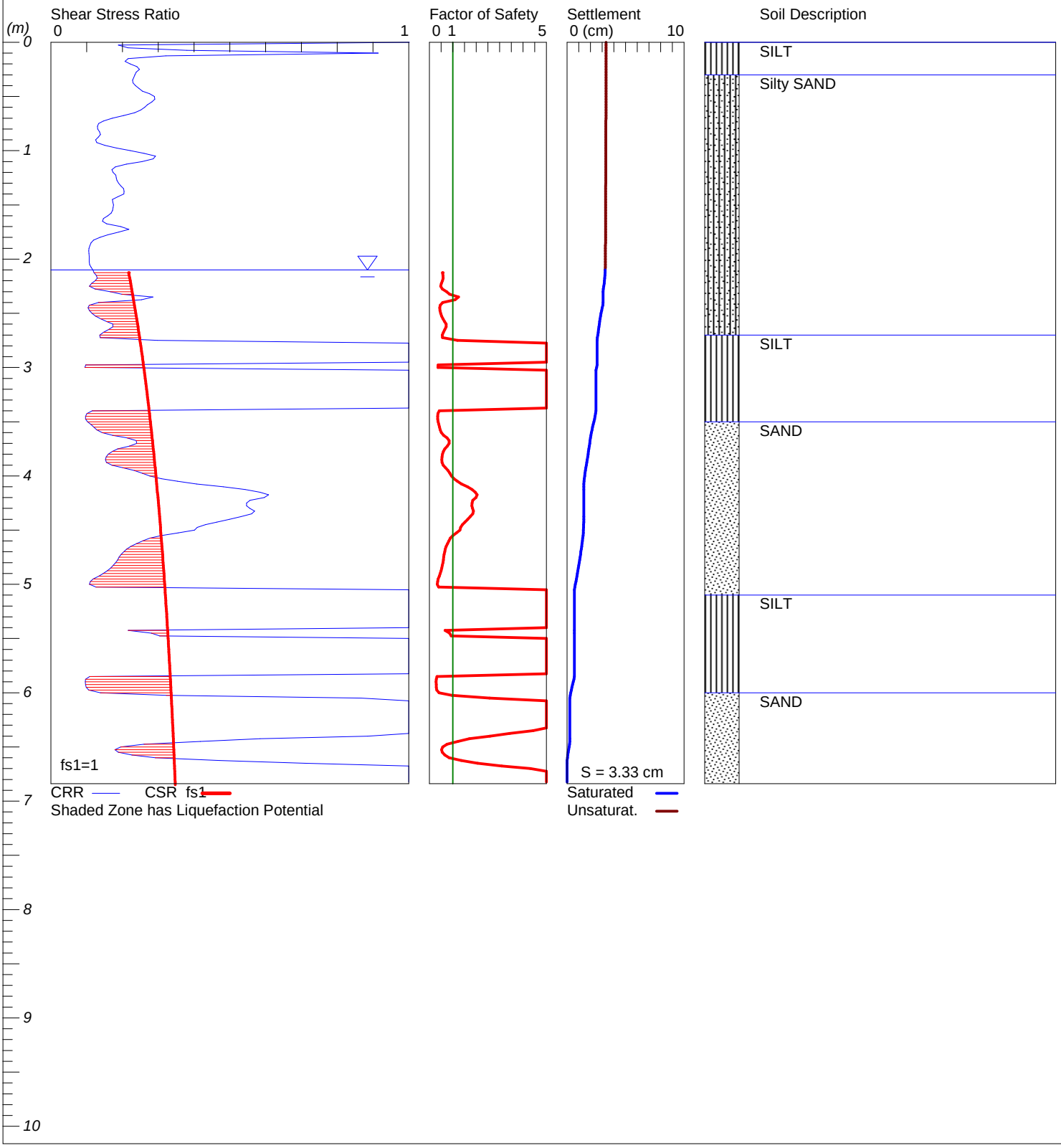
SLS Event **CPT37**

LIQUEFACTION ANALYSIS

Rosemerryn Residential Development

Hole No.=CPT37 ***Water Depth=2.1 m***

Magnitude=7.5
Acceleration=0.34g

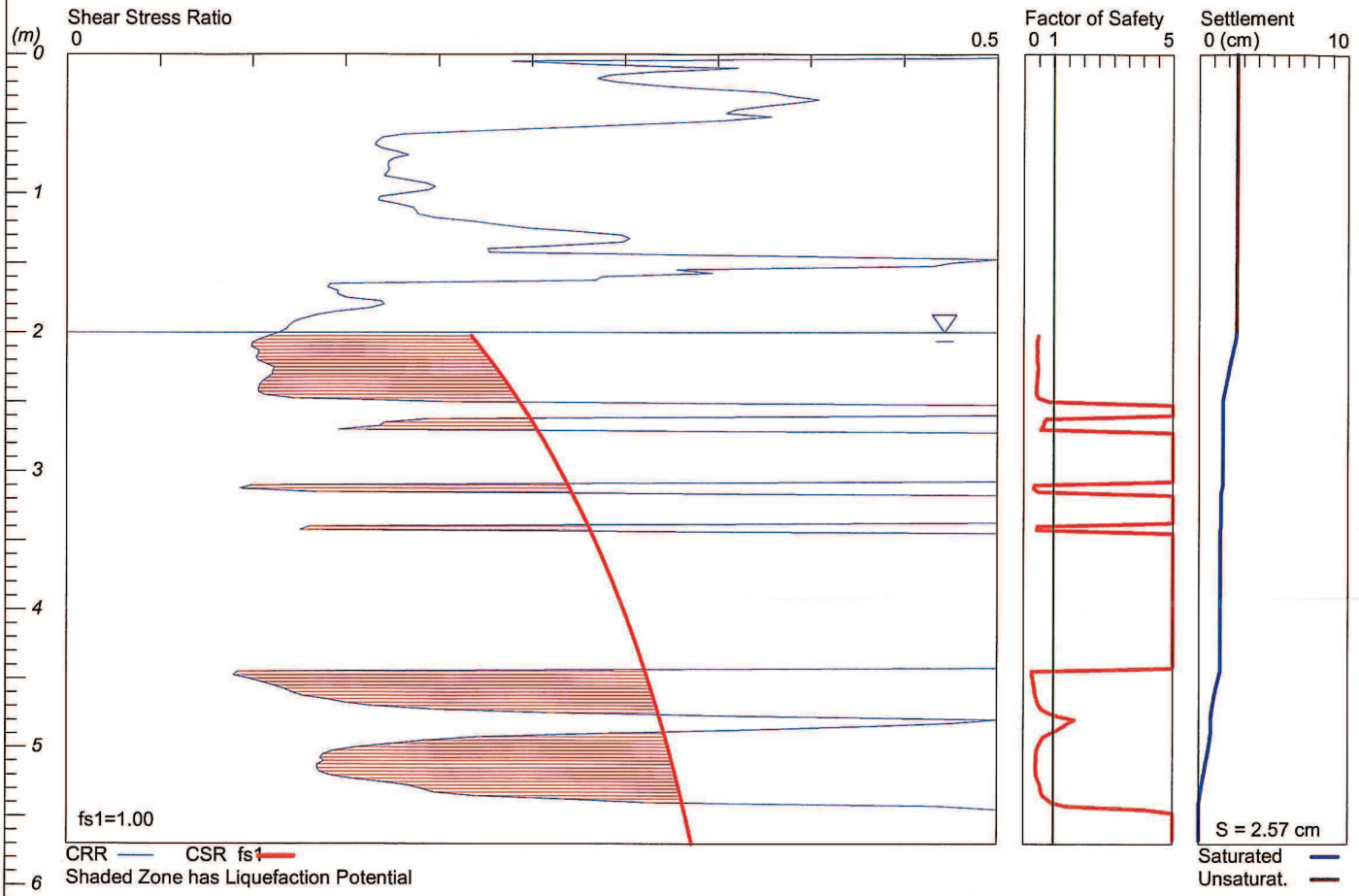


LIQUEFACTION ANALYSIS

Rosemerryn Farm

Hole No.=CPT38 Water Depth=2 m

Magnitude=7.5
Acceleration=0.34g

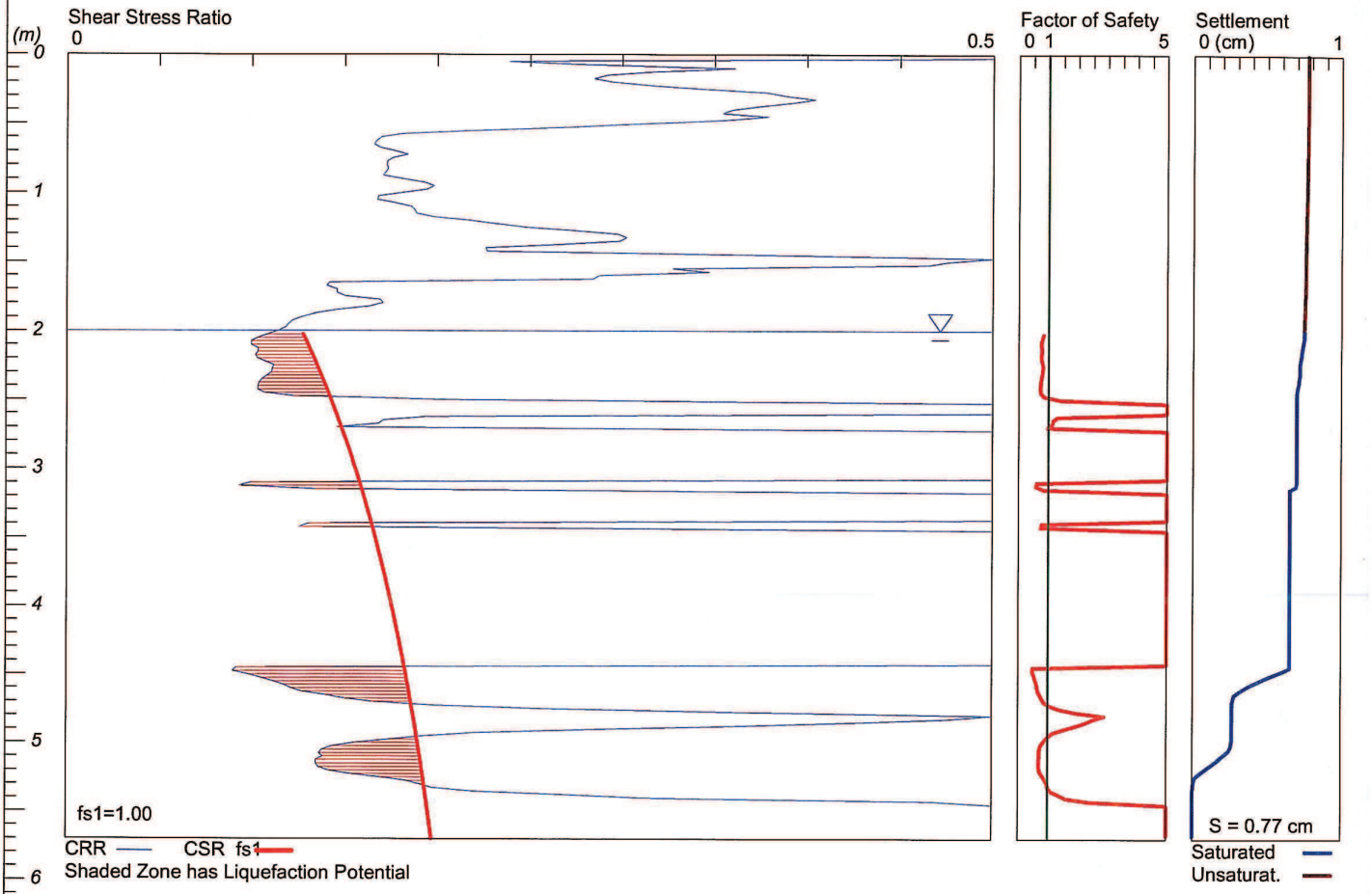


LIQUEFACTION ANALYSIS

Rosemerryn Farm

Hole No.=CPT38 Water Depth=2 m

Magnitude=7.5
Acceleration=0.2g

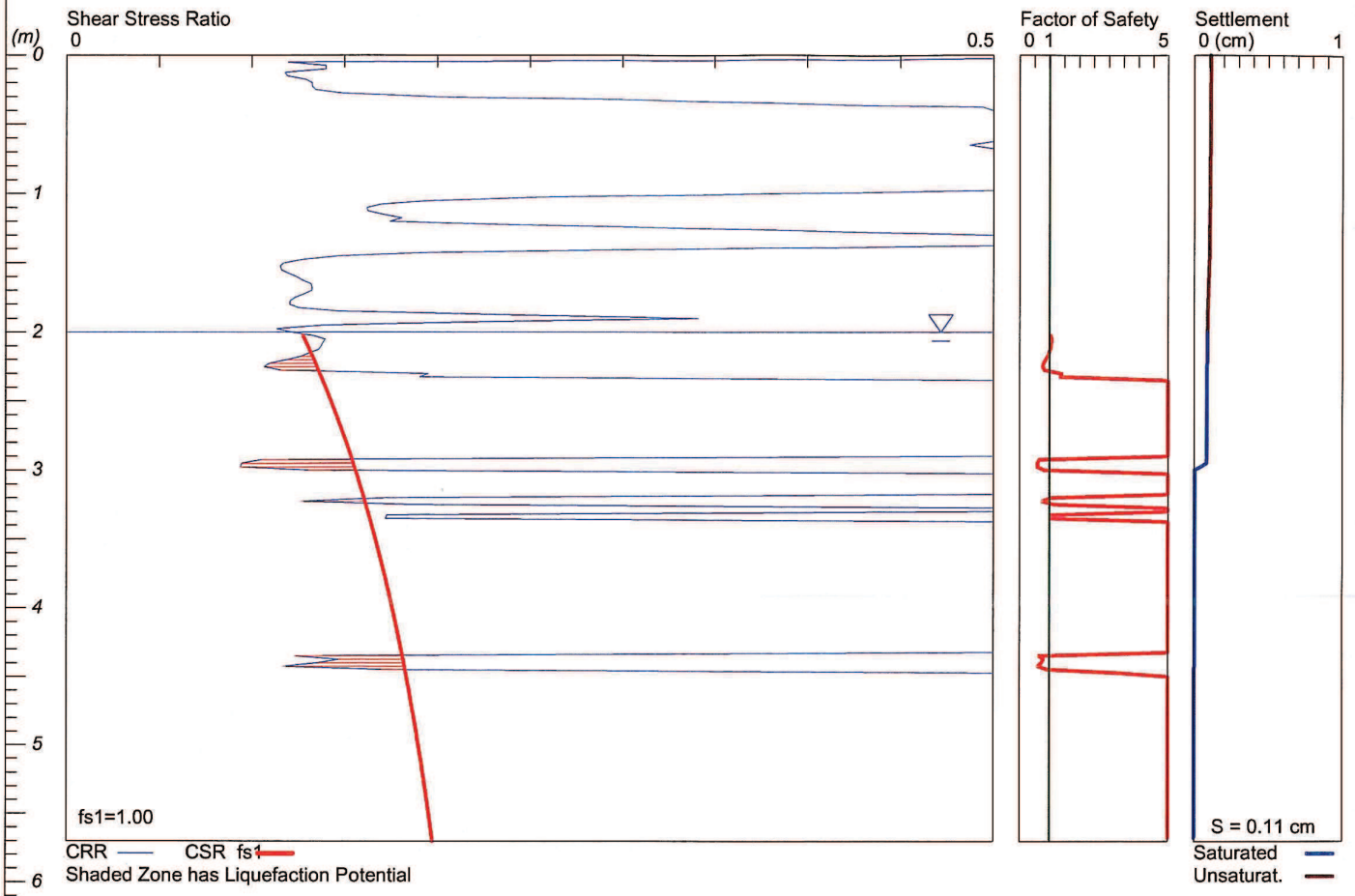


LIQUEFACTION ANALYSIS

Rosemerryn Farm

Hole No.=CPT39 Water Depth=2 m

Magnitude=7.5
Acceleration=0.2g

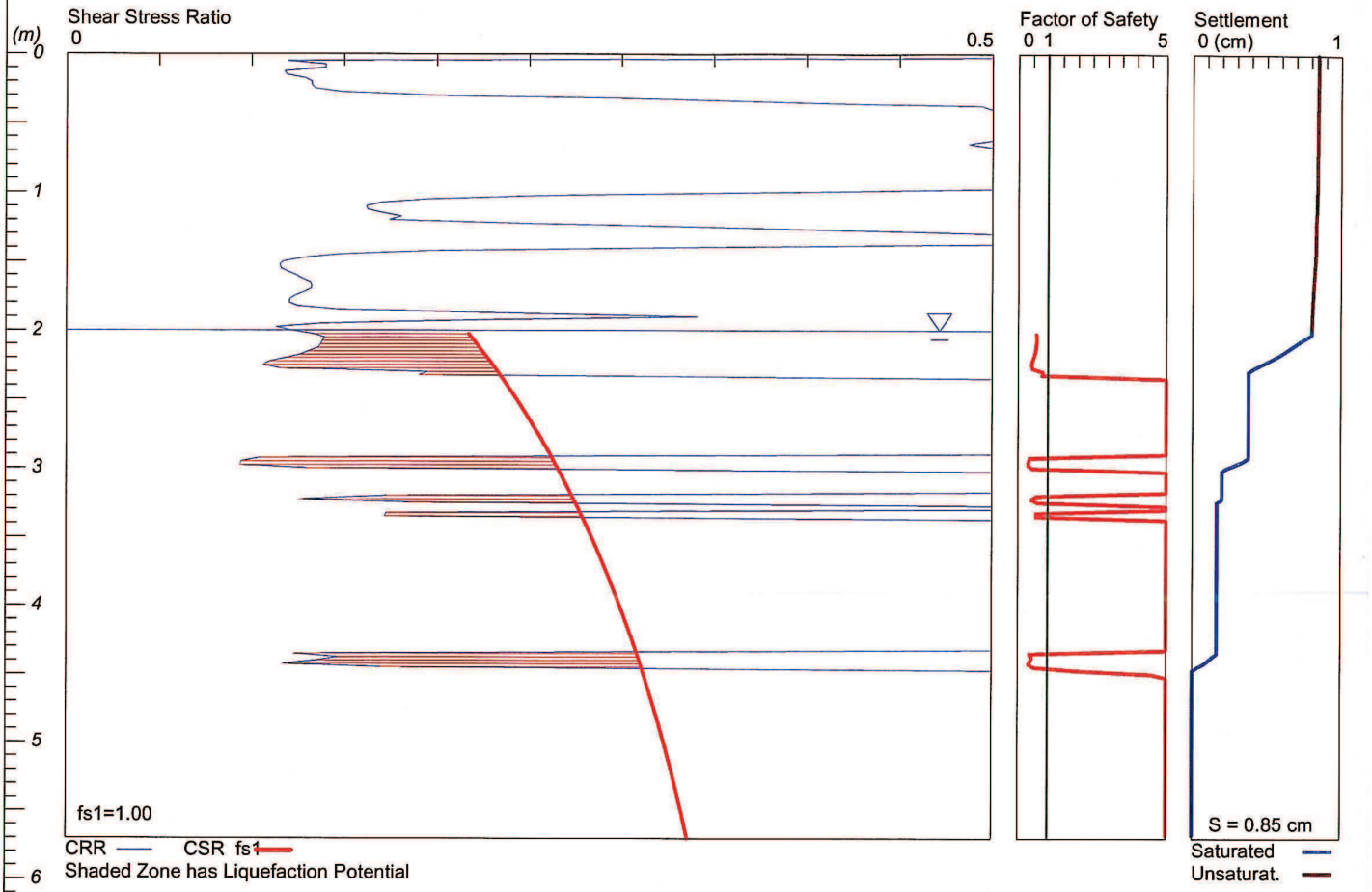


LIQUEFACTION ANALYSIS

Rosemerryn Farm

Hole No.=CPT39 Water Depth=2 m

Magnitude=7.5
Acceleration=0.34g

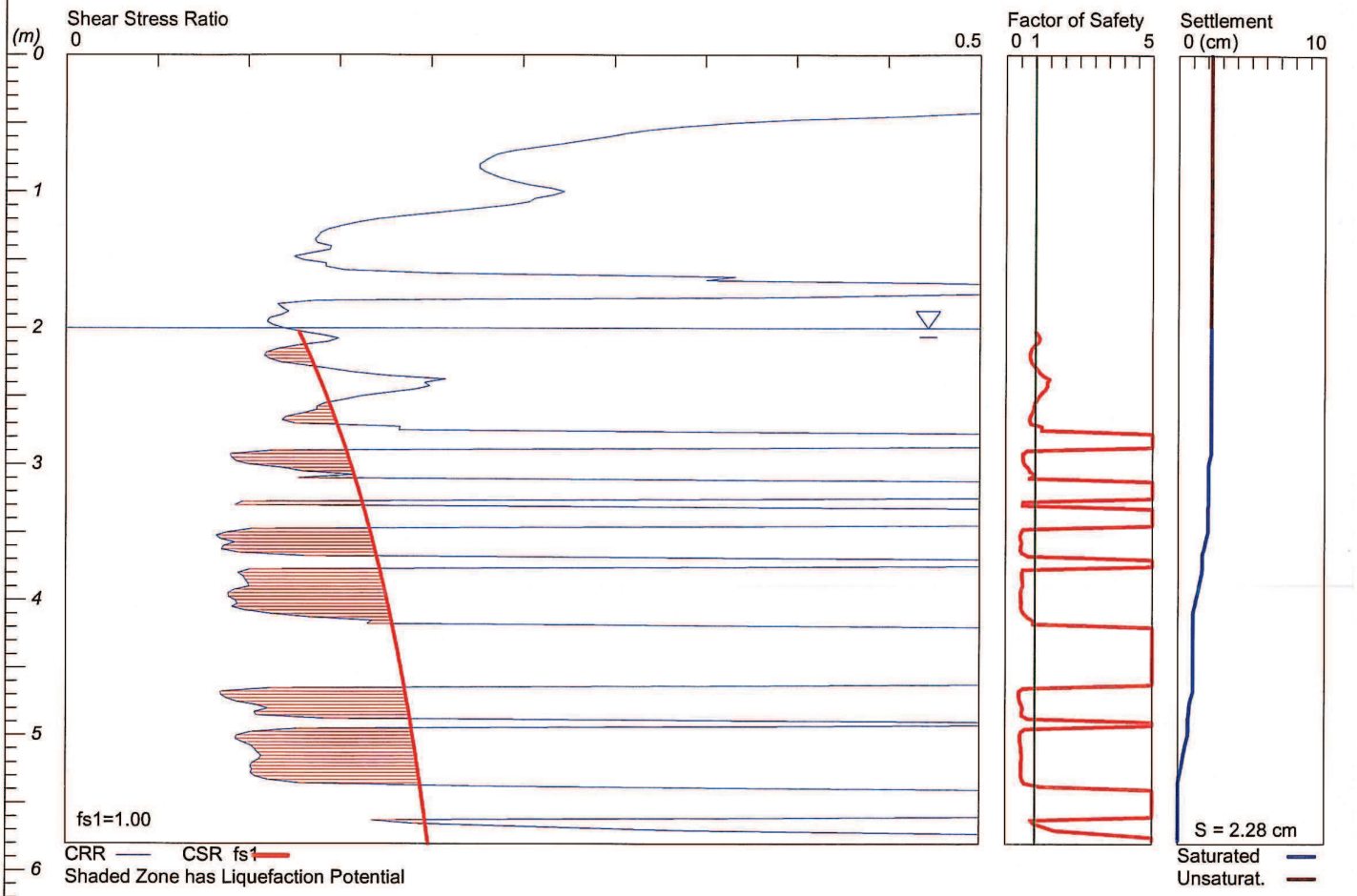


LIQUEFACTION ANALYSIS

Rosemerryn Farm

Hole No.=CPT40 Water Depth=2 m

Magnitude=7.5
Acceleration=0.2g

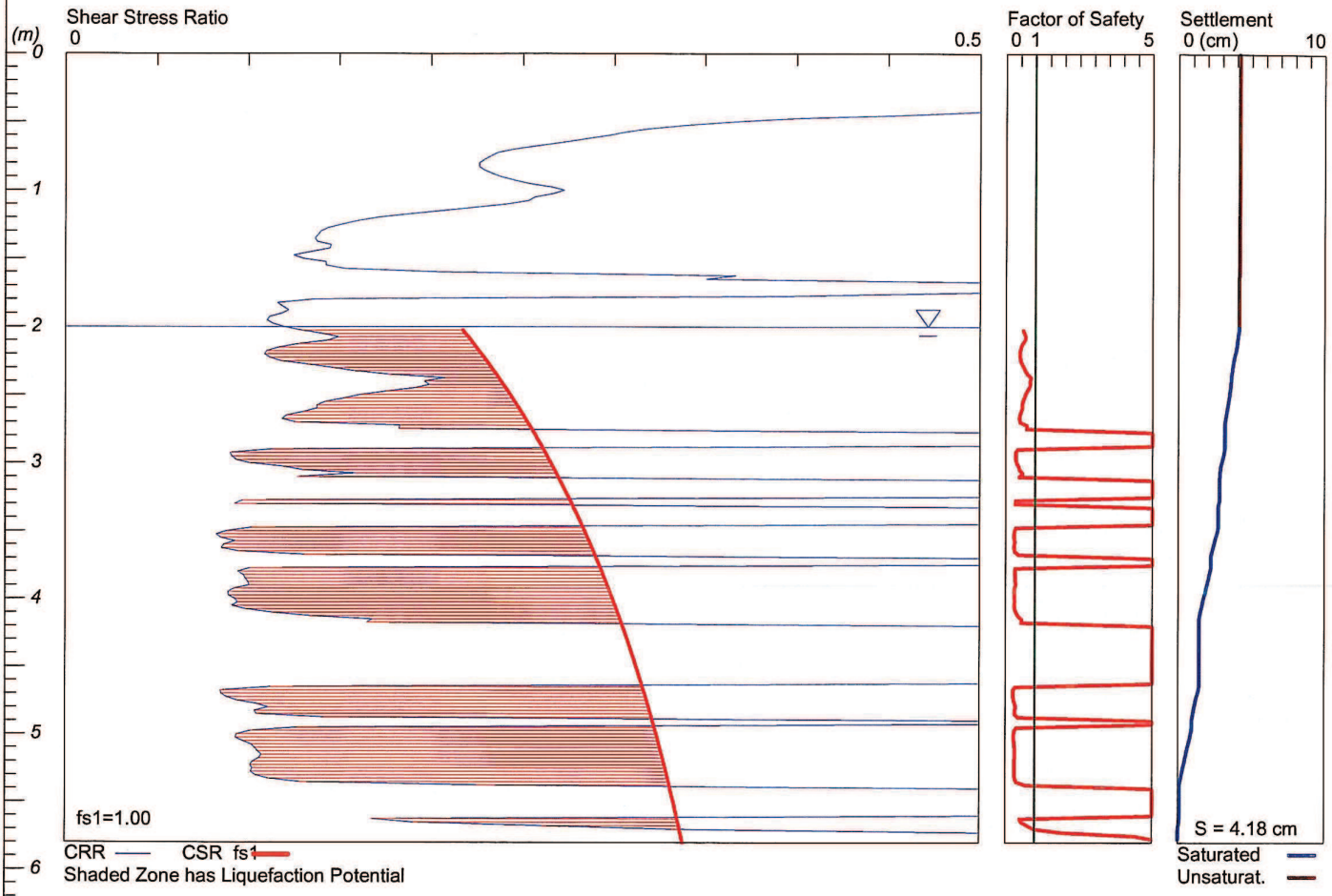


LIQUEFACTION ANALYSIS

Rosemerryn Farm

Hole No.=CPT40 Water Depth=2 m

Magnitude=7.5
Acceleration=0.34g



Appendix I
Geotechnical Certification

Statement of Professional Opinion on the Suitability of Land for Building Construction

ISSUED BY: Aurecon NZ Limited
(Engineering firm or suitably qualified Engineer)

TO: Fulton Hogan Land Development Limited
(Owner/Developer)

TO BE SUPPLIED TO: Selwyn District Council
(Territorial authority)

IN RESPECT OF: Stage 3 to 6 Rosemerryn Subdivision

AT: Lot 26 DP 432078, Lincoln, Christchurch
(Address)

I, Dr Jan Kupec, (Geotechnical Engineer)
on behalf of Aurecon NZ Limited
(Engineering firm)

hereby confirm that:

1. I am a suitably qualified and experienced Geotechnical Engineer and was retained by the owner/developer as the Geotechnical Engineer on the above development.

2. The extent of my inspections, and the results of all tests carried out are as described in the geotechnical report *Geotechnical Assessment Report, Rosemerryn Farm Stage 3 to 6, Fulton Hogan Land Development Ltd, Rev3, dated 23 May 2012.*

3. In my professional opinion, not to be construed as a guarantee, I consider that:

(a) The completed works give due regard to land slope and foundation stability considerations.

(b) The original ground not affected by filling and the filled ground are suitable for the construction of a development/subdivision and are not subject to erosion, subsidence or slippage in accordance with the provisions of Section 106 of the Resource Management Act 1991 provided that:

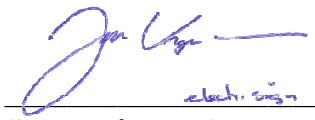
(i) The recommendations made in the Aurecon Report *Geotechnical Assessment Report, Rosemerryn Farm Stage 3 to 6, Fulton Hogan Land Development Ltd, Rev3, dated 23 April 2012* are followed.

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.

5. This certificate shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than $250,000.

(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)



_____ _____23 May 2012_____

(Signature of Engineer) (Date)

Qualifications and experience:

PhD, MSc, candIng, MIPENZ, CPEng(Geotechnical & Project Management), IntPE